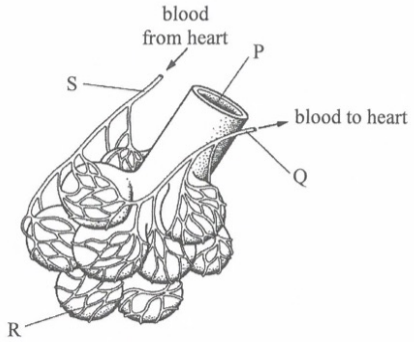
2022

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

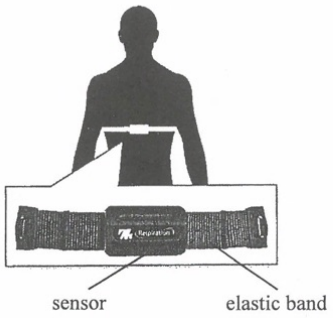
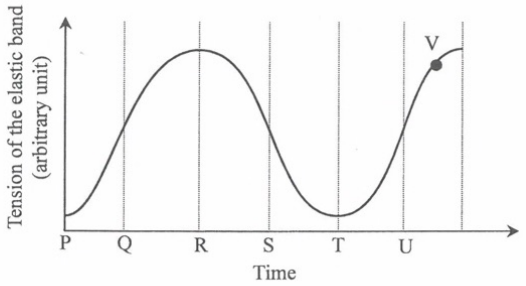


Diagram II



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.

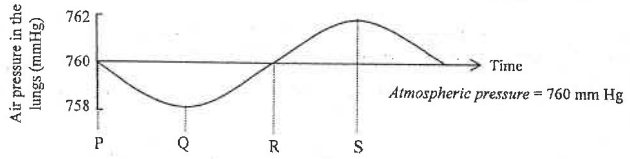
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

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:



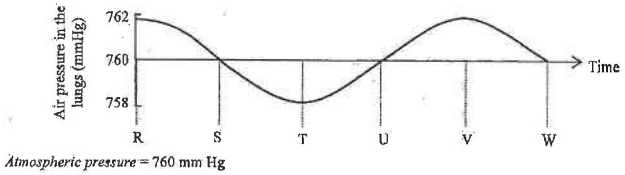
At which point of time on the graph is the volume of the lung the largest

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:

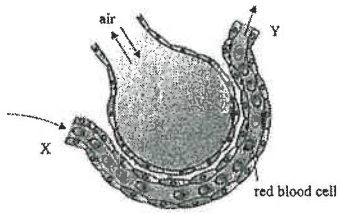


His diaphragm muscles are in a state of contraction during the period

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%)

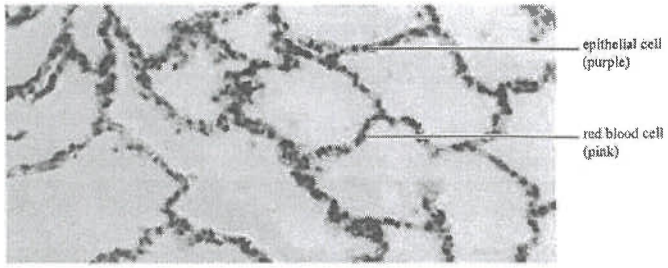
Which of the following organs are protected by the rib cage?

(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

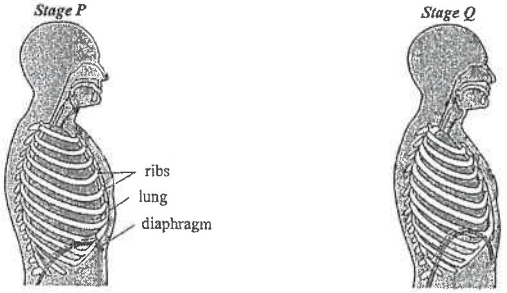
2012 Q.22 (82%)

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)

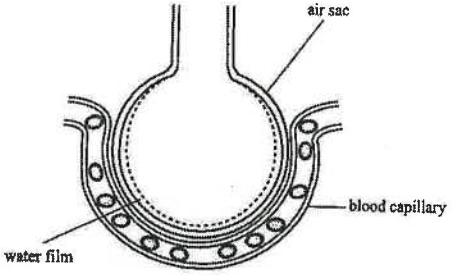
(iv) Suggest why it is necessary to do the following when carrying out mouth-to-mouth ventilation:

(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)

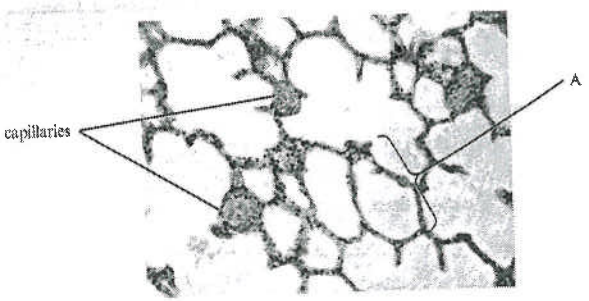
(ii) SARS patients may have fluid accumulated in the air sacs. Explain how the accumulation of fluid may affect the oxygen content of the blood of the patients. (3)

