# 8C
# Breathing and respiration

**Under the broad theme of water sports, this unit covers gas exchange in humans and other organisms, together with details of aerobic and anaerobic respiration in humans.**

*Recommended teaching time for unit: 7.5–10 hours*

There is an opportunity for focused development of Working Scientifically skills in Topic 8Cb and of Literacy & Communication skills in Topic 8Cc. You may wish to spend additional time on these units should you feel that your students would benefit from these skills-development opportunities.

From Year 7, most students should be able to:

- recall how cells, tissues, organs and organ systems are related (7A)
- describe how some cells are adapted for certain functions (7A, 7B, 7C)
- recall that respiration and breathing are not the same (7C)
- describe how certain drugs affect the body (7C)
- describe how the circulatory system carries food and oxygen around the body (7C)
- describe diffusion (7G)
- explain the concept of air pressure (7G).

**Topic 8Ca** starts with a look at why humans need air and how the discoveries of Boyle, Mayow, Priestley and Lavoisier helped to shape our modern understanding of aerobic respiration.

**Topic 8Cb** looks in more detail at the human gas exchange system, including how breathing occurs and the importance of surface area in gas exchange. A Working Scientifically spread, which shows how ranges and means are calculated, follows this, and will help students to process results from practical work on the effects of exercise on breathing and pulse rates.

**Topic 8Cc** considers the role of blood in transporting oxygen to tissues and how a lack of oxygen can affect cells. This is followed by a Literacy & Communication spread on writing different types of paragraph.

**Topic 8Cd** looks at gas exchange in other organisms, including plants. The various ways in which respiration can be detected is also covered.

**Topic 8Ce** focuses on anaerobic respiration, including the concept of EPOC (oxygen debt).

## National Curriculum coverage

This unit covers the following statements from the UK National Curriculum for Science (2013):

- the role of diffusion in the movement of materials in and between cells
- the structure and functions of the gas exchange system in humans, including adaptations to function
- the mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume
- the impact of exercise, asthma and smoking on the human gas exchange system
- the role of leaf stomata in gas exchange in plants
- aerobic and anaerobic respiration in living organisms, including the breakdown of organic molecules to enable all the other chemical processes necessary for life
- a word summary for aerobic respiration
- the process of anaerobic respiration in humans and microorganisms, including fermentation, and a word summary for anaerobic respiration
- the differences between aerobic and anaerobic respiration in terms of the reactants, the products formed and the implications for the organism.

N.B. Statements in grey are covered in another unit (8D).

In addition to covering a variety of Working Scientifically statements, this unit has a focus on:

- understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review
- apply mathematical concepts and calculate results.

### Literacy & Communication skills

- information can be presented in different ways to communicate scientific ideas clearly. This includes understanding how sentences can be constructed to show cause and effect.

### Maths skills

- identify the ranges of readings in data
- explain why data with a small range is of good quality
- calculate means and explain their use
- identify anomalous results in data.

## Cross-disciplinary opportunities

8Ca – Chemistry 8Ea – combustion
8Cb – Physics 8Ic – pressure in fluids
– Biology 8Ae – surface area

## Cross-curricular opportunities

8Cb – PE – effects of exercise on pulse and breathing rates
8Cc – History – use of chemical weapons, for example, in the First World War

## 8C Background information

### 8Ca Water sports and breathing/Aerobic respiration

During respiration, energy is released from a sugar called glucose. There are different types of respiration in humans (see Topic 8Ce), but aerobic respiration requires oxygen and happens in special organelles in the cytoplasm of cells called mitochondria. Cells that require a lot of energy, for example muscle cells and sperm cells, contain more mitochondria than less active cells.

As energy is not a substance it should not be referred to as a product of respiration. The energy released in respiration is not used instantly, but is stored in a molecule called ATP until it is needed, i.e. the energy is transferred from the glucose to ATP. This level of detail, though, is not required for KS3.

The energy released in respiration is used for movement and for biochemical reactions within the body. In mammals and birds a lot of the energy is transferred by heating, which helps to maintain a constant body temperature.

The word equation for aerobic respiration shows that the reactants are glucose and oxygen, and the products are carbon dioxide and water.

glucose + oxygen → carbon dioxide + water

The September 2013 National Curriculum omits the term 'word equation' from biological reactions, and uses the term 'word summaries'. The reasons for this are that biological 'reactions', such as aerobic respiration, are a series of reactions and not just one. Furthermore, some authors will add 'energy' into a summary, but word equations do not show energy. We have continued to use the term 'word equation' whilst pointing out that these are summaries of what happens. All reactions proceed via a series of intermediate steps that are not shown in word equations. Word equations are only designed to show the reactants and products of a process. For this reason, energy is not shown in our word equation summaries, since that can introduce the misconception that energy is a reactant or product (not being a substance, it cannot be either).

Although the word equations for aerobic respiration and burning are the same, glucose *does not* burn inside cell mitochondria. A series of reactions take place and the rate of each reaction is carefully controlled by enzymes. Heating cells damages the enzymes and so biochemical reactions stop. Various chemicals also inhibit enzyme activity (for example, cyanide compounds) and cause biochemical reactions, such as respiration, to stop.

### 8Cb Gas exchange system/Means and ranges

There are various terms used for the gas exchange system, including breathing system and respiratory system. Gas exchange system is the terminology used by the National Curriculum and so is used in this course. The term 'respiratory system' is the least useful because it can contribute to confusion about the difference between respiration and breathing.

Breathing is a process involving muscles that change the size of the thorax. Respiration is a cellular process that releases energy. The term 'ventilation' describes the movement of air into and out of the lungs. So, the lungs are ventilated by breathing.

The gas exchange system is the set of organs involved in getting oxygen into the blood and carbon dioxide out of it (gas exchange). This includes the lungs, trachea, bronchi, the muscles attached to the ribs and the diaphragm.

Gas exchange is facilitated by the walls of the alveoli in the lungs and the walls of the capillaries surrounding the alveoli. Both are only one cell thick so that gases can diffuse quickly between the two. The alveoli are designed to increase the surface area of the lungs and so allow diffusion to occur more rapidly.

The calculation of ranges and means is a simple way of processing data. A small range in a set of repeated readings tells an experimenter that the readings are precise measurements and therefore of good quality. It also tells an experimenter that there is a lack of error.

Means are used to estimate a more accurate value for a measurement. Repeated readings will always vary to some extent, but taking many readings and finding a mean can obtain a value that takes account of this variation. Datasets with large ranges produce less good estimates of a true value using a mean than do datasets with small ranges.

### 8Cc Getting oxygen/Cause and effect

Oxygenated blood from the lungs flows back to the heart, from where it is then pumped around the rest of the body. Arteries lead away from the heart and veins carry blood back towards the heart. Most arteries carry oxygenated blood, whilst most veins carry deoxygenated blood. The exceptions are the arteries and veins to and from the lungs, in which the reverse is true.

There are about 5 000 000 red blood cells (or erythrocytes) per cubic millimetre of blood. Red blood cells carrying oxygen are bright red in colour. Those not carrying oxygen are a much duller dark red. This is the source of some confusion since veins look blue underneath the skin, whilst arteries look purple. Differences in tissue structure in veins and in the surrounding tissue cause more blue light to be reflected, which makes veins under the skin appear blue – but they are not blue in dissections. To avoid misconceptions, the veins are shown in a browny-red colour in the Student Book and not in blue.

Unlike most cells, mammalian red blood cells do not have nuclei when mature. This allows them to be packed full of an iron-rich substance called haemoglobin, which carries oxygen. Human red blood cells last about 120 days before being destroyed in the liver and spleen, and some of their component parts are recycled. They have a bi-concave shape, which increases their surface area so that gases diffuse in and out of them quickly.

Carbon dioxide is mainly carried by the blood as hydrogen carbonate ions dissolved in the straw-coloured fluid that surrounds the blood cells (the plasma). Only about 7% is dissolved as actual carbon dioxide in the plasma. And about 23% is actually carried by the red blood cells (which is not mentioned in the student materials).

When oxygenated blood reaches the network of capillaries found in a tissue, oxygen from red blood cells dissolves

into the blood plasma. The plasma then leaks out of the capillaries as 'tissue fluid', providing the cells with oxygen and nutrients (including glucose). The Student Book simplifies things and makes no mention of the lymphatic system, which is well beyond the scope of KS3.

Diseases or lifestyle choices causing high blood pressure (for example, smoking, high cholesterol consumption) can lead to artery walls weakening. Arteries may split (haemorrhage) and narrowed blood vessels may become obstructed by a blood clot (thrombosis). If either of these occurs in the head, it is called a stroke. In the blood vessels supplying the heart muscle, it causes a heart attack, because the heart muscle cells do not get enough oxygen and start to die.

Smoking also causes various problems with lungs. The heat and chemicals from cigarette smoke paralyse the cilia. These are constantly-moving hair-like structures that sweep mucus out of the lungs. The mucus contains particles. If the cilia do not move, the mucus gets trapped in the lungs. Not only does this increase the likelihood of infection, but the mucus also coats some of the surfaces used for gas exchange, reducing the surface area.

The fine particles in smoke can cause emphysema. The particles inflame the walls of the alveoli, causing them to lose their elasticity. (Normally, when you breathe out, the elastic walls of the alveoli help to expel air, rather like inflated balloons.) Once alveoli have lost their elasticity, carbon dioxide-rich air gets trapped inside them causing them to remain overstretched. If this occurs over a period of time, the alveoli rupture forming large air pockets. This reduces the surface area of the lungs still further.

Prolonged exposure to dust can also cause emphysema and also pneumoconiosis. In this disease, dust gets trapped in the lungs in aggregations that cause inflammation and fibrous tissue to form. Slowly, this starts to kill the lung tissue. Coalminers are particularly susceptible to this.

### 8Cd Comparing gas exchange

The reactants in respiration are glucose and oxygen. The products of respiration are carbon dioxide and water. The carbon dioxide is excreted from the body via the lungs. Limewater or hydrogen carbonate indicator can be used to show the increased amount of carbon dioxide in exhaled air compared with inhaled air. The colour change of hydrogen carbonate indicator is related to the acidity of carbon dioxide gas in solution. The more yellow it appears, the more carbon dioxide is present.

The water produced by respiration tends to stay in the cell, or, if it is not needed, it is released into the tissue fluid and then into the bloodstream. The lungs need to be kept moist so that oxygen can dissolve in the water before diffusing into the blood. Evaporation of water from the respiratory surfaces can be a problem for terrestrial mammals living in dry areas.

The release of energy by organisms and the associated temperature rise can also be used to show respiration. However, dead and decaying organisms will also show a temperature rise due to the respiration of microorganisms involved in the decay process. This is why compost heaps are warm.

Small organisms, such as amoebae, absorb oxygen and excrete carbon dioxide by diffusion across their cell membranes. They have no special organs for gas exchange. Plants use simple diffusion through pores called stomata. Insects have a system of branching tubes called tracheae. Air enters the tracheae through tiny holes called spiracles found along the surface of the insect. The tracheae end in fine tubes called tracheoles that penetrate all the tissues. The tracheoles have thin moist walls for gas exchange. Amphibians carry out simple diffusion across their moist skin and mouth cavity. Their skin is kept moist with mucus secreted from glands in the skin. When the animal is active and needs more oxygen it takes a large gulp of air, which it forces into its lungs. In fish, water flows into the mouth and is forced over the gills. Exchange of gases occurs, and the water flows out through the opercular opening. The flow of water is maintained by the opening and closing of the mouth and flapping of the operculum in bony fish.

### 8Ce Anaerobic respiration/Fitness training

There are two sites of respiration in human cells – the cytoplasm and the mitochondria. Glucose is broken down into a molecule called pyruvate in the cytoplasm of cells. A small amount of energy is released (enough to produce two molecules of ATP for each glucose molecule – see Topic 8Ca above). This cytoplasmic process does not require oxygen. The pyruvate is then broken down further in the mitochondria, into carbon dioxide and water, and it is this process that requires oxygen. Another 26 molecules of ATP are produced in this series of mitochondrial reactions. Aerobic respiration is the complete breakdown of glucose by a cell, using oxygen. It releases 16.1 kJ of energy per gram of glucose.

If there is not enough oxygen (such as when doing strenuous exercise), then some of the pyruvate in the cytoplasm is converted into lactate (lactic acid). When this happens we refer to it as anaerobic respiration. It releases much less energy, only 0.8 kJ per gram of glucose.

It used to be thought that the build-up of lactate/lactic acid in the muscles caused muscle fatigue. More recent research has suggested that it has the opposite effect, and allows muscles to carry on working for longer. Instead, muscle fatigue may be caused by a build-up of potassium ions outside the muscle cells, which reduces the ability of the muscle fibre to contract quickly (so-called 'muscle depolarisation').

Excess lactic acid/lactate is removed from cells. A lot of it is broken down in the liver. This requires energy from aerobic respiration and so there is a requirement for additional oxygen – part of the cause of EPOC (excess post-exercise oxygen consumption).

Other reasons for EPOC include the replacement of oxygen in the red blood cells. In addition, muscle cells contain a substance called myoglobin, which also stores oxygen, and so, after hard exercise, these stores also need to be replenished. Additional oxygen is also required after hard exercise due to the increased activity of the heart and breathing muscles (requiring increased levels of respiration). It is the multi-factorial nature of EPOC that is the reason why this term is now preferred, rather than the older 'oxygen debt'.

# 8Ca
# Aerobic respiration

This grid shows the basic concepts met in this topic, together with a scheme of cognitive progression for each concept. Opportunities to cover learning and progression are given. Working Scientifically concepts are integrated throughout the materials.

| Conceptual statement | Cognitive progress | | | | | |
|---|---|---|---|---|---|---|
| | Remembering (a) | Understanding (b) | Applying (c) | Analysing (d) | Evaluating (e) | Synthesising & creating (f) |
| Aerobic respiration releases energy from glucose using oxygen. | Recall what happens in aerobic respiration. | Describe how respiration can be detected using [limewater, hydrogen carbonate indicator, temperature].<br><br>Explain how aerobic respiration can change the surroundings. | Model aerobic respiration using a word equation. | Compare burning (combustion) and respiration. | Evaluate the use of a word equation to model aerobic respiration. | |
| Organisms need energy for activities, such as movement. | Recall what happens in respiration. | | | Compare respiration in plants and animals. | | |

**Objectives**
Developing:

1. Recall what happens in respiration (in terms of needing oxygen to release energy from food and producing carbon dioxide).
2. Recall what happens in aerobic respiration (in terms of oxygen and glucose being used up).
3. Explain how aerobic respiration can change the surroundings.

