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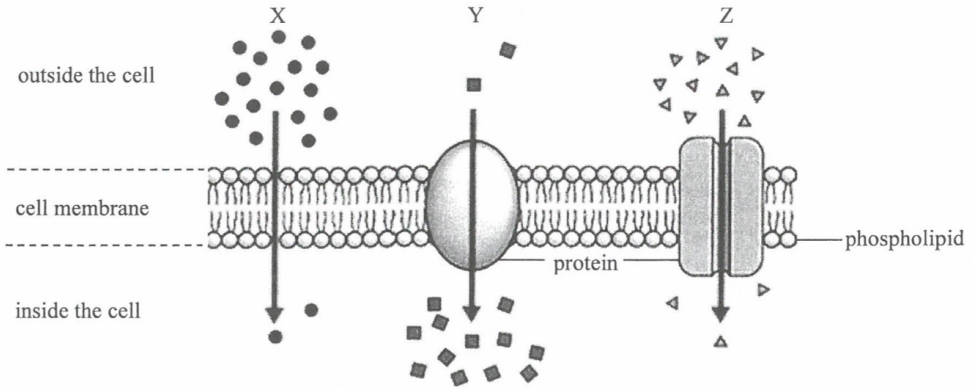
2022

1. The diagram below shows three different ways by which substances pass through a cell membrane:



Which of the following combinations correctly matches the substances with their corresponding ways of passing through the cell membrane?

	X	*Y*	*Z*
A.	oxygen	glucose	water
B.	glucose	water	oxygen
C.	water	oxygen	glucose
D.	water	glucose	oxygen

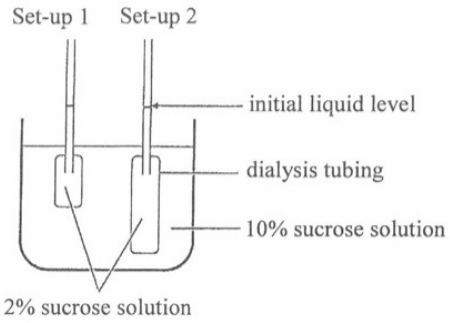
Directions: Questions 13 and 14 refer to the table below, which shows the effect of different substrates on the rate of anaerobic respiration of yeast:

Substrate	Average amount of carbon dioxide produced after 10 min (ppm)
Glucose	395.2
Maltose	345.8
Sucrose	222.2
Fructose	198.2

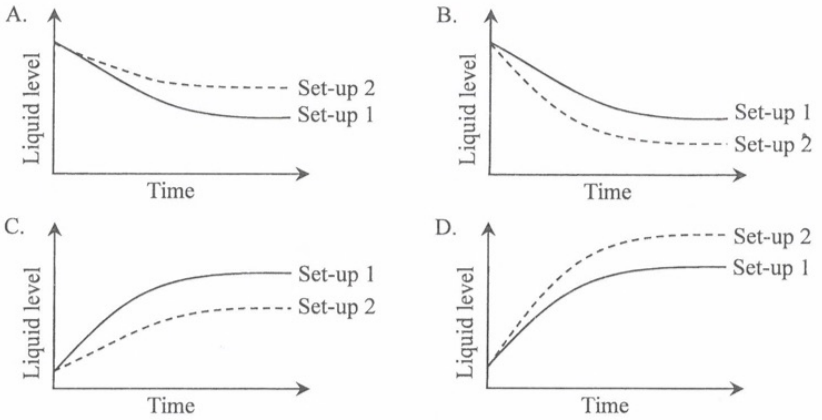
14. In this investigation, which part of the yeast cell produces carbon dioxide?

A. cytoplasm
B. cell membrane
C. matrix of mitochondria
D. inner membrane of mitochondria

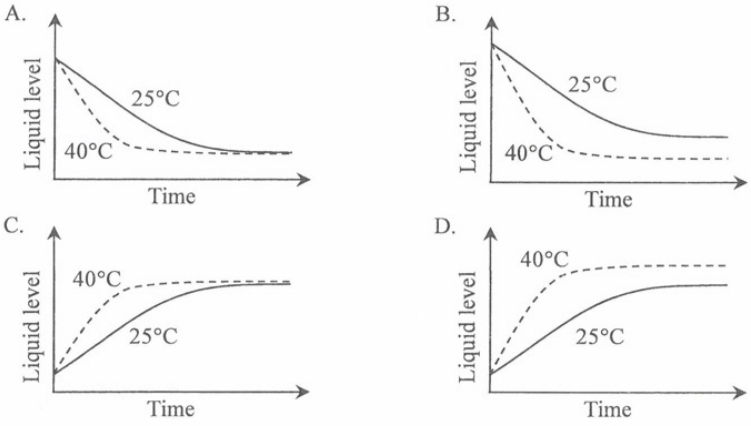
Directions: Questions 35 and 36 refer to the diagram below, which shows two set-ups used for investigating osmosis. Two dialysis tubings of different lengths were filled with 2% sucrose solution and then submerged in 10% sucrose solution. All solutions were kept at 25°C.



35. Which of the following graphs correctly shows the change in the liquid levels of set-ups 1 and 2?



36. If the experiment was repeated with the same setting except that the solutions were kept at 40°C, which of the following graphs correctly shows the change in the liquid levels of set-up 1 at different temperatures?



Answer **ALL** questions. Write your answers in the spaces provided.

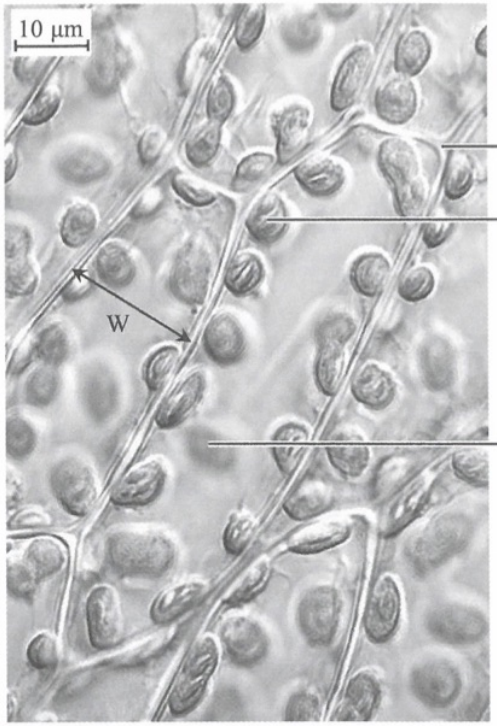
1. The following are some life processes in humans:

Egestion (A)
Excretion (B)
Feeding (C)
Growth (D)
Respiration (E)

(a) Use the letters to construct an equation showing the relationship of these processes in energy flow. (1 mark)

☐ = ☐ – ☐ – ☐ – ☐

3. The photomicrograph below shows some unstained plant cells:



(a) Label structure M. (1 mark)

(b) What is the actual length of W shown in the photomicrograph? (1 mark)

(c) Chloroplast 1 appears sharp in this photomicrograph while chloroplast 2 appears blurred. To obtain a sharper image of chloroplast 2, how should you operate the microscope? (1 mark)

(d) Some structures of chloroplast cannot be distinguished in this photomicrograph. State ***one*** of these structures. (1 mark)

(e) Give ***one*** equipment that can be used to observe the structure stated in (d). (1 mark)

DSE M.C. Questions - Cell and membrane transport
(sort by difficulty)

Challenging

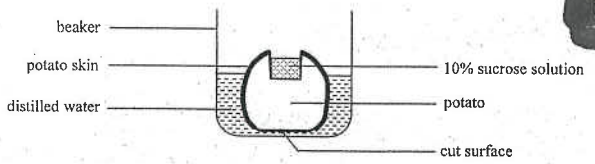
2012 Q.2 (33%)

Plants carry out photosynthesis to produce glucose which is required for the formation of

(1) cellulose
(2) protein
(3) starch

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1),(2) and (3)

Directions: Questions 23 to 25 refer to the diagram below, which shows an experiment on osmosis using a potato tuber. A washed potato was cut to form a base. After that, a cavity was made and a 10% sucrose solution was added into the cavity. The whole potato was then placed into a beaker containing some distilled water. After 1 day, the level of the sucrose solution rose.



2013 Q.25 (24%)

Which of the following treatments will lead to a higher final level of the sucrose solution after 1 day?

(1) using 5% sucrose solution instead of 10% sucrose solution
(2) using 20% sucrose solution instead of 10% sucrose solution
(3) peeling off all the potato skin instead of just cutting the bottom of the potato

A. (1) only B. (2) only C. (1) and (3) only D. (2) and (3) only

2013 Q.26 (33%)

Which of the following nutrients enter the epithelial cells of the small intestine mainly by simple diffusion?

A. amino acids B. fatty acids C. monosaccharides D. nucleotides

Challenging

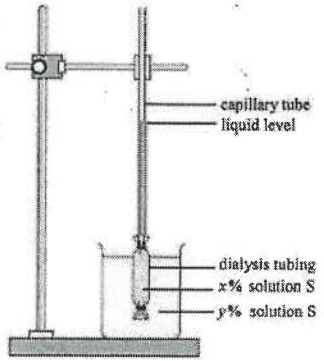
2014 Q.2 (32%)

Which of the following events ***does not*** involve the functioning of membrane proteins?

A. Transmission of nerve impulses across a synapse
B. Absorption of glucose in the small intestine
C. Transport of oxygen by haemoglobin
D. Recognition of pathogens

2016 Q.24 (36%)

Directions: Questions 24 and 25 refer to the diagram below, which shows an experimental set-up for studying osmosis:



After three hours, the liquid level has risen. What can be deduced from this result?

(1) Solution S diffuses into the dialysis tubing.
(2) Value of x is larger than that of y.
(3) Solute of solution S cannot pass through the dialysis tubing.

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

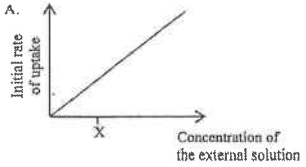
Challenging

2019 Q.11 (23%)

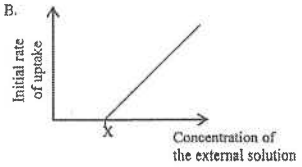
Solutions of different concentrations of a solute with a small molecular size were prepared and some plant cells were immersed in each of the solutions. Which of the following graphs shows the initial rate of uptake of the solute by means of diffusion?

(Note: X is the concentration of the solute inside the plant cells)

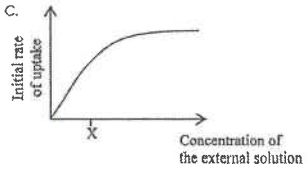
A.



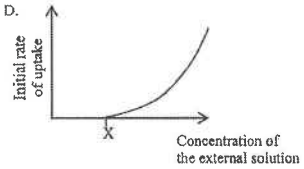
B.



C.



D.



Average

2012 Q.1 (73%)

Which of the following tissue types has the greatest number of mitochondria?

A. the wall of an air sac
B. the wall of a capillary
C. the inner wall of a lymph vessel
D. the inner wall of the small intestine

Directions : Question 1 to 3 refer to the table below, which shows the relative amountsof the mitochondria, chloroplasts and endoplasmic reticulum in four cell types P,Q,R and S:

Cell type	*Relative amount of the sub-cellular structure*		
	Mitochondrion	*Chloroplast*	*Endoplasmic reticulum*
P	+	++	+
Q	+++	-	+
R	+++	-	+++
S	+	-	-

Key: number of '+' indicates the relative amount of the sub-cellular structure
'-' indicates the absence of the sub-cellular structure

2013 Q.1 (54%)

Which cell type is found in the lining of the air sacs in the lungs?

A. P B. Q C. R D. S

2013 Q.3 (72%)

Which of the following carbohydrate(s) is/are likely to be found in cell type P?

(1) Starch
(2) Glucose
(3) Glycogen

A. (1) only B. (2) only C. (1) and (2) only D. (2) and (3) only

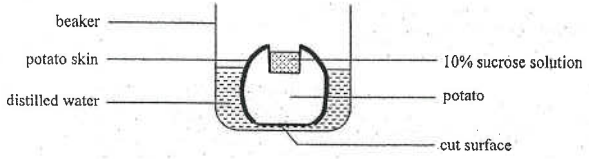
2013 Q.5 (41%)

Which of the following descriptions of the function of membrane proteins is ***incorrect***?

A. Some membrane proteins serve as antigens for cell recognition.
B. Some membrane proteins serve as enzymes for cellular metabolism.
C. Some membrane proteins act as barriers which prevent the entry of some substances.
D. Some membrane proteins act as carriers which transport some substances across the membrane.

Average

Directions: Questions 23 to 25 refer to the diagram below, which shows an experiment on osmosis using a potato tuber. A washed potato was cut to form a base. After that, a cavity was made and a 10% sucrose solution was added into the cavity. The whole potato was then placed into a beaker containing some distilled water. After 1 day, the level of the sucrose solution rose.



2013 Q.23 (48%)

The level of sucrose solution inside the cavity rose because osmosis has taken place, which means that

A. water was drawn mainly from the cells in contact with the sucrose solution.
B. water was initially drawn from the cells in contact with the distilled water.
C. water moved from the distilled water along the cell wall of the potato cells to the cavity.
D. water moved from the distilled water through the cell membrane of the potato cells to the cavity.

2013 Q.24 (65%)

The diagram shows the appearance of a cell in contact with distilled water in the beaker at the beginning of the experiment:

Which of the following diagrams correctly shows the appearance of the same cell at the end of the experiment?

A.


B.


C.


D.


Average

2014 Q.1 (64%)

Which of the following is a catabolic process?

A. Conversion of glucose to glycogen
B. Absorption of glucose
C. Emulsification of fat
D. Digestion of starch

Directions: Questions 3 to 5 refer to the following study:

A study wants to use an ordinary light microscope to observe the binary fission of a photosynthesizing protist under high magnification. A temporary mount of the protist is placed on the stage of the microscope.

2014 Q.3 (59%)

Below are some steps in using a light microscope:

(1) Focus with 10X objective
(2) Focus with 40X objective
(3) Search the field with 10X objective
(4) Search the field with 40X objective
(5) Move the slide until the protist is located in the centre of the field
(6) Adjust light intensity if necessary

Which of the following is the most reasonable sequence of steps for the above study?

A. (1), (3), (5), (6)
B. (2), (6), (4), (5)
C. (1), (2), (4), (5), (6)
D. (1), (3), (5), (2), (6)

2014 Q.5 (41%)

Which of the following structures would be observable in the above study?

A. Ribosome B. Chloroplast C. Mitochondrion D. Endoplasmic reticulum

2014 Q.23 (61%)

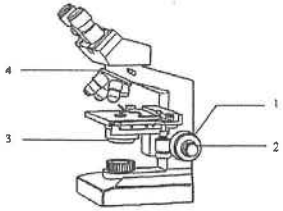
Which of the following cell types has the highest density of mitochondria?

A. Root hair cell
B. Leaf epidermal cell
C. Spongy mesophyll cells
D. Palisade mesophyll cells

Average

2015 Q.1 (49%)

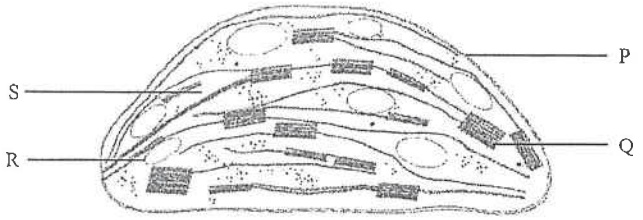
Which of the following parts of the microscope should be adjusted to obtain a clear and sharp image when you switch from low-magnification to high-magnification observation?



A. 1 and 4 only
B. 2 and 3 only
C. 1, 3 and 4 only
D. 2, 3 and 4 only

2015 Q.5 (74%)

Directions: Questions 4 and 5 refer to the schematic diagram below, which shows the structures of a chloroplast:



Which of the following kingdoms contain organisms that possess the above organelle?

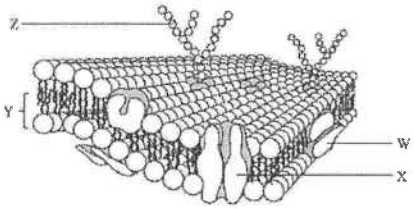
(1) Eubacteria
(2) Protista
(3) Plantae

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Average

Directions:

Questions 1 and 2 refer to the schematic diagram, which shows the structure of a cell membrane:



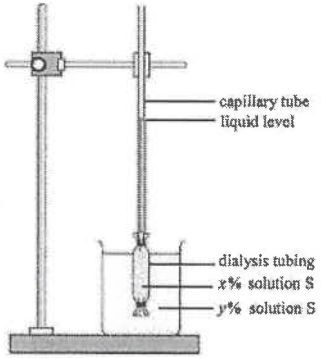
2016 Q.2 (69%)

If the membrane is located at the inner surface of the small intestine, the absorption of amino acids is likely to be achieved via

A. W B. X C. Y D. Z

2016 Q.25 (58%)

Directions: Questions 24 and 25 refer to the diagram below, which shows an experimental set-up for studying osmosis:



Which of the following modifications will result in a faster rise in the liquid level?

A. use a smaller volume of x% solution S
B. use a larger volume of y% solution S
C. use a shorter capillary tube
D. use a longer piece of dialysis tubing

Average

2018 Q.36 (66%)

Which of the following processes mainly involves osmosis?

A. movement of water along the xylem in plants
B. movement of water vapour out of stomata in plants
C. movement of water from tissue fluid lo capillaries in humans.
D. movement of water from tissue fluid to lymph capillaries in humans

2019 Q.8 (73%)

According to the requirements of various methods of transport across the cell membrane,

which of the following combinations is correct?

	Requirements		
	Energy input	***Membrane protein***	***Concentration gradient***
A.	phagocytosis	active transport	osmosis
B.	diffusion	osmosis	active transport
C.	active transport	phagocytosis	phagocytosis
D.	osmosis	diffusion	diffusion

Easy

2013 Q.2 (76%)

Directions : Question 1 to 3 refer to the table below, which shows the relative amountsof the mitochondria, chloroplasts and endoplasmic reticulum in four cell types P,Q,R and S:

Cell type	*Relative amount of the sub-cellular structure*		
	Mitochondrion	*Chloroplast*	*Endoplasmic reticulum*
P	+	++	+
Q	+++	-	+
R	+++	-	+++
S	+	-	+

Key: number of '+' indicates the relative amount of the sub-cellular structure
'-' indicates the absence of the sub-cellular structure

Which cell type would you expect to be insulin-producing cells in the pancreas?

A. P B. Q C. R D. S

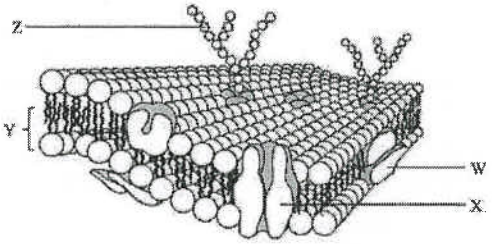
2015 Q.2 (78%)

Which of the following processes requires metabolic energy?

A. glucose moves across the epithelium of the ileum
B. carbon dioxide moves across the wall of air sacs
C. oxygen moves into mesophyll cells
D. water moves along the xylem

2016 Q.1 (85%)

Directions: Questions 1 and 2 refer to the schematic diagram below, which shows the structure of a cell membrane:



Which of the following molecules contributes to the fluidity of the cell membrane?

A. W B. X C. Y D. Z

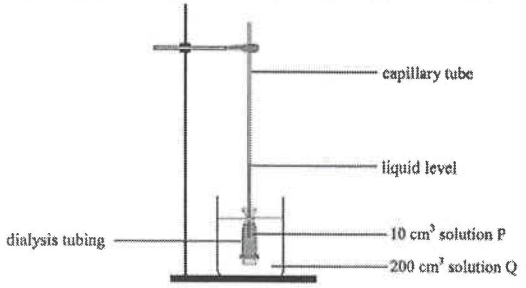
2020 Q.1

1. Which of the following sub-cellular structures can be found in a prokaryotic cell?

A. cell wall, ribosome, cell membrane
B. ribosome, cell membrane, chloroplast
C. cell wall, cell membrane, mitochondria
D. cell membrane, chloroplast, mitochondria

2020 Q.2

Directions: Questions 2 and 3 refer to the diagram below, which shows a set-up for investigating the permeability of dialysis tubing. 10 cm^3 of solution P was added to the dialysis tubing, with one end tied and the other end connected to a capillary tube. The dialysis tubing was then placed in a beaker with 200 cm^3 of solution Q. When solutions P and Q are mixed, a blue colour will be observed.



2. At the end of the investigation, the liquid level inside the capillary tube had risen and only the solution inside the dialysis tubing became blue. Which of the following conclusions can be drawn from the results?

(1) Solute of solution P can pass through the dialysis tubing.
(2) Solute of solution Q can pass through the dialysis tubing.
(3) There is a net movement of water into the dialysis tubing.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

2020 Q.3

3. If the investigation is repeated with water instead of solution Q, which of the following results will be obtained?

A. The liquid level in the capillary tube will not rise at all.
B. The liquid level in the capillary tube will rise to a lower level.
C. The liquid level in the capillary tube will rise to a higher level.
D. The liquid level in the capillary tube will rise to the same level.

2020 Q.9

9. The electron micrograph below shows an organelle P:

Which of the following are possibly produced by organelle P in the cells of the pancreas?

(1) amylase
(2) insulin
(3) lipase

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

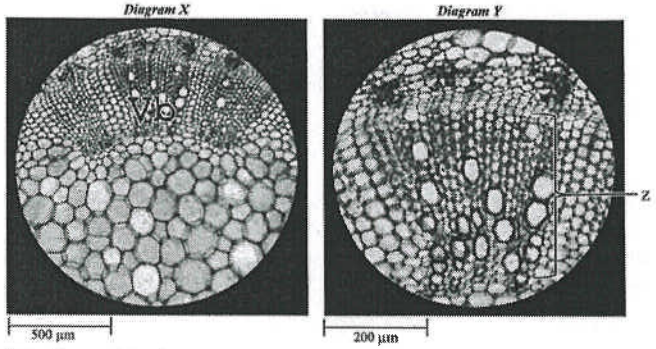
2020 Q.14

14. Which of the following combinations correctly matches the water movement in the human body with its major driving force?

	Water movement	*Major driving force*
A.	water in tissue fluid enters lymph vessels	osmosis
B.	water in blood leaves capillaries at the arterial end	hydrostatic pressure
C.	water in tissue fluid enters capillaries at the venous end	active transport
D.	water enters capillaries from the lumen of the small intestine	diffusion

2020 Q.22

Directions: Questions 22 to 24 refer to the photomicrographs below, which show the stem section of a plant observed under a microscope. Diagram Y shows a higher magnification of the vascular bundle (Vb) in Diagram X:



Key: Vb = vascular bundle

22. Which of the following combinations shows the correct steps for using the microscope in order to obtain the image in Diagram Y from that of Diagram X?

	Step 1	*Step 2*
A.	Move the slide towards the observer so that Vb is in the centre of the field of view.	Change the objective from 4X to 10X and adjust the focus.
B.	Change the objective from 10X to 40X and adjust the focus.	Move the slide towards the observer so that Vb is in the centre of the field of view.
C.	Move the slide away from the observer so that Vb is in the centre of the field of view.	Change the objective from 4X to 10X and adjust the focus.
D.	Change the objective from 10X to 40X and adjust the focus.	Move the slide away from the observer so that Vb is in the centre of the field of view.

2020 Q.24

24. Which of the following structures is commonly found in all the cells shown in Diagram Y?

A. vacuole
B. cell wall
C. cytoplasm
D. cell membrane

2021 Q.24

8. Which of the following combinations correctly lists the requirements of both osmosis and diffusion?

	Concentration gradient	*Energy supply*	*Selectively permeable membrane*
A.	Yes	No	Yes
B.	Yes	No	No
C.	No	Yes	Yes
D.	No	Yes	No

Answers

Challenging

2012	2013	2014	2016	2019
2 [D]	25 [B] 26 [B]	2 [C]	24 [C]	11 [B]

Average

2012	2013	2014	2015	2016	2018	2019
1 [D]	1 [D] 3 [C] 5 [C] 23 [D] 24 [A]	1 [D] 3 [D] 5 [B] 23 [A]	1 [D] 5 [C]	2 [B] 25 [D]	36 [C]	8 [A]

Easy

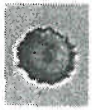
2013	2015	2016
2 [C]	2 [A]	1 [C]

2020
1[A]
2[C]
3[C]
9[D]
14[B]
22[C]
24B]

Past Questions -- Cell and membrane transport

CE - 2003

1. (b) A student carried out a study on the effect of two different sodium chloride solution on red blood cells. He added a drop of citrated mammalian blood to 2 cm^3 of each solution in separate test tubes, A and B. After five minutes, the mixtures in both tubes appeared light red in colour. He then examined a drop of each mixture under the microscope. After repeated examinations, he found that intact red blood cells were present in tube B only and they were in two different forms as shown below:


Wrinkled


Smooth

The results are recorded in the table below:

Tube	Concentration of solution (%)	Average number of different forms of intact red blood cells	
		Wrinkled	Smooth
A	0.3	0	0
B	1.5	15	5

Note : All observations were done under the same magnification.

(i) (1) In tube B, some red blood cells became wrinkled. How would you explain this? (3)
(2) Both forms of red blood cells were observed in tube B. Give a reason for this.(1)

(ii) How could the student be sure that the red blood cells in tube B had reached equilibrium with the surrounding solution at the time when he made the observation? (2)

(iii) Account for the absence of intact red blood cells in the mixture in tube A and the light-red appearance of the mixture. (4)

CE - 2007

1. **Three** samples of specimen were examined in a laboratory. The results are shown below:

Feature of specimen	Sample 1	Sample 2	Sample 3
Size(mm)	0.0002	0.003	100
Cell wall	-	+	+
Mitochondrion	-	-	+
Nucleus	-	-	+
Deoxyribonucleic Acid(DNA)	+	+	+

Key: '+'means present '-'means absent

The following paragraph summarizes the report about the three samples. Complete the paragraph with suitable word(s). (4 marks)

With reference to the results, the groups that samples 1 and 2 belong to are (a)_____ and (b)_____ respectively. For sample 3, it remains unclassified. It could belong to one of the following groups: plants, (c)_____ or (d)_____.

CE - 2007

2. One day, when Keith and Jane walked past a fresh fruit juice shop, Keith noticed that some pears were cut into pieces and stored in a tank of water before use.

(a) Keith thought that the shopkeeper stored the cut pears in water in order to extract more juice. Explain the biological principle behind Keith's idea. (3 marks)

(b) Jane disagreed with Keith because she found that the shopkeeper also stored whole pears in water tanks. Explain why this observation provides Jane with evidence to oppose Keith's idea. (2 marks)

(c) Suggest one possible hygienic problem of storing the cut pears in water tanks. (1 mark)

CE - 2008

4. Read the passage below and answer the questions that follow.

The Discovery of Cells

Most cells are too small to be observed with the naked eye. Thus the existence of cells remained unnoticed until the 17th century. In 1665, Robert Hooke studied a thin section of cork under his self-made compound microscope. He found that the cork was made up of many units which he named 'cells'. According to his observation, a cell is an empty space bounded by a thick wall. At that time, Antonie van Leeuwenhoek, using the single-lens microscope he made, discovered single-celled organisms.

(a) Single-celled organisms can be classified into different kingdoms. Name ***two*** kingdoms that include single-celled organisms. (2)

(b) Later, scientists found that living cells are made up of many cellular structures. State ***two*** cellular structures present in all living cells. (2)

(c) The following table shows some steps of preparing a temporary slide of onion epidermis and the purpose behind each step. Complete the table. (2)

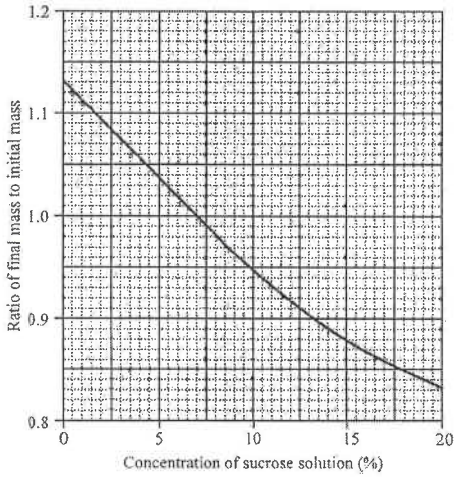
Step	Purpose
Peeling of epidermis	Separate a thin tissue for observation
Staining with iodine solution	(i)
Adding a drop of water	Reduce the refraction of light
(ii)	Flatten the tissue

CE - 2009

4. A student carried out an investigation to determine the water potential of potato tissue. He immersed five identical potato strips separately into five beakers containing sucrose solution of different concentrations for one hour. The masses of the potato strips before and after the immersion were measured and recorded. He then made the following calculation for each potato strip:

$$\text{Ratio of final mass to initial mass} = \frac{\text{mass of strip after immersion}}{\text{mass of strip before immersion}}$$

The graph below shows the results of the investigation:



(a) (i) 'When the ratio of final mass to initial mass is 1.0, the potato tissue has the same water potential as the corresponding sucrose solution.' Explain the biological principle behind this statement. (3 marks)

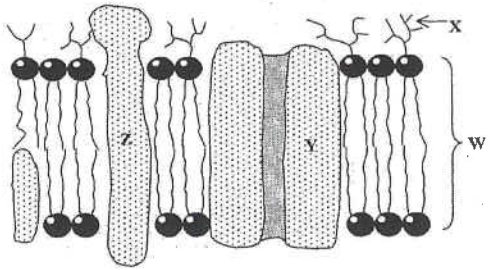
(ii) Based on the statement in (i), the student should be able to conclude that the water potential of the potato tissue is equal to the water potential of_____ sucrose solution. (1 mark)

(b) Describe the state of the potato strip after being immersed in 10 % sucrose solution for one hour. Explain your answer. (3 marks)

(c) What would be the change in water potential of a fresh potato after it has been stored for a long time? Explain your answer. (2 marks)

AL - 2003 2A

1. The following diagram is a model illustrating the structure of a plasma membrane:

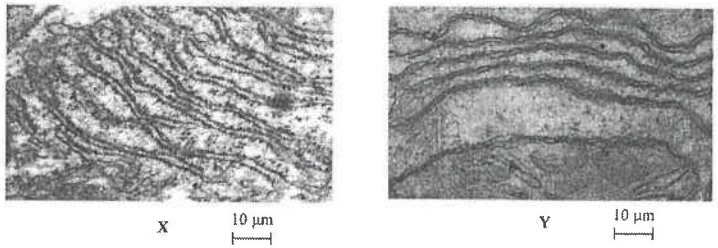


(a) Name this model. Give *two* features that justify such a name. (3)

(b) Explain how the nature and arrangement of molecules at W are related to the permeability of the membrane. (4)

AL - 2005 1A

7. The electron micrographs below show two types of organelles:



Complete the following table :

	X	Y
Name of organelle	(a)	(b)
Product	(c)	Testosterone (male sex hormone)

(3)

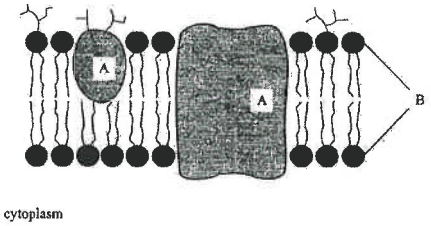
AL - 2005 2A

3. (a) It has been proposed that both the mitochondrion and the chloroplast might have been prokaryotic organisms such as an aerobic bacterium and a photosynthetic bacterium respectively. They had been engulfed by a larger eukaryotic cell and then evolved to establish a relationship of mutualism with the eukaryotic cell.

(i) Use ***labelled*** diagrams to illustrate the process of a bacterium being engulfed by a eukaryotic cell and subsequently becoming a part of the cell.(4)

AL - 2006 1A

9. The diagram below shows a model of the cell membrane:



Complete the following paragraph with suitable words: (4)

The membrane is composed of proteins which are labelled as A in the diagram and (a)..... molecules labelled as B. The layer of molecules B makes the membrane impermeable to (b)..... . The proteins on the membrane serve important functions; one example is (c)..... Carbohydrates are also found on the membrane. Sugar units attached to the proteins act as (d)..... on the membrane surface for recognition by other cells.

AL - 2008 1A

2. The following is a schematic diagram of an animal cell:

(a) In the secretory cells of the salivary glands, some of the organelles shown above work together for the production of salivary amylase. The table below lists three of these organelles and their functions in amylase production. Complete the table.

Structure	Name of the organelle	Function in salivary amylase production
E	rough endoplasmic reticulum	(i)
A	nucleus	(ii)

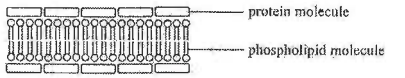
(b) Other than salivary amylase, name one secretory substance produced by the cells of the salivary glands and state its function. (2)

AL - 2008 2B

4. (a) Models have been used to explain the structure and function of biological systems such as membranes in cells. With reference to the current membrane model, discuss how phospholipids contribute to membrane properties and thereby lead to various membrane functions in cells. (6)

AL - 2010 1A

7. The table below lists some historical events in the research into the molecular structure of the cell member (based on models proposed by scientists):

Time	Scientist	Historical event
1925	E. Gorter and F. Grendel	Extracted phospholipid molecules from the cell membrane of red blood cells and spread them into a thin layer on the surface of water. It was found that the area of the thin layer was double that of the surface area of red blood cells.
1935	H. Davson and J. Danielli	Proposed the 'sandwich model' to illustrate the structure of the cell membrane. 
1972	S. Singer and G. Nicolson	Proposed the 'fluid mosaic model' to illustrate the structure of the cell membrane.

(a) How did Davson and Danielli make use of the findings of Gorter and Grendel to build the 'sandwich model'? (1 mark)

(b) In the space below, draw a labeled 2D-diagram to show the molecular arrangement of the 'fluid mosaic model'. (3 marks)

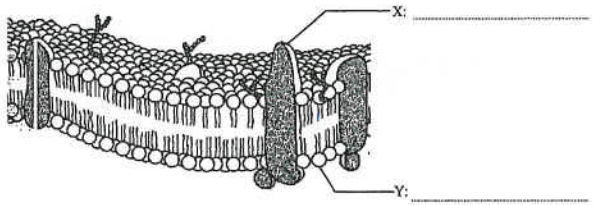
(c) Based on the 'fluid mosaic model', describe the importance of three key features of the cell membrane in cell functions. (3 marks)

HKDSE 2013 1B

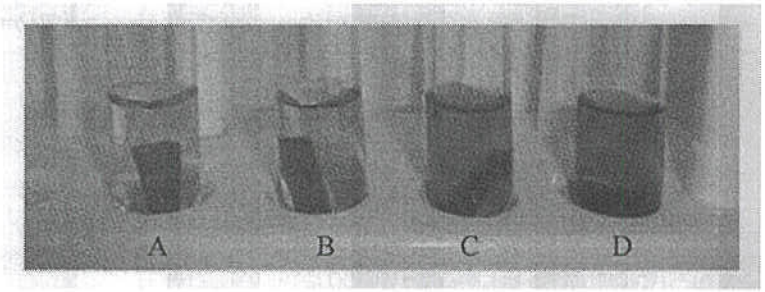
10. Proteins serve different functions in our body and their functional role is closely related to their conformation (shape). Describe how protein molecules can have different conformations and explain how the different conformations enable them to carry out different functions. (11marks)

HKDSE 2014 1B

7. (a) The following is a schematic diagram of a cell membrane. In the spaces provided, label membrane components X and Y. (2 marks)



(b) The vacuoles of beetroot cells contain a red pigment which will be released from the cells if the cell membrane and vacuole membrane are damaged. In an investigation, Gary placed identical cylinders of beetroot tissues into four test tubes. Each tube contained the same volume of alcohol at different concentrations. The following photograph shows the appearance of the solutions bathing the beetroot cylinders after 30 minutes:



(i) From the result of the above investigation, deduce which test tube contained the highest concentration of the alcohol. (4 marks)

(ii) After three hours, Gary found that the colour intensity of the solutions of all the test tubes became the same. Suggest an explanation for this. (2 marks)

HKDSE – 2015 1B

6. The table below lists some historical developments about the discovery of the structure of cell membrane:

Year	*Scientists*	*Historical events*
1895	Overton	Discovered that lipid-soluble substances could penetrate cells easily
1917	Langmuir	Discovered that the major component of cell membrane exhibited both water-loving and water-hating properties
1925	Gorter & Grendal	Extracted lipids from the cell membrane of red blood cells and spread the lipids in a single layer on a water surface; found that the area of the layer was double the surface area of the cell membrane
1972	Singer & Nicolson	Proposed the Fluid Mosaic Model to explain the structure of cell membranes

(a) What is the major component noted by Overton and Langmuir? (1 mark)

(b) Gorter and Grendal proposed that the major component identified in (a) existed as a bilayer (Bilayer Model). With reference to the observation of Langmuir, suggest how this major component is oriented and arranged in the cell membrane. Explain your answer. (3 marks)

(c) (i) The Bilayer Model proposed by Gorter and Grendal did not mention another major component of the cell membrane. What is this component? (1 mark)

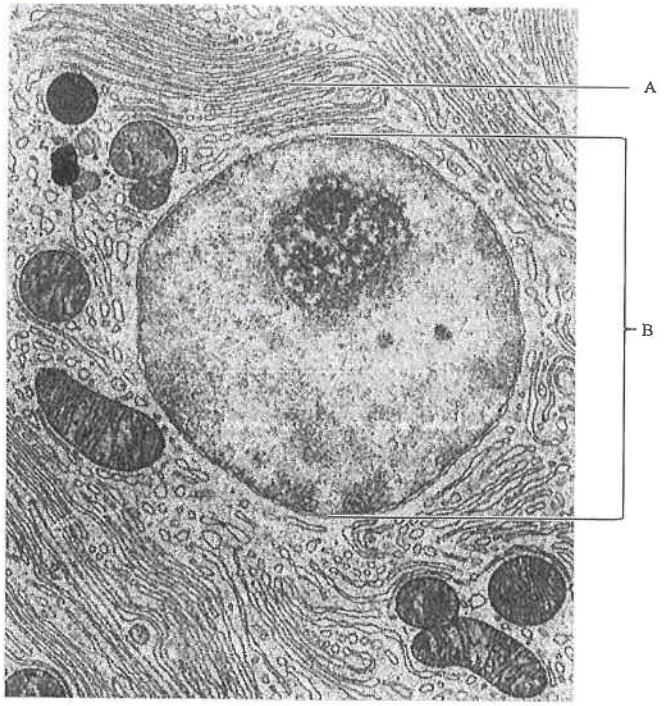
(ii) With reference to the Fluid Mosaic Model, briefly describe the orientation of this component in the cell membrane. (2 marks)

(d) Models are often used by scientists to explain their findings. Complete the following table to elaborate on the aspects of the nature of science involved in the use of scientific models. (2 marks)

Nature of science	*Elaboration*
Science is evidence based	
	Models are used to simulate an invisible structure or illustrate a theory.

HKDSE - 2017 1B

4. The electron micrograph on the opposite page shows some structures of a human cell.



a. Label A and B. (2 marks)

b. Which stage of the cell cycle is shown in this photomicrograph? Give a reason to support your answer. (2 marks)

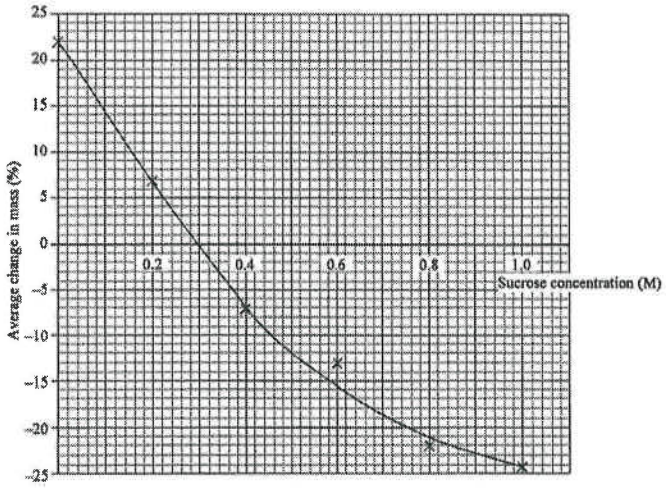
c. The cell was obtained from the pancreas. How do A and B work together such that this cell can perform its function? (4 marks)

HKDSE - 2019 1B

6. Johnny conducted an experiment to determine the water potential of potato tuber cells. He measured the masses of fresh potato cylinders before and after immersing them in sucrose solutions at different concentrations (0M, 0.2M, 0.4M, 0.6M, 0.8M, and 1.0M). Below shows the major steps in the experiment:

Step 1: Cut potato tubers into cylinders
Step 2: Blot dry the surface of the potato cylinders
Step 3: Weigh the potato cylinders (initial mass)
Step 4: Immerse three potato cylinders in each concentration of sucrose solution for two hours
Step 5: Remove and blot dry the surface of the potato cylinders
Step 6: Reweigh the potato cylinders (final mass)
Step 7: Calculate the average percentage change in mass of the potato cylinders in each solution

The results are shown in the graph below:



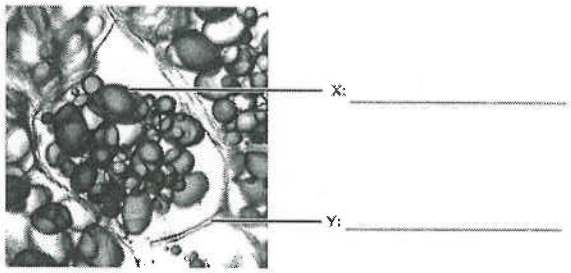
(a) With reference to the graph, which sucrose solution concentration has the same water potential as the potato cells? Explai your answer. (3 marks)

(b) If Johnny skipped step 2 by mistake for all samples, how would this affect th curve and the deduced value of the concentration of the sucrose solution in (a)? Sketch a curve on the graph on the facing page to show the effect. (1 mark)

(c) In terms of experimental design, what is the importance of putting three potato cylinnders in each concentration of sucrose solution? (1 mark)

HKDSE - 2019 1B

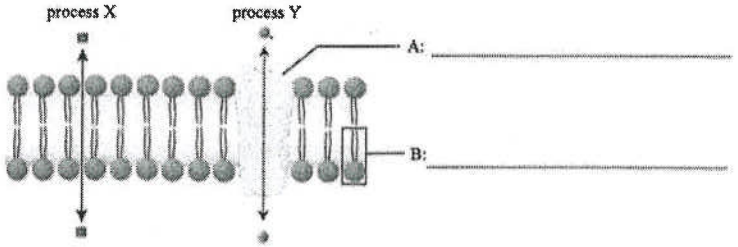
6. (d) Johnny prepared a slide of freshly sectioned potato cylinder and stained it with iodine solution. The photomicrograph below shows the section. Label structure X and Y. (2 marks)



(e) In the middle of the 19th century, there was a severe attack on potato ccrops by a pathogen in Ireland. As the potato was the major staple food at that time, many Irish people died of starvation. Vegatative propagation of potatoes was blamed for the high vulnerability of the potato crops. Explain the rationale for this claim. (2 marks)

HKDSE - 2020 1B

4. The following diagram's shows a cell membrane and the movement of some substance across it:



(a) Label structures A and B. (2 marks)

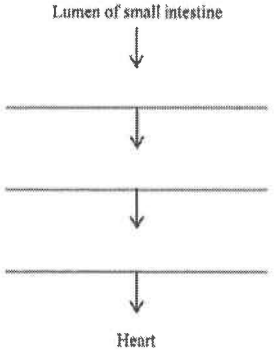
(b) X and Y represent two different processes by which substances pass through the cell membrane.

(i) Give ***one*** digested product which is absorbed through process X in the human body. (1 mark)

(ii) Give one digested product which is absorbed through process Y in the human body. (1 mark)

HKDSE - 2020 1B

4. (b) (iii) The digested products absorbed through process X are transported from the small intestine to the heart. Complete the following flowchart to show the vessels involved in the transport. (3 marks)



Past Papers Marking Scheme – Cell and membrane transport

CE - 2003 Q.1 (b)

(i) (1) The water potential of the red blood cells was higher than that of the surrounding solution 1
As a result, the cells shrank and became wrinkled 1
(2) Because the water potential of some red blood cells was higher than, while that of others was equal to /lower than the water potential of the surrounding solution 1

(ii) Observe the red blood cells again after some time 1
The proportion of the two forms should remain the same if they had reached equilibrium in the previous observation. 1

(iii) The water potential of the red blood cells was lower than that of the surrounding solution 1
Water entered the cells 1
The red blood cells expanded and burst 1
Releasing the haemoglobin to the solution, thus making it red 1

CE - 2007 Q.1

(a) virus 1
(b) prokaryotes 1
(c) fungi / protoctist 1
(d) Protoctist / fungi 1

CE - 2007 Q.2

(a) The water outside has a higher water potential than the cells of pears 1
water moves into the cells 1
increasing the volume of the cell content / water content of the cell 1
As a result, more fruit juice can be extracted

(b) The skin of the fruit acts as barrier to water 1
Little / no water movement will occur 1

(c) The water / pear may be contaminated with pathogens / lead to food poisoning 1

CE - 2008 Q.4

(a) * Prokaryotes / prokaryotae
* Protoctists / protoctista / protista
* Fungi
} any two 1, 1

(b) Cell membrane, cytoplasm 1, 1
(c) (i) Make cell structure / nucleus / cell wall / cell more distinct 1
(ii) Cover the tissue with a cover slip 1

CE - 2009 Q.4

(a) (i) When the ratio is 1.0, there is no change in the mass of the potato strip before and after the treatment 1
This shows that there is no net gain or loss of water throughout the investigation 1
by osmosis 1
(ii) 7 % 1

(b) The potato strip became flaccid 1
due to a net loss of water by osmosis 1
because the water potential of potato tissue is higher than that of the 10% sucrose solution 1

(c) After storing the potato for a long time, the water potential if the potato will become lower 1
because of evaporation of water during storage 1

2003 2A

1. (a) • *fluid mosaic model (1) 3
• fluidity: lateral movement of protein (1) / phospholipid molecules (accept alternative expression)
• mosaic: protein molecules interspersed among phospholipid molecules (1) (accept: a mosaic of protein and phospholipid molecules)

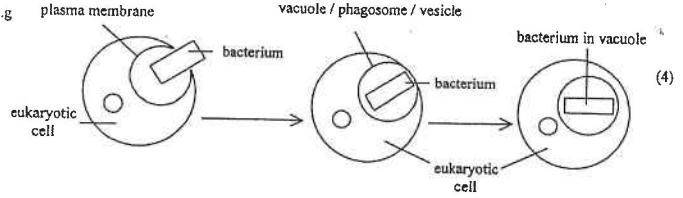
(b) Structural-functional relationships: max. 4
• W consists of 2 layers of phospholipid molecules (1) / phospholipid bilayer; allows lipid soluble substances to go through (1) as they dissolve in it
• hydrophobic tails of the phopholipid molecules point inwards (1); form an inner hydrophobic zone (1); make the membrane impermeable to charged molecules (1)

AL - 2005 1A

7. (a) Rough endoplasmic reticulum (1) / RER 3
(b) Smooth endoplasmic reticulum (1) / SER
(c) Insulin (1) / Glucagon

AL - 2005 2A

3. (a) (i)



(4)

AL - 2006 1A

9. (a) phospholipids (1) 4
(b) ions (1) / polar or charged molecules such as glucose, amino acids, proteins, water
(c) acting as ion channels (1) / trans-membrane carriers / electron carriers / enzymes / receptors / maintaining structural integrity of membrane
(or state the function of proteins e.g. for active transport across cell membrane)
(d) antigens (1) / recognition markers

AL - 2008 1A

2. (a) (i) • as the site of formation of the polypeptide / for transporting the polypeptide (1) / modification of the polypeptide
(ii) • as the site of formation of the mRNA of amylase (1) / as the site of transcription / contains genetic information coding for amylase
(iii) • (B) (1)
(iv) • *Golgi apparatus (1)
(b) • *mucin (1) / mucus
• for lubricating the swallowing of food (1) / sticking food particles together

AL - 2008 2B

4. (a)

- the phospholipids molecules in the membrane are capable of slight lateral movements (1), giving fluidity (1) to the membrane
  - this allows the membrane to invaginate (1) / carry out endocytosis / bud off vesicles from ER and Golgi apparatus
  - also allows membrane fusion (1), thus supporting the export of materials contained in vesicles by exocytosis (1), and the intracellular vesicular transport of materials (1) e.g. transport of proteins in vesicles from RER to the Golgi apparatus

} max.4

- due to the hydrophobic nature (1) of the fatty acid chains, phospholipids molecules spontaneously form a bilayer (1) in aqueous surroundings
  - the bilayer makes the membrane a good physical barrier for compartmentalization (1) and can help restrict the entry / exit of ions and polar molecules (1), thus establishing gradients of charges / concentration across membranes
  - the bilayer also forms a matrix / structural framework for the embedment of proteins (1) so that they can exert their respective functions

} max. 4

(max. 6)

AL - 2010 1A

7. (a) · cell membrane consists of two layers of phospholipid (1) (1)

(b) · correct drawing showing integral proteins (1) and asymmetrical arrangement of peripheral proteins (1) (max. 3)
· title and labels (2)

(c) · (transmembrane) integral proteins serve as ion channel/ carrier protein for transport of materials across membrane(1)
· peripheral proteins serve as antigen for cell recognition/ receptor site for receiving chemical messenger (1) (3)
· fluid nature of the lipid bilayer allows phagocytosis/ pinocytosis (1)/ permeability

HKDSE - 2013 1B

10. Factors determining the different conformations of protein molecules (S)

- amino acid sequence:
  - ✓ proteins are built from 20 different amino acids (1)
  - ✓ held / joined together to form a polypeptide (1)
  - ✓ the amino acids sequence determines the final conformation of protein molecule (1)
  - ✓ this amino acid sequence is encoded by the base sequence of a gene / code / nucleotide on DNA (1)

S=max. 3

- folding of the polypeptide:
  - ✓ the polypeptide chains then coil / fold up (1)
  - ✓ while some polypeptide chains bind together (1) to form a molecule with specific conformation

The unique shape of each protein allows different proteins to perform different functional roles in our body, e.g. it gives rise to (R)

- enzymes with unique active sites / substrate binding sites (1) that fit with specific substrates for controlling cellular metablism (1)
- receptors with binding sites for neurotransmitters (1) that allows transmission of nerve impulses across synpase (1)
- antibodies which allow recognition of antigens / pathogens (1) for body defence (1)
- haemoglobin with binding site (1) for carrying oxygen (1)

R=max. 5

C=max. 3
11 marks

HKDSE - 20141B

7. (a) X: * protein (1)
Y: * phospholipid (1) (2)

(b) (i)
- tube D should have the highest concentration of alcohol (1)
- the amount of pigment released to the bathing solution would be the highest, as indicated by the highest colour intensity (1)
- this is because the phospholipids of the membrane dissolve in alcohol (1)
- the cell membrane and vacuole membrane of the beetroot tissue bathing in the test tube with highest concentration of alcohol would be most damaged (1)

(4)

(ii)
- when the cell membrane and vacuole membrane are damaged, the pigment leaks out of the vacuole by diffusion (1)
- as time passes, it allows the diffusion of the red pigment in all 4 tubes to reach an equilibrium state at which the same concentration of red pigment are found in the bathing solutions / the bathing solution becames saturated with the same amount of red pigment in all 4 tubes, i.e. same colour intensities (1)

(2)

8 marks

HKDSE – 2015 1B

6. (a) phospholipids 1

(b) the water-loving parts of phospholipids point outward while the water-hating parts point inward (1)
both the medium inside and the medium outside the cell are aqueous solutions (1)
hence, only the water-loving part of the phospholipids is in contact with the cell sap and extracellular fluid (1) 3

(c) (i) protein 1
(ii) proteins are interspersed in the bilayer / a mosaic pattern (1)
in an asymmetric manner (1) 2

(d)

Nature of science	*Elaboration*
-	Scientific models / theory are built based on experimental findings / observations (1)
Doing science requires imaginations / creativity (1)	-

2

HKDSE – 2017 1B

4. (a) • A: endoplasmic reticulum* (1) [accept rough endoplasmic reticulum/ smooth endoplasmic reticulum] (2)
• B: nucleus* (1)

(b) • interphase / resting stage (1) / (1+1)
Accept G1, S or G2 (whole set must be given, if candidates answered either one, no mark for 1st point but continue to mark 2nd point, i.e. 0+1)
• because DNA is in the format of chromatin / the chromosomes are invisible (NOT accept no chromosomes) (1) [no mark will be given with wrong stage of the cell cycle]

(c) • B carries the genetic materials [accept DNA/ genes/ chromatin/ chromosome] (1)coding for the hormone / digestive enzymes*
• transcription takes place in B to produce mRNA(1)^
• which is transported to A for translation/ protein synthesis (1)^*@ (4)
• to produce protein hormones# / digestive enzymes#(1)for discharge / secretions

^ Some candidates may mix up the terms transcription and translation yet with correct descriptions; candidates will be only penalised once for such mixing up.
** No mark will be given if candidates mix up A and B.*
 # Accept if suitable examples are given (e.g. insulin, glucagon, trypsin, chymotrypsin, protease, amylase, lipase).
@No mark will be given if the candidate fails to indicate/imply the functional link between B and A.

8 marks

HKDSE – 2018 1B

2. (a) • vacuole (1) (1)

(b) Any ***two*** of the following:
• the cell membrane / cytoplasm of the leaf cells has detached from the cell wall / the leaf cell is plasmolysed (1)
• chloroplasts condense to the centre of the cell (1) (2)
• the vacuole / X has shrunk (1)

(c) • sucrose solution has a lower water potential than the cell content (1)
• there is a net movement of water from the cell content to the bathing solution by osmosis (1) (2)

5 marks

HKDSE – 2019 1B

6. (a) • 0.3 M sucrose solution (1) *[accept ± 0.01]*
• there was no change of mass at this concentration (1)
• this shows that there was no net movement of water [accept no osmosis] in or out of the cells (1) (3)
i.e. the bathing solution had the same water potential as the potato cells

(b) • the curve would shift downward (1) / to the left (1)

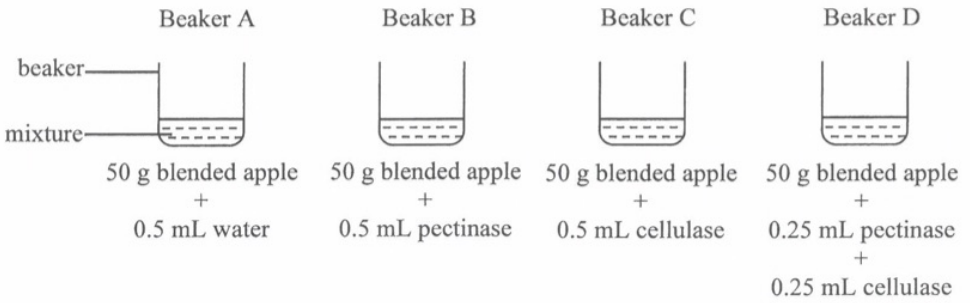
(c) • this can increase the reliability of the results by minimizing the individual differences of the cylinders (1) / can help to spot the presence of experimental error when there is inconsistent data (1). [discard inconsistent data (x)] (1)

(d) • X: starch granule / starch grain / amyloplast (1) [x starch] (2)
• Y: cell wall (1)

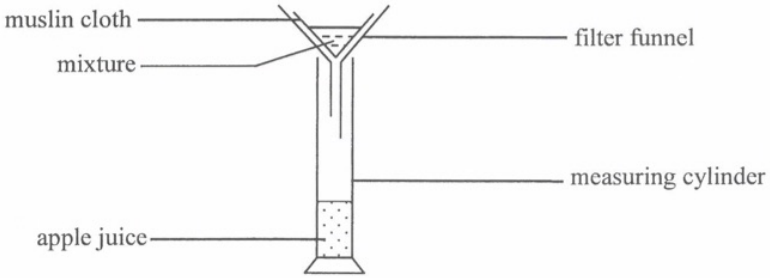
(e) • offspring produced will have the same genetic makeup as parents / low (no) genetic variation (1) (2)
• this provides limited raw materials for the selection of resistant strain (1) / if parent genotype [accept parent / one of the offspring] is susceptible to the pathogen attack, the whole population will be susceptible (1)

9 marks

5. Pectinase and cellulase are enzymes that break down the chemical components of plant cell walls. The following experiment investigates the effects of these two enzymes on the production of apple juice:



stir each mixture for 10 minutes and then carry out filtration



The experiment was repeated three times and the results are shown below:

Beaker	Mixture	Volume of apple juice produced (mL)				Cost of enzyme(s) for producing 1 mL apple juice
		Trial 1	Trial 2	Trial 3	Average	
A	0.5 mL water + 50 g blended apple	2.0	1.0	3.0	2.0	---
B	0.5 mL pectinase + 50 g blended apple	33.5	31.0	28.5	31.0	
C	0.5 mL cellulase + 50 g blended apple	4.5	4.0	3.5	4.0	
D	0.25 mL pectinase + 0.25 mL cellulase + 50 g blended apple	34.0	32.0	36.0	34.0	

(a) State the independent variable and dependent variable of this experiment. (2 marks)

.....

.....

(b) Why are three trials better than one trial? (1 mark)

DSE M.C. Questions - Enzymes and metabolism
(sort by difficulty)

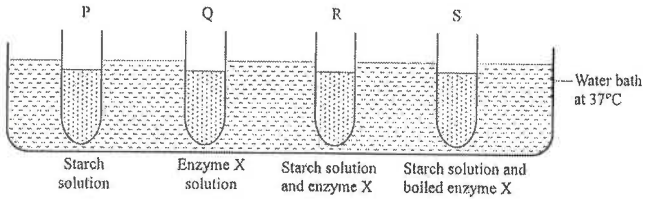
Challenging

2016 Q.27 (18%)

Which of the following statements about enzymes is incorrect?

A. Enzymes are produced by cells.
B. Enzymes are denatured at extreme temperatures.
C. There could be more than one specific enzyme to catalyse the same reaction.
D. When an enzyme encounters the same substrates, it always produces the same products.

Directions: Questions 2 to 4 refer to the diagram below, which shows four test tubes prepared by a student to investigate the action of a starch-digesting enzyme X:



2017 Q.3 (34%)

The student conducted some tests on the content of each test tube at the beginning and after 30 minutes. Which of the following correctly shows the results of the tests for tube R at the beginning?

	Benedict's test	*Iodine test*	*Test for protein*
A.	negative	positive	positive
B.	negative	positive	negative
C.	positive	negative	negative
D.	positive	negative	positive

Challenging

2017 Q.4 (23%)

Which of the following is ***not*** the purpose of the experimental design?

	Design	*Purpose*
A.	setting up tube P	to show the result of iodine test if starch is present
B.	setting up tube Q	to show that enzyme X alone cannot give positive result in Benedict's test
C.	setting up tube S	to show that enzyme X is denatured after boiling
D.	setting up water bath	to simulate the temperature of the human body

2018 Q.5 (37%)

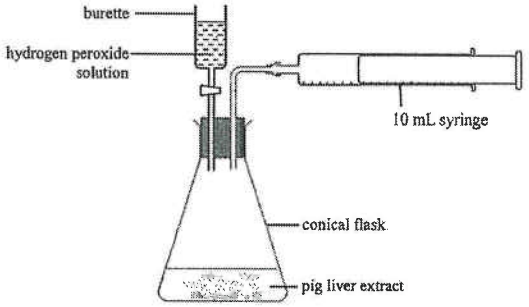
'Lock and Key' is a scientific model which is a selective representation used to explain that enzymes

A. Are biological catalysts
B. Are specific in action
C. Are protein in nature
D. Are required in small amounts

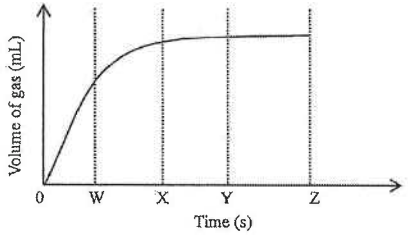
Challenging

2019 Q.10 (22%)

Directions: Question 9 to 10 refer to the diagram below, which shows an experimental set-up prepared by a student to investigate the effect of temperature on catalase activity. Pig liver extract contains catalase which speeds up the breakdown of hydrogen peroxide into oxygen and water. A fixed volume of hydrogen peroxide solution was added to the liver extract and a 10 mL syringe was used to collect the oxygen gas released from the reaction mixture.



After modifying the set-up, the following graph was obtained which shows the volume of gas collected over time at room temperature:

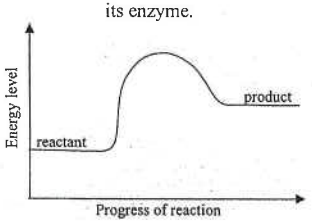


The student planned to use the volume of gas collected over a fixed period of time as the dependent variable to study the effect of different temperatures on catalase activity. Which of the following is the most suitable time period for the measurement?

A. 0-W B. 0-X C. 0-Y D. 0-Z

Average

Directions: Question 6 and 7 refer to the graph below, which shows the energy levels of the reactant and product of a biochemical reaction in the presence of its enzyme.



2013 Q.6 (47%)

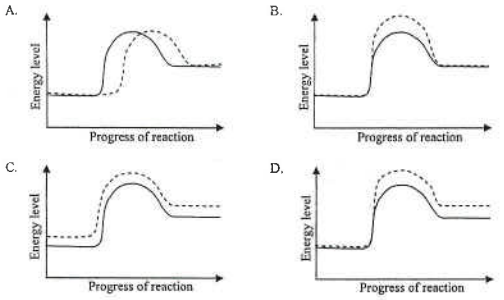
The reaction shown in the graph is

A. an anabolic process because energy is absorbed.
B. an anabolic process because energy is released.
C. a catabolic process because energy is absorbed.
D. a catabolic process because energy is released.

2013 Q.7 (44%)

Which of the following graphs correctly shows the change in the energy level of the reaction if the enzyme involved is absent?

Key: ——— with the enzyme
---------- without the enzyme

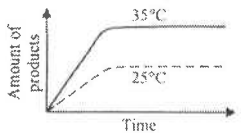


Average

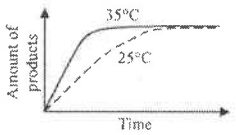
2014 Q.9 (70%)

Which of the following graphs correctly shows the changes in the amount of products in a reaction catalyzed by a human enzyme at different temperatures?

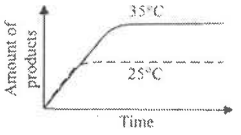
A.



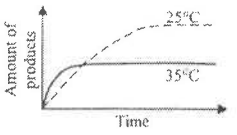
B.



C.

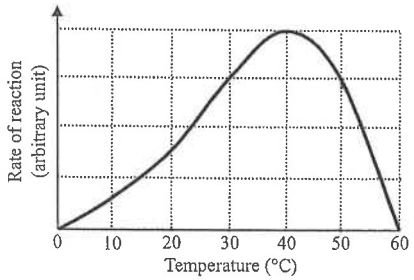


D.



2015 Q.3 (60%)

The graph below shows the effect of temperature on enzyme activity:



Which of the following statements correctly describes the enzyme reaction?

A. The enzyme is denatured at 0°C and 60°C.
B. The reaction taking place at 50°C is faster than that at 20°C.
C. There are more collisions between substrate and enzyme molecules at 40°C than 60°C.
D. The amount of product collected at the end of the reaction is the greatest if the reaction takes place at 40°C

Average

2016 Q.8 (64%)

Which of the following combinations correctly matches the biochemical reaction with the type of metabolism involved?

	Biochemical reaction	*Type of metabolism*
A.	Conversion of glucose to pyruvate	Anabolism
B.	Conversion of protein to amino acid	Anabolism
C.	Conversion of amino acid to urea	Catabolism
D.	Conversion of glucose to glycogen	Catabolism

2017 Q.1 (67%)

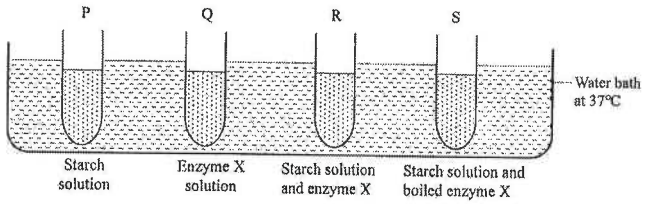
Which of the following combinations correctly matches the process with the type of metabolism involved?

	Process	*Type of metabolism*
A.	digestion of lipids in the small intestine	anabolism
B.	storage of excess energy in the form of glycogen	catabolism
C.	assimilation of amino acids to form muscle fibres	anabolism
D.	absorption of digested food in the small intestine	catabolism

Average

2017 Q.2 (67%)

Directions: Questions 2 to 4 refer to the diagram below, which shows four test tubes prepared by a student to investigate the action of a starch-digesting enzyme X:



In which of the following regions of the human alimentary canal can enzyme X be found?

(1) mouth cavity
(2) stomach
(3) small intestine

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2017 Q.5 (60%)

Different animals produce different maltases to digest maltose. The maltases produced have different molecular sizes. Which of the following description of these maltases is correct?

A. Their active sites have similar shape.
B. Their amino acid sequences are the same.
C. They have the same optimum temperature.
D. They have the same three-dimensional structure.

Average

2018 Q.1 (71%)

Which of the following processes involves enzymes on cell membranes?

A. Excretion of carbon dioxide by the lungs
B. Transport of water along the xylem vessel
C. Calvin cycle in the chloroplast of plant cells
D. Digestion of carbohydrates in the small intestine

Directions: Question 2 to 4 refer to an experiment on the enzyme catalase, which speeds up the breakdown of hydrogen peroxide to release oxygen. John added a 1 cm^3 cube of pig liver to boiling tube containing 5 mL hydrogen peroxide solution. Gas bubbles were released and he used a glowing splint to test the gas. He repeated the experiment with beef, potato and apple. The results are shown below:

Tissue	*Rate of bubbles released*	*Glowing splint re-lit*
Pig liver	Moderate	Yes
Beef	Moderate	Yes
Potato	Slow	Yes
Apple	Slow	Yes

2018 Q.2 (54%)

Which of the following statements is an observation of the experiment?

A. These tissues contained catalase
B. Oxygen gas was released in the reaction
C. The gas released re-lit the glowing splint
D. Animal tissues had more catalase than plant tissues

2018 Q.4 (69%)

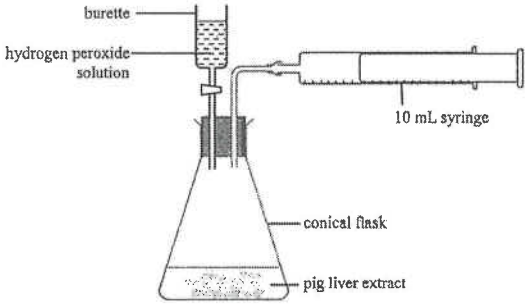
In order to prove that hydrogen peroxide is the substrate of this enzymatic reaction, which of the following steps should be used as a control?

A. Repeat the experiment using water and the tissues
B. Repeat the experiment using water and boiled tissues
C. Repeat the experiment using hydrogen peroxide but no tissues
D. Repeat the experiment using hydrogen peroxide and boiled tissues

Average

2019 Q.9 (72%)

Directions: Question 9 to 10 refer to the diagram below, which shows an experimental set-up prepared by a student to investigate the effect of temperature on catalase activity. Pig liver extract contains catalase which speeds up the breakdown of hydrogen peroxide into oxygen and water. A fixed volume of hydrogen peroxide solution was added to the liver extract and a 10 mL syringe was used to collect the oxygen gas released from the reaction mixture.



In the trial run conducted at room temperature, the students found that the volume of oxygen released was greater than the maximum collection volume of the syringe. How should he modify the set-up in order to collect valid data when repeating the experiment at different temperatures?

(1) use a larger syringe
(2) use a larger conical flask
(3) reduce the volume of the hydrogen peroxide solution added

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Easy

2018 Q.3 (76%)

Directions: Question 2 to 4 refer to an experiment on the enzyme catalase, which speeds up the breakdown of hydrogen peroxide to release oxygen. John added a 1 cm^3 cube of pig liver to boiling tube containing 5 mL hydrogen peroxide solution. Gas bubbles were released and he used a glowing splint to test the gas. He repeated the experiment with beef, potato and apple. The results are shown below:

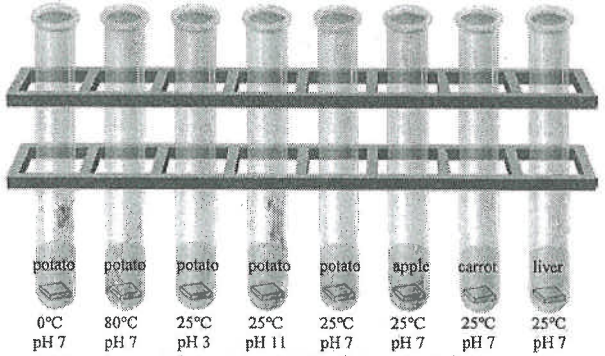
Tissue	*Rate of bubbles released*	*Glowing splint re-lit*
Pig liver	Moderate	Yes
Beef	Moderate	Yes
Potato	Slow	Yes
Apple	Slow	Yes

When the release of gas bubbles had stopped, John added more hydrogen peroxide solution to the boiling tubes. Which of the following combinations correctly shows the expected result and the explanation of this additional experiment?

	Expected result	*Explanation*
A.	Gas bubbles released	Catalase is specific in its action
B.	Gas bubbles released	Catalase is reusable
C.	No gas bubbles	Catalase has been used up
D.	No gas bubbles	Catalase is denatured

2020 Q.6

Directions: Questions 6 and 7 refer to the diagram below, which shows a set-up for investigating the activity of catalase in living tissues. Catalase is an enzyme which can break down hydrogen peroxide. Each test tube contains the same amount of hydrogen peroxide solution at the same concentration. A piece of living tissue is added into each tube as indicated below:



6. How many independent variables are being studied in this investigation?

A. 2
B. 3
C. 4
D. 8

2020 Q.7

7. Which of the following control variables is most important for a fair comparison in the above investigation?

A. mass of living tissues
B. shape of living tissues
C. volume of living tissues
D. surface area of living tissues

2020 Q.8

8. Which of the following descriptions of the active site of an enzyme is correct?

(1) It can be used again.
(2) It is the part of the enzyme on which its substrate can fit.
(3) Its shape is determined by the amino acid sequence of the enzyme.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Answers

Challenging

2016	2017	2018	2019
27 [B]	3 [A] 4 [C]	5 [B]	10 [A]

Average

2013	2014	2015	2016	2017	2018	2019
6 [A] 7 [B]	9 [B]	3 [B]	8 [C]	1 [C] 2 [B] 5 [A]	1 [D] 2 [C] 4 [A]	9 [B]

Easy

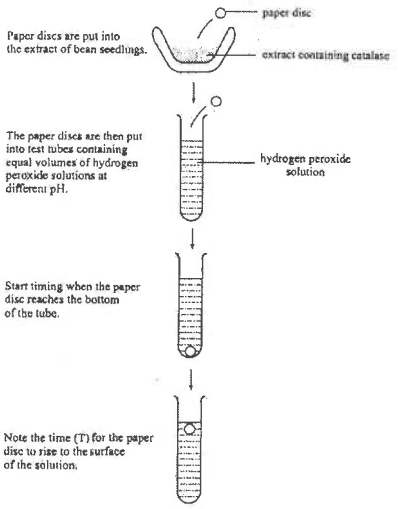
2018
3 [B]

2020
6[B]
7[D]
8[D]

Past Questions – Enzyme

CE – 2003

3. (b) The following shows the procedure of an experiment to study the effect of pH on the activity of catalase extracted from bean seedling :



The results of the experiment are shown below :

pH of hydrogen peroxide solution	T (s)
3	>100
5	50
7	20
9	20
11	27

(i) Explain why the paper discs rose to the surface of the solution in some of the tubes. (2)

(ii) (1) Work out the rate of reaction from the value of T for each tube. Tabulate your answer. (2)

(2) Using the data obtained in (1), plot a graph on graph paper to show the effect of pH on catalase activity. (3)

(iii) (1) Based on your graph, estimate the optimum pH of catalase. (1)

(2) In order to get a more accurate estimate of the optimum pH, what further work would you carry out in this experiment? (1)

(iv) A sample of bean extract was refrigerated at 4°C and then allowed to warm to room temperature. If the experiment was repeated using this sample, would the catalase activity be different from that of the pervious experiment? Explain your answer. (2)

CE – 2008

6. Ginger milk curd (薑汁撞奶) is a Chinese dessert. Below is a recipe of this dessert.

Recipe:
1. Grind the ginger to obtain some ginger juice.
2. Boil the milk.
3. Wait until the temperature of the milk drops to around 65°C.
4. Pour 220 mL of milk into 15 mL of ginger juice.
5. Ginger milk curd is made as the milk coagulates.

Having studied the recipe, a science student, Kelvin, conducted an investigation on the making of ginger milk curd. He followed the steps in the recipe with the use of raw ginger juice for one setup and boiled ginger juice for another setup. The results are shown below:

	Result
Boiled ginger juice	No coagulation
Raw ginger juice	Coagulation occurred

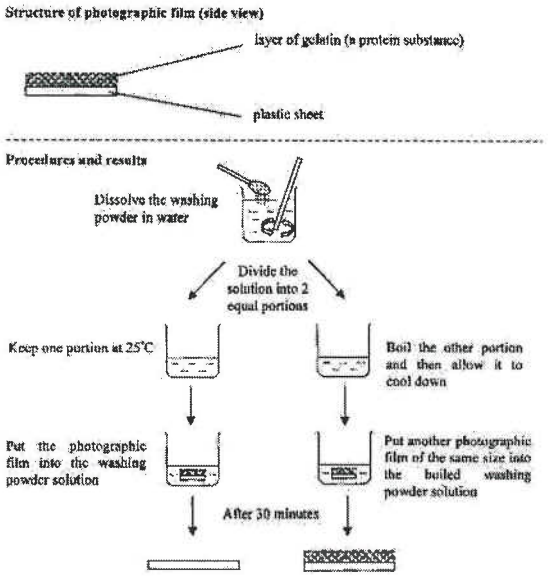
(a) With reference to the treatment used by Kelvin, what do you think is his hypothesis about the coagulation of milk in making ginger milk curd? (1)

(b) What is the principle behind the design of this investigation? (3)

(c) Kelvin then carried out another investigation on the effect of temperature on milk coagulation by cooling the boiled milk to different temperatures before mixing it with ginger juice. He found that milk coagulation only occurs at around 65°C. After that, he would like to test if boiling of milk is necessary. Suggest the procedures he would have to carry out in this test. (2)

CE - 2010

1. A certain brand of washing powder claims to contain protease that can remove egg stains on clothes. To find out if protease was present in the washing powder, a student carried out an investigation using photographic film. The procedures and results of his investigation are shown in the diagram below.



(a) (i) To make the investigation a fair test, the boiled washing powder solution should be cooled down to_____before the photographic film is put into it. (1 mark)

(ii) Explain why cooling the boiled washing powder solution to the temperature you stated in (i) would make the investigation fair. (1 mark)

(b) How can the results of the investigation support the claim that the washing powder contains protease? Explain your answer. (4 marks)

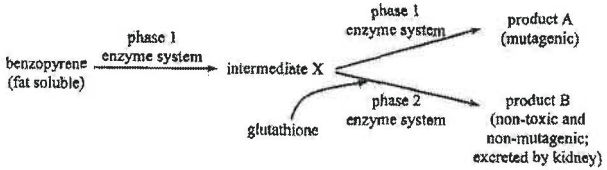
(c) Explain why egg stains on clothes can be removed by using this washing powder. (2 marks)

AL - 2000 1A

6. Yeast produces an extracellular invertase to breakdown sucrose into glucose and fructose. Design an experiment to show the presence of extracellular invertase activities in a yeast culture and state *two* appropriate controls. (7)

AL - 2007 2A

1. Benzopyrene is a harmful compound commonly found in coal tar, automobile exhaust fumes, tobacco smoke, burnt toast, and the crust of barbecued meat. When taken into the body, benzopyrene can be metabolized in the liver by two enzyme systems, known as phase 1 and phase 2, as shown in the pathway below:



(b) In order to protect the body against the mutagenic consequence of benzopyrene metabolism, which enzyme system (phase 1 or phase 2) should be more active? Explain your answer. (4)

(c) Glutathione is manufactured in the mitochondria. However, the number of mitochondria in the liver decreases when one ages. Explain the effect of this phenomenon on the detoxification of benzopyrene in the liver. (3)

(e) Phase 1 reactions occur on the smooth endoplasmic reticulum. Suggest how the structural features of the smooth endoplasmic reticulum facilitate the phase 1 reactions. (3)

HKDSE - 2014 1B

6. It is generally believed that domestic dogs evolved from ancient wolves. A recent study comparing the genomes of wolves and dogs suggests that genes with key roles in starch digestion were selected during the domestication of wolves into dogs. One of these genes was gene A, which codes for amylase.

(c) Describe an experiment which can compare the different amylase activities of wolves and dogs. (4 marks)

HKDSE – 2015 1B

7. Hydrogen peroxide is by-product of some metabolic reactions inside our body. If it were allowed to accumulate, it would kill our cells. Fortunately, we have an enzyme called catalase which speeds up the breakdown of hydrogen peroxide into water and oxygen. A student planned to investigate the effect of temperature on the activity of catalase. Below are the steps the student has drafted for his investigation:
   (1) Extract catalase from an animal organ.
   (2) Mix 5 mL 0.1% hydrogen peroxide solution with 1 mL catalase extract.
   (3) Place the mixture in a water bath set at 0℃
   (4) Measure and record the volume of oxygen gas release in the first 5 minutes.
   (5) Repeat steps (2) to (4) with the water bath set at 20℃, 40℃ and 60℃.

   (a) Suggest an animal organ in which catalase is present in great abundance and from which the enzyme can be obtained. Explain why this organ has so much catalase. (2 marks)

   (b) The student has missed out an important step in his drafted procedure. What is it? Explain the importance of this step. (2 marks)

   (c) You are provided with the following apparatus and materials:

   measuring cylinder, boiling tube, one-hole stopper, glass tubing, rubber tubing, pipette, ink, water trough, clip

   Choose the appropriate apparatus and materials to assemble a set-up for measuring the rate of oxygen production. Draw the set-up in the space below. (3 marks)

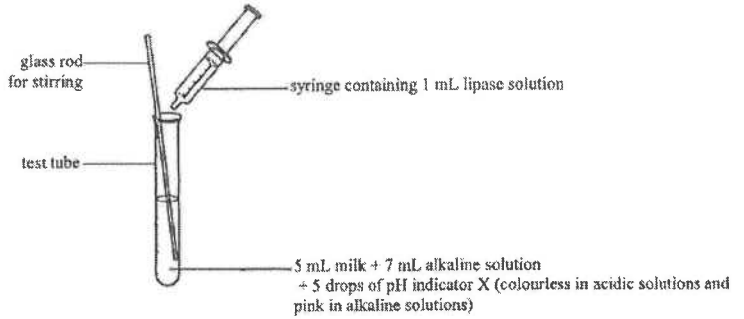
   Set-up for measuring the rate of oxygen production

HKDSE - 2017 1B

2. Denise ate a piece of pineapple preserved in a sugar solution and noticed that it was softer than fresh pineapple. Explain this phenomenon. (3 marks)

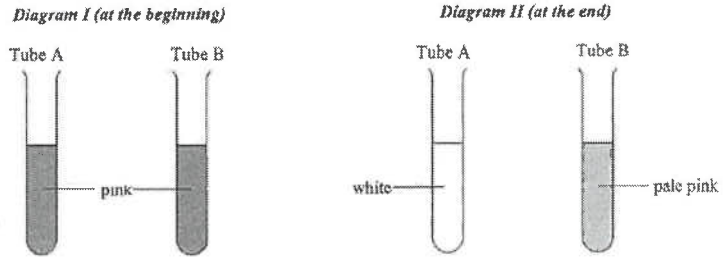
HKDSE - 2018 1B

8. A student used the following set-up to compare the fat digestion of full fat fresh milk and half fat fresh milk:



   (a) Write a simple word equation of fat digestion. (2 marks)

   (b) Two test tube, each with a different type of milk, were prepared. The colour of each mixture was recorded immediately after the addition of lipase solution, and then monitored until there was no more change in colour. The colours of the mixtures at the beginning and the end are shown in Diagram I and Diagram II respectively:



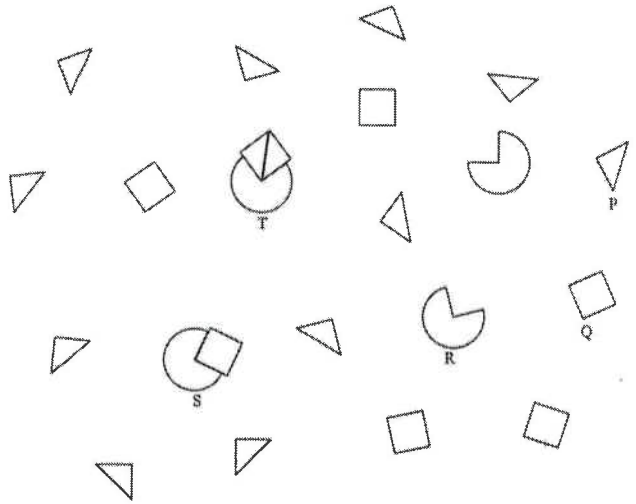
   (i) What is the independent variable in this investigation? (1 mark)

   (ii) Describe the results of this investigation. (2 marks)

   (iii) Which test tube(A or B) was the one with full fat fresh milk? Explain your answer. (4 marks)

HKDSE – 2019 1B

2. The schematic diagram below shows a reaction mixture of an anabolic reaction catalysed by an enzyme. Drawings P, Q, R, S, and T represent different components of the mixture:



(a) Which drawing represents the substrate in this anabolic reaction? Explain your answer. (2 marks)

(b) Which drawing represents the enzyme? Explain the answer. (2 marks)

HKDSE – 2021 1B

4. Glycogen and a disaccharide named trehalose are two common types of energy reserve found in insect species A. An experiment was conducted to study the energy reserve used for flying in this insect species. Three groups of insect species A were respectively injected with equal volumes of physiological saline, an inhibitor of trehalose-digesting enzyme and an inhibitor of glycogen-digesting enzyme. The insects were then stimulated to fly until they were exhausted. The flight time of each individual was recorded in the following table:

Solution injected	Samples of insect species A	Flight time (s)	Mean flight time (s)
physiological saline	1	150	165.6
	2	138	
	3	168	
	4	210	
	5	162	
inhibitor of trehalose-digesting enzyme	6	42	
	7	78	
	8	114	
	9	90	
	10	102	
inhibitor of glycogen-digesting enzyme	11	132	
	12	192	
	13	174	
	14	162	
	15	156	

(a) Complete the above table by calculating the mean flight time (to the nearest 1 decimal place) for the groups injected with the respective inhibitors. (1 mark)

(b) With reference to the aim of the experiment, what conclusions can you draw from the data? Explain your answer. (4 marks)

(c) Among individual insects, suggest ***one*** difference which led to different flight times within each group. (1 mark)

10. In humans, breast milk provides not only nutrients but also protective effects to infants. Recently, scientists discovered a new constituent of breast milk: short RNA fragments enclosed in vesicles. Scientists have very diverse views about the roles of these short RNA fragments. The following are two of the hypotheses:

Hypothesis 1: the short RNA fragments serve as food particles
Hypothesis 2: the short RNA fragments regulate gene expression in infants

(a) To test Hypothesis 1, scientists performed an experiment of *in vitro* digestion of breast milk. The method is shown below:

Method of *in vitro* digestion with 20 mL of fresh breast milk

Step 1	Addition of hydrochloric acid solution
Step 2	Addition of enzyme mixture 1
Step 3	Incubation at 37°C for 20 minutes
Step 4	Addition of sodium hydrogen carbonate solution
Step 5	Addition of enzyme mixture 2
Step 6	Incubation at 37°C for 30 minutes
Step 7	Incubation at 85°C for 3 minutes
Step 8	Measurement of the level of short RNA fragments and nucleotides

(ii) What is the purpose of Step 7?

Past Papers Marking Scheme – Enzyme

CE - 2003 Q.3 (b)

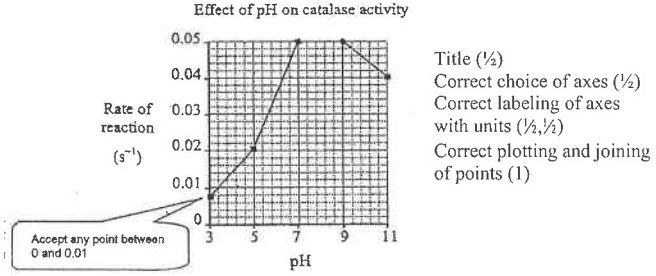
(i) The catalase in the paper disc broke down hydrogen peroxide, releasing oxygen 1
When the amount of oxygen evolved reached a certain level, the oxygen bubbles buoyed up the disc to the surface of the hydrogen peroxide solution 1

(ii) (1)

pH	Rate of reaction (s^{-1})
3	<0.01
5	0.02
7	0.05
9	0.05
11	0.04

½
½
1 0r 0

(2)



Title (½)
Correct choice of axes (½)
Correct labeling of axes with units (½,½)
Correct plotting and joining of points (1)

(iii) (1) any value between 1 and 9 / any value read from the graph drawn 1
(2) Repeat the experiment using hydrogen peroxide with smaller pH intervals between 7 and 9 1

(iv) The catalase activity would be similar to that of the previous investigation 1
because catalase is not denatured at 4°C and it can become active again at room temperature 1

CE - 2008 Q.6

(a) Ginger juice contains an enzyme that causes the coagulation of milk 1

(b) Enzyme is protein in nature 1
which is denatured by high temperature 1
Therefore, if enzyme is involved, the action of enzyme will be lost after boiling 1

(c) Follow the steps in the recipe for one set-up 1
and heat the milk to 65 °C instead of steps 2 and 3 in another setup 1

Other ways of expression:
Boil the milk, cool down to 65 °C and mix with ginger juice
Heat the milk to 65°C and mix with ginger juice
OR
Heat the milk to 65 °C and mix with ginger juice
Compare with the results of the experiment of cooling down boiled milk to 65 °C

CE - 2010 Q.1

1. (a) (i) 25 (1)
(ii) To make the results of the set-ups comparable/ to eliminate the effect of temperature difference on the results (1)

(b) The gelatin layer of the photographic film is removed by the unboiled washing powder solution (1)
This shows that the washing powder contains protein-digesting substance (1)
However, the ability to remove the gelatin layer is lost when the washing powder solution is boiled. (1)
This shows that the protein-digesting substance in the washing powder is heat sensitive/ is denatured/ inactivated at high temperature (1)
This substance is probably protease

(c) Egg stains contain proteins (1)
Protease digests the insoluble protein into peptides which are soluble, so it can be removed by water easily (1)

AL - 2000 1A

6. incubate yeast culture with sucrose solution for some time (1), centrifuge / dialyse / filter to separate cell from supernatant (1), test supernatant (1) with Benedict's solution (1), red ppt indicates presence of invertase activity (1) (Accept correct alternatives) 5

Controls:
- yeast without sucrose (1),
- sucrose without yeast (1),
- boiled yeast with sucrose (1), (any 2) 2

(Accept correct alternatives) (7)

AL - 2007 2A

1. (b)
- phase 2 enzyme system should work faster than phase 1 enzyme system (1)
- so that intermediate X could be quickly transformed to product B (1) for fast elimination from the body (1)
- and less product A would be formed (1) to produce mutagenic effect (4)

(c)

Concept for mark award: (3)
- effect of decline in mitochondria number on glutathione production (1) and phase 2 enzyme activity (1) / the relative production of product A and product B
- implication on benzopyrene metabolism (1)

e.g.
- the production of glutathione in the liver would drop (1) due to a reduction in the number of mitochondria
- activity of the phase 2 enzyme system / reaction would decrease (1) / product A would accumulate and less product B would be formed
- detoxification of benzopyrene in the liver would be impaired (1) / danger of mutagenesis would increase (3)

(e)
- the SER is a network of folded / stacked membranes (1)
- it provides a large surface area for various enzymes to align for carrying out the biochemical process in sequence (1)
- the SER network also helps to transport the metabolites from one area to another for further processing (1) (3)

HKDSE- 2014 1B

6. (c)
- obtain digestive juice from the digestive tract (mouth / stomach? / intestine/ pancreas) of a wolf & a dog (1)
- mix 1 mL of digestive juice with 5 mL of starch solution (1)
- at regular time intervals, remove a fixed amount of the mixture for iodine test (1)
- record the time taken for the tested mixture to remain brown in colour /the blue colour no longer appears (1)
- the one that takes a shorter time to remain brown in colour has a higher amylase activity (1) (4)

HKDSE – 2015 1B

7. (a) liver (1)
it is the organ where many metabolic reactions take place / it is the organ for detoxification (1) 2

(b) the hydrogen peroxide and catalase solution should be incubated at the set temperature for 10 minutes before mixing (1)
such that the mixture has reached the set temperature at the beginning of the reaction (1) 2

(c) the set-up could collect gas (1)
the set-up could measure the volume of the gas (1)
labels (1) 3

HKDSE – 2017 1B

2.
- sugar solution has a lower water potential / higher osmotic (solute) potential or pressure (do NOT accept: water concentration) than the cell content (of fresh pineapple) / cytoplasm or vacuole of fresh pineapple cells (1)
- as a result, pineapple cells lose water (do NOT accept: solution) to the sugar solution by osmosis (accept: water diffuses out by osmosis but do NOT accept: diffuse only) (1) (3)
- pineapple cells become flaccid / lose their turgor pressure / pressure potential / less turgid to press against one another (1)

hence, the texture of pineapple preserved in sugar solution is softer than that of fresh pineapple

3 marks

HKDSE – 2018 1B

8. (a)
- Triglyceride / fat $\xrightarrow{\text{lipase}}$ glycerol + fatty acids (2)

(b) (i)
- Type of milk (1) (1)

(ii)
- colour of the mixture in Tube A turned from pink to white (1)
- colour of the mixture in Tube B turned from pink to pale pink / became pale (1) (2)

(iii)
- Tube A (1)
- Tube A turned white, showing that the mixture in Tube A was acidic (1)
- Tube B remained pale pink, showing that the mixture in Tube B was alkaline (1)
- full fat fresh milk release more fatty acid than half fat fresh milk after fat digestion (1), eventually resulting in to the acidic condition of the mixture in Tube A (4)

9 marks

HKDSE – 2019 1B

2. (a)
- P (1)
- because two molecules of P are joined together / Ps are joined together to form one molecules of Q (1) (not acceptable: product / enzyme-substrate complex) (2)

(b)
- R (1)
- it has (a specific site / active site for) binding with P or Q / it remains unchanged or is regenerated after the reaction (1) (2)

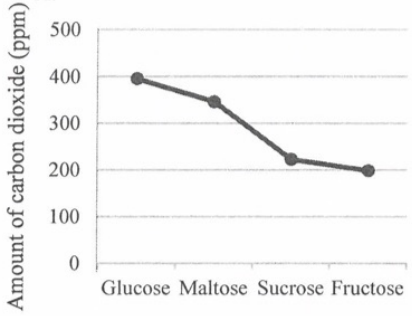
4 marks

Directions: Questions 13 and 14 refer to the table below, which shows the effect of different substrates on the rate of anaerobic respiration of yeast:

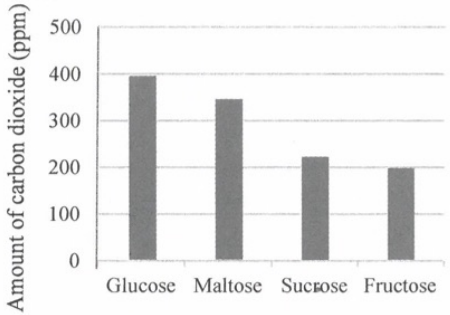
Substrate	Average amount of carbon dioxide produced after 10 min (ppm)
Glucose	395.2
Maltose	345.8
Sucrose	222.2
Fructose	198.2

13. Which of the following graphs is most suitable for presenting the data in the table?

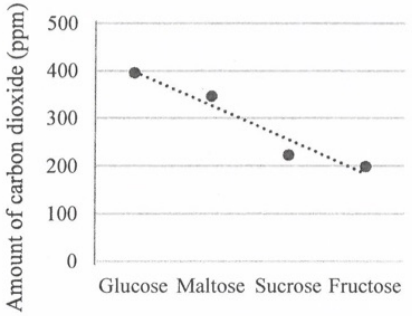
A.



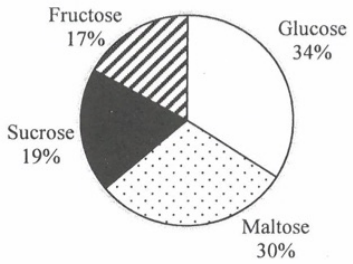
B.



C.



D.



You are required to present your answer to the following question in essay form. Criteria for marking will include relevant content, logical presentation and clarity of expression.

11. Recently, the use of the ketogenic diet for achieving weight loss is becoming popular. In fact, this high-fat, moderate-protein and very-low-carbohydrate diet has been used as an approach to control the blood glucose level in diabetics. However, the effectiveness of this diet in achieving weight loss is still controversial.

