Human Biology Notes Year 12

Science inquiry (Chapter 1)

Independent variable: The variable which is changed
Dependent variable: The variable which you measure in response to the independent variable
Placebo: A substance that has no therapeutic effect, used as a control in testing new drugs.
Meta-analysis: Combines data from multiple studies. Used to contrast and to find a common effect
Double blind experiments: Information is hidden from administrator and subjects until the study is over. Is designed to eliminate bias
Error: A deviation or inaccuracy acquired from obtaining data
Limitation: An impact on the experiment due to equipment or method

Longitudinal studies	
Retrospective	**Prospective**
- Examine records of past events to build up a picture of change over time	- Planned and initiated at the current time

Control group	**Controlled variables**
- The group kept separate from the experimental group	- Factors that are kept the same for both the control and experimental groups

Validity	**Reliability**
- Testing what is meant to be tested - Data represents the phenomenon you are measuring	- An experiment gives the exact same result each time it is performed

Chemical Messengers (Chapter 2)

Glands

- **Exocrine** = secretes into a duct that exits the body
  - Eg, sweat and salivary glands

- **Endocrine** = secretes hormones into the extracellular fluid that surrounds the cells that make up the gland. The secretion normally passes into the capillaries via diffusion, don't have ducts

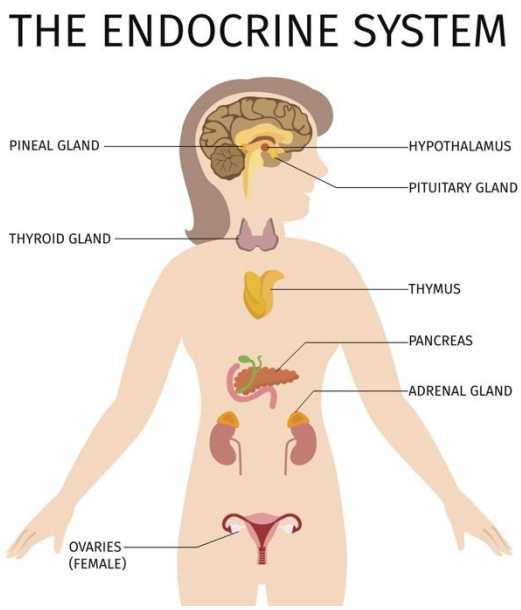
Cellular effects of hormones

- Activates a gene/s
- Changes shape of enzymes
- Changes the rate of transcription and translation

Protein and amine hormones	**Steroid hormones**
Water soluble	Lipid soluble
Attaches to receptor proteins on the membrane of the target cell	Combines with a receptor inside the cell.
The combination of the hormone with the receptor causes a **secondary messenger to**	**Activates the genes** to synthesise a particular protein

be released and diffuse through the cell and activate particular enzymes	

Major glands of the body



Hypothalamus

- Controls secretions to the pituitary gland via **releasing and inhibiting factors**
- **Negative feedback** tells the hypothalamus to stop secreting a particular hormone, and therefore the target gland stops producing the hormone
- Located at the base of the brain
- Regulates **body temperature, water balance and heart rate (homeostasis)**
- Produces hormones that are carried to the pituitary gland
- Connected to pituitary by **infundibulum**
- Hormones produced here either inhibit or stimulate hormone production in the anterior pituitary
- Other hormones pass through the nerve fibres to the posterior where they are secreted
- Makes hormones for posterior pituitary

Pituitary Gland

- Lies under the hypothalamus and is joined to it by the infundibulum
- Consists of an anterior and posterior lobe
- Anterior lobe is at the **front** and is connected to the hypothalamus by a complex network of **blood vessels**
- Posterior lobe is to the **rear** and is joined to the hypothalamus **by nerve fibres**, does not make hormones
- Secretes hormones that control other endocrine glands

Hormone	**Target Organ**	**Main Effects**
Anterior lobe of pituitary		
Follicle Stimulating (FSH)	Ovaries Testes	Growth/development of follicle Production/maturation of sperm
Luteinising hormone (LH)	Ovaries Testes	Ovulation + maintenance of corpus luteum Secretion of testosterone
Growth Hormone (GH)	All cells	Growth of skeleton increased amino acid uptake to build proteins

		(synthesis) and maintains organ size
Thyroid Stimulating Hormone (TSH)	Thyroid Gland	Stimulates hormone production on the thyroid
Adrenocorticotropic hormone (ACTH)	Adrenal Cortex	Stimulates hormone production in the adrenal cortex
Prolactin (PRL)	Mammary Glands	Initiates and maintains milk secretion in females
Posterior lobe of pituitary		
Antidiuretic hormone (ADH)	Kidneys	Causes increased reabsorption of water from the kidneys
Oxytocin (OT)	Uterus Mammary Glands	Stimulates contraction of the muscles of the uterus. Stimulates contraction of cell in the mammary glands causing the release of milk

Endocrine glands

Gland	**Hormone**	**Target Cell**	**Main Effects**
Thyroid	Thyroxine	Most cells	Increases metabolic rate and therefore oxygen consumption and heat
Parathyroid	Parathyroid hormone (PTH)	Bones Kidneys	Bones release calcium Reabsorption of calcium
Thymus	Thymosins	T lymphocytes	Stimulates development and maturation of T lymphocytes
Pineal	Melatonin	N/A	Sleep patterns, stimulated by darkness and inhibited by light
Adrenal Cortex	Aldosterone Cortisol	Kidney Most cells	Reduces the amount of sodium and increases the amount of potassium in urine Promotes normal metabolism. Helps the body deal with stress and promotes the repair of damaged tissues
Adrenal Medulla	Adrenaline + noradrenaline	Most tissues	Prepares the body for fight-or-flight responses. Increases in rate and force of heart beat
Pancreas	Insulin Glucagon	Most cells Liver + fat storage	Stimulates the uptake of glucose. Lowers blood glucose levels Stimulates the breakdown of glycogen and fat to

			increase blood glucose levels
Testes	Androgens	Many tissues	Stimulates sperm production. Growth of skeleton and muscles and secondary sexual characteristics
Ovaries	Estrogen	Many tissues	Stimulates the development of female characteristics and regulates the menstrual cycle
	Progesterone	Uterus + Mammary Glands	Regulates menstrual cycle, pregnancy and prepares mammary glands for milk secretion

Enzyme amplification

- Series of chemical reactions
- 1 hormone activates 1000's of enzyme molecules
- 1 hormone causes a hormonal cascade which could trigger the production of over a billion enzyme molecules

Hormone clearance

- Hormone is turned off
- The breaking down of a hormone once it's finished its job
- Broken down at kidney or liver
- Excreted in bile or as urine

Control of hormone secretions

- Regulation of hormones
- Hormonal secretions are regulated by negative feedback
- Negative feedback is when the response produced by the secretion of the hormone is the opposite of the stimulus that caused the secretion
- Releasing factors stimulate the release of a hormone
- Inhibiting factors slow down the secretion of a hormone

Nerve Cells and Nerve Impulses (Chapter 3)

Neuron	A nerve cell
Nerve fibre	Any long extension of cytoplasm of a nerve cell body, although the term usually refers to an axon
Nerve	A bundle of nerve fibres held together by connective tissue

Central Nervous System: Consists of the spinal cord and the brain.
Peripheral Nervous System: Nerves that connect the central nervous system with the receptors, muscles and glands of the body

Interneurons: Neurons that are able to receive messages from other adjacent neurons. It links the sensory neurons to the motor neurons
Nerve impulses: Messages
Myelinated fibres: An axon with the myelin sheath covering
Unmyelinated fibres: An axon without the myelin sheath covering

Grey matter: Consists of nerve cell bodies and unmyelinated fibres
White matter: Composed of myelinated fibres (fatty tissue)

Nerve Cells

Part of neuron	**Where is it**	**Function**
Cell Body (soma)	Big chunky bit. It's pretty obvious	Contains nucleus and the other organelles
Dendrites	Short and highly branched	Carries messages into the cell body of another nerve fibre
Axon	Between the cell body and axon terminal. The big long thing.	Carries the nerve impulses away from the cell body
Myelin Sheath	Around the Schwann cell and axon	Layer of **fatty material** which acts as an **insulator,** speeds up movement of nerve impulses
Schwann Cell	The cell inside of the myelin sheath	Cells that form the myelin sheath outside the brain and spinal cord
Node of Ranvier	Along the axon there are gaps in the myelin sheath called the node of Ranvier	N/A

Types of Neurons

Neuron Types	**Description**	**Location**
Functional types		
Sensory/Receptor	Carry messages from receptors in the sense organs or skin to the central nervous system (brain and spinal cord)	N/A
Motor/Effector	Carry messages from the central nervous system (brain and spinal cord) to the muscles and glands	N/A
Interneurons	Connects sensory and motor neurons together	Spinal cord and for reflexes in the grey matter of the spinal cord
Structural Types		
Multipolar neurons (motor)	Has 1 axon and multiple dendrites extending from the cell body	Motor neurons
Bipolar neurons (interneurons)	Has 1 axon and 1 dendrite	Ear, eye and nose (interneuron)
Unipolar neurons (sensory)	Cell body is to one side of the axon	Sensory neurons

Synapses

- The junction between the branches of adjacent neurons
- Neurons do not join at a synapse, there is a very small gap

- Occurs between a branch at the end of an axon and a dendrite or the cell body of another neuron
- Messages are carried across the synapse
- The tiny gap between an axon and a skeletal muscle is called **neuromuscular junction**

Transmission across a synapse

1) An action potential arrives at the pre-synaptic axon terminal
2) Local depolarisation causes voltage gated calcium ion channels to open
3) Calcium ions from the extracellular fluid diffuses through the presynaptic membrane of the axon terminal and enters the cytoplasm of the axon terminal
4) The calcium ions cause neurotransmitter vesicles to migrate to the pre-synaptic membrane of the axon terminal
5) The neurotransmitter leaves the vesicles and enters the synaptic cleft through exocytosis
6) The neurotransmitter diffuses across the synapse to the post-synaptic membrane of the dendrite of the adjacent neuron
7) Sodium ions flood in, causing depolarisation in the postsynaptic dendrite
8) An action potential will be generated

Nerve impulses

- The message that travels along a nerve fibre
- Potential is measured in volts
- **Membrane potential** is difference between the charge inside the cell and the change outside the cell
- Transmitted very quickly, making it possible for the body to respond rapidly to a change in the internal or external environment
- A nerve impulse is an **electrochemical change** because it involves a change in the electrical voltage that is brought about by the concentration of ions inside and outside the cell membrane
- Speed of impulses depends on whether the nerve fibre is myelinated or unmyelinated and also the diameter of the fibre. Unmyelinated travels at 2m/s or 7km/h. Myelinated travels at 18m/s or 65km/h to 140m/s or 500km/h with the help of **saltatory conduction** which is when the nerve impulse jumps from one node of Ranvier to the next

1) A resting neuron has a positive charge on the outside of the membrane and a negative charge on the inside (resting membrane potential -70mV)
2) There is a high concentration of positive sodium ions on the outside and a high concentration of positive potassium ions on the inside
3) There is a greater concentration of negatively charged ions on the inside of the membrane than positive potassium ions making the inside negatively charged
4) A stimulus causes voltage gated sodium ion channels to open and sodium ions rush into the intracellular fluid
5) -55mV is threshold for voltage gated sodium channels
6) The inward movement of positively charged sodium ions reverses the charges either side of the membrane
7) The cell becomes depolarised, the charge on the inside is positive and the charge on the outside is negative
8) After the inside of the membrane becomes flooded with sodium ions, gated potassium channels open and allow the potassium ions to move to the outside
9) As soon as the potassium ions are released, the sodium ion channels close (membrane is repolarised)
10) The sodium potassium pump restores the concentration of sodium and potassium ions when the membrane is a resting state