Securing:

4. Model aerobic respiration using a word equation.
5. Compare burning (combustion) and respiration.

Exceeding:

6. Evaluate the use of a word equation to model aerobic respiration.

## Student materials

**Be prepared**
Exploring 1 may need a smartphone pulse oximeter app.

Explaining 2: There is an opportunity to use a video clip from a medical drama, where oxygen 'sats' are mentioned.

### STARTERS

**1: Quick Quiz**
**Developing/Securing/Exceeding**
**BA**
Use the 8C Quick Quiz for baseline assessment. Students can use the 8C Quick Quiz Answer Sheet to record their answers. You could use all of the Quick Quiz as a starter for the whole unit and then at the end of the unit to show progress. Or, you could just use the first four questions, which relate to this topic. These questions could be revisited formatively in a plenary for this topic. You could get students to identify areas that they are more confident in and those that need to be a focus during this topic. See the ASP for more information about Quick Quizzes. Advice on dealing with any misconceptions highlighted by this activity can be found in the Background information.

**Course resources**
**ASP:** 8C Quick Quiz; 8C Quick Quiz Answer Sheet.

**2: Digestion and respiration slides**
**Securing**
**BA**
This unit looks at the use of glucose in respiration, so it is helpful to start by reminding students of what they learned in Unit 8A (if this unit has been covered) and Unit 7C.

The AT interactive *Unit 7C revision* asks students to decide whether the definitions given for words used in Unit 7C are true or false, or allows them to choose 'unsure' if they don't know.

The AT interactive *Unit 8A revision* asks students to decide whether the definitions given for words used in Unit 8A are true or false, or allows them to choose 'unsure' if they don't know. Do not use this interactive if Unit 8A has not yet been covered.

*Developing:* Display the word cards one at a time. Ask students to hold up a certain number of pens to show how confident they are of the meaning. Five pens means 'I am absolutely certain', one pen means 'I'm not very sure at all'. Ask a random student with a medium number of pens to say what they think and then ask a student with a high number of pens to say how the definition could be improved. Then click through to the true/false question for the word and ask a student who originally showed a low number of pens to say whether the sentence is true or false and to explain why.

*Securing:* Ask students to work in groups to discuss each word as it is displayed and then to create true/false questions for each word. Ask different groups to submit their questions to the class and ask individual students to answer with explanations for their choices. This can either be done on a word-by-word basis or at the end when students have created sentences for all the words.

Correct misconceptions as they arise. Group the words into those that students are confident about and those that need further work. Use this information for planning appropriate scaffolding for ideas in the following lessons and review the lists at the end of the topic to monitor improvement.

**Course resources**
**AT:** Interactives *Unit 7C revision*; *Unit 8A revision.*

### 3: Why you need food and oxygen

**Securing**

**BA**

Ask students to write a list of reasons why they need food and oxygen. Some may need to be reminded that oxygen is a gas present in the air. Select students and ask them to submit ideas to the class. Write the list of ideas on the board – categorising these into some main 'key ideas'. Correct misconceptions as they arise, including use of the term 'transfer' when describing energy going from one place/thing to another. You can return to this list in Plenary 3.

## EXPLORING TASKS

### 1: Pulse oximeters

**Developing/Securing**

**Prac** **WS**

Students use pulse oximeters to measure oxygen saturation and pulse rate. There are a variety of things that can be explored using pulse oximeters, although it is recommended that students do not investigate the relationship between oxygen saturation and exercise until Topic 8Cc. Skills Sheets MS 3, PD 3 and PD 6 from the Year 7 Activity Pack could be useful for this task.

*Developing:* Students measure their own oxygen saturation levels and pulse rates and use them to compile group datasets (or a whole class dataset). Ask students to plot bar charts of the results for their group or challenge them to calculate the ranges and means of the readings. It may be worth going through 8Cb Means and ranges in the Student Book before students try this. Worksheet 8Ca-2 contains instructions on how to use a pulse oximeter.

*Securing:* Challenge students to use the oximeter to try to find out if there is a relationship/correlation between resting pulse rate and oxygen saturation. They should use scatter graphs to do this. Students should appreciate that the more data they have the more certain they can be about the existence of a correlation. They may be able to find a weak correlation – for example, the lower the oxygen saturation, the higher the pulse rate – but more often than not the correlation will not be obvious due to differences in each body.

*Exceeding:* Ask students to compare the results from the pulse oximeter with phone apps that claim also to be able to measure oxygen saturation.

⚠ Follow the manufacturer's instructions when using a pulse oximeter.

**Course resources**
**AP:** Skills Sheets MS 3 (Year 7); PD 3 (Year 7); PD 6 (Year 7). Worksheet 8Ca-2.

**Equipment**
Pulse oximeter, smartphone apps with a pulse oximetry function.

### 2: O2POW

**Securing**

**Lit**

Worksheet 8Ca-4 contains a spoof advert, such as you might find on the Internet, extolling the virtues of additional oxygen. Students are asked

to identify the scientifically correct statements and then answer further questions. Weaker readers will find it useful to work in groups, and to facilitate this the advert contains six main paragraphs, each of which contains one scientific fact. These facts are all correct, apart from the one in the last paragraph, which only mentions water as a product of aerobic respiration.

If students have studied the use of weighting and bias in writing (Topic 8Ab in the Student Book), encourage them to use strong adjectives and verbs to write their own adverts.

**Course resources**
**AP:** Worksheet 8Ca-4.

**Equipment**
Possibly poster paper and coloured pencils if students are to design their own posters.

**3: Combustion and respiration**
**Securing/Exceeding**

Worksheet 8Ca-3 provides a set of cards for students to cut up and sort into different groups, in order to compare combustion with aerobic respiration.

*Developing:* Ask students to work in groups to identify one phrase in each category from those shown. Then go around the room, asking random groups for a phrase in each category, correcting misconceptions as you go.

*Securing:* Use the sheet as set.

*Exceeding:* Give students the sheet with the sentences on the cards blanked out (you could leave the equation in place as a hint). Challenge students to add their own sentences to produce a sheet that could be used by others to fulfil the instructions at the top of the sheet.

**Course resources**
**AP:** Worksheet 8Ca-3.

## EXPLAINING TASKS

**1: 8Ca Water sports and breathing (Student Book)**
**Developing/Securing/Exceeding**
**BA**

The first page of the Student Book for this unit looks at ways in which people doing water sports get air for respiration. All the questions can be used for baseline assessment for concepts that will be met and extended in this unit.

The **AT** interactive *Unit 7C revision* asks students to decide whether the definitions given for words used in Unit 7C are true or false, or allows them to choose 'unsure' if they don't know. See Starter 2.

The **AT** interactive *Unit 8A revision* asks students to decide whether the definitions given for words used in Unit 8A are true or false, or allows them to choose 'unsure' if they don't know. See Starter 2.

**Course resources**
**AT:** Interactives *Unit 7C revision; Unit 8A revision*.

**2: 8Ca Aerobic respiration (Student Book)**
**Developing/Securing/Exceeding**
**FA**

This introduces the idea of aerobic respiration, refining previous definitions by making it clearer that oxygen is needed. This is presented in the context of the work and ideas of various scientists over time. Worksheet 8Ca-1 is the Access Sheet.

As a quick introduction to the page, find a clip on the Internet from a medical drama or fly-on-the-wall documentary in which doctors or paramedics refer to 'sats'. Ask students if they know what this means.

Question 6 is suitable for formative assessment, with students working on the question in groups.

The **AT** presentation *Respiration presentation* invites students to build a script associated with the respiration of glucose.

The **AT** presentation *8Ca Thinking skills* is also on aerobic respiration. See Plenary 2.

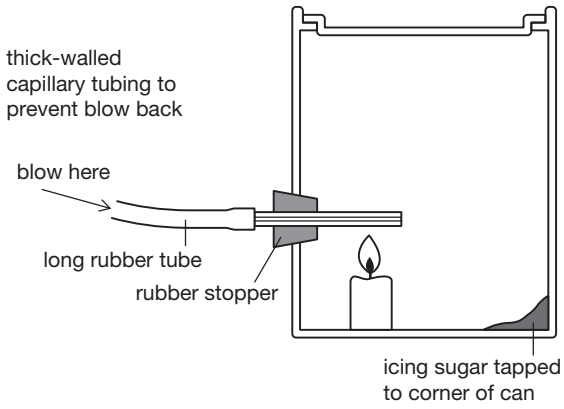
**Course resources**
**AP:** Worksheet 8Ca-1.
**AT:** Presentations *8Ca Thinking skills; Respiration presentation*.

**3: Combustion**
**Securing**
**Prac** **WS**

Show students these experiments to demonstrate that combustion is similar to respiration, but happens in a much less controlled way.

Ignite some granulated sugar on a deflagrating spoon and put it into a gas jar of oxygen to show the release of heat and light. Water vapour is also usually seen on the inside of the gas jar.

Make a tin can bomb as shown in the diagram. The can will need a tight-fitting lid. A sustained rather than a quick puff of air is needed to disperse the powder into a cloud inside the can. When the dust explodes the lid is blown off, dramatically demonstrating that energy is released when something burns.




Wear eye protection. A safety screen should be used for the 'bomb' experiment and students should be at least 2–3 m away.

**Equipment**
Gas jars of oxygen sealed with greased lids, deflagrating spoon, granulated sugar, tin can with lid, icing sugar, candle, thick-walled capillary tubing, long length of rubber tubing and stopper, eye protection, safety screen.

## PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

### 1: Quick Check

**Developing/Securing/Exceeding**

**FA**

*Assessment:* The 8Ca Quick Check sheet contains instructions and cards for a game.

*Developing:* Students play a game of snap that can be used to reinforce what they have learned during this topic.

*Securing:* The cards are used for a memory game. All the cards are turned face down and the students take it in turns to turn up two cards. If the two cards 'match' they are removed, but if they don't match they are turned back over. To make a 'match' one card must show a substance or energy and the other must describe that substance as 'reactant', 'product' or 'released' (for energy). Students need to check with members of their group whether they all agree that a match has been made and how they learned that this is a match (to get them to think about how they learned the topic material).

*Feedback:* Ask groups to say which substances (or energy) caused the most mistakes to be made.

*Action:* Ask students to attempt to write the word equation for aerobic respiration in pairs. Then ask for a volunteer to write this up on the board. Allow time for any corrections for students to clearly label reactants and products on their equations.

**Course resources**
**ASP:** 8Ca Quick Check.

**Equipment**
Scissors.

### 2: Thinking about aerobic respiration

**Developing/Securing**

**FA**

*Assessment:*
**Plus, Minus, Interesting:** Cells should be able to release energy from any type of food, not just glucose. (Possible answers: **Plus** – Our bodies would not need to waste energy on breaking down carbohydrates into glucose; **Minus** – The body might use up substances needed for other jobs (for example, cell repair); **Interesting** – Do all organisms respire in the same way? Some bacteria do not use glucose for respiration.)

**Odd One Out:** oxygen, glucose, carbon dioxide. (Possible answers: carbon dioxide is a product of respiration, the other two are needed for it; glucose is not a gas.)

**Odd One Out:** protein, water, glucose. (Possible answers: glucose is the only carbohydrate; water is the only liquid; protein is the only one that is not part of aerobic respiration.)

**What Was The Question:** aerobic. (Possible questions: What word means 'needing/with air/oxygen'?; What is respiration that requires oxygen called?; What sort of respiration do mammals use most of the time?)

*Feedback:* Students answer the thinking skills questions in groups, thereby feeding back their thoughts to one another. Ask students to write down their best answers and consider why they think they are the best.

*Action:* Ask a spokesperson from a number of groups to read out their best answers. Identify any ideas that are missing and share them with the class. If understanding is poor then revise the concepts using the Student Book. Review the features of a 'good answer' based on students' ideas in this activity.

The **AT** presentation *8Ca Thinking skills* can be used for this activity.

**Course resources**
**AT:** Presentation *8Ca Thinking skills*.

**3: Why you need food and oxygen revisited**
**Developing/Securing**
**FA**
Revisit Starter 3 and ask students to make corrections and/or additions to their lists of ideas. Make the link between their lists, the word equation for respiration, food and oxygen, and the energy transferred during respiration. Ask students to comment on how they have learnt about the things they are now adding to their lists.

## HOMEWORK TASKS

**1: Ideas about respiration**
**Developing/Securing**
Worksheet 8Ca-5 contains straightforward questions about aerobic respiration.

**Course resources**
**AP:** Worksheet 8Ca-5.

**2: La vie est une fonction chimique**
**Securing**
Worksheet 8Ca-6 contains questions about aerobic respiration, including interpretation of data. Ensure that students understand how to identify a trend from a graph before they tackle this sheet.

**Course resources**
**AP:** Worksheet 8Ca-6.

**3: Aerobic respiration and oximetry**
**Securing/Exceeding**
**WS**
Worksheet 8Ca-7 challenges students to use information to evaluate the use of a word equation to model aerobic respiration.

**Course resources**
**AP:** Worksheet 8Ca-7.

**ActiveLearn**
Three ActiveLearn exercises are available for this topic: Aerobic respiration 1; Aerobic respiration 2; Aerobic respiration 3.

# 8Cb
# Gas exchange system

This grid shows the basic concepts met in this topic, together with a scheme of cognitive progression for each concept. Opportunities to cover learning and progression are given. Working Scientifically concepts are integrated throughout the materials.

| Conceptual statement | Cognitive progress | | | | | |
|---|---|---|---|---|---|---|
| | Remembering (a) | Understanding (b) | Applying (c) | Analysing (d) | Evaluating (e) | Synthesising & creating (f) |
| The lungs are adapted for gas exchange. | Describe the structure of the lungs. | Explain how the lungs are adapted for efficient gas exchange. | | Compare the efficiency of gas exchange organs. | Explain how and why a concentration gradient is maintained for oxygen and carbon dioxide between the blood and lungs.<br>Identify the limitations of [lungs, gills, body surface covering] as sites of gas exchange. | |
| Breathing ventilates the lungs. | State the meaning of: breathing, breathing rate, ventilation, inhalation, exhalation. | Describe how muscles attached to ribs and the diaphragm produce breathing movements. | Use a knowledge of respiration and ventilation to explain why inhaled air differs from exhaled air.<br>Use a model to explain how lungs expand and contract. | Use a pressure model to explain ventilation.<br>Suggest reasons for differences in [lung capacity, tidal volume, vital capacity]. | | |
| The gaseous exchange or breathing system allows gases to enter and leave the blood. | [Identify, recall] the main [parts, organs] of the human [gaseous exchange, breathing] system.<br>State the function of: the [gaseous exchange, breathing] system. | Describe the functions of the main parts of the human gaseous exchange system.<br>Describe what happens during gas exchange. | [Suggest, explain] the effects of [diseases that affect, damage to] the [gaseous exchange, breathing] system.<br>[Suggest, explain] the effects of differences (e.g. in size or organs) between the gaseous exchange system in different people. | Compare the human gaseous exchange system with those of other animals.<br>Describe how gas exchange occurs in plants. | Identify the limitations of lungs, gills and body surface covering as sites of gas exchange. | Suggest how problems with the [gaseous exchange, breathing] system could be [overcome, treated]. |

**Objectives**
Developing:

1. Identify and recall the main organs in the human gaseous exchange system.
2. Correctly use the terms: breathing, breathing rate, ventilation, inhalation, exhalation.
3. Describe the functions of the organs in the human gaseous exchange system and what happens during gas exchange.
4. Describe how muscles attached to ribs and the diaphragm produce breathing movements and use a model to explain how lungs expand and contract.
5. Describe the structure of the lungs.
6. Explain how diffusion occurs in terms of movement of particles

Securing:

7. Use a pressure model to explain ventilation.
8. Explain how specialised cells keep the lungs clean (mucus production and ciliated epithelial cells).
9. Explain how the lungs are adapted for efficient gas exchange.

