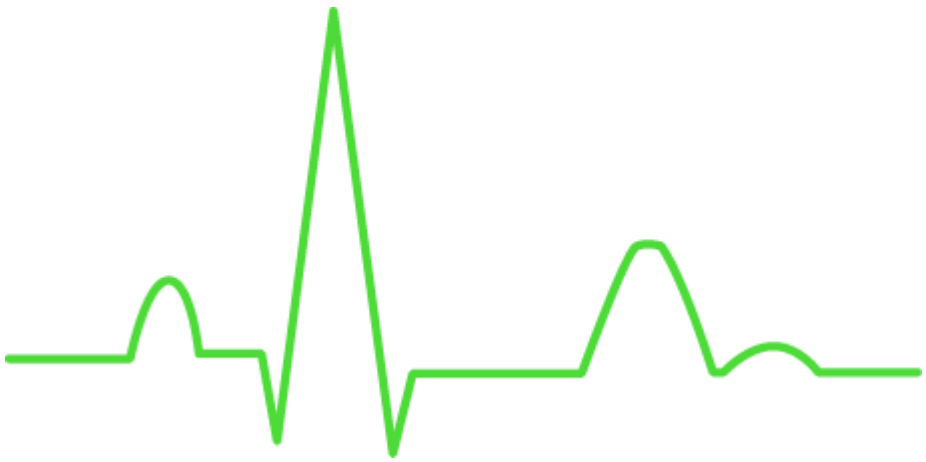
WJEC MEDICAL SCIENCE

UNIT 1

REVISION GUIDE



1.1 Biological Molecules

You need to recognise the following examples of carbohydrates

Monosaccharides

Type of carbohydrate	Example	Key information
Monosaccharides - Triose	Glyceraldehyde	
Monosaccharides - Pentose	Ribose Deoxyribose	Important for making DNA and RNA
Monosaccharides - Hexose	Alpha-Glucose Beta-Glucose Fructose Galactose	Important for making disaccharides. Used by the body for energy.

Disaccharides

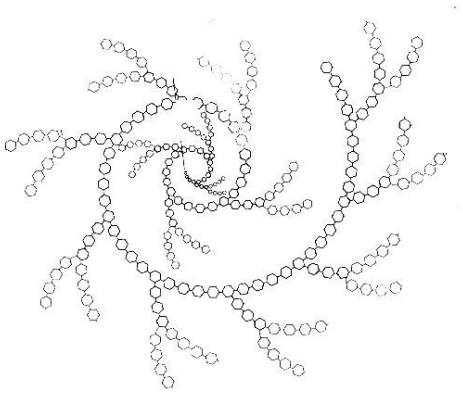
Disaccharide	**Monomer 1**	**Monomer 2**	**Use in living organisms**
Maltose	α-glucose	α-glucose	Product of starch digestion
Sucrose	α-glucose	fructose	Table sugar
Lactose	galactose	α-glucose	Milk sugar

All disaccharides can be hydrolysed into its monomers by enzymes.

Polysaccharides - Glycogen

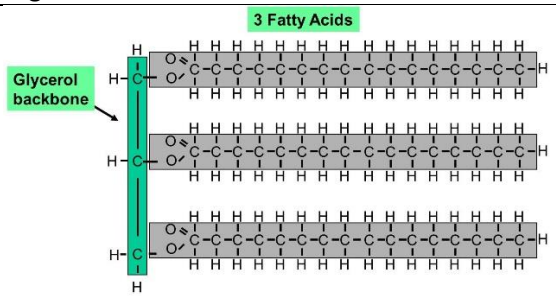
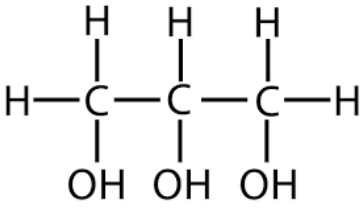
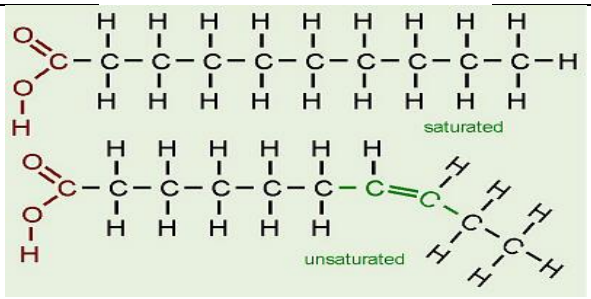
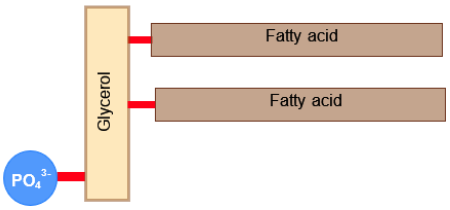
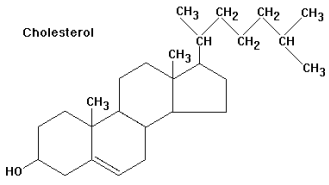
Glycogen is a branched polymer of alpha-glucose.

It is use by the human body as an energy store on muscle and liver cells. As it is branched it can be easily hydrolysed back into alpha-glucose.



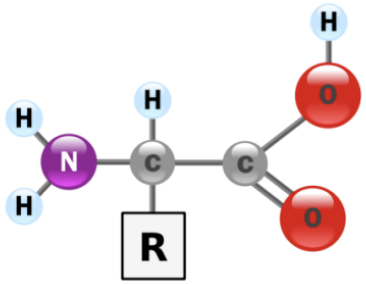
Lipids

This summarises the key points of information you need to know for lipids.

Molecule	Diagram	Key information
Triglyceride		Important for insulation, energy store and protecting delicate organs. Made from glycerol and three fatty acids.
Glycerol		Joins with 3 fatty acids via condensation reactions to form a triglyceride
Fatty Acids		**Saturated** – no carbon-carbon double bonds **Unsaturated-** contains 1 carbon-carbon double bond **Polyunsaturated –** contains 2 or more carbon-carbon double bond
Phospholipid		Hydrophilic – head Hydrophobic -tails Main component of cell membranes. Heads face out, tails face in.
Steroids		All steroids contain 4 rings. Steroids include oestrogen and testosterone which are made from cholesterol. Cholesterols is vial component of cell membranes.

Proteins

You need to be able to label this diagram of an amino acid.



Components of every amino acid:

- Central carbon (C), or **alpha carbon**, to which are attached 4 different chemical groups.
- **NH_2 = Amino group**. A basic group. Attached to the alpha carbon by a covalent bond. It is attached at one end of the molecule, called the N terminal.
- **COOH = Carboxyl group**. An acidic group. This is attached at the other end of the molecule, called the C terminal.
- H = **Hydrogen atom**.
- **R group**= Variable group. This is different in each of the 20 amino acids. It could be as simple as a single hydrogen, (glycine), or more complex groups.

Glycine: R is an H atom. Alanine: R is CH_3 Valine: R is C_3H_7

- The **'R' groups** of amino acids can have quite diverse chemical properties.
- This "R" group can form **disulfide bridges** with other cysteines to create cross linkages in a polypeptide chain.
- This "R" group gives the amino acid its **alkaline or acidic** properties

Amino acids combine to make a **polymer** called a **polypeptide.**
Polypeptides combine to form **proteins.**

Protein Structure

You need to know the 4 levels of Protein structure and the bonds involved

Level	Key features	Bonding
Primary	Sequence of amino acids	Peptide bonds
Secondary	Folding of poly peptide chains into an alpha helix or beta pleated sheet.	Hydrogen bonds
Tertiary	Further folding into a more complex three dimensional structure	Hydrogen bonds Disulphide bonds Ionic bonds Hydrophobic interactions
Quaternary	When two or more polypeptide chains join.	

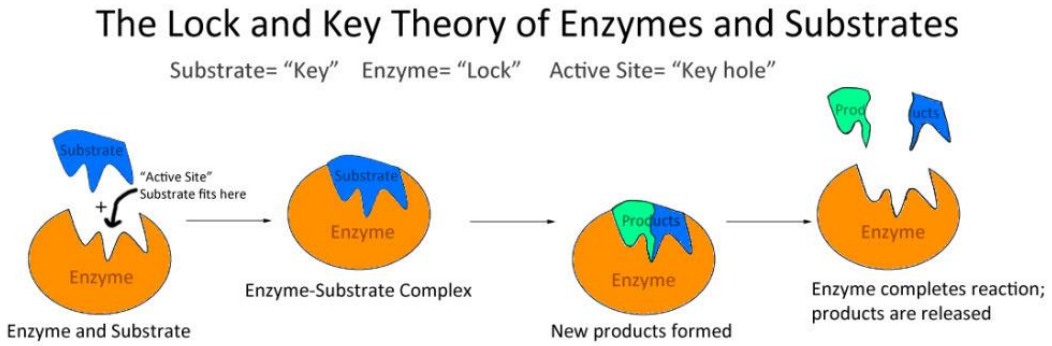
Types of Protein

Depending on the bonding and 3D structure there are two types of protein

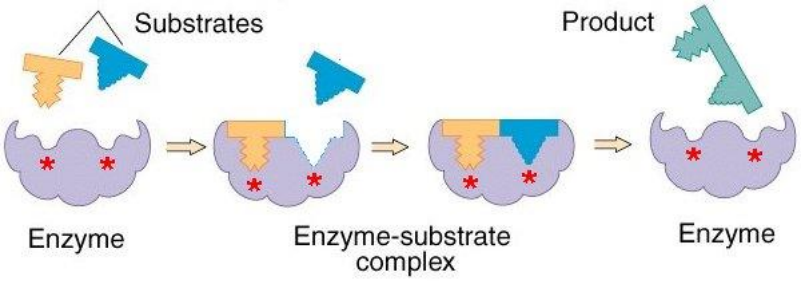
- Globular – soluble spherical molecules with metabolic functions eg) Enzymes
- Structural – insoluble molecules with a structural function eg) keratin

Enzymes

Collision Theory - Enzymes work when they collide with substrate. There are two models on how enzymes work.



Induced Fit

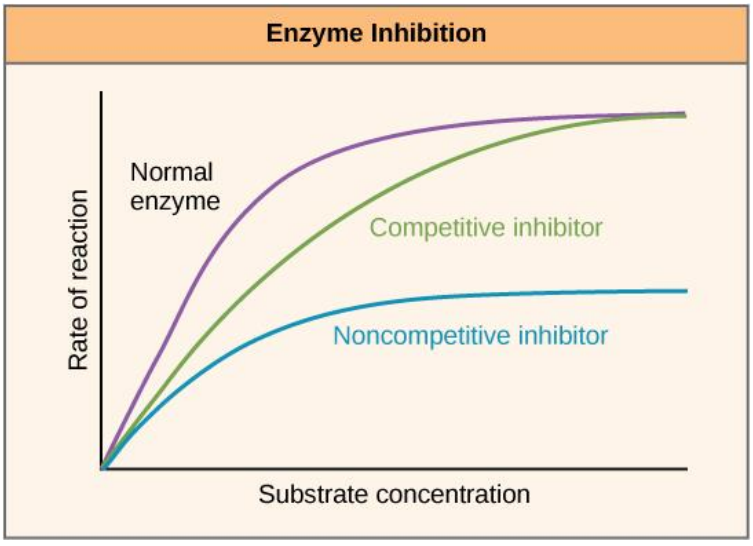


- The substrates bind with the active site on the specific enzyme. The active site has a specific 3D shape as a result of enzyme's tertiary structure
- The active site changes shape around the substrate forming and ESC putting strain on the bonds in the substrate making it easier to make/ break bonds as the activation energy is lowered.
- The product(s) are released from the active site. The active site returns to its original shape.

Factors that affect enzyme activity

You should understand that high temperatures and pH (away from the optimum) alter the three dimensional structure of enzyme molecules. Bonds involved in the tertiary structure may be broken and hence the configuration of the active site is altered, reducing the ability to form enzyme-substrate complexes and hence the reaction rate. High temperatures and extreme changes in pH cause a permanent change in an enzyme's structure, this is called denaturation.

