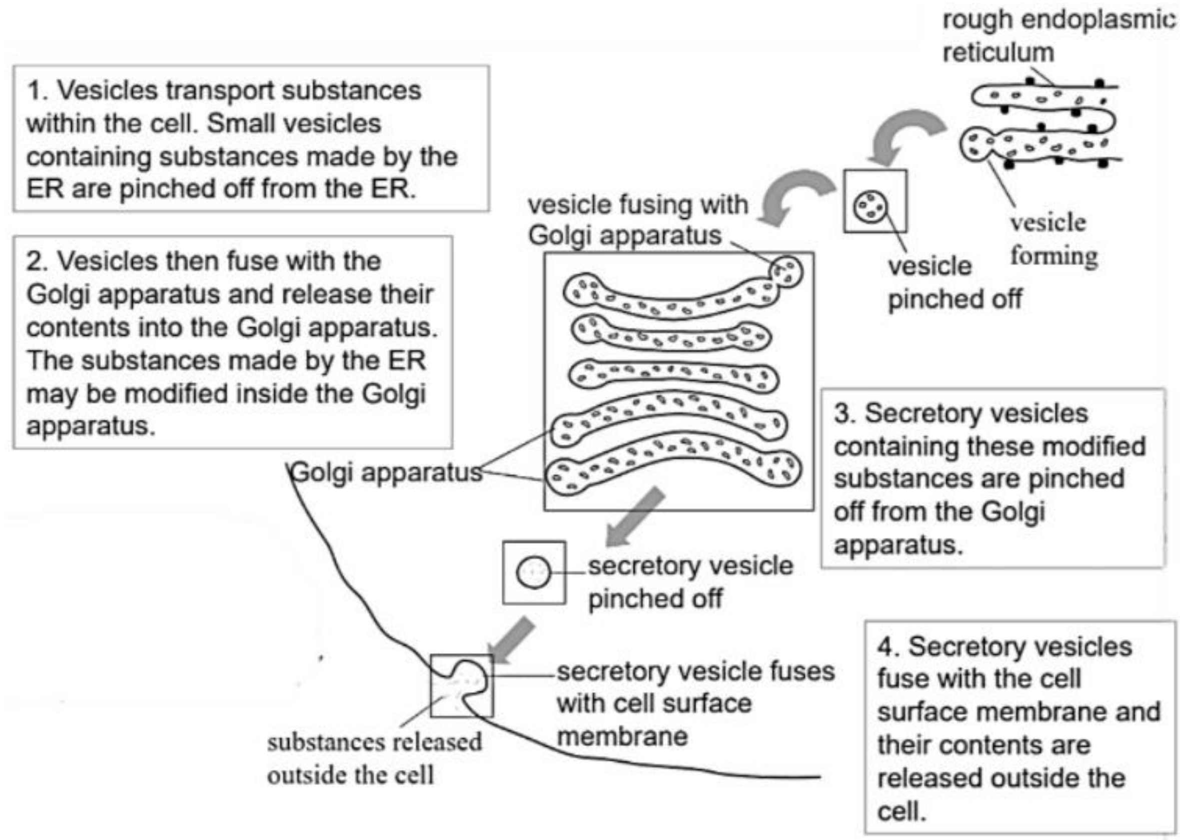
Biology – Essay questions

Chapter 2: Cells

Secretion of proteins out of cell

1. Rough endoplasmic reticulum synthesises proteins
2. Small vesicles containing proteins pinched off from RER
3. Vesicle fuse with Golgi apparatus, release contents into Golgi apparatus
4. Golgi apparatus carries out chemical modifications to proteins
   1) sort and chemically modify substances made by ER
   2) store and package substances in vesicles to be secreted out
5. Secretory vesicles containing modified proteins, pinched off from Golgi apparatus
6. Vesicles move to cell surface membrane and fuse with CSM, release contents outside cell



Differences between plant and animal cells

Structure	Animal cell	Plant cell
1. **Cell wall**	present	absent
2. **Chloroplast**	present	absent
3. **Vacuole**	one / a few large, central permanent	small many temporary
4. Centriole	present	absent

Adaptation of specialised cells

Cell	Adaptation
1. **Red blood cell**	1) Contain haemoglobin: bind with oxygen reversibly in lungs → oxyhaemoglobin + transport oxygen 2) Lack nucleus: pack more haemoglobin + transport more oxygen per unit time 3) Circular biconcave shape: increase SA:V + oxygen diffuse at faster rate
2. **Xylem vessel**	1) Lack cross walls, protoplasm: water & mineral salts move faster & easily through hollow lumen 2) Lignin: strengthen walls, prevent collapse 3) Vessels bundled: provide mechanical support
3. **Root hair cell**	1) Long narrow outgrowths: increase SA:V + faster rate of absorption of water & dissolved mineral salts 2) Thin cell walls: higher rate of uptake of water & dissolved mineral salts 3) Partially permeable membrane: " " 4) Absence of cuticle layer: " "