Exceeding:

10. Explain how and why a concentration gradient is maintained for oxygen and carbon dioxide between the blood and lungs.

**Focused Working Scientifically Objectives**
This topic provides an opportunity to focus on key Working Scientifically skills.

1. Identify the ranges of readings in data.
2. Explain why data with a small range is of good quality.
3. Calculate means and explain their use.
4. Identify anomalous results in data.

## Student materials

**STARTERS**

**1: Quiz time**
**Securing**
**BA**

Carry out a verbal quiz to revise the work of the last topic and the idea of pressure. Ask students to answer questions at random, but before giving you an answer they should tell you how confident they are of the answer on a Certainty of Response Index (CRI) scale (See Introduction) of one to five (where five is supremely confident and one is 'haven't a clue'). Correct misconceptions as you go and make a note of answers that are wrong and those that have low CRI scores.

Questions to ask: • What is the pulse rate a measure of? – heart beats per minute • What organ gets oxygen into your blood? – lung • What is meant by your 'breathing rate'? – number of breaths per minute • What does respiration release from glucose? – energy • Why does a mouse under a jar die? – it runs out of oxygen • Why do cells need energy? – to stay alive, to make new substances, to help us to move • Which cells make blood red? – red blood cells • What is the word equation for aerobic respiration? glucose + oxygen → carbon dioxide + water • Name the smallest blood vessels – capillaries • What do red blood cells do? – carry oxygen • What is the liquid part of the blood called? – plasma • What would you find dissolved in the blood plasma? – glucose, carbon dioxide, drugs and chemicals (and various other things like amino acids) • What does aerobic mean? – requiring air or oxygen • Where does most glucose enter the blood? – small intestine • What does 'excrete' mean? – to get rid of • What gas does your body excrete? carbon dioxide • What is a specialised cell? – a cell that has features that let it carry out a certain function • Give an example of a specialised cell – for example, sperm cell, muscle cell • What is the movement of air into and out of the lungs called? – ventilation • What is breathing? – the movement of muscles to increase and decrease the size of your chest • Name one place breathing muscles are found – diaphragm; on or between the ribs • When you suck on a straw, why does the liquid go into your mouth? – because you reduce the pressure inside the straw, and atmospheric pressure pushes the liquid into your mouth • Why does air come out of a blown-up balloon if you let go of it with the end untied? – the walls of the balloon push on the air inside, increasing the pressure. The pressure is more inside the balloon than atmospheric pressure and so air flows out of the balloon • What is surface area? – how big the area of something is if we spread it out flat • What is diffusion? – the movement of particles from a place where there are many of them to a place where there are fewer of them.

Discuss with students how they should build on their personal CRI scores. For example, help them to identify where these ideas will be revisited and built upon later in this unit.

**2: Thinking about breathing and respiration**
**Securing**
**BA**

Give groups of students the Odd One Out exercises below and ask them to work on them for a few minutes. Ask students which of the three they found the most difficult and why, and then ask random groups for suggested answers. Students should, by now, have a good grasp of the first two of these exercises, whereas the last one will be a challenge because of the unknown words (although consider providing a biology dictionary or the Student Book glossary for students to look these up).

**Odd One Out:** stomach, lung, windpipe/trachea. (Possible answers: the stomach is not part of the breathing system; the windpipe/trachea is the only one that is shaped like a tube; the windpipe/trachea is the only one that does not get bigger and smaller.)

**Odd One Out:** breathing, respiration, combustion. (Possible answers: combustion does not happen in living things; breathing is not a chemical reaction; respiration is the only one that a cell does.)

**Odd One Out:** alveolus, air sac, trachea, breathing, bronchus. (Possible answers: trachea is the only thing we have one of; breathing is not a part of the body/it is the only process.)

Extend this activity by asking students to make a concept map showing the links between all these words – they can categorise them in any way they find logical, as long as they can explain this. Students can compare concept maps to see some different ways that the ideas can be linked.

**3: Tell me three things**

**Developing/Securing**

**BA**

Ask students to work in groups to come up with three facts that they know about the gas exchange (breathing) system. After a few minutes, ask one group to suggest a fact, then ask another group 'Can you add a fact?'. Keep going until there are no more facts to add or time has run out (you could do this against the clock, telling the class that you're going to see how many correct lung facts they can tell you in one minute). Either correct misconceptions as they arise or note them down and go over them at the end of the starter.

You could run this as 'last one standing': so students all stand up once you start listening to their 'facts' and have to sit down if they can't think of a new one (or if their 'fact' is incorrect). Focus on supporting understanding of the facts that were only volunteered by the last group standing.

**4: Starters from other units**

**Developing/Securing**

**BA**

The starters from the other units listed here may also be useful: Topic 7Ca Starter 2; Topic 7Ge Starter 1 or 2; Topic 8Ic Starter 1, 2 or 3.

## EXPLORING TASKS

**1: Model lung**

**Securing**

**Prac** **WS**

Students construct a model that can be used to explain ventilation of the lungs caused by breathing muscles.

*Developing:* Students use Worksheet 8Cb-3 to construct their models. Rather than asking students to complete the rest of the questions on the sheet, ask them to prepare a short presentation to explain how their models show what happens during breathing.

*Securing:* Students follow the instructions on Worksheet 8Cb-3 and answer the questions. They should spot weaknesses in their models, such as lungs come in pairs, the diaphragm springs back to shape rather than needing to be pushed, the model does not show the contribution made by the muscles between the ribs.

*Exceeding:* Ask students to complete the 'optional extra' question at the bottom of Worksheet 8Cb-3 and to consider other models of breathing and ventilation. Give students models to compare: for example, the **AT** animation *Ventilation and muscle action*, which explains the process of inhalation and exhalation, the role of muscles in breathing and muscle action. There is another model in diagram A on Student Book spread 8Cb Gas exchange system (Mayow's model). The **AT** animation *Mayow's model of ventilation* shows Mayow's pressure model of ventilation, using bellows and a pig bladder. Further models are shown on page 41 of Exploring Science Student Book 7 and in Topic 7Ca Explaining 4 of the Year 7 TTPP.

Extend this work by replacing the bin liner with a piece of balloon to correct the 'exhalation' part of the model (although you will need a hard, thick bottle for this).

Reinforce this work by using the **AT** video *Pneumothorax and collapsed lungs*, which explains how a collapsed lung is diagnosed, the causes of the problem and the difficulties it causes for lung inflation and deflation. You could model a collapsed lung by using a scalpel to cut a hole in the side of the bottle used for one of the models produced above. This should help to reinforce the idea that the lungs are not stuck to the chest wall.

**Course resources**

**AP:** Worksheet 8Cb-3.

**AT:** Animations *Mayow's model of ventilation*; *Ventilation and muscle action*. Video *Pneumothorax and collapsed lungs.*

**Equipment**

Top 10–15 cm of an empty 2 litre drinks bottle (thicker bottles work better), balloon, 30 cm circle cut from a black bin liner, elastic band, masking tape.

Optional for demonstration: scalpel, cutting board.

**2: Tidal volumes and lung volume**

**Securing**

**Prac** **WS**

Exploring 4 in Topic 7Ca details ways for students to

measure the amount of air in a single breath (the so-called 'tidal volume'). Exploring 5 in Topic 7Ca details ways for students to measure the total volume of air that their lungs could contain (although in essence this practical measures 'vital capacity' since there is always an amount of air inside the lungs that cannot be exhaled – the 'residual volume').

These practicals could be done here or revisited later. Or the measurements could be taken using a different method, such as using lung volume bags. To prepare the bags, students should place a clean mouthpiece into the opening of the bag and secure with an elastic band. Seated, they should then find the sealed end of the bag and place it on their thighs in order to run their hands up the bag and so push any air out of it (avoiding the mouthpiece touching the floor). This is made easier by using a piece of paper towel. To measure tidal volume, students take a normal breath in and then breathe out normally into the bag. The air is then squashed down to the bottom of the bag and the volume of air can be read off the scale. To squash the air down to the bottom of the bag, hold the top of the bag against your thigh in one hand and hold a paper towel in the other hand. Now push the paper towel against the top of the bag and your thigh, and pull the bag upwards. The constriction between your thigh and the paper towel will push the air along the bag. The same thing can be done to measure lung volume (vital capacity), but with students taking the biggest breath possible and exhaling as much as possible into the bag.

Various sensor and datalogging systems are also available for measuring tidal and lung volumes.

Encourage students to work out ranges and means of their results.

⚠ Use only disposable mouthpieces with the bags. Students with lung problems should be given the opportunity to opt out of the practical work. Students with asthma may be advised to use their inhalers before carrying out the practical work.

**Course resources**
**AP:** Worksheets 7Ca-2 (Year 7); 7Ca-4 (Year 7) (optional).

**Equipment**
For lung volume bag method: new disposable mouthpiece, paper towel, elastic band.

### 3: Peak flow and height

**Developing/Securing**

Prac WS

Using a peak flow meter, students measure their peak flows and their heights to try to find a correlation between the two. At this age, taller students should have higher peak flows. Full instructions are given on Worksheet 8Cb-2. Skills Sheet PD 6 from the Year 7 Activity Pack may be useful here.

Various sensor and datalogging systems are also available for measuring tidal and lung volumes.

*Securing:* Encourage students to work out the ranges of repeated results and to identify more and less precise groups of repeated readings, and anomalous results.

⚠ Use only disposable mouthpieces with the peak flow meter. Avoid giving students the opportunity of becoming over-competitive. Students with lung problems should be given the opportunity to opt out of the practical work. Students with asthma may be advised to use their inhalers before carrying out the practical work.

**Course resources**
**AP:** Skills Sheet PD 6 (Year 7).
Worksheet 8Cb-2.

**Equipment**
Tape measure, peak flow meter, disposable mouthpiece.

### 4: A model for ventilation

**Securing/Exceeding**

Worksheet 8Cb-4 provides an opportunity for students to explain how the breathing muscles cause ventilation.

*Developing:* Remove the bottom half of the sheet (removing the drawings of the bellows and the explanations in terms of pressure).

*Securing:* Students use the whole sheet. When finished, ask students to explain ways in which the Mayow bellows model is good and ways in which it is poor. For example, it is a poor model of exhalation because no force should be needed to collapse the chest; muscles only contract to increase the size of the chest. It is a good model because it shows how the lungs can be inflated and deflated without being attached to the chest wall.

**Course resources**
**AP:** Worksheet 8Cb-4.

**Equipment**
Scissors, glue.

**5: Mouth-to-mouth resuscitation**
**Securing/Exceeding**

Worksheet 8Cb-5 provides an opportunity for students to apply what they know about the gas exchange system to an unfamiliar context. The last two answers will need research.

**Course resources**
**AP:** Worksheet 8Cb-5.

**Equipment**
Internet/library access.

**6: Lung structure**
**Developing/Securing**

The AT presentation *Lung structure* provides students with a variety of artworks and labels that they can use to create a short presentation on lung structure.

*Developing:* Students use the artworks, and copy and paste the labels from the first slide of labels.

*Securing:* Students use the artworks, and copy and paste the labels from both slides of labels (which include an explanation of how lungs are adapted for efficient gas exchange).

*Exceeding:* Challenge students to label the artworks without reference to the slides.

**Course resources**
**AT:** Presentation *Lung structure.*

**7: Exploring tasks from other units**
**Securing**

Exploring 6 in Topic 7Ca challenges students to create a model of the breathing muscles.

Exploring 3 and Exploring 4 in Topic 8Ae both deal with surface area and its importance.

Note that there are other activities on the concept of pressure that may be useful in Topic 7Ge and Topic 8Ic.

## EXPLAINING TASKS

**1: 8Cb Gas exchange system (Student Book)**
**Securing/Exceeding**
FA

These pages remind students of how the breathing muscles cause the chest to expand and contract, and how this ventilates the lungs. As well as this, the idea of atmospheric pressure is now introduced to fully explain the process. The pages go on to consider lung structure and how lungs are adapted for efficient gas exchange. This includes a brief look at the importance of surface area, which students may have met if they have done Unit 8A at this stage (see Topic 8Ae, particularly the Working Scientifically pages). Worksheet 8Cb-1 is the Access Sheet.

Questions 3, 5 and 9 are all suitable for formative assessment, with students working in groups to prepare answers. Ask groups to swap their answers and identify strong points of the answers and one way in which the answer could be improved.

The AT links *Mayow's model*, *Inhalation* and *Alveoli in lungs* allow you to switch the labels on and off on figures A, B and E.

The AT animations *Mayow's model of ventilation* and *Ventilation and muscle action* were also used in Exploring 1.

The AT video *Pneumothorax and collapsed lungs* explains how a collapsed lung is diagnosed, the causes of the problem and the difficulties it causes for lung inflation and deflation. See Exploring 1.

The AT presentation *Lung structure* examines the structure of lungs. See Exploring 6.

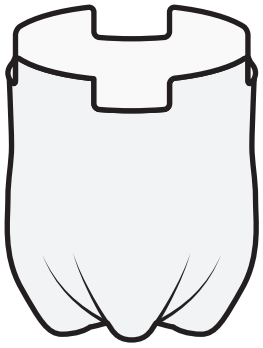
The AT video *Cilia function* shows how ciliated cells lining the trachea move in coordinated waves in order to move mucus and trapped particles up and out of the lungs.

The AT presentation *8Cb Thinking skills* can be used for this activity. See Plenary 3.

**Course resources**
**AP:** Worksheet 8Cb-1.
**AT:** Animations *Mayow's model of ventilation*; *Ventilation and muscle action*. Labels on/off *Alveoli in lungs*; *Inhalation*; *Mayow's model*. Presentations *8Cb Thinking skills*; *Lung structure*. Videos *Cilia function*; *Pneumothorax and collapsed lungs*.