Unmyelinated	Myelinated
Depolarisation of one area of the cell membrane causes an action potential to flow onto the membrane immediately adjacent to the stimulus. (1)	Depolarisation of one area of the cell membrane causes an action potential to jump from one node of Ranvier to another. (1)
The nerve impulse/exchange of ions (NOT action potential) moves along the entire length of the neuron/axon. (1)	The nerve impulse/exchange of ions (NOT action potential) only occurs at the nodes of Ranvier or cannot occur where the axon is myelinated. (1)
Lower concentration gradient of ions either side of the membrane. (1)	Higher concentration gradient of ions either side of the membrane at the nodes of Ranvier. (1)
The nerve impulse / message (NOT action potential) travels along the whole length of the fibre, reducing its speed. (1)	The action potential jumps from one node of Ranvier to the next on the myelinated fibre (saltatory conduction), the impulse can travel faster. (1)

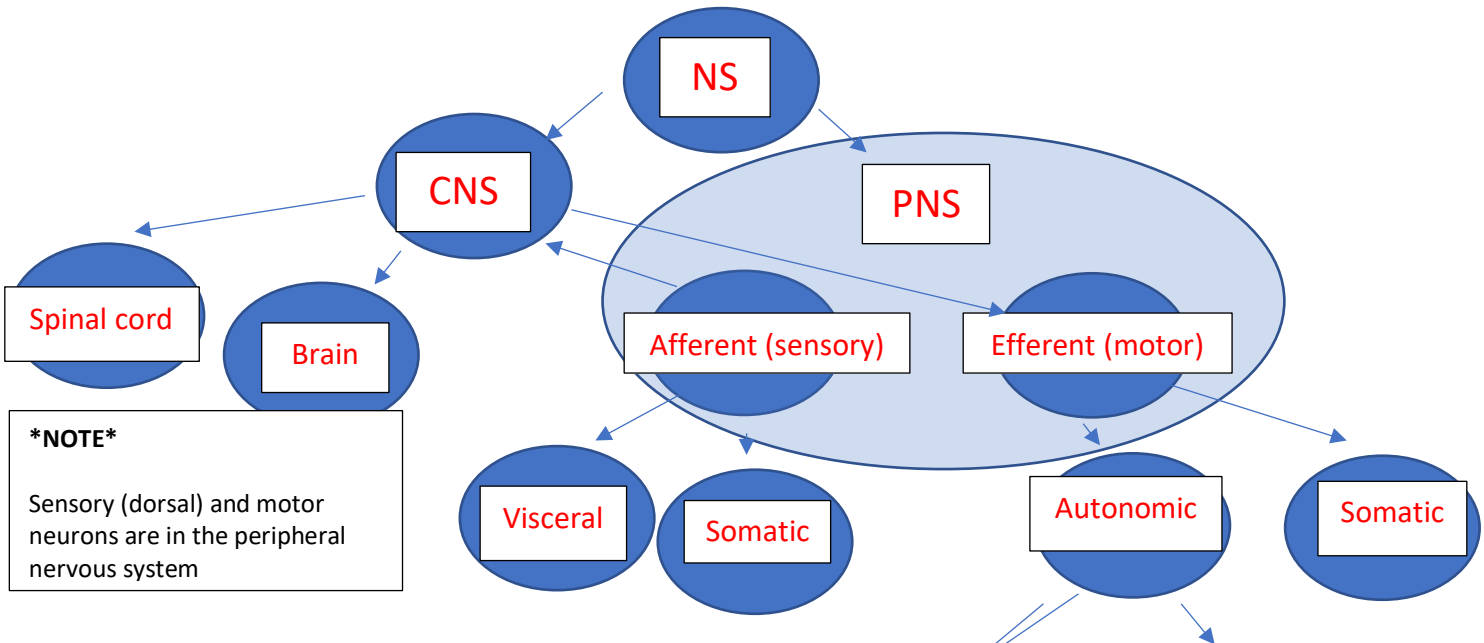
Chapter 4

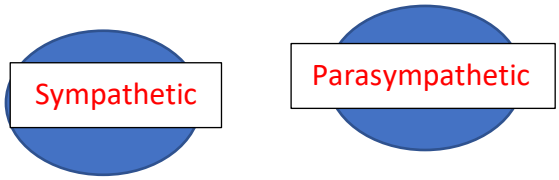
Central Nervous System: Consists of brain and spinal cord
Peripheral Nervous System: Neurons that aren't in the CNS. 43 pairs comprised of 12 cranium nerves and 31 spinal nerves. Divided into;

Afferent (sensory)
Somatic: Carries impulses from receptors around the muscle and skin to the CNS
Visceral: Carries impulses from the internal organs to the CNS

Efferent (motor)
Autonomic: Carries impulses from skeletal muscles to the CNS
Somatic: Carries impulses to the heart and other involuntary muscles

Sympathetic: Fight or flight response, prepares body for strenuous activity
Parasympathetic: Rest and digestion, maintains body during quiet and restful conditions
Sensory neurons (dorsal root): From the cells of the body and to the CNS
Motor neuron (ventral root): From the brain and spinal cord and to the cells of the body





Divisions of the efferent nervous system		
Characteristic	**Autonomic**	**Somatic**
Effectors	Involuntary muscles/organs	Skeletal muscles (voluntary)
General function	Adjustment of the internal environment	Response to the external environment
Efferent (motor) pathway	2 nerve fibres from the CNS to the motor neuron with a synapse in a ganglion.	One nerve fibre from the CNS to the motor neuron, no synapse and no ganglion
Neurotransmitter at effector	Noradrenaline = sympathetic Acetylcholine = parasympathetic	Acetylcholine at neuromuscular junction
Control	Involuntary	Voluntary
Nerves to target	2 sets, sympathetic and parasympathetic	One set, excitation of skeletal muscles
Effect target organ	Excitation or inhibition	Always excitation

Structure	**Effect of sympathetic NS**	**Effect of parasympathetic**
Neurotransmitter	Noradrenaline	Acetylcholine
Heart	Increases rate and strength of contraction	Decreases rate and strength of contraction
Lungs	Dilates bronchioles	Constricts bronchioles
Stomach	Decreases movement	Increases movement
Liver	Increases breakdown of glycogen and released as glucose	Increases uptake of glucose and synthesis of glycogen
Iris of the eye	Dilates pupils	Constricts pupils
Sweat glands	Increase sweat secretion	No effect
Salivary glands	Decreases saliva secretion	Increases saliva secretion
Blood vessels of: Skin Skeletal muscles Internal organs	 Vasoconstriction Vasodilation Vasoconstriction (except heart and lungs)	 Little effect No effect Little effect
Urinary bladder	Relaxes muscles of wall	Constricts muscles of wall
Adrenal medulla	Stimulates hormone secretion	No effect

Neurotransmitters

Sympathetic Nervous System	**Parasympathetic Nervous System**
Noradrenaline	Acetylcholine

- Fight or flight - Increases bodily functions	- Rest and digest - Decreases bodily fluids

Vasoconstriction: Blood vessels shrink, blood goes away from the organ to areas that need it more
Vasodilation: Blood vessels enlarge, blood goes to the organ from the area that doesn't need the blood like your organs

	Nervous System	***Endocrine System***
Speed	Rapid	Slow
Duration	Quick	Long
Transmission	Neurons	Hormones
Nature	Electro-chemical	Chemical
Cells affected	Muscles and glands	All body cells
Type of response	Specific/local	Widespread

Chapter 5 (CNS)

Protection of NS

Bone (outer)	Cranium and vertebral canal = tough outermost protective layer
Meninges (connective tissue) - Outer layer (dura matter) - Middle layer (arachnoid matter) - Inner layer (pia matter)	 Tough and fibrous Loose mesh of fibres Contains blood vessels that stick closely to the brain and spinal cord
Cerebrospinal fluid (between pia and arachnoid matter)	Shock absorber, cushions the brain and spinal cord

Parts of the brain

Structure	**Function**
Cerebral cortex	Higher order functions such as thinking, reasoning, memory, learning and conscious awareness of surroundings. Comprised of 4 lobes
Corpus callosum	Nerves fibres that allow communication between the 2 cerebral hemispheres

Cerebellum (below conscious level)	Coordination of fine contraction of voluntary muscle for smooth movements, balance and posture
Hypothalamus	Homeostasis; appetite, thirst, metabolism, body temperature, response to fear, water levels, sleeping
Medulla oblongata - Cardiac centre - Respiratory centre - Vasomotor centre	Regulates heart, breathing and diameter of blood vessels Regulates rate and force of heart beat Regulates rate and depth of breathing Vasoconstriction and vasodilation of blood vessels
Spinal cord - Ascending tracts - Descending tract - Spinal reflexes	Made up of grey matter and surrounded by white matter Sensory axons carrying impulses towards the brain Bundles of motor axons carrying impulses from the brain to the muscles Responsible for reflexes by nerve cells in the spinal cord without input from the brain

Folded patters of cerebral cortex

Longitudinal fissure	A deep cleft that separates the cerebrum into 2 halves. Stops at corpus callosum
Convolutions (gyrus or gyri)	Folds on the surface of the cerebrum
Sulci (sulcus)	Shallow downfolds of the surface of the cerebrum
Fissures	Deep downfolds

Functional areas

Sensory Area	Motor area	Association area
Interprets impulses from receptors	Controls muscular movements (skeletal muscles)	Interprets information from the senses and makes it useful

Chapter 6 (detecting and regulating change)

Receptors: Detect change in the body's internal and external environment
Homeostasis: Maintaining internal environment (steady state). Input and output of material and energy is balanced
Internal environment: Also known as the interstitial fluid. Is the cells immediate environment and provides optimum conditions for cell functions.

- **Properties of interstitial fluid**
- Body temperature
- Blood pressure
- Fluid concentrations (osmotic pressure)
- Acidity

- Concentration of nutrients (glucose, metabolic waste and gases)

Tolerance limit: range of conditions in which the body can function are referred to as our tolerance limits

Steady state control: body processes are responsible for maintaining homeostatic balance are called steady state control mechanisms

Feedback model: self-regulating control processes, the response continually modifies the stimulus. These feedback processes are referred to as feedback loops

Negative feedback and homeostasis: The response reverses the original stimulus. Controlled by endocrine and nervous system

Osmotic pressure: The amount of chemicals dissolved in the water. Less water = higher osmotic pressure

Receptor	Location	Detects
Thermoreceptors	Hypothalamus (central) Skin (peripheral)	Core body temperature External temperature
Osmoreceptors	Hypothalamus	Osmotic pressure
Chemoreceptors	Nose Mouth Blood vessels Medulla oblongata	Regulation of chemicals in the body. pH levels
Touch receptors	Skin (lips, fingertips, eyelids and genitals)	Responds to touch
Pain receptors	Skin Mucous membranes Most organs (not brain)	Damaged tissues
Pressoreceptors	Aorta Right carotid artery Right atrium	Blood pressure
Glucoreceptors	Pancreas	Blood sugar levels (glucose)

Thermoreceptors

Peripheral receptors	Central receptors
Found in skin and mucous membranes	Found in the hypothalamus = thermoregulatory centre
2 types; - Cold - Heat	Hypothalamus receives information from peripheral receptors

