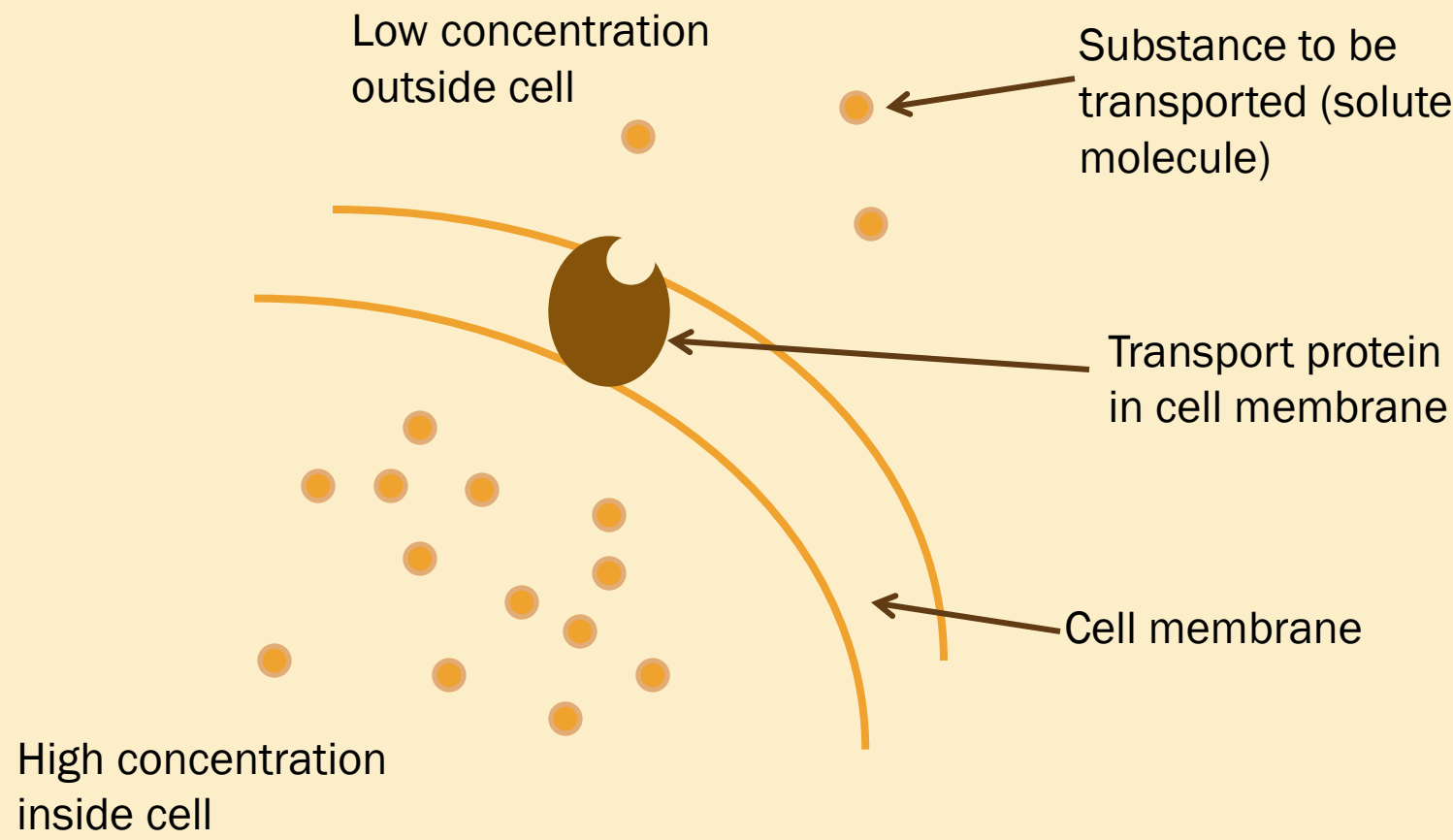


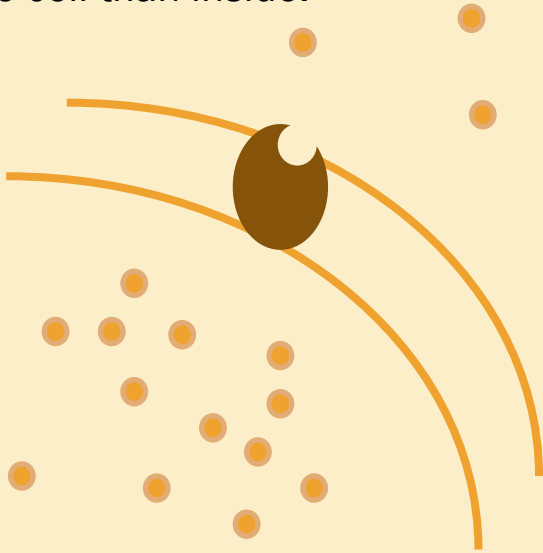
Unit B3 Exchange of Materials

Active transport

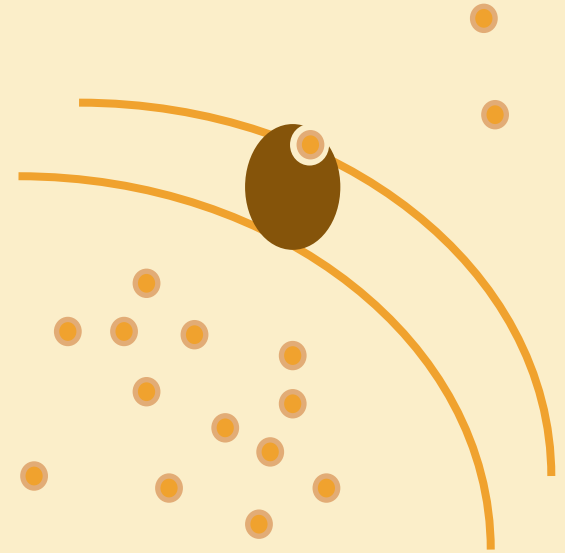
This is the movement of substances against a concentration gradient (from an area of low concentration to an area of high concentration). This process requires **energy**. This is provided by aerobic respiration which is carried out in **mitochondria**. Active transport often occurs across cell membranes and is carried out by **transport proteins**. Mitochondria are often located very close to the region of the cell where active transport takes place.



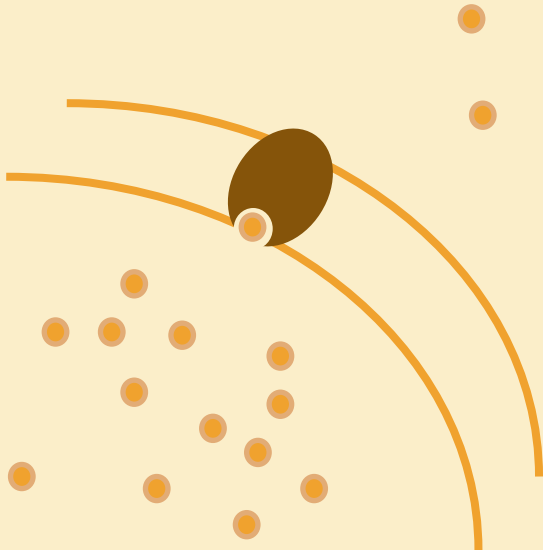
Solute molecule in lower concentration outside cell than inside.



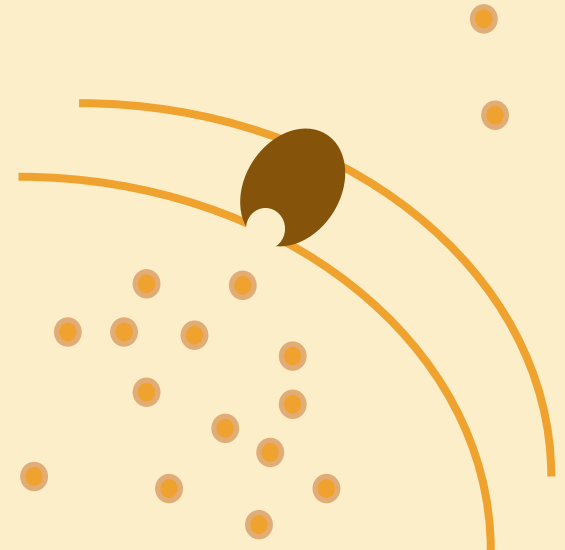
Solute molecule binds to transport protein.



Transport protein rotates in cell membrane. This requires energy from aerobic respiration.

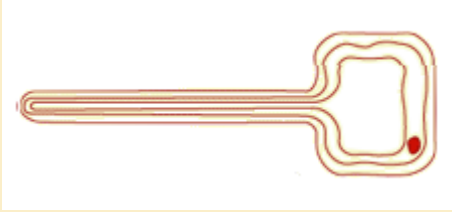


Solute molecule is released into cytoplasm.



Where does active transport occur?

Plant root hair cells



Plant root hair cells move mineral ions from the soil (low concentration) into plant cells (higher concentration).

In the small intestine



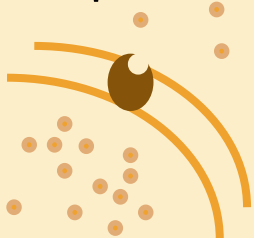
Glucose and other dissolved food molecules can be moved from the small intestine into the blood by active transport.

In salt glands



Marine birds and reptiles take in a lot of salt in the water they drink. They have special **salt glands** found near the nostrils to remove this excess salt. Marine iguanas in the Galapagos Islands have white patches on their heads due to the large amount of salt that is 'sneezed' out through these glands.