Chapter 3: Movement of Substances

Definition of diffusion, osmosis and active transport

Diffusion	Osmosis	Active transport
Net movement of substances: region of higher → lower concentration	Net movement of water molecules: solution of higher → lower water potential	Movement of particles: region of lower → higher concentration
X membran	√ PPM	√ membrane with channel / carrier proteins
• Speed of diffusion decreases as diffusion proceeds • Particles move in all directions but net movement is towards region of lower concentration • Equilibrium is reached when average motions of particles are same in all directions but particles have not stopped moving (dynamic state)	• Continues until ratio of water molecules to solute molecules on both sides of membrane are equal • Size of solute particles does not affect osmosis	•
• Movement: high → low conc • Energy not required	• Movement: high → low conc • Energy not required	• Movement: low → high conc • Energy required

Changes in water potential affect animal and plant cells

Water potential	Animal cells (cytoplasm)	Plant cells (vacuole)
Increase above norm	expand and burst	turgid
Decrease below norm	shrink and cremate	flaccid and plasmolysed

Chapter 4: Nutrients

Functions of food, water, carbohydrates, fats and proteins

Substance	Functions
1. **Food**	1) Provide energy 2) Provide raw materials to make new protoplasm 3) Stay healthy
2. **Water**	1) Solvent for chemical reactions 2) Main component of protoplasm & body fluids 3) Regulate body temperature 4) Transport dissolved substances within body
3. **Carbohydrates**	1) Substrate for respiration, provide energy for cellular activities 2) Form supporting structures 3) Converted into organic compounds 4) Form nucleic acids 5) Synthesise lubricants 6) Synthesise nectar
4. **Fats**	1) Source + store energy 2) Prevent excessive heat loss (insulating layer) 3) Solvent for fat-soluble vitamins 4) Essential part of protoplasm 5) Reduce water loss from skin surface (form hydrophobic layer to prevent water from evaporating)
5. **Proteins**	1) Synthesise new protoplasm (growth + repair worn-out body cells) 2) Synthesise enzymes + hormones 3) Form antibodies

Tests for presence of nutrients

Benedict's test

[Name] Use Benedict's test

[Subst] to test for the presence of reducing sugars in the food sample.

[Steps]
1. Place the food sample into a test tube.
2. Add 2 cm^3 of Benedict's solution into the test tube.
3. Shake the mixture thoroughly.
4. Boil the test tube in a water bath.

[Result] If a brick-red precipitate is formed, reducing sugar is present.
If the mixture remains blue, reducing sugar is absent.

Iodine test

[Name] Use iodine test

[Subst] to test for the presence of starch in the food sample.

[Steps]
1. Add a few drops of iodine solution to the food sample.

[Result] If the iodine solution turns blue-black, starch is present.
If the iodine solution remains brown, starch is absent.

Ethanol emulsion test

[Name] Use ethanol emulsion test

[Subst] to test for the presence of fats in the food sample.

[Steps] Liquid food sample
1. Place the food sample in a test tube.
2. Add 2 cm^3 of ethanol into the test tube.
3. Shake the mixture thoroughly.
4. Add 2 cm^3 of water into the test tube and shake thoroughly.

Solid food sample
1. Grind the food sample and place it into a test tube.
2. Add 2 cm^3 of ethanol into the test tube.
3. Shake the test tube thoroughly and allow solid particles to settle.
4. Decant ethanol into a test tube filled with 2 cm^3 of water.

[Result] If a cloudy white emulsion is formed, fats are present.
If the solution remains clear, fats are absent.

Biuret test

[Name] Use biuret test

[Subst] to test for the presence of proteins in the food sample.

[Steps]
1. Place 2 cm^3 of food sample into a test tube.
2. Add 2 cm^3 of sodium hydroxide solution into the test tube.
3. Add copper(II) sulfate drop by drop, and shake thoroughly after every drop.

OR

1. Place 2 cm^3 of food sample into a test tube.
2. Add 2 cm^3 of biuret solution to the test tube.
3. Shake the mixture thoroughly.

[Result] If the mixture turns violet, proteins are present.
If the mixture remains blue, proteins are absent.

Chapter 5: Enzymes

Characteristics of enzymes

A1: Speed up chemical reactions

A2: Providing an alternative pathway with lower activation energy through formation of enzyme-substrate complex.

B1: Required in minute amounts

B2: Reusable as enzymes remain chemically unchanged at the end of a reaction. Thus, a small amount of enzymes can catalyse a large number of chemical reactions.

C1: Highly specific

C2: Specificity of each enzyme is due to its three-dimensional shape of the active site, which can only fit a certain substrate.

D1: Catalyse reversible reactions

D2: Some enzyme-catalysed reactions in living cells are reversible.
For example, the formation of carbonic acid from carbon dioxide and water catalysed by the enzyme carbonic anhydrase.

Mode of action of enzymes

1. During an enzyme-catalysed reaction, the enzyme provides an alternative pathway with a lower activation energy needed for the reaction to occur.
2. Here, the substrate is like a key while the enzyme is like a lock according to the 'lock-and-key' hypothesis.
3. The substrate binds to the active site, which is complementary in three-dimensional shape to the substrate to form an enzyme-substrate complex.
4. In the enzyme-substrate complex, bonds in the substrate are broken in catabolic reactions to form new products. Bonds are formed between substrates in anabolic reactions to form a new product.
5. The products then detach from the active site of the enzyme.
6. The enzyme remains chemically unchanged and is free to catalyse a new round of reaction.