Reflexes

A rapid autonomic response to a change in the internal or external environment

Properties of a reflex

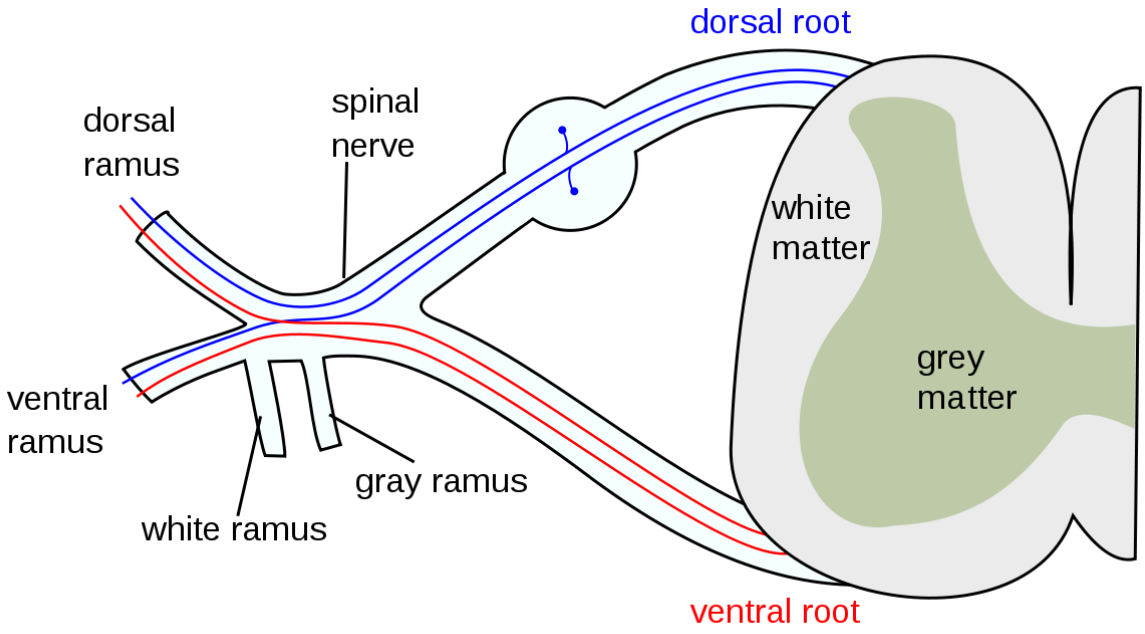
1) Requires a stimulus
2) Involuntary and occurs without conscious thought
3) Response is rapid, only a small number of neurons involved
4) Response is stereotyped, the impulse travels the same way each time it happens

Spinal reflex arc

- Pathway of a nerve impulse travels from a receptor to an effector
- Most are coordinated in the brain (and brain in unconscious thought)
- Involuntary (even though contraction of skeletal muscles may occur)

- Conscious awareness occurs after the response has been initiated

1) A receptor which is on a sensory neuron reacts to a change in the internal or external environment by initiating a nerve impulse along the sensory neuron
2) A sensory neuron carries the impulse from the receptor to the CNS (brain or spinal cord)
3) The nerve impulse is passed to an interneuron via a synapse which is in the grey matter of the spinal cord
4) The impulse is then passed to the motor neuron via a synapse in the grey matter of the spinal cord.
5) The motor neuron carries the nerve impulse to an effector
6) The effectors carry out the appropriate response, normally a skeletal muscle cell or secretory cells



Examples of reflexes

- Saliva
- Pain

Learned reflexes

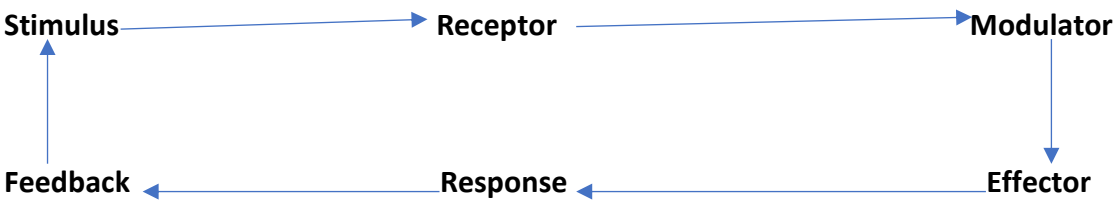
Innate reflexes: complex motor patterns that appear during development

- Determined genetically
- Suckling
- Chewing
- Following movements with their eyes

Acquired: Through constant repetition

- Muscular adjustments required for bike riding
- Jamming the brakes on a car
- Catching a ball

Negative feedback loop



Stimulus: the change in environment causing the system to operate, Eg core temp above 37
Receptor: detects the change, Eg thermoreceptors
Modulator: the control centre, process the information from the receptor and sends the information to the effector to act. Hypothalamus
Effector: carries out appropriate response. Eg, sweat glands
Response: counteracts the effect of the stimulus, Eg sweat secretion
Feedback: the original stimulus has been changed by the response, Eg core temp lowered to 37

Positive feedback

- No role in homeostasis
- Response to stimulus is intensified
- For body processes that must be completed quickly
- Release of oxytocin from posterior pituitary during child birth
- Blood clotting

Heat production

Cellular respiration: Produces heat for maintenance of core body temperature
Metabolic rate: Rate at which energy is released by the breakdown of food. Exercise increases metabolic rate. Stress also increases metabolic rate as it stimulates the sympathetic nervous system

Heat transfer

Radiation: No direct contact with the heat source, the sun
Convection: when hot or cold air passes over the body, a fan
Conduction: when heat moves from a warmer object to a cooler object. The objects must come in contact with each other, standing on hot sand
Evaporation: Evaporation of sweat results in heat loss which then cools the body down

Behavioural responses to change in temperature

- Conscious responses to maintaining body temperature
- Putting a jumper on
- Put heater on
- Putting clothes on
- Taking clothes off

Physiological responses in cold conditions

Vasoconstriction	Contraction of smooth muscles which squeezes the arteriole and reduces blood flow to the skin. Pre capillary sphincter muscles contract and stop blood flow into the cutaneous capillary beds
Secretion of adrenaline and noradrenaline	Increases the rate of cellular respiration, which results in heat production and an increase in body temperature
Shivering	Oscillating rhythmic muscle tremors occur at a rate of about 10-20% per second
Piloerection	Goosebumps. Contract the hair strands
Thyroxine	Increased levels of thyroxine which increases metabolic rate

Physiological in hot conditions

Physiological response	Description	Heat transfer
Vasodilation	Relaxation of blood vessels which increase blood flow to the skin	Heat loss via radiation and convection
Sweating	Sweat glands secrete sweat carried by sweat ducts to the skin	Heat loss via evaporation

Urine formation

- Filtration (in the renal corpuscle)
- Selective reabsorption (mainly in the proximal convoluted tubule, also in loop of Henle and distal)
- Tubular secretion (proximal and distal convoluted tubules)
- Only source of water loss that can be regulated
- Nephrons are the effectors in regulating fluid levels in the body

Reabsorption of water

- 60-70% of water reabsorption occurs in the proximal convoluted tubule
- 30-40% is selectively reabsorbed in the loop of Henle, distal convoluted tubule and collecting ducts
- Reabsorption in the distal convoluted tubule is an active transport process

Osmoreceptors

- Measure of osmatic pressure of blood
- If blood volume decreases, then osmotic pressure is raised
- If blood volume increases, then osmotic pressure is lowered
- Located in the thirst centre in the hypothalamus

Role of antidiuretic hormone

- The thirst centre in the hypothalamus stimulates the posterior lobe to release ADH
- ADH targets distal convoluted tubules and collecting tubules of the nephron
- This causes more water to be reabsorbed into the blood plasma
- ADH increases permeability of distal and collecting tubules to water
- Water leaves the tubules by means of osmosis

Dehydration

- Noticeable when you have lost 2% of your normal fluids
- Results in severe thirst, low blood pressure, dizziness and a headache
- If left untreated you could die

Water intoxication

- Cells increase uptake of water via osmosis
- Light-headedness, headache and vomiting

Chapter 8 (Blood sugar)

Regulation of blood sugar

- Sugar in the blood is in the form of glucose
- Glucose is the source of energy to cells; movement, reproduction and synthesis of molecules
- Energy is released from glucose molecules by cellular respiration
- Glucose + oxygen = carbon dioxide + water + energy
- Carbohydrates are absorbed into the blood through the walls of the small intestine
- Glucose is stored as glycogen = long chain of glucose molecules
- Glycogen is stored in the liver and muscle cells

Role of the liver

- Converts glucose to glycogen for storage and glycogen to glucose to be released
- Converts glycogen into glucose for release into the blood
- Livers supply comes from the hepatic portal vein

Role of the pancreas

- Hormone secreting cells called Islets of Langerhans
- Cells in the islets are of two types, alpha and beta
- Alpha cells secrete glucagon
- Beta cells secrete insulin

Insulin (beta cells)	Glucagon (alpha cells)
Decrease blood sugar levels	Increase blood sugar levels
1) Accelerates transport of glucose from the blood inti the cells, especially skeletal muscles	Converts glycogen into glucose
2) Accelerates the conversion of glucose into glycogen	Glucose is released into blood, increasing blood sugar levels
3) Also stimulates conversion of glucose into fat and adipose tissues	Produce new sugar molecules from fats and amino acids (gluconeogenesis)
Chemical sensors in beta cells stimulate secretion of insulin	
Glycogenolysis	Glycogenesis

Hormone: Insulin	1
Effector: Beta cells	1
Processes • Glycogenesis – conversion of glucose to glycogen in liver/muscles. • Lipogenesis – conversion of glucose to lipids in adipose tissue	2
Hormone: Glucagon	1
Effector: Alpha cells	1
Processes • Glycogenolysis – conversion of glycogen to glucose in liver/muscles. • Gluconeogenesis – conversion of lipids and amino acids to glucose in the liver	2
Hormone: Adrenaline or noradrenaline	1
Effector: Adrenal medulla	1
Processes • Glycogenolysis – conversion of glycogen to glucose in liver/muscles. • Glycogenolysis (Cori cycle) – lactic acid produced can be transported to liver and converted into glucose	2
Hormone: Thyroxine	1
Effector: Thyroid gland	1
Processes • Increases absorption of glucose from the small intestine into the bloodstream • Increases rate of cellular respiration, leading to increased rate of glucose absorption into all cells of the body.	2

Term	Meaning
Glycogenesis	Conversion of glucose into glycogen from other carbohydrates, especially glucose

Glycogenolysis	Breakdown of glycogen to glucose
Gluconeogenesis	Conversion of fats and amino acids into glucose

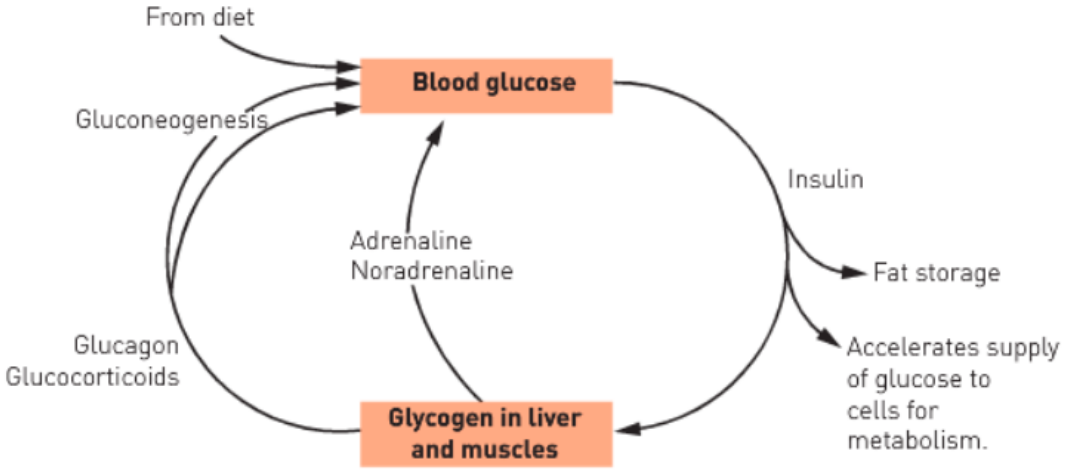
Role of the adrenal glands

- Play a role in blood glucose levels
- Composed of adrenal cortex and medulla
- ACTH from anterior pituitary stimulates secretion of glucorticoids, eg cortisol
- Increases carbohydrate metabolism by increasing rate of glycogenolysis and gluconeogenesis

