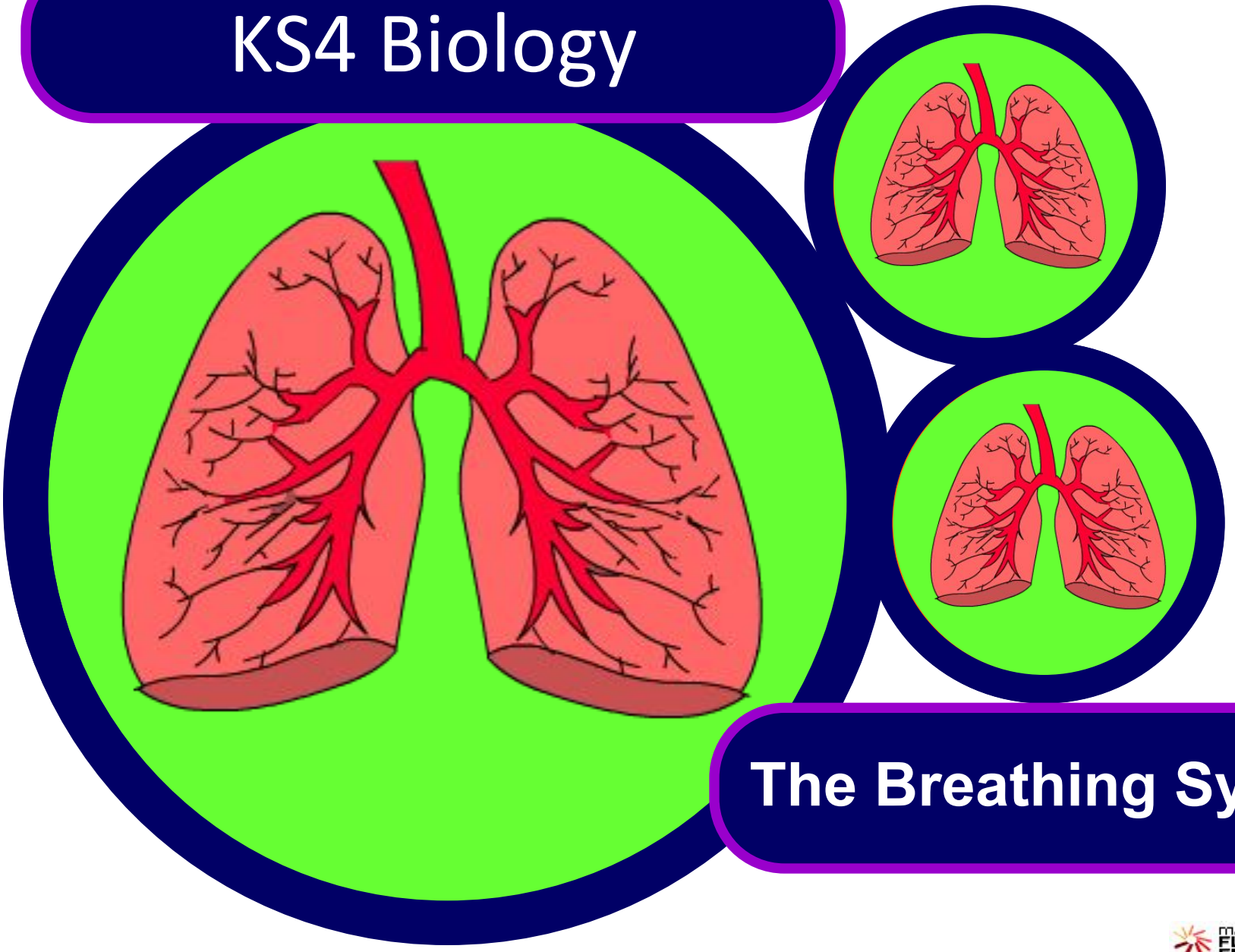
KS4 Biology



The Breathing System

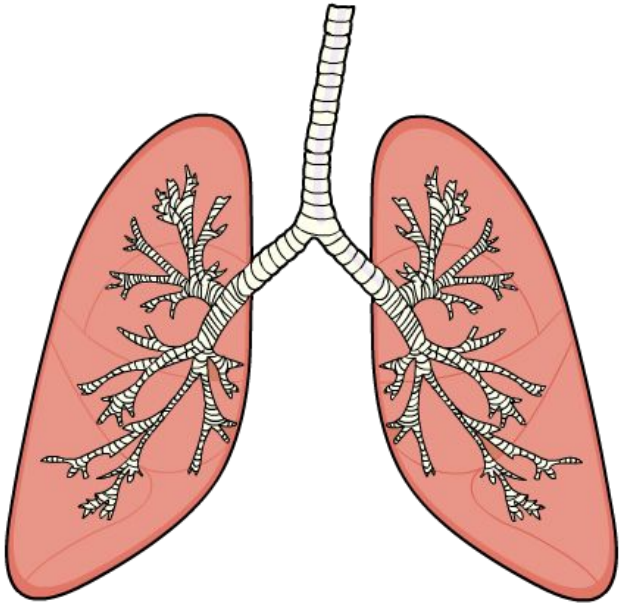
Contents

The Breathing System

What is breathing?

The body uses the respiratory system to get the oxygen needed for respiration.

It is also used to get rid of one of the waste products of respiration: the gas carbon dioxide.



Breathing in and breathing out are separate processes in the body.

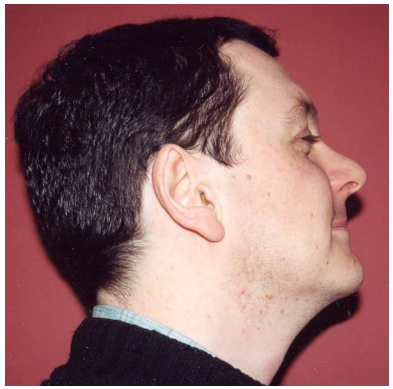
Breathing in is called inhalation. When you inhale, you breathe air, including oxygen, into your lungs.

Breathing out is called exhalation. When you exhale, you breathe out the contents of your lungs and get rid of the waste gas carbon dioxide.

Basics of breathing

Humans breathe to ensure that oxygen enters the body and that carbon dioxide leaves the body.

The breathing system



Oxygen (O_2)

Carbon Dioxide (CO_2)

Exercise, respiration and ventilation

Energy is used up by the active muscles during exercise. The rate of respiration must therefore increase to supply enough energy to the muscles.

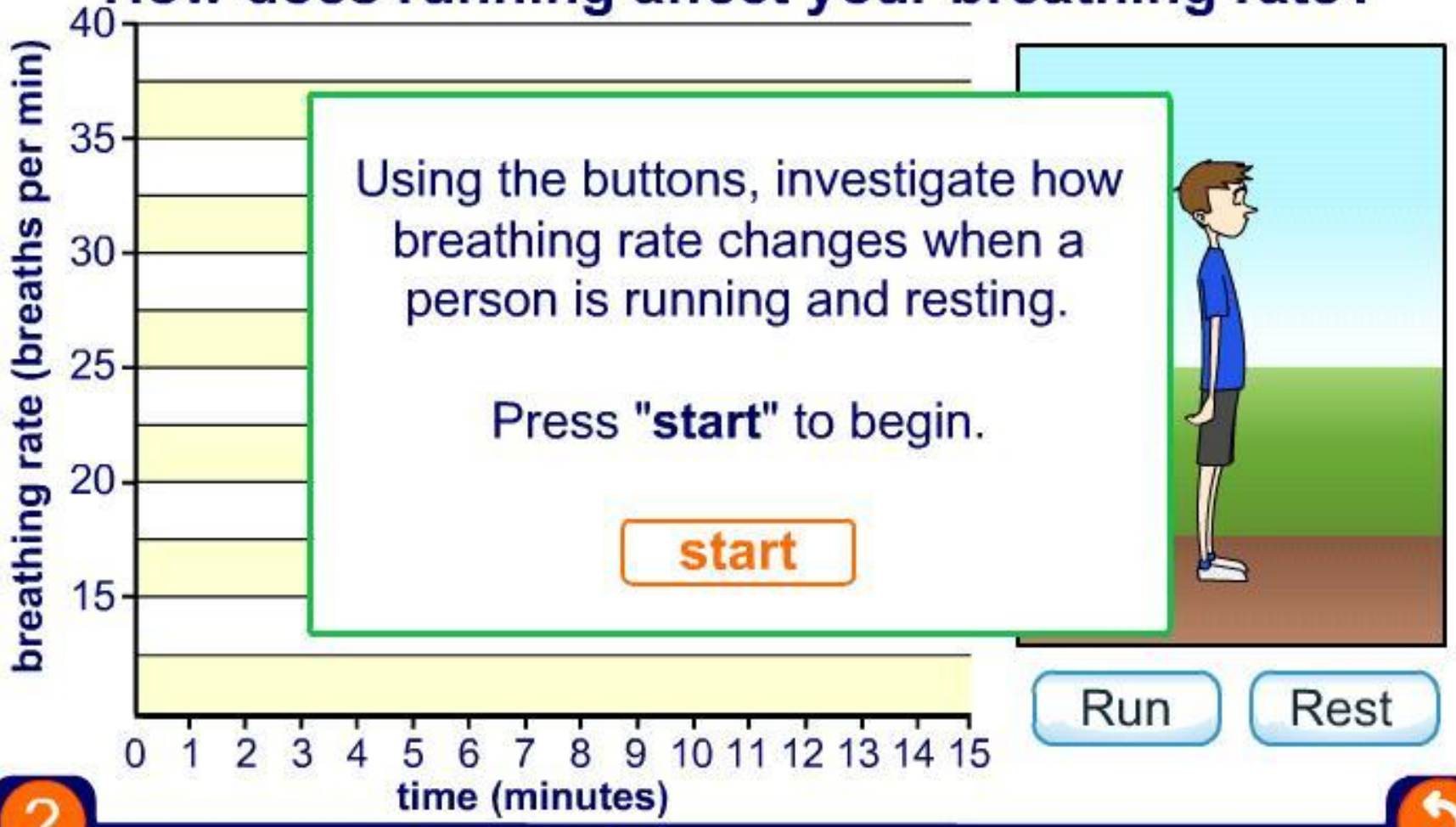
This means that more oxygen must be breathed in and more carbon dioxide breathed out.

During exercise, why does:

- the heart rate increase
- the rate and depth of breathing increase
- the arteries supplying the muscles dilate?

Running and breathing rates

How does running affect your breathing rate?



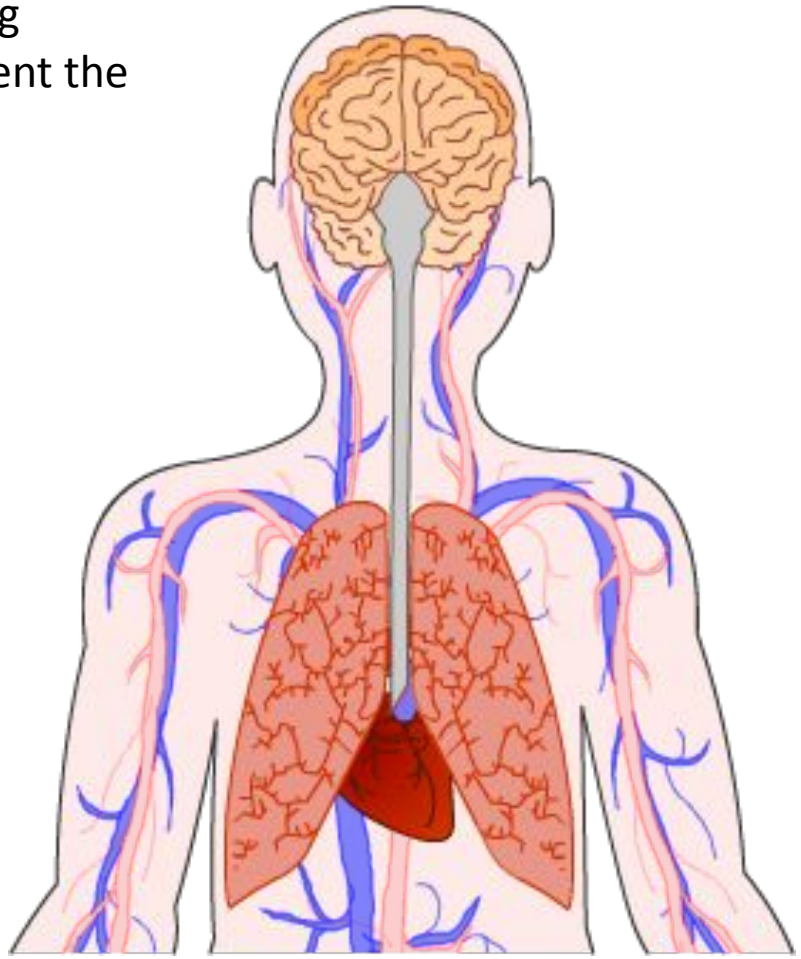
Carbon dioxide

The brain can detect the level of carbon dioxide in cells.

When the level of carbon dioxide increases during exercise, the brain must coordinate ways to prevent the levels reaching **toxic** levels.

One way the brain deals with a build up of carbon dioxide during exercise is by increasing the **rate of breathing**.

This increases the rate of gas exchange and the removal of carbon dioxide from the lungs.



What if you forget to breathe?

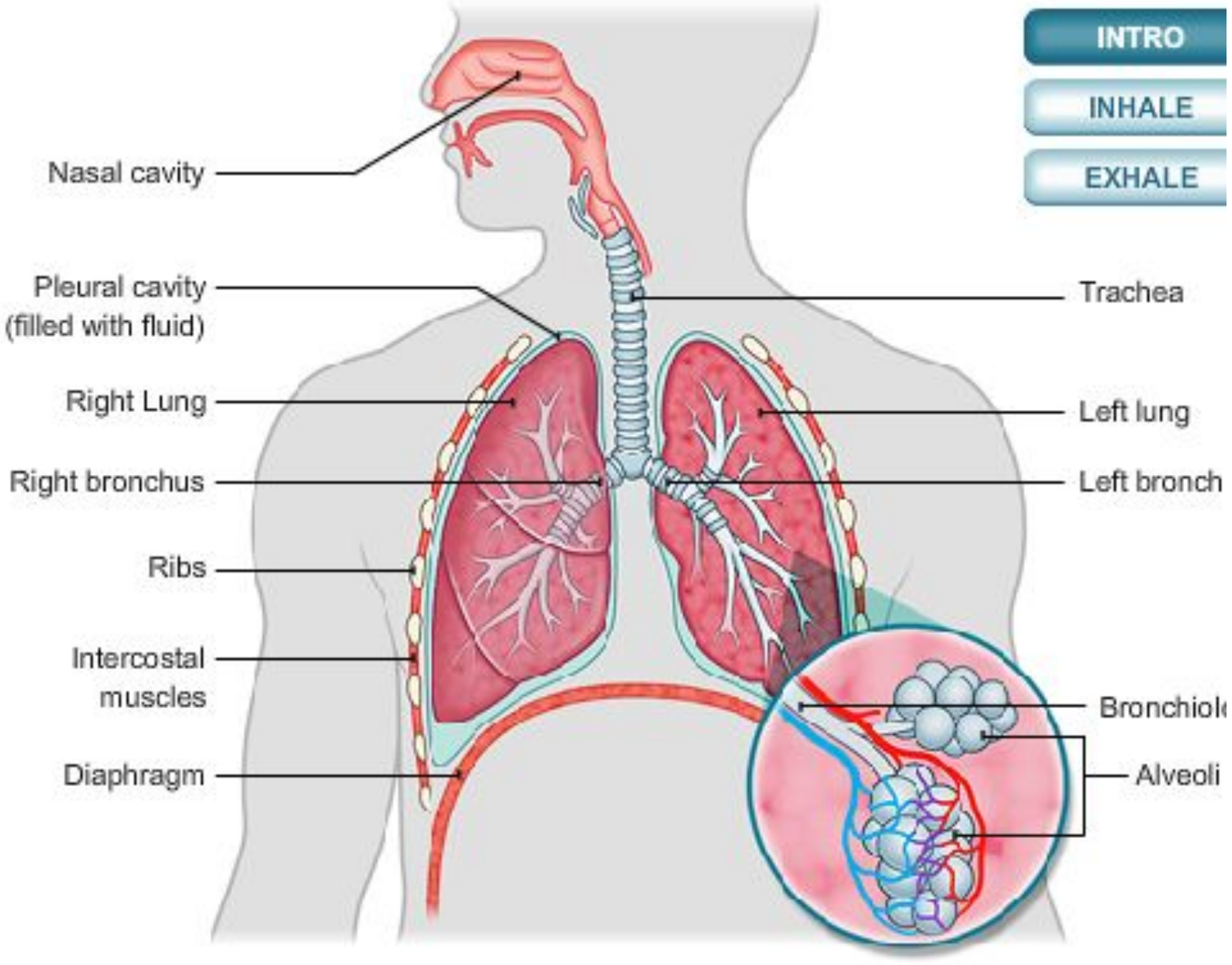
Firstly the breathing system must inhale **oxygen** and secondly it must exhale **carbon dioxide.**

It is designed to be able to perform both tasks using the same organs.

