Glenlola Collegiate School

excellence through commitment, contribution and caring

1.5 BREATHING AND THE RESPIRATORY SYSTEM

homework menu

FRONTER

There are 3 sections:

STARTER; **MAIN;** **DESSERT**.

Over the next 3 weeks you have to chose **ONE ACTIVITY FROM EACH SECTION**.
Download the homework menu sheet and follow the instructions provided.

starter activity

- On the whiteboard, make a list of key words which you associate with respiration.
- Share your list with your pair & class.

RESPIRATION

is NOT breathing!

it IS

the release of energy

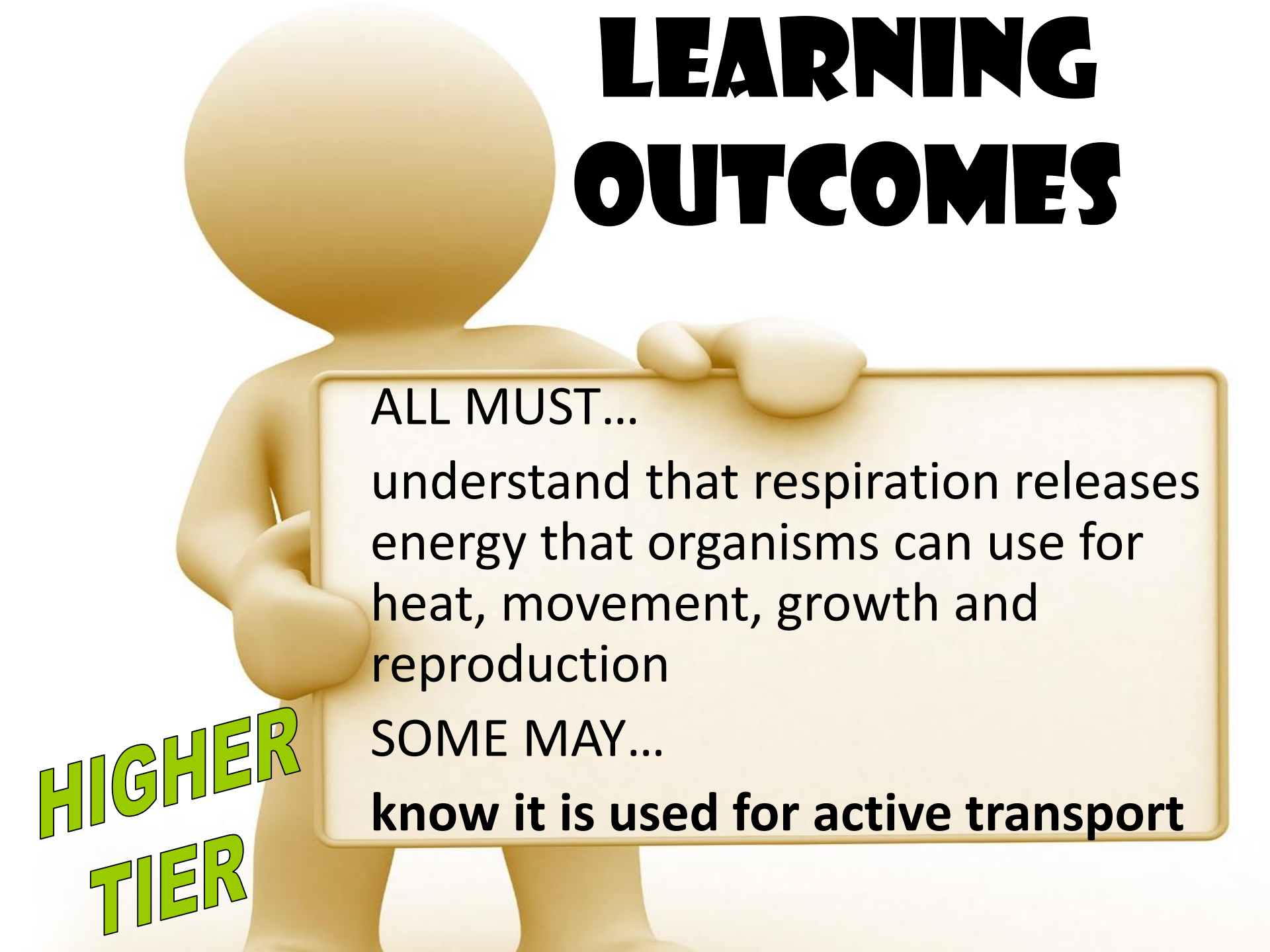
from food

and occurs

in all body cells

DO NOT COPY THIS DOWN

LEARNING OUTCOMES



ALL MUST…

understand that respiration releases energy that organisms can use for heat, movement, growth and reproduction

SOME MAY…

know it is used for active transport

HIGHER TIER

Breathing and the Respiratory System

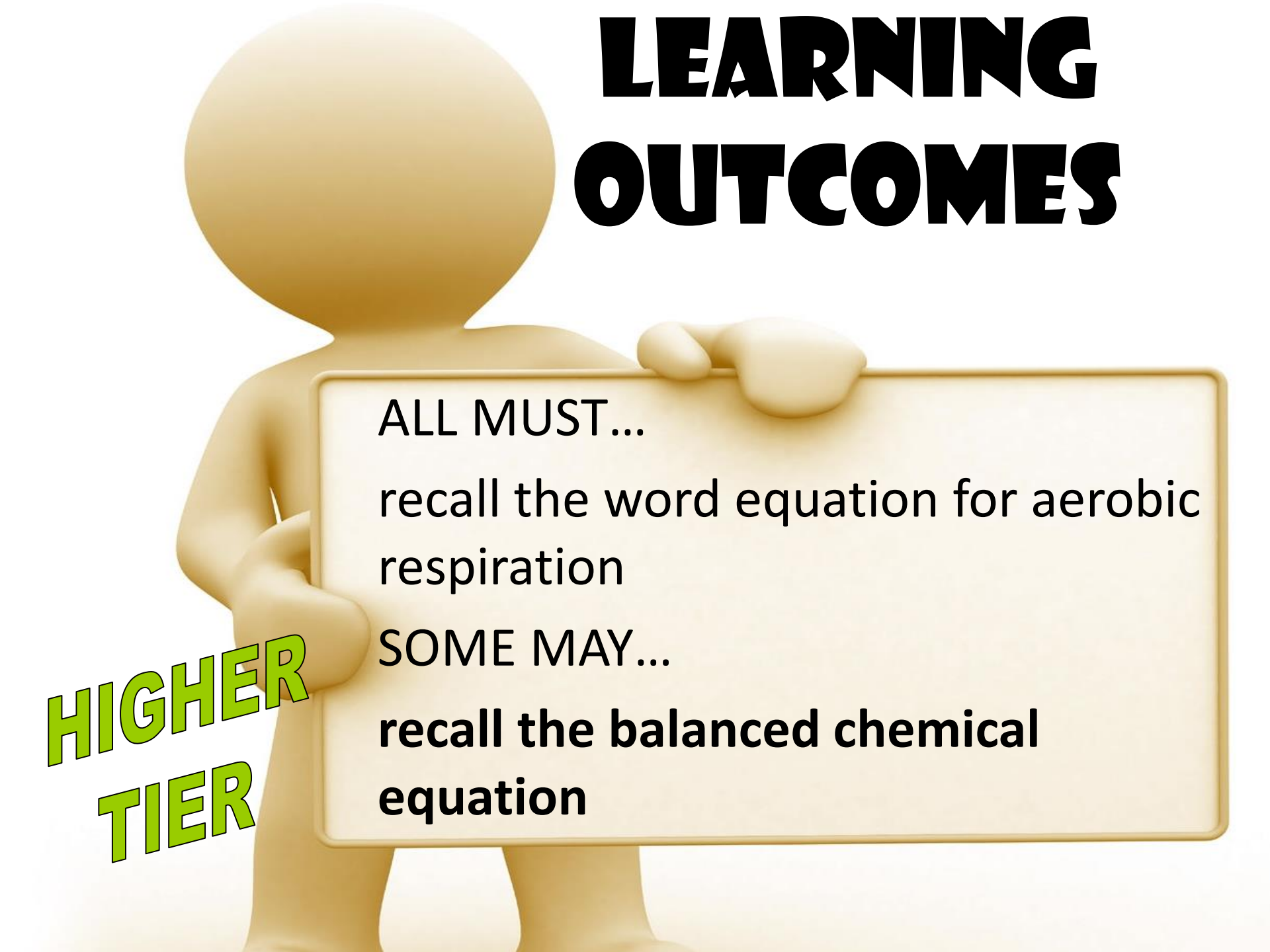
•The **respiratory system provides** the cells and tissues with **oxygen** and **removes carbon dioxide** to facilitate the process of respiration.

•**Respiration** is a **chemical process** that occurs **inside cells.**

•It **releases** stored chemical **energy from food**, which can be **used for heat, movement, growth, reproduction and active transport**.

•**Breathing** moves air in and out of the lungs.

LEARNING OUTCOMES



ALL MUST…

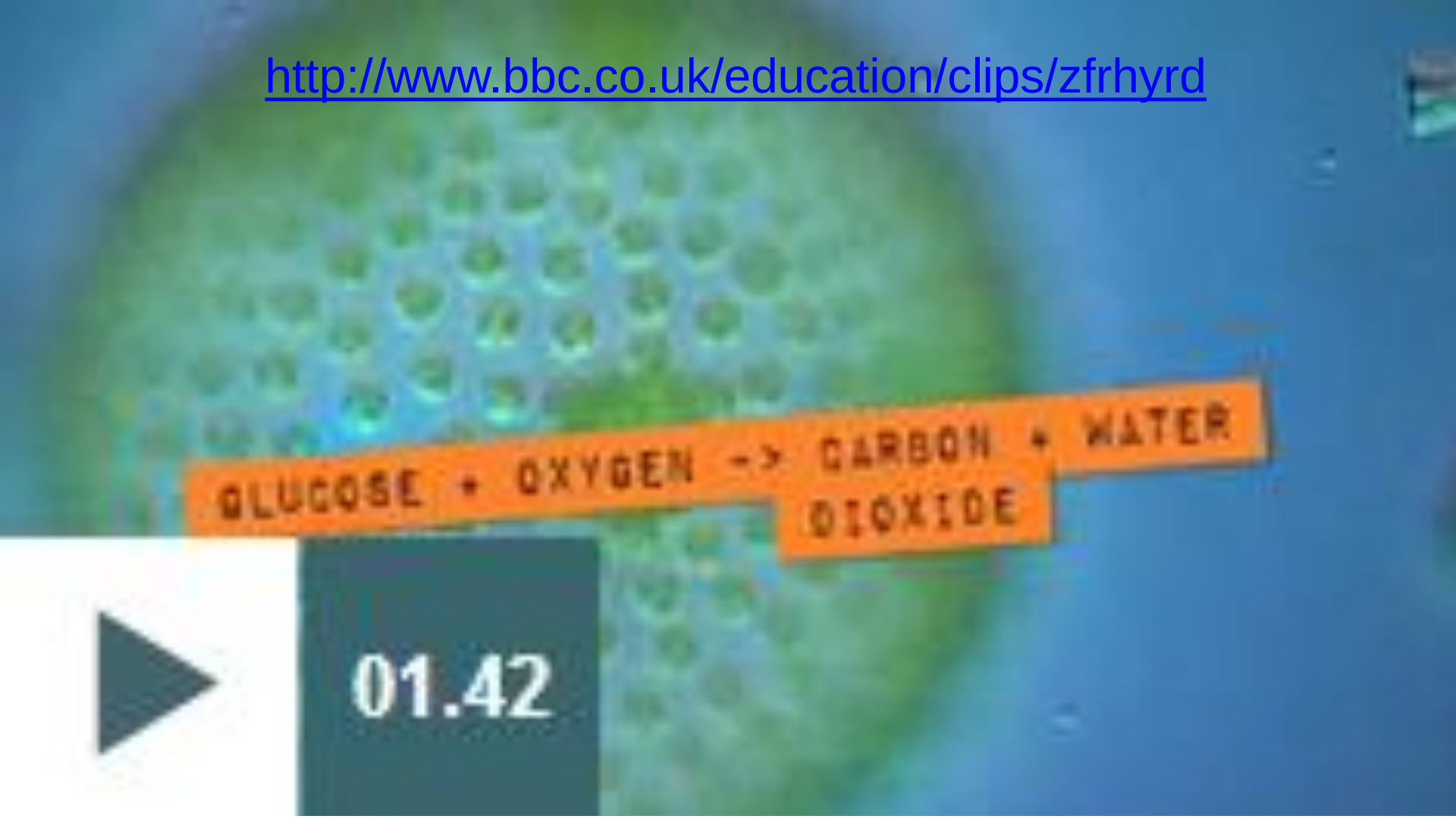
recall the word equation for aerobic respiration

SOME MAY…

recall the balanced chemical equation

HIGHER TIER

http://www.bbc.co.uk/education/clips/zfrhyrd



Aerobic respiration

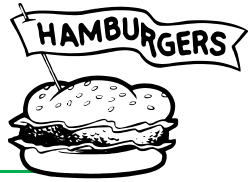
Science presenter Jon Chase explains aerobic respiration.

Every cell in every living organism needs energy (i.e. plants and animals). Cells get this energy by releasing energy from food (stored chemical energy).

respiration word equation

glucose + oxygen → carbon dioxide + water + energy

The glucose comes from **the food that we eat**



The oxygen comes from **the air we breathe in**

When **oxygen** is used to break down the food we call it ***AEROBIC RESPIRATION.***

The sugar normally broken down is glucose, ($C_6H_{12}O_6$). The balanced chemical equation for aerobic respiration is:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$$

(count the C, H and O – is it balanced?)

The carbon dioxide and water are by-products and are excreted by the body

showing the products of respiration

carbon dioxide

changes limewater

from clear & colourless

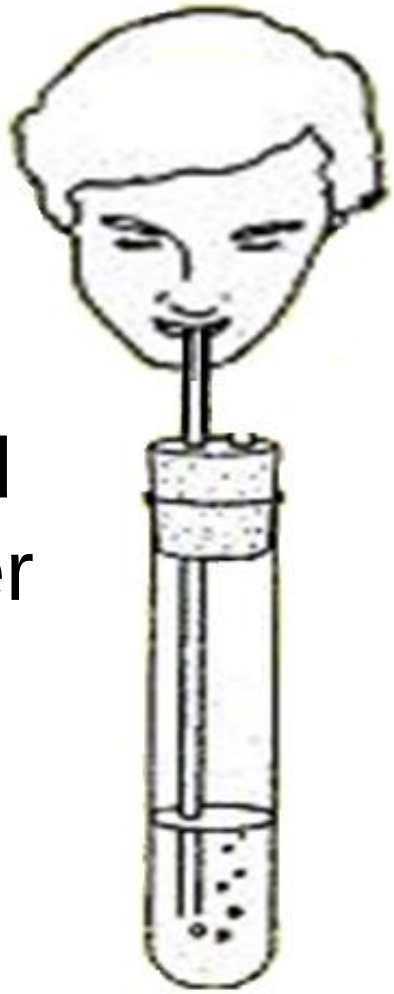
to cloudy

class expt

- Gently blow into the lime water and observe the changes.

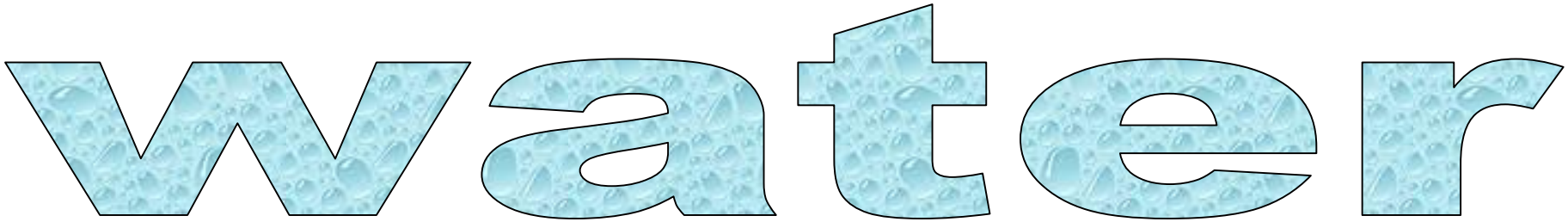
DO NOT SUCK UP!

- Compare the limewater left exposed to the atmosphere with the limewater mixed with exhaled air, what do you notice?
- What does this prove?



There is more carbon dioxide in exhaled air than in the atmosphere i.e. it is made by respiration

showing the products of respiration



changes cobalt chloride paper

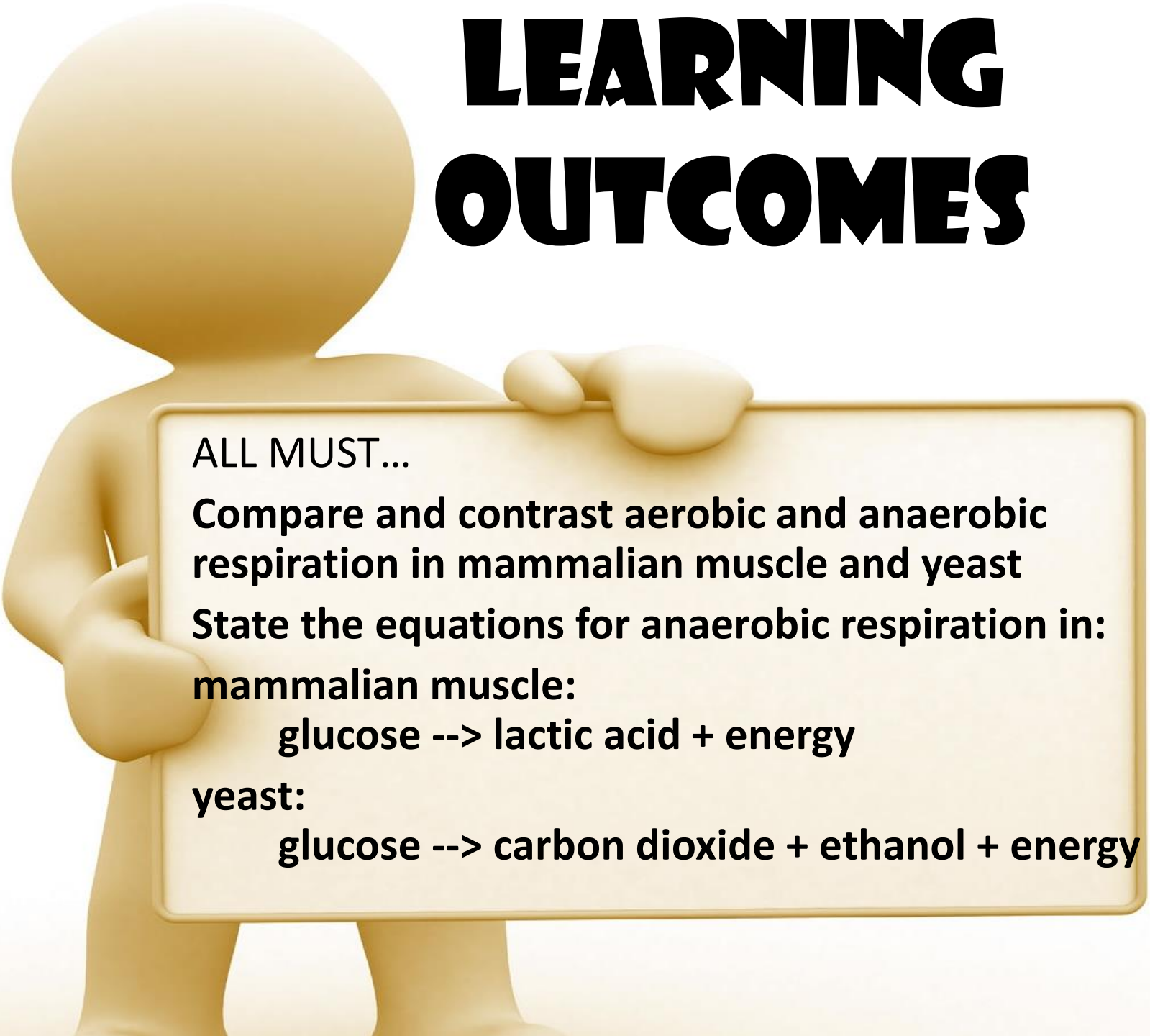
from blue

to pink

class expt

•Lift a piece of blue cobalt chloride paper with a pair of forceps.
•Hold the paper close to your mouth and breathe in & out over the paper.

