Breathing and gas exchange

Teacher review edition. Ask your teacher if anything is unclear.

How do your lungs supply oxygen to your cells?

What you will learn

- Trace the route of air into the lungs.
- Explain breathing in and breathing out.
- Explain how alveoli help gas exchange.
- Distinguish breathing from respiration.

Why do we breathe?

> **Ventilation**
> Movement of air into and out of the lungs.

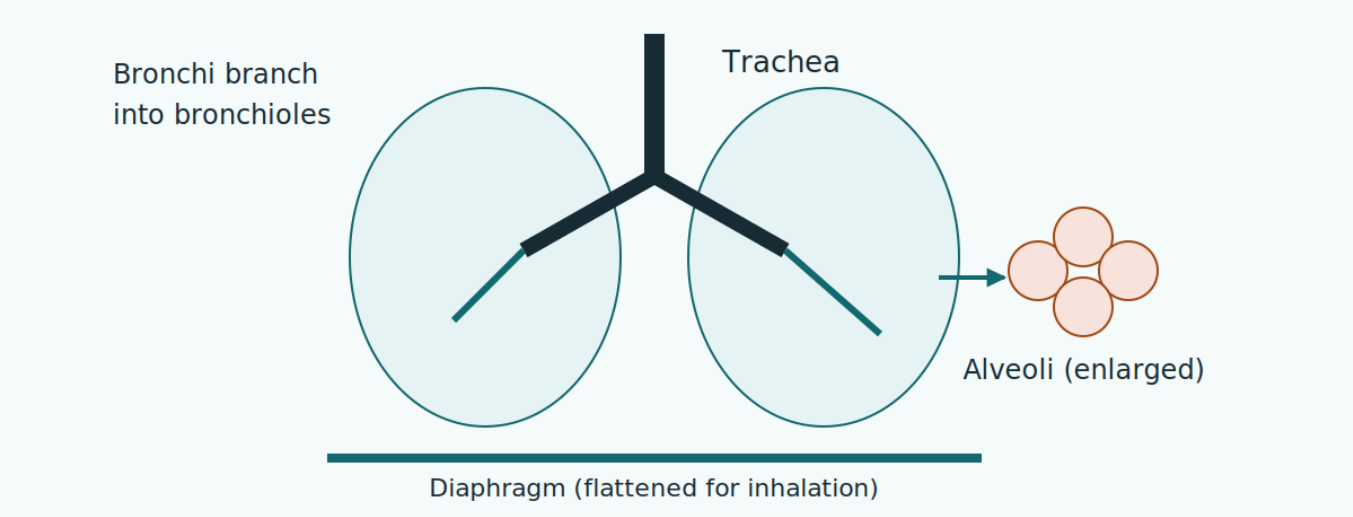
Breathing moves air into and out of the lungs. It brings in oxygen and removes carbon dioxide. The movement of air is also called ventilation.

Cells use oxygen in aerobic respiration, which releases energy from food. Respiration produces carbon dioxide. The blood carries oxygen from the lungs to cells and returns carbon dioxide to the lungs.

The route air takes

Air enters through the nose or mouth. Its route through the lungs becomes more finely branched:

- Trachea: the windpipe carrying air towards the lungs.
- Bronchi: the two branches of the trachea, one leading to each lung.
- Bronchioles: smaller branches inside the lungs.
- Alveoli: tiny air sacs at the ends of the bronchioles. One air sac is an alveolus.



Air passes through the trachea, bronchi and bronchioles to the alveoli. The enlarged air sacs are shown separately for clarity.

Breathing in

Diaphragm
The sheet of muscle below the lungs that helps move air in and out.

The diaphragm is a sheet of muscle below the lungs. During breathing in:

- The diaphragm contracts, flattens and moves down.
- Muscles between the ribs move the ribcage up and out.
- The space in the chest increases, so the lungs expand.
- Air pressure inside the lungs falls below outside air pressure. Air flows in.

Breathing out

During normal, quiet breathing out:

- The diaphragm relaxes and moves upwards.
- The ribcage moves down and in, and the lungs spring back towards their smaller size.
- The space inside the lungs decreases.
- Air pressure rises above outside air pressure, so air flows out.

Gas exchange at the alveoli

Gas exchange
Movement of oxygen and carbon dioxide between the lungs and the blood.