One final important fact to remember is that breathing can be performed **without** humans having to think about it.

Just imagine that as well as everything else you have to think about, you would have to remember to tell your body to inhale, then exhale, then inhale, exhale, inhale, … etc.

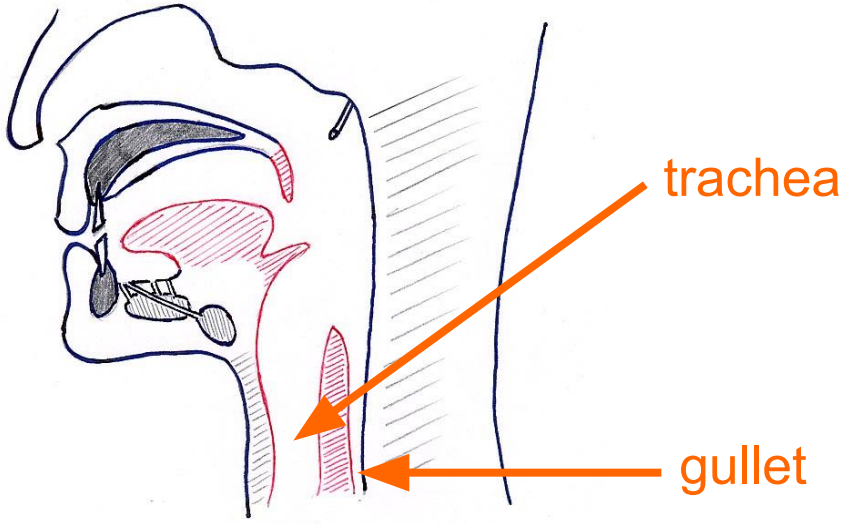
There would be no time for anything else.


INTRO
INHALE
EXHALE
Nasal cavity
Pleural cavity
(filled with fluid)
Right Lung
Right bronchus
Ribs
Intercostal
muscles
Diaphragm
Trachea
Left lung
Left bronch
Bronchiole
Alveoli

The pharynx

As the air passes through the nasal cavity, the air is smelt, warmed, filtered and moistened slightly.
The air meets at the pharynx, a junction at back of the oral cavity.

The pharynx is a junction between two tubes. The air must travel down only one of these tubes. One is the windpipe (trachea) and the other is the gullet (oesophagus).



As the name suggests, air must pass down through the windpipe (trachea).

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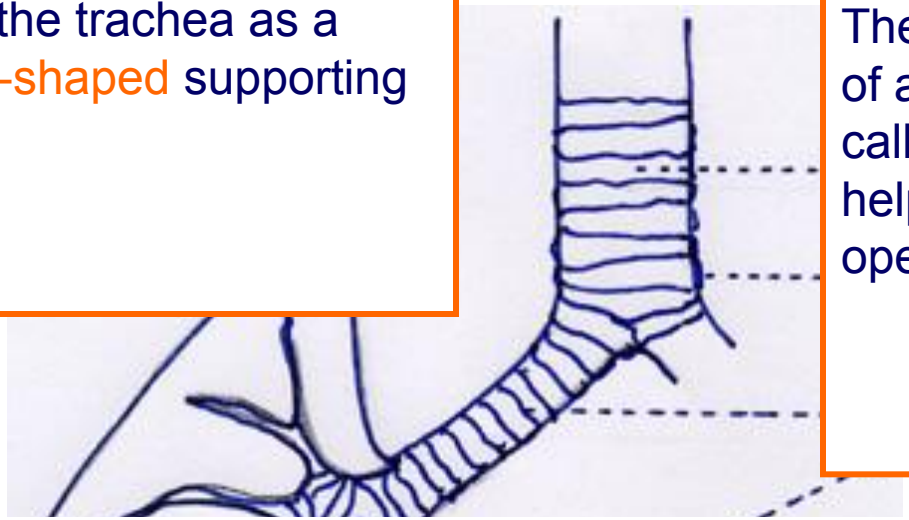
The Breathing System

Cartilage in trachea

Diagram of trachea with cartilage rungs.

You can think of the trachea as a tube lined with C-shaped supporting rungs.

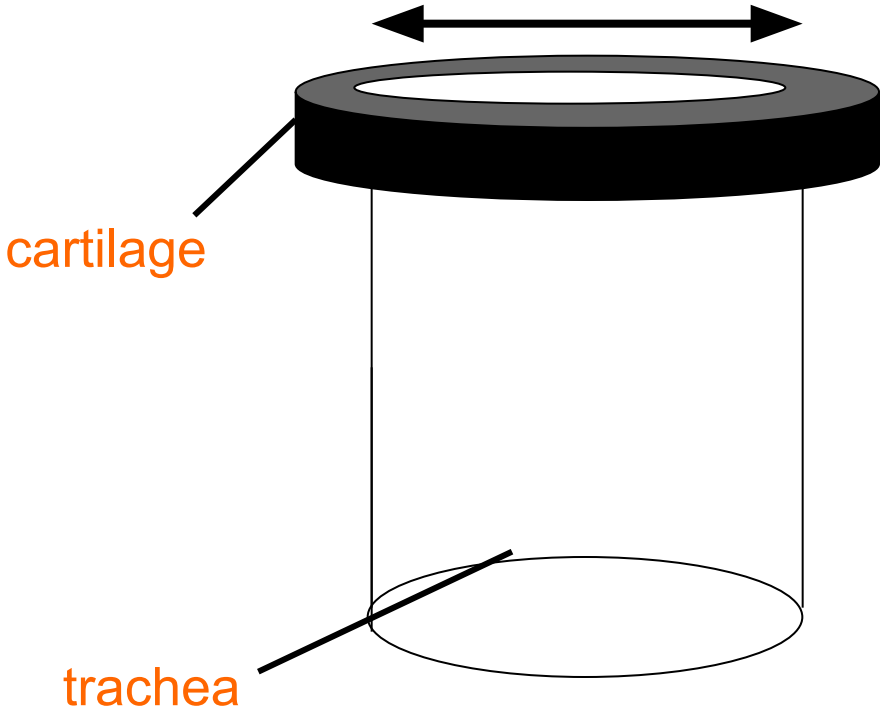


These rings are made of a tough material called cartilage. They help to hold the tube open.

You may be wondering why they are *C-shaped* and not *full circles*.

A clever design

Well, if a tube were lined with fixed circles of cartilage, it would have a fixed diameter…

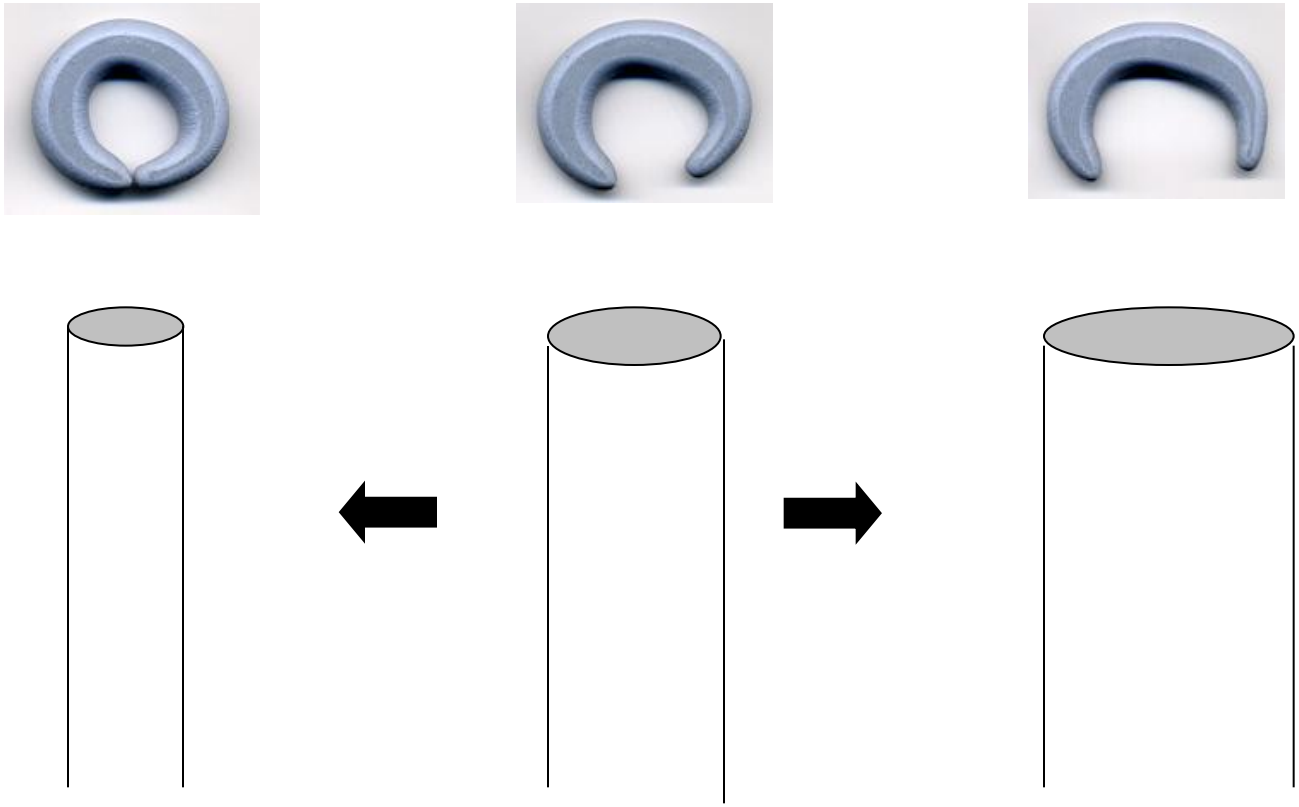


Although this would stop the tube from collapsing, this would also mean that the tube would not be able to expand.

When we breathe in, the trachea must expand to allow more air in.

Expansion potential

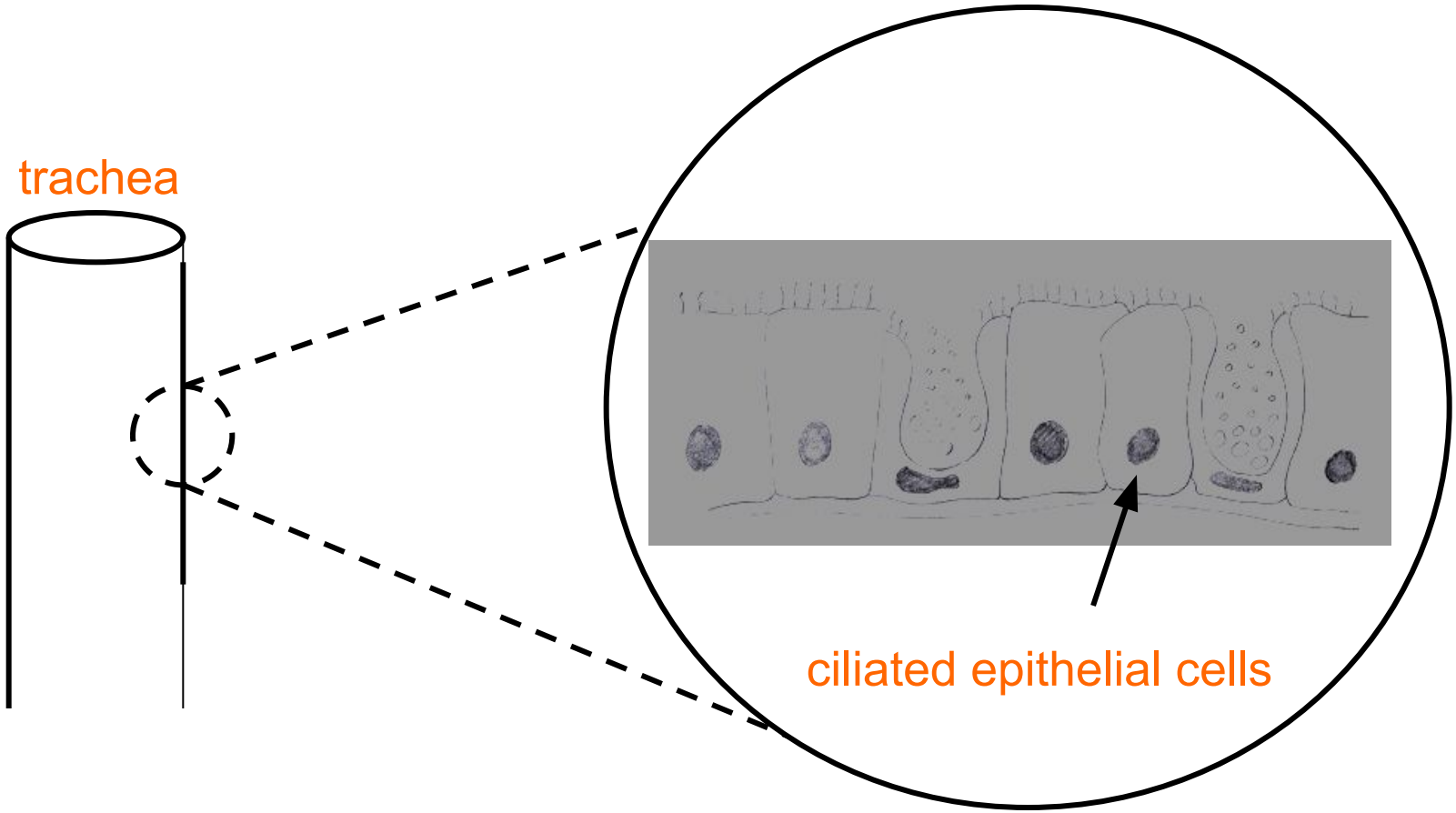
Therefore, a C-shaped piece of cartilage can change shape.



The trachea

As well as being adapted on its outer surface, the trachea shows adaptations on its inner lining.