Effect of temperature on rate of reaction

When temperature is low, rate of enzyme-catalysed reaction is low.

- Kinetic energy of molecules is low.
- Chance of substrate molecules colliding with enzyme + fitting into active sites is very low.
- Rate of formation of enzyme-substrate complex is low.
- Enzyme is inactive.

When temperature increases, rate of enzyme-catalysed reaction increases.

- Kinetic energy of molecules increases.
- Chance of substrate molecules colliding with enzyme + fitting into active sites increases.
- Rate of formation of enzyme-substrate complex increases.

At optimum temperature, rate of enzyme-catalysed reaction is highest.

- Kinetic energy of molecules is at its highest.
- Chance of substrate molecules colliding with enzyme + fitting into active sites is at its highest.
- Rate of formation of enzyme-substrate complex is at its highest.
- Enzyme is most active.

When temperature increases above optimum temperature, rate of enzyme-catalysed reaction rapidly decreases.

- High temperature breaks the bonds that keep the enzyme protein in shape.
- Active site of enzyme loses it three-dimensional shape.
- Substrate molecules can no longer fit into the active site.
- As temperature continues to increase, rate of denaturation increases until the enzyme is completely denatured.

Chapter 6: Nutrition in Humans

Peristalsis

Circular muscles contract + longitudinal muscles relax
- Lumen of alimentary canal becomes narrower
- Length of alimentary canal becomes longer
- Food substances are pushed along the gut

Circular muscles relax + longitudinal muscles contract
- Lumen of alimentary canal becomes wider
- Length of alimentary canal becomes shorter
- Food substances are allowed to enter the region

Digestive enzymes

Region	Source	Enzyme	Hydrolysis	Nutrient
Mouth	Salivary gland	salivary amylase	Starch → maltose	C
Stomach	Gastric gland	pepsin	Protein → polypeptides	P
Small intestine	Liver	bile		F
	Pancreas	pancreatic amylase	Starch → maltose	C
		pancreatic lipase	Fats → fatty acid + glycerol	F
		pancreatic trypsin	Protein → polypeptides	P
	Intestinal gland	intestinal maltase	Maltose → glucose + glucose	C
		intestinal lactase	Lactose → glucose + galactose	C
		intestinal sucrase	Sucrose → glucose + fructose	C
		intestinal lipase	Fats → fatty acid + glycerol	F
		intestinal peptidases	Polypeptides → amino acids	P

Adaptation of small intestine

A1: Numerous microvilli on epithelial cells

A2: to increase surface area of small intestine

A3: for faster rate of absorption of digested nutrients from lumen of SI → villus

B1: Epithelium of villus is one cell thick

B2: to reduce diffusion distance between lumen of SI & villus

B3: for faster rate of absorption …

C1: Villus has a dense blood capillary network

C2: to transport digested nutrients away quickly + continuously to maintain steep concentration gradient of digested nutrients between lumen of SI & villus

C3: for faster rate of absorption …

D1: Small intestine is about 6 metres long.

D2: Digested nutrients can travel through the small intestine for a longer time

D3: to provide sufficient time for increased absorption of digested nutrients …

E1: Epithelial cells have numerous mitochondria.

E2: This increases rate of cellular respiration

E3: to increase release of energy for increased rate of active transport of digested nutrients from lumen of SI → villi

Functions of liver

A1: Regulate blood glucose concentration

A2: When blood glucose concentration is higher than normal,
- islets of Langerhans in pancreas secrete more insulin
- to stimulate liver cells to convert excess glucose into glycogen, to be stored in liver and muscle cells,
- decreasing blood glucose concentration back to normal.

A3: When blood glucose concentration is lower than normal,
- islets of Langerhans in pancreas secrete more glucagon
- to stimulate liver cells to convert stored glycogen, then glucose molecules diffuse into bloodstream,
- increasing blood glucose concentration back to normal.

B1: <u>Secrete bile</u>

B2: Bile secreted is stored temporarily in the gall bladder before use during emulsification of fats.

C1: <u>Store iron</u>

C2: Worn out red blood cells are destroyed in the spleen.
Haemoglobin from these red blood cells is transported to the liver and broken down to release iron stored in the liver, and produce bile pigments.

D1: <u>Synthesise protein</u>

D2: Ribosomes in liver cells synthesise proteins such as prothrombin and fibrinogen from amino acids.

E1: <u>Deaminate amino acids</u>

E2: Deamination is the process where amino groups are removed from amino acids and converted to urea.

E3: Amino groups are converted into toxic ammonia, which is then converted to urea. Urea is excreted in urine.

E4: Carbon residue is converted to glucose and oxidised during cellular respiration to release energy. Excess glucose is converted to glycogen and stored in the liver.

F1: <u>Detoxification</u>

F2: Harmful substances are converted to harmless products.

F3: Alcohol is converted into toxic acetaldehyde by the enzyme alcohol dehydrogenase.
Acetaldehyde is then converted into non-toxic acetic acid by the enzyme acetaldehyde dehydrogenase.

