SAMPLE TEXTBOOK ANSWERS

Chapter 8 The respiratory system

The following are sample answers only. Other answers to the same questions may also be correct.

Science inquiry

Activity 8.1 Structure of the lungs

1 Identify the structures that can be seen:

a the lungs themselves divided into a number of lobes

b the trachea with its rings of cartilage; examine the rings to see whether they form a complete circle

Answer: The rings do not form a complete circle. They extend about two-thirds of the way around the trachea with a gap at the rear.

c the two bronchi that branch from the trachea

d the thin transparent membrane that covers the lungs.

2 Squeeze the lungs between your thumb and a finger. Describe what you feel.

Answer: The lungs should feel soft and spongy.

3 Cut off a piece of lung and place it in a beaker of water. Does it float? What does this tell you about the lung?

Answer: Pieces of lung do float, indicating that the lung tissue contains a lot of air.

4 Cut open the trachea and observe the interior. Record your observations.

Answer: The rings of cartilage can be clearly seen on the inside of the trachea. They are very elastic.

5 Continue the cut in the trachea down through one of the bronchi, then through a secondary bronchus. Keep cutting until the air tubes become too small to see. Do the secondary bronchi have rings of cartilage? As you go along the air tubes from large to small, where do the cartilage rings stop?

Answer: The cartilage rings continue from the trachea into the main bronchi. In the secondary bronchi the cartilage becomes irregular and the cartilage is in the form of plates rather than rings.

Activity 8.2 Investigating breathing

- Propose a hypothesis that links the two variables – some aspect of breathing and the factor that you have selected.
  Answer: For example, students may choose hypotheses that relate to:
  - the rate of breathing versus exercise
  - the volume of expired air in a person who suffers from asthma compared with that of a person with normal airway function
  - the effect of posture on breathing rate or volume; for example, lying down compared with standing up.
- Design an experiment to test your hypothesis.
  Answer: See *Designing experiments* on page 18. Ensure that as many variables as possible are controlled so that the experiment is a fair test. Design the experiment so that the results will clearly either support or disprove the hypothesis being tested.

Review questions

1 List the characteristics of the lungs that make them well suited for gas exchange.

Answer:

- The alveoli give the lungs a huge internal surface area so that large amounts of gases can be exchanged in a relatively short time.
- Each alveolus is well supplied with blood vessels so that as much blood as possible is close to the air in the alveolus.
- Continuous flow of blood maintains a gas concentration difference between the air in the alveoli and the blood.
- The membrane that forms the wall of the alveolus is very thin, so that gas molecules do not have far to travel to move into or out of the blood.
- The lungs are positioned deep inside the body to prevent excessive evaporation of the fluid that covers the respiratory surfaces. It is important that the membrane of the alveolus be covered by a thin layer of moisture, because gases can diffuse into and out of the blood only when they are dissolved in fluid.
- Lung volume can be changed by respiratory muscles so that air is moved in and out of the lungs.

2 Why is it that, in the lungs, oxygen diffuses into and carbon dioxide out of the blood, whereas in other body tissues oxygen diffuses out of and carbon dioxide into the blood?

Answer: Diffusion occurs because of differences in concentration. The concentration of oxygen in the air breathed in is higher than the concentration in the alveolar blood, so it diffuses from the air into the blood. The opposite is true of carbon dioxide. In the tissues, the concentration of oxygen is lower than in the blood, so oxygen diffuses from the blood into the cells. Again, the opposite is true for carbon dioxide, because the cell produces large amounts of carbon dioxide as waste from cellular respiration.

3 a Draw a diagram showing inspiration. As labels for your diagram, list the sequence of events that occur in inspiration.

Answer: Refer to Figure 8.5a on page 101.
The drawing and labels should show that the:

- diaphragm contracts so that the chest cavity is enlarged downwards
- rib muscles contract, so that the rib cage moves up and out
- air pressure is now lower in the lung because of the larger volume
- air flows from higher pressure outside the lungs to lower pressure inside.

b Draw a diagram showing expiration. As labels for your diagram, list the sequence of events that occur in expiration.

Answer: Refer to Figure 8.5b on page 101.
The drawing and labels should show that the:

- diaphragm relaxes and curves upwards so that the chest cavity becomes smaller
- rib muscles relax so that the rib cage moves down and inwards
- air pressure is now higher in the lung because of the smaller volume
- air flows from higher pressure inside the lungs to lower pressure outside.

4 a Why is a concentration gradient important for the exchange of gases?

Answer: Movement of gases into and out of the blood occurs by diffusion, which can only occur when there is a concentration difference; gases diffuse from a region of higher concentration to one that is lower.

b Explain how a concentration gradient for oxygen and carbon dioxide is maintained between the blood and the air in the alveoli.

Answer: The concentration gradient for oxygen and carbon dioxide is maintained by the following mechanisms:

- Blood flows constantly through the capillaries. As the blood flowing through the capillaries around each alveolus picks up oxygen and loses carbon dioxide, it is replaced by more blood pumped into the capillaries. This 'new' blood is low in oxygen and high in carbon dioxide so that the concentration gradient is maintained.
- Air moves in and out of the alveoli as we breathe in and out. The air that has picked up carbon dioxide from, and lost oxygen to, the blood is replaced by 'new' air with each breath. The 'new' air is low in carbon dioxide and high in oxygen.