LEARNING OUTCOMES



ALL MUST…

Compare and contrast aerobic and anaerobic respiration in mammalian muscle and yeast

State the equations for anaerobic respiration in:

mammalian muscle:

glucose --> lactic acid + energy

yeast:

glucose --> carbon dioxide + ethanol + energy

anaerobic respiration

- Most organisms must respire **aerobically** (**using O_2**)
- Many can also respire **anaerobically** in certain circumstances.
- **Anaerobic respiration takes place without using O_2.**

There are two main instances of this occurring:
In yeast cells when there is little oxygen available
In mammals during strenuous exercise
Each has different balanced chemical equations.

yeast cells

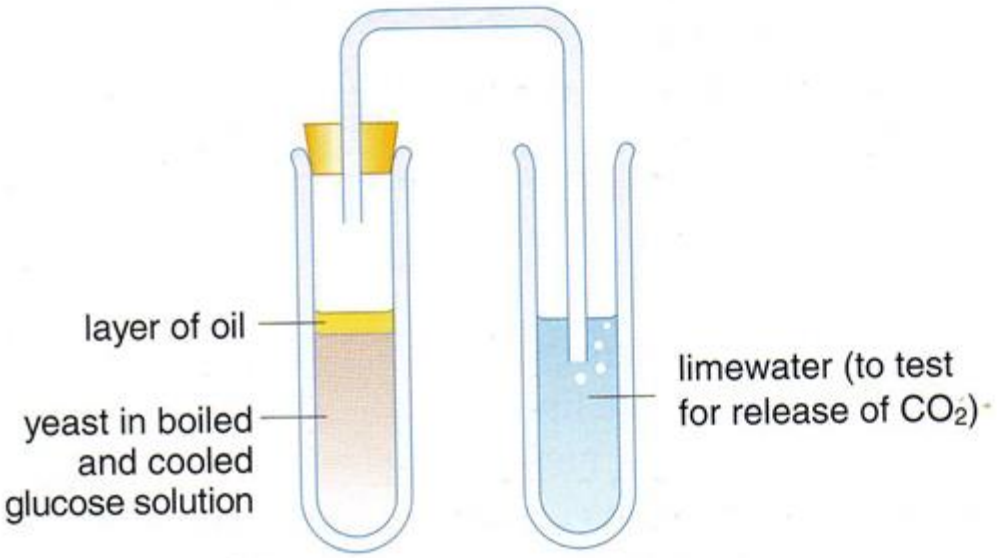
Yeast is a type of single celled fungus used in bread and alcohol manufacture).

When there is very little oxygen available yeast cells may stay alive using the small amount of energy released from anaerobic respiration alone.

glucose → carbon dioxide + alcohol + small amount of energy

Practical activity – Anaerobic respiration in yeast

WEAR GOGGLES



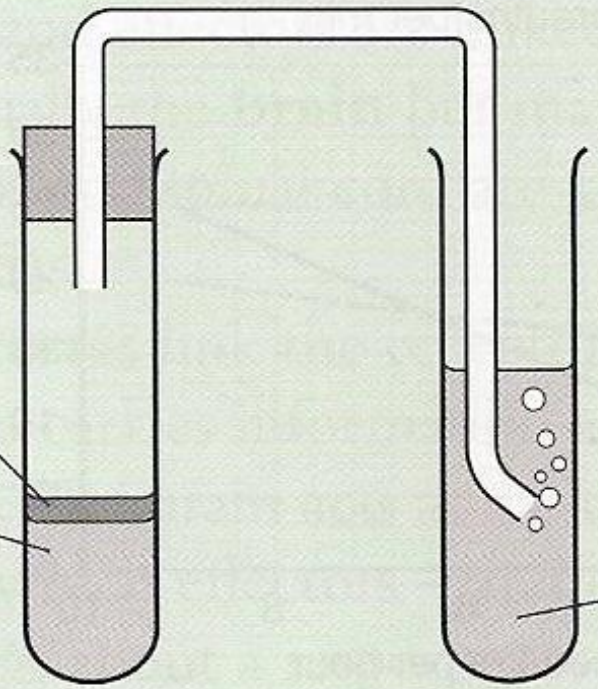
HIGHLIGHT THE STAGES AT WHICH OXYGEN IS REMOVED

1. Put a 10 % solution of glucose into a boiling tube to a depth of 2 cm.
2. Boil the glucose solution to remove any oxygen present.
3. Cool it, then add a little yeast.
4. Pour a thin layer of liquid paraffin on top of the glucose solution to stop oxygen getting to the yeast.
5. Set up the boiling tube as shown in the diagram.
6. Set up a second boiling tube exactly like the first one, but do not add any yeast to the glucose. This is your control.
7. Leave the boiling tubes in a warm place for at least an hour. Then examine them.

Practical DEMO:

Demonstrating anaerobic respiration in yeast

The glucose solution is boiled (to remove oxygen and to sterilise it) and allowed to cool (to prevent the yeast cells being killed) before the yeast is added.



layer of oil prevents oxygen entering solution

after a period of time the glucose and yeast solution is slightly warmer and contains alcohol due to anaerobic respiration

carbon dioxide turns limewater milky

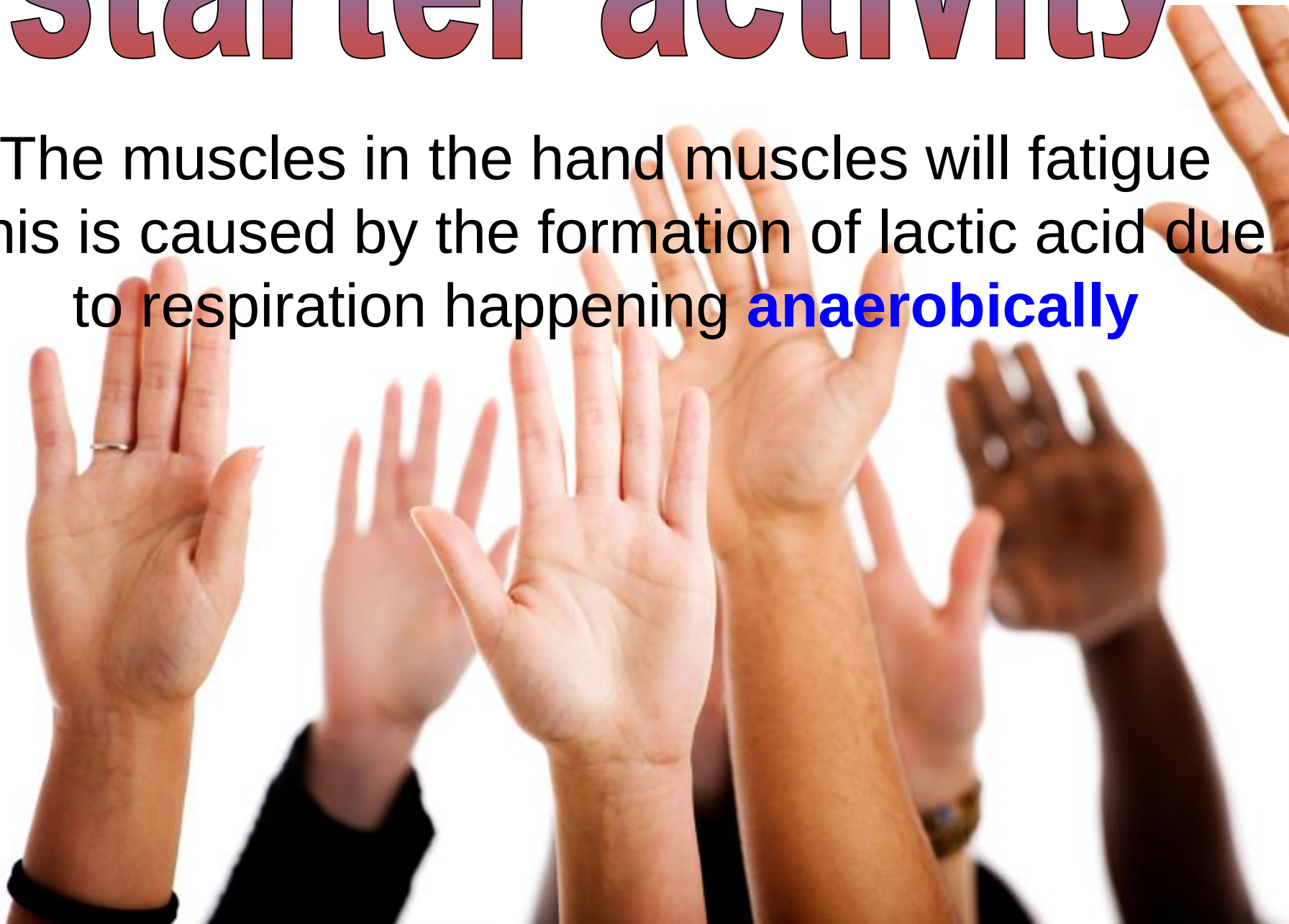
Now complete the questions on your page…

starter activity

Raise a hand and make rapid fist movements.
What happens?

starter activity

The muscles in the hand muscles will fatigue
This is caused by the formation of lactic acid due to respiration happening **anaerobically**



mammalian muscle

In humans anaerobic respiration
occurs when aerobic respiration doesn't meet their energy needs
e.g. during strenuous exercise

It ALWAYS occurs alongside aerobic respiration.

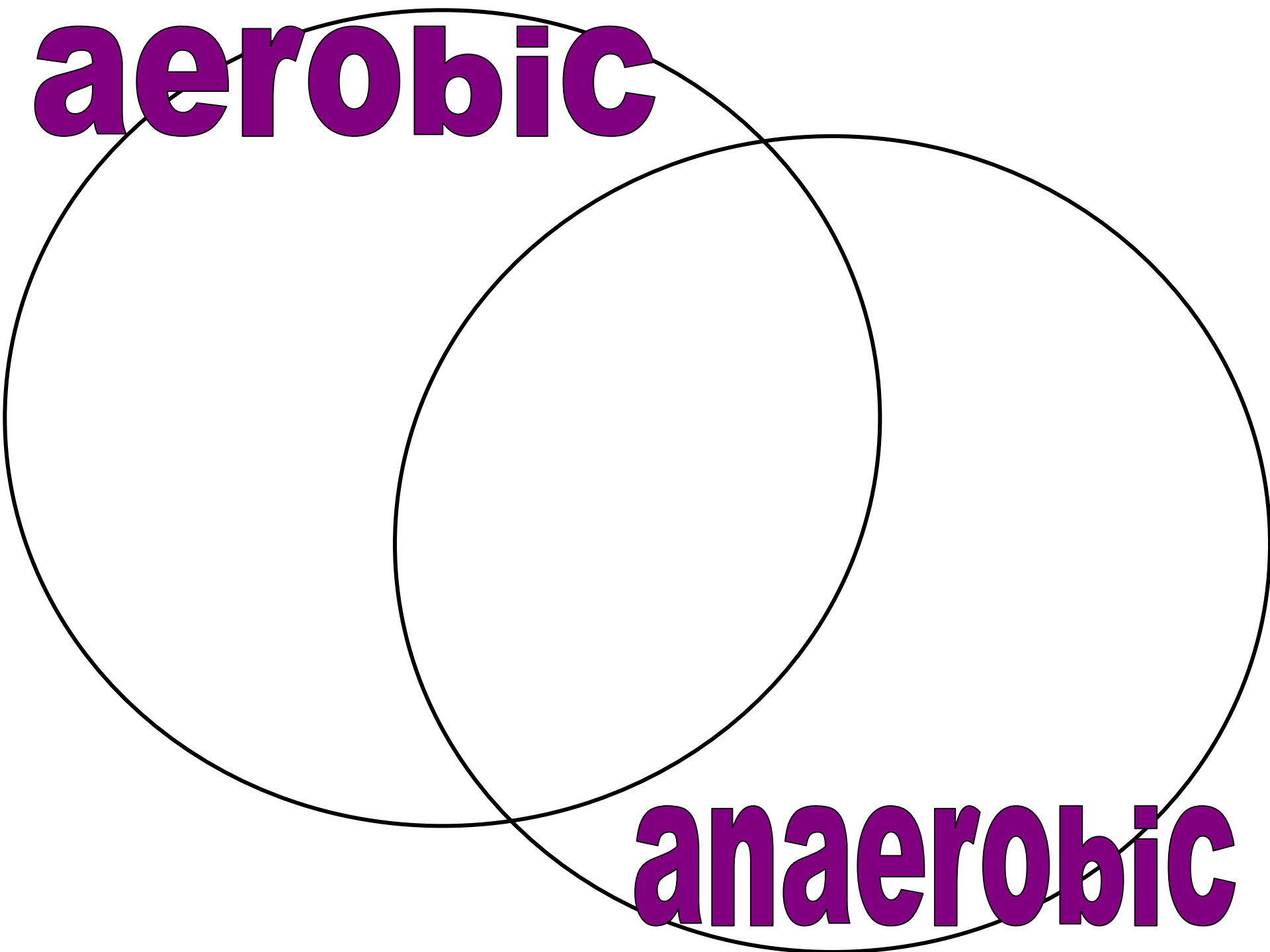
Glucose → lactate + small amount of energy

- During strenuous exercise the muscle cells are **respiring aerobically as fast as possible**, using the oxygen and glucose provided by the blood.

- The **extra energy** from **anaerobic respiration** allows muscles to work even harder for a short period.

- The **lactate** released in anaerobic respiration is **poisonous**, so **must be removed** by the body as soon as possible.
- It is carried to the **liver** to be **broken down** into **carbon dioxide and water**
- This process **requires oxygen**.
- This is why you **continue to breathe rapidly after strenuous activity**.
- The oxygen needed to break down lactate is known as the '**oxygen debt**'

Graphic organiser to compare aerobic & anaerobic respiration


aerobic
anaerobic

AEROBIC RESPIRATION		ANAEROBIC RESPIRATION
	USES GLUCOSE	
	USES OXYGEN	
	PRODUCES ENERGY	
	PRODUCES WATER	
	PRODUCES CARBON DIOXIDE	
	PRODUCES LACTATE	
	PRODUCES ALCOHOL	

AEROBIC

ANAEROBIC

AEROBIC

uses oxygen

makes water

large amount of energy

makes CO_2

uses glucose

release energy

ANAEROBI

mammals

lactate

alcohol + yeas

small amount of energ

starter activity

- On the whiteboard, jot down all the things that your body needs energy for.
- Share your list with your pair & class.

What is energy used for?

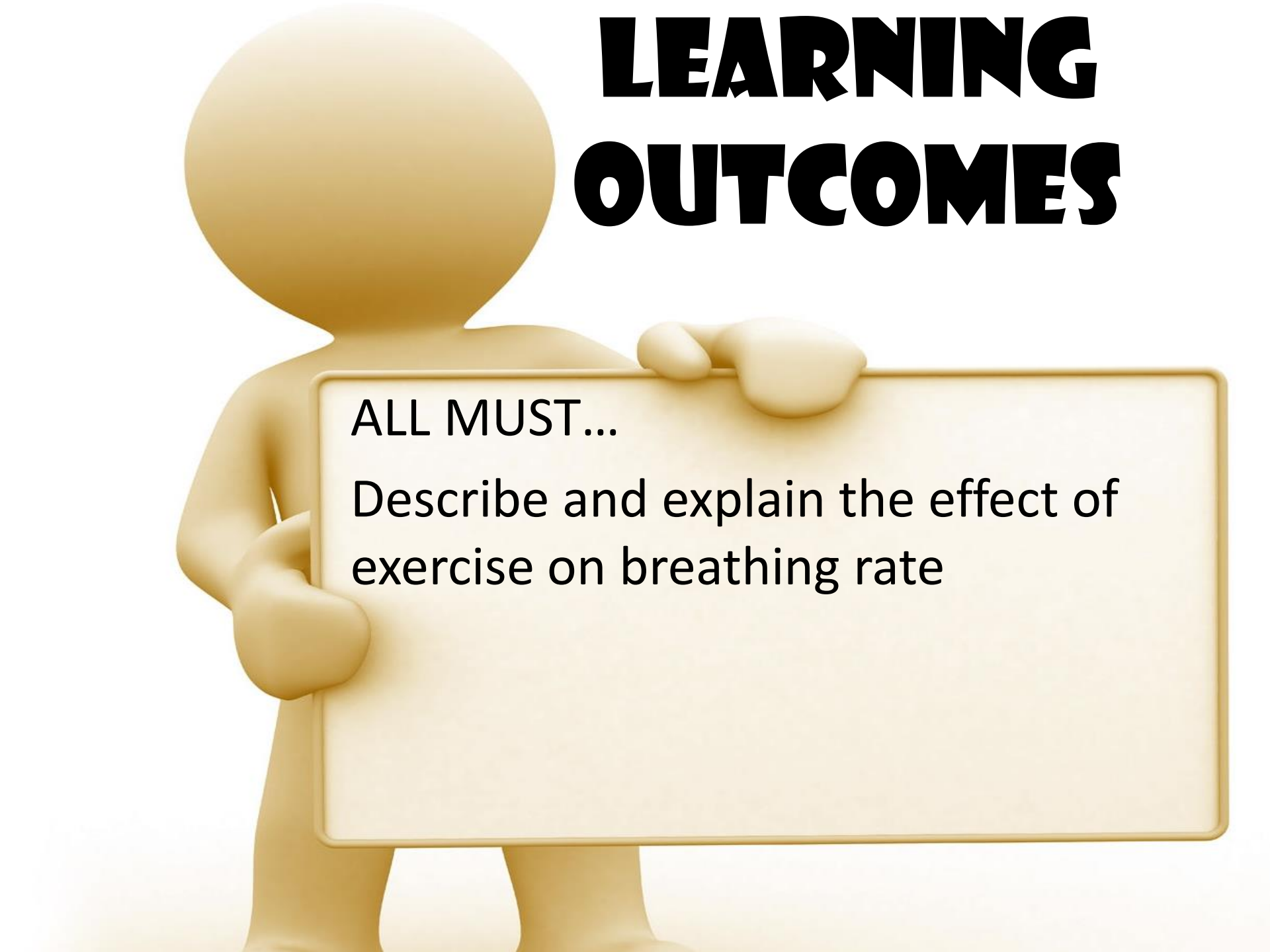
The energy released by respiration is used to keep organisms alive. Energy is needed for:

- Heat
- Movement
- Growth
- Reproductio
- **Active transport**

active transport

Active transport occurs when **molecules** are **moved against a concentration gradient** (from where they are in a low concentration to where they are in a high concentration).
It requires energy, from respiration.
Plants use active transport to move **nitrates into roots**.
Animals use **it to transmit impulses through nerve cells.**

LEARNING OUTCOMES



ALL MUST…

Describe and explain the effect of exercise on breathing rate

practical activity

Investigating the effects of exercise on breathing rate

Pupils with health problems or if recovering from recent illness should not attempt this!

www.curriculumonline.ie
(in search box key in 'Effect of Exercise')

Practical – *Investigating the effects of exercise on breathing rate*

Breaths	At rest	After 1 minute of exercise	After 2 minutes	After 3 minutes	After 4 minutes
Per 15 seconds					
Per minute					

http://www.online-stopwatch.com/large-stopwatch/

You should be able to use the results you obtain to discuss the following points.

1. Use your biological knowledge to explain why breathing rate increases during exercise.
2. Why did the breathing rate not return to normal immediately after exercise?
3. Was there a difference between the time taken to return to normal (known as the recovery rate) for different people?
4. What factors might affect the recovery rate?
5. If a person became fitter over time, how would this affect his/her recovery rate?

