

Transport and exchange surfaces

Revision notes · Why organisms must move substances in and out, why large animals need exchange surfaces and a transport system, and how alveoli work.

For Edexcel GCSE Biology 1BI0 and Combined Science 1SC0. **Triple only** is not in Combined Science. **Higher tier** is only on the Higher paper.

Transport and exchange surfaces **Spec 8.1-8.3**

The need to transport substances **Spec 8.1**

Every cell in an organism needs a supply of some substances and must get rid of others. These substances have to be **transported into and out of** the organism and its cells.

Substances that are transported and why		
Substance	Direction	Why it is needed
Oxygen	Into cells	Used in aerobic respiration to release energy
Carbon dioxide	Out of cells	Waste product of respiration. It must be removed from the body
Water	Into and out of cells	Needed for cell reactions and to keep cells working. Water is also lost from the body, for example in urine and sweat
Dissolved food molecules	Into cells	Provide a source of energy and the materials for growth and repair, for example glucose and amino acids
Mineral ions	Into cells	Needed for many cell processes
Urea	Out of cells	A waste product that is made in the body. It is carried in the blood to the kidneys and removed in urine

In a single-celled organism these substances can simply diffuse across the cell surface. In a large animal many cells are far from the outside world, so substances have to be moved over long distances. Blood is the transport medium in humans.

Exam tip: When asked to describe the need for transport, name the substance, say whether it goes in or out, and give the reason. For example: carbon dioxide is a waste product of respiration, so it must be removed.

Exchange surfaces, transport systems and surface area : volume ratio **Spec 8.2**

The **surface area : volume ratio** tells you how much surface an organism has compared with its size. The bigger the organism, the smaller this ratio becomes.

$$\text{surface area : volume ratio} = \text{surface area} \div \text{volume}$$

Surface area : volume ratio of a cube

A cube-shaped block of tissue has sides of 3 cm. Calculate its surface area : volume ratio.

1. A cube has 6 faces. Area of one face = $3 \times 3 = 9 \text{ cm}^2$.
2. Surface area = $6 \times 9 = 54 \text{ cm}^2$.
3. Volume = $3 \times 3 \times 3 = 27 \text{ cm}^3$.
4. Ratio = 54 : 27. Divide both sides by 27.

Answer: 2 : 1

As a cube gets bigger, its surface area : volume ratio gets smaller

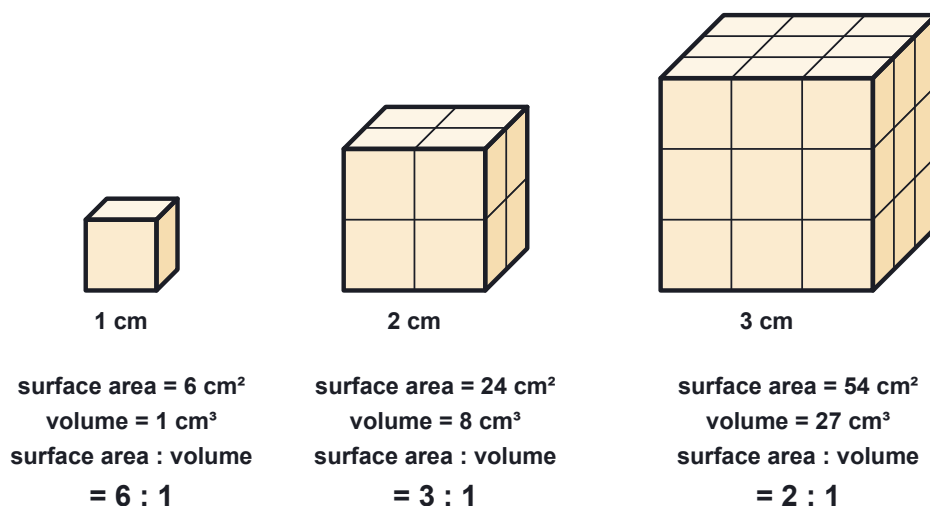
Side of cube	Surface area	Volume	Surface area : volume
1 cm	6 cm ²	1 cm ³	6 : 1
2 cm	24 cm ²	8 cm ³	3 : 1
3 cm	54 cm ²	27 cm ³	2 : 1

Single-celled and multicellular organisms

- A single-celled organism has a **large surface area : volume ratio**. Substances only have a short distance to diffuse, so diffusion across the surface is fast enough.
- A multicellular organism has a **small surface area : volume ratio**. Many cells are deep inside the body, so the diffusion distance is long and diffusion across the body surface is far too slow.

