

Gas exchange in humans

Revision notes · The parts of the breathing system, how the alveoli are adapted for gas exchange, and how exercise changes the rate and depth of breathing.

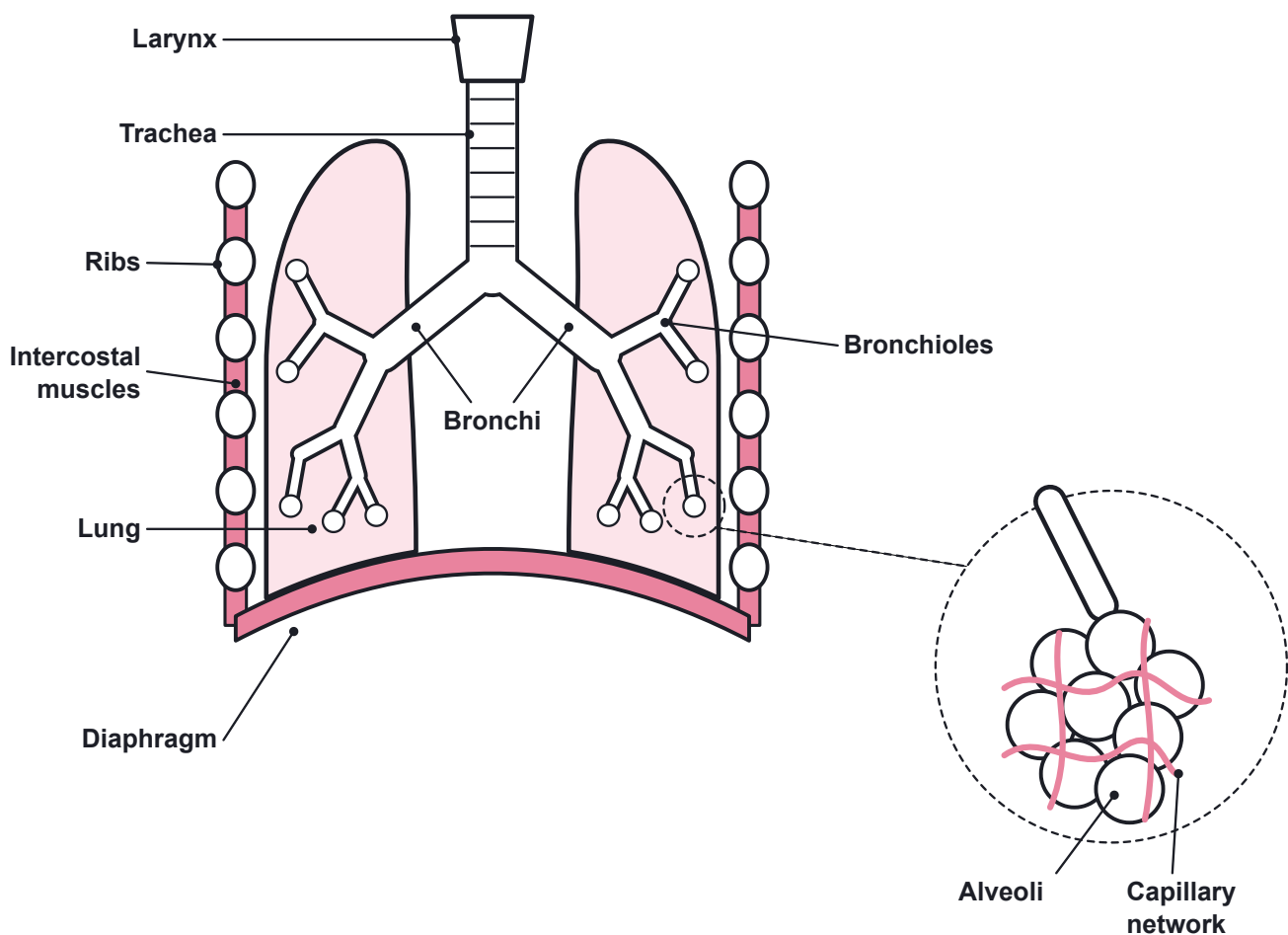
For Cambridge IGCSE Combined Science 0653. **Supplement** is Extended content, only examined on Papers 2 and 4.

Gas exchange in humans Spec B11.1

The breathing system Spec B11.1.1

Air enters the body through the nose or mouth and travels to the lungs along a series of tubes. The lungs sit inside the thorax (chest), protected by the ribs. The **diaphragm** forms the floor of the thorax.

1. Air passes through the larynx (voice box) into the trachea (windpipe).
2. The trachea divides into two bronchi (singular: bronchus), one to each lung.
3. Each bronchus branches into many smaller tubes called bronchioles.
4. The bronchioles end in tiny air sacs called alveoli (singular: alveolus).
5. Each alveolus is surrounded by a network of capillaries, where gas exchange happens.



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Air passes through the larynx, trachea, bronchi and bronchioles to the **alveoli**, which are surrounded by a network of capillaries.

Parts of the breathing system	
Part	Description or function
Lungs	Organs in the thorax where gas exchange takes place
Ribs	Bones that protect the lungs and move to change the volume of the thorax
Intercostal muscles	Muscles between the ribs that move the ribs
Diaphragm	Sheet of muscle below the lungs that separates the thorax from the abdomen
Larynx	Voice box at the top of the trachea
Trachea	Windpipe: carries air to the bronchi
Bronchi	Two tubes that carry air into the lungs
Bronchioles	Small tubes that carry air to the alveoli
Alveoli	Air sacs where oxygen and carbon dioxide are exchanged with the blood in the capillaries

Exam tip: Spell bronchi (plural, two tubes) and bronchioles (the small tubes) carefully. They are often mixed up, and the mark is lost if the wrong one is written.