EXERCISE & BREATHING RATE

breathing rate

The number of times you breath in and out in a given time e.g. no. of breaths per minute

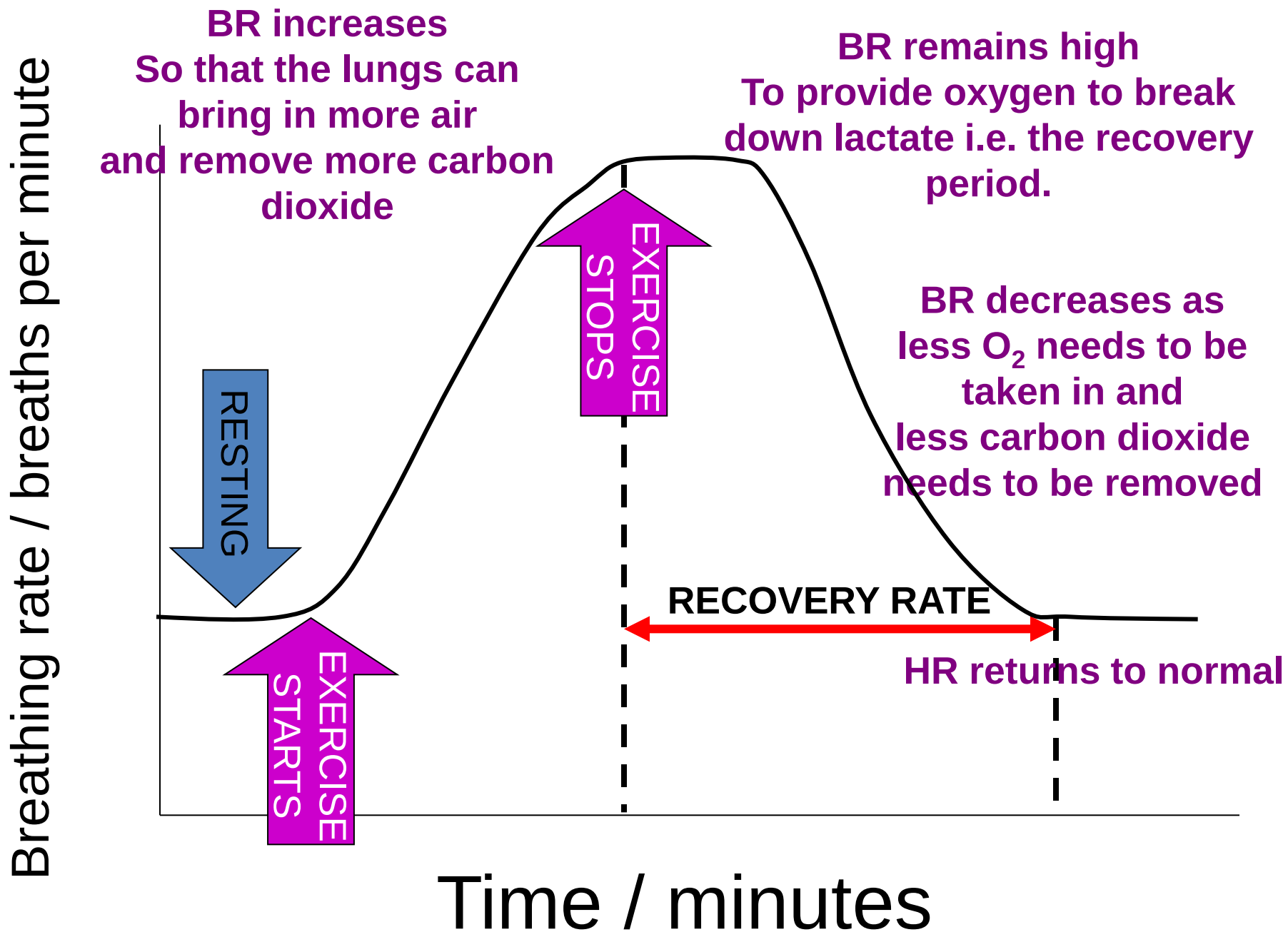
Maximum volume of air breathed into the lungs

lung volume

recovery rate

Time it takes the breathing rate to return to normal after exercise

Changes in breathing rate as a result of exercise!



USE WHITEBOARD

- Draw a graph to compare the breathing rates of a fit and a healthy person at rest, during exercise and after exercise.
    - Mark the following on the graph

A: Unfit person has a greater resting BR

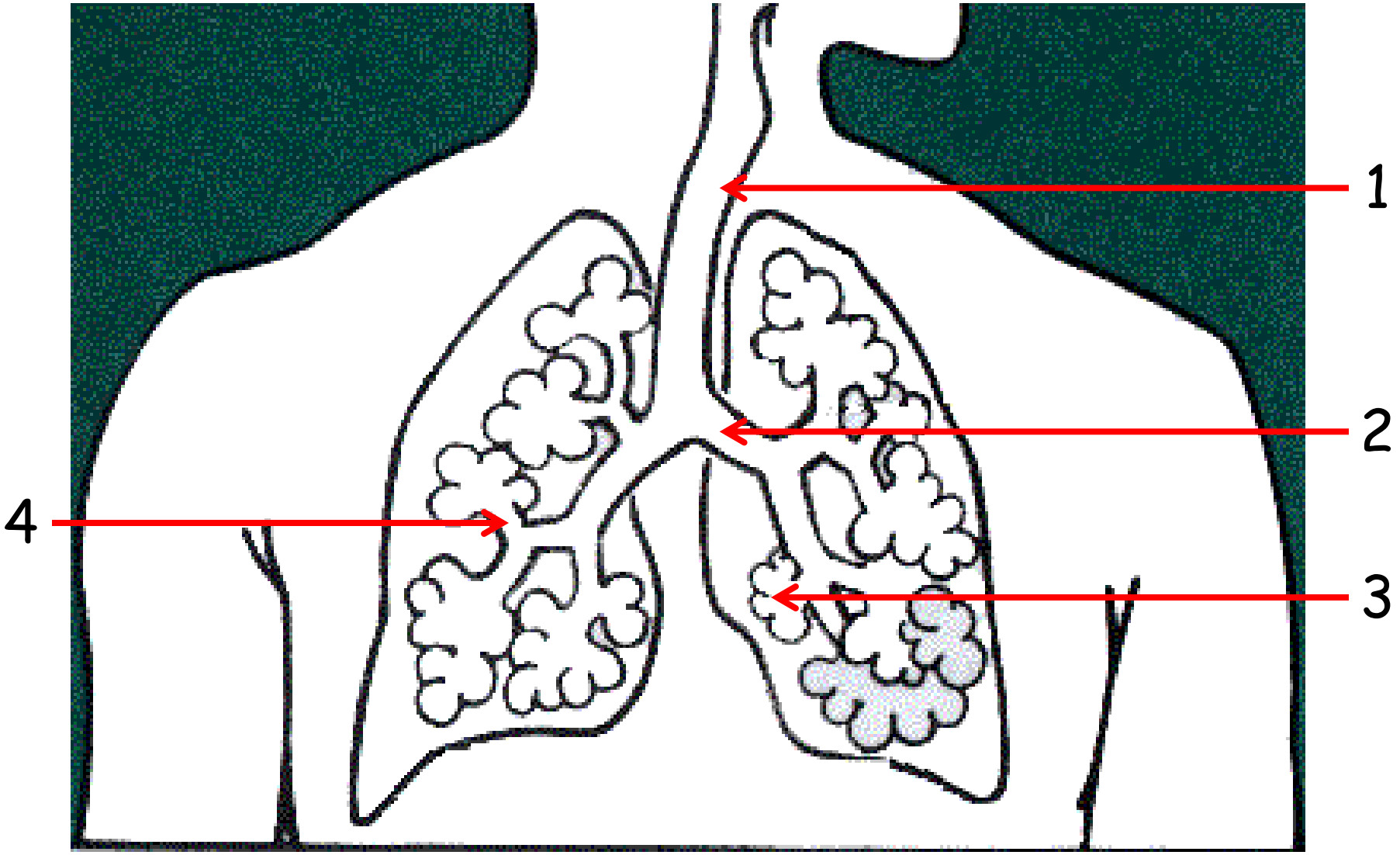
B: Unfit person has a greater BR during exercise

C: Unfit person takes longer for the BR to return to normal

NOW COPY THIS INTO YOUR BOOKLET

starter activity

- On the whiteboard, name the parts of the respiratory system numbered on the diagram on the next slide.


1
2
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the respiratory system in animals

This is designed to deliver oxygen to a surface where it can be absorbed, and taken to cells to be used in respiration.

Waste products e.g. carbon dioxide and water need to be delivered back to the respiratory surface and removed.

A very large surface area is needed so gas exchange can happen at a fast enough rate to supply all cells with the oxygen they need.

The lungs have many small air sacs called alveoli, which have folded surfaces to increase surface area.

Ventilation (breathing) also ensures a fresh, frequent air supply and maintains a concentration gradient for the diffusion of gases.

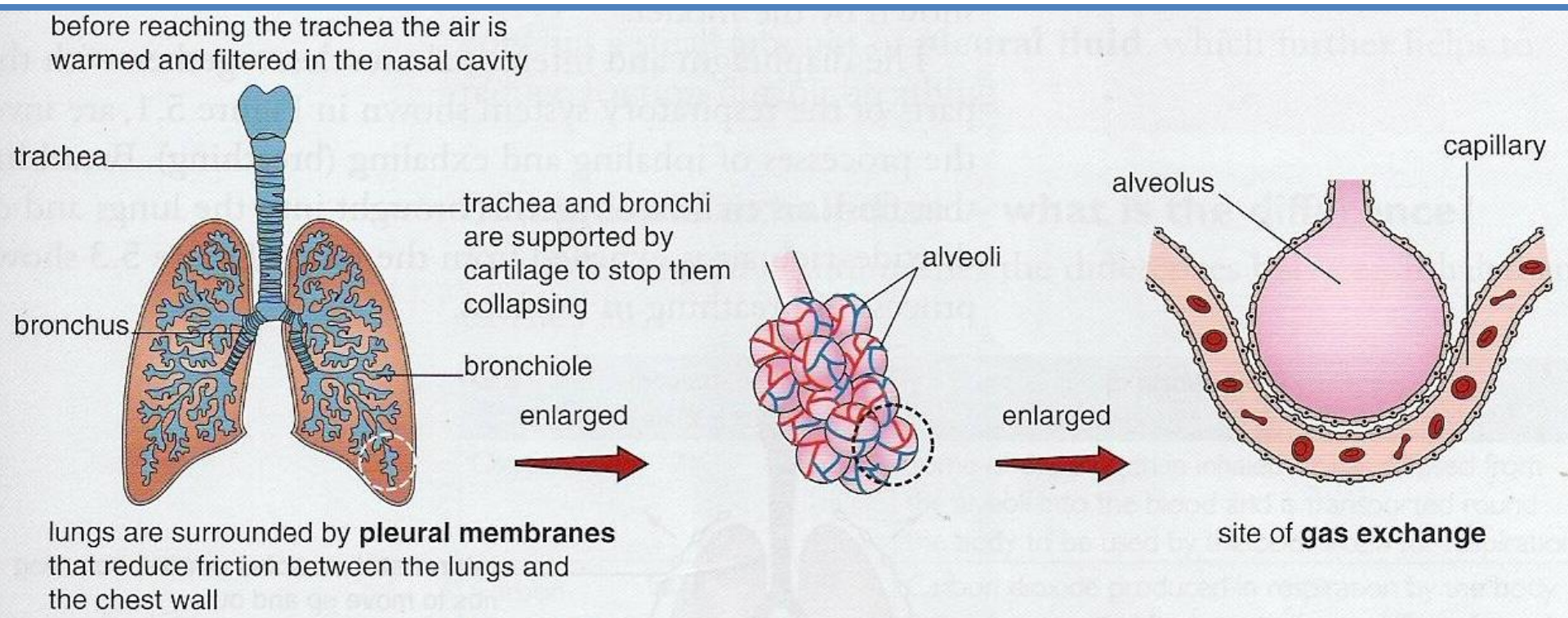
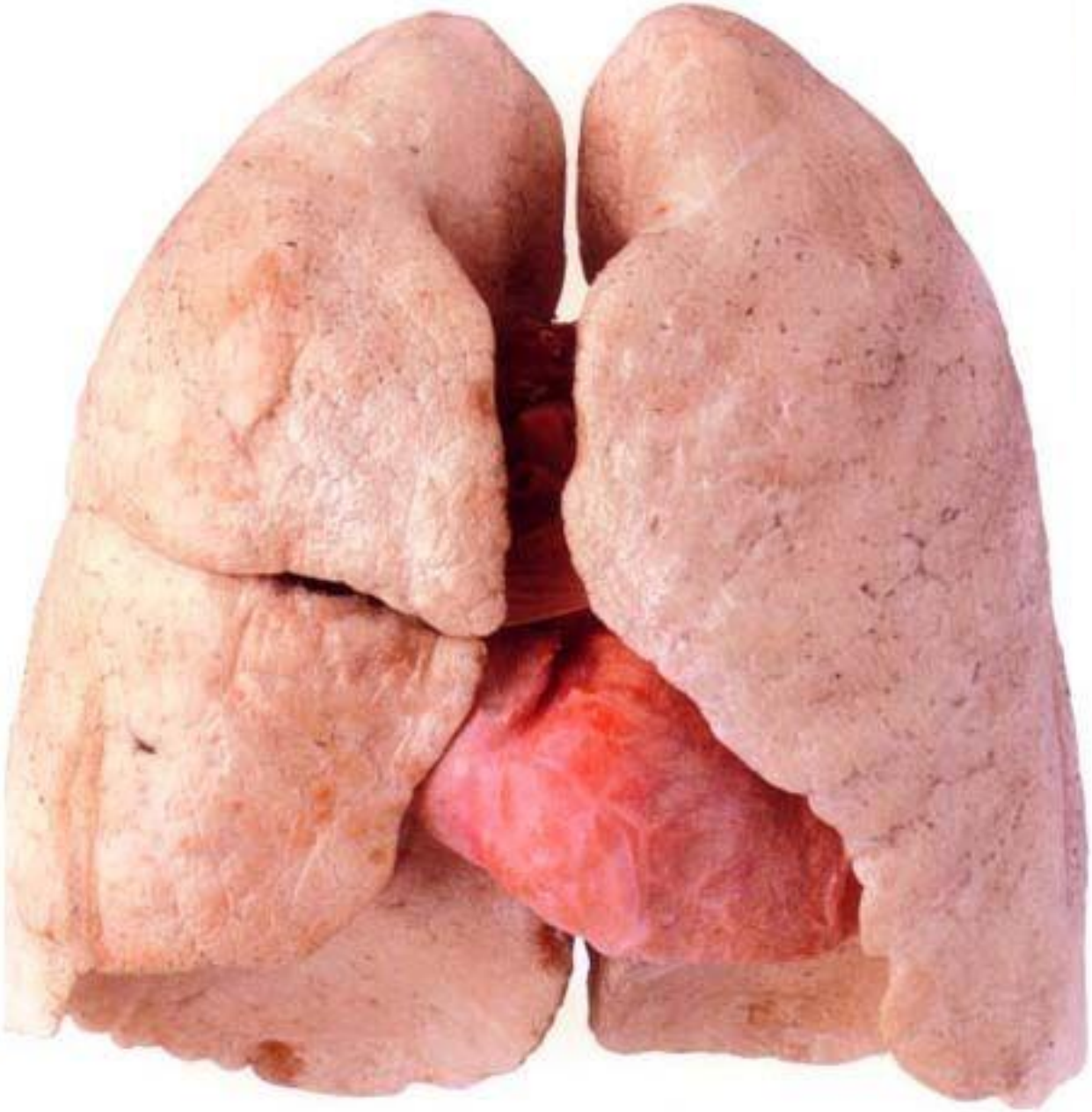
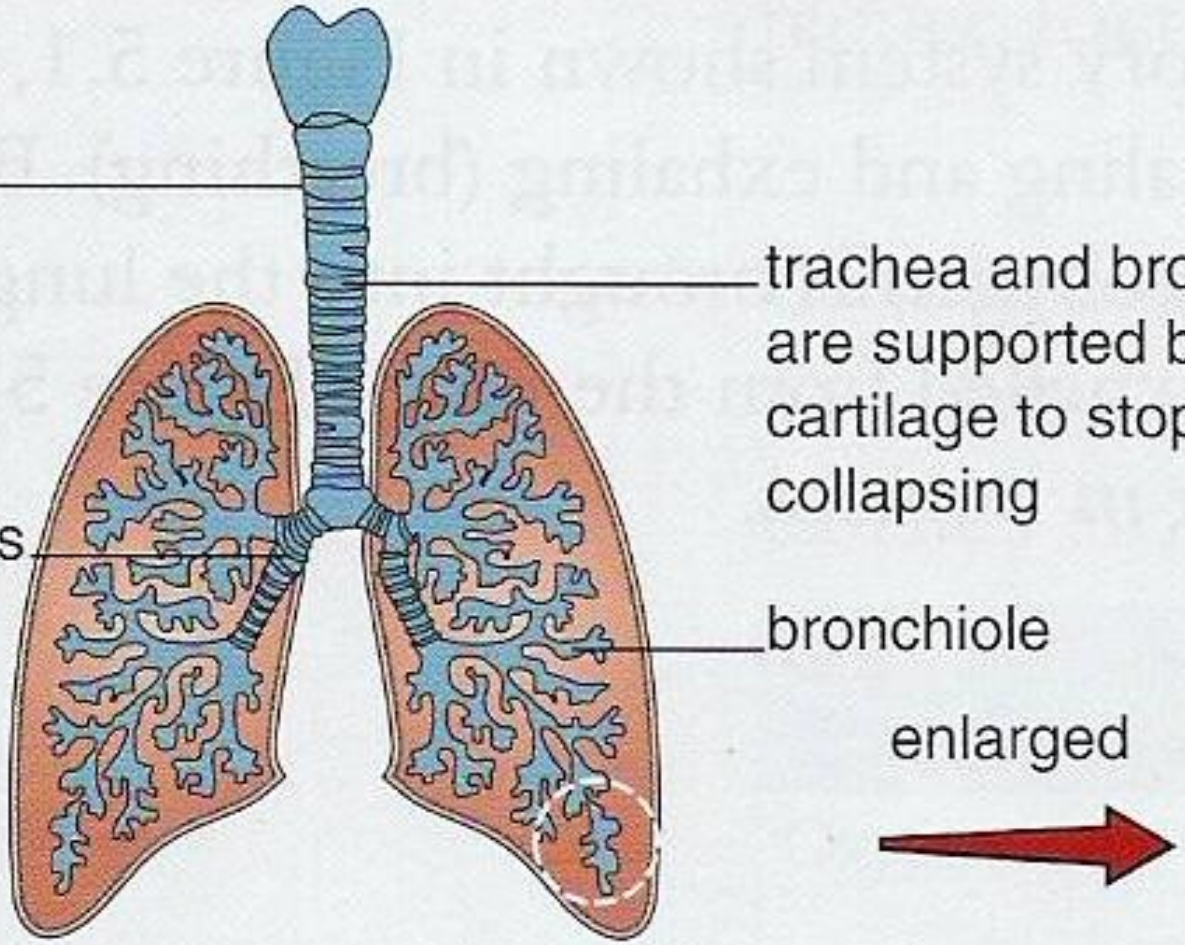