Describe how a ketogenic diet can be used to control the blood glucose level in diabetics. Evaluate the possibility of using this diet for weight loss and discuss the health concerns of adopting such a diet for healthy persons. (12 marks)

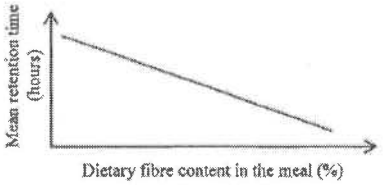
DSE M.C. Questions - Food and humans and Nutrition in humans
(sort by difficulty)

Challenging

2015 Q.9 (36%)
Which of the following combinations correctly describes the absorption of water in the alimentary canal?

	Occurs mostly in	*Major reason*
A.	ileum	it is the longest part of the digestive tract
B.	ileum	most digested food is absorbed in this region
C.	large intestine	its function is water absorption
D.	large intestine	absorption of food has completed in this region

2018 Q.25 (36%)
The graph bellow shows the relationship between the dietary fibre content of a meal and the mean retention time (i.e the duration for which the undigested material stay in the large intestine) in the human body:



Which of the following can be deduced from the graph?

A. Meals with more dietary fibre can increase the bulk of the faeces
B. Meals with more dietary fibre can hold more water, and so soften faeces better
C. Meals with less dietary fibre have more nutrients and a longer time is required for complete absorption
D. Meals with less dietary result in harder faeces due to an increased time for water absorption

Average

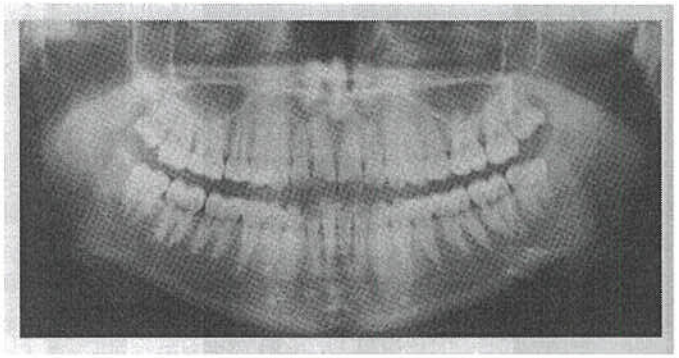
2012 Q.20 (64%)
Which of the following descriptions about the function of the liver is correct?

A. detects blood glucose level
B. breaks down red blood cells
C. secretes glucagon into the blood
D. secretes enzymes into the small intestine

2012 Q.34 (74%)
After consuming a boiled egg, chemical digestion begins in the

A. mouth. B. oesophagus C. stomach. D. small intestine.

2014 Q.24 (63%)
Which of the following dental formulae best represents the dentition shown in the photograph of the X-ray?

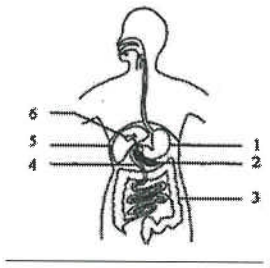


A. $\frac{2123}{2123}$ B. $\frac{2132}{2132}$

C. $\frac{3212}{3212}$ D. $\frac{2312}{2312}$

Average

Directions: Questions 25 and 26 refer to the diagram below, which shows the human digestive system:



2014 Q.25 (47%)

Physical digestion takes place at

A.1 and 3. B. 1 and 4. C.3 and 4. D.1, 3 and 4.

2014 Q.26 (62%)

Which of the following structures are responsible for producing digestive juices that help the digestion of fat?

A. 2 and 5 B. 2 and 6 C.5 and 6 D.2, 5 and 6

2015 Q.7 (47%)

Which of the following combinations correctly matches the gland, the enzyme secreted and the optimum pH of the enzyme?

	Gland	*Enzyme*	*Optimum pH*
A.	gastric gland	carbohydrase	2
B.	liver	lipase	8
C.	salivary gland	amylase	11
D.	pancreas	protease	11

2015 Q.10 (43%)

After absorption in the small intestine, most fat is first transported to the

A. large intestine. B. pancreas. C. heart. D. liver.

2016 Q.3 (43%)

In which of the following pairs of carbohydrates can Benedict's test be used to distinguish the two carbohydrates from one another?

(1) sucrose and starch
(2) sucrose and maltose
(3) glucose and maltose
(4) glucose and starch

A. (1) and (3) only B. (1) and (4) only C. (2) and (3) only D. (2) and (4) only

Average

Directions: Questions 5 and 6 refer to the diagram below, which shows the nutrition label of a food product:

Nutrition Information	Per serving
Energy	62 Kcal
Protein	3.1 g
Total fat	3.5 g
- Saturated fat	2.4 g
- Trans fat	0 g
Total carbohydrate	4.6 g
- Dietary fibre	0 g
- Sugars	4.6 g
Sodium	44 mg
Calcium	110 mg

2016 Q.5 (52%)

Which of the following food substances provides most of the energy content in this food product?

A. fat B.protein C. sodium D. carbohydrate

2016 Q.6 (68%)

The food product bearing this nutrition label is most likely to be

A. milk. B. bread. C. sausages. D. potato chips.

2018 Q.18 (63%)

Some people claim that we should chew food for a longer time before swallowing. Which of the following statements about this claim is ***incorrect***?

A. This stimulates the secretion of saliva
B. This moisten the food for easier swallowing
C. This provide enough time for digestion of starch into glucose
D. This increases the surface area of the food for chemical digestion

Average

2018 Q.23 (74%)

The following picture shows an X-ray photograph of the dentition of a person:

Which of the following dental formulae correctly describes the dentition in the above photograph?

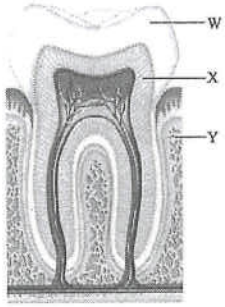
A. $\frac{2212}{2212}$

B. $\frac{2122}{2122}$

C. $\frac{2131}{2131}$

D. $\frac{2113}{2113}$

Directions: Questions 23 and 24 refer to the diagram below, which shows a section of one type of tooth and its associated structures:



2019 Q.23 (45%)

Which of the following are living tissues that contain a large amount of calcium salt?

A. W and X
B. W and Y
C. X and Y
D. W, X and Y

2019 Q.24 (41%)

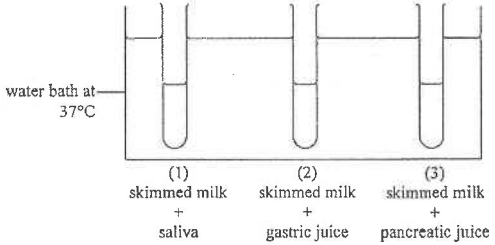
The number of this type of tooth in the milk dentition is

A. 0.
B. 4.
C. 8.
D. 12.

Average

2019 Q.25 (68%)

The diagram bellows shows a water bath with three test-tubes containing different mixtures:



Chemical digestion of food takes place in test-tubes

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Easy

2015 Q.8 (76%)

After eating a hamburger, chemical digestion begins in the

A. mouth cavity.
B. oesophagus.
C. stomach.
D. small intestine.

2016 Q.7 (80%)

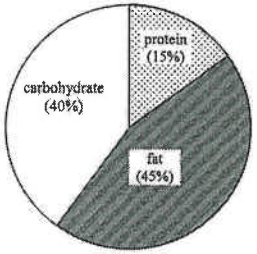
Which of the following organs produces digestive juice that does not contain enzymes?

A. liver B. mouth C. stomach D. pancreas

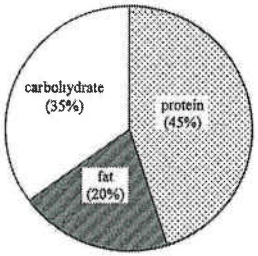
2019 Q.26 (80%)

The following charts show the composition of four different foodstuffs. Which foodstuff yields the highest amount of energy per gram?

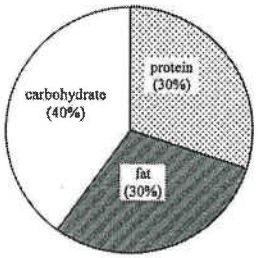
A.



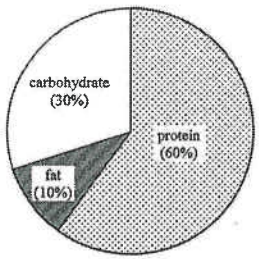
B.



C.



D.



2020 Q.10

10. Which of the following explain why a person cannot swallow food and talk at the same time?

(1) The epiglottis covers the opening of the trachea during swallowing.
(2) Swallowing is a reflex action while speaking is a voluntary action.
(3) Air must flow through the larynx to produce sounds.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

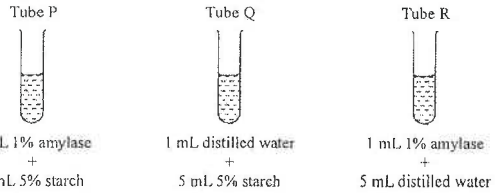
2020 Q.12

13. Both the villi of the small intestine and the air sacs of the lung are sites for material exchange. Which of the following is an adaptive feature common to the epithelium of both structures?

A. The epithelium is one cell thick.
B. There is a water film on the surface of the epithelium.
C. The epithelial cells contain a large number of mitochondria.
D. The epithelial cells have a modified cell membrane to increase surface area.

2021 Q.9,10

Directions: Questions 9 and 10 refer to the diagram below, which shows three set-ups used in the study of the activity of amylase:



9. We can conclude the action of amylase on starch by comparing the results of tubes

A. P and Q only.
B. P and R only.
C. Q and R only.
D. P, Q and R.

10. If the following tests are conducted on the reaction mixture of tube P, which test(s) will give the same result at the beginning of the experiment and after 10 minutes?

(1) iodine test
(2) albustix paper
(3) Benedict's test

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

2021 Q 7,19

7. Which of the following correctly describe the absorption of amino acids in the small intestine?

(1) Amino acids are absorbed into lacteals.
(2) The absorption is assisted by membrane proteins.
(3) Amino acids can move along or against a concentration gradient.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

19. Which of the following segments of the alimentary canal absorbs the largest amount of water?

A. the oesophagus
B. the stomach
C. the small intestine
D. the large intestine

Answers

Challenging

2015	2018
9 [B]	25 [A]

Average

2012	2014	2015	2016	2018	2019
20 [B]	24 [A]	7 [D]	3 [D]	18 [C]	23 [C]
34 [C]	25 [B]	10 [C]	5 [A]	23 [B]	24 [C]
	26 [A]		6 [A]		25 [C]

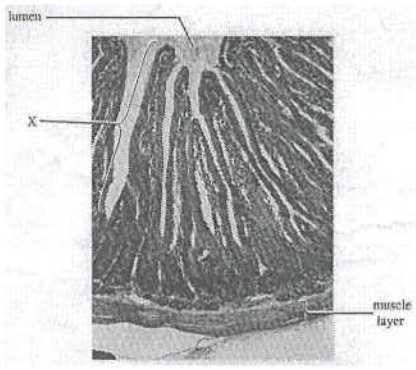
Easy

2015	2016	2019
8 [A]	7 [A]	26 [A]

2020
10[B]
12[D
]

CE - 2004

1. (a) The photomicrograph below shows a cross section of the small intestine of a mammal:



(i) With reference to two features of X observable from the photomicrograph, explain how these features facilitate the absorption of digested food substances. (4)

(ii) Use a flowchart to show how amino acids are transported to the heart after entering X. Indicate the major organs and blood vessels along the pathway. (2)

(iii) Describe how the muscle layer helps the movement and digestion of food inside the small intestine. (3)

CE - 2005

3. Read the passage below and answer the questions that follow:

> For many years, doctors believed that gastric ulcer (damage and bleeding of the stomach wall) was caused by excessive acid secretion in the stomach, so they used certain chemicals to treat ulcer patients. However, after recovery, many patients might develop gastric ulcer again. In the 1980s, an Australian doctor, Barry Marshall, observed that all his ulcer patients had a type of bacteria called *Helicobacter pylori* (幽門螺旋桿菌) in their stomach. He therefore put forward a new hypothesis about gastric ulcer. Based on this hypothesis, he treated his patients with antibiotics which are chemicals that kill bacteria. Many of his patients recovered rapidly and did not develop gastric ulcer again.

(a) If gastric ulcer is caused by excessive secretion of acid, what kind of chemicals should be used for treatment? (1)

(b) Many doctors were surprised at Marshall's observation because they thought that bacteria could not survive in the stomach. Why did they think so? (1)

(c) With reference to the treatment used by Marshall, what do you think is his hypothesis about gastric ulcer? (1)

(d) Suggest a method to test Marshall's hypothesis. What result would be obtained if his hypothesis is correct? (2)

(e) Explain the importance of the churning action of the stomach in the digestion of food.(3)

CE - 2005

6. Some vegetarians eat plant foods only.
   (a) From the nutritional point of view, explain two advantages of having a diet rich in plant foods over that with little plant foods. (4)
   (b) Most plant foods have a low protein content. Suggest a plant food that can provide a lot of protein to the vegetarians. (1)

CE - 2006

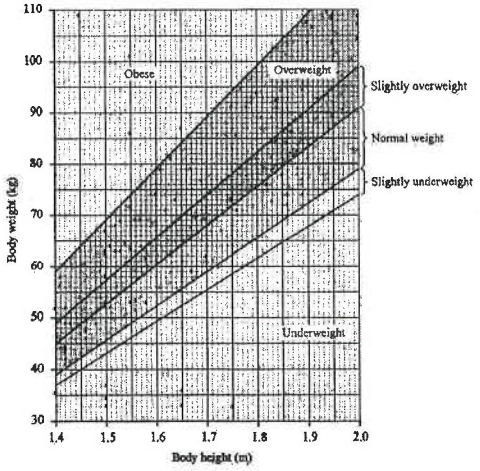
2. The table below shows the average amount of water entering the alimentary canal and the average amount being absorbed in the intestine of a person each day :

Water entering the alimentary canal		Water absorbed by the intestine	
Source	Volume (mL)	Site	Volume (mL)
Ingestion	2000	Small intestine	9000
Secretions along the alimentary canal	8000	Large intestine	850

   (a) Based on the above information, how much water is egested with the faeces each day?(1)
   (Note:Neglect the amount of water absorbed in the other parts of the alimentary canal.)
   (b) Give two examples of secretions that enter the alimentary canal. (2)
   (c) (i) Based on one structural difference between the small intestine and the large intestine, explain why a much larger volume of water is absorbed in the small intestine. (2)
   (ii) Explain how the absorption of digested food facilitates the absorption of water in the small intestine. (2)

CE - 2006

5. Body mass index (BMI) is a figure used to assess the body weight condition of a person. It is determined by two factors: weight and height of the person. The BMI chart below allows people to check their body weight conditions based on their weight and height:



   (a) (i) Mr. Wong weights 70 kg and his height is 1.7m. Using the descriptions given on the chart, state the body weight condition of Mr. Wong. (1)
   (ii) Mr. Wong's son is 1.55 m tall.
   What should be the ideal range of his body weight if he wants to be fit and healthy? (1)

   (b) According to the deposition of fat in the body, scientists classify body shape into two basic categories: apple shape and pear shape. To determine the category of body shape, the waist-to-hip ratio (WHR) can be used and it is represented by the following formula :

$$\text{WHR} = \frac{\text{waist circumference}}{\text{hip circumference}}$$

   The table below shows the categorization of the body shapes of men and women using the WHR :

	WHR	
	Men	Women
Apple shape	> 0.90	> 0.85
Pear shape	≤ 0.90	≤ 0.85

   (i) For most people, having extra fat around their waist increases health risk more than having extra fat around their hip. With reference to this information, which body shape has a higher health risk? (1)
   (ii) Mr. and Mrs. Wong have similar BMI, but their body shapes are different. Mr. Wong's waist and hip circumferences are 0.87 m and 0.97 m respectively, whereas Mrs. Wong's are 0.87 m and 0.95 m. Who has a higher health risk? Show how your arrive at your answer. (3)
   (c) Dieticians recommend that overweight people should have a diet with more vegetables. Suggest two reasons to explain why this diet may help these people to reduce the chance of becoming obese. (4)

CE - 2007

6. Read the paragraph below and answer the questions that follow.

> Gastric reflux describes a backflow of the gastric juice from the stomach into the oesophagus. This can irritate and sometimes damage the lining of the oesophagus, giving a feeling of heartburn. In Hong Kong, the rate of patient suffering from gastric reflux rose from 2.3 per 10 000 in 1996 to 6.2 per 10 000 in 2005. It is believed that the alarming rise is related to the lifestyles of people in Hong Kong. These include having midnight snack right before sleeping, excessive fatty foods, large meals, irregular mealtime, and drinking a lot of alcohol or coffee.

   (a) (i) With reference to the content of gastric juice, suggest a probable reason for its damage to the oesophagus. (1)
   (ii) Food entering the small intestine carries some gastric juice from the stomach. Explain why the gastric juice does not normally damage the small intestine. (3)
   (b) Suggest why the backflow of gastric juice is more likely to occur if a person has a meal just before sleeping. (3)
   (c) A patient suffering from severe gastric reflux will also likely to have tooth decay. Give an explanation for this. (2)

CE - 2007

9. (b) Glycemic Index(GI) is a ranking of foods containing carbohydrates. It is based on their immediate effect on the blood glucose level after consumption. The higher the GI value of a food, the quicker the rise of blood glucose level. Below are the major food constituents and the GI values of some common food items:

Food item	Major food constituents			GI value
	Carbohydrate	Fat	Protein	
Whole milk	✓	✓	✓	27
Fat-free milk	✓	×	✓	32
Cornflakes	✓	✓	✓	92
Oatmeal	✓	✓	✓	49

Key: '✓' means present
'×' means absent

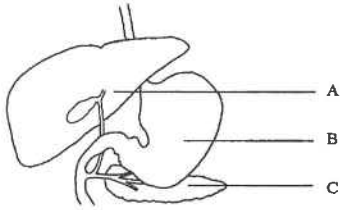
(i) With reference to the major constituents of whole milk and fat-free milk in the above table, suggest why whole milk has a lower GI value. (3)

(ii) For a diabetic person, which breakfast food item, cornflakes or oatmeal, is more suitablw? Explain your choice. (3)

(iii) Besides GI values, state and explain two other considerations regarding the nutritional content of food when you plan a healthy diet to reduce body weight. (4)

CE - 2008

1. The following diagram shows part of the human digestive system.



(a) Describe how structure A helps the digestion of food. (4)

(b) The table below lists some information about the components of the secretion from structures B and C. Complete the table. (5)

	Some components of the secretion	Function
B	Mucus	(i)
	Hydrochloric acid	(ii)
	Protease	(iii)
C	Amylase	Break down starch into maltose
	Lipase	(iv)
	(v)	Neutralize acid from gastric juice

CE - 2008

7. A person joined a fitness programme which involves both weight training and cardio-respiratory training for one month. The table below shows some data about his fitness status before and after the training.

	Before training	After training
Muscle mass (kg)	30.3	31.4
Mass of body fat (kg)	18.8	17.7
Mass of minerals in bone (kg)	3.15	3.29
Basal metabolic rate* (kcal per day)	1543	1580
Average heartbeat rate (beat per minute) when running at 6 km per hour for 5 minutes	143	135

* It is the minimum amount of energy needed to maintain basic body activities.

(a) With reference to the above data, suggest an explanation for the increased basal metabolic rate after the training programme. (2)

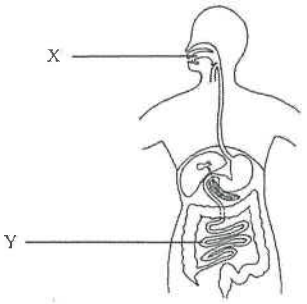
(b) How does the training result in the decrease in body fat of the person? (3)

(c) During this training, the diet should be changed accordingly. With reference to two changes in the fitness status shown above, state ***two*** nutrients that may require an increased intake. Explain how the increased intake of these nutrients contributed to the changes in the fitness status. (4)

(d) There is a change in the person's stroke volume (volume of blood pumped out of the heart in each heartbeat) when running at 6 km per hour before and after the training. Suggest the change in his stroke volume and explain the significance of such a change.(3)

CE - 2009

1. The diagram below shows the human digestive system.



(a) Describe the digestion processes that take place at part X. (2 marks)

(b) (i) Name structure Y. (1 mark)

(ii) With reference to ***one*** feature of structure Y observable in the above diagram, explain how this feature facilitates the absorption of digested food. (2 marks)

(c) Explain a role of the digestive system in body defence. (2 marks)

AL - 2004 2A

1. Vitamin A and vitamin D are fat-soluble while vitamin C is water-soluble. They are essential for normal growth and body functions.
   (a) Explain why an excessive intake of fat-soluble vitamins in general is undesirable whereas an excessive intake of water-soluble vitamins is not. (2)
   (b) Give ***one*** major function in the human body of vitamin A and vitamin C. (2)
   (c) By means of a flow chart, show the major vessels involved in the transport of vitamin D from the small intestine to the heart. (3)
   (d) Vitamin D undergoes the following enzymatic activation to form a highly active metabolite Y:

Vitamin D in blood $\xrightarrow{\text{enzyme 1}}$ X $\xrightarrow{\text{enzyme 2}}$ Y $\longrightarrow$ Increase in intestinal Calcium absorption

   i. Elderly people usually have problems in calcium absorption due to decreased concentration of X. Suggest ***two*** possible causes for this decrease of X. (2)
   iii. Explain how vitamin D deficiency might lead to skeletal problems in adults. (4)
   iv. Why is vitamin D deficiency more damaging to children than to adults? (3)

AL - 2008 1A

7. A man was diagnosed with a kind of pancreatic cancer which is characterized by overgrowth of endocrine pancreatic cells. He sometimes felt dizzy but became less so after drinking a solution of glucose.
   (a) Based on the above observation, suggest why this pancreatic cancer would cause dizziness in the man. (4)
   (b) After having an operation to remove a large part of the pancreas, the man was advised to take a low protein and low fat diet. Explain the biological reasons behind this advice. (2)

DSE-2012 1B

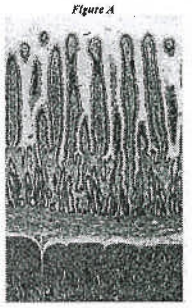
10. In mammals, the production of bile salts is very limited at birth and during early developmental stages. In an investigation of the effect of bile supplementation on fat digestion in piglets, four groups of piglets were fed with the same diet except that bile was added to diets in the proportion of 0, 0.15%, 0.30% and 0.45% respectively for 15 days. Faecal samples were collected each day for analysis and the body weights of the piglets were monitored. The results are shown in the table below:

	Bile level in diet (%)			
	0	**0.15**	**0.30**	**0.45**
Average initial body weight (kg)	4.90	4.46	4.65	4.52
Average final body weight (kg)	7.15	7.36	7.81	7.92
Average dry weight of fat in the faeces (%)	6.52	5.81	4.65	3.78

   (a) How do bile salts help with fat digestion? (2 marks)
   (b) What was the effect of bile supplementation on fat digestion in the above investigation? Explain your answer. (2 marks)
   (c) Suggest why it is important to monitor the body weight of the piglets in this investigation. (1 mark)
   (d) Suggest an in vitro experimental method that allows a direct measurement of the digestion of fat in a laboratory. (3 marks)

HKDSE - 2013 1B

3. Figure A shows a section of part of the human alimentary canal. Figure B shows another section of the same part with blood vessels stained.



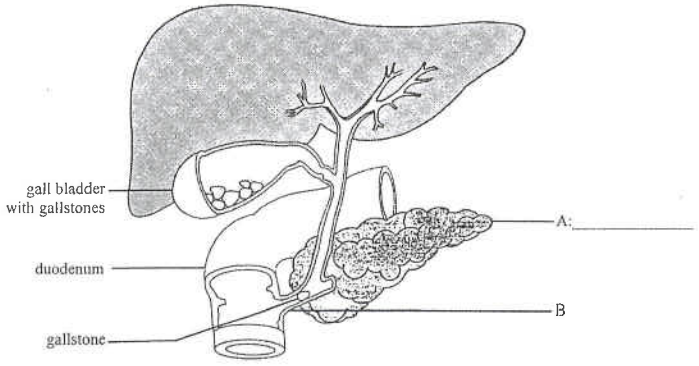
   (a) Which part of the alimentary canal is shown in the figures? Support your answer with evidence. (2 marks)
   (b) For each of the above figures, describe one observable feature and explain how it is related to the functioning of this part of the alimentary canal. (5 marks)

HKDSE - 2014 1B

11. Recently, some people have adopted a diet rich in lean meat in order to lose weight and build muscle. They may be able to achieve these aims but there are some health problems associated with this diet. Discuss the pros and cons of the controversial diet with regard to the nutritional needs of our body and protein metabolism. (12 marks)

HKDSE - 2021 1B

1. The diagram below shows the presence of gallstones in some parts of the human digestive system:



(a) Label structure A. (1 mark)

(b) With reference to *two* components of the secretion released from duct B, explain how the condition shown in the above diagram would lead to a decrease in the rate of fat digestion. (4 marks)

Past Papers Marking Scheme – Nutrition in humans

CE - 2004 Q.1 (a)

(i) X s a finger-like projection of the intestinal wall 1+
This feature provides a large surface area-for food absorption 1
The epithelium of X is very thin / one-cell thick 1 +
This shortens the distance of diffusion / transport of digested food substances 1

(ii) X → hepatic portal vein → liver→ hepatic vein →vena cava→ (heart) 4 x ½
(No arrow sign, deduct 1 mark)

(iii) The peristaltic contraction of the muscle layer 1
pushes food along the small intestine 1
This also helps to mix food with digestive enzymes 1

CE - 2005 Q.3

(a) alkaline substance / substance that inhibits acid secretion / substance that protects the stomach wall 1

(b) Because usually bacteria are killed by the acid secreted by the stomach 1

(c) *Helicobactor pylori* is the cause of ulcer 1

(d) Introduce *Helicobactor pylori* into the stomach of healthy mammals 1
If the hypothesis is correct, these animals would develop gastric ulcer symptoms 1

(e) The churning action of the stomach will break down food into smaller pieces 1
This helps to increase the surface area of food for the action of enzymes 1
It also helps to mix the food with the digestive enzymes 1

CE - 2005 Q.6

(a) A vegetarian diet has low fat content 1
This will reduce the risk of obesity / heart diseases 1

A vegetarian diet has a high content of dietary fibre 1
This helps maintain normal peristalsis / prevent constipation / reduce the risk of colon cancer / avoid overeating 1

A vegetarian diet has a high vitamin C content 1
This helps the formation of connective tissue/preventing scurvy 1
any two sets

(b) beans / peas / nuts / mushroom (accept other reasonable answers) 1

CE - 2006 Q.2

(a) 150 mL 1
(b) saliva/mucus, gastric juice, pancreatic juice, bile, intestinal juice (any two) 1,1
(c) (i) The small intestine is longer than the large intestine 1+
so the time for water absorption is longer / surface are for water absorption is larger 1
or The inner wall of the small intestine is highly folded / has a large number of villi 1+
Thus the surface area for water absorption is larger 1
(ii) The absorption of digested food into blood increases the water potential of

the gut content 1
As a result, water is drawn into the blood by osmosis 1

CE - 2006 Q.5

(a) (i) slightly overweight 1
(ii) 49.0-56.5 kg 1
(b) (i) apple shape 1
(ii) WHR of Mr Wong = 0.90, thus he is of pear shape 1
WHR of Mrs Wong = 0.92, thus she is of apple shape 1
Mrs Wong has a higher health risk 1
(c) This diet has high content of dietary fibre 1
which is indigestible / add bulk to the food to give the sense of fullness 1
It also has low fat content 1
and hence the overall energy intake through this diet will be lowered 1
reducing the change of obesity

CE - 2007 Q.6

(a) (i) Gastric juice is acidic / contains hydrochloric acid 1
(ii) Pancreatic juice / bile / intestinal juice in the small intestine 1
are alkaline 1
which neutralizes the gastric juice 1

(b) After meal, the release of gastric juice increases 1
and the pressure inside the stomach increases 1
Also, the stomach and oesophagus are at the same level while sleeping 1
These increase the chance of gastric reflux
(c) The acid in the gastric content dissolves 1
the enamel / calcium salts of the tooth 1

CE - 2007 Q.9 (b)

(i) Whole milk has more fat than fat-free milk 1
Presence of fat slow down the digestion of carbohydrates 1
and hence a slower absorption of glucose 1
(ii) Diabetics cannot lower their blood glucose level if it is too high 1
Oatmeal has a low GI value / causes a slow rise in blood glucose level 1
Therefore, oatmeal is better than cornflake 1
(iii) The overall energy intake should be less than the overall energy expenditure 1
so that the food reserve will be mobilized and used 1
The diet should contain sufficient amount and types of nutrient 1
for proper functioning of the body 1

CE - 2008 Q.1

(a) Structure A produces bile / bile salt 1
which is released into the duodenum 1
to emulsify fat and increase the surface area 1
this facilitates the action of enzyme on fat 1

(b) (i) Protect inner surface of the stomach from self-digestion / the action of enzyme or acid (gastric juice) 1
(ii) Provide optimum / suitable pH for enzyme activity / to kill bacteria 1
(release calcium salt from bones; hydrolyze larger molecule into smaller molecules)
(iii) Break down proteins into peptides / polypeptides / amino acids 1
(iv) Break down fat into glycerol and fatty acid 1
(accept monoglycerides as alternative to glycerol)
(v) Sodium hydrogencarbonate / hydrogencarbonate salts / hydrogencarbonates 1

CE - 2008 Q.7

(a) There is greater muscle mass after the training 1
Muscles are active cells that require more energy / respiration rate of muscle cells is higher 1
(b) There is an increase in the daily energy expenditure due to increased basal metabolic rate / energy expenditure also increases during training 1
Thus the energy expenditure is greater than the energy intake 1
our body has to utilize the stored fat to meet the energy demand 1
(c) The intake of protein should be increased ..... 1 +
as it is the major raw material for building muscles 1
The intake of calcium / phosphorous should be increased 1
as it is the major raw material for building bones 1
(d) The stroke volume increases after the training 1
This increases the amount of oxygen and carbon dioxide transported per heartbeat / a lower heartbeat rate can supply sufficient oxygen to muscles 1
A lower heartbeat rate is sufficient to sustain the same intensity of exercise / Exercise of higher intensity can be performed by the person 1

CE - 2009 Q.1

(a) Mastication breaks food down into smaller pieces 1
Amylase in saliva helps the breakdown of starch into maltose 1
(b) (i) small intestine 1
(ii) Structure Y is long 1+
to provide a large surface area / increase surface area for absorption of food 1
(c) Presence of hydrochloric acid in the stomach
kills most of the ingested bacteria
pH in different parts of the digestion system varies extremely } any one 1+
most bacteria cannot survive in such a great change of pH } any one 1
Presence of digestive enzymes
Enzymes digest most of the ingested bacteria

AL - 2004 2A

1. (a) • fat-soluble vitamins are not readily excreted in urine, but excessive water-soluble vitamins can be excreted in urine (1) — 2
   • fat-soluble vitamins accumulate in the body to reach toxic levels (1) / cause harm to the body

   (b) • vitamin A – retinal pigment / visual pigment / rhodopsin formation (1) (also accept pigment in rods, responsible for dim light vision) OR control normal epithelial structure and growth — 1
   • vitamin C (any one function):
   > proper metabolism / formation of connective tissue (1) /
   > healing of wound (1)
   (N.B. do not accept deficiency disease as answer)

   (c) small intestine → [(1) lymphatic vessels / lacteal] → [(1) thoracic duct] → [(1) (left) subclavian vein] → [(1) (anterior) vena cava] → heart — max. 3

   [If wrong concept included from vena cava → heart: max. 2 marks only.]

   (d) (i) Any two: — max. 2
   • indoor life, lack of sunlight for vitamin D synthesis (1)
   • lack of vitamin D in food (1)
   • poor vitamin D absorption (1)
   • lower enzyme 1 activity (1) / absence of or not enough enzyme 1 production (any other acceptable answer)

   (iii) • deficient vitamin D → decreased dietary Ca^{++} absorption (1) — 4
   • Ca^{++} level in blood decreased (1) / lower than normal
   • **Ca^{++} drawn from bone to maintain homeostasis (1)**
   • reduce bone mass (1) / bone weakens / bones easily break

   (iv) • children need more calcium than adults (1) as children continue to grow whereas adults stop growth / less growth (1) — 3
   • insufficient vitamin D → poor bone formation (1) / bone deformity / rickets / soft bone / poor teeth development

AL - 2008 1A

7. (a) • due to uncontrolled growth of insulin-secreting cells (1), this pancreatic cancer probably leads to an excessive secretion of insulin (1) — max. 3
   • as insulin stimulates the conversion of blood glucose by the liver (1)
   • / uptake of blood glucose by cells, excessive insulin secretion would reduce the blood glucose to a low level (1)
   • As a result of insufficient blood glucose supply to the brain(1), the man would feel dizzy — 1

   (b) • some tissues of the pancreas secrete protease and lipase (1) — (2)
   • they may be removed together with the cancerous tissues(1), and this would make the digestion of protein and fat difficult

DSE-2012 1B

10. (a) • bile salts emulsify fat into droplets (1) — (1)
    • such that there is an increase in surface area for the action of the lipase / enzyme (1) — (1)

    (b) • as the bile supplementation increased, the fat content of the faeces decreased (1) — (1)
    • this indicates increased digestion of fat (1) — (1)
    Remarks: If absorption instead of digestion is mentioned, no mark will be given

    (c) • to show that the addition of bile supplementation does not adversely affect **the growth of the pigs (1) / indicate the** effectiveness of the bile supplementation on promoting piglets' growth / effectiveness of fat absorption — (1)

    (d) Concept for mark award:
    • 1st pt: suitable substrate and correct enzyme used in the experiment
    • 2nd pt: the identification of parameter for meausring the dependent variable
    • 3rd pt: provide expected results

    e.g. • prepare a mixture of lipase, (bile salts) and oil (1) — (1)
    • add pH indicator into the mixture / use a data logger with pH sensor/ pH meter to show the change in pH of the mxiture (1) — (1)
    • the faster the drop in the pH of the mixture, the faster the digestion of fat (1) — (1)
    Accept other reasonable experiments

DSE-2013 1B

3. (a) • it is taken from the small intestine / ileum (1) (accept duodenum) — (1)
   • as evidenced by the presence of villi (1) in the region — (1)

   (b) Figure A: finger-like projections (villi) (1) provide a larger surface area for the absorption of digested food substances (1) — (2)
   Figure B: rich supply of blood / dense capillary network (1) helps transport away the absorbed food substances quickly (1), this maintains a steep concentration gradient of these food substances to (1) facilitate the absorption — (3)

DSE-20141B

11. Lose weight and build muscle (max. 4 marks) (A)
   • lean meat does not contain much fat and carbohydrates, this reduces the energy intake (1)
   • **when the** energy intake is lower than the energy expenditure (1), our body will utilise food **reserve, body fat in this case, to support** our daily activities (1)
   • protein will be digested to form amino acids (1)
   • amino acids will be assimilated to form muscle fibres (1) according to the needs of the body

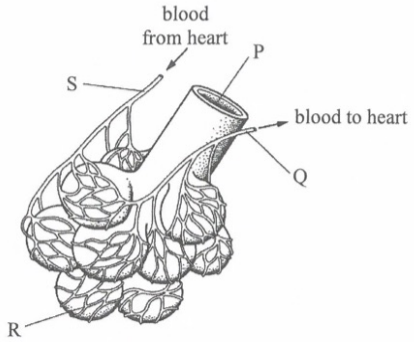
   Health problems associated with the unbalanced diet (max. 2 marks) (D)
   • **such diet may lack other essential nutrients which are also important** for our health (1) such as certain mineals and vitamins:
   • insufficient intake of minerals **and vitamins le**ads to deficiency diseases (1) (may cite specific examples)

   Health problems associated with protein metabolism (max. 3 marks) (P)
   • excess amino acids will be deaminated in the liver forming urea (1)
   • and the urea will be excreted through the kidney (1)
   • this creates heavy workload to both the liver and the kidney (1) and may lead to failure of their functioning (1)

   C=max. 3

2022

Directions: Questions 15 and 16 refer to the diagram below, which shows the end of the respiratory tract and the associated blood vessels in humans:



16. Which of the following adaptive features for gas exchange can be illustrated in the above diagram?

(1) The respiratory tract ends in numerous spherical structures.
(2) The end of the respiratory tract has a thin wall.
(3) The end of the respiratory tract is covered with blood vessels.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Directions: Questions 17 and 18 refer to the diagrams below. Diagram I shows a device which is used to monitor the breathing pattern of a person. It consists of an elastic band strapped around a person's chest and a sensor which detects the tension of the elastic band. Diagram II shows the change in the tension of the elastic band during breathing.

Diagram I

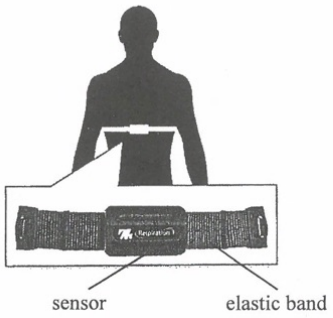
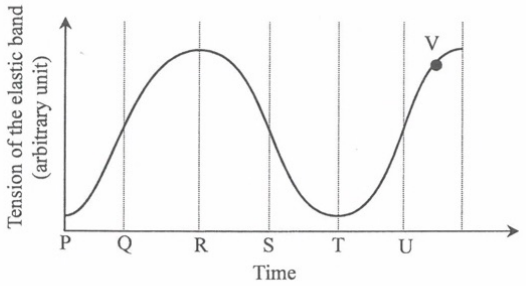


Diagram II



17. Exhalation takes place during period

A. PR.
B. QS.
C. RT.
D. SU.

18. Which of the following interpretations about Diagram II is/are correct?

(1) The diaphragm is contracting during period QR.
(2) Air pressure inside the lungs increases during period TU.
(3) Air pressure inside the lungs is greater than atmospheric pressure at point V.

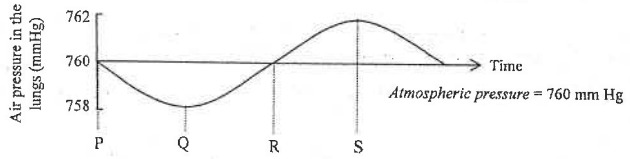
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE M.C. Questions - Gas exchange in humans
(sort by difficulty)

Challenging

2013 Q.30 (7%)

The graph below shows the change in air pressure in the lungs of a person:



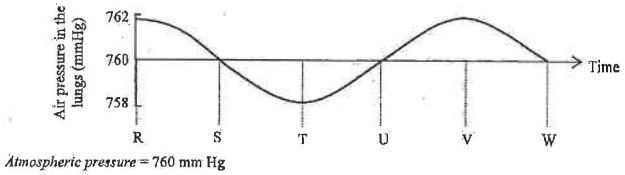
At which point of time on the graph is the volume of the lung the largest

A. P B. Q C. R D. S

Average

2014 Q.27 (62%)

The graph below shows the change in air pressure in the lungs of a man:

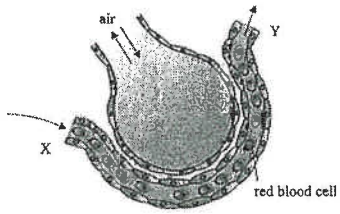


His diaphragm muscles are in a state of contraction during the period

A. RT.
B. SU.
C. TV.
D. UW.

Average

Directions: Questions 13 and 14 refer to the diagram below, which shows a section of an air sac and its associated blood capillary in humans:



2015 Q.13 (73%)

Which of the following combinations correctly describes the changes in blood composition when blood flows from X to Y?

	Oxygen content	*Glucose content*	*Urea content*
A.	increases	remains unchanged	increases
B.	increases	decreases	remains unchanged
C.	remains unchanged	decreases	remains unchanged
D.	remains unchanged	remains unchanged	increases

2015 Q.14 (67%)

As the blood in the capillary continues to flow, the red blood cell will first return to the

A. left atrium.
B. right atrium
C. left ventricle.
D. right ventricle.

Average

2016 Q.33 (46%)

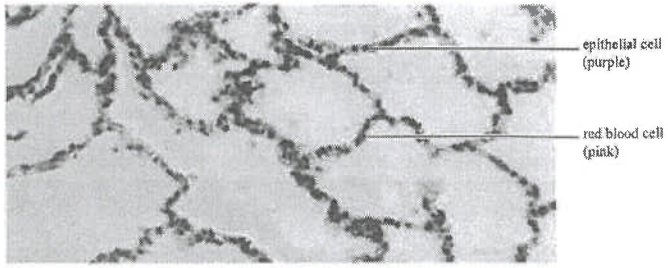
Which of the following organs are protected by the rib cage?

(1) lung
(2) liver
(3) heart

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

2018 Q.8 (63%)

The photomicrograph below shows a section of human lung:



With reference to the structures shown in the photograph, which of the following are adaptive features for gas exchange?

(1) Presence of water film
(2) Short diffusion distance
(3) Rich supply of blood capillaries

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Easy

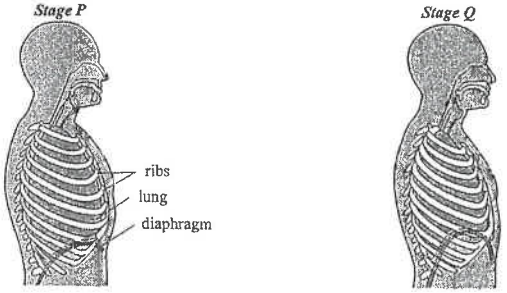
2012 Q.22 (82%)

Which of the following descriptions about the function of the cilia lining the trachea is correct?

A. to warm the incoming air
B. to moisten the incoming air
C. to move mucus away from the trachea
D. to produce mucus to protect the trachea

2015 Q.15 (76%)

The diagrams below show the relative positions of the human respiratory system and its associated structures in two different breathing stages:



Which of the following statements correctly describes the change that takes place from stage P to stage Q?

A. Pressure inside the lungs is increasing.
B. Diaphragm muscle is contracting.
C. Volume of the lungs is increasing.
D. Rib cage is moving upward.

11. Which of the following descriptions of breathing is correct?

A. The air rushes in to expand the lungs.
B. The trachea expands to draw in more air.
C. Pressure in the lungs decreases to draw in air.
D. The expansion of the lungs pushes the diaphragm downward.

Answers

Challenging

2013
30 [C]

Average

2014	2015	2016	2018
27 [B]	13 [B] 14 [A]	33 [B]	8 [C]

Easy

2012	2015
22 [C]	15 [A]

2020
11[C]

Past papers – Gas exchange in humans

CE - 2003

1. (a) To study the effect of concentration of oxygen and carbon dioxide on the breathing rate, a healthy person was asked to inhale different gas mixtures. The results are shown in the table below

Gas mixture	Concentration of gas (%)		Breathing rate (breathe per min)
	Oxygen	Carbon	
P	21	0.03	17
Q	21	4.00	34
R	16	0.03	17
S	16	4.00	34

(i) With reference to the above information, state the factor that affects the breathing rate of the person. Explain how you arrive at your answer. (3)

(ii) Which of the four gas mixtures has similar concentrations of oxygen and carbon dioxide as exhaled air? (1)

(iii) Mouth-to-mouth ventilation is a method for rescuing a person who fails to breathe but still has heartbeat. It involves blowing exhaled air into the patient's body through the mouth as shown below:

Based on the composition of exhaled air, explain why this method can help the patient stay alive before he can breathe again. (2)

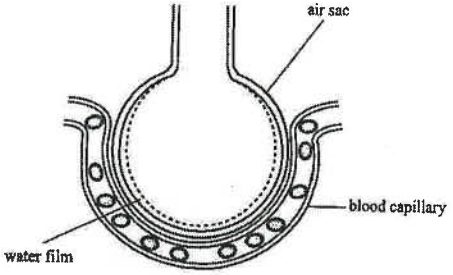
(iv) Suggest why it is necessary to do the following when carrying out mouth-to-mouth ventilation:

(1) Tilt the patient's head as shown in the diagram, instead of letting it lie flat. (1)
(2) Observe whether the patient's chest rises when blowing air into the patient. (1)

(v) Which part of the brain controls the breathing rate? (1)

CE - 2004

1. (c) The diagram below shows an air sac of the lung and its blood supply:



(i) Explain the importance of the water film in gaseous exchange. (2)

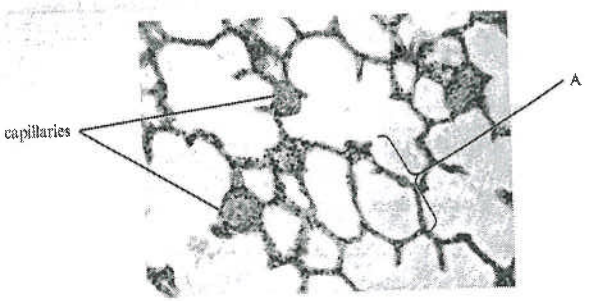
(ii) SARS patients may have fluid accumulated in the air sacs. Explain how the accumulation of fluid may affect the oxygen content of the blood of the patients. (3)

(iii) One method of confirm whether a patient is infected with the SARS virus is to test for the presence of antibodies against this virus in the patient's blood. Explain why these antibodies will be produced by a SARS patient. (2)

(iv) Suggest a method that can help the body develop immunity against SARS. Explain how the immunity is developed. (4)

CE - 2005

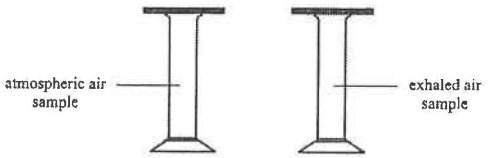
4. The photomicrograph below shows a section of a mammalian lung:



(a) With reference to two features observable in the photomicrograph, explain how the lung tissue is adapted to gas exchange. (4)

(b) Oxygen moves continuously from the air in A into the capillaries. However, the oxygen content in A remains relatively high. Explain how this is achieved. (2)

(c) Eric wanted to compare the oxygen content of atmospheric air and exhaled air, so he prepared two jars of gas as shown below:

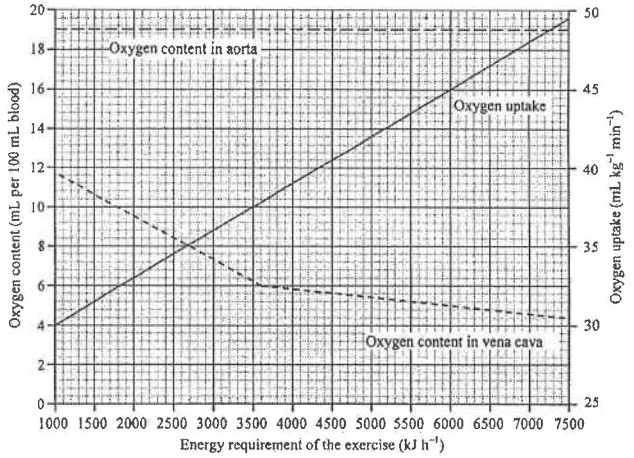


(i) Draw a labeled diagram to show a sep-up that can be used to collect the air exhaled from his lungs. (4)

(ii) Describe what Eric should do in order to compare the oxygen content of the two air samples. (2)

CE - 2006

10. (b) The graph below shows the oxygen content of blood in the aorta and that in the vena cava, and the oxygen uptake of a person performing exercise of different intensities. The intensity of exercise is expressed as the energy requirement of the exercise.



(i) How does the oxygen uptake change with exercise of different energy requirements?(1)

(ii) From the graph, find out the blood oxygen content in the aorta and the vena cava for boxing, which has an energy requirement of 4500 kJ h^{-1}. (1)

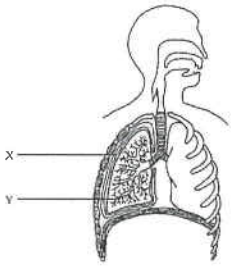
(iii) The energy requirements for running and cycling leisurely are 3600 kJ h^{-1} and 1800 kJ h^{-1}. Calculate the difference in the blood oxygen content between the aorta and the vena cava for each type of exercise. (2)

(iv) How does the difference in blood oxygen content between the two blood vessels change with the intensity of exercise? Explain the significance of this change. (3)

(v) As exercise intensity increases, there is a great change in the blood oxygen content in the vena cava, but that in the aorta remains constant and high. Explain how the constant and high blood oxygen content in the aorta can be achieved. (3)

CE - 2008

3. The following diagram shows part of the human respiratory system.



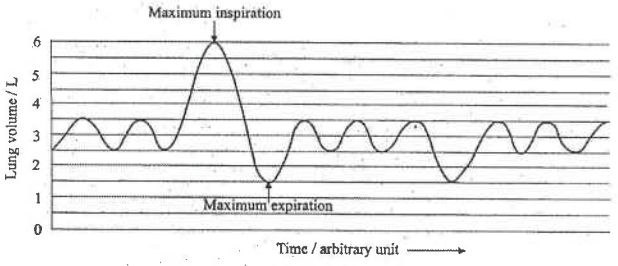
(a) Name structure X and describe its function. (3)

(b) Construct a flowchart to show the path of air passing from the atmosphere to the air sacs of the lungs. (2)

(c) Asthma is a respiratory disease. When it attacks, structure Y constricts and the patient will have breathing difficulty. Explain the effect of asthma on the rate of removal of carbon dioxide from the blood of the lungs. (4)

AL - 2002 1A

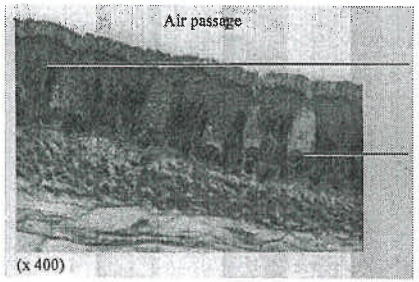
6.



The chart shows the lung volume changes during breathing. The vital capacity is calculated to be _____ The vital capacity can be used as an index of pulmonary function because it provides useful information about the strength of the _____ muscles. A patient suffering from asthma has a greatly reduced 'timed vital capacity' (i.e. vital capacity in a fixed time interval) in which the resistance of the airways is _____ owing to bronchial constriction. (3)

HKDSE - 2014 1B

2. The photomicrograph below shows a section of the inner wall of the human trachea:



(a) In the space provided, label the cells shown in the photomicrograph. (2 marks)

(b) With reference to the features of the inner wall shown in the photomicrograph, describe how the inner wall of the trachea can protect our body against bacterial invasion. (3 marks)

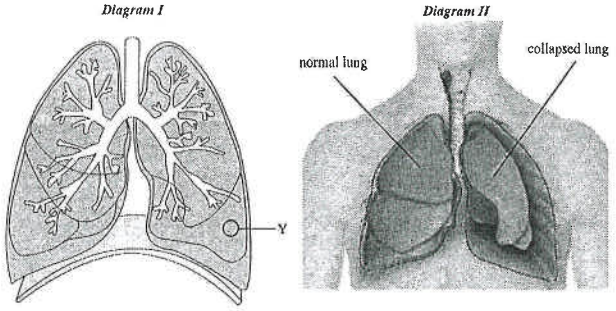
HKDSE – 2016 1B

11. Gas exchange in organisms mainly relies on diffusion. As an efficient organ for gas exchange, plants' leaves and human's lungs have some common principle on structural adaptation. Discuss how their structures adapt to conform these common principles. In addition to these similarities, explain why human's respiratory system is more efficient in operation. (11 marks)

HKDSE - 2017 1B

5. a. Briefly describe the breathing actions that bring air into the lungs. (4 marks)

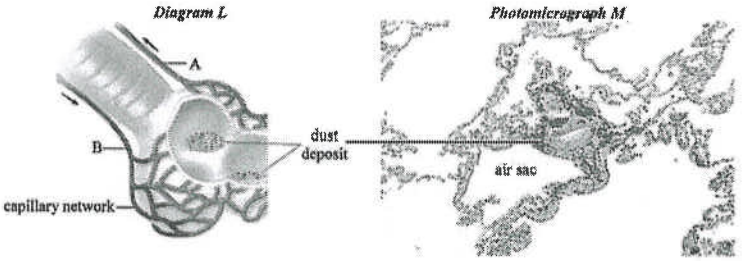
b. In the following diagrams, Diagram I shows some structures of a human lung while Diagram II shows a collapsed lung if it is ruptured at location Y:



Explain why the lung collapses if it is ruptured at location Y. (2 marks)

HKDSE - 2019 1B

5. Diagram L below shows part of the lung in a patient suffering from a certain lung disease. A hardened layer of dust deposit was found on the respiratory surface of the air sacs. Photomicrograph M shows the lug tissue taken from the patient.



(a) Compare the oxygen and glucose content of the blood in vessels A and B. Explain your answer. (4 marks)

(b) With reference to the above information about the lung disease, suggest two possible ways in which the disease adversely affects gas exchange in the patient. (4 marks)

Past Papers Marking Scheme – Gas exchange in humans

CE - 2003 Q.1 (a)

(i) Concentration of carbon dioxide 1
Because the breathing rate increases / change with the concentration of CO_2 1
While it remains the same regardless of the change in oxygen concentration 1

(ii) S 1

(iii) Exhaled air still contain 16% oxygen 1
When blown into the patient's lungs, the oxygen can be supplied to the body cells for respiration 1

(iv) (1) To ensure the entrance of the trachea is clear / free from obstructions 1
(2) To ensure that air is blown into the lungs 1

(v) medulla 1

CE - 2004 Q.1 (c)

(i) Oxygen in air dissolves in the water film 1
so that it can diffuse readily through the wall of the air sac into the blood capillary 1

(ii) The accumulation of fluid increases the distance for diffusion / reduces the surface area for dissolving oxygen 1
thereby decreases the rate of diffusion of dissolved oxygen into the blood capillaries 1
Thus the oxygen content of the blood decreases / becomes lower than normal 1

(iii) The antigen of the SARS virus 1
stimulates the white blood cells of the patient to produce the specific antibodies 1

(iv) injection of the weakened virus / the antigen into the body 1
This will stimulate the white blood cells to develop memory for the antigen 1
When the same virus enters the body, 1
a large amount of antibodies can be produced rapidly 1

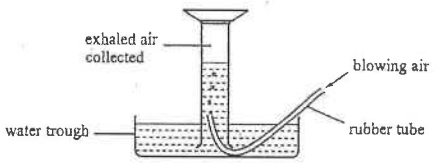
CE - 2005 Q.4

(a) The wall of A is very thin 1
so as to reduce the distance of diffusion of respiratory gases 1

A is richly supplied with blood capillaries 1
This allows a rapid transport of gas to and away from the air sacs / can maintain a steep concentration gradient of gases between A and the blood 1
The lung tissue is made up of numerous air sacs 1
so that there is a large surface area for gas exchange/the diffusion of gases 1
any two sets

(b) During ventilation / breathing, some air in the lungs is replaced by fresh air 1
which contains a high oxygen content 1

(c) (i)



Set-up for collecting exhaled air

Title ½
Workable set-up: inverted gas jar, collecting gas under water, tube 1
Label: water/water trough, blowing air, rubber tube, exhaled air collected (any 3) 1½
Quality of drawing 1

(ii) Put a burning candle into the gas samples 1
Compare the time that the candle can burn 1

CE - 2006 Q.10 (b)

(i) Oxygen uptake increases with exercise of increasing energy requirement 1

(ii) Oxygen content in aorta : 19 mL per 100 mL blood
Oxygen content in vena cava : 5.6 mL per 100 mL blood (1 or 0)

(iii) Difference in oxygen content for running = 19 - 6 = 13 mL per 100 mL blood 1
Difference in oxygen content for cycling = 19 - 10 = 9 mL per 100 mL blood 1

(iv) The difference in blood oxygen content between the aorta and the vena cava increases with increased exercise intensity 1
This shows that more oxygen is consumed by tissue 1
for respiration to release more energy for increased exercise intensity 1

(v) During vigorous exercise, there is an increase in ventilation rate / rate and depth of breathing 1
The oxygen content in air sac increases 1
The diffusion gradient across alveolar wall increases / this increases the diffusion of oxygen into the blood 1
thus maintaining the blood oxygen content of the aorta at a constant and high level 1

CE - 2008 Q.3

(a) X: * pleural membrane / inner pleural membrane 1
It secretes pleural fluid 1
to reduce friction during breathing movement / act as lubricant during breathing movement 1

(b) (atmosphere) → nostril / nasal cavity → pharynx → trachea → bronchus → bronchioles → (air sacs) 2

Mark by pairs (put a ✓ above the arrow)
Put a ✓ above the last arrow if atmosphere and air sacs are included
A maximum of 4 ✓
Missing but correct sequence: continue marking
Wrong sequence: stop at the wrong one
Ignore additional structure given in correct sequence, e.g. mouth, nose, larynx

(c) Volume of the inspired air decreases 1
Less *fresh air mixes* with the residual air 1
Thus concentration of carbon dioxide in the air sacs remains relatively high / The concentration gradient of carbon dioxide between the alveolar air and the blood becomes smaller 1
The rate of removal if carbon dioxide from blood decreases 1

OR (Any one set)
Volume of the expired air decreases 1
carbon dioxide removed from air sacs to atmosphere decreases 1
Thus concentration of carbon dioxide inside the lungs remains relatively high / The concentration gradient of carbon dioxide between the alveolar air and the blood becomes smaller 1
The rate of removal if carbon dioxide from blood decreases 1

AL - 2002 1A

6. • 4.5 L (1)
   • *intercostals (½) and *diaphragm (½) / *respiratory (½)
   • increased (1)

HKDSE - 2014 1B

2. (a) * ciliated epithelial cell (1)
   * mucus-secreting cell (1)

   (b) • mucus secreting cells secrete mucus to trap dust and germs from incoming air (1)
   • cilia sweep the trapped dust and germs away to the throat for swallowing (1) (3)
   • epithelial cells are closely packed to prevent entry of bacteria / form a physical barrier (1)

5 marks

HKDSE – 2016 1B

11. **Adapations to be an effective organ for gas exchange (A) max.=5**

- large surface area for diffusion of gases (1)
  - numerous air sacs in the lungs of humans vs spongy mesophyll with numerous air spaces in leaves / numerous leaves in plants (1)
- a moist surface for dissolving of gas (1)
  - presence of a water film on the inner surface of the air sac vs that of the surface of spongy mesophyll (1)
- short distance for exchange of gas between internal and external environment (1)
  - one-cell thick wall of air sacs and capillary versus flat and thin leaves (1)

Human lungs are considered more effective in gas exchange (S) max. = 3

- there is active ventilation in humans, breathing movements draw in and expel air actively (1)
- oxygen diffused in are transported away by the blood of the capillary network surrounding the air sacs (1)
- both of the above maintain a steep concentration gradient for diffusion of gases (1)
- while leaves rely on passive ventilation / diffusion only (1)

Adaptations (A) = max. 5
Effective breathing system (S) = max. 3
Effective communication (C) = max. 3

11 marks

HKDSE – 2017 1B

5. (a) • intercostal muscle contracts to result in upward and outward movement of rib cage / raise the rib cage (1)*[accept external intercostal muscle, not internal intercostal muscle contracts]
   • diaphragm(muscle)contracts and diaphragm becomes flattened (1)*
   • both actions increase the volume of the thoracic cavity (1)#[NOT accept lung volume] (4)
   • as a result, the pressure inside the lungs drops below atmospheric pressure# (1)
   hence air is forced into the lungs

* *accept "contraction of intercostal muscle and diaphragm muscle (1) lead to upward and outward movement of rib cage and flattening of diaphragm (1)", though not encouraged as it doesn't show causal relationship.*
\# *if the candidates mention pressure change first and then volume change, then only bullet point 4 (about pressure) will be marked; no mark will be given to bullet point 3 (about volume)*

Marks

(b) • air will leak into the pleural cavity (1)from outside (through the lungs) / the negative pressure of pleural cavity cannot be maintained (1) (2)
• the lung collapses due to its own elasticity (1)

6 marks

HKDSE – 2019 1B

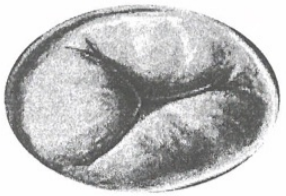
5. (a)
- A contains more oxygen than B or vice versa (1)
  *because gas exchange takes place at air sac *[not accept at blood vessel A or B]* where oxygen is taken up by blood (diffusion) (1), blood leaving air sac should have more oxygen
- A contains less glucose than B or vice versa (1) (4)
  *because the cells in the lung tissues# have taken up glucose from blood for respiration (1), blood leaving air sac should have less glucose

* *No need to mark if 0 mark for previous bullet point*
\# *accept: lung cells / cells in air sac ; not accept air sac / lung / body cells*

(b) Any *two* sets:
- dust deposit forms a barrier (1) and this increases the diffusion distance (0+1) (4)
- a significant portion of the inner surface [not accept water film] of the air sacs was covered / blocked by dust (1), thus the area available for diffusion was reduced (0+1)
- a hardened layer of dust deposit reduces the elasticity of the lung (1), hence a smaller lung volume when the lung inflates (0+1)

8 marks

19. Imagine that you were a red blood cell travelling along a blood vessel and had reached the heart. After passing through the 'gate' shown in the diagram below, there was another 'gate' ahead. Which heart chamber were you situated now?

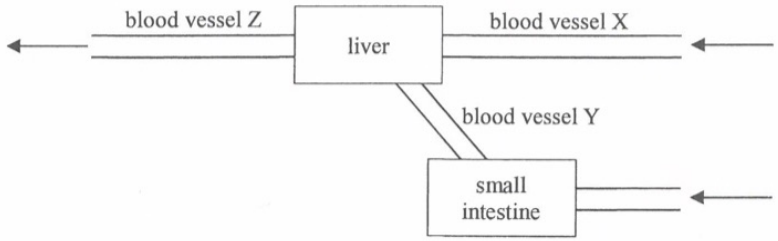


A. left atrium
B. left ventricle
C. right atrium
D. right ventricle

20. Some babies are born with a heart defect which is a hole in the septum separating the left and right ventricles. When the ventricles contract at the same time, some blood flow will deviate from the normal route. Which of the following is most likely the deviated route?

A. left ventricle → right ventricle → aorta
B. left ventricle → right ventricle → pulmonary artery
C. right ventricle → left ventricle → aorta
D. right ventricle → left ventricle → pulmonary artery

Directions: Questions 21 and 22 refer to the diagram below, which shows part of the human circulatory system and the associated organs:



22. Which of the following descriptions about blood vessel Y are correct?

(1) It transports hormones.
(2) It carries deoxygenated blood.
(3) It has capillary networks at both ends.

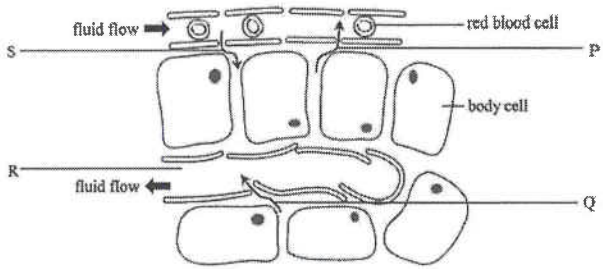
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE M.C. Questions - Transport in humans
(sort by difficulty)

Challenging

2016 Q.28 (18%)

Directions: Questions 28 and 29 refer to the diagram below, which shows the cells and the associated vessels in a tissue:



Which of the following combinations correctly identifies the major causes of fluid flow represented by P, Q and S?

	P	*Q*	*S*
A.	osmosis	diffusion	hydrostatic pressure
B.	hydrostatic pressure	hydrostatic pressure	diffusion
C.	osmosis	hydrostatic pressure	hydrostatic pressure
D.	diffusion	diffusion	osmosis

2018 Q.34 (38%)

Which of the following contribute to the continuous blood flow in the aorta?

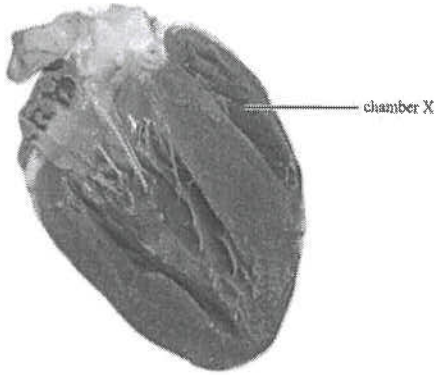
(1) pumping action of the heart
(2) elastic nature of the wall of the aorta
(3) contraction and relaxation of muscle wall of the aorta

A. (1) and (2) only B. (1) and (3) only C. (2) arid (3) only D. (1), (2) and (3)

Challenging

2018 Q.35 (20%)

35. The following photograph shows a dissected pig heart:



Which of the following descriptions about chamber X is correct?

A. It receives blood from the pulmonary vein.
B. It pumps out blood to the aorta.
C. It receives blood from the vena cava.
D. It pumps out blood to the pulmonary artery.

2019 Q.15 (35%)

Which of the following description(s) of human red blood cells is/ are correct?

(1) they cannot synthesise enzymes or proteins for repair because of the absence of the nucleus
(2) they will stop functioning one day because haemoglobin will be used up
(3) they do not have an energy supply because of the absence of mitochondria

A. (1) only B. (2) only C. (1) and (3) only D. (2) and (3) only

Challenging

2019 Q.22 (39%)

When ventricles contract, the valves between ventricles and atria close. Which of the following is the cause of the valve closure?

A. The heart tendons hold the valves in position.
B. The refilling of blood at the atria pushes the valves so that they close.
C. The closure of valves prevents the blood from flowing back to the atria.
D. The higher blood pressure resulting from ventricular contraction pushes the valves so that they close.

Average

2013 Q.31 (64%)

Muscles are found in

(1) arterioles.
(2) capillaries.
(3) veins.

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2016 Q.13 (47%)

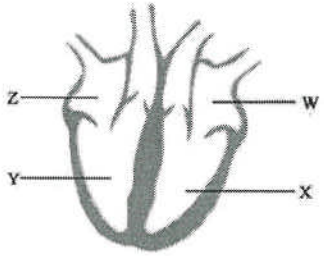
Of the following blood vessels, which one contains blood with the highest urea content?

A. renal vein B. hepatic vein
C. pulmonary vein D. hepatic portal vein

Average

2016 Q.17 (40%)

Directions: Questions 16 and 17 refer to the diagram below, which shows a section of the heart:

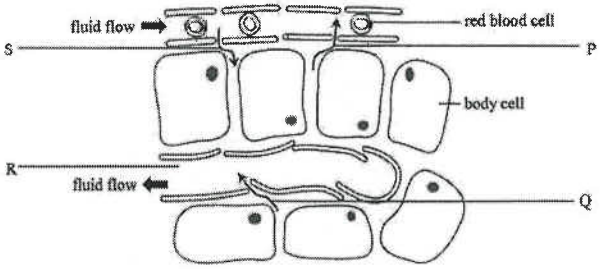


Which of the following statements about the heart is correct?

A. Z receives oxygenated blood from the lungs.
B. Y and Z pump out same volume of blood.
C. Blood in Z has higher glucose content than that of W.
D. Blood pumped out from Y travels a longer distance than that of X before returning to the heart.

2016 Q.29 (73%)

Directions: Questions 28 and 29 refer to the diagram below, which shows the cells and the associated vessels in a tissue:



Fluid in R eventually returns to the heart at the

A. left atrium. B. right atrium. C. left ventricle. D. right ventricle.

Average

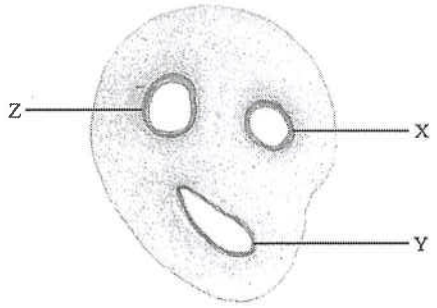
2017 Q.18 (49%)

Which of the following descriptions of the circulatory system is correct?

A. Veins have a large lumen because the blood pressure inside them is low.
B. Arteries have a thick layer of elastic tissue because they have small lumen.
C. The aorta has the highest blood pressure because it supplies blood to the whole body.
D. the capillary network is a suitable site for material exchange because capillaries have the thinnest walls.

2019 Q.27 (50%)

The photomicrograph below shows a section of a human umbilical cord with three blood vessels:



Which of the following comparisons of the content of the blood vessels is correct?

A. The blood in vessel X has a higher oxygen content than that in vessel Y.
B. The blood in vessel Z has a higher glucose content than that in vessel X.
C. The blood in vessel Y has a higher amino acid content than that in vessel X.
D. The blood in vessel Y has a higher carbon dioxide content than that in vessel Z.

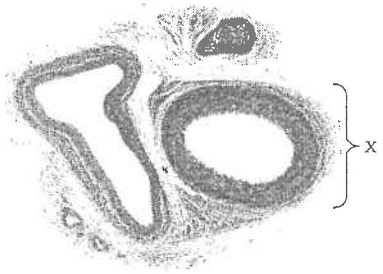
Easy

2012 Q.21 (83%)

A red blood cell leaves the aorta, travels through the body and arrives at the capillaries of the air sacs. The correct sequence of organs through which the red blood cell may have travelled is

A. liver, lungs, small intestine and heart.
B. lungs, heart, small intestine and liver.
C. small intestine, heart, liver and lungs.
D. small intestine, liver, heart and lungs.

Directions: Questions 31 and 32 refer to the photomicrograph below, which shows some blood vessels found in the human body:



2012 Q.31 (90%)

Blood vessel X is an artery because it has a

A. thick muscular wall to withstand high blood pressure.
B. thick muscular wall to generate high blood pressure.
C. large lumen to slow down the blood flow.
D. large lumen to accommodate more blood.

2012 Q.32 (75%)

If blood vessel X is connected with the lung, it carries

A. oxygenated blood towards the heart.
B. oxygenated blood towards the lungs.
C. deoxygenated blood towards the heart.
D. deoxygenated blood towards the lungs.

Easy

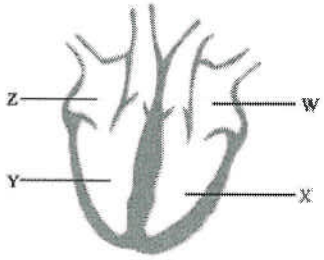
2012 Q.33 (76%)

In the circulatory system, the highest blood pressure is developed in the

A. left atrium.
B. right atrium.
C. left ventricle.
D. right ventricle.

2016 Q.16 (76%)

Directions: Questions 16 and 17 refer to the diagram below, which shows a section of the heart:



When W contracts, which of the following combinations about the conditions of the valves is correct?

	Semi-lunar valve	*Bicuspid valve*
A.	open	open
B.	open	closed
C.	closed	open
D.	closed	closed

2020 Q.12

12. Which of the following descriptions of the hepatic portal vein is correct?

A. It carries blood away from the liver.
B. It carries blood with lower oxygen content than that in the hepatic vein.
C. It carries blood with lower amino acid content than that in the hepatic artery after meals.
D. It carries blood with lower glucose content than that in the hepatic vein when one is hungry.

2021 Q.20

20. Carbon dioxide produced in the small intestine is passed to the lungs for gas exchange. Which of the following correctly shows the transport route of the carbon dioxide?

A. small intestine → lungs
B. small intestine → liver → lungs
C. small intestine → heart → lungs
D. small intestine → liver → heart → lungs

Answers

Challenging

2016	2018	2019
28 [C]	34 [A]	15 [A]
	35 [D]	22 [D]

Average

2013	2016	2017	2019
31 [B]	13 [B]	18 [D]	27 [C]
	17 [C]		
	29 [B]		

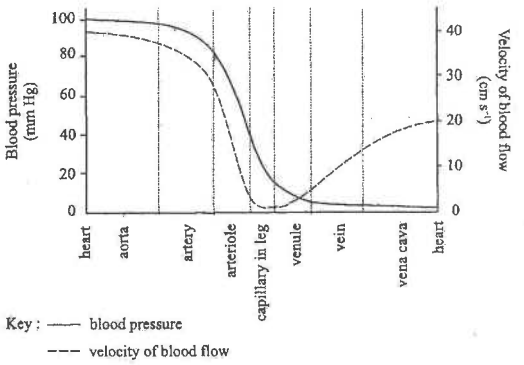
Easy

2012	2016
21 [D]	16 [C]
31 [A]	
32 [D]	
33 [C]	

2020
12[D]

CE - 2002

4. (b) The graph below shows the changes in blood pressure and velocity of blood flow as the blood travels from the heart to the leg and returns to the heart:



(i) Compare the blood pressure in the artery with that in the vein. Suggest two reasons for the difference. (3)

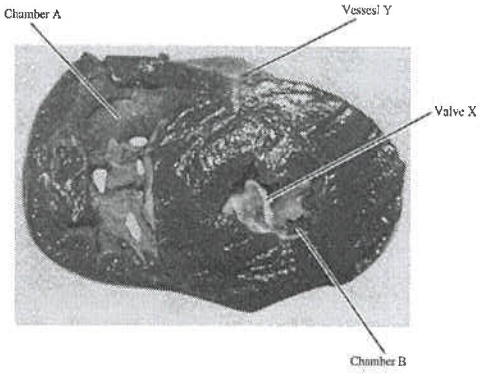
(ii) Explain the importance of the low velocity of blood flow in the capillary. (2)

(iii) In the vein of the leg, the blood pressure is very low while the velocity of blood flow is quite high. Describe how such a high velocity of blood flow in the vein is maintained. (2)

(iv) Using the same x-axis given above, sketch a graph to show the change in the oxygen content of the blood as it passes through the blood vessels. (3)

CE - 2003

4. (b) The photograph below shows the transverse section of a pig's heart, which has a structure similar to that of the human heart.



(i) Which chamber of the heart, A or B, is responsible for sending out blood to all parts of the body except the lung? Explain your choice. (1)

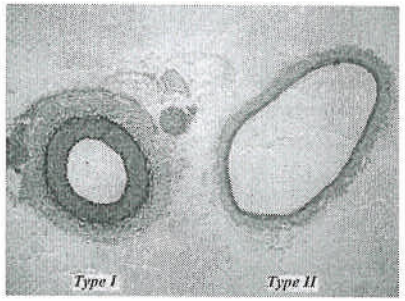
(ii) (1) Name valve X. (1)

(2) In a type of heart disorder, valve X cannot close properly. A man suffering from this disorder may faint easily when he performs vigorous exercise. How would you explain this? (4)

(iii) Vessel Y is an artery found in the heart wall. Explain why the risk of heart attack would be higher if fatty substances are deposited on the inner wall of vessel Y. (2)

CE - 2004

3. (c) The photomicrograph below shows the sections of two types of blood vessels in the human body :



(i) State two functions of the thick muscular wall of vessel type I. (2)

(ii) Vessel type II has a larger lumen than vessel type I. Explain the importance of this. (2)

The table below shows the gas content of the blood in the two types of vessels transporting blood between the heart and an organ A :

	Gas content (arbitrary unit)	
	Vessel type I	Vessel type II
Carbon dioxide	44	40
Oxygen	40	100

(iii) Identify organ A. (1)

(iv) With reference to organ A,

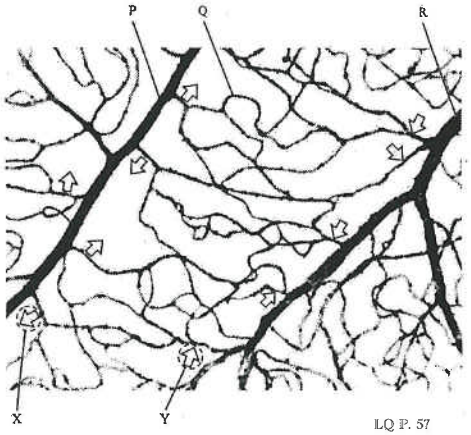
(1) account for the difference in carbon dioxide content between the blood in vessel types I and II. (3)

(2) explain the low oxygen content of the blood in vessel type I. (3)

CE - 2005

8. (a) The photomicrograph below shows three types of blood vessels, P, Q and R, in a tissue. The cells of the tissue are not shown.

Key : ⇨ direction of fluid movement between the blood and the tissue cells



(i) (1) Judging from the direction of fluid movement shown above, which blood vessel, P or R, would have a more muscular wall? (1)

(2) Explain the importance of the muscular tissue in the wall of the blood vessel. (3)

(ii) Q forms a highly branched network. What is the significance of this? (2)

(iii) Explain how the fluid movement as indicated by the arrows is brought about at

(1) site X (2)

(2) site Y (2)

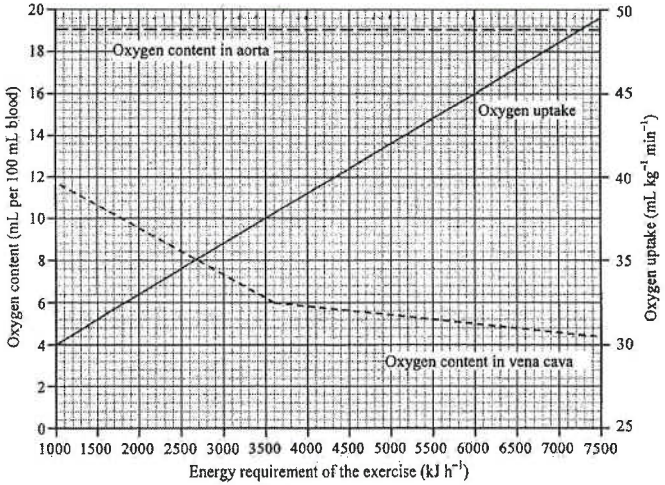
CE - 2006

1. The following paragraph describes the blood flow and a defective condition in the veins of the legs. Complete the paragraph with suitable words. (5)

Blood flow in veins is usually under .....(a)..... pressure. In the legs, blood in veins flows upwards against .....(b)..... to return to the heart. The upward flow is assisted by the contraction of .....(c)..... lying next to the veins. The .....(d)..... in the veins help to ensure that blood flows in one direction only. If they cannot .....(e)..... properly in performing its function, it may result in the accumulation of blood and hence a higher blood pressure in the veins of the legs. Consequently, veins located near the surface of the skin tend to bulge and become visible, forming varicose veins.

CE - 2006

10. (b) The graph below shows the oxygen content of blood in the aorta and that in the vena cava, and the oxygen uptake of a person performing exercise of different intensities. The intensity of exercise is expressed as the energy requirement of the exercise.



(i) How does the oxygen uptake change with exercise of different energy requirements?(1)

(ii) From the graph, find out the blood oxygen content in the aorta and the vena cava for boxing, which has an energy requirement of 4500 kJ h^{-1}. (1)

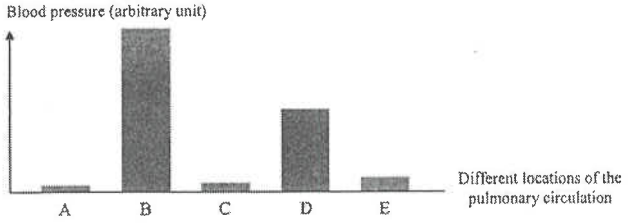
(iii) The energy requirements for running and cycling leisurely are 3600 kJ h^{-1} and 1800 kJ h^{-1}. Calculate the difference in the blood oxygen content between the aorta and the vena cava for each type of exercise. (2)

(iv) How does the difference in blood oxygen content between the two blood vessels change with the intensity of exercise? Explain the significance of this change. (3)

(v) As exercise intensity increases, there is a great change in the blood oxygen content in the vena cava, but that in the aorta remains constant and high. Explain how the constant and high blood oxygen content in the aorta can be achieved. (3)

CE - 2008

9. (b) The graph below shows the blood pressure of blood vessels at different locations of the pulmonary circulation.



(i) (1) Using the letters A to E in the graph, construct a flowchart to show the direction of blood flow from the heart along the pulmonary circulation. (1)

(2) State the criterion you should use in constructing the flowchart in (1). (1)

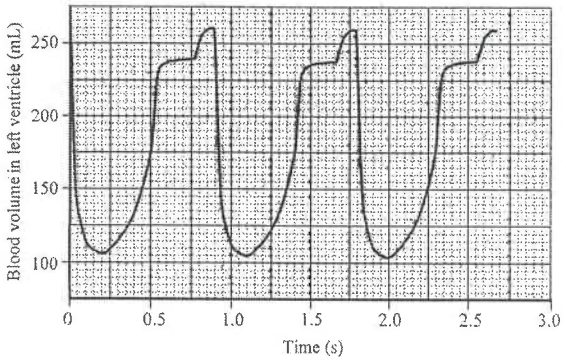
(ii) The blood vessels of two of the above locations show rhythmic changes in blood pressure. Explain how these blood pressure changes are related to the heart activity. (2)

(iii) State two blood components responsible for killing specific pathogens in the human body. (2)

(iv) Immunity can be acquired by vaccination. Vaccine may be injected into the tissue under the skin. Describe how the vaccine can be transported to the heart after injection. (3)

CE - 2009

2. The following graph shows the change in blood volume in the left ventricle of a man over time.



(a) With reference to the graph, calculate his heartbeat rate. (2 marks)

(b) State the conditions of the following heart valves at 1.0 s. (2 marks)
bicuspid valve:_____semi-lunar valve: _____

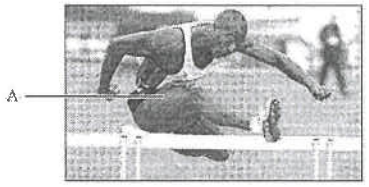
(c) Explain the increase in blood volume in the left ventricle from 1.1 s to 1.5 s (3 marks)

CE - 2009

3. (b) Aged red blood cells are destroyed in the liver. What is the fate of haemoglobin after the red blood cells are destroyed? (2 marks)

CE - 2009

7. The photograph below shows an athlete leaping a hurdle.



(c) After the race, athletes would apply some ointment which enhances local blood circulation to relieve muscle fatigue. Explain how the enhanced blood circulation could help the recovery of the muscle from fatigue. (1 mark)

AL - 2005 2B

5. (b) Explain how fluid is interchanged between blood and tissue fluid. (4)

AL - 2006 2C

7. In mammals, structures responsible for gas exchange between the body and the atmosphere are closely related to the circulatory system. In terrestrial flowering plants, the corresponding structures for gas exchange are also closely related to the system for water transport. Write separate accounts of this relationship in mammals and in terrestrial flowering plants. Comment on the significance of this relationship in each type of organisms. (15)

HKDSE – 2015 1B

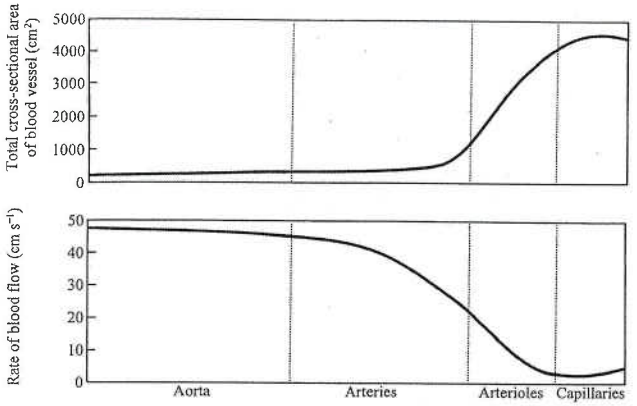
11. Although both arteries and veins are blood vessels, they are very different in their structure. Discuss how their structural differences are related to the different ways of maintaining blood flow inside the blood vessels. (11 marks)

HKDSE - 2017 1B

11. Some natural therapists claim that applying pressure along one's limbs toward the body trunk can improve the circulation of lymph and result in reduced body weight. However, the effects of this treatment are controversial. Briefly describe how lymph is formed from the blood and returned to the blood circulatory system. For each of the claims above, discuss whether it is scientifically valid. (11 marks)

HKDSE - 2021 1B

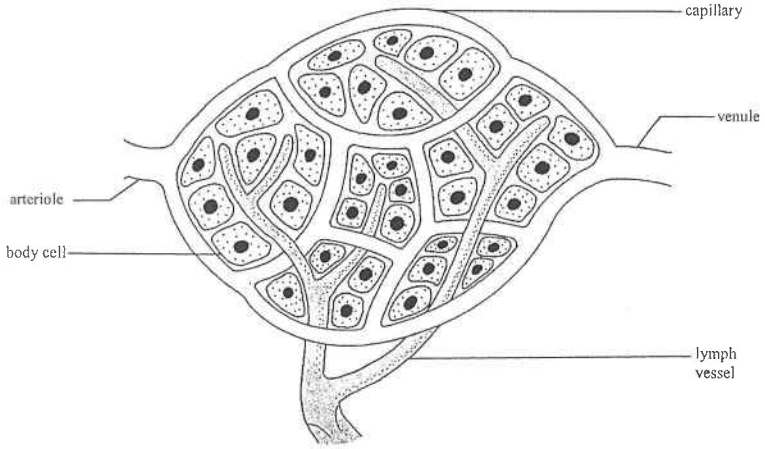
3. (a) The graph below shows the total cross-sectional area and the rate of blood flow of different types of blood vessels:



(i) Describe the overall relationship between the total cross-sectional area of blood vessels and the rate of blood flow. (1 mark)

(ii) Explain how the relationship described in (i) can facilitate the material exchange that takes place in the capillaries. (2 marks)

(b) The following schematic diagram illustrates a capillary network and the associated structures:



With reference to *two* features of the capillary network illustrated in the above diagram, explain the importance of these features to the material exchange in the capillary network. (4 marks)

Features illustrated in the diagram	*Importance to the material exchange*

Past Papers Marking Scheme – Transport in humans

CE - 2002 Q.4 (b)

(i) The blood pressure in the vein is much lower than that in the artery 1
Reasons :
- the blood in the artery is directly under the pumping action of the heart, while that the vein is not
- the blood in the vein has overcome great friction / resistance after traveling over a long distance
- there is a loss of fluid from the blood during the formation of tissue fluid
any two 1,1

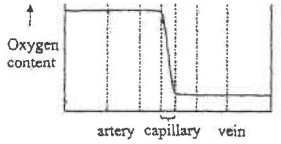
(ii) To allow more time 1
for the exchange of materials between the blood and the tissue cells 1

(iii) The volume of blood flow through each section of the circulation per unit time is the same 1
From the capillary to the vein, the total cross-sectional area decreases, so the velocity of blood flow increases 1

OR

Contraction of skeletal muscle adjacent to the vein helps to force the blood to flow / inspiration helps to draw blood toward the thorax 1
At the same time, valves are present in the veins to prevent the backflow of blood 1

(iv) Title (T) ½
Shape of the curve showing the drop in oxygen content at the capillary 1½
Correct axis labels : oxygen content, heart-heart / artery-vein / aorta-vena cava
arteriole – venule 2 x ½



Change in oxygen content of the blood in its circulation between the heart and the leg

CE - 2003 Q.4 (b)

(i) Chamber B 1
The wall of B is thicker / more muscular than that of A 1
showing that it is the left ventricle / it can generate a greater force for pumping blood 1

(ii) (1) bicuspid valve 1
(2) If X does not close properly, oxygenated blood in the left ventricle will flow back to the left atrium when the ventricle contracts 1
This reduces the amount of oxygenated blood pumped out of the heart in each beat 1
During vigorous exercise, the oxygen consumption of the skeletal muscle is very high 1
This increases the risk of insufficient oxygen supply to the brain 1
thus the person would faint easily

(iii) The deposition of fatty substances on the inner wall of vessel Y would block the vessel 1
This would reduce the oxygen supply to the heart muscle 1
hence increase the risk of heart attack

CE - 2004 Q.3 (c)

(i) To withstand the high blood pressure 1
To regulate the blood flow to the organ / control the diameter of the vessel lumen 1

(ii) The blood pressure in vessel type II is lower 1
The larger lumen would have a smaller resistance, thus facilitating the blood flow1

(iii) Lung 1

(iv) (1) Vessel type II of organ A has a lower carbon dioxide content than vessel type I 1
As blood flows from vessel type I to the lung, then to vessel type II 1
carbon dioxide diffuses out of the blood to the air sac in the lungs 1

(2) Blood in vessel type I of organ A comes from the veins / the right side of the heart 1
which collect blood from the body tissues 1
where oxygen is consumed in respiration 1

CE - 2005 Q.8 (a)

(i) (1) P 1

(2) The muscular tissue can contract and relax 1
to change the diameter of vessel P 1
so as to regulate the blood flow to the tissue cells 1

(ii) To provide a large surface area 1
for the exchange of materials between the blood and the tissue cells 1

(iii) (1) Due to a high blood pressure in the capillary at X 1
some plasma is forced out through the wall of the capillary 1

(2) Due to the retention of plasma proteins / low blood pressure at the venule end of the capillary 1
the water potential of the tissue fluid around Y is higher than that of the blood / water in the tissue fluid is drawn into the capillary by osmosis 1

CE - 2006 Q.1

(a) low 1
(b) gravity 1
(c) (skeletal) muscle 1
(d) valves 1
(e) close 1

CE - 2006 Q.10 (b)

(i) Oxygen uptake increases with exercise of increasing energy requirement 1

(ii) Oxygen content in aorta : 19 mL per 100 mL blood
Oxygen content in vena cava : 5.6 mL per 100 mL blood (1 or 0)

(iii) Difference in oxygen content for running = 19 - 6 = 13 mL per 100 mL blood 1
Difference in oxygen content for cycling = 19 - 10 = 9 mL per 100 mL blood 1

(iv) The difference in blood oxygen content between the aorta and the vena cava increases with increased exercise intensity 1
This shows that more oxygen is consumed by tissue 1
for respiration to release more energy for increased exercise intensity 1

(v) During vigorous exercise, there is an increase in ventilation rate / rate and depth of breathing 1

The oxygen content in air sac increases 1
The diffusion gradient across alveolar wall increases / this increases the diffusion of oxygen into the blood 1
thus maintaining the blood oxygen content of the aorta at a constant and high level 1

CE - 2008 Q.9 (b)

(i) (1) (Heart) → B → D → E → C → A 1
(2) Blood flows from a high pressure region to a low pressure region 1

(ii) When the ventricle of the heart contracts, blood is forced into the artery B, resulting in the increase of blood pressure 1
Blood in the artery flows forward along the blood vessels while the ventricle of the heart relaxes, as a result the blood pressure drops... 1

(iii) Any *two* of the following:
Lymphocyte / B- or T- lymphocyte } White blood cell
Phagocyte
Antibodies ... 1, 1

(iv) Vaccine injected reaches the tissue fluid 1
which drains back to lymph capillary / blood capillary 1
and returns to the heart via a vein 1

CE- 2009 Q.2

(a) Calculation (60 s / 0.9 s) 1
Accurate result with unit (67 beats min^{-1}) 1

(b) bicuspid valve: closed 1
semi-lunar valve: open 1

(c) From 1.1 s to 1.5 s, the left ventricle is relaxing 1
causing a drop in blood pressure inside the left ventricle to become lower than that of the left atrium 1
Blood flows from the left atrium to the left ventricle 1

CE - 2009 Q.3 (b)

(b) The haemoglobin will be broken down and converted into bile pigment
Iron and } any 2
protein / amino acid will be released 1,1

CE - 2009 Q.7 (c)

(c) Enhanced blood circulation helps to transport lactic acid away from muscle cells more quickly 1

AL - 2005 2B

5. (b)

Concept for mark award:	
• interchange of fluid occurs in the capillaries (1) • movement of fluid from blood to interstitial spaces (2) • return of fluid from interstitial spaces to blood (3)	max. 4

e.g. • interchange of fluid between blood and tissue fluid occurs in the capillaries (1) 1

- some components of the plasma (1) are forced from blood into interstitial spaces by blood pressure (1) at the arterial end of the capillary } 2
- some of the tissue fluid is collected back into blood at the venule end of the capillary network by osmosis (1), as the retention of plasma proteins in the blood results in a lower solute potential (1) } 3
- some tissue fluid is collected by the lymphatic vessels (1) and subsequently returned to the blood circulation

(max. 4)

AL - 2006 2C

7.

	Relationship	Significance
Mammal	• structure for gas exchange with atmosphere: alveoli of lungs (1) • alveoli are in close contact (1) with numerous capillaries (1) • alveoli and circulatory system are closely coupled in function / rate of breathing and rate of blood flow is closely coupled (1) and controlled by medulla / ANS (1) **1 + max. 3**	• the close contact shortens the distance of diffusion of gases (1) • the rich blood supply helps to transport oxygen away rapidly (1), thus assisting to maintain a steep concentration gradient between blood and alveoli (1); the same applies to the removal of carbon dioxide (1) • haemoglobin with high affinity of oxygen (1) allows efficient oxygen uptake (1) • all the above allows efficient oxygen uptake (1) and transport to body tissues (1), and efficient removal of carbon dioxide from tissues (1) • so that oxygen supply and carbon dioxide removal are kept at a rate that suits the physiological needs of the body (1) **max. 6**

max. 9

	Relationship	Significance
Flowering plant	• structure for gas exchange with atmosphere: stomata in leaves (1) • opening of stomata leads to inevitable water loss (1) • results in transpiration pull (1) for water transport in xylem (1) **1 + max. 2**	• assist in water absorption (1) in roots • conditions (i.e. light intensity) (1) affecting stomatal opening also influence the rate of water transport (1) • when the rate of water transport is lower than the rate of water loss (1), the plant becomes deficient in water, this induces the closure of stomata (1), and results in slowing down gas exchange (1), thus limiting the rate of photosynthesis and respiration (1) **max. 5**

max. 8

max. 15

HKDSE – 2015 1B

11.