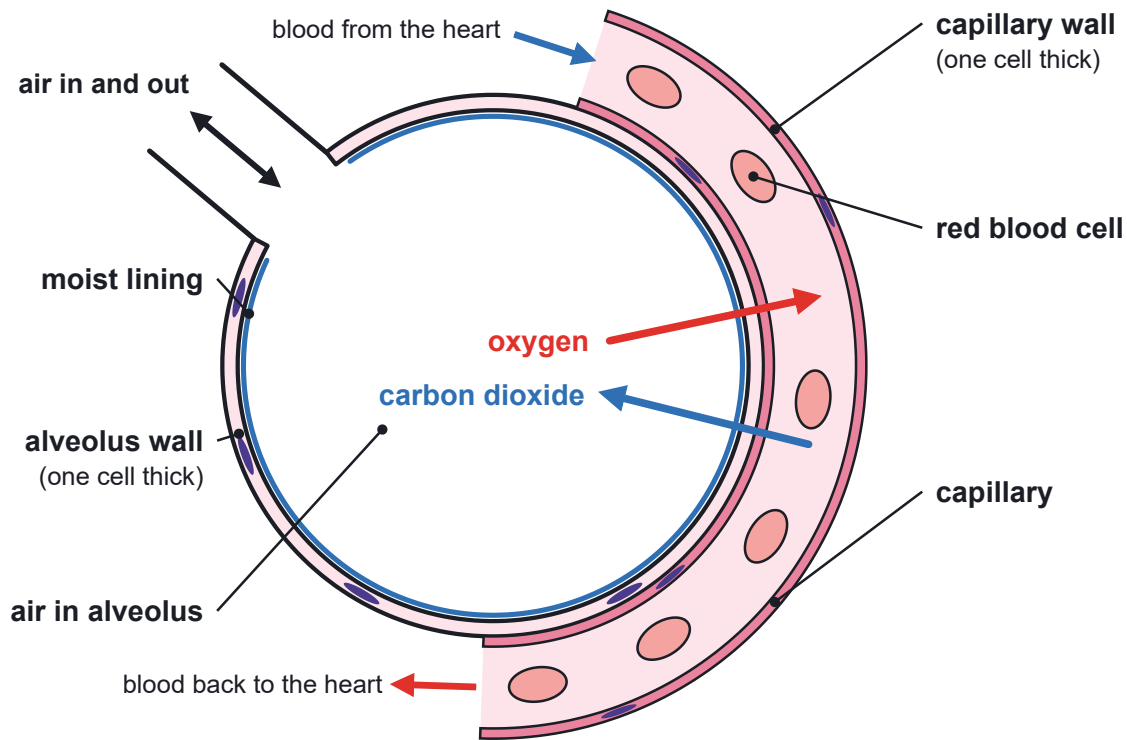
Features of gas exchange surfaces Spec B11.1.3 Supplement

Gas exchange happens at the surface of the alveoli. Oxygen moves from the air in the alveoli into the blood, and carbon dioxide moves from the blood into the air in the alveoli. Both gases move by diffusion.

A good gas exchange surface in humans has four features: a **large surface area**, a **thin surface**, a **good blood supply** and **good ventilation with air**.

How the alveoli are adapted for gas exchange	
Feature	Why it helps
Large surface area (millions of alveoli)	More space for oxygen and carbon dioxide to diffuse across, so more gas can be exchanged at once
Thin surface (walls of the alveoli and capillaries are one cell thick)	Short distance for the gases to diffuse, so diffusion is fast
Good blood supply (network of capillaries around each alveolus)	Blood carries oxygen away and brings carbon dioxide, which keeps a steep concentration gradient
Good ventilation with air (breathing in and out)	Fresh air keeps the oxygen concentration high and the carbon dioxide concentration low in the alveoli, which keeps a steep concentration gradient

Exam tip: Do not stop at the feature. Link it to its effect: for example, thin walls give a short diffusion distance, so diffusion is faster.



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Oxygen diffuses into the blood and carbon dioxide diffuses out, across **two walls that are each one cell thick**.

Physical activity and breathing Spec B11.1.2

During physical activity, your **rate of breathing** (the number of breaths per minute) increases. Your **depth of breathing** (the volume of air in each breath) also increases. Together, these bring more oxygen into the body and remove more carbon dioxide.

Investigating the effect of exercise on breathing

1. Sit still and count the number of breaths taken in one minute (or count for 30 seconds and double it). This is the resting breathing rate. Repeat and calculate a mean.
2. Do a set amount of exercise, such as running on the spot for 2 minutes.
3. Immediately count the breaths in one minute.
4. Record the rate every minute until it returns to the resting value. To measure depth, use a spirometer to find the volume of each breath, or measure chest expansion with a tape measure around the chest.
5. Repeat with different intensities of exercise, allowing full recovery between each.

Example results (for practice)

Activity	Breathing rate / breaths per minute
At rest	16
After walking	22
After running	34

Practical skill: The independent variable is the type or amount of exercise. The dependent variable is the breathing rate. Control the time for each exercise and the time of counting, use the same person, and repeat to find a mean.

Percentage change in breathing rate

A student breathes 16 times per minute at rest and 34 times per minute after running. Calculate the percentage increase.

1. Increase = $34 - 16 = 18$ breaths per minute
2. Percentage increase = $18 \div 16 \times 100$

Answer: 112.5% (about 113%)

Quick check

1. Name the tubes that carry air into each lung.
2. **Supplement** State the four features of a gas exchange surface in humans.

Quick check answers

Gas exchange in humans

1. Bronchi.
2. Large surface area, thin surface, good blood supply and good ventilation with air.