1 Respiration

› 1.1 The human respiratory system

In this topic you will:

- learn the names of the different parts of the human respiratory system
- observe carefully, and record your observations, as the structure of lungs is demonstrated.

Getting started

Respiration is one of the characteristics of living things.

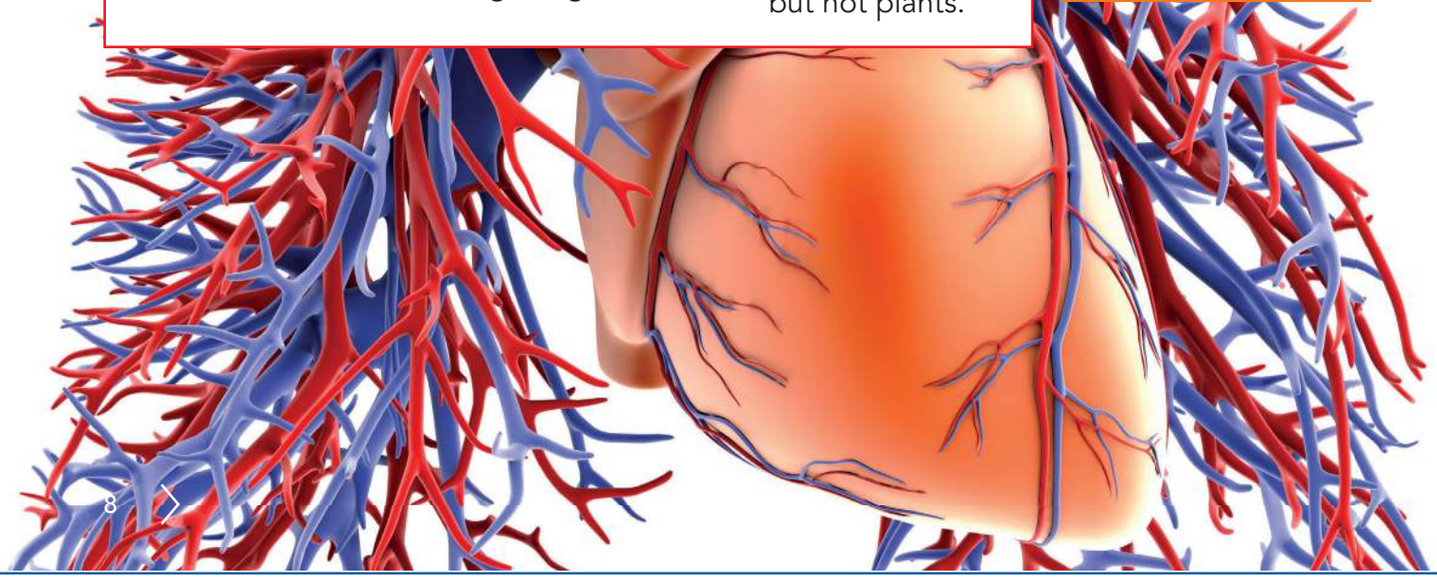
With a partner, decide which statement in each pair is correct.

Be ready to share your ideas.

First pair:	Respiration happens inside all the cells in your body.	or	Respiration only happens in cells in your lungs.
Second pair:	Respiration releases energy from food.	or	Respiration uses up energy.
Third pair:	Respiration happens in all living things.	or	Respiration happens in animals but not plants.

Key words

aerobic respiration
air sac
bronchiole
bronchus
cartilage
larynx
respiration
respiratory system
trachea
vocal cords
voicebox
windpipe



Why we need oxygen

You may remember that one of the characteristics shared by all living things is **respiration**. Respiration is a series of chemical reactions that happens inside every living cell.

The kind of respiration that usually happens inside our cells is called **aerobic respiration**. Aerobic respiration uses oxygen. The cells produce carbon dioxide as a waste product.

The air around you contains oxygen. When you breathe, you take air into your lungs. Some of the oxygen from the air goes into your blood. The blood delivers the oxygen to every cell in your body, so that the cells can use it for respiration. The blood collects the waste carbon dioxide from the cells, and takes it back to your lungs.