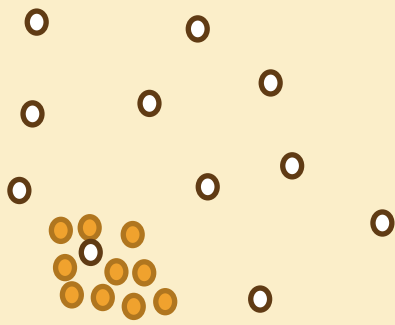
CFTR protein



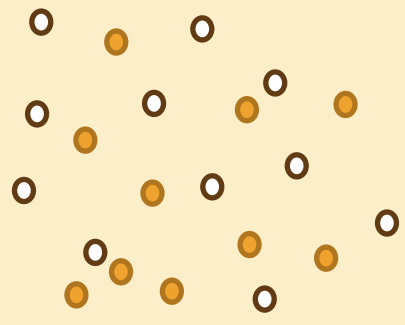
Defects in the CFTR protein cause cystic fibrosis. This is a transport protein located in the cell membrane in lung, gut and reproductive system cells. People who have cystic fibrosis produce thick, sticky mucus.

Diffusion

Diffusion is the net movement of particles of a gas or a solute from an area of high concentration to an area of low concentration (along a concentration gradient)



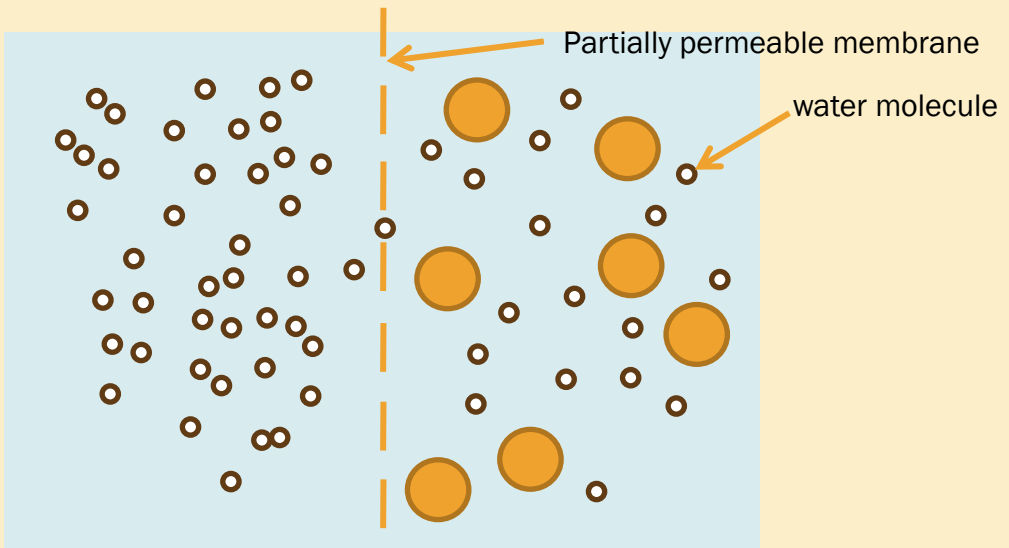
Before diffusion - particles are in an area of high concentration.



After diffusion - particles are mixed evenly.

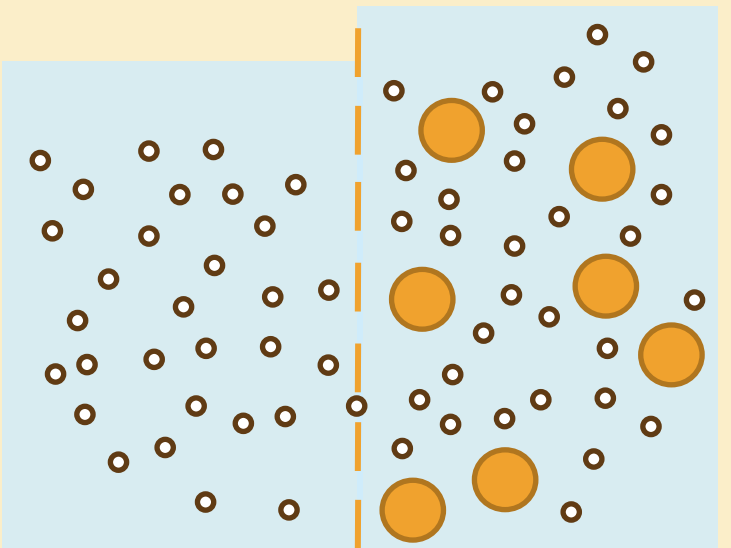
Osmosis

Osmosis is the net movement of **water** molecules from an area of high water concentration to an area of low water concentration through a partially permeable membrane



Area of high water concentration

Area of low water concentration



Water molecules move from left hand side to right hand side causing the level to rise.

Exchange of materials

Many organ systems are specialised for exchanging materials.

In humans these include:

- the surface area of the lungs is increased by the alveoli
- the surface area of the small intestine is increased by villi.