Structural differences (S: max. 3)	Ways of maintaining blood flow (F: max. 5)
• wall of arteries is thicker than that of veins (1)	• pumping of heart (created a high blood pressure) to drive the blood flow in arteries (1), the thick wall can withstand the high blood pressure (1)
• wall of arteries contains more elastic tissue than that of veins (1)	• elastic nature of the arterial wall allows recoil of the wall (1) which maintains the blood flow along the arteries
• valves are present in veins but not in arteries (1)	• blood flow in veins is maintained by the contraction of adjacent skeletal muscle (1), which squeeze the blood along, presence of valves can prevent the back flow of blood (1)
• lumen of veins is larger than that of arteries (1)	• blood pressure inside veins is relatively low (1), having a larger lumen reduces the resistance to blood flow / to increase the rate / amount of blood flow (1)

(The exceptional examples: pulmonary artery and vein are not accepted as correct alternative answers)

C=max. 3

11

HKDSE – 2017 1B

11. Formation of tissue fluid and its return (max. 5) — F=max.5

- (high) blood pressure / hydrostatic pressure at the arteriole end of the capillary bed forces some of the plasma /blood components out (1) to form tissue fluid
- the remaining blood cells / proteins are left in the blood and drain to the venous end (1)
- due to the presence of plasma proteins, the blood inside the capillary at the venous end has a lower water potential / higher osmotic potential or pressure than the tissue fluid (1)
- water moves into the capillary bed at the venous end by osmosis (1)
- (excess) tissue fluid will enter the lymph vessels to form the lymph (due to hydrostatic pressure) (1) in the tissue spaces — max. 5
- with the assistance of the contraction of (skeletal) muscles to squeeze the lymph vessels (1)
- and the presence of valves in lymph vessels to prevent the back flow (of lymph)(1)
- the lymph will (flow along the lymph vessels and) eventually return to the heart / veins or vena cava near the heart (1)

whether the claims are scientifically valid (max. 3)

Improvement of Circulation — S=max.1

Can:

- pressing along the lymph vessels / due to the neighbouring muscles / or the presence of valves especially in limbs does help the return of lymph (back to heart) (1) — (1)

Cannot:

Lymph vessels are usually found deep inside the body (1) — (1)

Reduction in Body weight — N=max.2

Cannot:

- this may reduce the accumulation of tissue fluid / lymph at the limbs, (giving a slimmer appearance temporarily) (1) — max. 2
- the lymph only returns to the circulatory system but is not eliminated (1), i.e. no change in body weight

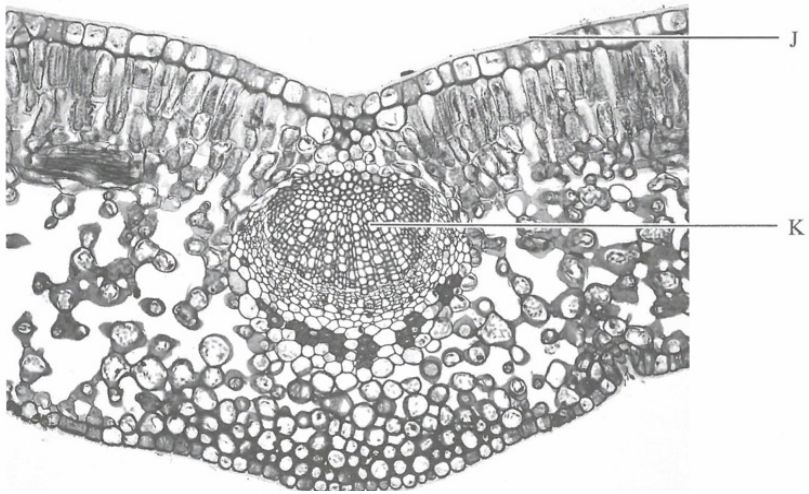
OR

- this does not affect the energy input / energy output / food consumption of the body (1)
- therefore, there should be no effect on body weight

Effective communication (0-3) — max.3

11 marks

Directions: Questions 28 and 29 refer to the photomicrograph below, which shows a section of a leaf:



28. Which of the following correctly describes the major function of layer J?

A. It reduces water loss.
B. It allows light to pass through.
C. It protects the leaf from infection.
D. It increases the photosynthetic rate.

29. Which of the following substances will move out of the leaf through stomata from cell K in the daytime?

A. water
B. oxygen
C. mineral
D. carbon dioxide

Directions: Questions 30 and 31 refer to the investigation below. Diagram I shows a set-up for measuring the transpiration rate of a leafy shoot under different environmental conditions. For each treatment, the experiment was conducted for three hours. Table II shows the initial and final readings of the water level in different treatments.

Diagram I

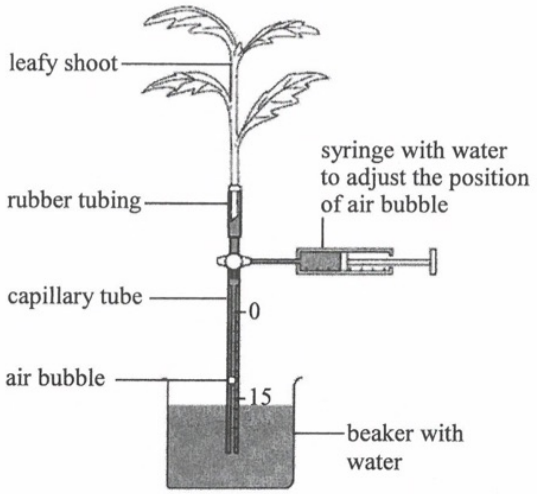


Table II

Treatment	Environmental conditions		Initial reading (cm)	Final reading (cm)
	Light intensity	Humidity		
1	Low	Low	14	7.4
2	Low	High	15	12.5
3	High	Low	15	5.6
4	High	High	14	10.6

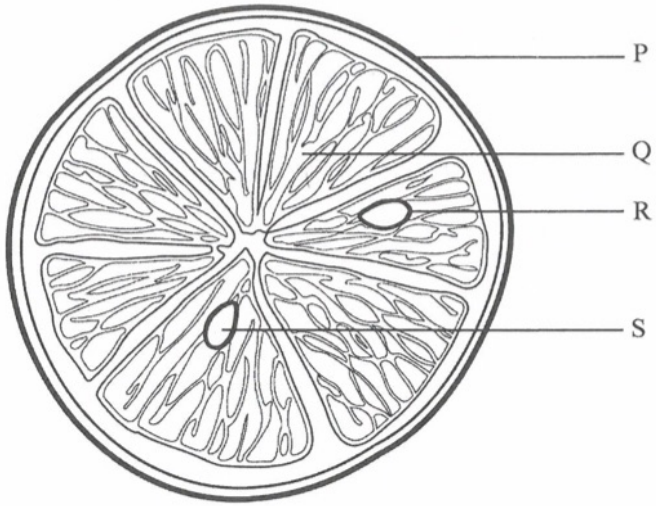
30. In which treatment does the leafy shoot have the highest transpiration rate?

A. 1
B. 2
C. 3
D. 4

31. According to the results of the investigation, which of the following changes in environmental conditions will lead to a greater reduction in the transpiration rate of the leafy shoot?

A. At low humidity condition, adjust the light intensity from high to low.
B. At high humidity condition, adjust the light intensity from high to low.
C. At low light intensity, adjust the humidity from low to high.
D. At high light intensity, adjust the humidity from low to high.

Directions: Questions 32 to 34 refer to the following diagram which shows a section of a fruit:



32. Which of the following structures is developed from the ovum?

A. P
B. Q
C. R
D. S

33. Which of the following pairs of structures have the same genetic composition?

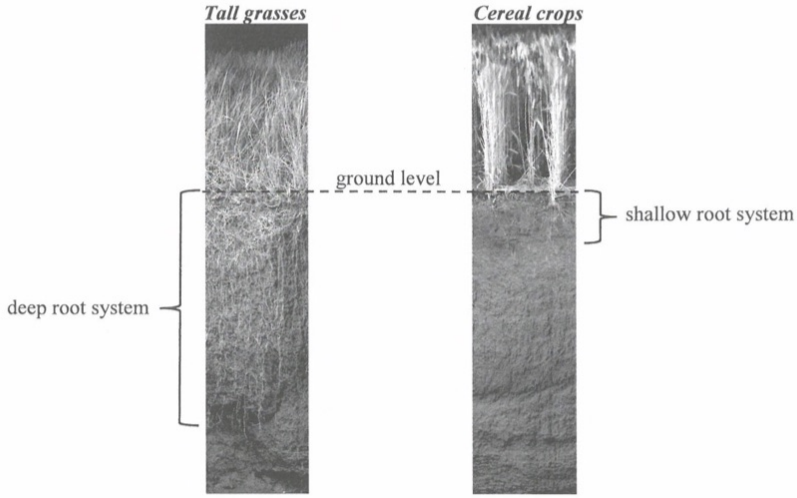
(1) P and Q
(2) Q and R
(3) R and S

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

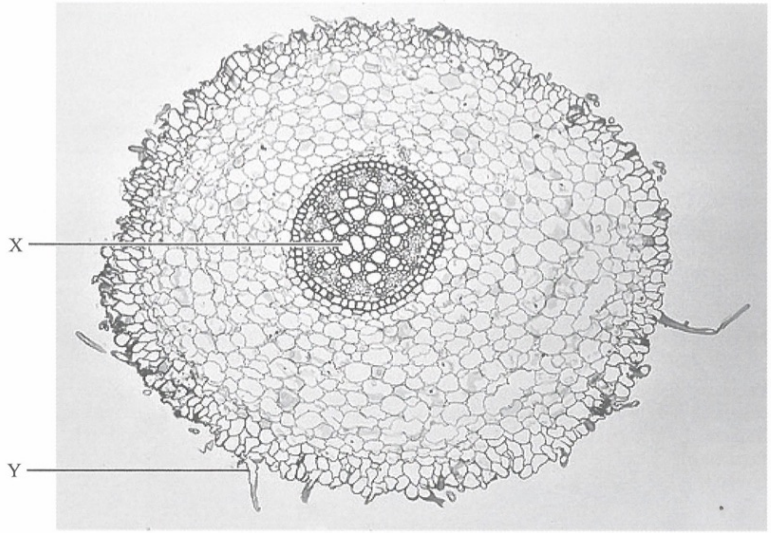
34. Which of the following statements correctly describes the major role of Q?

A. It protects the seeds by acting as a cushion.
B. It provides nutrients to the seeds for germination.
C. It helps seed dispersal by attracting animals to eat the fruit.
D. It allows the seeds to survive through adverse conditions by storing food.

8. Tall grasses and cereal crops belong to the same family and share a common ancestor. Cereal crops have been artificially selected for agriculture and their seeds harvested as food. The roots of the tall grasses in grasslands range in depth from 1.5 m to 4.5 m while those of cereal crops rarely exceed 1 m. The photographs below show the root depths of tall grasses and cereal crops under the same magnification:



(b) The photomicrograph below shows the cross-section of the root of a cereal crop:



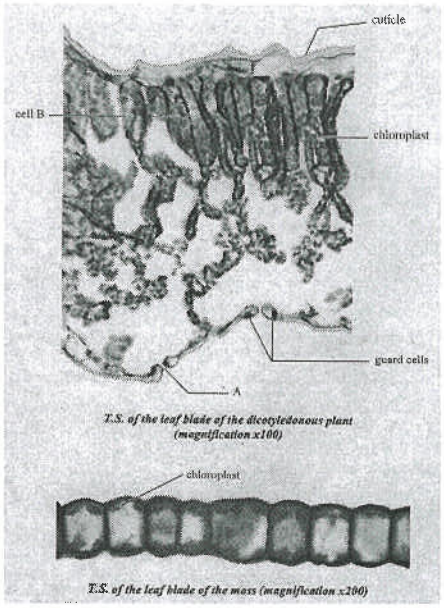
(i) Complete the table below to show how an observable feature of the structures X and Y is related to its function. (4 marks)

	Observable feature	Function
X		
Y		

(ii) Explain how water is transported from structure Y to structure X. (3 marks)

CE- 2002

2. (b) The photomicrographs below show part of the transverse section of the leaf blade of a terrestrial dicotyledonous plant and that of a moss:



(i) (1) Name structure A. (1)

(2) Explain one way in which A contributes to the function of cell B under bright sunlight. (2)

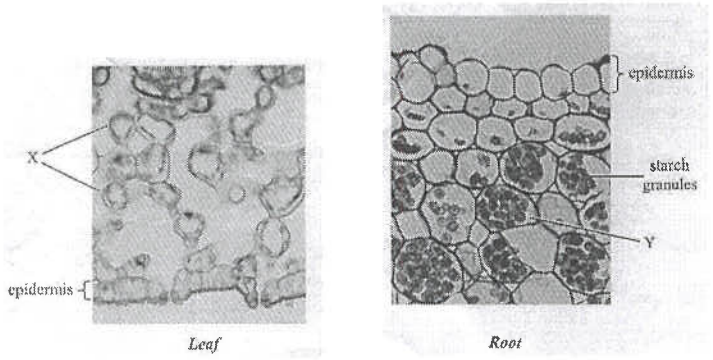
(ii) The moss above is restricted to damp and shady environments and it is often covered with a thin film of water.

(1) With reference to the leaf structures shown in the two photomicrographs, suggest two reasons why the moss cannot grow well in dry environments. (4)

(2) Describe how the moss leaf obtains oxygen from the atmosphere at night. (3)

CE - 2004

4. (c) The photomicrograph below show the sections of a leaf and a root :



(i) What is the significance of the following features ?
(1) the presence of cuticle on the leaf epidermis (1)
(2) the absence of cuticle on the root epidermis (1)

(ii) With reference to one feature shown in the photomicrograph, explain how gaseous exchange can occur at the leaf epidermis. (2)

(iii) Describe how the activity of cell type X leads to the storage of starch granules in cell type Y. (4)

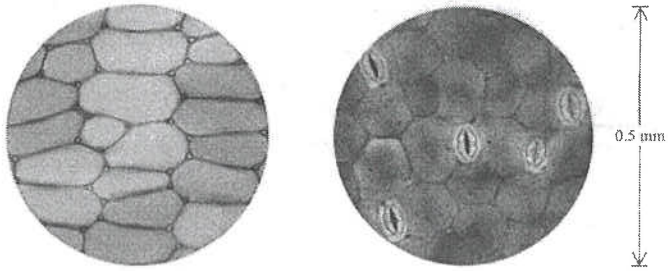
(iv) The table below shows the concentration of certain minerals in the soil water and the cell sap of the root epidermal cells:

	Concentration (mmol dm^{-3})		
	Potassium	Sodium	Chloride
Soil water	0.1	1.1	1.3
Cell sap of root	93.0	51.0	58.0

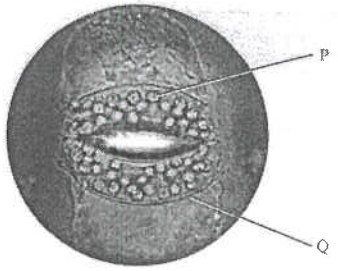
According to these data, what mechanism is probably used by the root to absorb minerals from the soil water ? Explain your answer based on the information provided. (3)

CE - 2005

9. (b) Mary examined the epidermis of the leaf of a land plant under the microscope. The photomicrographs below show the appearance of the upper and lower epidermis under different magnification:



1. Upper epidermis (low power) 2. Lower epidermis (low power)



3. Lower epidermis (high power)

(i) Using the information provided in photomicrograph 2, calculate the stomatal density (i.e. number of stomata per unit area) of the lower epidermis. (2)
(Take $\pi = 3.14$)

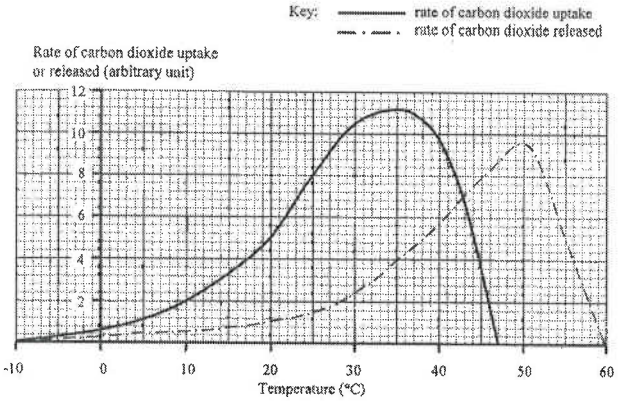
(ii) Compare the stomatal density of the upper and lower epidermis of the leaf. Explain the significance of this pattern of stomatal distribution to the plant when it is under direct sunlight. (3)

(iii) Name structures P and Q. (2)

(iv) Under certain conditions, the stomata of the leaves may become closed during daytime. Explain how this would affect the rate of photosynthesis of the plant. (2)

CE - 2008

10. (b) In a study about the growth of a crop plant in a greenhouse, the rate of carbon dioxide uptake by photosynthesis and the rate of carbon dioxide released by respiration at different temperatures were determined. The results are shown in the graph below.



(i) With reference to the above graph, describe the effect of temperature on the rate of carbon dioxide uptake. (2)

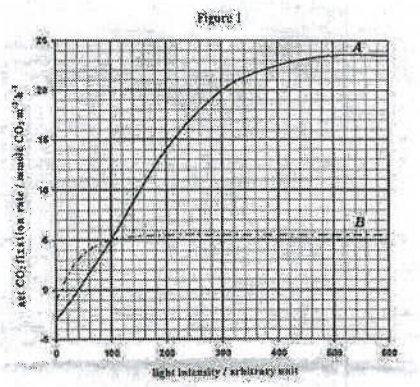
(ii) Account for the change in the biomass of the crop plant if it is cultivated at 45°C for several days. (3)

(iii) Find out the optimum temperature for the production of this crop. (1)

(iv) Explain how the plant may avoid overheating on a hot sunny day when the soil is well-watered. (3)

AL - 1997 1B

10. (a) Figure 1 presents the results of an experiment about the effect of light intensity on the net CO_2 fixation rate of two flowering plants A and B. This experiment was conducted in a greenhouse under controlled conditions.



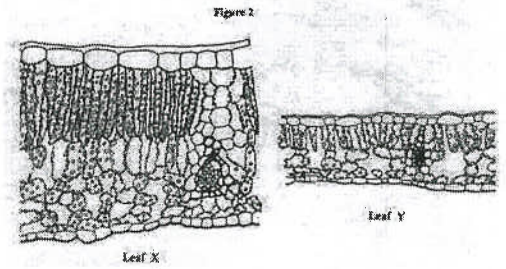
(i) State *two* variables that must be kept constant to achieve the aim of this experiment. (1)

(ii) What is meant by net CO_2 fixation ? (1)

(iii) Account for the net CO_2 fixation rate of plants A and B at light intensities below 40 arbitrary units. (3)

(iv) Compare the net CO_2 fixation rate of plants A and B at light intensities above 40 arbitrary units. (4)

(b) Figure 2 shows the cross sections of two different leaves, X and Y, taken from the same tree. They are of equal magnification and are at the same stage of maturity.



(i) State the structural differences between the photosynthetic tissue(s) of these two leaves. (1½)

AL - 2009 2B

4. (b) Unlike mammals, flowering plants do not have a specialized system for oxygen transport. Explain why flowering plants can still survive. (5)

Past Papers Marking Scheme – Nutrition and gas exchange in plants

CE - 2002 Q.2 (b)

(i) (1) stoma 1

(2) It allows carbon dioxide to enter the leaf 1
for photosynthesis in cell B 1

(ii) (1) The moss leaf has no cuticle / no waterproof covering 1
And it is one-cell thick 1
so the surface area to volume ratio is large 1
This would lead to a high rate of water loss from the plant / so the moss would become dehydrated easily in dry environment 1

(2) Atmospheric oxygen dissolves into the water film on the moss leaf 1
and then diffuse in 1
through the entire surface of the leaf 1

OR

At night, moss cells carry respiration only thus lower the oxygen concentration in the cells 1
Atmospheric oxygen dissolves into the water film on the moss leaf 1
and diffused into the leaf 1

CE- 2004 Q.4 (c)

(i) (1) Presence of cuticle helps to reduce water loss/transpiration of the leaf 1
(2) Absence of cuticle allows water movement / gaseous exchange to occur freely at the root epidermis 1

(ii) The leaf epidermis has stomata 1 +
which allow diffusion / free movement of gases 1

(iii) Cell type X carries out photosynthesis 1
to produce sugar 1
which will be transported through the phloem to the root 1
The sugar will then be converted to starch in cell type Y 1

(iv) Active transport 1
Because the mineral concentration in the cell sap is higher than that in the soil water 1
thus the minerals are absorbed against a concentration gradient 1

CE - 2005 Q.9 (b)

(i) Stomatal density of lower epidermis = $\frac{5}{3.14x(0.25)^2}$ mm^{-2} 1

$= 25.48\ mm^{-2}$ 1

(ii) The upper epidermis has a lower stomatal density than the lower epidermis / the upper epidermis has no stomata while the lower epidermis has stomata 1
This helps to reduce water loss/the rate of transpiration of the leaf 1
because the temperature at the upper epidermis is higher when the plant is under direct sunlight 1

(iii) P : chloroplast Q : cell wall 1,1

(iv) The closure of the stomata limits the diffusion / intake of CO_2 into the leaf 1
Thus the rate of photosynthesis of the plant is reduced 1

CE - 2008 Q.10 (b)

(i) Below 35°C (-10 - 35°C), the rate of carbon dioxide uptake increases with the increase in temperature 1
Above 35°C (35-47°C), the rate of carbon dioxide uptake decreases 1

(ii) The biomass will decrease 1
because the rate of respiration is faster than the rate of photosynthesis 1
There is a net consumption of food / organic matter 1

(iii) 30-32°C 1

(iv) When there is light, stomata of the plant open 1
When air temperature is high, transpiration is fast 1
A lot of water evaporates from mesophyll cell surface and carries heat away 1

AL - 1997 1B

10. (a) (i) temperature (½)
carbon dioxide concentration / supply (½)

(ii) amount of carbon dioxide fixed in photosynthesis less carbon dioxide released from respiration / photosynthesis carbon dioxide fixation less carbon dioxide released from respiration 1

(iii) For both plants A and B, light intensity increases, rate of net carbon dioxide fixation increase (½) as light is the limiting factor (½)

Plant A:
- no/negative net carbon dioxide fixation occurs (½) because its rate of respiration exceeds its rate of photosynthesis (½) which is very slow.

Plant B:
- at light intensity below 10 units, no net CO_2 fixation occurs (½), because its rate of respiration exceeds its rate of photosynthesis (½)
- between 10 and 40 units, net CO_2 fixation occurs (½), because photosynthetic CO_2 fixation exceeds respiratory CO_2 production (½)

(iv) - between 40-100 arbitrary intensity units : A has a slower rate of net CO_2 fixation than B / B has a higher rate of net CO_2 fixation than A 1
- at 100 arbitrary intensity units, the rate of net CO_2 fixation for A and B is the same (½)
- between 100-500 arbitrary units, the rate of net CO_2 fixation for A increases with increasing light intensity (½) and is higher than that of B (½). The rate of net CO_2 fixation for B reaches a maximum (½) / 5-6 mmole CO_2 m^{-2} h^{-1}, and stays unchanged despite of further increases in light intensity (½)
- between 500-600 arbitrary intensity units, the rate of net CO_2 fixation for A reaches a maximum (½) / 23-24 CO_2 m^{-2} h^{-1}, and stays unchanged despite of further increases in light intensity (½)

(b) (i) X = longer / larger palisade cells (½) and 2 layers of palisade cells, only 1 layer in Y (½), denser / more chloroplasts in both mesophyll / photosynthetic tissues (½)

AL - 2009 2B

4. (b) • transport of oxygen by diffusion can suffice the needs of plant cells (1) because (1)

- > the metabolic rate of plant cells is relatively low (1)
- > in the presence of light, photosynthetic tissues can provide oxygen (1) which can be provided to the nearby respiring tissues by diffusion
- > in flowering plants, oxygen can be readily obtained from the environment at different parts of the plant body (1), including the stomata of the leaves (1) / lenticels of the woody stem and surface of root hairs (1) (max. 2)
- > distance of diffusion of gases between the plant surface and the underlying layers of living cells is relatively short (1)
- > interconnecting intercellular air spaces provide passages for / offer little resistance to gas diffusion (1)

} (max. 4)

DSE M.C. Questions - Transpiration, transport and support in plants
(sort by difficulty)

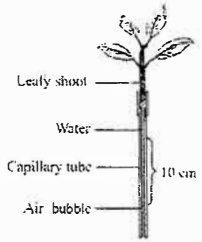
Challenging
/

Average

2012 Q.3 (68%)
Which of the following is the major cause that accounts for the ascent of water in trees?

A. the loss of water from leaves
B. the absorption of water in roots
C. the thickness of tree trunks
D. the diameter of xylem vessels

Directions: Questions 10 to 11 refer to the following set-up, which is used to investigate the effect of different environmental conditions on the rate of water loss from a leafy shoot:

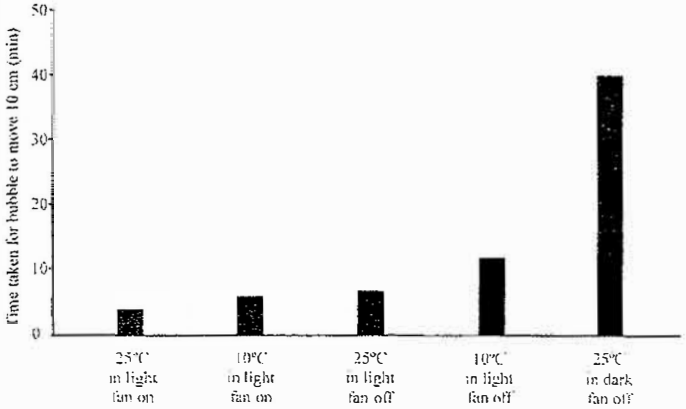


2012 Q.10 (69%)
It is important to cut the leafy shoot under water at the beginning of the experiment because this

A. allows the leafy shoot to adjust to the new environment.
B. prevents the drying up of the cut end of the leafy shoot.
C. avoids the forming of air bubbles in the xylem of the leafy shoot.
D. makes sure that there is no water loss from the leafy shoot before the experiment.

Average

2012 Q.11 (64%)
The results of the experiment conducted under different environmental conditions are shown in the bar chart below:



Which of the following changes in conditions results in the greatest decrease in water loss from the leafy shoot?

A. switching off the light
B. switching off the fan
C. increasing the temperature from 10°C to 25°C
D. decreasing the environment from 25°C to 10°C

2012 Q.12 (48%)
Leaves were taken from four different plants and the number of stomata was counted. The results are shown in the following table:

Plant	*Mean number of stomata per cm²*	
	Upper surface of the leaf	*Lower surface of the leaf*
P	4 000	28 000
Q	0	800
R	8 500	15 000
S	8 000	26 000

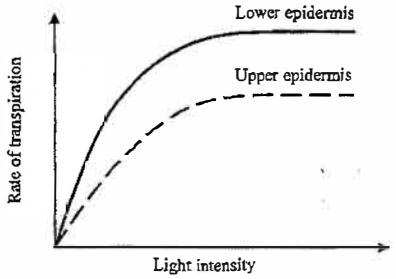
Which plant will wilt first when it is grown in a very dry region?

A. P B. Q C. R D. S

Average

2014 Q.21 (65%)

Directions: Questions 20 and 21 refer to the graph below, which shows how the transpiration rates through the upper and lower epidermis of a leaf vary with light intensity:



Which of the following methods can be used to measure the rate of transpiration through the upper epidermis of the leaf?

A. Peel the upper epidermis of the leaf and count the number of stomata under a microscope, and then repeat with the lower epidermis.
B. Put the leaf into warm water and then count the number of bubbles that appear on each side of the leaf in a fixed period of time.
C. Shine light on the upper epidermis of the leaf and measure the rate of water absorbed using a bubble potometer, and then repeat with the lower epidermis.
D. Smear the upper epidermis of the leaf with Vaseline and measure the rate of water loss using a weight protomer, and then repeat with the lower epidermis.

2014 Q.22 (73%)

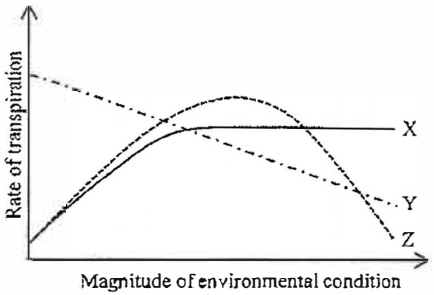
The transpiration rate of a tree is much higher than that of a herbaceous plant because the tree

A. is much taller than the herbaceous plant.
B. has many more roots than the herbaceous plant.
C. has many more leaves than the herbaceous plant.
D. has much more xylem than the herbaceous plant.

Average

2016 Q.11 (73%)

The graph below shows the changes of the transpiration rate of a plant under different environmental conditions:



Which of the following correctly matches the environmental conditions represented by X, Y and Z?

	X	*Y*	*Z*
A.	light intensity	wind speed	relative humidity
B.	wind speed	light intensity	relative humidity
C.	relative humidity	light intensity	wind speed
D.	light intensity	relative humidity	wind speed

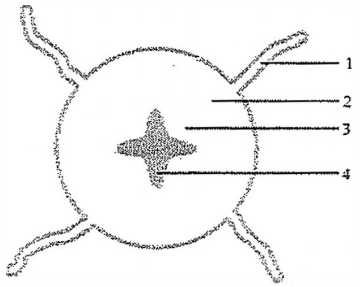
2016 Q.12 (69%)

A student wants to estimate the stomatal density of the upper and lower epidermis of a leaf using a microscope. Which of the following combinations correctly shows the magnification that should be used and the reason?

	Magnification	***Reason***
A.	low magnification	show a larger field of view
B.	low magnification	give a brighter image
C.	high magnification	show more cellular details
D.	high magnification	give a clearer image

Average

Directions: Questions 21 to 23 refer to the diagram below, which shows the cross section of a young dicotyledonous root:



2016 Q.21 (71%)

Which of the following parts provides rigidity to support the plant?

A. 1 B. 2 C. 3 D. 4

2016 Q.23 (73%)

Which of the following parts is most likely to have more mitochondria?

A. 1 B. 2 C. 3 D. 4

2017 Q.13 (57%)

Water absorbed by trees is mostly used

A. to replenish water loss.

B. for storage in vacuoles.

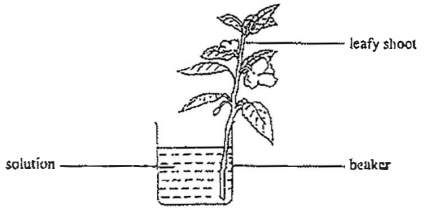
C. as a raw material in photosynthesis.

D. as a medium for reactions to take place.

Average

Directions:

Questions 14 to 16 refer to the set-up below, which is used to investigate the effect of environmental factors on the transpiration rate of a leafy shoot. The leafy shoot was put into a beaker of red-coloured solution. After five hours, cross-sections of the shoot were cut starting from the top until red colour appeared in the cut section. The length of the remaining shoot was then measured.



2017 Q.14 (53%)

Which of the following step(s) is/are necessary when preparing the set-up?

(1) Smear Vaseline onto the lower surface of the leaves.

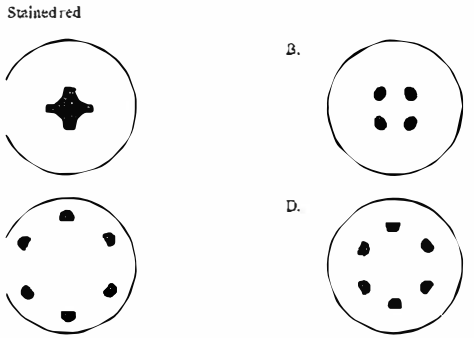
(2) Add a layer of oil on the surface of the red-coloured solution

(3) Cut the lower end of the leafy shoot under the red-coloured solution.

A. (1) only B. (3) only C. (1) and (2) only D. (2) and (3) only

2017 Q.16 (61%)

A section of the remaining shoot was observed under a microscope. Which of the following diagrams correctly shows the appearance of the shoot section?



Average

2017 Q.17 (51%)

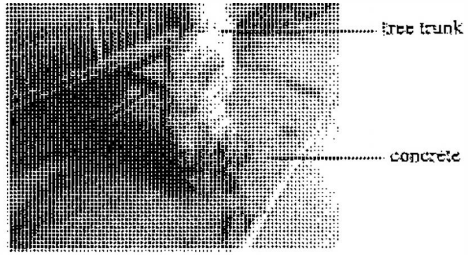
Which of the following cell types contribute(s) to the support of a leaf in a woody flowering plant?

(1) guard cells
(2) xylem vessels
(3) mesophyll cells

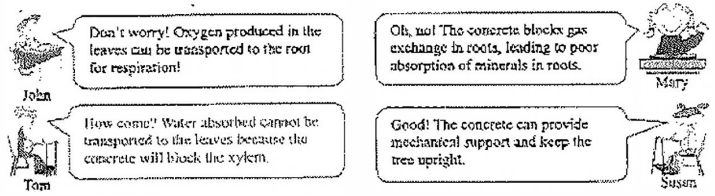
A. (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2018 Q.24 (51%)

The following photograph shows a tree with roots covered by concrete:



Four students have expressed their views about this:



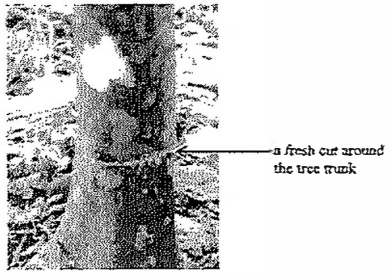
Whose view is correct?

A. John's view
B. Mary's view
C. Tom's view
D. Susan's view

Average

2019 Q.32 (50%)

The photograph below shows a fresh cut around the trunk near the bottom of a tree:



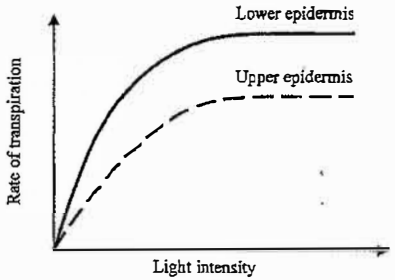
The tree eventually died. Which of the following is the most likely reason for the death of the tree?

A. Water could not be transported to the leaves for transpiration.
B. Water could not be transported to the leaves for photosynthesis.
C. Minerals could not be transported upward for protein synthesis.
D. Photosynthetic products could not be transported to the roots for respiration.

Easy

2014 Q.20 (78%)

Directions: Questions 20 and 21 refer to the graph below, which shows how the transpiration rates through the upper and lower epidermis of a leaf vary with light intensity:

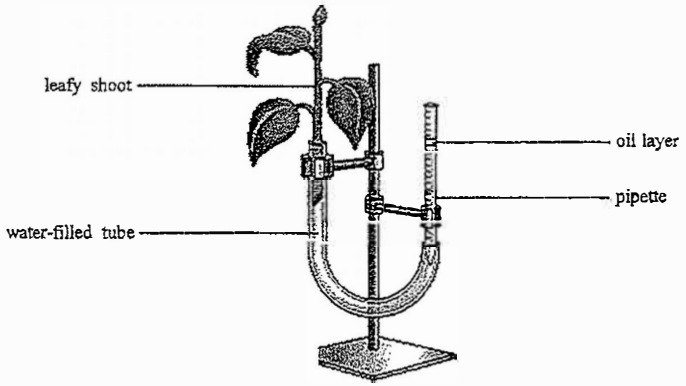


Which of the following accounts for the difference in the transpiration rates through the upper and lower epidermis shown above?

A. The mesophyll layer near the lower epidermis has more air spaces.
B. The upper epidermis is more exposed to light.
C. The air temperature below the leaf is lower.
D. The upper epidermis has fewer stomata.

Easy

Directions: Questions 17 and 18 refer to the set-up below, which is used to measure the rate of transpiration of a leafy shoot:



2015 Q.17 (75%)

The assumption behind the use of this set-up for measuring the rate of transpiration is that

A. the connections in the set-up are sealed off.
B. the rate of water uptake is equal to that of water loss.
C. the stomata of the leaves remain open throughout the experiment.
D. the cutting of the shoot does not introduce air bubbles into the xylem vessels.

2015 Q.18 (78%)

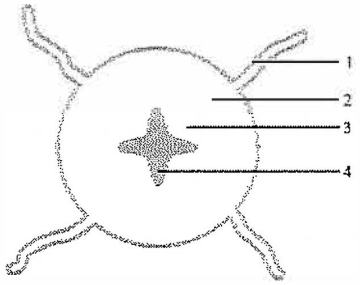
Which of the following variables has the greatest influence on the rate of transpiration of the leafy shoot?

A. the area of the leaves
B. the thickness of the leaves
C. the length of the leafy shoot
D. the number of xylem vessels

Easy

2016 Q.22 (85%)

Directions: Questions 21 to 23 refer to the diagram below, which shows the cross section of a young dicotyledonous root:

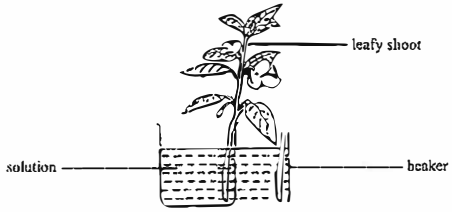


Which of the following parts is responsible for the transport of food?

A. 1 B. 2 C. 3 D. 4

Directions:

Questions 14 to 16 refer to the set-up below, which is used to investigate the effect of environmental factors on the transpiration rate of a leafy shoot. The leafy shoot was put into a beaker of red-coloured solution. After five hours, cross-sections of the shoot were cut starting from the top until red colour appeared in the cut section. The length of the remaining shoot was then measured.



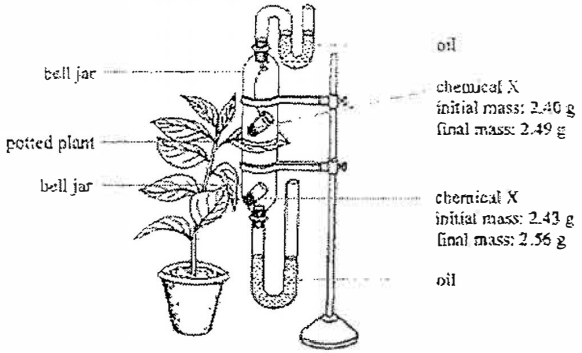
2017 Q.15 (76%)

The length of the remaining shoot will be the longest if the experiment is conducted in

A. hot and bright conditions.
B. hot and humid conditions.
C. cold and bright conditions.
D. cold and humid conditions.

Easy

Directions: Questions 30 and 31 refer to the set-up below. The set-up consists of two boll jars placed on above the ether with the leaf of a potted plant in between. Chemical X was placed into the jars to absorb water vapour. The whole set-up was made air-light. The masses of chemical X in the two jars were measured at the beginning and after five hours.



2018 Q.30 (76%)

The change in mass of chemical X was mainly caused by

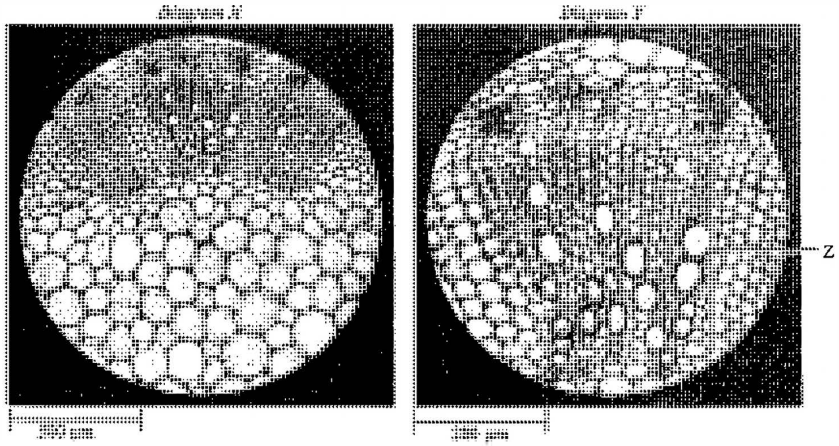
A. water uptake by the plant.
B. water Loss in transpiration.
C. water produced in respiration.
D. water consumed by photosynthesis.

2018 Q.31 (81%)

Which of the following conclusions can be drawn from the results?

A. Water absorption by the root is mainly driven by the lower epidermis of the leaf.
B. There are more stomata at the Lower epidermis than the upper epidermis of the leaf
C. The respiration rate is higher than the photosynthetic rate during the experiment
D. The photosynthetic rate of the upper layer of the leaf is higher than that of the lower layer.

Directions: Questions 22 to 24 refer to the photomicrographs below, which show the stem section of a plant observed under a microscope. Diagram Y shows a higher magnification of the vascular bundle (Vb) in Diagram X:



Key: Vb = vascular bundle

23. Which of the following descriptions of the function of tissue Z shown in Diagram Y is correct?

A. It transports proteins upwards.
B. It transports minerals upwards.
C. It transports water downwards.
D. It transports sugars downwards.

Answers

Challenging

Average

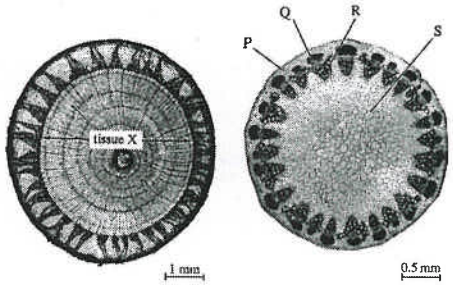
2012	2014	2016	2017	2018	2019
3 [A]	21 [D]	11 [D]	13 [A]	24 [B]	32 [D]
10 [C]	22 [C]	12 [A]	14 [B]		
11 [A]		21 [D]	16 [D]		
12 [D]		23 [A]	17 [C]		

Easy

2014	2015	2016	2017	2018	2020
20 [D]	17 [B]	22 [C]	15 [A]	30 [B]	23[B]
	18 [A]			31 [B]	

CE - 2001

3. (c) The photomicrographs below show the transverse sections of stems taken from two plants:



T.S. Stem of plant A *T.S. Stem of plant B*

(i) (1) Name tissue X. (1)

(2) Explain one way in which the cells in tissue X are structurally adapted to the function of transport. (2)

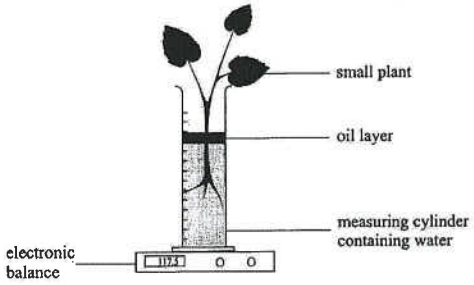
(ii) Which region(s) (P, Q, R, or S) in the stem of plant B contains tissue X? (1)

(iii) (1) On a hot sunny afternoon, plant B becomes wilted and its stem bends. Explain why this occurs. (4)

(2) In contrast to plant B, the stem of plant A remains upright under the same conditions. Account for this. (2)

CE - 2002

3. (a) The diagram below shows a set-up used to study the water balance of a small plant. The whole set-up was put in a well-ventilated and well-illuminated room for 8 hours:



The initial and final readings in the measuring cylinder and the balance are tabulated below :

	Initial reading	Final reading	Change in reading
Water level in the measuring cylinder (cm^3)	45.0	43.5	x
Reading of the balance (g)	117.5	116.3	y

(i) (1) Find values x and y. (1)

(2) With reference to the water balance of the plant, what do x and y represent respectively? (2)

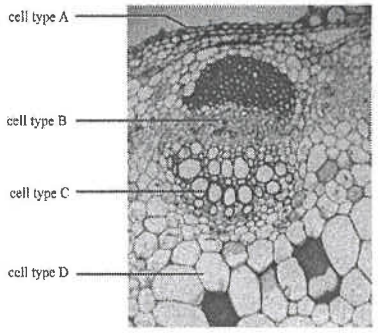
(3) Compare values x and y. Explain the significance of their difference to the healthy growth of the plant. (3)

(Given : 1 cm^3 of water weighs 1 g)

(ii) Predict, with reasons, the change in value x if the study is repeated with the leaves of the plant smeared with Vaseline on both surfaces. (4)

CE - 2003

3. (c) The photomicrograph below shows part of the transverse section of a herbaceous stem:



(i) Based on the photomicrograph, state two features that can be observed in cell type C but not in cell type B. (2)

(ii) Some insects use their tube-like mouthparts to obtain a continuous supply of carbohydrate from one of the cell types shown above. Using the letters in the photomicrograph, state which cell type it is. What is the main carbohydrate that can be obtained? (2)

(iii) When this stem is heavily infected by a fungus, cell type C is often blocked by the fungal hyphae.

(1) On a hot day, the infected stem droops and bends whereas an uninfected stem remains upright. Account for the appearance of the infected stem. (4)

(2) State the ecological relationship between the fungus and the infected plant. (1)

CE - 2006

9. (b) In 1890, a German scientist named Edward Strasburger conducted an experiment to study the transport of water in plants. He cut the stem of a woody plant and immersed the cut end in a poisonous solution. Upon contact, the poisonous solution killed all living cells in its way.

(i) Strasburger found that the plant continued to take up 30 litres of solution and transport the solution up to a height of 20 metres in two weeks. Based on his findings, what conclusion can you draw regarding the cells involved in water transport? (1)

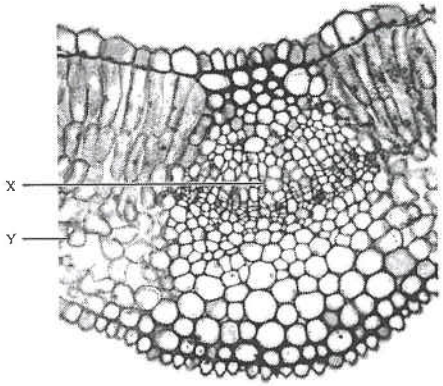
(ii) Based on present day knowledge of the mechanism of water transport in plants, explain why the treated plant can continue to transport the solution up the stem.(3)

(iii) Describe how you would carry out an investigation with a small dicotyledonoous plant that allows you to identify the cell type for water transport. (3)

(iv) Explain why the cut stem of the woody plant can remain upright even after the cells had been killed by the poisonous solution. (2)

CE - 2007

3. The photomicrograph below shows a cross section of a dicotyledonous leaf:



(a) With reference to the photomicrograph, give two structural differences between cell types X and Y. (2 marks)

(b) (i) In the presence of light, carbohydrates are formed and then stored in cell type Y.

(1) State the carbohydrate stored. (1 marks)

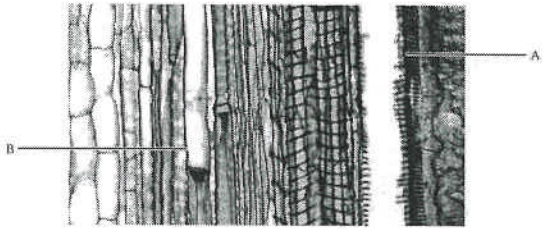
(2) If you have prepared a thin section of a leaf, how would you show the presence of the stored carbohydrate in it? (3 marks)

(ii) Explain why the stored carbohydrate in cell type Y disappears when the plant ~~presence of the stored carbohydrate in it?~~ is kept in darkness (3 marks)

(c) During transpiration, water evaporates from the surface of cell type Y. How does this help cell type Y to obtain minerals? (3 marks)

CE - 2008

5. The photomicrograph below shows a vertical section of a plant stem. Both cell types A and B are located in the tissues for transport.



(a) With reference to the photomicrograph, state ***two*** structural differences between cell types A and B. (2)

(b) Describe how the structure of cell type A facilitates its role in transport. (2)

(c) Transport of substances downward through the phloem is very important to roots. Explain why. (3)

CE - 2009

9. (b) Figure I and II show two plants, X and Y, from different plant groups. Figure III shows the cross-section of the stem of plant Y.

Figure I – plant X

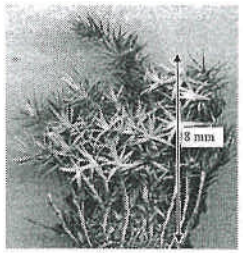


Figure II – plant Y

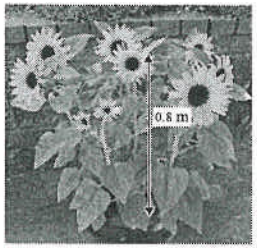
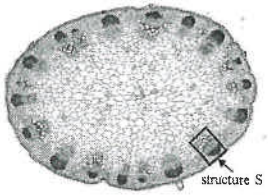


Figure III – cross-section of the stem of plant Y



(i) Structure S in Figure III is found in plant Y but not in plant X.

(1) What is structure S? (1 mark)

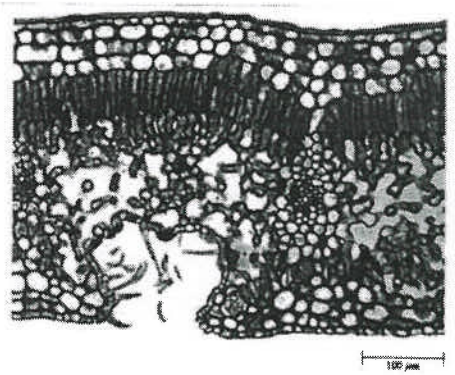
(2) With reference to Figure I, Figure II and your answer in (1), identify the groups to which plants X and Y belong. (2 marks)

(3) **Based on your knowledge of structure S,** suggest why plant Y can grow taller than plant X. (2 marks)

(ii) State one characteristic of the habitat of plant X. Explain your answer. (2 marks)

AL - 1998 1A

2. The following photomicrograph shows the transverse section of a leaf of plant X. Suggest a natural habitat for plant X. With reference to ***three*** features, describe how these features show adaptations to the habitat of plant X. (5)

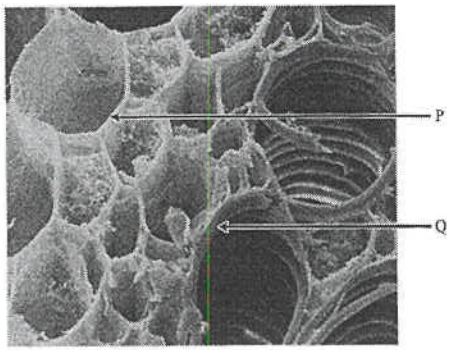


AL - 2009 2B

6. (c) A woody flowering plant has not been watered for a few days ,during which time the whether was dry and sunny. Account for the appearance of different parts of the leafy shoot of this plant. (5)

DSE – 2012 1B

3. The electron micrograph below shows part of the stem of a plant containing two cell types, P and Q:

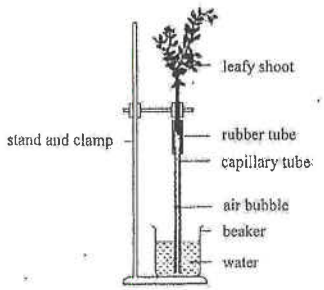


(a) Based on the photograph shown, state the difference between cell types P and Q in the structure indicated by the arrow heads. (1 mark)

(b) Describe how these cells contribute to the support of the plant. (4 marks)

HKDSE - 2013 1B

6. The following set-up can be used to determine the transpiration rate of a leafy shoot:

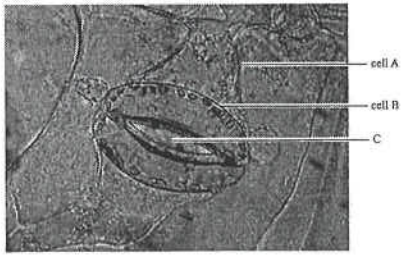


(a) In setting up this experiment, the lower end of the shoot should be cut under water. Why? (1 mark)

(b) Give one assumption for using this set-up to measure the transpiration rate. (1 mark)

(c) Explain how the transpiration rate will change if the fan placed near the shoot is switched on. (4 marks)

(d) The photomicrograph below shows the appearance of the surface of a leaf during daytime:

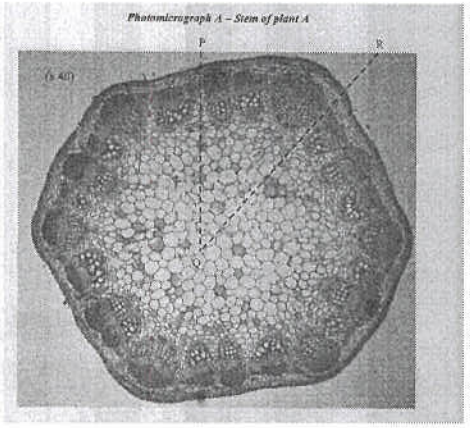


(i) In terms of sub-cellular structure, state two differences between cell A and cell B. (2 marks)

(ii) What will happen to the size of C at night? Discuss the functional significance of this change. (3 marks)

HKDSE - 2014 1B

4. Cross sections of the stems from two different dicotyledonous plants, A and B, are shown in Photomicrograph A and Photomicrograph B



(a) With reference to Photomicrograph A, draw a labelled low-power diagram of sector POR in the space below. (5 marks)

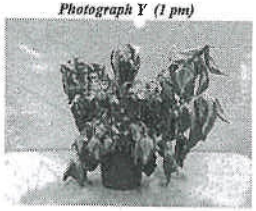
(b) With reference to the photomicrographs, deduce the major means of support in plants A and B. (4 marks)

HKDSE – 2015 1B

9. The photographs below show the appearance of the leaves of a well-watered potted plant at 9 am and 1 pm on a sunny day in summer.

Photograph X (9 am)

Photograph Y (1 pm)



(a) Briefly describe how the appearance of the leaves shown in photograph X is maintained. (2 marks)

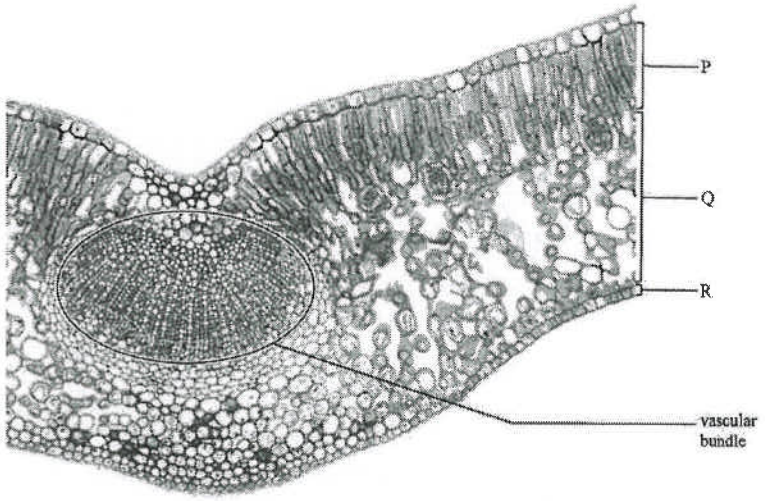
(b) Suggest an explanation for the appearance of the leaves at 1 pm (Photograph Y). (3 marks)

(c) With reference to the appearance of the leaves in the two photographs, which one is more effective for photosynthesis? Explain your answer. (4 marks)

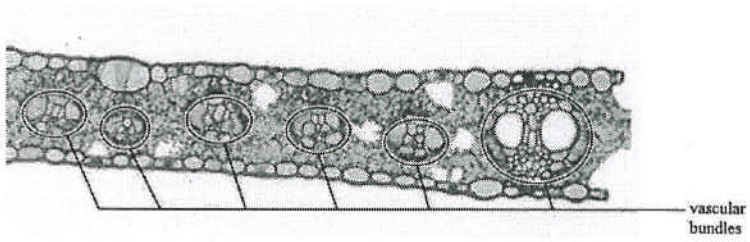
HKDSE – 2018 1B

3.

Photomicrograph X



Photomicrograph Y



(a) (i) Comparing the cell shapes of both leaves, which labelled tissue(P, Q or R) in photomicrograph X is absent from Photomicrograph Y? (1 mark)

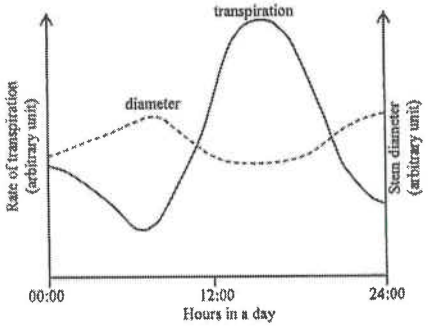
(ii) With reference to Photomicrograph X, what is the observable adaptive feature of the tissue identified in (i) ? What is the significance of this adaptive feature? (2 marks)

(b) The leaf in photomicrograph Y was taken from a plant species with leaves oriented vertically, as shown in the following photograph:

Explain how the distribution of the photosynthetic tissue in these leaves is related to the vertical orientation of the leaves. (3 marks)

HKDSE – 2019 1B

10. The graph below shows the change in the rate of transpiration and the change in stem diameter of a plant over 24 hours:



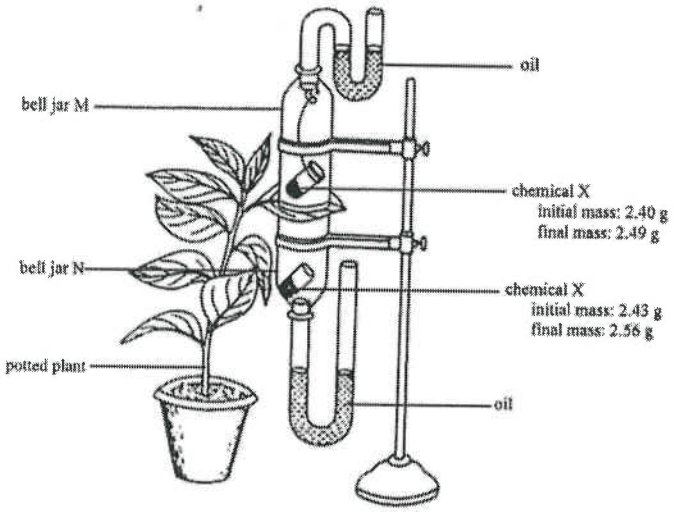
(a) Describe the relationship between the rate of transpiration and stem diameter. (1 mark)

(b) It is known that the change in stem diameter is related to the diameter of the xylem vessels. With reference to the way in which water is transported along the stem, explain the relationship between the rate of transpiration and stem diameter described in (a). (2 marks)

(c) Describe ad explain *two* adaptive features of xylem vessels as a structure for water transport. (4 marks)

HKDSE – 2020 1B

5. The diagram below shows an experimental set-up used to compare the transpiration rates of the upper and lower epidermis of the leaf of a potted plant. The set-up consists of two identical bell jars placed one above the other with the leaf of a potted plant in between. Chemical X was placed into the jars to absorb water vapour. The whole set-up was made air-tight. The masses of the chemical X in the jars were measured at the beginning and after five hours.



(a) (i) Which of the following parameters is used to measure the transpiration rate of the plant in this investigation? Put a '✓' in the appropriate box to indicate your choice. (1 mark)

- ☐ amount of water lost by the leaf
- ☐ amount of water absorbed by the leaf

(ii) How can the above set-up measure the parameter chosen in (a) (i)? (2 marks)

(b) List ***two*** variables which have been controlled by this set-up during the investigation. (2 marks)

(c) (i) Compare the changes in the mass of chemical X in bell jars M and N. What conclusion can you draw? (2 marks)

(ii) Suggest ***one*** possible explanation for the conclusion. (1 mark)

(iii) Propose ***one*** workable method to test your hypothesis in (c) (ii). (2 marks)

HKDSE – 2021 1B

8. The table below shows the average blade area, blade thickness and thickness of the palisade mesophyll of leaves collected from the upper and lower regions of a tree species:

Location of leaves	Average blade area (cm^2)	Average blade thickness (μm)	Average thickness of palisade mesophyll (μm)
Upper region	62	177	45
Lower region	72	152	33

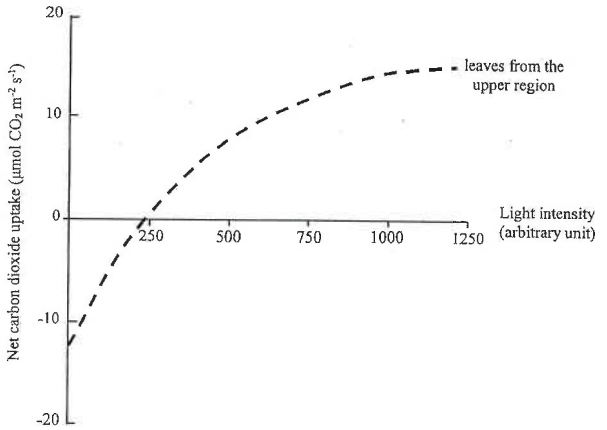
(a) Compare the average blade area of leaves from the upper region and that from the lower region. With respect to the difference in surface area, suggest ***one*** adaptive advantage of the leaves from the lower region. (2 marks)

(b) (i) Compare the average thickness of the palisade mesophyll of leaves from the upper region and that from the lower region. (1 mark)

(ii) Between the two types of leaves, suggest ***one*** possible structural difference which would lead to the difference stated in (b)(i). (1 mark)

(iii) How would you confirm your answer in (b)(ii)? (2 marks)

(c) Leaves at different regions of a tree are adapted to different light intensities. The graph below shows the change in the net carbon dioxide uptake by leaves from the upper region of a tree at different light intensities:



(i) Why are there negative values for net carbon dioxide uptake? (1 mark)

(ii) On the above graph, sketch a line to show the change in net carbon dioxide uptake by leaves from the lower region of a tree at different light intensities. (2 marks)
(Note: Neglect the difference in the average blade area between the two types of leaves when you sketch the line.)

Past Papers Marking Scheme – Transpiration, transport and support in plants

CE - 2001 Q.3 (c)

(i) (1) xylem 1

(2)

Structural feature	Adaptation
The xylem vessels in X have no cell content / no end walls / large lumen	This allows a free flow of water inside
The xylem vessels in X have thick cell wall	This can prevent the collapse of the xylem vessels

any one set 1+1

(ii) Region R 1

(iii) (1) The support of the stem of plant B is mainly due to the turgidity of cells in region S / thin-wall cells 1
Under a hot and sunny condition,
the rate of transpiration of the plant becomes greater than the rater of water absorption 1
The cells in region S lose water 1
and hence lose their turgidity / become flaccid 1
and thus causing the bending of the stem 1

(2) The support of the stem A is due to the presence of xylem / independent of the water content of the plant 1
because the xylem contains thick-wall cells 1

CE - 2002 Q.3 (a)

(i) (1) x = 1.5 y = 1.2 ½, ½

(2) x represents the amount of water absorbed by the plant 1
y represents the amount of water transpired / lost by the plant 1

(3) Value x is larger than value y 1
This indicates that there is a net gain of water by the plant 1
The water gained is essential for various life processes 1
e.g. formation of new cells, photosynthesis...

(ii) Value x would decrease 1
because Vaseline blocks the stomata and the leaf surfaces 1
so the rate of transpiration would drop 1
As transpiration enhances the absorption of water 1
less water would be absorbed by the plant

CE- 2003 Q.3 (c)

(i) Presence of thick / lignified cell wall 1
no cell content / empty lumen 1

(ii) B 1
sucrose 1

(iii) (1) As the fungal hyphae block the xylem vessels of the infected stem, water cannot be transported to the stem 1
On a hot day, the rate of transpiration is high 1
The water loss of the stem / plant becomes greater than the water gain 1
Thus cell type D becomes flaccid / loses turgidity 1
and can no longer give support to the stem 1

(2) Parasitism 1

CE - 2006 Q.9 (b)

(i) Living cells are not required in the transport in the transport of water up the stem 1

(ii) Water is transported up the stem mainly by transpiration pull 1
which is resulted from a physical process and thus can occur outside living cells 1
The transport of water occurs in dead xylem tissues 1
which remains functional even in the treated plants

(iii) Immerse the cut end of the small plant in a dye solution 1
After a few hours, cut a thin section of the upper part of the stem 1
Identify the cell type stained by the dye under the microscope 1

(iv) The woody stem is mainly supported by mechanical strength / rigidity / hardness 1
of the thick walls cells / xylem vessel 1

CE - 2007 Q.3

(a) Cell type X has no cellular content while cell type Y has 1
Cell type X has a thicker cell wall than cell type Y 1

(b) (i) (1) Starch 1

(2) Add a drop of iodine solution to the leaf section 1
Observe the leaf section under the microscope 1
The section turns blue black 1

(ii) In darkness, photosynthesis stops 1
The stored carbohydrate is converted to sugars 1
which are transported away to other parts of the plant / are used in respiration 1

(c) When water evaporates from cell type Y, a transpiration pull is set up 1
Water is drawn from xylem to cell type Y 1
together with dissolved minerals 1

CE - 2008 Q.5

(a) Cell type A has a thicker cell wall
There is no end wall for cell type A while there are end walls for cell type B
Cell type A is hollow / has no cell content while cell type A has cell content
} any two 1, 1

(b) It forms a hollow tube / has no cytoplasm / no end wall ..... 1 +
which offers less resistance to the transport of water 1

OR Any one set
It has rings of thickening / thicker cell wall ..... 1 +
to keep the tube open for transport / prevent collapsing 1

(c) Roots cannot carry out photosynthesis / cannot make food by themselves 1
Therefore, they rely on the transport of sugars / food / organic substances from the leaves 1
for respiration / growth / metabolism 1

CE - 2009 Q.9 (b)

(b) (i) (1) Vascular bundle — 1

(2) X: mosses — 1
Y: flowering plant — 1

(3) The vascular bundle contains xylem tissue . thick walled cells which provide support to the plant so that plant Y can grow taller — any one set
The vascular bundle contains xylem tissue which helps transport water up to a higher position so that plant Y can grow taller — 1, 1

(ii) Damp / moist / wet areas — 1
Plant X lacks cuticle to prevent water loss / lacks vascular tissue for transport of water — 1

AL - 1998 1A

2. Habitat : desert (½) — ½
(Any three features, 1½ marks each, 4½ marks max. for the features)

thick cuticle (½) : impermeable to water thus reduces water loss (1) / reduces water loss by evaporation — 1½

sunken stomata (½): space outside sunken stomata / hairs trap water vapour / moisture (½), lower diffusion gradient between mesophyll cells and the exterior (1), reduce transpirational water loss (½) — 3
and / or hairs in epidermal invagination (½)

multiple epidermis (½): increases diffusion distance / barrier to reduce water loss through the epidermis (1) — 1½ (max. 5)

AL - 2009 2B

6. (c)

	Leaves	Stem
Appearance	• drooped (1) / wilt	• remained upright (1) / erect
Reason	• excessive transpiration results in water loss from cells (1) / amount of water loss exceeds amount of water absorbed • the mesophyll cells and other thin-walled cells of the petiole will lose turgor (1) / turgidity which is the major means of support for the leaf blade and the petiole (1) respectively **(max. 2)**	• stem is mainly supported by mechanical tissues / xylem which is composed of cells with thick rigid cell wall (1)

(2) (max. 3)

(5)

DSE-2012 1B

3. (a) • the cell wall of cell type Q is much thicker than that of cell type P (1) (1)
(✓ accept other answers such as spiral thickening or thickened with ring structures)
(× cell type Q being hollow not accepted)

(b) • when there is ample supply of water (1) (1)
• cell type P provides turgidity to the plant (1) (1)
• cell type Q has thickened cell wall (1) (1)
• which provides rigidity to the plant (1) (1)

HKDSE - 2013 1B

6. (a) • avoid blockage of xylem by the air bubble (1) formed during cutting (1)

(b) • the rate of transpiration is the same as the rate of water absorption / the water absorbed is used for transpiration only (1) (1)

(c) • the transpiration rate will increase (1) (4)
• because the air current sweeps away the water vapour around the leafy shoot (1)
• the concentration gradient of water vapour between the atmosphere and the air space in the leaf becomes steeper (1)
• water vapour diffuses out to the atmosphere at a faster rate (1)

(d) (i) • cell B contains chloroplasts but cell A does not (1)
• the cell wall of cell B has uneven thickness while that of cell A is even (1) (2)

(ii) • the size of C will be reduced (1)
• to reduce transpiration / water loss (1)
• when the need for gas exchange decreases in the absence of photosynthesis (1) (3)

HKDSE - 2014 1B

4. (a) Title 1 mark
Drawing 1 mark (resemblance)
Labels 1 mark @, any three (5)
* epidermis, * vascular bundle, * xylem, * phloem, * cortex, * pith

(b) - the stem of plant A has a large proportion of thin-walled cells (1),
- therefore it is likely that plant A is mainly supported by turgidity of the thin-walled cells (1)
- while the stem of plant B has a large proportion of xylem / thick-walled cells / woody tissues (1) (4)
- **therefore it is mainly supported by mechanical or physical strength** / rigidity of the thick-walled cells / xylem / woody tissues (1)

9 marks

HKDSE – 2015 1B

9. (a) it is maintained by the ridgidity of the veins / vascular bundles / xylem running through the leaves (1)
and the turgidity of the mesophyll cells / thin-walled cells (1) 2

(b) a large amount of water is lost from the leaves by transpiration (1) / transpiration rate is very high
water absorption rate cannot keep up with the rate of water loss (1)
mesophyll cells become flaccid (1)
and thus can no longer support the leaves to maintain their upright position / so the leaves become drooped 3

(c) appearance shown in photograph X (1)
(if this part is wrong, no mark for the whole part (c))
the leaves are flat / fully extended (1)
(accept 'open', not accept 'broad')
And thus the exposed surface can be oriented towards the light source (1)
Therefore maximizing light absorption for photosynthesis (1) 4

HKDSE – 2018 1B

3. (a) (i) • P (1) (1)
(ii) • closely packed / located at the upper side facing the sun directly (1) (1+1)
• this maximizes light absorption for photosynthesis (1)

(b) • when the leaves are oriented vertically, both sides of the leaves have chance of receiving sunlight (1)
• therefore, the photosynthesis tissues are evenly distributed on both sides of the leaf (1)
• such that photosynthesis can be carried out effectively regardless of the change in the orientation of sun / the direction of illumination from sun during daytime (1) (3)

6 marks

HKDSE – 2019 1B

10. (a) • the diameter of the stem decreases as the rate of transpiration increases, or vice versa (1) (1)

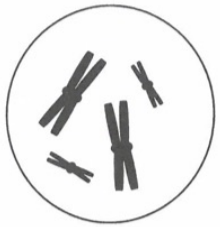
(b) • water is transported up the stem by transpiration pull (1) / water transport results in negative pressure / tension / suction force / pull-up force (1) in xylem vessels.
• this pulls the xylem vessel's walls inwards (1), thus reducing the diameter of the xylem, hence the stem (2)

(c) • hollow tube*(1) to allow the passage of water with low resistance (0+1)
• thickened / lignified wall^ *[accept lignified cell; not accept thickened cell]* (1) to withstand the negative pressure of the transpiration pull / prevent the collapse of xylem vessels *[not accept maintain the shape of xylem vessel]* (0+1) (4)

*: *no end wall / no protoplast → incomplete answer, 0 mark*
^: *rigid / strong wall → insufficient answer, 0 mark*
Remark: wrong features, no marks. With incomplete or insufficient feature, proceed to mark the corresponding explanation.

7 marks

Directions: Questions 4 and 5 refer to the diagram below, which shows the appearance of chromosomes in a cell at the early stage of meiotic cell division.

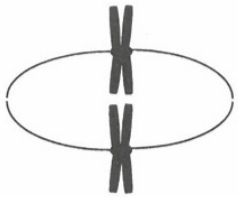


4. What is the chromosome number in the somatic cells of this organism?

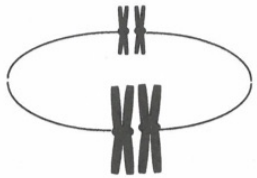
A. 2
B. 4
C. 8
D. 16

5. Which of the following diagrams correctly shows the arrangement of chromosomes found at a later stage of the cell division?

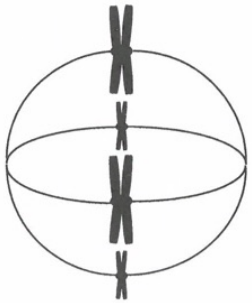
A.



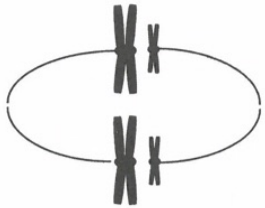
B.



C.



D.



DSE M.C. Questions - Cell division and Reproduction
(sort by difficulty)

Challenging

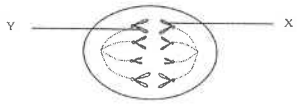
2012 Q.24 (37%)

Which of the following descriptions about pollen grains is correct?

A. Pollen grains are the male gametes of a plant.
B. Pollen grains can produce nectar to attract insects.
C. Pollen grains germinate when they land on the stigma of the same species.
D. Pollen grains of insect-pollinated flowers are usually smaller than those of wind-pollinated flowers.

2013 Q.18 (32%)

The diagram below shows a dividing cell which is forming an animal's egg cell:

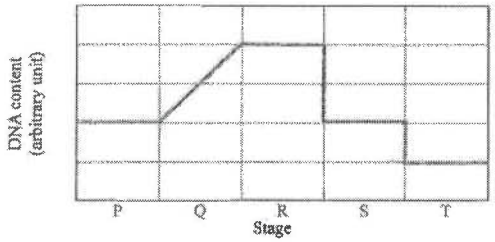


What conclusion about the cell division can be drawn from the diagram?

A. The diagram shows a mitotic cell division.
B. The diagram shows the first meiotic cell division.
C. X and Y are homologous chromosomes.
D. Each daughter cell will have four chromosomes.

2016 Q.19 (34%)

Directions: Questions 18 to 20 refer to the graph below, which shows the change in the DNA content of a cell undergoing a certain division:



Which of the following stages best represent(s) interphase?

A. P only
B. Q only
C. P and Q only
D. P, Q and R only

Challenging

2016 Q.32 (30%)

Structure Y serves as

(1) food store for seed germination.
(2) attraction to animals for seed dispersal.
(3) cushion to protect the seed during falling.

A. (1) only B. (2) only C. (1) and (3) only D. (2) and (3) only

Average

2012 Q.28 (58%)

Which of the following pairs of reproductive structures in humans and flowering plants have the same function?

	Humans	*Flowering plants*
A.	sperm	anther
B.	penis	pollen tube
C.	uterus	carpel
D.	vagina	petal

2012 Q.29 (46%)

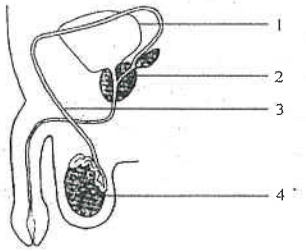
Which of the following is ***not*** a secondary sexual characteristic of a man?

A. growth of beard
B. production of sperms
C. broadening of shoulders
D. enlargement of larynx

Average

2013 Q.36 (55%)

Directions: Questions 35 and 36 refer to the diagram below, which shows the reproductive system of a man:



Which of the following may still occur after structure 3 on the both sides of the body has been tied up and cut?

(1) production of sperms
(2) erection of penis
(3) ejaculation

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

2014 Q.4 (41%)

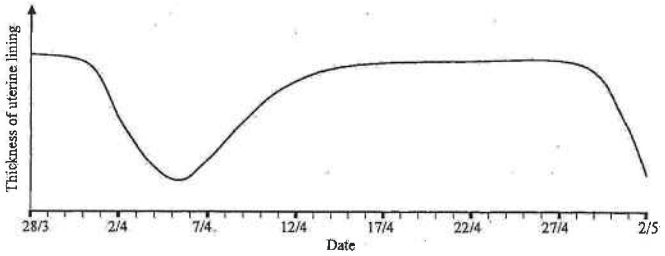
Which of the following correctly describes binary fission of the protist?

A. The amount of organelles in the daughter cell is the same as that in the mother cell.
B. The number of chromosomes in the daughter cell is half of that in the mother cell.
C. The alleles found in the daughter cells are different from each other.
D. The sizes of the daughter cells are similar to each other.

Average

2014 Q.28 (53%)

The diagram below shows the changes in the uterine lining of a woman:



During which of the following periods would the woman most likely get pregnant after copulation?

A. 28/3 to 1/4
B. 4/4 to 8/4
C. 11/4 to 15/4
D. 18/4 to 21/4

2015 Q.19 (40%)

Which of the following can be the functions of roots in flowering plants?

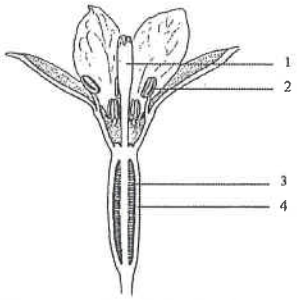
(1) anchorage
(2) absorption
(3) vegetative propagation

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Average

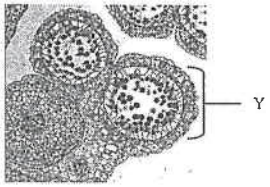
2015 Q.25 (64%)

Directions: Questions 24 and 25 refer to the diagram below, which shows the structures of a flower:



The photograph below shows the cross section of structure 2.

Which of the following parts of the human reproductive system serves a function similar to that of Y?



A. ovum
B. sperm
C. testis
D. ovary

Average

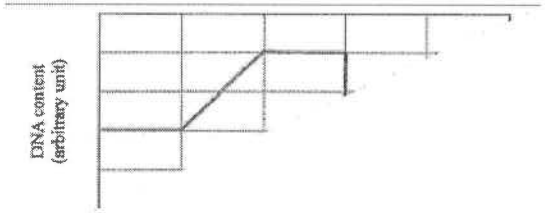
2015 Q.26 (42%)

During pregnancy, amniotic fluid containing foetal cells can be obtained for karyotyping. This helps to determine whether the foetus

(1) is male or female.
(2) has Down syndrome or not.
(3) is a carrier of Sickle-cell anaemia.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Directions: Questions 18 to 20 refer to the graph below, which shows the change in the DNA content of a cell undergoing a certain division:



2016 Q.18 (67%)

Which of the following can be deduced from the graph?

(1) There are two divisions.
(2) There is one DNA duplication.
(3) DNA content is halved at the end of the whole process.

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2016 Q.20 (59%)

Sister chromatids separate from one another during the transition from

A. P to Q. B. Q to R. C. R to S. D. S to T.

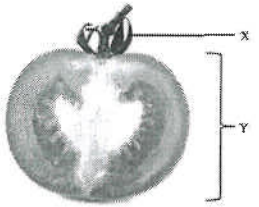
Average

2016 Q.31 (70%)

Directions:

Questions 31 and 32 refer to the diagram below, which shows the section of a fruit:

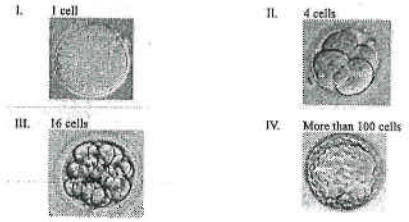
Which of the following combinations correctly shows the floral parts that develop into structures X and Y?



	X	*Y*
A.	carpel	petal
B.	carpel	ovary
C.	sepal	petal
D.	sepal	ovary

Directions:

Questions 21 to 23 refer to the following photomicrographs of the same magnification. The photomicrographs show some early stages of embryo development:



2017 Q.21 (53%)

Which of the following processes are taking place from stage I to stage IV?

(1) cell division
(2) cell enlargement
(3) cell differentiation

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2017 Q.22 (63%)

How many cell cycles has the cell in stage I gone through to reach stage III?

A. 2 cycles B. 3 cycles C. 4 cycles D. 5 cycles

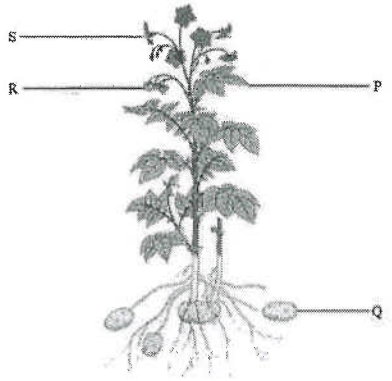
2017 Q.23 (49%)

Which of the following stages is ready for implantation?

A. I B. II C. III D. IV

Average

Directions: Question 15 to 17 refer to the following diagram, which shows the structures of a potato plant:



2018 Q.15 (61%)

Which of the following labelled structure(s) is / are involved in the reproduction of this potato plant?

A. Q only B. S only C. R and S only D. Q, R and S only

2018 Q.16 (51%)

Which of the following labelled structures contain cells with different genotypes?

A. P and Q B. P and S C. Q and R D. R and S

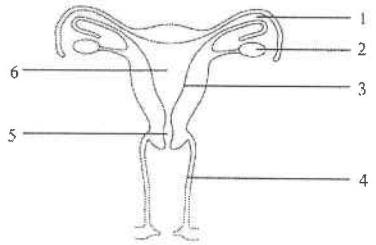
2018 Q.17 (59%)

Farmers usually grow potato plants by vegetative propagation. This is probably because vegetative propagation

A. Produces tubers for harvesting
B. Does not involve seed dispersal
C. Takes a shorter time to reproduce
D. Allows rapid colonization of an area

Easy

Directions: Questions 25 and 26 refer to the following diagram, which shows part of the female reproductive system:



2012 Q.25 (93%)

Which of the following structures undergo periodic changes?

A. 1 and 3 B. 1 and 4 C. 2 and 3 D. 2 and 4

2012 Q.26 (82%)

In which of the following structures does implantation normally take place?

A. 1 B. 3 C. 5 D. 6

2012 Q.27 (79%)

Which of the following contraceptive methods prevents the formation of mature gametes?

A. using diaphragm
B. using rhythm method
C. intake of contraceptive pills
D. using intrauterine device

2013 Q.14 (80%)

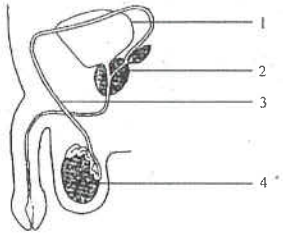
Which of the following consists of individuals that are genetically different from each other?

A. Seeds of the same fruit
B. Stigmas of the same flower
C. Petals of the same plant
D. Buds of the same tuber

Easy

2013 Q.35 (90%)

Directions: Questions 35 and 36 refer to the diagram below, which shows the reproductive system of a man:



Which of the following structures are involved in the production of the content of semen?

A. 1 and 3 B. 1 and 4 C. 2 and 3 D. 2 and 4

2014 Q.29 (78%)

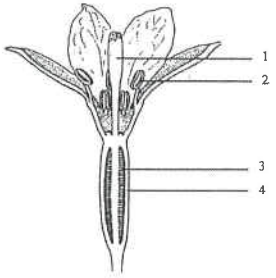
During foetal development, the placenta has functional roles similar to

(1) the bone.
(2) the lungs
(3) the small intestine.

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2015 Q.24 (78%)

Directions: Questions 24 and 25 refer to the diagram below, which shows the structures of a flower:

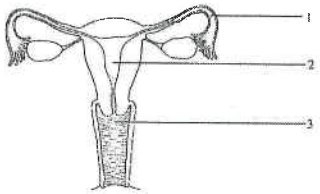


Which structure will develop into the fruit wall?

A. 1 B. 2 C. 3 D. 4

Easy

Directions: Questions 19 and 20 refer to the diagram below, which shows some structures of the female reproductive system in humans:



2017 Q.19 (78%)

Which of the following combinations correctly shows the location where fertilization and discharge of semen normally take place?

	Fertilisation	*Discharge of semen*
A.	1	2
B.	1	3
C.	2	2
D.	2	3

2017 Q.20 (76%)

If location 1 is blocked in a 14-year-old girl, which of the following is most likely to occur?

A. There is no ovulation.
B. Her fertility decreases.
C. There is no menstruation.
D. Her breasts fail to develop.

2019 Q.12 (87%)

Which of the following statements about the human egg and sperm is correct?

A. Both have the same number of genes.
B. Both have the same amount of cytoplasm.
C. Both have the same amount of food reserve.
D. Both have the same number of chromosomes.

2020 Q.21

21. In flowering plants, asexual reproduction is considered less favourable than sexual reproduction in terms of natural selection because offspring produced from asexual reproduction

A. are genetically identical to each other.
B. have keen competition with each other.
C. cannot invade and colonise new environments.
D. can grow rapidly only in favourable conditions.

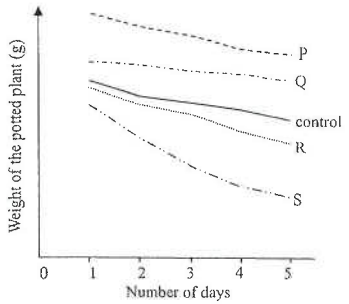
2020 Q.25

25. Which of the following descriptions of floral structures is correct?

A. The ovule forms seeds.
B. The ovary forms seed coats.
C. Pollen grains are male gametes.
D. The filament contains pollen grains.

2021 Q.30,31,22,21

Directions: Questions 30 and 31 refer to the graph below, which shows the effect of environmental conditions on the transpiration rate of a potted plant placed in a small room. The weight of the potted plant was recorded daily at noon for five consecutive days (control experiment). The experiment was repeated by changing one of the environmental conditions: increased light intensity, increased air current, increased relative humidity, or increased temperature.



30. Which of the following lines represents the results with an increased relative humidity?

A. P
B. Q
C. R
D. S

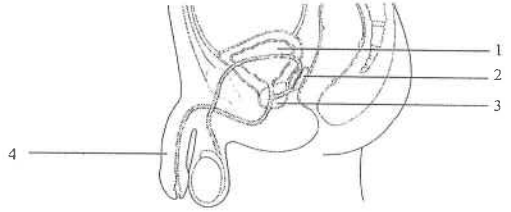
31. In the above study, which of the following steps is necessary?

A. Remove any fallen leaves.
B. Wrap the pot with a plastic bag.
C. Water the plant every day in the morning.
D. Smear vaseline on the lower epidermis of the leaves.

22. With reference to structure 4 above, which of the following structures of flowering plants has a similar function?

A. style
B. anther
C. filament
D. pollen tube

Directions: Questions 21 and 22 refer to the diagram below, which shows the male reproductive system and its associated structures:



21. Which of the labelled structures are responsible for producing seminal fluid?

A. 1 and 2 only
B. 1 and 3 only
C. 2 and 3 only
D. 1, 2 and 3

Answers

Challenging

2012	2013	2016
24 [C]	18 [D]	19 [C]
		32 [B]

Average

2012	2013	2014	2015	2016	2017	2018
28 [B]	36 [D]	4 [D]	19 [D]	18 [D]	21 [B]	15 [D]
29 [B]		28 [C]	20 [D]	20 [D]	22 [C]	16 [D]
			31 [D]	31 [D]	23 [D]	17 [C]

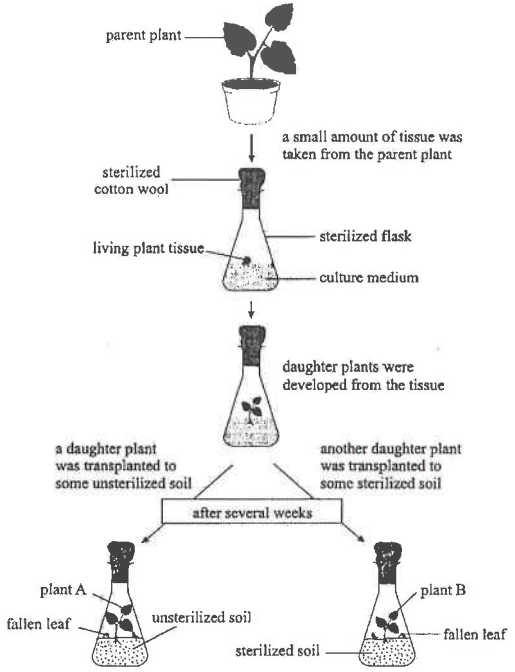
Easy

2012	2013	2014	2015	2017	2019
25 [C]	14 [A]	29 [C]	24 [D]	29 [B]	12 [D]
26 [B]	35 [D]			20 [B]	
27 [C]					

2020
21[A]
25[A]

CE - 2002

1. (a) Some plants can be propagated vegetatively using tissue culture. In this method, the culture medium is sterilized before use and it provides essential materials for plant growth. The diagram below shows an outline of an investigation involving tissue culture. The whole process is conducted in the presence of light.



(i) Sugar is one of the essential components of the culture medium. Explain why sugar must be added. (3)

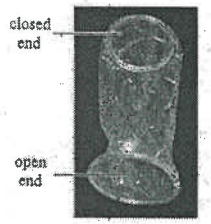
(ii) Compare the genetic make-up of the daughter plants with that of the parent plant. Give a reason for your answer. (2)

(iii) After several weeks, plant B showed signs of yellowing while plant A remained green. Based on the information provided, suggest an explanation for the yellowing of plant B. (3)

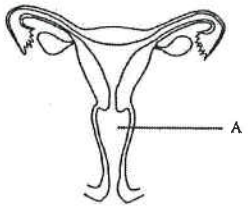
(iv) Give two advantages of this method of plant propagation over the propagation using seeds. (2)

CE - 2002

2. (a) The following photograph shows a female condom while the diagram on the right shows the human female reproductive system:



Female condom



Female reproductive system

(i) The female condom is placed in A during sexual intercourse. How does the female condom contribute to contraception? (2)

(ii) Give an example of an infectious disease that can be prevented by wearing the condom. (1)

(iii) Another contraceptive method is to tie and cut both the oviducts. State whether or not menstruation will still occur in a young woman who has received this operation. Explain your answer with reference to the physiological processes involved. (4)

(iv) The following is a simplified diagram of a cell which is undergoing cell division to form an ovum.

(Only two pairs of homologous chromosomes are shown in the diagram.)

Based on the above diagram, make a drawing of the ovum formed showing the chromosomes contained inside. (3)

CE - 2003

2. (b) The cartoon below shows a foetus crying for help inside the mother's body:

(i) Smoking during pregnancy is hazardous to the foetus. The foetus may be affected in a number of ways, such as a reduced supply of oxygen and the entry of toxic chemicals.

(1) Suggest an explanation for the reduced oxygen supply to the foetus. (2)

(2) Using a flowchart, show the route by which nicotine in cigarette smoke is transported from the mother's lung to the foetus. Indicate only the major organs and blood vessels involved. (3)

(ii) (1) An early sign of the birth process is the breaking of the amnion. What is the significance of this event in the birth process? (2)

(2) Describe what happens afterwards that leads to the birth of the baby. (3)

CE - 2004

2. (a) The table below shows the average number of pregnancies for women adopting different contraceptive methods :

Contraceptive method	Pregnancies per 100 women in 12 months
Condom	15
Diaphragm	13
Intra-uterine device (IUD)	2
Rhythm method	25

(i) The use of condoms and diaphragms are based on the same principle in bringing about contraception. What is this principle? (1)

(ii) How can an IUD prevent pregnancy to occur? (1)

(iii) (1) Explain the biological basis of the rhythm method. (3)

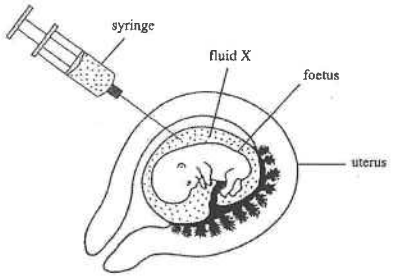
(2) Why does this contraceptive method have a high rate of failure? (1)

(iv) Even though some couples do not use any contraceptive methods and have regular intercourse, the wives fail to become pregnant. Suggest two reasons for this. (2)

(v) A man received an operation for contraception and had his sperm ducts tied and cut. Explain why his secondary sexual characteristics will not be affected after this operation. (3)

CE - 2005

10. (a) The diagram below shows how the fluid surrounding the foetus (fluid X) can be collected using a syringe. The fluid collected contains some foetal cells. These cells are cultured for several weeks and then examined under the microscope to determine whether the foetus has certain genetic disorders.



