

Definitions and Concepts for OCR (A) Biology A-Level

Topic 3 - Exchange and Transport

Topic 3.1: Exchange surfaces

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

Breathing rate: The number of breaths per minute.

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.

Cartilage: Strong, flexible connective tissue that supports the walls of the trachea and bronchi, preventing collapse. It is found in an incomplete ring shape.

Ciliated epithelial cells: Specialised cells with tiny hair-like cilia found lining the trachea that waft bacteria-containing mucus up to the back of the throat, where it is swallowed.

Countercurrent flow: An adaptation for gaseous exchange in bony fish. Blood in the gill filaments and water moving over the gills flow in opposite directions, maintaining a steep oxygen concentration gradient.

Elastic fibres: Fibres of elastin that allow the alveoli to stretch as air is drawn in and recoil back to normal size, expelling air. They are also found in the trachea, bronchi and bronchioles.

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.

Expiration: During expiration (exhalation) the diaphragm relaxes and reverts to a dome. The external intercostal muscles relax, moving the ribs down and in. The volume of the thorax decreases and thoracic pressure exceeds air pressure. Air moves out of the trachea.



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. They are contained in a gill cavity and are made up of gill lamellae, gill filaments and gill plates.

Goblet cells: Specialised cells that secrete mucus onto the trachea lining. The mucus traps harmful substances and microorganisms, preventing their entry into the lungs.

Inspiration: During inspiration (inhalation) the diaphragm contracts and flattens and the external intercostal muscles contract, moving the ribs up and out. The volume of the thorax increases and thoracic pressure falls below air pressure. Air moves into the trachea.

Internal intercostal muscles: Muscles found between the ribs which are responsible for forced exhalation.

Mammalian gaseous exchange system: A complex system found in mammals in which oxygen and carbon dioxide gases are exchanged.

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.

Smooth muscle: An involuntary muscle found in the walls of the trachea and bronchi. It constricts the lumen of the bronchi by contracting, reducing airflow to the lungs.

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. Spiracle sphincters open and close the spiracles to control gas exchange.

Spirometer: A device used to examine patterns of breathing and determine different aspects of lung volume.

Surface area to volume ratio: The surface area of an object divided by its volume. The larger the surface area to volume ratio, the smaller the object.

Tidal volume: The volume of air that moves into and out of the lungs during a normal breath.

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.



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.

Tracheal fluid: A fluid found at the ends of the tracheoles. The amount of fluid affects the surface area available for gaseous exchange and water loss.

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.

Ventilation: The movement of fresh air into the lungs and stale air out of the lungs via inspiration and expiration.

Vital capacity: The largest volume of air that can be breathed in following the strongest possible exhalation.

Topic 3.2: Transport in animals

Affinity: The tendency of one substance to bind with another substance.

Aorta: The artery that takes oxygenated blood away from the heart to the body.

Arteriole: A type of blood vessel that connects the arteries and capillaries. The walls of the arterioles contain large amounts of smooth muscle, some elastic fibres and some collagen.

Artery: A type of blood vessel that carries blood away from the heart to the tissues, under high pressure. The walls of the arteries contain collagen, smooth muscle and elastic fibres.

Atrial fibrillation: An arrhythmia that involves the rapid contraction of the atria, preventing complete ventricular filling.

Atrial systole: The stage of the cardiac cycle in which the atria contract, pushing blood into the ventricles. The AV valves are pushed open fully and the atria are emptied of blood.

Atrioventricular node (AVN): A group of cells located between the atria that slow down the wave of excitation and pass it between the ventricles, along the bundle of His.

Atrioventricular (AV) valves: The valves found between the atria and ventricles. They prevent the backflow of blood from the ventricles into the atria. There are two types of atrioventricular valves: bicuspid and tricuspid.



Bicuspid valves: The atrioventricular valves found between the left atrium and left ventricle.

Blood: The transport medium in the mammalian circulatory system. It consists of plasma, red blood cells, white blood cells and platelets.

Bohr effect: The loss of affinity of haemoglobin for oxygen as the partial pressure of carbon dioxide increases.