**2: Marble diffusion**
**Developing/Securing/Exceeding**
Prac

Cut the bottom off a clear, coloured 2 litre fizzy drinks bottle, so that you are left with a cup shape, about 5–10 cm tall. Cut slots into the rim so that marbles will easily pass through. Cut a total of four slots.



On a small tray (with sides) place 10 or so red marbles in a group in the centre and then place 10 or so marbles of a different colour (for example, black) elsewhere in the tray. Place the upturned 'cup' over the central group of marbles and then, holding the cup steady, gently shake the tray back and forth along a bench. The 'cup' represents an alveolus and the rest of the tray represents the blood in capillaries around it. The red marbles are oxygen molecules and the black ones are carbon dioxide molecules. As you shake the tray, students should be able to appreciate that this is modelling diffusion and that over time oxygen molecules enter the blood and carbon dioxide molecules enter the alveolus. The model's main weakness is that the molecules are not removed by blood and air flow. Ask students to spot this weakness (or any others).

The use of a video camera, angled directly over the tray, will help students to see how the model works.

*Securing:* Extend the model to consider what would happen if surface area were reduced in the alveolus, by creating a 'cup' that only has two slots in it.

**Equipment**
Small tray with sides, cup or cups made out of the bottoms of 2 litre fizzy drinks bottles with slots cut in the rims, red (or other colour marbles) to represent oxygen molecules, black (or other colour marbles) to represent carbon dioxide molecules.
Optional: video camera.

### 3: 8Cb Means and ranges (Student Book)

**Developing/Securing/Exceeding**

**FA** **WS**

This spread provides work on means and ranges. Students should have met both terms in maths and should appreciate that a mean is one type of average (the others that they will have met are mode and median). The term range is used here as students will understand from their maths studies and is the calculated difference between the highest and lowest values. The term range is sometimes applied to the *spread* of values (i.e. what the highest and lowest readings are), but this should be avoided.

The **AT** presentation *Spirometer trace* shows students how to interpret a spirometer trace.

The **AT** spreadsheet *Ranges, means and anomalous results* has three tabs: 'ranges', 'means', 'anomalous results'. Information in each tab explains what these different things are and their importance. There is also data for practice. The data includes the data in table C of the Student Book.

**Course resources**
**AT:** Presentation *Spirometer trace*. Spreadsheet *Ranges, means and anomalous results.*

### 4: Explaining tasks from other units

**Developing**

**WS**

The dissection of sheep's lungs (Explaining 3 from Topic 7Ca) may also be useful here. Refer to page 89 in the Year 7 TTPP.

Starter 4 from Topic 8Ae provides a demonstration of surface area and further explanatory work on surface area can be found in Explaining 1 in the same topic. See the **AT** presentation *Rectangles and cuboids*.

Starter 2 from Topic 8Ic looks at the effects of air pressure and provides explanations. See the **AT** presentation *Air pressure explanations*.

**Course resources**
**AT:** Presentations *Air pressure explanations*; *Rectangles and cuboids*.

## PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

### 1: Quick Check

**Developing/Securing/Exceeding**

**FA**

*Assessment:* The 8Cb Quick Check sheet shows a drawing of the lungs, air sac and alveolus. Ask students to work in groups to annotate the sheets to explain the functions of the organs in the gas exchange system and how they allow efficient gas exchange. Groups could divide the labour out with a pair of students working on each part of the diagram. They could label up their own copies of the diagram to pool into a central neat-copy or use sticky notes to add their information to a central sheet (which could be blown up to A3 size).

*Feedback:* Show students the objectives for this topic and then give them some extra time to discuss which they have covered in their annotated diagram and which they need more information on to improve their work. Get students to review the work of one other group – and to share and gather further information. Ask a spokesperson from randomly selected groups to describe how they improved their work after the revisions and which aspects still need further work.

*Action:* Get each group to allocate tasks (for example, researching and making notes) for completing the diagram and annotations during the following lesson. Make a note of aspects that more than one group had difficulty with. In the next lesson, provide an opportunity for students to improve their diagrams/posters and check the points that caused difficulties using the second round of revisions or with reference to diagram E on page 41 of the Student Book.

**Course resources**
**ASP:** 8Cb Quick Check.

**Equipment**
Students may require calculators.

### 2: Quick Check WS

**Developing/Securing/Exceeding**

**FA** **WS**

*Assessment:* The 8Cb Quick Check WS sheet asks students to carry out some straightforward range and mean calculations and explain the uses of these calculations. Ask students to complete the sheet individually.

*Feedback:* Students should work in groups to compare their answers and then come up with an agreed statement about how to calculate ranges and means and the uses of each of these calculations. This could be in the form: 'We calculate ranges by…', 'We calculate ranges in order to…', etc.

*Action:* Ask for ideas about the sentences and agree on a set of class sentences that are written on the board. For example: 'We calculate ranges by subtracting the lowest value from the highest value', 'We calculate ranges in order to see how precise data is', 'We calculate means by adding all the values together and then dividing by the number of values', 'We calculate means in order to estimate more accurate values from a set of repeated results'.

Extend this activity by challenging students to re-write the calculation method sentences in the form of an ordered instruction list for each calculation. Each instruction in the list must be the smallest possible stage; that is, a single operation. Get students to agree which member of their group has succeeded in writing the clearest instructions.

**Course resources**
**ASP:** 8Cb Quick Check WS.

**Equipment**
Students may require calculators.

### 3: Thinking about the gas exchange system

**Securing**

**FA**

*Assessment:*
**Plus, Minus, Interesting:** We should breathe faster. (Possible answers: **Plus** – We could get more oxygen into our bodies; **Minus** – We may not need that amount of oxygen so we would be wasting energy on breathing more quickly; **Interesting** – Do people with smaller lungs breathe more quickly than people with large lungs? Smaller mammals breathe more rapidly than larger ones; for example, a mouse breathes about 100 times faster than an elephant.)

**What Was The Question:** alveoli. (Possible questions: What do the tubes in the lungs end in? Where does gas exchange happen in the lung? What are air sacs made of?)

**What Was The Question:** large surface area. (Possible questions: What do the air sacs and alveoli give the lungs?; Why does gas exchange happen efficiently in the lungs?)

**Consider All Possibilities:** Mike is short of breath. (Possible answers: he is a heavy smoker and mucus has collected in his lungs reducing the surface area; he has asthma and it is more difficult for air to get into and out of the lungs; Mike has been running.)

**Odd One Out:** breathing, ventilation, aerobic respiration. (Possible answers: aerobic respiration does not involve something moving; aerobic respiration happens in cells; ventilation can be carried out by physical things not just by parts of the body.)

*Feedback:* Ask students to compare their answers in groups and pick one question that was more difficult to think of answers for than the others.

*Action:* Take a class vote for the most difficult question and give students the answers (above) to this question first. Get students to analyse why they found this question difficult. Was it, for example, that they did not understand the question, or do they lack confidence about the science ideas? Clarify misconceptions by referring to the Student Book.

The **AT** presentation *8Cb Thinking skills* can be used for this activity.

**Course resources**
**AT:** *8Cb Thinking skills.*

### 4: In the hot seat

**Developing/Securing**

**FA**

Ask each student to think up a challenging question and its correct answer, using material from this topic. Pull a name 'out of a hat' to select a student to put in

the hot seat (or use yourself). Ask this student to sit at the front (or in the centre of a circle of students), dim the lights and illuminate the hot seat with a lamp or torch. Draw further names 'out of the hat' to select students to ask their questions. Start a stop clock to count down one minute, during which the hot seat student has to answer the questions. The questioner student should say whether the answer given is 'correct' or 'incorrect'. After a minute, count up the hot seat student's score. Ask students to give the correct answers for any that were deemed incorrect and to discuss the wording of any questions that were ambiguous. Then put another student in the hot seat if there is time.

The collected questions (with any necessary corrections) could then be collected and used as a quick test at the start of the next lesson. If students know this before the activity, this will motivate them to concentrate on the questions and answers.

**Equipment**
Stop clock.

## HOMEWORK TASKS

### 1: Breathing, ventilation and respiration
**Developing/Securing**

Worksheet 8Cb-6 contains straightforward questions on the gas exchange system.

**Course resources**
**AP:** Worksheet 8Cb-6.

### 2: Lungs and gas exchange
**Securing/Exceeding**

Worksheet 8Cb-7 contains questions on the gas exchange system and its functioning.

**Course resources**
**AP:** Worksheet 8Cb-7.

### 3: Gas exchange rates
**Securing/Exceeding**

Worksheet 8Cb-8 gives students information about concentration gradients and asks them to explain how the maintenance of concentration gradients increases the efficiency of gas exchange.

**Course resources**
**AP:** Worksheet 8Cb-8.

### ActiveLearn

Three ActiveLearn exercises are available for this topic: Gas exchange system 1; Gas exchange system 2; Gas exchange system 3.

# 8Cc
# Getting oxygen

This grid shows the basic concepts met in this topic, together with a scheme of cognitive progression for each concept. Opportunities to cover learning and progression are given. Working Scientifically concepts are integrated throughout the materials.

| Conceptual statement | Cognitive progress | | | | | |
|---|---|---|---|---|---|---|
| | Remembering (a) | Understanding (b) | Applying (c) | Analysing (d) | Evaluating (e) | Synthesising & creating (f) |
| Reduced oxygen levels affect aerobic respiration. | Recall ways in which gas exchange in the lungs can be reduced. | Describe how asthma, emphysema and tobacco tar can reduce gas exchange. | Explain some of the effects of reduced oxygen supply on the [body, heart]. | | Evaluate methods of mouth-to-mouth resuscitation and cardiopulmonary resuscitation (CPR). | |
| Exercise causes changes in the circulatory, gaseous exchange and locomotor systems. | Describe how breathing rate and heart rate are affected by exercise.<br>State what the pulse rate is used to measure.<br>Recall where a pulse can be [measured, felt].<br>State the meaning of: heartbeat, heartbeat rate, pulse rate. | Describe the [short-, long-] term effects of exercise on the locomotor system. | Explain the changes in heartbeat and breathing rate during exercise. | Explain why exercise is recommended to [prevent, help people with] cardiovascular disease. | | Use secondary sources to plan an investigation into the effect of exercise on the body. |
| Tobacco smoke contains harmful chemicals. | Recall some chemicals in tobacco smoke. | Describe the effects of some chemicals in tobacco smoke on the body. | Explain the effects of some chemicals in tobacco smoke on the body. | Use knowledge of the effects of smoking to describe the social issues surrounding the use of tobacco. | Evaluate data relating to the correlation between smoking and its negative effects on health. | |

**Objectives**

Developing:

1. Describe how breathing rate and heart rate are affected by exercise.
2. Recall some harmful chemicals in tobacco smoke.
3. Recall ways in which gas exchange in the lungs can be reduced.
4. Describe how substances reach respiring cells from the blood and how waste products are returned to the blood.
5. Describe the effects of nicotine, tar and carbon monoxide in tobacco smoke.
6. Describe how asthma, emphysema and tobacco tar can reduce gas exchange.

Securing:

7. Explain the changes in heartbeat and breathing rate during exercise.
8. Explain some of the effects of reduced oxygen supply on the body.
9. Explain the effects of some chemicals in tobacco smoke on the body.

Exceeding:

10. Explain why exercise is recommended to help people with cardiovascular disease.

**Focused Literacy & Communication Objectives**
This topic provides an opportunity to focus on key Literacy & Communication skills.

1. Correctly use the terms: fact, opinion.
2. Distinguish between facts and opinions.
3. Develop logical sequences of points in writing (e.g. by using words that show cause and effect).

## Student materials

**Topic notes**
- **Misconception:** The pulse is not a direct 'feeling of blood flowing through blood vessels'. It is actually a shockwave in the walls of the arteries caused by the contraction of heart muscle as it pumps.
- **Misconception:** Neither blood nor veins are ever blue. They are only ever variations of red/brown. See the Background information.

### STARTERS

**1: Changes when exercising**
**Developing/Securing**
**BA** **Lit**
Start by asking students what exercise they take on a regular basis. Next, ask them to carry out a free-writing exercise to describe the changes they notice in their body when exercising. If students do not exercise, ask them to suggest what changes they might notice based on TV images or photos of athletes or footballers in action. Students then share ideas in small groups or as a whole class discussion. Follow this up by asking students why they think these changes occur.

*Developing:* Ask students to write a list of keywords to describe the changes they notice when exercising.

*Securing:* Ask students to write a descriptive paragraph for one minute on the subject.

**2: Pulse rates**
**Developing**
**BA**
Ask students to find their pulses and estimate their pulse rates (see page 94 of the Year 7 TTPP, 7Cb Exploring 1). Ask students what the pulse rate is a measure of and establish that it is a measure of the heartbeat rate (but note that the pulse is actually a pressure wave in the artery walls caused by the heart beating: it is not a 'wave of blood'). Ask students why blood needs to be pumped around the body and elicit the idea that it supplies all the cells with substances they need, such as oxygen and glucose, and removes the waste substances. Ask students to predict what will happen to the pulse rate when we exercise.

Explanations for the change in pulse rate are met in subsequent activities in this topic, although you could extend this activity to ask students for explanations and then ask for volunteers to read out their predictions and explanations – encouraging the class to support these or to suggest improvements.

**3: Gas exchange and circulation 1**
**Securing**
**BA**
Revise what students can remember about the circulatory system from Unit 7C by asking them to annotate the drawing on Worksheet 8Cc-4 with notes. They should pay particular attention to how oxygen gets from the lungs to the rest of the body.

*Developing:* Assist students by posing directed questions to help them with their thoughts, such as: 'Which organs are shown?', 'How many different types of blood vessel are there?', 'Why are there lots of small blood vessels in the lungs/brain?', etc.

Having completed the sheet, ask random students to read out one of their annotations. Correct misconceptions as they arise and then ask students to write down one thing about the circulatory or gas exchange system that they would like to find out about during this topic.

**Course resources**
**AP:** Worksheet 8Cc-4.

**4: War poetry**
**Securing**
**BA**
Read out the following; an extract from *Dulce et decorum est* by Wilfred Owen, written in 1917 in the trenches of the First World War. If you do not want to read it yourself, there are plenty of good readings on the Internet, including on well-known video sites.

Gas! Gas! Quick, boys! – An ecstasy of fumbling,
Fitting the clumsy helmets just in time;
But someone still was yelling out and stumbling,
And flound'ring like a man in fire or lime...
Dim, through the misty panes and thick green light,
As under a green sea, I saw him drowning.
In all my dreams, before my helpless sight,
He plunges at me, guttering, choking, drowning.