If we look closely at the inner surface of the trachea…

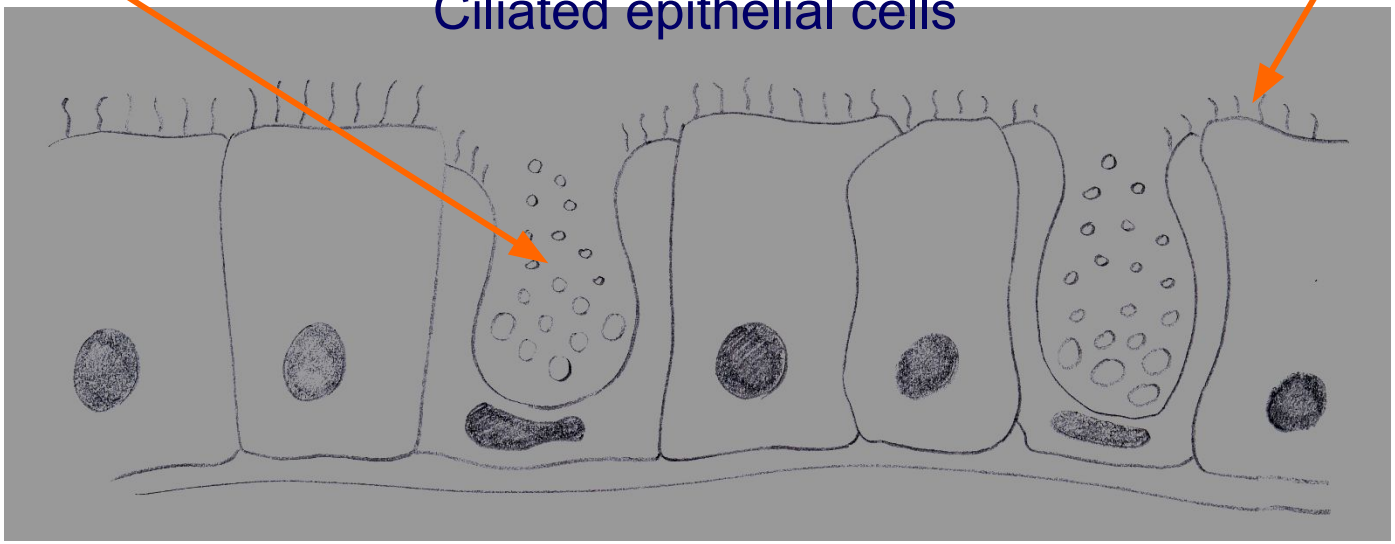


Ciliated epithelial cells

The cells that line the wall of the trachea show two special adaptations.

tiny hairs called cilia

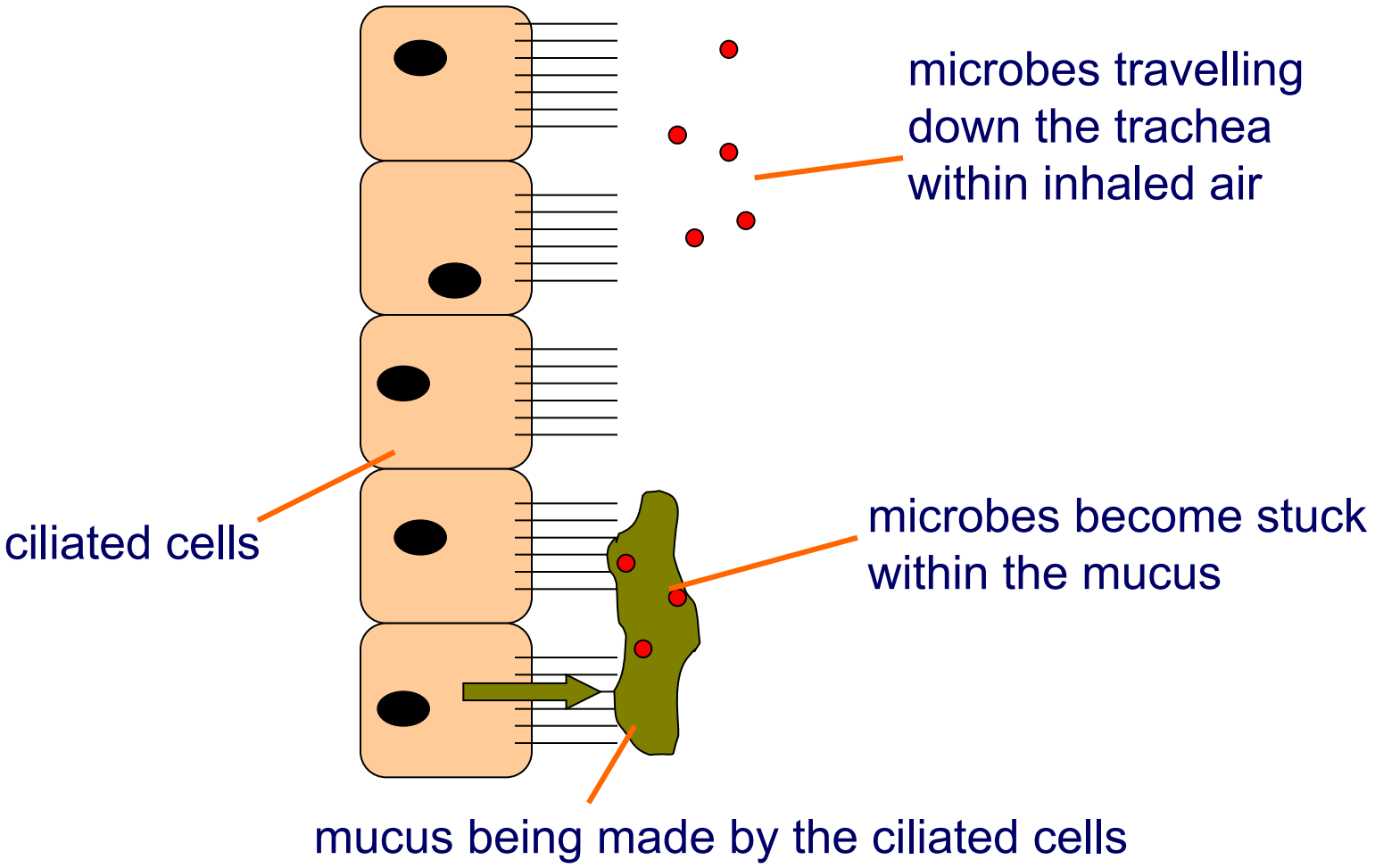
produce a sticky liquid - mucus



We say the cells show specialisation.

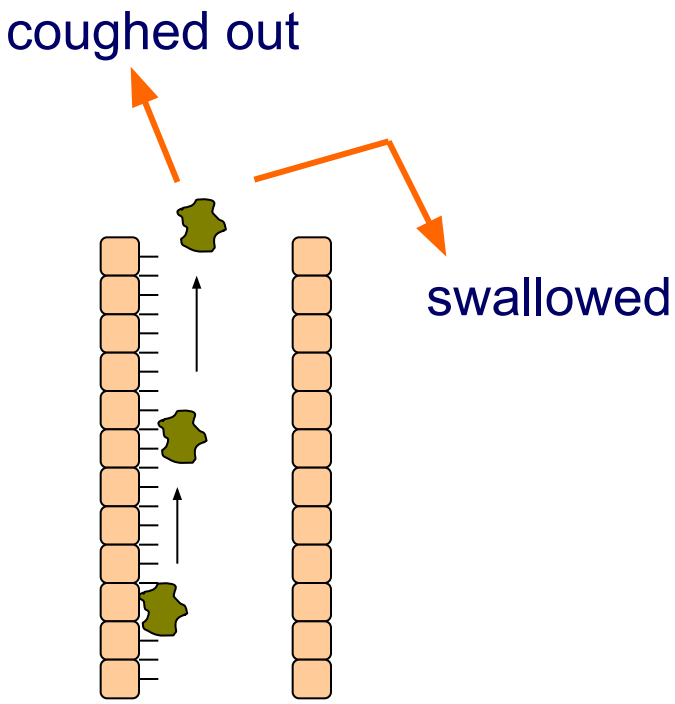
These specialised cells have a particular job to do.

The presence of mucus and cilia on the lining of the trachea ensures that the air we breathe is clean and free from disease.



Elevator action

Once the microbes are stuck in the mucus, the cilia move the mucus upwards using a wafting action. The mucus passes up to the top of the trachea where it can either be swallowed or coughed out of the body.



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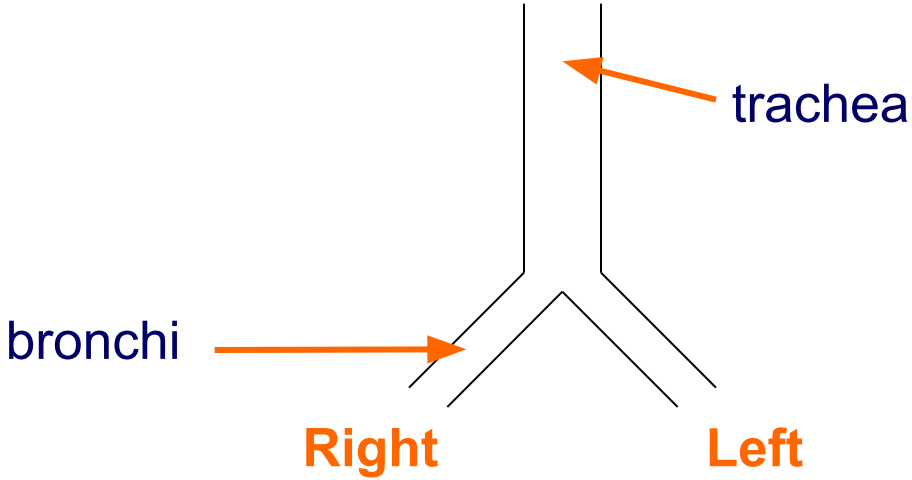
The Breathing System

Bronchi

Eventually the trachea branches, dividing into two smaller tubes called the left and right **bronchi**. The air travels along this tubes into the lungs.

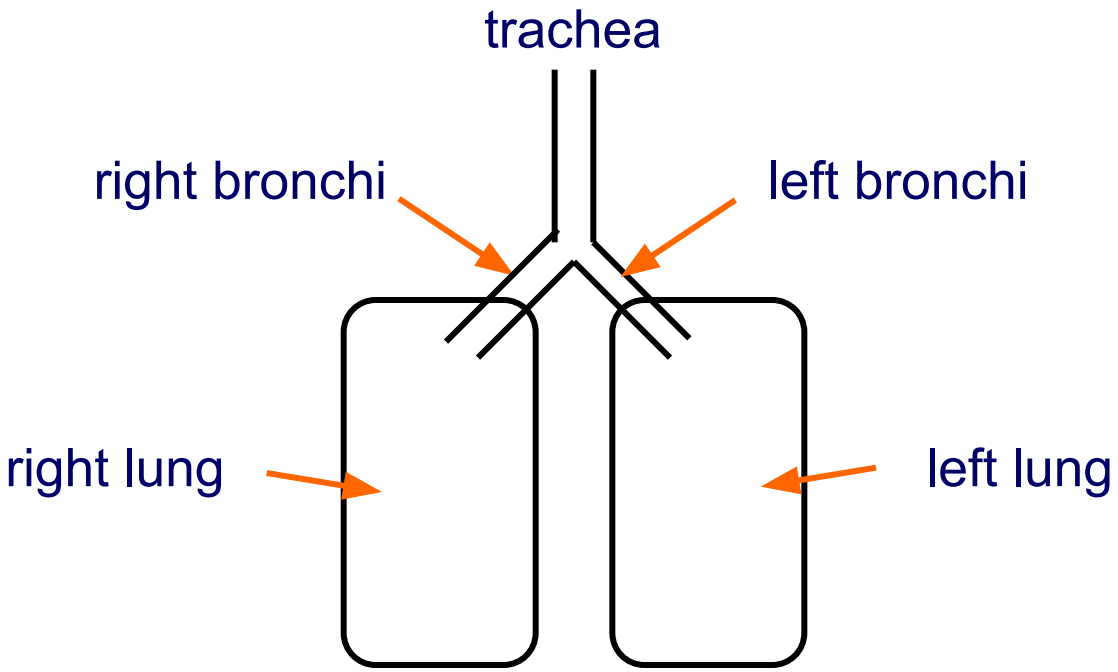
(The singular of bronchi is a bronchus.)



Don’t forget that in a picture of the human body, right becomes left and left becomes right.
Check by holding up your right hand in a mirror. The person staring back at you will be holding up their left hand.

Lungs and bronchi

Each Bronchus connects the trachea to a large air sac known as a **lung**. Lungs are made of tiny air sacs called alveoli. where oxygen comes into your body and you get rid of carbon dioxide from the flood. You have two bronchi and therefore your body has two lungs, a left and a right.