(i) (1) Name the membrane that surround fluid X. (1)

(2) Give two reasons why fluid X is important to the foetus during its development. (2)

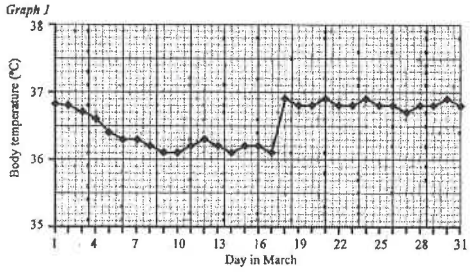
(ii) Suggest why it is necessary to culture the foetal cells for several weeks before they are examined under the microscope. (1)

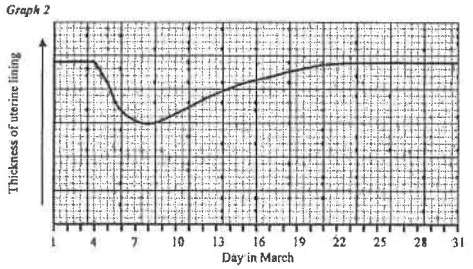
(iii) If microscopic examination shows that the foetus has Down Syndrome, the parents will have to decide whether to continue with the pregnancy or to end the pregnancy by abortion. Which choice do you support? Justify your answer. (2)

(iv) Explain how we can find out the sex of the foetus through microscopic examination of the cultured cells. (2)

CE - 2006

7. Lily is a healthy young woman. She adopts the 'safe period' method for contraception. In order to do so, she measures her body temperature every morning when she wakes up. Graph 1 below shows the body temperature recorded in March and Graph 2 shows the change in the thickness of her uterine lining in the same month:





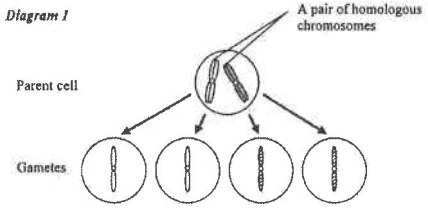
(a) Identify the period that corresponds to menstruation. Give one piece of evidence from the information provided to support your answer. (2)

(b) Referring to the graphs, state the period in which there will be a high chance of pregnancy if sexual intercourse occurs. Explain your answer. (4)

(c) The 'safe period' method is not very reliable for contraception because it can only predict part of the fertile period. Explain why it cannot predict the whole fertile period.(2)

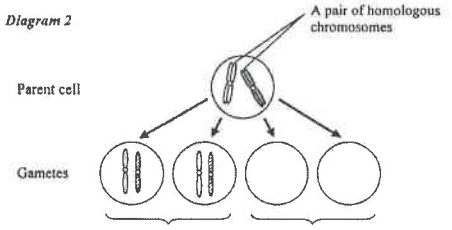
CE - 2006

8. (b) Diagram 1 below shows the result of meiotic cell division in gamete formation in humans: (Note : Only one pair of homologous chromosomes is shown.)



(i) Based on Diagram 1, give two features that are characteristic of meiotic cell division. (2)

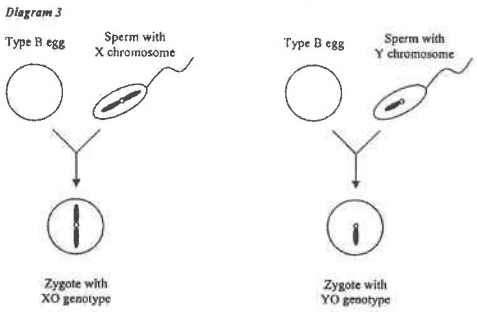
(ii) Sometimes, an abnormality occurs during meiotic cell division in gamete formation in humans. Diagram 2 below shows the abnormality concerning a pair of homologous chromosomes :



(1) Distinguish between type A and type B gametes. (1)

(2) Name a genetic disorder that will develop if a type A egg is fertilized successfully by a normal sperm. (1)

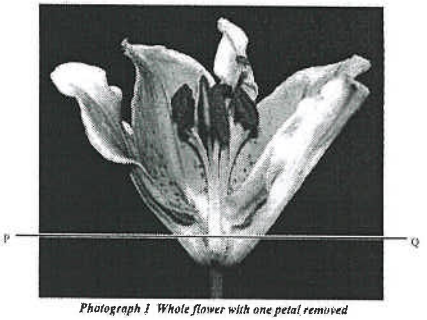
(3) This type of abnormality in cell division may occur in the sex chromosomes. The type B eggs may fertilize with normal sperms to form zygotes with different genotypes as shown in Diagram 3 below: (Note: Only the sex chromosome is shown.)



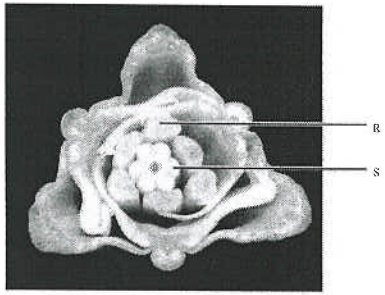
Suggest why zygotes with XO genotype may develop into an individual but not those with YO genotype. (3)

CE - 2007

8. (a) The photographs below show the structure of a lily flower:



Photograph 1 Whole flower with one petal removed



Photograph 2 Cross section at PQ (enlarged)

(i) Label the following structures: (2)
R:_____
S:_____

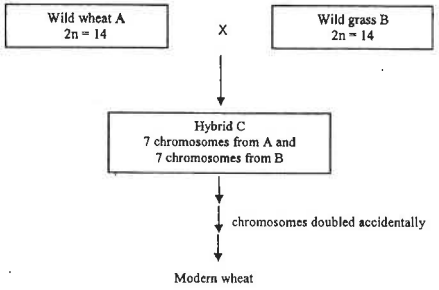
(ii) State the method of pollination for this flower. Support your answer with two observation features from Photograph 1. (3)

(iii) After pollination, describe how the male gamete meets the female gamete. (4)

(iv) The lily plant can also reproduce asexually. What is this type of asexual reproduction? (1)

CE - 2008

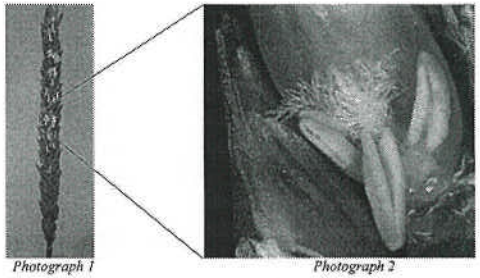
9. (a) A study of the wheat genome reveled that modern wheat is originated from the crosses among wild wheat and wild grasses. Below is one of the crosses.



(i) Hybrid C cannot produce gametes but it can produce offspring asexually. State the type of asexual reproduction employed by hybrid C. (1)

(ii) With reference to the process of meiotic cell division, suggest why hybrid C cannot produce gametes. (2)

(iii) The following photographs show the reproductive structures of wheat.

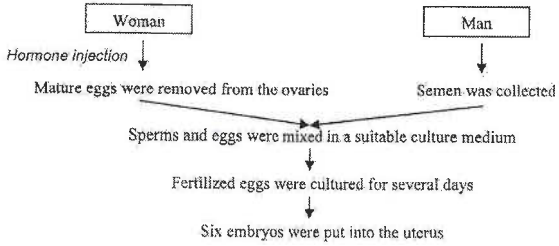

Photograph 1 *Photograph 2*

(1) What is the pollinating agent for wheat? Support your answer with two observable features from photograph 2. (3)

(2) A scientist performed a genetic experiment by crossing two different wheat plants. Describe the procedures done in order to ensure cross-pollination, but not self pollination to occur. (3)

CE- 2009

8. (b) A couple can produce gametes but are still not able to produce children. A doctor advised them to undertake an *in vitro* fertilization treatment. The chart below outlines the stages involved in their *in vitro* fertilization treatment.



(i) Suggest *one* possible cause of infertility for this couple. (2 marks)
The man and the woman.

(ii) Explain why the woman had to undertake hormone injection at the beginning but not the man. (3 marks)

(iii) Of the six embryos put into the uterus, eventually only two embryos have successfully developed.
(1) Why were some embryos not able to develop in the uterus? (1 mark)
(2) Is it possible that the two embryos are of different sexes? Explain your answer. (2 marks)

AL - 2002 2B

4. (b) Describe how the mammalian foetus obtains amino acids from proteins in the maternal diet. (5)

AL - 2004 1A

8. (a) The diagram below shows a mammalian sperm with its mitochondria localized in the region shown:

(i) Relate the location of the mitochondria to their function. (2)

(b) It is known that the nuclei from two sperms of the same individual can be made to combine inside an anucleate ovum (ovum without nucleus) to form a diploid cell which can further develop into an embryo. Explain the sex(es) of the embryo that can be produced by this method.(2)

AL - 2006 2B

4. (a) During sexual reproduction in humans, sperms are transferred from the penis to the vagina, whereas in terrestrial flowering plants, pollen grains are transferred from the anther of the flower to the stigma. Contrast the processes involved in the transfer of sperms and pollen grains mentioned above, and the subsequent fusion of the male and female gametes. (10)

DSE-2012 1B

11. Mitosis and meiosis are important processes that ensure the continuity of life. Contrast the two processes and state the significance of their differences. (11 marks)

DSE-2014 1B

3. Before the early 20th century, scientists generally held the belief:

"Cell division resulted in the loss of genetic material so that each cell in a multicellular organism would contain only the genetic material specific to its particular cell type."

In 1902, Hans Spemann performed one of the earliest experiments on animal cloning. He used a fine hair to separate the cells of a two-celled amphibian embryo, and found that each cell was able to develop into a complete organism.

(a) Why did Spemann's experiment disprove the early belief about cell division? (1 mark)

(b) Elaborate on how the above example can be used to demonstrate the two aspects of the nature of science listed in the table below. (2 marks)

Nature of Science	*Elaboration*
Scientific knowledge is tentative and subject to change.	
Interpretation of observations is guided by our prior understanding of other theories and concepts.	

(c) Using the current understanding about cell division, explain how genetic material is preserved in mitosis. (3 marks)

DSE-2014 1B

8. A primrose plant is a flowering plant that has two different types of flowers. Photograph I and Photograph II show the appearances of the two types of flowers (P and Q) and Photograph III and Photograph IV show the sections of the flowers respectively. Each primrose plant produces either type P flowers or type Q flowers.

(a) Apart from the presence of nectarines, give *two* observable features of type P flowers which support the claim that the primrose is an insect-pollinated plant. (2 marks)

(b) Butterflies collect nectar from flowers using a mouth structure in the form of a long sucking tube.

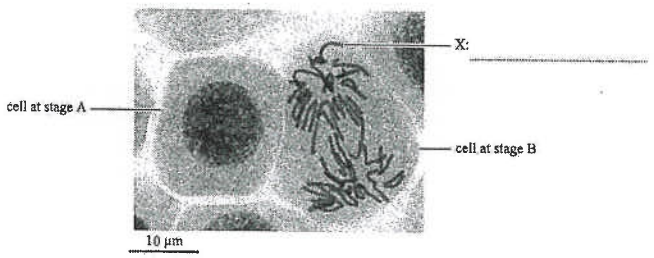
(1) When a butterfly visits a type P flower, which part of the sucking tube will the pollen grains stick to? (1 mark)

(2) When the same butterfly visits another flower, which type of flower will be more readily pollinated? Why? (2 marks)

(3) What is the advantage of having the different positioning of anthers and stigmas in the primrose? (2 marks)

HKDSE – 2015 1B

2. The photomicrograph below shows the appearance of genetic materials at two different stages of the cell cycle:



(a) Label structure X shown in the photomicrograph. (1 mark)

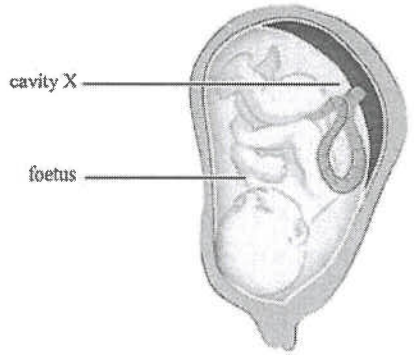
(b) With reference to the appearance of the genetic materials shown in the photomicrograph, at which stage, A or B, is transcription more likely to take place? Explain your answer. (2 marks)

(c) In the space provided below, state the cause for the different outcomes of mitosis and meiosis. (2 marks)

	Outcome		*Cause*
	Mitosis	*Meiosis*	
Number of daughter cells	2	4	
DNA content in daughter cells	2N	1N	

HKDSE – 2016 1B

2. The following diagram shows a foetus and the associated structures inside the uterus:

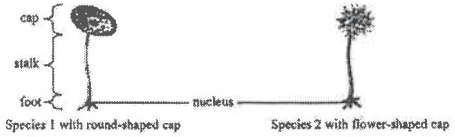


(a) What is the fluid found in cavity X? (1 mark)

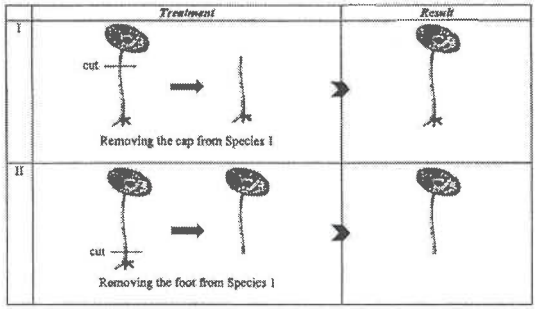
(b) On the diagram, label the structure where the exchange of materials between the foetal blood and maternal blood takes place. (1 mark)

(c) Give two reasons why foetal blood has to be separated from maternal blood.(2 marks)

8. In 1930s, a Danish biologist J. Hammerling tried to find out where the genetic information was stored inside the eukaryotic cell. He used some unicellular algae called Acetabularia to carry out a series of experiments. The diagram below shows the morphology oftwo species of algae used in his study:



He divided Species 1 into two groups, removing the cap from one group (I) and the foot from another group (II). He then observed if any regeneration occurred in the remaining parts. The diagram below shows the treatments and the results:

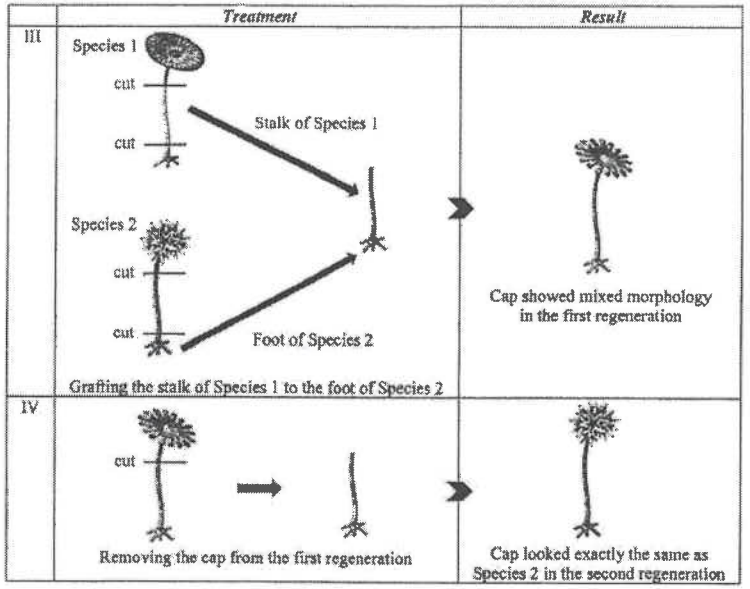


(a) Describe the results of the above experiment. (2 marks)

(b) Based on the results, Hammer ling hypothesized that:

The hereditary information is stored in the foot of the algal cell.

Hammerling further studied the expression of hereditary information by grafting the stalk of Species I to the foot of Species 2. After grafting, the cap formed from the first regeneration showed a mixed morphology (III). He then removed the regenerated cap. The cap formed from the second regeneration looked exactly the same as Species 2 (IV). The diagram below shows the treatments and the results:



(i) Hammerling concluded that when the cut stalk was transplanted, it contained some short-lived instruction derived from the foot of Species I, resulting in a mixed morphology of the cap in the first regeneration.

(1) Suggest the type of biomolecule that carried the short-lived instruction. (1 mark)

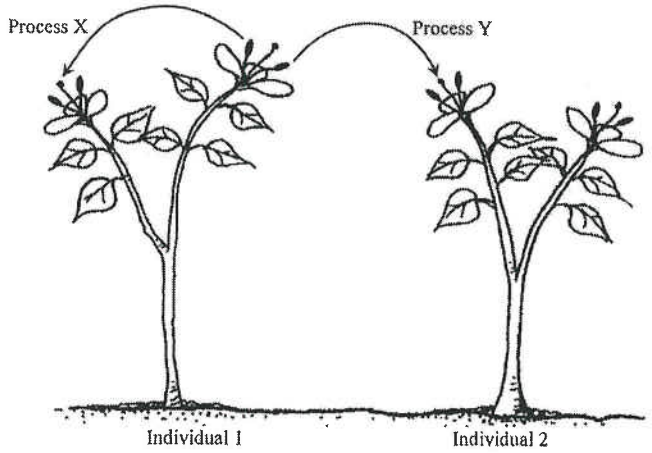
(2) How could the biomolecule suggested in (1) affect the morphology of the cap? (2 marks)

(ii) How do the results from this experiment support Hammerling's hypothesis? (2 marks)

(c) Give one aspect about the nature of science that can be demonstrated in the above discovery and give a reason to support your answer. (2 marks)

HKDSE - 2017 1B

3. The diagram below shows certain processes occurring in a species of flowering plant:



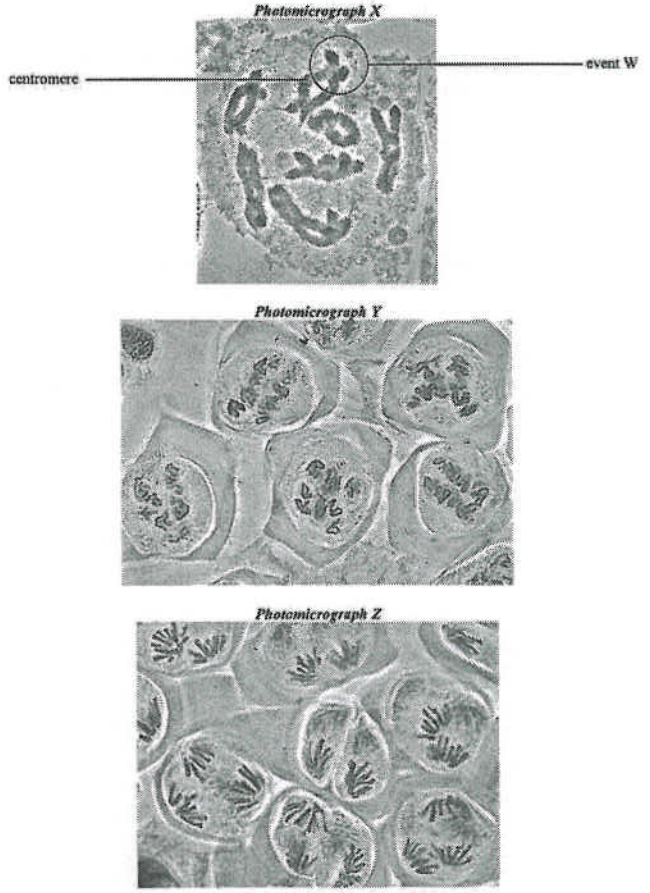
a. What is process Y? (1 mark)

b. Describe the sequence of events leading to fertilization after process Y has completed. (4 marks)

c. Explain briefly why process Y is better than process X in terms of evolution. (2 marks)

HKDSE - 2019 1B

3. The photomicrographs below show some stages of meiosis taking place in a flower:



(a) State *one* floral structure in which this type of division takes place. (1 mark)

(b) (i) Name event W shown in Photomicrograph X. (1 mark)

(ii) Briefly describe what happens in event W. What is the importance of event W? (2 marks)

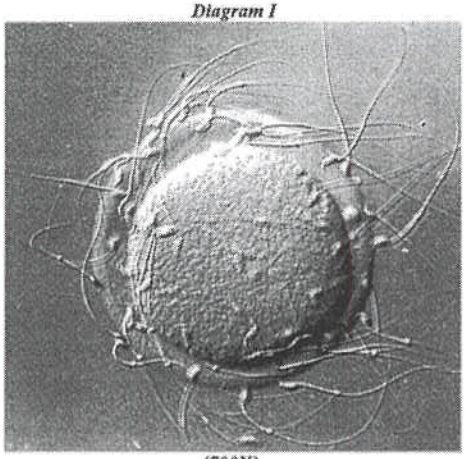
(c) (i) Which photomicrograph, Y or Z, shows the first meiotic division? Give a piece of evidence to support your answer. (2 marks)

(ii) What is the purpose of the first and second meiotic divisions respectively. (2 marks)

HKDSE - 20201B

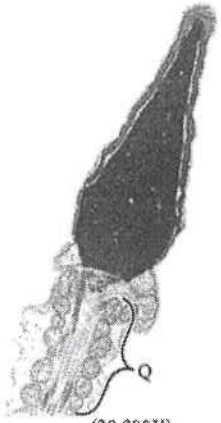
10. Diagram I shows a photomicrograph of human sperm and a human ovum during fertilisation while Diagram II shows an electron micrograph of an enlarged view of human sperm.

Diagram I



(700X)

Diagram II



(30 000X)

(a) Under normal circumstances, in which structure of the female reproductive system does the process shown in Diagram I take place? (1 mark)

(b) With reference to Diagram II, what is the significance of organelles Q to the sperm's function? (1 mark)

(c) (i) Explain the significance of the chromosome number of the sperm and ovum to sexual reproduction. (2 marks)

(ii) Briefly describe how identical twins may arise after fertilization. (2 marks)

HKDSE – 2021 1B

5. A student prepared cells of an onion root tip for observing cell division under a light microscope.

(a) What type of cell division is likely to take place in the root tip of an onion? Explain your answer. (2 marks)

(b) Suggest *one* necessary step to make the chromosomes observable under a light microscope. (1 mark)

(c) Some events of the cell division are randomly shown in the following photomicrographs:

V

W

X

Y

Z

(i) Starting with photomicrograph W, arrange the photomicrographs in the correct order to show the sequence of events in cell division. (1 mark)

W → → → →

(ii) A normal onion root cell has 16 chromosomes. Complete the following table to show the number of chromosomes and chromatids in photomicrographs Y and Z. (2 marks)

Photomicrograph	Number of chromosomes	Number of chromatids
Y		
Z		

Past Papers Marking Scheme – Cell division and reproduction

CE - 2002 Q.1 (a)

(i) The plant tissue cannot carry out photosynthesis / produce its own sugar 1
So it needs an external supply of sugar for respiration to release energy 1
and as raw material for growth 1

(ii) The genetic make-up of the daughter plants was the same as that of the parent plant 1
because the daughter plants were formed by mitosis of the parent tissue cells 1

(iii) For plant B, the sterilized soil had no microorganism 1
for recycling the fallen leaves into minerals 1
After several weeks, the minerals in the soil became exhausted, so insufficient chlorophyll was made 1

(iv) This method is a faster / surer way of producing daughter plants 1
The desirable characteristics of the parent can be retained in the daughter plants 1

CE - 2002 Q.2 (a)

(i) It forms a physical barrier 1
to prevent sperms from meeting the ovum 1

(ii) AIDS / hepatitis B, C or E / gonorrhea / syphilis (accept other correct answers) 1

(iii) Menstruation will still occur 1
because the operation does not affect the production of the female sex hormone by the ovary 1
and the transport of the hormone by blood 1
Under the influence of the female sex hormone, the uterine lining will get thicker 1
and shed off later

(iv) Title (T) ½
Drawing including cell outline (D) ½
Two chromosomes shown i.e. haploid, chromosome as single thread 1+1

The ovum

CE - 2003 Q.2 (b)

(i) (1) Tar in cigarette smoke deposits on the surface of the air sacs in the mother's lungs 1
As a result, less oxygen can be absorbed into the mother's blood 1
Hence reducing the oxygen supply to the foetus

(2) (mother's lung) → pulmonary vein → heart → aorta → artery to uterus → placenta → umbilical vein → (foetus) 6 x ½
(no arrows, deduct 1 mark)

(ii) (1) This results in the discharge of the amniotic fluid 1
Which lubricates the passage of the foetus through the vagina 1

(2) The cervix continues to dilate 1
The uterus and the abdominal muscles contract strongly 1
to expel the foetus through the vagina 1

CE - 2004 Q.2 (a)

(i) Both of them are based on the use of a barrier / prevent the sperms from meeting the egg 1

(ii) IUD prevents the implantation of the embryo 1

(iii) (1) Egg and sperms are viable for only a few days once they are released 1
The rhythm method is to avoid having intercourse around the time of ovulation 1
so that sperms and egg will have no chance of meeting each other 1

(2) Because it is hard to predict the time of ovulation accurately 1

(iv) Time of intercourse does not necessarily fall in the period around ovulation
Gametes produced may not be viable / may be defective
Oviducts of some women may be blocked
The sperm count of the husbands is too low any two 1,1

(v) Because the development of secondary sexual characteristics is controlled by the male sex hormone 1
which is still produced by the testes 1
and transported in the blood after the operation 1

CE - 2005 Q.10 (a)

(i) (1) amnion 1
(2) Fluid X helps to protect the foetus from mechanical shock
It can prevent desiccation of the foetus
It allows movement of the foetus in the uterus
It can maintain a constant internal environment for the growth of the foetus
any two 1,1

(ii) To allow time for obtaining enough foetal cells for analysis 1

(iii) Continue with pregnancy: (accept other reasonable answers)
• the foetus has life; we have no right to terminate the life of an individual
• people with Down Syndrome can lead a quality and meaningful life
• abortion may have potential risk to the mother and may have psychological impact on the mother 1,1

End pregnancy: (accept other reasonable answers)
• the child may become a burden to his / her parents / society as it needs more care
• the child may be discriminated due to his physical / mental disabilities 1, 1
any one set

(iv) Under the microscope, if two X chromosomes are found / the sex chromosomes are identical, the foetus is a female 1
If an X and a Y chromosome are found / the sex chromosomes are different, the foetus is a male 1

CE - 2006 Q.7

(a) 4^{th} to 8^{th} March 1
There is a great drop in the thickness of the uterine lining in the blood 1

(b) 12^{th} to 21^{st} March 1
The rise in body temperature indicates that / Uterine lining is thickened and ready for implantation 1
ovulation occurs at around day 17 1
Also, sperms and the egg can survive for a couple of days in the female reproductive tract 1
If sexual intercourse occurs in this period, there is a high chance of pregnancy

(c) This method only allows her to detect ovulation when there is a rise in the body temperature 1
But it fails to predict the fertile period before ovulation 1

CE - 2006 Q.8 (b)

(i) Four daughter cells are formed from a single parent cell,
The two members of a pair of homologous chromosomes are separated; / each goes to a different daughter cell
Each daughter cell contains the haploid number of chromosomes Any two 1,1

(ii) (1) Type A gamete has both members of the homologous pair, while type B gamete has none of that homologous pair 1
(2) *Down / Down's syndrome 1
(3) The X chromosome carries more genes than the Y chromosome 1
Absence of the X chromosome will result in the loss of more genes/alleles that may be essential to the survival of the zygotes and its subsequent development 1 1

CE- 2006 Q.10 (a)

(i) The average dry mass of both samples decreases from day 0 to day 12 1
because the stored food in cotyledon / seed 1
is used in respiration / is broken down to carbon dioxide and water 1

(ii) The average dry mass of the seedlings grown in daylight increases from day 12 to day 18, while that of seedlings grown in darkness continues to decrease 1
because under daylight, the seedlings have developed green leaves 1
for photosynthesis 1
The rate of food production is faster than the rate of food consumption resulting a net gain in dry mass 1

(iii) The dry mass shows the actual biomass / organic matter of the seedlings /
The water content of the seedlings varies and hence the fresh mass cannot indicate the actual growth 1

CE - 2007 Q.8 (a)

(i) R : filament S : ovary / ovule 1,1
(ii) Insect pollination 1
- large / brightly coloured petal
- anther / stigma located inside flower
- presence of insect guide any two 1,1

(iii) Pollen grain develops to form a pollen tube 1
Pollen tube carries the male gametes 1
down the style to the ovary / and digests the tissues of the style 1
and releases the male gametes into the ovule 1
(iv) Vegetative propagation 1

CE - 2008 Q.9 (a)

(i) Vegetative propagation 1
(ii) The chromosomes from A fail to pair up with the chromosomes from B during meiotic cell division 1
because they are not homologous chromosomes 1
Therefore, hybrid C fails to produce gametes
(iii) (1) Wind 1
Feathery stigma
Stigma exposed } Absence of petals } any two 1, 1
Anthers exposed

(2) During the experiment, use a plastic bag to wrap the treated flowers except during the following treatments 1
Remove the anthers from the flowers 1
Use a brush to transfer the pollen grains from other flowers to the stigma of the treated flowers 1

CE - 2009 Q.8 (b)

(b) (i) The man: low sperm count / poor sperm mobility / sperms with structural defects / fail to copulate# 1
The woman: blocked oviduct / unsuccessful implantation / no or few ovulation / fail to copulate# 1
(# award mark once)

(ii) It is necessary to stimulate development of ova through hormone injection so that more ova can be collected 1
One ejaculation of the male already contains millions of sperms 1

(iii) (1) Some embryos fail to implant in the uterus 1

(2) Yes
Since the embryos may develop from the fertilization of two different sperms with two ova 1
The two sperms may carry different sex chromosomes 1

AL - 2002 2B

4. (b) • maternal digestion: protease breaks down proteins to amino acids (1) / peptides, in stomach and small intestine (1) — 2
• absorbed into the maternal blood stream at the ileum (1) — 1
• a.a. carried via veins to hearts, then along artery to uterine wall (1) — 1
• a.a. diffuse across the *placenta into foetal blood circulation (1) — 1

AL - 2004 1A

8. (a) (i) • mitochondria close to the tail (1)
• provide energy for motility of the tail of sperm (1) — 2
(ii) (1) • from the ovum (1) / female — 1
(2) Any one (1 mark): — 1
• trace genetic line from female
• parentage identification

(b) • male sperm contains X and Y chromosomes, when 2 nuclei are combined (1), — 2
• the result is either female, when the nuclei of two sperms containing X chromosome are used, or male, when the nucleus of one sperm containing X chromosome and one sperm containing Y chromosome are used (1)

AL - 2006 2B

4. (a)

e.g.	Humans	Flowering plants	
Transfer process	• no external agents required for the transfer of sperms	• in many plants, external agents (1) such as insects or wind (1) are required	1, 1
	• copulation (1) to bring male and female parents together for the transfer	• male and female parts are separated during the transfer (1)	1 + 1
	• throughout the transfer process, sperms re within the human body (1)	• pollen grains are often released to the environment (1) when transferred from anther to stigma	1 + 1 max. 4
Fertilization	• a liquid medium (1) / semen is needed for the motility of the sperms • sperms are propelled up the female reproductive tract by the contraction of the uterus and oviduct (1)	• male gametes are transferred by pollen tube (1) which grow into the ovule (1) containing the female gamete	2 + 2
	• no digestion of tissues during the movement of sperms up the female tract	• tissue of style is digested during the growth of the pollen tube (1)	1
	• active movement of sperms involved	• passive transfer of male gametes (1)	1
	• single fertilization (1) of one sperm with one ovum	• double fertilization (1) with one male gamete fusing with the female gamete and the other male gamete fusing with the endospermic nucleus (1)	1 + 2 max. 8

max. 10

DSE-2012 1B

11.

Differences	*Significance*	
• Pairing of homologous chromosomes along the equatorial plane in first division of meiosis but no such process in mitosis (1)	• Such that the daughter cells formed contain the whole set of chromosome / one member of each homologous pairs (1) after meiosis	
• The pairs of homologous chromosomes segregate into the daughter nuclei during the first meiotic cell division (1)	• Random segregation of homologous chromosomes results in variations between gametes formed in meiosis (1)	(5)
	• Crossing over may occurs, the exchange of genetic materials between non-sister chromatids gives rises to new genetic combinations (1)	
• Mitosis involves one division only but meiosis involves two divisions (1)	• The daughter cells resulted from mitosis are genetically identical to the parent cell (1) which is important for growth of the organisms (1) / asexual reproduction	
	• The daughter cells / gametes formed in resulted from meiosis contain half / haploid the genetic content of the parent cell (1) such that the amount of genetic content can be restored after fertilisation (1)	(5)
D = (3)	**S = max.5**	Max. 8

Communication — **C = max.3**

11 marks

DSE-2014 1B

3. (a) • since each of the separated cells was able to develop into a complete organism, this implies a whole set of genetic material is present in each cell / there was no reduction in the quantity of genetic material during the first division (1) — (1)

[For deliberation in markers' meeting: if there was a reduction in genetic material, the separated cell would not be able to develop into a complete organism (1)]

(b)

Science knowledge is tentative and subject to change.	Spemann's results disproved the general belief, showing that scientific knowledge will change when there is new evidence evolved (1)	(1)
Interpretation of observation is guided by our prior understanding of other theories and concepts.	Scientist observed that cells divides into two and believed that all the materials inside will be divided too without knowing that genetic materials will be duplicated (1) / Spemann found that each of the two separated cells developed into a complete organism and interpret that each cell contain complete set of genetic materials because all genetic materials are required to form a whole organism	(1)

(c) • in mitosis, DNA / chromosomes / genetic material is duplicated right before cell division (1) (1)
• the duplicated chromosomes will line up at the middle part of the cell for division (1) (1)
• each member / half of the duplicated chromosomes will then separate and eventually divide equally into each daughter cell (1) (1)

6 marks

DSE-2014 1B

8. (a) • coloured /large petals (1) and anther within the flower tube (1) (2)

(b) (i) • middle part (1) (1)

(ii) • type Q flower (1)
• because its stigma is located at the middle level of the flower tube (1) which is at the same position where the middle part of the sucking tube will touch upon (2)

(iii) • this ensures that pollination is done between different individuals (1)
• so that the genetic variation of the offspring can be increased (1) (2)

7 marks

DSE – 2015 1B

2. (a) *chromosome / chromatid 1

(b) stage A (1)
Genetic materials are dispersed/ not condensed/ loosely packed at stage A (1) which indicates that the DNA molecules are ready for transcription 2

(c)

	Outcome		*Cause*
	Mitosis	*Meiosis*	
Number of daughter cells	*2*	*4*	Mitosis involves one division while meiosis involves two divisions (1)
DNA content in daughter cells	*2N*	*1N*	Homologous chromosomes (pair up) and separate into each daughter cell in meiosis but not in mitosis (1)

2

DSE – 2016 1B

2.

8. (a) those with the cap removed could regenerate the cap / the stalk and foot alone could regenerate the cap (1)
those with the foot removed could not regenerate the foot / the cap and stalk alone could not regenerate the foot (1) 2

(b) (i) (1) RNA 1
(2) RNA directs the protein synthesis through translation (1)
the protein produced determine the morphology of the cap by acting as enzymes or structural proteins (1) 2

(ii) the final morphological feature of the cap resembles that of Species 2 (1) showing that the trait is determined by the foot of Species 2 but not the stalk from Species 1 (1) and thus the permanent heredity information is stably stored in the foot 2

HKDSE – 2017 1B

3. (a) • cross-pollination (1) (1)

(b) • after landing on the stigma, pollens germinate to form pollen tubes (1)
• which carry the male gametes /male nuclei/pollens containing male gametes /male nuclei (1)
• pollen tubes grow along the style to reach the ovules/ the micropyle in the ovary / towards the ovules in the ovary (1) (4)
• the male gametes/male nuclei will be released to fuse with the female gametes/female nuclei (1) in the ovules

Instructions to markers: (1) candidates should elaborate on the fertilization process with the correct sequence of events, and (2) candidates must correctly mention ovules in the answer in order to score the fourth mark.

(c) • process Y involves combination of genes from two different individuals (1)
• hence, the fertilised eggs / offspring from process Y have greater genetic variations than those from process X (1) for contributing to evolution

Instructions to markers: (1) candidates must mention fertilized eggs/offspring in order to score the second mark.

OR

process Y could give rise to greater genetic variations than process X (1) individuals with variants would be candidates for natural selection which is one of the mechanisms of evolution (1). (2)

7 marks

HKDSE – 2019 1B

3. (a) • anther / ovary / ovule / pollen sac (1) (1)

(b) (i) • crossing over* / crossing-over* / formation of chiasma* (1) (1)

(ii) • exchange of genetic materials between (non-sister chromatids of) the homologous pair of chromosomes (1) (2)
• is an important source of genetic variation / new combination of alleles in chromosomes in sexual reproduction / this produces recombinant chromosomes (1)

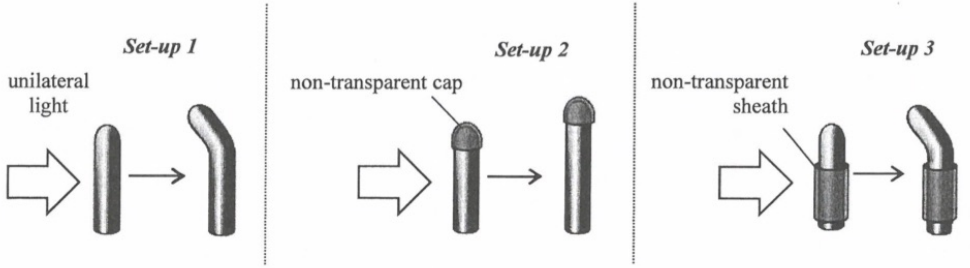
(c) (i) • Photomicrograph Y belongs to the first meiotic cell division (1)

- because pairing or separation of homologous chromosomes is shown (1), which is the characteristic feature in first meiotic cell division (2)

(ii)
- first meiotic cell division separates the two sets of homologous chromosomes / produces haploid nuclei / 2N to 1N (1) (not acceptive: reductive division)
- while second meiotic cell division separates the (duplicated) chromosomes / the (sister) chromatids (1) (not acceptable: halve the number of chromosomes, to form haploid gametes, to restore the diploid state of a cell after fertilization) (2)

8 marks

25. Darwin performed some experiments on the study of the phototropic response of coleoptiles of young seedlings. The coleoptile in each set-up was exposed to a unilateral light source and the appearance of the coleoptiles after three days are shown below:

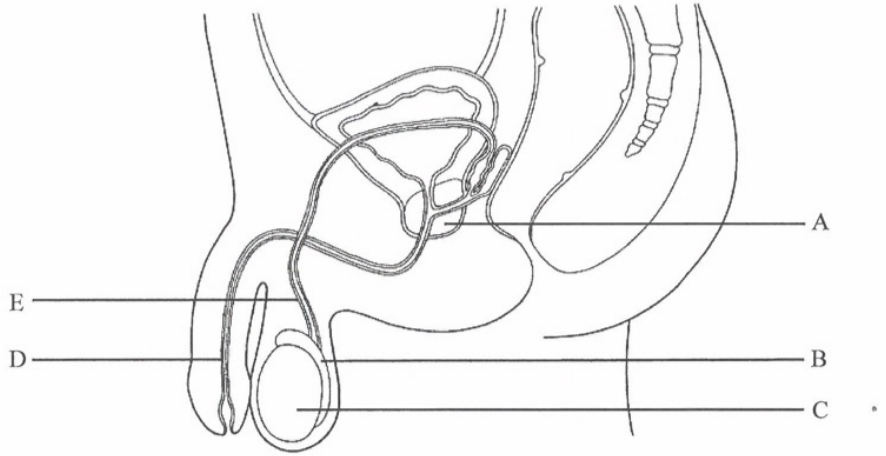


Which of the following can be deduced from Darwin's experiment?

(1) Auxins is produced from the tip of the coleoptile.
(2) The coleoptiles show positive phototropic response.
(3) The tip of the coleoptile detects the direction of light.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

2. The diagram below shows the human male reproductive system and its associated structures:



(a) In which structure does meiosis take place? Give your answer using the letters in the diagram. (1 mark)

(b) State the functions of structures A and B respectively. (2 marks)

(c) Vasectomy is an operation for achieving permanent contraception in males.

(i) Using the letters in the diagram, state the structure which is affected in this contraceptive method. (1 mark)

(ii) What is the biological basis of this contraceptive method? (2 marks)

DSE M.C. Questions - Growth and development
(sort by difficulty)

Challenging

2018 Q.29 (28%)
Which of the following substances contribute(s) most to the increase in biomass of plant?

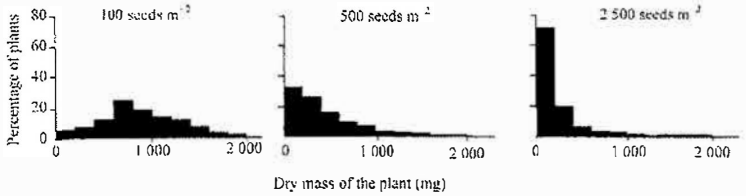
A. Water
B. Oxygen
C. Minerals
D. Carbon dioxide

2019 Q.30 (18%)
Which of the following parameters is best used for recording the growth of a potted germinating seedling over a period of time?

A. The dry mass of the seedling
B. The fresh mass of the seedling
C. The total surface area of the seedling's leaves
D. The time taken for the seedling's first leaf to appear

Average

Directions: Question 13 and 14 refer to an investigation described below. Pots were planted with seeds at densities of 100, 500 and 2500 m^{-2} respectively. The soil, water and lighting conditions were similar for each pot. The dry masses of mature plants are shown in the following graphs:



2012 Q.13 (54%)

The investigation was most likely performed to study

A. the effect of symbiosis.
B. the effect of competition.
C. the success rate of seed germination.
D. the optimum density for seed germination.

2012 Q.14 (61%)

Which of the following best describes the effect on the plants as the density of seeds planted increases?

A. biomass of individual plants is reduced
B. genetic variability of the plants is increased
C. dry masses of plants are normally distributed
D. leaves become smaller and stems get thinner

2015 Q.28 (59%)

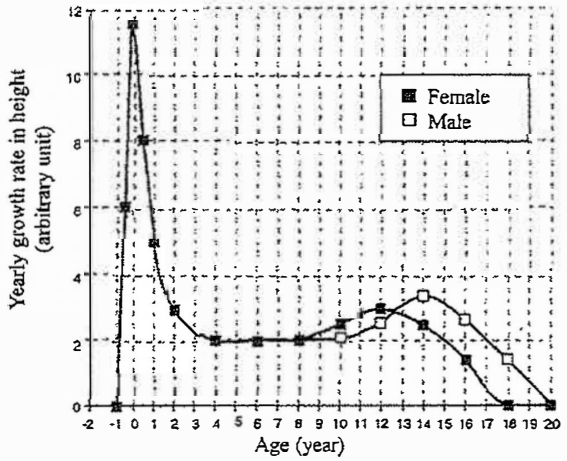
Which of the following parameters is best for measuring the growth of the broad bean after germination?

A. the length of the shoot
B. the area of the leaves
C. the weight of the embryo
D. the volume of the cotyledon

Average

2019 Q.31 (45%)

The graph below shows the growth rate of humans:



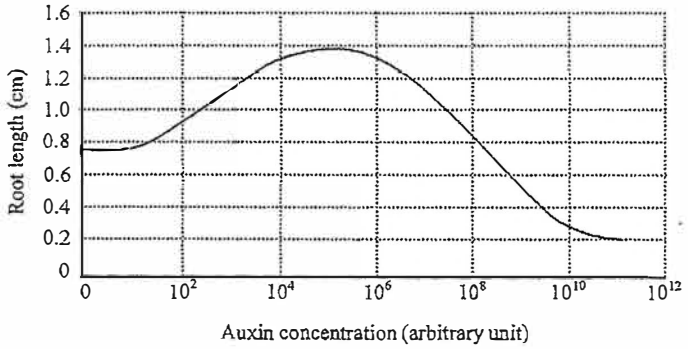
Which of the following can be deduced from the graph?

A. The brain grows rapidly from age 0 to age 4.
B. There is no more changes in growth for males after age 20.
C. The duration of adolescence is the same in males and females.
D. Growth of the reproductive organs begins at age 10 in females.

Easy

2015 Q.29 (91%)

The graph below shows the average root length of germinating seeds irrigated with different auxin concentrations?



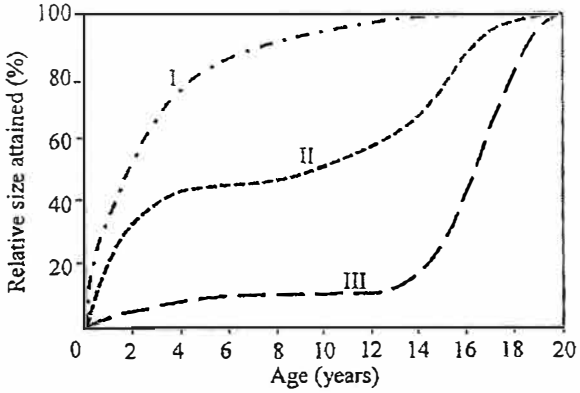
Which of the following can be deduced from the above graph?

A. Auxins promote the elongation of the root.
B. Auxins promote cell division that results in the elongation of the root.
C. Auxins promote water absorption that results in the elongation of the root.
D. Different concentrations of auxins result in differences in the extent of root elongation.

Easy

2017 Q.24 (87%)

The graph below shows the growth curves of the head, reproductive system and the whole body in humans:



Which of the following combinations correctly identifies curves I, II and III?

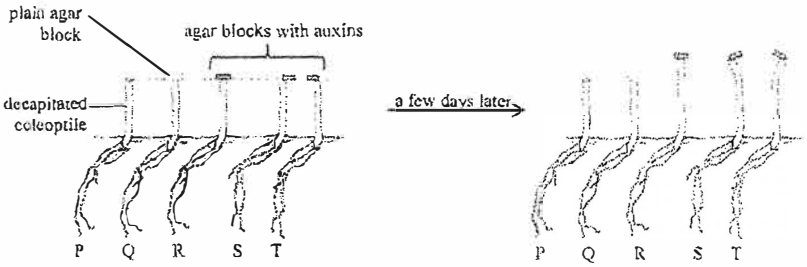
	I	*II*	*III*
A.	whole body	reproductive system	head
B.	head	reproductive system	whole body
C.	head	whole body	reproductive system
D.	reproductive system	whole body	head

2020 Q.26

26. On which of the following parts of the root can root hairs be found?

A. root cap
B. region of elongation
C. region of cell division
D. region of differentiation

Directions: Questions 27 and 28 refer to the diagram below, which shows an investigation into the effect of auxins on the growth of plant shoots:



27. Which of the following serve(s) as the control set-up(s) in this investigation?

A. P only
B. R only
C. P and Q only
D. Q and R only

2020 Q.28

28. Which of the following conclusions can be drawn based on the results of the investigation?

A. The tip of the coleoptile produces auxins.
B. Auxins stimulate the growth of coleoptiles.
C. The coleoptile shows positive phototropism.
D. Coleoptiles stop growing when the tip is removed.

Answers

Challenging

2018	2019
29 [D]	30 [C]

Average

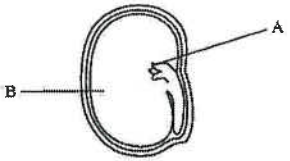
2012	2015	2019
13 [D]	28 [A]	31 [C]
14 [A]		

Easy

2015	2017	2020
29 [D]	24 [C]	26[D]
		27[C]
		28[B]

CE - 2004

1. (b) The diagram below shows a section of a seed:



(i) (1) Name structure A. (1)
(2) What organs will A develop into during seed germination? (2)

(ii) During germination, amylase activity is detected in region B. Explain the importance of amylase activity to the growth of the seedling. (4)

(iii) The dry mass of the seedling decreases in the initial stage of germination but starts to increase after one week. Explain the increase in dry mass of the seedling in the later stage. (3)

CE - 2006

10. (a) In a study of the growth of mung bean seedlings, two samples of mung bean seeds were grown under the same conditions except that one sample was kept in daylight while the other in darkness. The same number of seedlings was collected from each group every 6 days. The average dry mass of the seedlings of each group was determined and the results are shown below :

Time of growth (day)	Average dry mass of seedlings (g)	
	In daylight	In darkness
0	0.81	0.80
6	0.65	0.65
12	0.57	0.52
18	0.79	0.41

(i) Explain the change in the average dry mass of the seedlings in both daylight and dark conditions from day 0 to day 12. (3)

(ii) From day 12 to day 18, how do the seedlings grown in daylight differ from those grown in the dark in terms of the change in the average dry mass? Account for this difference. (4)

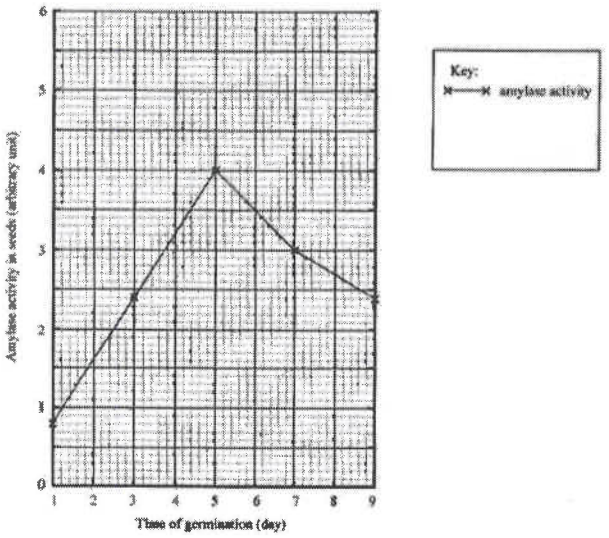
(iii) Suggest why the dry mass of seedlings was measured instead of the fresh mass in this study. (1)

CE - 2010

8. (b) A study was conducted to find out the change of amylase activity and the amount of reducing sugars in seeds during germination. The seeds were washed with water and soaked in dilute sterilizing solution for 10 minutes. They were then rinsed with distilled water and germinated under suitable conditions. The results of the study are shown in the following table.

Time of germination (day)	Amylase activity in seeds (arbitrary unit)	Amount of reducing sugars in seeds (mg/100g)
1	0.8	6.8
3	2.4	10.8
5	4.0	11.6
7	3.0	7.2
9	2.4	6.4

(i) The data on amylase activity in seeds is plotted on the graph. Present the data on the amount of reducing sugars in seeds on the same graph and give a title to the completed graph. (4 marks)



(ii) With reference to the data from day 1 to day 5, describe and explain the relationship between the amylase activity and the amount of reducing sugars in seeds during germination. (2 marks)

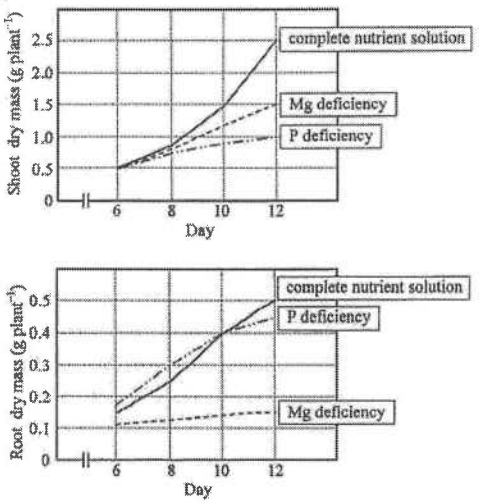
(iii) The amount of reducing sugars in seeds in day 9 is lower than that in day 3 even though the amylase activity in seeds in these two days are the same. Suggest a reason for the lower amount of reducing sugars in day 9. (1 mark)

(iv) State *two* uses of reducing sugars in the seeds during germination. (2 marks)

HKDSE – 2016 1B

9. To study the effect of mineral deficiency on shoot and root dry masses, bean plants were grown in a complete nutrient solution (a solution containing all essential nutrients for growth) or a nutrient solution without either phosphorus (P) or magnesium (Mg) for 12 days respectively. The dry masses of shoot and root were then measured. The results are shown in the graphs below:

Key: complete nutrient solution
P deficiency
Mg deficiency



(a) Briefly describe how the dry mass of a plant can be determined. (2 marks)

(b) The leaves of the bean plants grown under Mg deficient conditions appeared yellow.

(i) Why did the leaves appear yellow? (1 mark)

(ii) Use this phenomenon to explain the results of the shoot dry mass and root dry mass of the bean plants under Mg deficient conditions. (3 marks)

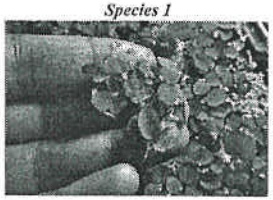
(c) (i) Explain the difference in the overall dry mass of the plant grown under P deficient conditions and that in the complete nutrient solution. (2 marks)

(ii) It was hypothesized that P inhibits the export of photosynthetic products from leaves to roots. Use this hypothesis to explain the results of the shoot dry mass and root dry mass of the bean plants under P deficient conditions. (3 marks)

HKDSE – 2021 1B

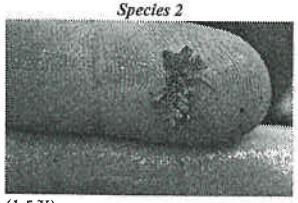
9. The photographs below show the appearances of two species of free-floating, freshwater plants, Species 1 and Species 2:

Species 1



(0.58 X)

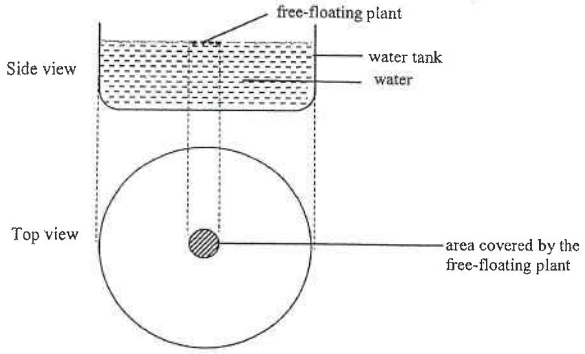
Species 2



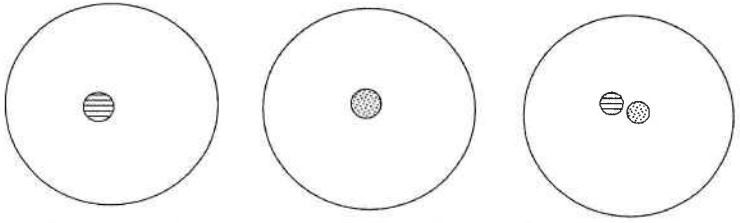
(1.5 X)

To study the interaction between these two plant species, each species was grown either alone or together with another species in a water tank for 50 days. Each species covered 10% of the area of water surface at the beginning of the experiment. The experimental set-up and design are shown in the following diagrams:

Experimental set-up:

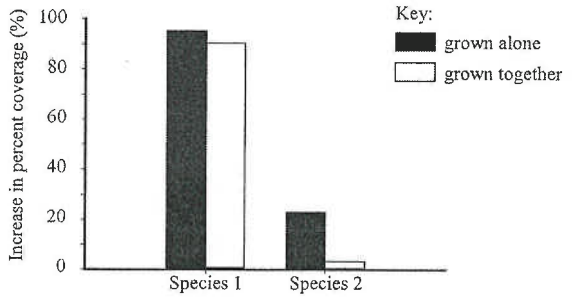


Experimental design (top view):



Species 1 grown alone | Species 2 grown alone | Species 1 and 2 grown together

The percent coverage of each plant species was measured at the beginning and at the end of the experiment. The increases in the percent coverage are shown below:



(c) The table below shows two other methods of measuring plant growth and whether these methods would be feasible in this experiment. Complete the table by giving justifications for the feasibility of the methods. (2 marks)

Method	*Feasibility*	*Justifications*
Fresh weight	Feasible	
Number of leaves	Not feasible	

Past Papers Marking Scheme – Growth and development

CE - 2004 Q.1 (b)

(i) (1) *plumule 1
(2) stem and leaf 1, 1

(ii) Amylase hydrolyses the starch stored in the seed 1
into maltose / sugar 1
which is used for forming new cells 1
and for respiration / release of energy for the growth of the seedling 1

(iii) The seedling has developed green leaves 1
The rate of photosynthesis of the leaves is greater than the rate of respiration of the seedling 1
so there is a net gain in the amount of organic substances / new cells are produced 1

CE- 2006 Q.10 (a)

(i) The average dry mass of both samples decreases from day 0 to day 12 1
because the stored food in cotyledon / seed 1
is used in respiration / is broken down to carbon dioxide and water 1

(ii) The average dry mass of the seedlings grown in daylight increases from day 12 to day 18, while that of seedlings grown in darkness continues to decrease 1
because under daylight, the seedlings have developed green leaves 1
for photosynthesis 1
The rate of food production is faster than the rate of food consumption 1
resulting a net gain in dry mass

(iii) The dry mass shows the actual biomass / organic matter of the seedlings /
The water content of the seedlings varies and hence the fresh mass cannot indicate the actual growth 1

CE- 2010 Q.8 (b)

8. (b) (i) Title (T): Change in amylase activity and amount of reducing sugars in seeds during germination (1)
Correct plotting and joining of all points (P) (1)
Correct key or labeling of curve (K) ($^1/_2$)
Correct labeling of axis with unit and appropriate scale(L) ($1\ ^1/_2$)

(ii) When the amylase activity increases, the amount of reducing sugars in seeds increases (1)
because more starch is being broken down by amylase to form reducing sugar (1)

(iii) More reducing sugars are consumed in day 9/ less starch (food storage) is available for amylase activity in day 9/ more reducing sugars are transported away from the seed in day 9 (1)

(iv) For energy release for the growth of the embryo (1)
For forming structural component of new cells (e.g. cellulose) for growth (1)

HKDSE – 2016 1B

9. (a) • dry the harvested plant in an oven at around 100°C (1)
• until a constant mass is obtained upon repeated weighing (1) (2)

(b) (i) • without magnesium, chlorophyll cannot be formed (1), leaving the leaves yellow (1)

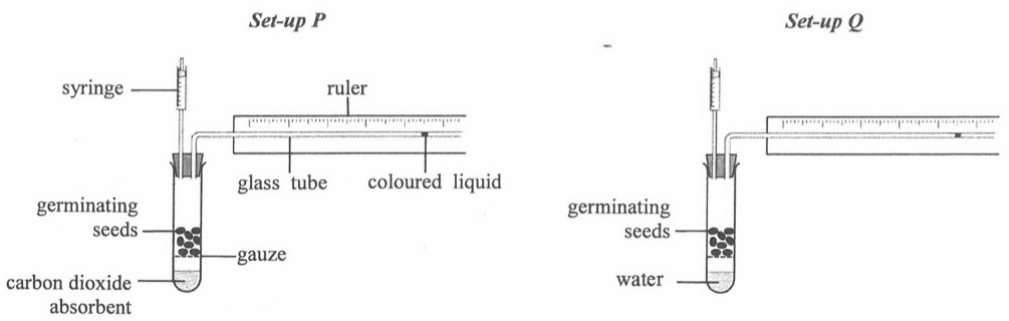
(ii) • without chlorophyll, the rate of photosynthesis of the plant is lowered (1)
• as a result, there is not enough food produced for the growth of plants (1)
• therefore, both the shoot and root dry mass are smaller than that of the control / that grown in complete nutrient solution (1) (3)

(c) (i) • the overall dry mass of the plant under P deficient conditions is much smaller (1)
• because P is necessary for the formation of protein / nucleic acids / ATP (1) which are important for growth (2)

(ii) • without P, more photosynthetic product is transported from leaves to root (1)
• as a result, the shoot dry mass is a lot lower than that of control (1)
• while the root dry mass maintains more or less the same (1) (3)

11 marks

Directions: Questions 11 and 12 refer to the diagram below, which shows two set-ups used for the investigation of the gas exchange in germinating seeds:

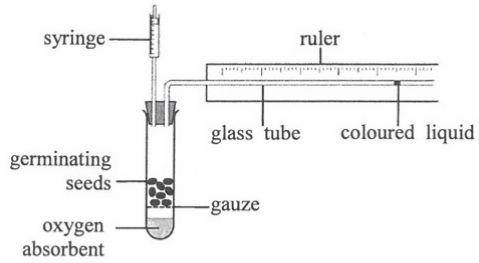


11. Assuming that the environmental conditions are the same, what will happen to the coloured liquid in each set-up?

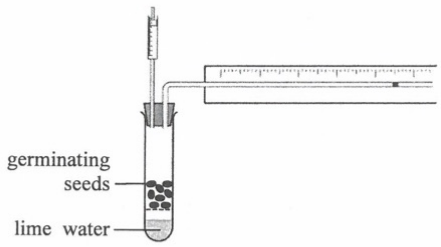
	Set-up P	*Set-up Q*
A.	moves to the right	moves to the left
B.	moves to the left	stays still
C.	stays still	moves to the left
D.	stays still	moves to the right

12. Which of the following modified set-ups can be used to show the identity of the gas produced in the investigation?

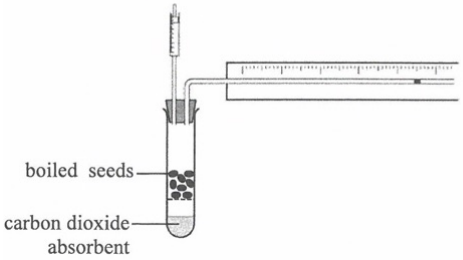
A.



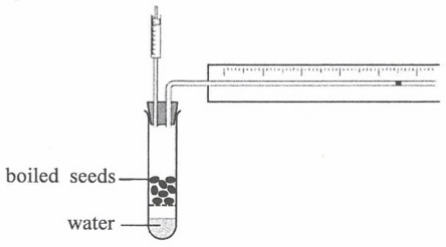
B.



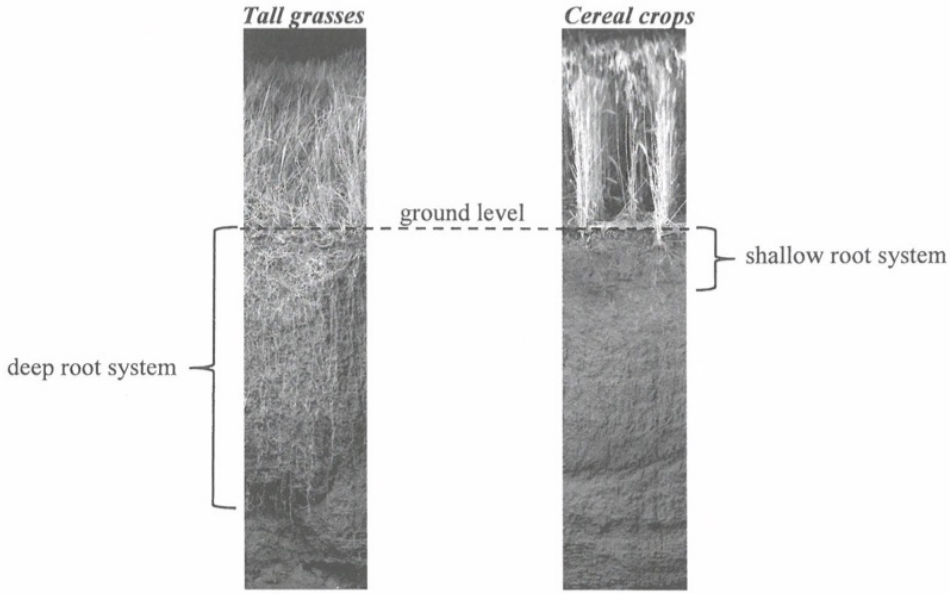
C.



D.



8. Tall grasses and cereal crops belong to the same family and share a common ancestor. Cereal crops have been artificially selected for agriculture and their seeds harvested as food. The roots of the tall grasses in grasslands range in depth from 1.5 m to 4.5 m while those of cereal crops rarely exceed 1 m. The photographs below show the root depths of tall grasses and cereal crops under the same magnification:



(a) (i) Grassland is a region of treeless plain which is mainly occupied by tall grasses. It is usually found in regions with moderate rainfall. The tall grasses have evolved with a deep root system. What is the selection pressure involved in this evolutionary process? What is the advantage of the greater root depth in tall grasses? (2 marks)

(ii) In terms of energy usage of the plant, explain why having a shallow root system for cereal crops is considered an advantage to farmers. (2 marks)

DSE M.C. Questions - Detecting the environment (plant)
(sort by difficulty)

Challenging

2012 Q.30 (35%)

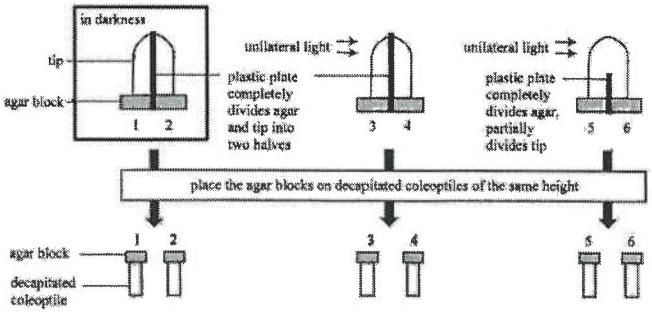
Which of the following correctly describe the importance of phototropism to plants?

(1) It ensures that the root can get water from the soil.
(2) It ensures that the root can anchor to the soil for support.
(3) It allows the shoot reach a position where there is sunlight.

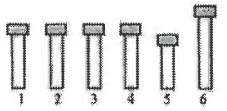
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

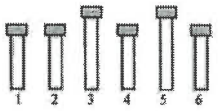
Average

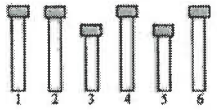
Directions:
Questions 35 and 36 refer to the diagram below, which shows an experiment that collects auxins from the tip of coleoptiles under different conditions. After that, the agar blocks are placed on decapitated coleoptiles of the same height:



2016 Q.35 (42%)
Which of the following correctly shows the growth response of the decapitated coleoptiles?

A.


B.


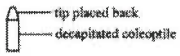
C.


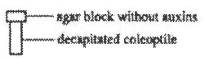
D.


2016 Q.36 (64%)
Which of the following can be used as a control set-up for the above experiment?

A.

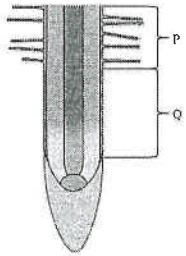

B.


C.


D.


Average

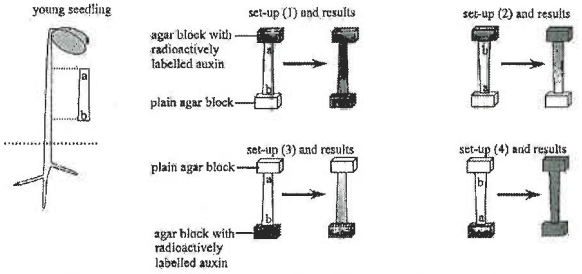
2017 Q.31 (65%)
The diagram below shows a low power drawing of the cut section of a root:



Which of the following correctly describes the relationship of auxin and different regions of the root?

A. It affects cell division at P.
B. It affects cell division at Q.
C. It affects cell elongation at P.
D. It affects cell elongation at Q.

2019 Q.28 (45%)
To investigate the transport of auxins in the stem of a young seedling, a plain agar block and an agar block soaked in radioactively labelled auxins were prepared and placed at different ends of a cut stem, as shown in the diagram below. The relative amounts of radioactivity in different parts are shown as different intensities of shaded area.



Which of the following conclusions can be drawn from the above results?

(1) Transport of auxins in the stem is not affected by gravity.
(2) Transport of auxins in the stem involves an active process.
(3) Transport of auxins in the stem mainly takes place from a to b.

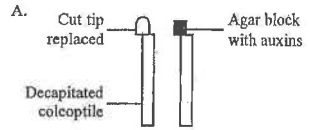
A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

Easy

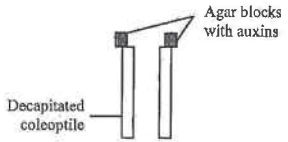
2014 Q.36 (77%)

Which of the followings pairs of set-ups can be used to test the hypothesis that auxins are growth-promoting substance in oat coleoptiles:

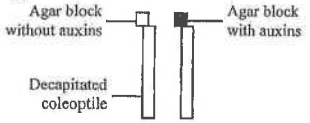
A.



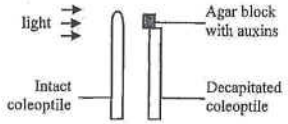
B.



C.



D.



2020

27. Which of the following serve(s) as the control set-up(s) in this investigation?

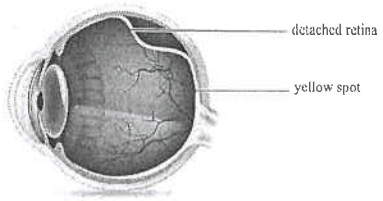
A. P only
B. R only
C. P and Q only
D. Q and R only

28. Which of the following conclusions can be drawn based on the results of the investigation?

A. The tip of the coleoptile produces auxins.
B. Auxins stimulate the growth of coleoptiles.
C. The coleoptile shows positive phototropism.
D. Coleoptiles stop growing when the tip is removed.

2021

18. The diagram below shows an early stage of an eye defect:

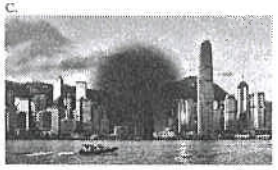


If a person suffers from this eye defect, which of the following diagrams is the most likely vision perceived by this person?

A.

B.

C.



D.

Answers

Challenging

2012
30 [D]

Average

2016	2017	2019
35 [A] 36 [D]	31 [D]	28 [B]

Easy

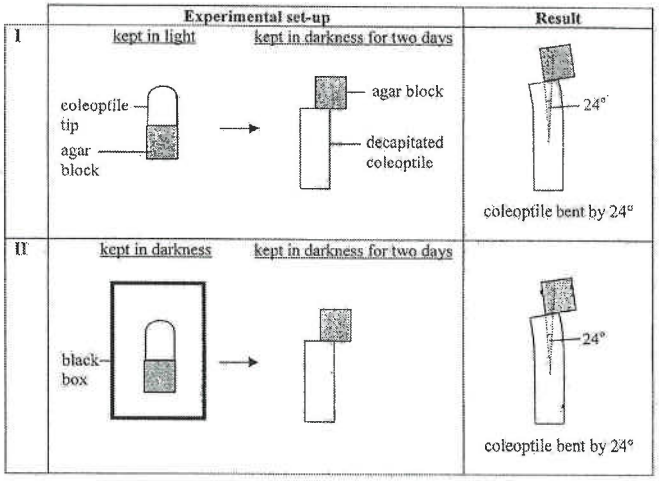
2014
36 [C]

CE - 2009

10. (b) Scientists have proposed two hypotheses to explain why a greater amount of auxins is found in the shaded side than the lighted side when a coleoptile is illuminated with unilateral light.

Hypothesis A: Light destroys auxins in the lighted side of the plant.
Hypothesis B: Auxins move from the lighted side to the shaded of the plant

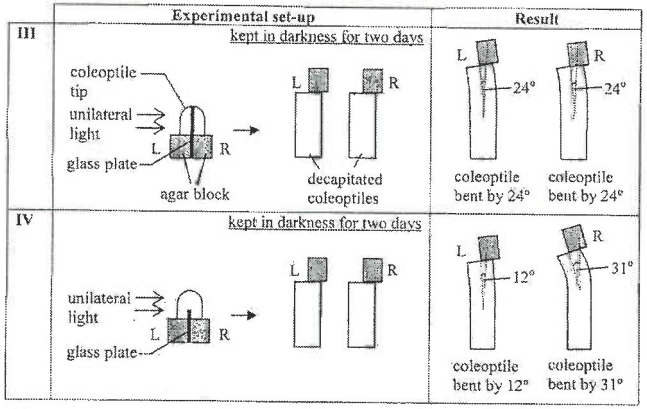
(i) A scientist performed an experiment to test Hypothesis A. He used agar blocks to collect auxins from coleoptile tips under different conditions. Then he placed each agar block on one side of a decapitated coleoptile. The set-up was kept in darkness for two days. He then measured the degree of bending of the coleoptile. The diagrams below show his experiment set-ups and the results:



(1) State the dependent variable in the above experiment. (1 mark)

(2) Do the results of the above experiment support Hypothesis A? Explain your answer. (3 marks)

(ii) The scientist performed another experiment to test Hypothesis B. The diagram below shows his experiment set-ups and the results:

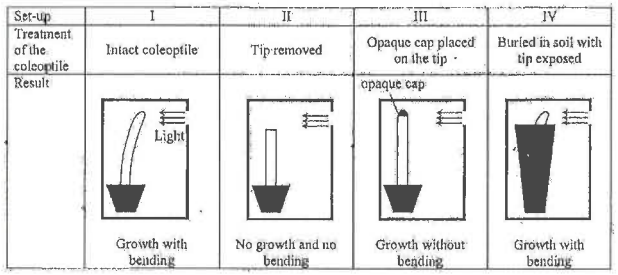


(1) What is the purpose of inserting a glass plate into the coleoptile and agar block in the way shown in Experiment set-up III? (1 mark)

(2) If Hypothesis B is correct, explain the results obtained from Experimental set-up IV. (4 marks)

HKDSE - 2013 1B

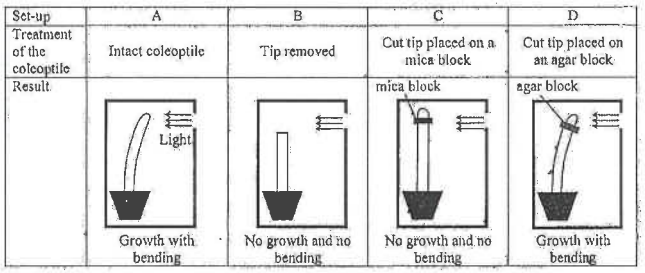
7. In 1880, Darwin conducted an experiment to investigate the phototropism of plants. He placed some coleoptiles in dark boxes, each with a hole at one side to allow light to pass through. The results after various treatments of coleoptiles are shown in the diagrams below:



(a) From the results of the experiment, which part of the coleoptiles is responsible for detecting unilateral light? Support your answer with reasons. (3 marks)

(b) Explain why it is necessary to have set-up III in the experiment. (1 mark)

(c) In 1913, Boysen-Jensen performed some other experiments to study the nature of the signal transmission involved in phototropism. The diagram below shows his experimental set-ups:



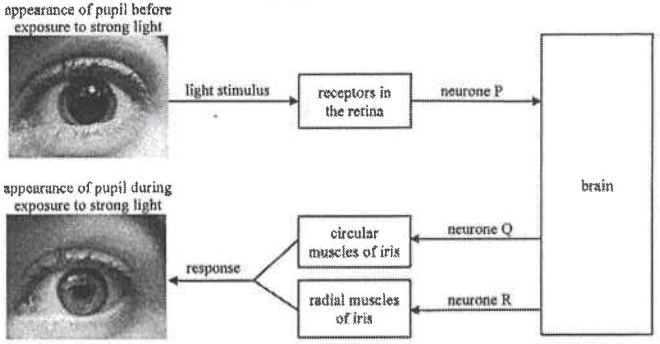
What conclusion can be drawn from Boysen-Jensen's experiment? (3 marks)

(d) Which of the following statements about the nature of science are demonstrated in the above historical events? Put a '✓' in the space next to the statement and provide an explanation. The first one is an example for your reference. (4 marks)

Statement		*Evidence from the historical events*
Doing science requires creativity and imagination.	✓	Both Darwin and Boysen-Jensen used innovation and imagination to design their experiments.
Science is socially and culturally embedded.		
Science is based on evidence.		
Science knowledge is tentative and dynamic.		

HKDSE - 2020 1B

3. The diagram below shows a neural pathway involved in the coordination of pupil size when a human eye is exposed to strong light:



(a) With reference to the above neural pathway,
(i)state the ***two*** types of receptors located in the retina. (1 mark)
(ii)state the type of neurone represented by Q and R. (1 mark)

(b) Describe how the two sets of iris muscles work together to bring about the change in the pupil size shown above. State the significance of this response. (4 marks)

(c) If someone falls unconscious, the response of the above neural pathway will be assessed to confirm if this pathway is still functioning. What does this assessment tell you about the nature of this neural coordination (1 mark)

Past papers Marking Scheme – Growth responses of plants

CE - 2009 Q.10 (b)

(b) (i) (1) amount of auxins measured by degree of bending of the coleoptiles 1

(2) Hypothesis A i not supported / Light does not destroy auxins 1
The coleoptiles in experimental set-ups I and II have the same degree of bending 1
This shows that the agar blocks have collected the same amount of auxins regardless of light or dark condition 1

(ii) (1) To stop the lateral transport of auxins 1

(2) Unilateral light causes a migration of auxins from the lighted to the shaded side 1
Hence, there is less auxins diffusing to block L / more auxins diffusing to the block R 1
When the blocks are placed on the right side of the coleoptiles, block R stimulates a greater extent of growth on the right side than that of block L 1
resulting in a greater degree of bending towards the left side 1

HKDSE - 2013 1B

7. (a)
- the tip is responsible for detecting the unilateral light (1)
- because if it is removed / blocked from the stimulus, no bending growth movement occurs (1)
- on the other hand, the same response is produced even if the lower part of the coleoptile is covered in soil (1)

(3)

(b)
- to show that the failure to produce response in set-up II is not due to the effect of injury / damage (1) when the tip is removed

(1)

(c)
- some substances are produced from the tip of the coleoptiles (1)
- which can diffuses through the agar block (1) to reach the lower part of the coleoptile
- and exert effect / lead to bending growth at the lower part of the coleoptile (1)

(3)

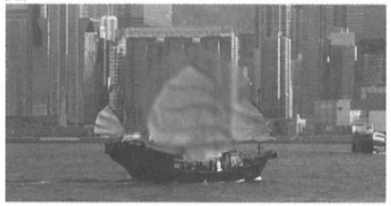
(d)

Science is based on evidence.	✓ (1)	Both Darwin and Jensen used the results from their experiment to develop their understanding about phototropism in plants (1)
Science knowledge is tentative and dynamic.	✓ (1)	Darwin's work only provided some understanding about phototropism and Jensen's results helped develop further the science knowledge (1)

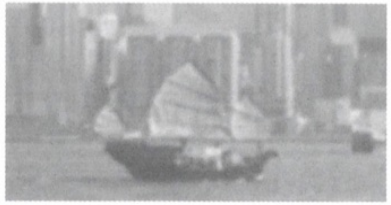
(4)

24. During aging, some people may suffer from an eye defect which is caused by the degeneration of light-sensitive cells in the yellow spot. Which of the following diagrams is the most likely vision perceived by a person suffering from this eye defect?

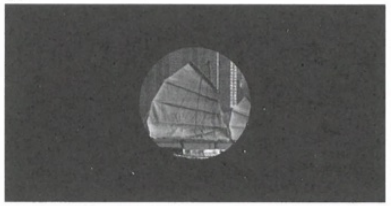
A.



B.

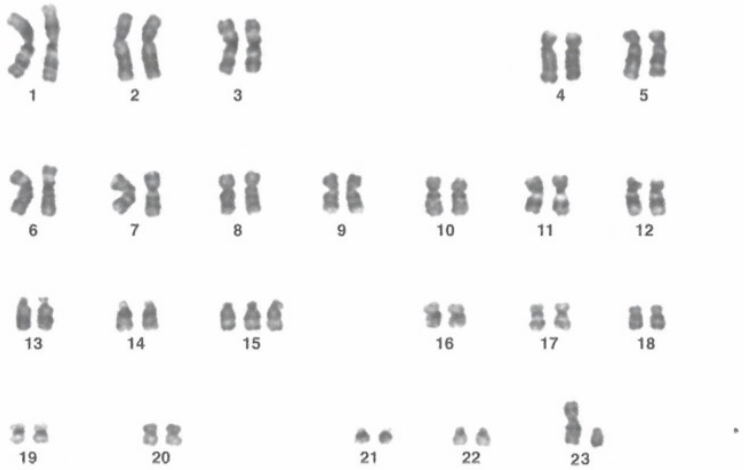


C.



D.

4. The photomicrograph below shows the karyotype of a patient who is suffering from a certain brain disease:



(a) What is the gender of this patient? Describe ***one*** observable feature from the karyotype to support your answer. (2 marks)

(b) (i) Describe the abnormality shown in the karyotype. (1 mark)

(ii) State the type of mutation involved in this abnormality. (1 mark)

(iii) How would this abnormality affect the mRNA level in the brain cells of this patient? (1 mark)

(c) The cerebellum is one of the regions affected by this disease. In relation to the function of the cerebellum, suggest ***one*** difficulty that would be experienced by this patient. (1 mark)

DSE M.C. Questions - Coordination in humans
(sort by difficulty)

Challenging

/

Average

2012 Q.4 (63%)

Which of the following gives the correct direction of impulse transmission in a neurone?

A. axon → cell body → dendrites
B. dendrites → cell body → axon
C. cell body → axon → dendrites
D. dendrites → axon → cell body

2012 Q.5 (61%)

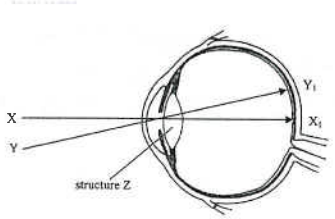
Chemicals released at the synapse are responsible for the impulse transmission from

(1) sensory neurone to interneurone
(2) interneurone to motor neurone
(3) motor neurone to muscle

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3) only

Direction:

Question 27 and 28 refer to the diagram below, which shows a section of the human eye and the positions X_1 and Y_1 where the images of two coloured objects X and Y are formed respectively on the retina:



2013 Q.27 (64%)

Which of the following correctly describes a person's visual perception in day time?

A. X appears brighter because cone cells are found at position X_1.
B. X appears sharper because cone cells are found at position X_1.
C. Y appears black and white because rod cells are found at position Y_1.
D. Y appears blurred because rod cells are found at position Y_1.

Average

2013 Q.28 (55%)

When a person ages, structure Z becomes less elastic. When this happens, a person will probably have difficulty focusing on

A. a nearby object because structure Z cannot be thicken fully.
B. a nearby object because structure Z cannot be pulled thin fully.
C. a distant object because structure Z cannot be thicken fully.
D. a distant object because structure Z cannot be pulled thin fully.

2013 Q.29 (62%)

Which of the following combinations correctly matches the structure of the human ear and its function?

	Structure	*Function*
A.	ear flap	protecting the ear
B.	ear drum	amplifying sound waves
C.	ear bones	transmitting vibrations
D.	round window	setting the endolymph in motion

2015 Q.27 (72%)

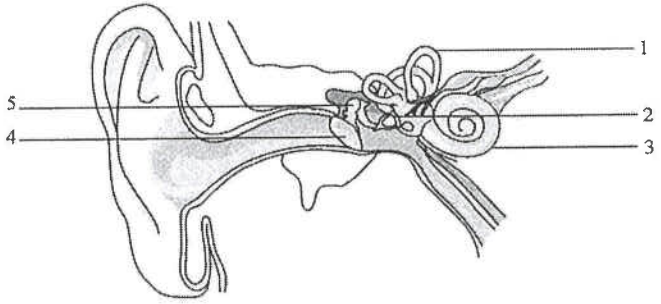
Which of the following combinations correctly shows the conditions of different parts of the eyes when a person is looking at an object moving towards him?

	Lens	*Suspensory ligament*
A.	becoming thinner	slackening
B.	becoming thinner	tightening
C.	becoming thicker	slackening
D.	becoming thicker	tightening

Average

2017 Q.26 (73%)

Directions: Questions 25 and 26 refer to the diagram below, which shows the structures of a human ear:



Which of the following structures will vibrate when there are sound waves?

A. 1 and 3 only B. 2 and 3 only C. 2, 3 and 4 only D. 2, 4 and 5 only

2017 Q.27 (71%)

Which of the following combinations correctly matches the problem of short sightedness and its correction?

	Problem	*Correction*
A.	image focused behind the retina	wear concave lens
B.	image focused behind the retina	wear convex lens
C.	image focused in front of the retina	wear concave lens
D.	image focused in front of the retina	wear convex lens

2017 Q.28 (66%)

Which of the following correctly explains why our eyes feel tired if we have been reading a book for a long time?

A. The ciliary body has contracted for a long time.
B. The photosensitive cells have been over-stimulated.
C. The lens has maintained a curved state for a long time.
D. The suspensory ligament has been under tension for a long time.

Average

2017 Q.29 (53%)

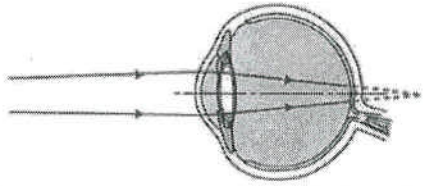
The diagram below shows a motor neurone:

Which of the following statements correctly describes the motor neurone?

A. X is connected to a muscle fibre.
B. Electrical impulses are transmitted from Y to X.
C. Synapses can be found at the end of both X and Y.
D. Electrical impulses are sent out at Y to the next neurone.

2018 Q.7 (74%)

Below is a ray diagram of a common eye defect:



Which of the following combinations correctly identifies the eye defect and type of lens to be worn to remedy it?

	Eye defect	*Type of lens*
A.	Long-sightedness	convex lens
B.	Long-sightedness	concave lens
C.	Short-sightedness	convex lens
D.	Short-sightedness	concave lens

Average

2019 Q.16 (56%)

Peter wanted to throw a crumpled paper into the rubbish bin in the dim room. He found that he could see a bin more clearly if he tried to focus on objects right next to the bin. Which of the following statements about the image formation of the bin is correct?

A. Image of the bin is formed on the yellow spot where there are cone cells only.
B. Image of the bin is formed on the yellow spot where there are more cone cells than rod cells.
C. Image of the bin is formed on the periphery of the retina where there are rod cells only.
D. Image of the bin is formed on the periphery of the retina where there are more rod cells than cone cells.

2019 Q.17 (59%)

Wearing contact lenses for too long will have an adverse effect on the eyes because this decreases the amount of oxygen reaching the eyes. Which of the following eye structure is most affected in this case?

A. iris B. lens C. cornea D. sclera

2019 Q.21 (54%)

Daisy is very hungry. When the waiter puts her favourite dish on the table, her saliva secretion increases. Which of the following body parts controls this response?

A. cerebrum
B. cerebellum
C. salivary gland
D. medulla oblongata

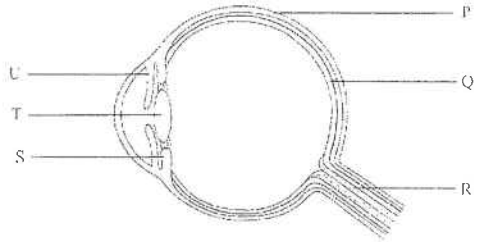
Easy

2012 Q.6 (79%)

Which of the following activities is coordinated by the cerebellum?

A. muscular movements during dancing
B. breathing movements during sleeping
C. secretion of digestive juices when one is hungry
D. withdrawal of hand when one touches a hot object

Directions: Question 8 and 9 refer to the diagram below, which shows a section of the human eye:



2012 Q.8 (81%)

Which part of the eye is tough and white in colour?

A. P B. Q C. R D. S

2012 Q.9 (87%)

Which of the following parts are made of muscle?

A. P and S B. Q and R C. R and T D. S and U

2015 Q.22 (86%)

Toys are often used to develop children's fine motor skills. Which of the following parts is trained when children play with toys?

A. cerebellum
B. spinal cord
C. pituitary
D. medulla oblongata

Easy

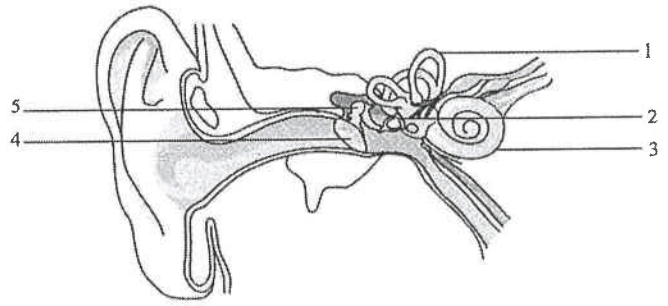
2015 Q.23 (84%)

Which of the following correctly compares reflex actions and voluntary actions?

	Reflex actions	*Voluntary actions*
A.	responses may vary	responses are always the same
B.	stimulus is optional	stimulus is required
C.	initiated by receptors	initiated in the brain
D.	effectors must be muscles	effectors can be muscles or glands

2017 Q.25 (79%)

Directions: Questions 25 and 26 refer to the diagram below, which shows the structures of a human ear:



Which of the following structures is ***not*** involved in hearing?

A. 1 B. 2 C. 3 D. 4

Easy

2017 Q.30 (87%)

Which of the following ***does not*** belong to the central nervous system?

A. medulla oblongata
B. spinal cord
C. cerebellum
D. eye

2018 Q.22 (76%)

Which of the following combinations correctly identifies the distribution of grey matter and white matter in the cerebrum and spinal cord?

	Inner part of the cerebrum	*Inner part of the spinal cord*
A.	White matter	grey matter
B.	White matter	white matter
C.	Grey matter	grey matter
D.	Grey matter	white matter

Answers

Challenging

Average

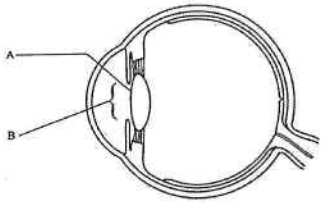
2012	2013	2015	2017	2018	2019
4 [B]	27 [B]	27 [C]	26 [D]	7 [A]	16 [D]
5 [D]	28 [A]		27 [C]		17 [C]
	29 [C]		28 [A]		21 [D]
			29 [C]		

Easy

2012	2015	2017	2018
6 [A]	22 [A]	25 [A]	22 [A]
8 [A]	23 [C]	30 [D]	
9 [D]			

CE - 2003

3. (a) The diagram below shows a section the human eye:



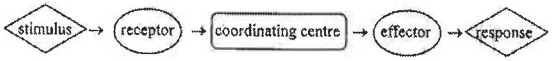
(i) Structure A has no blood capillaries.
(1) Why is this feature important to the formation of a clear image? (1)
(2) From where does structure A obtain nutrients? (1)

(ii) When a person steps out from a dark room into broad daylight, B becomes constricted.
(1) Explain the importance of this response. (2)
(2) State the type of response illustrated by the constriction of B. (1)
(3) The person also puts on his sunglasses. With regard to the nature of the response, state two ways in which this action is different from the constriction of B. (2)

(iii) In recent years, dark-coloured sunglasses are in fashion, but some of these sunglasses cannot cut off ultra-violet light. Suggest why wearing such sunglasses under bright sunlight would be more damaging to the eye than not wearing any sunglasses. (3)

CE - 2004

2. (c) Irritability is the ability of an organism to respond to an external stimulus. Most cases of irritability work in the following pattern :



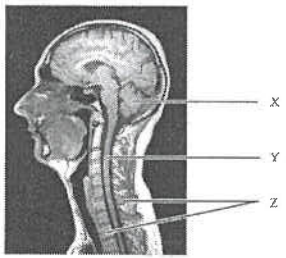
Below are three examples of irritability in humans:

(I) Secretion of saliva when food is ingested
(II) Constriction of pupil under bright light
(III) Running out of the classroom upon hearing of fire alarm

(i) For case I, state the receptor and the effector involved. (2)
(ii) Based on the above pattern, use a flowchart to show the nervous pathway for case II, including the types of neurons involved. (3)
(iii) (1) Name the region of the brain where the coordinating centre for case III islocated. (1)
(2) State two features of the responses controlled by this region. (2)

CE - 2006

3. The figure below shows a magnetic resonance image of the lateral side of the upper body of a person.



(a) Name structure X and state its function. (2)

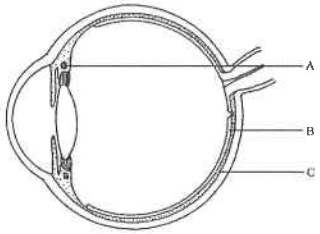
(b) What is the importance of structure Z to structure Y? (1)

(c) The diagram below shows the transverse section of structure Y and an outline of the arm:

On the above diagram, draw the reflex arc for the withdrawal reflex of the arm and label the different components of the reflex arc. (4)

CE - 2007

7. (a) The diagram below shows a section of a human eye:



(i) (1) Name structureA. (1)

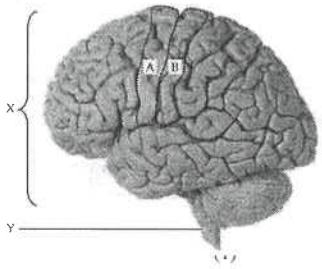
(2) Structure A becomes weak in an old man. Explain how this will affect his eye sight when he looks at a nearby object. (4)

(ii) Suggest one possible change of the lens which will also weaken the eyesight. (1)

(iii) With reference to the function of layer C, explain why the falling off of layer B from layer C may cause blindness. (4)

CE - 2008

2. The photograph below shows the lateral view of a human brain.



(a) The surface of structure X is highly folded. What is the significance of this feature? (1)

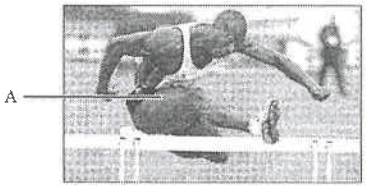
(b) Name structure Y and state ***one*** of its functions. (2)

(c) A patient who suffered from a stoke was diagnosed to have part of area A damaged. After the stroke, it was found that he had difficulty in moving his arm. What is area A? (1)

(d) Area B is located behind area A. What is area B?

CE - 2009

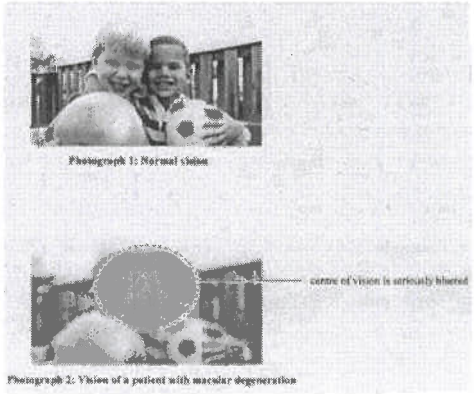
7. The photograph below shows an athlete leaping a hurdle.