Multicellular organisms therefore need two things. An **exchange surface** has a large surface area so that enough oxygen can enter and enough carbon dioxide can leave. A **transport system** (the circulatory system in humans) then carries substances between the exchange surface and all the cells in the body.

Maths skill: Write the ratio in its simplest form, in the form $x : 1$, unless the question asks otherwise. Check that the surface area is in cm² and the volume in cm³.



As the cube gets bigger, its **surface area : volume ratio gets smaller**.

Alveoli and gas exchange Spec 8.3

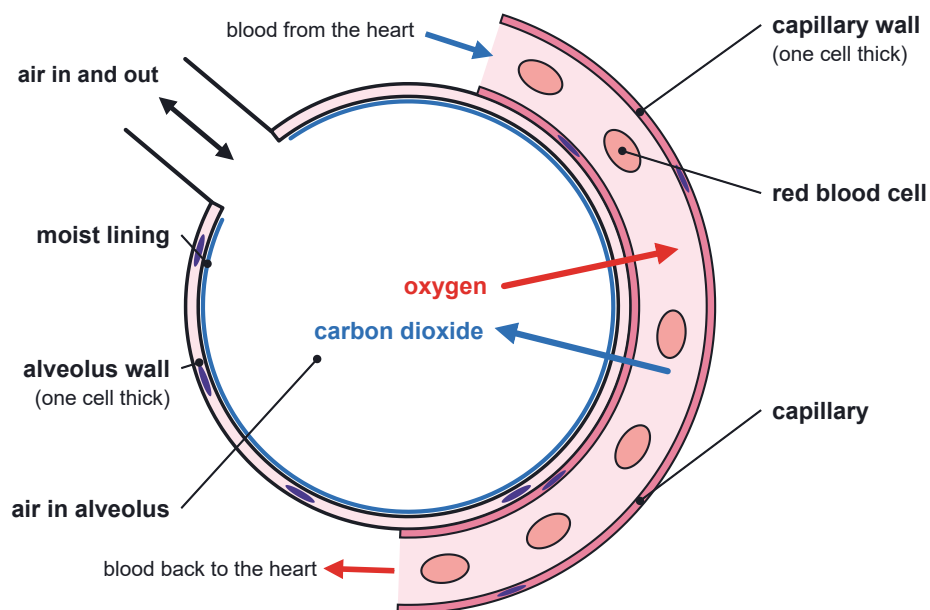
The lungs are the exchange surface for oxygen and carbon dioxide. Each lung contains millions of tiny air sacs called **alveoli**. Gases move between the air in the alveoli and the blood in the capillaries around them by **diffusion**.

- Oxygen diffuses from the air in the alveoli (high concentration) into the blood (low concentration).
- Carbon dioxide diffuses from the blood (high concentration) into the air in the alveoli (low concentration), and is breathed out.

How alveoli are adapted for gas exchange

Adaptation	Why it helps
Millions of alveoli	Gives a very large surface area for diffusion
Walls only one cell thick	Short diffusion distance, so gases diffuse quickly
Capillary walls only one cell thick	Short diffusion distance between the air and the blood
Rich network of capillaries (good blood supply)	Blood carries oxygen away and brings carbon dioxide, keeping a steep concentration gradient
Moist lining	Gases dissolve, which helps them to diffuse
Ventilation (breathing in and out)	Keeps a high oxygen concentration in the alveoli and a low carbon dioxide concentration, which maintains the concentration gradient

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



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

Quick check

1. Why must urea be transported out of the body's cells?
2. Does a large animal have a larger or smaller surface area : volume ratio than a single cell?
3. Why do multicellular organisms need a transport system?
4. State two ways alveoli are adapted for gas exchange.

Quick check answers

Transport and exchange surfaces

1. It is a waste product that is carried in the blood to the kidneys and removed in urine.
2. Smaller.
3. Many cells are far from the surface, so diffusion alone is too slow to supply them.
4. Any two of: large surface area, walls one cell thick, moist lining, good blood supply, ventilation.