F4: Acetic acid is broken down to release energy, and is further processed to form glucose which is oxidised during cellular respiration to release energy for cellular activities.

Chapter 8: Transport of Humans

Blood groups

		Donor (antigen)			
		A (A)	B (B)	AB (A + B)	O (-)
Recipient (antibody)	A (b)	✓	✗	✗	✓
	B (a)	✗	✓	✗	✓
	AB (-)	✓	✓	✓	✓
	O (a + b)	✗	✗	✗	✓

Blood clotting mechanism

1. Damaged tissues + platelets produce thrombokinase.
2. In the presence of calcium ions, inactive prothrombin is converted to active thrombin by the enzyme thrombokinase.
3. Soluble fibrinogen is converted to insoluble fibrin by the enzyme thrombin.
4. Fibrin threads entangle red blood cells, causing the whole mass to form a clot which seals the wound.
5. This prevents excessive loss of blood and prevents foreign particles from entering the bloodstream.

Adaptation of blood capillaries – site for exchange of materials b/w blood & tissue

A1: Blood capillary walls are made up of a single layer of flattened endothelium.

A2: This reduces the diffusion distance,

A3: thus increasing the rate of diffusion of substances.

B1: Repeated branching of the blood capillaries

B2: increases the total cross-sectional area and lowers the blood pressure. Blood flow is slowed down, allowing more time for the exchange of substances between blood and tissue cells.

B3: The numerous branches provide a large surface area for the exchange of substances b/w blood and tissue cells.

Differences between arteries and veins

Aspect	**Artery**	**Vein**	**Blood capillary**
Structure	Thick, elastic muscular walls	Thin, less elastic muscular walls	One cell thick, non-elastic endothelium
Function	Carry blood away from heart	Carry blood towards heart	Connect artery to vein
	Carry oxygenated blood (except pulmonary)	Carry deoxygenated blood (except pulmonary)	Oxygenated (arteriole end) → deoxygenated (venule end)
Blood flow	High blood pressure	Low blood pressure	Blood pressure reduced

Bell-shaped red blood cells

A1: <u>Diameter</u> of red blood cells is reduced

A2: to allow red blood cells to pass through lumen of capillaries more easily.

B1: <u>Surface area to volume ratio</u> is increased

B2: to speed up absorption and release of oxygen between red blood cells and bloodstream

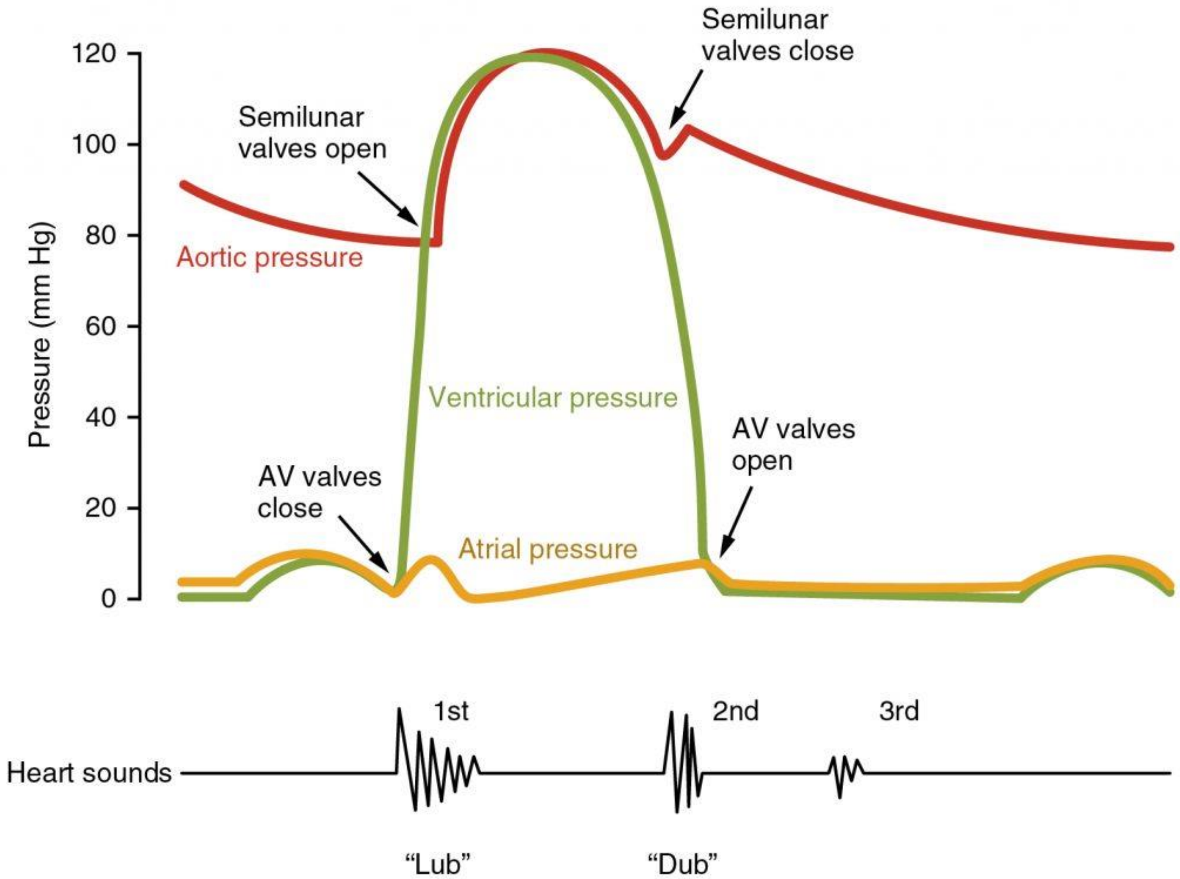
C1: <u>Rate of blood flow</u> is reduced as red blood cells move through the lumen of blood capillaries in a line, one behind the other