(b) Describe the roles of different parts of the brain in bringing about the action of leaping the hurdle. (4)

CE - 2010

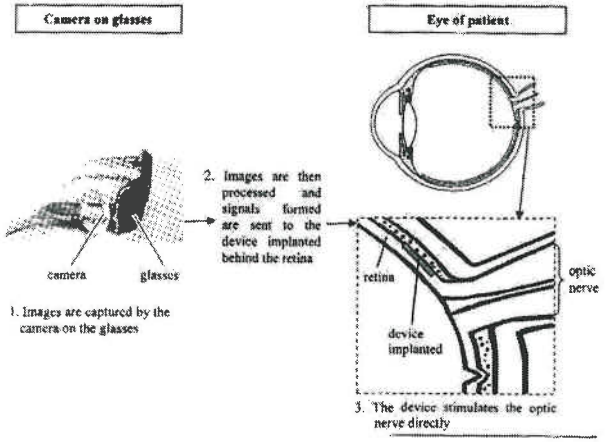
5. (a) Macular degeneration(視網膜黃斑變性) is a disease resulting in the loss of light-sensitive cells in the yellow spot of patients, The following photographs show normal vision and the vision of a patient with macular degeneration.



(i) State the type of light-sensitive cell that is lost in this disease. (1)

(ii) Explain why the vision of the patient with macular degeneration is seriously blurred in the centre. (2)

(b) The vision of patients with macular degeneration may be helped by bionic eyes. A bionic eye consists of a camera mounted on a pair of glasses worn by the patient. Signal from the camera are sent to a device implanted behind the retina of the eye of the patient. The diagram below show how the bionic eye works.



(i) Why can the bionic eyes also help the patients to see even when the lenses in their eyes become cloudy? (1)

(ii) Can the bionic eyes used to help other patients without any light-sensitive cells in their retina? Give one reason for your answer. (2)

(iii) In another type of bionic eye, a device is implanted in the brain. After receiving signals, the device will directly stimulate the brain to generate vision.

(1) Name the part of the brain where the device should be implanted. (1)

(2) Give one advantage of this type of bionic eye over the type illustrated in the diagrams in part (b). (1)

AL - 2002 2B

5. (a) What are the roles played by the different parts of the nervous system in the reception of various stimuli, signal integration and response initiation in the following incident?

'While riding a bicycle on the street, a boy saw a red traffic light in front and stopped his bicycle.' (9)

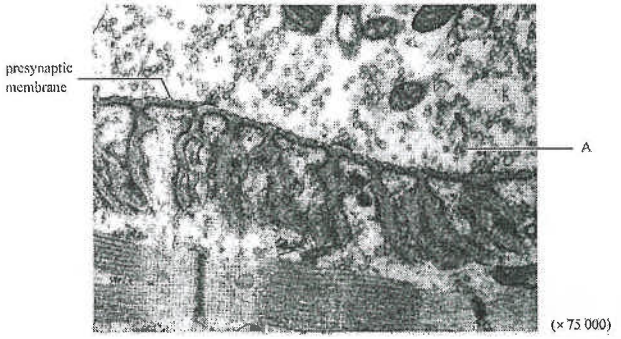
(b) Based on the differences between hormonal and nervous co-ordination, explain how their modes of action enable mammals to cope with different situations in life. (N.B. Reference to specific hormones is NOT necessary.) (7)

AL - 2004 2B

4. (a) When a boy entered a cinema from broad daylight, he could not see in the dark surroundings immediately. However, his vision resumed after a short while. After being seated, he could **clearly see** the actresses on the screen wearing colourful dresses but he could not see the people around him clearly. Explain the visual experiences of the boy in the cinema based on your knowledge and understanding of the rods and cones in the eye. Present your answer in paragraphs. (8)

AL - 2007 1A

6. The following electron micrograph shows a neuromuscular junction:



(a) Name the chemical substance inside A. (1)

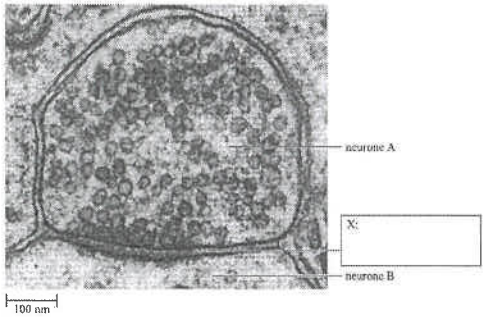
(b) A certain type of food pisoning - botulism - is caused by the ingestion of a bacterial toxin. This toxin acts by blocking the presynaptic membrane, resulting in muscle paralysis. Based on this information and features in the micrograph above, explain how this toxin brings about the paralytic effect. (3)

AL - 2008 2B

5. (a) Reflex and tropism are important responses of humans and flowering plants respectively. Contrast these two types of responses. Using suitable examples, discuss the significance of these responses to the organisms concerned. (11)

AL - 2009 1A

1. The following electron micrograph shows the junction between two neurones A and B



(a) Give a label for X in the box provided above. (1)

(b) With reference to ***one*** observable feature shown in the electron micrograph, deduce the direction of signal transmission between the two neurones. (3)

AL - 2010 1A

2. A visually normal person stared at a blue cross printed on a piece of white paper for 60 seconds. After that, he looked at a plain white screen and an image of a yellow cross was perceived. This can be explained by the mechanism of colour vision. Complete the following paragraphs with suitable word(s). (5)

Visual perception of the colour blue is due to the stimulation of the cone cells responsible for _(a)_____. After staring at the blue cross for some time, these cone cells became temporarily _(b)_____. On the retina where the image of the blue cross was previously formed, only the _(c)_____cone cells were stimulated when the person looked at the plain white screen. These cone cells sent signals via the _(d)_____to the visual centre at the _(e)_____of the brain. Thus, an image of a yellow cross was perceived.

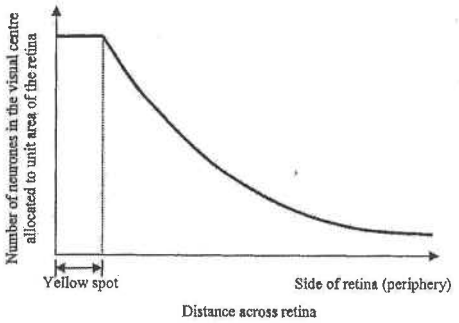
HKDSE - 2013 1B

1. For each of the brain parts listed in column 1, select from column 2 one phrase that matches it. Put the appropriate letter in the space provided.

Column 1		Column 2
Cerebellum	.....	A. Damage causes inability to make decisions
Medulla oblongata	.....	B. Damage causes loss of body balance
Cerebrum	.....	C. Damage causes loss of control of breathing rate
		D. Damage causes loss of withdrawal reflex

HKDSE - 2014 1B

10. The visual centre of the brain is responsible for processing nerve impulses from the retina. The number of neurons in the visual centre allocated to receiving impulses from a unit area of the retina is shown below (only half of the retina is shown):



(a) With reference to the types of photoreceptor cells and their distribution on the retina, explain why more neurons in the visual centre are allocated to unit area of the yellow spot. (4 marks)

(b) After the perception of what we 'see', what it means to us depends on other parts of the brain. Explain how this works. (2 marks)

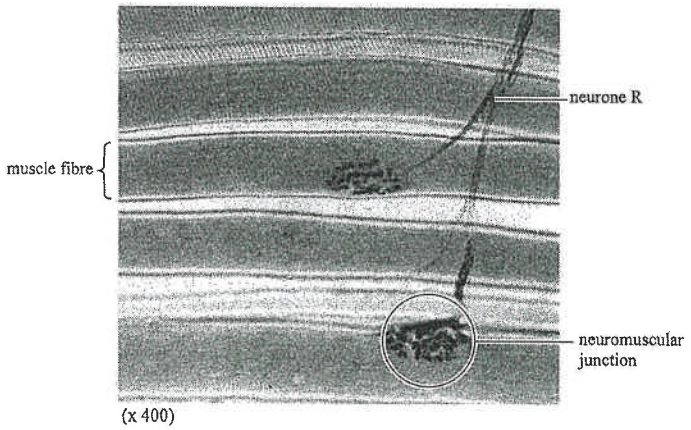
HKDSE – 2015 1B

1. For each of the ear parts listed in column 1, select from column 2 one phrase that matches it. Put the appropriate letter in the space provided. (3 marks)

Column 1		Column 2
Ear bones	_____	A. Transmitting vibrations
Eustachian tube	_____	B. Transmitting sound waves
Cochlea	_____	C. Converting sound waves to vibrations
		D. Converting vibrations to nerve impulses
		E. Equalizing the air pressure on either side of the ear drum

5. On the opposite page, Photograph P shows several muscle fibres associated with the terminal parts of neurone R and Photograph Q shows the detailed structure of a neuromuscular junction.

Photograph P



(x 400)

Photograph Q

(x 4500) part of muscle fibre

(a) Which type of neurones does R belong to? Give a reason for your answer. (2 marks)
(b) What is the functional relationship between S and T shown in Photograph Q?(2 marks)
(c) Describe how nerve impulses can be transmitted across the neuromuscular junction leading to muscle contraction. (3 marks)

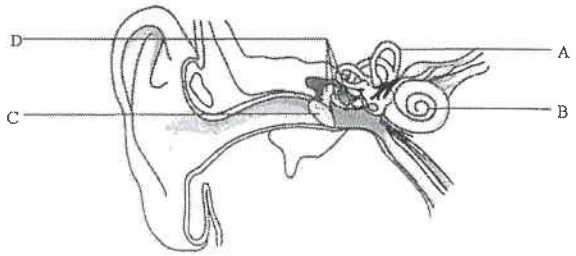
HKDSE – 2016 1B

1. The table below shows the condition which may result from damage to a certain part of the brain. Complete the table by filling in either the condition or the structural part of the brain affected. (3 marks)

Condition	*Structural part of the brain*
Difficulty in breathing	
	Cerebellum
Difficulty in speech and vision	

HKDSE - 2018 1B

1.The diagram below shows the human ear and its associated structures:



(a) The table below lists two types of hearing loss. Using the label(s) in the above diagram, indicate which structure(s) is/are most likely to be defective in each case. (2 marks)

	Type of hearing loss	Structure
X	Damage to sensory hair cells	
Y	Failure of sound conduction	

Ludwig van Beethoven, a famous 18th century composer, suffered from type Y hearing loss in his 20s and became deaf in his 40s. some records say that he could hear music through his jawbone and skull by biting on a metal rod attached to his piano. Based on the structures and functions of human ears, complete the following flow chart to show the major steps involved in his method of hearing music.

(i)_____ of the metal rod

↓

transmission through bones to reach (ii)_____

↓

detection of (iii)_____ movement by sensory hair cells

↓

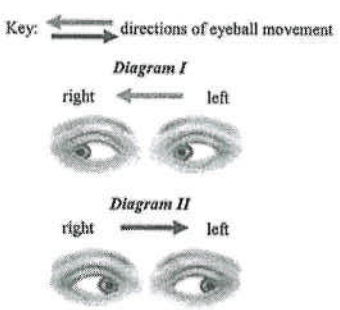
generation and transmission of nerve impulses through (iv)_____

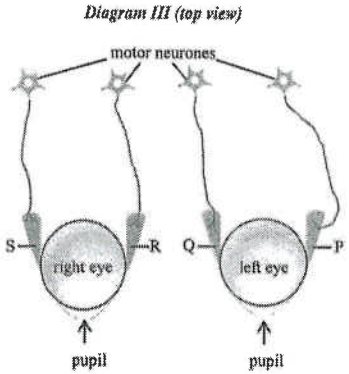
↓

interpretation at the sensory area of the cerebrum

HKDSE - 2019 1B

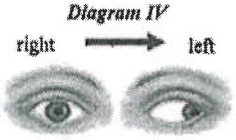
4. Diagrams I and II below show a person with both eyes moving right and then left. This eyeball movement is brought about by the coordination of different eye muscle pairs. Diagram III shows four of the muscles (P, Q, R, and S), all connected to motor neurons controlling eyeball movement.





(a) To bring about the eyeball movement shown in Diagram I, which muscle(s) (P, Q, R, or S) contract(s)? (1 mark)

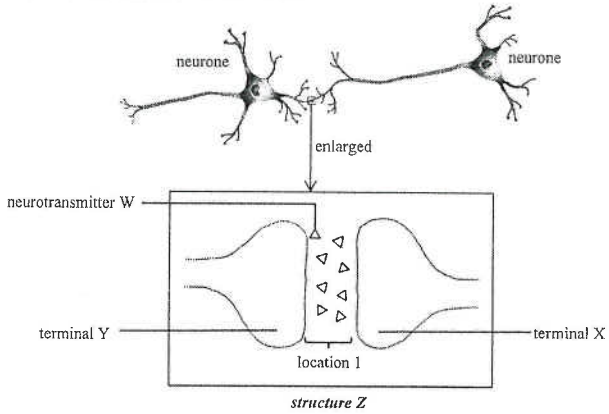
(b) A person suffers from impaired eyeball movement when turning his eyes from right to left, as shown in Diagram IV.



It is found that one of his eye muscles cannot fully contract. Based on your knowledge of neurotransmission at the neuromuscular junction, suggest two possible defects that would lead to the impaired eyeball movement shown in Diagram IV. (2 marks)

HKDSE - 2021 1B

2. The diagram below shows two adjacent neurones. When a nerve impulse arrives at structure Z, the amount of neurotransmitter W at location 1 increases.



(a) Name structure Z. (1 mark)

(b) (i) Neurotransmitter W at location 1 is released from one of the terminals of structure Z. Which terminal (X or Y) releases neurotransmitter W? (1 mark)

(ii) Describe how the neurotransmitter W at location 1 can bring about the transmission of nerve impulses at structure Z. (2 marks)

(c) What is the significance of the process in (b) to the transmission of nerve impulses? (1 mark)

Past papers Marking Scheme – Coordination in humans

CE - 2003 Q.3 (a)

(i) (1) To allow the transmission of light to the retina without obstruction 1
(2) aqueous humour / choroids 1

(ii) (1) It helps to reduce the amount of light entering the eyes 1
so as to prevent over-stimulation / damage of the light-sensitive cells 1
(2) reflex action 1
(3)

Constriction of B	Putting on sunglasses
Does not involve the cerebrum	Involves the cerebrum
Inborn	Learned action
Faster in action	Slower in action
Stereotyped response i.e. same stimulus always evokes the same response	Variable responses to the same stimulus

any 2 1,1

(iii) Dark-coloured sunglasses reduce the light intensity entering the eye 1
so the pupil will not constrict / constrict to a smaller extent in bright sunlight 1
As a result, more UV light can enter the eye and cause damage 1

CE- 2004 Q.2 (c)

(i) Receptor: taste buds / smell receptor Effector: salivary glands 1,1

(ii) (light) → light sensitive cells —sensory neurone→ relay neurone in brain —motor neurone→ muscle of iris → (contraction of iris muscle / pupil constriction)
6 x ½

(iii) (1) *cerebrum 1
(2) The responses can be .controlled voluntarily
They are not stereotyped
They need to be learned any two 1,1

CE - 2006 Q.3

(a) *cerebellum 1
It is for coordinating the activities of muscles in maintaining body balance 1
(b) Z protects Y from mechanical damage 1
(c) Drawing of different neurones: correct position of cell bodies, presence of 2 synapses only, ½, ½
Label: receptor/nerve ending, sensory neurone, interneurone, motor neuron, effector/biceps/muscle (any four) 4 x ½
Correct pathway : Indicate the direction of nerve impulse transmission
Or direction can be identified from the label(s) of the component 1

CE - 2007 Q.7 (a)

(i) (1) ciliary muscles 1
(2) When the man is looking at near object, the weakened ciliary muscle contract with less force 1
and the tension of the suspensory ligament remains high 1
Hence, the lens is not thick enough 1
and fails to converge light to form a clear image on the retina 1
(ii) The lens becomes less elastic / cloudy 1
(iii) Layer B contains light sensitive cells 1
cannot obtain nutrients / oxygen from layer C 1 +
As a result, light sensitive cells die 1
Light falling on layer B cannot be detected / no nerve impulse can be produced 1
Therefore the vision is impaired

CE - 2008 Q.2

(a) To harbour more neurones / nerve cells
(✓ cell bodies / interneurone; × cells / brain cells) 1

(b) Y: * medulla oblongata / medulla 1
It acts as the reflex centre for some reflex actions
It controls involuntary actions } any one 1

Correct function with wrong example → 0
Correct function with example of reflex and involuntary action mixed up → 1
Give correct example instead of function → 1

(c) Motor area 1
(d) Sensory area 1

CE- 2009 Q.7 (b)

(b) Cerebellum coordinates muscular contraction of the whole body 1
to maintain body balance 1
Cerebrum sends nerves impulses to various muscles 1
for contraction to leap the hurdle / to initiate the voluntary action of leaping the hurdle 1

CE - 2010 Q.5

5. (a) (i) Cone (1)
(ii) Vision in the centre mainly relies on the detection of light falling on the yellow spot (1)
As the yellow spot contains cone cells only, light falling on this spot can hardly be detected by the patient with this disease (1)
The vision becomes blurred in the centre

(b) (i) The use of the bionic eyes replaces the normal light path through the lenses for image formation (1)
(ii) Yes (2 or 0)
Signals from the camera are sent to the device which stimulate the optic nerve directly/ light-sensitive cells are not required for the stimulation of optic nerve
(iii) (1) *Cerebrum/ *cerebral cortex/ *sensory area/ * visual area (1)
(2) This type of bionic eye can give visual sensation to a person with damage in optic nerve/ rupture of eyeball/ no eyeball (1)

AL - 2002 2B

5. (a) Stimuli reception
- cones on retina of eye stimulated by red light (1), $^{+}$produce sensory impulses (1) 2
- utriculus / sacculus perceive position of head (1), $^{+}$generate sensory impulse (1) 1
- semi-circular canals perceive rotational movement of the head (1) at deceleration / stopping 1

Signal integration
- association centre in the cerebral cortex (1) processes impulses from the visual cortex (1) and medulla (1) / cerebellum, and relay them to the motor centre in the cerebral cortex (1) 4

Response initiation
- motor centre in cerebral cortex sends impulses (1) 3
- to the muscles of the hands / legs to stop bicycling (1)
- sends impulses to other skeletal muscles to maintain balance (1)

(N.B. $^{+}$mark to be given once only, candidates must show that they have attempted in all 3 areas to earn full mark of 9) (max. 9)

(b)

Hormonal co-ordination	Nervous co-ordination	
Different situations in life		
• cope with stimuli which involves gradual change (1), deal with prolonged response (1) (Bonus (1): for sustaining long term survival / adaptations)	• cope with sudden stimuli (1) / emergency situations, and the need for short-duration response (1)	4 + bonus = 1
Mode of action of the hormonal and nervous systems		
• hormones are circulated in blood (1)	• electrical nature of nervous impulse conduction (1) allows quick co-ordination (1)	3 } max. 5
• diffuse / systematic response (1), synchronizes different parts of the body to contribute to overall response (1)	• localized response (1), enables specific parts of the body to cope with the situation (1)	4

(max. 7)

AL - 2004 2B

4. (a) Reasons for unable to see for a while upon entry into the cinema then vision resumed:
- $^{+}$rods responsible for dim light vision as the surrounding is dim (1)
- bright light bleaches / splits the pigment (1) in the rods (1)
- no response can be generated from the rods to produce vision (1) max. 4
- during pigment regeneration time, the boy cannot see in the dimly lit surrounding (1) / pigment takes time to regenerate
- vision resumes when pigment in the rods is reformed / regenerated (1)

Reasons for clearly seeing the colourful dresses of the actresses on the screen:
- screen is brightly lit and cones are responsible for colour vision in bright light (1) max. 3
- concept of one cone one neurone (1), ∴ visual acuity (1)
- high density of cones at fovea increases resolving power to see clearly (1)

Reasons for not seeing the people around the body clearly: 3
- $^{+}$rods responsible for dim light vision as the surrounding is dim (1)
- concept of many rods share 1 neurone (1), ∴ low acuity (1) / vagueness

(N.B. $^{+}$ = concept to be awarded mark once only) (max. 8)

AL - 2007 1A

6. (a) acetylcholine (1) / neurotransmitter (1)

(b)
- the toxin blocks the release of the neurotransmitter into the cleft (1) (max. 3)
- there will be no neurotransmitter to stimulate the post-synaptic membrane (1) / no depolarization of sarcolemma
- the post-synaptic membrane / sarcolemma will not develop action potential (1)
- in the absence of nervous stimulation, myofilaments will not slide over one another (1), thus muscles will fail to contract

AL - 2008 2B

5. (a)

Reflexes	Tropism	
• response is elicited by external or internal stimuli	• response is elicited by external stimuli	1
• Stimuli involved may or may not be unilateral	• stimuli involved are unilateral	1
• messages involved are electrochemical in nature (1)	• messages involved are chemical in nature (1)	1, 1
• most are non-directional responses	• directional responses, either towards or away from the stimulus	1
• quick responses	• slower responses	1
• non-growth responses	• growth responses	1

max. 6

Significance:	Significance:
• protection against danger (1) / damage > pupil reflex protects retina /photoreceptors from damage by strong light (1) > withdrawal from heat / sharp points protect the skin from being burnt / cut (1) > blinking reflex / tear production protects the eyes from mechanical damage (1)	• to position its body parts so as to obtain adequate supply of light, nutrients, water for better growth and survival (2) **or** • phototropism helps to bring leaves towards light for more food production (1) / photosynthesis, for proper growth and development of shoot (1) • geotropism helps to bring root into the soil for nutrient and water absorption (1) and for anchorage (1)

Significance:	Significance:
• adjustment to changes in internal environment for optimum body function (1) > breathing rate increases in response to increased carbon dioxide level in arterial blood so as to speed up the removal of carbon dioxide (1) • as reactions to perform body functions (1) > proprioceptors for keeping muscle tone in maintaining posture (1) > salivation in anticipation of food to prepare for digestion in mouth (1) > dilation of pupil under dim conditions allows more light to reach the retina (1) > when distended by food peristalsis of intestine increases to help movement of food inside (1) **max.4**	• hydrotropism helps to bringroots to areas of the soil with higher water content (1) **max .4**

max. 7

AL - 2009 1A

1. (a) *synaptic cleft / gap (1) ×synapse (1)

(b) • signal transmits from neurone A to neurone B (1) (1)
• presence of a large number of vessicles in the synaptic knob of neurone A (1) (1)
• shows that A is the presynaptic neurone (1)
• which releases neurotransmitter to depolarize the membrane of B / next neurone (1) } any one (1)

4 marks

AL - 2010 1A

2. (a) · detecting blue light (1) [not colour vision]
(b) · bleached/ overstimulated/ fatique/ unavailable for further stimulation (1) (5)
(c) · red and green
(d) · optic nerve (1)
(e) · cerebral cortex/ cerebrum (1)/ visual cortex (not accept sensory area)

5 marks

HKDSE - 2013 1B

1. B (1)
C (1)
A (1)

HKDSE - 20141B

10. (a) • yellow spot contain a high density of cones cells (1)
• and there are three types of cones for colour perception (1),
• as a result, there are more sensory nerve impulses coming from the yellow spot (1) (4)
• from the yellow spot (1), hence more neurones are allocated to analysis of the nerves impulses

(b) • impulses received from the visual cortex will be interpreted at the association area (1)
• where relevant information about the image will be retrieved from the previously stored information (1) (2)

6 marks

HKDSE – 2015 1B

1. A, E, D 1,1,1

5. (a) motor neurone(1)
it is connected to an effector (1), i.e. muscle fibre in this case 2

(b) S provide energy (1)
for the synthesis / secretion / resynthesis of the neurotransmitter / chemical messenger stored in T (1) 2

(c) arrival of nerves impulses at the motor nerve ending triggers the release of neurotransmitters into the neuromuscular junction (1)
these neurotransmitters diffuse across the synapse (1) and
to initiate electrical impulse in muscle fibres / bind to the receptor sites on the membrane of the muscle fibre (1) to trigger muscle contraction 3

HKDSE – 2016 1B

1.

HKDSE – 2018 1B

1. (a) • B (1)
• C and D (1) (2)

(b) (i) vibrations (1)

(ii) oval window / cochlea (1)

(iii) lymph / fluid (1) (4)

(iv) auditory nerve (1)

6 marks

HKDSE – 2019 1B

4. (a) • Q and S (1) (not acceptable: Q or S) (1)

(b) Any two of the following: (not acceptable : axon, neurone, neurotransmitter cannot diffuse across synaptic cleft) (2)

- insufficient amount of / abnormal or damaged vesicles at the synaptic knob or in sufficient amount of mitochondria to provide energy for vesicles to synthesize neurotransmitters (1)
- insufficient amount of neurotransmitters is released at the neuromuscular junction (to stimulate R) (1) (no mark: P or Q or S)
- neurotransmitter is degraded too rapidly (1)
- insufficient amount of / abnormal or damaged receptors to bind with neurotransmitters (1)

3 marks

23. Which of the following structures are the components of a joint?

(1) bone
(2) tendon
(3) ligament

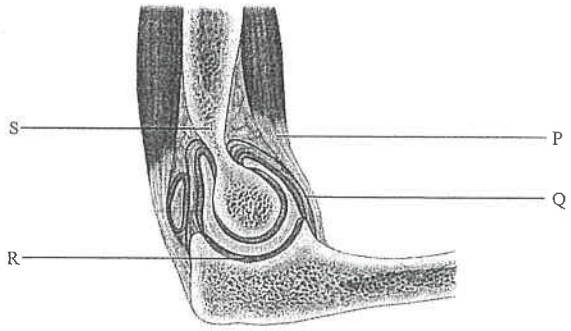
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE M.C. Questions - Movement in humans
(sort by difficulty)

Challenging

2015 Q.21 (39%)

Directions: Questions 20 and 21 refer to the diagram below, which shows an elbow joint and its associated structures:



Structure S is able to

(1) carry out respiration.
(2) store minerals.
(3) produce blood cells.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Average

Directions: Questions 34 and 35 refer to the Diagram I and Diagram II below. Diagram I shows a yoga instructor in a yoga posture. Diagram II shows some of the muscles associated with her left leg.

Diagram I

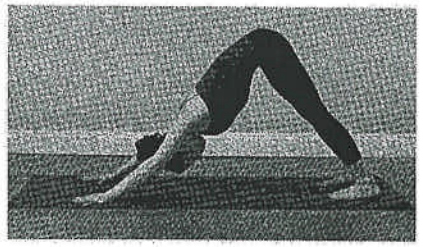
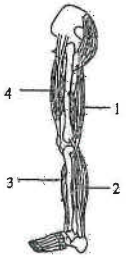


Diagram II



2014 Q.34 (54%)

Which muscles of the left leg of the yoga instructor are contracting when she maintains the posture shown in diagram I?

A. 1 and 2 B. 1 and 3 C. 2 and 4 D. 3 and 4

2014 Q.35 (58%)

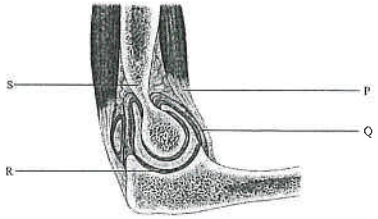
Which muscles of the left leg are flexors?

A. 1 and 2 B. 1 and 3 C. 2 and 4 D. 3 and 4

2015 Q.20 (67%)

Directions:

Questions 20 and 21 refer to the diagram below, which shows an elbow joint and its associated structures:



Which of the above structures are elastic?

A. P and R only B. P and S only C. Q and R only D. Q and S only

Average

Directions: Question 19 to 21 refer to the diagrams below. Diagram I shows the reflex arc of the knee jerk reflex while diagram II shows three types of neurons:

Diagram I

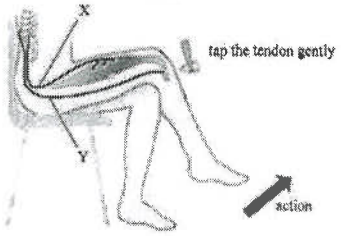
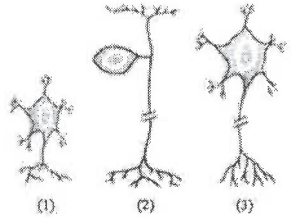


Diagram II



2018 Q.19 (73%)

The effector in the reflex are in Diagram I is

A. a flexor because its response bends the limb
B. an extensor because its response straightens the limb
C. a flexor because it shortens to bring about the movement
D. an extensor because it lengthens to bring about the movement

2018 Q.20 (50%)

Which of the following combinations correctly identifies the types of neurons to which X and Y belong?

	X	Y
A.	(1)	(3)
B.	(2)	(1)
C.	(2)	(3)
D.	(3)	(2)

2018 Q.21 (58%)

Another neural pathway allows the man to feel the tapping action. Which of the following parts should this pathway connect to?

A. Cerebellum
B. Spina cord
C. Cerebral cortex
D. Medulla oblongata

Average

2019 Q.20 (65%)

Directions: Question 19 to 20 refer to Diagram I and Diagram II below. Diagram I shows a leg and its associated muscles while Diagram II shows a woman practicing yoga.

Diagram I

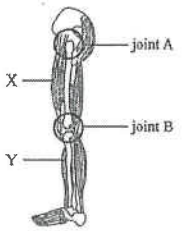


Diagram II

Which of the following combinations correctly indicates the state of muscles X and Y when the woman is maintaining the yoga posture shown in Diagram II?

	X	*Y*
A.	contracted	contracted
B.	contracted	relaxed
C.	relaxed	contracted
D.	relaxed	relaxed

Easy

2012 Q.7 (76%)

In a movable joint, the tissue holding the bones together is called

A. ligament.
B. cartilage.
C. muscle.
D. tendon.

2019 Q.19 (84%)

Directions: Question 19 to 20 refer to Diagram I and Diagram II below. Diagram I shows a leg and its associated muscles while Diagram II shows a woman practicing yoga.

Diagram I

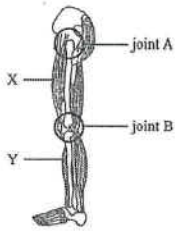


Diagram II

Which of the following combinations correctly identifies joints A and B in Diagram I?

	Joint A	*Joint B*
A.	Hinge joint	Hinge joint
B.	Hinge joint	Ball and socket joint
C.	Ball and socket joint	Ball and socket joint
D.	Ball and socket joint	Hinge joint

2021

23. Which of the following correctly describe the functions of the intervertebral disc?

(1) It prevents the wearing of the vertebrae.
(2) It encloses the spinal cord.
(3) It allows the bending of the vertebral column during movement.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Answers

Challenging

2015
21 [D]

Average

2014	2015	2018	2019
34 [D]	20 [C]	19 [B]	20 [B]
35 [B]		20 [D]	

Easy

2012	2019
7 [A]	19 [D]

CE - 1997

4. (c) The photographs below show two postures of a woman doing sit-up exercises :

Photograph 1 (Posture 1)

Photograph 2 (Posture 2)

(i) Describe how the movement of the head can be detected by the semi-circular canals of the ear when the woman changes her posture from 1 to 2. (5)

(ii) Referring to photograph 2, which muscles in her arms biceps or triceps, are in a contracted state so that she can touch her knees? (1)

(iii) Give two structural features of the backbone which allow it to bend to a smooth and curved shape as shown in photograph 2. (2)

(iv) Suggest one advantage of doing regular exercise. (1)

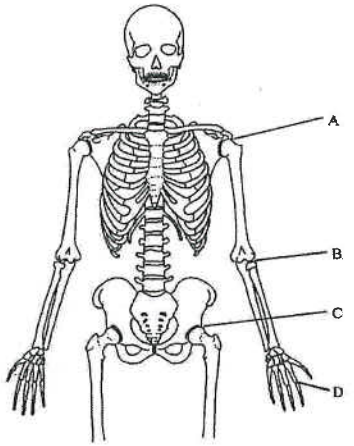
CE - 1998

2. (c) The diagram below shows part of the human skeleton:

(i) Joints A, B, C and D can be classified into two types according to their freedom of movement. Name these two types of joints. Classify A, B, C and D into these two types. (4)

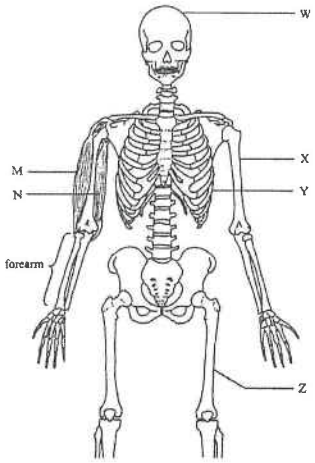
(ii) State how the vertebrae help to maintain the upright posture of a person. (2)

(iii) Osteoporosis is a condition in which the bone material of a person decreases and the bones become more porous and lighter than normal. It is more common in old people. Suggest, with a reason, one way in which people could reduce the chance of getting osteoporosis.(2)



CE - 2002

1. (b) The diagram below shows the human skeleton and two muscles of the right arm, M and N:



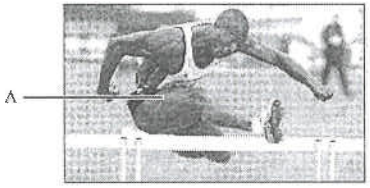
(i) Deficiency of vitamin D in childhood will lead to deformity of bones.
(1) Using the letters in the diagram, indicate which part of the skeleton is most easily deformed. Explain your choice. (3)
(2) Apart from diet, suggest another way by which the body gets vitamin D. (1)

(ii) Why are muscles M and N described as an antagonistic (opposing) pair? (1)

(iii) Draw a diagram to show the lever system involved in lifting the right forearm. Indicate the positions of the load, and the fulcrum in your diagram. In lifting the right forearm, what will form the load, the effort and the fulcrum respectively? (5)

CE - 2009

7. The photograph below shows an athlete leaping a hurdle.



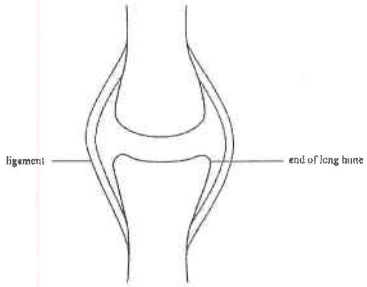
(a) The contraction of muscle A leads to the raising of the lower leg. How do muscle A and other related structures of the leg bring about this action? (3 marks)

AL - 2006 2B

6. (c) Describe how bones and the associated skeletal muscles work together to bring about locomotion. (4)

AL - 2007 1A

5. (a) The diagram below shows some structures of a hinge joint:
On the diagram, draw and label those components that serve to reduce friction at the joint during movement. (4)



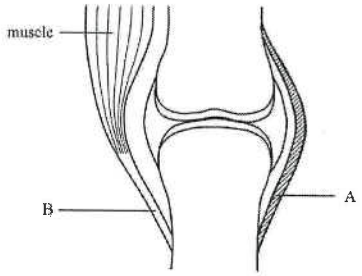
(b) Ligaments are elastic while tendons have very low elasticity. Explain how the elasticity of each structure is important to its function. (2)

AL - 2010 2B

5. (b) In the elderly, knee joints degenerate and the secretion of synovial fluid decrease. This results in knee pain when they walk. Account for the phenomenon in relation to the structure and functioning of the knee joint. (4)

HKDSE - 2013 1B

2. The diagram below shows the structures of a joint.



(a) Name the type of joint shown and suggest an example of such a joint in the body. (2)
Type of joint:
Example in the body:

(b) Briefly describe how A and B work together to bring about movement at the joint shown. (4 marks)

HKDSE - 2017 1B

1. For each of the components of the musculoskeletal system listed in Column I, select from Column II one phrase that correctly describes it. Put the letter in the space provided.(3 marks)

Column I		*Column II*
Ligament	_____	A. Inelastic tissue found at the two ends of a skeletal muscle
Tendon	_____	B. Elastic tissue found at the two ends of a long bone
Cartilage	_____	C. Inelastic tissue that surrounds a joint
		D. Elastic tissue that binds bones together

Past papers Marking Scheme – Movement in humans

CE - 1997 Q. 4 (c)

(i) The movement of the head results in the movement of the endolymph / the gelatinous structure of the semi-circular canal 1
in the direction opposite to the head movement 1
This stimulates the sensory hair cells 1
and nerve impulses are generated and 1
carried to the cerebrum for interpretation 1
Effective communication (c) *1*

(ii) triceps 1

(iii) The backbone is made up of many vertebrae / small bones which are articulated by joints
There are compressible cartilage discs between the vertebrae any two 1,1

(iv) Improve the functioning of the lungs / the heart
Help to reduce body weight
Improve musculature / improve strength of muscles
Improve / maintain the flexibility of joints
Reduce stress / tension any one 1

CE - 1998 Q.2 (c)

(i) *ball and socket joint ; A and C 1+1
*hinge joint ; B and D 1+1

(ii) Vertebrae are linked together by ligaments)
to form a column) any
and they allow the attachment of muscles for maintaining the posture) two 1,1

(iii) Take in more vitamin D [1] to help the absorption of calcium from food [1]

Take in more calcium [1] for bone formation [1] any one set

Do regular weight-bearing exercise [1] to stimulate the increase in bone mass [1]

CE - 2002 Q.1 (b)

(i) (1) Z 1
Deficiency of vitamin D will lead to poor bone growth 1
As Z is not strong enough, the body weight exerting on it will cause it to bend 1
(2) The body produces its own vitamin D under sunlight / UV light 1

(ii) because when producing movements, one muscle contracts, the other relaxes / the contraction of M bends the arm and that of N extends the arm 1

(iii) Title (T) ½
Position of load, effort, fulcrum correct (P) 1 0r 0
Direction of arrows correct (A) ½

The weight of the forearm forms the load 1
The force generated by the contraction of muscle M forms the effort 1
The elbow joint forms the fulcrum 1

CE - 2009 Q.7 (a)

(a) The contraction of muscle A provides a pulling force 1
the force is transmitted o the bone of he lower leg via inelastic tendons 1
This allows movement across the knee joint 1
to raise the lower leg
Effective communication (c) 1

AL – 2006 2B

6. (c) • bones provide a surface for muscular attachment (1) max. 4
• bones and their associated skeletal muscles form a lever system (1) with the joint being the fulcrum (1)
• contraction of skeletal muscles provides the effort (1) / force for pulling onto the bone to bring about movement (1)
• antagonistic pairs of skeletal muscles attached to bones (1) bring about movements in opposite directions (1)

AL - 2007 1A

5 (a) · drawing to show the synovial membrane and articular cartilage (4)
· labels: articular cartilage / cartilage (1)
synovial membrane (1)
synovial fluid (1)

(b) · ligaments have to be elastic so as to allow a certain degree of flexibility in the movement (1) of bones relative to one another at the joint (2)
· tendons have to be of lower elasticity as this will ensure most of the force of muscle contraction is used to pull onto the bones (1) / effective / efficient transfer of force to the bones to bring about movement, instead of stretching the tendons

AL – 2010 2B

5. (b) · when one walks, the knee joint is bent and straightened alternately to bring about movement (1) and bears the weight of the upper body (1) (4)
· as there is less synovial fluid, there is more friction between the articular cartilages (1)
· continuous rubbing leads to wearing of the articular cartilage (1) of the bones at the knee joint
as a result, it would result in pain when they walk

HKDSE - 2013 1B

2. (a) Type of joint: hinge joint * 1
Example in our body: elbow joint / knee joint 1

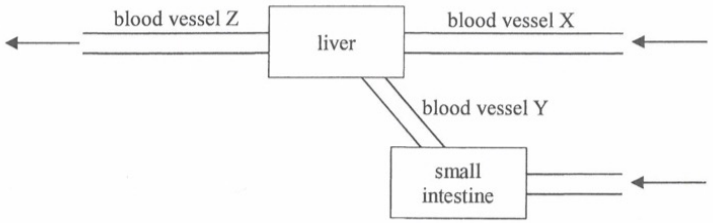
(b) • A binds bones together (1)
• and prevents dislocation of the bones (1) during movement
• B attaches the muscle to the bone (1) (4)
• and transmits the pulling force (1) produced by muscle contraction

HKDSE – 2017 1B

1. • D (1)
• A (1)
• B (1) (3)

3 marks

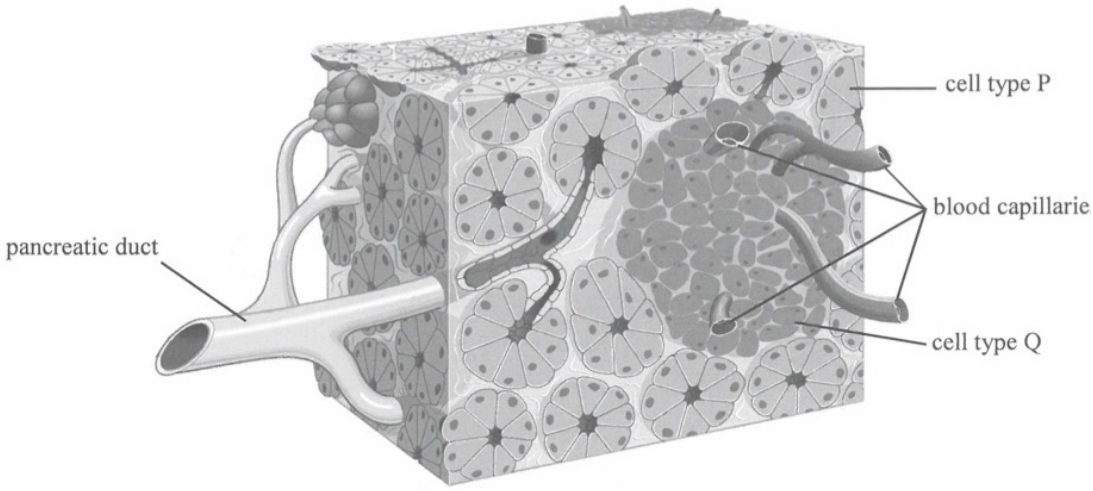
Directions: Questions 21 and 22 refer to the diagram below, which shows part of the human circulatory system and the associated organs:



21. Which of the following correctly compares the blood glucose concentration in blood vessels X, Y and Z when a person is fasting?

A. X > Z > Y
B. Y > X > Z
C. Z > Y > X
D. Z > X > Y

6. The schematic diagram below illustrates the distribution of different cell types in the human pancreas:



(a) Which type of cells, P or Q, secretes hormones? Support your answer with ***one*** observable feature illustrated in the diagram. (3 marks)

(b) A person jogs slowly for an hour. Describe how the hormones from the pancreas can regulate the blood glucose level of the person while jogging. (4 marks)

DSE M.C. Questions - Homeostasis

(sort by difficulty)

Challenging

/

Average

2019 Q.18 (61%)

Which of the following organs serves both endocrine and exocrine functions?

A. Pancreas
B. Pituitary
C. Oesophagus
D. Adrenal gland

Easy

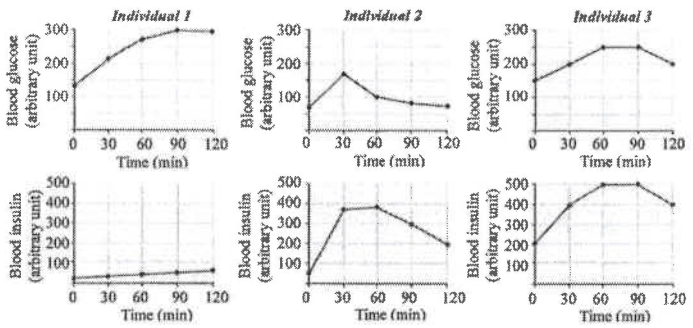
2013 Q.33 (79%)

A person has not taken any food for 24 hours. Which of the following will increase in concentration in blood?

A. glucagon
B. glucose
C. glycogen
D. insulin

2020 Q.31

31. The graphs below show the changes in blood glucose level and the blood insulin level of three individuals after consuming a sugary drink:

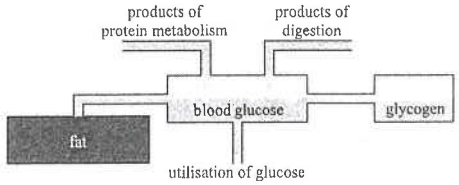


Which of the following combinations correctly shows the health conditions of these three individuals?

	Individual 1	*Individual 2*	*Individual 3*
A.	No diabetes	Type 1 diabetes	Type 2 diabetes
B.	Type 1 diabetes	Type 2 diabetes	No diabetes
C.	Type 2 diabetes	No diabetes	Type 1 diabetes
D.	Type 1 diabetes	No diabetes	Type 2 diabetes

2021 Q.26,27

Directions: Questions 26 and 27 refer to the model below, which shows the regulation of blood glucose level in humans:



26. A student adds the following remarks to this model. Which remark is *incorrect*?

A. Glycogen can be stored in muscles.
B. Insulin converts glucose to glycogen for storage.
C. The products of digestion take the form of simple sugars.
D. The products of protein metabolism come from the liver.

27. When the blood glucose level is higher than normal, which of the following changes is *incorrect*?

A. The utilisation of glucose will increase.
B. The conversion of fat to glycogen will increase.
C. The conversion of blood glucose to fat will increase.
D. The conversion of blood glucose to glycogen will increase.

Answers

Challenging

Average

2019
18 [A]

2020
31 [D]

Easy

2013
33 [A]

Past papers – Homeostasis

CE - 2000

3. (b) Diabetes mellitus is a disease found in humans and other mammals. The main symptom of this disease is the presence of glucose in the urine. In the early twentieth century, the cause of diabetes mellitus was still known. In order to study this disease, a scientist performed the following experiments on dogs :

Experiment	Experimental subject	Treatment	Result
1	Healthy dogs	Removing the pancreas	Symptoms of diabetes appeared
2	Diabetic dogs from experiment 1	Injecting extracts of pancreas	Symptoms of diabetes disappeared
3	Diabetic dogs from experiment 1	(a) Injecting extracts of pancreas which had been treated with protease	Symptoms of diabetes remained
		(b) Injecting extracts of pancreas which had been treated with lipase	Symptoms of diabetes disappeared

(i) Comparing the results of experiments 1 and 2, what conclusion can be drawn? (2)

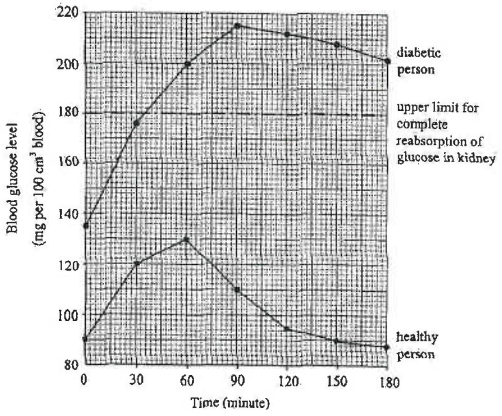
(ii) What is the aim of performing experiment 3? (2)

(iii) Based on the results of experiments 2 and 3 (a), explain whether the diabetic dogs would show symptoms of the disease if they were treated with the extracts of pancreas by feeding instead of by injection. (3)

(iv) Based on your biological knowledge, explain why the urine of a diabetic person usually contains glucose. (5)

CE - 2002

1. (c) In a study, a healthy person and a person with diabetes mellitus fasted for 12 hours. They then stayed at rest in the same room and drank equal volumes of glucose solutions of the same concentration. Their blood glucose levels were measured immediately afterwards and at 30-minute intervals for three hours. The results are shown in the graph below:



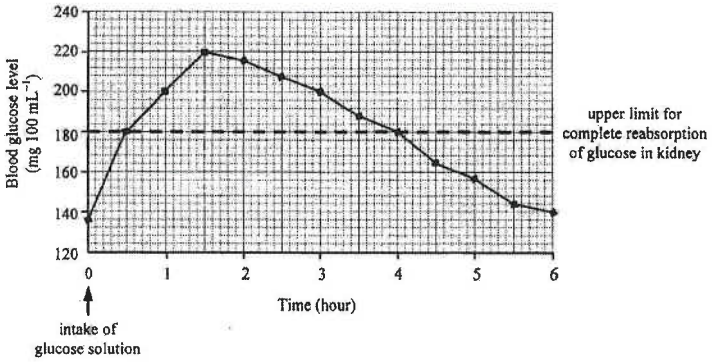
(i) What is the increase in the blood glucose level after 1 hour in
(1) the healthy person
(2) the diabetic person? (2)

(ii) Explain why the healthy person had a smaller increase in blood glucose level in the first hour when compared with the diabetic person. (4)

(iii) During the study, a larger volume of urine was produced by the diabetic person than the healthy person. Suggest an explanation for this. (4)

CE - 2005

9. (a) In a medical test, George drank a glass of glucose solution. The graph below shows the subsequent changes of his blood glucose level:



(i) Based on the graph, state the period in which the urine of George would contain glucose. Explain why glucose in the blood would appear in the urine during this period. (4)

(ii) The doctor diagnosed that George had diabetes mellitus and advised him to get insulin injection for treatment. Which organ of George was likely to be defective? (1)

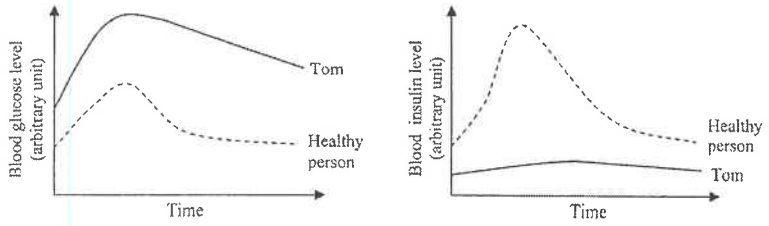
(iii) The insulin used for treating diabetes mellitus can be obtained from pigs and cattle, or produced by genetically modified bacteria. State two advantages of using insulin produced by the bacteria over that obtained from mammals. (2)

(iv) (1) Besides insulin, name another hormone that is responsible for the regulation of blood glucose level. (1)

(2) State one effect of this hormone on the activity of liver cells. (1)

DSE-2012 1B

7. Tom suffers from diabetes. His doctor asked him to drink, after overnight fasting, a large volume of a glucose solution. After that, blood samples were taken at regular time intervals, to measure insulin and glucose contents. The following graphs show the changes in Tom's blood glucose level and blood insulin level after the test, and those of a healthy person:



(a) Which type of diabetes does Tom suffer from? Explain your answer. (4 marks)

(b) Explain the difference in blood glucose response to the oral consumption of glucose solution between Tom and the healthy person. (3 marks)

(c) What medical treatment should Tom be given? (1 mark)

HKDSE – 2015 1B

8. In a health check, Lisa was found to have glucose in her urine. She undertook a further check in which she has fasted for 12 hours before a blood sample was taken for examination. The results of the blood tests are shown below:

Test	Result	Normal range	Units
Blood glucose	8.4	4-6	mmol L^{-1}
Insulin	0.2	3-32	μU mL^{-1}
Glucagon	130	20-100	μg L^{-1}

(a) State the type of diabetes Lisa is suffering from. (1 mark)

(b) With reference to the production and actions of the two hormones, account for the results of Lisa's blood tests.

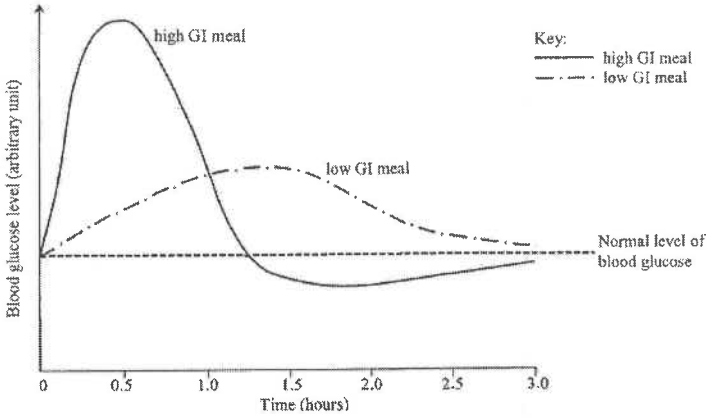
(i) Insulin (3 marks)

(ii) Glucagon (3 marks)

(c) Suggest *two* dietary habits that Lisa should establish. (2 marks)

HKDSE – 2018 1B

7. The glycemic Index (GI) is an indication of the effect of food on the blood glucose level. The higher the GI value of a food, the quicker is the rise in blood glucose level. The graph below shows the changes in the blood glucose level of a healthy individual after consuming the same quantity of a low GI or high GI meal over a period of three hours:



(a) Describe how the consumption of a meal leads to an increase in the blood glucose level (2 marks)

(b) (i) Name the key hormone which lowers the blood glucose level. (1 mark)

(ii) Describe how this hormone lowers the blood glucose level. (3 marks)

(iii) On the graph on the opposite page (page10), sketch a curve to show the change in the level of this key hormone in response to the consumption of high GI meal by the healthy person. (2 marks)

(c) Explain why diabetic patients should consume low GI meals. (2 marks)

Past papers Marking Scheme – Homeostasis

CE - 2000 Q.3 (b)

(i) Diabetes is caused by the absence of certain substance(s) 1
which can be found in pancreas 1

(ii) To determine whether the substance in the pancreas extract effective in treating diabetes is a protein 1
or a fat 1

(iii) Symptoms of diabetes would remain 1
This is because protease in the alimentary canal 1
will digest the active substance which is protein in nature 1

(iv) In the diabetic person, the pancreas cannot produce enough insulin 1
Thus the liver cannot convert excess glucose in the blood into glycogen 1
His blood glucose concentration remains high 1
leading to a high level of glucose in the glomerular filtrate 1
The kidney tubules cannot reabsorb all the glucose from the filtrate 1
thus glucose is excreted in the urine
Effective communication (c) *1*

CE - 2002 Q.1 (c)

(i) (1) 40 mg per 100 cm^3 blood 1
(2) 65 mg per 100 cm^3 blood 1
Deduct ½ mark for each answer if the unit is left out; wrong unit, no mark

(ii) In the healthy person, the initial rise in blood glucose level stimulates the secretion of insulin 1
by the pancreas 1
while there is no / less insulin secretion in the diabetic person 1
Insulin stimulates the conversion of glucose into glycogen in the liver / uptake of glucose by body cells 1
so the increase in blood glucose level in the healthy person is smaller 1
Effective communication (c) *1*

(iii) Since the 36th minute, the blood glucose level of the diabetic person is higher than the upper limit for complete reabsorption of glucose 1
so glucose is present in the filtrate / urine in the collecting duct 1
The water potential of the filtrate / urine is lowered by the glucose present 1
thus the reabsorption of water is reduced 1
and a larger volume of urine would be produced 1

CE - 2005 Q.9 (a)

(i) 0.5 to 4 hour 1
Blood glucose is filtered into the kidney tubule 1
In this period, the glucose level in the glomerular filtrate is higher than the upper limit for complete reabsorption of glucose 1
so some glucose will be left in the glomerular filtrate / cannot be reabsorbed and excreted in the urine 1

(ii) Pancreas 1

(iii) Less side effects
More effective in action
Insulin produced from genetically modified bacteria is cheaper and in greater supply
(accept other reasonable answers) any two 1,1

(iv) (1) glucagon 1
(2) Glucagon will stimulate the conversion of glycogen in liver cells to glucose 1

exceed the threshold value 1
that glucose cannot be completely reabsorbed in the kidney 1
Thus it appears in the urine
Effective communication (c) *1*

CE - 2007 Q.8 (b)

(i) Glucose consumption increases during exercise 1
because glucose is used in respiration / respiration rate is faster 1
to provide more energy for muscle concentration 1

(ii) More glucagons is released during exercise 1
which stimulates the conversion of glycogen to glucose in liver 1
to restore the blood glucose level / compensates for the increase in glucose consumption 1
Effective communication (c) *1*

(iii) Trends:
Increase during exercise 1
Decrease after exercise 1

CE - 2008 Q.8 (b)

(b) (i) Diabetic patients lack insulin / do not have enough insulin in their blood 1
and hence the liver fails to convert glucose into glycogen for storage ... 1
During intense exercise, blood glucose is consumed for muscle activities / more blood glucose is consumed 1
The blood glucose level drops continuously without replenishment from the glycogen stored 1

(ii) (1) It takes time for starchy food to be digested before absorption 1
As a result, a small amount of glucose is absorbed gradually 1
The fluctuation of blood glucose level is less / blood glucose level will not increase too fast after a normal meal 1

(2) Sugar is easily digested / absorbable 1
Blood glucose level can be raised immediately / quickly /
Faster to alleviate the symptoms of hypoglycaemia 1

AL - 2006 1B

10. (a)
- absorption of glucose from the gastrointestinal tract (1) results in an elevation of plasma glucose level
- this rise triggers the release of insulin (1) which stimulates glucose uptake into its target tissues (1) / the conversion of glucose into glycogen in the liver, resulting in the decline in plasma glucose level

3

(b) Any two of the following:
- B shows a sharper rise in plasma glucose level (1)
- plasma glucose level of B rises to a higher peak than A (1)
- the peak of plasma glucose level in B occurs later than that in A (1)
- its level fails to return to its basal level after 3 h, while that of A drops back to the basal level (1)

2

(c)
- B has no / very low insulin secretion (1) despite an increase in plasma glucose level,
- indicating that B has insulin-dependent diabetes mellitus (1) / type 1 diabetes mellitus
- C shows a sharp increase in the plasma insulin level (1), yet his / her plasma glucose level remains higher than normal
- indicating that C has no-insulin-dependent diabetes mellitus (1) / type 2 diabetes mellitus

4

(9)

AL - 2008 1A

7. (a)
- due to uncontrolled growth of insulin-secreting cells (1), this pancreatic cancer probably leads to an excessive secretion of insulin (1)
- as insulin stimulates the conversion of blood glucose by the liver (1)
- / uptake of blood glucose by cells, excessive insulin secretion would reduce the blood glucose to a low level (1)

max. 3

- As a result of insufficient blood glucose supply to the brain(1), the man would feel dizzy

1

(4)

(b)
- some tissues of the pancreas secrete protease and lipase (1)
- they may be removed together with the cancerous tissues(1), and this would make the digestion of protein and fat difficult

AL 2009 2A

2. (b)
- insulin serves to enhance glucose uptake into body cells (1) from the plasma,
- if the drug is overdosed, a sudden over-secretion of insulin would cause the plasma glucose level to become much lower than the normal (1) and there would be insufficient supply of glucose to the brain cells (1) which depend solely on glucose for respiration (1)

(4)

(c) (i) Any two of the following sets: 2 x (1+1)
- vegetables consist of much indigestible dietary fibre (1) which will not contribute to the blood glucose level (1)
- the fibre can bond with other carbohydrates (1) / slow down their digestion, and reduces the absorption of glucose into the blood (1)
- the fibre also gives a sense of satiety, thus reducing food intake (1) and subsequently helps restrict the increase in plasma glucose level (1)

(4)

(ii)
- small meals will restrict the amount of glucose to be absorbed in each meal (1)
- frequent meal provides sufficient glucose in between meals (1)

(2)

DSE-2012 1B

7. (a)
- despite the high blood glucose level detected in his blood, his fasting blood insulin level was lower than that of the healthy person (1) (1)
- although there is an increase in blood glucose level, the insulin level only shows little change (1) (1)
- this shows that Tom failed to produce the normal amount of insulin (1) (1)
- therefore, Tom suffered from insulin-dependent diabetes (1) / type I diabetes (1)

(b)
- with insufficient insulin, his body cells will not take up extra glucose from the blood as efficiently as the healthy person (1)
- as a result, the blood glucose concentration rised to a higher level (1) after glucose consumption (3)
- and remains high for a longer time / decreases slower than the healthy person (1)

Remarks: conversion of glucose to glycogen by insulin is not acceptable

(c)
- by injection of insulin (1) / aerosal spray of insulin applied to nasal cavity (1)

8 marks

HKDSE – 2015 1B

8. (a) type I diabetes / insulin-dependent diabetes mellitus 1

(b) (i) Lisa's pancreas failed to secrete enough insulin (1)
as a result her body / liver cells cannot be sufficiently stimulated to increase the uptake of glucose from blood / liver cells cannot be stimulated to convert glucose to glycogen / body cells cannot be stimulated to increase glucose oxidation (1)
hence, her blood glucose level dropped very slowly / remained at high level / exceeded the normal range (1) even after 12 hours of fasting 3

(ii) Without the inhibitory effect of insulin, Lisa's pancreas secretes a large amount of glucagon (1)
her liver cells are stimulated (1)
to promote the conversion of glucose from glycogen / amino acid (1)
leading to a high glucose level in blood 3

(c) having frequent meals but in small portions (1)
Avoid food which elevates blood glucose level in a short time (1) 2

HKDSE – 2018 1B

7. (a)
- digestion of foods containing carbohydrates to form glucose (1)
- absorption of glucose from the small intestine into the blood (1) (2)

(b) (i)
- insulin (1) (1)

(ii)
- it stimulates the body cells and liver cells to take up more glucose from blood (1)
- increases respiration in body cells to consume glucose (1) (3)
- it stimulate the conversion of glucose to glycogen by the liver / muscle cells (1)

(iii)
- has initial basal value and drops back to basal value at the end (1), effect lags behind (1) (2)

(c)
- low GI food will lead to small fluctuations in blood glucose level (1) (2)
- the chance of having too high blood glucose level / glucose appearing in urine is reduced (1)

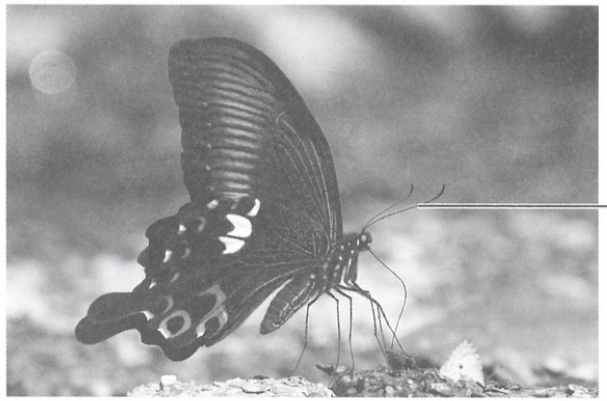
10 marks

10. *Habenaria* is a genus of orchids with dull-coloured and scented flowers, which attract moths for pollination at night. In the group, *H. rhodocheila* is an exceptional species with reddish flowers which lack a detectable scent. It was found that no insects visited the flowers of *H. rhodocheila* at night for pollination while insect species A consumed nectar from the flowers in the daytime.

(a) The following dichotomous key can be used to identify the group to which insect species A belongs:

1a	with wings	.....	2
1b	without wings	.....	Group P
2a	antennae longer than head	.....	3
2b	antennae shorter than head	.....	Group Q
3a	wings rest at their sides	.....	Group R
3b	wings rest together upright	.....	Group S

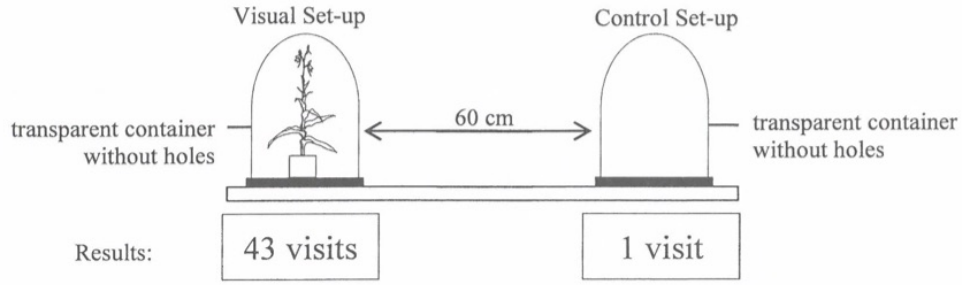
The photograph below shows the appearance of species A at rest. Using the above key, write down the sequence which leads to the identification. (1 mark)



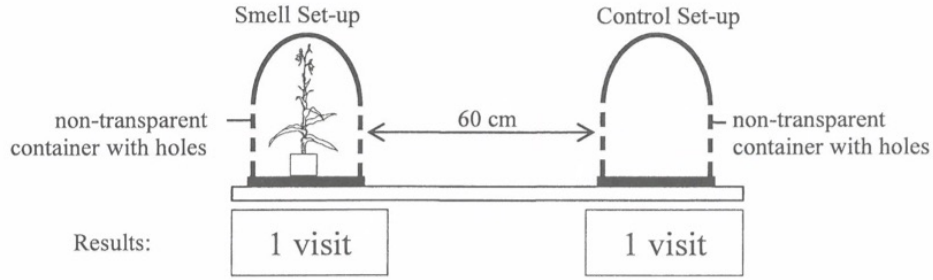
(b) In this case, *H. rhodocheila* was evolved from other *Habenaria* species. Suggest how the speciation of *H. rhodocheila* could be facilitated by different insect pollinators. (3 marks)

(c) To determine if insect species A is attracted to the flowers of *H. rhodocheila* by its appearance or its smell (if any), researchers designed an investigation as shown in the diagrams below:

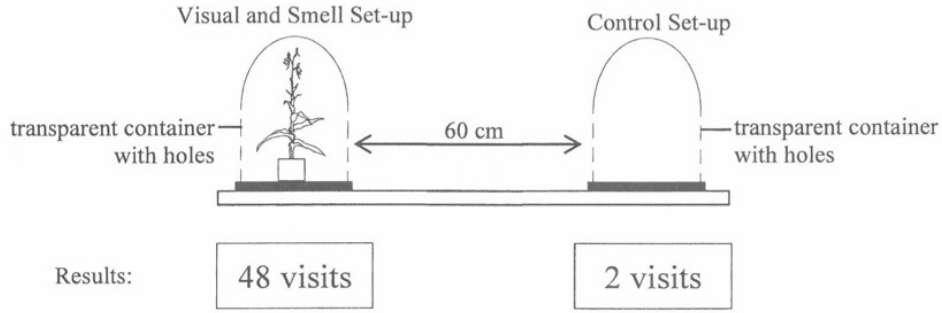
Treatment 1:



Treatment 2:



Treatment 3:



In each treatment, two set-ups were placed in an open area at a distance of 60 cm from each other for one hour. After that, the position of the two set-ups was exchanged for another hour. During the two-hour period, if an individual of species A approached any set-up to a distance of less than 10 cm, it was counted as one visit. The number of visits to each set-up is shown in the boxes in the above diagrams.

(i) To ensure that the investigation was a fair test, exchanging the positions of the two set-ups was a necessary step. Explain why. (1 mark)

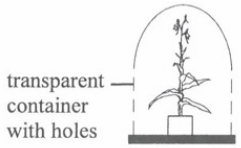
(ii) With reference to the aim of the investigation, what conclusions can you draw from the results of Treatment 1 and Treatment 2 respectively? (4 marks)

(iii) When Ann and Ken compared the results of the three treatments, they had different interpretations. Ann thought that the larger number of visits in Treatment 3 might reflect a synergistic effect of visual and smell attractions while Ken thought that it might be simply due to random variations. To verify Ann's idea, they decided to conduct a further investigation with two more treatments for comparison.

The diagrams below show the Visual and Smell Set-up. In each treatment, complete the corresponding Control Set-up by putting a '✓' in the appropriate boxes to show the conditions that should be adopted. (2 marks)

Treatment 4:

Visual and Smell Set-up



Conditions for the corresponding Control Set-up:

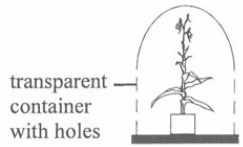
☐ with plant ☐ without plant

☐ transparent container ☐ non-transparent container

☐ container with holes ☐ container without holes

Treatment 5:

Visual and Smell Set-up



Conditions for the corresponding Control Set-up:

☐ with plant ☐ without plant

☐ transparent container ☐ non-transparent container

☐ container with holes ☐ container without holes

DSE M.C. Questions - Biodiversity
(sort by difficulty)

Challenging

2014 Q.15 (35%)

Which of the organisms below belong to the domain Eukarya?

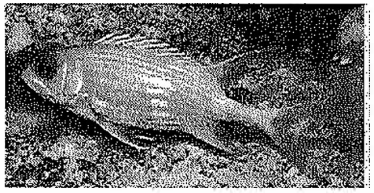
(1) Yeast
(2) Amoeba
(3) Mouse

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2014 Q.18 (31%)

Directions: Questions 17 and 18 refer to the following photographs of two different fish:

Fish X ***Fish Y***



Which of the following allow further study of the phylogenetic relationship between the two fish?

(1) Compare the amino acid sequences of their functional proteins
(2) Compare their internal body structure
(3) Compare their living habitats and behaviours

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Average

2013 Q.21 (54%)

Which of the following combinations shows the correct information about Eubacteria and Protista?

	Eubacteria	***Protista***
A.	bigger in size	smaller in size
B.	absence of cell wall	presence of cell wall
C.	presence of true nucleus	absence of true nucleus
D.	absence of mitochondria	presence of mitochondria

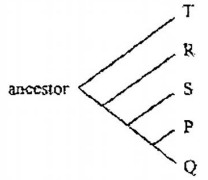
Directions: Questions 14 and 15 refer to the information below. Five new species of eubacteria were discovered in Antarctic ice core samples. The nucleotide sequences of the gene that codes for an essential protein of these new species were compared. The table below shows the number of nucleotide differences between the species:

2016 Q.14 (68%)

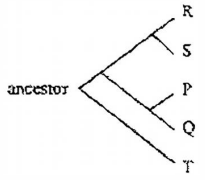
	Number of nucleotide differences				
Species	P	Q	R	S	T
P	-	4	12	11	22
Q		-	12	11	19
R			-	4	22
S				-	22
T					-

Which of the following evolutionary trees best illustrates the phylogenetic relationship of the five species?

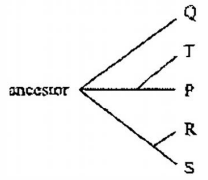
A.



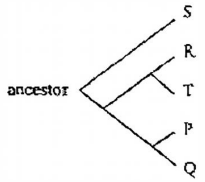
B.



C.



D.



Average

2016 Q.15 (51%)

Which of the following cell components can be found in these species?

A. nucleus
B. cell wall
C. chloroplast
D. mitochondrion

2018 Q.9 (41%)

Which of the following statements provides the best reason for classifying unicellular organisms into domain Bacteria and Archaea?

A. Archaea are more ancient than bacteria
B. Archaea are smaller than bacteria
C. The DNA sequences of archaea are distinct from those of bacteria
D. The compositions of the cell wall and cell membrane of archaea are different from those of bacteria

2018 Q.32 (64%)

Organisms P and Q are found in the same local habitat. Their population sizes have continued to grow in the last few years. Which of the following statements best describes organisms P and Q?

A. They are heterotrophs.
B. They are top predators.
C. They have different niches.
D. They have different predators.

Easy

2014 Q.17 (81%)

Directions: Questions 17 and 18 refer to the following photographs of two different fish:

Fish X

Fish Y

Using the dichotomous key below to identify the fish:

1a Both eyes on the top of the head..... 2
1b One eye on each side of the head..... 3

2a Has long whip-like tail..... *Aetobatus narinari*
2b Has short, blunt tail ..... *Bothus mancus*

3a Has spots on its surface..... 4
3b Does not have spots on its body surface..... 5

4a Has chin whiskers..... *Pseudupeneus maculatus*
4b Does not have chin whiskers..... *Sphoerosides spengleri*

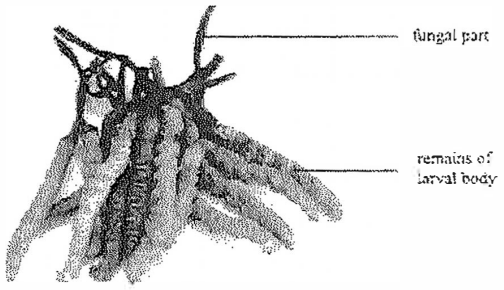
5a Has stripes on its body surface ..... *Holocentrus rufus*
5b Does not have stripes on its body surface..... *Parapriacanthus guentheri*

	Fish X	***Fish Y***
A.	*Bothus mancus*	*Pseudupeneus maculatus*
B.	*Bothus mancus*	*Holocentrus rufus*
C.	*Aetobatus narinari*	*Parapriacanthus guentheri*
D.	*Aetobatus narinari*	*Sphoerosides spengleri*

Easy

2018 Q.14 (91%)

Caterpillar fungus is kind of Chinese herbal medicine. When the spores of this fungus land on the larvae of moths, the spores will germinate inside the body of the larvae and grow out of their heads, as shown in the photograph below:



Which of the following best describes the role of this fungus?

A. Parasite
B. Predator
C. Producer
D. Consumer

Answers

Challenging

2014
15 [D]
18 [A]

Average

2013	2016	2018
21 [D]	14 [B]	9 [C]
	15 [B]	32 [C]

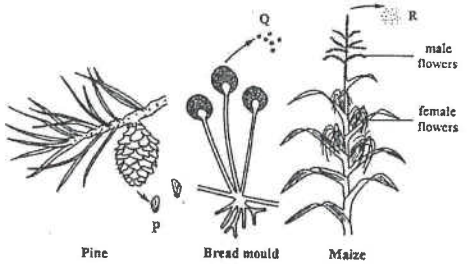
Easy

2014	2018
17 [B]	14 [A]

Past papers - Biodiversity

CE - 1996

1. (a) The diagrams below show three kinds of plants :



(i) Pine and bread mould belong to the same major plant group and maize belongs to another group.

(1) State one feature that distinguishes these two major plant groups. (1)

(2) Bread mould belongs to the sub-group fungi. Name the sub-group to which pine belongs. (1)

(ii) State the role of the following structures in the reproduction of the plants :

(1) P (1)

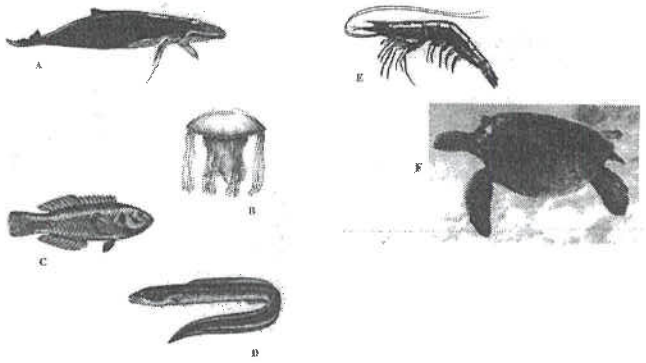
(2) R (2)

(iii) State one feature that is common to structures Q and R which enables them to be carried by wing. (1)

(iv) Referring to the diagram, explain how bread mould is adapted for obtaining nutrients. (4)

CE - 1998

1. (a) In a marine museum, living marine animals are kept in different exhibition areas according to their animal group. Some of the animals in the museum are shown in the diagrams below :



(i) Using letters provided, state all the animal(s) that should be placed in the exhibition area for reptiles. (1)

(ii) B and E are kept in the same exhibition area. Name the animal group to which they belong. (1)

(iii) State two structural differences between A and C which explain why they are kept in different exhibition areas. (2)

(iv) The amount of daily food intake per unit mass of A is much greater than that of C. Suggest an explanation for this. (4)

(v) The population of F in Nature has decreased continuously in recent years. Suggest two ways of preventing the extinction of F. (2)

CE - 2002

3. (b) In an ecosystem, there are various types of bats. One type of bats, A, is shown in photograph 1 below. When a sample of its faeces was examined, pieces of legs and wings of a certain group of animals were found as shown in photograph 2.

Photograph 1 (magnification $\times\frac{1}{5}$)

Photograph 2 (magnification x4)

(i) (1) To which group of vertebrates do bats belong? (1)

(2) Referring to photograph 1, state one external features of bat A through which it is classified into the group you stated in (1). (1)

(ii) With reference to photograph 2, suggest the group of animals that bat A feed on.(1)

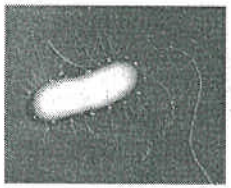
(iii) The faeces of another type of bats, B, are found to contain some seeds. Suggest an explanation for the presence of intact seeds in the faeces of bat B. (2)

(iv) A third type of bat, C, feeds on the blood of large animals. Assuming that bats B and C have the same amount of daily food intake, compare the daily amount of faeces they produce. Explain your answer. (2)

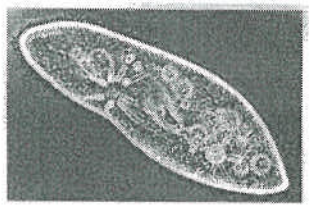
(v) Having different types of bats is advantageous to the survival of bats in an ecosystem. Suggest an explanation for this using the information about bats A, B and C given above. (2)

CE - 2005

1. The following pictures show four different organisms:



P (x 12 000)



Q (x 1500)

R (x 4)

S (x 1)

(a) Organisms can be classified into five kingdoms. Name the kingdom that P and Q each belongs to. (2)

(b) State two cell structures that can be found in Q, R and S, but not in P. (2)

(c) Explain the role of S in the cycling of materials in nature. (2)

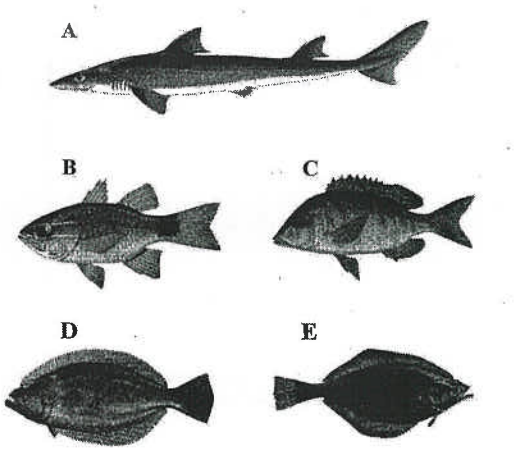
(d) A number of human diseases such as influenza and SARS are caused by viruses. Some scientists consider viruses as organisms, but some do not. Give one reason for each of these views. (2)

AL - 2002 IA

4. The following key is constructed for identifying the fishes A-E shown below.

1a	Both eyes on the same side of the head ----------	2
1b	One eye on each side of the head ----------	3
2a	Both eyes on the right side of the head ----------	Paralichthys olivaceus
2b	Both eyes on the left side of the head ----------	Cleisthenes herzensteini
3a	Caudal fin asymmetrical ----------	Squalus mitsukurii
3b	Caudal fin symmetrical ----------	4
4a	Two dorsal fins ----------	Apogon fleurieu
4b	One dorsal fin ----------	Lethrinus haematopterus

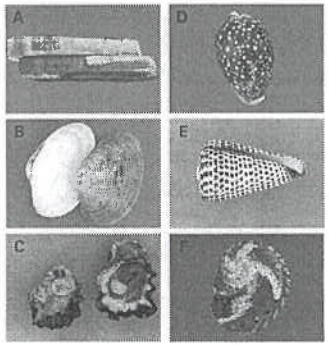
Using this key, identify each of the fishes A, C and D, and state the key sequence you went through in making the identification (5)



Source: 中國科學院海洋研究所，《中國海洋魚類原色圖集（1）》，上海：上海科學技術出版社，1992。

AL -2005 1A

1. The key below is constructed for identifying animals A to F, the shell(s) of which are shown below:



1a	The animal has only one piece of shell.....	2
1b	The animal has two pieces of shell.....	4
2a	The shell is flat.....	Haliotis ovina
2b	The shell is not flat.....	3
3a	The shell becomes narrower toward one end.....	Conus littertus
3b	The shell becomes narrower toward both ends.....	Cypraea vitellus
4a	The two pieces of shell are equal in size.....	5
4b	The two pieces of shell are unequal in size.....	Ostrea nigromarginata
5a	The shell is elongated in shape.....	Solen grandis
5b	The shell is oval in shape.....	Paphia euglypta

Using this key, identify animals B, C and D. Write down the full scientific name of each and the key sequence taken for making the identification. (5)

Animal	Scientific name	Key sequence for identification
B		
C		
D		

DSE-2012 1B

4. The following key can be used for identifying organisms under the same phylum:

1a	Absence of eyes ----------	2
1b	A pair of eyes ----------	3
2a	Six legs ----------	Class A
2b	More than six legs ----------	Class B
3a	Six legs ----------	Class C
3b	More than six legs ----------	Class D

(a) Using the above key, identify which class organism X shown in the photograph below belongs to. (1 mark)

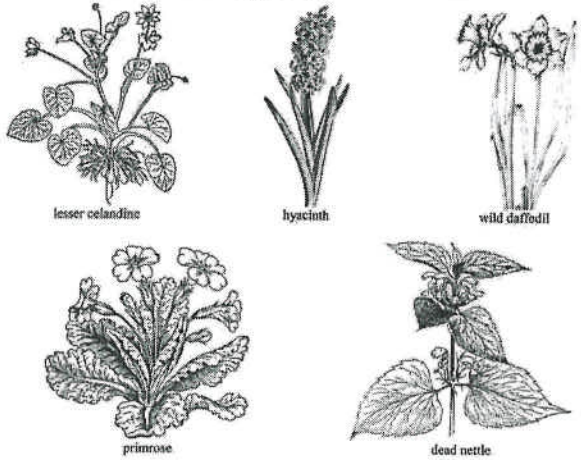
(b) Suggest a characteristic of the habitat of organism X. Explain your answer. (2 marks)

(c) A newly found organism Y has a pair of eyes and fewer than six legs. Although it is believed that this organism belongs to this phylum, it cannot be identified by using the above key. Explain why this problem occurs. (1 mark)

(d) Suggest ***one*** way to collect more information which can be used for deciding whether organism Y belongs to this phylum. (2 marks)

DSE – 2016 1B

4. The following diagrams show the appearance of five flowering plants:



(a) In the following table, put a '√' in the appropriate boxes to show the features of each flowering plant. (2 marks)

	Leaves with parallel veins	Leaves with network veins	Single flower	Cluster of flowers	Other features
lesser celandine					heart-shaped leaves
hyacinth					funnel-like flowers
wild daffodil					trumpet-like flowers
primrose					club-shaped leaves
dead nettle					two-lipped flowers

(b) Using the information from the table in (a), complete the following dichotomous key: (3 marks)

1a The plant has leaves with parallel veins 2
1b The plant has leaves with network veins 3

2a [ ] ..... hyacinth
2b [ ] ..... wild daffodil

3a The plant has two-lipped flowers ..... [ ]
3b The plant does not have two-lipped flowers ..... [ ]

4a [ ] ..... lesser celandine
4b [ ] ..... primrose

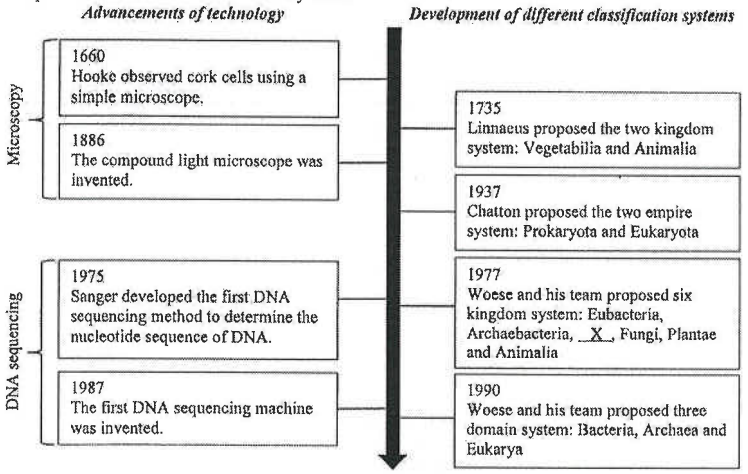
(c) Study the following statement:

The dichotomous key shows that the lesser celandine and primrose have a closer evolutionary relationship.

Do you agree? Explain your answer. (2 marks)

HKDSE - 2017 1B

6. The chart below shows the timeline of some major advancements of technology and the development of different classification systems:



a. Name kingdom X in the six kingdom system proposed by Woese and his team in 1977. (1 mark)

b. How did the following technological advancements contribute to the development of different classification systems? (4 marks)

Microscopy:

DNA sequencing:

Past papers Marking Scheme – Biodiversity

CE - 1996 Q. 1 (a)

(i) (1) The major plant group to which maize belongs produces flowers / fruits, while the other group does not 1
(2) *gymnosperm 1

(ii) (1) To form a new plant / to protect the embryo / for dispersal of the plant 1
(2) To carry the male gamete 1
to the female gamete for fertilization 1

(iii) dry, small, light (any one) 1

(iv) Bread mould has branching rhizoids / root-like structures 1
to provide a large surface area 1
for secreting digestive enzymes / enzymes to digest the organic food 1
and then absorb the digested products 1

Effective communication (c) 1

CE - 1998 Q.1 (a)

(i) F 1

(ii) invertebrate 1

(iii)

A	C		
has mammary glands	no mammary glands	)	
no scales	has slimy scales	)any two	1,1
no lateral line	has lateral line	)	
breathes by lungs	breathes by gills	)	

(iv) A has a higher body temperature than C 1
This enables A to achieve a higher metabolic rate 1
Thus A needs more food for respiration to release more energy 1
to compensate for the faster heat loss to the surrounding 1

Effective communication (c) 1

(v) Prohibit the overhunting of F
Prohibit the trading of F
Protect the breeding grounds of F
Establish a reserve area to protect F
Educate people to protect the animals any two 1,1

CE - 2002 Q.3 (b)

(i) (1) mammal 1
(2) body covered with hair 1

(ii) insects / invertebrates 1

(iii) Bat B feeds on fruits 1
Some seeds escape the chewing action of the teeth / the seed coat protects the seeds from being digested in the alimentary canal 1
Thus intact seeds are egested in the faeces

(iv) Bat B produces a larger amount of faeces per day than bat C 1
because bat B feeds on plants which contains more indigestible material / bat C feeds on blood which contains less indigestible material 1

(v) Different types of bats have different diets 1
thus the competition for food among the bats would less / more resources would be available to the bats / the risk of extinction of bats due to the disappearance of a certain food source would be smaller 1

CE - 2005 Q.1

(a) P : Prokaryotes 1
Q: Protoctists 1
(b) nucleus, mitochondria 1,1
(c) S breaks down organic matter 1
into inorganic matter which can be used by plants for growth 1
(d) Support virus as organisms : because it can reproduce in a cell / it has genetic materials to control its life processes 1
Against virus as organisms : because it is non-cellular / has no cytoplasm / cannot replicate by itself / has no metabolism unless it is within a host cell 1

AL- 2005 1A

1.

	Scientific name	Key sequence for identification	5
Animal B:	Paphia euglypta (½)	1b → 4a → 5b (1)	
Animal C:	Ostrea nigromarginata (½)	1b → 4b (1)	
Animal D:	Cypraea vitellus (½)	1a → 2b → 3b (1)	

½ mark for underlining the scientific names of all animal specimens.

DSE-2012 1B

4. (a) • Class A (1) (1)

(b) • the light intensity of the habitat is very low / the habitat is completely dark (1) (1)
• as organism X does not have eyes to survive in the habitat (1) (1)

(c) • the key is constructed based on the morphological characteristics of exisiting organism found (1) / not all the morphological characteristics of the phylum are listed in the key (1)

(d) • carry out a comparative study about the amino acid sequence of similar proteins / base sequence of DNA template / mRNA of similar proteins found in organism Y and other organisms in this phylum (1) (✓ accept comparison of developmental process / cellular structure / chemical composition) (1)
• to establish the phylogenetic relationship between them (1) (1)

6 marks

DSE – 2016 1B

4. (a)

	Leaves with parallel veins	Leaves with network veins	a single flower	a cluster of flowers	Other features
lesser celandine		✓	✓		heart-shaped leaves
hyacinth	✓			✓	funnel-like flowers
wild daffordil	✓		✓		trumpet-like flowers
primrose		✓	✓		club-shaped leaves
dead nettle		✓		✓	two-lipped flowers

(each correct pair of characteristics 1) [mark on the bottom left and bottom right comers respectively; accept '/' but not 'O' or "X" or other symbols] 2

(b) 2a The plant has a cluster of / funnel-like flowers
2b The plant has a single / trumpet-like flower } (1)
[accept negative statement, e.g. The plant does not have a cluster of flowers]
3a dead nettle
3b 4 } (1)
4a The plant has heart-shaped leaves
4b The plant has club-shaped leaves } (1)
[accept negative statement, e.g. The plant does not have heart -shaped leaves]
Remarks: These three sets of answers should be marked separately 3

(c) this is incorrect (1)

because a dichotomous key is used to identify organisms from a group based on the observable / morphological features which may not be related to their evolutionary / phylogenetic relationship (1)
[accept: not all observable / morphological can reflect their evolutionary relationship]
[accept: a dichotomous key is purely for identifying organisms, not for phylogenetic classification]
[accept: observable / morphological features which may not be related to their evolutionary / phylogenetic relationship]
[accept: similarities in observable / morphological features can be resulted from adapting the similar environment / convergent evolution]
[NOT accept: observable I morphological cannot reflect their evolutionary relationship]
[NOT accept: only genetic/sequence similarities can reflect their evolutionary relationship]
Remarks: if the points are contradictory, no mark will be given 2

HKDSE – 2017 1B

6. (a) • X:Protista* (1) (1)

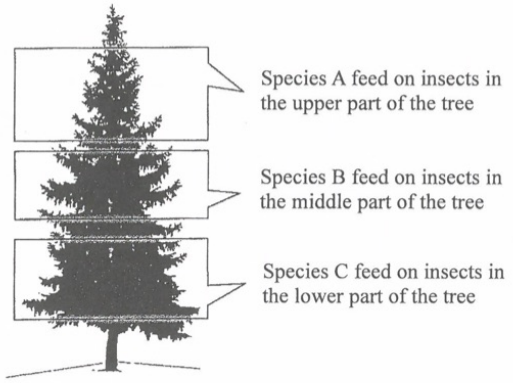
(b) Microscopy:
• microscopy allows the observation of cellular structures [accept membrane-bound organelles; NOT accept cell wall or cell membrane](1)
• this distinguishes prokaryotic cells from eukaryotic cells (1), giving rise to the basis of the two empiresystem proposed

DNA sequencing: (4)
• DNA sequencing determines the nucleotide sequence of the DNA of different organisms/ allows the comparison of their genetic makeups(1) [accept RNA sequence]
• so that the scientists can work out the phylogenetic relationship (1), giving rise to the basis of the 3 domains system

8. Decomposers can speed up the process of ecological succession because they

A. break down rocks into soil particles.
B. remove dead organic matter from the soil.
C. release carbon back into the atmosphere in the form of carbon dioxide.
D. release nitrogen back into the soil in the form of ammonium compounds.

9. Three bird species are living on the same tree species for years. They feed on the insects found at different regions of the tree as shown in the diagram below:

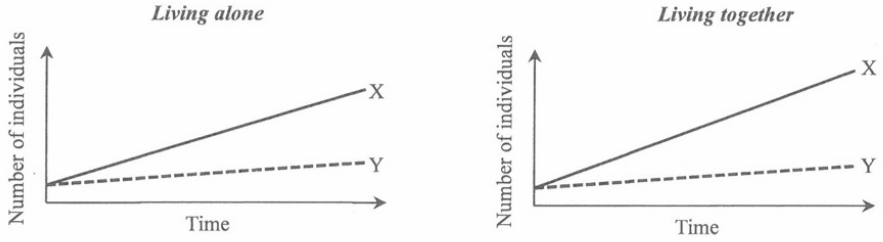


Which of the following can be deduced from the above phenomenon?

(1) The insects are evenly distributed on the tree.
(2) Birds species A, B and C have different ecological niches.
(3) There is less interspecific competition among bird species A, B and C.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

10. The graphs below show the changes in the population sizes of organisms X and Y over a period of time when they are living alone or living together.



Which of the following correctly describes the ecological relationship of X and Y?

A. predation
B. mutualism
C. competition
D. commensalism

DSE M.C. Questions - Ecosystems

(sort by difficulty)

Challenging

2018 Q.5 (37%)

The diagrams below show the pyramids of numbers and biomass of a food chain:

Which of the following is most likely to be the producer in this food chain?

A. Rice
B. Trees
C. Grass
D. Phytoplankton

Average

2014 Q.3[illegible] (69%)

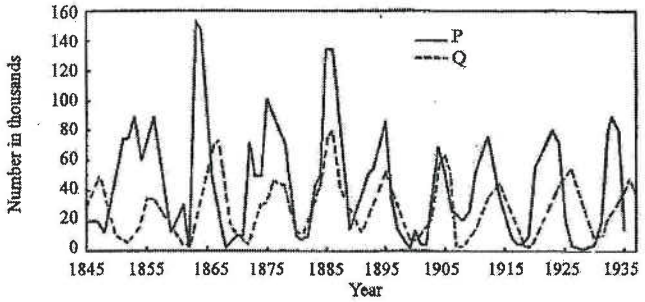
Some environmental protection groups claim that the vegetarian diet is good for our environment. This is probably because

A. vegetables grow faster than animals.
B. it protects endangered species as less animals are killed for food.
C. growing vegetables can produce oxygen but rearing animals only consumes oxygen.
D. it reduces the emission of carbon dioxide associated with rearing animals for food.

Average

2014 Q.31 (51%)

The graph below shows the changes in the populations of two organisms that exhibit a predator-prey relationship in a habitat:



Which of the following statements about the identity of the organism is correct?

A. P is the predator because its number fluctuates more than that of Q.
B. P is the predator because its lowest number is lower than that of Q.
C. Q is the predator because its number fluctuates less than that of P.
D. Q is the predator because its highest number is lower than that of P.

2014 Q.33 (45%)

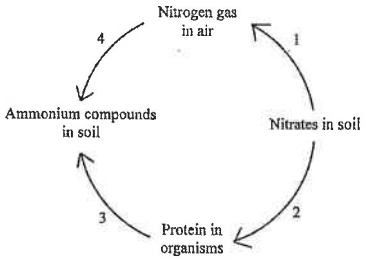
Which of the following processes releases nitrogen-containing compounds from organisms back into the environment?

