science

biology

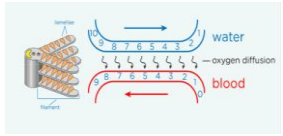
A-Level Exchange

Gas Exchange

Single celled organisms can exchange oxygen and carbon dioxide directly through their plasma membrane via diffusion.

Insects

Insects exchange gas in their tracheal system. Air enters via spiracles, travels through trachea and tracheoles, delivering oxygen directly to every tissue.



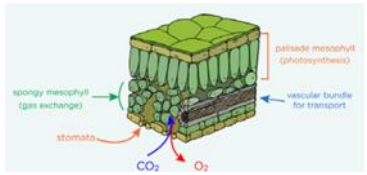
Fish

Gas exchange in fish occur via gills.

The orientation of the gill filaments and lamellae ensures that the water flowing over them moves in the opposite direction to the flow of blood through the capillaries (countercurrent flow), maintaining a diffusion gradient.

Dicotyledonous plants

Gas exchange in dicotyledonous plants occurs in the leaves. The stomata can open to allow gases diffuse in and out of the leaf. The mesophyll cells have a large surface area for rapid diffusion.



Gas exchange can lead to water loss. Plants can control the opening of their stomata to limit this.

Xerophytes may have additional adaptations such as: hairs, waxy cuticle, small leaves, sunken stomata, rolled leaves. Insects can also control water loss but controlling open and closing of their spiracles, hair around spiracles and a waterproof, waxy cuticle.

Surface area to volume ratio

The greater the size of an organism, the smaller its surface area: volume ratio

Larger organisms therefore require specialised exchange surfaces and transport mechanisms to meet their metabolic requirements

Surface area to volume ratio continued

Specialised exchange surface have: a large surface area, thin barriers and associated transport systems to maintain a steep diffusion gradient.

Also, organisms with a higher metabolic rate require more nutrients and produce more waste, therefore require a specialised exchange surface.

Digestion

During digestion, large biological molecules are hydrolysed to smaller molecules that can be absorbed across cell membranes.

Digestion enzymes in mammals includes:

Enzyme		Substrate	Product(s)
Amylase		Starch	Maltose
Membrane-bound disaccharidases	Maltase	Maltose	α-glucose molecules
	Sucrase	Sucrose	Glucose & fructose
	Lactase	Lactose	Glucose & galactose
Lipase		Lipids	Monoglyceride & fatty acids
Endopeptidases (pepsin, trypsin & chymotrypsin)		Hydrolyse peptide bonds in the middle region of proteins	Produce several polypeptide chains
Exopeptidases		Hydrolyse peptide bonds on terminal amino acids	Release single amino acids and dipeptides
Membrane-bound dipeptidases		Dipeptides	Single amino acids

The ileum is the final section of the small intestine where both hydrolysis and absorption occurs.

Bile salts made by the liver, emulsify lipids in order to increase the surface area of the lipids, for greater access to lipases.

Micelles are the products of lipase digestion that remain in association with the bile salts to form structures. The micelles travel to the ileum where, upon contact with the surface of ileum epithelium cells, they are broken down. This releases the non-polar monoglyceride and fatty acids, which diffuse straight into the epithelial cell.

Amino acids and carbohydrates are absorbed via co-transportation with sodium.

Human Gas Exchange System

In humans, gas exchange occurs via the lungs.

The alveolar epithelium is adapted for gas exchange by having a large surface area, good blood supply, thin walls & elastic fibres which help recoil.

Ventilation is the process of breathing in (inspiration) and out (expiration).

Inspiration: external intercostal muscles contract, rib cage moves up & out, diaphragm contracts, volume of the thorax is increased, atmospheric pressure is greater than pulmonary pressure and air is forced into the lungs.

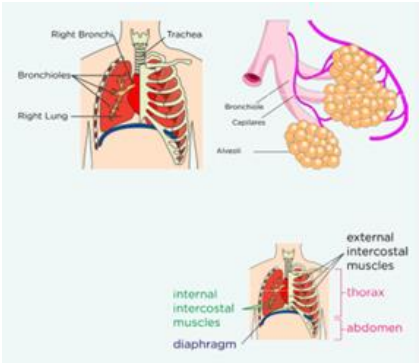
Expiration: internal intercostal muscles contract, ribs move down and inwards, diaphragm relaxes, volume of the thorax is decreased, pulmonary pressure is greater than atmospheric pressure, air is forced out of the lungs

Pulmonary ventilation rate is the total volume of air moved into the lungs during a minute.

Tidal volume is the volume of air moved in and out of the lungs with a normal breath.

Breathing rate is the number of breaths per minute.

Pulmonary Ventilation Rate (dm3min−1) = Tidal Volume (dm3) × Breathing Rate (min−1)



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