C2: for more time and increased efficiency of exchange of materials between blood and tissue cells

Cardiac cycle

1. Muscular walls of the left atrium contract, increasing atrial pressure. Blood is forced from the left atrium into the relaxed left ventricle.
2. Muscular walls of the left ventricle contract, increasing ventricular pressure. When blood pressure in the left ventricle is higher than that in the left atrium, bicuspid valves are forced close to prevent backflow of blood.
3. Muscular walls of the left ventricle continue to contract, increasing ventricular pressure. When blood pressure in the left ventricle is higher than that in the aorta, semilunar valves are forced open. Blood is forced from the left ventricle into the aorta.
4. Then, muscular walls of the left ventricle relax, decreasing ventricular pressure. When blood pressure in the left ventricle is lower than that in the aorta, semilunar valves are forced close to prevent backflow of blood.
5. Muscular walls of the left ventricle continue to relax, decreasing ventricular pressure. When blood pressure in the left ventricle is lower than that in the left atrium, bicuspid valves are forced open. Blood is forced from the left atrium into the left ventricle, and the whole cardiac cycle repeats.

Graph of pressure changes in heart



Chapter 10: Respiration in Humans

Difference between aerobic and anaerobic respiration

Aspect	**Aerobic respiration**	**Anaerobic respiration**
Oxygen	present	absent
Product	carbon dioxide, water	lactic acid
Energy	large quantity	small quantity
Equation	glucose + oxygen → carbon dioxide + water + large quantity of energy	glucose → lactic acid + small quantity of energy

Oxygen debt

- During vigorous exercise, muscular contractions increase.
- Body requires more energy. A lot more oxygen + glucose is required to reach respiring cells. Increased breathing rate increases the rate of oxygen intake. More oxygen is used for increased rate of respiration for increased release of energy, meeting needs of the body for more energy.
- When more energy is required and oxygen supply is insufficient for aerobic respiration to take place, muscle cells carry out anaerobic respiration, releasing lactic acid as a byproduct.
- Accumulation of lactic acid causes fatigue and muscle pain.
- Oxygen debt: extra oxygen required to remove lactic acid
- The oxygen uptake remains high after the exercise to provide more oxygen to the muscles, to repay the oxygen debt.
- As the muscles respire anaerobically, lactic acid is produced.
- Lactic acid will be removed from the muscles and transported to the liver.
- In the liver, lactic acid is oxidised to release energy. The energy is used to convert remaining lactic acid to glucose, which is transported back to muscles.

Adaptations of alveoli

A1: Numerous alveoli

A2: provide a large surface area for the exchange of gases,

A3: increasing rate of diffusion of gases in and out of the lungs across alveoli.

B1: The alveolar wall is one cell thick,

B2: providing a short diffusion distance for gases

B3: for faster rate of diffusion of gases in and out of the lungs across alveoli.

C1: A thin film of moisture covers the alveolar wall,

C2: allowing gases to dissolve when diffusing across alveolar wall.

D1: Alveolar walls are richly supplied with blood capillaries

D2: so that blood is carried away quickly and continuously between lungs and tissue cells

D3: to maintain a steep concentration of gases between blood and air in the alveoli

Inhalation process

(1) Diaphragm muscles contract, causing the diaphragm to flatten.

(2) External intercostal muscles contract, and internal intercostal muscles relax.

(3) Ribs move upwards and outwards; sternum moves up and forward.

(4) Volume of thoracic cavity increases. Lung expands, increasing in volume and air pressure in lungs decreases.

(5) Atmospheric pressure is higher than air pressure within lungs.
Atmospheric air is forced in from the exterior environment into the lungs.

Exhalation process

(1) Diaphragm muscles relax, causing the diaphragm to arch upwards.

(2) External intercostal muscles relax, and internal intercostal muscles contract.

(3) Ribs move downwards and inwards; sternum moves back down.

(4) Volume of thoracic cavity decreases. Lung is compressed, decreasing in volume and air pressure in lungs increases.

(5) Air pressure within lungs is higher than atmospheric pressure.
Atmospheric air is forced out from the lungs into the exterior environment.

Chapter 11: Excretion in Humans

Formation of urine

1. Ultrafiltration
2. Selective reabsorption

Ultrafiltration

(1) High hydrostatic blood pressure in the glomerulus
- is caused by the afferent arteriole being wider than the efferent arteriole.
- Substance in blood plasma is forced out of the glomerulus into the Bowman's capsule.