Figure 5.1 The respiratory system

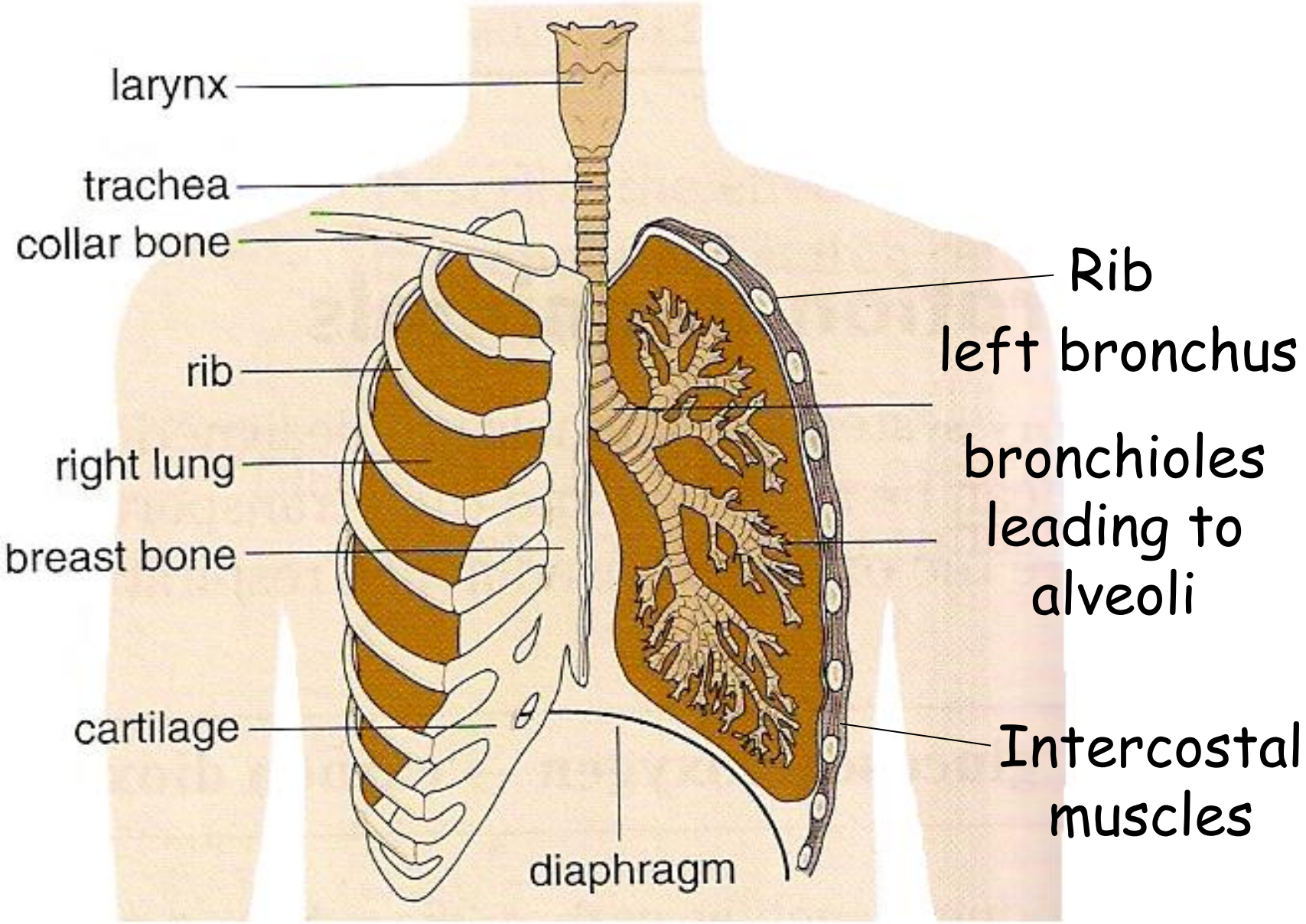
https://www.youtube.com/watch?v=9xhxALk9gm8



before reaching the trachea the air is warmed and filtered in the nasal cavity



lungs are surrounded by **pleural membranes** that reduce friction between the lungs and the chest wall



Structure of the lungs

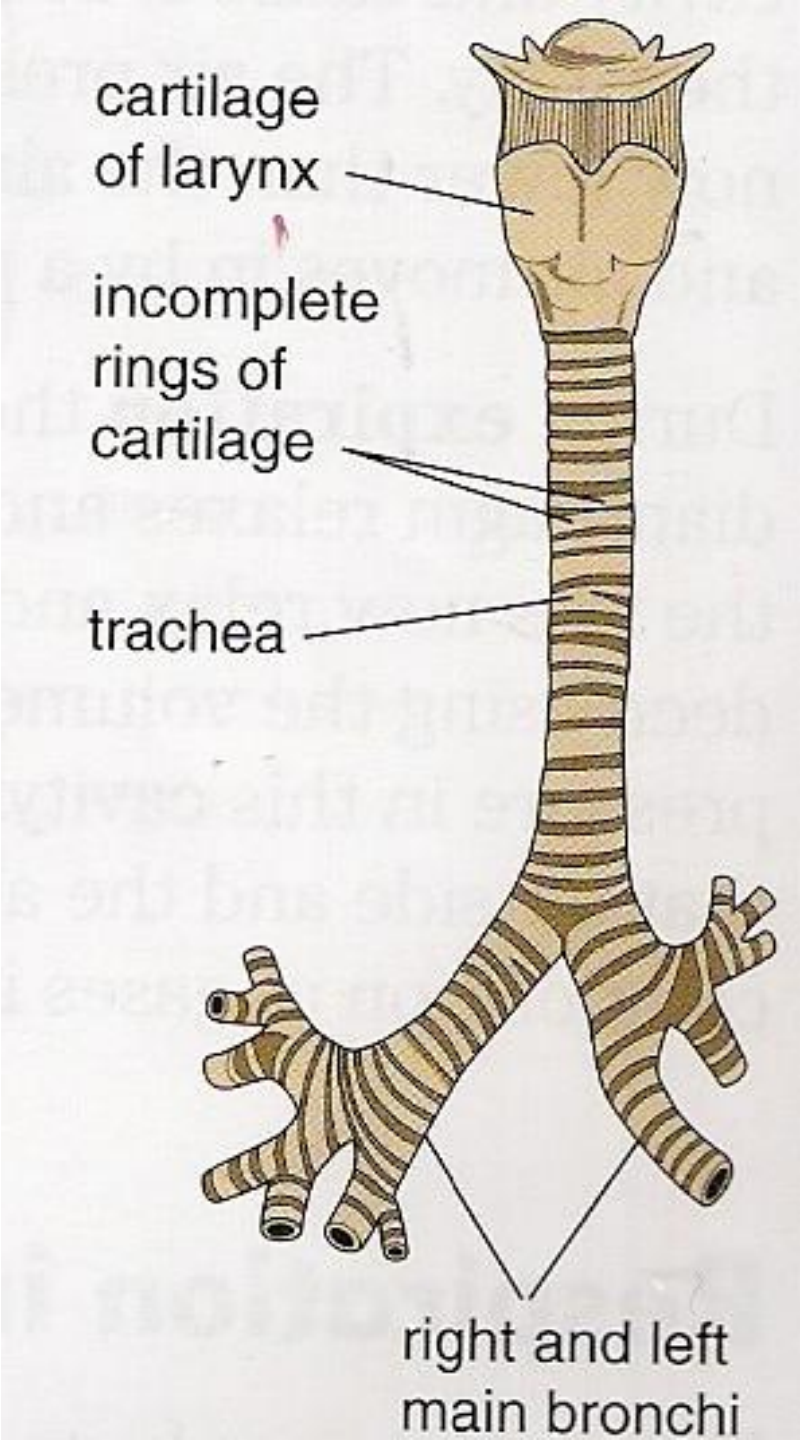
Structure of the lungs

Location of various organs in the respiratory system.

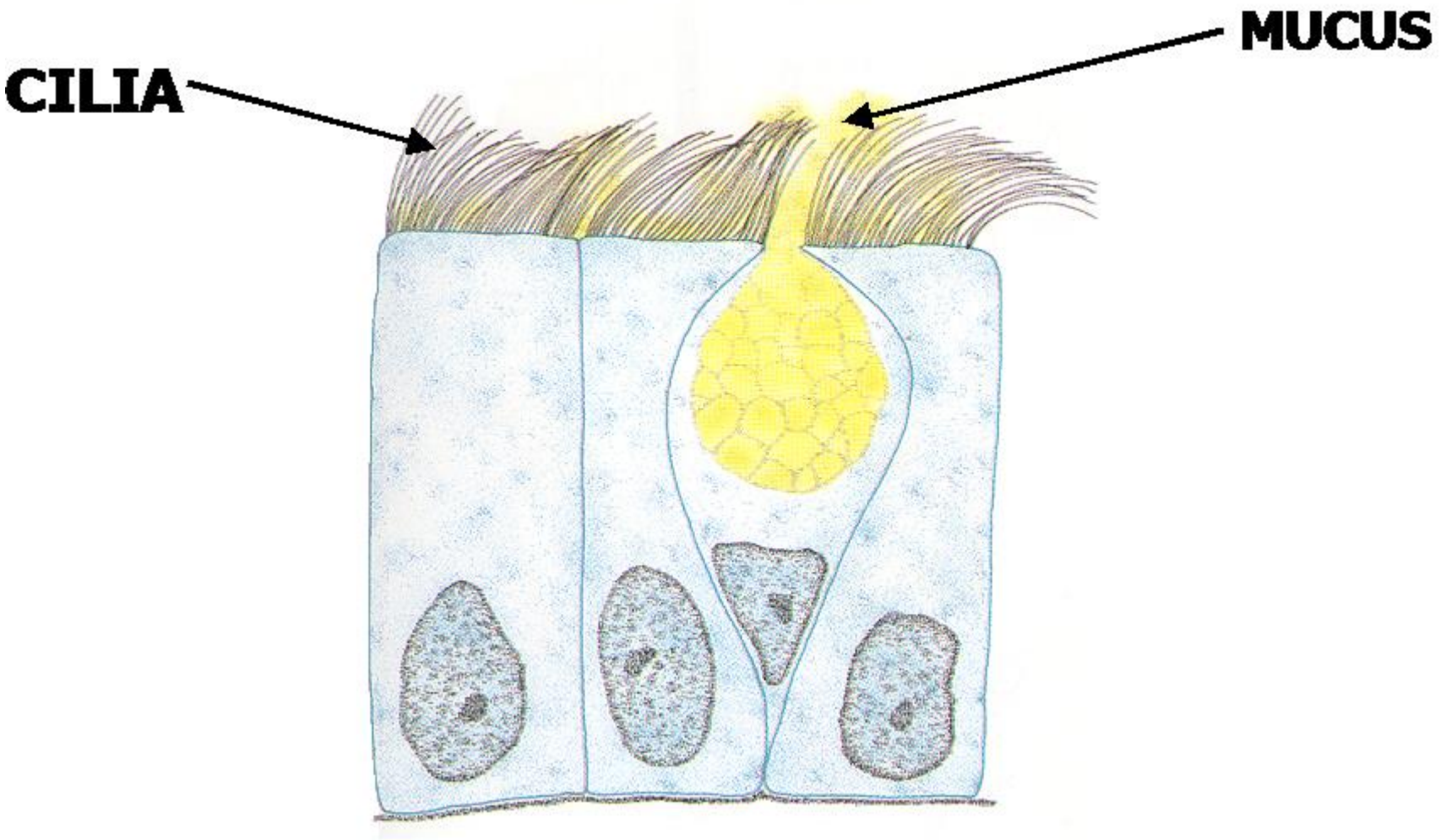
http://www.bbc.co.uk/education/clips/zndrkqt

Did you know?

The human respiratory system consists of a series of tubes: Nasal passages, trachea, bronchi and bronchioles – which carry the air gases to and from the lungs. The trachea stays open during the pressure changes (inhaling and exhaling) as it has c-shaped (incomplete) rings of cartilage in its walls.



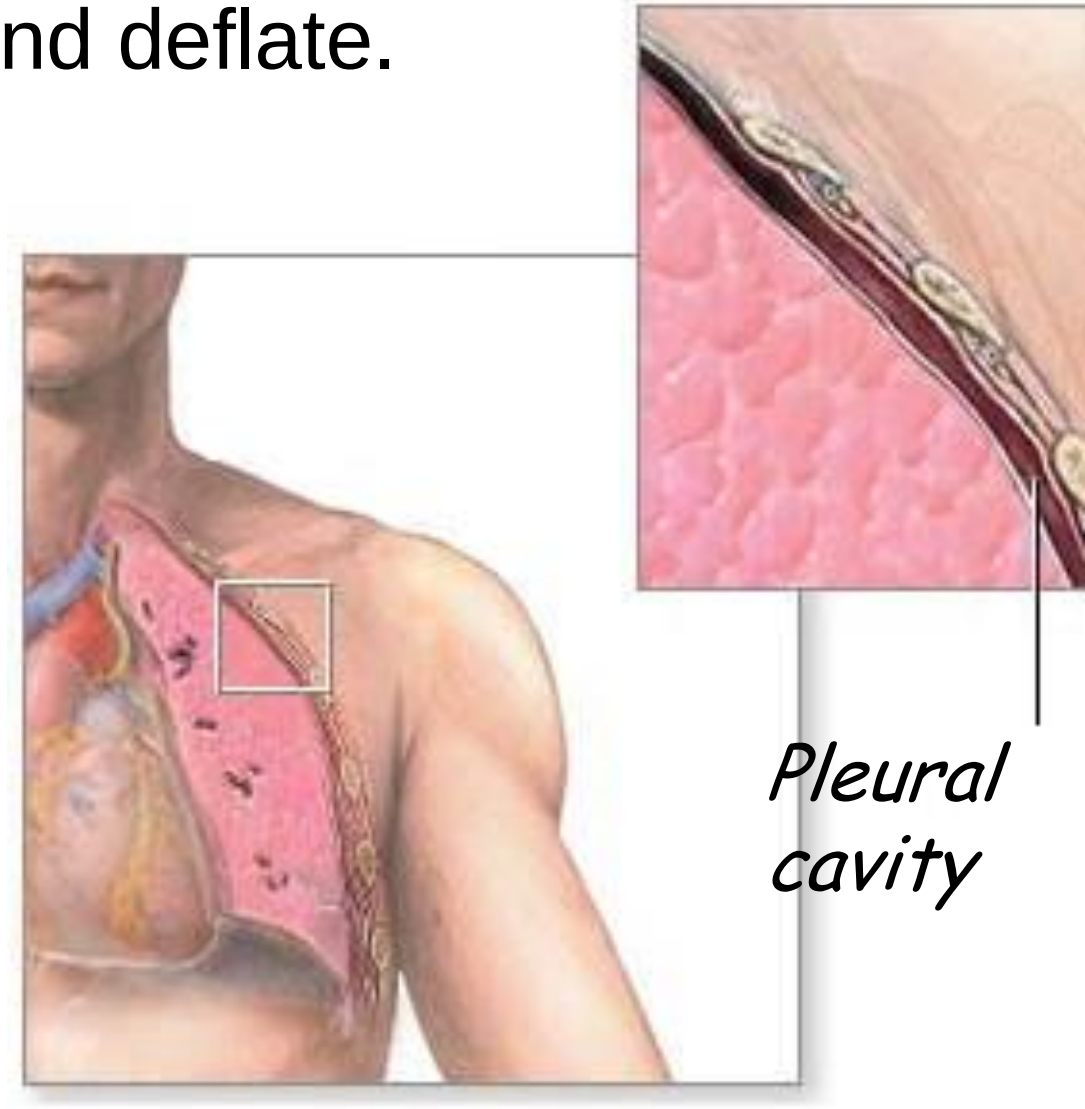
The nasal passages are lined with ciliated epithelial cells (have hairs) that make mucus and trap micro-organisms, to filter and heat the incoming air.



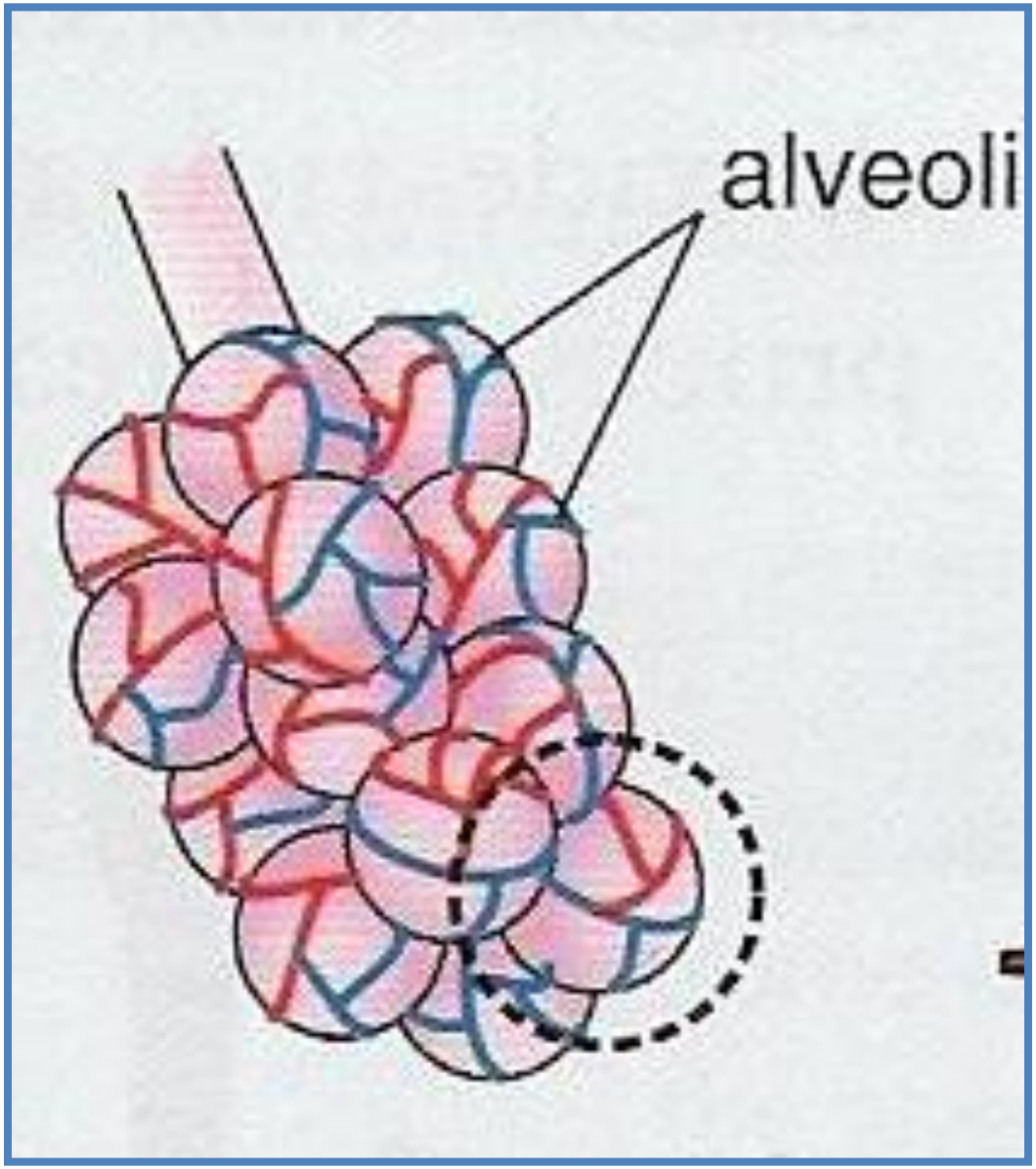
Going deeper into the respiratory system...

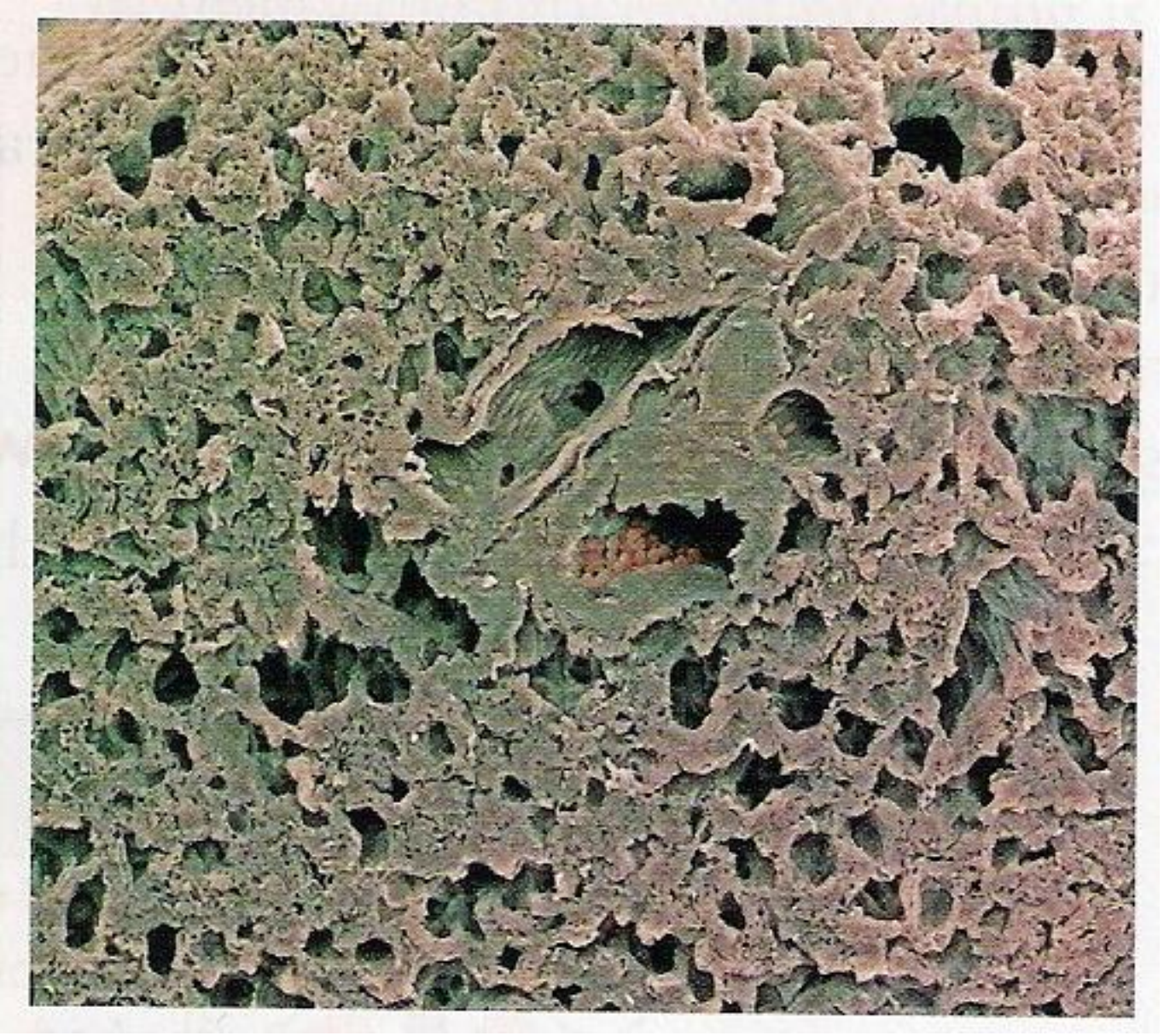
The **pleural membranes** line the inside of the chest wall (the ribs) and also the outside of the lungs. They **reduce friction** during breathing as the lungs fill with air and deflate.