Tell students where the poem is set and ask them what it is describing. Why do they think that the man cannot breathe? After discussion tell students that the gas concerned is chlorine. It forms hydrochloric acid in the lungs, which causes the production of a lot of mucus, meaning that those affected literally drown. Ask students why they think this gas can make breathing difficult, applying what they know about lung structure, gas exchange across the alveoli and surface area. Mucus is also produced in an asthma attack, making breathing difficult.

Extend this activity by asking students to write a paragraph of 'scientific commentary' on the Owen poem.

## EXPLORING TASKS

### 1: Exercise and breathing rate

**Securing**

**Prac** **WS**

Students may have carried out Exploring 2 in Topic 7Cb, in which they measured pulse and breathing rates before and after exercise, and watched how these rates returned to their resting values after exercise. In this task, students will try to correlate the strenuousness of an activity with the effect it has on pulse and breathing rates. Before starting, ensure that students can find their pulses. The activity can be run as two separate activities or as one activity. Or groups could work in such a way that half a group measures pulse rates and the other half measures breathing rates, and then compare and combine their findings. Skills Sheet PD 3 from the Year 7 Activity Pack may be useful for this task.

Other variables could also be measured if you have the right equipment, such as a spirometer to measure tidal volume (volume of air in each breath). Also note that there are a variety of sensor and datalogging set-ups that can be used to measure breathing rates, lung volumes and heart rates (e.g. PASCO PS-2187 breath rate sensor, PS-2152 spirometer, PS-2129A heart rate sensor connected to suitable datalogger and display devices; see the PASCO website for further details).

*Developing:* Students use Worksheet 8Cc-2 (breathing rates) and Worksheet 8Cc-3 (pulse rates) to determine the effect that different demands of exercise have on the body. They are asked to draw bar charts and to suggest reasons for their findings.

*Securing:* Students should be able to design their own investigations. They should be encouraged to identify the independent variable (the variable that they are changing, which is the demand of the exercise) and propose a suitable exercise and amount of time for this variable. Students should also consider whether to record the heartbeat and breathing rates (the dependent variables) for whole minutes, or to record them for portions of minutes (for example, 15 seconds) and multiply up to get a reading 'per minute'.

*Exceeding:* Discuss how heartbeat rates are measured and if students think that using a heartbeat sensor and datalogger would increase the accuracy of this practical. Students should understand that measuring the heartbeat rate using a stopclock gives an appropriate degree of accuracy for this practical, but that using a datalogger should eliminate human error. That will enable more accurate data to be obtained although this is unlikely to be enough to change any conclusions. Using a datalogger does, though, make the recording of the results much easier.

The **AT** spreadsheet *Exercise and rates* provides datasets for students to use to draw graphs and conclusions if students have not collected data of their own.

The needs of students who are excused from PE or who have specific medical conditions should be considered before deciding who should take part. Those who cannot do the exercise should be paired with someone who can. It is important not to draw attention to a student's physical or medical limitations. The teacher should pair up students so that the whole class is not made aware of a particular student's problems. Asthmatics may need to be warned to use their inhalers during exercise. Over-competitiveness must be avoided and teachers should ensure that students realise that there are more aspects to overall fitness than stamina. Ensure that students have plenty of room around themselves to exercise. If students are to step on and off a block, ensure that the block is stable and well constructed. If students are to run up and down stairs, they *must* hold on to the hand rail.

**Course resources**
**AP:** Skills Sheet PD 3 (Year 7). Worksheets 8Cc-2; 8Cc-3.
**AT**: Spreadsheet *Exercise and rates.*

**Equipment**
Stop clock, graph paper.
Optional: 1 kg mass, step or other sports equipment, datalogger and relevant sensors, or smartphone app for heartbeat rate and/or breathing rate, spirometer.

### 2: Gas exchange and circulation 2

**Developing/Securing**

Worksheet 8Cc-5 asks students to colour in various parts of drawings of an air sac, a capillary bed and a model of the circulatory system to illustrate how the products and reactants of respiration are moved to and from respiring cells.

*Developing:* Students may need help with the questions at the bottom of the second page. For very weak students, or those with poor writing/motor skills, these questions could be answered orally or removed.

**Course resources**
**AP:** Worksheet 8Cc-5.

**Equipment**
Coloured pencils.

**3: Diagnosis attempted murder?**
**Securing/Exceeding**

This card-sort activity invites students to sort information about various poisons into a table. It will take a fair bit of time for them to work it out and this is better suited to small group work. The cards are on Worksheet 8Cc-6.

*Securing:* Do not photocopy the bottom row of cards on the sheets that students use. Further help can be given by telling students what headings they might use: Condition/Cause/Symptoms/Treatment.

*Exceeding:* Photocopy the whole sheet for students to use.

Extend this activity by asking students to write descriptive and explanatory paragraphs about each of the poisons, using the information on the cards.

**Course resources**
**AP:** Worksheet 8Cc-6.

**Equipment**
Scissors, glue.

**4: Molecule travelogues**
**Securing**
**Lit**

Ask students to imagine that they are a glucose molecule in the small intestine or an oxygen molecule in the lung and to describe their journey to a muscle tissue in a leg. Consider asking students to work in pairs with one doing oxygen and then the other doing glucose. Ask them to check each other's work and then to work together to describe the journey of a molecule of carbon dioxide out of a muscle cell and into the air inside a lung.

Encourage students to think about using words that show cause and effect.

**5: Writing about getting enough oxygen**
**Securing**
**Lit**

The top of page 45 in the Student Book lists three main ways in which insufficient oxygen can get to cells: narrowed (or blocked) blood vessels, poisons and poor gas exchange in the lungs.

*Developing:* Students find causes and effects in each of the last five paragraphs on page 45 of the Student Book.

*Securing:* Working in groups, students re-write each of the last five paragraphs using words that indicate cause and effect. For each of the 10 sentences, they underline the cause, circle the effect and arrow the word or phrase used to link the two together.

*Exceeding:* Working in groups, students use this part of the Student Book as an initiator to do some further research about the causes of reduced oxygen in the blood. Challenge students to produce a poster or webpage about their findings.

The **AT** presentation *Writing about lack of oxygen* shows the last five paragraphs and highlights the causes and effects before showing ways in which these sentences could be constructed.

**Course resources**
**AT:** Presentation *Writing about lack of oxygen.*

**Equipment**
Internet/library access.

## EXPLAINING TASKS

**1: 8Cc Getting oxygen (Student Book)**
**Developing/Securing/Exceeding**
**FA**

These pages cover the effect of exercise on the pulse and breathing rates, together with the effects on cells of getting too little oxygen. Worksheet 8Cc-1 is the Access Sheet.

Questions 4 and 5 are suitable for formative assessment, with students working in groups to prepare answers.

An **AT** link allows you to turn the labels on and off on figure B.

In the **AT** interactive *The functions of arteries, veins and capillaries* students select blood vessels to answer questions about structure and function.

The **AT** interactive *Transporting substances around the body* shows students how blood flows through the circulatory system.

The **AT** animation *Capillaries* shows how substances enter and leave the capillaries in order to supply cells and tissues with what they need.

The **AT** presentation *The circulatory system* will help remind students of the different parts of the circulatory system (met in Topic 7Cb).

The **AT** spreadsheet *Exercise and rates* provides datasets for students to chart how pulse and

breathing rates are affected by exercise. See Exploring 1.

The (AT) video *Asthma* explains what this condition is, how an asthma attack is triggered and how the condition is monitored.

The (AT) presentation *Writing about lack of oxygen* is a literacy activity based upon the effects of a lack of oxygen. See Exploring 5.

The (AT) presentation *8Cc Thinking skills* can be used for this activity. See Plenary 3.

**Course resources**
**AP:** Worksheet 8Cc-1
**AT:** Animation *Capillaries*. Interactives *The functions of arteries, veins and capillaries*; *Transporting substances around the body*. Labels on/off *Transporting oxygen, glucose and waste materials*. Presentations *8Cc Thinking skills*; *The circulatory system*; *Writing about lack of oxygen*. Spreadsheet *Exercise and rates*. Video *Asthma.*

**2: Clogged arteries**
**Securing**
Prac
You can make a model of the fatty stuff that builds up in arteries (due to poor diet and/or smoking) using a length of gas tubing and some thick semolina or porridge. Mix the semolina/porridge with the recommended amount of water. Bung one end of the tubing, and then use a funnel to pour the mixture into the tubing and seal with another bung. Don't worry about trying to fill the tube all the way with semolina/porridge. If you then leave this in a cold fridge overnight, you can demonstrate how the porridge impedes flow of water by quickly suspending the tube next to an empty one and pouring cold water through them. Ask students to identify the different parts of the model and to explain how blocked/narrowed arteries affect cells. Then squeeze the mixture out of the pre-prepared tube to show students.

**Equipment**
Two 30–50 cm lengths of gas tubing, semolina or porridge, water, two small bungs to fit tubing, funnel to fit tubing, two retort stands and clamps, bowl, access to a fridge.

**3: 8Cc Cause and effect (Student Book)**
**Developing/Securing/Exceeding**
FA Lit
This Literacy & Communication spread reminds students about facts and opinions, and then looks at how language can be used to show cause and effect. Encourage students to think back to previous work on different types of sentences (for example, see Year 7 Student Book pages 48–49) and the overall structure of paragraphs (for example, see Year 7 Student Book pages 64–65).

The (AT) interactive *Facts and opinions* asks students to decide whether statements about smoking are fact or opinion, or they choose 'unsure' if they don't know.

The (AT) presentation *Causes and effects* asks students to write different versions of the same sentences showing cause and effect.

The (AT) presentation *Writing about lack of oxygen* shows the last five paragraphs on page 45 and highlights the causes and effects before showing ways in which these sentences could be constructed.

**Course resources**
**AT:** Interactive *Facts and opinions*. Presentations *Causes and effects*; *Writing about lack of oxygen.*

## PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

**1: Quick Check**
**Developing/Securing/Exceeding**
FA
*Assessment:* The 8Cc Quick Check sheet challenges students to think of a question and to design a mark scheme for it. You could get half the class to do one of the suggested questions and the other half to do the other or, if there is time, students could do both questions using two copies of this sheet.

*Feedback:* Students swap papers (keeping their mark schemes) and try out each other's questions. The answers are then marked jointly between the question-setter and the student who wrote the answer. Together they agree on good points about the question and the answer, and one way that each could be improved.

*Action:* Ask random students about what they could have improved about their questions and what they could have improved about their answers. Allow time for students to make any improvements to their own questions and answers following this discussion. Ascertain which aspects were a particular problem for students and go over these again, with reference to the Student Book.

You could ask students to suggest a list of 'features of good questions for assessing learning', as this will encourage them to pay attention to, for example, the structure of questions and the difference between application of knowledge and factual recall.

**Course resources**
**ASP:** 8Cc Quick Check.

**Equipment**
Students may require calculators.

**2: Quick Check Literacy**
**Developing/Securing/Exceeding**
**FA** Lit

*Assessment:* The 8Cc Quick Check Literacy sheet asks students to identify facts, opinions, causes and effects, and challenges them to link some sentences together with appropriate words to clearly show cause and effect.

*Feedback:* Students work in pairs to check their answers.

*Action:* Ask students to contribute their completed sentences and build up a list on the board of words and phrases that are the most commonly used to show cause and effect. Compare this with the list on page 47 of the Student Book.

**Course resources**
**ASP:** 8Cc Quick Check Literacy.

**3: Thinking about getting oxygen**
**Securing**
**FA**

*Assessment:*
**Plus, Minus, Interesting:** Capillary walls should not be leaky. (Possible answers: **Plus** – Poisonous chemicals/viruses in the blood could not get to cells; **Minus** – No oxygen or food could get to the cells and you would die; **Interesting** – Do some people have leaky capillaries? Extra-leaky capillaries are present in people with Clarkson syndrome.)

**What Was The Question:** tissue fluid. (Possible questions: What does plasma form when it leaks out of capillaries?; From what liquid do respiring cells get the oxygen and glucose that they need?)

**What Was The Question:** carbon monoxide. (Possible questions: What gas prevents red blood cells carrying oxygen?; Name a poisonous gas that is found in cigarette smoke.)

**Consider All Possibilities:** An old man was gasping for breath. What could the reasons be? (Possible answers: he has been exercising; his lungs are not working properly; he has emphysema; there is not much oxygen in the air for him to breathe.)

**Consider All Possibilities:** A boy's heart was beating very fast. What could have caused this? (Possible answers: he has been exercising; he is nervous/anxious/worried; his body is starved of oxygen; he is using a medication such as a salbutamol inhaler; he has been taking some illegal drugs or drunk very strong coffee.)

**Odd One Out:** tar, carbon monoxide, mucus. (Possible answers: carbon monoxide is a gas; mucus is not poisonous; mucus is not found in cigarette smoke; carbon monoxide does not coat the lungs and so reduce the speed of gas exchange.)

**Odd One Out:** frostbite, heart attack, fast pulse rate. (Possible answers: fast pulse rate is not necessarily caused by cells dying; frostbite only happens when it's cold; frostbite does not affect the heart.)

*Feedback:* Ask students to compare their answers in groups and pick one question that was more difficult to think of answers for than the others.

*Action:* Take a class vote for the most difficult question and give students the answers (above) to this question first. Ask them to analyse why this question was difficult. Clarify misconceptions by referring to the Student Book.

The (AT) presentation *8Cc Thinking skills* can be used for this activity.

**Course resources**
**AT:** *8Cc Thinking skills.*

**4: Word definitions**
**Developing/Securing/Exceeding**
**FA**

Give students copies of the Word Sheets for this topic and the previous two, but with the definitions missing (either edit them out of the digital version of the sheet or photocopy with a piece of paper over the definitions). Ask students to put a number from 1 to 5 against each word to show how confident they are that they know the meaning (5 meaning 'absolutely certain', 1 meaning 'no idea'). Then read out the words one by one and ask for a show of hands for Certainty of Response Index scores of 4 and 5 (see Introduction). Identify the two or three words that students are least sure about and revise their meanings, before quickly running through the meanings of the other words.

Extend this activity by encouraging students to build their own topic glossaries with words, definitions and sentences that use each word as these are covered during lessons.

**Course resources**
**ASP:** 8C Word Sheets.

## HOMEWORK TASKS

**1: Capillaries and respiration**
**Developing/Securing**
Worksheet 8Cc-7 contains straightforward questions on how oxygen is delivered to cells and causes of a lack of oxygen.

**Course resources**
**AP:** Worksheet 8Cc-7.

**2: Reducing and increasing gas exchange**
**Developing/Securing/Exceeding**
Worksheet 8Cc-8 contains questions on gas exchange in lungs and tissues.

**Course resources**
**AP:** Worksheet 8Cc-8.

**3: Coronary heart disease**
**Securing/Exceeding**
Worksheet 8Cc-9 asks students to apply what they know about the effects of smoking and exercise to coronary heart disease.