(2) Partially permeable basement membrane
- forces molecules smaller than pores of basement membrane out of the glomerulus into Bowman's capsule (e.g. water, glucose, amino acids, dissolved mineral salts, nitrogenous waste products)
- does not force molecules larger than pores of basement membrane out of the glomerulus into Bowman's capsule, which retain in blood (e.g. blood cells, platelets, fats)

Selective reabsorption

(1) Since the body cannot afford to lose too much water, glucose and other useful substances, these substances are selectively absorbed into the bloodstream.

(2) In the proximal convoluted tubule, most of the filtrate is reabsorbed from lumen of renal tubule into blood capillaries, including glucose molecules, amino acid molecules and dissolved mineral salts through diffusion and active transport, water molecules through osmosis.

In the loop of Henle, some water molecules are reabsorbed from lumen of renal tubule into blood capillaries through osmosis.

In the distal convoluted tubule, some dissolved mineral salts are reabsorbed from lumen of renal tubule into blood capillaries through active transport and diffusion.

In the collecting duct, some water molecules are reabsorbed from lumen of renal tubule into blood capillaries through osmosis.

(3) The remaining fluid in the renal tubule is transported from the collecting duct to the renal pelvis, thus forming urine.

Osmoregulation

Large intake of water

(1) Stimulus: Water potential in blood plasma increases above normal.

(2) Receptor: Hypothalamus in the brain detects the stimulus and is stimulated.

(3) Effector: Pituitary gland releases less antidiuretic hormone (ADH) into the bloodstream.

(4) Effect: Cells in walls of collecting ducts become less permeable to water molecules.
Less water molecules are selectively reabsorbed from the lumen of collecting duct into the bloodstream.
More water is present in the collecting duct.

(5) Outcome: Larger volume of more diluted urine is produced.
Water potential of blood plasma returns to normal.

Large loss of water

(1) Stimulus: Water potential in blood plasma decreases below normal.

(2) Receptor: Hypothalamus in the brain detects the stimulus and is stimulated.

(3) Effector: Pituitary gland releases more antidiuretic hormone (ADH) into the bloodstream.

(4) Effect: Cells in walls of collecting ducts become more permeable to water molecules.
More water molecules are selectively reabsorbed from the lumen of collecting duct into the bloodstream.
Less water is present in the collecting duct.

(5) Outcome: Smaller volume of more concentrated urine is produced.
Water potential of blood plasma returns to normal.

Dialysis

Dialysis machine

A1: Dialysis fluid contains the same concentration of essential substances as healthy blood.

A2: This sets up a zero concentration gradient of essential substances between the patient's blood and dialysis fluid,

A3: ensuring that essential substances do not diffuse out of blood into dialysis fluid (e.g. glucose, amino acids, dissolved mineral salts).

B1: Dialysis fluid does not contain metabolic waste products.

B2: This sets up a steep concentration gradient of metabolic waste products between the patient's blood and dialysis fluid, B3: so that metabolic waste products diffuse out of the patient's blood into dialysis fluid, thus removed from the patient's blood.

C1: Dialysis tubing is narrow, long and coiled.

C2: This increases surface area to volume ratio of the dialysis tubing,

C3: speeding up the rate of exchange of substances between the patient’s blood and dialysis fluid.

D1: Direction of blood flow is opposite to the flow of dialysis fluid.

D2: This ensures metabolic waste products diffused from the patient’s blood into dialysis fluid are transported away quickly and continuously

D3: to maintain a steep concentration gradient of metabolic waste products between patient’s blood and dialysis fluid, for high rate of removal of waste products from patient’s blood.

E1: Walls of dialysis tubing are partially permeable.

E2: This allows molecules smaller than the pores of the walls of dialysis tubing to diffuse from patient’s blood into dialysis fluid across walls of dialysis tubing (e.g. urea, metabolic waste products),

E3: whereas molecules larger than the pores of the walls of dialysis tubing retain in the dialysis tubing (e.g. blood cells, platelets).

Differences between dialysis and kidney

Dialysis	Kidney
Involves diffusion + osmosis	Involves diffusion + osmosis + active transport
Does not involve ultrafiltration + selective reabsorption	Involves ultrafiltration + selective reabsorption
Pressure provided by dialysis machine	Pressure provided by narrower lumen of efferent arteriole as compared to afferent arteriole
Does not involve any hormone	Involves antidiuretic hormone
Dialysis fluid needed.	Dialysis fluid is not needed. Only glomerular filtrate is required.

Chapter 12: Homeostasis

Regulation of blood glucose concentration

Large intake of glucose

(1) Stimulus: Blood glucose concentration increases above normal

(2) Receptor: Islets of Langerhans in the pancreas detect the stimulus and are stimulated.

(3) Effector: Islets of Langerhans secrete more insulin into the bloodstream. Blood transports insulin to the liver and muscles.

(4) Effect: Insulin increases permeability of cell surface membrane of liver and muscle cells to glucose. Glucose molecules diffuse into these cells more quickly.
Insulin stimulates liver and muscle cells to convert excess glucose into glycogen, which is stored in the liver and muscles.

(5) Outcome: Blood glucose concentration decreases back to normal.

Large loss of glucose

(1) Stimulus: Blood glucose concentration decrease below normal

(2) Receptor: Islets of Langerhans in the pancreas detect the stimulus and are stimulated.