Adrenal cortex	Adrenal medulla
ACTH from anterior pituitary stimulates secretion of glucorticoids, eg cortisol	Synthesises adrenaline and nor adrenaline
Increases carbohydrate metabolism by increasing rate of glycogenolysis and gluconeogenesis	Results in glycogenolysis

Blood sugar homeostasis

- Normal level of glucose in the blood is between 4 and 6 millimoles per litre



Breathing

- All cells produce carbon dioxide and is removed via the lungs
- All cells require oxygen for respiration. Enters via the lungs
- Both gases are transported by the circulatory system

Control of breathing

- Diaphragm and intercostal muscles cause air to move in and out of the lungs
- Phrenic nerve stimulates contraction of the diaphragm
- Intercostal nerves stimulate the contraction of intercostal muscles
- Spinal nerves originate in the neck and thorax
- Respiratory centre is located in the medulla oblongata
- Respiratory centre is split into expiratory and inspiratory centre

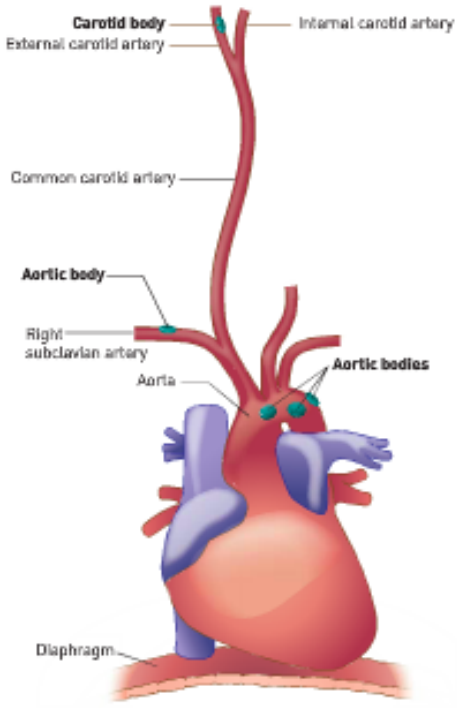
Respiratory centre	
Expiratory centre	**Inspiratory centre**
Controls breathing out	Controls breathing in
Sends impulses to internal intercostal muscles	Sends impulses to diaphragm and external intercostal muscles

Carbon dioxide/pH/hydrogen

- As carbon dioxide is dissolved in water, it forms **carbonic acid** which then dissociates to form **hydrogen** and **bicarbonate ions**
- Increase in hydrogen = decrease in pH
- Hydrogen/carbon dioxide stimulate peripheral chemoreceptors (aortic and coarotid bodies) which then send impulses to the respiratory centre of the medulla oblongata
- The impulses from the medulla stimulates the diaphragm and intercostal muscles via the phrenic and intercostal nerves respectively

Receptors – measuring gas concentrations

Central chemoreceptors	Peripheral chemoreceptors
In medulla oblongata	In aortic and carotid bodies
Detect CO2 concentration, pH of blood plasma and cerebrospinal fluid	Measures changes in pH (hydrogen ion concentration), CO2 and O2 of blood plasma
Takes a few minutes to respond and communicate	Responds quicker due to their location
Responsible for majority control of breathing	Small control over O2 breathing rate
	Responds largely to 8 gen ion levels and CO2 with the breathing rate. More sensitive



Carbon dioxide and breathing rate

- Small changes in CO2 can affect breathing rates
- Chemoreceptors in medulla oblongata are sensitive to CO2
- Large changes to O2 to affect breathing rate
- Chemoreceptors aren't as sensitive to O2 than CO2

Voluntary control of breathing

- Cerebral cortex has connections via the descending tracts of the spinal cord that bypass the respiratory centre
- As a result, we can consciously control our breathing (necessary for speech)

- Don't have to rely on medulla oblongata all the time
- When holding your breath, the respiratory centre will take over once CO2 levels are too high

Hyperventilation

- Rapid and deep breathing to provide more oxygen and remove more carbon dioxide than necessary
- More O2 in, more CO2 out
- Can occur due to severe physical and emotional stress
- It will correct itself as the chemoreceptors will not be stimulated and breathing will not be required until it returns to normal
- Can be done intentionally to hold breath
- However, as the breathing reflex responds to CO2, the person may require O2 before CO2 levels rise to the point where the body stimulates the breathing reflex.
- This could result in a lack of oxygen to the brain, causing the person to fall unconscious and drown

Cardiac output

- Heart rate = number of times heart beats in a minute
- Stroke volume = amount of blood leaving the heart with each contraction
- Cardiac output (mL/min) = heart rate * stroke volume

Factor	Effect on blood pressure
Pumping action of heart	Greater cardiac output, the higher the arterial pressure
Blood volume	The greater the blood volume the higher the arterial pressure
Viscosity of the blood	The more vi
Condition of blood vessels (resistance)	

Hearts Pacemaker

- Sinoatrial node = pacemaker and initiates heartbeat, right wall of right atrium
- Atrioventricular node = regulates beating of the ventricles

Receptors

- Called pressoreceptors = responds to change in blood pressure
- Found in aorta, right carotid artery and right atrium

Cardiac centre

- In medulla oblongata
- Connected to SA and AV nodes via sympathetic and parasympathetic nerve fibres

Factors that influence stroke volume

- Length of ventricle relaxation (diastole)
- Venous return = more blood enters the heart will result in more being pumped
- Noradrenaline increases the force of cardiac contraction therefore pumping a greater volume of blood

Factors on heart rate

- Age = heart rate is fast at birth and slows as we get older
- Gender = males tend to have a lower heart beat than females
- Emotional state = anger, fear and anxiety cause heart rate to increase

Response to exercise

Response to exercise	Factors affecting responses
Increased heart rate	Influence autonomic nervous system

	Effect of adrenaline
Increased stroke volume	Length of diastole Influence of autonomic nervous system Effect of venous return
Increased venous return	Activity of skeletal muscles Respiratory movements Blood flow through arterioles
Increased blood flow to muscles	Effects of carbon dioxide and lactic acid Iinfluence of autonomic nervous system

Chapter 9 (disruptions to homeostasis)

Homeostasis fails

- Maintained with tolerance limits
- Sick and die

Diabetes: high blood glucose levels where insulin is not being produced or not enough of it is being produced

	Type 1	**Type 2**
Causes	Caused by autoimmune response on beta cells in the pancreas	Caused by lifestyle factors, eg overweight, lack of exercise
Insulin	Does not produce insulin but cells do respond to it	Does produce insulin but cells don't respond to it
Treatment	Requires daily injections of insulin to manage conditions	Require management of diet, eg increase activity
When	Normally begins in childhood/early life	Normally begins onwards of 40

Effects of high sugar levels

- Damage to blood vessels
- Blindness
- Kidney failure
- Cardiovascular disease
- Loss of sensation
- Ulcers and gangrene
- Amputation of toes or foot

Treatment for hormone disruptions

- Hormone replacement therapy, oestrogen and progesterone in small doses
- Corticosteroid

Hyperthyroidism	
Causes	- Thyroid gland produces too much thyroxine - Overactive thyroid -
Symptoms	- Increased metabolism - Rapid heart beat - Unexplained weight loss - Increased appetite - Fatigue - Sweating - Anxiety

	- Protruding eyeballs
Treatment	- Surgery to remove part of the thyroid gland - Drugs that block the thyroids' use of iodine
Diseases	Graves' disease = immune system attacks thyroid

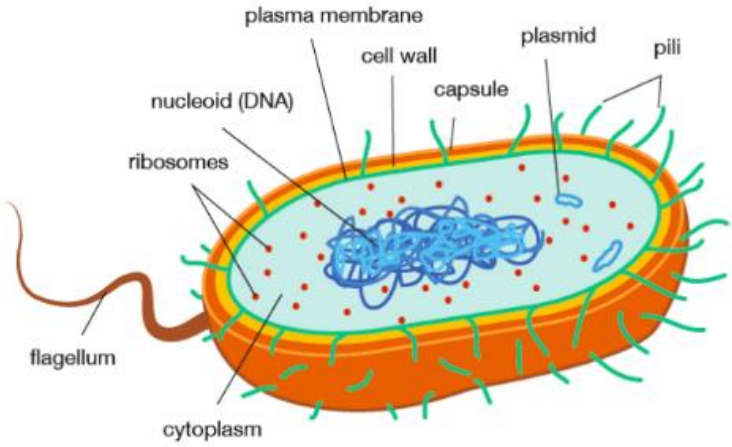
Hypothyroidism	
Causes	- Lack of iodine available to the thyroid gland - Thyroid not producing enough thyroxine
Symptoms	- Slow heart rate - Unexplained weight gain - Fatigue - Lack of energy - Intolerance to cold
Treatment	- Synthetic hormones containing iodine
Diseases	Hashimoto's disease

Chapter 10 (Protection Against Invaders)

Infectious disease: a disease passed from one person to another by infection with micro-organisms
Pathogens: a disease-causing organism
Contagious: a disease passed on by direct contact
Vectors: an agent capable of transferring a disease-causing organism from one person to another
Bacteriophages: a virus that infect bacteria
Bacteria:
Viruses: an infectious agent which are dependent on living cells for reproduction
Non-specific defences: defences of the body that act against **all** pathogens
Specific defences: defences of the body that are directed against **specific** pathogens
Sebum: an oily substance secreted by glands in the skin
Sweat: the liquid produced by the sweat glands on the skin
Cilia: hair like projections from a cell, they move materials across a tissue surface
Lysozyme: an enzyme that kills bacteria, found in tears, saliva and perspiration

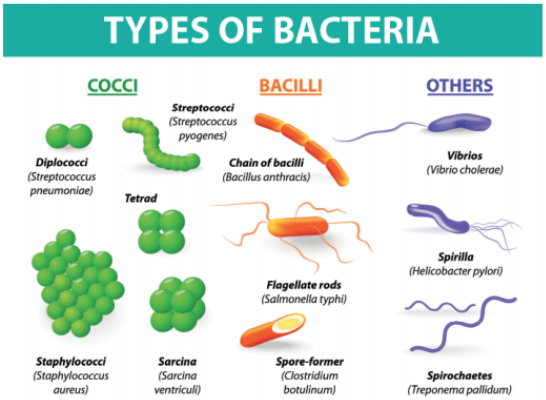
Structure of bacteria

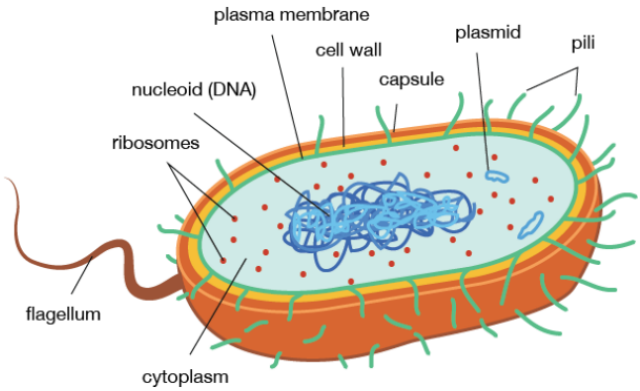
Structure	Description	Location
Slime layer	For protection of the bacteria from antibiotics	Around the very outside of some bacteria
Cell wall	Made of peptidoglycan, a combined carbohydrate protein	Covering the cell membrane
Cell membrane	Controls movement of substances in and out of the cell	Most inner wall
DNA	No nuclear membrane, so DNA forms a tangle inside the cells. Some DNA is in the form of loops called plasmids	Inside the cell
Plasmids	DNA in loops inside the bacteria	Inside the cell
Flagella	Allow for movement	Extensions of bacteria
Cytoplasm	Where the organelles hang out in	Everywhere inside the cell
Capsule	Formed of complex carbohydrates for protection.	Between the slime layer and cell wall