Inhibitors



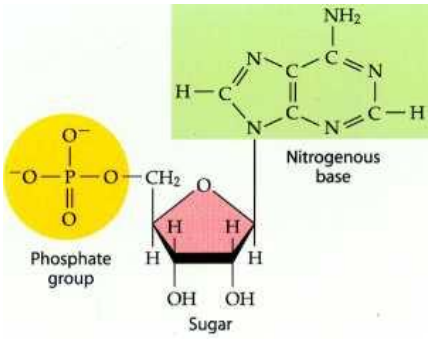
You should be able to distinguish between competitive and non-competitive inhibition,

- Competitive – inhibitor is similar shape to substrate so competes with enzyme for active site.
- Non-competitive - inhibitor is complementary to another site on the enzyme and distorts active site shape so substrate cannot bind to active site.

You need to be able to describe the effect of increasing substrate concentration when in the presence of each inhibitor.

You must understand that inhibition can be reversible or irreversible.

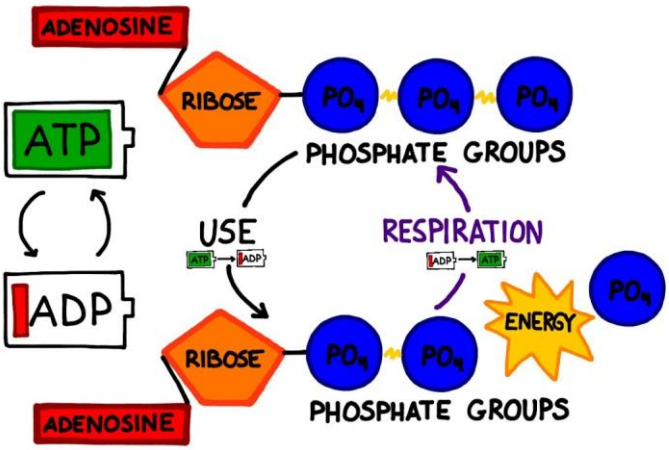
Nucleotides



ALL NUCLEOTIDES HAVE:

- ✓ A 5 carbon sugar – ribose or deoxyribose
- ✓ A nitrogenous base (thymine, adenine, guanine, cytosine or uracil)
- ✓ A phosphate group

ATP



✓ ATP is formed in an endergonic reaction. A chemical reaction that takes in energy.

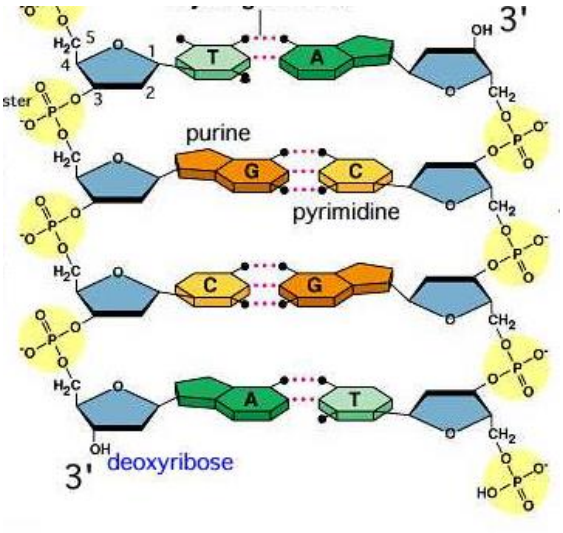
✓ The energy required to combine ADP and inorganic phosphate to form ATP (and water) comes from exergonic reactions, e.g. cell respiration.

✓ 30.6kJ mol^{-1} of energy is released when ATP is hydrolysed to ADP and phosphate.

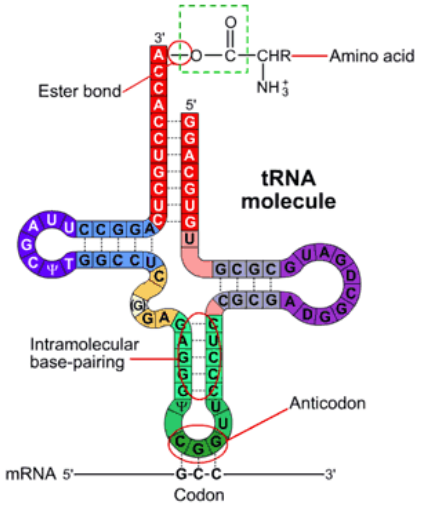
✓ ATP may be called the 'universal energy currency' in organisms because it is a common energy source used in all living organisms.

DNA and RNA

RNA	DNA
Smaller than DNA	Larger than RNA
Single stranded	Double stranded
Sugar = ribose	Sugar = deoxyribose
Bases = G, C, A, U.	Bases = G, C, A, T
Not a double helix	Double helix – strands run antiparallel to each other.



- ✓ Bases hydrogen bond via complementary base pairing.
- ✓ Bases are either purines (2 ring structures) or pyrimidines (1 ring structures)



mRNA, rRNA and tRNA

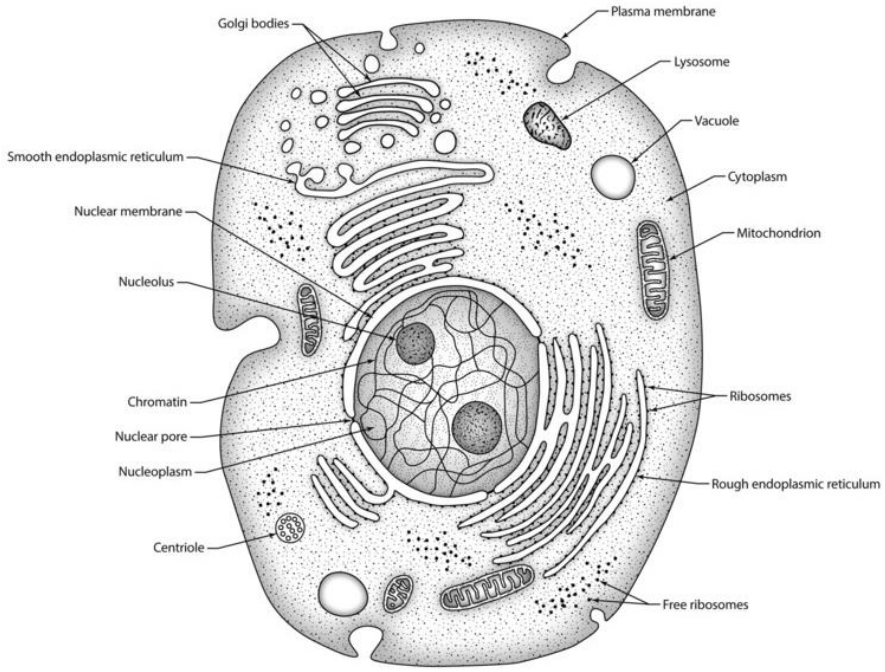
✓ mRNA – is a single strand wound into a helix. IT is complementary to DNA and carries genetic code to a ribosome.

✓ rRNA - Makes up ribosomes along with proteins. Ribosomes are made up of 2 subunits; 1 small and one large one. They are the site of translation, in protein synthesis.

✓ tRNA – specific to amino acid, small molecule with around 80 nucleotides folded into a clover leaf shape. You need to be able to recognise its structure.

Base	Pairs with base
Adenine	Thymine (in DNA) Uracil (in RNA)
Guanine	Cytosine

1.2 The Cell



The only features of the cell you need to learn are:

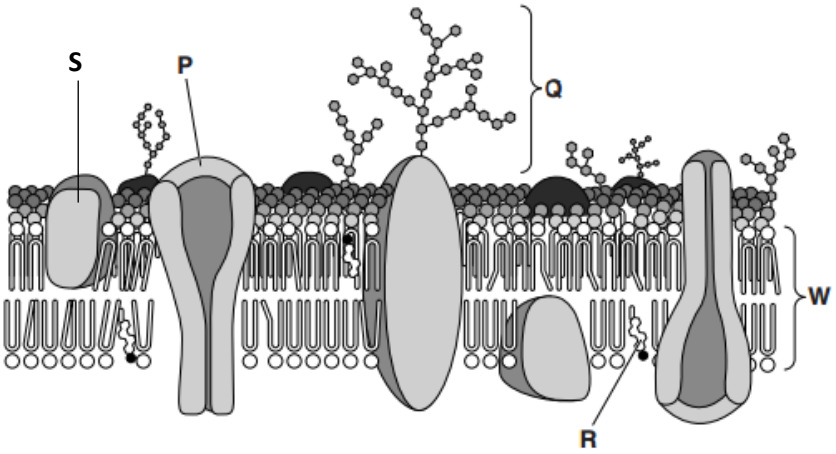
- ✓ plasma membrane – controls materials that move in and out of the cell
- ✓ nucleus – contains DNA for protein synthesis
- ✓ nucleolus – makes ribosomes
- ✓ rough endoplasmic reticulum – contains ribosomes for protein synthesis.
- ✓ Smooth endoplasmic reticulum – synthesis lipids and carbohydrates
- ✓ golgi apparatus – packages proteins into membrane bound sacks called vesicles.
- ✓ Mitochondria – site of aerobic respiration and ATP synthesis.
- ✓ nuclear envelope – double membrane around nucleus that has pores to allow mRNA to leave.

You should understand that organelles work together to carry out functions within cells, e.g. in the synthesis and transport of biological molecules such as glycoproteins.

The Cell Membrane – Fluid Mosaic Model

You need to know and draw the main parts of the membrane including:

- ✓ **P** -intrinsic proteins – go through the membrane
- ✓ **S** - extrinsic proteins – only found on the surface
- ✓ **Q** - glycoproteins – made of polysaccharide and protein
- ✓ **W** - phospholipids and cholesterol (**R**) – see page 3

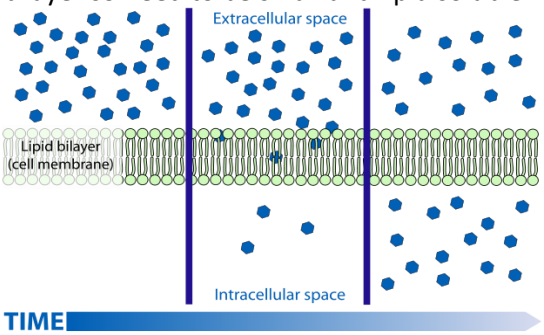


The polarity of protein molecules affects their position in the membrane. Intrinsic proteins include channel proteins and carrier proteins. The extracellular (outside) surfaces of the proteins can be glycosylated have sugar chains attached.

1.3 Transport across membranes

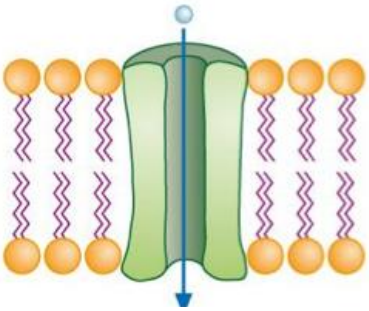
Transport across cell membranes is affected by surface area, the concentration gradient, temperature, the size of the molecule, lipid solubility and thickness of the membrane. This then determines how different molecules are transported across the membrane.

Simple Diffusion – involves small lipid soluble molecules from an area of high concentration to low concentration. Particles need to move through the bilayer so need to be small and lipid soluble.