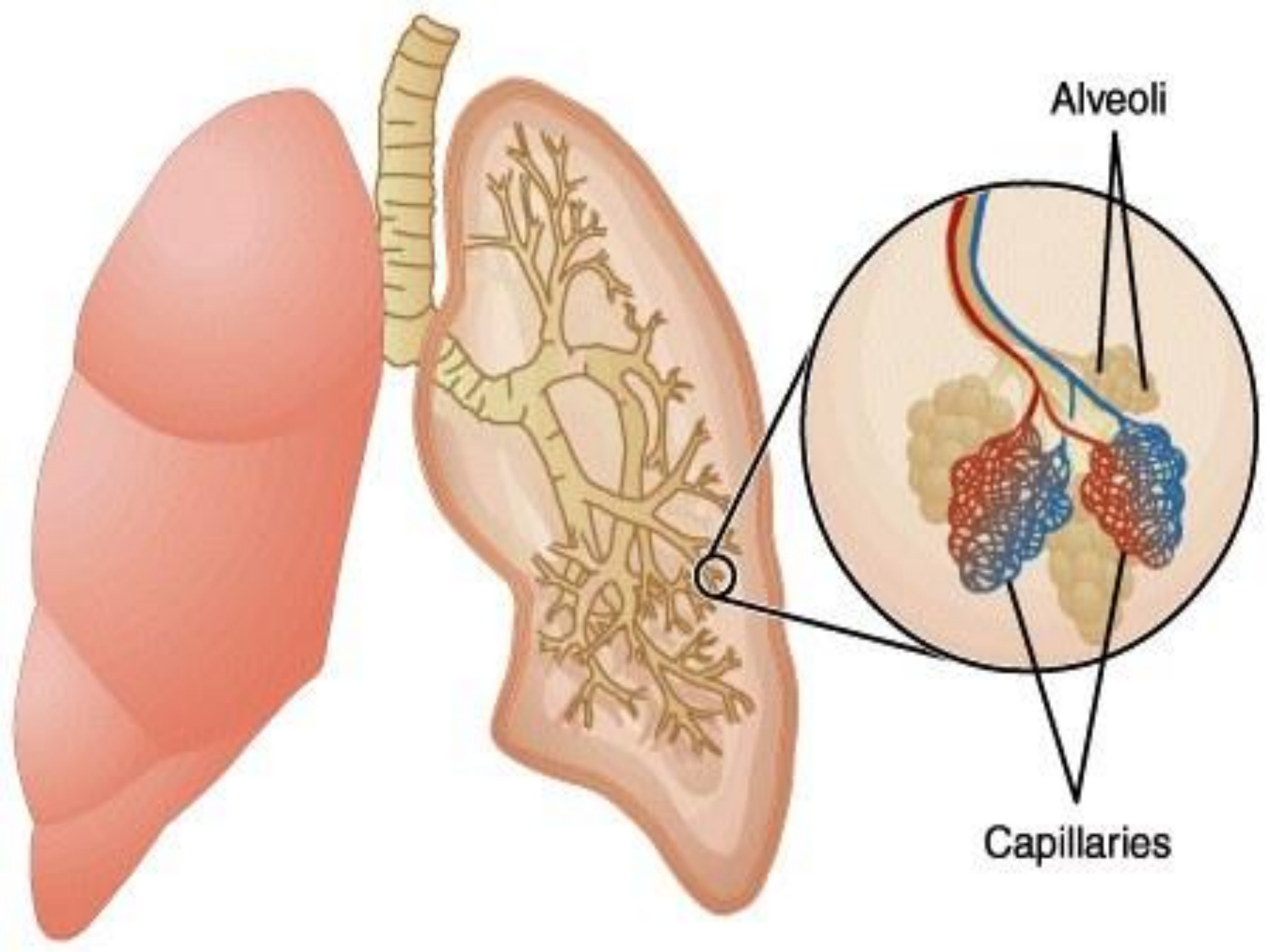
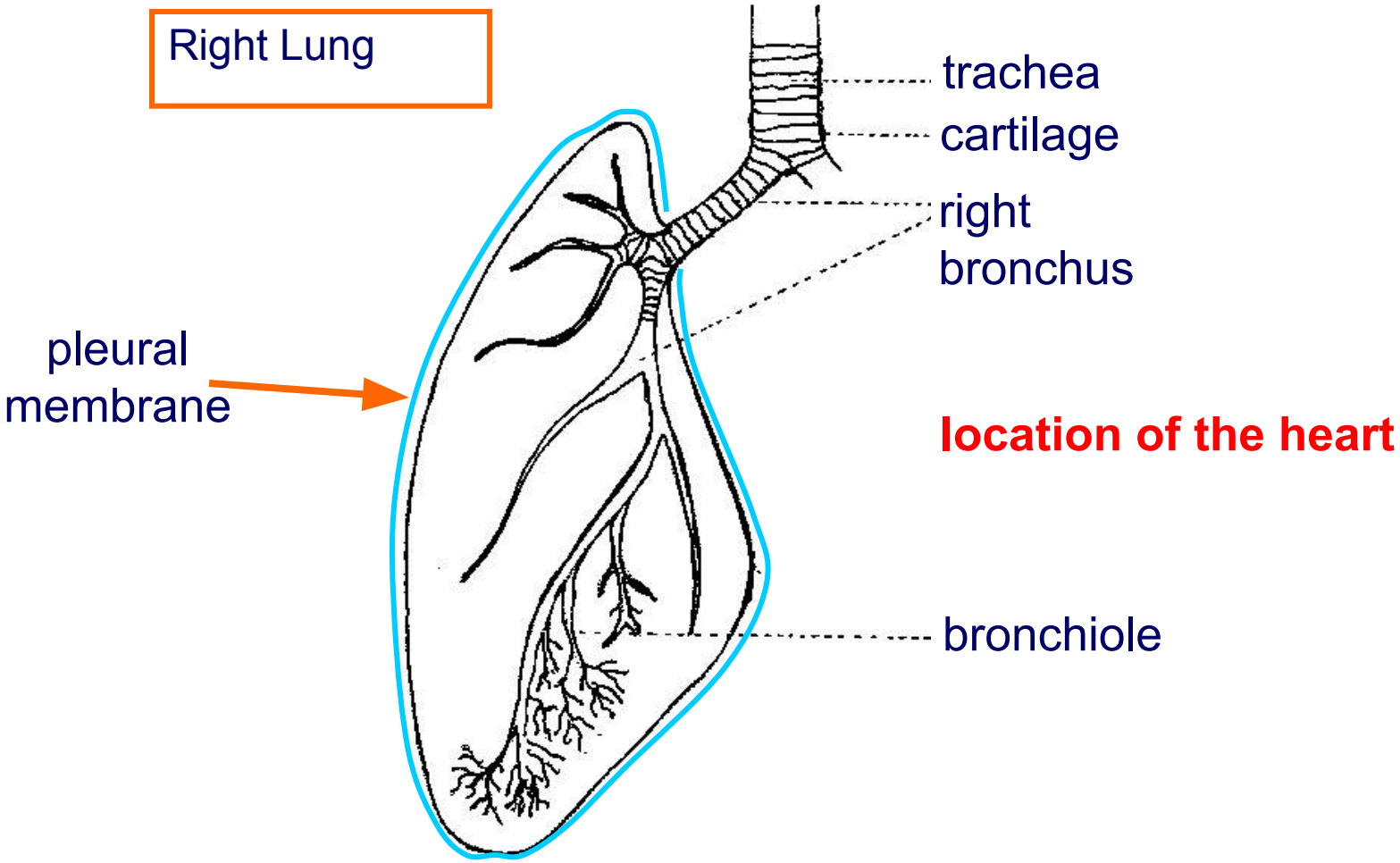

Alveoli
Capillaries

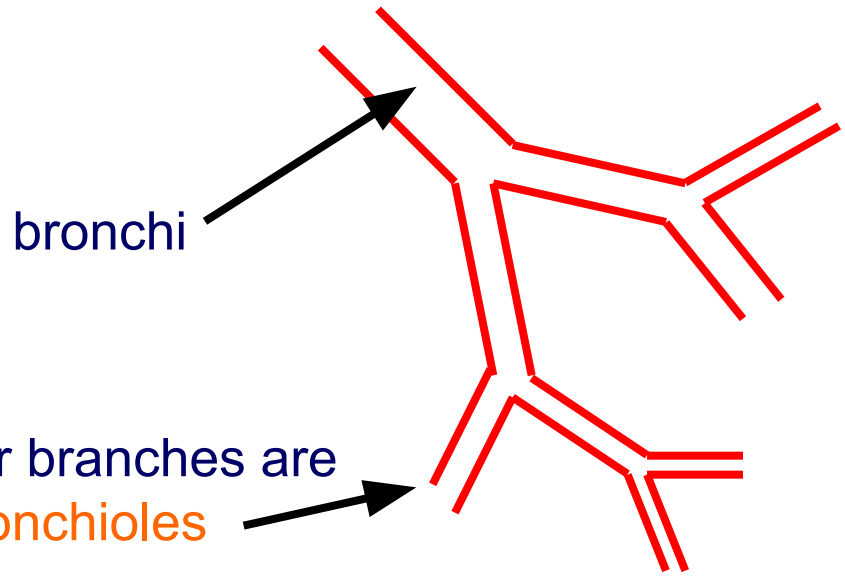
Diagram of a lung

In reality, the lungs are different in shape.
Here is a more accurate diagram.



Branching bronchi

Each bronchus now starts branching to produce smaller and smaller tubes.

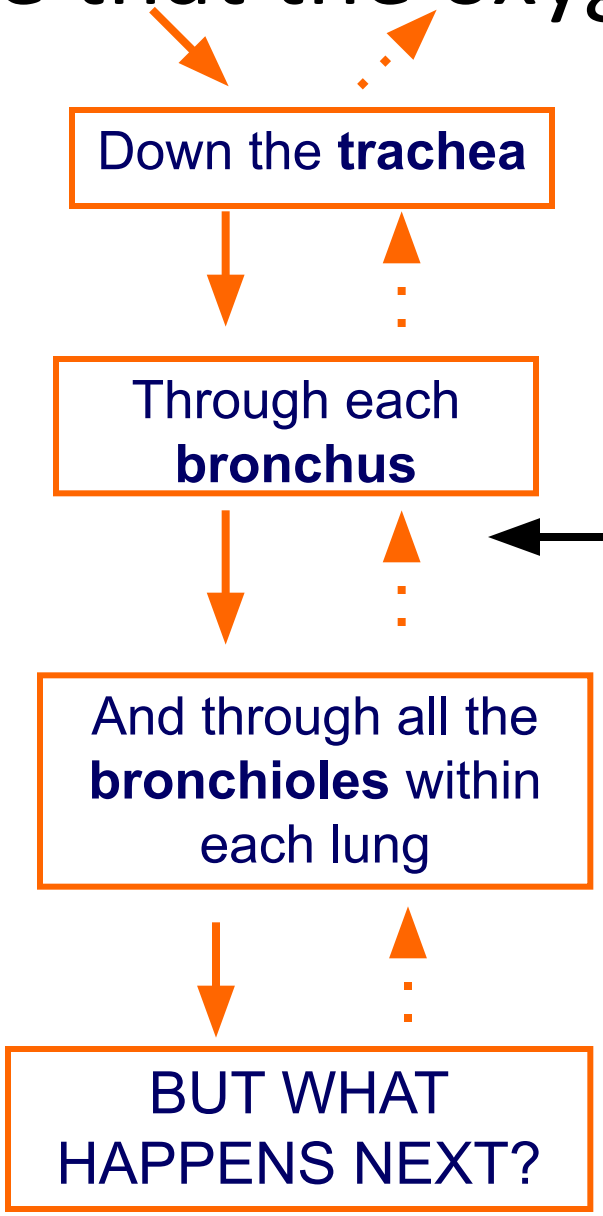


One bronchus gives rise to many bronchioles. The overall effect is similar to the branching of a tree from a central trunk.

This branching of the bronchi occurs within both lungs.

The route that the oxygen gas takes

Oxygen will pass…



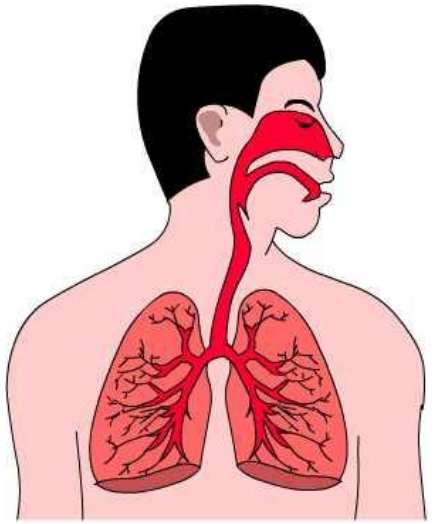
Always remember that the CO_2 is moving in the opposite direction!

Problems with lung expansion

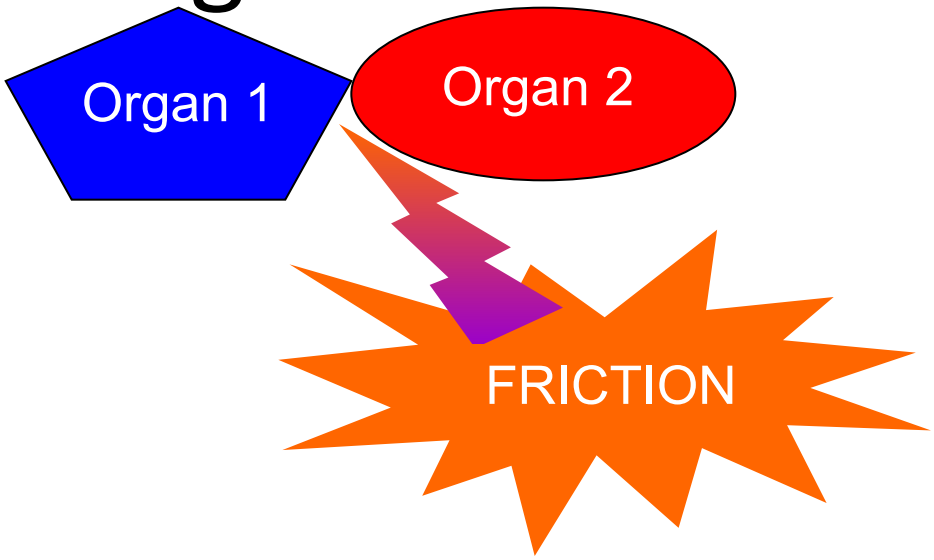
With air entering and leaving the lungs, they increase and decrease in size on a regular basis.

When organs in the body increase in size, they will touch other organs because of the lack of space.

This is a danger because living tissue is very delicate and when tissues rub against each other, friction could be generated.



Danger of friction



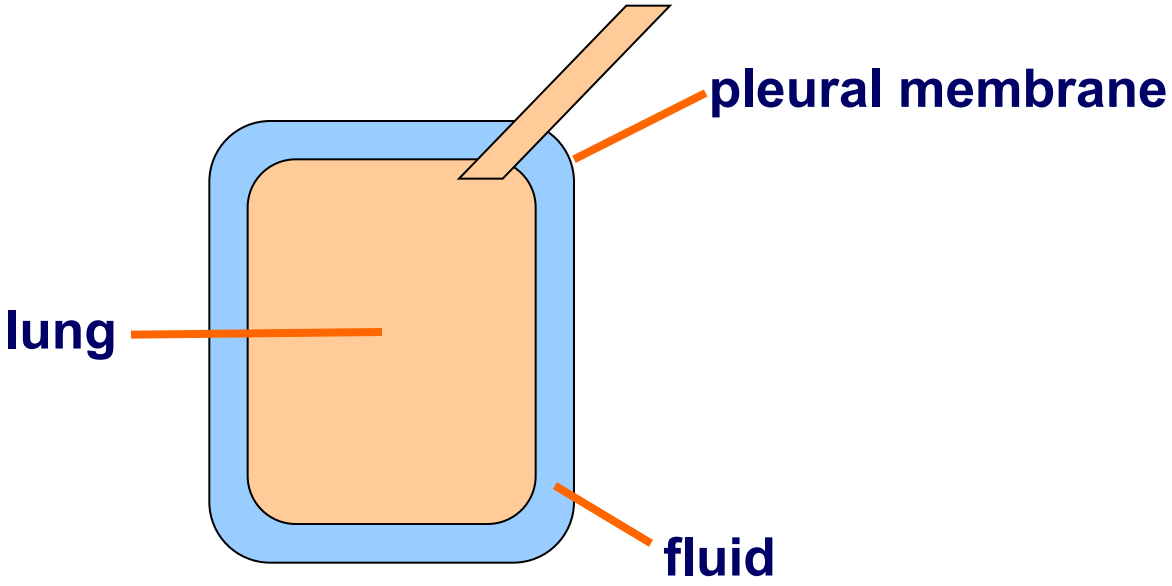
This friction could damage the tissue and kill cells.

Therefore, a protective bag called the **pleural membrane** surrounds the lungs, which are likely to rub against other organs during the breathing process.