Types of Bacteria

Type of bacteria	Description
Cocci (spheres)	Spherical cells that can occur singularly, pairs or in clusters
Rods (bacilli)	Rod shaped cells with flagella for movement
Spirilla	Have twisted cells
Vibrio	Curved rods and shaped like a comma





Transmission of a pathogen

- Bacteria and viruses can be passed from one person to another (communicable/infectious)

Transmission	Description	Example
Transmission by contact	Direct: physically touching an infected person Indirect: touching an object which has been touched by an infected person	STI's
Transmission of body fluids	From an infected person which comes into contact with the mucous membrane or bloodstream of the uninfected person	HIV Hepatitis B and C
Droplets	Contains the pathogen which is breathed in or ingested. Emitted through coughing, sneezing or breathing	Measles Colds Influenza
Ingestion	Eating or drinking food which had been contaminated with pathogens	Typhoid fever Salmonella Dysentery

Airborne	Similar to transmission by droplets. If virus and bacteria survive it can cause infection once inhaled	Chickenpox Measles
Vectors	An agent which is capable of transferring a pathogen from one person to another. Vectors can spread directly or indirectly. Vectors are specific to a disease	Malaria = mosquitos Dengue fever

Bacteria vs Virus

Feature	**Bacteria**	**Virus**
Size	0.5-5 micrometres	20-400 nanometres
Protein coat	No	Yes
Cell wall	Yes	No
Plasma membrane	Yes	No
Cytoplasm	Yes	No
Nucleus	No	No
Membrane-bound organelles	Yes	No
DNA/RNA	DNA and RNA	DNA or RNA
Diseases caused	Salmonella Pneumonia Norovirus Listeria E. coli.	HPV HIV AIDS Common cold Warts

Defences against disease

Non-specific defences: work against **all** pathogens
Specific defences: directed at a **particular** pathogen

External non-specific defences

External non-specific defences	**Description**	**Location**
Skin	Physical barrier. Secretes sebum which is an oily fluid which kills pathogens. Fatty acids and salts in sweat also prevent micro-organisms from growing	Outside of the body
Sebum	An oily secretion produced by sebaceous glands which kill some pathogenic bacteria	Secretes into the blood
Sweat	Secreted by sweat glands and contains salts and fatty acids which prevent the growth of many micro-organisms	Skin Mucus membranes
Mucous membrane	Lines the body cavities that open to the exterior. Secrete mucus which prevents the entry of micro-organisms to the body	Lines the body cavities
Hairs	The hairs and a layer of mucus enable the nose to trap up to 90% of particles when breathing to stop them from moving through the respiratory system	Nose Ears
Cilia	Tiny like hair projections from cells which trap particles and micro-	Mucus membranes of nose Trachea

	organisms and take it back to the throat in a beating motion	
Acids	Acid fluids kills many of the micro-organisms taken in with food or mucus swallowed from the nose	Stomach Vagina
Lysozyme	An enzyme which kills bacteria. It weakens the cell wall.	Eyes = tears Saliva Sweat Secretion of nose
Cerumen (ear wax)	Slightly acidic and contains lysozymes which protect the outer ear	Ear
Flushing action	Movements of fluids prevent pathogens from infecting the body	Urine in urethra Tears Sweat Vagina

Protective reflexes

An automatic response to a stimulus with the goal of protecting the body. Protective reflexes include;

- Sneezing = something bad in nose
- Coughing = something bad in mouth
- Vomiting= something bad in stomach/throat
- Diarrhoea = something bad in the intestines

Internal non-specific responses	**Description**	**Location**
Phagocytes	Cells which ingulf and digest micro-organisms and cell debris	Capillaries
Leucocyte	Have the ability to leave the blood capillaries and migrate through tissues to the place of infection	Capillaries
Macrophage	Develop from some leucocytes. Can be either fixed in one place or some can wonder. Secrete substances that kill bacteria	Capillaries
Inflammation	Shows signs of redness, swelling, heat and pain. Occur as a result of the process which shows in response to an infection	Where the damaged tissue is
Fever	Elevation of body temperature caused by an increase in the body's thermostat (controlled by hypothalamus). Inhibits growth of bacteria/viruses and speeds up the rate of chemical reactions which allow cells the repair at a faster rate	
Pyrogens	Chemicals released by white blood cells during an	

	inflammatory response which acts directly on the hypothalamus, causing it to increase body temperature	

Inflammatory response

1) When stimulated by mechanical or chemical damage, mast cells release histamine, heparin and other substances. Mast cells stimulate and co-ordinate inflammation by releasing chemicals
2) Histamine increases blood flow through the area and causes the walls of the blood capillaries to become more permeable so that fluid is filtered from the blood. This increase in blood blow causes the heat and redness associated with inflammation, and the escape of fluid from the blood causes swelling
3) Heparin prevents clotting, so the release of heparin from the mast cells prevents clotting in the immediate area of the injury. A clot of the fluid around the damaged area does form and this slows the spread of the pathogen into healthy tissues
4) The chemicals released by the mast cells attract phagocytes. Macrophages and leucocytes actively consume micro-organisms and debris by phagocytosis
5) The abnormal conditions in the tissue stimulate pain receptors, and so the person feels pain in the inflamed area
6) The phagocytes, filled with bacteria, debris and dead cells, begin to die. The dead phagocytes and tissue fluid form a yellow liquid called pus
7) New cells are produced by mitosis and repair of the damaged tissues takes place

Lymphatic system

- Lymph fluid carries pathogens to the lymph nodes
- Lymph nodes form a mesh which traps in bacteria
- This allows macrophages to come into lymph node and engulf

Helping the body's non-specific defences

Good hygiene	Mechanical barriers
Wash hands	Surgical mask
Cover your mouth	Protective clothing
Wear gloves	Safety glasses
Wipe surfaces	Condoms
Use tongs, pliers or tweezers	
Don't share personal items	

Chapter 11

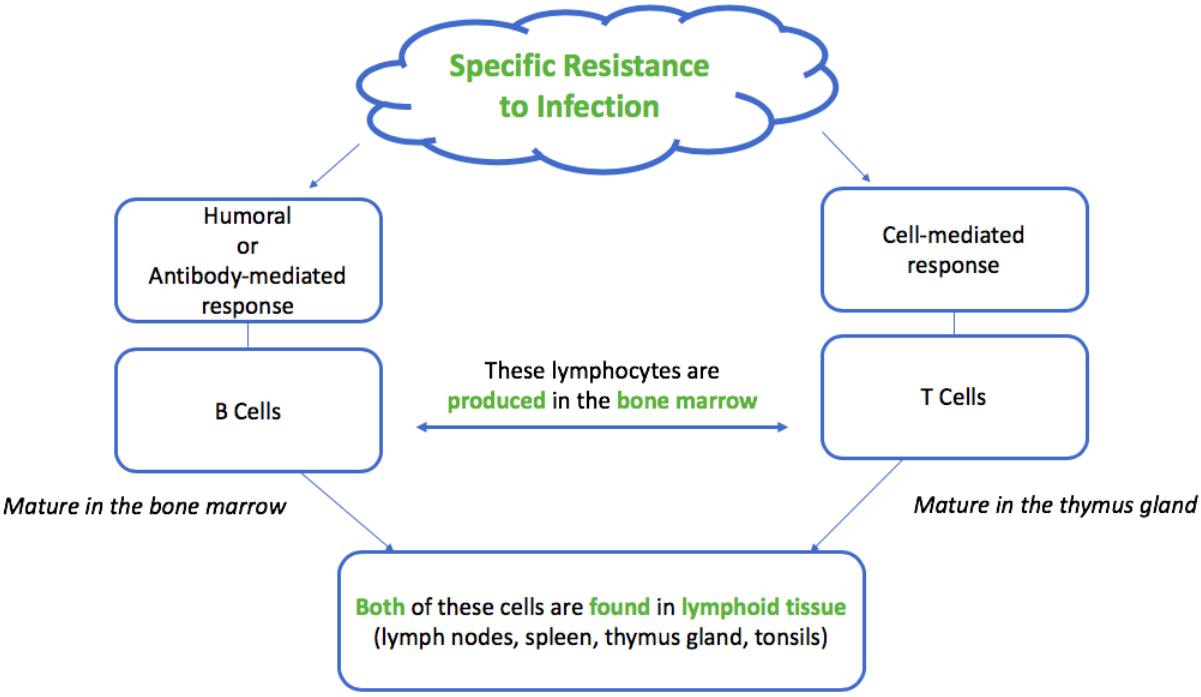
White blood cells

- Lymphocytes are produced in the bone marrow and lymphoid tissue, roam throughout the body
- Macrophages are involved in specific and non-specific defences. Non-specific = engulfing pathogens. Specific = alerts the immune system to the presence of foreign material. They are phagocytic

Difference between leukocytes and lymphocytes

Leukocytes	Lymphocytes
A white blood cell	A sub type of a white blood cell

Parts of the immune response



Characteristics	Humoral (antibody-mediated response)	Cell mediated
Type of cell	B-cells	T-cells
Where are they produced	Bone marrow	Bone marrow
Location of maturation	Bone marrow	Thymus gland
Where are they found	Lymphoid tissue Lymph node Spleen Thymus gland Tonsils	
Location of resistance to infection	Extracellular fluid (blood, lymph)	Intracellular fluid

Humoral or antibody-mediated immunity

Antigen: any substance capable of causing a specific immune response. Proteins on surface of cell
Self-antigens: large molecules produced in the person's body that don't trigger an immune response
Non-self-antigens: compounds that trigger an immune response. Activates B-lymphocytes

Antibody: a substance produced in response to a specific antigen. Combines with the antigen to neutralise it or destroy it
Antigen-antibody complex: antibodies binding to active sites on its corresponding antigen
Antibody-mediated immunity: the production and release of antibodies into the blood and lymph

How antibodies act on pathogens

1) Combine with foreign enzymes or bacterial toxins to inactivate them
2) Bind to the surface of viruses and prevent them from entering cells
3) Coat bacteria to make them easier to be consumed by phagocytes
4) Agglutination, making phagocytosis easier.
5) Dissolve organism/antigen/pathogen
6) Combining with soluble antigens to make them insoluble

Foreign antigen in body

1) B-cells are sensitised by non-self-antigens in the extracellular fluid
2) B-cells enlarge and divide into groups called clones
3) Most of clones become antibody-secreting plasma cells, the rest become memory cells
4) Antibodies circulate in the blood, lymph and extracellular fluid
5) Antibodies combine with antigens to form antigen-antibody complexes
6) Memory cells spread to all body tissues, so that a rapid response can occur should the antigen enter the body again

Primary response	Secondary response
First exposure to non-self-antigen	Second exposure to non-self-antigen
Slow response	Fast response
B-cells to multiply and differentiate into plasma cells	There's already heaps of plasma cells and memory cells from the primary response
Takes several days to build up large amounts of antibodies	Antibodies are released straight away preventing severe symptoms

Cell-mediated immunity

- T-lymphocytes are responsible
- Provides resistance to the intracellular phase of bacterial and viral infections
- Involved providing resistance to fungi/parasites
- Cancer cells
- Rejection of transplanted tissue

Killer T-cells: migrate to site of infection and attach to invading cells and secrete a substance that will destroy the antigen
Helper T-cells: Intensifies the immune response by attracting more macrophages, intensifies the phagocytic activity of macrophages
Suppressor T-cells slows down immune response after infection is dealt with successfully. Releases substances that inhibit T and B cell activity
Memory cells: cells that remember the antigen