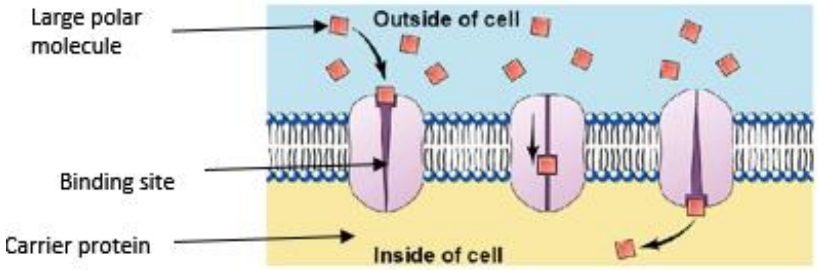


Facilitated Diffusion – involves the movement of mainly water soluble substances that cannot move through the bilayer so move via special proteins. There are two types:

Channel Proteins

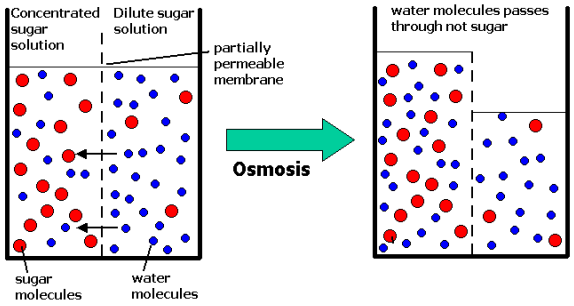


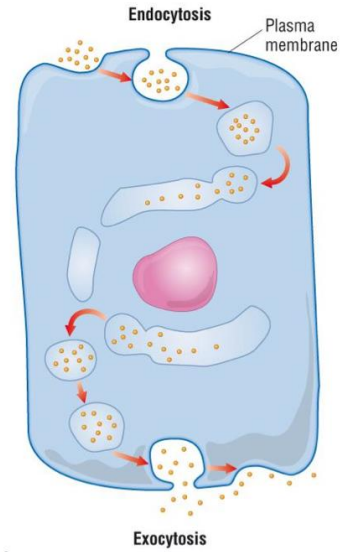
Carrier Proteins



Active Transport – involve movement of substances from a lower concentration to a higher concentration against the concentration gradient. This is carried out by proteins and needs energy in the form of ATP to take place.

Osmosis – movement of water from a region of high water concentration (water potential) with which is more dilute to a region of low water concentration (water potential) which is less dilute across the partially permeable cell membrane.

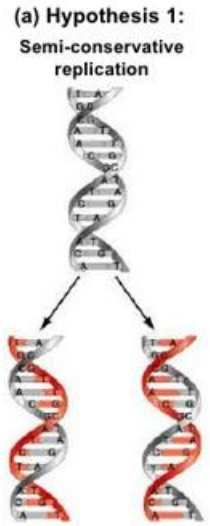




Endocytosis and Exocytosis – this is the bulk transport of large molecules in and out of a cell and requires a lot of energy.

Eg) Phagocytosis – a type of endocytosis where a cell takes in bacteria for destruction.

1.4 DNA Replication and Protein Synthesis

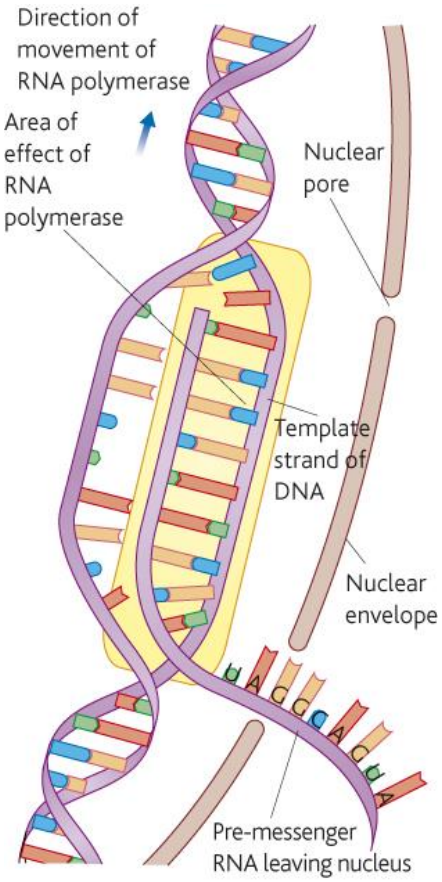


DNA Replication – Semi conservative replication

- DNA helicase breaks the hydrogen bonds between the bases in the helix
- This unwinds the DNA, exposing unpaired bases.
- DNA polymerase then forms bonds between adjacent nucleotides in the new strands of DNA being formed.

You should be able to draw a representative diagram of the replication fork with a small number of nucleotides just like this image.

Diagram of Transcription



Genetic code – Triplet code

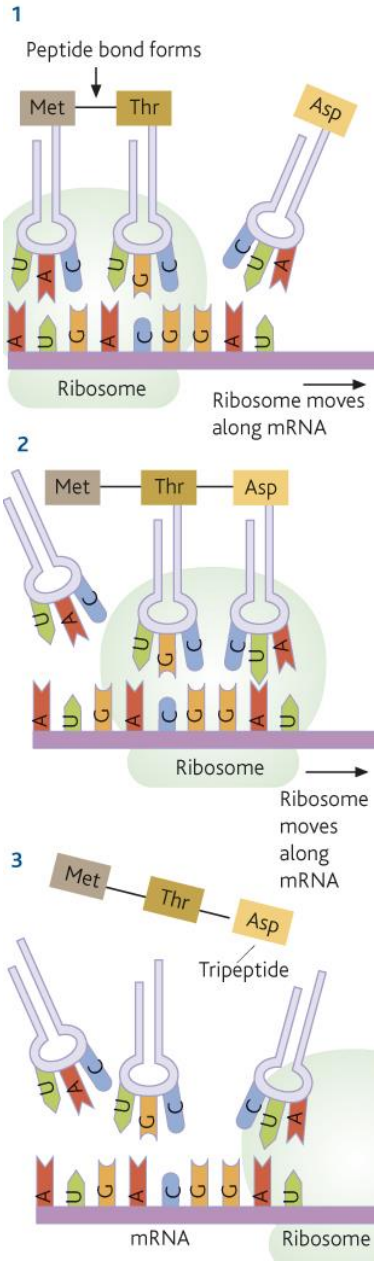
Amino acids are coded for by triplets of bases in the DNA. The DNA is transcribed to produce codons in mRNA and then translated to produce a sequence of amino acids.

The genetic code is a linear, triplet, non-overlapping, degenerate (more than one codon for each amino acid), unambiguous, universal code for the production of polypeptides in all organisms.

Protein Synthesis – Transcription

- DNA helicase breaks the hydrogen bonds between the bases in the helix.
- DNA unwinds, exposing unpaired bases on the template strand.
- RNA polymerase links to the template strand of DNA, inserting mRNA nucleotides one at a time, according to the rules of complementary base pairing and forming bonds between them.
- Beyond the end of the gene there is a stop sequence (stop codon), where RNA polymerase leaves DNA.

Diagram of Translation



Protein Synthesis Translation

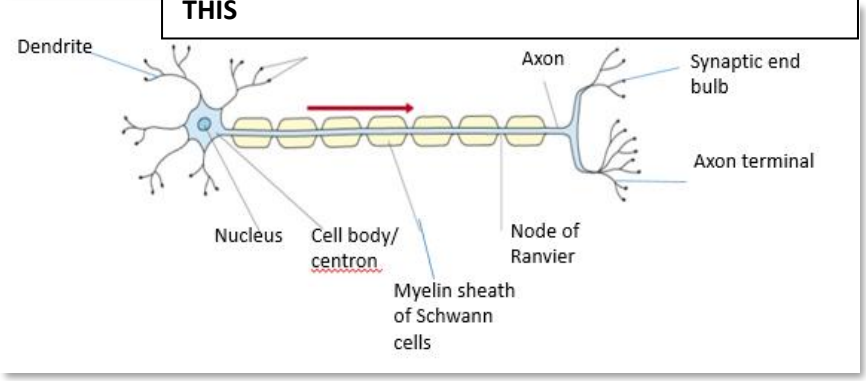
- Ribosomes have two attachment sites for tRNA (on the larger sub unit) and one attachment site for
- mRNA (on the smaller sub unit).
- Each tRNA molecule carries a specific amino acid.
- The Ribosome binds to the start codon on the mRNA.
- tRNA molecules bind to the ribosome through codon-anticodon interactions.
- A peptide bond is formed between the two amino acids.
- The ribosome moves along the mRNA one codon at a time.
- This continues until a stop codon is reached.

2.1 and 2.2 Structure and Function of Human Body Systems – Nervous System

The **Central Nervous System** is comprised of the brain and the spinal cord. Information is sent from receptors to the CNS where it is processed. The brain and spinal cord are surrounded by tough, connective membranes (**the meninges**) for protection. They are also enclosed by bone (the cranium and vertebrae).

The **Peripheral Nervous System** is comprised of all the other nerves to the extremities and organs.
Sensory Neurones – carry messages from the peripheral sensory organs to the CNS.
Motor Neurones – convey instructions from the CNS to effector organs such as muscles or glands

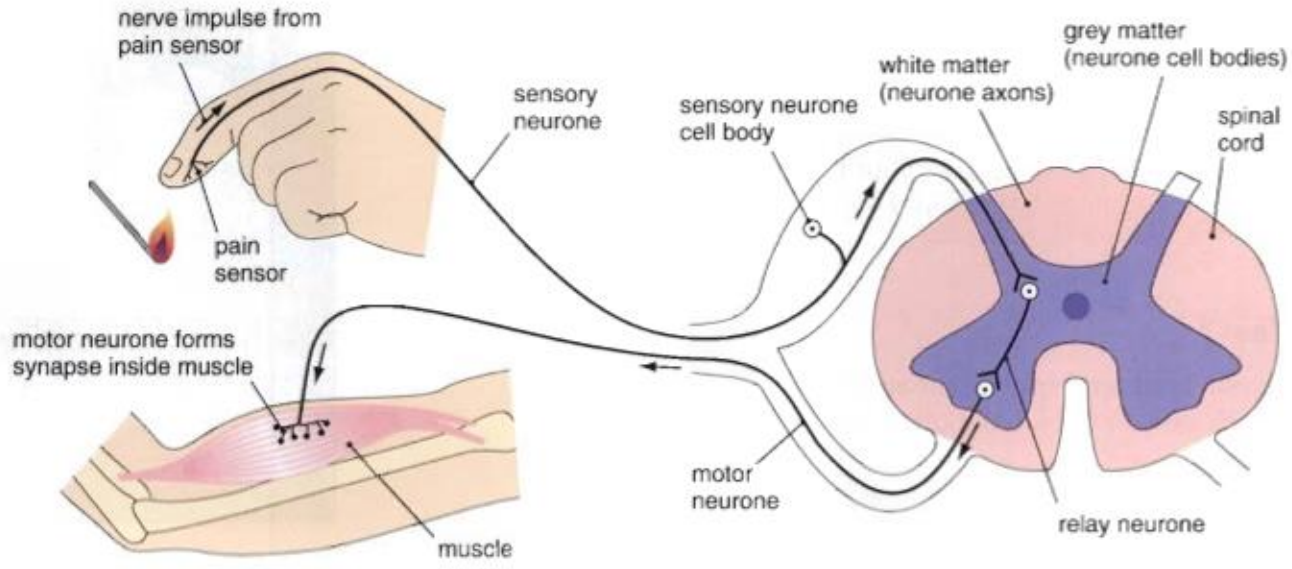
The Motor Neurone – NEED TO BE ABLE TO LABLE THIS



The main parts of the cell are:

- **Dendrites** – fibre carrying impulse towards the cell body.
- **Cell Body** – contains the nucleus and most of the cytoplasm
- **Nucleus** – contains DNA for protein syntheis
- **Axon** – fibre carrying impulse away from the cell body.
- **Myelin Sheath** made of **Schwann cells** – an insulating material that covers the axon. It has small gaps in it called **nodes of Ranvier** that speed up conduction of a nerve impulse.
- **Axon endings** – where neurotransmitters are made.
- **Synaptic End Bulbs –** secretes neurotransmitter into synaptic clefts causing impulses to transmit in the next neurone.