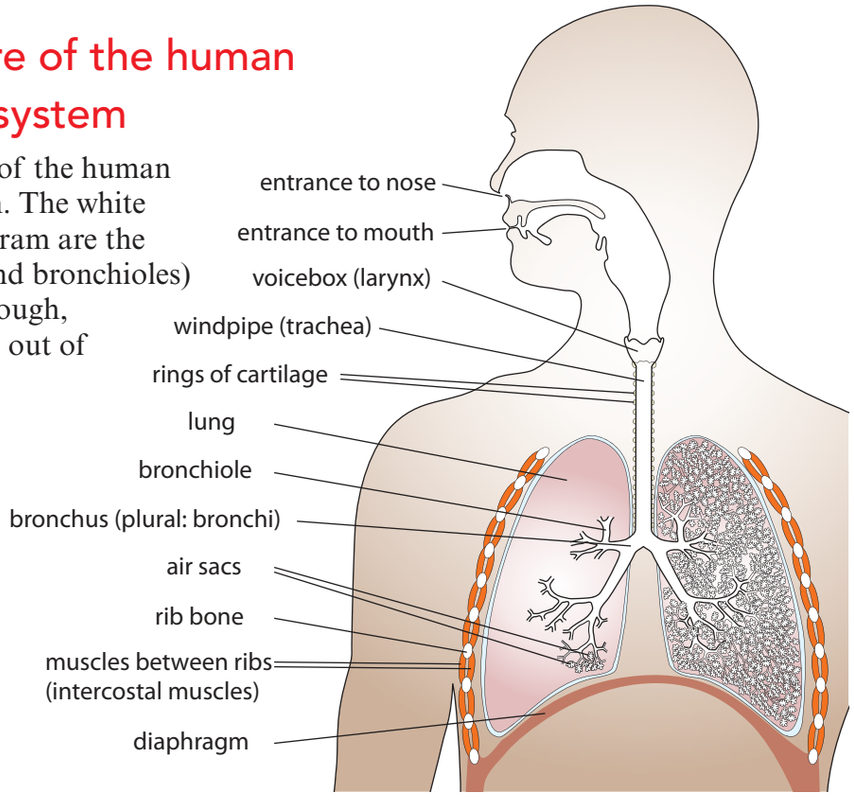
The organs that help you to take oxygen out of the air, and get rid of carbon dioxide, make up the **respiratory system**.

Can you name any of the other organs shown in the picture on the right?

In this model of the human body, the lungs are shown in pink

The structure of the human respiratory system

This is a diagram of the human respiratory system. The white spaces in this diagram are the 'tubes' (bronchi and bronchioles) that air moves through, as it goes into and out of your lungs.



The human respiratory system

Questions

1 Put your finger on the entrance to the nose or mouth in the diagram of the respiratory system. Move your finger along the white space and down into the lungs.

Write down the structures that the air passes through, as it moves down into your lungs. Write them in the correct order.

2 Now write the same structures in the order in which air passes through them as it moves out of your lungs and back into your surroundings.

Air gets into your body through your mouth or nose. Your mouth and nose both connect to your **trachea**. The trachea is sometimes called the **windpipe**. It has strong rings of **cartilage** around it. These rings of cartilage keep the trachea open and prevent it collapsing, so that air can be kept moving in and out of your body. If you put your fingers on the front of your neck and move them downwards, you can feel the rings of cartilage on your trachea.

The trachea branches into two **bronchi** (singular: **bronchus**). The bronchi also have cartilage to support them. One bronchus goes to each lung. Each bronchus carries air deep into the lungs. Each bronchus divides into several smaller tubes called **bronchioles**. The structure of these branches allows the air to reach deeper into the lungs.

The bronchioles end by branching into many tiny structures called **air sacs**. This is where the oxygen goes into the blood, and the carbon dioxide comes out. You can find out more about this in the next topic.

Think like a scientist

Looking at lungs

In this activity, you are going to look carefully at some real lungs. You will practise using your senses of touch and sight to make observations, and record your observations. Before you start this activity, look carefully at the questions and make a risk assessment. Think about how you will reduce or overcome any risks. Be prepared to share your ideas.

You will need:

- a set of lungs from an animal, such as a sheep or goat (from a butcher)
- a big board to put the lungs onto
- hot water, soap and towels to wash your hands after handling the lungs

Questions

1 Describe what the lungs look like.

If you prefer, you could make a labelled drawing instead of writing about them.

Continued

2 Touch the lungs.

What do they feel like when you push them? Can you suggest why they feel like this? (Look at the diagram of the human respiratory system to help you.)

3 Look at the tube that carries air down into the lungs.

a What is the name of this tube?

b Feel the tube. What does it feel like?

c Follow the tube towards the lungs. Can you find where it divides into two?

What are the names of these two tubes?

d Now look at the top of the big tube, where it is wider.

What is the name of this wide part? What is its function?

The diagram of the respiratory system includes a lot of new words.

How are you going to learn this diagram and all of its labels?