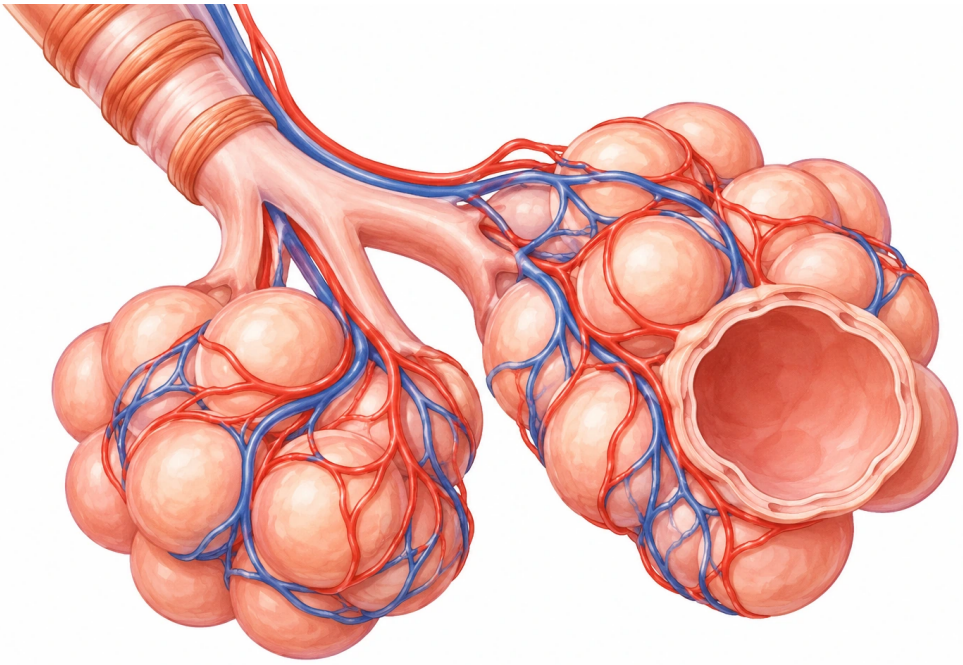
Alveolus
A tiny air sac in the lungs where gases pass between air and blood.

Diffusion
The overall movement of particles from a higher concentration to a lower concentration.

Alveoli are surrounded by tiny blood vessels called capillaries. Oxygen moves from the air in the alveoli into the blood. Carbon dioxide moves from the blood into the alveoli and is breathed out.

These gases move by diffusion: overall, particles move from where their concentration is higher to where it is lower.

- Many alveoli provide a large surface area.
- The alveolar and capillary walls are very thin, so gases have only a short distance to cross.
- Blood flow carries oxygen away and brings more carbon dioxide.
- Breathing replaces the air, keeping oxygen available.



Alveoli are tiny air sacs surrounded by capillaries. Oxygen diffuses into the blood; carbon dioxide diffuses into the air sacs. Red and blue distinguish oxygen levels: blood itself is red.

What changes during exercise?

Active muscles need more energy, so their rate of respiration increases.

- Muscles use more oxygen and produce more carbon dioxide.

- Breathing rate and heart rate usually rise to help meet this demand.
- Exhaled air still contains oxygen. It contains less oxygen and more carbon dioxide than inhaled air.

Breathing and respiration are different

> **Respiration**
> Chemical reactions in cells that release usable energy from nutrients.

Breathing is the physical movement of air. Respiration is a series of chemical reactions inside cells. Breathing, gas exchange and blood circulation work together to supply those cells with oxygen.

Worked examples

In a bell-jar lung model, pulling the rubber sheet down makes the balloons expand. The model shows how changing the space around the lungs changes air pressure.

Work through it

1. Pull the rubber sheet down to increase the space inside the jar.
2. Air pressure inside falls below the outside pressure.
3. Air enters the balloons and they expand.
4. The model does not show the movement of real ribs.

Common mistakes

Common mistake: Breathing is the same as respiration.

Remember: Breathing moves air. Respiration releases energy through chemical reactions inside cells.

Common mistake: Exhaled air contains only carbon dioxide.

Remember: Exhaled air still contains oxygen and other gases. It has less oxygen and more carbon dioxide than inhaled air.

Answering questions

- Explain breathing with a cause-and-effect chain: muscle movement → volume change → pressure change → airflow.
- For gas exchange, name both the gas and its direction: oxygen from alveoli to blood; carbon dioxide from blood to alveoli.

Try an investigation

Use a teacher-approved lung model to explain breathing. Compare supplied breathing-rate data before and after activity. Use teacher-planned alternatives if an activity is unsuitable for you.

Plan, record and review

- Question and prediction: What are you testing, and what do you think will happen? Give a reason.
- Change, measure, keep the same: What will you deliberately change? What will you measure, and in what units? What stays the same to make it a fair test? For an observation, say what you will record consistently instead.
- Record and look for a pattern: Use a table with headings and units. Look for a pattern or a result that does not fit.
- Conclude from evidence: Answer your question using a result or observation. Say if the evidence is unclear.
- Improve the investigation: What would you repeat or change, and how would that make the evidence better?

Do practical work with your teacher and follow the laboratory safety instructions.