The Reflex Arc – heat example

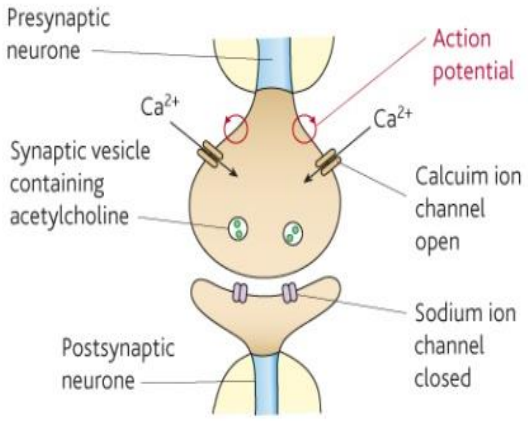


- **Stimulus** – heat from the hot object.
- **Receptor** – (detect stimulus), here temperature receptors in the skin on your hand. These create a nerve impulse in a sensory neurone.
- **Sensory neurone** – pass impulse from receptors to spinal cord/CNS.
- **An relay/ connector neurone** – links the sensory neurone to the motor neurone in the spinal cord.
- **Motor neurone** – carried the impulse from the spinal cord/CNS to the effectors, (a muscle in the upper arm).
- **Effector** – muscle in upper arm, which is stimulated to contract.
- **Response** – pull hand away from hot object.

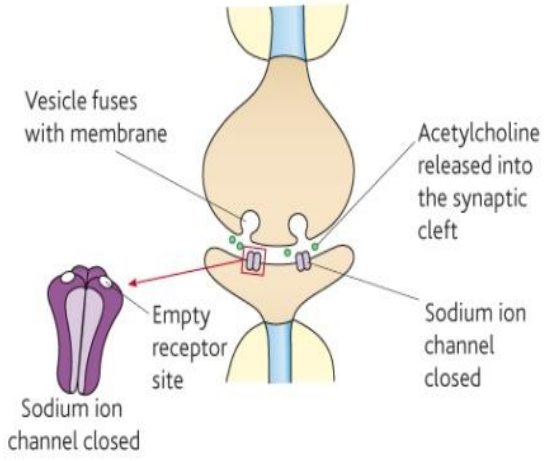
The Synapse

The nerve impulse travel in one direction along an axon. When they reach the synaptic end bulb the impulse is passed to the next neurone via neurotransmitters.

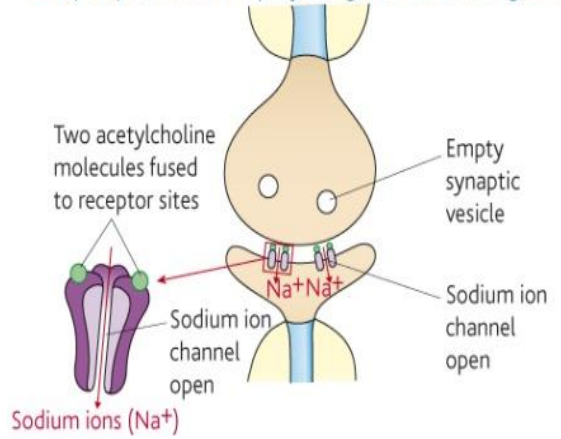
1 The arrival of an action potential at the end of the presynaptic neurone causes calcium ion channels to open and calcium ions (Ca^{2+}) enter the synaptic knob.



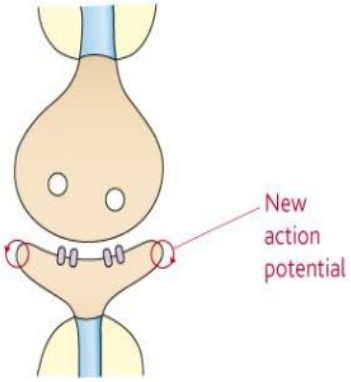
2 The influx of calcium ions into the presynaptic neurone causes synaptic vesicles to fuse with the presynaptic membrane, so releasing acetylcholine into the synaptic cleft.



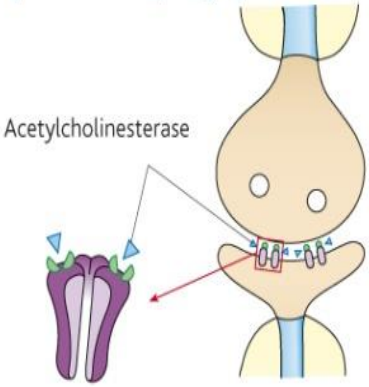
3 Acetylcholine molecules fuse with receptor sites on the sodium ion channel in the membrane of the postsynaptic neurone. This causes the sodium ion channels to open, allowing sodium ions (Na^+) to diffuse in rapidly along a concentration gradient.



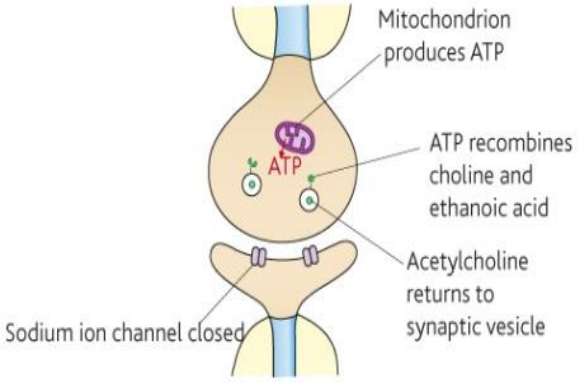
4 The influx of sodium ions generates a new action potential in the postsynaptic neurone.



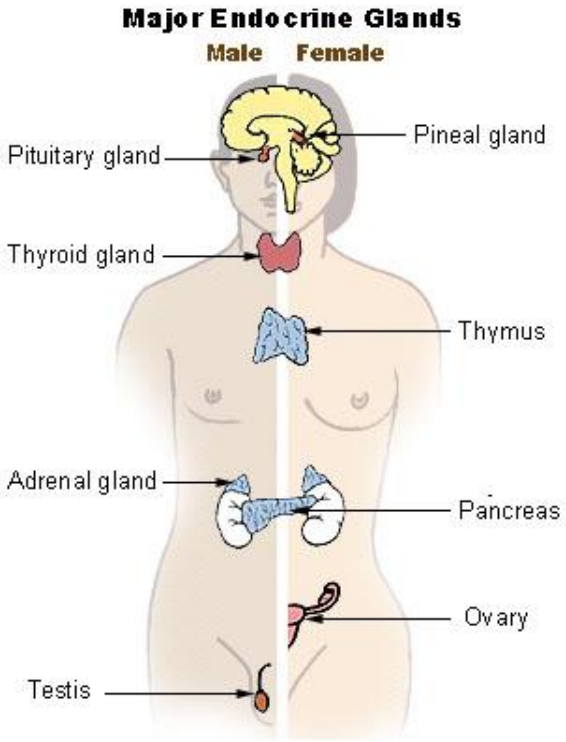
5 Acetylcholinesterase hydrolyses acetylcholine into choline and ethanoic acid (acetyl), which diffuse back across the synaptic cleft into the presynaptic neurone (= recycling). In addition to recycling the choline and ethanoic acid, the breakdown of acetylcholine also prevents it from continuously generating a new action potential in the postsynaptic neurone.



6 ATP released by mitochondria is used to recombine choline and ethanoic acid into acetycholine. This is stored in synaptic vesicles for future use. Sodium ion channels close in the absence of acetylcholine in the receptor sites.



2.1 and 2.2 Structure and Function of Human Body Systems – Endocrine System



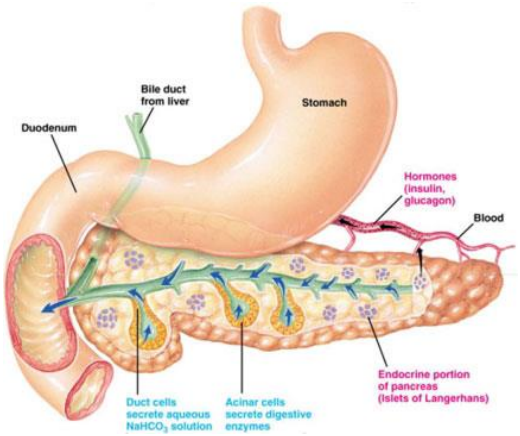
You should understand that the endocrine system is made up of several glands that secrete hormones directly into the bloodstream. Each hormone has a cell that is targets. You need to learn the location of the **pituitary gland**, **pancreas** and **kidneys.**

The purpose of the endocrine system is mainly for homeostasis and regulating the body's chemical reactions.

You should know the pituitary gland is split in two half's called lobes. The front (anterior) lobe and back (posterior) lobe.

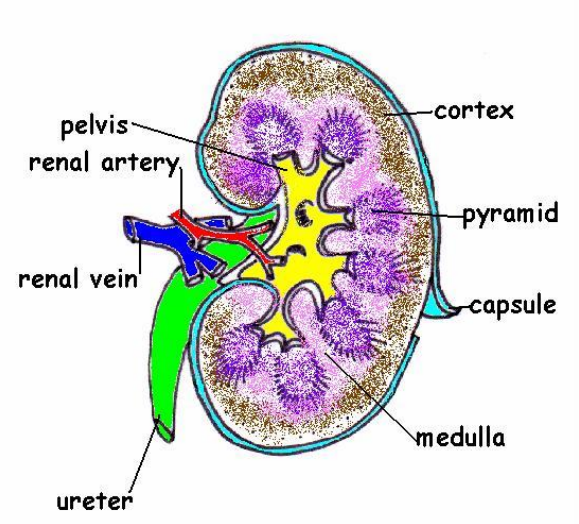
The Pancreas

- Regulates blood glucose
- Has special areas called the Islets of Langerhans which has cells which produce insulin and glucagon.
- Alpha Cells – make glucagon
- Beta Cells – make insulin.
- Blood glucose is regulated by a negative feedback mechanism.
- When blood glucose is high insulin is secreted causing the liver to convert blood glucose in to glycogen – **glycogenosis**. This lowers blood glucose concentration.
- When blood glucose is low glucagon is secreted causing the liver to hydrolyse its stored glycogen to glucose **– glycogenolysis.** This increases blood glucose concentration.

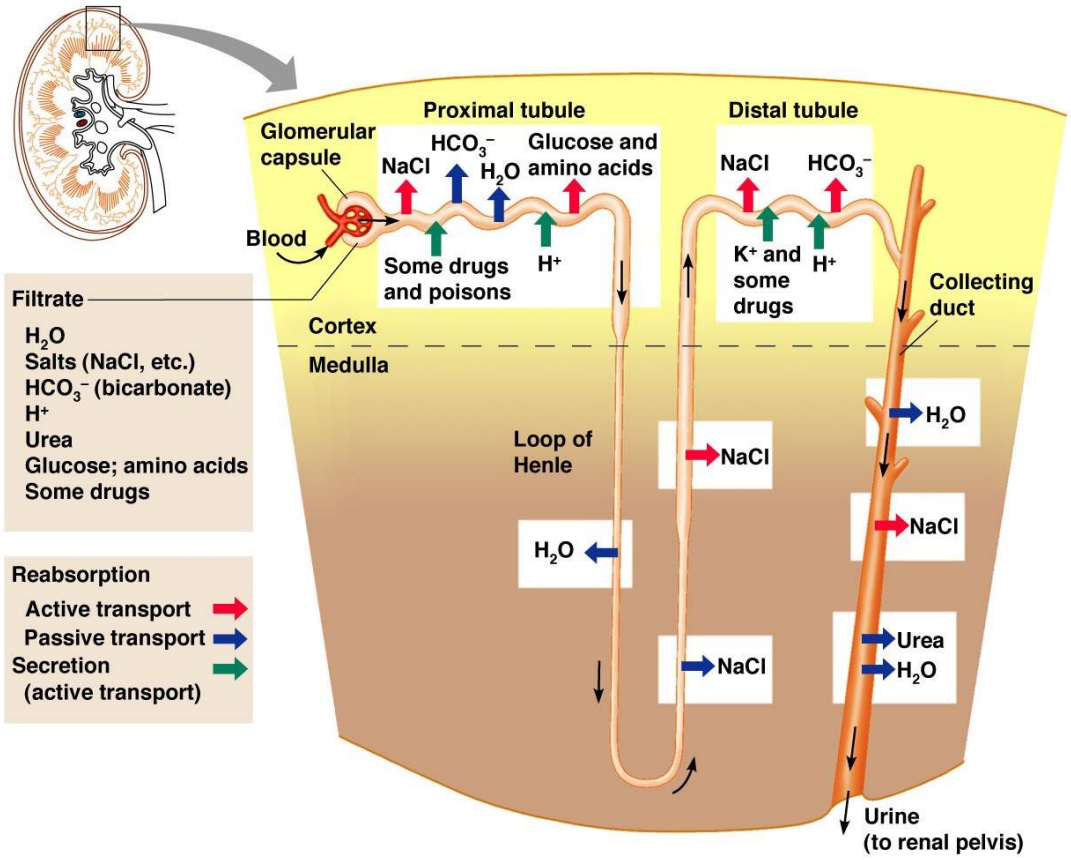


Water Regulation and the Kidney

You need to be able the main parts of the kidney.



