

# OCR (B) Biology A-level

## Topic 5.3 - Homeostasis

### Definitions and Concepts

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### 5.3.1 The principles and importance of homeostasis

**Acetylcholine** - A type of neurotransmitter that is used for communication between neurons.

**Adrenaline** - A hormone that is secreted by the adrenal glands under stressful conditions. It serves as a 'primary messenger', activating adenylyl cyclase.

**Axillary temperature** - A noninvasive but slow measure of core temperature taken by placing a thermometer under the armpit.

**Blood glucose concentration** - The level of glucose in the blood is maintained around 4 - 7 mmol/L after fasting and 8.5 - 9 mmol/L two hours after eating.

**Blood pressure** - Pressure exerted on circulatory vessels by the blood.

**Climate change** - Long-term changes in usual weather and temperature patterns.

**Core body temperature** - The temperature of the body's internal environment, which is maintained at 36 - 37.5°C in humans.

**Diastolic blood pressure** - Systemic blood pressure during diastole, which is usually 60 - 80mmHg.

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

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

**Fever** - A hyperthermic state in which the body's 'set point' for optimum temperature rises and core body temperature increases above 38.5°C.

**Fuel poverty** - Inability to afford adequate heating.

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

**Hyperthermia** - When core body temperature increases above the usual range. Symptoms include nausea, muscle cramps, dizziness, and potentially seizures or coma.

**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.

**Hypothermia** - When core body temperature decreases below the usual range. Symptoms include shivering, cold skin, slurred speech, passing out, and slow, shallow breaths.

**Metabolic rate** - The amount of energy used for chemical reactions in the body per unit time.

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



**Oral temperature** - A measurement of core temperature taken by placing a thermometer under the tongue.

**Oxytocin** - A peptide hormone secreted by the hypothalamus in response to uterine contractions. It triggers a positive feedback response.

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

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

**Positive feedback** - A process which causes an increase in change away from the normal.

**Receptor** - Specialised structure that detects a specific type of stimulus.

**Rectal temperature** - A reliable measurement of core temperature taken by inserting a thermometer into the rectum.

**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.

**Systolic blood pressure** - Systemic blood pressure during ventricular systole, which is usually 90 -120mmHg.

**Thermoregulation** - The homeostatic maintenance of a stable core temperature in endotherms.

**Thermoregulatory centre** - The region of the hypothalamus which coordinates a response to impulses from thermoreceptors.

**Thyroxine** - A hormone secreted by the thyroid gland that increases metabolic rate.

**Tympanic temperature** - A measurement of core temperature taken by inserting a thermometer in the ear which is quick but somewhat unreliable since repeated readings may vary.

**Vasoconstriction** - Contraction of muscle in arterioles narrows their lumen.

**Vasodilation** - Relaxation of muscle in arterioles widens their lumen.

### **5.3.2 The hormonal control of blood glucose and the management of diabetes**

**Alpha cells ( $\alpha$  cells)** - Cells found in the pancreas which secrete glucagon into the blood to raise glucose concentration.

**Beta cells ( $\beta$  cells)** - Cells found in the pancreas which secrete insulin into the blood to lower glucose concentration.



**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.

**Endocrine gland** - Groups of specialised cells which produce and secrete hormones.

**Fasting blood glucose test** - A test for diabetes which measures blood glucose concentration after fasting. Diabetes is characterised by a fasting plasma glucose concentration  $\geq 7.0$  mmol/l or a fasting whole blood glucose concentration  $\geq 6.1$  mmol/l.

**Glucagon** - A hormone secreted by alpha cells ( $\alpha$  cells) in the pancreas. It increases blood glucose concentration.

**Glucose tolerance testing** - A test for diabetes in which 75g of anhydrous glucose is administered orally. If plasma glucose concentration  $\geq 11.1$  mmol/l after two hours, the patient has diabetes.

**Glycosylated haemoglobin concentration** - A measure which provides an average of blood glucose concentration for the previous 60 days. Healthy patients have values in the range 4.5% - 6.0%.