Also, the space between the pleural membranes (**in the pleural cavity**) contains a small amount of **pleural fluid**; this helps to further reduce friction during breathing.



At the ends of the bronchiole tubes we find the alveoli:



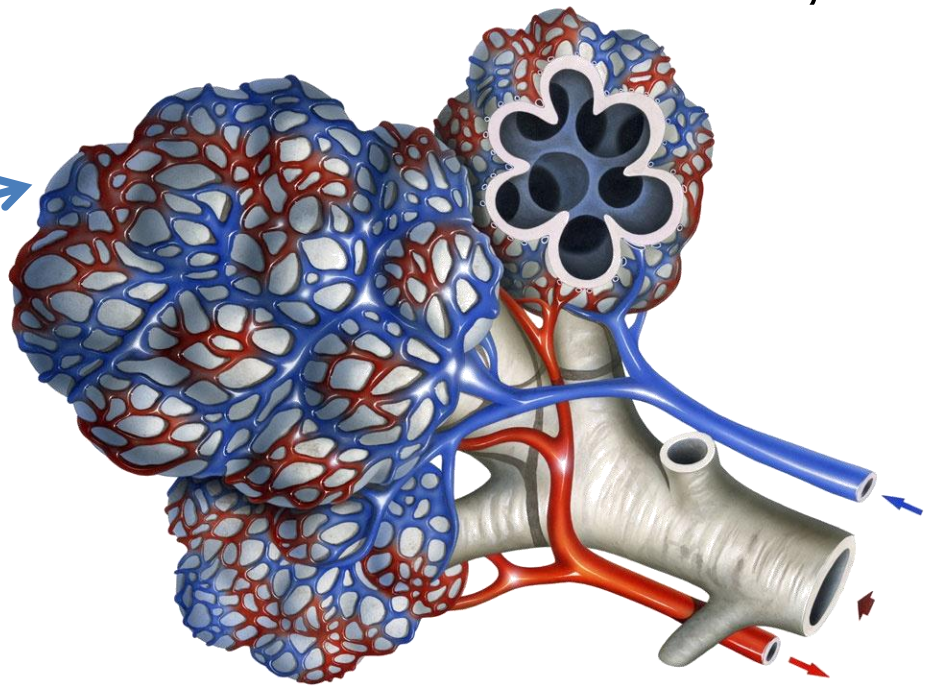


This section through the lungs shows many air spaces, these are the alveoli

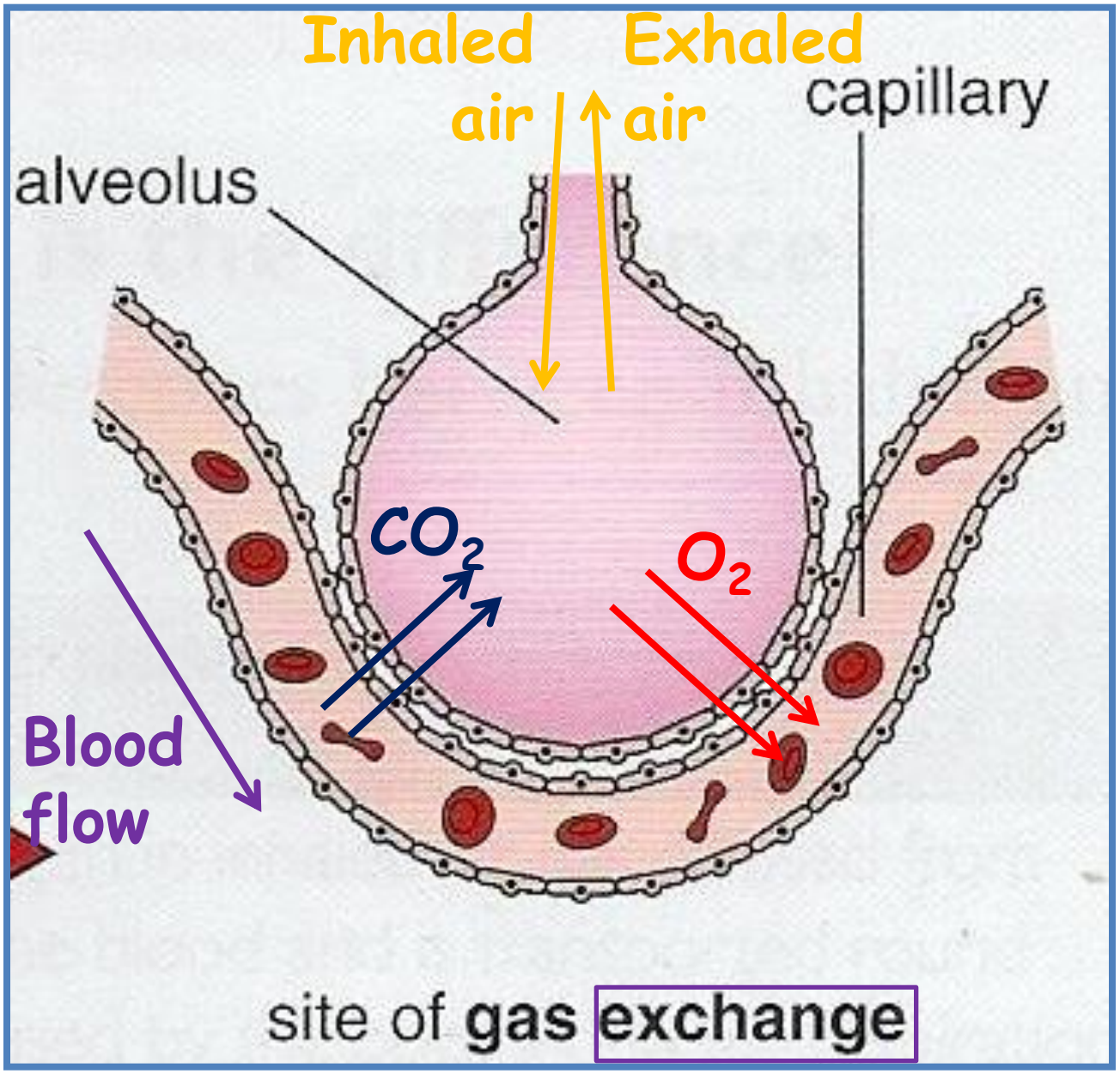
the alveoli are the respiratory surface in humans

This is where **gas exchange** takes place between the atmosphere and the blood. In humans oxygen diffuses into the blood from the alveoli and carbon dioxide goes the other way, diffusing from the blood into the alveoli, where it is breathed out.

One alveolus, many alveoli!



Label your diagram with coloured arrows:



Exchange means that gases go both directions across the cell membranes!

QUESTION ???
HOMEWORK BOOKLET

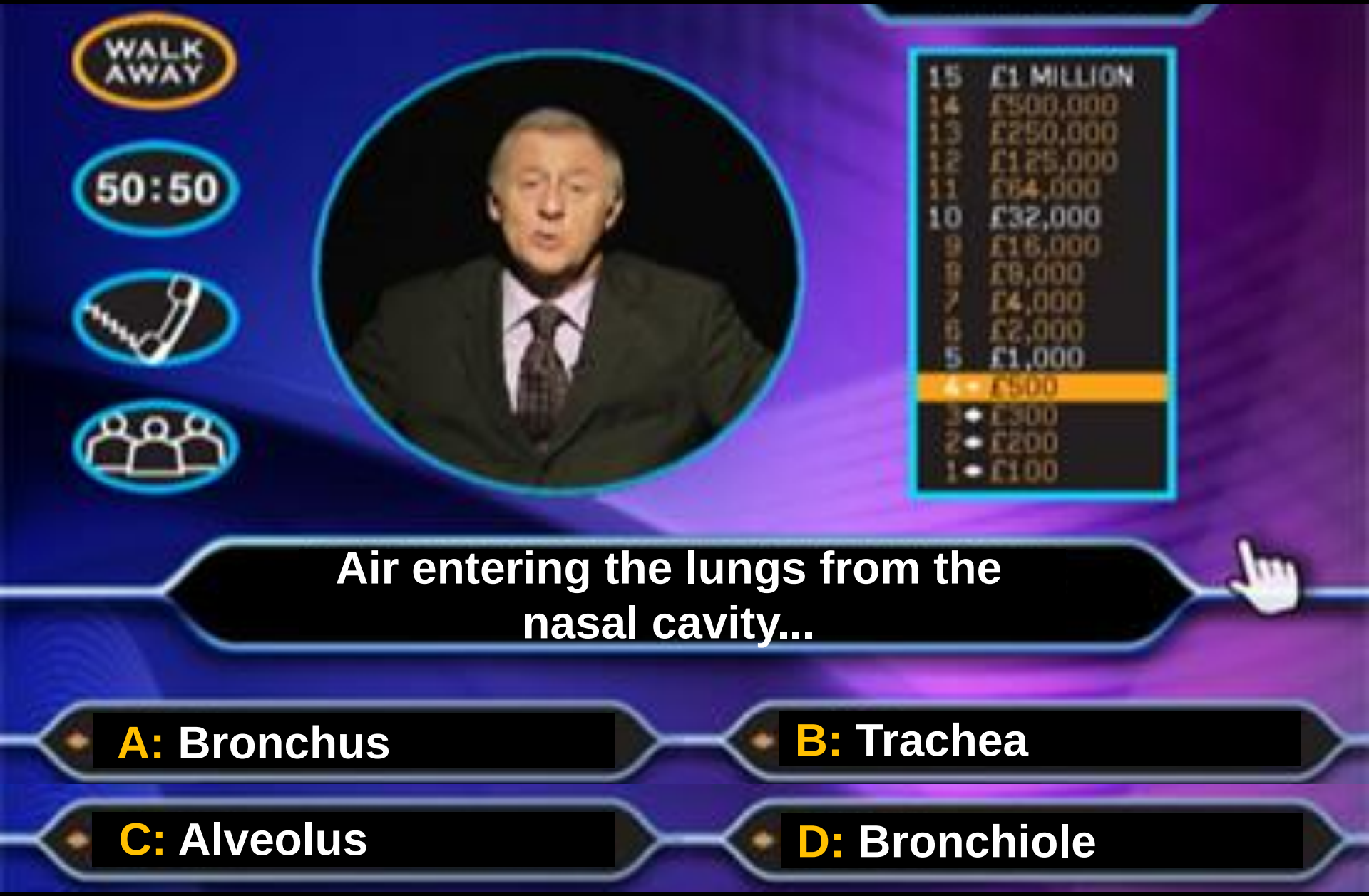
GAS EXCHANGE IN AN ALVEOLUS

REMEMBER TO DESCRIBE ONE GAS AT A TIME!

- **OXYGEN** diffuses from a high concentration in the alveoli to a low concentration in the blood.

- **CARBON DIOXIDE** diffuses from a high concentration in the blood to a low concentration in the alveolus.

Put into the right order:



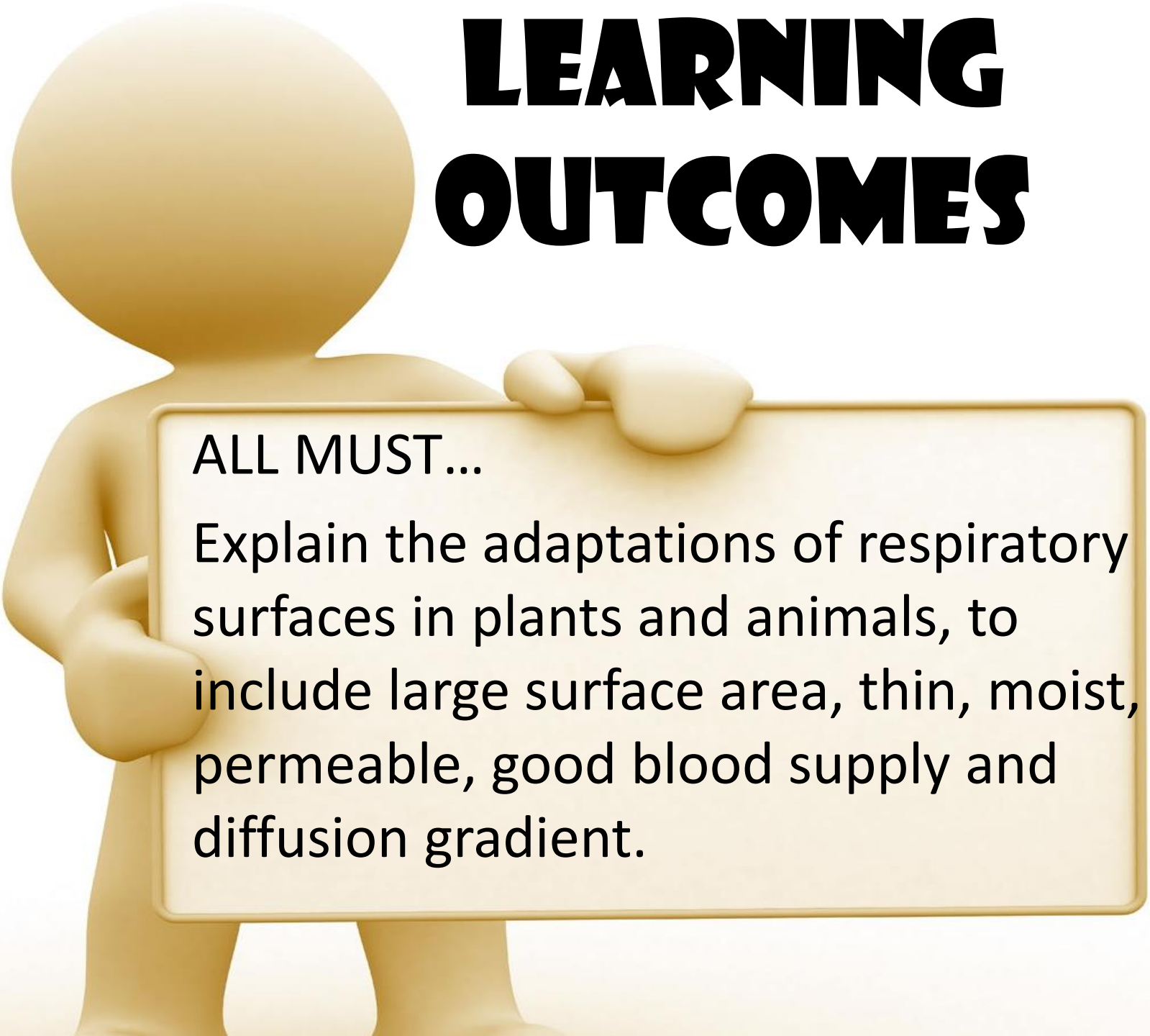
B: Trachea

A: Bronchus

D: Bronchiole

C: Alveolus

LEARNING OUTCOMES



ALL MUST…

Explain the adaptations of respiratory surfaces in plants and animals, to include large surface area, thin, moist, permeable, good blood supply and diffusion gradient.

Respiratory surfaces have special adaptations for gas exchange...

SORT CARD ACTIVITY

Make notes on the adaptations of the alveoli as respiratory surfaces for gas exchange!...

Or put them into a handy table...

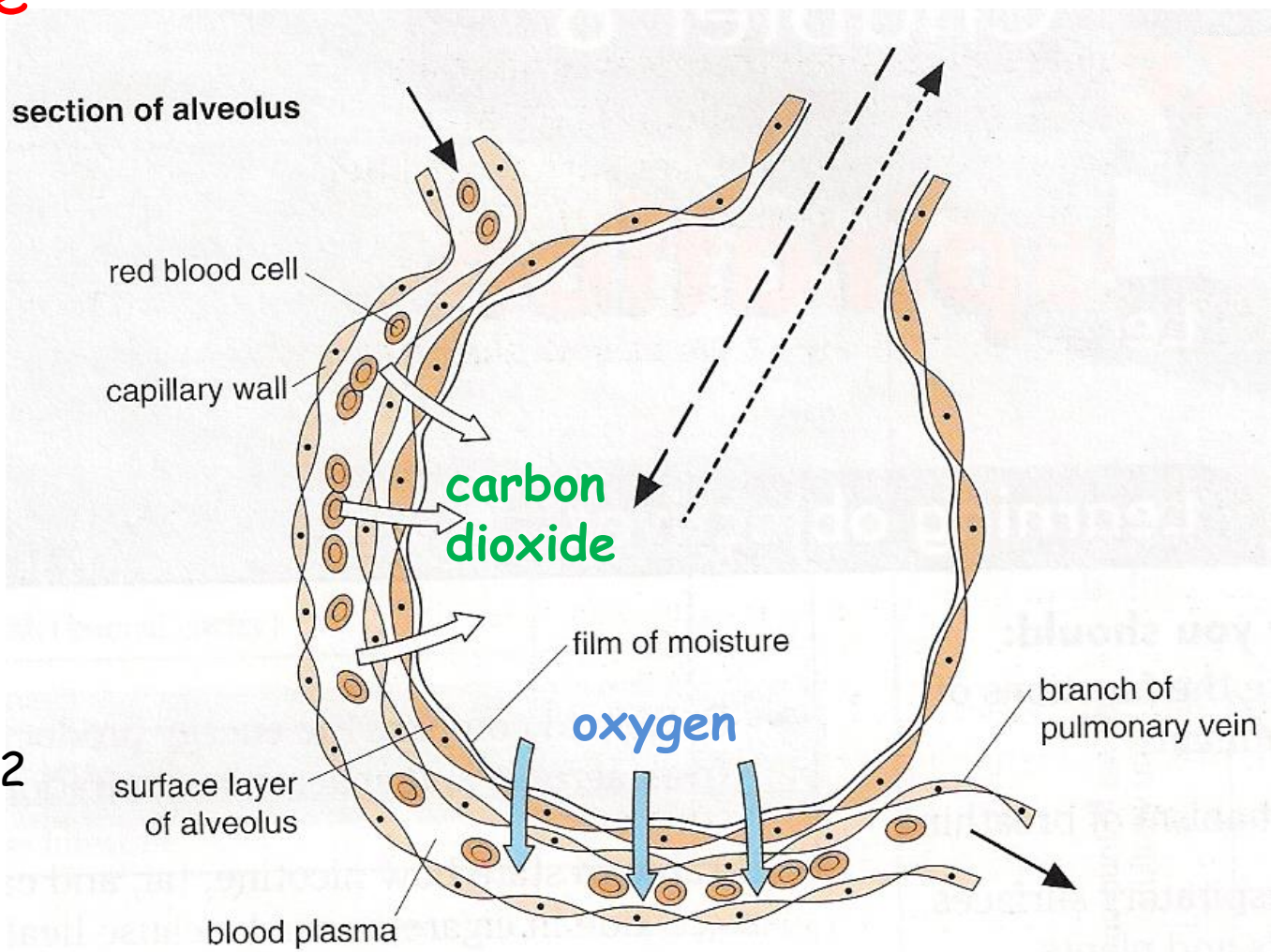
* **a large surface area** – there are many alveoli in each lung and each alveolus has a large surface area. Together this gives a gas exchange surface (where the alveolar walls are in contact with blood capillaries) in humans of many square metres
* **thin walls with short diffusion distances** – Figure 5.1 shows that there are only two layers of cells separating the oxygen in the alveolus from the red blood cells. This means that there is a short diffusion distance for the gases involved
* **moist walls** – these help the gases to pass through the respiratory surfaces because the gases dissolve in the moisture
* **permeable surfaces** – the moist, thin walls make the respiratory surfaces permeable
* **a good blood supply –** alveoli are surrounded by capillaries to ensure that any oxygen diffusing through is carried around the body. This also ensures that carbon dioxide is continually taken back to the lungs

* **a diffusion gradient** – the process of breathing ensures that there is a large diffusion gradient that encourages oxygen to diffuse into the blood and carbon dioxide to diffuse from the blood into the alveoli. When fresh air rich in oxygen is breathed in, it makes the concentration of oxygen in the alveoli higher than that in the capillary and therefore oxygen diffuses from the alveoli into the capillaries.