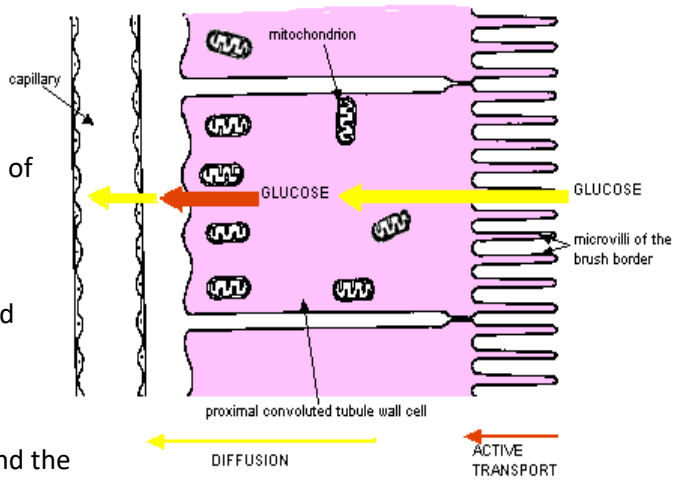
You also need to be able to label the main parts of the nephron.



Key information

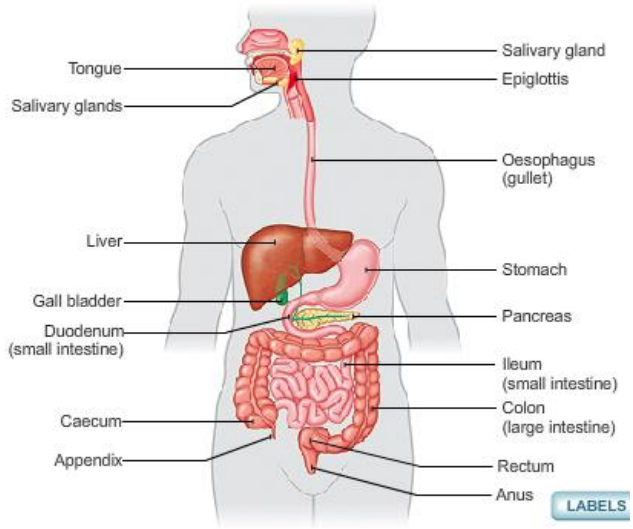
- The glomerulus, Bowman's capsule (including podocytes) and the afferent and efferent arterioles are involved in ultrafiltration of the blood and produce glomerular filtrate in the first stage in the production of urine.
- The proximal convoluted tubule (PCT) in adapted to selectively reabsorb useful materials like glucose, amino acids and salts to the peritubular capillaries.
- This is because the PCT lined with cells with a brush boarder of microvilli for a high surface area and has cells with many membrane proteins and mitochondria for active transport.
- The loops of Henlé concentrate salts in the tissue fluid of the medulla and that causes an osmotic flow of water out of the collecting ducts and distal convoluted tubules.
- ADH secretion has a role in negative feedback restoring the normal osmotic concentration in the blood. This includes the role of:

  - ✓ detectors - osmoreceptors in the hypothalamus;
  - ✓ coordinator - posterior lobe of pituitary secreting ADH
  - ✓ effector - distal convoluted tubules and collecting ducts of the kidneys.



- ADH enables more concentrated urine to be formed:
- ADH makes the plasma membranes of the distal convoluted tubule cells and collecting duct cells
- more permeable to water;
- water is reabsorbed, by osmosis, from the filtrate into the surrounding tissue fluid (and hence blood capillaries) around the DCTs and collecting ducts.

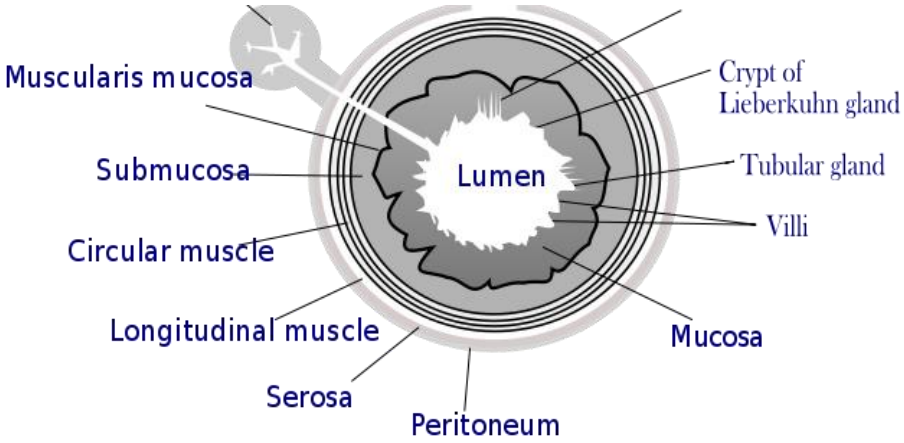
2.1 and 2.2 Structure and Function of Human Body Systems – Digestive System



You need to be able to recall the location of the following organs:

- mouth (buccal cavity,
- teeth,
- tongue,
- salivary glands),
- oesophagus,
- stomach,
- liver (secretes bile via the gall bladder and bile duct)
- duodenum,
- pancreas,
- ileum,
- colon,
- rectum
- anus.

You must know the histology of the gut an know the layers of the gut wall.



- ✓ **Epithelium- site** of absorption and secretion of mucus
- ✓ **Mucosa**- innermost layer lined with epithelium
- ✓ **Submucosa** – contains connective tissue, nerves, blood and lymph capillaries.
- ✓ **Muscle Layers-** helps move food by peristalsis
- ✓ **Serosa** – outer layer made of thick connective tissue

The roles of the digestive system

- The role of each part of the digestive system and the enzymes involved I summarised on the table on the next page.
- All enzyme reactions are hydrolysis reactions.

Key Points about Protein Digestion

There are two types of protease enzymes.

- Endopeptidases – break protein from long chains in to short chains
- Exopeptidases – finish protein digestion by hydrolysing short chain polypeptides into amino acids.

Endopeptidases

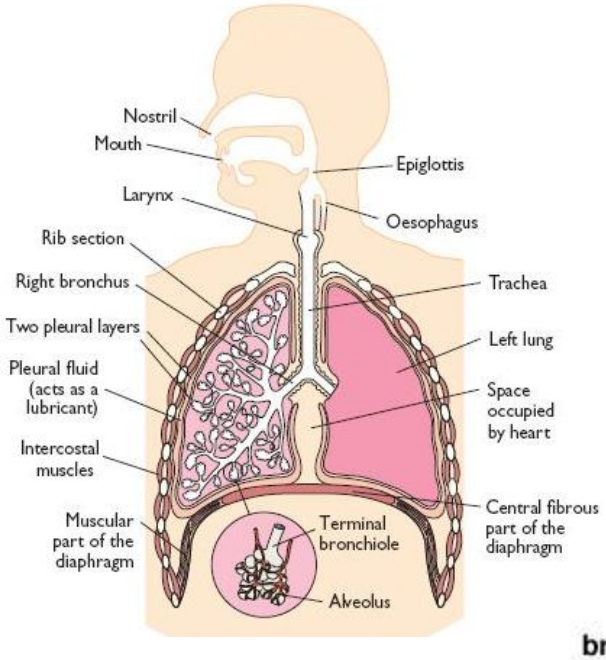
Endopeptidases are always secreted in their inactive form and then get activated outside the cell to stop the enzyme from digesting cell proteins.

- **Pepsin** is secreted as inactive **pepsinogen** by **gastric glands** and converted into **pepsin** by **hydrochloric acid**
- **Trypsin** is secreted as inactive **trypsinogen** by the **pancreas** and converted into **trypsin** by the enzyme **enterokinase.**

Summary of digestive system

Part of intestine	What is digested?	Name of enzyme and site of secretion	Products of digestion	Any other special feature
Mouth	Starch and glycogen	Salivary Amylase – Salivary Gland	Maltose	Saliva lubricates food Chewing → mechanical digestion
Oesophagus	N/A	N/A	N/A	Peristalsis – movement of food.
Stomach	Protein	Pepsin (endopeptidase) – stomach	Shorter polypeptides	• Churning → mechanical digestion • Acidic → optimum enzyme pH is low and kills bacteria • Pepsinogen is activated by acid
	Lipids	Lipase - stomach	Fatty acid and glycerol	
Duodenum	Lipids	Pancreatic Lipase – pancreas	Fatty acid and glycerol	• **Pancreatic juice** is made in the **pancreas** contains enterokinase, amylase, trypsinogen (activated by enterokinase), lipase and hydrogen carbonate ions → alkali for optimum enzyme low pH • **Bile** is made by the **liver** and stored in the **gall bladder** secreted to emulsify lipids (increase SA for enzymes).
	Protein	Trypsin -pancreas	Shorter polypeptides	
	Starch	Pancreatic Amylase - pancreas	Maltose	
Ileum	Polypeptide	Exopeptidase -ilium	Amino acids	This is where digestion finishes and most amino acids, monosaccharides, fatty acids and glycerol.
	Sucrose	Sucrase –ilium	Glucose and fructose	
	Maltose	Maltase -ilium	Alpha-Glucose	
	Lactose	Lactase - ilium	Glucose and galactose	
Colon	N/A	N/A	N/A	Absorption of water and water soluble vitamins

2.1 and 2.2 Structure and Function of Human Body Systems – Respiratory System

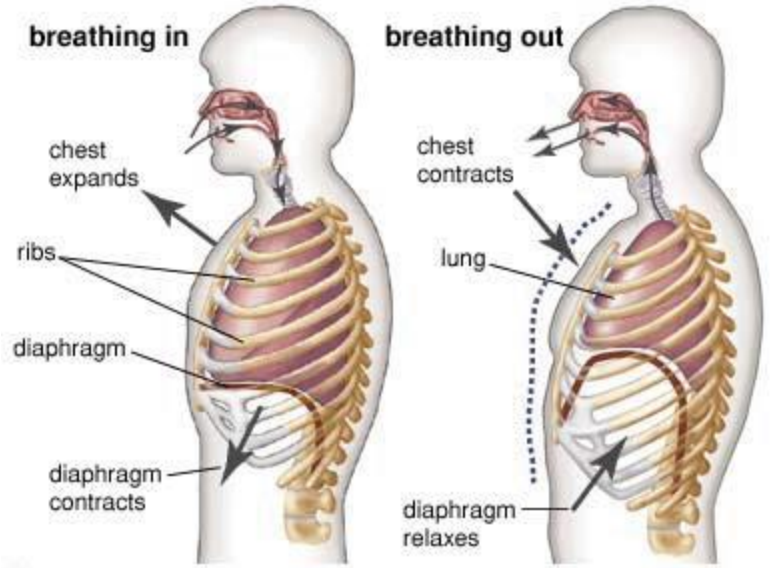


You need to know this diagram fully.

The respiratory system is a site of gas exchange and is adapted to give a large surface area to do this. We breath in oxygen rich air and out carbon dioxide rich air.