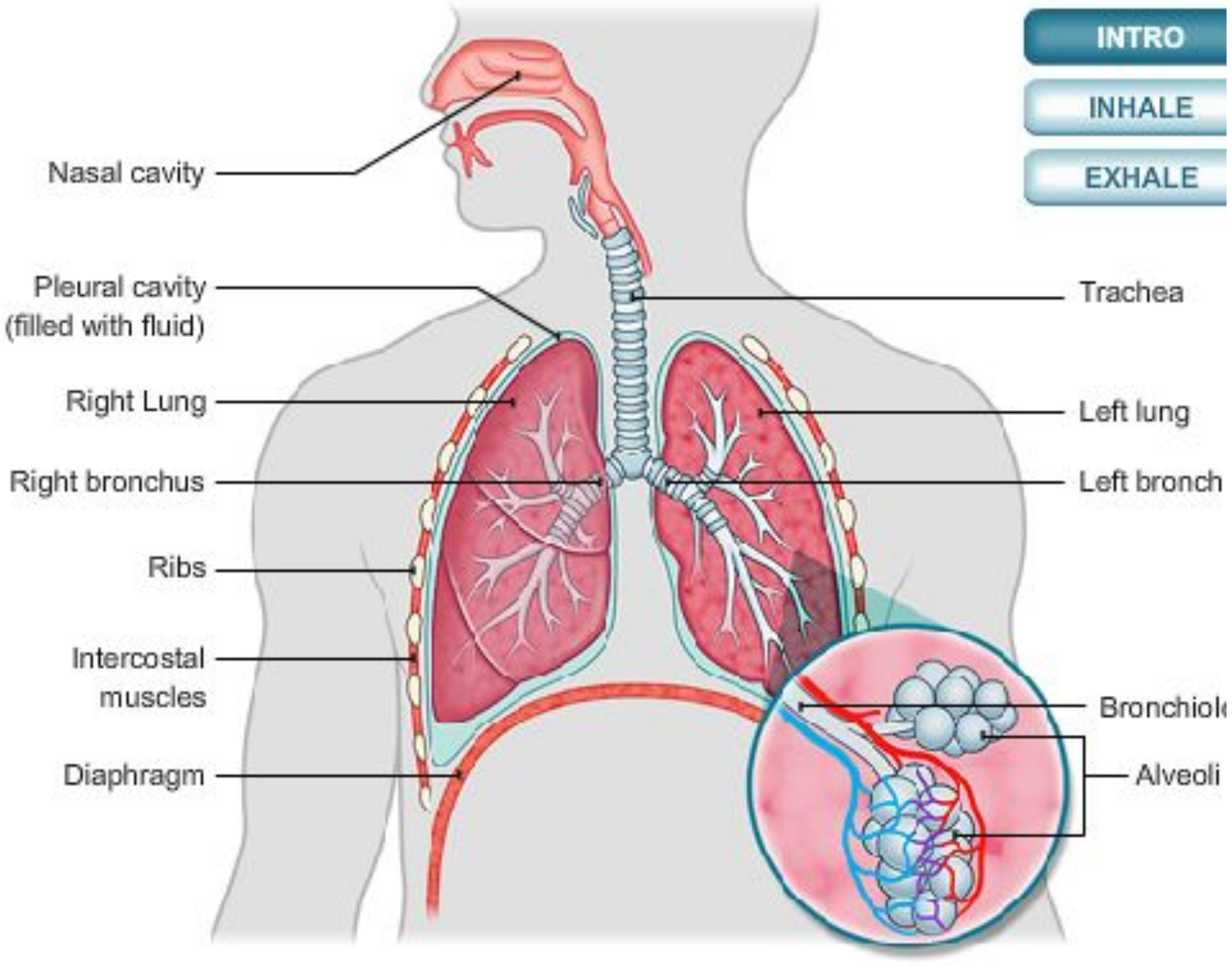
The pleural membrane

A fluid is found within this bag, surrounding the lungs.

This fluid lubricates the lining of the lungs and stops friction being generated.



http://www.brainpop.co.uk/science/lifeprocesseshumans/respiratorysystem/


INTRO
INHALE
EXHALE
Nasal cavity
Pleural cavity
(filled with fluid)
Right Lung
Right bronchus
Ribs
Intercostal
muscles
Diaphragm
Trachea
Left lung
Left bronch
Bronchiole
Alveoli

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The Breathing System

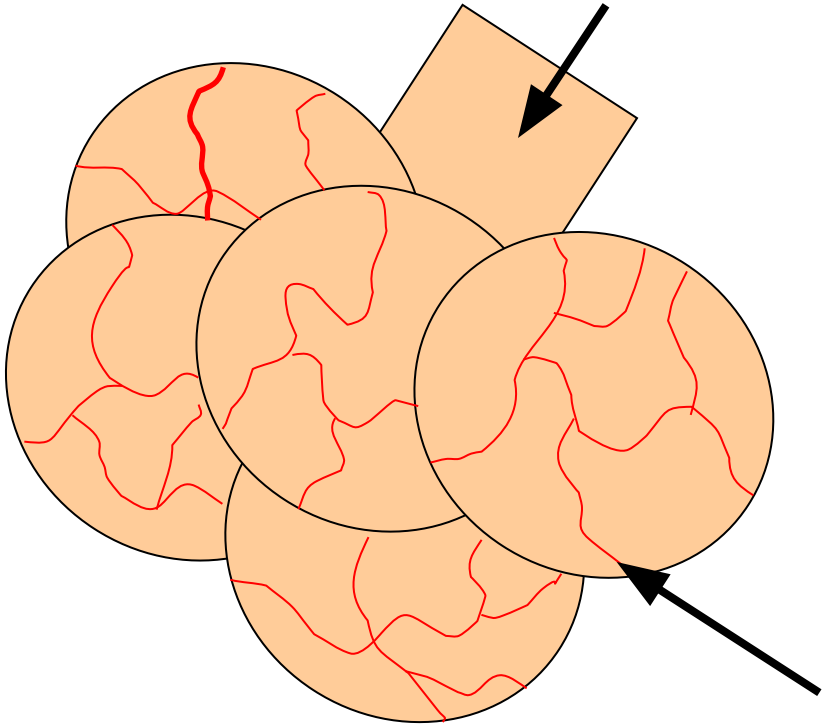
http://www.bbc.co.uk/schools/gcsebitesize/pe/appliedanatomy/1_anatomy_respiratorysys_rev3.shtml

The alveoli

Gas exchange

Inside an alveolus

Oxygen makes its way to special air sacs.

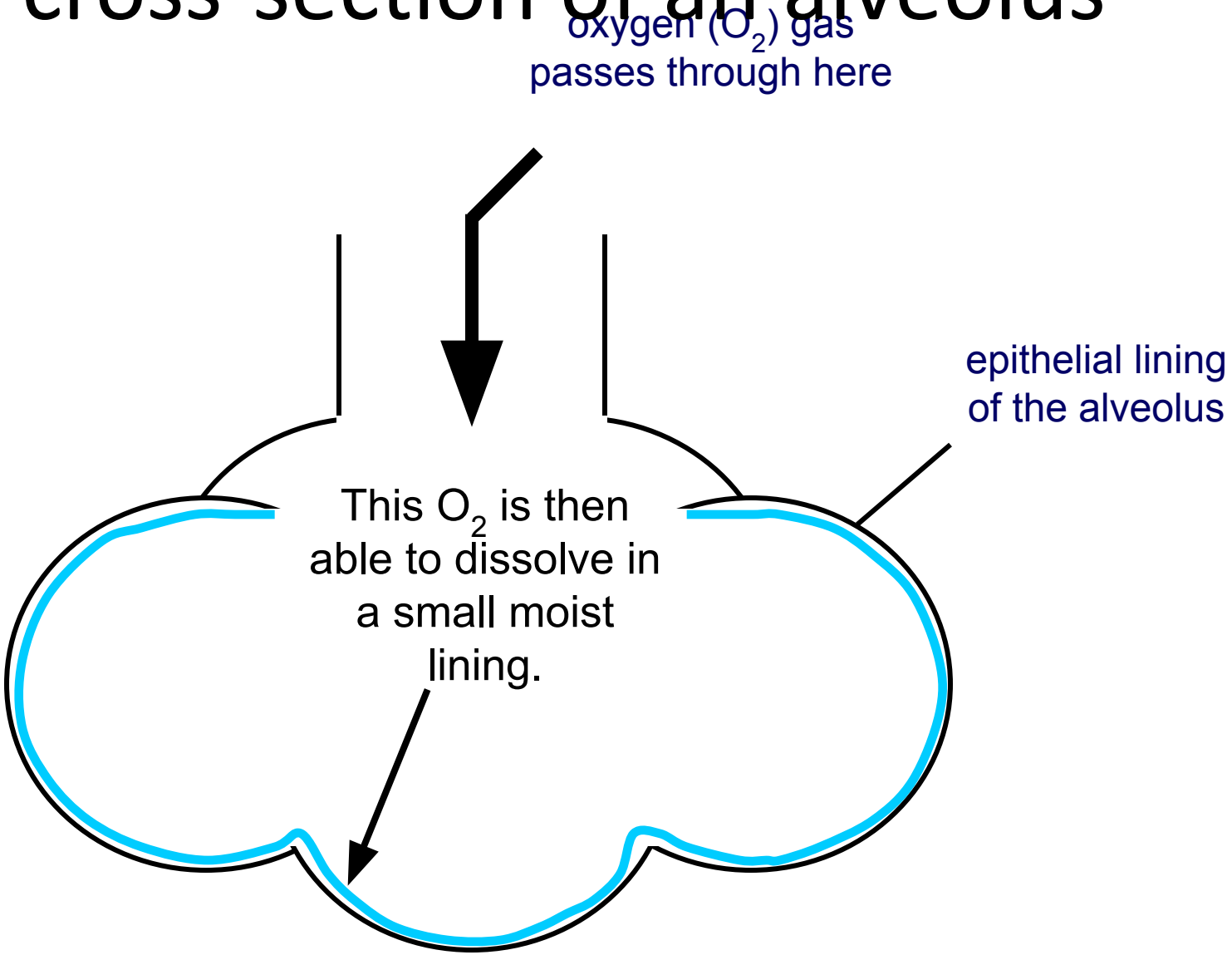


Actually, each air sac is found to be a bundle of air sacs. Together, they are known as an **alveolus**.

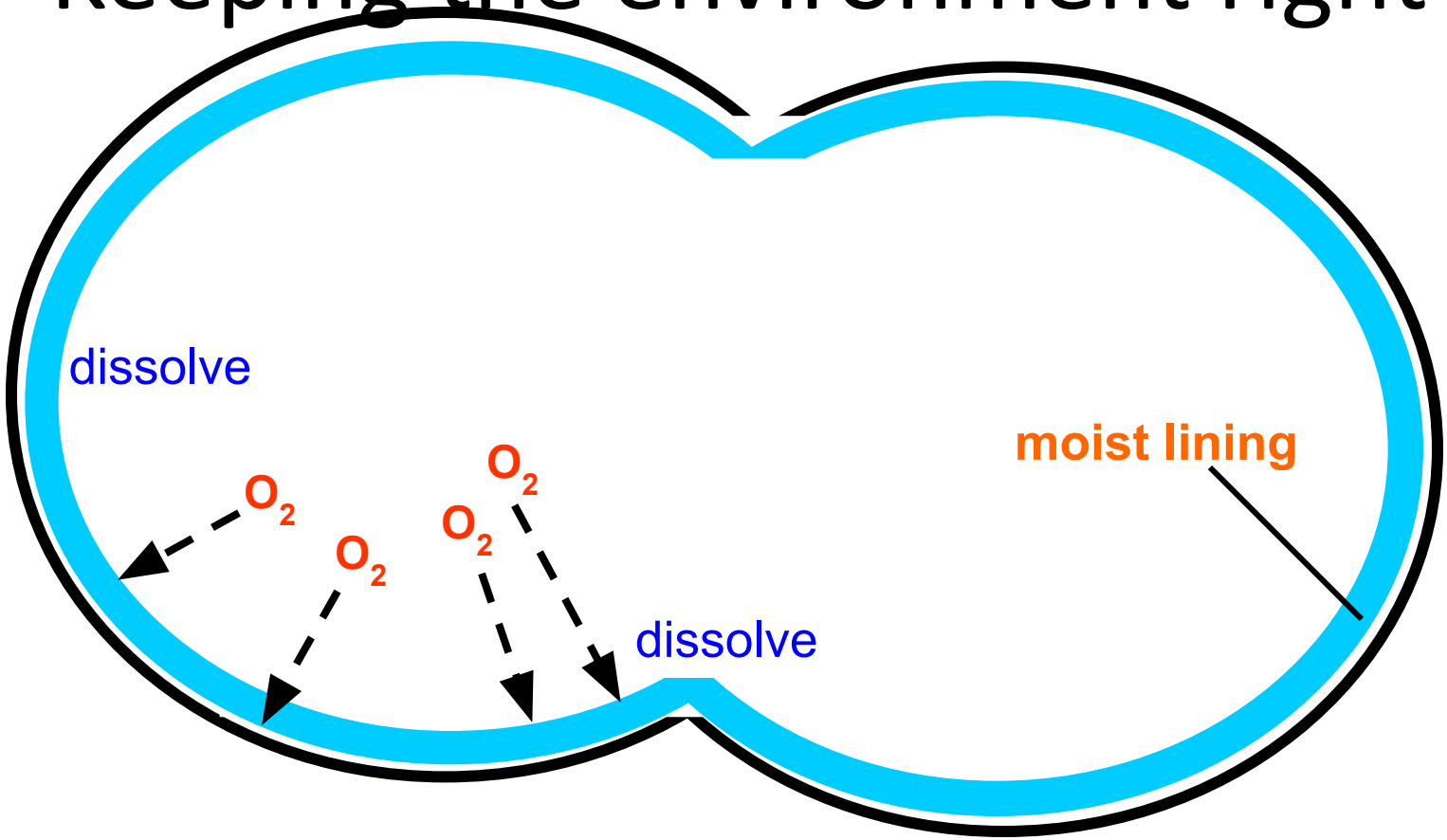
The outside of the alveolus is covered with tiny blood vessels.

We can look inside the alveolus to get some idea of why they are shaped the way they are.

A cross-section of an alveolus



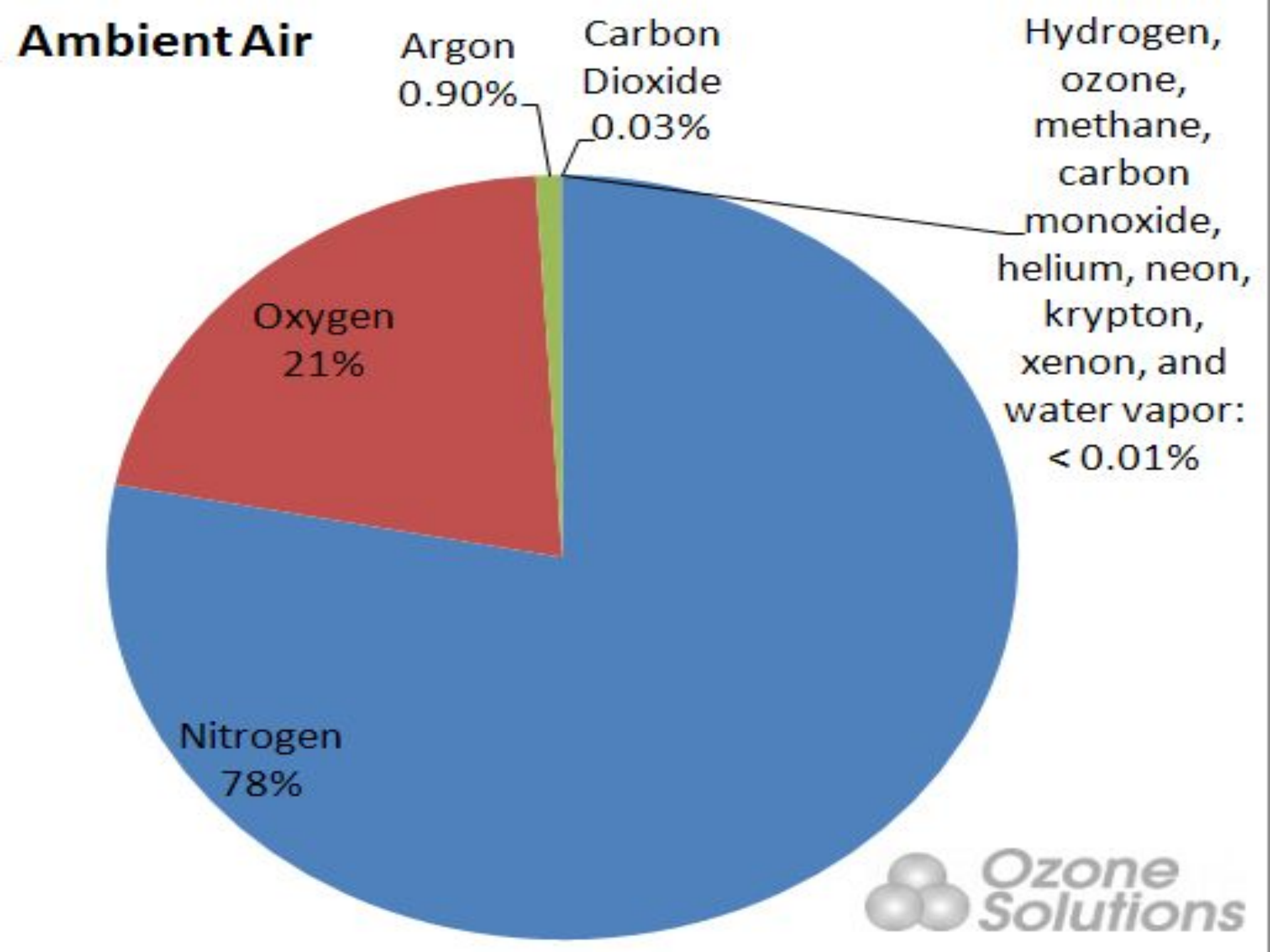
Keeping the environment right



This moist lining also stops the alveolus from drying and cracking. It lubricates the insides of the air bag.