Bradycardia: A slow resting heart rate below 60 bpm.

Bundle of His: A collection of Purkyne fibres which run from the AVN down to the apex of the ventricles.

Capillaries: Microscopic blood vessels that form a large network through the tissues of the body and connect the arterioles to the venules. They are the site of exchange of substances between the blood and the tissues.

Carbonic anhydrase: An enzyme that catalyses the reversible reaction between water and carbon dioxide to produce carbonic acid.

Cardiac cycle: Describes the sequence of events involved in one complete contraction and relaxation of the heart. There are three stages: atrial systole, ventricular systole and diastole.

Cardiac output: The volume of blood pumped by the heart through the circulatory system in one minute. It is calculated using the equation:

$$\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$$

Chloride shift: The process by which chloride ions move into the erythrocytes in exchange for hydrogen carbonate ions which diffuse out of the erythrocytes. This maintains the electrochemical equilibrium of the cell.

Circulatory system: The transport system in animals.

Closed circulatory system: A circulatory system in which the blood pumped by the heart is contained within blood vessels. The blood does not come into direct contact with the cells. Closed circulatory systems are found in animals, e.g. vertebrates.

Diastole: The stage of the cardiac cycle in which the heart muscle relaxes. The atria and ventricles fill with blood.

Double circulatory system: A circulatory system in which the blood flows through the heart twice in two circuits. Blood is pumped from the heart to the lungs before returning to the heart. It is then pumped around the body, after which it returns to the heart again. Double circulatory systems are found in mammals.



Ectopic heartbeat: Additional heartbeats outside of the normal heart rhythm.

Electrocardiogram (ECG): A technique used to indirectly measure the spread of electrical activity through the heart by measuring tiny changes in the skin's electrical conductivity. This produces a trace which is used to detect abnormalities in heart rhythm.

Haemoglobin: The red pigment found in erythrocytes that binds reversibly with four oxygen molecules to form oxyhaemoglobin. It is a globular protein that consists of four polypeptide chains, each with a prosthetic haem group.

Haemoglobinic acid: The product formed when haemoglobin accepts free hydrogen ions. This enables haemoglobin to act as a buffer, reducing changes in blood pH.

Heart rate: The number of times the heart beats in one minute.

Hydrostatic pressure: The pressure exerted on the sides of a vessel by a fluid.

Inferior vena cava: The vein that returns deoxygenated blood to the heart from the lower body.

Lymph: Modified tissue fluid that drains into the lymphatic system. It carries less oxygen and fewer nutrients than tissue fluid, but also contains fatty acids.

Myogenic: Describes cardiac muscle tissue that initiates its own contraction, without outside stimulation from nervous impulses.

Oncotic pressure: The movement of water into the blood by osmosis due to the tendency of plasma proteins to lower the water potential of the blood.

Open circulatory system: A circulatory system in which the transport medium pumped by the heart is not contained within vessels, but moves freely. The transport fluid comes into direct contact with the cells. Open circulatory systems are found in invertebrates, e.g. insects.

Oxygen dissociation curve: A graph that describes the relationship between the partial pressure of oxygen and the percentage saturation of haemoglobin in the blood.

Plasma: The main component of the blood that carries red blood cells. It is a yellow liquid that contains proteins, nutrients, mineral ions, hormones, dissolved gases and waste.

Pulmonary arteries: The arteries that carry deoxygenated blood away from the heart to the lungs.

Pulmonary veins: The veins that carry oxygenated blood from the lungs to the heart.

Purkyne tissue: Specialised cardiac muscle fibres which make up the bundle of His and conduct the wave of excitation through the septum, from the AVN down to the apex of the ventricles.



Semilunar valves: A pair of valves found between the ventricles and arteries. They prevent the backflow of blood from the arteries into the ventricles.

Septum: The wall of muscle which separates the left side of the heart from the right side of the heart, preventing oxygenated and deoxygenated blood from mixing.