1) T-cells are sensitised by non-self-antigens in the intracellular fluid
2) T-cells enlarge and divide into groups called clones
3) Most of clones become killer T-cells or helper T-cells and migrate to where a large number of non-self-antigens are present. Some T-cells become memory cells as well
4) Killer T-cells attach to antigens and destroy them
5) Helper T-cells promotes phagocytosis by macrophages
6) Suppressor T-cells slow down the immune response after the infection is dealt with

Specific Immune Response Steps

1) An antigen is necessary to cause an immune response
2) Macrophages engulfs the pathogen and displays the antigen on its surface of helper T-cells
3) Specific B and T lymphocytes recognize the antigen
4) B and T cells are sensitised and enlarge producing clone cells
5) B-lymphocytes produce plasma cells which are capable of producing antibodies
6) Antibodies move throughout the bloodstream
7) Antibodies bind to antigens to form antigen-antibody complex
8) Antibodies destroy pathogens through agglutination/neutralisation/enhanced phagocytosis
9) T-lymphocytes produce killer T-cells which move to the site of infection to destroy the antigen
10) Actions of killer T-cells sensitives other lymphocytes and enhance phagocytosis
11) Memory B and T cells are also produced for the secondary response to be quicker

Active immunity: results from the production of antibodies by the immune system in response to the presence of an antigen. Long term immunity which results in memory cell
Passive immunity: short term immunity which results from the introduction of antibodies from another person or animal. Doesn't create memory cell

Natural immunity: Resistance to infection by a pathogen that occurs without any outside human intervention
Artificial immunity: occurs when a person is injected with an antibody or an antigen

	Natural	**Artificial**
Passive	Antibodies enter the bloodstream across the placenta or in breast milk (maternal antibodies)	Antibodies are injected into the bloodstream (antibody transfer) (tetanus)
Active	Ability to manufacture antibodies results from an attack of a disease (infection). Antibodies and memory cells get manufactured from the antigen	An antigen is injected, and the body responds to the antigen creating antibodies and memory cells

Immunisation: programming the immune system so that the body can respond rapidly to infecting micro-organisms. Can occur naturally or artificially
Vaccination: the artificial introduction of antigens of pathogenic organisms so that the ability to produce the appropriate antibodies is acquired without the person having to suffer the disease
Vaccine: is the antigen mixture that is given to the person
Antiserum: a blood serum containing antibodies against specific antigens, injected to treat or protect against a specific disease

Types of vaccines

Type of vaccine	**Description**	**Example**
Living attenuated micro-organism	Reduced virulence. Bacteria is kept at a high temperature for a period of time and then given as a vaccine	Polio Measles Tuberculosis
Dead micro-organisms	The immunity is shorter lived. Inactivated micro-organisms	Typhoid Cholera Whooping cough
Toxoids	Filtrates of bacterial cultures. Toxins are separated and inactivated before being injected into the person	Diphtheria Tetanus
Sub-unit	A fragment of the micro-organism is used to provoke the immune response	HPV (Gardasil) Hepatitis B

Type of vaccine	**Positive**	**Negative**
Dead micro-organisms	**Cholera** vaccine gives good protection against the disease	Every 1 in 1 million children vaccinated with dead **whooping cough** bacteria dies from damage to the nervous system

		Cholera is only effective for a short period of time

Side effects

- Very effective, usually harmless
- Severe allergic reactions can occur
- 1/million children given the whooping cough vaccine die from severe damage to the nervous system
- There is an ethical debate that surrounds the vaccination of children

Recombinant DNA

- DNA that has been formed artificially by inserting or changing the DNA in the micro-organism
- Used in 1 way
    1) Taking a bit of DNA from a pathogen and a bacterial cell and combine them to create recombinant DNA
- Developers of modern vaccines will use this more because the vaccines created have no longer the potential to cause disease

Delivery of vaccines

- Injection from a syringe
- Oral via a syrup
- Sugar cubes
- Nasal spray
- Skin patches

Vaccination and booster cells

- First dose of vaccine doesn't enable enough B-cells to become activated
- Booster shots are therefore needed
- Booster shot timing is essential
- Booster shot is given after 3 weeks which activate B-cells which produce more antibodies

Public health considerations

- World health organisation push vaccination because of the significant effect it has on preventing suffering from a disease

Why object to vaccinations

- Allergic reactions
- Dangerous preservatives
- Cross contamination, between species as a result of preparation conditions. HIV was transmitted from apes to humans via faulty polio virus

Ethical concerns

- Animal welfare, many vaccines were first tested on animals
- Religious reasons
- Political
- Complacency, contracting the disease is less than the chances of suffering side effects

Antibiotics

- Drugs used to fight infections
- 2 types
    1) Broad spectrum = targets wide range of bacteria
    2) Narrow spectrum = targets specific bacteria
- Bactericidal antibiotics kill bacteria by changing the structure of the cell wall/membrane
- Bacteriostatic antibiotics stop bacteria reproducing by disrupting protein synthesis
- Over use of antibiotics leads to multiple drug resistance or total drug resistance

Antiviral

- Specifically treats viral infections by inhibiting the development of the virus
- Antibiotics are ineffective against viruses

Herd Immunity

- A type of 'group immunity' that occurs when such a high proportion of the people in a population are immunised so people who aren't immunised are also protected.
- The pathogen is less likely to be transmitted between people
- This is important for young infants because it greatly reduces illness in them and also prevent the spread of infectious diseases.
- Immunocompromised refers to in which the immune system's ability to fight infectious disease and cancer is compromised or entirely absent. (impaired immune system)
- If a child is immunocompromised and a high proportion of infants have received a vaccination for a specific pathogen then the immunocompromised will also be protected from it.

Social/Economic/Cultural Influence Participation

Social

- In developing countries, parental education is poor
- The level of education of women has a significant influence on vaccination rates of children
- Parents may be aware of the benefits of vaccinations, but the cost might be too much
- In Australia, the internet and media are sources of misinformation about the risks and benefits of immunisation

Economic

- In Australia most immunisations are free
- However, in other countries this may not be the case
- The economic circumstances of an individual may prevent participation
- In developing nations, average income level is low

Religious

- Religion is a reason why some Australian parents refuse to immunise their children
- None of the major religions in Australia oppose this however (Christianity, Muslim and Jewish)
- This is often not the case in other countries
- Christians in Nigeria have an immunisation rate of 66% whilst Muslims only have a 32% immunisation rate
- In many places traditional medicine is considered superior to evidence-based medicine

Chapter 12 (Mutations and Gene Pools)

Chromosomes

- Found in the nucleus of the cell
- Packaged into thread like structures called chromosomes
- Each chromosome is made up of tightly coiled DNA around proteins called histones

Genes

- Made up of segments of DNA
- Code for proteins = chain of amino acids
- Haemoglobin, actin, myosin, insulin and amylase are all proteins

Alleles: alternative form of a gene that are found in the same place on a chromosome

Population: A group of organisms of the **same species** living **together** in a particular place at a particular **time**

Gene pools: The sum of all alleles of all individuals in a genetic population

- A genetic population is an array of gene which recombine and combine in the process of sexual reproduction
- Tell us the kind of genes present in a population
- How genes are distributed among. Individuals of a population

Mutations

- A permanent change in the DNA. If it's in a gene or chromosome it may lead to a new characteristic in an organism
- Two types, gene and chromosomal

Mutagen: increases the rate of mutations, eg mustard gas, sulfur dioxide, X-rays and UV rays

Somatic	**Germline**
Affects specific body cells	Mutations occur in gamete cells
Only the individual is affected and is not passed onto offspring	Individual normally not affected
Involved in cancerous growths	Passed onto offspring
Nerves, muscles cells	Affected embryos are naturally aborted

Chromosomal mutation

- Involves all or part of a chromosome and therefore affects not just 1, but a number of genes

Types of chromosomal mutations	**Definitions**	**When**
Non-disjunction	Chromosome pairs that do not separate, therefore resulting in 1 daughter cell having 1 too many and 1 less	Cell division (meiosis)
Translocation	A part of a chromosome breaks off and is re-joined to a different chromosome	Cell division
Inversion	A chromosome breakage and re-arrangement on the same chromosome	Cell division
Deletion	A sequence of DNA is removed	DNA replication
Duplication	A section of chromosome that occurs more than once	DNA replication

Types of conditions	**Definitions**	**Chromosome involved**
Trisomy 21 (down syndrome)	A person having 3 '21' chromosomes	21
Trisomy 13 (Patau syndrome)	A person having 3 '13' chromosomes. This causes - Mental retardation - Small head	13

	- An extra finger on each hand - Lip, eye and ear malformations	
Trisomy XXY (Klinefelter's syndrome)	Produces 2 'X' chromosome and 1 'Y'. This causes - Small testes which do not produce sperm - Enlarged breasts - Little body hair	X
Partial monosomy 5 (Cri-du-chat syndrome)	Also known as cri-du-chat syndrome. Missing portion of chromosome 5. This causes - Problems with larynx - Problems with the nervous system	5
Monosomy X (Turner's syndrome)	When a female is born with 1 'X' chromosome This causes - Short stature - Lack of secondary sexual characteristics - Infertility	X

Gene mutations

- Affects individual genes
- Genes code for amino acids, and amino acids together make up proteins
- Disruptions of base sequences may result in
  -no change
  -change of protein structure
  -disrupt protein production

Point mutation = A change in just 1 base sequence

Types of gene mutations	**Description**
Point mutation	A change in 1 base sequence
Insertion	Addition of a nucleotide into a DNA sequence
Deletion	A removal of a nucleotide from a DNA sequence

<u>Conditions associated</u>

Albinism is a mutation of the genes involved in melanin production.

Features include

- Absence of pigment in hair, skin and eyes
- Hair = whitish blond
- Skin = extremely pale
- Eyes = pinkish

Duchenne Muscular Dystrophy is a mutation in a mother which can be passed down to her son, or a mutation in the zygote.

Features include
- Wasting of muscles (legs first, then arms)
- Evident by 3-5-year old's due to muscle weakness
- Death due to failure of respiratory muscles

Cystic Fibrosis is a mutation found on chromosome 7. The gene codes for a protein that regulates the passage for chloride ions across the cell membrane

Features include
- Salty-tasting skin
- Coughing
- Pneumonia
- Mutant allele is recessive

Tay-Sach's disease is a disorder of lipid metabolism

Features include
- Autosomal recessive
- Condition is lethal due to missing enzyme
- Results in fatty substance in the nervous system

Lethal recessives
- Most gene mutations produce a recessive allele
- Some mutations are lethal if they are not masked by a dominant normal allele
- Causes death of embryo or foetus (miscarriage)

Chapter 13 (Biotechnology)

Biotechnology: the exploitation and manipulation of cellular processes for industrial production of products used by humans

DNA sequencing
- Determining the precise order of nucleotides in a sample of DNA
- Allows for comparison of DNA sequences
- Detects small insertions and deletions
- Can show whether a person will develop an inherited disease

Sanger sequencing
- Synthetic nucleotides are man made
- The synthetic nucleotides lack a hydroxyl group
- Prevents chain elongation
- Allows for comparison of DNA molecules and determination of sequences

1) Lacks a hydroxyl group which terminates elongation

Recombinant DNA Technology involves the introduction of DNA into cells where the DNA is foreign that organism or has been modified in some way

Transgenic organism
- When an organism's genome has been altered by the transfer of a gene from another organism
- Becomes part of the organism's DNA
- Passed onto next generation

Bacteriophages

- Viruses that infect bacterial cells
- Enzymes in bacteria are able to restrict the duplication of infecting viruses by cutting up viral DNA at specific base sequences
- Sequences that are cut are known as the **recognition site**