A. Nitrification
B. Decomposition
C. Denitrification
D. Nitrogen fixation

Average

2015 Q.31 (58%)

Directions: Questions 30 and 31 refer to the diagram below, which shows the conversion of some nitrogen-containing substances in nature:

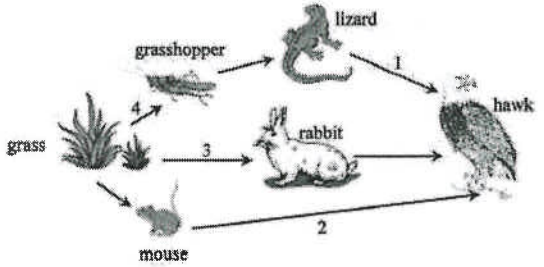


Which of the following processes does ***not*** require the action of bacteria?

A. 1
B. 2
C. 3
D. 4

2016 Q.30 (61%)

The following is a food web found in grassland:



If the energy input for each food chain is the same, the transfer of energy between two trophic levels is the smallest in

A. 1 B. 2 C. 3 D. 4

Average

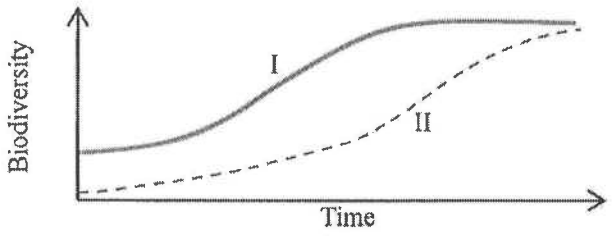
2016 Q.34 (47%)

Symbiotic bacteria found in the root nodules of bean plants are able to convert

A. nitrite ions to nitrate ions.
B. nitrogen gas to nitrate ions.
C. organic nitrogenous compounds to nitrate ions.
D. nitrogen gas to ammonium ions.

2017 Q.12 (71%)

The following graph shows the predicted change in biodiversity during the processes of primary and secondary succession in an ecosystem:

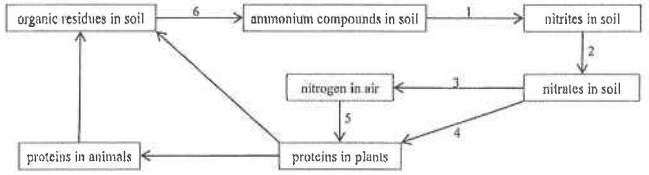


Which of the following combinations is correct?

	Type of succession	*Explanation*
A.	I is primary succession.	A climax community is reached in I.
B.	I is secondary succession.	I has a higher biodiversity than II at the beginning.
C.	II is primary succession.	Pioneer community is involved in II.
D.	II is secondary succession.	II shows a slow increase in biodiversity.

Average

Directions: Questions 32-33 refer to the diagram below, which shows some processes in the nitrogen in nature:



2017 Q.32 (56%)

Which of the following combinations correctly matches the microorganisms involved in processes 3 and 6?

	3	*6*
A.	denitrifying bacteria	nitrogen-fixing bacteria
B.	nitrogen-fixing bacteria	fungi
C.	fungi	denitrifying bacteria
D.	denitrifying bacteria	fungi

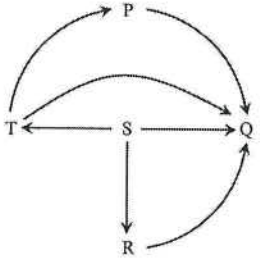
2017 Q.33 (62%)

Which of the following processes ***does not*** require the action of bacteria?

A. 1 B. 2 C. 4 D. 5

Average

Directions: Questions 34 and 35 refer to the diagram below, which shows the flow of energy among organisms found in a grassland:



2017 Q.34 (62%)

Which of the following statements correctly describe(s) the above organisms?

(1) S is a heterotroph.
(2) P is the secondary consumer.
(3) Q has the largest total biomass

A. (1) only B. (2) only C. (1) and (3) only D. (2) and (3) only

2017 Q.35 (56%)

If there is a decomposer in this group of organisms, it is most likely to be

A. Q B. R C. S D. T

2019 Q.29 (68%)

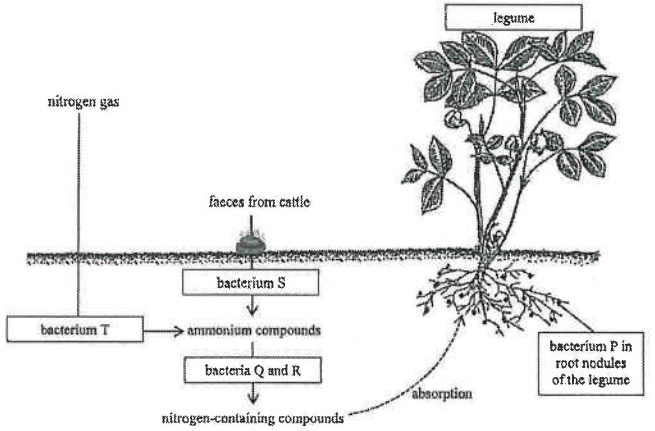
If a student wants to find out whether the distribution of plant species is affected by the slope of a hillside, which of the following sampling methods should be used?

A. Set up a line transect along the hillside and record the plant species that touch the line.
B. Set up a line transect around the hillside and record the plant species that touch the line.
C. Randomly place quadrats along the hillside and record the plant species within the quadrat.
D. Randomly place quadrats around the hillside and record the plant species within the quadrat.

Average

2019 Q.33 (70%)

Directions: Questions 33 and 34 refer to the diagram below, which shows some processes of the nitrogen cycle:

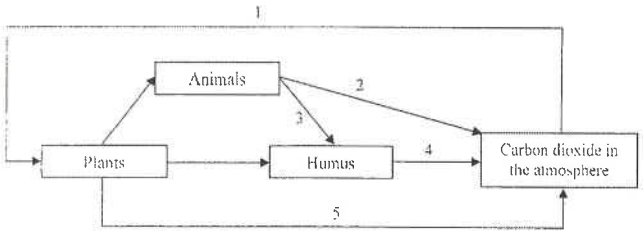


Which of the following statements about the bacteria shown in the diagram is correct?

A. P belongs to parasitic bacteria.
B. Q belongs to nitrifying bacteria
C. R belongs to nitrogen-fixing bacteria.
D. S belongs to denitrifying bacteria.

Easy

Directions: Questions 16 and 17 refer to the following diagram, which shows the flow of carbon in an ecosystem:



2012 Q.16 (78%)

Which of the following combinations correctly shows the process indicated by labels 1,4 and 5?

	1	*4*	*5*
A.	respiration	photosynthesis	decomposition
B.	photosynthesis	respiration	decomposition
C.	photosynthesis	decomposition	respiration
D.	decomposition	photosynthesis	respiration

2012 Q.17 (80%)

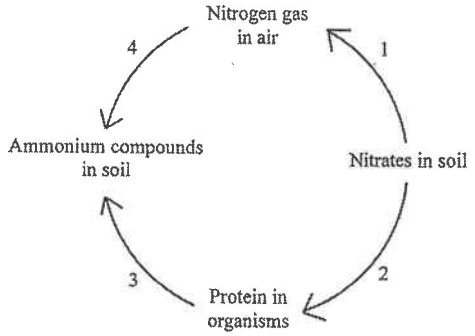
Saprophytes are involved in process

A. 1. B. 2. C. 3. D. 5.

Easy

2015 Q.30 (79%)

Directions: Questions 30 and 31 refer to the diagram below, which shows the conversion of some nitrogen-containing substances in nature:



Process 3 is

A. nitrification.
B. denitrification.
C. decomposition.
D. nitrogen fixation.

2018 Q.6 (89%)

Protecting sharks in the wild is important for maintaining the ecological balance of the marine ecosystem because

A. Sharks are an endangered species
B. Shark fin is a popular dish for banquets
C. The dead bodies of sharks are an important food source for decomposers
D. Sharks are top predators that regulate the population sizes of other consumers

Easy

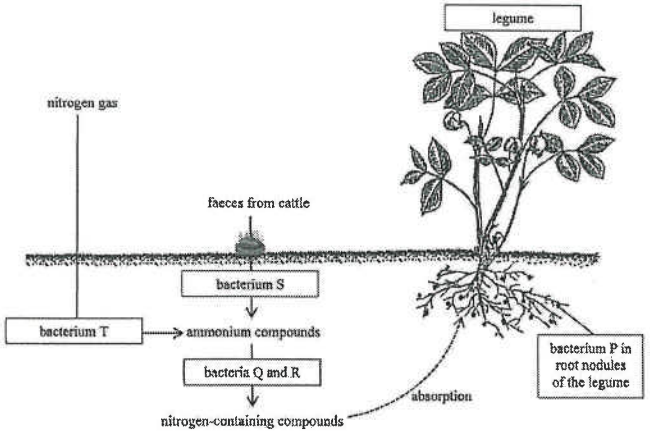
2018 Q.33 (77%)

Which of the following statements about primary succession and secondary succession is correct?

A. Primary succession is always followed by secondary succession.
B. Primary succession always starts with a barren area while secondary succession does not.
C. Secondary succession always ends with a climax community while primary succession does not.
D. Secondary succession always ends with a climax

2019 Q.34 (81%)

Directions: Questions 33 and 34 refer to the diagram below, which shows some processes of the nitrogen cycle:



Which of the following bacteria has a similar role to fungi in the cycling of materials?

A. Q.
B. R.
C. S.
D. T.

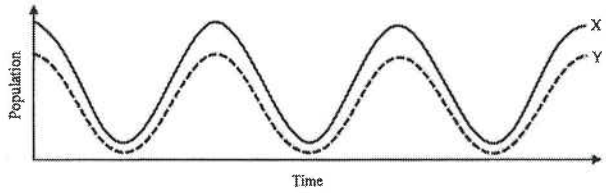
2020 Q.16

16. Australia has some plant and animal species which cannot be found elsewhere in the world. Which of the following is likely to be the key factor that led to the occurrence of these unique plant and animal species in Australia?

A. isolation
B. mutation
C. competition
D. environmental stress

2020 Q.32

32. The following graph shows the change in the populations of organisms X and Y living in the same habitat:

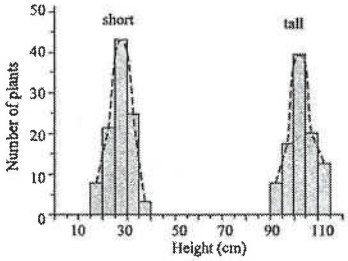


Which of the following is the most likely ecological relationship between organisms X and Y?

A. predation
B. mutualism
C. competition
D. commensalism

2020 Q.33

Directions: Questions 33 and 34 refer to the following graph, which shows the variations in the height of a certain type of plant:



33. Which of the following conclusions can be drawn from the above graph?

A. The short and tall plants are of two different species.
B. The two traits, short and tall, are controlled by a pair of alleles.
C. More samples should be taken to cover the full range of heights.
D. The height of the plants displays the properties of continuous and discontinuous variations.

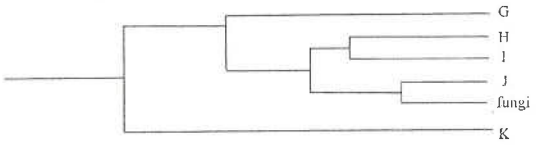
2020 Q.34

34. Which of the following factors contributes *least* to the variations shown?

A. the height of the parental plants
B. the light intensity in the environment
C. the independent assortment of chromosomes
D. the oxygen concentration in the environment

2021 Q.28,29,32,33,34,35,36

Directions: Questions 28 and 29 refer to the diagram below, which shows an evolutionary tree demonstrating the phylogenetic relationship of the six kingdoms:



28. Which of the following combinations correctly shows the kingdoms represented by G, J and K in the evolutionary tree?

	G	*J*	*K*
A.	Archaebacteria	Animalia	Eubacteria
B.	Archaebacteria	Plantae	Eubacteria
C.	Eubacteria	Plantae	Protista
D.	Eubacteria	Animalia	Protista

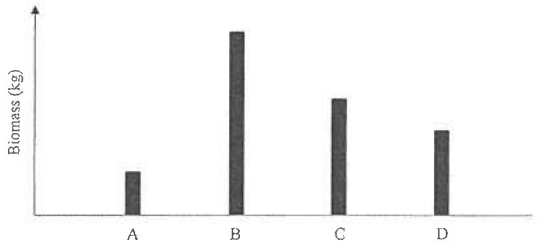
29. Which of the following pairs of organisms belongs to the same domain?

A. G and K
B. G and H
C. H and J
D. J and K

32. During primary succession in a terrestrial habitat, which of the following descriptions about the ecosystem is *incorrect*?

A. The nutrient level of the soil decreases.
B. The complexity of the food web increases.
C. The abundance of non-vascular plants decreases.
D. The energy available to the community increases.

Directions: Questions 33 and 34 refer to the following graph, which shows the biomasses of four populations forming a food chain in a terrestrial habitat:



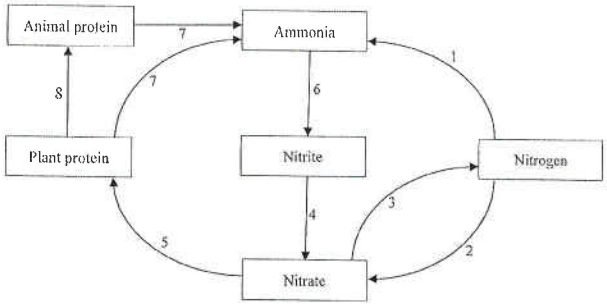
33. Which population is most likely the autotrophs in this habitat?

A. A
B. B
C. C
D. D

34. What would you expect to happen if the number of individuals in population D decreased?

A. The number of individuals in population A would increase.
B. The number of individuals in population C would decrease.
C. The amount of energy passed to population A would decrease.
D. The amount of energy passed to population C would increase.

Directions: Questions 35 and 36 refers to the diagram below, which shows some natural processes involved in the nitrogen cycle:



35. Process 2 refers to

A. lightning.
B. nitrification.
C. denitrification.
D. nitrogen fixation.

36. Which of the following pairs of processes involves the action of bacteria?

A. 1 and 5
B. 2 and 6
C. 3 and 7
D. 4 and 8

Answers

Challenging

2018
5 [C]

Average

2014	2015	2016	2017	2019
30 [D]	31 [B]	30 [A]	12 [B]	29 [A]
31 [D]		34 [D]	32 [D]	33 [B]
33 [B]			33 [C]	
			34 [B]	
			35 [A]	

Easy

2012	2015	2018	2019
16 [C]	30 [C]	6 [D]	34 [C]
17 [C]		33 [B]	

2020
16[A]
32[B]
33[D]
34[D]

Past papers – Ecosystems

CE - 2003

1. (c) The photographs below show a Hong Kong newt and a lizard which can be found in Tai Mo Shan Country Park.

Hong Kong newt

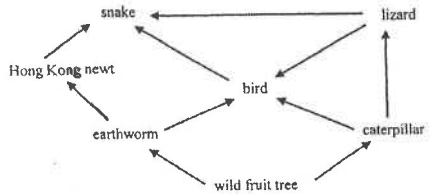
Lizard

(i) The two animals above belong in different vertebrate groups. Based on the photograph, state one external feature of the newt that is characteristic of its group (1)

(ii) Name the vertebrate group to which the Hong Kong newt belongs. (1)

(iii) Only a small number of Hong Kong newts exist today and it is listed as a protected species. Suggest two reasons to account for its small population. (2)

(iv) The diagram below shows a simplified food web in Tai Mo Shan Country Park:



(1) With reference to the given food web, draw a food chain that consists of five trophic levels. (1)

(2) Construct a pyramid of numbers for this food chain. (2)

(3) Explain the shape of this pyramid of numbers. (4)

CE - 2005

5. Every year, people in Hong Kong consume a lot of big marine fish such as humphead wrasse (蘇眉). This fish takes five years to reach maturity. Because of the strong market demand, young fish are often caught together with the mature ones, and as a result, the population of this fish has decreased greatly in the past ten years.

(b) Suggest two ecological consequences of the overfishing of humphead wrasse. (2)

(c) Some people propose that the catching of young humphead wrasse should be prohibited. Explain why this may maintain the population of this fish. (3)

CE - 2005

8. (b) The picture below shows a school garden with some tomato plants:

(i) Explain why continuous harvesting of tomatoes may lead to the depletion of nitrate in the garden soil. (2)

(ii) Which organism in the soil turns some of the nitrate into atmospheric nitrogen? (1)

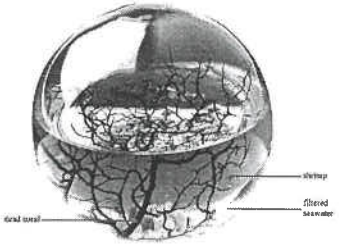
(iii) Suggest two ways to restore the nitrate content of the soil. (2)

(iv) A student flooded the soil with water. As a result, the air content of the soil became very low. Explain why this condition may lead to poor plant growth. (3)

CE - 2007

9. (a) The photograph below shows an ecosphere:

The ecosphere is a self-sustaining ecosystem sealed in glass container. It contains bacteria, microscopic algae, shrimps and branches of dead coral in filtered seawater.



(i) Why is it essential to put the algae into the ecosphere to make it self-sustaining? (4)

(ii) How can the activity of the bacteria contribute to the growth of algae? (2)

(iii) This ecosphere can only support two trophic levels. Suggest a possible explanation for this. (2)

CE - 2008

8. (a) In order to increase the yield of crops, farmers may add inorganic fertilizers and fungicides to the field. Fungicides can kill fungi which may infect crop plants. The table below shows the effect of applying these chemicals to a wheat field.

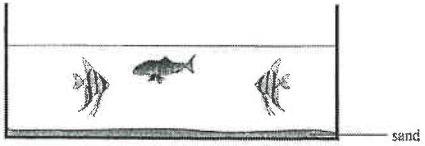
Mass of inorganic fertilizers added (kg)	Yield of wheat (arbitrary unit)	
	With the addition of fungicides	Without the addition of fungicides
0	33	33
80	54	52
160	64	60
240	68	61
320	70	58

(i) Plot a graph to show the yield of wheat when different amounts of inorganic fertilizers are added in the presence and in the absence of fungicides. (3)

(ii) With the reference to the graph plotted, describe the effect of fungicides and inorganic fertilizers on the yield of wheat. (3)

CE - 2009

10. (a) The following diagram shows the freshwater aquarium set up by Cindy.



All the fish died after one week. She learnt from the internet that a high level of ammonia in water is harmful to the fish. She suspected that this caused their death.

(i) Account for the presence of ammonia in the aquarium. (2 marks)

(ii) After searching on the internet, she found that the ammonia concentration in water can be lowered by installing a biological filter seeded with bacteria. To set up the aquarium again, she purchased a biological filter and noted to following instructions:

I. Leave the tap water in the aquarium for at least one night before installing the filter.

II. Allow the filter to operate for four weeks before putting fish in the aquarium.

(1) What kind of bacteria is seeded in the biological filter? Explain how this kind of bacteria can lower the ammonia concentration in the aquarium. (2 marks)

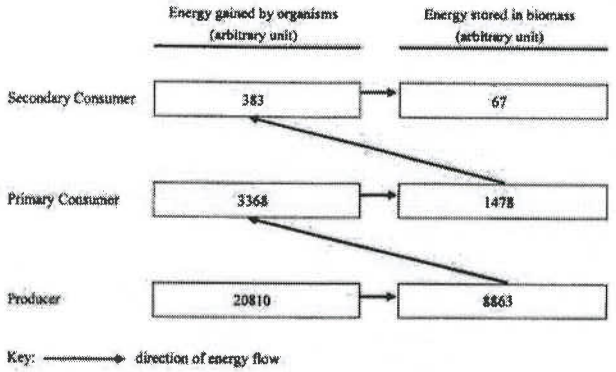
(2) With reference to the process of water treatment in Hong Kong, explain why instruction I is necessary. (2 marks)

(3) Why is it necessary to leave the filter operating for four weeks before putting fish in the aquarium? (1 mark)

(iii) Cindy is advised to grow some water plants in the aquarium. What is the role of the water plants in the cycling of materials in the aquarium?(2 marks)

CE - 2010

7. The diagram below shows the energy flow in a food chain.



(a) Explain the difference between the energy stored in biomass and the energy gained at each trophic level. (2)

(b) Suggest *two* reasons to explain why in each trophic level the energy gained is always less than the energy that can be provided by the previous trophic level. (2)

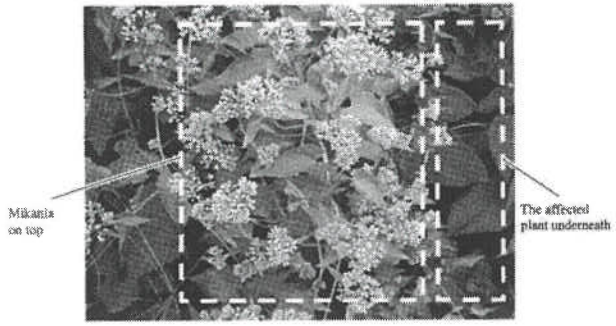
(c) Below is the comparison of the average mass of individual organisms in a food chain:

	Average mass of individual organisms (arbitrary unit)
Producer	100000
Primary consumer	1
Secondary consumer	100

Sketch a pyramid of numbers relating the three trophic levels. (3)

CE- 2010

9. (b) Mikania is a climber plant which originates in South America. It climbs up other plants to reach for better sunlight. Its leaves grow extensively and cover the affected plants, eventually leading to the death of the plants. The photograph below shows Mikania and the affected plant.



(i) With reference to the photograph, identify the plant group to which Mikania belongs. (1)

(ii) State the relationship between Mikania and the affected plant. Suggest how Mikania can lead to the death of the affected plant. (3)

(iii) A researcher wanted to find a way to control the spread of Mikania. He discovered that a native parasitic plant, dodder(菟絲子), coils around the Mikania and absorbs nutrients form them. He then conducted a study by growing dodder in Mikania-affected areas A and B on an island. The results are shown in the table below:

	% coverage of Mikania on the affected plant	
	with dodder coiled	without dodder coiled
Area A	20	98
Area B	75	99

(1) State ***one*** limitation of using dodder for controlling the spread of Mikania. Give supporting evidence from the above results. (2)

(2) Apart from dodder, an invertebrate from another country can also control the spread of Mikania by feeding on them. From the ecological point of view, suggest three reasons why this invertebrate should not be introduced to Hong Kong to control Mikania. (3)

AL - 2006 1A

2. Each of the following figures shows the changes in population density of two interacting species:

Figure 1

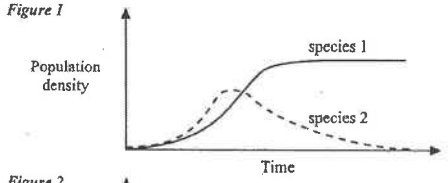
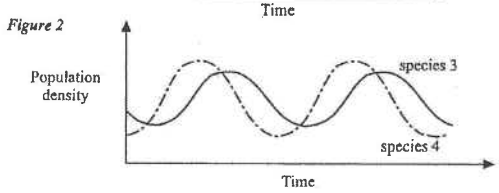


Figure 2



Name the type of interaction between the species in each case. (2)

Figure 1 : ..... Figure 2 :.....

AL - 2007 1A

1. The following flowchart shows part of the nitrogen cycle in the aquatic ecosystem.

(a) In each of the boxes below, state a compound which contains nitrogen. (3 marks)

(b) In the flowchart, circle the process that incorporates inorganic nitrogen into the living system. (1 mark)

dissolved nitrogen in aquatic environment

↓ nitrogen fixation

(i)

↓ feeding

organic nitrogen in animal tissue

↓ decomposition

(ii)

↓ nitrification

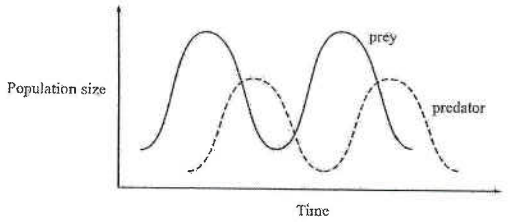
(iii)

↓ denitrification

nitrogen

AL - 2007 1A

2. The graph below shows the change in the population size of a prey species and its predator species in the natural environment over a period of time:



(a) Explain why the predator and prey populations fluctuate as shown in the graph. (4)

(b) Explain why the prey population does not drop to zero. (1)

AL - 2009 1A

3. Line transect is a kind of sampling method used in ecological studies.

(a) What is the criterion for choosing a location to place the transect line in a habitat? (2)

(b) State two limitations of this sampling method. (2)

AL - 2010 1A

4. The following flowchart shows the amount of energy incorporated into the biomass at each trophic level when energy flows through a food chain (all energy values are given in arbitraryunits):

(a) Using the above data, complete the following table to show the energy transfer efficiency in this food chain. (1)

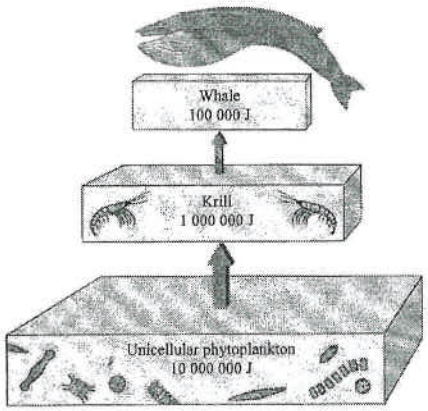
	Energy transfer efficiency (%)
From producers to primary consumers	10
From primary consumers to secondary consumers	
From secondary consumers to tertiary consumers	20

(b) Explain the low energy transfer efficiency from producers to primary consumers. (3)

(c) The tertiary consumers of this food chain are ectotherms. If these tertiary consumers were endotherms, what would the change be in the energy transfer efficiency from secondary consumers to tertiary consumers? Give an explanation for your answer. (2)

DSE-2012 1B

6. The diagram below shows a food chain in an ocean. The energy content of each trophic level is shown in the boxes:



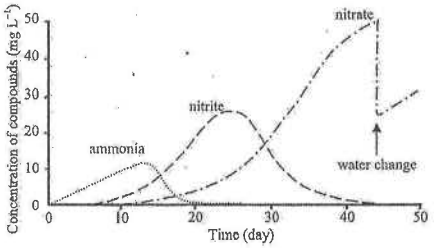
(a) In the space below, calculate the percentage decrease in energy content from unicellular phytoplankton to krill. (2 marks)

(b) Give two reasons why there is a decrease in energy content from a lower trophic level to a higher one. (2 marks)

(c) In another food chain, the producer is tree and the primary consumer is caterpillar. Would the percentage decrease in energy content be greater or smaller than the value found in (a)? Explain your answer. (2 marks)

HKDSE - 2013 1B

5. Knowing that the nitrogen cycle is important to the healthy growth of fish, Tom purchased testing kits to monitor the levels of ammonia, nitrite and nitrate in his aquarium. He kept the aquarium aerated with an air pump. The graph below shows the changes in the concentrations of the three compounds over 50 days:



(a) Name the process that led to the changes shown in the graph. (1 mark)

(b) After three weeks, Tom observed a high concentration of nitrite in the water and the fish were showing symptoms of nitrite poisoning. Therefore, Tom added a suspension of a bacterial culture to the water to lower the nitrite concentration. Suggest the type of bacteria he added and explain how it lowered the nitrite concentration. (2 marks)

(c) To prevent the accumulation of nitrate, Tom regularly replaced some water in the aquarium with fresh water. What else could Tom do to lower the nitrate concentration?(2 marks)

HKDSE - 2013 1B

8. A study was carried out to investigate the distribution and abundance of animal species A and B on a rocky shore. The table below shows the results obtained from the back of the shore to the waterfront:

Distance from the back of the shore (m)	Abundance (number of individuals m^{-2})	
	Species A	Species B
1	10	0
2	25	2
3	40	8
4	38	10
5	20	20
6	18	35
7	15	33
8 (waterfront)	11	28

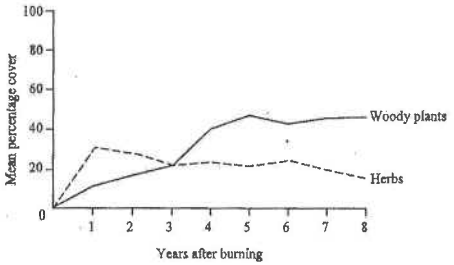
(a) Plot a graph to show the results. (5 marks)

(b) Based on the information in the graph, suggest which species would have a higher tolerance to desiccation. Explain your answer. (4 marks)

(c) Briefly describe the sampling procedure used to obtain the above data. (3 marks)

HKDSE - 2014 1B

5. In a study, a plot of land was burnt by fire. After this, the vegetation on this land, classified into herbs and woody plants, was monitored for 8 years. The percentage cover of each type of vegetation is shown in the graph below:



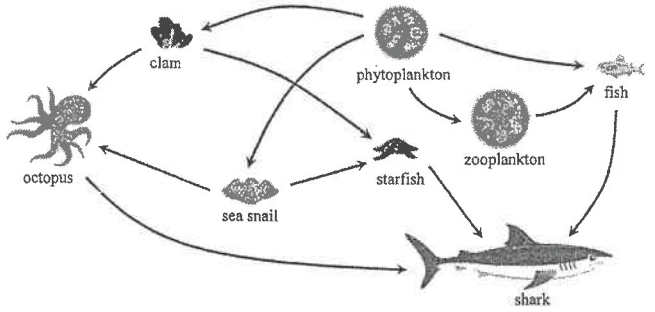
(a) Which type of succession is shown in the above case? Explain your answer. (2 marks)

(b) (i) Describe briefly how the dominant community of vegetation changes with time after the fire. (2 marks)

(ii) Explain the changes in the dominant described in (i). (4 marks)

HKDSE – 2015 1B

3. The diagram below shows the feeding relationships among some organisms in a marine ecosystem:



(a) Write down the shortest food chain found in the diagram. (1 mark)

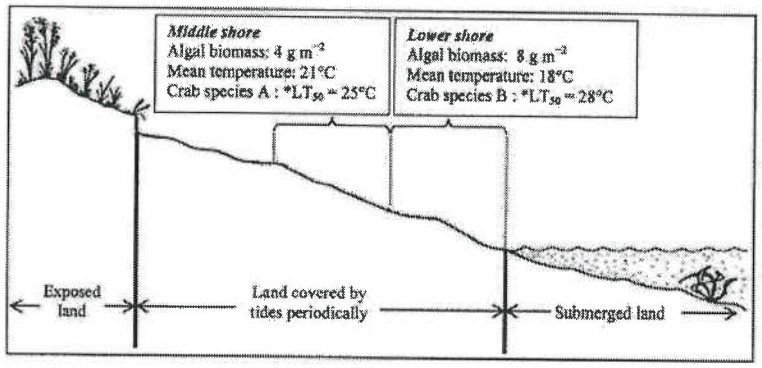
(b) In the space provided below, draw the pyramid of numbers for the food chain in (a). (2 marks)

(c) Explain the shape of the pyramid of numbers drawn in (b). (3 marks)

(d) Suggest *two* practical methods that allow you to confirm the feeding relationships among various organisms in this ecosystem. (2 marks)

HKDSE – 2016 1B

5. The diagram below shows some biotic and abiotic factors of a rocky shore, the distribution of two crab species and their temperature tolerance:



* Median lethal temperature (LT_{50}): When a species is exposed to that temperature for 24 hours, half of the individuals die.

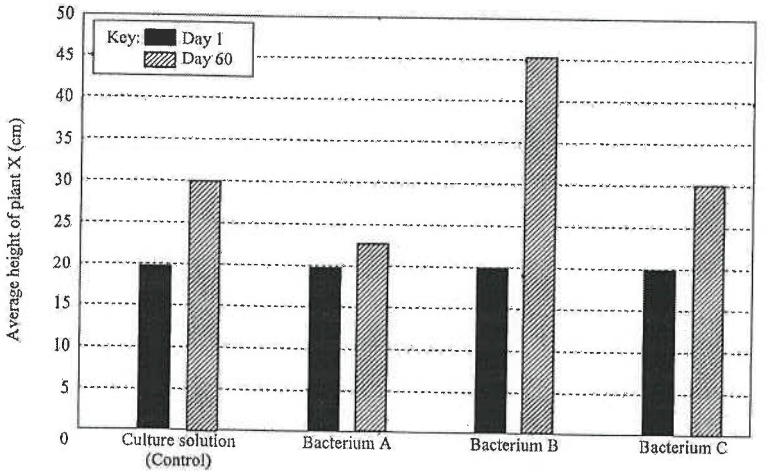
(a) The two species coexist on a rocky shore and feed on the same species of alga. When the two crab species are kept in a simulated habitat with the algal species, they will fight against each other. According to the information given in the diagram, deduce which crab species, A or B, would be a stronger competitor. (3 marks)

(b) Deduce whether temperature tolerance is a determining factor for the distribution of these crab species. (4 marks)

(c) Explain why quadrats are unsuitable for studying the abundance of crabs on the rocky shore. (2 marks)

HKDSE - 2017 1B

8. In an investigation about the effect of soil bacteria on the growth of plant X, three types of soil bacteria (A, B and C) were grown separately in one type of culture solution. After this, each bacterial culture was added to the soil of separate pots of plant X. A control was prepared by adding the culture solution only. The average height of plant X was recorded at day 1 and day 60 of the experiment. The results are shown in the chart below:



a. With reference to the above results, state the effect of each type of bacterium on the growth of plant X. (3 marks)

Bacterium A :

Bacterium B :

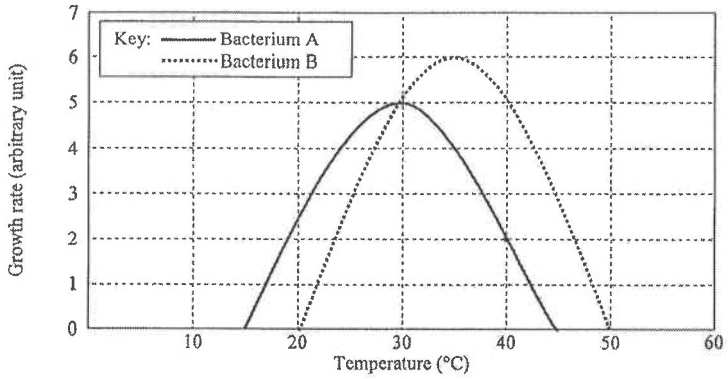
Bacterium C:

b. It is known that both bacteria A and B are able to colonise the root of plant X and obtain nutrients from the root for growth. Suggest the possible ecological relationships between each type of bacterium and plant X. (2 marks)

Bacterium A:

Bacterium B:

c. In a subsequent experiment, the effect of temperature on the growth of bacteria A and B was tested and the results are shown in the graph below:



i. Indicate the optimum temperature for the growth of bacteria A and B respectively. (1 mark)

Bacterium A:

Bacterium B:

ii. Normal soil temperature in Hong Kong is around 30°C in summer. Global warming has led to an increase in soil temperature within 2°C. With reference to the above graph, predict the changes in the population sizes of bacteria A and B in soil in summer. (2 marks)

d. Plant X is a foreign species that is more competitive than the native plant species in Hong Kong. With reference to your answers in (a) and (c)(ii), suggest a possible impact of global warming on the native plant community. Explain your answer. (2 marks)

HKDSE - 2019 1B

7. The table below shows the changes in soil nitrogen content and the number of species of herbaceous plants and woody plants before and after a landslide on a hillside:

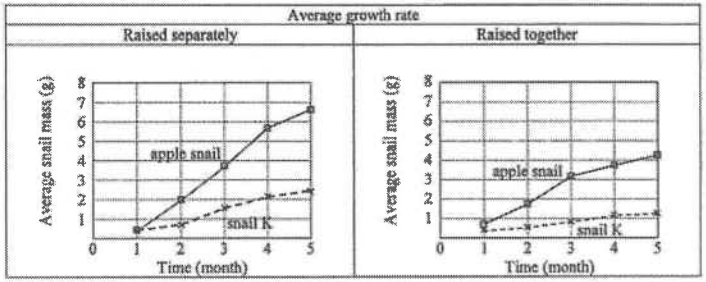
	Soil nitrogen content ($mg\ g^{-1}$)	Number of plant species	
		Herbaceous plants (e.g. grass)	Woody plants (e.g. shrubs and trees)
Before landslide	6	10	15
2 years after landslide	1	17	2
20 years after landslide	3	14	9

(a) What type of ecological succession occurred on the hillside after the landslide? Explain your answer. (2 marks)

(b) (i) Explain the change in the soil nitrogen content shown in the above table. (3 marks)

(ii) With reference to the change in soil nitrogen content, explain the change in the plant composition after the landslide in terms of the number of species of herbaceous and woody plants. (3 marks)

9. The apple snail originates from South Africa. It was first imported to Asian countries for human consumption. However, it escaped to the local wetland habitat. Below are data regarding the average growth rates of apple snail and a local species K when they were raised separately and raised together:



(a) With reference to the above data, what would happen to the population of snail K in the wetland habitat once the apple snails have escaped to this habitat? Support your answer with data from the graphs above. (4 marks)

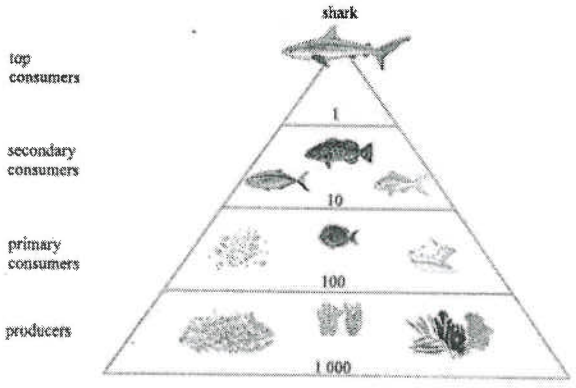
(b) It has been noted that apple snails consume wetland plants at a high rate, especially buds and young leaves. Suggest why the feeding habitats of apple snails may have an adverse effect on the community of local wetland habitats. (3 marks)

(c) Apart from the above, suggest another biotic factor which may explain why an imported species would turn into an invasive or dominant species. (1 mark)

(d) Suggest one human activity which might lead to an invasion of imported species in Hong Kong. (1 mark)

HKDSE - 2020 1B

2. The diagram below shows the total biomass (arbitrary unit) at each trophic level in a marine ecosystem:



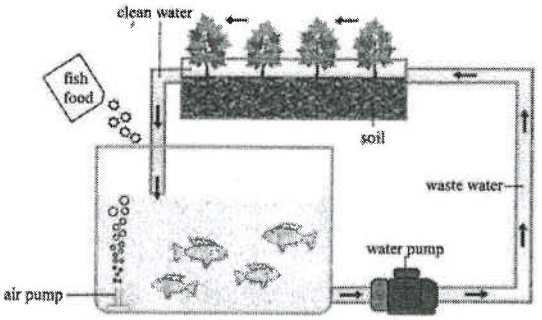
(a) As the trophic level becomes higher, the total biomass of each level decreases. Give *two* reasons for this phenomenon. (2marks)

Reason 1:

Reason 2:

(b) Sharks, being the top consumers in the ocean, play an important role in keeping the populations of other marine organisms under control. It is predicted that the extinction of sharks would result in overpopulation of producers. Explain how this would happen. (3 marks)

6. The diagram below shows a mini-ecosystem in which waste water from a fish tank is used as a source of nutrients for plant growth by making use of the interaction among fish, microorganisms and plants. Adding fertilisers and periodic change of water are not necessary. This is an eco-friendly way to grow vegetables and raise fish for human consumption.



(a) Ammonia, a toxic substance, is the major waste product excreted by fish. Ammonia in waste water from the fish tank can be converted to nitrate, which is required by plants for growth.

(i) Name the bacteria involved in the conversion. (1 mark)

(ii) Describe how plants can obtain nitrate from waste water and make use of it for protein synthesis in their leaves. (3 marks)

(b) The air pump performs some important functions in this system. Describe these functions. (2 marks)

(c) If double the amount of fish food is added accidentally, some fish will die a few days later. Based on your knowledge of the cycling of materials, suggest an explanation for this phenomenon. (4 marks)

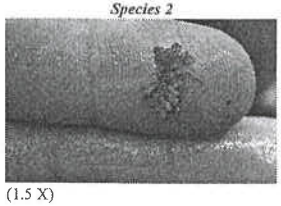
HKDSE - 2020 1B

9. The photographs below show the appearances of two species of free-floating, freshwater plants, Species 1 and Species 2:

Species 1

(0.58 X)

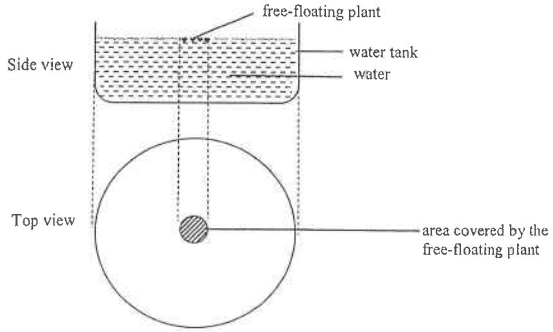
Species 2



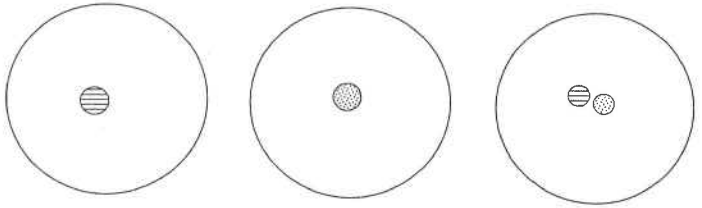
(1.5 X)

To study the interaction between these two plant species, each species was grown either alone or together with another species in a water tank for 50 days. Each species covered 10% of the area of water surface at the beginning of the experiment. The experimental set-up and design are shown in the following diagrams:

Experimental set-up:

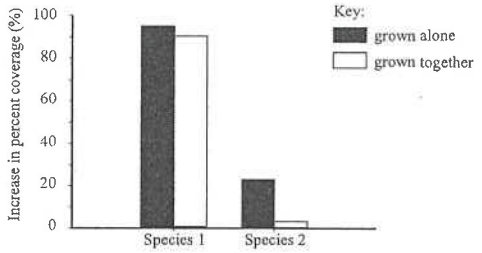


Experimental design (top view):



Species 1 grown alone | Species 2 grown alone | Species 1 and 2 grown together

The percent coverage of each plant species was measured at the beginning and at the end of the experiment. The increases in the percent coverage are shown below:



(a) With reference to the aim of the experiment, what conclusions can be drawn about the interaction between Species 1 and 2? Explain your answer. (4 marks)

Conclusion 1:

Conclusion 2:

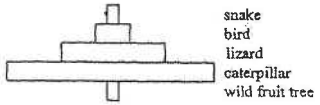
(b) With reference to the photographs of Species 1 and 2, suggest an explanation for the difference in the percent coverage of the two plant species when they were grown together. (2 marks)

Past papers Marking Scheme – Ecosystems

CE - 2003 Q.1 (c)

(i) naked skin 1
(ii) Amphibia / Amphibian 1
(iii) Destruction / lack of habitats for the Hong Kong newt
The newt may have low reproductive potential
Poor ability to find food / insufficient food supply
Poor defensive mechanism against natural enemies
Hunted by humans any two 1,1

(iv) (1) wild fruit tree → caterpillar → lizard → bird → snake 1
(2) Drawing of the pyramid : upright inverted bottom 1,1



(3) Energy is lost along the food chain 1
due to respiration / excretion / incomplete ingestion and digestion of food / death 1
thus the number of organisms in each trophic level decreases from caterpillar to snake 1
However, the biomass/energy/size of the fruit tree is much greater than that of a caterpillar, so a fruit tree can support many caterpillars 1

CE - 2005 Q.5

(b) Because it leads to extinction of the species / decrease in bioversity 1
and an increase in the population of its prey 1
(c) It allows the young fish to reach sexual maturity 1
so that they can carry out reproduction 1
As a result, the production of offspring can compensate for the loss of fish 1

CE - 2005 Q.8 (b)

(i) The nitrate in the soil is absorbed by the tomato plant for growth 1
When tomatoes are harvested, the nitrogen in the tomatoes is not recycled to the soil 1
(ii) denitrifying bacteria 1

(iii) add chemical fertilizer
bury leaves / organic matter into the soil
grow leguminous plants any two 1,1

(iv) When the soil became poorly aerated, plant roots would not have oxygen for respiration 1
Thus they cannot absorb mineral salts from the soil 1
by active transport 1
resulting in poor plant growth

CE - 2007 Q.9

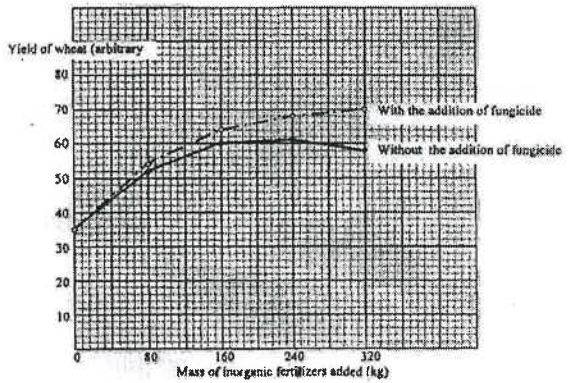
(a) (i) It converts light energy to chemical energy 1
which is passed along the food chain to support other organisms 1
It also maintains a steady air composition 1
by releasing oxygen and absorbing carbon dioxide 1
(ii) Bacteria break down the organic matter to inorganic matter 1
which is then absorbed and used by algae for growth 1
(iii) The biomass of algae is limited in the ecosphere 1
Energy is lost along food chain 1
and cannot support more trophic levels

CE - 2008 Q.8

(a) (i) Title (T) 1
Correct plotting and joining of points (P) 1 1/2
Correct labelling of curves (G) 1/2

Other alternative for the title:
Effect of different amount of fertilizers on the yield of wheat in the presence and in the absence of fungicide
The yield of wheat when different amounts of fertilizers are added in the presence and in the absence of fungicide
The effect of fertilizers and fungicides ont the yield of wheat

e.g. Title: Effect of the use of fungicide on the yield of wheat when different amount of fertilizers were added



(ii) Any three of the following: 1, 1, 1
In the presence of fungicide, the yield of wheat increases with the increase in the amount of fertilizer added (from 0 kg to 320 kg)
In the absence of fungicide, the yield of wheat increases with the increase in the amount of fertilizers added till 240 kg, and decreases when fertilizers added is higher than 240 kg
The yield of wheat is higher in the presence of fungicide than in the absence of fungicide
The difference in the yield of wheat between the presence and the absence of fungicide increases when the use of fertilizers increases

1st and 2nd points can be written as: The yield of wheat increases with the increase in the amount of fertilizer added in both cases until 240 kg of fertilizers added Beyond 240 kg fertilizers added, the yield of wheat increases in the presence of fungicides but decreases in the absence of fungicides

(iii) Leaching of fertilizers to the aquatic habitat nearby, e.g. rivers, ... 1
will lead to the rapid growth of algae / algal bloom 1

Any one of the following: 1
Other organisms in the habitat will suffocate due to oxygen depletion atnight
The algae may block the gills of the fish and suffocate it
The algae may produce toxins which kills other aquatic organisms
Abundant of suspended algae prevents light from reaching the aquatic plants below

CE - 2009 Q.10 (a)

(a) (i) Nitrogenous wastes released by the fish 1
is decomposed to ammonia by bacteria 1

(ii) (1) Nitrifying bacteria 1
They convert ammonia into nitrate 1
(2) The residual chlorine in the tal water may kill the bacteria 1
Leaving the tap water for at least one night allows time for chlorine gas to escape 1
(3) To allow the multiplication of bacteria to a sufficient population 1

(iii) Water plants can absorb the nitrates in the aquarium
The nitrates are sued for synthesis of proteins

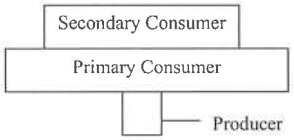
Water plants can carry out photosynthesis
to provide oxygen for other organisms / to lower the carbon dioxide concentration in water
} 1, 1 any one set

CE - 2010 Q.7

7. (a) The amount of energy stored in biomass is always less than the amount of energy gained at each trophic level (1)
because energy is lost as heat during respiration/ only part of the energy gained is used for growth/ energy is lost in form of metabolic wastes (1)

(b) Energy is lost/ trapped in the undigested/ unabsorbed parts of organisms of the previous level any two
Energy is lost in the uneaten parts of organisms of the previous level (2)
Energy trapped in the dead bodies of organism is not available to the organisms of next higher trophic level/ is redirected to the decomposers

(c)



Shape.....(2 or 0)
Label..... (1)

CE - 2010 Q.9b

9. (b) (i) Flowering plant/ dicotyledons (1)

(ii) competition (1)
Mikania covers the affected plant so the underlying plant cannot get sufficient amount of light (1)
for photosynthesis to make enough food (1)

(iii) (1) The effectiveness of using dodder for controlling the spread of Mikania varies greatly in different areas (1)
because the reduction in % coverage of Mikania caused by the dodder in area B is much lower than those in area A. (1)

OR
The use of dodder is not a perfect / ideal solution for complete elimination of Mikania (1)
as the % coverage of Mikania in both areas A and B does not drop to zero even when dodder is introduced (1)

(2) (A) Because there is no predators/ parasites/ natural enemies for this introduced invertebrate in HK
(B) They may feed on other local organisms/ disturb the local food chains or webs
(C) They may carry pathogens that do not exist in HK before
(D) They may upset the existing ecological equilibrium
} any three(3)

AL -2006 1A

2. • Figure 1: *competition (1) 2
• Figure 2: *predation (1)

AL - 2007 1A

1. (a) i. proteins (1) / amino acids
ii. ammonia (1) / ammonium compounds
iii. nitrate (1) / nitrite
(b) circle - nitrogen fixation 1

AL - 2007 1A

2. (a) • when the predation pressure / predator population is low, the prey population can increase rapidly (1)
• a greater population of prey can support rapid growth of / increase in the predator population (1) / reproduction of the predator, thus the predator population increases subsequently
• the prey population will drop due to increased predation (1)
• when the food supply (prey) becomes less, predator population will drop subsequently (1) and the cycle repeats (1)
(b) • when the prey population becomes extremely low, it is very hard for the predator to locate the remaining prey (1) / predator is forced to feed on other prey

AL - 2009 1A

3. (a) Any **ONE** of the following:
- place the transect line across a selected site where there is zonation of plants and animals (1) along with physical factors (1)
- place the transect line across a selected site where is sucessional change (1) along with physical factors (1)
- changes in physical factors (1) that are suspected to affect plants and animals distribution (1)

(2)

(b) any **TWO** of the following:
- only organisms that touch the line transect are recorded (1)
- the population / density / abundance of the organisms are not estimated (1)
- applicable to sessile organisms only (1)

(2)

AL - 2010 1A

4. (a) · 20 (1)

(b) · plants contain a high proportion of cellulose and sometimes lignin (1) (3)
· which are relatively indigestible (1)
· and therefore unavailable as energy sources for most herbivores (1)

(c) · the energy transfer efficiency would be lower (1)/ less energy would be incorporated (2)
· endotherms spend more energy in maintaining a constant body temperature

DSE-2012 1B

6. (a) (10 000 000 – 1 000 000) / 10 000 000 x 100% = 90% (Remark: accept -90%)
Method / equation 1 mark
Correct answer 1 mark (1,1)

(b) • some energy is not obtained by the organisms of higher trophic level as part of the body of prey is not consumed (1) / part of the food is not digestible or is egested (1) (1)
• some energy is lost by the organisms at the higher trophic level through excretion (1) / respiration (1) / in the form of heat (1) (1)
Remarks:
- Any two of the above.
- The words "higher trophic level" are not required. However, if the wrong trophic level is mentioned, the mark will not be awarded.
- some individuals escape from predation is not accepted.

(c) • the percentage decrease in energy content is greater (1) (1)
• as caterpillars mainly feed on leaves of trees, leaving most of the part of the biomass of tress unconsumed (1) / lignin is not consumed (1)

6 marks

HKDSE - 2013 1B

5. (a) nitrification * (1) (1)

(b) • nitrifying bacteria (1).
• which convert nitrite to nitrate (1) and help lower the nitrite level (2)

(c) • adding aquatic plants to the aquarium (1)
• the plants would assimilate / absorb / convert nitrate into their biomass (1). (2)

HKDSE - 2013 1B

8. (a) • correct title (1)
– concept: distribution of species, defined location, e.g.
> The distribution and abundance of animal species A and B on a rocky shore
> Abundance of animal species from the back of a shore to the waterfront
• choice of axes (1)
• with labels and units (1)
– X: distance from the back of the shore (m); Y: abundance (number of individuals m^{-2} or m^{-2})
• correct plotting and joining of line showing the distribution of species A and B (1,1) (5)

(b) • species A is found to be more abundant at the back of the shore than species B (1)
• the back of the shore has a lower chance / less period of time to be covered by water (1)
• thus, organisms found at this region is more likely to face the problem of desiccation (1)
• therefore, it can be deduced that species A has a higher tolerance of desiccation (1) (4)

(c) • place a transect line from the back of the shore to the waterfront (1)
• place a quadrat along the transact line at regular intervals (1)
• count the number of Species A and B in the quadrat (1) and record the results (3)

HKDSE - 2014 1B

5. (a) • secondary succession (1)
• because it involves the restoration of the community after a major disturbance, i.e. fire (1) (2)

(b) (i) • from year 0 to 3, herbs is the dominant vegetation (1)
• from year 3 to 8, woody plant is the dominant vegetation (1) (2)

(i • the underground sprouting organs and seeds were not damaged in the fire (1),
)
• herbs generally germinate and grow faster than woody plants (1)
• hence the percentage cover of herbs increased rapidly at first (1) and become the dominant vegetation in the first three years
• as woody plants continue to grow and over-shadow the herbs, thus out-compete the herbs for light (1), they replace herbs as the dominant vegetation (4)

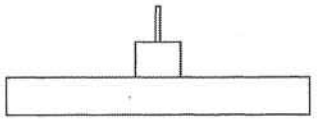
HKDSE – 2015 1B

3. (a) phytoplankton → fish → shark (1) 1
(Text description is not accepted)

(b) Shark:

Fish: 2

Phytoplankton:



correct shape (1)
lables (1) 2

(c) Not all energy in the lower tropic level is transferred to the next higher level (1) / energy is lost along the food chain due to respiration
and the organisms at lower levels are smaller in size / biomass of individual (1)
(Not accept biomass of the whole trophic level)
therefore, a larger number of individuals at a lower trophic level is required to support those at upper levels (1) 3

(d) Any two of the following:
- by dissecting the gut of the predators to find out what prey items are inside (1)
- field observation of the feeding relationship (1)
(direct observation is not accept)
- laboratory study by offering different preys to a predator (1) 2

HKDSE – 2016 1B

5. (a) species B (1)
the lower shore has higher algal biomass which indicates that it is a more favourable area (1)
a stronger competitor normally occupies a more favourable habitat (1) 3

(b) mean temperature at the lower shore is lower than that at the middle shore / vice versa (1)
if temperature tolerance is a determining factor, middle shore should be unfavourable to species A / lower shore should be more favourable to species A (1)
however, species A occupied middle shore instead of lower shore (1)
therefore, there are other factors determining the distribution / temperature tolerance is not the determining factor (1) 4

(c) quadrat sampling relies on counting organisms in a confined area (1)
so it is only useful for studying plants or very slow moving organisms / crabs may move away from the quadrat (1) 2

HKDSE – 2017 1B

8. (a) Bacterium A: inhibits/hinders/slows down/prevents/decreases/has negative effect on (do NOT accept "stops") (the growth of plant X) (1)
(all symbols like + are not accepted)
Bacterium B: promotes/increases/has positive effect on (the growth of plant X) (1)
Bacterium C: has no obvious effect on /a neutral effect on / does not change (the growth of plant X) (1) (3)

(b) Bacterium A: parasitic (1) / pathogenic
Bacterium B: mutualistic (1) (do NOT accept symbiotic) (2)

(c) (i) Bacterium A: 30(°C) /30/29/31
Bacterium B: 35(°C) /35/34/36
} (1) (1)

(ii)
- population size of bacterium A decreases (1) while
- population size of bacterium B increases (1) (2)

(d)
- native plant community decreases in size/diversity (due to the threat of plant X) (1) (do NOT accept: "native plant community may die" or "plant X becomes dominant")
- because inhibition on the growth of plant X decreases as the population size of bacterium A decreases /the growth of plant X increases as the population size of bacterium B increases (1) (2)

10 marks

HKDSE – 2019 1B

7. (a)
- secondary succession(1)
- because succession occurred in pre-existing soil / pre-existing plants (1) (2)

(b) (i)
- after the landslide, the original vegetation / top soil was removed, so the soil nitrogen content fell / after the landslide, rapid growth of herbaceous plant absorbed nitrogen from the soil, so the soil nitrogen content fell (1)
- some plant species have symbiotic nitrogen fixing bacteria in their root nodules, which enrich the soil nitrogen content by fixing atmosphere nitrogen (1)
- as time went by, the dead mass of the new vegetation was decomposed by soil bacteria (1)
- hence releasing nitrogen compounds back into the soil (1), and so soil nitrogen content increased with time (max. 3)

(ii)
- in the early stage / 2 years after the landslide, there were many more herbaceous plant species than woody plant species (1)
- since the nutrient requirements of herbaceous plant species are lower than those of woody plant species (1), low soil nitrogen content favours the growth of herbaceous plants / does not favour the growth of woody plants
- subsequently, the number of woody plants species increased as the soil nitrogen content continued to increase (1) (3)

8 marks

HKDSE – 2019 1B

9. (a)
- both apple snails and snail K showed a lower growth rate when they were raised together (1)
- this shows that there was competition between apple snails and snail K for habitat and / or food (1)
- the growth rate of snail K would be slower and some of them would fail to reach maturity for reproduction / death rate of snail K would be higher (1)
- so the population of snail K would fall / decline (1)

OR

- apple snails had a higher growth rate when raised separately from snail K (1),
- the growth rate of snail K fell significantly when raised together with apple snails (1)
- this shows that apple snails were more competitive than snail K (1)
- hence the population of snail K would fall / decline (1)

(4)

(b)
- in the long term, plants would fail to reach maturity for reproduction (1)
- it reduces the size of the plant community in the habitat (1),
- this would reduce food availability / shelter for other animals (1)

OR

- in the short term, plants would grow more slowly (1)
- the biomass of producers would decrease (1)
- this would reduce food availability for other herbivores / animals (1)

(3)

(c)
- lack of natural predators in the local habitat / a high rate of reproduction (1)

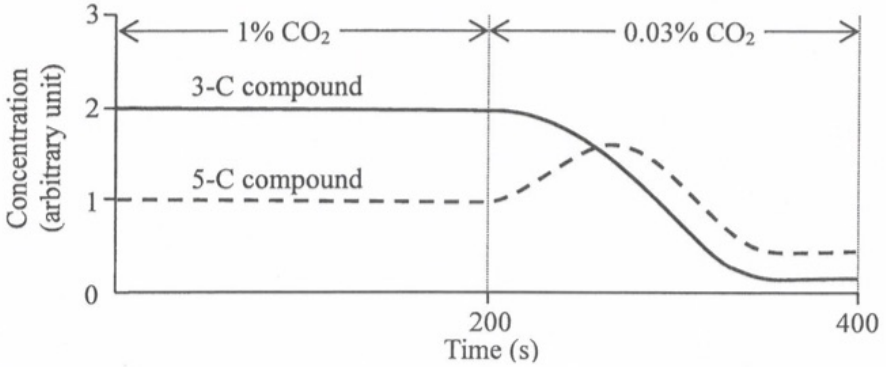
(1)

(d) any reasonable answers such as:
- release of imported pets to the natural environment once owners cannot / do not want to keep them anymore (1)
- release of imported organisms to the natural environment for religious purposes (1)
- bringing in non-local seeds / plants which the reproduce and spread to the wild habitat through seed dispersal (1)

(1)

9 marks

Directions: Questions 26 and 27 refer to an experiment in which a green algal culture was supplied with 1% carbon dioxide for 200 s and then followed by 0.03% carbon dioxide for another 200 s. The changes in the relative concentrations of a 3-C compound and a 5-C compound in the Calvin cycle of the green algae are shown below:



26. When the carbon dioxide concentration switched from 1% to 0.03%, which of the following combinations correctly shows the initial change of the concentration of the compound and its explanation?

	Initial change in concentration	***Explanation***
A.	3-C compound decreases	reduction of 3-C compound has increased
B.	3-C compound decreases	ATP from photochemical reactions has decreased
C.	5-C compound increases	carbon fixation has decreased
D.	5-C compound increases	regeneration of carbon dioxide acceptor has increased

27. Which of the following factors should be kept constant throughout the experiment?

(1) pH
(2) temperature
(3) light intensity

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

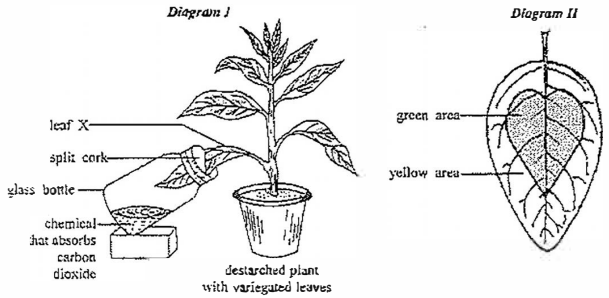
DSE M.C. Questions - Photosynthesis

(sort by difficulty)

Challenging

2019 Q.7 (31%)

Direction : Questions 6 and 7 refer to Diagram I and Diagram II below. Diagram I shows a set-up prepared by a student to study the conditions for photosynthesis. Diagram II shows the leaf surface of a variegated leaf X before the experiment.



How many independent variables were being studied in the experiment?

A. 1 B. 2 C. 3 D. 4

Average

2012 Q.23 (68%)

Which of the following descriptions about the role of light in photosynthesis are correct?

(1) Activation of chlorophyll provides high energy electrons.
(2) Photolysis of water releases oxygen for use in carbon fixation.
(3) Photolysis of water releases hydrogen for the formation of NADPH.

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2013 Q.8 (42%)

Which of the following processes in photosynthesis require energy input from ATP?

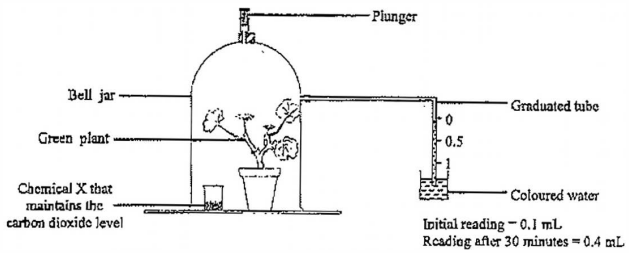
(1) fixation of carbon dioxide and the formation of 3-C compound
(2) reduction of 3-C compound leading to the formation of glucose
(3) regeneration of carbon dioxide acceptor

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

Average

Directions:

Questions 6 to 8 refer to the diagram below, which shows a set-up used to determine the rate of photosynthesis of a green plant. During the study, the position of the plunger remained unchanged.



2014 Q.6 (70%)

Based on the results, what was the rate of photosynthesis of this plant?

A. 0.6 mL oxygen released per hour
B. 0.3 mL oxygen released per hour
C. 0.6 mL carbon dioxide absorbed per hour
D. 0.3 mL carbon dioxide absorbed per hour

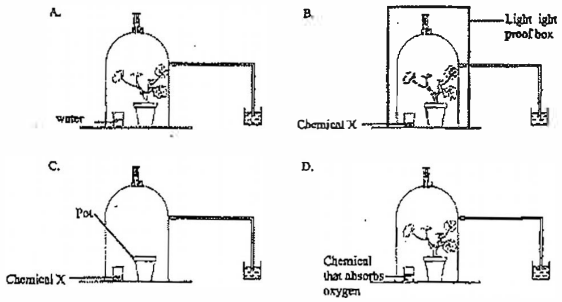
2014 Q.7 (74%)

The rate obtained was lower than the actual rate of photosynthesis of the plant. Which of the following is the most probable reason for this?

A. The plant also carried out respiration during the study.
B. The plant also carried out transpiration during the study.
C. The air temperature might have increased during the study.
D. The atmospheric pressure might have decreased during the study.

2014 Q.8 (47%)

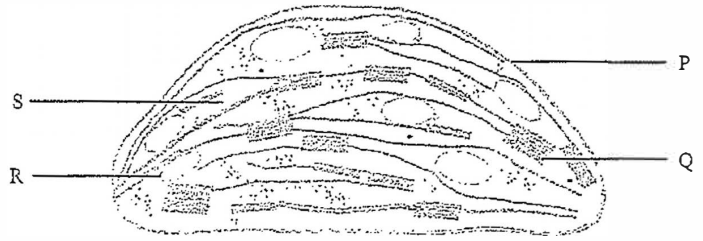
Which of the following set-ups can be used as a control for the above study to find out the actual rate of photosynthesis?



Average

2015 Q.4 (57%)

Directions: Questions 4 and 5 refer to the schematic diagram below, which shows the structures of a chloroplast:



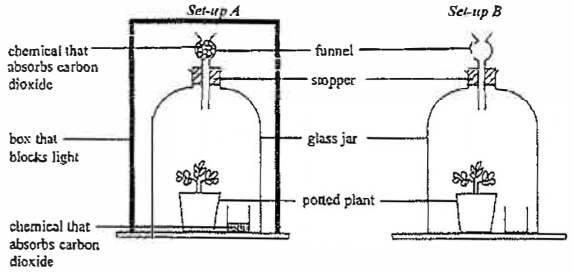
Regeneration of the carbon dioxide acceptor takes place at

A. P. B. Q. C. R. D. S.

2015 Q.12 (60%)

Directions:

Questions 11 and 12 refer to the following experiment. A student put two similar plants in darkness for 24 hours and then placed them in the following set-ups to conduct an investigation on photosynthesis:



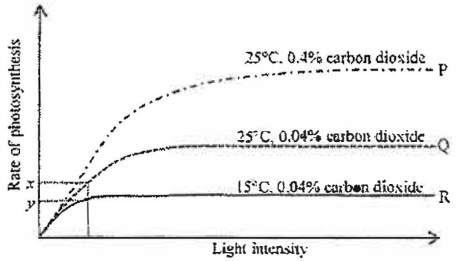
After the iodine test, the leaf taken from the set-up A was brown while the leaf taken from set-up B was blue-black. Which of the following conclusions can be drawn from the results?

A. Light is necessary for photosynthesis.
B. Carbon dioxide is necessary for photosynthesis.
C. Both light and carbon dioxide are necessary for photosynthesis.
D. Photosynthesis occurs in the plant in set-up B but not in set-up A.

Average

2016 Q.10 (67%)

Directions: Questions 9 and 10 refer to the diagram below, which shows the rate of photosynthesis of a plant under different conditions:



Which of the following descriptions best accounts for the higher rate of photosynthesis of P as compared to Q?

A. All conditions are optimum in P.
B. There is a faster diffusion of carbon dioxide into the leaves.
C. More carbon dioxide can be used as raw material for photosynthesis.
D. Carbon dioxide concentration in P is much higher than that in the atmosphere.

2017 Q.6 (73%)

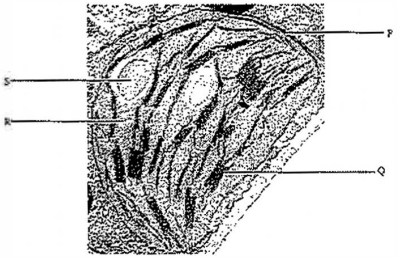
Which of the following reactions in photosynthesis takes place on the thylakoid membrane?

A. regeneration of carbon dioxide acceptor
B. reduction of 3-C compound
C. photolysis of water
D. carbon dioxide fixation

Average

2019 Q.2 (44%)

Directions: Questions 1 and 2 refer to the electron micrograph below, which shows a chloroplast of a plant cell:

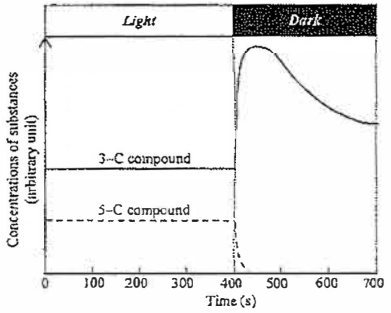


Carbon dioxide with radioactively labelled oxygen was provided to the plant cell for photosynthesis. Radioactivity can be detected in

A. Oxygen produced at Q.
B. Oxygen produced at R.
C. Glucose produced at Q.
D. Glucose produced at R.

2019 Q.4 (49%)

The graph below shows the changes in the relative concentrations of a 3-C compound and a 5-C compound (carbon dioxide acceptor) in the Calvin cycle in green plant cells which have been kept in bright light and then in darkness.



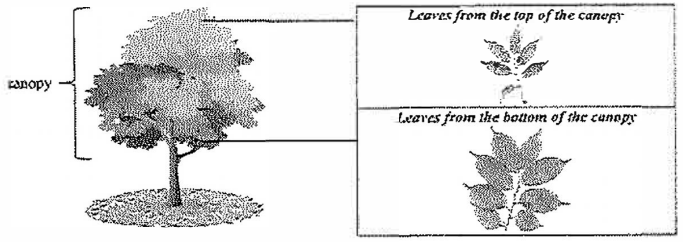
Which of the following is ***not*** a reason why the concentration of the 5-C compound decreased in the dark?

A. The 5-C compound was converted to the 3-C compound.
B. The 5-C compound combined with carbon dioxide to form glucose directly.
C. Regeneration of 5-C compound stopped because there was no ATP from photochemical reactions.
D. Regeneration of 5-C compound stopped because there was no NADPH from photochemical reactions.

Average

2019 Q.5 (45%)

The photographs on the right below show leaves taken from different parts of the canopy
of the same tree. (Note : The photographs are of the same magnification .)



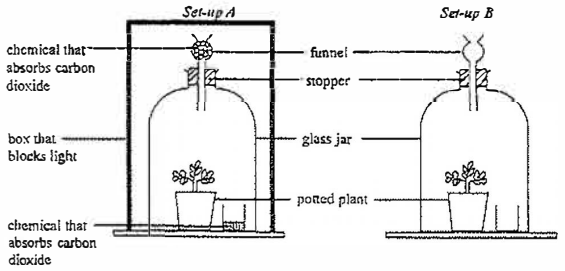
Which of the following is the most likely explanation for the differences between the leaves taken from the two parts of the canopy?

A. The leaves from the top of the canopy are smaller because they do not receive sufficient water for growth.
B. The leaves from the top of the canopy are smaller because they can reduce water loss due to transpiration.
C. The leaves from the bottom of the canopy are larger because they can store more food from photosynthesis.
D. The leaves from the bottom of the canopy are larger because they can collect light escaped through the top of the canopy .

Easy

2015 Q.11 (96%)

Directions:
Questions 11 and 12 refer to the following experiment. A student put two similar plants in darkness for 24 hours and then placed them in the following set-ups to conduct an investigation on photosynthesis:



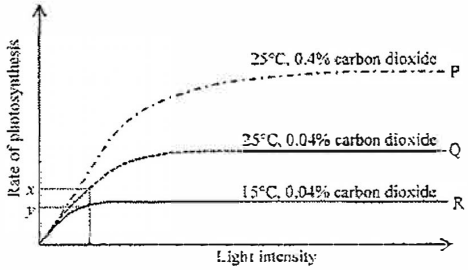
At the end of the experiment, leaves were taken from the plants in set-ups A and B for the iodine test. Arrange the following steps in the correct order:

(1) Put the leaf in boiling water for 5 minutes.
(2) Add iodine solution to the leaf.
(3) Put the leaf in hot alcohol solution for 5 minutes.
(4) Put the leaf in water at room temperature for a few seconds.

A. (1), (2), (3), (4)
B. (1), (3), (4), (2)
C. (2), (3), (4), (1)
D. (4), (3), (2), (1)

2016 Q.9 (79%)

Directions: Questions 9 and 10 refer to the diagram below, which shows the rate of photosynthesis of a plant under different conditions:



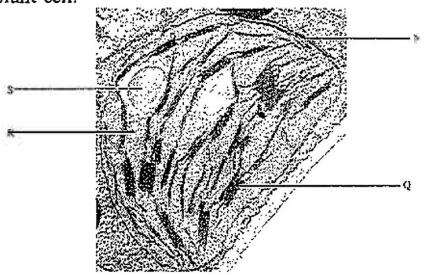
The factor(s) that determine(s) the difference in the values of x and y in the diagram is/are

A. temperature.
B. light intensity.
C. carbon dioxide concentration.
D. light intensity and temperature.

Easy

2019 Q.1 (83%)

Directions: Questions 1 and 2 refer to the electron micrograph below, which shows a chloroplast of a plant cell:

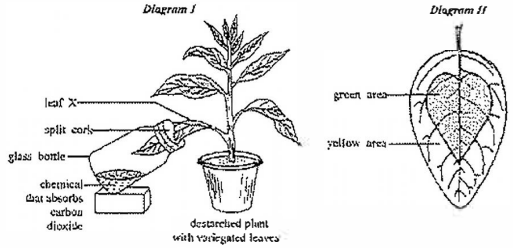


During photosynthesis, light is captured at

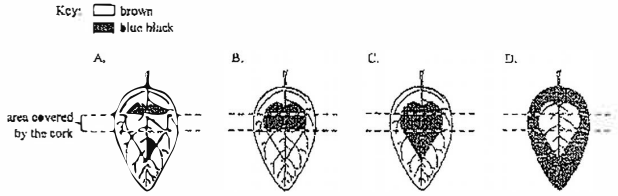
A.P. B.Q. C.R. D.S.

2019 Q.6 (77%)

Direction : Questions 6 and 7 refer to Diagram I and Diagram II below. Diagram I shows a set-up prepared by a student to study the conditions for photosynthesis. Diagram II shows the leaf surface of a variegated leaf X before the experiment.



After leaving the set-up under sunlight for several hours, iodine test was carried out on leaf X. Which of the following diagrams correctly shows the results?



Answers

Challenging

2019

7 [C]

Average

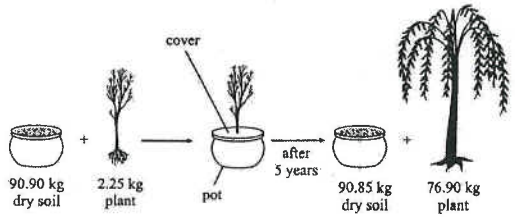
2012	2013	2014	2015	2016	2017	2019
23 [B]	8 [C]	6 [A]	4 [D]	10 [C]	6 [C]	2 [D]
		7 [A]	12 [D]			4 [B]
		8 [B]				5 [D]

Easy

2015	2016	2019
11 [B]	9 [A]	1 [B]
		6 [A]

CE - 2003

4. (a) In the 17th century, a Dutch scientist, van Helmont, wanted to test the following hypothesis: the soil is the main source of food for plant growth. He grew a young willow plant in a known mass of soil for five years. In this period, he only supplied the plant with water. His investigation is summarized in the diagram below:



(i) Calculate the change in mass of the dry soil and that of the plant in these five years. (1)

(ii) Based on the results obtained in (i), what conclusion can you draw with reference to the above hypothesis? Explain your answer. (3)

(iii) Explain why it is important to put a cover on the pot in this investigation. (2)

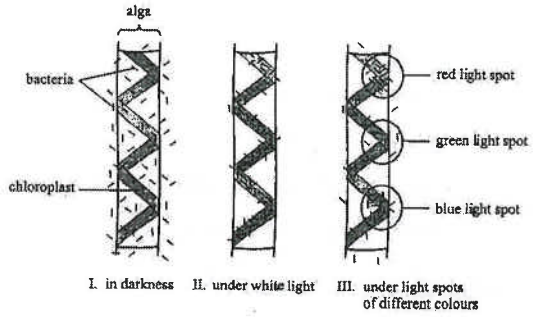
(iv) At van Helmont's time, people did not know that carbon dioxide in the air is also needed by plants for making food.

(1) You are provided with a destarched potted plant. Draw a labeled diagram of an experimental set-up which can be used to show that carbon dioxide is necessary for the plant to make food. (3)

(2) What is the purpose of destarching the plant before the experiment? State how you would destarch the plant. (2)

CE - 2004

2. (b) In 1883, a German scientist, Engelmann, used a green alga to study the effect of light on photosynthesis. This alga has long ribbon-like chloroplasts. He placed the alga on a slide with a suspension of bacteria which would migrate to regions with high oxygen concentration. He observed the distribution of the bacteria under different light conditions. The results are shown in the diagram below:



(i) Describe the distribution of bacteria in I and II. (2)

(ii) How would you account for the bacteria distribution in II? (2)

(iii) What did Engelmann wish to find out by setting up the experiment in III? (1)

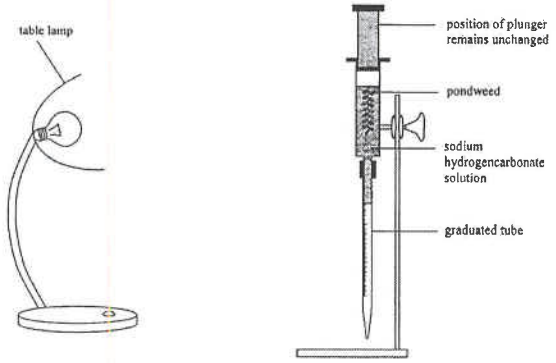
(iv) What conclusions can you draw from the results in III? (2)

(v) (1) Draw a labeled diagram to show in experimental set-up used to test whether the conclusions in (iv) is correct or not. You are provided with a waterweed, a table lamp, colour filters and materials that you can get in the laboratory. (3)

(2) What data would you collect with this set-up? (1)

CE - 2006

8. (a) The diagram below shows a set-up used to measure the rate of photosynthesis of a pondweed. A lamp was placed at different distances from the pondweed. At each distance, the volume of gas collected per minute was taken as the rate of photosynthesis.



The results of the experiment are shown in the table below:

Light intensity (arbitrary unit)	Rate of photosynthesis (mm^3 min^{-1})
0.4	0.0
0.6	0.8
1.6	2.0
2.5	2.7
5.0	3.5
10.0	3.5

(i) How would you measure the volume of gas collected per minute using this set-up? (1)

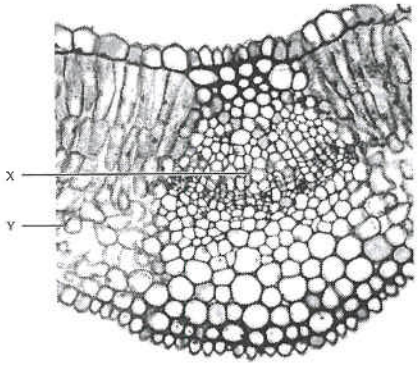
(ii) Present the results of the experiment in the form of a graph. (4)

(iii) Describe and explain the change in the rate of photosynthesis with light intensity.(4)

(iv) Explain why the rate of photosynthesis becomes 0 even there is 0.4 arbitrary unit of light. (2)

CE - 2007

3. The photomicrograph below shows a cross section of a dicotyledonous leaf:



(a) With reference to the photomicrograph, give two structural differences between cell types X and Y. (2 marks)

(b) (i) In the presence of light, carbohydrates are formed and then stored in cell type Y.

(1) State the carbohydrate stored. (1 marks)

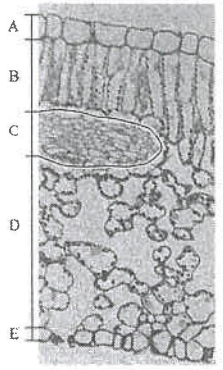
(2) If you have prepared a thin section of a leaf, how would you show the presence of the stored carbohydrate in it? (3 marks)

(ii) Explain why the stored carbohydrate in cell type Y disappears when the plant is kept in darkness? (3 marks)

(c) During transpiration, water evaporates from the surface of cell type Y. How does this help cell type Y to obtain minerals? (3 marks)

CE - 2009

5. (a) The photomicrograph below show the cross-section of a leaf of a dicotyledonous plant. A to E show the different parts of the leaf.



(i) Using the letters in the photomicrograph, list the parts in descending order of their photosynthetic rates. (1 mark)

(ii) State two features of the part with highest photosynthetic rate shown in the photomicrograph and explain how these features contribute to its high photosynthetic rate. (3 marks)

(iii) Explain how the arrangement of the cells in part D facilitates photosynthesis. (2 marks)

(b) The arrangement of the leaves of an African violet is shown in the photograph below.

How does the arrangement of the leaves of this plant help photosynthesis? (1 mark)

CE - 2010

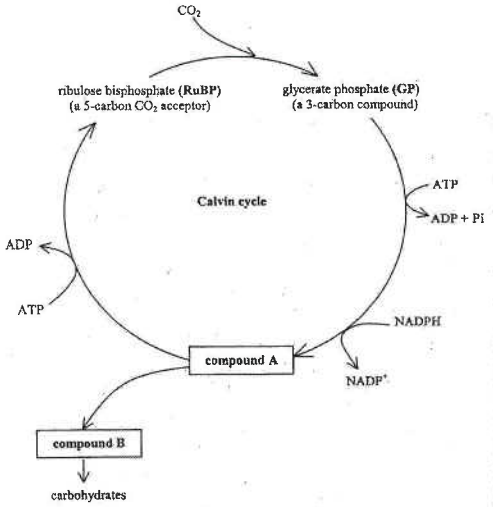
6. The following table shows the comparison of two vital processes -- photosynthesis and aerobic respiration. Complete the table with suitable words.

	Photosynthesis	Aerobic respiration
Type of metabolic process	Anabolism	(a)
Organelle where the process occurs	Chloroplasts	(b)
Raw materials needed	(c)	Glucose and oxygen
Energy conversion	from (d) _____ energy to chemical energy in glucose	from chemical energy in glucose to chemical energy in ATP and (e)_____ energy

Total: 5 marks

AL - 2004 2A

2. The following flow chart shows the Calvin cycle:



(a) The rate of GP formation can be affected by a number of external factors. Explain why two of these external factors can have this effect. (2)

(b) Describe the roles of ATP and NADPH in the conversion of GP to compound A. (2)

(c) If all of compound A is channeled to form compound B, what will be the effect on the Calvin cycle? Why? (3)

(e) Other than carbohydrates, plants need to synthesize nutrients such as proteins.

(ii) Suggest two additional substances that have to be acquired from the environment to form proteins. (2)

(f) Oxygen is a by-product of photosynthesis. Suggest and outline a method that could be used to determine whether this oxygen comes from CO_2 or H_2O. (5)

AL - 2006 2B

5. (b) Explain how the structural features of the chloroplast are adapted to the photochemical reactions of photosynthesis. (5)

AL - 2008 1A

9. Select the appropriate substance listed in column 2 to match with the description given in column 1. Put the appropriate letter in the space provided. (3)

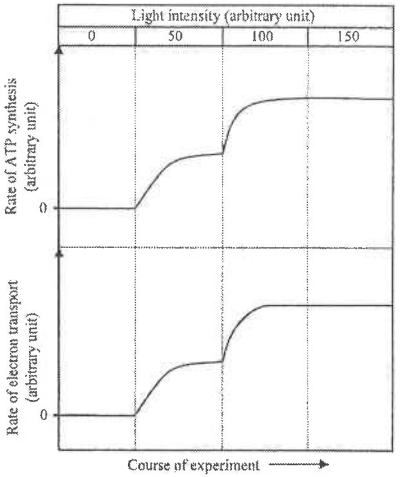
Column 1		Column 2
Substance that donates hydrogen to the Calvin cycle	(a)	A. NADH B. NADPH C. oxygen D. acetyl CoA E. carbon dioxide F. triose phosphate
Substance that is produced in the Calvin cycle and is used to form starch in the chloroplasts	(b)	
Substance that serves as the final electron acceptor in the electron transport chain in the mitochondria	(c)	

AL - 2008 2B

6. (c) Unlike animals, plants can make their own proteins from different inorganic substances. Briefly outline how these substances are assimilated to form proteins after their uptake into the mesophyll cells. (4)

AL - 2009 1B

9. The following figure shows the results of a study on the photochemical process of photosynthesis.
In this study, grana taken from chloroplasts were incubated with an adequate amount of ADP and inorganic phosphate (Pi) and treated with different light conditions during the course of the experiment,



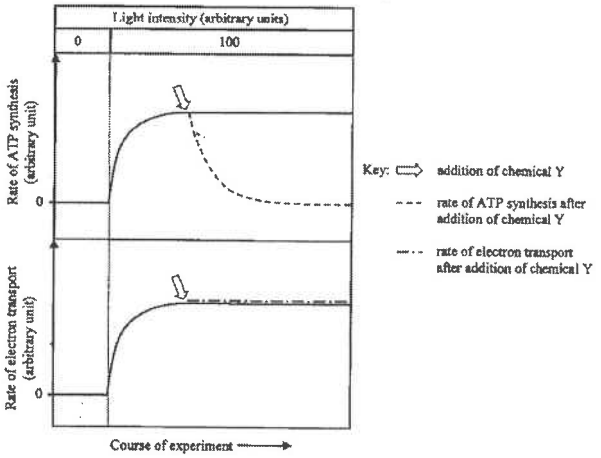
N.B. Incubated with an adequate supply of ADP and Pi

(a) Both ATP synthesis and electron transport are events of the photochemical process of photosynthesis. How do the results provide evidence that the photochemical process is light dependent? (3 marks)

(b) Explain why the rate of ATP synthesis and the rate of electron transport levelled off at 50 arbitrary units of light intensity. (2 marks)

(c) Give a reason why the rate of ATP synthesis and the rate if electron transport remained unchanged when light intensity increased from 100 to 150 arbitrary units. (1 mark)

(d) It is known that ATP synthesis and electron transport are linked to each other in the photochemical process. To study this relationship, chemical Y was added to the reaction mixture exposed to light intensity of 100 arbitrary units. Chemical Y served to break the linkage of the two events. The results of this study are shown below:



N.B. Incubated with an adequate supply of ADP and Pi

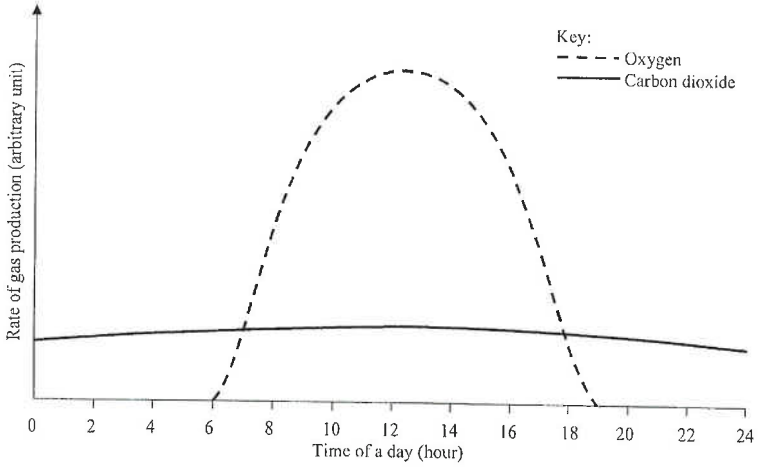
(i) Describe the results after the addition of chemical Y. (2 marks)

(ii) Hence deduce how ATP synthesis and electron transport are linked to each other. (1 mark)

(e) Explain why intact chloroplasts should not be used in these studies. (2 marks)

DSE-2012 1B

5. The graph below shows the oxygen production rate and carbon dioxide production rate of a local plant on a summer day:



(a) State times at which there is no net exchange of gases into or out of the leaves. (1 mark)

(b) Sketch a line on the above graph to show the oxygen production rate of the plant on a winter day. (2 marks)

(c) The area below the line showing the oxygen production rate is usually greater than the area below the line showing the carbon dioxide production rate. Explain the importance of this observation. (4 marks)

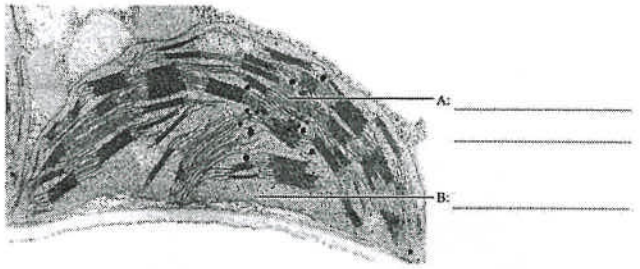
DSE-2014 1B

1. For each of the brain parts listed in column 1, select from column 2 one phrase that matches it. Put the appropriate letter in the space provided. (3 marks)

Column 1		Column 2
NADPH	____	A. a product of oxidative phosphorylation
pyruvate	____	B. a product of photochemical reactions
NAD	____	C. a product of carbon dioxide
		D. a product of glycolysis

DSE – 2016 1B

3. The diagram below shows the electron micrograph of an organelle:



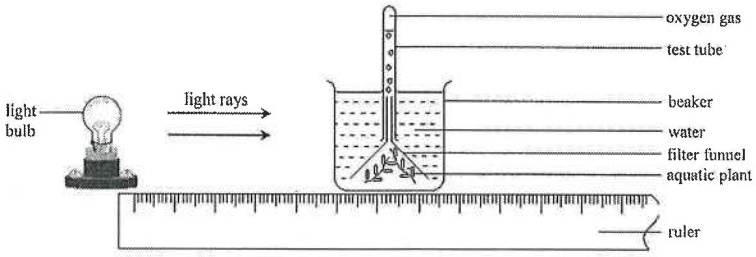
(a) Label A and B. (2 marks)

(b) State a type of plant cell that contains this organelle. (1 mark)

(c) What is the functional relationship between A and B? (3 marks)

HKDSE - 2017 1B

7. The diagram below shows an experiment set-up for investigating the effect of light intensity on the rate of photosynthesis:



a. What is the assumption behind using the volume of oxygen released per unit time to indicate the photosynthetic rate? Explain your answer. (2 marks)

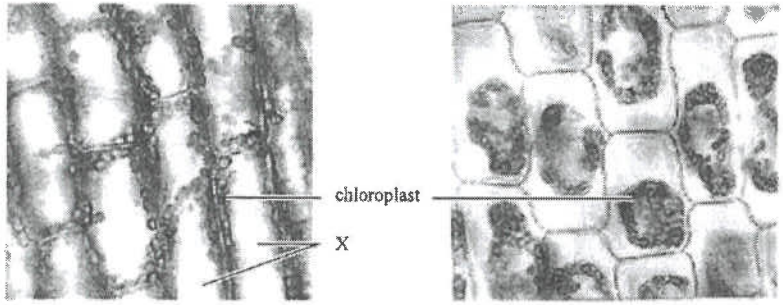
b. Suggest ***one*** modification to this experimental set-up to make sure that the result is due to the independent variable only. Explain your answer. (3 marks)

c. What is the significance of the ***two*** products of the photochemical reactions to the whole photosynthetic process? (4 marks)

HKDSE - 2018 1B

2. The leaf of an aquatic plant was placed in a concentrated sucrose solution and observed under a light microscope. Photomicrographs A and B show the appearance of the cells at the beginning of the experiment and after five minutes respectively:

Photomicrograph A – at the beginning ***Photomicrograph B – after five minutes***



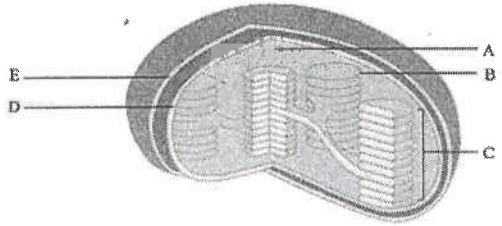
(a) X is an organelle which is invisible without staining. Name this organelle. (1 mark)

(b) Comparing the photomicrographs, state ***two*** observable changes in the appearance of the cells after five minutes. (2 marks)

(c) Explain how the observable changes stated in (b) are brought about. (2 marks)

HKDSE - 2020 1B

1. The diagram below shows the structures in a chloroplast:

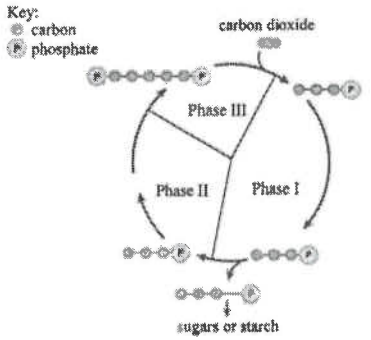


(a) Using the letters from the diagram, list ***all*** of the structures that contain photosynthetic pigments. (1 mark)

(b) Structure C produces intermediates that are used in the Calvin Cycle. State the intermediates. (1 mark)

HKDSE - 2020 1B

1.(c) The diagram below shows a simplified Calvin Cycle:



Match the three phases with the following reactions: (2 marks)

Reactions	***Phase***
Regeneration of carbon dioxide acceptor	.....
Reduction of 3C compound	.....
Carbon dioxide fixation	.....