5 a Describe how oxygen is carried in the blood.

Answer: 97% of the oxygen is carried in the red blood cells. It is combined with haemoglobin in the form of oxyhaemoglobin. The other 3% is dissolved in the blood plasma.
Refer back to Chapter 7, page 77.

b Describe how carbon dioxide is carried in the blood.

Answer: 70% of carbon dioxide is carried in the plasma as bicarbonate ions.
22% is carried in the red cells combined with haemoglobin as carbaminohaemoglobin.
8% is dissolved in the plasma.
Refer back to Chapter 7, page 78, Table 7.1.

6 Describe precautions that you can take to reduce your risk of developing emphysema or lung cancer.

Answer: The greatest risk factor for lung disease is smoking, so do not smoke.
Exposure to asbestos fibres and some chemicals also increase the chances of getting lung cancer, so wear a face mask in situations where these materials are likely to be present.

7 Describe the types of lung damage that can be caused by smoking.

Answer: Smoke irritates the mucous membranes lining the air passages causing excessive production of mucus.
Accumulating mucus cannot be removed and the trapped mucus causes alveoli to rupture, resulting in emphysema. This reduces the surface area available for gas exchange so that breathing becomes difficult.
Cancerous growths may develop in the lungs or air passages.
Secondary tumours may occur in other parts of the body.

8 Why does pneumonia often cause difficulty in breathing?

Answer: Inflammation caused by pneumonia results in fluid being secreted into the alveoli. This reduces the amount of air the alveoli can contain so that the body cannot get enough oxygen to maintain normal body functioning.

Apply your knowledge

1 To be effective, any surface where materials are taken into the body, or passed out of the body, must have a very large surface area. For the lungs, explain how a large surface area is achieved.

Answer: In the lungs a large surface area is achieved by having clusters of alveoli at the end of each bronchiole. The massive quantity of alveoli and the huge surface area they provide – compared with the small volume of air contained – make gas exchange in the lungs very efficient.

2 The exchange surfaces of the lungs rely on concentration differences so that substances diffuse across the surface. Explain how the concentration difference is maintained.

Answer: Blood flows through the capillaries around the alveoli, so that blood low in oxygen and high in carbon dioxide is constantly brought close to the air in the alveoli.
Air moves in and out of each alveolus as breathing occurs, so that air low in carbon dioxide and high in oxygen is constantly supplied.

3 If air enters the chest cavity through a puncture wound to the chest wall, the lung may collapse. As the collapsed lung is no longer attached to the chest wall, air cannot be made to move into and out of the lung. However, a person with a collapsed lung can function fairly normally.

a Explain how it would be possible for such a person to function in a fairly normal way.

Answer: The internal surface area of the lungs greatly exceeds that required for exchange of gases for normal activity. Thus, the surface area of one lung is sufficient.

b Would there be any activities that such a person would not be able to perform?

Answer: A person with only one functioning lung would not be able to engage in strenuous activity because the internal surface of one lung would not be sufficient to supply the increased demand for oxygen or to remove the increased amount of carbon dioxide produced.

4 Students measured the breathing rate and depth of breathing of a girl before and after exercise. Their results are shown in Table 8.2.

Answer:

Table 8.2 Breathing rate and depth before and after exercise

	Breaths per minute	Volume of air per breath (cm^3)
At rest	19	460
After running	38	1075

a Calculate the total volume of air that the girl breathed in 1 minute before and after exercise.

Answer: Before exercise: $= 19 \times 460 = 8740\,cm^3$ or 8.74 litres

After exercise: $= 38 \times 1075 = 40850\,cm^3$ or 40.85 litres

b What is the reason for the increase in rate and depth of breathing after exercise?

Answer: The increased rate and depth of breathing would have continued after exercise because the girl had incurred an oxygen debt caused by muscles respiring anaerobically (see page 68).

c Describe the changes that would occur in the body to bring breathing back to the normal resting level after exercise.

Answer: The oxygen debt would have to be repaid. This would occur in the liver where lactic acid produced by anaerobic respiration is converted back to glucose.

5 The ability to voluntarily control breathing is important when speaking, but it is also important when eating or drinking. Explain why this is so.

Answer: When swallowing, the epiglottis closes off the trachea so that food and drink cannot enter the lungs and are instead directed down the oesophagus. (See Figure 8.2 on page 99.) Thus, it is important to control breathing while eating or drinking.

6 List five occupations in which people could be at risk of contracting emphysema. What precautions could be taken to reduce the risk of workers contracting the disease?

Answer: Any five of:

- timber mill workers
- chemical plant workers
- miners
- outdoor workers in cities that have high atmospheric pollution
- hospitality workers where smoking is allowed
- people working in smoky environments; for example, fire fighters.

Other correct occupations may be listed by students – evaluate on a case-by-case basis.
Reduce risks by (for example):

- wearing masks/breathing apparatus
- reducing daily exposure
- installing extraction fans
- prohibiting smoking in areas where non-smokers are likely to be affected.

7 In expired air resuscitation (mouth-to-mouth resuscitation), air from the rescuer's lungs is blown into the patient's lungs. How is expired air able to keep the patient alive? (Refer to Table 8.1 on page 102.)

Answer: Expired air still contains 15.8% oxygen. Considering the lungs only take approximately 5% from inspired air anyway, this is an adequate amount to sustain life.