(3) Effector: Islets of Langerhans secrete more glucagon into the bloodstream. Blood transports glucagon to the liver and muscles.

(4) Effect: Glucagon stimulates liver and muscle cells to convert stored glycogen into glucose. From the liver, glucose molecules diffuse out of these cells into the bloodstream.

(5) Outcome: Blood glucose concentration increases back to normal.

Regulation of blood water potential

Large intake of water

(1) Stimulus: Water potential of blood plasma increases above normal

(2) Receptor: Hypothalamus in the brain detects the stimulus and is stimulated.

(3) Effector: Pituitary gland releases less antidiuretic hormone (ADH) into the bloodstream. Less ADH is transported to the kidneys.

(4) Effect: Cells in walls of collecting ducts become less permeable to water molecules. Less water molecules are reabsorbed from lumen of collecting ducts into the bloodstream. More water is excreted out of the body.

(5) Outcome: Larger volume of more diluted urine is produced.
Blood water potential decreases back to normal.

Large loss of water

(1) Stimulus: Water potential of blood plasma decreases below normal

(2) Receptor: Hypothalamus in the brain detects the stimulus and is stimulated.

(3) Effector: Pituitary gland releases more antidiuretic hormone (ADH) into the bloodstream. More ADH is transported to the kidneys.

(4) Effect: Cells in walls of collecting ducts become more permeable to water molecules. More water molecules are reabsorbed from lumen of collecting ducts into the bloodstream. Less water is excreted out of the body.

(5) Outcome: Smaller volume of more concentrated urine is produced.
Blood water potential increases back to normal.

Regulation of body temperature

Hot exterior environment

(1) Stimulus: Body temperature increases above normal.

(2) Receptor: Thermoreceptors are stimulated and send nerve impulses to the hypothalamus. This increase in temperature of blood is detected by hypothalamus. The hypothalamus is stimulated and sends nerve impulses to the relevant body parts.

(3) Effector:

(4) Effect:

Skin arterioles dilate. More warm blood flows through blood capillaries in skin, more heat is carried to skin surface, so more heat is lost into the surroundings through skin by radiation, convection and conduction.

Sweat glands become more active. This increases the rate of production of sweat, thus more water in sweat evaporates from the skin surface, so more latent heat of vaporisation is lost from the body into the surroundings.

(5) Outcome: Heat loss from body into surroundings is increased, thus body temperature decreases back to normal.

Cold exterior environment

(1) Stimulus: Body temperature decreases below normal.

(2) Receptor: Thermoreceptors are stimulated and send nerve impulses to the hypothalamus. This decrease in temperature of blood is detected by hypothalamus. The hypothalamus is stimulated and sends nerve impulses to the relevant body parts.

(3) Effector:

(4) Effect:

Skin arterioles constrict. Less warm blood flows through blood capillaries in skin, less heat is carried to skin surface, so less heat is lost into the surroundings through skin by radiation, convection and conduction.

Sweat glands become less active. This decreases the rate of production of sweat, thus less water in sweat evaporates from the skin surface, so less latent heat of vaporisation is lost from the body into the surroundings.

(5) Outcome: Heat loss from body into surroundings is decreased, thus body temperature increases back to normal.

Chapter 13: The Nervous System

Differences between sensory & motor neurone:

Neurone	Sensory	Motor
Structural	long dendron	short dendron
	short axon	long axon
	cell body irregularly shaped	cell body round
Functional	transmit nerve impulses: receptor → CNS	transmit nerve impulses: CNS → effector

Differences between voluntary action & reflex action

Voluntary action	Reflex action
Receptor may not be necessary as they can be initiated by the brain	Receptors are necessary to generate nerve impulses
Nerve impulses initiated by brain	Nerve impulses generated by receptors
Does not involve sensory neurone	Involves sensory neurone
Different response to same stimulus	Same response to same stimulus
Can be controlled by the will	Cannot be controlled by the will

Pathway of nerve impulses in reflex action

(1) Name + situation	A named reflex action is the knee-jerk reflex. In this reflex action, the leg kicks upwards when the knee is hit with much force.
(2) Stimulus	When an external force is applied on the leg below the kneecap, the pressure applied onto it stretches the upper thigh muscle.
(3) Receptor	The sudden increase in the stretching at the leg is detected by stretch receptors at the thigh muscles, which are stimulated and generate nerve impulses.
(4) SN	Nerve impulses are transmitted along sensory neurones to the relay neurones located in the spinal cord.
(5) CNS + RN +	In the spinal cord, nerve impulses are transmitted first across

synapse	a synapse to the relay neurone, and then across another synapse to the motor neurone through the diffusion of neurotransmitters.
(6) MN	Nerve impulses are then transmitted along motor neurones from the spinal cord to the effector, i.e. the upper thigh muscles in the leg.
(7) effector + response	The upper thigh muscles receive nerve impulses and contract, thus kicking the leg upwards.