Air sacs in the lungs – Alveoli

Don't copy:

There is a dense network of capillaries around the alveoli, allowing oxygen to pass across into the blood which carries it away (and CO_2 from blood to alveolus). This helps maintain a concentration gradient for diffusion across the alveoli



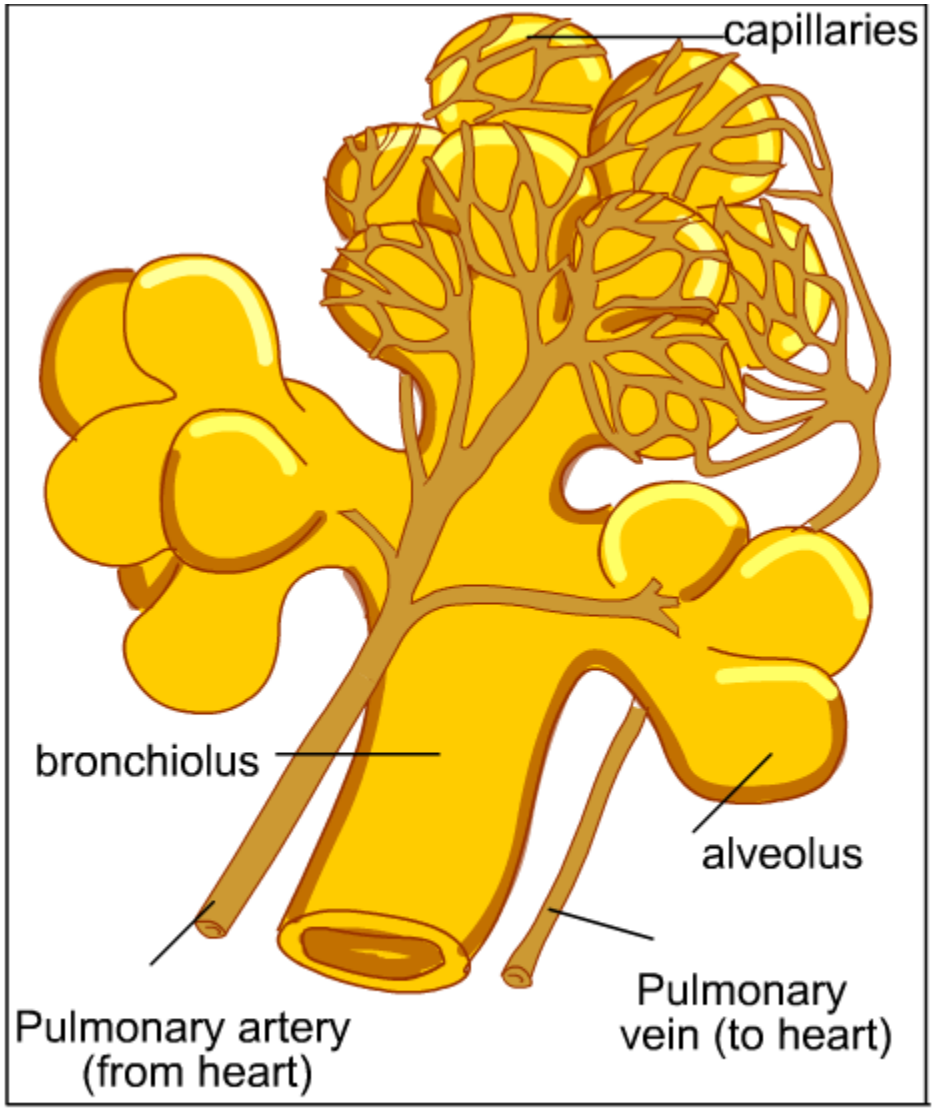
Alveolus animation

maintaining the diffusion/concentration gradient for gas exchange

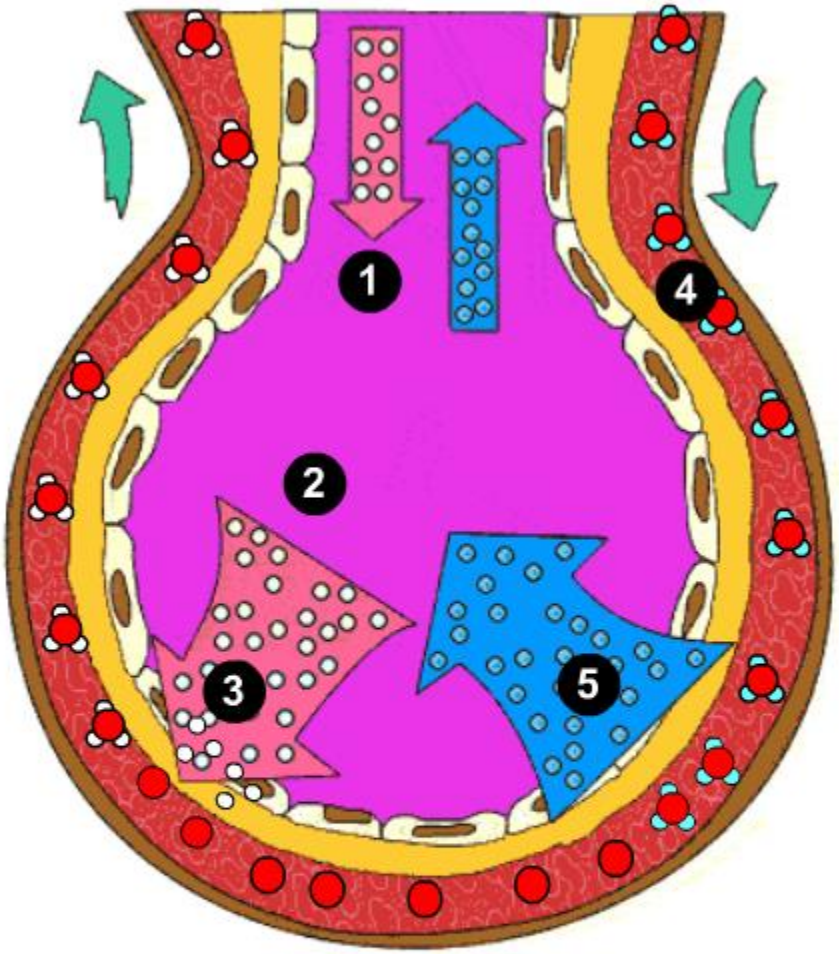
http://www.abpischools.org.uk/page/modules/breathingandasthma/asthma4.cfm?coSiteNavigation_allTopic=1

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

The alveolus – the gas exchange surface



Start Animation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5

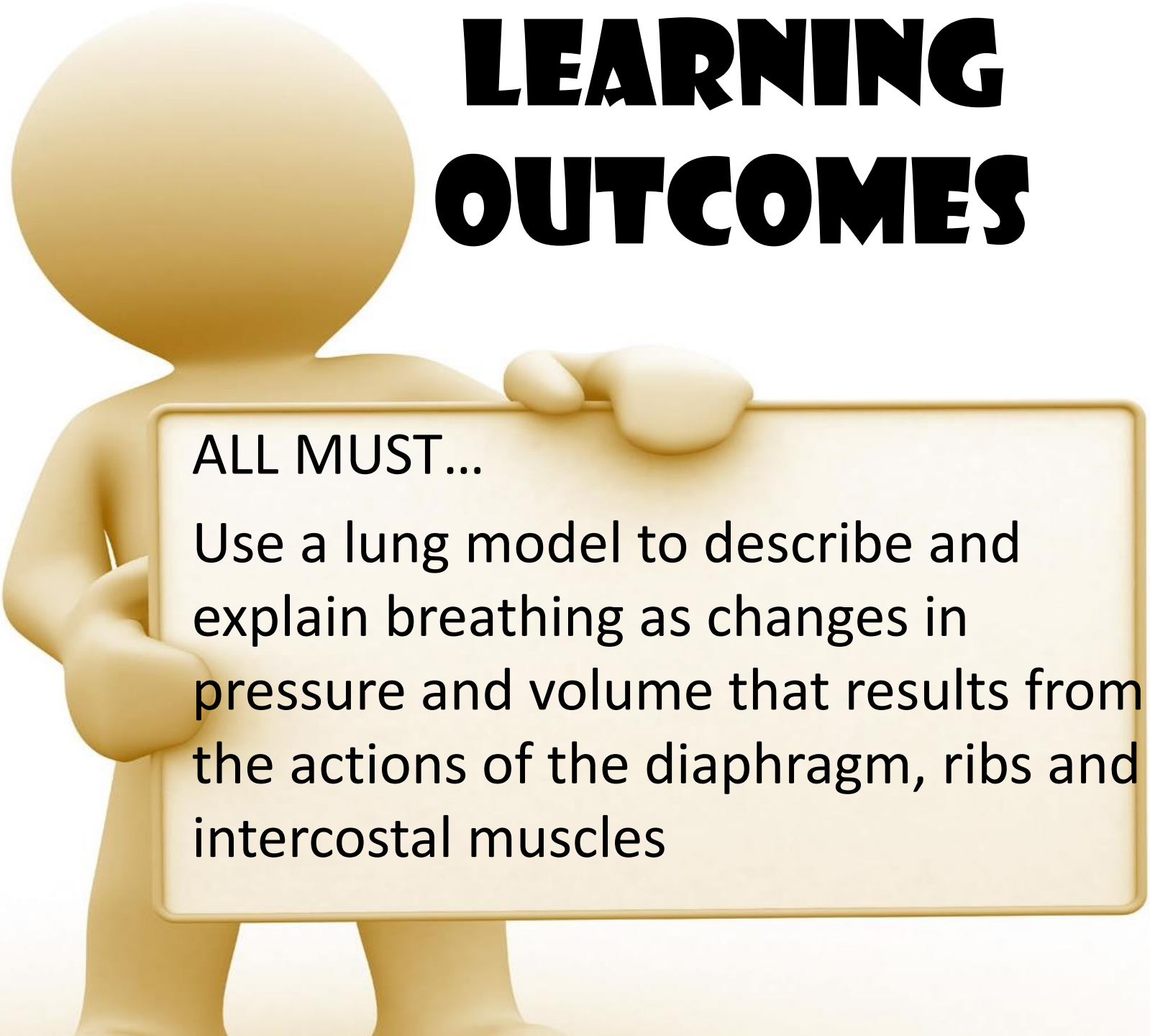
Gas exchange video

(18 gas exchange(ASG) at **5:55-8:37**)

Starter activity

- Place one hand on your chest and the other on your abdomen.
- Take a deep breath.
- What happens?
- Breath out as much as you can.
- What happens?

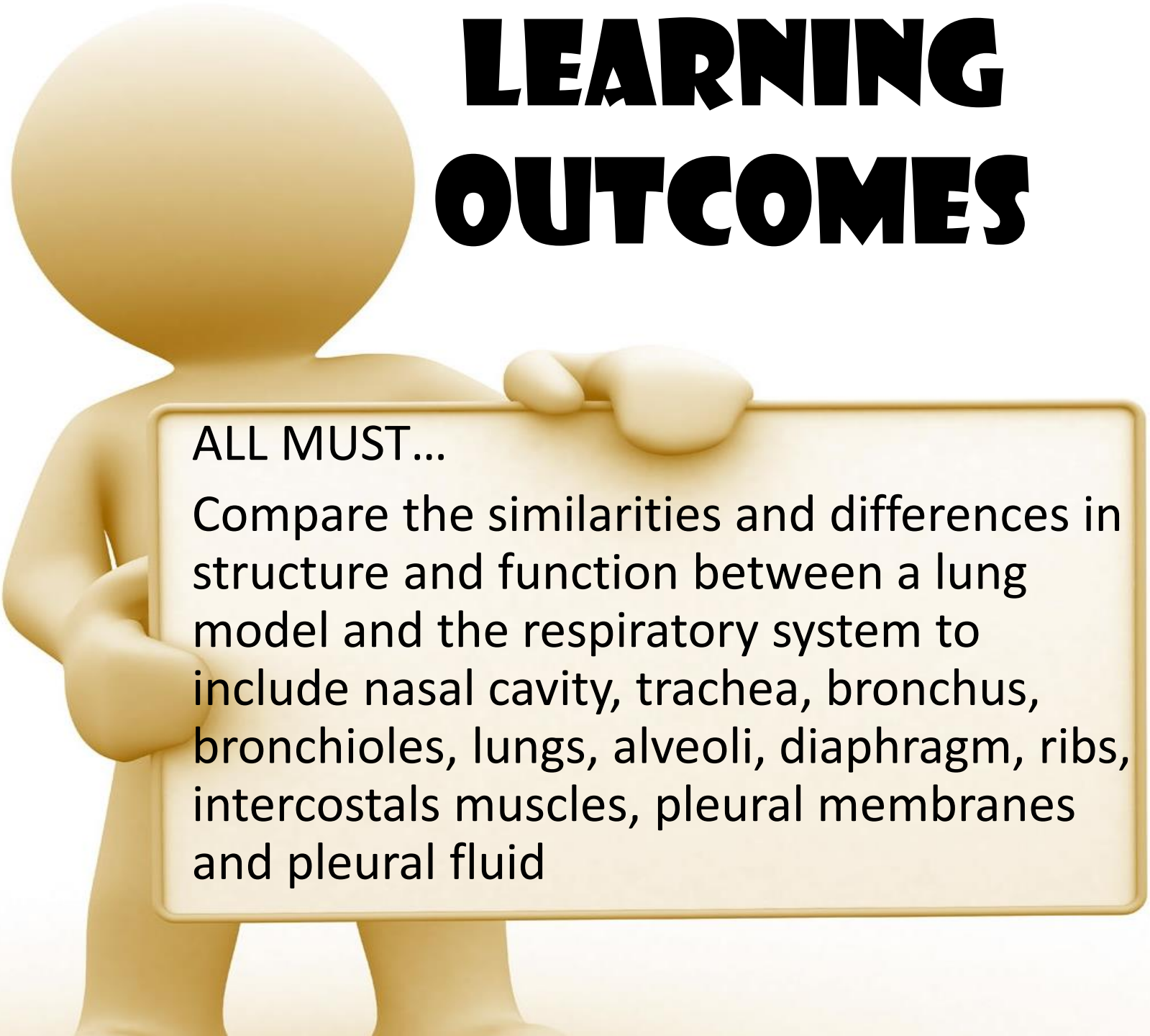
LEARNING OUTCOMES



ALL MUST…

Use a lung model to describe and explain breathing as changes in pressure and volume that results from the actions of the diaphragm, ribs and intercostal muscles

LEARNING OUTCOMES



ALL MUST…

Compare the similarities and differences in structure and function between a lung model and the respiratory system to include nasal cavity, trachea, bronchus, bronchioles, lungs, alveoli, diaphragm, ribs, intercostals muscles, pleural membranes and pleural fluid

bell jar model lungs

glass tube

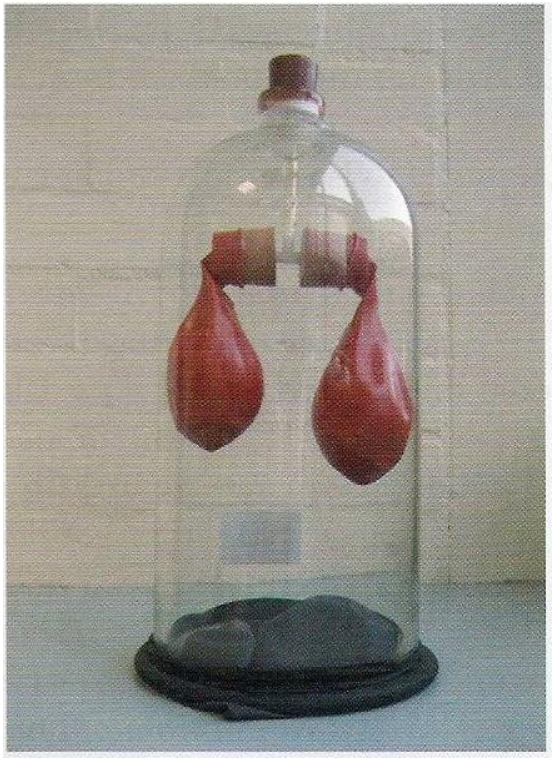
bell jar

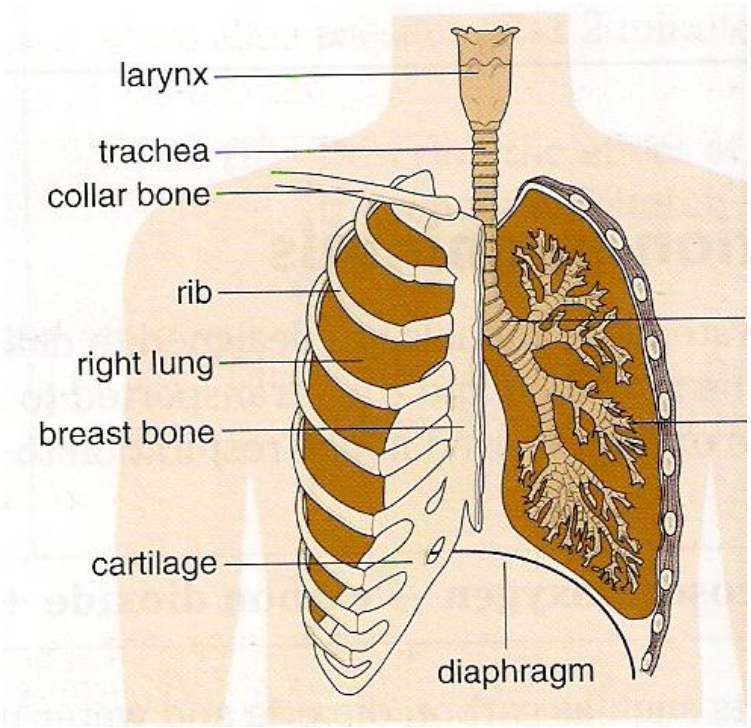
balloons

thin rubber sheet

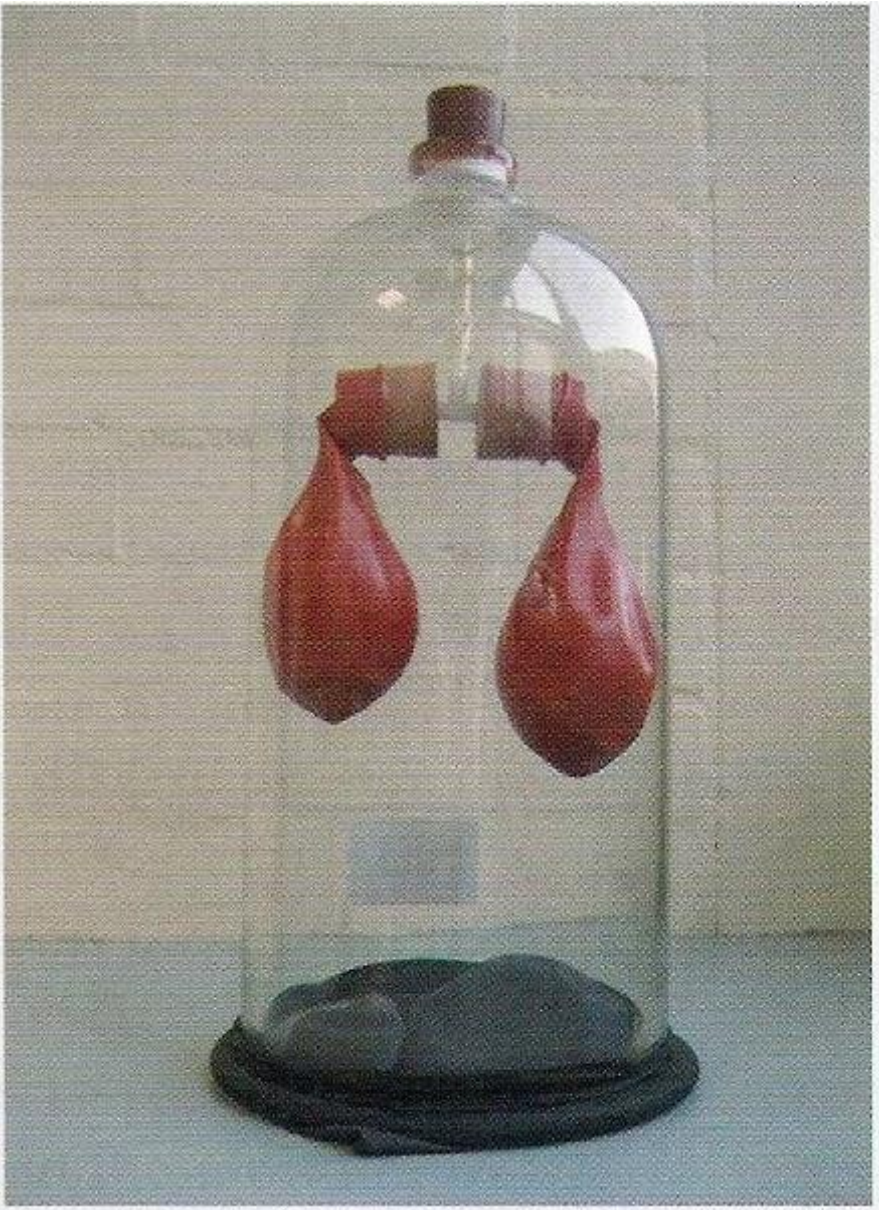
Discuss...