**Course resources**
**AP:** Worksheet 8Cc-9.

**ActiveLearn**
Five ActiveLearn exercises are available for this topic: Getting oxygen 1; Getting oxygen 2; Getting oxygen 3; Cause and effect 1; Cause and effect 2.

# 8Cd
# Comparing gas exchange

This grid shows the basic concepts met in this topic, together with a scheme of cognitive progression for each concept. Opportunities to cover learning and progression are given. Working Scientifically concepts are integrated throughout the materials.

| Conceptual statement | Cognitive progress | | | | | |
|---|---|---|---|---|---|---|
| | Remembering (a) | Understanding (b) | Applying (c) | Analysing (d) | Evaluating (e) | Synthesising & creating (f) |
| Aerobic respiration releases energy from glucose, using oxygen. | Recall what happens in aerobic respiration. | Describe how respiration can be detected using [limewater, hydrogen carbonate indicator, temperature].<br>Explain how aerobic respiration can change the surroundings. | Model aerobic respiration using a word equation. | Compare burning (combustion) and respiration. | Evaluate the use of a word equation to model aerobic respiration. | |
| The lungs are adapted for gas exchange. | Describe the structure of the lungs. | Explain how the lungs are adapted for efficient gas exchange. | | Compare the efficiency of gas exchange organs. | Explain how and why a concentration gradient is maintained for oxygen and carbon dioxide between the blood and lungs.<br>Identify the limitations of [lungs, gills, body surface covering] as sites of gas exchange. | |
| The gaseous exchange or breathing system allows gases to enter and leave the blood. | [Identify, recall] the main [parts, organs] of the human [gaseous exchange, breathing] system.<br>State the function of the [gaseous exchange, breathing] system. | Describe the functions of the main parts of the human gaseous exchange system.<br>Describe what happens during gas exchange. | [Suggest, explain] the effects of [diseases that affect, damage to] the [gaseous exchange, breathing] system.<br>[Suggest, explain] the effects of differences (for example, in size of organs) between the gaseous exchange system in different people. | Compare the human gaseous exchange system with those of other animals.<br>Describe how gas exchange occurs in plants. | Identify the limitations of lungs, gills and body surface covering as sites of gas exchange. | Suggest how problems with the [gaseous exchange, breathing] system could be [overcome, treated]. |
| Organisms need energy for activities, such as movement. | Recall what happens in respiration. | | | Compare respiration in plants and animals. | | |

**Objectives**
Developing:

1. Compare respiration in plants and animals.
2. Describe ways in which respiration can be detected (limewater, hydrogen carbonate indicator, heat).

Securing:

3. Describe how gas exchange occurs in plants.
4. Compare the human gaseous exchange system with those of other animals.

Exceeding:

5. Compare the efficiencies of different gas exchange organs.
6. Identify the limitations of lungs, gills and body surface covering as sites of gas exchange.

## Student materials

**Topic notes**

- **Misconception:** Water from respiration is not directly excreted by the lungs. The reason that we breathe out air containing more moisture is because gas exchange only occurs if the surfaces are damp.
- **Misconception:** The lungs remove all the oxygen from inhaled hair and a burning candle uses up all the oxygen if left under an upturned beaker. Neither of these is true.

**Be prepared**
Exploring 1: The practical set-up is quite complex.

### STARTERS

**1: Differences in air 1**
**Developing/Securing**
**BA**
Ask students to list the ways they think that inhaled air is different from exhaled air. Students should justify their answers (for example, in a three-column table for comparison plus explanations). Get students to compare their list with another student's and to add any information they gain from each other. Create a chart on the board that contains a list of differences and a list of explanations for those differences. Come back to the chart during Exploring 1 and/or in Plenary 3.

**2: Burning and respiration**
**Developing/Securing**
**BA** **Prac**
Place an inverted jar or bell jar over a burning tea light. Ask students why the tea light eventually goes out and how they think the air in the jar at the end of the demonstration is different from the air at the beginning. Then ask students how this demonstration is similar to respiration. Exploring 1 extends this idea. Note that 15% oxygen is needed to support a flame during combustion and below this concentration a flame will go out.

Extend this activity by asking students to sketch a diagram of the candle and bell jar, annotating it with a description and explanation of what happened.

**Equipment**
Tea light, inverted jar/bell jar.

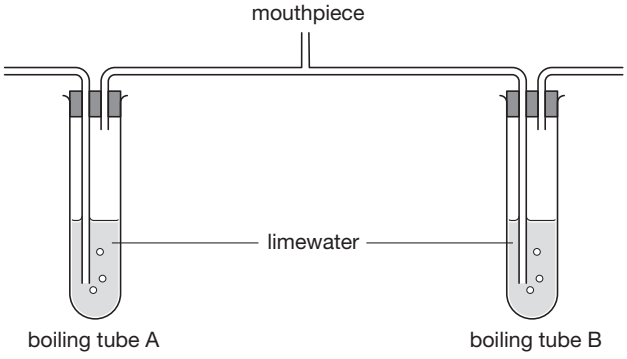
**3: Gas exchange systems**
**Developing/Securing**
**BA**
Write a list of organisms up on the board, including a fish, a mammal and a plant. Ask students which of the organisms require oxygen. Establish that they all need oxygen for respiration. Then ask how the organisms get oxygen. If necessary, prompt with keywords: lungs, gills, leaves.

Extend this activity by asking students to make a two-column table naming the organisms and describing how they get their oxygen for respiration.

### EXPLORING TASKS

**1: Investigating inhaled and exhaled air**
**Securing**
**Prac** **WS**
Full instructions for this practical are given on Worksheet 8Cd-2.

**Test 1:** Students will probably encounter problems in assembling the apparatus and it is wise to pre-prepare this apparatus for students. The experiment gives a quick and reliable comparison of the carbon dioxide content of inhaled and exhaled air (inhaled air bubbles through the limewater in tube A in the diagram and exhaled air bubbles through the limewater in tube B).

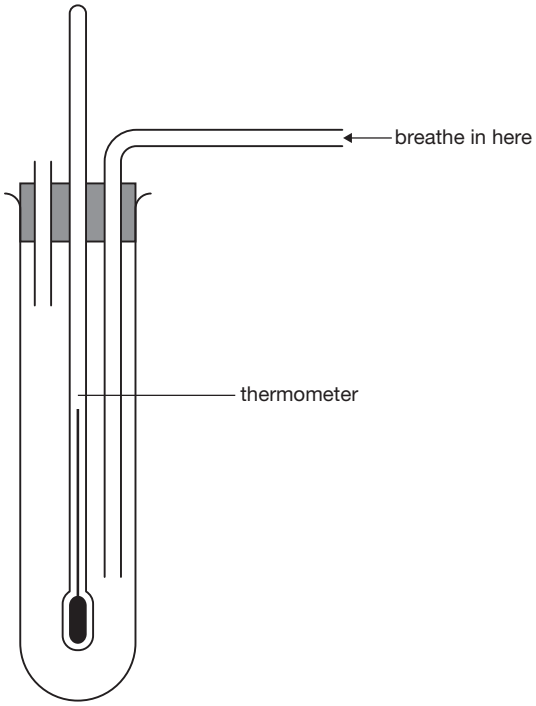


Eye protection should be worn. Breathe *gently* to avoid getting limewater in the mouth. If this happens spit it out and rinse the mouth with water. Mouthpieces must be disinfected between uses by putting them in sterilising solution for 30 minutes. It is better to use lengths of pre-disinfected tubing that can be attached to the apparatus.

**Test 2:** Condensation is seen on the mirror, but this could be any colourless liquid. The use of cobalt chloride paper shows it to be water. Commercially prepared cobalt chloride paper is often very pale in colour and paper prepared in school is often better as it can be stained darker. The paper should be kept in a desiccator, since it quickly turns pink with moisture from the air. If this happens it can be dried in an incubator.

Cobalt chloride paper should not be handled with fingers. If it is, hands should be washed immediately.

**Test 3:** The bulb of a thermometer is cupped in the hand and exhaled onto several times. The bulb itself should not be touched; the hand just serves to catch the breath. How long this is done for obviously affects the final temperature. A more sophisticated version of the apparatus can be made using a boiling tube and bung with a thermometer and breathing tube going through the bung as shown in the diagram.




The tube must be disinfected for 30 minutes in sterilising solution before and after each use. Alternatively, use lengths of pre-sterilised tubing as in Test 1.

The testing of gases in inhaled and exhaled air can also be undertaken using sensors (e.g. PASCO PS-2110 carbon dioxide gas sensor, PS-2126A oxygen gas sensor) together with appropriate datalogging and display equipment.

**Course resources**
**AP:** Worksheet 8Cd-2.

**Equipment**
**Test 1:** Two boiling tubes, two bungs with a short and long piece of glass tube through them, delivery tubing, mouthpiece, limewater, eye protection.
Optional: carbon dioxide/oxygen gas sensors and datalogging/display equipment.
**Test 2:** mirror, two pieces of blue cobalt chloride paper, forceps, pipette, access to water.
**Test 3:** thermometer.
Optional: boiling tube, short length of glass tubing, elbow of glass tubing.

### 2: Exhaled air and burning

**Developing/Securing/Exceeding**

**Prac** **WS**

Instructions for the practical are given on Worksheets 8Cd-3 and 8Cd-4. Students may need guidance on the collection of exhaled air by the displacement of water method. Similar-sized gas jars with well-fitting deflagrating spoons need to be provided. Make sure that the gas jars are large. Smaller ones will mean that the candle goes out too quickly with exhaled air.

*Developing:* Students use Worksheet 8Cd-3 to do a simple investigation into the differences between inhaled and exhaled air. A good evaluation point is that upon opening the jars to put in the candles, some of the air inside escapes, meaning that the test is not very fair. Another control variable that students may not have considered is the length of time the candle is left to burn for before adding it to the air.

*Securing:* Students use Worksheet 8Cd-4 to plan and carry out an investigation to find out if there is a difference between exhaled air at resting and exhaled air during exercise. The exercise variable could be the strenuousness of the exercise or how long the exercise continues for. In the latter case, it may be found that the oxygen levels in exhaled air decrease at the start, but then begin increasing again as the breathing rate increases

and the lungs are absorbing as much oxygen from the air as they can. A good evaluation point is that exercise is difficult to quantify. In sports centres, they put people on treadmills or exercise bikes with speedometers on them to get a constant level of 'measurable' exercise. Where space is limited, students can vertically raise a fixed mass, for example 1 kg, held in the hand, through a specified distance, for example 1 m, and repeat a specified number of times. In this way, the amount of exercise is similar for all students.

It is suggested that teachers/assistants light the tea lights. Heavy masses need to be handled with care and with appropriate adult supervision.

**Course resources**
**AP:** Worksheets 8Cd-3; 8Cd-4.

**Equipment**
Two similar-sized large gas jars with greased lids, a deflagrating spoon and tea light, trough of water, clean tubing, stop clock.

**3: Respiring organisms**
**Developing/Securing/Exceeding**

Worksheet 8Cd-5 challenges students to plan an investigation using bromothymol blue indicator to predict how a certain variable will affect the amount of carbon dioxide released by respiring organisms.

The (AT) interactive *Indicating respiration* challenges students to predict the results of an investigation into respiration in maggots, using hydrogen carbonate indicator. This will make a useful introduction to this activity.

Students should be guided in their choice of living material, for example germinating seeds, maggots, pondweed, pond snails. Maggots and germinating seeds can be suspended in a gauze bag over a solution of indicator (for example, in a conical flask). Pond weed and pond snails can be placed in a weak bromothymol blue solution without harming the organisms. It is envisaged that students apply what they know about indicators and set up flasks or tubes containing indicator and organisms, which they then leave for 24–48 hours and observe the colour change.

Variables that could be investigated include: mass of the living material used or number of organisms, temperature, activity. Whichever variable is to be investigated, a control should be set up.

Students may need reminding to avoid breathing out over open tubes of indicator as exhaled carbon dioxide will affect the indicator.

The instructions at the top of Worksheet 8Cd-5 suggest that students use pond or mineral water and add a few drops of bromothymol blue, and then to add sodium hydroxide if the bromothymol blue is not blue (but still yellow). An alternative is to provide students with ready-made solutions of bromothymol blue. Bromothymol blue changes colour at around pH 7. As distilled water is often very acidic due to carbon dioxide from the air dissolving when the water is produced, the indicator may be yellow before the experiment. To avoid this, make up the solution for students to use (by adding bromothymol blue solution until there is obvious colour in the water) and then equilibrate the solution with room air by bubbling air through it using a fish tank aerator. A blue solution will be obtained and this will change to yellow as carbon dioxide is added in the experiment.

This practical can be used to carry out a Working Scientifically investigation. A set of assessment descriptions is provided in the ASP. Note that use of the worksheets will prevent the assessment of some strands (notably planning). Even if this is not formally assessed, the assessment descriptors could be used for students to mark each other's work and to provide formative feedback to each other.

*Developing:* Students work in groups to plan their investigations, using Worksheet 8Cd-5 and input from the teacher.

*Securing:* Students use Worksheet 8Cd-5.

*Exceeding:* Students plan their investigations without help and without using the worksheet.

Students should be encouraged to consider the welfare of any small animals used. All animals used in the experiment should not be harmed by the experiment, and should be released back into the environment or killed humanely as appropriate. Consult CLEAPSS guidance for specific advice. As pathogens may be present in the water or on the animals' bodies, students should cover any cuts with waterproof plasters. They should also wash their hands thoroughly with bactericidal handwash after handling living material. Wipe benches with disinfectant after the practical.

**Course resources**
**AP:** Worksheet 8Cd-5.
**ASP:** 8C WS Investigations.
**AT:** Interactive *Indicating respiration.*

**Equipment**
Depending on plans: 0.1% aqueous bromothymol blue solution (possibly made up into final solution to be used by students and equilibrated with room air before use – see activity instructions); 0.1 mol $dm^{-3}$ NaOH; boiling tubes or conical flasks; bungs; gauze; access to balance; selection of living materials (for example, germinating seeds, pond weed, maggots, pond snails), stop clocks, pipettes. Optional: pond or mineral water.

**4: Respiration card sort**
**Developing/Securing**

Worksheet 8Cd-6 provides a card-sort exercise to help students to think about the similarities between respiration in animals and plants. Before using the worksheet, you may wish to remind students that plants make food by photosynthesis, but that the cells in plants still need to convert the food to energy for the plant's life processes. Students can then be asked to work in groups to sort the cards into piles for things that only apply to plants, things that only apply to animals and things that apply to both. Once each group has sorted their cards, encourage students to share their results and explain their reasoning.

*Developing:* Students use only the cards on the first three rows of the sheet.

*Securing:* Students use the whole sheet.