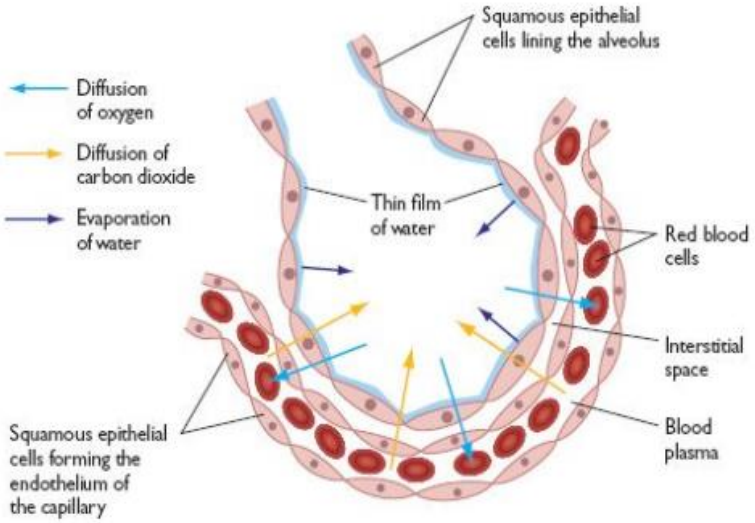
Breathing in (Inspiration)

External intercostal muscles contract
Internal intercostal muscles relax
Ribs are pulled upward & outward – increasing thorax volume
Diaphragm muscles contract, causing it to flatten – also increases volume
Increase of thorax volume causes reduction of lung pressure
Air moves HIGH → LOW (from atmosphere to Lungs)



Breathing out (Expiration)

- Internal intercostal muscles contract
- External intercostal muscles relax
- Ribs are pulled downward & inward – decreasing thorax volume
- Diaphragm muscles relax, return to domed shape – also decreasing volume
- Decrease of thorax volume causes increase of lung pressure
- Air moves HIGH → LOW (from lungs to atmosphere)



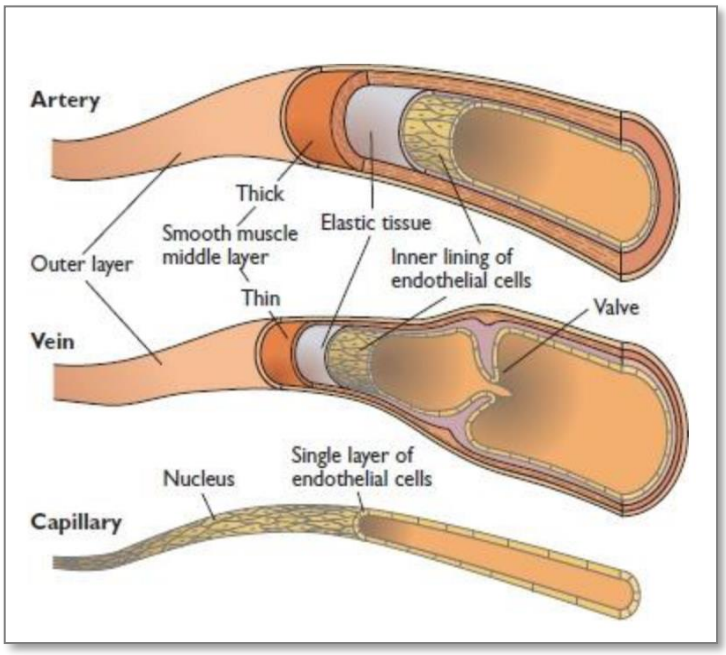
Control of breathing

- Our breathing rate increases during times of stress or respiratory fatigue by taking more shallow but more frequent breaths
- It decreases when we are relaxed or during times of illness. We tend to take deep but slow breaths.

The alveoli

The Alveoli are the site of gas exchange they need support to prevent the sacks from collapsing during expiration. Therefore a **pulmonary surfactant** is released to reduce **surface tension** and prevent the collapse.

2.1 and 2.2 Structure and Function of Human Body Systems – Cardiovascular System



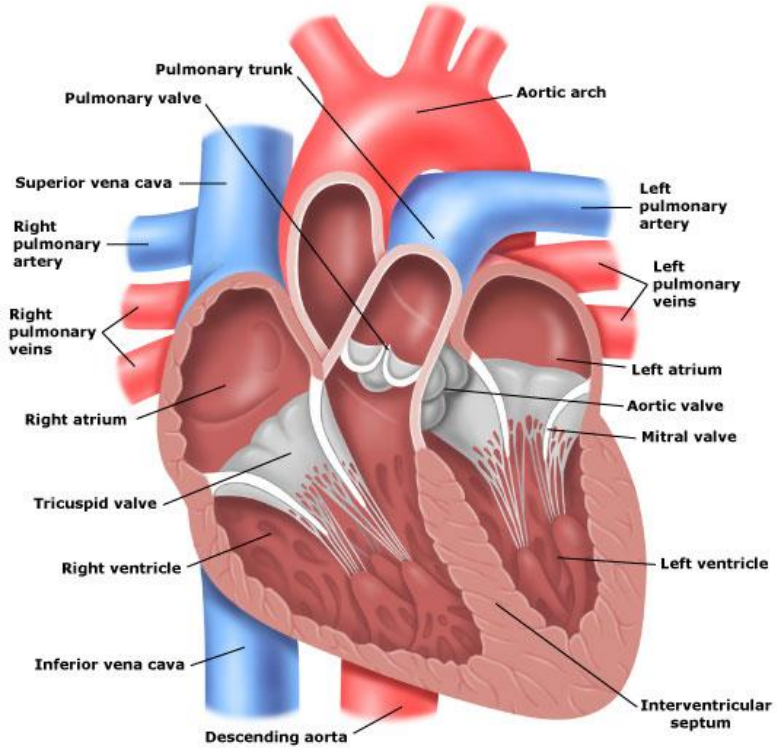
You need to be able to compare the structures of arteries, arterioles veins, venules and capillaries.

- Capillaries, arteries and veins all have endothelial cells and a lumen
- Capillaries are tissues (one cell type only) whereas arteries and veins are organs.
- Veins have valves but arteries and capillaries do not.
- Capillaries do not have an outer layer, muscle layer or elastic layer, arteries and veins do.
- Arteries have a thicker muscle layer than veins.
- Arteries have a thicker elastic layer than veins.
- Capillaries have a much narrower lumen

The Heart

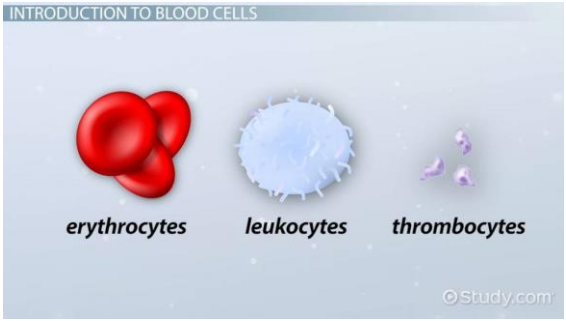
You need to be able to label the following features of the heart:

- Coronary arteries
- Atria
- Ventricles
- The aorta
- The pulmonary arteries
- The pulmonary veins
- The vena cava
- The bicuspid, tricuspid and semilunar valves
- Cardiac Muscle



Blood

You need to know the constituents of blood.



- **Erythrocytes** – contain haemoglobin and are important for transporting oxygen.
- **Leukocytes –** white blood cells that are involved with immunity and engulf pathogens.
- **Thromocytes –** form clots when blood vessels are breached to stop bleeding.

Blood is a medium for transporting material around the body. As well as the cells above it transports waste products such as **urea** and **carbon dioxide** in the form of **hydrogen carbonate, electrolytes, amino acids, proteins** and **hormones** all within the liquid portion of the blood. The blood **plasma**.

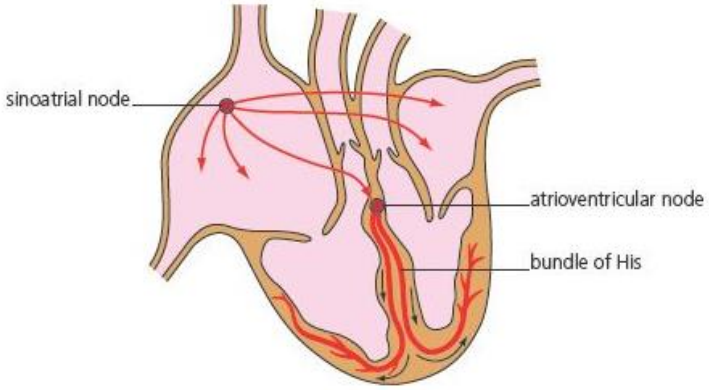
ABO Blood Groups				
Antigen (on RBC)	Antigen A	Antigen B	Antigens A + B	Neither A or B
Antibody (in plasma)	Anti-B Antibody	Anti-A Antibody	Neither Antibody	Both Antibodies
Blood Type	**Type A** Cannot have B or AB blood Can have A or O blood	**Type B** Cannot have A or AB blood Can have B or O blood	**Type AB** Can have any type of blood Is the universal recipient	**Type O** Can only have O blood Is the universal donor

Blood Types

- Blood is grouped depending on the presence or lack of antigens on the erythrocyte (red blood cell) surface. This is called ABO blood groups.
- Blood is also grouped according to the presence of the Rhesus D antigen. Those who have it are **Rhesus Positive** and those who don't are **Rhesus Negative.**

Purpose of the Cardiovascular System

- The cardiovascular system is adapted to maximise the efficiency of moving blood and its constituents to the tissues and back to the heart.
- The blood vessels are adapted to maximise the pressure changes initiated by the heart.
- When the atria contracts (atrial systole) pressure increases moving blood to the ventricles via the bicuspid and tricuspid valves.
- When the ventricle contracts the pressure increases moving blood to the arteries under high pressure via the semilunar valves.
- The valves in both cases prevent back flow.
- The arteries always take blood away from the heart, under high pressure. They are elastic and have lots of muscle to control this.
- Arterioles have high pressure and have muscles to control the flow of blood to different parts of the body.
- Capillaries – very thin to maximise exchange of materials.
- Venules and veins have a large lumen to minimise resistance and have valves to ensure unidirectional flow.



Control of the heartbeat

The cardiac muscle is **myogenic** - it naturally contracts and relaxes of its own accord, it doesn't need nerve impulses to contract as is the case with other muscles.

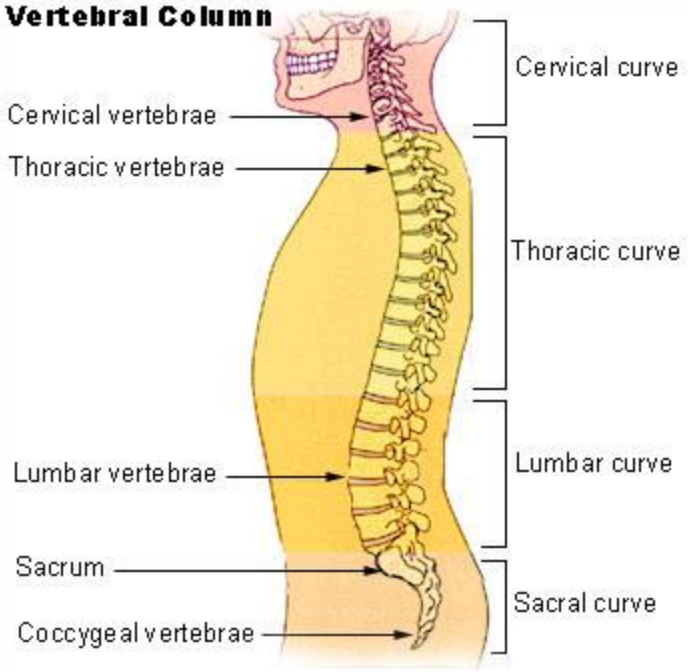
Excitation	Action in atria and ventricles	Name of Stage
The SAN generates an impulse; the impulse spreads along Purkinje fibres to all parts of the atria.	Cardiac muscle in atria contracts, cardiac muscle in ventricles is relaxed — blood is forced through AV valves from atria to ventricles.	Atrial Systole
The impulse is held up at the AVN, allowing time for atria to empty.	Cardiac muscle in atria contracts, cardiac muscle in ventricles is relaxed — blood continues to be forced through AV valves.	Atrial Systole
The impulse is conducted along the bundles of His through the ventricle walls.	Cardiac muscle in atria is relaxed, cardiac muscle in ventricles contracts; AV valves closed; semi-lunar valves opened – blood ejected into main arteries.	Ventricular systole Atrial diastole
No impulse	Cardiac muscle in atria and ventricles is relaxed – passive ventricular following.	Atrial and ventricular diastole

2.1 and 2.2 Structure and Function of Human Body Systems – Musculoskeletal System

The musculoskeletal system provides form, support, stability, and movement to the body. It is made up of the bones of the skeleton, muscles, cartilage, tendons, ligaments, joints, and other connective tissue that supports and binds tissues and organs together. The musculoskeletal system's primary functions include supporting the body, allowing motion, and protecting vital organs.