Label the alveolus

Diffusion at work


Ambient Air
Argon
0.90%
Carbon
Dioxide
0.03%
Hydrogen,
ozone,
methane,
carbon
monoxide,
helium, neon,
krypton,
xenon, and
water vapor:
< 0.01%
Oxygen
21%
Nitrogen
78%
Ozone
Solutions

Comparing inhaled and exhaled air

What are the differences between inhaled and exhaled air?

inhaled air

- nitrogen (78%)
- oxygen (21%)
- carbon dioxide (0.04%)
- other

exhaled air

- nitrogen (78%)
- oxygen (17%)
- carbon dioxide (4%)
- other

How could you test for the differences between inhaled and exhaled air?

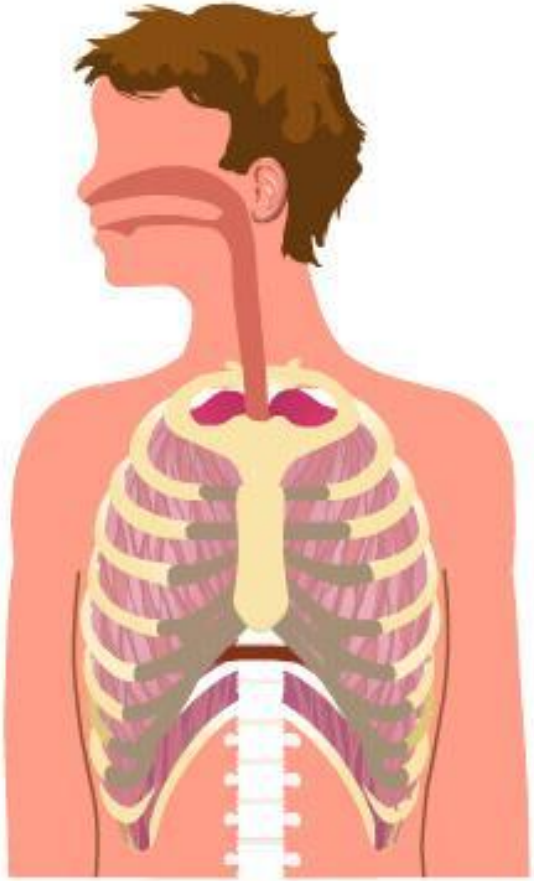
Inhalation and exhalation

The mechanism of ventilation

Inhalation and exhalation

The muscles and bones of the thoracic (chest) cavity work together to increase and decrease the size of the lungs during breathing.

Press "**play**" to see an animation of ventilation, or press the buttons to find out more about each structure.



diaphragm

ribcage

external intercostal muscles

internal intercostal muscles

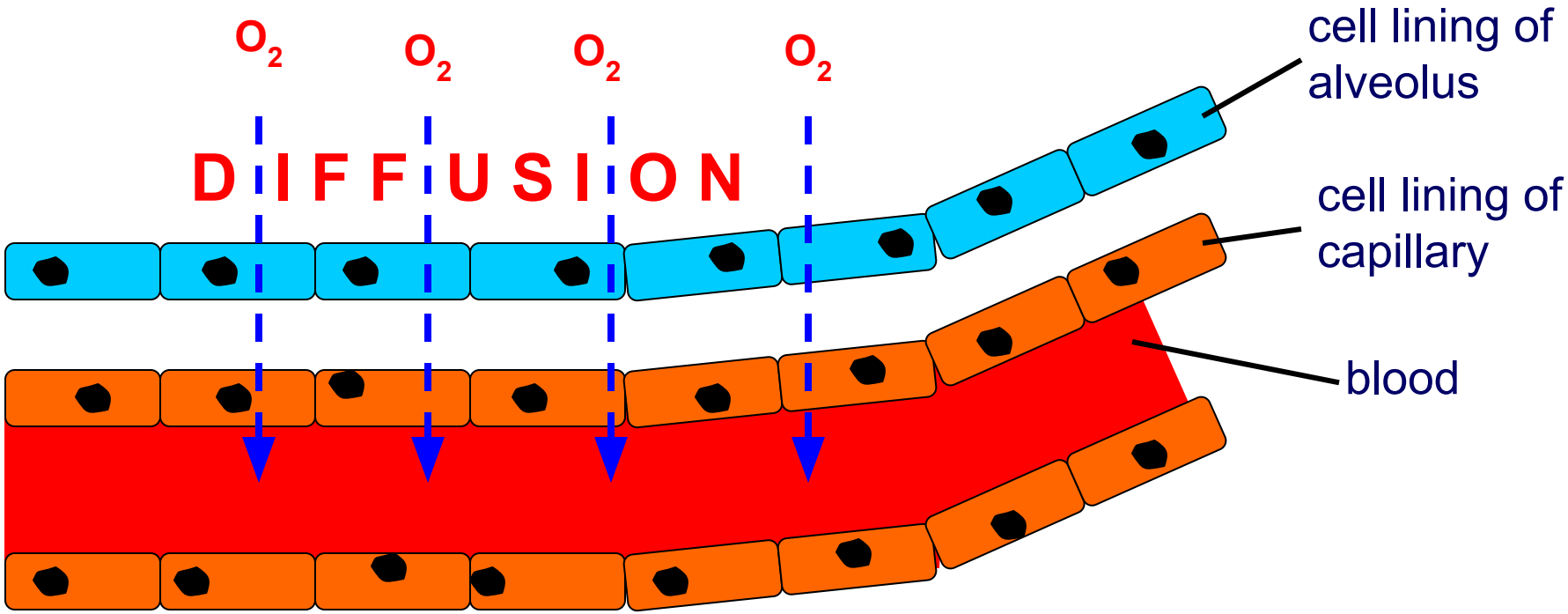
show all

anterior view | lateral view

Respiration

Oxygen diffusion into red blood cells

After the oxygen dissolves it also diffuses.

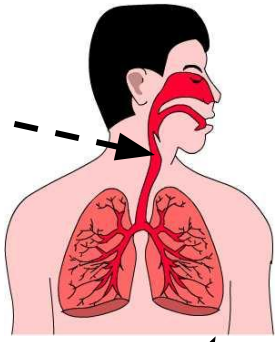


The oxygen molecules must diffuse through both the lining of the alveolus and the lining of the blood capillary.

They are eventually picked up by red blood cells.

Blood leaving the lungs

The blood now carries this oxygen to the cells of the body.



Right Lung

Left Lung

blood vessel

O_2

O_2

body cells

blood

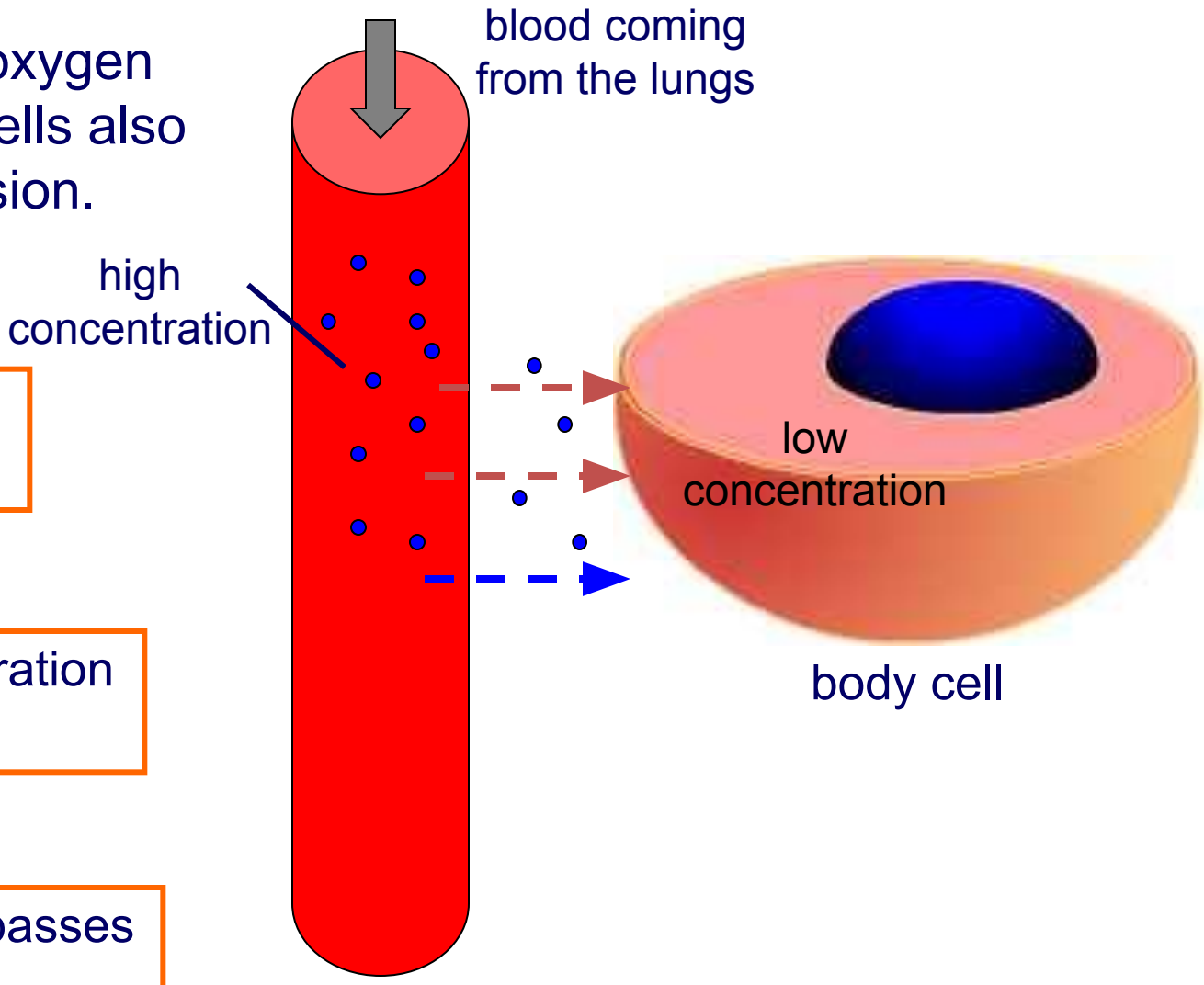
Laws of diffusion

The movement of the oxygen from the blood to the cells also follows the law of diffusion.

It is highly concentrated within the blood.

Meanwhile the concentration is low within the cell.

Therefore the oxygen passes into the body cells.



Breathing system summary

Remember that the process of inhalation brings O_2 into the body whilst exhalation removes CO_2.

So, how does our breathing system enable us to do this?

Well, inhaling and exhaling are brought about by certain *changes in the position* of the components within our breathing system.

Let's next look at the general structure of this system.

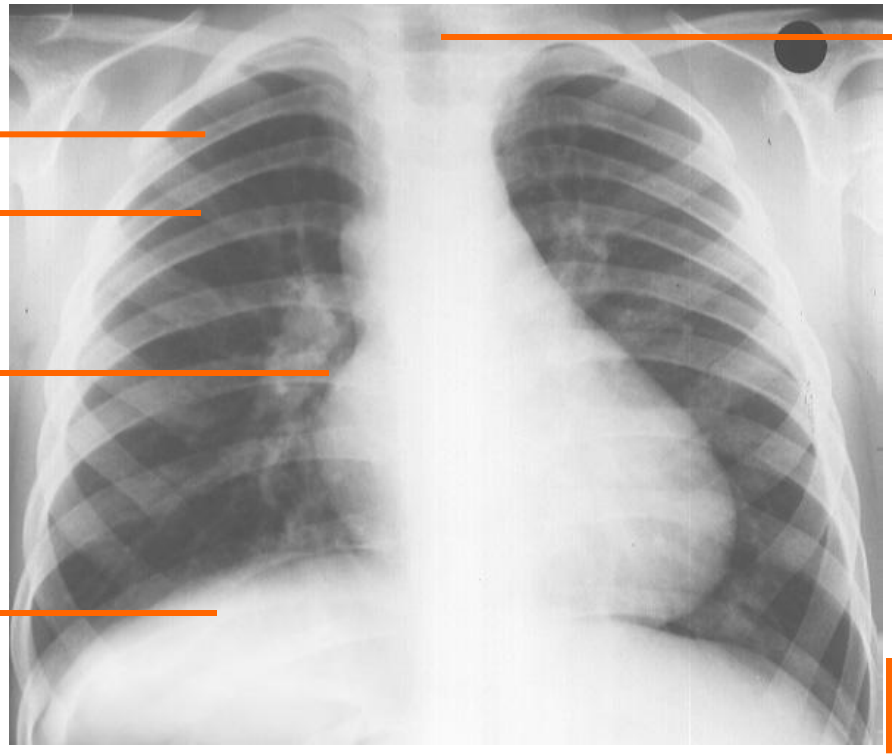
Remember, the breathing system is found in the upper region of the body. This is known as the **thorax**.

Contents

The Breathing System

Breathtaking features

The breathing system does not have a fixed shape.



It has the ability to move, whilst remaining enclosed within the protection of the ribcage.

A mobile ribcage?

This means that the rib cage must also be able to change position.

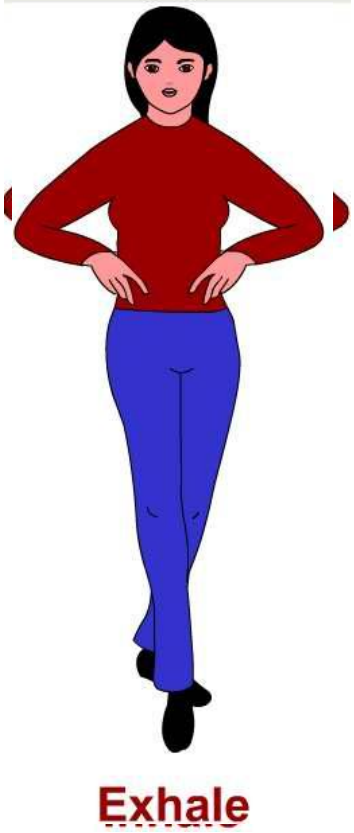
Take your hands and place them flat on your chest just above your hips on each side of your body. Now breathe in and out very deeply. Whilst you do this, watch to see what happens to your hands.

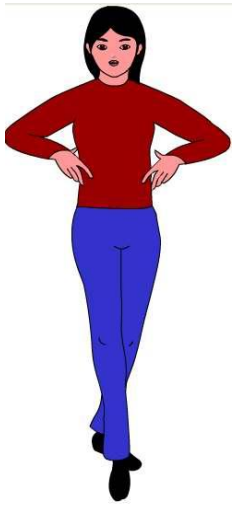
You should notice the following things…..

Take a breath

When you breathe in (inhale), your hands move up and outwards.

When you breathe out (exhale), your hands move down and inwards.





Inhaling: chest expansion

When we inhale, our lungs fill with air.

↓

As they fill, they become enlarged.