Remember that, in a test, the diagram might not be exactly the same as this one.

Activity 1.1.1

What does the larynx do?

Hold the fingertips of one hand against your **larynx** (**voicebox**).

Keep your lips together, and make a loud humming sound.

Can you feel the larynx vibrating?

Your larynx contains your **vocal cords**. These are bands of muscle that stretch across your larynx. You can think of them as being like guitar strings. When your vocal cords vibrate, they make a sound.

Now make a higher-pitched humming sound. Then try a really deep pitched sound. Can you feel the larynx changing when you make the different sounds?

Summary checklist

- ☐ I can name the parts of the respiratory system, and identify them on a diagram.
- ☐ I can list the organs that air passes through, as it moves into and out of the lungs.

1.2 Gas exchange

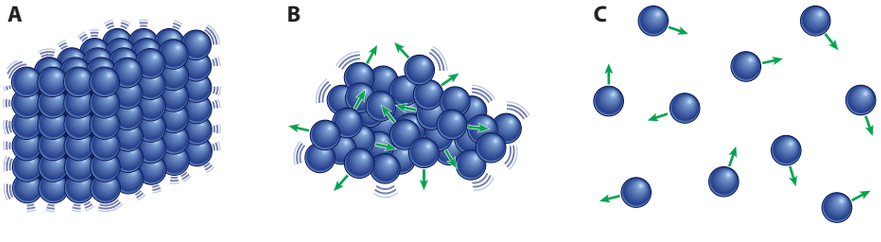
In this topic you will:

- find out how oxygen gets into your blood from the air, and how carbon dioxide goes in the other direction
- do an experiment to help you to think about why the air sacs in the lungs need to be very small
- do an experiment to compare how much carbon dioxide there is in the air you breathe in and the air you breathe out.

Getting started

This topic is about two gases – oxygen and carbon dioxide.

Look at these diagrams.



With your partner, answer these questions.

1 Which diagram shows the particles in a gas?

2 Choose the correct phrases to complete these sentences:

In a gas, the particles are **far apart** / **touching each other**.

In a gas, the particles **move freely** / **vibrate on the spot**.

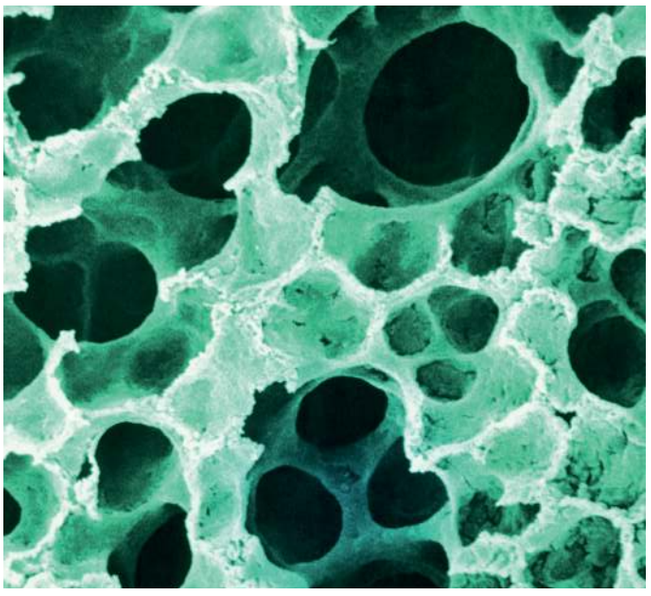
Key words

alveoli
analogy
capillaries
diffusion
expired air
gas exchange
haemoglobin
inspired air
limewater

Air sacs

The photograph shows a tiny part of the lungs, seen through a powerful microscope. You can see the lungs are mostly holes. These holes are called air sacs. Another name for them is **alveoli**.