Skeleton

The diagram on the previous page shows the human skeleton. It is made up of all the bones of the human body.
The bones are attached to muscles so they can move at joints.
YOU DO NOT NEED TO LEARN ANY SPECIFIC EXAMPLES OF BONES EXCEPT FOR THE SPINE

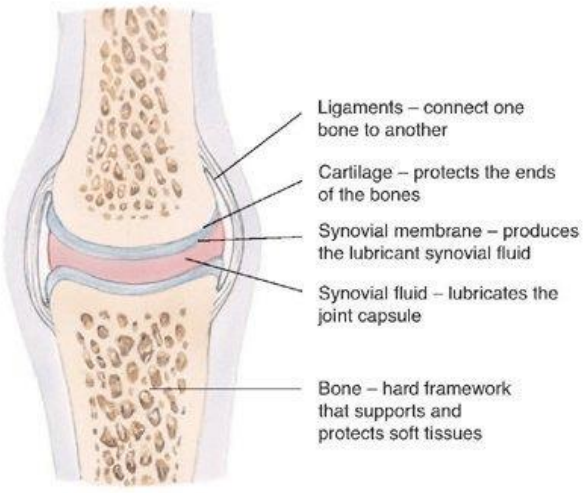


The Spine – IMPORTANT EXAMPLE

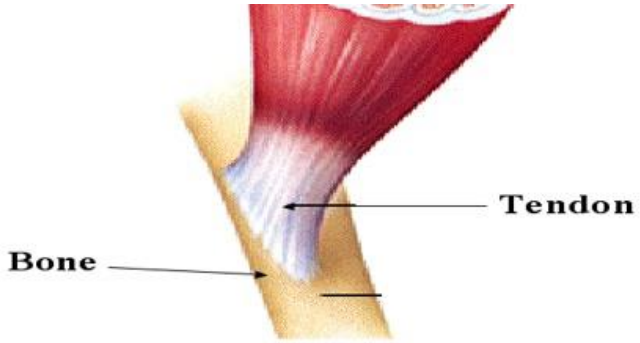
The spinal column is also known as the vertebral column. It is a series of small bones forming a flexible and supportive structure down the back.
Each bone is called a **vertebrae.**
There are discs of cartilage found between the vertebrae to cushion them during locomotion (movement).
When the discs are moved out of position it is known as a 'slipped disk' and it is often a cause of lower back pain.
You are not expected to name regions of the vertebral column.

Joints

Joints are structures that connect individual bones and may allow bones to move against each other to cause movement.
There are several types of joint that you need to know about:
Fibrous joints – eg the skull joined at the neck.
Cartilaginous joints – eg discs of cartilage between vertebrae holding them together
Synovial joints – eg the knee



You will need to know the structure of the synovial joint.



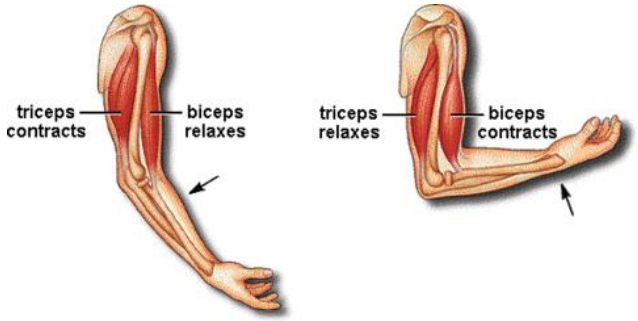
Muscles

Muscles contract to allow bones to move.

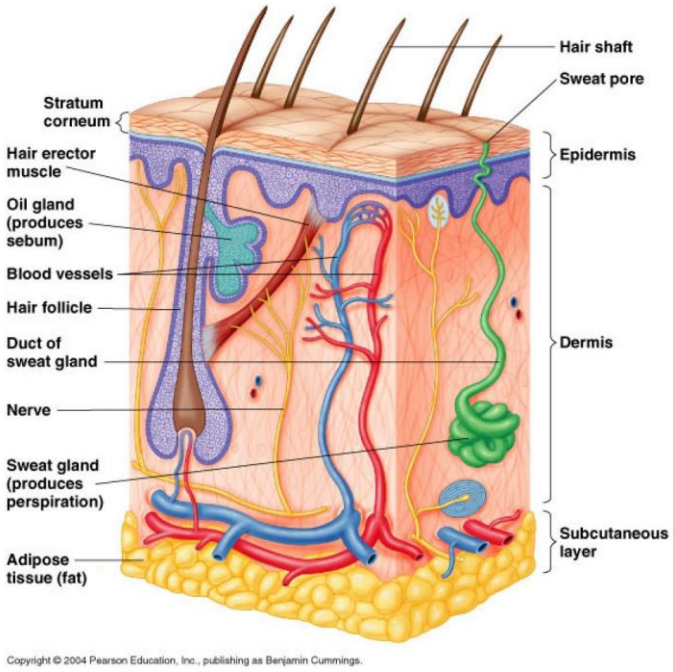
They are often paired together antagonistically, meaning when one muscle in a pair is contracting the other is relaxing. An example of this is the biceps and triceps. When the bicep is contracting the tricep is relaxing and visa versa.

How do muscles work?

Muscles are made of fibres. These fibres contain filaments which slide over each other when a muscle contracts (This is called sliding filament theory). One filament is thick, the other is thin. The filaments slide over each other this causes the muscle to contact.



2.1 and 2.2 Structure and Function of Human Body Systems – Skin (Integumentary System)



You should know the purpose of the skin to include thermoregulation, protection against foreign bodies, mechanical damage and solar radiation, energy storage and production of vitamin D.

THERMOREGULATION

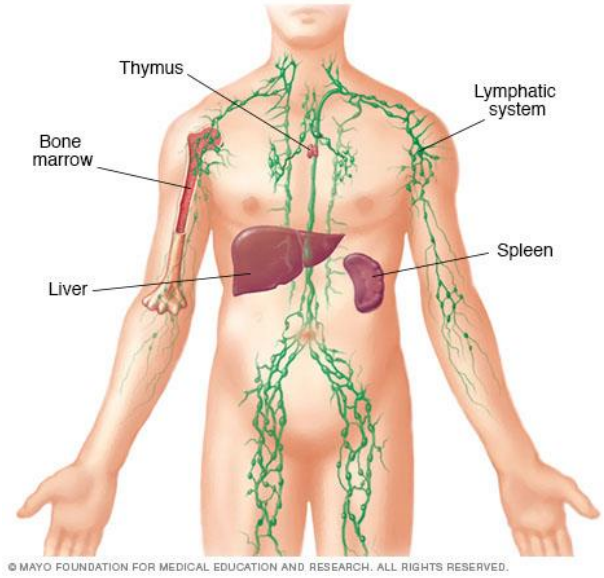
Low Temperatures

- Hypothalamus detects decrease in blood temperature and sends nervous impulses to the skin which bring about the following changes:
- Rapid contraction of skeletal muscles (shivering) to produce metabolic heat from ATP used.
- Erector muscles contract which causes hair to rise and trap an insulating layer of air close to the skin surface.
- Caseation of sweating.
- Vasoconstriction of arterioles that supply blood to capillaries at the skin surface in order to prevent further heat loss by radiation.

High Temperatures

- Hypothalamus detects increase in blood temperature and sends nervous impulses to the skin which bring about the following changes:
- Sweat glands produce sweat which travels up the sweat duct and is deposited at the skin's surface. Heat radiated from the body is used to evaporate sweat and cause heat loss away from the body.
- Erector muscles relax which causes hair to lay flat on the skin surface.
- Caseation of shivering.
- Vasodilation of arterioles that supply blood to capillaries at the skin surface in order to cause further heat loss by radiation.

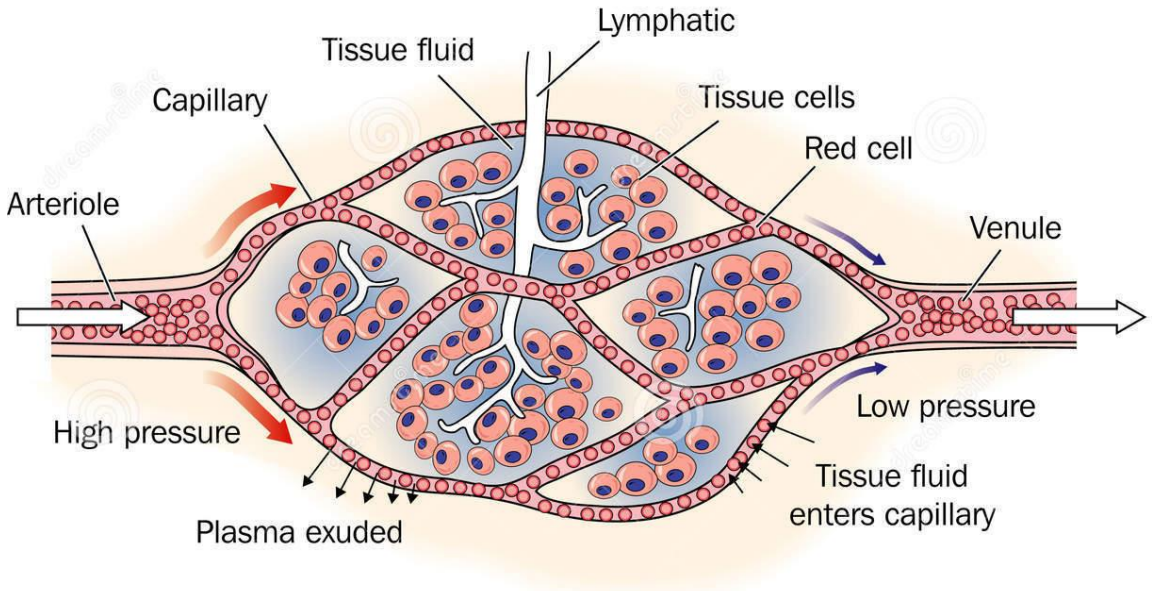
2.1 and 2.2 Structure and Function of Human Body Systems – Lymphatic System



You should know that the lymphatic system is an extensive network of vessels. The **spleen** is the largest organ in the lymphatic system. Along the larger lymph vessels are sac-like structures called **lymph nodes.**

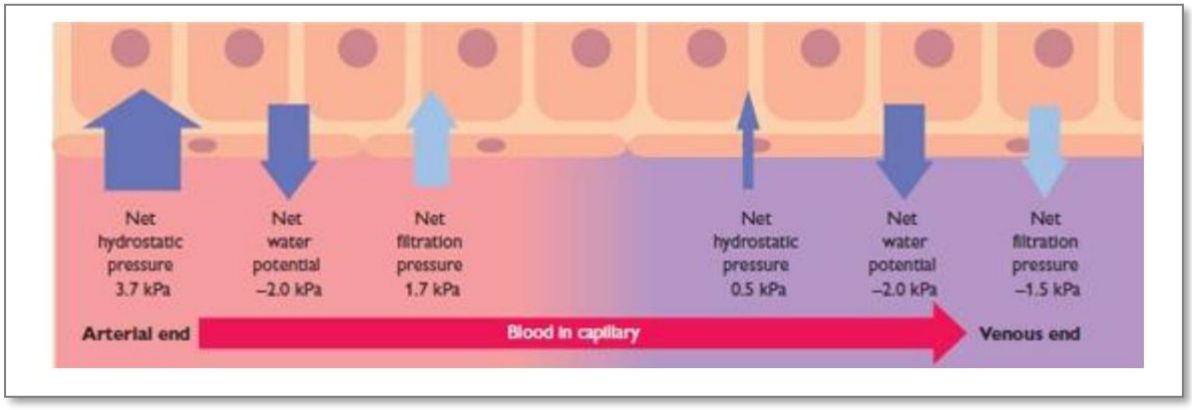
Lymph is transported within a network of vessels. The spleen contains an emergency supply of blood and also white blood cells.