Past Papers Marking Scheme – Photosynthesis

CE - 2003 Q.4 (a)

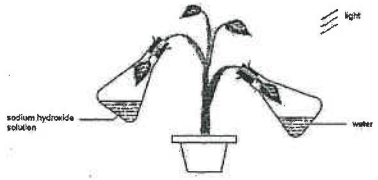
(i) dry soil : 50g / 0.05 kg plant : 74.65 kg ½,½
(no unit, no mark)

(ii) The soil is not the main source of food for plant growth 1
because the drop in mass of the dry soil is very small 1
in comparison with the gain in mass of the plant 1

(iii) To reduce the amount substance in air added to the soil / the amount of soil lost to the air 1
so that the loss in weight of the soil is mainly due to the plant 1

(iv)

(1) Title ½
Design of set-up :
leaf with CO_2 supply (1),
leaf in a container having sodium hydroxide solution (1)
light source (½)



Experimental set-up for showing that CO_2 is necessary for the plant to make food

(2) To make sure that the starch detected at the end of the experiment was made during the experiment 1
By keeping the plant in darkness for two days 1

CE - 2004 Q.2 (b)

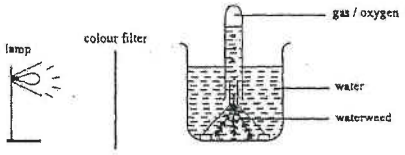
(i) The bacteria distributed evenly in I 1
but concentrated on the chloroplast in II 1

(ii) In the presence of light, the chloroplast produced oxygen during photosynthesis 1
This led to the movement of bacteria toward the chloroplast 1

(iii) To study the effect of light of different colours on (the rate of) photosynthesis 1

(iv) Photosynthesis occurs at similar rates in red and blue lights 1
which are higher than that in green light 1

(v) (1) Workable set-up (S): (must include light source, water, waterweed & colour filters) 1
Labels (L): colour filters, waterweed, water/ lamp / gas or oxygen 3 x½
Title(T) ½



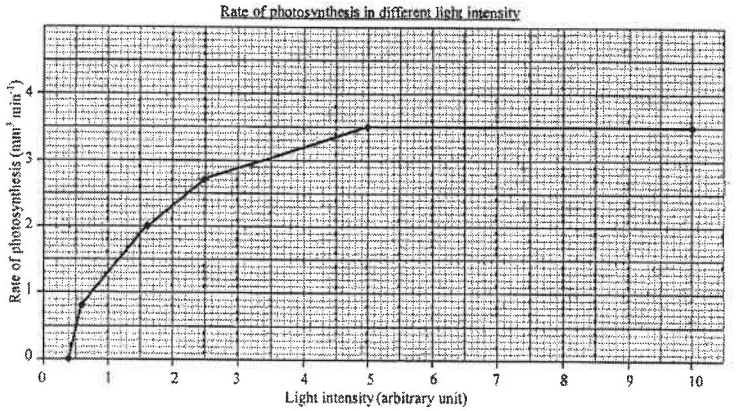
Set-up for studying the effect of light colours on photosynthesis

(2) Measure the volume of oxygen produced / number of oxygen bubbles released per unit time / over a period of time 1

CE - 2006 Q.8 (a)

(i) Measure the displacement of the solution level in the graduated tube 1

(ii) Title 1
Correct choice of axes ½
Correct labelling of axes together with units ½,½
Correct plotting and joining of points (deduct ½ for 1 mistake) 1½



(iii) From 0.4 - 5.0 arbitrary units light intensity, the rate of photosynthesis increases with increasing light intensity 1
because there is more energy trapped for dark reaction 1
Above 5.0 arbitrary units light intensity, the rate of photosynthesis remains the same 1
because there is insufficient supply of carbon dioxide at high light intensity 1
/ enzyme activity is not high enough at high light intensity 1

(iv) Because at 0.4 arbitrary unit of light, the rate of respiration is greater than or equal to the rate of photosynthesis 1
so there is no net oxygen released 1

CE - 2007 Q.3

(a) Cell type X has no cellular content while cell type Y has 1
Cell type X has a thicker cell wall than cell type Y 1

(b) (i) (1) Starch 1
(2) Add a drop of iodine solution to the leaf section 1
Observe the leaf section under the microscope 1
The section turns blue black 1

(ii) In darkness, photosynthesis stops 1
The stored carbohydrate is converted to sugars 1
which are transported away to other parts of the plant / are used in respiration 1

(c) When water evaporates from cell type Y, a transpiration pull is set up 1
Water is drawn from xylem to cell type Y 1
together with dissolved minerals 1

CE - 2009 Q.5

(a) (i) B, D, E, A & C 1

(ii) B is at the upper part of the leaf / close to upper surface exposing directly to sunlight 1
The chloroplast density is highest in B 1
These help to maximize the amount of light absorbed for photosynthesis 1

(iii) Cells in part D are loosely packed with a lot of air spaces between the cells 1
This is to allow carbon dioxide to move freely by diffusion to the mesophyll cells 1

(b) There is little overlapping among the leaves which enables leaf to receive maximum amount of light 1

CE - 2010 Q.6

(a) catabolism/ catabolic process/ breaking down process (1)
(b) mitochondria (1)
(c) carbon dioxide and water (1 or 0)
(d) light/ solar (1)
(e) heat (1)

AL - 2004 2A

2. (a)

Concept for mark award (Any two):
- why CO_2 concentration can affect the rate of GP formation (1) max. 2
- why temperature can affect the rate of GP formation (1)
- why light intensity can affect the rate of GP formation (1)
- why water in soil can affect the rate of GP formation (1)

e.g.
- CO_2 is raw material for GP (1)
- temperature will affect the kinetic energy of the reactants (1) max. 2

or
- temperature will affect the rate of enzyme catalysis (1)
- light for ATP synthesis which is necessary for the resynthesis of RuBP, which in turn forms GP (1) / light opens up stomata and increases CO_2 availability

(b)
- ATP provides the energy for the conversion of GP to TP (1) 2
- NADPH reduces GP to TP (1) / supply H

(c)
- Calvin cycle will stop (1) 3
- no regeneration of RuBP from TP / A (1)
- RuBP is necessary to fix CO_2 (1)

(e) (ii) Any two (1 mark each):
- ammonium / nitrate
- sulphate 2
- phosphate

(f)
- use tracer technique (1) max. 5
- label the O of CO_2 with ^{18}O (1) / the isotope of O
- let photosynthesis take place (1) / expose the plant to light
- collect the gas (O_2) evolved (1)
- in a separate experiment, label the O of H_2O with ^{18}O (1) / the isotope of O
- interpretation of result: whichever experiment releases the labeled O_2 will determine the source (1)

AL - 2006 2B

5. (b)

Concept for mark award:
- structural feature: thylakoid stacking / grana (1) 1
- significance of stacking:
  - > increase surface area (1) for trapping light (2) and electron transport (2) } max. 4
  - > within a small space (1)

5

e.g.
- within the chloroplast are many stacks of thylakoids (1) / grana 1
- this provides a large surface area (1) for holding the chlorophyll molecules (1) for trapping light (1), and for holding carriers of electron transport (1) and enzyme for ATP synthesis (1) without taking up too much space (1) } max. 4

AL - 2008 1A

9. (a) B (1)
(b) F (1)
(c) C (1)

AL - 2008 2B

6. (c)
- in photosynthesis, carbon dioxide and water (1) is assimilated to form glucose (1) / sugars / triose phosphate
- nitrate (1) / ammonium ions and the carbon skeleton derived from glucose / sugars (1) are used for synthesizing amino acids(1) (max .4)
- amino acids are then condensed / polymerized to form proteins (1)

AL - 2009 1B

9. (a)
- in darkness, the rates of the two events are both 0 (1) (3)
- at 50 arbitrary units of light intensity, the rates increase (1)
- at 100 arbitrary units of light intensity, the rates increase further (1), and are nearly double that at 50 arbitrary units of light intensity (1 bm)

(b)
- because light is limiting at the given conditions (1) as further increase in light intensity increases the rate of ATP synthesis and rate of electron transport (1) (2)

(c)
- because factors other than light intensity and ADP + Pi supply (e.g. amount of chlorophyll / grana / NADP[marker's mtg.]) become limiting (1) (1)

(d) (i)
- in the presence of chemical Y, the rate of ATP synthesis decreased sharply (1) while the rate of electron transport remained the same (1) (2)

(ii)
- this indicates that ATP synthesis is dependent in the coupling to electron transport (1) / electron transport provides energy for ATP synthesis (1)

(e)
- intact chloroplasts contain stroma (1) where the Calvin cycle will consume the ATP formed in the photochemical process (1) (2)

DSE-2012 1B

5. (a)
- 7:00 and 18:00 (1) (1)

(b)
- shorter light period (1), overall rate lower (1) (1,1)

(c)
- the area below the line showing oxygen production rate represents the food production in 24 hrs (1) (1)
- whereas the area below the line showing carbon dioxide production rate represents the food consumption in 24 hrs (1) (1)
- it is therefore important for food production to be greater than food consumption such that there is a net amount of food produced (1) (1)
- as a result, this provide energy for the plant to survive, grow and produce fruits (1) (1)

7 marks

DSE-2014 1B

1. B (1)
D (1)
A (1)

3 marks

DSE – 2016 1B

3. (a) A: thylakoid membrane (1) / thylakoid
B: stroma (1) 2

(b) mesophyll cell / palisade mesophyll cell / spongy mesophyll cell / guard cell (photosynthetic cell not accepted) 1

(c) light-dependent reactions take place at A (1)
which supplies ATP and NADPH (1)
for light-independent reactions that take place at B (1)
Or
light-independent reactions take place at B (1)
which regenerate NADP (1)
for light-dependent reactions that take place at A (1) 3

HKDSE – 2017 1B

7. (a) • the rate of respiration remains constant throughout the experiment (1)
• so that any change in the net production of oxygen can be attributed to the change in the photosynthetic rate (1)

OR

The size of oxygen bubbles should be uniform (1)
thus the rate of release of bubbles **is directl**y proportional to the rate of photosynthesis (1) (2)

(b) • add a heat shield / water bath between the light bulb and the beaker/use a cold light source/use a bigger beaker containing more water instead to conduct this experiment (1)
• to avoid the heating up of water in the beaker (1)
• as temperature is also a factor that may affect the photosynthetic rate (1) (3)

OR

• place a thermometer in the beaker (1)
• to ensure the temperature is constant (1)
• as temperature is also a factor that may affect the photosynthetic rate (1)

(c) • Photochemical reactions produce ATP (1)
• Which provides energy to drive the light-independent reactions / regeneration of CO_2 acceptor (1)
• Photochemical reactions also produce NADPH (1)
• In photosynthesis, reducing power/H/H^+ is required for reduction of 3-C compound to form glucose (1) (4)

Instructions to markers: if candidates presented a wrong/irrelevant reaction to describe the significance of ATP or NADPH, no mark is awarded to the first and third points.

9 marks

HKDSE – 2018 1B

2. (a) • vacuole * (1) (1)

(b) Any *two* of the following:
• the cell membrane / cytoplasm of the leaf cells has detached from the cell wall / the leaf cell is plasmolysed (1)
• chloroplasts condense to the centre of the cell (1)
• the vacuole / X has shrunk (1) (2)

(c) • sucrose solution has a lower water potential than the cell content (1)
• there is a net movement of water from the cell content to the bathing solution by osmosis (1) (2)

5 marks

DSE M.C. Questions - Respiration
(sort by difficulty)

Challenging
/

Average

2013 Q.10 (67%)
Which of the following combination best describes the process involved in respiration?

	Oxygen is required	Carbon dioxide is released
A.	Conversion of pyruvate to acetyl CoA	Glycolysis
B.	Conversion of pyruvate to acetyl CoA	Krebs Cycle
C.	Oxidative phosphorylation	Glycolysis
D.	Oxidative phosphorylation	Krebs Cycle

2014 Q.14 (45%)
Which of the following processes produce ATP?
(1) Glycolysis
(2) Krebs cycle
(3) Conversion of pyruvate to lactic acid

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

2015 Q.6 (53%)
Which of the following combinations correctly compares the aerobic respiration and anaerobic respiration of muscle cells?

	Aerobic respiration	*Anaerobic respiration*
A.	occurs only when oxygen is present	occurs only when oxygen is absent
B.	produces more NADH	produces less NADH
C.	glycolysis takes place	no glycolysis
D.	takes place only inside the mitochondria	takes place only in the cytoplasm

Average

2016 Q.26 (65%)
Which of the following processes in aerobic respiration release NADH?
(1) glycolysis
(2) Krebs cycle
(3) oxidative phosphorylation

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2017 Q.7 (58%)
Which of the following combinations correctly matches the reaction in aerobic respiration with the location where it takes place?

	Reaction in aerobic respiration	*Location*
A.	regeneration of NAD	cytoplasm
B.	production of carbon dioxide	cytoplasm
C.	conversion of pyruvate to acetyl-coA	mitochondrion
D.	conversion of triose phosphate to pyruvate	mitochondrion

2018 Q.11 (69%)
Which of the following processes takes place at the inner membrane of mitochondria?

A. Glycolysis
B. Conversion of pyruvate to acetyl CoA
C. Krebs cycle
D. Oxidative phosphorylation

2018 Q.26 (50%)
After vigorous exercise, the blood lactic acid concentration of an athlete increases. Which of the following word equation correctly shows the process that leads to the formation of lactic acid?

A. Glucose → lactic acid
B. Glucose → lactic acid + water
C. Glucose → lactic acid + carbon dioxide
D. Glucose + oxygen → lactic acid + carbon dioxide

Average

2019 Q.3 (61%)

Which of the following process(es) in the respiratory pathways release(s) carbon dioxide?

(1) Oxidative phosphorylation
(2) Reactions in the Krebs cycle
(3) Conversion of glucose to pyruvate

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

Easy

/

2020 Q.4

4. Which of the following descriptions of anaerobic respiration in muscles is correct?

A. It involves glycolysis.
B. It produces lactic acid and carbon dioxide.
C. It takes place in the matrix of mitochondria.
D. It takes place on the inner membrane of mitochondria.

2020 Q.5

5. Which of the following combinations correctly matches the stages of cellular respiration and the metabolites produced?

	Stage	*Metabolite produced*
A.	Glycolysis	acetyl-CoA
B.	Glycolysis	ATP
C.	Krebs Cycle	NAD
D.	Krebs Cycle	pyruvate

Answers

Challenging

Average

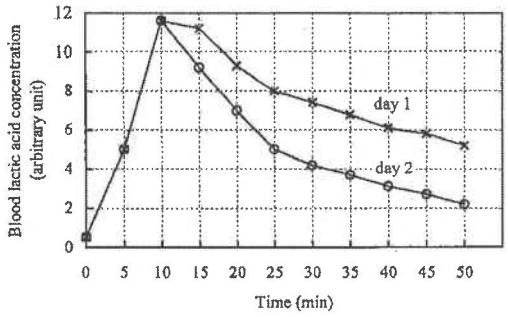
2013	2014	2015	2016	2017	2018	2019
10 [D]	14 [A]	6 [B]	26 [A]	7 [C]	11 [D]	3 [B]
					26 [A]	

Easy

2020
4 [A]
5 [B]

CE - 2004

4. (a) An experiment was carried out to study the changes in blood lactic acid concentration of an athlete during and after exercise. On day I, the athlete ran for 10 minutes and then sat down to rest for 40 minutes. On day 2, she performed the same exercise, followed by slow jogging for 40 minutes. The results of the experiment are shown in the graph :



(i) Account for the increase in blood lactic acid concentration in the first 10 minutes (3)

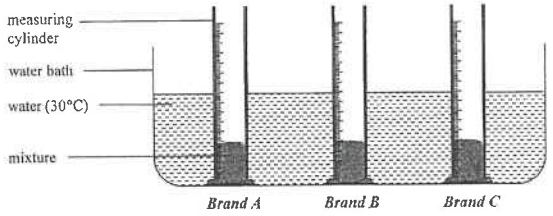
(ii) The rate of carbon dioxide production also increased in the first 10 minutes. Write a word equation to show how carbon dioxide is produced. (2)

(iii) Why is it harmful to the body cells if the blood contains a high level of lactic acid ?(1)

(iv) Referring to the graph, which method, sitting down or slow jogging, is more effective in removing lactic acid from the blood after exercise ? Based on your biological knowledge, explain why this method is more effective. (4)

CE - 2007

4. A student carried out an investigation to compare the activity of three brands of yeast. He added a mixture of fixed amounts of dough and yeast into a measuring cylinder and recorded the volume of the mixture. After putting the measuring cylinder in a water bath at 30oC for one hour, the volume of the mixture was recorded again. The diagram below shows his set-up:



(a) The results of the investigation are shown in the table below. Complete the table by finding out the percentage change in the volume of mixture for brand C. (1 mark)

Brand of yeast	Initial volume of mixture (cm^3)	Volume of mixture after 1 hour (cm^3)	Percentage change in the volume of mixture (%)
A	20	28	40
B	20	49	145
C	20	46	

(b) Draw a bar chart to show the activity of the three brands of yeast in terms of the percentage change in the volume of mixture. (3 marks)

(c) Explain why the yeast can make the mixture rise. (3 marks)

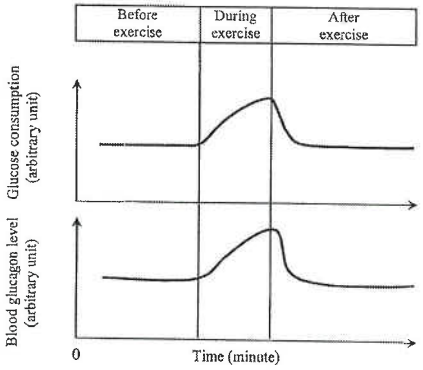
(d) The student wants to make a cake that is the most spongy. Based on the above results, which brand of yeast should be used? (1 mark)

(e) Why should the set-up be kept in a water bath? (1 mark)

(f) If the student wanted to study the effect of temperature on the activity of yeast, suggest two changes that should be made in his experimental design. (2 marks)

CE - 2007

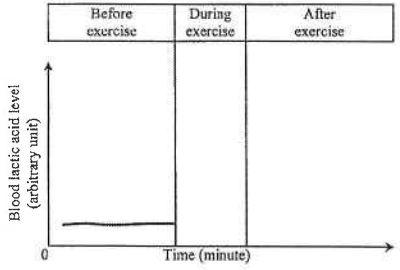
8. (b) The graphs below show the changes in the glucose consumption and the blood glucagon level in a person before, during and after exercise:



(i) Explain the change in glucose consumption during exercise.(3)

(ii) During exercise the blood glucose level remains relatively steady. Explain this phenomenon by referring to the change in the blood glucagon level. (3)

(iii) Draw a line on the graph below to show the change in the blood lactic acid level during and after vigorous exercise. (2 marks)



CE - 2010

6. The following table shows the comparison of two vital processes -- photosynthesis and aerobic respiration. Complete the table with suitable words. (5)

	Photosynthesis	Aerobic respiration
Type of metabolic process	Anabolism	(a)
Organelle where the process occurs	Chloroplasts	(b)
Raw materials needed	(c)	Glucose and oxygen
Energy conversion	from (d) _____ energy to chemical energy in glucose	from chemical energy in glucose to chemical energy in ATP and (e)_____ energy

Total: 5 marks

AL - 2005 1A

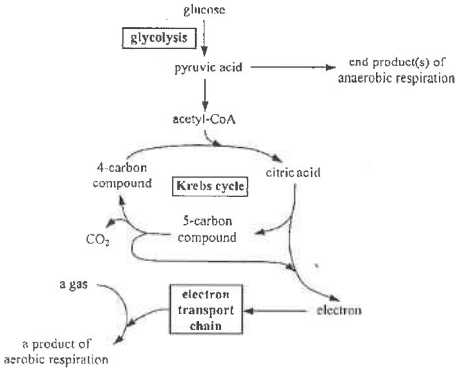
2. The diagram below oulines the biochemical pathway of respiration in animal and plant cells:

(a) (i) State the end product(s) of anaerobic respiration:

Animal cells

Plants cells (2)

(ii) Based on your knowledge of biochemical reactions, suggest a reason why the same substrate (pyruvic acid) can be broken down into different end products in the anaerobic respiration of animal and plant cells. (1)



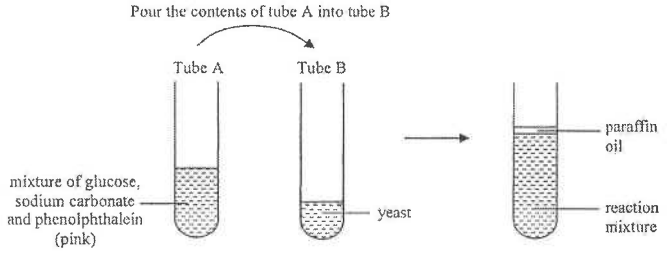
(b) Give one carrier that transfers electrons from the Krebs cycle to the electron transport chain. (1)

(c) Explain why the electron transport chain cannot operate under anaerobic conditions. (1)

(d) Indicate on the diagram two other sites where carbon dioxide is released in the aerobic pathway. (2)

AL - 2009 1A

5. To estimate the rate of anaerobic respiration of yeast at room temperature, a student poured the contents of tube A into tube B and covered the reaction mixture with a layer of paraffin oil as shown below:



N.B. Phenolphthalein is an indicator which is colourless at round pH 8 or below, but pink at higher pH.

The time taken for the disappearance of the pink colour in the reaction mixture can be used to indicate the rate of anaerobic respiration of yeast.

(a) Account for the colour change in the reaction mixture. (3 marks)

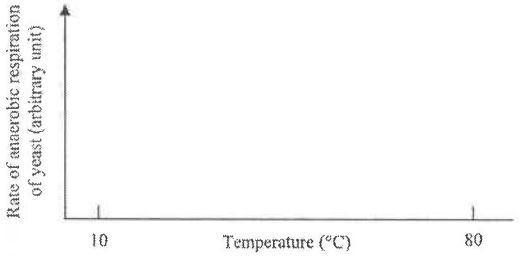
(b) The above method can be used to study the effect of temperature on the rate of anaerobic respiration of yeast.

(i) List three variables that have to be kept constant for the results to be comparable. (3 marks)

(ii) What additional steps are necessary to manipulate the independent variable of the experiment? (3 marks)

(iii) After recording the time taken for the disappearance of the pink colour, what further manipulation of the data is necessary to obtain the rate of anaerobic respiration of yeast? (1 mark)

(iv) In the space below, sketch a graph to show the effect of temperature on the rate of anaerobic respiration of yeast. (1 mark)



AL - 2010 2C

7. Both chloroplast and mitochondria are important organelles for handling energy transformation. Explain how the structural similarities of the two organelles contribute to efficient energy transformation. (11 marks)

DSE-2012 1B

9. Drugs X and Y may inhibit enzymes involved in glycolysis, the Krebs cycle or oxidative phosphorylation. To study the effects of the drugs, some muscle cells were isolated and treated with these two drugs separately in the presence of oxygen. The cellular levels of ATP, NADH, and pyruvate were determined. The results are shown in the table below:

	ATP	NADH	Pyruvate
Control (without treatment)	100%	100%	100%
Drug X	2%	3%	5%
Drug Y	20%	15%	150%

The data for the control are set as 100% for comparative purpose.

(a) Suggest the key process that is inhibited by drug X. Explain your answer. (3 marks)

(b) Suggest the key process that is inhibited by drug Y. Explain why there is an accumulation of pyruvate in the muscle cells after treatment with drug Y. (3 marks)

(c) Instead of incubating in the presence of oxygen, the untreated muscle cells were incubated under anaerobic conditions. Predict the change in the cellular ATP, NADH and lactate levels. (3 marks)

(d) A student would like to study the enzymes involved in glycolysis, the Krebs cycle and oxidative phsophorylation separately. Suggest which cellular components he needs to isolate for the investigation. (3 marks)

DSE-2014 1B

1. For each of the brain parts listed in column 1, select from column 2 one phrase that matches it. Put the appropriate letter in the space provided. (3 marks)

Column 1		Column 2
NADPH	____	A. a product of oxidative phosphorylation
pyruvate	____	B. a product of photochemical reactions
NAD	____	C. a product of carbon dioxide
		D. a product of glycolysis

Past Papers Marking Scheme – Respiration

CE - 2004 Q.4 (a)

(i) The muscles carry out anaerobic respiration 1
to release additional energy for muscle contraction 1
As anaerobic respiration produces lactic acid 1
it will lead to an increase in blood lactic acid concentration

(ii) glucose + oxygen → carbon dioxide + water 2 or 0

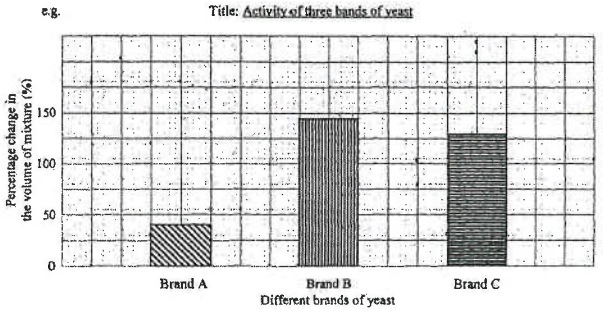
(iii) Because it lowers the pH of the blood / tissue fluid which adversely affects cellular activities/ it inactivates enzymes 1

(iv) Slow jogging 1
Because slow jogging can maintain a relatively high rate of heart beat / blood flow / breathing 1
which increases the rate of oxygen supply to the body 1
thus enhances the breakdown of lactic acid / conversion of lactic acid to glycogen 1

CE - 2007 Q.4

(a) 130 1

(b) correct title ½
correct labeling of axes ½,½
correct drawing and labeling of bars 1½



(c) Anaerobic respiration of yeast 1
produce carbon dioxide 1
which is trapped inside the dough 1
making it rises 1

(d) Brand B 1

(e) To ensure the temperature of the three mixtures are the same / maintain the temperature at 30°C throughout the investigation 1

(f) Use only one brand of yeast 1
Put the measuring cylinder in water baths at different temperatures 1

CE - 2007 Q.8 (b)

(i) Glucose consumption increases during exercise 1
because glucose is used in respiration / respiration rate is faster 1
to provide more energy for muscle concentration 1

(ii) More glucagons is released during exercise 1
which stimulates the conversion of glycogen to glucose in liver 1
to restore the blood glucose level / compensates for the increase in glucose consumption 1

(iii) Trends:
Increase during exercise 1
Decrease after exercise 1

CE - 2010 Q.6

(a) catabolism/ catabolic process/ breaking down process (1)

(b) mitochondria (1)

(c) carbon dioxide and water (1 or 0)

(d) light/ solar (1)

(e) heat (1)

AL - 2005 1A

2. (a) (i) Animal cells: lactic acid (1) 2
Plant cells: ethanol and carbon dioxide (1)
(ii) because the enzyme(s) involved in the breaking down of pyruvic acid in animal cells is / are different from those in plant cells (1) 1

(b) $NADH / FADH_2$ (1) 1

(c) because oxygen is required as the final electron acceptor (1) 1

(d) On the diagram: CO_2 is released from the steps of pyruvic acid → acetyl-CoA (1), citric acid → 5-C compound (1) 2

(7)

AL - 2009 1A

5. (a)
- yeast carries out anaerobic respiration to produce carbon dioxide and alcohol (1)
- carbon dioxide dissolves in water to form carbonic acid / a weak acid (1)
- which neutralizes the sodium carbonate (1) / which lowers the pH to / below 8

Therefore, the pink colour disappears (3)

(b) (i)
- amount of yeast (1) / use yeast solution from the same culture
- amount of glucose (1)
- amount of sodium carbonate (1) (3)

(ii)

Concept for mark award: (3)
- vary the temperature (1)
- for each temperature, kept the tubes in a water bath for equilibration before mixing (1)
- maintain the reaction mixture at the target temperature after mixing (1)

e.g.
- prepare water baths set at different temperatures, e.g. 10℃, 20℃, 30℃, 40℃, 50℃, 60℃, 70℃ and 80℃ (1)
- for each temperature, keep tubes A & B in the water bath for 10 minutes (1) (3)
- after mixing, keep the reaction mixture in its corresponding water bath (1)

(iii) Convert the time to rate by taking the reciprocal of the time taken (1)
(iv) Correct shape of curve (1)

AL - 2010 2C

7.

Structural similarities	Significance for energy transformation
· both are double-membrane bounded organelles (1)	· to provide an isolated environment (1) so that the energy transformation processes will not be interfered by other cellular processes (1)
	· substrate concentration can be increased (1) by entrapping the necessary raw materials inside the organelles (1)
· contain large amount of internal membrane (1) / i.e. thylakoid and grana in chloroplast and cristae in mitochondrion	· provide large surface area (1) to hold more membrane-bound enzymes (1) for more efficient energy transformation
· presence of membrane-bound enzyme systems (1)	· related enzymes are located next to one another (1) to allow the passage of metabolic product from one pathway to another pathway (1)
· presence of own circular DNA (1)	· produce specific enzymes and structures (1) which are required for their related energy transformation processed
(4)	(9)

max.12

DSE-2012 1B

9. (a)
- drug X inhibits glycolysis (1) (do not accept more than 1 process) (1)
- as glycolysis is the first step in the respiratory pathway, the inhibition of glycolysis will halt the processes that follow, i.e. Krebs cycle and oxidative phosphorylation (1) (1)
- hence, the overall production of pyruvate, ATP and NADH are greatly reduced, showing that the whole respiratory pathway was jeopardized (1) (1)

Remarks:
- No mark will be given to bullet point 1 when minor steps in each process instead of the key process are mentioned.

Alternative answer:
- Pyruvate is the product of glycolysis (1)
- As the production of pyruvate is greatly reduced after treating with drug X (1)
- Glycolysis is inhibited in this case (1)

(b)
- drug Y inhibits Krebs cycle (1) (do not accept more than 1 process) (1)
- when the respiratory pathway is halted at Krebs cycle, pyruvate would not be metabolised (1) (1)
- but glycolysis still proceeds as usual and produce pyruvate (1), as a result, pyruvate will accumulate (1)

(c)
- in anaerobic conditions, muscle cells undergoes anaerobic respiration and produce less ATP (1) and less NADH (1) than aerobic respiration (1,1)
- at the same time, lactic acid level rises as it is produced (1) as a result of incomplete oxidation (1)

(d)
- glycolysis: cytoplasm (1) (1)
- Krebs cycle: mitochondrial matrix (1) (1)
- oxidative phosphorylation: mitochondrial inner membrane (1) (1)

Remarks:
- if the key processes are not mentioned but the three cellular components are mentioned in the correct sequence, 3 marks will be given
- if only two or one cellular component(s) are mentioned, no mark will be scored

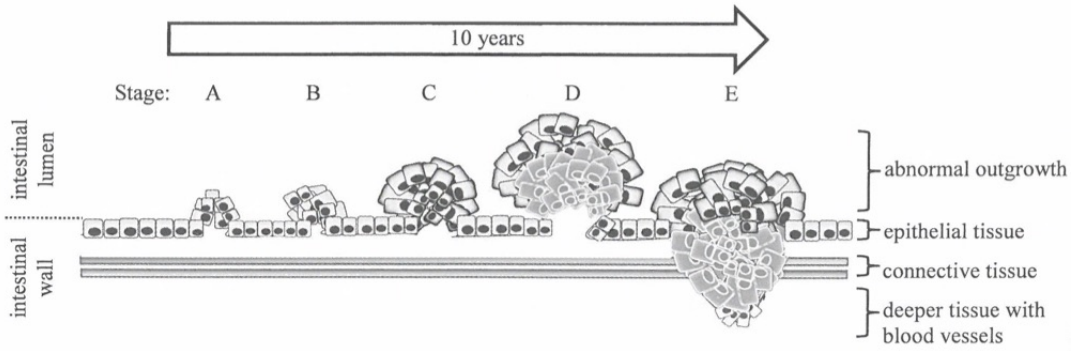
12 marks

DSE-2014 1B

1. B (1)
D (1)
A (1)

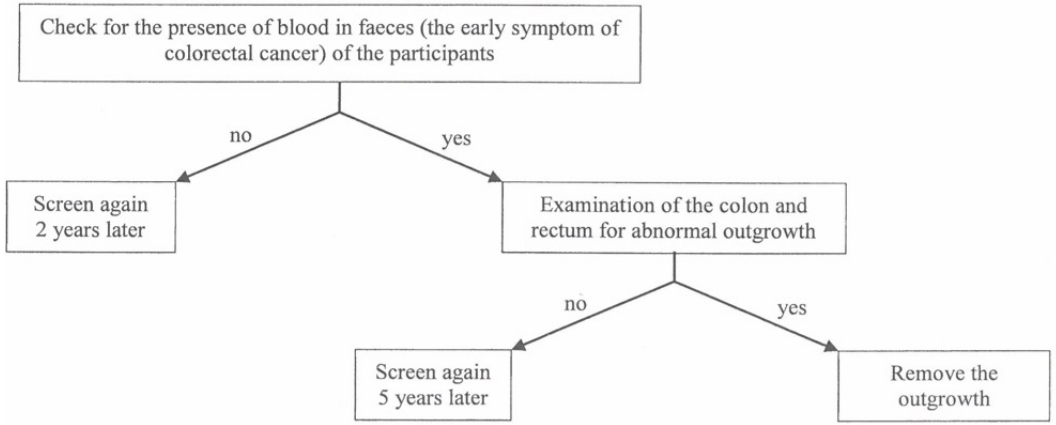
3 marks

7. Colorectal cancer is one of the most common cancers in Hong Kong. The schematic diagram below shows the developmental stages of colorectal cancer over time:



(a) Which stage of colorectal cancer has a high risk of spreading? Explain your answer. (2 marks)

(b) The Department of Health in Hong Kong has launched a regular screening programme for the prevention of colorectal cancer. The flowchart below illustrates the screening programme:



(i) The screening programme is recommended for people aged 50 or above. Give ***two*** reasons why this group of people is more susceptible to colorectal cancer. (2 marks)

(ii) If there is no abnormal outgrowth of the epithelium of the large intestine, the next screening can be conducted 5 years later. With reference to the developmental stages of colorectal cancer, explain this practice. (1 mark)

(iii) Recently, there is a growing trend of people diagnosed with colorectal cancer at a younger age. Suggest ***two*** eating habits which may lead to this growing trend. (2 marks)

You are required to present your answer to the following question in essay form. Criteria for marking will include relevant content, logical presentation and clarity of expression.

11. Recently, the use of the ketogenic diet for achieving weight loss is becoming popular. In fact, this high-fat, moderate-protein and very-low-carbohydrate diet has been used as an approach to control the blood glucose level in diabetics. However, the effectiveness of this diet in achieving weight loss is still controversial.

Describe how a ketogenic diet can be used to control the blood glucose level in diabetics. Evaluate the possibility of using this diet for weight loss and discuss the health concerns of adopting such a diet for healthy persons. (12 marks)

DSE M.C. Questions - Health and diseases
(sort by difficulty)

Challenging

2015 Q.32 (38%)

Directions: Questions 32 and 33 refer to the table below, which shows the results of blood tests for the presence of antigens and antibodies of hepatitis B in four individuals:

	Individual 1	Individual 2	Individual 3	Individual 4
Antigens of hepatitis B	Negative	Positive	Negative	Positive
Antibodies of hepatitis B	Negative	Negative	Positive	Positive

Which individual(s) would you recommend for vaccination against hepatitis B?

A. 1 only
B. 4 only
C. 1 and 2 only
D. 1 and 3 only

2015 Q.36 (34%)

Which of the following components of blood are involved in forming a blood clot?

(1) Blood platelets
(2) Red blood cells
(3) White blood cells

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Average

2012 Q.35 (71%)

Which of the following belongs to humoral immune response?

A. blood clotting
B. production of antibodies
C. phagocytosis of pathogens
D. production of memory T cells

2012 Q.36 (70%)

After injury, the wound usually becomes swollen due to

A. accumulation of bacteria at the wound.
B. accumulation of tissue fluid at the wound.
C. increased phagocytosis at the wound.
D. increased blood flow to the capillaries around the wound.

2014 Q.32 (61%)

Infants can obtain antibodies from breast feeding. Which of the following combinations correctly describes this type of immunity in infants?

	Type of immunity	*Explanation*
A.	active	the antibodies are produced from white blood cells
B.	active	the antibodies attack pathogens bearing foreign antigens
C.	passive	the antibodies do not trigger the production of memory cells
D.	passive	the antibodies work only when there is re-entry of the same pathogen

2015 Q.34 (47%)

Directions: Questions 34 and 35 refer to the list of factors shown below.

(1) Smoking
(2) Family history
(3) Overweight
(4) Radiation

Which of the above factors can be controlled by lifestyle adjustment?

A. (1) and (3) only B. (2) and (4) only C. (1), (2) and (3) only D. (1), (3) and (4) only

Average

2019 Q.35 (48%)
Type II diabetic patients may feel dizzy after prolonged exercise. Which of the following is the most likely explanation for this?

A. Their blood glucose level has dropped to too low a level because they do not have enough stored glycogen to replenish the glucose level.
B. Their blood glucose level has dropped to too low a level because they do not have enough glucagon to stimulate the conversion of glycogen to glucose.
C. Their blood glucose level has risen to too high a level because they keep losing water during exercise.
D. Their blood glucose level has risen to too high a level because they do not have enough insulin to stimulate the conversion of glucose to glycogen.

2019 Q.36 (66%)
Antibodies are produced by

A. Memory B cells.
B. Memory T cells
C. Specialised B cells.
D. Specialized T cells.

Easy

2013 Q.32 (47%)
Which of the following descriptions about antibiotics is correct?

A. Antibiotics can engulf pathogens.
B. Antibiotics can be produced by fungi.
C. Antibiotics can bind to specific antigens.
D. Antibiotics can be produced by lymphocytes.

Easy

2013 Q.34 (81%)
Which of the following information concerning the characteristics of insulin-dependent diabetes and non-insulin-dependent diabetes is correct?

	Insulin-dependent diabetes	*Non-insulin-dependent diabetes*
A.	accounts for the majority of diabetic cases	accounts for a small portion of diabetic cases
B.	is mainly due to an unhealthy lifestyle	is mainly due to hereditary factors
C.	requires regular injections of insulin	may be controlled through proper diet
D.	body fails to respond to insulin	body produces a low level of insulin

2015 Q.33 (80%)
Directions: Questions 32 and 33 refer to the table below, which shows the results of blood tests for the presence of antigens and antibodies of hepatitis B in four individuals:

Hepatitis B is transmitted through
A. insects.
B. droplets.
C. body fluid.
D. skin contact.

2015 Q.35 (81%)
Directions: Questions 34 and 35 refer to the list of factors shown below.
(1) Smoking
(2) Family history
(3) Overweight
(4) Radiation

Which of the above are risk factors for coronary heart disease?
A. (1) and (3) only
B. (1), (2) and (3) only
C. (1), (2) and (4) only
D. (2), (3) and (4) only

Easy

2017 Q.36 (78%)

Which of the following combinations correctly matches the type of diabetes with its description?

Type of diabetes	*Description*
A. Insulin-dependent (type I)	Heredity is the major cause.
B. Insulin-dependent (type II)	Blood insulin remains high.
C. Non-insulin-dependent (type II)	Blood glucose revel remains low even after meal
D. Non-insulin-dependent (type II)	Blood glucose level will drop significantly after insulin injection.

2018 Q.10 (78%)

Which of the following statements best explain why vaccination against flu is administered annually?

A. The flu virus is constantly mutating
B. The antibodies against flu virus only last for one year
C. The flu vaccine is not very effective because it is made from a weakened virus
D. When memory cells encounter the flu vaccine again, a secondary response is triggered

2020 Q.29

29. Which of the following combinations of causative agents and ways of transmission of infectious diseases is correct?

	Infectious disease	*Causative agent*	*Way of transmission*
A.	cholera	virus	food
B.	cholera	bacterium	body fluid
C.	hepatitis B	virus	body fluid
D.	hepatitis B	bacterium	food

2020 Q.30

30. Which of the following provides immunity to the human body?

A. phagocytosis
B. inflammation
C. memory cell
D. formation of blood clots

2021 Q.24,25

24. Which of the following types of cells can be found in the tissue fluid?

(1) B cell
(2) T cell
(3) phagocyte

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

25. Which of the following is ***not*** the first line of defence against the invasion of pathogens in humans?

A. saliva
B. sweat
C. mucus
D. lymph

Answers

Challenging

2015
32 [A]
36 [D]

Average

2012	2014	2015	2019
35 [B]	32 [C]	34 [D]	35 [A]
36 [B]			36 [C]

Easy

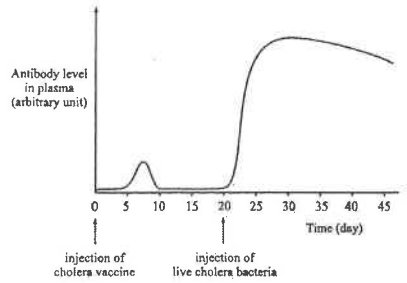
2013	2015	2017	2018
32 [B]	33 [C]	36 [A]	10 [A]
34 [C]	35 [B]		

2020
29 [C]
30 [C]

Past papers – Health and diseases

CE - 2003

4. (c) Cholera is a human disease caused by a type of bacteria. It is transmitted through contaminated water and food. A vaccine against this disease is made up of killed cholera bacteria. To study the effectiveness of the vaccine, a mouse was first injected with the vaccine and then with live cholera bacteria 20 days later. During the study, the mouse showed no sign of cholera. The changes in the antibody level in the plasma of the mouse are shown in the graph below:



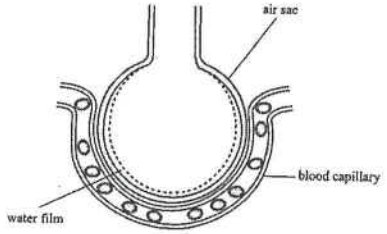
(i) Explain the rise in the antibody level between day 5 and day 7. (2)

(ii) State two differences between the patterns of antibody production as induced by the two injections. Suggest an explanation for such differences. (5)

(iii) People may be infected with cholera through eating contaminated seafood. Besides vaccination, suggest two ways to reduce the risk of cholera infection through eating seafood. (2)

CE - 2004

1. (c) The diagram below shows an air sac of the lung and its blood supply:



(i) Explain the importance of the water film in gaseous exchange. (2)

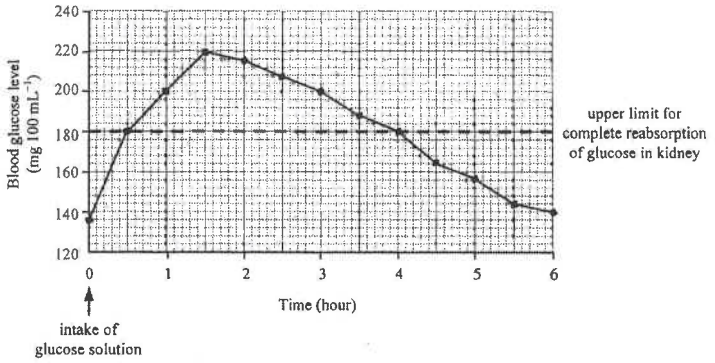
(ii) SARS patients may have fluid accumulated in the air sacs. Explain how the accumulation of fluid may affect the oxygen content of the blood of the patients.(3)

(iii) One method of confirm whether a patient is infected with the SARS virus is to test for the presence of antibodies against this virus in the patient's blood. Explain why these antibodies will be produced by a SARS patient. (2)

(iv) Suggest a method that can help the body develop immunity against SARS. Explain how the immunity is developed. (4)

CE - 2005

9. (a) In a medical test, George drank a glass of glucose solution. The graph below shows the subsequent changes of his blood glucose level:



(i) Based on the graph, state the period in which the urine of George would contain glucose. Explain why glucose in the blood would appear in the urine during this period. (4)

(ii) The doctor diagnosed that George had diabetes mellitus and advised him to get insulin injection for treatment. Which organ of George was likely to be defective? (1)

(iii) The insulin used for treating diabetes mellitus can be obtained from pigs and cattle, or produced by genetically modified bacteria. State two advantages of using insulin produced by the bacteria over that obtained from mammals. (2)

(iv) (1) Besides insulin, name another hormone that is responsible for the regulation of blood glucose level. (1)

(2) State one effect of this hormone on the activity of liver cells. (1)

CE - 2008

8. (b) The following information is extracted from a pamphlet for diabetic patients. Read the content and answer the questions that follow.

> Hypoglycaemia
>
> When there is a very low level of glucose in the blood (below 50 mg per 100 cm^3), hypoglycaemia occurs. Hypoglycaemia usually happens quickly and the symptoms include sweating, hunger, tiredness, anxiety and dizziness, etc. Hypoglycaemia may occur because:
> - you have eaten too little, or
> - you are late for a meal, or
> - you have injected too much insulin, or
> - you have a lot more exercise than usual.
>
> It is important always to carry some sweets with you and take them immediately when you suffer from hypoglycaemia.

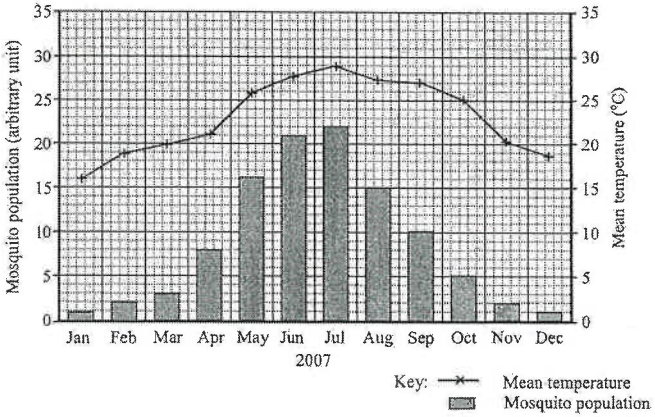
(i) Explain why a diabetic patient may suffer from hypoglycaemia if he has taken more exercise than usual. (4)

(ii) It is recommended for diabetic patients to take in complex carbohydrates (a variety of polysaccharides) in their normal meal instead of sugar. Suggest why these patients are advised to take different types of carbohydrates under normal and hypoglycaemic conditions.

(1) Take in complex carbohydrates in normal meal (3)
(2) Take in sugar when hypoglycaemia occurs (2)

CE - 2009

6. Dengue fever is an acute viral disease. Prevention of this disease mainly depends on controlling the mosquito population. Since 2000, the Food and Environment Hygiene Department (FEHD) has been monitoring the mosquito population in Hong Kong. The graph below shows the monthly mosquito population in a certain district and the monthly mean temperature in 2007.



(a) Suggest why the mosquito population is related to the incidence of dengue fever. (1 mark)

(b) Based on the information from the graph, suggest how temperature may affect the breeding of mosquitoes. (2 marks)

(c) The risk of the spreading of dengue fever is graded by the FEHD as high when the mosquito population is 20 arbitrary units or above. The FEHD will conduct special operations to eliminate potential breeding places for mosquitoes.

(i) In which months were special operations conducted in 2007? (1 mark)

(ii) The Hong Kong Observatory has estimated that the annual temperature in Hong Kong will increase in the coming decades. Predict how this will affect the transmission of dengue fever. Justify your answer. (3 marks)

(iii) If the mosquito population in the district you live is reported to be above 20 arbitrary units, suggest ***one*** way to protect yourself from contracting dengue fever. (1 mark)

CE - 2010

8. (a) Influenza is a common disease caused by viruses. The Centre for Health Protection of Hong Kong states. "Influenza vaccination is important because it is one of the effective ways in preventing this disease."

(i) Explain how vaccination can help to prevent influenza. (4)
(ii) Suggest why elderly people are recommended to receive influenza vaccination. (1)
(iii) It is known that smoking can inhibit the beating of cilia in the respiratory tract. Suggest how smoking may result in a higher chance of influenza infection. (2)
(iv) Influenza viruses undergo mutation easily. Explain why this characteristic of viruses makes the control of influenza more difficult. (2)

AL - 2005 1A

3. Complete the following paragraph with suitable word(s):

Cholera is caused by a bacterium, Vibrio cholerae, which is transmitted directly through (a)_____. In sub-tropical areas, there is a distinct seasonal pattern of this disease, with the highest incidence in the (b)_____season. The incidence of cholera can be reduced by taking proper precautionary measures such as (c)_____and (d) _____. (4)

AL - 2005 1C

12. Read the following passage and then answer the questions that follow.

Lifestyle and major diseases in Hong Kong

Lifestyle plays an important role in health and disease. Several major diseases in Hong Kong can be linked to unhealthy lifestyles

Coronary heart disease is one the major causes of death in developed countries. In Hong Kong, it accounts for over 3000 deaths every year and is the second most common cause of death. In the past, this disease affected people of higher social status more than the working class. This trend reversed in Western countries during the 1970s, and about a decade later, in Hong Kong. Males and the aged are at a higher risk of developing coronary heart disease. The incidence of this disease is also affected by a number of lifestyle-related risk factors including diet, exercise and others.

Cancer is the most common cause of death in Hong Kong. The number of cancer cases has been increasing steadily, with over 21 000 new cases in the year 2000, and an annual increment of about 2%. There are two major causes for this increase. First and the foremost is the ageing population, and old age is the single important risk factor in developing cancer. The second is the westernized lifestyle in Hong Kong.

Unlike coronary heart disease and cancer, diabetes mellitus is not a common cause of death. However, it is increasingly common among the younger generations of Hong Kong in recent years. Like the other two diseases, diabetes mellitus is also related to lifestyle factors.

To reduce the incidence of coronary heart disease, common cancers and diabetes mellitus and the mortality from these diseases, public health strategies are designed based on the prevalence (i.e. how common they are) of the various factors in the community.

b. In terms of disease control, why is it important to distinguish between lifestyle-related and lifestyle-unrelated risk factors? (lines 7-9) (2)

c. Give ***two*** reasons to explain why old age is the single most important risk factor for the development of cancer. (line 13) (2)

d. Some viral infections are found to be related to the development of certain cancers. Give ***one*** example of such cancers that is common in Hong Kong. Suggest ***two*** preventive measures that individuals can take to protect themselves from such viral infection. (3)

e. Some people believe that diabetes mellitus is caused by excessive intake of sugary food Discuss whether this idea is valid based on your knowledge of the two different types of diabetes mellitus. (4)

AL - 2006 1C

13. Read the following passage and then answer the questions that follow.

Infectious diseases: treatment and control

Up till the beginning of the last century, there was no proper treatment for infectious diseases and many people died of infections that can be easily treated today. The major breakthrough in the treatment of infectious diseases came with the discovery of antibiotics. In 1928, A. Fleming discovered the first antibiotic, penicillin, which is produced by a fungus. Since then, other types of antibiotics produced by other microorganisms were discovered. During the Second World War, many bacterial diseases were effectively treated by using antibiotics. As a result, people predicted that these diseases would not be a problem anymore for humans. However, this prediction has not come true.

During the 1960s, many prisoners in the former Soviet Union developed tuberculosis. This lung disease is caused by the bacterium *Mycobacterium tuberculosis* and transmitted in a similar way as influenza. Due to the crowded conditions in the prison, tuberculosis developed quickly and widely among the prisoners. Even worse was that the antibiotics that used to work well in controlling tuberculosis became ineffective, causing death of the diseased prisoners. Some years later, the same antibiotics were also found ineffective in treating tuberculosis in people in New York City, USA. The bacteria in these people were identical to those found in the prisoners in the Soviet Union.

Even today, with the development of many more types of antibiotics, bacterial diseases still pose a serious problem to human health. It is now known that indiscriminate use of antibiotics has resulted in the loss of their effectiveness in treating diseases. The medical profession thus calls for concerted effort from individuals in the community to help slow down the loss of the effectiveness of antibiotics.

Apart from using antibiotics, vaccination is also an effective alternative for controlling the outbreak of infectious diseases. For example, vaccination against influenza (flu) is recommended for people every year before the onset of the flu season. Since flu can be caused by a variety of flu viral strains, the World Health Organization (WHO) has set up a network to collect samples from flu patients around the world and to analyse the strains of the flu viruses. Based on the data collected, the WHO will predict the prevalent viral strains and then recommend annually the combination of the flu vaccines in the coming flu season.

(b) Explain why the crowded conditions in the prison led to the quick and wide spread of tuberculosis among the prisoners in the Soviet Union. (lines 11-12) (2)

(c) Antibiotics could control tuberculosis well in the past but subsequently failed to cure the diseased prisoners and eventually lost its effectiveness. Account for this. (lines 12-15) (4)

(e) Suggest ***two*** ways in which individuals can contribute to slowing down the loss of effectiveness of antibiotics in treating diseases in the community. Support your answer with biological rationales. (lines 19-21) (4)

(f) The use of antibiotics and vaccination are possible means of disease control. Give ***two*** differences in the principles of these two means in dealing with infectious diseases. (4)

(g) Suggest ***two*** reasons why the combination of the flu vaccines has to be reviewed and determined regularly. (lines 27-28) (2)

AL - 2009 1A

4. Select the appropriate description listed in Column 2 that matches with the cell type given in Column 1. Put the appropriate letter in the space provided. (4 marks)

Column 1		Column 2
B cell	_____	A. Contains a lot of lysosomes
T cell	_____	B. Kills own body cells that display foreign antigens on their surface
Phagocyte	_____	C. Is primarily responsible for the humoral immune response
Memory cell	_____	D. Can pass through the placenta and confer natural immunity to the foetus
		E. Proliferates rapidly upon second exposure to the same antigen

AL - 2010 2A

2. In recent years cancer has emerged as a major life-threatening disease in Hong Kong. It begins with a group of cells that display uncontrolled cell division. A lot of research and resources have been dedicated to the development of various cancer treatments to save the lives of cancer patients.

(a) Some cancers are treated by administering ionising radiation to kill cancer cells in the affected area. Suggest two harmful effects of this treatment on the cancer patients. (2)

(b) (iv) These anticancer drugs are not specific to cancer cells but harm all rapidly dividing cells. Therefore, cancer patients receiving chemotherapy often experience various side effects of the drugs. Suggest three cell types that are more susceptible to anticancer drugs. (3)

(c) The incidence of cancer is higher in the older age group. Suggest two reasons for this. (2)

(d) In some lung cancer patients, there is excessive accumulation of fluid in the alveoli. These patients will suffer from shortness of breath. What is the physiological basis of this symptom? (5)

DSE - 2012 1B

1. For each type of the blood cells listed in column 1, select from column 2 ***one*** phrase that correctly describes its function. Put the appropriate letter in the space provided. (3 marks)

Column 1		*Column 2*
Lymphocytes	___	A. Involved in blood clotting
Blood platelets	___	B. Involved in oxygen transport
Red blood cells	___	C. Involved in antibody production
		D. Involved in phagocytosis
		E. Involved in transporting hormones

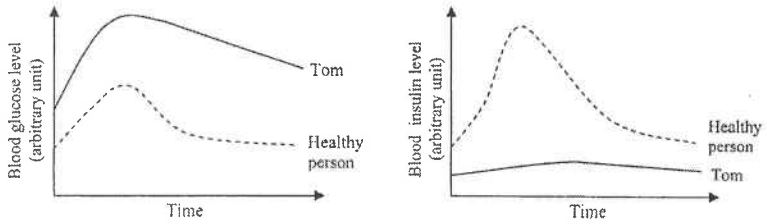
DSE - 2012 1B

2. Dengue Fever is a vector borne disease transmitted by mosquitoes. The table below shows two methods adopted by the Government to break the transmission link of this disease. Complete the table below to show how each method works and comment on its advantage ***or*** disadvantage. (4 marks)

Method	How it works	Comment (advantage or disadvantage)
Spraying of pesticides or larvicidal oil around mosquito's habitat		
Clearance of accumulated water in a neighbourhood		

DSE-2012 1B

7. Tom suffers from diabetes. His doctor asked him to drink, after overnight fasting, a large volume of a glucose solution. After that, blood samples were taken at regular time intervals, to measure insulin and glucose contents. The following graphs show the changes in Tom's blood glucose level and blood insulin level after the test, and those of a healthy person:



(a) Which type of diabetes does Tom suffer from? Explain your answer. (4 marks)

(b) Explain the difference in blood glucose response to the oral consumption of glucose solution between Tom and the healthy person. (3 marks)

(c) What medical treatment should Tom be given? (1 mark)

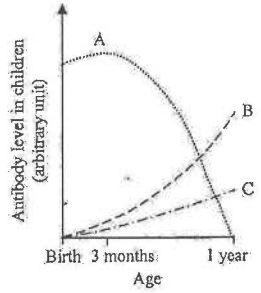
HKDSE - 2013 1B

9. (a) The following graph shows the change in levels of antibodies in children's bodies:

(A) antibodies from mother

(B) children's own antibodies with vaccination

(C) children's own antibodies without vaccination



(i) State the types of immunity resulting from A, B and C. (3 marks)

(ii) Suggest two possible ways that newborns can acquire antibodies from their mother. (2 marks)

(b) Explain why children who have been vaccinated against diseases are better protected than those who have not. (4 marks)

HKDSE - 2014 1B

9. Table I shows the number of deaths in Hong Kong caused by certain diseases. The deaths are categorised according to sex and age.

Table I

Cause of death	Sex	Age group						
		All ages	0	1-4	5-14	15-44	45-64	≥ 65
Heart disease	Male	3352	1	2	2	104	679	2564
	Female	2981	2	2	0	20	146	2811
Diabetes mellitus	Male	213	0	0	0	2	43	168
	Female	246	0	0	0	10	19	217
Colon cancer	Male	725	0	0	0	16	177	532
	Female	627	0	0	0	8	131	488

(a) Rank the diseases in the descending order of mortality (death rate). (1 mark)

(b) From the data above, generalize a trend of mortality that is exhibited by all the diseases. (1 mark)

(c) Table II shows the relative proportions of males and females in the above table who had particular lifestyles:

Table II

Lifestyle	Male	Female
Smoking daily	78.9%	21.1%
Never smoked	36.9%	63.1%
≥ 4 servings of processed meat per week	57.7%	42.3%

From the following diseases, explain how these lifestyles of the males and females are related to the number of deaths in Table I.

Heart disease (3 marks)

Colon cancer (3 marks)

HKDSE – 2016 1B

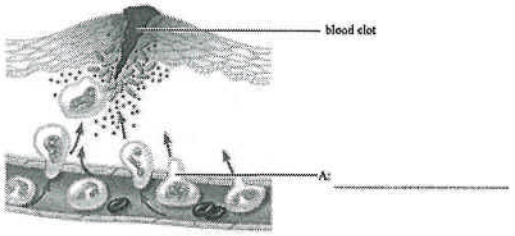
6. (a) Kitty and Karen are identical twins. Kitty has preferred meats to vegetables in her diet since her childhood. Kitty suffered from colon cancer at age 35 while Karen had the same disease 10 years later.

(i) Why did both sisters suffer from colon cancer? (1 mark)

(ii) Why did the disease occur at different ages? (1 mark)

(b) Give two other lifestyles that increase the risk of suffering from cancer. (2 marks)

7. The diagram below shows a site of injured skin exhibiting an inflammatory response:



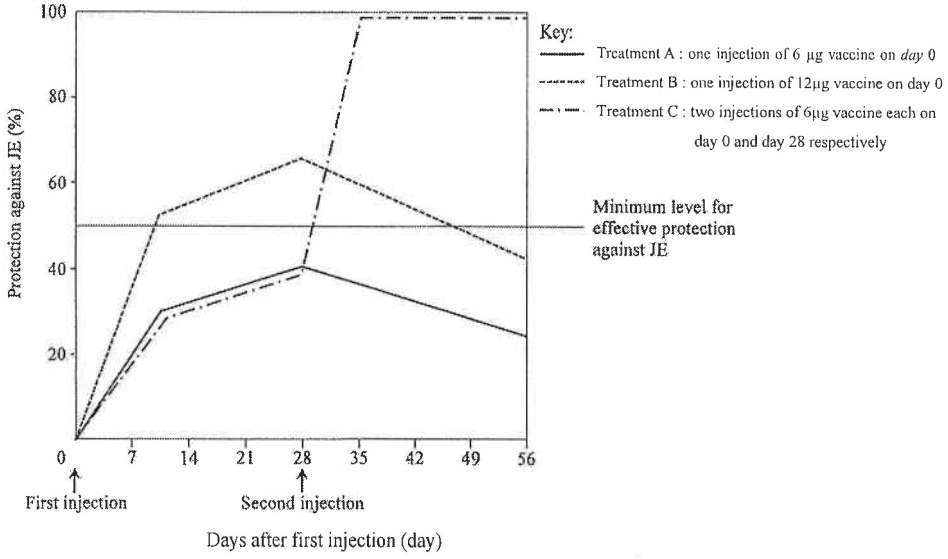
(a) Label the type of white blood cell represented by cell A in the above diagram.(1 mark)

(b) Explain why the tissue exhibiting the inflammatory response usually shows symptoms such as redness, swelling and pain. (3 marks)

(c) Cell A will present the antigens of the invading pathogens to the lymphocytes. Describe what will happen subsequently. (3 marks)

HKDSE - 2017 1B

9. Japanese encephalitis (JE) is an inflammation of the brain caused by a viral infection. Scientists have developed a vaccine against the JE virus. In a study of the effectiveness of the vaccine, three groups of healthy people received different vaccination treatments and the level of protection against JE was monitored over a period of time. The results are shown in the graph below:



a. What is the vector for transmitting the JE virus? (1 mark)

b. For treatment C, explain why there is a sharp rise in protection against JE from day 28 to day 35. (4 marks)

c. Give ***one*** more benefit of treatment C. (1 mark)

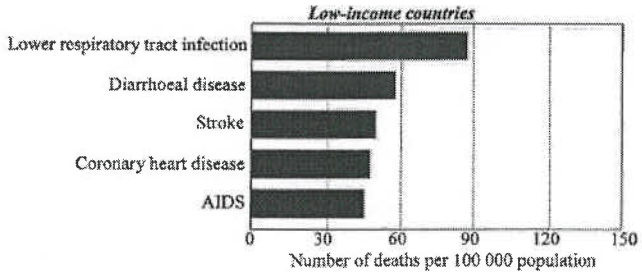
d. Mathew plans to visit a country with many JE cases in 10 days and will stay there for 15 days.

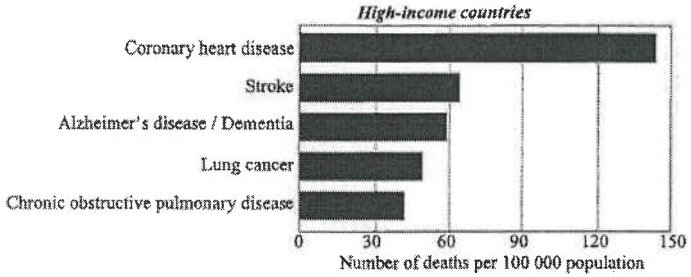
i. With reference to the graph, which vaccination treatment (A, B or C) should he receive at this moment? Explain your answer. (2 marks)

ii. As a responsible citizen, Mathew will continue to use repellant as a precaution for two weeks after he is back from that country. Suggest a rationale for this precaution. (1 mark)

HKDSE - 2018 1B

4. The bar chart below show the top five diseases that caused death in low-income countries and high-income countries respectively in the year 2015:





(a) With reference to the bar charts, which countries(low-income or high-income) have more infectious diseases as the top five diseases that caused death? (1 mark)

(b) Suggest *two* reasons to account for the phenomenon stated in (a). (2 marks)

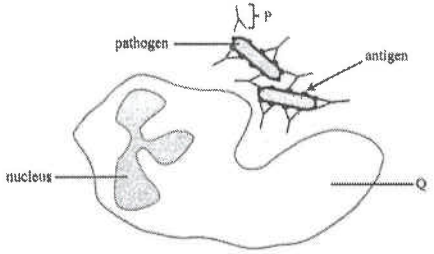
(c) Coronary heart disease is the top cause of death in high-income countries. Explain how *one* of the lifestyle habits in high-income countries is related to coronary heart disease. (4 marks)

HKDSE - 2019 1B

1. (a) Physical and chemical barriers are the first line of defence in the human body. Select from Column II ***all*** correct example(s) that belong(s) to the two types of barriers in Column I and put the letter(s) in the spaces provided. (2 marks)

Column I		*Column II*
(i)	physical barrier _____	A. skin
		B. tear
		C. antibody
(ii)	chemical barrier _____	D. blood clot
		E. gastric juice

(b) The diagram below shows the process of phagocytosis. Q is a phagocyte while P is a protein molecule produced by a type of lymphocyte.



Describe the function of P in phagocytosis. (3 marks)

HKDSE - 2020 1B

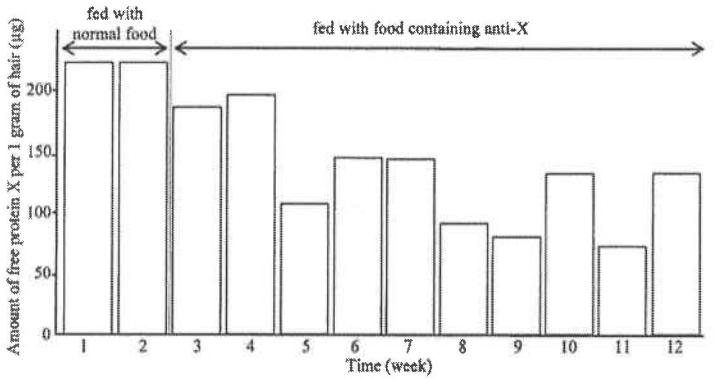
8. Some people suffer from sneezing and coughing when there are cats nearby. These unwanted immune responses, known as allergies, are caused by a protein X secreted by cats' salivary and sebaceous glands. When cats lick their body surface, this protein X is spread to their hair. Protein X can accumulate in their living environment over time.

(a) Recent research shows that the amount of free protein X on cats' hair can be reduced by adding antibodies against protein X (anti-X) to cat food.

(i) Why can anti-X reduce the amount of free protein X on cats' hair? (1 mark)

(ii) There are no proteases in the saliva of cats. Explain why this is important for the success of this method of reducing free protein X. (1 mark)

8. (b) In the research, a group of domestic cats were fed with normal cat food for 2 weeks, followed by cat food containing anti-X for 10 weeks. The amount of free protein X found on their hair during the research is shown in the bar chart below:



(i) Research team member A thought anti-X was effective in reducing the amount of free protein X on cats' hair while team member B thought anti-X was not effective. Based on the bar chart, give ***one*** reason to support team member A and ***another*** reason to support team member B. (2 marks)

Supporting reason for team member A:

Supporting reason for team member B:

(ii) How would you modify the research to confirm whether anti-X in cat food is effective in reducing the amount of free protein X on cats' hair? (2 marks)

(c) Based on the information in the introductory paragraph of this question, suggest *two* limitations of this approach to reducing allergies caused by cats. (2 marks)

CDSE - 2021 1B

6. Pathogen X is a pathogen that infects humans. Research has discovered an antigen Y present on the surface of pathogen X. Using recombinant DNA technology, antigen Y can be produced and serves as a vaccine to induce immunity against pathogen X.

(a) Explain how the injection of antigen Y can induce immunity against pathogen X. (4 marks)

Past Papers Marking Scheme – Health and diseases

CE - 2003 Q.4 (c)

(i) The antigen in the cholera vaccine 1
stimulates specific white blood cells to produce antibody 1
resulting in the rise in antibody level

(ii) For the second injection, the rise in antibody level occurs earlier,
the rise in antibody level is faster
and the peak of the antibody is higher any two 1,1
This is because as a result of the first injection, certain white blood cell will develop
a memory for the antigen 1
When the same antigen enters the body in the second injection, 1
the white blood cells will produce a large amount of antibodies within a short time 1

(iii) Cook the seafood thoroughly 1
Irradiate seawater used in fish tanks with UV light 1
(accept other reasonable answers)

CE- 2004 Q.1 (c)

(i) Oxygen in air dissolves in the water film 1
so that it can diffuse readily through the wall of the air sac into the blood capillary 1

(ii) The accumulation of fluid increases the distance for diffusion / reduces the surface area for dissolving oxygen 1
thereby decreases the rate of diffusion of dissolved O_2 into the blood capillaries 1
Thus the oxygen content of the blood decreases / becomes lower than normal 1

(iii) The antigen of the SARS virus 1
stimulates the white blood cells of the patient to produce the specific antibodies 1

(iv) injection of the weakened virus / the antigen into the body 1
This will stimulate the white blood cells to develop memory for the antigen 1
When the same virus enters the body, 1
a large amount of antibodies can be produced rapidly 1
to kill the virus

CE - 2005 Q.9 (a)

(i) 0.5 to 4 hour 1
Blood glucose is filtered into the kidney tubule 1
In this period, the glucose level in the glomerular filtrate is higher than the upper limit for complete reabsorption of glucose 1
so some glucose will be left in the glomerular filtrate / cannot be reabsorbed and excreted in the urine 1

(ii) Pancreas 1

(iii) Less side effects
More effective in action
Insulin produced from genetically modified bacteria is cheaper and in greater supply
(accept other reasonable answers) any two 1,1

(iv) (1) glucagon 1
(2) Glucagon will stimulate the conversion of glycogen in liver cells to glucose 1

CE- 2008 Q.8 (b)

(b) (i) Diabetic patients lack insulin / do not have enough insulin in their blood 1
and hence the liver fails to convert glucose into glycogen for storage ... 1
During intense exercise, blood glucose is consumed for muscle activities / more blood glucose is consumed 1
The blood glucose level drops continuously without replenishment from the glycogen stored 1

(ii) (1) It takes time for starchy food to be digested before absorption 1
As a result, a small amount of glucose is absorbed gradually 1
The fluctuation of blood glucose level is less / blood glucose level will not increase too fast after a normal meal 1

(2) Sugar is easily digested / absorbable 1
Blood glucose level can be raised immediately / quickly / Faster to alleviate the symptoms of hypoglycaemia 1

CE - 2009 Q.6

(a) Mosquito is the vector for transmitting dengue fever 1

(b) The mosquito population increased with the monthly mean temperature 1
This shows that high temperature favours breeding of mosquito 1

(c) (i) June and July 1

(ii) The breeding period of mosquitoes will be longer / The number of months with mosquito population above 20 arbitrary units would increase 1
The population of mosquitoes will be larger 1
This increases the risk of the transmission of dengue fever 1

(iii) Any one of the following:
- wearing clothes of light colour / clothes with long sleeves 1
- using insect repellent

CE- 2010 Q.8 (a)

8. (a) (i) Antigens/ dead viruses in vaccine are recognized by white blood cells (1)
Memory cells for these antigens are formed (1)
When they encounter the same viruses/ antigens again (1)
they will produce large amount of antibodies (and phagocytes)/ a quicker immune response (1)

(ii) Because they have relatively poor resistance to infectious diseases or influenza/ more difficult to recover from diseases/ relatively weak immunity (1)

(iii) Due to the inhibition of beating of cilia, smoking reduces the efficiency of removal of influenza virus (1)
trapped in the mucus on the respiratory tract (1)

(iv) The virus will form new strain (with new surface antigens) easily (1)
Memory cells developed previously become ineffective against the new strain/ the existing population does not have the immunity against the new strain/ existing vaccine becomes ineffective (1)

AL - 2005 1A

3. a. the intake of contaminated food / water
b. summer / hot
c & d cooking food / boiling drinking water thoroughly / washing hands after going to toilets / proper disposal of sewage / proper treatment of drinking water / vaccination

AL - 2005 1C

12. (b)
- lifestyle factors are those that are under the control of individuals (1) / individuals can make efforts to rectify / avoid; 2
or non-lifestyle factors are inborn (1) / those that an individual can do nothing to change
- regular exercise / balanced diet / medication for disease control after distinguishing the two factors (1)

(c)

Concept for mark award:
- decrease in body immunity to destroy / remove cancerous cell (1) 2
- prolonged exposure to environmental carcinogen / cumulative effect of carcinogens (1)

- decline in immune response by the body / to remove cancerous cells (1) (accept other reasonable alternatives) 2
- environmental carcinogens have a longer time to act as one ages, and hence have a higher chance to cause cancer / cumulative effect of carcinogens as one ages (1)

(d)

Concept for mark award:
- Name of disease (1) (have to be viral induced and common in Hong Kong) 1 +

2 Measures
- immunization / vaccination, if applicable to the disease named (1) max. 2
- prevent the transmission of the virus causing the named disease (1-2)

- liver cancer (1) 1 +
- immunization / vaccination against hepatitis B virus (1) max. 2
- take safety measures to prevent infection by blood (1), safe sex by wearing condom (1), avoid sharing needles (1)

(e)

Concept for mark award:
- agree that excessive sugary food will lead to non-insulin-dependent diabetes mellitus (1), and why (1) 4
- disagree, that is excessive intake of sugary food will not lead to insulin-dependent diabetes (1), and why (1)

- too much sugary food will lead to obesity (1) / overweight (or other reasonable alternatives), increases risk of non-insulin-dependent diabetes mellitus (type II) (1) 4
- sugary food will not lead to insulin-dependent diabetes mellitus (type I) (1) because it is due to autoimmune response (1) / viral infection affecting the pancreas / insufficient secretion of insulin

Bonus: apart from sugary food, high energy food / food rich in carbohydrate + bonus = 1
also lead to obesity (1)

AL - 2006 1C

13. (b) • tuberculosis is transmitted through air (1) / droplets 2
• the bacteria would be transmitted easily over a short distance (1) from infected individuals to uninfected individuals in the crowded prison / uninfected individuals have a high chance of exposure to the bacteria from infected individuals in the crowded prison

(c) • in the past, the predominant population of *Mycobacterium tuberculosis* was sensitive to antibiotics (1), so antibiotics were effective in controlling tuberculosis max. 4
• there were variations in the bacterial resistance against antibiotics (1)
• excessive use of antibiotics eliminated the sensitive strains (1) / selected for the resistant strains
• resistant strains multiplied (1) and became the predominant populations (1), hence antibiotics became no longer effective

(e)

Concept for mark award: 4
Action to take (1) + rationale (1) any two 2 × (1 + 1)

Action	Rationale	
• take antibiotics only when necessary (1) / when one's immune response cannot cope with the bacterial infection / avoid using antibiotics for viral diseases	• to reduce the exposure of the pathogens to the antibiotics (1)	1 + 1
• complete the whole course of antibiotics prescribed (1)	• to let the antibiotics eradicate the bacterial population in the body leaving no strains to propagate (1)	1 + 1
• take precautions against being infected (1) / spreading one's infection / improve sanitation	• to reduce the chance of using antibiotics (1) / to reduce the chance of spreading the resistant gene	1 + 1

4

(f)

Concept for mark award: 4
Contrast on any ***two*** of the following:
• nature of the control measure
• agent for killing pathogens / action of antibiotics vs action of vaccine
• scope of efficacy (the types of diseases being controlled)

e.g. any two sets

Antibiotics	Vaccination	
• curative measure (1) / for treatment	• preventive measure (1) / for prevention / controlling the spread of diseases	1 + 1
• kill pathogens directly (1)	• stimulate the development of immunological memory (1) / pathogen is killed by T-cells / antibiotics produced by human body	1 + 1
• effective against bacterial diseases only (1)	• effective against both bacterial and viral diseases (1)	1 + 1

4

(g) • the flu virus may undergo mutation frequently (1) to form new strains
• the epidemic strains may vary in different seasons (1)

AL - 2009 1A

4. (a) C (b) B (c) A (d) E (1) x 4

AL - 2010 2A

2 (a)
· it kills normal cells near the affected area (1) (2)
· it may induce mutation of the nearby normal cells (1)

(b) (iv) Any *three* of the following:
· cells of intestinal lining (1) / epithelial cells of the intestinal lining (3)
· cells of the hair follicle responsible for the growth of hair (1)
· cells of bone marrow that responsible for producing blood cells (1)
· germ cells in testes (1) (not sperm)
· lymphocytes (1)

(c) Any two of the following:
· exposure to carcinogenic substances for a longer time / accumulate more carcinogenic chemicals (2)
· the mutations of genes have accumulated to a level that cancer develops
· a weaker autocorrection mechanism / immune system

(d)

Concept for mark award:
· slow diffusion rate in liquid medium (1) leads to decrease in the efficiency of gas exchange (1) (5)
· elevated CO_2 conc. in blood (1) and its subsequent effect on breathing rate (2)

e.g.
· gas diffusion in liquid medium is slower than that in gas medium (1) / this reduces the surface area for gas exchange (5)
· efficiency of gas exchange decreases (1)
· carbon dioxide accumulates in blood (1) / less oxygen is taken up into the blood
· chemoreceptors at the medulla are stimulated (1) / carotid body / aortic body
· nerve impulses from medulle are sent to increase the breathing rate (1) / inflammation (1) / effector (1)

DSE-2012 1B

1. C (1)
   A (1)
   B (1)

DSE-2012 1B

2.

Method	*How it works*	*Comment (advantage or disadvantage)*	
Spraying of pesticides or larvicidal oil to mosquito's habitat	Directly kill the larvae / adult mosquitoes (1) so that they cannot serve as vector	Pros: quickly put mosquito population down in short term (1) Cons: mosquitoes may develop resistance to the pesticides (1) / environmental contamination when pesticides leak to water bodies / pesticides are toxic to humans	1,1
Clearance of accumulated water in the neighbourhood	Eradicate the breeding places of mosquitoes (1)	Pros: does not have adverse impacts on environment (1) Cons: it is vritually impossible to clear up all stagnant water (1)	1,1

DSE-2012 1B

7. (a) • despite the high blood glucose level detected in his blood, his fasting blood insulin level was lower than that of the healthy person (1) (1)
   • although there is an increase in blood glucose level, the insulin level only shows little change (1) (1)
   • this shows that Tom failed to produce the normal amount of insulin (1) (1)
   • therefore, Tom suffered from insulin-dependent diabetes (1) / type I diabetes (1)

   (b) • with insufficient insulin, his body cells will not take up extra glucose from the blood as efficiently as the healthy person (1)
   • as a result, the blood glucose concentration rised to a higher level (1) after glucose consumption
   • and remains high for a longer time / decreases slower than the healthy person (1) (3)
   Remarks: conversion of glucose to glycogen by insulin is not acceptable

   (c) • by injection of insulin (1) / aerosal spray of insulin applied to nasal cavity (1)

DSE-2013 1B

9. (a) (i) A: (Natural) passive immunity (1)
   B: (Artificial) active immunity (1)
   C: (Natural) active immunity (1) (3)

   (ii) • some antibodies in the maternal blood pass through the placenta and enter into the foetal blood (1)
   • some maternal antibodies in the mother's milk pass to the newborn via breast feeding (1) (2)

   (b) • vaccine contains antigens (1)
   • which stimulate the immune system to produce memory cells for that particular antigens (1)
   • on the 2nd exposure to the same antigen (1)
   • these memory cells are capable of producing a large amount of antibodies (1) (4)
   therefore, child with vaccination has a better protection

DSE-20141B

9. (a) heart diseases > colon cancer > diabetes mellitus (1) (1)

   (b) number of death increases with age groups (1) / age (1)

   (c) Heart disease:
   • heart disease kills more male than females (1)
   • more male were daily smokers (1)
   • nicotine of cigarette smoke increases the chance of blocking the blood vessel (1) (3)
   Colon cancer:
   • colon cancer kills more males than females (1)
   • more male consumer less fruits and vegetables / more processed food (1)
   • vegetables stimulate peristalsis and removal of faeces or contain antioxidant to prevent DNA from the attack of free radicals / processed food contains chemicals that may stimulate mutations (1) of colon epithelium (3)

8 marks

DSE – 2016 1B

6. (a) (i) Karen is genetically identical to Kitty, hence they both have the cancer-causing genes 1
   (ii) Kitty's eating habit would trigger the development of colon cancer earlier 1

   (b) Any *two* of the following:
   • Smoking (1)
   • Drinking (1)
   • Stress (1) 2

7. (a) A: phagocyte [accept macrophage /neutrophil; accept plural form] 1

   (b) arterioles [accept blood vessels; NOT accept others, e.g. capillaries] of the tissue with inflammatory response dilate, increasing blood flow to the tissue and makes it red (1)
   permeability of capillary walls [accept blood vessel walls; NOT accept others] increases, thus increasing flow of plasma to the tissue / resulting in the accumulation of tissue fluid and makes it swell (1)
   more tissue fluid presses against nerve endings/ stimulating the pain receptors, giving pain sensation (1)
   Remarks: Three points should be marked separately. 3

   (c) Activity of B-lymphocytes will lead to the production of antibodies against the specific pathogens (1) [B-lymphocytes differentiate^ into plasma cells / memory cells$ (1); plasma cells produce antibodies (1) against the specific pathogens]
   T-lymphocytes will form killer cells to destroy the infected cells (1)
   [T-lymphocytes differentiate^ into killer cells / memory cells$ (1); killer cells destroy the infected cells (1)]
   memory cells will be formed for future immunity (e.g. quicker response in the 2nd attack) (1) [accept enhanced immunity, recognize/memorize the antigen/pathogen]
   $ The concept of differentiation into memory cells will be marked once only
   ^ accept transform/ convert/ change/ form/ turn; not accept stimulate/ activate
   max 3

   (d) Redness: red blood cells/ blood [Not accept blood platelets] flow to injured skin/

bleeding and formation of blood clot at injured area (1)
Swelling: accumulation of tissue fluid/blood/a large amount of white blood cells/ pathogens at the injured skin (1)
Pain: the pain receptors/ nerve endings I sensory neurons are stimulated I injured and give signals to the brain for pain sensation (1)
Remarks:
Three points should be marked separately.
Related knowledge learned from CS Bio:
- *Functions of blood*
- *Formation of tissue fluids*
- *Sensation* 3

HKDSE – 2017 1B

9. (a) • mosquitoes (1) (1)

(b) • memory cells are produced [accept develop/differentiate] when the person has received the first dose of vaccine (1)
• in the second dose, these memory cells encounter thesame antigens[accept that specific antigen, original antigen, antigen encountered before, etc.] (1)
• memory cells differentiate [NOT accept stimulate/activate] into plasma cells / killer cells / specific lymphocytes [accept specific B-cells/ specific T-cells] (1) (4)
• resulting in production of a large amount of antibodies/killer cells [accept T-cells]within a shorter time (1)
leading to the sharp rise in the protection against the infection

(c) • the protective effect [accept level of antibodies/killer cells if mentioned in (b)] does not wear off / remains high (1) from day 35 to 56 (1)

(d) (i) • vaccination treatment B (1) (1+1)
• as it offers protection over the minimum level of effective protection from day 10 [accept day 8/9]to day 47 [accept day 25 to day 49]after administration / for a period which fully covers Mathew's trip (1)
[no mark will be given with wrong choice of treatment]

(ii) • even if he has contracted JE during the trip, the precaution can help prevent / reduce the risk of transmission of the virus(1) to other people as the insect repellant prevents mosquito bite. (1)

9 marks

HKDSE – 2018 1B

4. (a) • low-income countries (1) (1)

(b) Any *two* of the following:
• poor public / personal hygienic conditions led to easy spreading of infectious diseases (1)
• poor healthcare systems failed to treat patients at critical time (1) (2)
• poor income could not afford the medical costs for treating infectious diseases (1)

(c) • consumption of high calories food / fatty food / lack of exercise (1)
• increase the risk of plaque formation / deposition of cholesterol / fat in coronary arteries (1)

• which leads to narrowing of the lumen of arteries / blockage in arteries / decrease blood flow to the heart (1) (4)
• heart muscles do not have enough nutrients / food and oxygen supply (1), resulting in heart attack

7 marks

HKDSE – 2019 1B

1. (a) (i) A, D (1)
B, E (1) (2)

(b) • P is a type of antibody which attaches to the antigens on the surface of the pathogens (1)
• P binds several pathogens together as a big mass / clumping *[accept agglutination / precipitation]* (1) (3)
• to enhance / facilitate the phagocytosis by Q (1) *[accept further explanation of role of antibody in phagocytosis]*

5 marks

2. Adenine (A) and cytosine (C) together make up 50% of the total amount of nitrogenous bases in DNA molecules. Which of the following features of DNA provide the basis to explain this phenomenon?

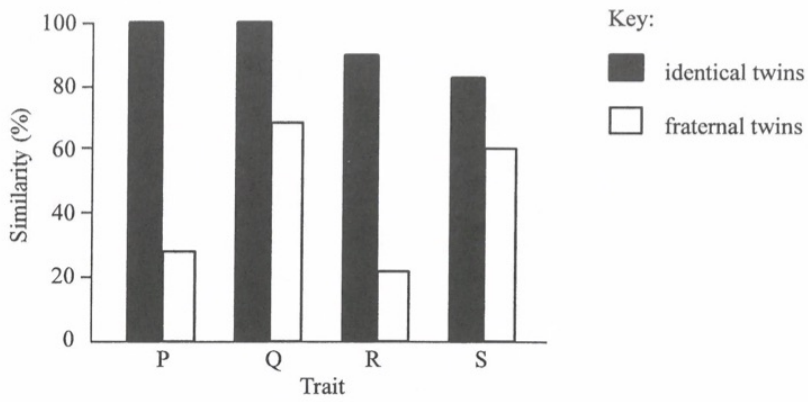
(1) DNA has a helical structure.
(2) DNA is a double-stranded molecule.
(3) The nitrogenous bases are paired complementarily.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

3. In Mendel's experiment, he proposed that a characteristic of the pea plants was controlled by a pair of 'heredity factors'. These factors can be separated in a 'process' before passing to the offspring. According to the current understanding of genetics, what do the 'heredity factors' and the 'process' represent respectively?

	Heredity factors	*Process*
A.	alleles	first meiotic cell division
B.	alleles	second meiotic cell division
C.	chromosomes	first meiotic cell division
D.	chromosomes	second meiotic cell division

6. A large survey about the inheritance of four traits in identical twins and fraternal twins has been conducted. The similarity of these four traits among the individuals in each type of twins are shown in the graph below:



Which trait is most affected by environmental factors?

A. P
B. Q
C. R
D. S

7. The table below shows the comparison among three groups of organisms X, Y and Z:

	X	Y	Z
Cell wall	Present	Present	Absent
Similarity of the amino acid sequence of a protein found in all three organisms (X as a reference)	100%	45%	55%

With reference to the information above, which of the following can be deduced?

A. Both X and Y are prokaryotes.
B. Y is least advanced among the three.
C. X has a closer phylogenetic relationship with Z than Y.
D. Y has a closer phylogenetic relationship with Z than X.

4. The photomicrograph below shows the karyotype of a patient who is suffering from a certain brain disease:

(a) What is the gender of this patient? Describe ***one*** observable feature from the karyotype to support your answer. (2 marks)

(b) (i) Describe the abnormality shown in the karyotype. (1 mark)

(ii) State the type of mutation involved in this abnormality. (1 mark)

(iii) How would this abnormality affect the mRNA level in the brain cells of this patient? (1 mark)

9. Antibiotics have been widely used to treat bacterial infections. They work by killing bacteria or inhibiting their growth. However, some strains of bacteria have developed resistance to antibiotics.

(a) How can antibiotics kill bacteria or inhibit their growth? State ***three*** possible ways. (3 marks)

(b) Bacterium R is a pathogenic bacterium which possesses an antibiotic resistance gene. Its gene product can break down antibiotic X. Scientists have suggested a new approach to fight against bacterium R. This new approach involves the use of a synthetic polynucleotide which binds to the mRNA transcribed from the antibiotic resistance gene. The expression of the gene is then inhibited. By administering this synthetic polynucleotide together with antibiotic X, bacterium R can be killed.

The base sequences of the synthetic polynucleotide and part of the mRNA are shown below:

synthetic polynucleotide: AGT GAC TCG GTC AGC

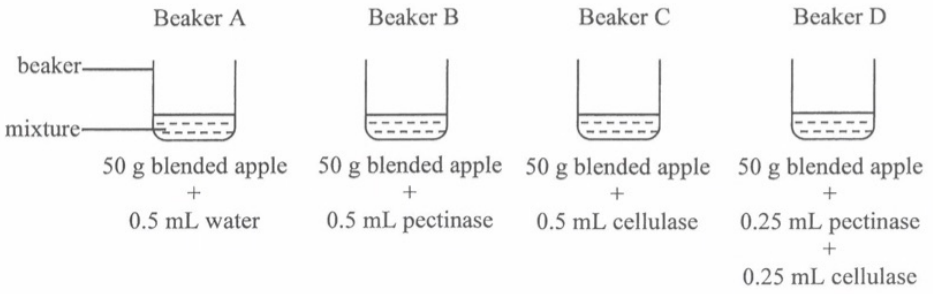
mRNA: ... AUG UCU GUU CCA UCA UCA CUG AGC CAG UCG GCC AUU AAU GCC AAC UAG ...

(i) On the mRNA, underline the base sequence to which the synthetic polynucleotide will bind. (1 mark)

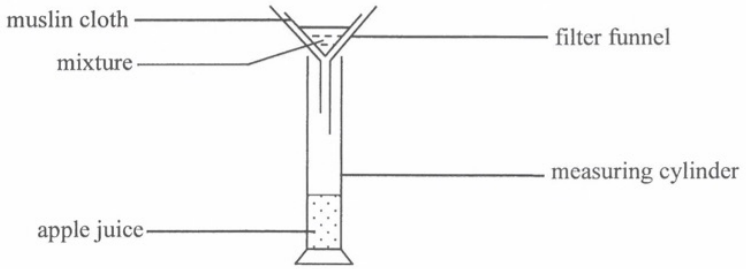
(ii) Explain how the synthetic polynucleotide can inhibit the expression of the antibiotic resistance gene. (3 marks)

(iii) Suggest ***one*** advantage of using synthetic polynucleotides to fight against antibiotic resistant bacteria. (1 mark)

5. Pectinase and cellulase are enzymes that break down the chemical components of plant cell walls. The following experiment investigates the effects of these two enzymes on the production of apple juice:



stir each mixture for 10 minutes and then carry out filtration



The experiment was repeated three times and the results are shown below:

Beaker	Mixture	Volume of apple juice produced (mL)				Cost of enzyme(s) for producing 1 mL apple juice
		Trial 1	Trial 2	Trial 3	Average	
A	0.5 mL water + 50 g blended apple	2.0	1.0	3.0	2.0	---
B	0.5 mL pectinase + 50 g blended apple	33.5	31.0	28.5	31.0	
C	0.5 mL cellulase + 50 g blended apple	4.5	4.0	3.5	4.0	
D	0.25 mL pectinase + 0.25 mL cellulase + 50 g blended apple	34.0	32.0	36.0	34.0	

(a) State the independent variable and dependent variable of this experiment. (2 marks)

(b) Why are three trials better than one trial? (1 mark)

(c) The enzyme solutions used in the experiment were at the same concentration. The prices of 0.5 mL pectinase and 0.5 mL cellulase were $13 and $7 respectively. Complete the above table to show the cost of enzyme(s) for producing 1 mL of apple juice. (2 marks)

(d) Based on the answer in (c), which is the most cost-effective means for producing apple juice? (1 mark)

(e) Explain why the apple juice collected from Beaker D is clearer than that from Beaker A. (1 mark)

DSE M.C. Questions - Basic genetics and Molecular genetics
(sort by difficulty)

Challenging

2012 Q.19 (31%)

The tRNA anticodon for the sequence AGT on the coding strand of DNA is

A. UCA. B. AGU. C. TCA. D. AGT.

2013 Q.11 (35%)

Which of the following statements about codons is correct?

A. A codon may consist of bases A, C, G or T.
B. A codon is a triplet of bases on transfer RNA.
C. Most amino acids are coded by more than one codon.
D. All codons code for amino acids.

2014 Q.11 (31%)

Directions: Questions 10 and 11 refer to the following two crosses of fruit flies. In a fruit flies, male are the heterogametic sex (XY) and the wing shape (normal wing or cut wing) is controlled by a single gene.

	Cross I	***Cross II***
Parents	Normal wing female x Cut wing male	Cut wing female x Normal wing male
F_1	12 normal wing females 11 normal wing males	11 normal wing females 11 cut wing males
F_2	71 normal wing females 34 normal wing males 35 cut wing males	32 normal wing females 33 cut wing females 36 normal wing males 38 cut wing males

From Cross II, we can conclude that

A. the gene for the wing shape is located on the X-chromosome because the cut wing phenotype was passed from the female parent to the F_1 males.
B. the law of independent assortment was demonstrated because new phenotypes, including normal wing females and cut wing males, were found in F_2.
C. the normal wing male parent is heterozygous because four combinations of phenotypes were observed in F_2.
D. the gene for the wing shape is located on an autosome because a ratio 1:1:1:1 was shown in F_2.

Challenging

2014 Q.19 (14%)

Which of the following is ***not*** an application of DNA fingerprinting?

A. Forensic science
B. Screening for genetic diseases
C. Sequencing of the human genome
D. Identification of Chinese medicines

2016 Q.4 (33%)

Which of the following parts of the nucleotide make up the backbone of a polynucleotide strand?

A. sugar and base
B. sugar and phosphate
C. base and phosphate
D. base, sugar and phosphate

2018 Q.12 (39%)

Directions: Questions 12 and 13 refer to the information below. Kathy had two pure-bred cats, one had long white fur while other had short black fur. It is known that fur colour are controlled by two different genes respectively. The two cats gave birth to four kittens which had long black fur.

Which of the following conclusions can be drawn based on the above case?

(1) Long fur is dominant over short fur
(2) The four kittens have the same genotype for fur length and fur colour
(3) The genes controlling fur length and fur colour are located on different chromosomes

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Average

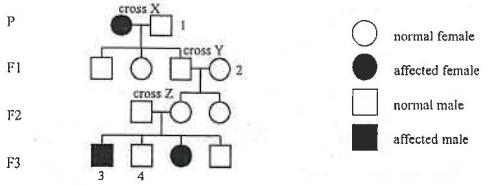
2012 Q.15 (63%)

Identical twins have the same

(1) genotype.
(2) traits involving continuous variations.
(3) traits involving discontinuous variations.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1),(2) and (3)

Directions: Questions 15 to 17 refer to the pedigree below, which shows the inheritance of a certain trait controlled by a pair of alleles located on an autosome (i.e. non-sex chromosome):



2013 Q.15 (47%)

Which cross(es) can be used to deduce which phenotype is dominant?

