

WJEC (Wales) Biology A-level

Topic 2.2 - Adaptations for Gas Exchange

Definitions and Concepts

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Alveoli - Tiny air sacs that serve as the primary gaseous exchange surface. They consist of a thin epithelial cell layer and elastic fibres.

Amoeba - A unicellular organism that has a large surface area to volume ratio for gaseous exchange; simple diffusion across the cell surface membrane is sufficient to meet the demands of respiratory processes.

Angiosperms - Plants that flower and bear their seeds within fruit.

Bronchi - Divisions of the trachea that lead into the lungs. They are small tubes supported by incomplete rings of cartilage.

Bronchioles - Many small divisions of the bronchi. They contain smooth muscle to restrict airflow to the lungs but do not have cartilage. They are lined with a thin layer of ciliated epithelial cells.

Buccal cavity - The mouth cavity in bony fish that has a role in ventilation.

Countercurrent flow - The mechanism by which a steep diffusion gradient is maintained across the whole gill filament in a bony fish; blood and water flow in opposite directions across the gill plate.

Diaphragm - A large sheet of muscle below the lungs used to reduce and increase the lung capacity to create pressure changes necessary for ventilation.

Dicotyledonous plants - Plants that produce seeds that contain two cotyledons. They have two primary leaves.

Earthworm - A multicellular organism that can rely on simple diffusion for gaseous exchange. It has a circulatory system that transports oxygen to the tissues and removes carbon dioxide.

Exchange surface - A surface over which materials are exchanged from one region to another. An effective exchange surface has a large surface area, thin layers, a good blood supply, and ventilation to maintain a steep diffusion gradient.

External intercostal muscles - A set of muscles found between the ribs on the outside that are involved in forced and quiet inhalation.

Flatworm - A multicellular organism that can rely on simple diffusion for gaseous exchange. It has a flat structure that provides a short diffusion distance.

Gill filaments - The main site of gaseous exchange in fish, over which water flows. They are found in large stacks, known as gill plates, and have gill lamellae which provide a large surface area for exchange.

Gill lamellae - The fine branches of the gill filaments. They are adapted for gaseous exchange by having a large surface area and good blood supply.

Gill plates - Large stacks of gill filaments.



Gills - The organs of gaseous exchange in fish adapted for aquatic environments. They have a large surface area due to gill filaments.

Guard cells - Cells that surround the stomata and change shape depending on water potential. They control the rate of transpiration by becoming turgid or flaccid, opening or closing the stomata.

Inspiration - During inspiration (inhalation) the diaphragm contracts and flattens and the external intercostal muscles contract, raising the ribcage. The outer pleural membrane moves out, reducing pleural cavity pressure and pulling the inner membrane out. The alveoli expand. Alveolar pressure falls below air pressure so air moves into the trachea.

Internal intercostal muscles - A set of muscles found between the ribs on the inside that are involved in forced exhalation.

Larynx - A hollow, tubular structure located at the top of the trachea involved in breathing and phonation.

Lower epidermis - A layer of cells on the leaf's lower surface, containing stomata and guard cells.

'Malate' theory - The theory that states that the accumulation or loss of K^+ ions by guard cells results in changes in turgor pressure that open or close the stomata.

Metabolic rate - The rate of energy expenditure by a living organism.

Operculum - A flap that covers the gills of bony fish. It protects the gills and helps to maintain a constant stream of water over them.

Palisade mesophyll - The main photosynthetic tissue located below the upper epidermis.

Parallel flow - Water and blood flow in the same direction across the gill plate. This occurs in cartilaginous fish such as sharks. Exchange of oxygen does not occur across the entire plate, and the rate of diffusion is lower.

Parenchyma - Thin-walled packing cells.

Phloem - A living plant transport vessel responsible for the transfer of assimilates to all parts of the plant.

Pleural cavity - The space between the pleural membranes of the lungs and the inner chest wall.

Pleural membranes - Thin, moist layers of tissue surrounding the pleural cavity that reduce friction between the lungs and the inner chest wall.

Ribs - A set of bones that surround and protect the chest cavity.

Spiracles - Small, external openings along the thorax and abdomen of most insects, through which air enters, and air and water leave the gaseous exchange system.



Spongy mesophyll - A type of loosely packed mesophyll tissue with air pockets found in plant leaves which is specialised for gas exchange. It also contains chloroplasts for photosynthesis.

Stomata - Small holes found on leaves that can be opened or closed by guard cells to control the amount of water loss and gas exchange.

Surface area to volume ratio - The volume of an object compared with the amount of area where it contacts its environment. Calculated by dividing the surface area of an object by its volume.

Surfactant - A fluid lining the surface of the alveoli that reduces surface tension and prevents collapse of the alveoli during exhalation.

Tracheae (insects) - Large tubes that run from the spiracles, into and along an insect's body. They are supported by spirals of chitin. The tracheae divide further into smaller tracheoles.

Trachea (mammals) - The primary airway which carries air from the nasal cavity down into the chest. It is a tube supported by incomplete rings of cartilage.

Tracheoles - Divisions of the tracheae that run throughout the tissues of an insect, forming a complex network. They are the main site of gas exchange and are completely permeable to gases.

Upper epidermis - A layer of transparent cells that allows light to strike the mesophyll tissue. The epidermal cells also synthesise the waxy cuticle.

Vascular bundle - The vascular system in dicotyledonous plants. It consists of two transport vessels, the xylem and the phloem.

Ventilation - The movement of fresh air into a space and stale air out of a space to maintain a steep concentration gradient of oxygen and carbon dioxide.

Ventilation (mammals) - The movement of fresh air into the lungs and stale air out of the lungs via inspiration and expiration.

Waxy cuticle - A waxy layer that reduces water loss from the leaf surface.

Xylem - A non-living plant transport vessel responsible for the transfer of water and minerals from the roots to the shoots and leaves.