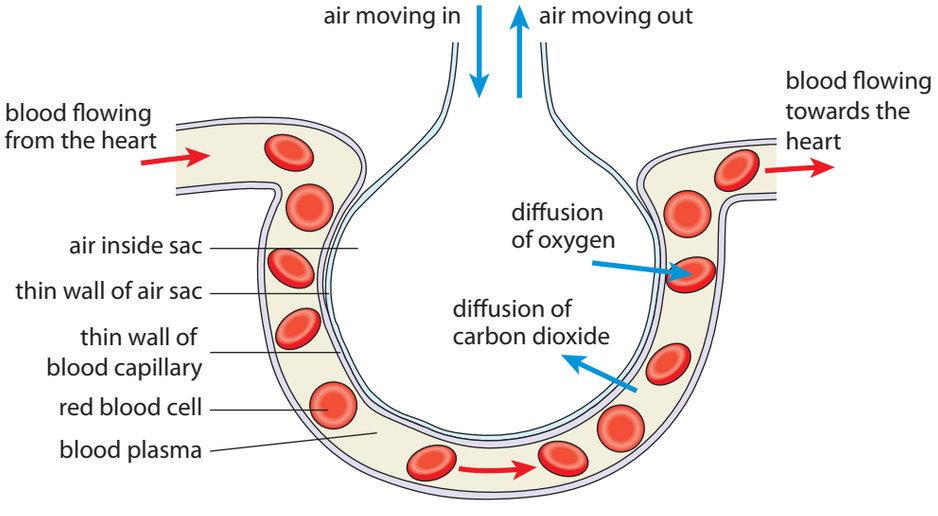
There are also lots of very tiny blood vessels in the lungs, wrapped around the air sacs. You cannot see them in the photograph, but they are shown in the diagram below. These blood vessels are **capillaries**.



Part of the lungs, viewed through a powerful microscope

The structure of an air sac

This diagram shows one of the air sacs in the lungs. The air sac has a wall made of one layer of cells. These cells are very thin.



An air sac in the lungs

You can see that there is a blood capillary around the outside of the alveolus. The capillary is pressed tightly against the alveolus. The wall of the capillary is also made of a single layer of very thin cells.

Gas exchange in the air sacs

Inside the air sacs, oxygen from the air goes into the blood. Carbon dioxide from the blood goes into the air. This is called **gas exchange**.

Think about the blood capillary on the left of the diagram. The blood inside this capillary comes from the heart. Before reaching the heart, it came from the organs in the body. These organs contain cells that respire, using up oxygen and making carbon dioxide. So the blood in this capillary contains only a small amount of oxygen, and a lot of carbon dioxide.

Now think about the air inside the air sac. It came from outside the body, where the air contains a lot of oxygen and only a small amount of carbon dioxide.

Inside the alveolus, this air is very close to the blood. There are only two very thin cells between the air and the blood.

The oxygen particles in the air are a gas, so they are moving freely. They can easily move from the air, through the thin-walled cells and into the blood. This is called **diffusion**. You can find out more about diffusion in Topic 3.7. The oxygen particules move from where there are a lot of them (in the air) to where there are fewer of them (in the blood).

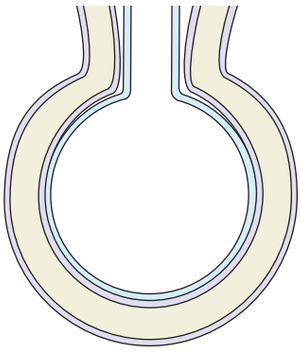
When the oxygen gets into the blood, it dissolves. (You can find out about dissolving in Topic 2.1.) The oxygen goes into the red blood cells where it combines with **haemoglobin**. You will find out what happens to it after that in Topic 1.6.

Now think about the carbon dioxide. There is a lot of it in the blood in the capillary, and only a small quantity in the air inside the air sac. So the carbon dioxide diffuses into the air in the air sac.

Activity 1.2.1

Gases in and out

Copy this diagram.



1. On your diagram, draw a **green** arrow to show how oxygen diffuses from the air into the blood.
2. How many cells does the oxygen move through, as it leaves the air and goes into the blood?
3. On your diagram, draw a **blue** arrow to show how carbon dioxide diffuses from the blood into the air.

Think like a scientist

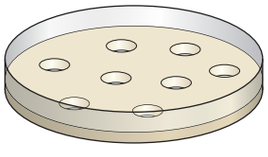
Why are air sacs so small?

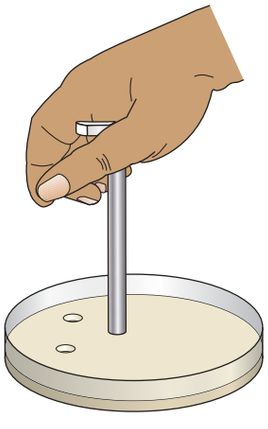
In this activity, you will use some agar jelly to represent the lungs, and some coloured liquid to represent oxygen in the air.