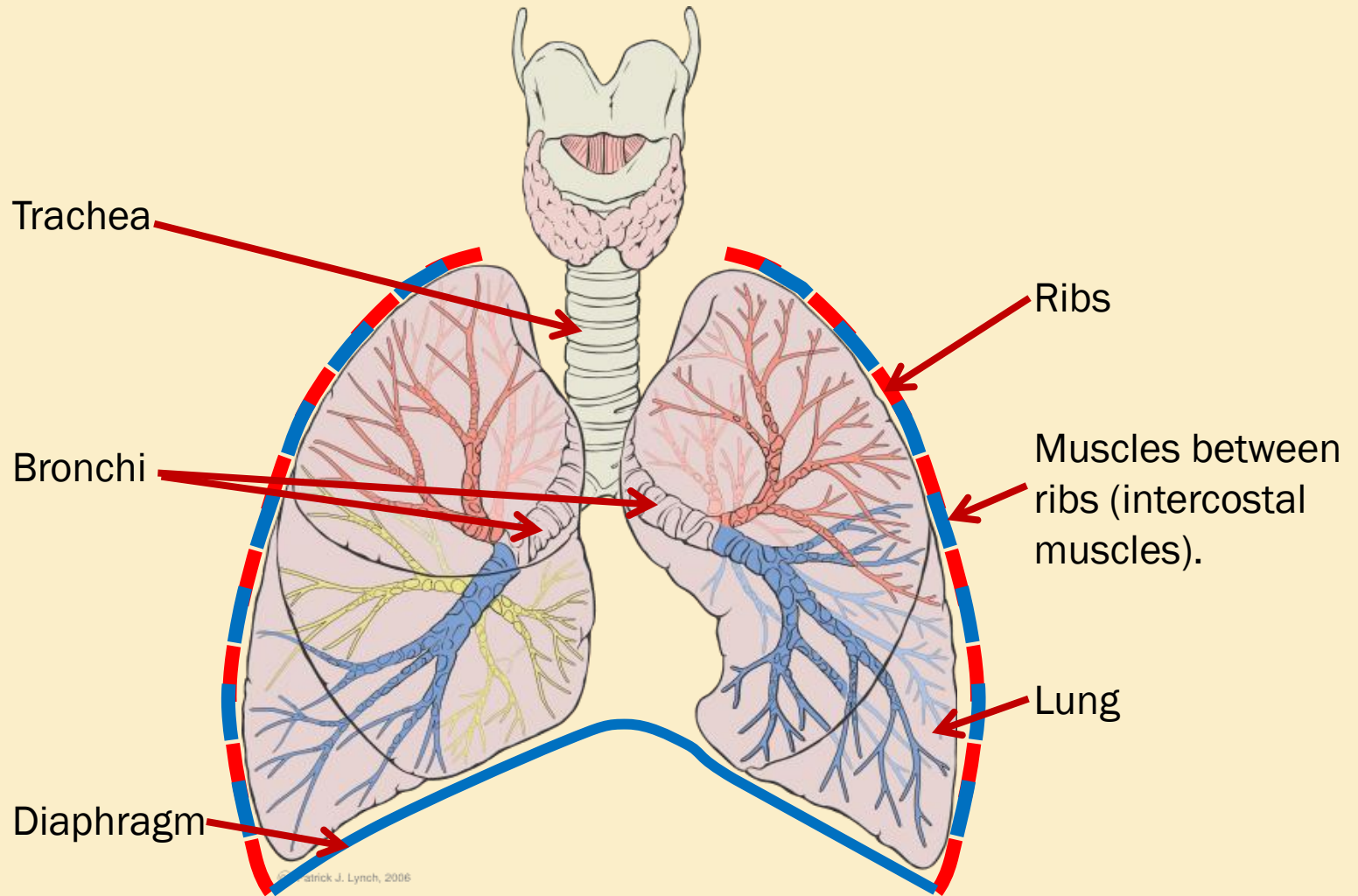
In plants:

- gases diffuse in and out of leaves through small holes called stomata.
- water and mineral ions are absorbed by root hair cells.

Fish exchange gases through their gills.

The following slides will describe how each of these processes occurs.