**Glycosylation** - The formation of a covalent bond between blood glucose and red blood cells.

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

**Islets of Langerhans** - Regions of the pancreas which contain  $\alpha$  and  $\beta$  cells.

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

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

**Podiatrist** - A healthcare professional who specialises in care of the foot and lower limb. Podiatrists are involved in diabetes care to manage and prevent foot ulcers caused by nerve damage and poor circulation.

**Polydipsia** - Excessive thirst.

**Polyuria** - Production of abnormally large volumes of urine (above 2.5L).

**Secondary 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.

**Type 1 diabetes** - An autoimmune disorder in which the beta cells are destroyed and the pancreas fails to produce sufficient insulin which is characterised by uncontrolled high blood glucose levels.



**Type 2 diabetes** - A type of diabetes where the body fails to produce enough insulin or when the pancreas no longer reacts to insulin which can be caused by a poor diet and a lack of exercise.

### **5.3.3 Kidney functions and malfunctions**

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

**Adrenal glands** - Glands which are located on the top of the kidneys and produce adrenaline and steroid hormones.

**Aldosterone** - A steroid hormone produced by the zona glomerulosa of the adrenal glands in the presence of angiotensin which promotes  $\text{Na}^+$  reabsorption in the collecting ducts.

**Amino acid** - The monomers containing an amino group ( $\text{NH}_2$ ), a carboxyl group ( $\text{COOH}$ ) and a variable R group that make up proteins.

**Angiotensin** - A protein which increases blood pressure by constricting blood vessels, thereby stimulating the secretion of more ADH.

**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.

**Bladder** - An organ located below the kidneys which stores urine before excretion.

**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.

**Cortex** - The region of the kidney between the renal capsule and the medulla.

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

**Deamination** - Deaminase enzymes in the liver and (to a lesser extent) the kidneys remove an amino group ( $\text{NH}_2$ ) from a molecule as part of the urea cycle.

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

**Erythropoietin (EPO)** - A hormone produced and secreted by the kidneys which stimulates bone marrow to produce red blood cells.

**Excretion** - The process of removing metabolic waste from an organism.



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

**Haemodialysis** - A treatment for kidney failure which involves removing blood from veins and pumping it through a machine. Blood runs countercurrent to dialysis fluid, separated by an artificial membrane.

**Kidney** - Organ involved in blood filtration and urine excretion. It produces EPO and renin.

**Kidney stones** - Hard mineral deposits that can lead to kidney failure.

**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 innermost region of the kidney.

**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.

**Peritoneal dialysis** - A treatment for kidney failure which involves putting dialysis fluid into the peritoneum. Exchange of molecules happens across the body's own peritoneal membrane.

**Posterior pituitary gland** - The region of the pituitary gland that stores and secretes hormones produced by the hypothalamus.

**Renal artery** - The artery that supplies the kidney.

**Renal vein** - The vein that drains the kidney.

**Renal pelvis** - The entrance from the kidney into the ureter.

**Renal pyramids** - Subdivisions of the medulla.

**Renin** - An enzyme produced and secreted by cells around the renal afferent arteriole which converts the precursor peptide angiotensinogen into its active form, angiotensin.

**Reproductive cloning** - The process of artificially producing an organism that is genetically identical to another.

**Selective reabsorption** - The selective reuptake of useful substances along the kidney nephron using membrane transport proteins.

**Stem cell** - A type of undifferentiated cell which has the ability to divide many times and differentiate into many different cell types.



**Therapeutic cloning** - Cloning somatic cells produces healthy cells to replace diseased tissues.

**Transplant surgery** - A long-term solution for organ failure which involves replacing a deceased organ with an organ from a healthy donor.

**Ultrafiltration** - The removal of small substances from the blood through the pressure created by the structure of the kidney nephron.

**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** - The tube which transports urine from the renal pelvis to the bladder.

**Urine** - A liquid produced by the kidneys which consists mainly of water, urea and variable concentrations of metabolic waste products.