Single circulatory system: A circulatory system in which the blood travels one circuit; blood flows through the heart and is pumped around the body before returning to the heart. Single circulatory systems are found in fish.

Sinoatrial node (SAN): A group of cells in the wall of the right atrium that generate electrical activity, causing the atria to contract. The SAN is often referred to as the heart's pacemaker.

Stroke volume: The volume of blood pumped by the left ventricle of the heart in a single contraction.

Superior vena cava: The vein that returns deoxygenated blood to the heart from the head and upper body.

Tachycardia: A rapid resting heart rate over 100 bpm.

Tissue fluid: The fluid that surrounds the cells of animals. It has the same composition of plasma but does not contain red blood cells or plasma proteins.

Tricuspid valves: The atrioventricular valves found between the right atrium and right ventricle.

Vein: A type of blood vessel that carries blood towards the heart under low pressure. They have a wide lumen, a smooth inner lining and valves. The walls of the veins contain large amounts of collagen, smooth muscle and little elastic fibre.

Ventricular systole: The stage of the cardiac cycle in which the ventricles contract, pushing blood into the arteries. The semi-lunar valves are pushed open fully.

Venule: A type of blood vessel that connects the capillaries and veins. The walls of the venules contain small amounts of collagen and smooth muscle.

Topic 3.3: Transport in plants

Active loading: The process by which hydrogen ions are actively pumped out of companion cells using ATP, before diffusing down a concentration gradient, back into the cells via co-transporter proteins, whilst carrying sucrose.



Adhesion (water movement): The formation of hydrogen bonds between carbohydrates in the xylem vessel walls and water molecules. This contributes to the capillarity of water and transpiration pull.

Apoplast route: One of two pathways by which water and minerals move across the root. Water moves through intercellular spaces between cellulose molecules in the cell wall.

Casparian strip: A waterproof strip surrounding the endodermal cells of the root that blocks the apoplast pathway, forcing water through the symplast route.

Cohesion (water movement): The formation of hydrogen bonds between water molecules. This contributes to the capillarity of water and transpiration pull.

Cohesion-tension theory: The model that explains the movement of water from the soil to the leaves, in a continuous stream.

Companion cells: The active cells of the phloem located adjacent to the sieve tube elements. They retain their nucleus and organelles, producing ATP for metabolic processes in both themselves and the sieve tube elements.

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

Hydrophytes: Plant that are adapted to live and reproduce in very wet habitats, e.g. water lilies.

Phloem: A living plant transport vessel responsible for the transfer of assimilates to all parts of the plant. The phloem consists of sieve tube elements and companion cells.

Plasmodesmata (phloem): Small pores between adjacent sieve tube elements and companion cells that allow communication and the exchange of materials.

Potometer: An apparatus used to measure water uptake from a cut shoot.

Root hair cells: Specialised cells responsible for the uptake of water and minerals from the soil. They have long hair-like extensions known as root hairs, which are adapted as exchange surfaces.

Sieve plates: The perforated end walls of sieve tube elements that allow plant assimilates to flow between cells unimpeded.

Sieve tube elements: The main cells of the phloem. They are elongated cells laid end-to-end with sieve plates between. They contain few organelles.

Sinks (plants): The regions of a plant that remove assimilates e.g. roots, meristem, fruits.



Sources (plants): The regions of a plant that produce assimilates e.g. leaves, storage organs.

Symplast route: One of two pathways by which water and minerals move across the root. Water enters the cytoplasm through the plasma membrane and moves between adjacent cells via plasmodesmata. Water diffuses down its water potential gradient by osmosis.

Translocation: The movement of organic compounds in the phloem, from sources to sinks.

Transpiration: Water loss from plant leaves and stems via diffusion and evaporation. The rate of transpiration is affected by light, temperature, humidity, air movement and soil-water availability.

Transpiration stream: The flow of water from the roots to the leaves in plants, where it is lost by evaporation to the environment.

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

Vascular system: A network of transport vessels in animals and plants.

Xerophytes: Plant that are adapted to live and reproduce in dry habitats where water availability is low, e.g. cacti and marram grass.

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