A. cross Y only B. cross Z only C. crosses X and Y only D. crosses X and Z only

2013 Q.16 (55%)

What are the probable genotypes of individuals 1 and 2?

	Individual 1	***Individual 2***
A.	homozygous	homozygous
B.	homozygous	homozygous or heterozygous
C.	homozygous or heterozygous	homozygous
D.	homozygous or heterozygous	homozygous or heterozygous

2013 Q.17 (71%)

If individual 3 and 4 are twins, which of the following conclusions can be drawn?

A. They are developed from the same fertilized egg.
B. They are developed from different fertilized eggs.
C. They are genetically different for characters displaying continuous variation.
D. They are genetically different for characters displaying discontinuous variation.

Average

2014 Q.10 (50%)

Directions: Questions 10 and 11 refer to the following two crosses of fruit flies. In a fruit flies, male are the heterogametic sex (XY) and the wing shape (normal wing or cut wing) is controlled by a single gene.

	Cross I	*Cross II*
Parents	Normal wing female x Cut wing male	Cut wing female x Normal wing male
F_1	12 normal wing females	11 normal wing females
	11 normal wing males	11 cut wing males
F_2	71 normal wing females	32 normal wing females
	34 normal wing males	33 cut wing females
	35 cut wing males	36 normal wing males
		38 cut wing males

Which of the following observations from Cross I best supports the conclusion that normal wing is the dominant phenotype?

A. All the F_1 individuals are normal wing.
B. The ratio of normal wing individuals to cut wing individuals in F_2 is 3:1.
C. There are more normal wing individuals that cut wing individuals in the F_2.
D. Normal wing males are more or less the same in number as cut wing males in the F_2.

2014 Q.16 (71%)

Which of the following biomolecules are associated with transcription?

(1) DNA
(2) mRNA
(3) amino acid

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

2017 Q.9 (53%)

If the base sequence on the coding strand of the DNA is AAC, which of the following combinations correctly shows the mRNA codon and the tRNA anticodon?

	mRNA codon	*tRNA anticodon*
A.	AAC	UUG
B.	AAC	TTG
C.	UUG	AAC
D.	TTG	AAC

Average

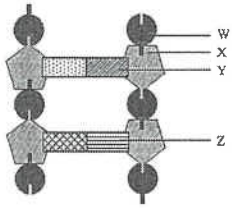
2018 Q.28 (63%)

The DNA model proposed by Watson and Crick leads to the understanding of how

A. Organisms store genetic codes
B. Organisms share a common ancestor
C. Cells produce instructions for protein synthesis
D. Cells can pass genetic information to the next generation

2019 Q.13 (45%)

The diagram below shows a DNA model:



Which of the following combinations shows the most probable identities of molecules W, X, Y and Z?

	W	**X**	**Y**	**Z**
A.	sugar	phosphate	cytosine	thymine
B.	sugar	phosphate	cytosine	guanine
C.	phosphate	sugar	adenine	thymine
D.	phosphate	sugar	adenine	guanine

2019 Q.14 (63%)

In the family, the father is red-green colour blind (a recessive X-linked trait) and is of blood group A, while the mother has normal vision and is of blood group B. Which of the following could be phenotypes of their biological child?

(1) A normal-vision girl with blood group O
(2) a red-green colour blind girl with blood group O
(3) a red-green colour blind boy with blood group AB

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

Easy

2012 Q.18 (78%)
Which of the following descriptions about transcription is correct?

A. tRNA pairs with ribosome to produce amino acids.
B. mRNA pairs with ribosome to produce proteins.
C. Free DNA nucleotides pair with DNA template strand to produce DNA.
D. Free RNA nucleotides pair with DNA template strand to produce mRNA.

2013 Q.4 (81%)
For different DNA nucleotides, the part that varies from one to another is the

A. base.
B. ribose.
C. deoxyribose.
D. phosphate group.

2013 Q.12 (80%)
The DNA of a eukaryotic cell contains 20% adenine (A) bases. What is the percentage of cytosine (C) bases in this DNA?

A. 60%
B. 40%
C. 30%
D. 20%

2013 Q.13 (84%)
A man and his wife are heterozygous for blood type A and B respectively. What is the probability of their son having blood type AB?

A. 0
B. 1/4
C. 1/2
D. 3/4

Easy

2014 Q.12 (80%)
Which of the following combinations of blood groups of parents may produce offspring with blood groups of parents may produce offspring with blood group AB?

(1) A x B
(2) AB x O
(3) AB x AB

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

2014 Q.13 (83%)
The average height of men in a developed country rose by 10 cm between 1890 and 1980. Which of the following is the most probable reason for this observation?

A. Chemical pollution induced mutations leading to the increase in height.
B. Spontaneous mutation resulted in a shift to taller height.
C. The better nutrition supply promoted growth.
D. A taller height had a better chance of survival.

2015 Q.16 (88%)
Variation in skin colour exists among different human races. Which of the following factors plays the major role in determining this variation?

A. exercise
B. nutrition
C. inheritance
D. exposure to sunlight

Easy

2017 Q.8 (79%)

In humans, blood group B is dominant to blood group O. In a family, the father and mother are of blood groups O and B respectively. They have two children who are of blood group B. The father concludes that his wife must be homozygous for blood group B. Is this conclusion correct?

A. No, because there are other blood groups besides blood groups B and O.
B. No, because even if the mother is heterozygous, each child has a 50% chance to be of blood group B.
C. Yes, because the father has no allele for blood group B, all alleles for blood group B must have come from the mother.
D. Yes, because if the mother is heterozygous, one child should be of blood group B and the other should be of blood group O.

2018 Q.13 (77%)

Directions: Questions 12 and 13 refer to the information below. Kathy had two pure-bred cats, one had long white fur while other had short black fur. It is known that fur colour are controlled by two different genes respectively. The two cats gave birth to four kittens which had long black fur.

After the kittens had grown up, they interbred and gave birth to the second filial generation (F2). Among the F2 kittens, there was one with short white fur. Which of the following processes mostly likely contributed to the occurrence of this new phenotype?

(1) Mutation
(2) Random fertilization of gametes
(3) Independent assortment of chromosomes

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

2020 Q.19

19. Which of the following descriptions of the molecular structure of DNA proposed by Watson and Crick is correct?

A. The two chains run in opposite directions.
B. The bases link up the nucleotides to form a chain.
C. The sugar that makes up nucleotides has two types.
D. The phosphate that makes up nucleotides has at least four types.

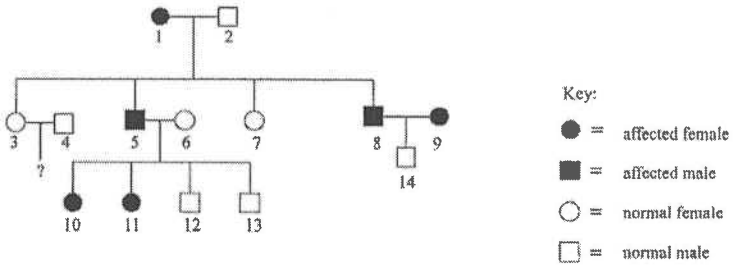
2020 Q.20

20. The amount of DNA in cell P immediately before mitosis is x. After division, there are 4 chromosomes in each daughter cell. Which of the following descriptions is correct?

A. The amount of DNA in the daughter cell is 0.5 x.
B. The amount of DNA in each chromosome is 0.25 x.
C. There are 8 chromosomes in the diploid state of cell P.
D. There are 8 chromosomes in cell P immediately before division.

2020 Q.35

Directions: Questions 35 and 36 refer to the pedigree below, which shows the inheritance of a genetic disorder.



35. Which of the following combinations correctly shows the possible types of inheritance of this disorder?

	Autosomal dominant	*Autosomal recessive*	*X-linked dominant*	*X-linked recessive*
A.	✓		✓	
B.	✓			✓
C.		✓	✓	
D.		✓		✓

2020 Q.36

36. What is the probability of individual 3 and individual 4 giving birth to a normal male?

A. 0
B. 0.25
C. 0.5
D. 1

2020 Q.17

17. 'Transgenic organisms produced by recombinant DNA technology have more potential in terms of evolution than those produced by traditional breeding.'

Which of the following is the best reason for this?

A. Recombinant DNA technology creates new species.
B. Recombinant DNA technology produces new phenotypes.
C. Recombinant DNA technology transfers genes within a species.
D. Recombinant DNA technology transfers genes between different species.

2020 Q.18

Directions: Questions 18 and 19 refer to the following passage about the discovery of DNA structure:

> Many scientists tried to uncover the structure of DNA. In 1952, Franklin took the first X-ray photograph of DNA, which revealed its helical shape. Her colleague, Wilkins, showed some of Franklin's unpublished findings to Watson without her knowledge. Shortly after, Watson and Crick made a crucial advance when they proposed that the DNA molecule was made up of two chains of nucleotides paired to form a double helix. In 1962, Watson, Crick and Wilkins were awarded the Nobel Prize.

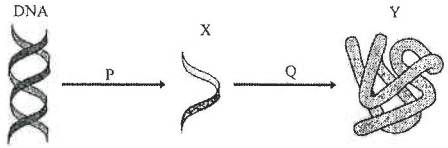
18. Which of the following aspects of the Nature of Science can be exemplified in the above story?

(1) A good scientific experiment must include carefully designed controls.
(2) Scientists are both collaborative and competitive by nature.
(3) Doing science requires imagination and creativity.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

2021 Q1,2,3,11,12,13,14,15,16,17

Directions: Questions 1 to 3 refer to the diagram below, which shows the flow of gene expression within a cell:



1. X represents

A. a transfer RNA.
B. a DNA template.
C. a ribosomal RNA.
D. a messenger RNA.

2. Y could be

(1) an enzyme.
(2) a hormone.
(3) an antibody.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

3. Which of the following combinations correctly states what process P is and where process Q takes place?

	What process P is	*Where process Q takes place*
A.	translation	cytoplasm
B.	translation	nucleus
C.	transcription	cytoplasm
D.	transcription	nucleus

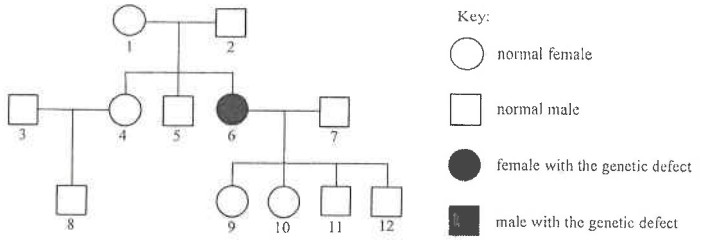
11. The human ABO blood group system is controlled by multiple alleles. Alleles I^A and I^B lead to the presence of antigens A and B on the surface of red blood cells respectively. Allele i leads to the absence of antigens A and B on the surface of red blood cells. How many genotypes are involved in the ABO blood group system?

A. 3
B. 4
C. 6
D. 8

12. A pair of identical twins were adopted by two different families. After the twins grow up, which of the following descriptions about them will most likely apply?

A. They have different shapes of earlobe.
B. They have the same pattern of fingerprint.
C. They have different degrees of short sightedness.
D. They have the same number of freckles on their faces.

Directions: Questions 13 to 15 refer to the pedigree below, which shows the inheritance of a certain genetic defect controlled by a pair of alleles.



13. The phenotype of individual 6 can be explained by the fact that this individual received a defective allele on

A. an autosome from each parent.
B. the Y chromosome from the father.
C. an X chromosome from the mother.
D. an X chromosome from each parent.

14. The offspring of individuals 6 and 7 are normal because each receives a

A. normal allele from the father.
B. normal allele from each parent.
C. defective allele from the father.
D. defective allele from the mother.

15. Which of the following correctly shows the possible genotype(s) of individual 8?

A. heterozygous only
B. homozygous dominant only
C. homozygous recessive only
D. homozygous dominant and heterozygous

16. In the crossing of a red-flowered plant with a white-flowered plant, half of the F1 offspring were red-flowered and the other half were white-flowered. When the F1 white-flowered plants were self-crossed, all the F2 offspring were white-flowered. What can be concluded?

A. The red-flowered parental plant was homozygous.
B. The white-flowered parental plant was heterozygous.
C. White flower is the dominant character in this species of plant.
D. Red flower is the dominant character in this species of plant.

17. Although Mendel proposed that the characteristics of the pea plants were controlled by a pair of 'heredity factors', it was not recognised during his lifetime. His idea was later accepted in the early 20th century because it was supported by

A. the theory of natural selection.
B. the same patterns of inheritance in fruit flies.
C. the behaviours of chromosomes in cell division.
D. the discovery of the double helix structure of DNA.

Answers

Challenging

2012	2013	2014	2016	2018
19 [A]	11 [C]	11 [A]	4 [B]	12 [A]
		19 [C]		

Average

2012	2013	2014	2017	2018	2019
15 [B]	15 [B]	10 [B]	9 [A]	28 [A]	13 [D]
	16 [D]	16 [A]			14 [D]
	17 [B]				

Easy

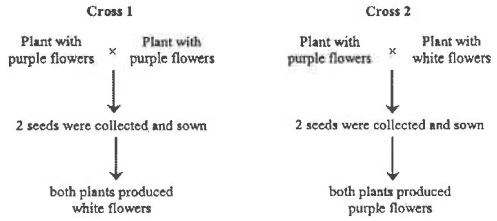
2012	2013	2014	2015	2017	2018
18 [D]	4 [A]	12 [B]	16 [C]	8 [B]	13 [C]
	12 [C]	13 [C]			
	13 [B]				

2020
17[D]
18[C]
19[A]
20[A]
35[A]
36[D]

Past Papers – Basic Genetics

CE- 2003

2. (a) Individuals of a certain type of plant produce either purple or white flowers. The flower colour is controlled by a pair of alleles. A gardener carried out two crosses with this type of plant and the results are shown below:



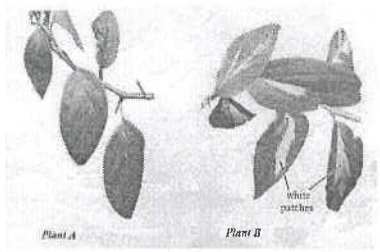
(i) Based on cross 1, deduce the dominant flower colour. Explain your deduction. (5)
(Marks will not be awarded for genetic diagrams.

(ii) Use symbols to show the possible genotypes of the parents in cross 2.
Define the symbols you use. (3)

(iii) If the purple-flower parent in cross 2 was self-pollinated (i.e. the stigma receives pollen grains from the same plant) and a large number of offspring was produced, predict the phenotypes of the offspring and their ratio. (3)

CE- 2004

3. (a) The following pictures show two plants of the same species. Plant A has green leaves. Plant B is a new form recently discovered by a scientist; it has variegated leaves.
The scientist performed an experiment by self-crossing plant A. A large number of offspring were obtained and they all produced green leaves. He then repeated the same procedure with plant B and all the offspring produced variegated leaves.



(i) Assuming that the colour pattern of the leaves is controlled by a pair of alleles, what deductions can be made from the above results regarding the genotypes of plants A and B ? Explain how you arrive at your deductions. (3)
(Marks will not be awarded for genetic diagrams,)

(ii) In order to find out which colour pattern is dominant, the scientist performed another experiment by crossing plant A with plant B. Explain how the results of this cross would enable him to determine the dominant phenotype. (3)

(iii) The white patches on the leaves of plant B might be caused by mineral deficiency instead of genetic changes.
If this is the case, what mineral is likely to be deficient ? What is the function of this mineral in plants ? (2)

CE - 2005

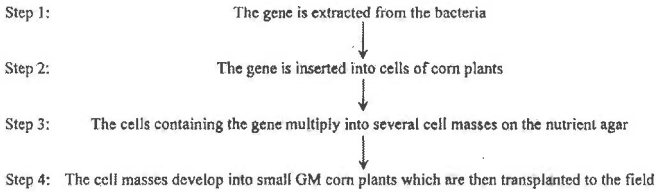
2. Complete the following paragraph with suitable words selected from the list below:

Chromosome	diploid	dominant	embryo	gamete
Haploid	heterozygote	homozygote	meiotic cell division	mitotic cell division
Mutation	protein	recessive		

Genes are the basic units of inheritance. They are carried on the (a)_____ in the nucleus of a cell. A gene may exist in different forms called alleles. When an organism contains two different alleles of the same gene, it is described as a (b)_____ and the allele that expresses itself is said to be (c)_____. During reproduction, some cells in the sex organs undergo (d)_____. During this process, the alleles in these cells separate from each other and every (e)_____ thus formed will possess only one allele for each gene. After fertilization, the zygote formed will contain alleles occurring in pairs and its chromosome number will become (f)_____.

CE- 2006

4. Long ago, scientists discovered that a certain kind of soil bacteria can produce a protein that is toxic to insects. The scientists intended to transfer the gene coding for this protein to crop plants, so as to reduce the damage of crops by insects. In 1995, the US first developed such a genetically modified (GM) corn plant containing this gene. The flowchart below outlines the development of the GM corn plant:



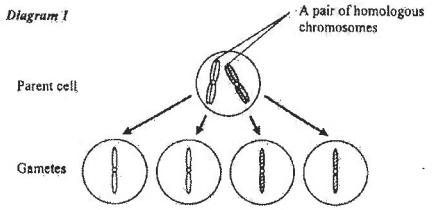
(a) Name the type of cell division that is involved in step 3. State the significance of this type of cell division in the production of the GM corn plants. (2)

(b) Discuss briefly one consequence of cultivating this GM corn plant in the field to the surrounding ecological community. (2)

(c) To improve the quality of food produced, state another character of cultivated plants that scientists would modify besides the insect-resistant character. Give an advantage of this genetic modification. (2)

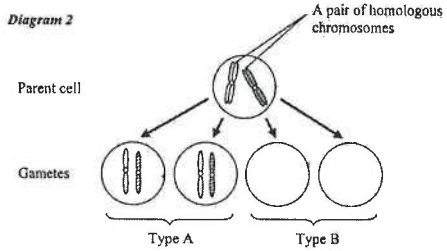
CE - 2006

8. (b) Diagram 1 below shows the result of meiotic cell division in gamete formation in humans: (Note : Only one pair of homologous chromosomes is shown.)



(i) Based on Diagram 1, give two features that are characteristic of meiotic cell division. (2)

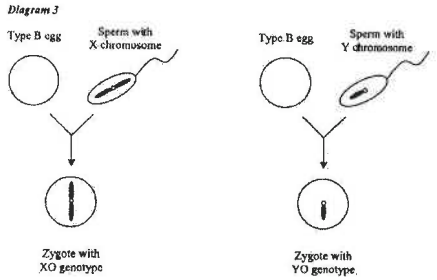
(ii) Sometimes, an abnormality occurs during meiotic cell division in gamete formation in humans. Diagram 2 below shows the abnormality concerning a pair of homologous chromosomes :



(1) Distinguish between type A and type B gametes. (1)

(2) Name a genetic disorder that will develop if a type A egg is fertilized successfully by a normal sperm. (1)

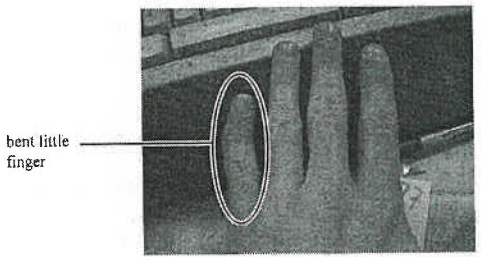
(3) This type of abnormality in cell division may occur in the sex chromosomes. The type B eggs may fertilize with normal sperms to form zygotes with different genotypes as shown in Diagram 3 below:
(Note: Only the sex chromosome is shown.)



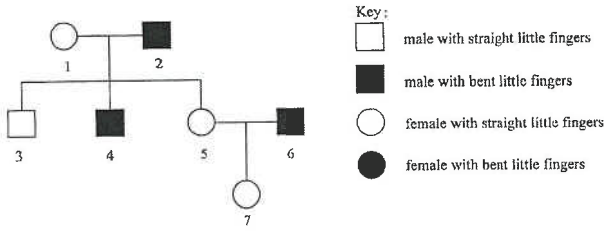
Suggest why zygotes with XO genotype may develop into an individual but not those with YO genotype. (3)

CE - 2007

5. The shape of the human little finger can be straight or bent. The photograph below shows a hand with a bent little finger:



The inheritance of the shape of the little finger is controlled by a pair of alleles. The following pedigree shows the inheritance of this trait in a family:



(a) After studying the pedigree, a student could not determine which little finger shape is dominant. However, he drew the following conclusion.

'Either individual 1 or 2 must be heterozygous.'

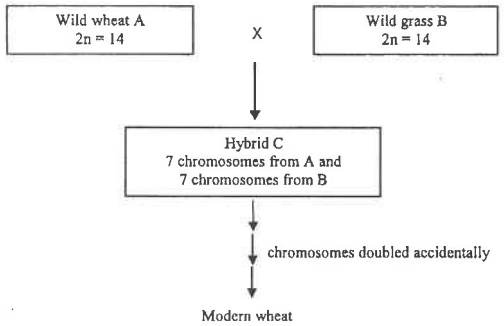
Do you agree with this conclusion? Explain your answer with reference to the role of gametes in inheritance. (3 marks)

(b) Provided that the allele for the bent little fingers is dominant, deduce the possible genotype(s) of individual 4. (4 marks)
(Marks will not be awarded for genetic diagrams.)

(c) Individuals 5 and 6 are going to have another child. What is the probability of their second child having straight little fingers? Illustrate your answer with a genetic diagram. (5 marks)

CE- 2008

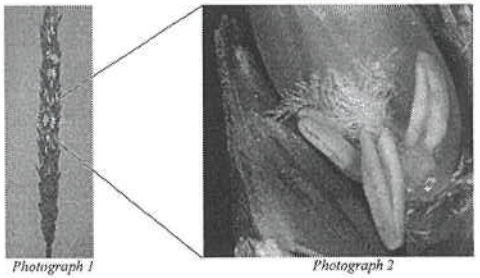
9. (a) A study of the wheat genome reveled that modern wheat is originated from the crosses among wild wheat and wild grasses. Below is one of the crosses.



(i) Hybrid C cannot produce gametes but it can produce offspring asexually. State the type of asexual reproduction employed by hybrid C. (1)

(ii) With reference to the process of meiotic cell division, suggest why hybrid C cannot produce gametes. (2)

(iii) The following photographs show the reproductive structures of wheat.



Photograph 1 *Photograph 2*

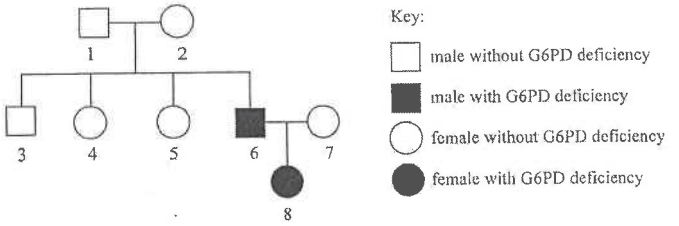
(1) What is the pollinating agent for wheat? Support your answer with two observable features from photograph 2. (3)

(2) A scientist performed a genetic experiment by crossing two different wheat plants. Describe the procedures done in order to ensure cross-pollination, but not self pollination to occur. (3)

CE-2009

3. (a) Glucose-6-phosphate dehydrogenase (G6PD) deficiency is an inherited disorder. People with G6PD deficiency will experience a massive destruction of red blood cells when exposed to certain drugs.

It is known that G6PD deficiency is controlled by a pair of alleles. The pedigree below show the inheritance of this trait in a family:



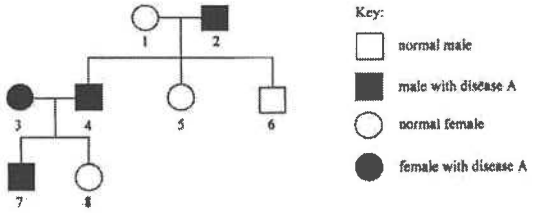
(i) Provided that the allele causing G6PD deficiency is recessive, deduce the possible genotype(s) of individual 7. (4 marks)
(Marks will ***not*** be awarded for genetic diagrams.)

(ii) Individuals 6 and 7 are going to have another child. What is the probability of their second child having G6PD deficiency? (1 mark)

(iii) Is the blood of individual 6 suitable for use in blood transfusion? Justify your answer. (1 mark)

CE - 2010

9. (a) Disease A is a kind of genetic disorder. Its occurrence is controlled by a pair of alleles. The following pedigree shows the inheritance of disease A in a family.



(i) Based on the pedigree above, a student deduced that the allele for disease A is dominant. Explain how he arrived at his answer. (Marks will ***not*** be awarded for genetic diagrams.) (4)

(ii) Individual 8 is going to marry a male heterozygous for disease A. What is the probability of their first child having disease A? (1)

(iii) Using the information in the pedigree for individuals 2, 5 and 6, explain why it is not possible for the allele of disease A to be located on the X chromosome or the Y chromosome. (4)

AL - 2001 2A

3. (a) Contrast the genetic control of ABO blood group and that of red-green colour blindness in humans (5)

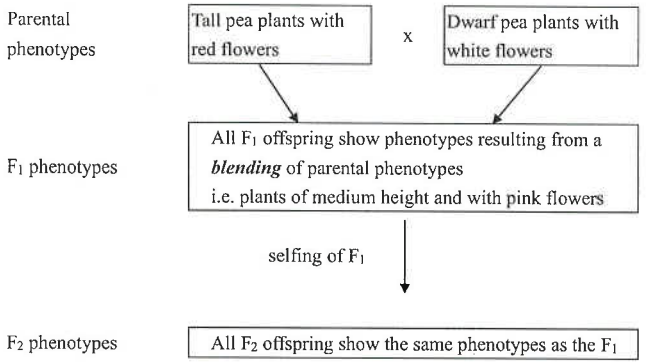
(b) When a man, Tom, of blood group A marries a woman, May, of blood group O, deduce the chances that a child of blood group A would be born to this couple. Use genetic diagram(s) to show your deduction. (7)

AL - 2005 2A

2. The experiments done by Gregor Mendel in the 19th century have led to the replacement of the old concept of heredity, i.e., the Blending Theory, and have given insights to the nature and physical basis of the hereditary materials involved.

In pre-Mendelian times, people observed that children look like both their mother and father. Thus the Blending Theory, which asserted that in inheritance, parental traits were mixed in the offspring, was proposed to explain this observation. However, when the Blending Theory is applied to Mendel's dihybrid experiments, it cannot account for the variations in the offspring.

The following flowchart illustrates the ***hypothetical*** results when the Blending Theory is applied to the inheritance of ***two qualitative traits***:



a. i. With reference to the above flowchart, how do the actual results of Mendel's experiments disprove the Blending Theory? (5)

ii. How do Mendel's laws of inheritance explain the results of his experiments? (4)

b. The ***design*** of Mendel's experiments contributed to his success. Give ***two*** reasons why the ***design*** of his experiments made his findings valid and reliable. (4)

c. In terms of present day knowledge, describe what Mendel's 'hereditary factors' are in diploid organisms and explain the physical basis of the activity of these 'factors' during gamete formation. (4)

AL - 2006 1A

6. A man of blood group A married a woman of blood group B. They have a son and a daughter. The blood group of the son is O.

(a) What is / are the possible blood group(s) of the daughter? Use a genetic diagram to show how you arrive at your answer. (4)
(Use I^A, I^B and i to represent the three alleles that determine the ABO blood groups in humans.)

(b) Explain whether the son can receive blood transfusion from his father. (3)

DSE-2012 1B

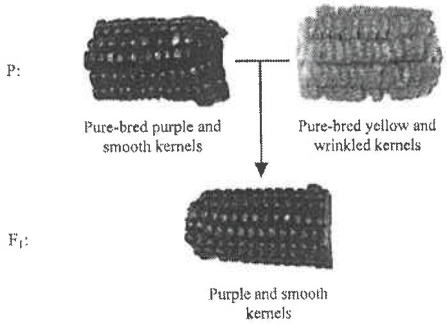
8. The photograph below shows the appearances of some kernels of a corn:

Kernel	Appearance
A	Purple and smooth
B	Purple and wrinkled
C	Yellow and smooth
D	Yellow and wrinkled

The purple colour is produced by a pigmented layer within the kernels. If the layer is not pigmented, the yellow colour of the inner tissue becomes visible. Whether the kernel is smooth or wrinkled is due to the type of food stored inside it. Smooth kernels (starchy corn) store starch while wrinkled kernels (sweet corn) store soluble sugars. The surface of the sweet corns becomes wrinkled when the corn dries up.

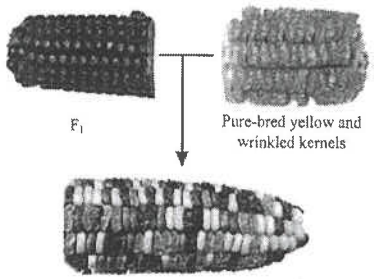
(a) With reference to osmosis, explain why the kernels of sweet corn become wrinkled when they dry up but the kernels of starchy corn remain smooth. (4 marks)

(b) The two traits of the kernels are controlled by genes located on different homologous chromosomes. The following diagram shows the result of a cross between two pure-bred corn plants, one with purple and smooth kernels and the other with yellow and wrinkled kernels:



(i) Based on the results of the cross, deduce which phenotypes are dominant. (3 marks)

3 (ii) The F1 generation produced was crossed with pure-bred corn plants with yellow and wrinkled kernels, as shown below:



Explain the results of the cross using Mendel's law of inheritance. (4 marks)
(Marks will not be awarded for genetic diagrams.)

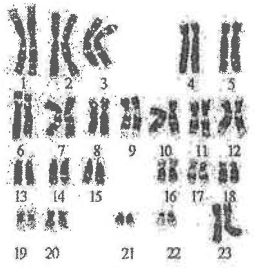
(c) When Mendel proposed how traits are inherited, chromosomes had not yet been discovered. In your opinion, how did Mendel come up with his hypothesis? (3 marks)

DSE - 2013 1B

4. Red-green colour blindness is an X-linked recessive trait in humans. Peter is red-green colour blind while his daughter, Mary, is normal.

(a) Deduce Mary's genotype without using a genetic diagram. (4 marks)

(b) Mary is an expectant mother. The photomicrograph below shows the karyotype of her foetus:

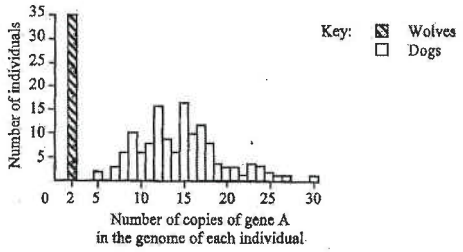


(i) From the photomicrograph, can we deduce whether this foetus will be red-green colour blind or not? Explain your answer. (2 marks)

(ii) Is the foetus a boy or a girl? Explain your answer with reference to the photomicrograph. (3 marks)

DSE - 2014 1B

6. It is generally believed that domestic dogs evolved from ancient wolves. A recent study comparing the genomes of wolves and dogs suggests that genes with key roles in starch digestion were selected during the domestication of wolves into dogs. One of these genes was gene A, which codes for amylase. This gene may exist in many copies in a genome. The following graph shows the number of individuals having different numbers of copies of gene A in 35 wolves and 136 dogs:



(a) Based on the data above and the gene expression processes, explain why the amylase activity in dogs is generally higher than that in wolves. (3 marks)

(b) It is hypothesized that in ancient times, wolves might have been attracted to waste dumps near early human settlements and consumed human food waste. Suggest how the domestication of wolves would have led to the selection of multiple copies of gene A. (5 marks)

DSE – 2015 1B

4. Roger is found to be suitable for donating blood to recipients with blood types different from his own. However, he cannot receive a blood transfusion from his parents. The blood types of his father and mother are A and B respectively.

(a) What is Roger's blood type? (1 mark)

(b) Given that:

I^A represents the allele for producing antigen A on the surface of red blood cells
I^B represents the allele for producing antigen B on the surface of red blood cells
i represents the allele that does not lead to the production of any antigens on the surface of red blood cells

(i) Using the above symbols, state Roger's genotype. (1 mark)

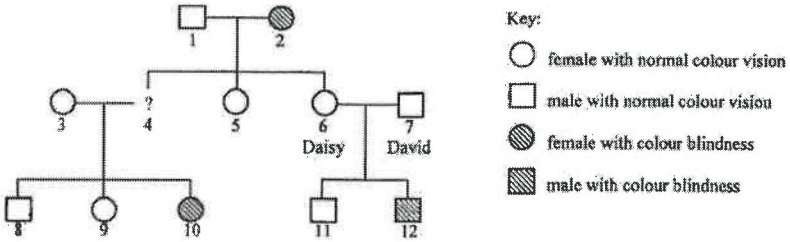
(ii) Using the above symbols, state the genotypes of his parents. (2 marks)

Father:_____ Mother:_____

(c) Explain why Roger cannot receive blood transfusions from his parents. (3 marks)

DSE – 2016 1B

10. Colour blindness is an X-linked recessive genetic disorder. The pedigree below shows the inheritance of colour blindness in a family:



(a) Colour blindness is due to the abnormal development of photoreceptors. State the relevant type of photoreceptors and the location inside the eyeball where these photoreceptors are most abundant. (2 marks)

(b) Given that the dominant allele of colour vision is represented by R while the recessive allele is represented by r, determine all the possible genotypes and phenotypes of the offspring of individuals 1 and 2 using a genetic diagram. (5 marks)
(Note: Punnett square is not accepted)

(c) Draw all possible representation(s) for individual4 with reference to the key of the pedigree. (1 mark)

(d) Daisy (individual 6) has recently given birth to a baby girl. Since one of her sons suffered from colour blindness (individual 12), Daisy worried that their daughter would have colour blindness too. David (individual 7) reassured her by saying that: Don't worry. Our daughter will be fine because I have normal colour vision! Justify David's claim. (5 marks)
(Note: Marks will not be awarded for genetic diagrams.)

HKDSE - 2017 1B

10. a. In 1940, scientist Alfred Sturtevant hypothesised that the ability to roll one's tongue is determined by a single gene. His hypothesis was based on the data below:

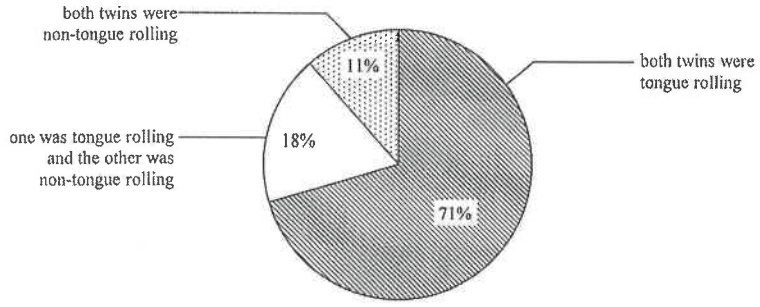
Case	Characters of parents	Tongue rolling offspring	Non-tongue rolling offspring
I	tongue rolling x tongue rolling	28	5
II	tongue rolling x non-tongue rolling	33	22

i. Does the trait of tongue rolling ability show continuous or discontinuous variation? Explain your answer. (2 marks)

ii. Sturtevant concluded that tongue rolling is the dominant phenotype while non-tongue rolling is the recessive phenotype. With reference to the above table, explain how he arrived at this conclusion. (2 marks)

b. In 1965, the offspring of a group of non-tongue rolling parents were studied. It was found that more than 30% of the offspring were tongue rollers. Does this finding support Sturtevant's conclusion in (a)(ii)? Explain your answer. (2 marks)

c. In 1971, another study on identical twins was carried out to further explore the factors influencing the tongue rolling trait. The results are summarized in the chart below:



i. What is the advantage of using identical twins as the subjects for the study?(2 marks)

ii. With reference to the above chart, complete the following table with data that support the conclusion. (2 marks)

Conclusion	Evidence
Genetic factors play a significant role in the determination of the tongue rolling trait	
There are other factors influencing the tongue rolling trait	

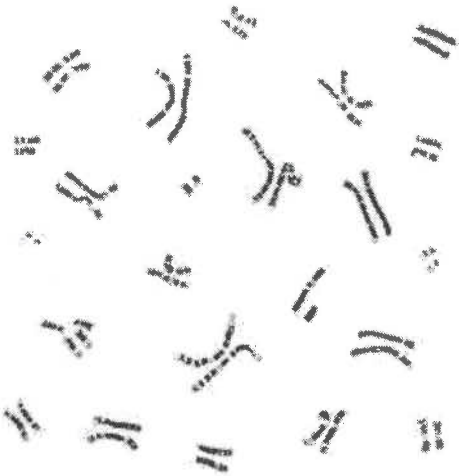
d. i. In the above case regarding the development of knowledge about the inheritance of the tongue rolling trait, which of the following ideas about science is demonstrate? (2 marks)

Ideas about science	Put a '✓' in the appropriate spaces below
Science is a process of ongoing inquiries.	
Science is affected by social and cultural factors.	
Scientists may not arrive at the same conclusions about the same set of data	
Scientific investigations may not require doing experiments in laboratories	

ii. Elaborate on how the development of knowledge about the inheritance of the tongue rolling trait can be used to demonstrate that scientists have to be open-minded. (1 mark)

HKDSE - 2018 1B

5. The photomicrograph below shows the paired homologous chromosomes of a normal boy for karyotyping:



(a) Circle the sex chromosomes on the above photograph.

(b) State the type of cells, somatic cells or gametes, from which the karyotype was obtained. Explain your answer. (2 marks)

(c) It is commonly thought that the sex of offspring is mainly determined by the mother. Explain why this is no/true. (3 marks)

6. Hong Kong Red Cross Blood Transfusion Service keeps stocks of different blood groups to ensure that there is enough blood supply for transfusion in hospitals.

(a) Of all the blood groups, blood group O is in greatest demand in the Accident and Emergency Departments of hospitals. Suggest why the demand for blood group O is the greatest. (3 marks)

(b) The table below shows some recommendations for adult female and male donors:

	Female donors	Male donors
Maximum number of donations in a year	4	5
Interval between donations	No less than 105 days	No less than 75 days

Suggest why there are different recommendations for female and male donors. (3 marks)

9. Although most DNA is stored in the nucleus, mitochondria also have a small amount of their own DNA. The mitochondrial DNA contains some genes coding for enzymes which are essential for oxidative phosphorylation. Mutations of these mitochondrial genes cause Leigh syndrome, which is rare and fatal metabolic disease.

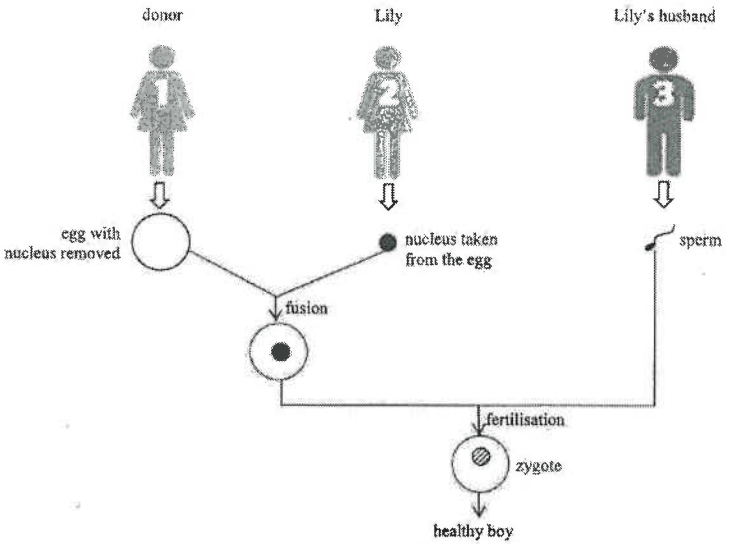
(a) Explain why gene mutations in the mitochondrial DNA can effect oxidative phosphorylation. (4 marks)

(b) What are the major products of oxidative phosphorylation? State their significance. (4 marks)

(c) Lily had two children who died from Leigh syndrome. It was found that her eggs contained mutated mitochondrial genes. Her children suffered from the disease because normally mitochondria in zygotes come from the eggs while sperms do not contribute any.

(i) With regard to the fertilization process and the structure of sperms, suggest why sperms do not contribute any mitochondria to zygotes. (1 mark)

(ii) By using a new method called the 'three-parent baby' technique, Lily gave birth to a healthy boy in 2016. Below are the main steps in the technique:



Identify the source(s) of DNA of the nucleus and mitochondria in the boy's cells. (2 marks)

Nucleus:

Mitochondia:

Past Papers Marking Scheme – Basic Genetics

CE- 2003 Q.2 (a)

(i) The offspring in cross 1 have white flowers, so they must have received at least one allele for white flower from either of the parents 1
Since both parents have purple flowers, each of them must carry at least one allele for purple flower 1
Thus at least one of the parents is heterozygous 1
In the heterozygous condition, only the dominant character is shown 1
Thus purple flower is the dominant character 1

(ii) F represents the allele for purple flower; f represents the allele for white flower 1
(accept other sets of symbols)
The possible genotypes of the purple-flower are FF or Ff 1 or 0
and that of the white-flower parent is ff 1

If gene is used instead of allele in (i) or (ii), deduct 1 mark

(iii) If the genotype of purple-flower parent is FF, all offspring will produce purple flowers 1
If the genotype if Ff, purple-flower offspring and white-flower offspring will be formed 1+
and they would be in the ratio of 3:1 1

CE- 2004 Q.3 (a)

(i) Plant A is homozygous for the green-leaf allele 1
Plant B is homozygous for the variegated-leaf allele 1
because all the offspring of each plant have the same phenotype as the parent 1

(ii) Both plants A and B are homozygous, but of different phenotypes 1
When they are crossed, all their offspring will be heterozygous 1
In heterozygous condition, the phenotype shown by the offspring is the dominant phenotype 1

Effective communication (c) *1*

(iii) Magnesium 1+
For the formation of chlorophyll 1

Or Nitrate 1+
For the formation of chlorophyll / protein 1

CE - 2005 Q.2

(a) chromosome 1
(b) heterozygote 1
(c) dominant 1
(d) meiotic cell division 1
(e) gamete 1
(f) diploid 1

CE - 2006 Q.4

(a) *mitotic cell division 1+
This ensures that all the GM corn plants produced carry the inserted gene / are genetically identical 1
(b) It may kill some other insects / lead to a drop in the insect population 1
thus resulting in the extinction of the species / reduction of biodiversity 1
or It may kill some beneficial insects 1
which may help the pollination of other plants 1
or If the corn grains are dispersed into the natural environment 1
the plants formed will outcompete / displace some other species 1
due to its resistance to insects 1
(c) Ability to fix nitrogen / nitrogen fixation 1
to increase nitrogen content of the food produced 1

CE - 2006 Q.8 (b)

(i) Four daughter cells are formed from a single parent cell,
The two members of a pair of homologous chromosomes are separated; / each goes to a different daughter cell
Each daughter cell contains the haploid number of chromosomes Any two 1,1

(ii) (1) Type A gamete has both members of the homologous pair, while type B gamete has none of that homologous pair 1
(2) *Down / Down's syndrome 1
(3) The X chromosome carries more genes than the Y chromosome 1
Absence of the X chromosome will result in the loss of more genes/alleles 1
that may be essential to the survival of the zygotes and its subsequent development 1

CE- 2007 Q.5

(a) Yes.
To produce offspring with different phenotypes 1
there must be two different combination of gametes 1
therefore, either one of the parents must be heterozygous, producing two types of gametes carrying different alleles 1

OR
The parents are of different phenotypes, hence, one of the parents must be homozygous recessive 1
To produce offspring with different phenotypes 1
the other parent must be heterozygous, producing two types of gametes carrying different alleles 1

(b) Individual 1 possesses straight little fingers, she must be homozygous recessive 1
and pass an allele for straight little fingers to individual 4 1
Individual 4 possesses bent little fingers, she must have at least one allele for bent little fingers 1
Hence, individual 4 is heterozygous 1

(c) Define symbol (S) 1
Let B be the allele for bent little fingers
and b be the allele for straight little fingers

HKDSE – 2017 1B

10. (a) (i)
- discontinuous trait (1)
- because there are distinctive categories with no intermediate categories (1) (2)

(ii)
- in case I, non-rolling offspring appeared even when both parents were tongue rollers (1)
- this shows that the allele for non-tongue rolling was masked in the **parents (1)**
hence, tongue rolling should be the dominant phenotype and non-tongue rolling should be the recessive phenotype

OR
- in case I, non-tongue rolling offspring must have inherited at least one allele for non-tongue rolling from at least one of their roller parents (1)
- however, both parents showed tongue rolling phenotype, i.e. non-tongue rolling phenotype was masked (1)
hence, tongue rolling should be the dominant phenotype and non-tongue rolling should be the recessive phenotype (2)

(b)
- no, it did not support the conclusion (1)
- if non-tongue rolling was the recessive phenotype, all the offspring of the non-tongue rolling parents would be non-tongue rollers (1)

OR

no, it did not support the conclusion (1)
tongue rolling offspring must have inherited at least one allele for tongue rolling from at least one of their non-tongue rolling parents, however, both parents showed non-tongue rolling phenotype, tongue-rolling should be recessive. (1+1)

(c) (i)
- the genetic composition of the identical twins is exactly the same (1)
- they should show the same phenotype / tongue rolling ability (1) if the trait is controlled by genetic factors (2)

(ii)

Conclusion	Evidence
Genetic factor plays a significant role in the determination of the tongue rolling trait.	82% of the identical twins showed same phenotype (1)
There are other factors influencing the tongue rolling trait.	18% of the identical twins showed different phenotypes (1)

(2)

Instructions to markers: (1) candidates must quote numerical data in this part (2) as the first evidence, candidates need to elaborate that two groups were identical twins with the same phenotype.

(d) (i)

Ideas about Science	
Science is a process of ongoing inquiries.	✓
Science is affected by social and cultural factors.	
Scientists having the same set of data may not arrive at the same conclusions.	
Scientific investigation need not necessarily be doing experiments in laboratories.	✓

(2)

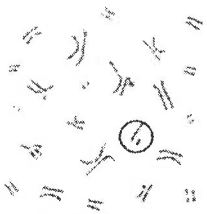
(deduct 1 mark for each mistake)

Instructions to markers:
Total 1 tick in the answer box, 1 correct tick (ONE mark) ; 1 incorrect tick (NO mark);
Total 2 ticks in the answer boxes, 2 correct ticks (TWO marks), 1 correct tick and 1 incorrect tick (ONE mark), 2 incorrect ticks (No mark);
Total 3 ticks, 2 correct ticks and 1 incorrect tick (ONE mark), 1 correct tick and 2 incorrect ticks (NO mark)
Total 4 ticks, NO mark

(ii)
- Scientists who conducted tongue rolling experiments in 1965 or 1971 should have been skeptical and have looked for evidence from different sources / perspectives (1) / have been ready to review / challenge current ideas / knowledge / theories (1)

13 marks

DSE - 2018

5. (a)
-  (1)

(b)
- somatic cells (1)
- because there are 2 sets of chromosomes / 46 chromosomes / 23 pairs of chromosomes (1) (1+1)

(c)
- mother will produce only one type of eggs with an X chromosome (1)
- father will produce two types of sperm cells, one with an X chromosome while another one with a Y chromosome (1)
- the sex of offspring will be determined by which type of sperm cells is involved in the fertilization (1), which is a random process (3)

6 marks

6. (a)
- the blood cells of blood group O contain neither antigen A nor B (1)
- therefore, it can be transfused to patients of any of the ABO blood groups / group O individuals are universal donors (1)
- it will be used for transfusion to other blood groups if there are not enough blood reserve for other blood groups, (1)
- the population of blood group O individuals is the largest of all blood groups in Hong Kong (1) (max. 3)

(b)
- male donors can donate blood more frequently than female donors or vice versa (1) because

Any *two* of the following:
- females have regular loss of blood (1)
- due to menstruation (1)
- compensatory production of blood cells after blood donation is faster in males (1) (3)

6 marks

9. (a)
- gene mutation involves alternation in the nucleotide / base sequence / triplet code in DNA of a single gene (1)
- polypeptide produced from the mutated gene has a different amino acid sequence (1)
- it folds into an enzyme with a different active site shape / 3D conformation (1)
- this enzyme can no longer function in the oxidative phosphorylation (1) / fail to produce a functional enzyme / active site of this enzyme can no longer fit the substrate (4)

(b)
- it regenerates NAD and FAD (1)
- which are important hydrogen carriers in glycolysis / Krebs cycle (1)
- it leads to the formation of ATP (1)
- which is an important energy source to support cellular activities / reactions (1) (4)

(c) (i)
- during fertilization, only the head of the sperm, which contains nucleus, will enter the egg / the middle piece of sperm, which contains mitochondria, will not enter the egg / be left outside the egg (1)
as a result, the sperm does not contribute any mitochondria to zygote (1)

(ii)
- Nucleus: from Lily and Lily's husband (1)
- Mitochondria: mainly from donor (1) (2)

11 marks

AL - 2003 2A

3. Crops that are drought resistant are economically desirable because they can survive well in environments that have a limited water supply, whereas crops that are drought sensitive cannot. Drought-resistant crops can produce a metabolite that can adjust the osmotic potential of the cell sap in the root.

(a) In drought conditions, explain how the root cells of the following plants response osmotically.

(i) drought-sensitive plants (2)

(ii) drought-resistant plants (2)

(b) In the drought-resistant plant, a gene encodes a key enzyme in the biosynthetic pathway of this metabolite. The nucleotide sequences of the drought-sensitive allele S and drought-resistant allele R are :

S : ATAAGCATGACATTA

R : ATAAGCAAGACATTA

(i) What is the nucleotide sequence of the mRNA for S? (2)

(ii) Using the universal codon table below, determine the amino acid sequence encoded by the allele S. (2)

(iii) How is allele R different from S? What difference would this make to the translated product? (3)

Universal codon table

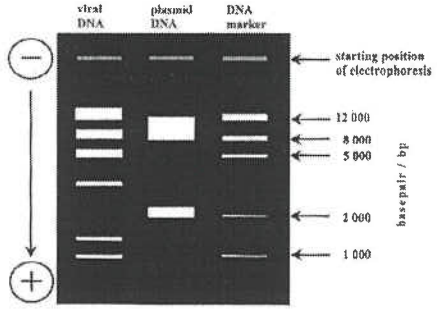
First base in the codon	Second base in the codon				Third base in the codon
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	Stop	Stop	A
	Leu	Ser	Stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Glu	Arg	A
	Leu	Pro	Glu	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

(U, C, A and G stand for the 4 different bases in nucleotides.)

(The various amino acids are represented by their short forms in the table.)

AL - 2004 1B

11. Three DNA samples were used in the following analysis. These included linear viral DNA, plasmid DNA and DNA marker. The same amount of DNA from each sample was completely cut with a restriction enzyme. This was followed by gel electrophoresis where the DNA fragment moved from the negative to the positive pole. The gel was then stained with a dye so that bands containing DNA fragments could be visualized under ultra-violet light. The DNA marker has a known molecular size in basepair (bp). The marker served as a standard to measure the molecular size of DNA fragments. A photograph of the electrophoresis pattern is shown below:



(N.B. Assume that within the same band, the DNA fragments have homogeneous molecular size and identical nucleotide sequence.)

(a) Based on the pattern shown, determine the number of sites that can be cut by the restriction enzyme in the

(i) plasmid DNA (1)

(ii) linear viral DNA (1)

(b) Based on the pattern shown, the molecular size of the DNA marker is 28 000 bp (found by the sum of the molecular size of its DNA fragments). What is the molecular size of the plasmid DNA? Show your calculation.

(N.B. Assume that the molecular size of an individual DNA fragment is measured by the leading edge of the fragment facing the positive pole.) (1)

(c) According to the pattern shown, explain whether the viral DNA or the plasmid DNA has a larger molecular size. (2)

(d) Suppose the patterns of DNA fragments shown are unique to the virus and the plasmid,

(i) what is the scientific name for these patterns? (1)

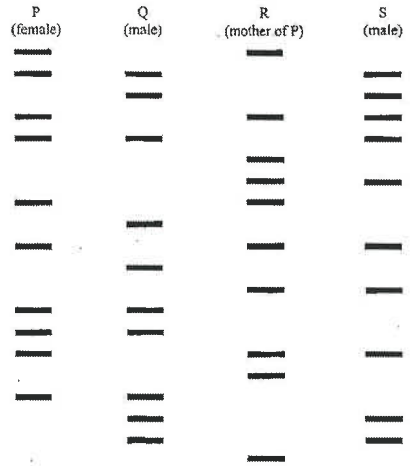
(ii) state *two* applications of these viral and plasmid DNA patterns. (2)

(e) If the same amount of human DNA is completely cut by the above-mentioned restriction enzyme and electrophoresed in the same way, a smear with no discrete DNA bands is obtained. Account for this result. (3)

AL - 2005 1A

8. DNA fingerprinting can be applied in different areas.

(a) One application of DNA fingerprinting is to identify the relationship among members in a family. The result of a DNA fingerprinting test performed on four individuals, P, Q, R and S, is shown below:



Based on the data above, deduce with reasons the most probable relationship of the following persons with P:

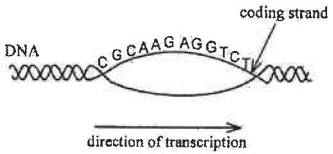
(i) Q (2)
(ii) S (2)

(b) Another application of DNA fingerprinting is to identify the evolutionary relationship among different groups of living organisms. What is the assumption involved in this application of DNA fingerprinting? (1)

AL - 2006 2A

2. DNA controls various metabolic processes in our body through encoding different types of proteins synthesized in the cells.

(a) The diagram below shows the process of transcription of a DNA strand, which encodes part of a polypeptide:



(i) According to the DNA sequence shown, deduce the mRNA produced (1)
(ii) Describe the process by which the mRNA obtained directs the synthesis of the polypeptide part. (5)

(c) In some people, a gene mutation results in the formation of a defective digestive enzyme that may cause a gastrointestinal disease.

(i) One way to treat this disease is by enzyme replacement, i.e. introducing an external source of the digestive enzyme into the patient's gastrointestinal tract. The enzyme used can be produced by recombinant DNA technology. Outline how the enzyme is produced by this technology. (4)
(ii) Gene therapy can be an alternative method for the treatment of this genetic disease. State *two* fundamental differences between the principles of gene therapy and enzyme replacement mentioned in (c)(i). (2)

(d) What potential hazards should scientists consider in the use of gene therapy in treating genetic diseases? (3)

AL - 2008 2A

1. In malaria prevalent areas, such as Africa and the Middle East, sickle-cell trait is quite common. People with sickle-cell trait are mildly anaemic and are heterozygous for the gene encoding the β-chain of haemoglobin. The beginning part of the coding DNA (non-template strand) of the β-chain for both the normal allele [A] and the mutated allele [S] are listed below. The first nucleotide is numbered as 1.

1 24
normal allele [A]: ATG GTG CAC CTG ACT CCT GAG GAG ..... (non-template strand)

1 24
mutated allele [S] ATG GTG CAC CTG ACT CCT GTG GAG ..... (non-template strand)

(a) Using the nucleotide number as a reference, identify the mutation in the [S] allele. (1)

(b) Give the corresponding mRNA sequence for the part of the [S] allele shown above. (2)

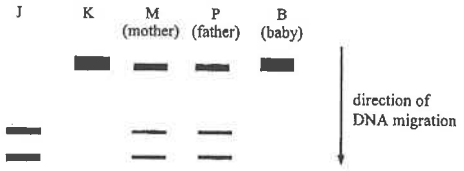
(c) Based on the codon table below, give the amino acid sequence encoded by the mRNA sequence in (b). (2)

First base in the codon	Second base in the codon				Third base in the codon
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	Stop	Stop	A
	Leu	Ser	Stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

Note: The various amino acids are represented by their short forms in the table.

(d) DNA testing was carried out on a married couple, M and P, their newborn baby B, and two individuals (J and K). In this test, the DNA that codes for the β-chain of each person was subjected to treatment by a restriction enzyme. This enzyme recognises the DNA sequence **CT*N*AG** and cuts the DNA between the C and T nucleotides. The DNA fragment(s) formed were then analysed by gel electrophoresis. The results are shown below:

(Note: *N* = any nucleotide A, T, C or G)



J: reference DNA sample from a person with normal β-chain

K: reference DNA sample from a person with sickle-cell anaemia, i.e. homozygous for the [S] allele

(i) In the gel electrophoresis results above, two DNA bands are observed in the J sample while only one DNA band is present in the K sample. Explain these results by referring to the DNA sequence of the alleles shown on the opposite page. (4)

(ii) From the results of the DNA testing, deduce the genotype of the mother and that of the father. Briefly explain your deduction. (2)

(iii) With the aid of a genetic diagram, find the probability of this married couple having a child with sickle-cell trait. (5)
(Use A and S to represent the two alleles as given in this question.)

(e) It is known that people with sickle-cell trait are more resistant to malaria. Based on this information, explain why the sickle-cell trait is more common in malarial prevalent areas than areas with low incidence of malaria. (4)

AL - 2009 1A

2. Complete the following paragraph with suitable word(s)

Scientists mark use of genetic technology to produce transgenic crops. An example is genetically modified (GM) maize that is resistant to insect pests. This involved the isolation of a bacterial (a) ,which is then introduced into the maize plant via a (b) the GM maize can produce a protein at the (c) inside its cells. This protein is toxic to the insect pests of maize but not humans. However, the production of GM crops has raised concerns in different aspects, such as (d) and (e) (5)

AL - 2009 1A

7. In a bacterial genome, cytosine contributes to 28% of the total number of nitrogenous bases in its double-stranded DNA

(a) What is the percentage of guanine in this DNA? Explain your answer. (2)

(b) Calculate the percentage of adenine in this DNA. (2)

(c) How much uracil can be found in this DNA? (1)

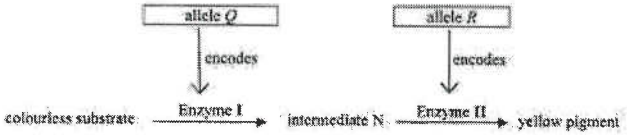
AL - 2010 2A

3. In honeybees, female are developed form fertilised eggs whereas drones (males) are developed from unfertilized eggs. Therefore, females are diploid and drones are haploid. There are two types of female bees: the queen and the workers. However, only the queen can lay eggs.

(a) State the type(s) of the cell division involved in gamete formation in the queen and the drones respectively. (2)

(b) A new queen usually mates with many drones before she settles down for the development of a new colony. Explain the biological significance of mating with many drones. (2)

(c) Honeybees are usually yellow in body colour. Without the yellow pigment, honeybees would appear greyish. Formation of the yellow pigment involves enzymes **I** and **II**. Its biochemical pathway is shown below:



Dominant alleles Q and R encode enzymes **I** and **II** respectively. Their recessive alleles q and r do not lead to the production of functional enzymes. These two genes are not linked.

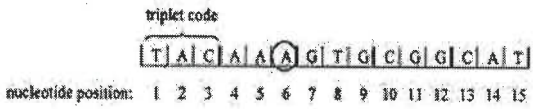
(i) In a cross, a queen of genotypes QqRr was allowed to mate with a drone of genotype qr.

(1) State the body colour of the queen and the drone. (2)

(2) Using the given allele representations, determine the genotypes and phenotypic ratio of worker offspring with the aid of a genetic diagram. (4)
(Note: Assume all the offspring produced are worker bees.)

(3) 15 000 greyish workers were produced form the above cross. If these workers are fed with intermediate N for several days, predict how many would become yellow. Explain your answer. (4)

(ii) Part of the nucleotide sequence of allele Q is shown below:



(1) If the nucleotide at position 6 is deleted in a mutation, how would this affect the production of enzyme **I**? (3)

(2) If the nucleotide at position 6 is replaced by another nucleotide with a different base, a functional enzyme may still be produced. How would you account for this? (3)

HKDSE - 2020 1B

9. The following DNA sequence shows the coding strand of part of a gene found in insect species A:

... ATG GTC GTA TAC GCT ACC CTG TCG ATG CTA GCT AGC ...

(a) Which of the following correctly shows the sequence of the mRNA corresponding to the underlined sequence of this coding strand? Put a '✓' in the appropriate box to indicate your choice. (1 mark)

☐ AUG GUC GUA UAC GCU ACC

☐ UAC CAG CAU AUG CGA UGG

(b) Using the following codon table, write the amino acid sequence of the protein translated from the mRNA in (a). (2 marks)

First base of the codon	Second base of the codon: U	C	A	G	Third base of the codon
U	Phe	Ser	Tyr	Cys	U
					C
	Leu		STOP	STOP	A
				Trp	G
C	Leu	Pro	His	Arg	U
					C
			Gln		A
					G
A	Ile	Thr	Asn	Ser	U
					C
			Lys	Arg	A
	Met				G
G	Val	Ala	Asp	Gly	U
					C
			Glu		A
					G

(c) It was found that the gene has two alleles. The difference between the two alleles in the underlined sequence is highlighted below:

allele1: ... ATG GTC GTA TA**C** GCT ACC ...

allele 2: ... ATG GTC GTA TA**G** GCT ACC ...
(mutated)

(i) What kind of mutation is this? (1 mark)

(ii) With reference to the codon table, describe how this mutation affects the protein translated from this gene. (3 marks)

(iii) Individuals from insect species A exist in two forms, green bodied and brown bodied. Individuals with a green body have only allele 1. Some of those with a brown body have both allele 1 and allele 2 while others have only allele 2.
If the body colour of insect species A was only caused by the mutation of this gene, which allele (1 or 2) would be recessive? Explain your answer. (3 marks)
(Note: Marks will not be awarded for genetic diagrams.)

HKDSE - 2021 1B

6. Pathogen X is a pathogen that infects humans. Research has discovered an antigen Y present on the surface of pathogen X. Using recombinant DNA technology, antigen Y can be produced and serves as a vaccine to induce immunity against pathogen X.

(c) Refer to the codon table below, answer the questions that follow:

UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys
UUC		UCC		UAC		UGC	
UUA	Leu	UCA		UAA	STOP codon	UGA	STOP codon
UUG		UCG		UAG		UGG	Trp
CUU	Leu	CCU	Pro	CAU	His	CGU	Arg
CUC		CCC		CAC		CGC	
CUA		CCA		CAA	Gln	CGA	
CUG		CCG		CAG		CGG	
AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser
AUC		ACC		AAC		AGC	
AUA		ACA		AAA	Lys	AGA	Arg
AUG	Met	ACG		AAG		AGG	
GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly
GUC		GCC		GAC		GGC	
GUA		GCA		GAA	Glu	GGA	
GUG		GCG		GAG		GGG	

(i) The starting sequence of the coding strand of the gene which encodes antigen Y is shown below:

ATG GCC ATA AAT TGC TGT ... ...

Referring to the codon table, write the corresponding amino acid sequence of the coding strand shown above. (2 marks)

(ii) Over the years, mutation has occurred in the gene encoding antigen Y in different strains of pathogen X. The variations in the starting sequence of this gene are shown below:

original strain: ATG GCC ATA AAT TGC TGT ... ...
strain P: ATG GCC ATA AAT TGC TGC ... ...
strain Q: ATG GCC ATA AAT TGA TGT ... ...
strain R: ATG GCT ATA AAC TGC TGT ... ...

One of these strains has the ability to infect people who have been injected with the vaccine containing antigen Y. With reference to the codon table, which strain (P, Q or R) will that be? Explain your answer. (4 marks)

10. In humans, breast milk provides not only nutrients but also protective effects to infants. Recently, scientists discovered a new constituent of breast milk: short RNA fragments enclosed in vesicles. Scientists have very diverse views about the roles of these short RNA fragments. The following are two of the hypotheses:

Hypothesis 1: the short RNA fragments serve as food particles
Hypothesis 2: the short RNA fragments regulate gene expression in infants

(a) To test Hypothesis 1, scientists performed an experiment of *in vitro* digestion of breast milk. The method is shown below:

Method of *in vitro* digestion with 20 mL of fresh breast milk

Step 1	Addition of hydrochloric acid solution
Step 2	Addition of enzyme mixture 1
Step 3	Incubation at 37°C for 20 minutes
Step 4	Addition of sodium hydrogen carbonate solution
Step 5	Addition of enzyme mixture 2
Step 6	Incubation at 37°C for 30 minutes
Step 7	Incubation at 85°C for 3 minutes
Step 8	Measurement of the level of short RNA fragments and nucleotides

(iii) After the *in vitro* digestion, the level of short RNA fragments in the reaction mixture was similar to that of fresh breast milk and no nucleotides were detected. Explain why the results disprove Hypothesis 1. (2 marks)

(b) Scientists will ask scientific questions when designing experiments to test Hypothesis 2. Suggest *one* example of these scientific questions. (1 mark)

6. Pathogen X is a pathogen that infects humans. Research has discovered an antigen Y present on the surface of pathogen X. Using recombinant DNA technology, antigen Y can be produced and serves as a vaccine to induce immunity against pathogen X.

(b) Other than the use of recombinant DNA technology, suggest another way to produce a vaccine. (1 mark)

Past Papers Marking Scheme – Molecular and Applied Genetics

AL - 2003 2A

3. (a) (i) • root cells have a higher water potential than soil water (1), water leaves the root cells by osmosis (1) — 2

(ii) • synthesis of the metabolite lowers the water potential (1) / lowers the solute potential of root cells to below that of soil water, cells will not lose water to the environment and survive (1) / cells can still absorb water — 2

(b) (i) mRNA of S : UAU UCG UAC UGU AAU (2) (concept of complementary bases) — 2

(ii) • amino acid sequence of S: Tyr Ser Tyr Cys Asn (2) — 2

(iii) • R has nucleotides AAG instead of ATG (1) in the third triplet of nucleotides (1) — 2

or The 8th base (1) T is replaced by A (1)

• the third amino acid changes from Tyr to Phe (1) / replaced by Phe in the encoded peptide — 1

AL - 2004 1B

11. (a) (i) 2 (1) — 1

(ii) 5 (1) — 1

(b) 8000 bp + 2000 bp = 10000 bp (1) — 1

(c) • viral DNA is larger (1), sum of base pair of all DNA fragments of viral DNA > that of plasmid DNA (1) — 2

(d) (i) • fingerprint (1) — 1

(ii) Any two uses of fingerprint (1 mark for each use): e.g. (accept correct alternatives)

- use in detecting the presence of this virus and plasmid (1)
- use in the identification of this virus and plasmid (1) — max. 2
- use in the study of the relationship between viruses and the relationship between bacteria (1)

(e)

Concept for mark award:	
• human DNA is large in size (1)	max. 3
• the restriction enzyme cuts the DNA into many different DNA fragments (1) / many restriction sites	
• some fragments are close in size (1)	
• cannot be separated effectively ∴ merge as a smear (1)	

(11)

AL - 2005 1A

8. (a) (i) The bands of P either come from R (mother) or from Q (1). Therefore, Q is her father (1). — 2

(ii) S has many bands common to P. The bands of S either come form Q or R (1). Therefore, he is a son of Q and R and a brother of P (1). — 2

(b) The closer the evolutionary relationship of two groups of living organisms, the more common bands they will have in their DNA fingerprinting patterns (1). — 1

(5)

AL - 2006 2A

2. (a) (i) CGCAAGAGGUCU (1) — 1

(ii)

Concept for mark award:	
· fate of mRNA after transcription (1-2)	max. 5
· amino acids carried by tRNA (1)	
· complementary pairing between anticodons of tRNA and codons of mRNA (1)	
· attachment of tRNA to ribosomes (1) in sequence	
· formation of peptide bond (1)	

e.g.

- the mRNA transcribed moves out to the cytoplasm (1) and attaches onto rRNA / the ribosomes (1) — max. 5
- different tRNA molecules carry different amino acids (1)
- aminoacyl-tRNA molecules / amino acid-tRNA complex with anticodons complementary to the codons of the mRNA (1) will attach to the ribosome (1) in sequence and a peptide bond will be formed between adjacent amino acids (1), thus forming the polypeptide

(c) (i)

Concept for mark award:	
· obtaining the gene coding for the enzyme (1)	max. 4
· introducing the gene into cultured cells through a vector (1)	
· expression of the gene forming the enzyme (1)	
· mass production of the enzyme (1)	
· purification of the enzyme (1)	

e.g.

- synthesize the DNA sequence coding for the functional enzyme in bacteria (1) / use restriction enzyme to cut the non-defective gene from the host cell — max. 4
- introduce the DNA / gene into cultured cells through a plasmid (1) / vector
- the gene is expressed in the cultured cells to produce the enzyme (1)
- mass culturing / fermentation of the cultured cells mass produces the enzyme (1)
- enzyme is purified for use (1)

(ii)

Concept for mark award:	
· comparison in terms of	2
> any introduction of the gene into patient's body (1)	
> source of enzyme (1)	

e.g.

Gene therapy	Enzyme replacement	
· foreign gene is introduced into the patient's cells	· no introduction of foreign gene into patient's cells	1
· enzyme is produced by the patient	· enzyme is obtained from an external source	1

(d) Any **three** of the following: (accept correct alternatives) max. 3

- there are potential adverse side effects due to misplacement of target gene (1) / mutation, errors in the process (1), defective or harmful gene products produced (1), absence of normal gene product (1)
- microbes / chemicals used to carry the gene into patient's cells may bring about adverse / unknown effect on human health (1) / the vector may elicit undesirable response in the patient / allergy / inflammation

(20)

AL - 2008 2A

1. (a) Nucleotide number 20 A is changed to T (1)

(b) Concept of mark award:
base sequence being the same as the coding sequence (1) except T replaced by U (1)/ (2 or 0)

AUG GUG CAC CUG ACU CCU GUG GAG

(c) Met Val His Leu Thr Pro Val Glu (2)

(d) (i)
- J has only the A alleles (1)
- the A / normal allele contains a sequence of CTGAG which can be recognized by the restriction enzyme (1); the β-chain gene is thus cut into two DNA fragments (1) of different lengths between C and T within this sequence
- in the S / mutated allele of K, the DNA sequence at the same position is CTGTG (1) / the restriction site is lost / not recognized / the enzyme cannot cut the allele; thus only one band appears on the gel

(ii)
- the genotype of M and P must be AS (1) / heterozygous because they have all the bands of J and K (1)

(iii)

Parent	AS	X	AS		
Gamete	A	S	A	S	1
Offspring	AA	AS	AS	SS	1
Offspring phenotypes	normal	sickle-cell trait		sickle cell anaemia	1,1

The chance for the couple to have a child with sickle-cell trait is 2/4 = ½ 1

(e)

Concept for mark award:
- advantage of sickle-cell trait outweighs disadvantage of being mildly anaemic in malarial prevalent areas (1)
- malarial infection as selection agent (1)
- preferential survival of individuals with sickle-cell trait (1)
- reproduction to pass the S allele to subsequent generations (1), hence a rise in proportion of individuals with sickle-cell trait from one generation to another (1)
- reasons for fewer cases of sickle-cell trait in areas with low incidence of malaria:
  - > no such selection advantage (1)
  - > being mildly anaemic is a disadvantage (1)

max. 4

e.g.
- in malarial prevalent areas, the survival advantage brought by sickle-cell trait against malarial infection outweighs the disadvantages of being mildly anaemic (1)
- malarial infection acts as a selection agent for people with sickle-cell trait (1)
- people with sickle-cell trait are able to survive (1) and reproduce, passing the S allele to the subsequent generations (1)
- the proportion of individuals within a population having the sickle-cell trait increases from one generation to another (1), making the trait more common in the population
- in areas with low incidence of malaria, people with sickle-cell trait would not have such a selection advantage (1), instead being mildly anaemic is a disadvantage (1), thus the trait is less common in these areas

max. 4

AL - 2009 1A

2. a. gene (1)
b. vector / plasmid (1)
c. rough endoplasmic reticulum / ribosome (1)
d & e.
- possible allergic reaction to human through affecting the metabolism of plant (1) / long term effect of GM crops on humans is unknown
- spread of the new gene from the GM crop to the wild species, upsetting the balance of nature (1) / unknown long-term effect on ecosystem

AL - 2009 1A

7. (a) 28% (1)
guanine forms complementary pairs with cytosine in a double-stranded DNA (1), therefore the amount of G is equal to the amount of C. (2)

(b) (100-28x2) / 2 (1)
= 22% (1) (2)

(c) There is no uracil in DNA (1)

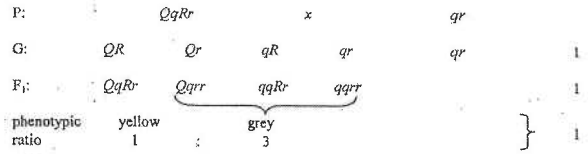
AL - 2010 2A

3 (a) · queen produces gametes by meiotic cell division (1) and mitosis (accept)
· drones produce gametes by mitotic cell division (1) (2)

(b) any ***one*** set of the following:
· this increases the variations of the offspring produced (1) so that some offspring may continue to survive even if there is a sudden environmental change (1) 1,1

(c) (i) (1) queen: yellow (1)
drone: greyish (1) (2)

(2)



Correct presentation of genetic diagram (1) 1

(4)

(3)

Concept for mark award:	
· correct perdition (1)	(4)
· identification of the ratio of offspring with genotype *qqRr* (1)	
· with the ability to produce functional enzyme **II** (1), these offspring can covert intermediate N into yellow pigment (1)	

e.g. · about 5000 (1) (4)
· only 1/3 of the offspring are of the genotype qqRr (1) which is capable of producing functional enzyme **II** (1) for the conversion of intermediate N into yellow pigment (1)

(ii) (1)

Concept for mark award:	
· deleting a nucleotide results in the shift of nucleotide sequence (1), leading to a change in the entire amino acid sequence (1)	(3)
· protein produced is completely different (1)	

e.g. · the loss of a nucleotide shifts the subsequent nucleotide sequence by one nucleotide (1) (3)
· hence the whole chain of amino acids that follows will be completely different (1) from the original one
· no enzyme **I** is produced (1) / a completely different protein is produced

(2)

e.g. · the substitution of a nucleotide only leads to the change of one triplet codon (1) / one codon
· any one set of the following
> the new code formed may be degenerate (1) / may encode for the same amino acid, so there is no change to the original polypeptide / the same polypeptide is formed (1)
> the new code formed encodes another amino acid which is not involved in the formation of active site (1), so the shape/ conformation of the active site remains the same (1)

DSE M.C. Questions - Evolution
(sort by difficulty)

Challenging
/

Average

2013 Q.19 (59%)

Directions: Question 19 and 20 refer to the nucleotide sequence of a certain functional gene segment found in four different species of organisms P, Q, R and S:

A A C G T C G A A A	(organism P)
A A C C T C G A A A	(organism Q)
A G G C T A G A A A	(organism R)
A G G C T A G T A A	(organism S)

The differences in the sequences shown above are most probably caused by

A. crossing over.
B. gene mutation.
C. random fertilization.
D. Chromosomal mutation.

2013 Q.22 (60%)

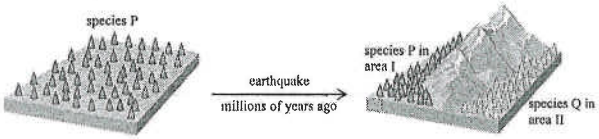
Which of the following observations is not related to the process of evolution?

A. Some variations are not inheritable.
B. Organisms compete for resources to survive.
C. Environmental changes give stress to organisms.
D. Variations exist among different individuals of the same species.

Average

2017 Q.10 (58%)

Directions: Questions 10 and 11 refer to the diagram below. A high mountain resulting from an earthquake millions of years ago has led to the separation of areas I and II. A new tree species Q is found in area II.



Which of the following processes were likely to have been involved in the formation of new species Q?

(1) mutation
(2) isolation
(3) natural selection

A. (1) and (2) only B. (1) and (3) only C. (2) and (3) only D. (1), (2) and (3)

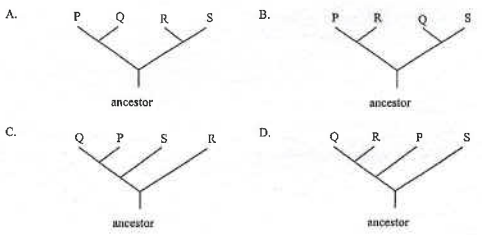
Easy

2013 Q.20 (78%)

Directions: Question 19 and 20 refer to the nucleotide sequence of a certain functional gene segment found in four different species of organisms P, Q, R and S:

A A C G T C G A A A	(organism P)
A A C C T C G A A A	(organism Q)
A G G C T A G A A A	(organism R)
A G G C T A G T A A	(organism S)

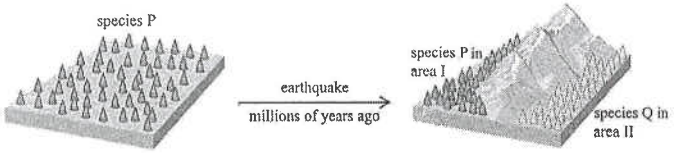
Based on the above information, which of the following diagrams best represents the evolutionary tree of organisms P, Q, R and S.



Easy

2017 Q.11 (81%)

Directions: Questions 10 and 11 refer to the diagram below. A high mountain resulting from an earthquake millions of years ago has led to the separation of areas I and II. A new tree species Q is found in area II.



Which of the following descriptions of the above incident is most likely to be correct?

A. Q is more adaptive than P.
B. P grows equally well in areas I and II.
C. Areas I and II have similar environmental conditions.
D. P and Q belong to the same Family in the classification system.

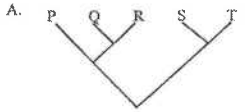
2020.Q15

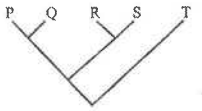
15. The table below shows the presence or absence of some traits in five species:

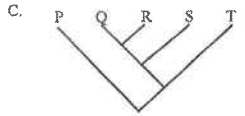
	Trait				
Species	1	2	3	4	5
P	+	+	−	+	−
Q	+	+	−	−	−
R	+	−	−	−	+
S	+	−	+	−	+
T	−	−	−	−	−

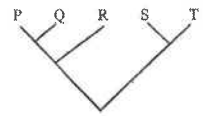
Key:
\+ presence of trait
− absence of trait

Which of the following evolutionary trees best illustrates the phylogenetic relationship of the five species?

A. 

B. 

C. 

D. 

Answers

Challenging

Average

2013	2017
19 [B]	10 [D]
22 [A]	

Easy

2013	2017	2020
20 [A]	11 [D]	15[B]

Past Papers – Evolution

CE - 2005

10. (b) Peter moved to a small island ten years ago. He found that there were a lot of mosquitoes, so he sprayed the area around his house with a certain kind of insecticides. The mosquito population dropped rapidly, but rose again after several months. He then sprayed the same insecticide to kill the mosquitoes and this was repeated whenever there was a rise in the mosquito population. However, Peter has found the insecticide has become less and less effective in recent years.

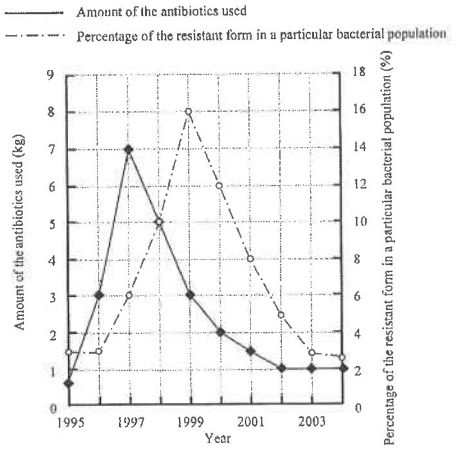
(i) Explain why the mosquito population rose again after a large number of them were killed by the insecticide. (2)

(ii) In the same population, the mosquitoes may show different degrees of resistance to the insecticide. Explain two genetic causes that may lead to this variation among the mosquitoes. (4)

(iii) Using the theory of natural selection, explain why the insecticide, explain why the insecticide has become less and less effects in killing the mosquitoes. (4)

CE – 2007

7. (b) Antibiotic is a drug commonly used to treat bacterial infections. In recent years, there have been more reported cases of resistant forms of bacteria strains found in hospitals. The graph below shows the percentage of the resistant form in a particular bacterial population and the amount of antibiotics used in one particular hospital each year from 1995 to 2004:



(i) Explain why the increased amount of antibiotics used will lead to the rise in the percentage of the resistant form in the bacterial population. (4 marks)

(ii) Some patient in hospitals will have a higher death rate if infected with resistant forms of bacteria. Suggest one group of these patients and give an explanation. (2 marks)

(iii) If you were a doctor, suggest two practices that you could adopt to slow down the rise of the resistant forms of bacteria. (2 marks)

AL - 2006 1A

8. (a) Suggest *two* ways in which scientists can make use of fossil records in their study of the evolutionary relationship of organisms. (2)
   (b) Suggest *two* limitations of using fossil records as evidence of evolution. (2)

AL - 2007 2A

2. To explain the diversity of life forms on Earth. Darwin proposed a theory that different species arose by gradual changes from ancestral stocks. It would be possible to identify the evolutionary relationships of different species by examining the similarities and differences between them and comparing them with pre-existing life forms. Evidence of evolution can be drawn from a wide range of sources, e.g. fossils, comparative anatomy, and comparative biochemistry.

   (a) (i) What are fossils? (2)
   (ii) Discuss how the study of fossils can provide evidence for evolution. What are the limitations of using fossils as evidence for evolution? (5)
   (b) In comparative anatomy, the pentadactyl limb is considered as a homologous structure found in tetrapods. List ***three*** criteria that the limbs of different tetrapods have to satisfy for them to be considered as homologous structures. (3)
   (c) In comparative biochemistry, one can study the structures of the same type of protein, such as haemoglobin, produced by different organisms. The table below shows the differences between the amino acid sequences in the polypeptide chains of haemoglobin of four primate species:

Primate species	Number of amino acids in the polypeptide chain different from that of humans		
	α-chain (141 amino acids)	β-chain (146 amino acids)	γ-chain (146 amino acids)
Human	0	0	0
Chimpanzee	0	0	1
Gibbon	3	3	2
Gorilla	1	1	1

   (i) Based on the above information, construct an evolutionary tree of the four primate species, assuming that they arose from the same ancestor. (2)
   (ii) What is the assumption made when constructing the evolutionary tree of organisms based on the information in the above table? Explain the biological principle underlying your assumption. (4)

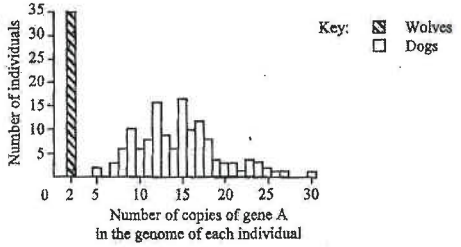
   (d) A modern classification system can reflect the evolutionary relationships of organisms.
   (i) Explain how the taxonomic hierarchy in the modern classification system reflects the evolutionary relationships of organisms. (3)
   (ii) Why is it impossible for two species of organisms grouped under the same family to be put in different classes? (1)

AL - 2010 2B

4. (c) Hair length in a kind of artic dog exhibits continues variation. With reference to the concept of natural selection, suggest the long term effect of global warming on the mean hair length of the arctic dog. (4 marks)

DSE - 2014 1B

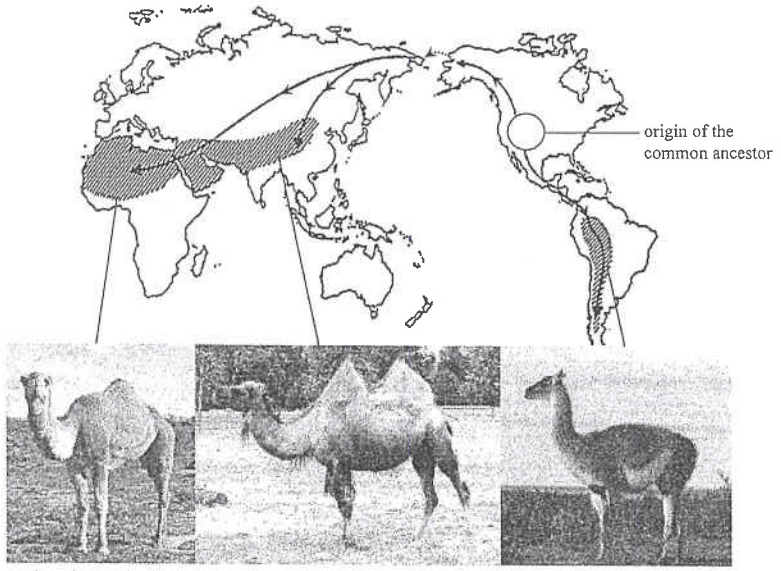
6. It is generally believed that domestic dogs evolved from ancient wolves. A recent study comparing the genomes of wolves and dogs suggests that genes with key roles in starch digestion were selected during the domestication of wolves into dogs. One of these genes was gene A, which codes for amylase. This gene may exist in many copies in a genome. The following graph shows the number of individuals having different numbers of copies of gene A in 35 wolves and 136 dogs:



   (a) Based on the data above and the gene expression processes, explain why the amylase activity in dogs is generally higher than that in wolves. (3 marks)
   (b) It is hypothesized that in ancient times, wolves might have been attracted to waste dumps near early human settlements and consumed human food waste. Suggest how the domestication of wolves would have led to the selection of multiple copies of gene A. (5 marks)

DSE – 2015 1B

10. Fossil records suggest that camels in Africa and Asia and llamas in South America evolved from a common ancestor 6 million years ago. The diagram below shows the possible migration routes of the common ancestor at the time before the continents were separated and the location (shaded areas) where the camels and llamas are found at present:



Camel in Africa Camel in Asia Llama in South America

(a) Based on the information given, draw a diagram to show the evolutionary tree of the three animals. (2 marks)

Evolutionary tree of camels in Africa and Asia and llamas in South America

(b) Explain how the common ancestor might have given rise to the two different animal species (camels and llamas) in the above case. (4 marks)

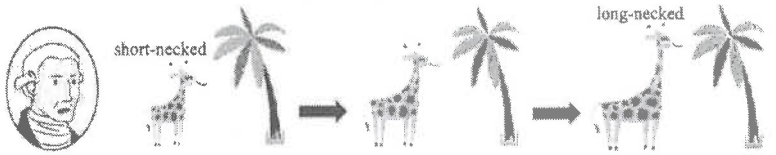
(c) Suggest another way to establish the evolutionary relationship among the above animals. (1 mark)

(d) Give ***two*** limitations of fossil records as evidence for evolution. (2 marks)

DSE – 2018 1B

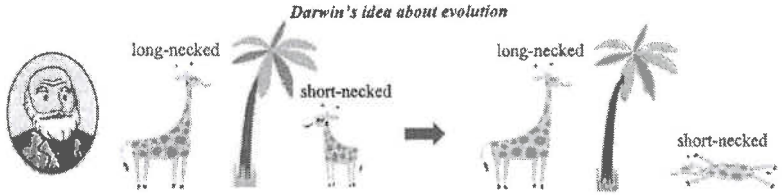
10. Both Lamarck and Darwin contributed greatly to the understanding of evolution. They proposed different explanations for the evolution of long necks in giraffes, as shown below:

Lamarck's idea about evolution



Long necks evolved as generations of giraffes stretched their necks to feed on leaves at high level above the ground

Darwin's idea about evolution



Giraffes with long necks were born by chance and had more offspring due to their competitive advantage over those with short necks

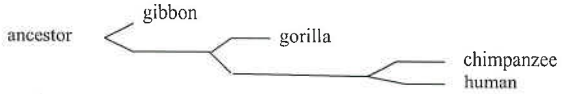
(a) Put a '✓' in the appropriate box to indicate whether the ideas listed were proposed by the scientists. You may put more than one '✓' for each idea. (2 marks)

	Lamarck	Darwin
Characters acquired during life time can be passed on to the next generation		
Organisms become more adaptive to the environment over the generations		

(b) Based on the current understanding of evolution, elaborate on the view of Darwin on the evolution of giraffe's long neck. (4 marks)

(c) In Darwin's era, his idea caused intense debates. The concept of humans evolving from common ancestors along with other species was unacceptable to many people due to their religious belief. What does this tell us about the nature of science? (1 mark)

(c) (i)



(ii) Assumption:
- the fewer the number of different amino acids, the closer the evolutionary relationship of the organisms (1)

Underlying biological principle
- each amino acid in a polypeptide is coded by a codon in the DNA (1)
- mutation in a codon would result in a different amino acid being incorporated in the polypeptide (1)
- organisms with closer evolutionary relationship would have fewer mutation (1) / more similar genetic code

(d) (i)
- the modern classification system is based on the phylogenetic relationship of organisms (1)
- organisms with some fundamental similarities are put into the same group (1)
- each group is then subdivided into smaller groups with organisms sharing more similarities going into the same subgroup, the lower the hierarchy, the closer they are linked in evolution (1)

(ii) - because class is a higher hierarchy than family (1)
/ same family, more similarities / same class, less similarities

AL -2010 2B

4. (c)
- when there is an increase in global temperature, arctic dogs with shorter hair length are at a selective advantage than those with longer hair length (1) / there is a higher selection pressure against those with longer hair length
- because those arctic dogs having longer hair length have a higher chance of being overheated (1) / arctic dogs having shorter hair length have a lower chance of being overheated
- over the generations, arctic dogs with shorter hair length have a higher chance of survival and reproduce (1)
- therefore, the mean hair length of the arctic dog population would decrease over time (1)

(4)

DSE - 2014

6. (a)
- dogs have many more copies of gene A in the genome than wolves (1)
- these genes will be transcribed into mRNA (1)
- which, in turn, translated into amylase, i.e. more amylase will be produced in dogs (1), resulting in higher amylase activity

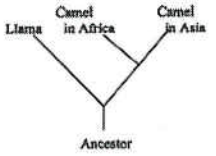
(3)

(b)
- (humans are omnivores,) the human food wastes usually contain carbohydrates such as starch (1)
- variations in copy number of gene A may exist in an ancient wolf population (1)
- those with higher gene copy numbers could produce more amylase and were more adapted to a starch-rich diet of human food waste (1)
- as wolves got used to feeding on human food wastes and gradually domesticated, they could then grow better & reproduce more than those with smaller gene copy number (1)
- their genes, including multiple copies of gene A could be passed to the **next generation (1),** resulting in the selection of multiple copies in the dogs' genome

(5)

HKDSE – 2015 1B

10. (a) Labeling (1)
Correct tree (1) 2



(b) separation of the continents resulted in isolation of the two groups of ancestors (1)
each isolated group was subjected to a different set of environmental conditions (1)
as a result, they evolved differently from each other due to natural selection (1) / adaptive traits specific to those particular environmental conditions were selected by natural selection
until their genetic compositions were so different that they could not interbreed again (1) 4

(c) compare their genetic compositions / biochemical compositions of essential proteins 1

(d) Any *two* of the following:
- not all organisms could be fossilized (1)
- Some fossils are incomplete / damaged (1) / the fossil may contain only part of the body rather than the whole organism
- some fossils are found in inaccessible areas (1)
- there are missing links in the fossil records (1) 2

HKDSE – 2018 1B

10. (a)

	Lamarck	Darwin
Characters developed during life time can be passed on to the ...	✓	
Organisms become more adaptive to the environment over generations	✓	✓

(2)

(b)
- genetic variation existed in the giraffe population, some with longer necks and others with shorter necks (1)
- individuals with longer necks has better ability to obtain food / could get more food than those with shorter necks (1)
- they have greater chance to survive and reproduce (1) (4)
- thus the population of the subsequent generations would have a greater proportion of giraffes with longer neck (1)

(c) - science is culturally embedded / influenced by social and cultural factors (1) (1)

6 marks

HKDSE – 2019 1B

8. (a) (i) • sight is not the sense used by bats when they avoid obstacles (1) (1)

(ii) Any *two*:

Nature of Science	Elaboration
Science is based on evidence from experiment	Spallanzani and Jurine could not provide sufficient evidence to show how bats navigated / scientists did not accept that ats use hearing for navigation until Griffin showed that bats could emit ultrasounds (1)
Scientists build on the work of other scientists	Griffin used Pierce's apparatus to show bats emitted ultrasounds / Griffin built on Spallanzani and Jurine's work, and showed that bats emitted ultrasounds, providing important evidence for the navigation (1)
Technology has impact on the development of science	Griffin could not have proved that bats emitted ultrasounds without Pierce's apparatus (1)

(2)

(accept other reasonable answers)

(b) (i) • the procedures of cutting & gluing back the wing tail itself did not affect the rate of successful escape (1)
• this shows that the results of C / D were related to the length of the wing tail and not related to the manipulation procedures (1) (2)

(ii)

Pair of treatments	Conclusion
A&C	• Removing / shortening the wing tail reduced the rate of successful escape (1)
A&D	• Elongating the wing tail enhanced the rate of successful escape (1)

(2)

(iii) • the data show that the longer the wing tail, the higher the rate of successful escape (1) (1)

(c) • within the moth population, there were genetic variations with some individuals having long wing tails and others having short wing tails (1)
• individuals with long wing tails had a higher chance of escape from the attacks of bats than individuals with short wing tails (1)
• therefore, individuals with long wing tails had a higher chance of survival and reproduced more offspring (1)
• after many generations, offspring which inherited the allele for long wing tails became the majority in the population (1) (4)

12 marks