Exchange of gases in the lungs

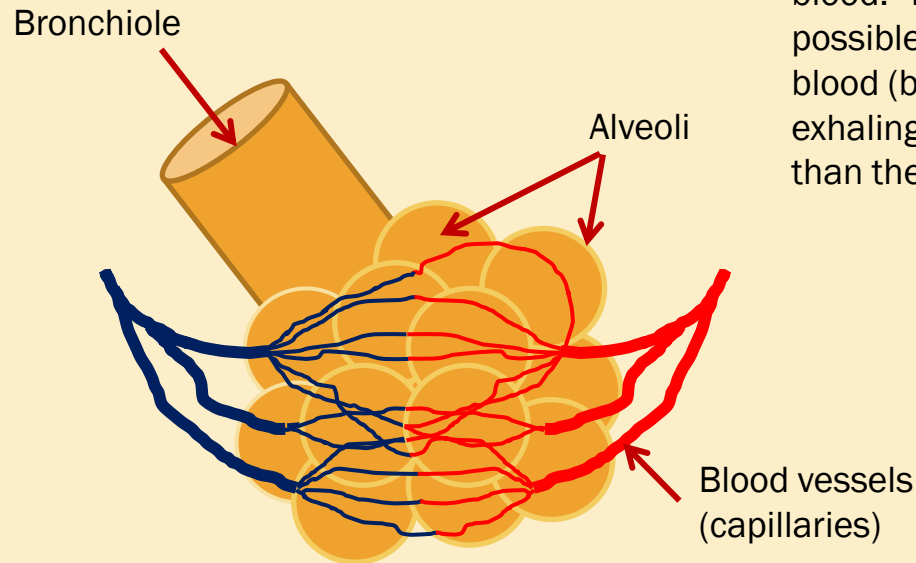


Modified from a diagram by Patrick J. Lynch, medical illustrator

The lungs are in the upper part of the body (thorax) and are protected by the ribcage. They are separated from the lower part of the body – the abdomen – by the diaphragm. This is a strong sheet of muscle that moves up and down as you breathe in and out. The breathing system takes air into and out of the body so that oxygen from the air (where it is in a higher concentration) can diffuse into the bloodstream (where it is in a lower concentration). Similarly carbon dioxide moves from the blood into the lungs, from where it is rapidly removed.

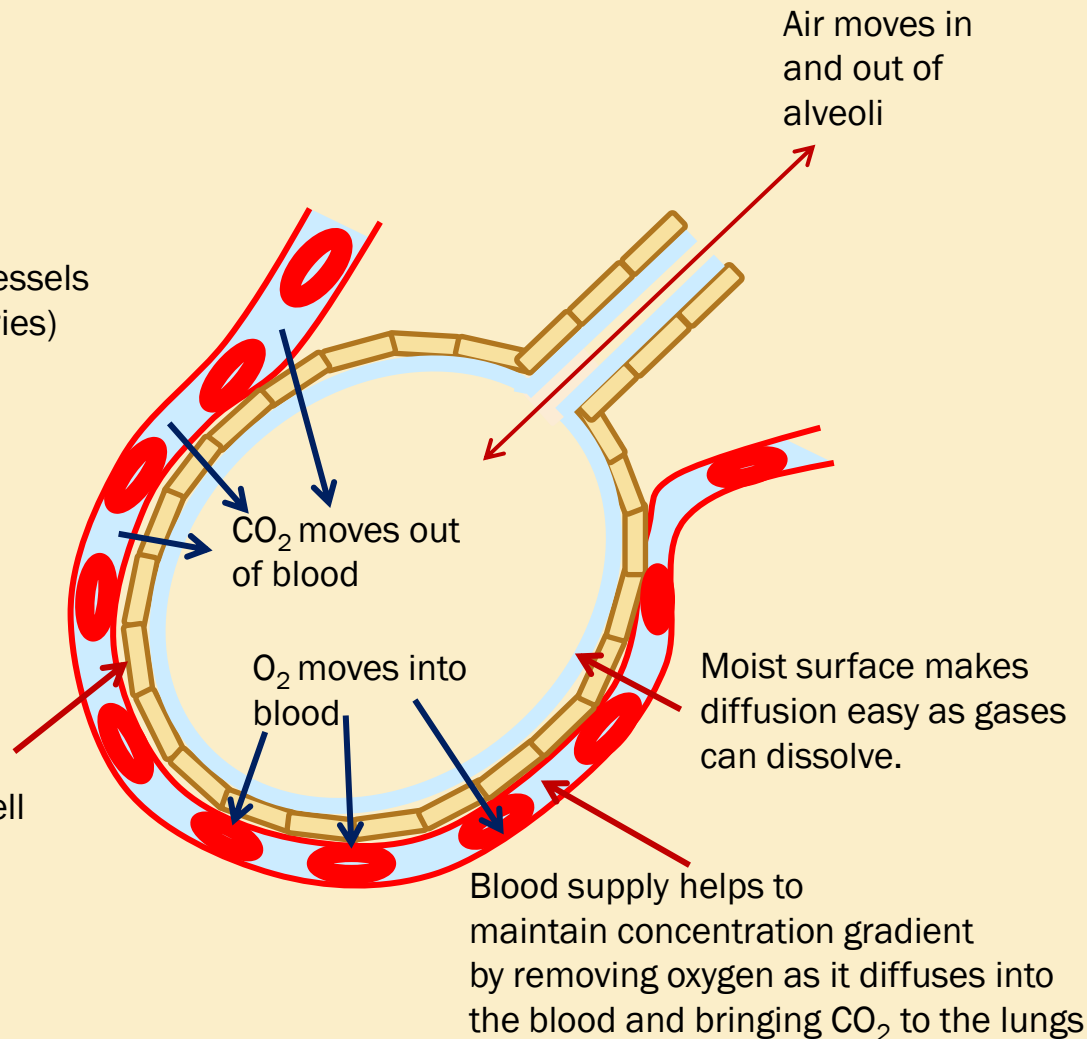
Alveoli (singular alveolus)

The alveoli provide a very large, moist surface, richly supplied with blood capillaries so that gases can readily diffuse into and out of the blood. They have very thin walls to make diffusion as effective as possible. The concentration gradient is maintained by the flow of blood (bringing CO_2 to the lungs and O_2 away) and by you inhaling and exhaling air. The air you breathe in contains more O_2 and less CO_2 than the air you breathe out.