Restriction enzymes: restricts the duplication of bacteriophages

Straight cut: restriction enzymes make a clean break across the two strands of DNA to produce a blunt end
Blunt end: when both strands terminate in a base pair

Staggered cut: cuts DNA into fragments with sticky ends
Sticky ends: a stretch of unpaired nucleotides in the DNA molecule that overhang at the break in the strands

DNA ligase: DNA joining enzyme
Ligation: the process of joining short strands of DNA

Vector

- An agent used to transfer genetic material from one cell to another
- Eg, plasmid
- A plasmid is a small circular strand of DNA **distant** from the main bacterial genome; it is composed of only a **few genes** and is able to **replicate independently** within a cell

Recombinant DNA Steps

1) A segment of DNA is isolated and is cut by a restriction enzyme
2) The restriction enzyme cuts the DNA at the recognition sites on either side of the gene which creates a staggered cut
3) Unpaired nucleotides overhang at the break which produces sticky ends
4) A plasmid is removed from a bacterium
5) The plasmid is cut with the same restriction enzyme which creates sticky ends
6) The sticky ends of the isolated gene and the plasmid are joined together by DNA ligase
7) The combined gene and plasmid are inserted into a bacterial cell where it undergoes mitosis
8) Large amounts of the gene is produced

Examples of recombinant DNA

- **Insulin** = no side effects because only the insulin gene is removed from human DNA
- **Human growth hormone** = E.coli has dramatically increased the supply of the hormone
- **Haemophilia A** = referred to as classic haemophilia, missing factor VIII which produces people that are unable to form blood clots. HIV and Hep C caused deaths of many
- **Vaccines** = development of recombinant DNA vaccines do not have disadvantages

Polymerase Chain Reaction

Polymerase Chain Reaction: Artificially multiplying segments of DNA through a series of repeated cycles of duplication using polymerase

PCR ingredients

1) DNA sample – what you want amplified

2) Deoxynucleotide triphosphates, eg adenine, thymine, guanine and cytosine
3) *Taq* polymerase, primers

Primers

- Short segments of DNA
- Complementary to the targeted sequence
- Primers bind to single stranded DNA molecules
- Initiates replication by DNA polymerase

DNA polymerase

- From hot spring bacterium = thermus aquaticus
- Taq polymerase
- Taq polymerase is a heat stable enzyme
- Optimum level for activity is 75-80 degrees

PCR cycle

- A single cycle will last approximately 2-3 minutes
- Cycles involves 3 phases
  -Denaturing
  -Annealing
  -Elongation/extension
- Each round of PCR lasts around
- Every replication cycle result in double the amount of targeted DNA

Denaturing (90-95 degrees)

1) The double stranded DNA molecule is separated by heating the DNA to 90-95 degrees
2) The heat breaks the weak hydrogen bonds between the complementary bases

Annealing (55-65 degrees)

3) Primers attach to each single stranded DNA molecule at a specific area
4) The primers provides an attachment site for Taq polymerase and primes the strand for elongation

Extension/Elongation (70-75 degrees)

5) Taq Polymerase synthesises the complementary strand by adding nucleotides
6) The amount of DNA is doubled after each cycle
7) Taq Polymerase works at optimum efficiency at this temperature

Applications of PCR

- Detects heredity diseases
  -targets gene of interest
  -sickle cell anaemia, cystic fibrosis
- Detects viral diseases
- Forensic science
  -blood, semen or strand of hair
- Determines the relationships between humans and their ancestors

Profiling techniques

- DNA is digested with restriction enzymes that cut at specific base sequences
- The length of the specific base sequences are distinct from one person to other
- Negatively charged DNA are put on a bed of semi sold gel
- An electric current is passed through the gel via electrodes at either end

Gel Electrophoresis

- Small DNA moves faster than larger ones because the DNA is negatively charged
- The larger DNA molecules move through the gel, towards the positive electrode, whilst the small molecules only travel a small distance
- Results in a pattern of bands
- These bands are known as DNA fingerprints

Applications

- Tracing ancestry
- Maternal or paternal identification
- Forensic science
- Identification of heredity diseases
  -can be used to identify carriers of a disease
  -cystic fibrosis and Huntington's disease

Gene therapy: correction of mutated genes by replacement or introduction of a healthy copy of a gene/DNA

- Replaces faulty genes with healthy ones
- Haemophilia, AIDS, diabetes, cancers
- Produces the correct protein

Aims of gene therapy

- Boosting the immune system = increase antibody levels in blood
- Makes cancer treatment more efficient
- Pro drug gene therapy = change an inactive drug to an active form
- Blocking processes
- Using alternative viruses

Processes

- Replacement or supplementing non-functional genes into cells and tissues
- Introduces genetic material to make beneficial proteins
  -injecting a vector
  -exposing a vector
- Inactivating or knocking out

Gene therapy strategies

- Gene augmentation therapy = treats loss of function disorders (cystic fibrosis)
- Gene inhibition therapy = eliminates the activity of a gene (cancers and inherited diseases), blocks production of
- Killing of specific cells = insert a marker or suicide gene into diseased cells that causes that cell to die (cancers)

Benefits of gene therapy

- Offers a cure to several diseases
- These benefits can be passed onto offspring
- Replaces defective cells
- May be the only way to treat some genetic disorders

Cell replacement therapy: the differentiation of stem cells into damaged cells with healthy ones

Stem cells: immature cells that are able to mature into specialised cells

Embryonic stem cells

- Found in fertilised eggs

Adult stem cells

- Found in bone marrow and fats
- Can become blood cells and platelets

Perinatal stem cells

- Found in amniotic fluid and umbilical cord

IPS cells

- Transformation of regular adult cells into stem cells

Parkinson's disease = when dopamine parts of the brain aren't working
- Loss of balance and fine motor control
- Stem cells into dopamine neurons
- Transplants healthy neurons into the brain

Bone marrow transplants
- Central venous catheter
- Conditioning
- Stem cell transfusion via CVC

Chapter 14 (Changes in Alleles Frequencies)

Types of variation	Definitions
Random assortment	Results in gametes that have a huge number of possible combinations of the chromosomes that originally came from the male and female parent. Occurs during **meiosis**.
Crossing over	Chromatids cross over during **meiosis** and may result in pieces of chromatids being broken off and attaching to a different chromatid
Non-disjunction	Where 1 or more members of a chromosome fail to separate during **meiosis**
Random fertilisation	There is an infinite number of possible combinations of alleles in the offspring
Mutations	Permanent changes in the DNA of a chromosome and may result

Allele frequencies: how often each allele occurs in a gene pool for a population

Natural selection (Charles Darwin)
- Survival of the fittest
- Selection of favouring alleles which are passed to enhance survival and reproduction of the species, which allows the species to adapt to their environment
- Nature begins to favour one set of alleles at the expense of others (**selection pressure**)
- Environment changes favours particular characteristics to enhance survival then frequency for alleles increase overtime as the generations adapt to it

Random genetic drift
- Known as the Sewall wright effect
- Recognises the random variation changes in allele frequencies which occurs by **chance**
- Driven by chance
- Non-directional
- Occurs only in small populations

Founder effect (under genetic drift)
- When a small group moves away from their homeland to a totally new area to establish a new community
- Examples include islanders
- New people from a population carry the new allele frequency into the new population
- The allele frequency the from the small group does not reflect that of the community they moved in to

Migration
- Results in changes in allele frequencies in a gene pool

- Gene flow: transfer of alleles from one population to another population through migration

Barriers to gene flow

- Inhibits the amount of interbreeding between populations
- Isolation contributes to the development of separate gene pools
- Geographical = oceans, mountain ranges, lakes and deserts
- Sociocultural = culture, language, economic status and education background

Genetic variation: the variation in the DNA sequences in each of our genomes

Tay-Sachs disease

- Heredity disorder via carriers
- Caused by a missing enzyme
- If you are heterozygous for Tay-Sach's you have increased resistance to **tuberculosis**
- Results in the accumulation of a fatty substance in the nervous system
- Occurs most frequently in Jewish people in Eastern Europe
- Death occurs by

Description	Marks
Population - Ashkenazi Jews/Jewish people	1
Cause – Missing enzyme which is essential for fat metabolism	1
Symptoms – - Build-up of fatty acids in the nervous system - From a few months of age mental and physical disabilities develop quickly	1 - 2
Inheritance – Recessive trait is passed from the 2 carrier parents	1
Effect on gene pool – - Affected individuals die in childhood/before reproductive age - Carrier couples choose to not reproduce - Heterozygous individuals are resistant to tuberculosis - Increase Tay-Sachs allele frequency in population	1 - 2

Thalassaemia

- Inherited disease
- Caused by a recessive allele
- Formation defects of haemoglobin
- People with this disease require frequent blood transfusions and drugs
- Occurs most frequently along the Mediterranean (Italy and Greece)

Description	Marks
Population – Mediterranean, Greece/Italy	1
Cause – Mutations of the gene responsible for haemoglobin production	1
Symptoms – - Defects in the formation of haemoglobin - Sufferers have fewer functioning red blood cells - Sufferers can have anaemia and be iron deficient	1 - 2
Inheritance – Recessive trait is passed from carrier parents to offspring	1
Effect on gene pool – - More mutations found in gene pool greatly increases mortality rate - Increases thalassemia allele frequency in population	1 - 2

Sickle-cell anaemia

- Inherited disease
- Blood being crescent or sickle shape

- Don't carry much oxygen, therefore reducing the surface area
- Carriers can have mild sickling/effects
- Heterozygous people are resistant to malaria and decrease chance of death

Description	Marks
Population - Black African population	1
Cause – Mutations of the gene responsible for haemoglobin production	1
Symptoms – - Red blood cells have a sickle shape (crescent) - Reduces oxygen carrying ability - Fatigue/shortness of breath	1 - 2
Inheritance – Recessive trait is from affected parent to offspring	1
Effect on gene pool – - Individuals who are homozygous usually die early, disease can be fatal - Individuals who are heterozygous are called 'sickler's' and have the sickle trait - Heterozygous individuals are resistant to malaria/ increases sickle cell allele frequency in population	1 - 2

Natural Selection

- Charles Darwin
- Evolution = gradual change in the characteristics of a species
- Resources are limited in nature
- Heritable traits that favour survival and reproduction will tend to produce more offspring

Components of natural selection

Variation

- Offspring in any generation will be different from one another in their traits
- Variation has to be heritable
- All members in a species vary due to the combinations of alleles passed on to the offspring

Overproduction

- When birth rate of a species is higher than the available resources needed for all individuals

Competition (struggle for existence)

- Organisms must struggle to get what they need to survive

Survival of the fittest

- Organisms with more favourable characteristics to their surroundings survive and reproduce

Selection

- The alleles for the traits are thus, selected and would increase over time
- Traits that are favourable and enhance chances of survival and reproduction are selected over time in the environment

Evolution steps

1) Sexual reproduction
2) Variation
3) Struggle for existence
4) Survival of the fittest
5) Changes to the gene pool

Africans

- Have long limbs and short bodies
- Have the ability to disperse heat more efficiently
- Due to hot climates

Inuits

- Endomorphic
- Short limbs and long bodies
- Conserves body heat

Species: groups of interbreeding natural populations that are reproductively isolated from other such groups

- Interbreeding
- Don't reproduce with other groups
- Look different
- Adapted to different resources

Speciation

1) Variation = exists within a population sharing a common gene pool
2) Isolation/barrier to gene flow = leads to reproductive isolation (no interbreeding), now there are populations with separate gene pools
3) Selection = Different selection pressures act on each population which favour different alleles and thus changing allele frequency. The change leads to the evolution of subspecies
4) Speciation = occurs over many generations whereby interbreeding to produce fertile offspring is no longer possible due to a great difference in gene frequencies

Chapter 15 (Evidence for Evolution)