**Course resources**
**AP:** Worksheet 8Cd-6.

**Equipment**
Scissors.

**5: Writing and research on different forms of gas exchange**
**Securing/Exceeding**
**Lit**

Ask students to work in groups to find out about gas exchange in frogs, insects, mammals and fish. This could be extended to include plants.

*Developing:* Students prepare a table to compare the different forms of gas exchange (skin, gills, spiracles and lungs).

*Securing:* Students prepare a series of presentation slides to compare and contrast the different methods of gas exchange, explaining how each of them works. Encourage students to write one complete paragraph on each slide and to use some 'cause and effect' sentences (see Student Book pages 46–47).

*Exceeding:* Students compare the efficiencies and limitations of the different types of gas exchange systems. Challenge students to use their findings to explain why organisms that do not have lungs are usually 'cold-blooded' (poikilotherms).

**Equipment**
Internet/library access.

## EXPLAINING TASKS

**1: 8Cd Comparing gas exchange (Student Book)**
**Developing/Securing/Exceeding**
**FA**

These pages consolidate learning about aerobic respiration by looking at how the products of respiration are detected. Some of the other ways in which organisms obtain oxygen for respiration are then introduced. Worksheet 8Cd-1 is the Access Sheet.

Note that the 'organ' referred to in the first paragraph in the Student Book is the spleen.

Questions 4 and 7 are suitable for formative assessment, with students working in groups to prepare answers.

The **AT** video *Long dives* explores how some animals manage to stay underwater for so long without breathing.

The **AT** spreadsheet *Inhaled and exhaled* provides the data in table C and challenges students to draw pie charts and bar charts in order to decide which is the better format for presenting the data.

The **AT** interactive *Indicating respiration* challenges students to predict the results of an investigation into respiration in maggots, using hydrogen carbonate indicator. See Exploring 3.

The **AT** presentation *How gills work* explains how gills allow gas exchange. See Explaining 3.

The **AT** presentation *Different methods of gas exchange* considers the gas exchange systems met in this topic (lungs, gills and stomata) and goes on to look at gas exchange in insects and microorganisms.

The **AT** links *Gas exchange using gills* and *Stomata on a geranium leaf* allow you to turn the labels on and off on figures E and G.

The **AT** video *Diffusion through the stomata* illustrates the gases that diffuse into and out of the leaf during the day and at night.

The **AT** presentation *8Cd Thinking skills* can be used for this activity. See Plenary 2.

**Course resources**
**AP:** Worksheet 8Cd-1.
**AT:** Interactive *Indicating respiration.* Labels on/off *Gas exchange using gills*; *Stomata on a geranium leaf*. Presentations *8Cd Thinking skills*; *Different methods of gas exchange*; *How gills work*. Spreadsheet *Inhaled and exhaled*. Videos *Diffusion through the stomata*; *Long dives*.

### 2: Smoking machine

**Securing**

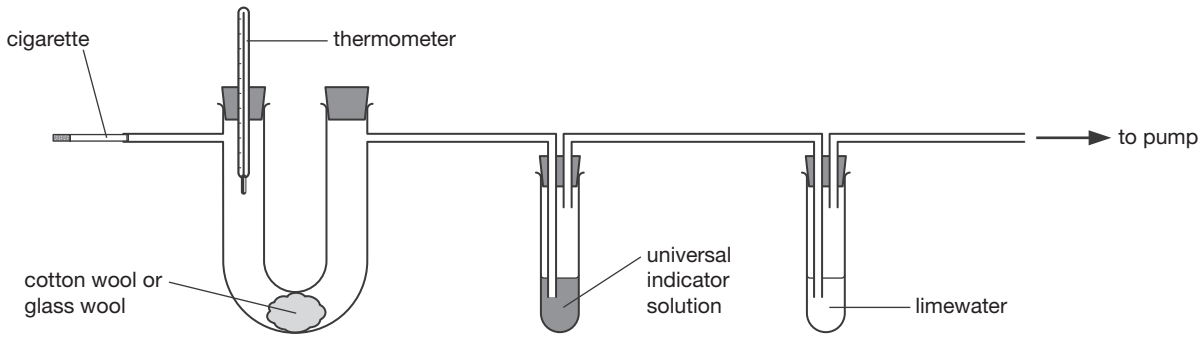
**Prac**

This demonstration seeks to link together ideas about detection of the products of respiration/combustion with ideas about smoking from the last topic. Set up the apparatus as shown in the figure below.

When air is drawn through with an unlit cigarette no changes are seen. With a lit cigarette, the temperature of the smoke can be measured, tar is seen to collect in the U-tube, the indicator turns red, showing the smoke is acidic, and the limewater turns cloudy, due to carbon dioxide. The most dramatic tar effects are seen when a high-tar cigarette is used. If a bung with a hole is used in the second arm of the U-tube, the effect of taking 'puffs' on the cigarette can be simulated by covering and uncovering the hole with a gloved finger.

If water pressure is low, a filter pump might not work. Using a hand vacuum pump is an alternative. Operating the smoking machine in a working fume cupboard will cause the cigarette to burn down quickly. You can counter this by turning the airflow right down or only turning on the airflow after the cigarette has burned. However, smoke should not be permitted to leak into the laboratory. If the cupboard leaks, it should be switched on during the experiment.

Ask students to predict what will happen before you carry out this demonstration. They should be able to see that cigarette smoke is hot, contains tar, contains acidic gases and contains carbon dioxide. The acidic gases are made up mainly of carbon dioxide with small amounts of nitrous oxides and carboxylic acids.




This demonstration must be carried out in a fume cupboard. Note that the tar collected on the glass wool must not be touched. It is acceptable for students to smell the contaminated glass wool by gently wafting air towards their noses from over the U-tube (with the bung removed), but not to inhale deeply. Technicians must dismantle the apparatus wearing chemical-resistant gloves and working in a fume cupboard. Consider disposing of the U-tube rather than cleaning it for reuse.

**Equipment**
Two boiling tubes with two-holed bungs, glass U-tube containing glass wool, two single-holed bungs for U-tube, high-tar cigarette, limewater, a few drops of universal indicator or 0.1% bromothymol blue in 2 cm depth of water in a boiling tube, or hydrogen carbonate indicator, delivery tubes to connect apparatus, suction pump.

### 3: Gills

**Securing**

The **AT** presentation *How gills work* explains how gills allow gas exchange. Supplement this by showing students gill movements in fish (if you have some in the lab or using Internet video material). Point out that many species of shark have to keep moving in order to allow water to continually flow over their gills, whereas bony fish can pump water over their gills whilst stationary.

**Course resources**
**AT**: Presentation *How gills work*.

**Equipment**
Optional: fish in tank, video camera and screen.

## PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

### 1: Quick Check

**Developing/Securing/Exceeding**

**FA**

*Assessment:* The 8Cd Quick Check sheet contains a range of questions for students to answer.

*Feedback:* Students compare their worksheets agreeing on the correct answers and improving answers that need more writing (4a).

*Action:* Ask random students about what they could have improved about their answers. Ascertain which aspects were a particular problem to students and go over these again, with reference to the Student Book.

**Course resources**
**ASP:** 8Cd Quick Check.

### 2: Thinking about comparing gas exchange

**Securing**

**FA**

*Assessment:*

**Plus, Minus, Interesting:** Fish should have lungs to breathe. (Possible answers: **Plus** – Fish would be able to breathe in air; **Minus** – Fish would not be able to breathe underwater; **Interesting** – Do some fish have lungs or both lungs and gills? Are there any organisms that have both lungs and gills at the same time or in different parts of their life cycle? The African lung fish has both lungs and gills.)

**What Was The Question:** stomata. (Possible questions: What is the plural of stoma?; What are the holes on a leaf called?; Through what does gas exchange happen in a leaf?)

**What Was The Question:** limewater. (Possible questions: What liquid is used to test for carbon dioxide?; What liquid goes cloudy if carbon dioxide is passed through it?)

**Consider All Possibilities:** Many fish use a flap (the operculum) over their gills to push water through their gills. Two fish in two different bowls are opening and closing their opercula at different rates. (Possible answers: they are different species and one species always flaps at a different rate; one bowl of water is hotter than the other; one bowl of water contains more oxygen than the other; one of the fish is sick.)

**Odd One Out:** nitrogen, oxygen, carbon dioxide, water vapour. (Possible answers: oxygen is the only one our bodies extract from air; carbon dioxide is the only one that makes limewater go cloudy or changes the colour of hydrogen carbonate indicator; water is the only one that changes the colour of cobalt chloride; water is the only one that is a liquid at room temperature.)

*Feedback:* Ask each group to appoint a spokesperson to read out the agreed answers to the class. Ask other spokespeople to add to the list.

*Action:* Get other groups to identify and, if possible, to correct any misconceptions evident in the answers given. Even if they can't correct an answer, students should be encouraged to identify where they are not sure that something is correct and to suggest an idea or topic that would help them produce a better answer. After a class discussion on the key ideas needed, students can then refer to the Student Book to improve their answers.

The **AT** presentation *8Cd Thinking skills* can be used for this activity.

**Course resources**
**AT:** *8Cd Thinking skills*.

### 3: Differences in air 2

**Developing/Securing**

**FA**

Repeat Starter 1 by referring to the chart created in that activity or by asking students to list the ways they think that inhaled air is different from exhaled air. Students should justify their answers. Create a chart on the board that contains a list of differences and a list of explanations for those differences and/or refer to the chart in the Student Book. Give each group of students a different challenge that they have to discuss for three minutes and then explain to the class. For example: 'What would happen to water in an aquarium that only had some fish in it?', 'Or a dark aquarium that only had pondweed in it?', 'Or to the air (and people) in a poorly ventilated room with many people in it?', 'Or the same room with plants in it?'. Challenge students to suggest ways in which the changes could be detected.

## HOMEWORK TASKS

### 1: Respiration in plants and animals

**Developing/Securing**

Worksheet 8Cd-7 contains straightforward questions on respiration in plants and animals and its detection.

**Course resources**
**AP:** Worksheet 8Cd-7.

**2: Differences in gas exchange**
**Securing**

Worksheet 8Cd-8 contains questions on gas exchange and respiration in fish, germinating peas and other plants.

**Course resources**
**AP:** Worksheet 8Cd-8.

**3: Efficient gas exchange**
**Securing/Exceeding**

Worksheet 8Cd-9 asks students to interpret information on the efficiencies and limitations of different methods of gas exchange.

**Course resources**
**AP:** Worksheet 8Cd-9.

**ActiveLearn**

Three ActiveLearn exercises are available for this topic: Comparing gas exchange 1; Comparing gas exchange 2; Comparing gas exchange 3.

# 8Ce
# Anaerobic respiration

This grid shows the basic concepts met in this topic, together with a scheme of cognitive progression for each concept. Opportunities to cover learning and progression are given. Working Scientifically concepts are integrated throughout the materials.

| Conceptual statement | Cognitive progress | | | | | |
|---|---|---|---|---|---|---|
| | Remembering (a) | Understanding (b) | Applying (c) | Analysing (d) | Evaluating (e) | Synthesising & creating (f) |
| Aerobic and anaerobic respiration can occur when we exercise. | Recall what happens in anaerobic respiration in humans. | Explain why aerobic and anaerobic respiration occur in humans at the same time.<br>Describe how lactic acid is removed from tissues. | Explain why anaerobic activity cannot be sustained. | Analyse and explain the changes in heartbeat and breathing rate during and after exercise (including EPOC/ oxygen debt). | Compare the different forms of respiration used by athletes in different types of activity. | |
| Anaerobic respiration does not require oxygen. | Recall that anaerobic respiration releases less energy than aerobic respiration.<br>State the meaning of: anaerobic respiration. | | Model anaerobic respiration using a word equation. | | Evaluate the use of a word equation to model anaerobic respiration. | |

**Objectives**
Developing:

1. Recall what happens in anaerobic respiration in humans.
2. Explain why aerobic and anaerobic respiration occur in humans at the same time.

Securing:

3. Recall that anaerobic respiration releases less energy than aerobic respiration.
4. Model anaerobic respiration using a word equation.
5. Describe how lactic acid is removed from tissues.
6. Explain why anaerobic activity cannot be sustained.
7. Analyse and explain the changes in heartbeat and breathing rate during and after exercise (including EPOC/oxygen debt).

Exceeding:

8. Explain the effects of poisons that disrupt certain metabolic processes.

## Student materials

### Topic notes

- Note that there is a general misconception that lactic acid produced by anaerobic respiration causes muscle fatigue. Current research does not really support this idea, and Worksheet 8Ce-4 considers how this theory is now changing. See Background information.

**Be prepared**
Exploring 3 requires a hand weight and a swimming armband.

### STARTERS

**1: Holding your breath**
**Securing**
**BA** **Lit**
Ask students to pose questions and to suggest answers on the topic of 'holding your breath'. Give groups a couple of minutes on this before asking groups to combine. The combined groups should compare their questions and answers and prepare two statements: one that compares a similarity between the groups' work and one that contrasts a difference. Ask a spokesperson from each group to present the statements. For example: 'Both the groups asked a question about why we can't hold our breaths for a long time', 'Their suggestion as to why we can't hold our breaths for very long is because oxygen runs out and that was what our group thought too', 'They asked a question about the longest time a human can hold their breath for, but we asked about

the mammal that could hold its breath for the longest'.

It may be useful to write some 'signal words or phrases' on the board: for example,

Comparison words: as well as, also, both, like, much as, similarly, similar to, too.

Contrast words: although, but, different from, however, on the other hand, though, unlike, while, yet.

**2: Anaerobic brainstorm**

**Securing**

**BA**

Write the term 'anaerobic respiration' on the board and ask students to write a definition for it. Students could work in groups or on their own. Take suggestions from randomly selected students and use them to construct one agreed final definition: Anaerobic respiration is the chemical breakdown of food/glucose in living cells that does not need oxygen.

Students should correct their first attempt with a different coloured pen, so they can see how they improved the definition after discussion.

**Equipment**
Random student-picker software (optional).

**3: Sprint video**

**Securing/Exceeding**

**BA**

Show students a video clip showing runners at the end of a long race (for example, 1500 m, 3000 m). Ask students what the runners feel like at the end of the race, compared with at the beginning. Elicit ideas such as they are breathing harder, their pulse rates are higher, they are hotter, their muscles are burning. Ask students why these changes have occurred (to increase the rate of respiration, as a result of respiration and muscles getting tired). Then ask students to spot what the runners do after the race and to suggest why they do this (bending over and panting). Explain that this is because their bodies need extra oxygen after a race, compared with normal.

Extend this activity by asking students to annotate a sketch of a runner to show what they feel like at the end of a race and why.

The **AT** video *End of a race* is a suitable video for this task.