(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

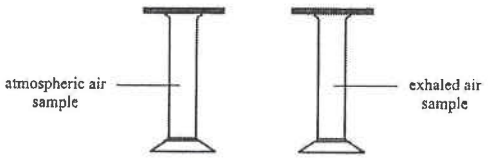
4. The photomicrograph below shows a section of a mammalian lung:



(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:

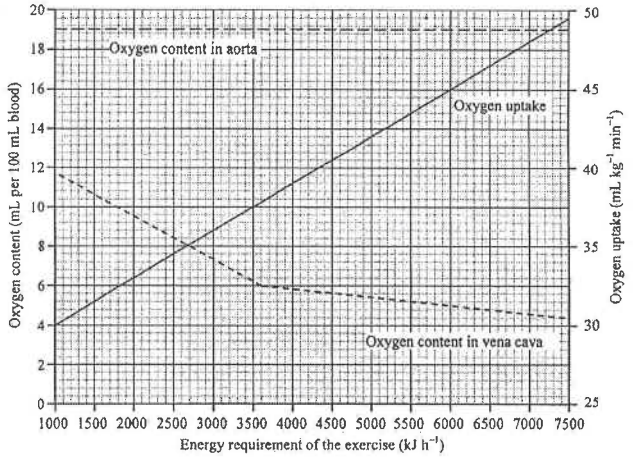


(i) Draw a labeled diagram to show a sep-up that can be used to collect the air exhaled from his lungs. (4)

(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)

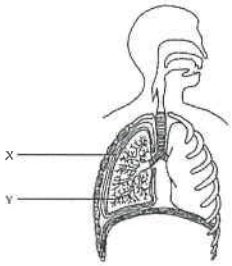
(iii) The energy requirements for running and cycling leisurely are 3600 kJ h^{-1} and 1800 kJ h^{-1}. Calculate the difference in the blood oxygen content between the aorta and the vena cava for each type of exercise. (2)

(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.



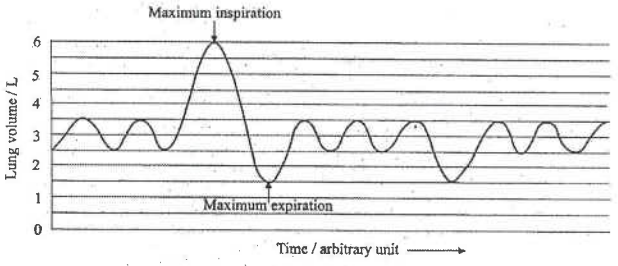
(a) Name structure X and describe its function. (3)

(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

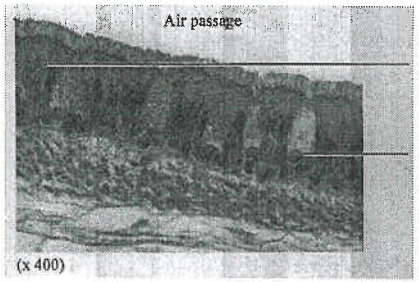
6.



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)

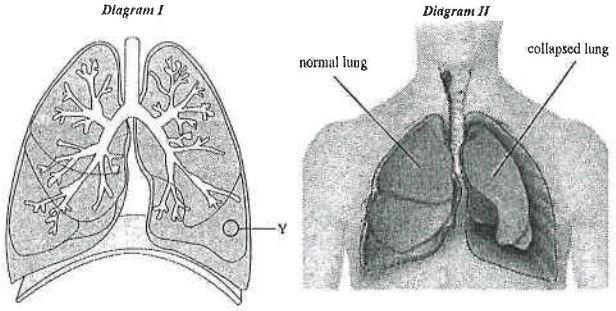
HKDSE – 2016 1B

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)

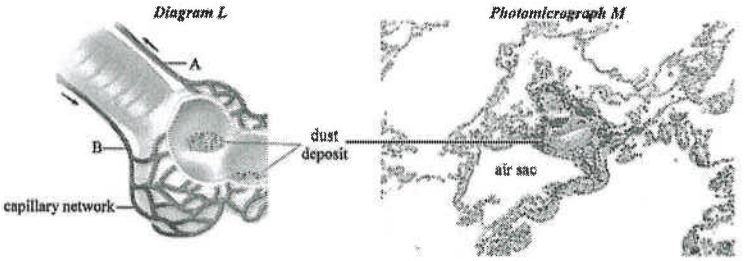
b. In the following diagrams, Diagram I shows some structures of a human lung while Diagram II shows a collapsed lung if it is ruptured at location Y:



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

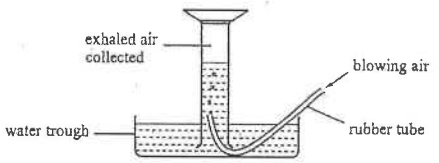
CE - 2005 Q.4

(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