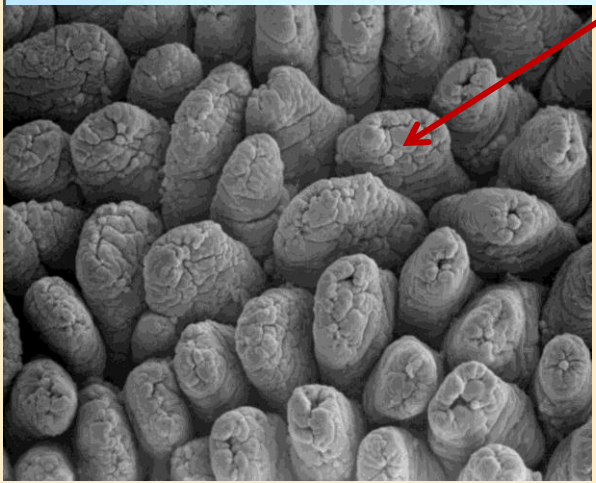
The alveoli are spherical sacs that have a large surface area. They are completely surrounded by a network of blood vessels (capillaries) to aid diffusion.

Very thin walls make diffusion easy (walls are a single cell thick)

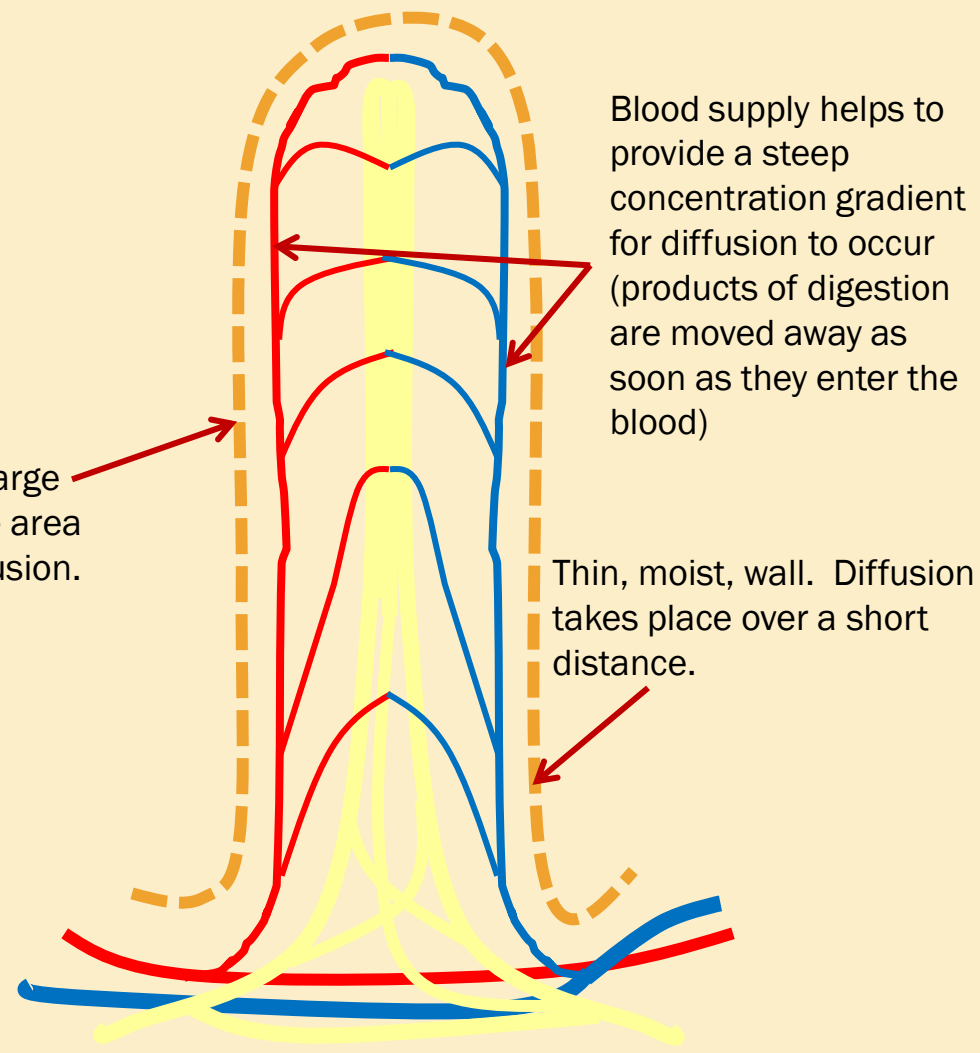


Villi

Villi (singular = villus) provide a large surface area with an extensive network of capillaries to absorb the products of digestion by diffusion **and active transport**. The photographs on the left show villi in the small intestine. The diagram on the right, shows how villi are adapted to allow the products of digestion to diffuse into the blood.