**Course resources**
**AT:** Video *End of a race.*

## EXPLORING TASKS

**1: Clenched fists**

**Securing**

This simple practical can be used on its own or as an introduction to Exploring 2 or Exploring 3. Ask pupils to hold their hands by their sides and clench and unclench their fists as fast as they can for 30 seconds. Then allow them to rest before asking them to do the same thing with their hands held in the air. They won't be able to do nearly as many clenches. Ask pupils if they have any hypotheses as to why this happens. Elicit the idea that holding the arm up reduces blood supply to the hand and so the muscle cells use more anaerobic respiration. Anaerobic respiration causes the muscles to fatigue much more quickly.

*Securing:* Challenge students to say how they might test their hypotheses if they had access to a blood flow meter (for example, by measuring blood flow to the hand in different positions).

**2: Finger exercises**

**Developing/Securing/Exceeding**

**Prac**

Worksheet 8Ce-2 contains instructions for this simple practical in which students open and close clothes pegs with their arms in different positions. Students will find that the number of times they can open a clothes peg decreases with time, as muscles start to get tired due to anaerobic respiration.

*Developing:* Students carry out the practical as set.

*Securing:* Ask students to suggest how the experiment could be modified in order to test the hypothesis that the length of time 'finger muscles' can work depends on the height of the arm. Note that the muscles that operate the fingers are in fact in the lower arm. They should find that when the arm is raised, their ability to do this is reduced due to less blood flowing to the muscles.

*Exceeding:* Ask students to suggest how the experiment could be altered to find the mean time required for 'finger muscles' to recover from anaerobic respiration (for example, by altering the length of the rest period in step C on Worksheet 8Ce-2).

Students with any muscular problem or arthritis/rheumatism should not take part in the activity. Students must stop if they feel the activity is becoming painful. Pegs must be in good condition with no rusting.

**Course resources**
**AP:** Worksheet 8Ce-2.

**Equipment**
Stop clock, clothes pegs.

### 3: Handweights and respiration

**Securing/Exceeding**

Prac WS

Ask students to propose a hypothesis and a prediction once the method for this practical has been explained.

One student places his/her arm on the bench and is given a handweight. They then see how many times they can raise and lower the weight in 30 seconds, keeping an elbow on the bench and bringing the weight into a vertical position each time. A swimming armband is then placed around the top of the arm, in its usual position, and inflated. This will reduce the blood flow to the hand. Students then repeat the weight lifting and record the results.

*Exceeding:* Challenge students to evaluate this experiment (for example, by thinking about whether having lifted the weight already will affect the second test, rather than the armband, and how this could be solved by different groups doing the tests in different orders).

**Equipment**
Hand weight (for example, from the PE department), stop clock, inflatable swimming armband.
Optional: towel (on which to rest elbow).

### 4: Comparing respiration

**Securing**

Worksheet 8Ce-3 is a simple cut-out-and-stick sheet, which asks students to compare aerobic respiration with anaerobic respiration.

*Developing:* Remove the bottom row of cards before giving the sheet to students.

*Securing:* Give students the entire sheet.

*Exceeding:* Challenge students to identify a further difference not given on the sheet (for example, anaerobic respiration releases less energy than aerobic respiration).

**Course resources**
**AP:** Worksheet 8Ce-3.

**Equipment**
Scissors, glue.

### 5: Changing ideas about anaerobic respiration

**Securing**

Worksheet 8Ce-4 challenges students to match phrases against a model of the 'scientific method', showing how scientists' ideas about the causes of muscle tiredness have changed over the last 80 years or so. This is a classic case of discovering that correlation does not necessarily show causation.

*Securing:* Tell students that the top six cards show one cycle of the scientific method and the bottom six cards show another. Give them copies of Skills Sheet SI 1 from the Year 7 Activity Pack to help them.

*Exceeding:* Give students the sheet as it is, without help.

**Course resources**
**AP:** Skills Sheet SI 1 *(*Year 7*)*. Worksheet 8Ce-4.

**Equipment**
Scissors, glue, piece of paper.

### 6: Respiration adverts

**Securing/Exceeding**

Lit

Challenge students to design an advert (for example, for a webpage, poster) for either aerobic or anaerobic respiration. Their advert is to be aimed at cells, trying to persuade them to use one type of respiration more than another.

**Equipment**
Computer with design software or coloured pens and paper (optional).

### 7: Respiration research

**Securing/Exceeding**

Ask students to find out about the differences between anaerobic respiration in humans and anaerobic respiration in other organisms. Students could produce a simple table giving the name of the organism and the products of anaerobic respiration in that organism. Note that anaerobic respiration in bacteria and yeast is covered in Unit 8D.

*Exceeding:* Challenge students to find examples of obligate/facultative aerobes/anaerobes.

**Equipment**
Computer with design software or coloured pens and paper (optional).

### 8: Debate

**Developing/Securing/Exceeding**

Lit

There is an opportunity for a debate presented on Student Book page 8Ce Fitness training. Refer to Skills Sheet RC 5 from the Year 7 Activity Pack for ideas on how to run a debate.

**Course resources**
**AP:** Skills Sheet RC 5 (Year 7).

## EXPLAINING TASKS

**1: 8Ce Anaerobic respiration (Student Book)**
**Developing/Securing/Exceeding**
**FA**

This spread looks at anaerobic respiration in humans and other mammals. Anaerobic respiration in microorganisms is covered in Unit 8D. Worksheet 8Ce-1 is the Access Sheet.

Note that the term 'lactic acid' has been used throughout, not 'lactate'. In very basic terms, the former is the acidic version of the latter, but it is the latter that is actually being measured in photo E in the Student Book.

Questions 5 and 7 are both suitable for formative assessment, with students working in groups to prepare answers. Ask random groups to give their answer for one of the plants and ensure that other groups agree. For question 5, students may find the 'signal words/phrases' lists from Starter 1 useful.

The **AT** animation *Anaerobic respiration in muscles* shows how muscles require energy from anaerobic respiration as activity level increases, and why breathing and heart rate remain raised after exercise. See Explaining 2.

The **AT** interactive *Why extra oxygen is needed* asks students to link sentences in order to show why extra oxygen is needed after strenuous exercise.

Using the **AT** interactive *Concept cartoon: Do plants respire?*, students can discuss whether or not plants breathe and respire as well as photosynthesising.

The **AT** link *EPOC* allows you to turn the labels on and off on graph D.

The **AT** spreadsheet *Lactic acid concentration* allows students to draw graphs of and interpret information about how lactic acid concentrations change when you undertake strenuous exercise, what happens to lactic acid concentrations if you train and what happens to lactic acid levels after exercise.

The **AT** video *Measuring lactate* explains why athletes have lactate measurements. Point out to students that lactic acid and lactate are 'the same thing' before using this material. See note above.

The **AT** video *End of a race* shows women athletes running across the finish line of a 5000 metre race being very out of breath. See Starter 3.

The **AT** presentation *8Ce Thinking skills* can be used for this activity. See Plenary 2.

**Course resources**
**AP:** Worksheet 8Ce-1.
**AT:** Animation *Anaerobic respiration in muscles*. Interactives *Concept cartoon: Do plants respire?*; *Why extra oxygen is needed*. Labels on/off *EPOC*. Presentation *8Ce Thinking skills*. Spreadsheet *Lactic acid concentration*. Videos *End of a race*; *Measuring lactate*.

**2: Anaerobic respiration in muscle cells**
**Securing/Exceeding**

The **AT** animation *Anaerobic respiration in muscles* shows muscle cells that are contracting and relaxing slowly, and explains how oxygen is delivered to the muscle to constantly replenish the muscle's own store of oxygen. The animation then goes on to show what happens when the muscle cells contract faster and anaerobic respiration kicks in. Point out to students that aerobic respiration does not stop as this happens.

**Course resources**
**AT:** Animation *Anaerobic respiration in muscles*.

**3: 8Ce Fitness training (Student Book)**
**Developing/Securing/Exceeding**
**FA**

This final page takes a look at the effects of fitness training on the body. The questions revise different ideas met in this unit.

The **AT** spreadsheet *Exercise correlations* allows students to draw graphs/charts showing the effects of training on the body. There are questions that challenge students to explain these effects.

**Course resources**
**AT:** Spreadsheet *Exercise correlations*.

## PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

**1: Quick Check**
**Developing/Securing/Exceeding**
**FA** **Lit**

*Assessment:* The 8Ce Quick Check sheet provides a set of cards containing various statements about respiration. You can limit this to cover only the work in this topic by using the cards in the top box on the sheet. Using all the cards will allow fuller coverage of learning from the whole unit. Ask students,

working in small groups, to discuss and sort the cards into two piles – true and false. They then use the true statements to write a summary/summaries paragraph(s) of their understanding, linking the phrases together using suitable conjunctions. (They can write the sentences individually or in pairs.)

*Feedback:* Ask students at random to read out one of their summary sentences. After five or six students have had a go, ask if any students have different sentences.

*Action:* Write out examples of good summary sentences on the board and ask students to explain why they are good. Summary Sheets are provided to help students with revision. Hand out the Summary Sheets for this unit and ask students to find sentences on the sheet that match those on the board the most closely.

**Course resources**
**ASP:** 8Ce Quick Check; 8C Summary Sheets.

**2: Thinking about anaerobic respiration**
**Developing/Securing**
**FA**

*Assessment:*
**Plus, Minus, Interesting:** We should not be able to respire anaerobically. (Possible answers: **Plus** – Our bodies would not need to get rid of lactic acid/change lactic acid back into glucose; **Minus** – We may not be able to release enough energy in an instant to escape from danger; **Interesting** – Some organisms can only respire aerobically and some can only respire anaerobically. Are there different types of anaerobic respiration?)

**Plus, Minus, Interesting:** We should only use anaerobic respiration. (Possible answers: **Plus** – We would not need to breathe air and so could live underwater or on land; **Minus** – Anaerobic respiration does not provide very much energy so we wouldn't be able to move very fast for very long; **Interesting** – Yeast cells can use just anaerobic respiration or just aerobic expiration (or both.) Does all anaerobic respiration produce lactic acid?)

**Consider All Possibilities:** Sasha's muscles are aching. (Possible answers: she has just been doing strenuous exercise; she did strenuous exercise two days ago; she has influenza.)

**Consider All Possibilities:** Jude's pulse rate is racing. (Possible answers: he's doing strenuous exercise; he's just stopped doing strenuous exercise; he's had a fright; he's very nervous.)

**Odd One Out:** water, carbon dioxide, lactic acid. (Possible answers: lactic acid is not produced by aerobic respiration; water is not acidic; carbon dioxide is a gas; carbon dioxide will turn limewater milky.)

*Feedback:* Students answer the thinking skills questions in groups, thereby feeding back their thoughts to one another. Ask students to write down their best answers and consider why they think they are the best.

*Action:* Ask a spokesperson from a number of groups to read out their best answers, explaining why they judge these to be good answers. Identify any ideas that are missing and share them with the class. If understanding is poor then revise the concepts using the Student Book.

The **AT** presentation *8Ce Thinking skills* can be used for this activity.

**Course resources**
**AT:** *8Ce Thinking skills.*

**3: Swim training: Open-ended Assessment Task**
**Developing/Securing/Exceeding**
**FA** SA

Tell students a talent scout has been asked to come to the school to watch the swimming gala and see if any students might be considered for training in the national team. The scout is going to watch the races, looking for certain things and also carry out some tests on the more promising students. Students need to write a letter home to parents to explain exactly what is going to happen and why and to ask for their consent. Instructions for students are given at the top of the Assess Yourself! sheet.

You can assess this activity by using the Open-ended Assessment Task sheet or students can assess their own performance by using the Assess Yourself! Sheet (see the ASP). Get students to reflect on what they did well in this activity and what they need to improve on. After feedback, give students an opportunity to improve their work and have it re-assessed by the teacher or a peer.

**Course resources**
**ASP:** 8C Assess Yourself!; 8C Open-ended Assessment Task.

**4: Quick Quiz**
**Developing/Securing/Exceeding**
**FA** SA

Revisit the 8C Quick Quiz to test students' knowledge of the content of this unit. Students could fill in their answers on the 8C Quick Quiz Answer Sheet.

Encourage students to identify for themselves areas where their understanding is still weak and decide how they are going to remedy this. For example, ask students why they found certain questions more difficult. They can categorise their issues as, for example, 'do not understand the science'; 'did not read the question properly'.

Extend this activity by challenging students to design Quick Quiz questions on the subjects that they still find difficult. The additional questions could be tried out in groups.

**Course resources**
**ASP:** 8C Quick Quiz; 8C Quick Quiz Answer Sheet.

**5: End of Unit Test**
**Developing/Securing/Exceeding**
**SA**

Use either or both of the End of Unit Tests. A Mark Scheme is given in the ASP. Encourage students to identify areas that are still weak and to formulate plans to strengthen those areas.

Using the Progression Check sheet, encourage students to identify areas in the test they marked that are still weak and to help their partner to formulate plans to strengthen those areas. Summary Sheets are provided to help students with revision.

Extend this activity by getting students to produce questions on areas where they need further clarification. Spread these out around the room. Other students then choose one question to attempt to answer – writing this on the same piece of paper. Students then return to their original question and comment on how well they think the answer provided helps them.

**Course resources**
**ASP:** 8C End of Unit Test Standard (S); 8C End of Unit Test Higher (H); 8C Mark Scheme; 8C Progression Check; 8C Summary Sheets.

**6: Progression Check**
**Developing/Securing/Exceeding**
**SA**

Students should circle the stars next to each statement on the Progression Check to record what they feel they know, and how certain they are of it. Encourage students to plan how to do further work on the things about which they remain unsure. Encourage students to note down any evidence they have for claiming 'confidence', for example an activity well done. Students can pair up with a 'critical friend' who is responsible for checking their action plan for addressing any remaining areas of uncertainty and checking that any suggested actions have been carried out. Notes on this check should then be reported to the teacher.

**Course resources**
**ASP:** 8C Progression Check.

## HOMEWORK TASKS

**1: Aerobic and anaerobic respiration**
**Developing/Securing**

Worksheet 8Ce-5 contains straightforward questions about aerobic and anaerobic respiration.

**Course resources**
**AP:** Worksheet 8Ce-5.

**2: Maggot and human respiration**
**Securing/Exceeding**

Worksheet 8Ce-6 asks students to apply their knowledge about aerobic and anaerobic respiration.

**Course resources**
**AP:** Worksheet 8Ce-6.

**3: Cellular respiration**
**Exceeding**

Worksheet 8Ce-7 challenges students to interpret experimental data about aerobic and anaerobic respiration.

**Course resources**
**AP:** Worksheet 8Ce-7.

**ActiveLearn**

Three ActiveLearn exercises are available for this topic: Anaerobic respiration 1; Anaerobic respiration 2; Anaerobic respiration 3.