The formation of Tissue Fluid and Lymph.



Capillary bed

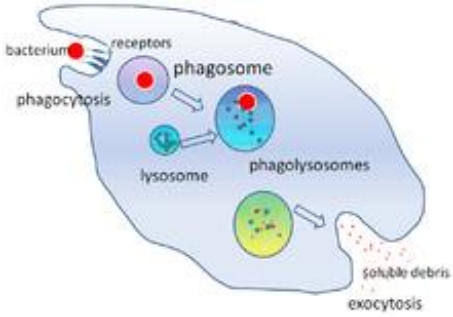
- At the arterial end of the capillary bed, hydrostatic pressure is higher than osmotic pressure.
- Therefore water and small soluble molecules are forced through the capillary walls.
- This forms tissue fluid between the cells.
- Proteins and cells in the plasma are too large to be forced out.
- Blood pressure falls along the capillary because of resistance of the walls and reduced volume of blood.
- At the venous end of the capillary bed, osmotic pressure of the blood is higher than the hydrostatic pressure and so most of the water from tissue fluid moves back into blood capillaries.
- The remainder of the tissue fluid is returned to the blood, via lymph vessels.



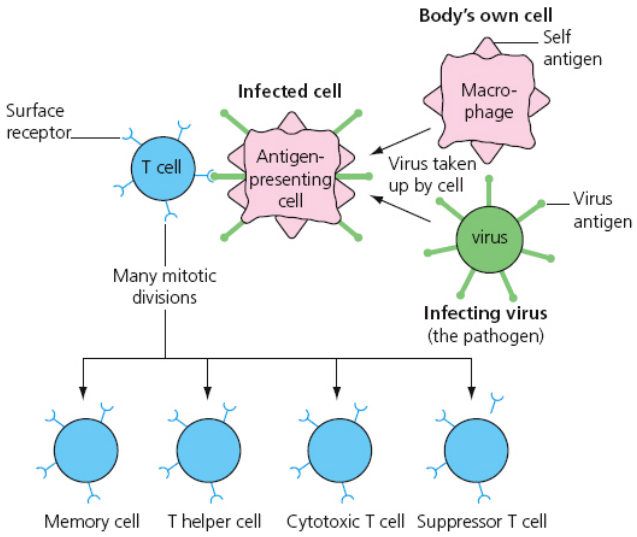
2.1 and 2.2 Structure and Function of Human Body Systems – Immune System

The immune system protects the body from infection

- Natural barriers reduce the risk of infection:
- the skin
- blood clotting to seal wounds
- inflammation to localise breaks in the barrier
- phagocytosis to destroy invading microbes
- ciliated mucous membranes that trap microbes in inhaled air
- lysozyme in tears, saliva and stomach acid that kills bacteria.



There are two specific responses to infection which are as a result of antigens being recognised as foreign to the body.

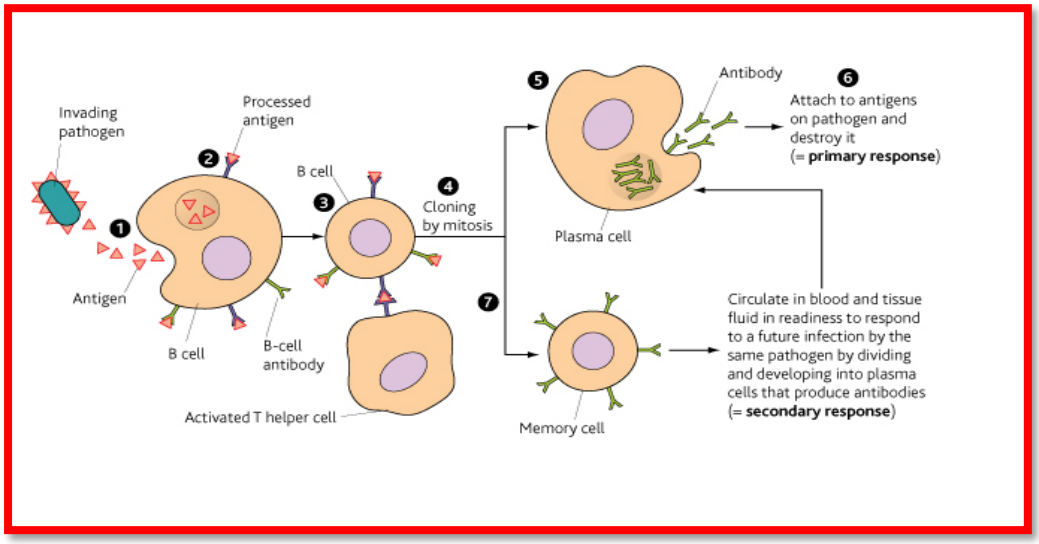


The Cell mediated immune response involves:

- detection of the corresponding specific antigen causes the production of T lymphocytes;
- there are many subpopulations of T cells including: effector cells (T killer or cytotoxic T lymphocytes) which cause lysis of the target cells; helper T cells which cooperate with B lymphocytes to initiate an antibody response; memory cells which remain dormant until the host is next exposed to the antigens;
- cell-mediated defences include the activation of phagocytes, antigen-specific killer / cytotoxic T lymphocytes;
- activation of B cells involves the release of various chemicals called cytokines in response to an antigen.

The Humoral response involves:

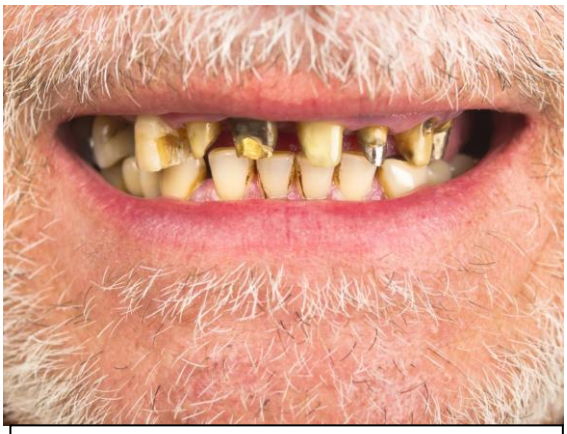
- B lymphocytes have receptors for the detection of its specific antigen;
- activation stimulates production of plasma cells, and memory cells;
- memory cells remain in the circulation ready to divide if the same antigen is encountered again;
- antibodies are proteins which are specific to the antigen with which they bind to form
- an antigen-antibody complex;
- an antigen-antibody complex renders the antigen inactive which increases the rate of
- engulfment by phagocytes.



3.1 Explain how lifestyle may affect major body systems

You need to be aware of the conditions that are risk factors for different conditions

- Coronary Heart Disease – cardiac arrest, angina
- Vitamin D deficiency – rickets (bow legs, weakness)
- Vitamin C deficiency – scurvy (loss of teeth and scaly skin)
- Iron deficiency – anaemia (tiredness)
- Obesity – arthritis, diabetes, CHD
- Alcohol dependency – withdrawal symptoms and liver disease
- Lung disease – asthma, emphysema, lung cancer, bronchitis



SCURVY

3.2 – Assess how lifestyle may impact health

You need to consider how these factors may impact health:

- Diet, alcohol, recreation drugs
- Smoking
- Exercise and physical health
- House
- Type of employment

3.3 – Assess how lifestyle may impact health

You need to know how the following pathogens cause harm and the effect they have on body systems:

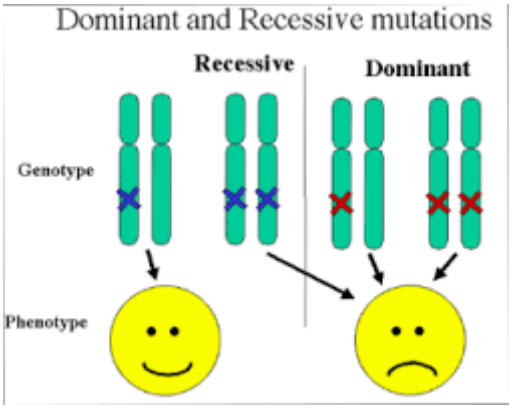
- **Viruses –** HIV and HPV both contain nucleic acid which when injected into a cell uses the cells ribosomes to replicate. When this happens the immune system is compromised in HIV or cells can become cancerous in HPV. Both are contracted sexually.
- **Bacteria –** Chlamydia and TB are both bacterial infections. TB damages lung tissue and can even kill patients. It is inhaled. Chlamydia is contracted from unprotected sexual contact and starves host cells of nutrients causing pain and inflammation.
- **Protozoan –** toxoplasmosis is caused by a single celled parasite which is contracted by accidentally eating uncooked meat or cat faeces. It invades host cells and can give flu-like symptoms but causes birth defects.
- **Fungal –** athletes foot is very contagious and spread by both direct and indirect with wet surfaces eg) sweaty socks. The fungus breaks down keratin in the skin which ultimately causes itching, red sore, flaky skin.
- **Worms –** Tapeworm. Contracted by eating infected meat. Lives in the digestive tract of humans and causes abdominal pain, bloating and loss of appetite.
- **Prions –** CJD is contracted from blood transfusions but can also be sporadic. It is caused by an abnormal protein which can self-replicate which damages hosts brain cells leading to sever psychological problems, loss of physical control and ultimately death.

Specific examples may described in pre-release articles or given as a context in exam questions.

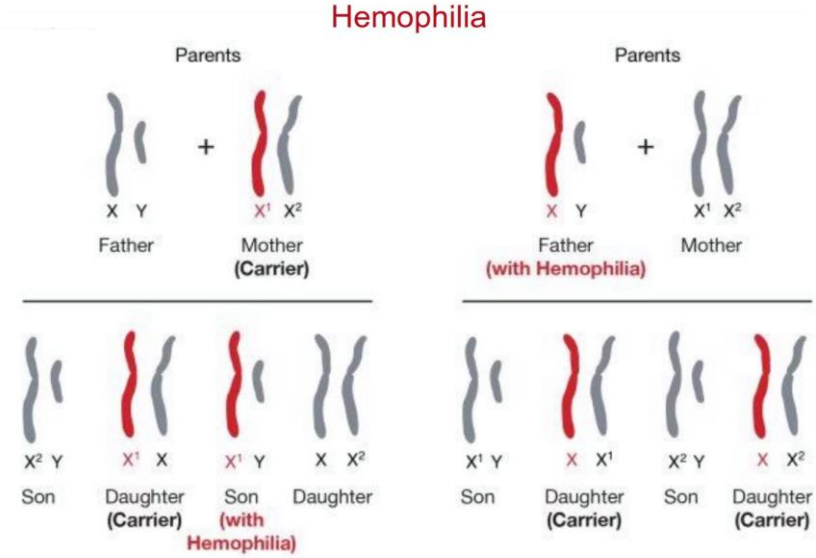
3.4 Explain how non-infectious diseases affect body systems

You should have an overview of the types of non-infectious conditions and are not expected to recall specific examples. Specific examples may described in pre-release articles or given as a context in exam questions.

Allergies – caused by hypersensitivity of the immune system to substances in the environment causing, rash, red eyes, swelling and shortness of breath.
Autoimmune diseases – where the bodies immune system fails to recognise body tissues as itself. So the immune system responds to what is healthy tissue.
Cancer – uncontrolled cell division leading to the growth of tumours which can spread damaging organs.
Inherited disease – diseases inherited from alleles from parents.



Dominant/Recessive diseases – you studied these at GCSE. Here is an example.



Sex Linked – is where the allele that causes a specific disease is only found on the X chromosome so males will never be carriers as they will have only one allele for a gene which is then expressed. Eg) Hemophilia

FINALLY

You could be asked anything from Unit 2 and 3. We will visit specific areas depending on the pre-release.