Chapter 14: The Human Eye

Pupil reflex

Dark → bright

(1) Stimulus	There is an increase in light intensity.
(2) Receptor	This increase is detected by photoreceptors in the retina, which are stimulated and generate nerve impulses.
(3) SN	Nerve impulses are transmitted to the brain via sensory neurones in the optic nerve.
(4) CNS + RN + synapse	Within the brain, nerve impulses are transmitted across two synapses from sensory neurone to relay neurone, then from relay neurone to motor neurone.
(5) MN	Nerve impulses are transmitted from the brain to circular and radial muscles of the iris along the motor neurone.
(6) effector	Circular muscles in the iris contract, and relay muscles in the iris relax.
(7) effect	The pupil is constricted to prevent excessive amounts of light from entering the eye, which may damage photoreceptors in the retina.

Bright → dark

(1) Stimulus	There is a decrease in light intensity.
(2) Receptor	This decrease is detected by photoreceptors in the retina, which are stimulated and generate nerve impulses.
(3) SN	Nerve impulses are transmitted to the brain via sensory neurones in the optic nerve.
(4) CNS + RN + synapse	Within the brain, nerve impulses are transmitted across two synapses from sensory neurone to relay neurone, then from relay neurone to motor neurone.
(5) MN	Nerve impulses are transmitted from the brain to circular and radial muscles of the iris along the motor neurone.
(6) effector	Circular muscles in the iris relax, and relay muscles in the iris contract.
(7) effect	The pupil is dilated to allow more light to enter the eye to see things more clearly in the dark.

Focusing

Distant object

(1) Stimulus	There is an increase in distance of object to focus on.
(2) Receptor	Light from the object is no longer focused on the retina. The photoreceptors in the retina are stimulated and generate nerve impulses.
(3) SN	Nerve impulses are transmitted to the brain via sensory neurones in the optic nerve.
(4) CNS + RN + synapse	Within the brain, nerve impulses are transmitted across two synapses from sensory neurone to relay neurone, then from relay neurone to motor neurone.
(5) MN	Nerve impulses are transmitted from the brain to ciliary muscles along the motor neurone.
(6) effector	Ciliary muscles relax, tightening their pull on the suspensory ligaments. Suspensory ligaments become taut, tightening their pull on the edge of the lens.
(7) effect	The elastic lens become thinner and less convex, increasing focal length and thus focusing light rays from distant objects on the retina.

Near object

(1) Stimulus	There is an decrease in distance of object to focus on.
(2) Receptor	Light from the object is no longer focused on the retina. The photoreceptors in the retina are stimulated and generate nerve impulses.
(3) SN	Nerve impulses are transmitted to the brain via sensory neurones in the optic nerve.
(4) CNS + RN + synapse	Within the brain, nerve impulses are transmitted across two synapses from sensory neurone to relay neurone, then from relay neurone to motor neurone.
(5) MN	Nerve impulses are transmitted from the brain to ciliary muscles along the motor neurone.
(6) effector	Ciliary muscles contract, relaxing their pull on the suspensory ligaments. Suspensory ligaments slacken, relaxing their pull on the edge of the lens.
(7) effect	The elastic lens become thicker and more convex, decreasing focal length and thus focusing light rays from near objects on the retina.

Chapter 15: Hormones

Effects of hormones

Insulin (islets of Langerhans)

A1: stimulates liver to convert excess glucose to glycogen to be stored in liver and muscle cells, to reduce blood glucose concentration back to norm

B1: increases oxidation of glucose during respiration to release energy

C1: increases permeability of cell membrane of cells of liver and muscles to glucose molecules to increase diffusion of glucose into cells

Glucagon (islets of Langerhans)

A1: Stimulates the liver to hydrolyse glycogen into glucose

B1: Stimulates the liver to hydrolyse fats and amino acids into glucose

C1: Stimulates the liver to hydrolyse lactic acid into glucose

Adrenaline (adrenal gland)

A1: Stimulates the liver to convert glycogen to glucose

A2: so that more glucose is available for a higher rate of respiration to release more energy for vigorous muscular contraction.

B1: Increases metabolic rate

B2: so that more energy released higher rate of respiration

C1: Increases heart rate and blood pressure

C2: so that more oxygen and glucose are transported to muscles for higher rate of respiration to release more energy for vigorous muscular contraction.

D1: Increase rate and depth of breathing

D2: to increase oxygen uptake by lungs to bring more oxygen to muscles for higher rate of respiration to release more energy for vigorous muscular contractions.

E1: Increase rate of blood clotting

E2: so that blood clots faster to prevent excessive blood loss.

F1: Constricts arterioles to the gut and decreases digestive activities

F2: so that more oxygen and glucose can be transported in blood to muscles for higher rate of respiration to release more energy for vigorous muscular contractions.

G1: Constricts arterioles in skin

G2: so that more oxygen and glucose can be transported in blood to muscles for higher rate of respiration to release more energy for vigorous muscular contractions.

H1: Dilates pupils

H2: to enhance vision.

Fight or flight response

1. Stimuli (fear, anger, anxiety, stress, excitement) stimulate hypothalamus. Nerve impulses are generated to the spinal cord via sensory neurone.
2. Adrenal gland is stimulated to produce + secrete adrenaline into the bloodstream.
3. Adrenaline is transported in blood to target organs.
4. Target organs respond to the short term effect of adrenaline.