You will need:

- two Petri dishes filled with agar jelly
- two cork-borers, one with a diameter of 10 mm and the other with a diameter of 5 mm
- some coloured dye
- a dropper pipette

Method





1. Use the larger cork-borer to make eight holes in the jelly in one of the dishes. Space the holes evenly in the dish.
2. Now use the smaller cork-borer to make 32 holes in the jelly in the other dish. Try to space the holes evenly in the dish.
3. Using the dropper pipette, carefully fill each hole in both dishes with the coloured dye. Try to put the same quantity of dye into each hole. It's really important not to get any dye on the jelly!
4. Leave both dishes for at least 15 minutes.
5. Predict what you think will happen.
6. After 15 minutes (or a little bit longer if things are happening slowly) record your observations.

Questions

1. The holes that you made in the jelly represent the air sacs in the lungs. The coloured dye represents oxygen in the air sacs. The holes in the jelly are an **analogy** for the air sacs, and the dye is an analogy for oxygen.

   Explain how your observations help to show what happens to oxygen in the lungs.
2. The total volume of the 32 small holes is the same as the total volume of the eight large holes. Use your observations to suggest why it is better to have a lot of very small air sacs in the lungs, rather than just a few large ones.
3. Do you think that the agar jelly with holes is a good model for what happens in the lungs? Explain your answer.

Think like a scientist

Comparing the carbon dioxide content of inspired air and expired air

In this activity, you will use **limewater** to compare how much carbon dioxide there is in the air that you breathe in, with how much carbon dioxide there is in the air that you breathe out.

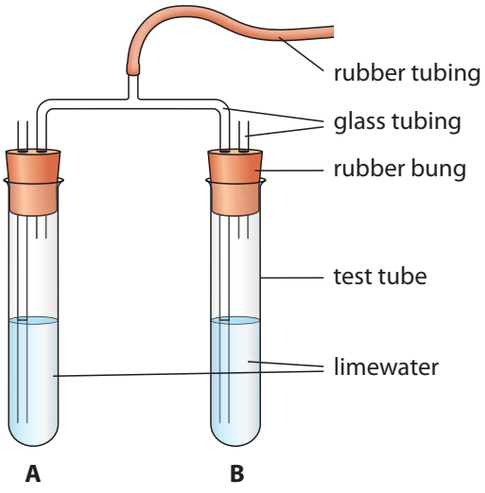
Work with a partner to do this activity.

You will need:

- rubber tubing
- glass tubing, as shown in the diagram
- two rubber bungs to fit the test tubes
- two test tubes
- limewater

Safety

It is very important that the rubber tubing is perfectly clean before you use it. Do not share the mouthpiece with anyone else or put it on the work surface when you have finished.



Method

1 Read through the method and make an assessment of all the risks. Decide how you will overcome or reduce these risks.

2 Look carefully at the apparatus.

Starting with the rubber tubing, follow the glass tube as it branches into the two test tubes.

What is different about the glass tubing that goes into test tube **A** and test tube **B**?

3 Now think about what might happen if you gently blow down the rubber tube.

Predict the tube in which you think bubbles will appear. Why do you think that?

4 Gently blow into the rubber tubing, until bubbles appear in one of the tubes. Was your prediction correct?

5 Now think about what might happen if you gently suck the rubber tube. Try it. Was your prediction correct?

6 Put your mouth over the end of the rubber tubing, and gently breathe in and out. Bubbles will appear in one tube as you breathe out, and in the other tube as you breathe in. Your partner will check the bubbles and can tell you if you are doing it correctly.

Be careful – don't suck too hard! Limewater is not poisonous, but it is not a good idea to get it into your mouth.

7 Continue until the limewater in one of the tubes has gone cloudy. Make a note of which tube it is.

Continued

Questions

1 The air that you breathe out is called **expired air**.

In which tube did your expired air bubble through the limewater?

2 The air that you breathe in is called **inspired air**.

In which tube did your inspired air bubble through the limewater?

3 In which tube did the limewater go cloudy first?

4 Name the gas that makes limewater go cloudy.

5 Copy and complete these sentences. Use some of these words:

A **B** **expired** **inspired** **less** **more**

The limewater went cloudy first in tube ……

This is the limewater that …… air bubbles through.

Our results show that expired air contains …… carbon dioxide than inspired air.

Self-assessment

Think about how you did the experiment.

Copy each bulleted statement, and then draw a face next to each one according to how well you think you performed.

☺ I think I did this really well.

😐 I did OK, but I could probably do better.

☹ I didn't do this very well at all.

- I worked out which tube the air would go into when I breathed in and when I breathed out.
- I managed to breathe in and out with just the right force to make the air bubble through the limewater.
- I stopped as soon as the limewater in one of the tubes went cloudy.
- I understand what this experiment shows about how much carbon dioxide there is in inspired air and expired air.

Is there anything that you would do differently if you did this experiment again?