↓

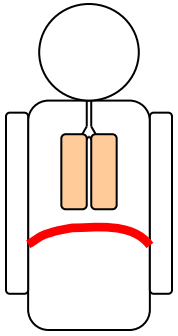
The ribs must then move upwards and outwards to make more room in the thorax.

↓

The overall effect of this is that our chest expands.

The diaphragm

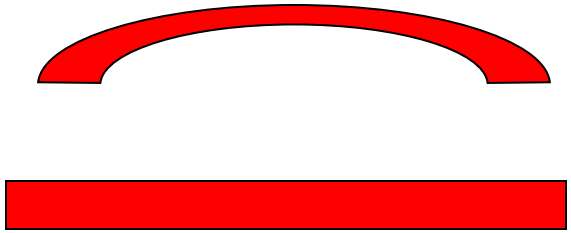
Your diaphragm is located beneath the lungs, which means that it separates the thorax from the abdomen.



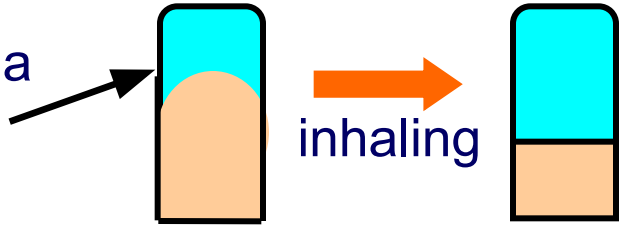
It is a sheet of muscle that spans the width of the body.

Before we inhale, it is found in a **dome** shape.

As we inhale, it contracts and **flattens**.



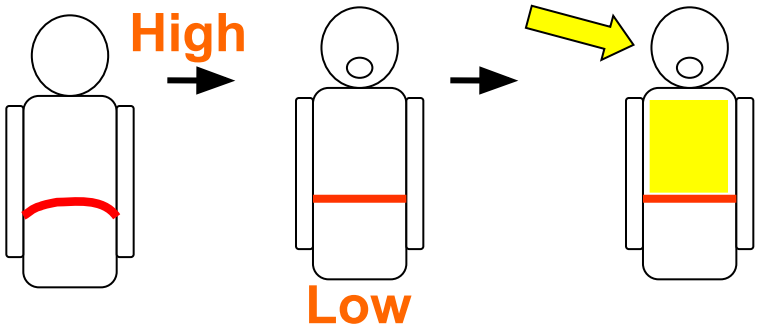
The result of this change in shape is a change in the **volume** of the thorax.



Pressure regulation

As the volume of the thorax increases, the internal air pressure drops.

This means that the air pressure outside the lungs is greater than the air pressure inside the lungs.



- High air pressure outside
- Low air pressure inside
- Air diffuses into the lungs

- Diaphragm flattens
- Thorax volume increases
- Air pressure drops

Features of inhalation and exhalation

If these changes occur when we breathe in, the opposite must happen when we breathe out.

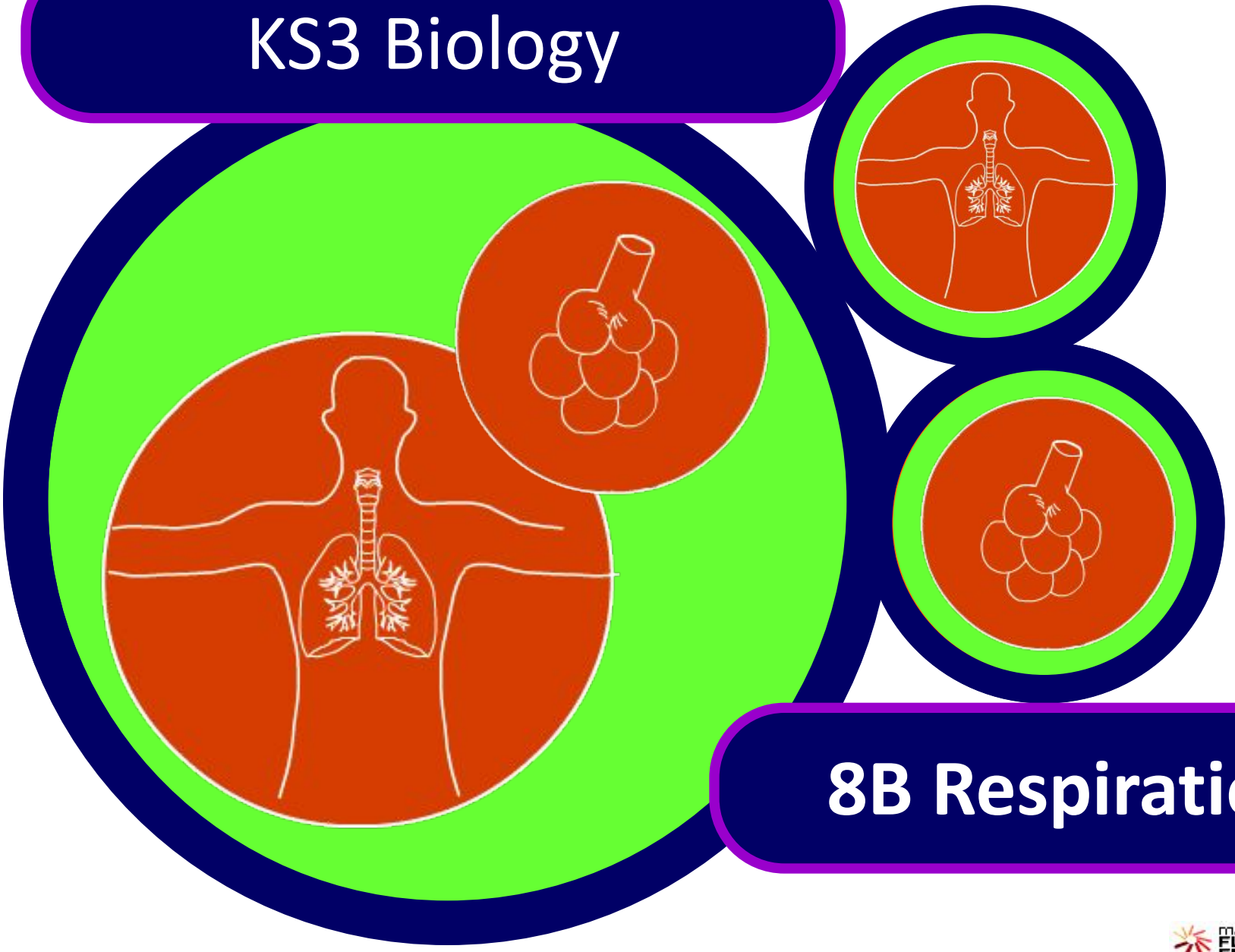
These changes can be summarised in the table below...

Feature	Inhaling	Exhaling
diaphragm shape	flat	domed
ribs	up and out	down and in
diaphragm muscle	contracted	relaxed
rib muscle	contracted	relaxed
lungs	inflated	deflated

Click on the “Air Drawn In” buttons

Click on the “Passage of air” buttons

KS3 Biology



8B Respiration

Contents

8B Respiration

How is digested food used by the body?

The body needs a constant supply of **energy** which comes from digested food.

Glucose, from digested carbohydrates, is an important substance that contains stored chemical energy.

When glucose reacts with **oxygen**, a lot of energy is released.

In the body's cells, glucose and oxygen react to release energy. Some of this is released as heat and the rest is used by the cells.

What is the release of energy from glucose called?

What is respiration?

Respiration is the process that the body uses to release energy from digested food (glucose):

glucose + **oxygen** → **carbon dioxide** + **water** (+ **energy**)

glucose	oxygen	carbon dioxide	water
from the digestive system	from the respiratory system	waste product (exhaled)	waste product (exhaled)

This type of respiration is called **aerobic** respiration because energy is released in the presence of **oxygen**.

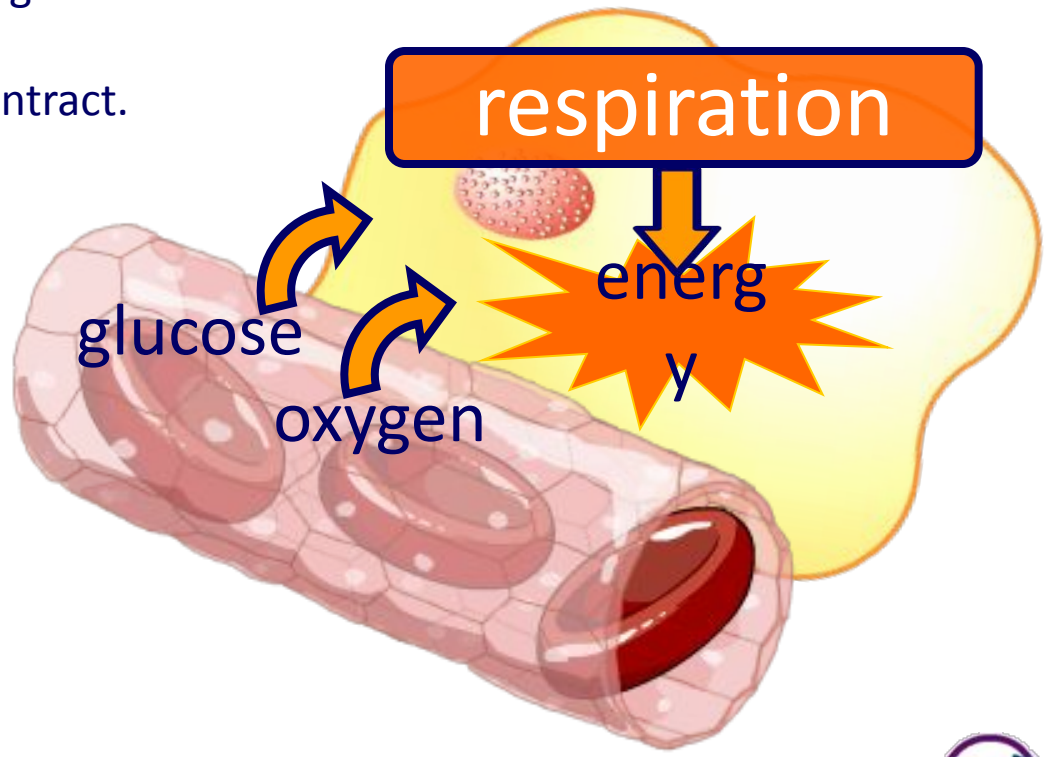
How do the glucose and oxygen needed for aerobic respiration get to the all the body's cells?

Respiration

Respiration is the process that takes place in living cells which releases energy from food molecules.

Glucose from food is used to fuel exercise.

Oxygen is required to 'break down' the glucose to produce energy.
This energy is used to make muscles contract.



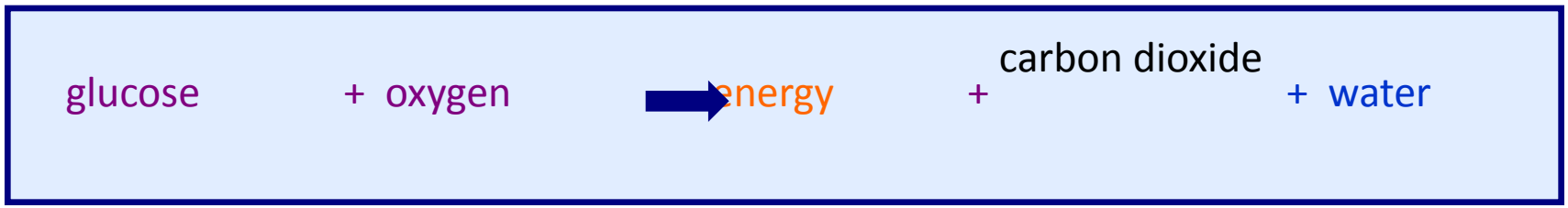
Waste products, including carbon dioxide, are produced as a result of the chemical reactions. These must be removed and excreted.

Aerobic respiration

There are two different types of respiration.

When you exercise at a steady, comfortable rate, the cardiovascular system is able to supply the muscles with all the oxygen they need.

Under these conditions, aerobic respiration takes place.



Aerobic exercise can be maintained for long periods without the performer getting breathless or suffering muscle cramps. Moderate activities like walking, jogging, cycling and swimming use aerobic respiration.

Aerobic and anaerobic respiration

Aerobic respiration

When the body is able to supply the cells with the oxygen and glucose that they need, it carries out aerobic respiration.

Anaerobic respiration

When the body cannot supply the cells with the oxygen needed to break down glucose, then it has to carry out anaerobic respiration. Energy is released without oxygen:

Not enough oxygen!

glucose → lactic acid + energy

When anaerobic respiration takes place, the lactic acid produced soaks the muscle cells and prevents muscles from doing their job. This causes fatigue and sometimes cramp.

After activity that has lead to anaerobic respiration, the person involved pants and breathes heavily.

This happens because they need lots of oxygen to get rid of lactic acid that has built up in their body.

lactic acid + oxygen → carbon dioxide + water

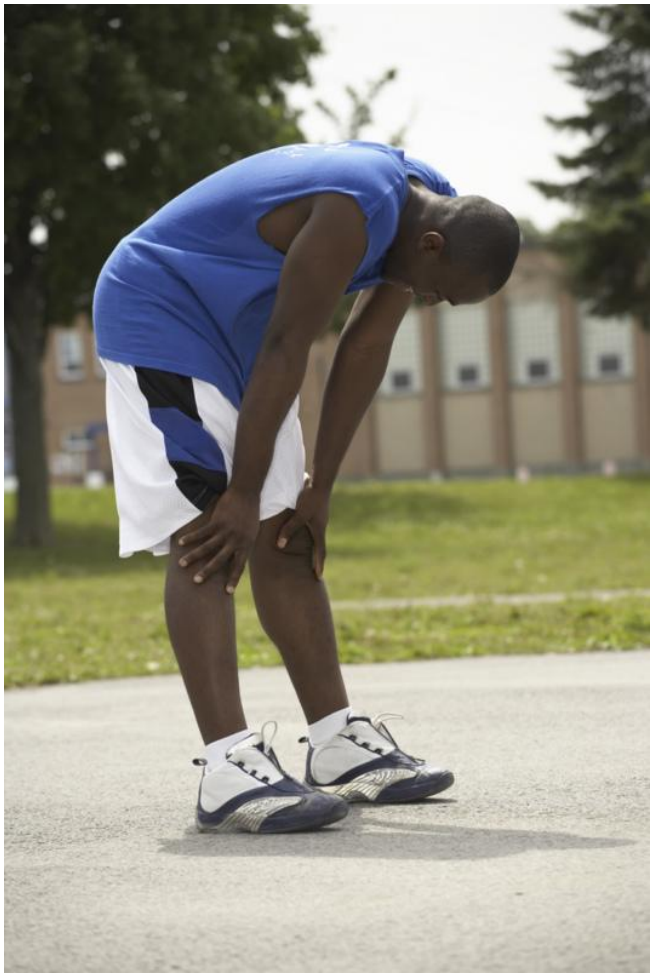
Oxygen debt

After anaerobic activity, oxygen is needed to neutralize the lactic acid. This is called an oxygen debt. It is repaid after exercise.

The oxygen reacts with the lactic acid to form CO_2 and water.

Rapid and deep breathing is needed for a short period after high intensity exercise in order to repay the debt.

This also helps to remove the carbon dioxide which accumulates in the blood during intense exercise.



- http://www.brainpop.co.uk/uk/science/lifeprocessescells/cellularrespiration/

Aerobic respiration

Contents

The Breathing System

Glossary

- aerobic – The type of respiration that occurs with oxygen.
- alveoli – Tiny air sacs in the lungs where gas exchange takes place.
- anaerobic – The type of respiration that occurs without oxygen.
- exhalation – The process of breathing out.
- glucose – A type of sugar that the body releases energy from during respiration.
- inhalation – The process of breathing in.
- respiration – The process that the body uses to release energy from digested food.