Villus
Has a large surface area for diffusion.



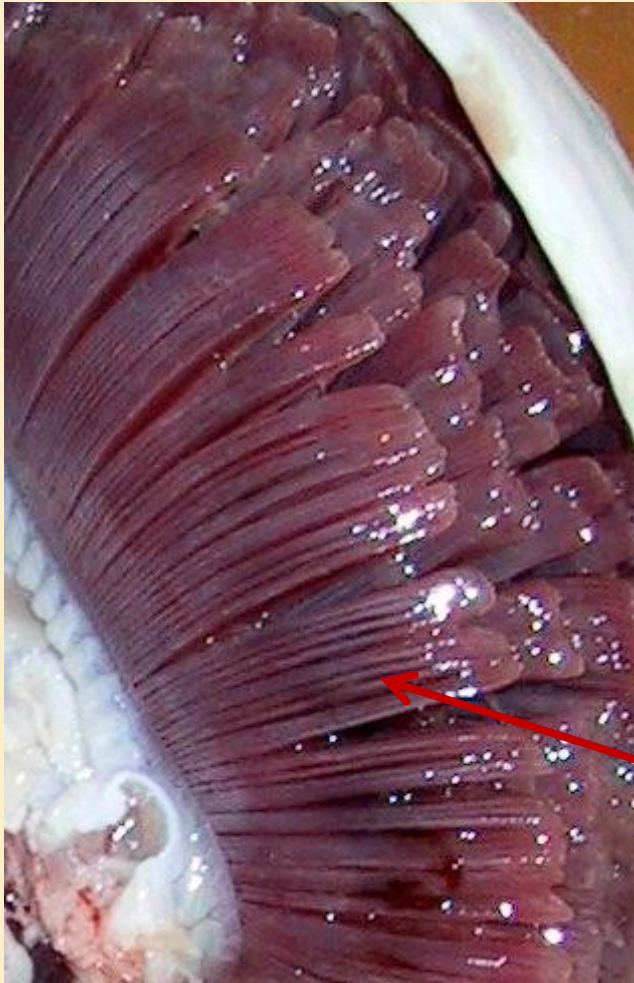
Blood supply helps to provide a steep concentration gradient for diffusion to occur (products of digestion are moved away as soon as they enter the blood)

Thin, moist, wall. Diffusion takes place over a short distance.

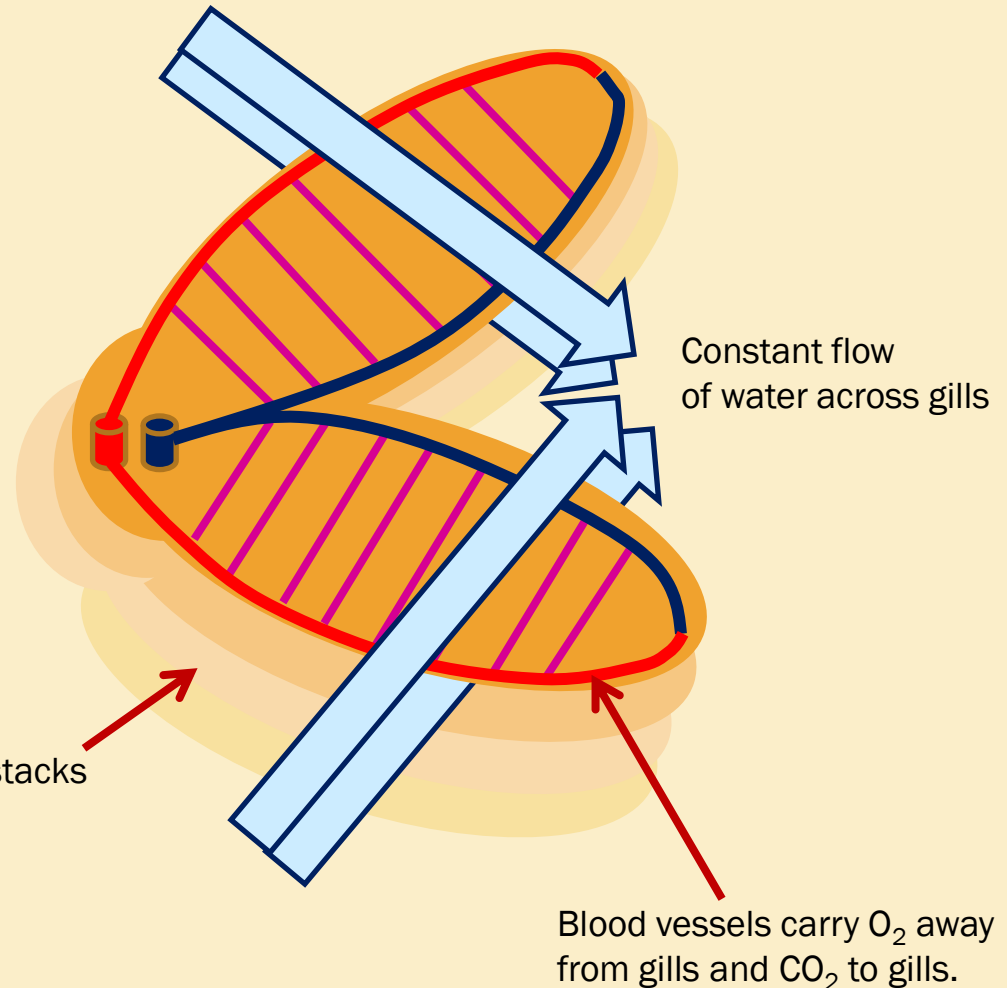
Gas Exchange in Fish

Fish exchange materials using their gills. Similarly to the cases we have discussed previously:

- They are moist and have a large surface area
- Oxygen diffusing into the blood is rapidly transported away (by the flow of blood) to maintain a high concentration gradient
- The constant flow of water transports carbon dioxide away and a fresh supply of oxygen to the gills
- The membranes which the gases diffuse across are very thin.



Tuna gills - [source Wikipedia.](#)



Gas Exchange in Plants

In plants, carbon enters the leaf by diffusion. Plant leaves contain pores called stomata to obtain carbon dioxide from the atmosphere. These are normally open during the daytime (when the plant is photosynthesising) and closed at night time. Plants also need oxygen to carry out respiration, in addition to carbon dioxide for photosynthesis. Plant leaves are flat and thin so gases do not need to diffuse very far.



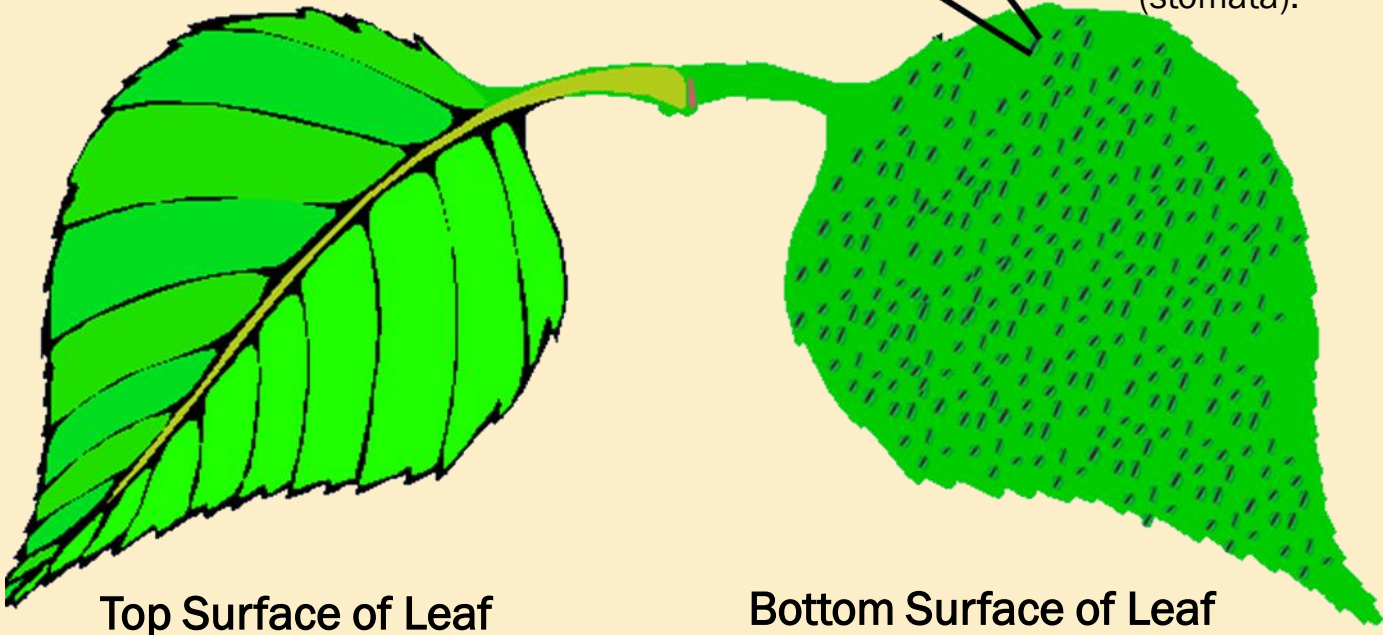
Photograph of guard cells and stoma

Stoma (plural = stomata)

Guard Cells



The top surface of the plant leaf is covered with a waxy layer and shaped to allow rainwater to run off. The bottom surface is covered with lots of pores (stomata).



Top Surface of Leaf

Bottom Surface of Leaf

Image source: <https://eapbiofield.wikispaces.com/Erika+Transpiration+Pre-Lab?f=print>; diagrams H Parry

Transpiration

Plants lose water vapour from the surface of their leaves. This loss of water vapour is called transpiration. Transpiration is more rapid in hot, dry and windy conditions. Most of the transpiration is through stomata. The size of stomata is controlled by guard cells which surround them. If plants lose water faster than it is replaced by the roots, the stomata can close to prevent wilting

