CAIE Biology A-level

Topic 14 - Homeostasis

Definitions and Concepts

Abscisic acid (ABA) - A plant hormone that stimulates stomatal cloning, maintains seed dormancy and triggers cold protective responses.

Afferent arteriole - The larger diameter arteriole which carries blood to the glomerulus for ultrafiltration.

Antidiuretic hormone (ADH) - A hormone released from the posterior pituitary gland that increases the reabsorption of water in the kidney tubules.

Aquaporin - A membrane channel used for the selective transport of water in and out of the cell.

Autonomic nervous system - A branch of the nervous system that carries nerve impulses to muscles and glands. It controls involuntary activities and has two divisions: the sympathetic nervous system and the parasympathetic nervous system.

Biosensor - A biological molecule is paired with a device that generates a thermal, optical or electrical signal when a specific reaction takes place in order to detect the presence of a particular chemical.

Bowman's capsule - The cup-like structure at the start of a nephron that surrounds the glomerulus. The inner layer of the capsule, through which filtration of the blood takes place, is composed of podocytes.

Central nervous system (CNS) - The brain and spinal cord.

Collecting ducts - A system of ducts and tubules which connect nephrons to a calyx or the renal pelvis which is a site for water reabsorption.

Coordinator - Coordinates information from the receptors and sends instructions to the effectors.

Cortex - The outer region of the kidney.

Cyclic AMP (cAMP) - A 'second messenger' involved in the action of adrenaline that activates protein kinase A.

Deamination - Deaminase enzymes in the liver and, to a lesser extent, the kidneys remove an amino group (NH_2) from a molecule as part of the urea cycle.

Dipstick - A device which can be used for chemical testing or to measure liquid volume.

Distal convoluted tubule (DCT) - The twisted region of the nephron between the loop of Henle and the collecting duct that alters the concentration of water and salts reabsorbed. Its permeability to water is altered by ADH.

Effector - An organ, tissue, or cell that produces a response to a stimulus.

Efferent arteriole - The smaller diameter arteriole which carries the blood away from the glomerulus after ultrafiltration.

Endocrine system - A chemical messenger system. It consists of glands, which produce and secrete hormones into the bloodstream, and effectors.

Endoderm - A type of organism which can regulate its own body temperature without relying on external heat sources.

Enzyme cascade - A series of successive enzymatic reactions in which the product of one reaction serves as the substrate for the next.

Excretion - The process of removing waste products from an organism.

Fibrous capsule - A tough layer that surrounds and protects the kidney. It consists of fibres, collagen and elastin.

Glomerular filtrate - The fluid produced by ultrafiltration of the blood into the renal capsule. It contains water, glucose, mineral ions and urea.

Glomerulus - The bundle of blood vessels at the beginning of a kidney nephron where ultrafiltration takes place.

Glucagon - A hormone secreted by alpha cells (α cells) of the Islets of Langerhans in the pancreas. It increases blood glucose concentration.

Glucose oxidase - An enzyme which oxidises glucose to hydrogen peroxide. It is often used alongside peroxidase to determine oxygen concentration via a dipstick method.

G-protein - A protein that serves as a 'molecular switch' inside cells. Activation of the G-protein in the control of blood concentration results in the stimulation of adenylyl cyclase.

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.

Homeostasis - Maintaining a constant internal environment around an optimum despite external change.

Hypothalamus - The region of the brain that serves as the control centre for the autonomic nervous system. It is responsible for production of hormones, the regulation of the water potential of body fluids and the control of behavioural patterns.

Insulin - A hormone secreted by beta cells (β cells) of the Islets of Langerhans in the pancreas that decreases blood glucose concentration.

Islets of Langerhans - Regions of the pancreas which contain α and β cells.

Ketones - Carbonyl compounds produced during beta-oxidation of fat in the liver. A high level of ketones in the blood may indicate diabetes.

Kidney - Organ involved in blood filtration and urine excretion. It also produces some hormones.

Loop of Henle - A large hairpin shaped loop found in the kidney tubule used to regulate the water and salt concentration of the blood.

Medulla - The inner region of the kidney consisting of renal pyramids made up of nephrons.

Negative feedback - The product of a process that counteracts change to maintain an equilibrium around a normal level.

Nephron - The basic functional unit of the kidney.

Osmoreceptor - A type of receptor found in the hypothalamus which can detect the water concentration of blood plasma to maintain an appropriate water balance in the body.

Osmoregulation - The homeostatic regulation of the osmotic pressure of body fluids.

Pancreas - An organ which has both exocrine and endocrine functions and is involved in both digestion and the homeostatic control of blood glucose levels.

Parasympathetic nervous system - A branch of the autonomic nervous system that is active under normal, resting conditions. It inhibits effectors, slowing down activity.

Peripheral nervous system - Pairs of nerves that originate from the CNS and carry nerve impulses into and out of the CNS. It is divided into the sensory nervous system and motor nervous system.

Peroxidases - A group of enzymes which catalyse reactions when hydrogen peroxide is present.

pH - A logarithmic scale used to measure the relative acidity/ alkalinity of a substance. It is calculated using the formula:

$$pH = -\log_{10}[H+]$$

Pituitary gland - A small, hormone-producing gland located at the base of the brain. It is divided into two regions, the anterior pituitary and the posterior pituitary.

Posterior pituitary gland - The region of the pituitary gland that stores and secretes hormones (such as ADH) produced by the hypothalamus.

Protein kinase A - An enzyme involved in the control of blood glucose concentration that modifies other proteins by phosphorylating them. Its activity depends on cellular concentrations of cAMP.

Proximal convoluted tubule (PCT) - The twisted portion of the nephron between the renal capsule and the loop of Henle. Its walls consist of epithelial cells that are adapted for the reabsorption of glucose and water into the blood.

Receptor - A specialised structure that detects a specific type of stimulus.

Renal arteries - Blood vessels that carry oxygenated blood to the kidneys.

Renal pelvis - The central region of the kidney that serves as a funnel for the flow of urine into the ureter.

Renal veins - Blood vessels that drain the kidneys.

Second messenger model - The mechanism by which a hormone (e.g. adrenaline or glucagon) has an effect inside a cell by triggering the production of a second messenger such as cAMP.

Selective reabsorption - The selective reuptake of useful substances (small molecules and ions) in the proximal convoluted tubule using membrane transport proteins.

Somatic nervous system - A branch of the nervous system that carries impulses to the skeletal muscles. It controls voluntary activities.

Stimulus - An internal or external change or factor which triggers a response.

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

Sympathetic nervous system - A branch of the autonomic nervous system that is active under stressful conditions. It stimulates effectors, speeding up activity.

Tissue fluid - A liquid formed when hydrostatic pressure at the arteriole end of a capillary bed forces fluid out into the surrounding tissue.

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.

Ultrafiltration - The removal of small molecules, water and ions from the blood in the glomerulus of the kidney at high pressure.

Urea - A diamide produced from ammonia when proteins are broken down.

Urea cycle - The cycle of reactions responsible for producing urea from ammonia for detoxification and excretion.

Ureter - A tube that carries urine to the bladder from the kidneys.

Urine - A waste liquid containing urea. It flows through the kidneys, which regulate its water content, and is stored in the bladder before excretion.

Water potential - A measure of the tendency of water molecules to move from one area to another measured in kilopascals (kPa) and given the symbol Ψ.