How does the lung model compare to the actual respiratory system?
Are there any limitations/differences/parts not represented?





We can examine the process of breathing using a Bell Jar Lung Model:



But what represents what?...

- *Balloons =*
  - **Lungs**
- *Thin rubber sheet =*
  - **Diaphragm**
- *Glass jar =*
  - **Chest cavity (thorax)**
- *Glass tube =*
  - **Trachea**

What happens when you pull the rubber down? Then release it?

The bell jar model illustrates these key features of the breathing process:

- As the **rubber sheet** (diaphragm) moves down, the **volume** inside glass jar **increases** (the thorax/chest cavity)

- This causes the **pressure** inside the glass jar to **decrease** below atmospheric pressure

- This caused **air to enter** the balloons (lungs) until the **pressures** inside and outside the bell jar become **equal**

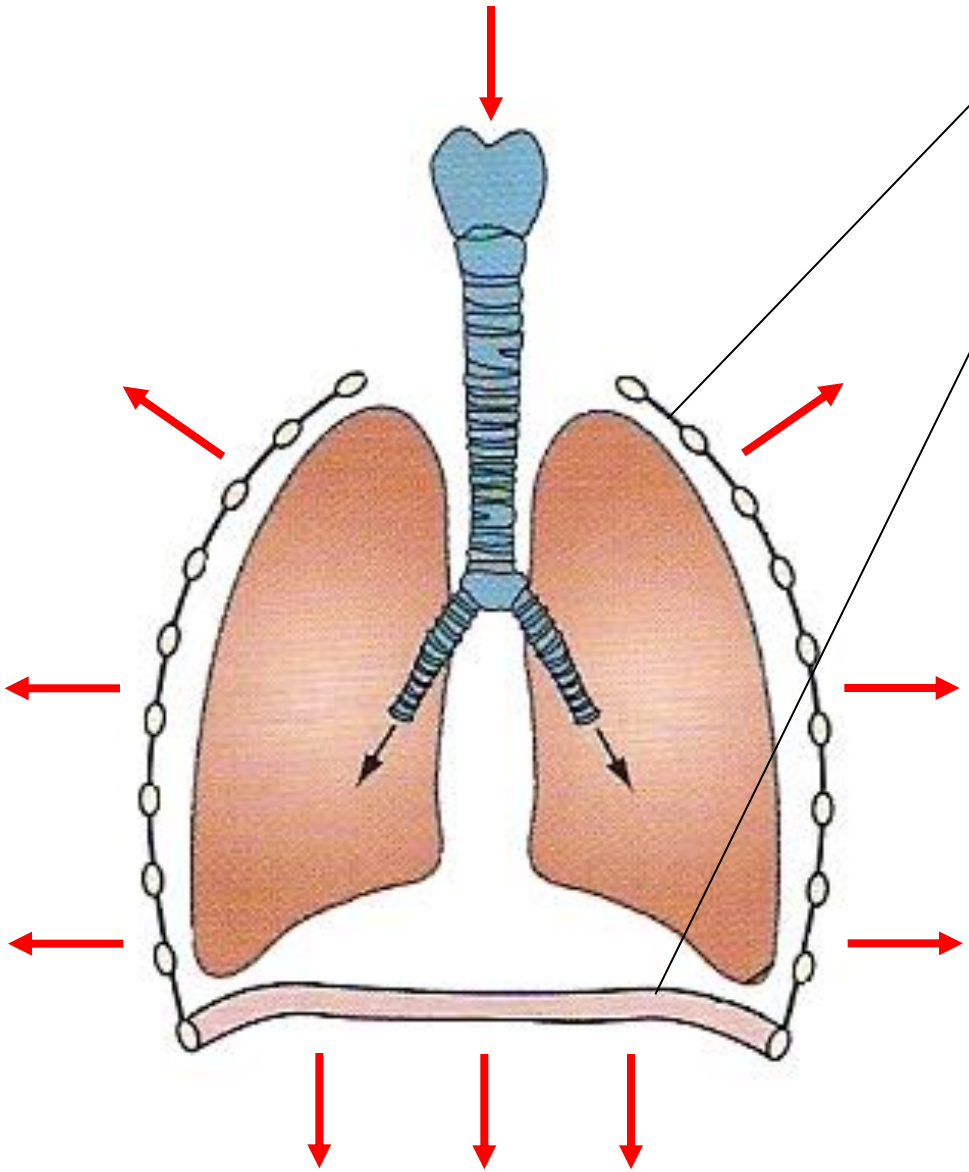
Ventilation & breathing

The process of breathing (ventilation) involves the movement of muscles and the ribs to cause changes in volume and pressure inside the chest cavity (thorax)

i.e. it's all muscles, volumes and pressures!

In the body TWO sets of muscle are involved in breathing:

- **Intercostal muscles** – between the ribs; there are internal ones and external ones and they move the rib cage up and out when they contract and down and in when they relax
- **Diaphragm muscle** – large sheet of muscle underneath the lungs that is flat when contracted (moves down) and dome shaped when relaxed



Intercostal muscles contract causing ribs to move up and out

Diaphragm contracts and moves down

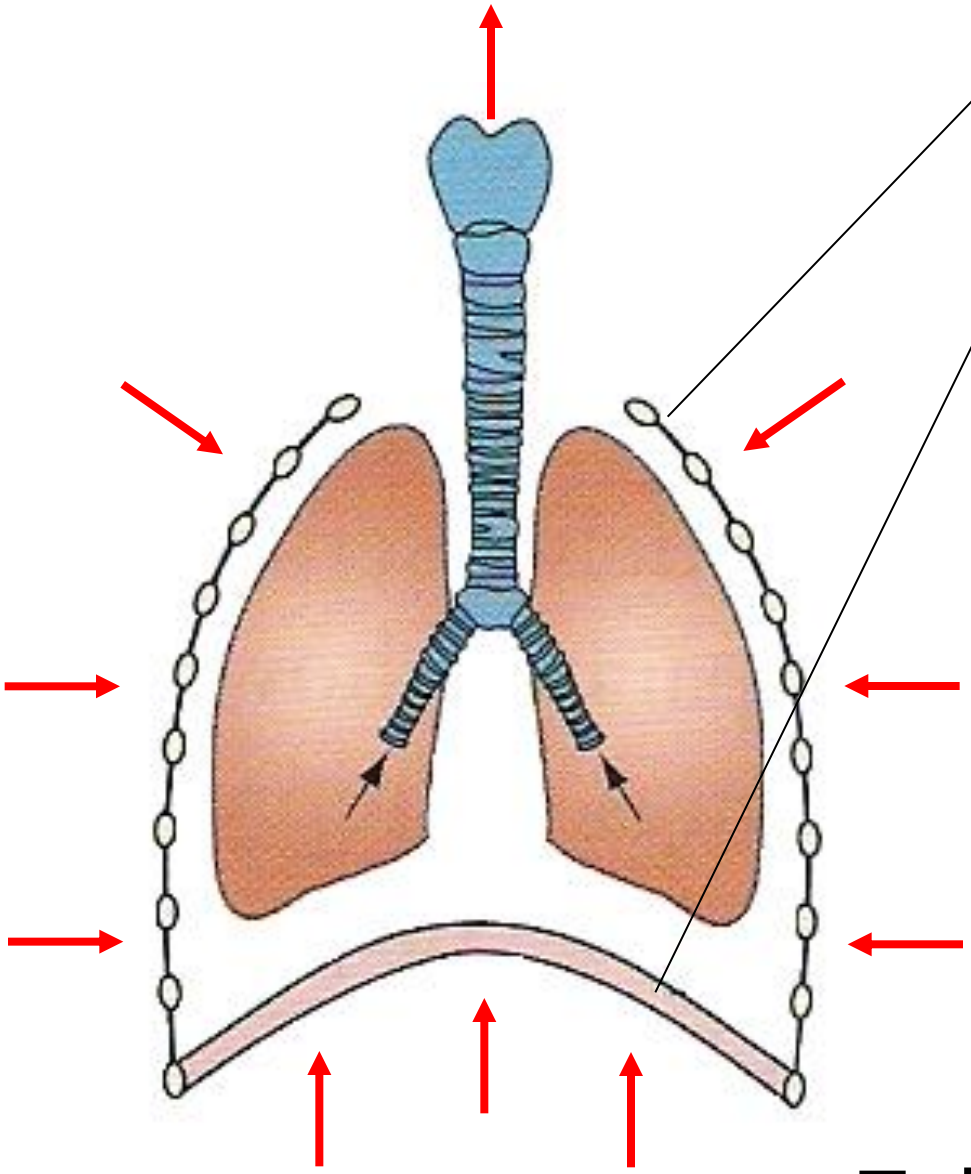
The **volume** of the chest cavity (thorax) increases causing the **pressure** to decrease.

Air enters the lungs because the lung pressure falls below the atmospheric pressure.

Inhaling (breathing in)

breathing in / inspiration / inhalation

1. the **diaphragm** muscle sheet **contracts** and moves **down** flat
2. At the same time the **intercostal muscles contract** (between ribs) and move the **rib cage up and out**.
3. Both processes **increase** the **volume** in the thoracic cavity and decrease the pressure.
4. Air pressure **inside the thorax** is now lower than air pressure outside the lungs, and **air is forced in**.



Intercostal muscles relaxes causing ribs to move down and in

Diaphragm relaxes and returns to a dome shape

The **volume** of the chest cavity (thorax) decreases causing the **pressure** to increase.

Air is forced out of the lungs because the lung pressure exceeds atmospheric pressure.

Exhaling (breathing out)

breathing out / expiration / exhalation

This is the reverse of inspiration:

1. The **diaphragm relaxes** and **moves up** Into a dome shape.
2. **Intercostal muscles relax**, and the **rib cage** moves **down and in**.
3. **Thorax volume decreases and** therefore the **air pressure increases** in this cavity.
4. Air **pressure inside** now **greater** than outside and **air is forced out.**

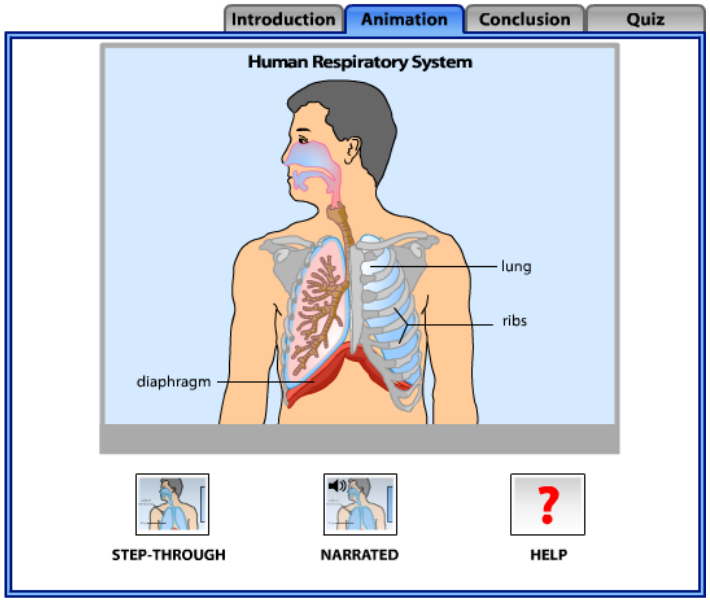
- **Quietly read over the breathing process for a few minutes**
- **Stand up and in pairs act out what is happening, explaining to your partner what is going on, using the correct terms, in inspiration and expiration; and then have your partner do it back for you.**

Draw a table to compare Inhalation & eXhalation

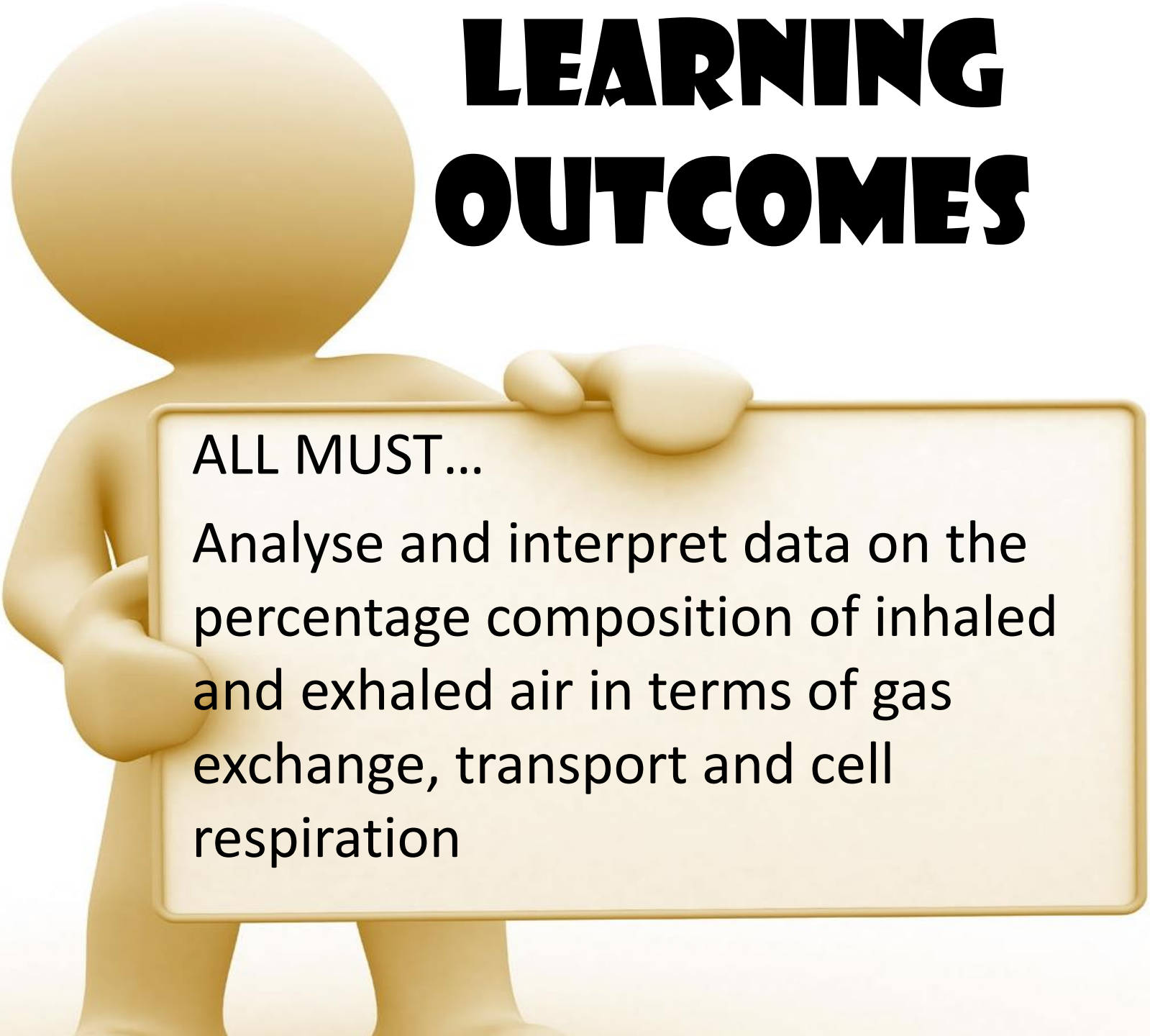
http://www.bbc.co.uk/learningzone/clips/how-do-we-breathe/10646.html

http://bcs.whfreeman.com/thelifewire8e/content/cat_010/4804002.html

Higher tier



LEARNING OUTCOMES



ALL MUST…

Analyse and interpret data on the percentage composition of inhaled and exhaled air in terms of gas exchange, transport and cell respiration

What can we learn from the *composition* of inhaled and exhaled air (i.e. from what's in it)?

Inhaled and exhaled air – what is the difference?

The following table summarises the differences between inhaled and exhaled air.

Gas	Inhaled air/%	Exhaled air/%	Explanation of change
Oxygen	21	16	?
Carbon dioxide	0.04	4	?
Nitrogen	78	78	?
Water vapour	Low	High	?

Can you explain the differences between inhaled and exhaled air?...

Remember also that air is filtered (by cilia) and heated as it passes through the nasal passages and airways

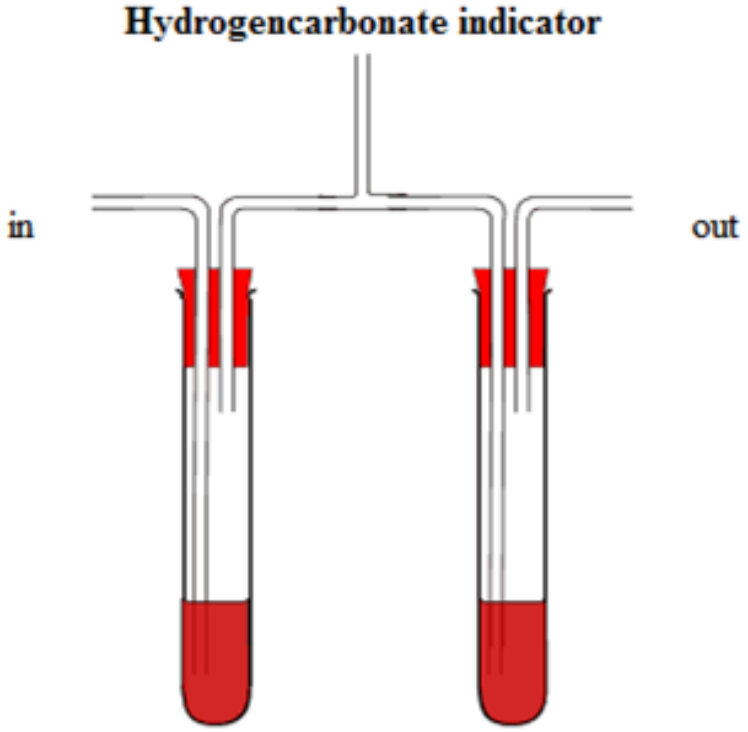
Did you know?