Breathing in or out?

Multiple choice section

Multiple-choice quiz

Homework

- Work in pairs
- Make a poster about respiration, do not use to much words
- Use internet for interesting ideas, use picture or draw by yourself to make your poster as nice as you can.

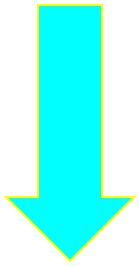
So far, we have considered both the structure of the breathing system and how it is adapted for breathing in and out.

BUT...

We have not talked about why the body needs to breathe.

If you remember, we know that we breathe constantly throughout life. Also, we know that if we stopped breathing we would eventually die.

So, breathing in Oxygen (O_2) must be linked to **something** that we need constantly and without it our bodies would die.



The answer is **ENERGY** making

The energy making process depends on the breathing system and the digestive system.

Imagine a fire...

This will produce energy in the form of **heat** but only if it is supplied with 2 main ingredients.

FUEL **OXYGEN**

Well, the bodies energy making reaction needs similar things to the energy making process of fire.

Like the fire, the body needs Oxygen and a Fuel.

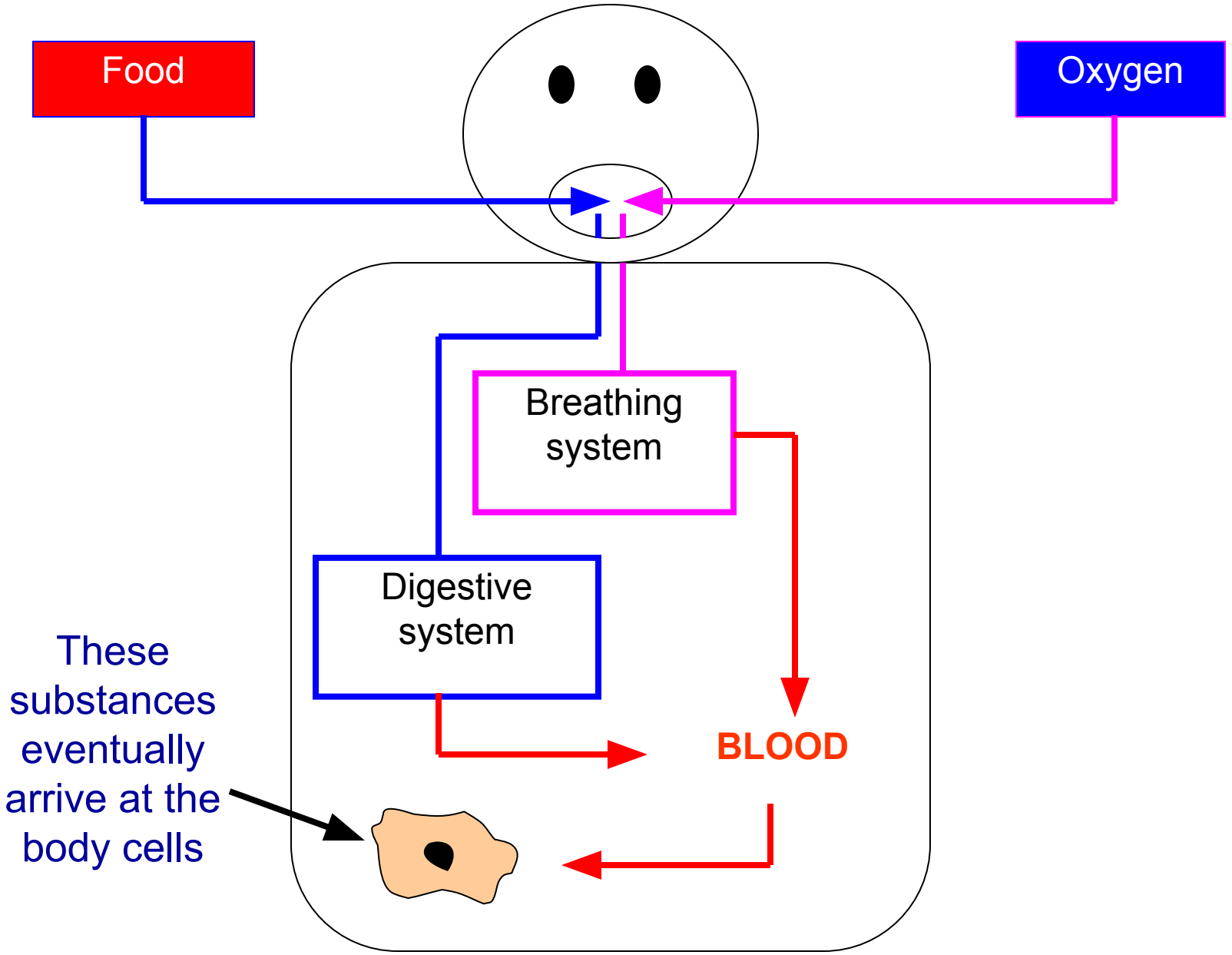
The **Oxygen** is supplied by the breathing system

2

+

And the **fuel** (in the form of digested food) comes courtesy of the digestive system

If we now think back over the journey of oxygen and digested food through the human body, we will realise that they both end up in the same place.



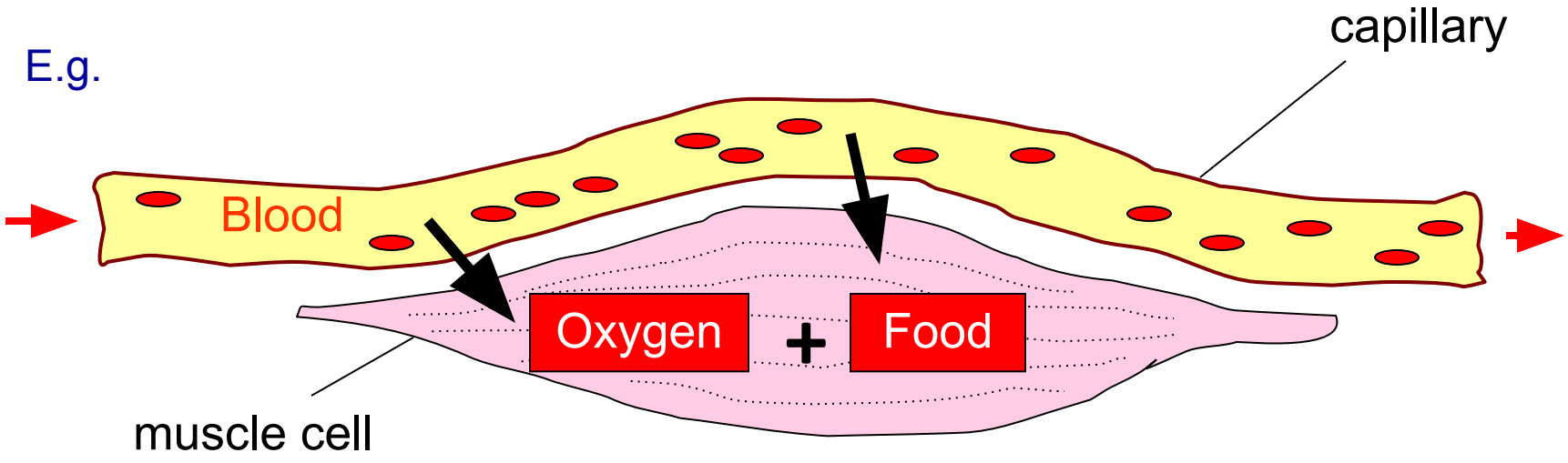
Therefore, the raw materials for the energy making process eventually arrive at the **body cells.**

This energy making process is known as...

RESPIRATION

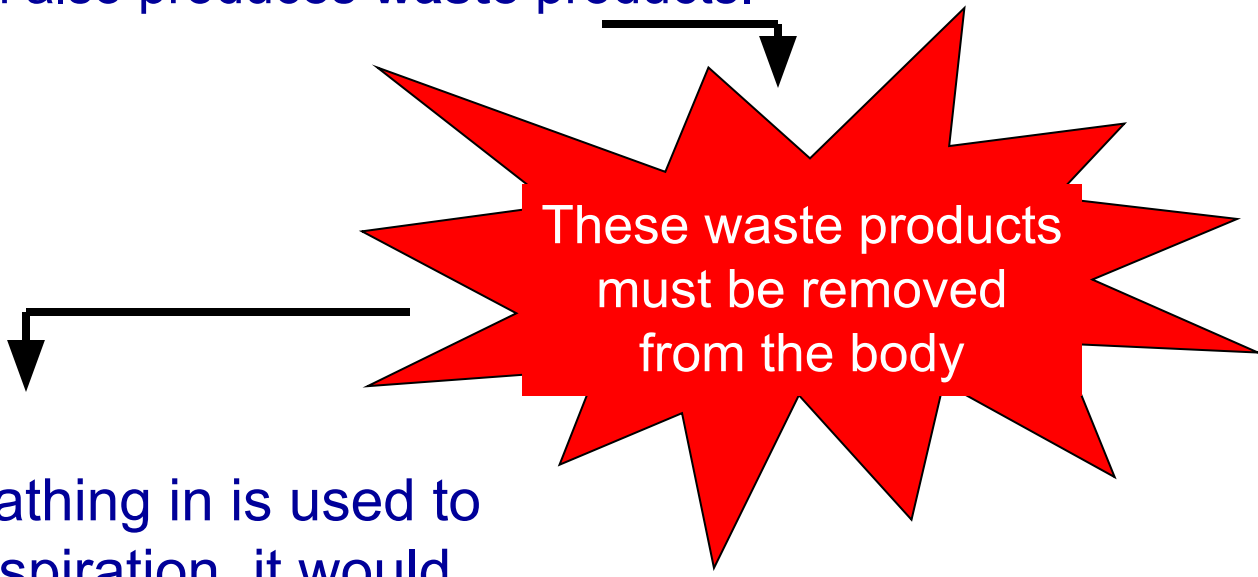
Each living cells is supplied with food and oxygen in order to generate energy

E.g.



No chemical reaction is 100% efficient.

Therefore, as well as producing the useful energy, respiration also produces **waste** products.



If the process of breathing in is used to obtain the O_2 for respiration, it would make sense for the body to use the process of breathing out to remove these waste products of this reaction.

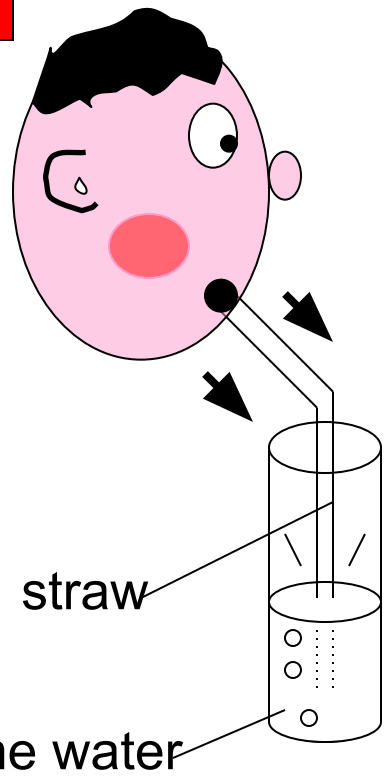
This is exactly what happens!!

If we study the composition of the air that is breathed out, we will identify the waste products of respiration.

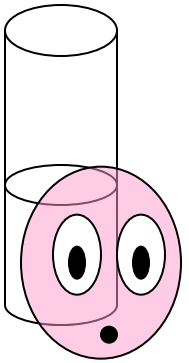
Two tests help us identify these waste products.

Test One

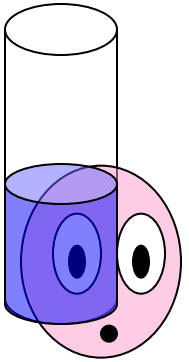
Blow gently through a straw into a test tube filled with lime water.



Before you start exhaling, the lime water is a clear liquid



After a short while, the lime water becomes cloudy.



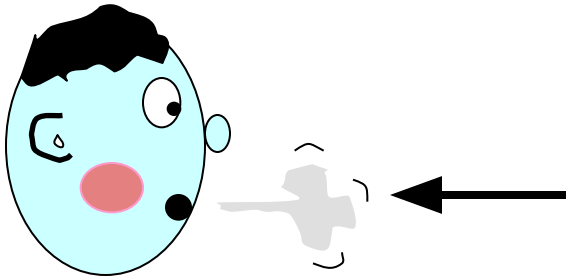
If a gas is bubbles through lime water and the liquid becomes cloudy, the gas is identified as….

Carbon Dioxide (CO_2)

This is the **first** of our **waste products** of respiration.

Test Two

On a freezing cold day, watch what happens when you breathe out.

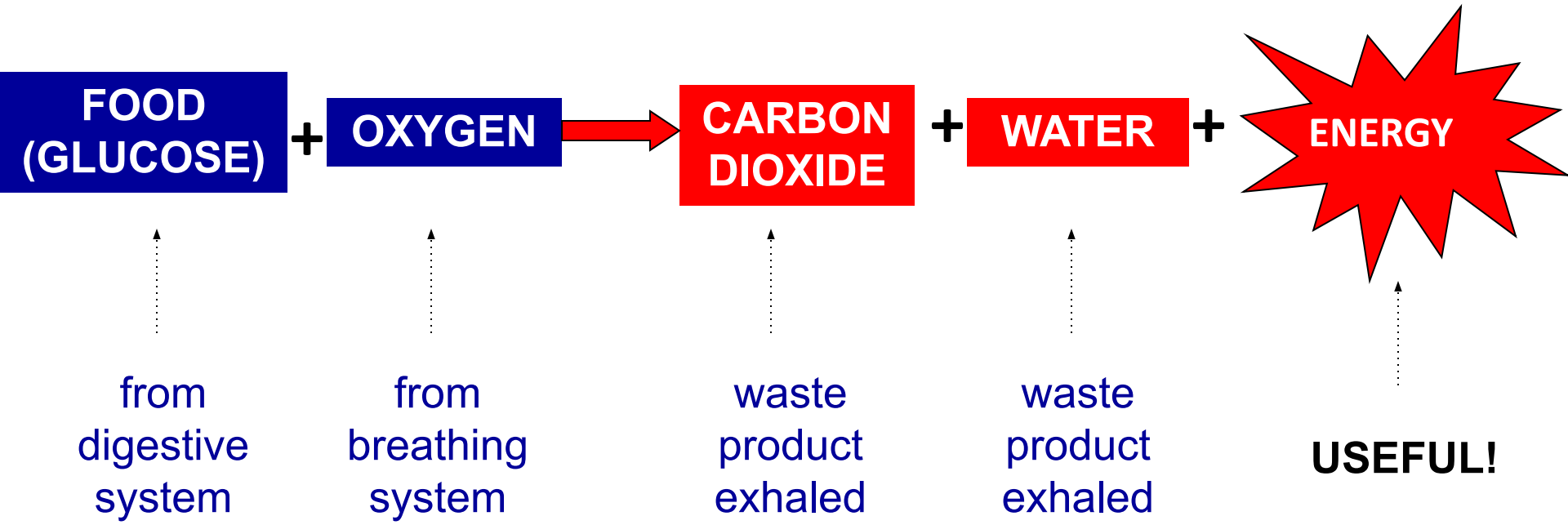


The air you breathe out is visible because the mystery waste product condenses back into a liquid.

This waste product is water vapour and so our final waste product of the process of respiration is...

Water

Using this information, we can now write out the full equation for respiration



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