We still exhale some oxygen - this is why CPR still works

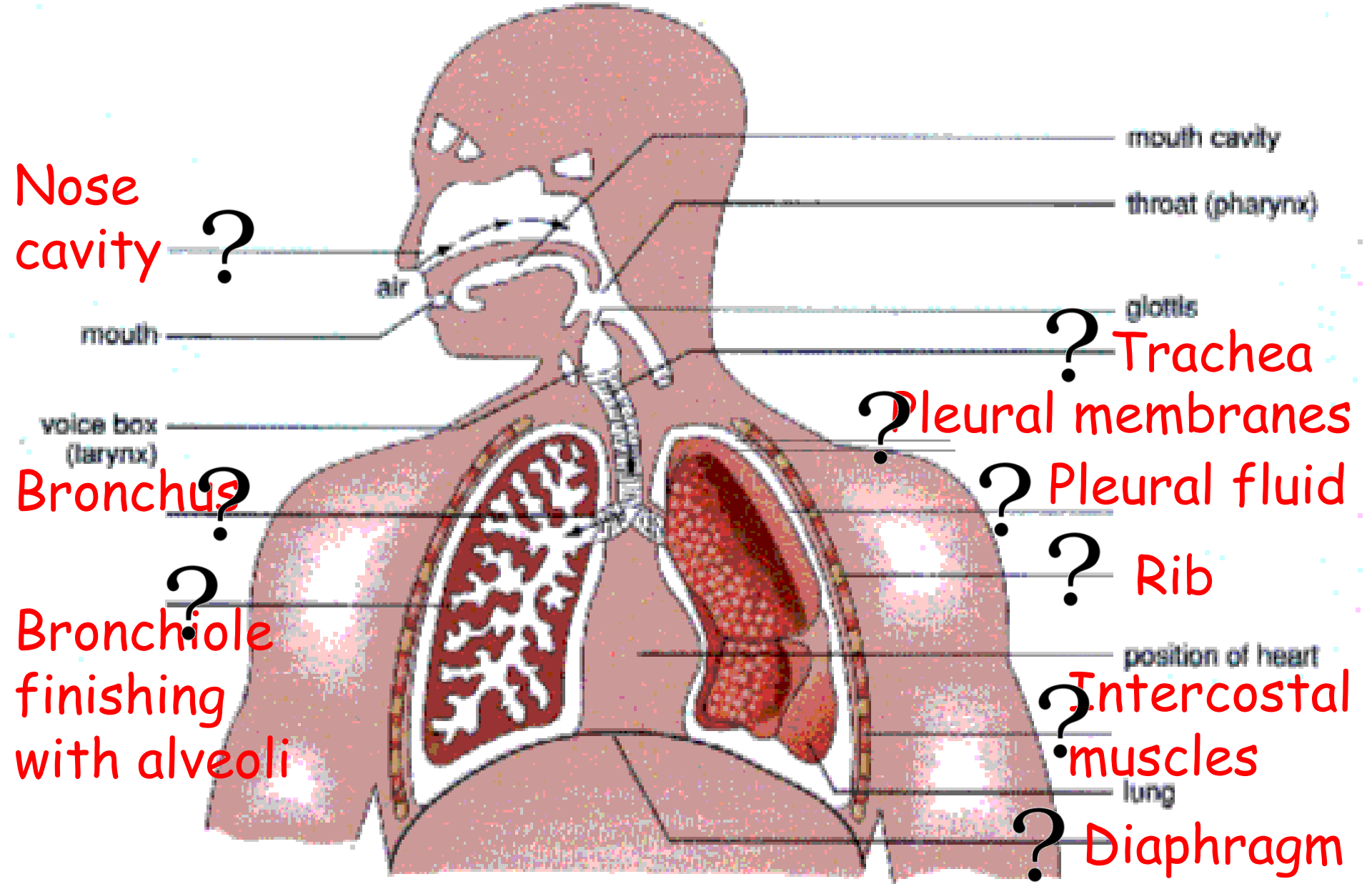
Practical – Using hydrogen carbonate indicator to investigate inhaled and exhaled air

With your partner discuss the results in terms of:

- Gas exchange (in the alveoli)
- Transport (in the blood), and
- Cell respiration (in cells)



Knowledge check – can you label the human respiratory system?



Nose cavity ?

? Trachea

? Pleural membranes

Bronchus ?

? Pleural fluid

? ?

? Rib

Bronchiole finishing with alveoli

? Intercostal muscles

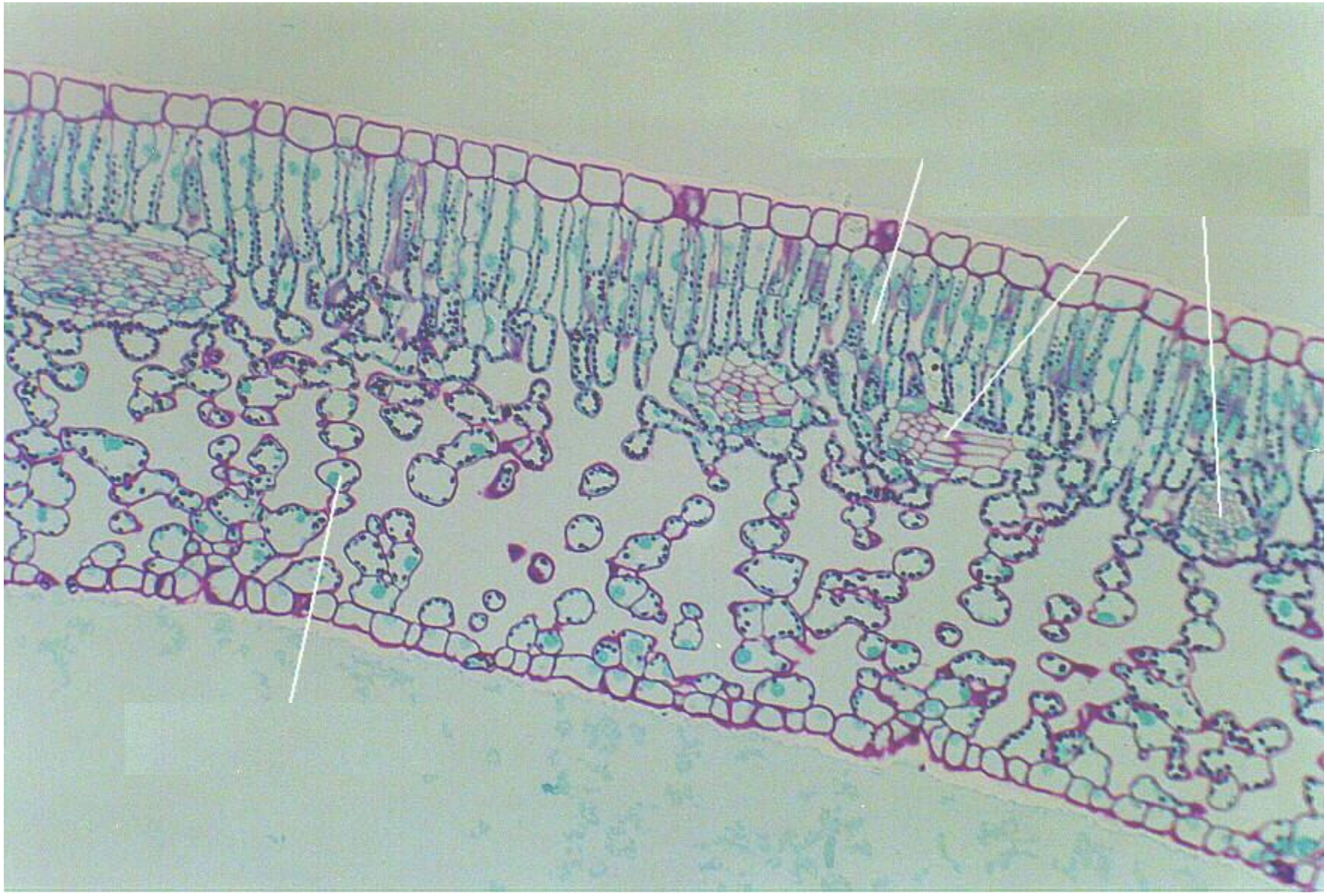
? Diaphragm


respiration
dominoes
revision

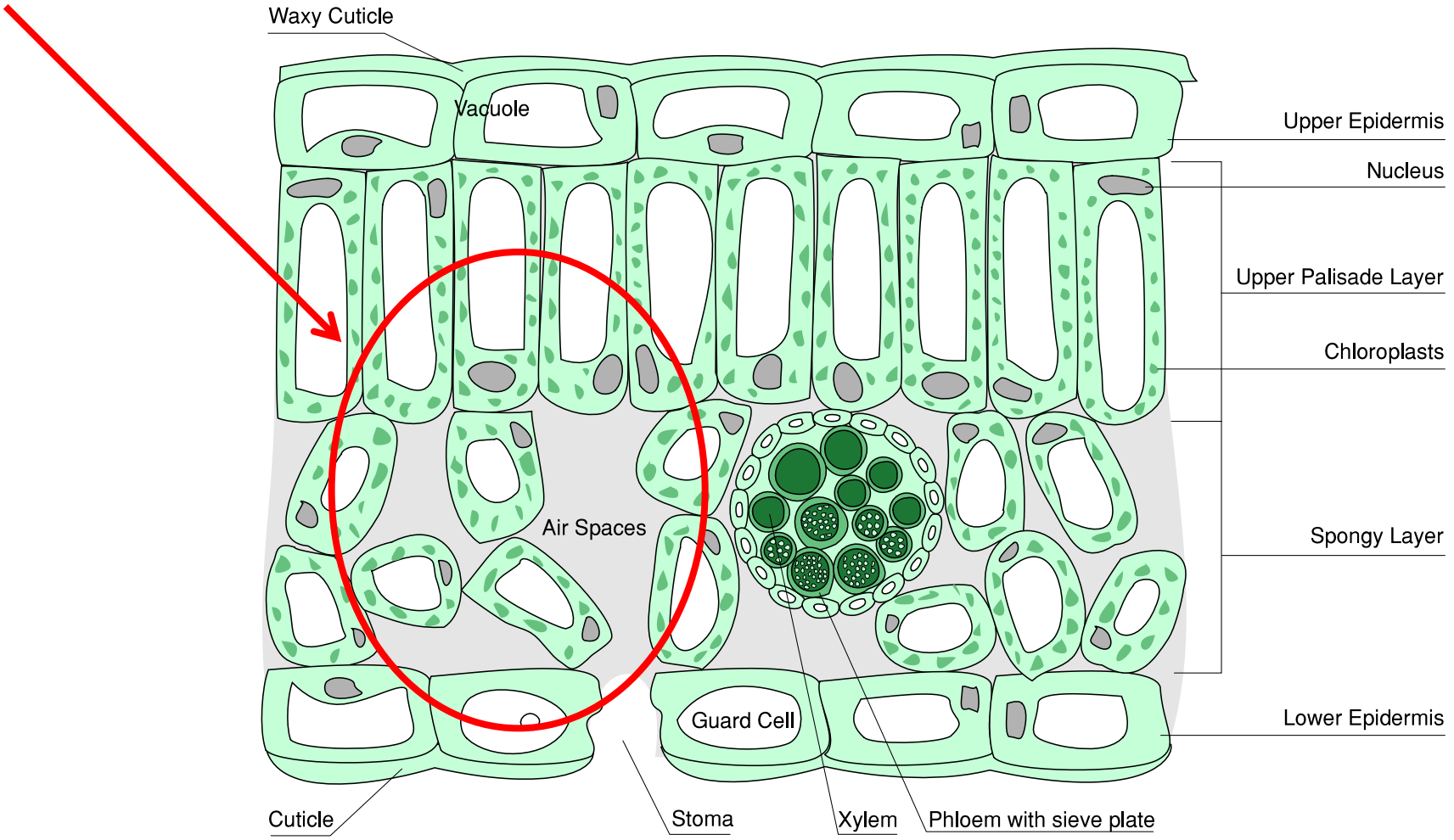
starter activity

- On the whiteboard, jot down as many key words as you can remember about the structure of the leaf
- Share your list with your pair & class.

Do you remember the structure of the leaf?



The main respiratory surfaces in plants are the cells surrounding the air spaces in the leaves (spongy mesophyll):



Gas exchange takes place across the cell membranes. Because there is a lot of cells in contact with those air spaces, there is:

- **A large surface area –** from spongy mesophyll and stomata
- **Thin cell membranes –** allows rapid diffusion/gas exchange
- **Moist cell membranes –** gases dissolve and diffusion happens faster
- **Permeable cell membranes –** to let gases across

http://www.bbc.co.uk/education/clips/z6cygk7

Respiration in plants

The main principles behind respiration in plants.

http://www.bbc.co.uk/education/clips/zvrhyrd

Stomata and the absorption of carbon dioxide

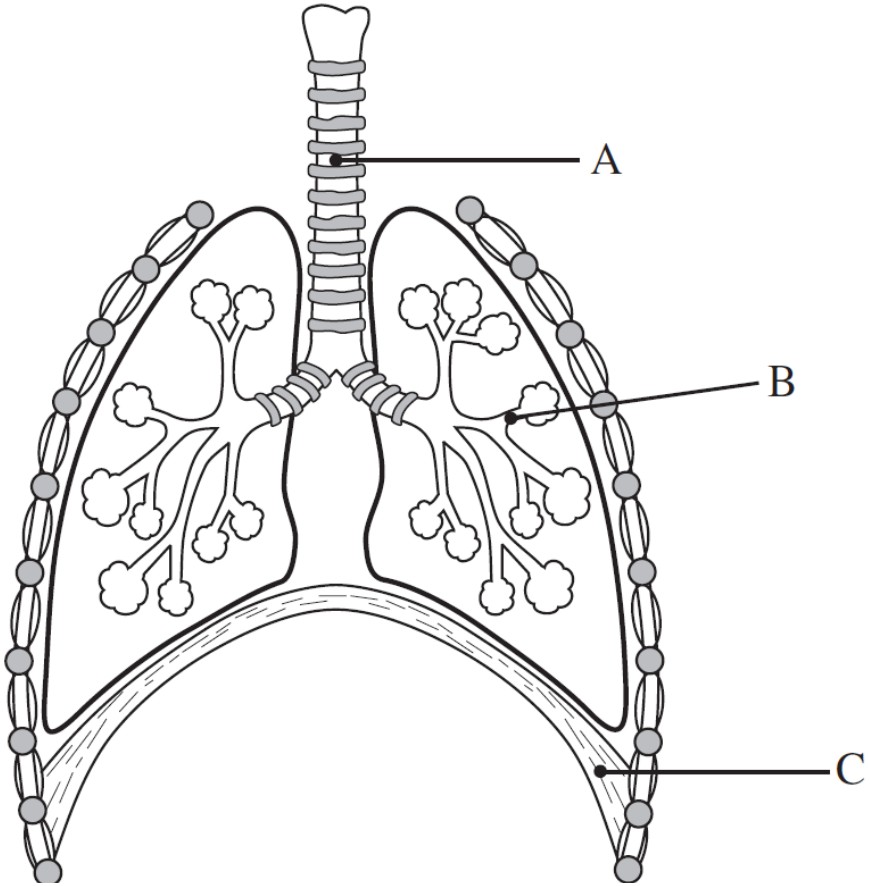
Leaves have stomata through which they absorb carbon dioxide.

Knowledge check:

Qu: How are the lungs adapted to be good surfaces for gas exchange?

1. Lots of alveoli provide a large surface area
2. Alveoli and capillary walls are thin for rapid diffusion of gases (each is only one cell thick!)
3. Alveoli lining is moist for faster gas diffusion
4. Alveoli and capillaries are permeable to gases
5. Alveoli are surrounded by a good blood supply (network of capillaries) to maintain a diffusion gradient and exchange gases easily

The diagram shows part of the respiratory system.



(a) Name parts A, B and C.

A _____ [1]

B _____ [1]

C _____ [1]

(b) Give **one** way respiratory surfaces are adapted for their function and explain how this adaptation helps gas exchange.

_____

_____

_____

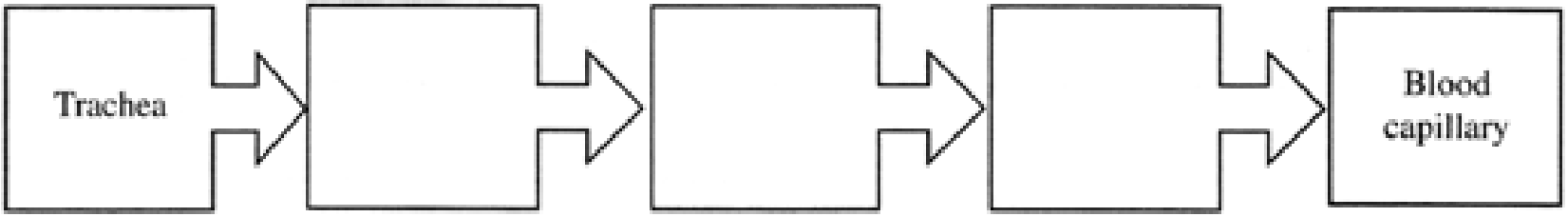
_____ [2]

Answers:

8 **(a)** A – Trachea;
B – Bronchiole;
C – Diaphragm; [3]

(b) Any **pair** from:
Large surface area; speeds up diffusion/exchange;
Thin; short (diffusion) distance;
Moist; gases dissolve;
Permeable; allows gases to pass through;
Good blood supply; maintain diffusion gradient/speeds up diffusion; [2]

Complete the flow chart, showing the pathway of a molecule of oxygen through the lung and into the blood.



[3]

Describe the part played by the contraction of the intercostal muscles in the mechanism of breathing.

Quality of written communication will be assessed in this question.

_____

_____ [3]

Quality of written communication [2]

Answers:

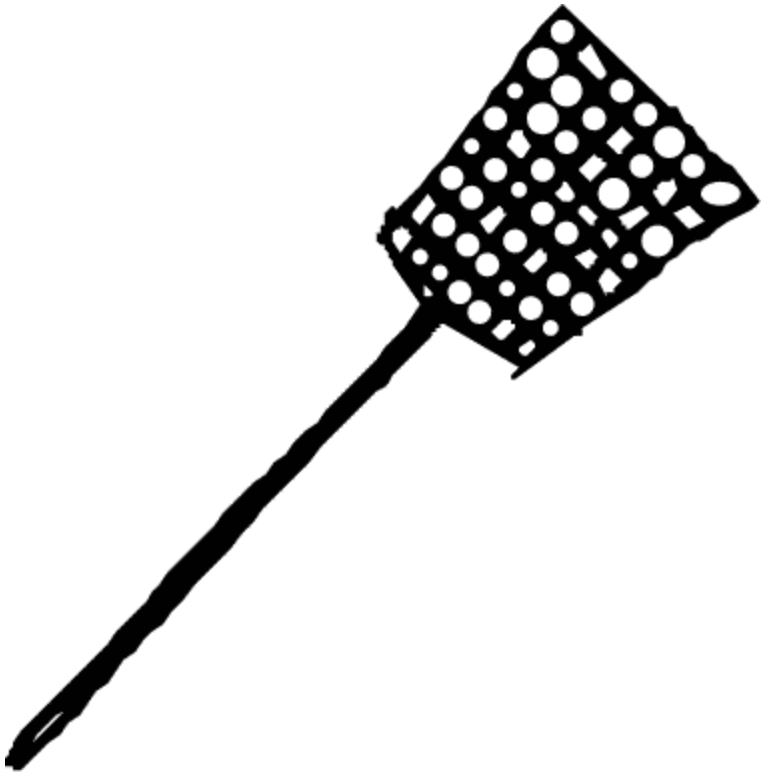
(iv) Bronchus;
bronchiole;
alveolus; [3]

(v) Any **three** from:
ribs move up/out;
chest volume increases;
pressure reduces;
to less than atmospheric pressure;
air enters into lungs; [3]

Quality of written communication [2]

It's time to play....

...Fly swat!



oxygen

diaphragm

lactic

Tar

intercostal

volume

thin

in

pressure

ethanol

surface area

low

trachea

cholesterol

haemoglobin

water

anaerobic

carbon monoxide

blood

bronchioles

glucose

energy

Revision website:

http://lgfl.skoool.co.uk/keystage4

http://www.bbc.co.uk/education/guides/z6h4jxs/revision/1

http://inteleducationresources.intel.co.uk/keystage4.aspx?id=315