Comparative Studies in Biochemistry

DNA

- Species that are more closely related have more similarities in their DNA; those which are distantly related have more differences
- Different species have different sequences of bases within their DNA
- **Endogenous viruses** are viral sequences that become part of an organism's genome. The retrovirus copies its RNA into DNA through reverse transcription.
- Only becomes endogenous when it inserts into the chromosomes
- If some species share the same retrovirus then they share a common ancestor
- Junk DNA/non coding

Mitochondrial DNA

- DNA is formed as circular molecules and in is abundance
- Mum always passes on their mtDNA to offspring (egg cell)
- Sperm loses all mitochondria travelling to the ovum
- Similarities between the mtDNA of any 2 individuals are used to estimate the closeness of their relationships through their maternal ancestors
- If mtDNA is near identical they will be closely related
- If mtDNA is very different, their last maternal ancestors lived long ago
- Has a very high mutations rate
- High copy number

Protein sequences

- The sequence of amino acids in a protein can be determined

- By comparing the sequence of amino acids in similar proteins from different species, the degree of similarity can be established
- Animals of the same species have identical amino acid sequences
- Animals from different species have different amino acid sequences
- **Ubiquitous proteins** are found in all species and carry out the same basic functions
  -therefore, comparisons can be made between these proteins
  -the number of differences in the sequence is observed
  -the more similarities, the more closely related they are
- **Cytochrome C** is a protein that is essential for the production of cellular energy
- 37 amino acids are found in the same position in every sequenced cytochrome molecules
- Scientists can determine the amino acid sequence of Cytochrome C and therefore make comparisons between species
- Other **ubiquitous proteins** include;
  -Alpha & Beta chains of haemoglobin

Bioinformatics

- Use of computers to describe molecular components of living things
- **Annotation** = identify genes and biological features within a DNA sequence
- Can be done through knowing the start and stop codon of genes

Comparative genomics

- Genome sequences of different species are mapped then compared
- Comparing the human genome to other organisms, researchers are able to identify regions of similarity and difference
- Helps to identify genes that are preserved among species and genes that give organisms their unique characteristics

Comparative Studies in Anatomy

Embryology

- Compares the early stages in the development of an organism
- Comparing vertebrate species reveals a remarkable similarity between different species at different times
- Reveals that vertebrate species share a 2 chambered heart, well developed tail and similar brain development. This adds up for striking evidence for a common ancestry with later evolution
- Have a tail
- Closely related organisms show embryological development in the same sequence
- Organisms have features in the embryo that are not found in adult form, eg tails

Homologous structures

- Comparison of structures that are similar in structure but function differently
- Forelimbs of vertebrates have similar structure
- Organs that are similar in structure
- Organisms possessing organs that are similar in structure are likely to have a common ancestor

Vestigial organs

- Structures of reduced size
- Appear to have no distinct function
- These structures are remains of organs that were functional in ancestral forms
- Examples
  -nictitating membrane = transparent third eye lid
  -third molars = (wisdom teeth)
  -coccyx = vertebrate for the tail
  -appendix = tube that it attached the cecum

-wings of flightless bird
-whales and snakes still retain and femur

Geographical distribution

- Isolated land areas or island group have evolved their own distinctive

Chapter 16

Fossil studies

Fossil: any preserved trace left by an organism that lived long ago. They can build up a sequence of evolutionary changes for a particular plant or animal

Lucy

- Discovered in 1972 in Ethiopia
- Dated back to 3.2 million years using argon-argon dating
- Earliest known sample of Australopithecine
- Australopithecus Afarensis

Fossil formation

- Organisms are completely destroyed by microorganisms
- Soil that contains no oxygen such as peat allow for preservation by preventing decomposition
- Organism can be fossilised if they are buried quickly and decomposition is slowed or prevented
- Volcanic ash and mud carried by flooding rivers contribute to the build up of sediments which cover the body of dead animals
- **Alkaline soils** produce the best fossils; the pores in the bone are filled with new minerals. The bone itself is not dissolved and the bone is petrified (turned into rock) and the details and structure are preserved

Dating fossils

- Fossils are aged so they can be put in the appropriate place in a historical sequence
- Absolute and relative

Absolute dating

- Uses radioactive isotope
- Potassium 39, 40, 41 and carbon 12, 14
- Comparing the amount/ratio of isotopes in a sample

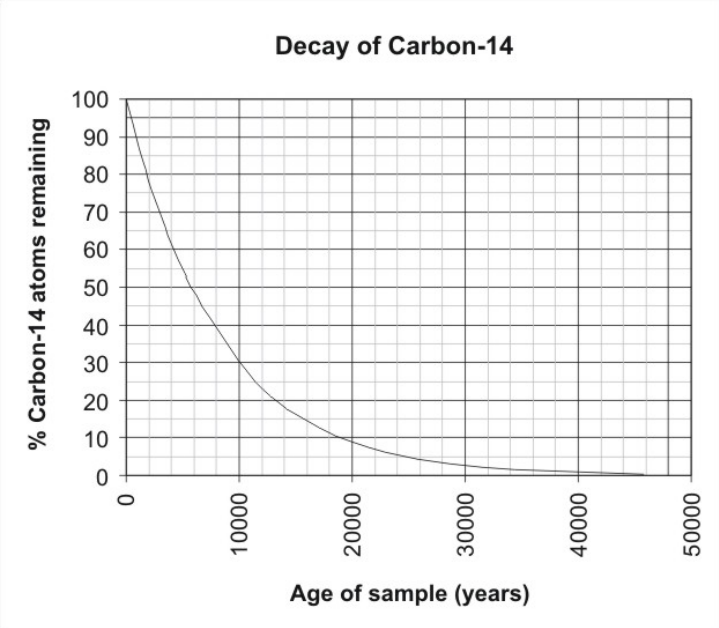
Potassium Argon (Calcium) dating

- Based on the decay of potassium-40 into calcium-40 and argon-40
- The ratio of potassium-40 and argon-40 determines the age of the fossil
- Potassium has a half life of 1.26 billion years
- **Limitations**
  -not all rocks contain potassium-40
  -can only date samples older than 100,000-200,000
  -a suitable rock with the same age as the fossil must be found, eg rocks formed from volcanic eruptions bury bones

Carbon dating

- Based on the decay of carbon-14 into nitrogen
- The ratio of carbon-14 and carbon-12 determines the age
- Carbon-14 has a half-life of 5730 years +/- 40
- In the atmosphere there is a 1 atom of carbon-14 for every million million for carbon-12
- Carbon-14 decays to nitrogen at a known rate when an organism dies

- Nitrogen-14 is measured
- **Limitations**
  -material over 60000 years old cannot be dated as the amount of carbon-14 is negligible
  -material dated needs to be organic in nature, eg cave painting, bones and wood
  -need at least 100 micrograms from sample
  -variations of the ratio between carbon-14 and carbon-12



Tree ring dating (Dendrochronolgy)

- Allows for corrections of carbon-14 fluctuations for the past 9000 years
- Rings on the surface of a tree trunk represent 1 years' worth of growth
- Living trees can be compared with timber taken from human structures and the marker rings can be used to correlate the 2 pieces
- Certain rings that produced in years of exceptional weather can be used as marker rings
- **Limitations**
  -tropic countries do not have sufficiently distant seasonal patterns that they can be used
  -has to be well preserved

Relative dating

- Involves determining the relative order of past events
- Comparison of objects which establishes a sequence of events
- The age of an object in comparison to another

Stratigraphy

- The study of rock layers (strata) and the layering of rocks (stratification)
- **Law of superposition** = the top layers are younger than those beneath them
- **Correlation of strata** = matching layers of rock from different area
- **Index fossils** = fossils that were widespread but were only found on Earth for a limited period of time. Enables relative dating of strata to be more precise

Fluorine dating

- Fluoride ions present in water will replace the ions in bones
- If all the fossils are of the same age, they should have the same levels of fluorine
- The older the fossil, the more fluorine it will have
- **Limitations**
  -amount of fluorine in water varies significantly over time and location
  -fossils need to be from the same area
  -relative dating of fossils within an area only

-there is an inverse relationship with nitrogen and fluorine

Phylogenetic trees (dendrogram)

- A diagram used to represent evolutionary relationships between species derived from a common ancestor
- The base of the tree is formed by the ancestral species and any species that has risen from that ancestor forms branches
- The closer together the branches, the more closely related species are thought to be

Problems with the fossil record

- Fossilisation occurs irregularly regarding time and location
- Quick burial
- Presence of hard body parts
- Absence of decay organisms
- Organism left undisturbed
- Discovery = only a small number of fossils have been discovered
- When discovered dating can be very difficult
- Fossils are usually found fragmented rather than whole
- Often from a few fragments – scientists need to infer a great deal about the structure of the organism as a whole

Type of problem	Explanation
Dating methods cannot be used	When samples are older than 60,000 years, then carbon dating cannot be used. Other dating techniques such as potassium-argon dating rely on material which is not always present in the samples like carbon is
Incomplete fossil record	- Need to be buried rapidly at time of death - Weathering and erosion can destroy fossil remains - Human/animals activity may destroy fossil remains - People may not be looking in the right place - Specific sediment features are required for fossilisations, no oxygen/alkaline soils - Fossils can be destroyed due to volcanic eruption and earthquakes
Few organisms become fossils	- Relies on quick burial - Presence of hard body parts is required

Chapter 17 (Primate Evolution)

Relative size of cerebral cortex

- Increase size of the cerebrum taking up a larger proportion of the brain
- Increased convolutions or folds on the surface of the cerebrum (increases surface area of the brain)
- **Enabled** the development of toolmaking skills in chimpanzees and humans
- **Enabled** complex social behaviour to develop that can respond to a variety of environmental problems

Mobility of the digits

- Digits are **prehensile** (grasping) allowing them to wrap around branches
- **Opposable** thumb and big toe – able to touch each of the other digits
- Humans have lost their opposable big toe to enable our feet to become weight-bearing base in **bipedalism**
- Primates have nails instead of claws which makes grasping easier
- Human thumb is long as strong allowing for the greatest manipulation of objects. Human thumbs have a better **precision grip** for writing
- **Increased**

-mobility
-ability to move digits
-length of opposite digit

- Primitive primates retain claws, higher primates (recent primates) have nails on all digits

Dentition

- Refers to the arrangement and structure of teeth in primates
- **Dental formula** = the number of each type of tooth in one quarter of the jaw

Prognathism

- Extension or bulging out of the lower jaw
- Occurs when teeth are not properly aligned due to the shape of the face bones
- Reduction in prognathism in higher order primates
- Enables skull to balance on top of the vertebral canal
- Reduction in neck muscles to support skull
- Causes reduction in teeth size and teeth number, change in diet and the development of speech

Zygomatic arch

- Reduction in size and prominence
- Bony arch behind the cheeks
- Larger in apes to accommodate much larger temporal muscle

Brow ridge

- Reduction of the prominence of a brow ridge in higher order primates

Sagittal crest

- Provides attachment for strong jaw muscles for chewing
- Present in bipedal hominids
- Paranthropus robustus

Sagittal crest: a bony ridge on the top of the skull to which the jaw muscles are attached
Zygomatic arch: bony arch just behind the cheeks
Brow ridge: reduction of the pr

Primate evolution

Characteristics	Specifics	Trend
Digits	Mobility	Increase mobility and ability to move digits independently to one another
	Opposability	First digit opposable and increasing length results in increased effectiveness of opposability
	Claws/nails	Primitive primates retain claws on some digits; higher primates have nails on all digits
Dentition		
Smell		Sense of smell reduced with gradual reduction in length of the snout
Vision	Eyes	Eyes become more forward facing to allow for stereoscopic vision
	Eye socket	Eyes gradually become enclosed in a protective bony socket
	Visual area of brain	Increased portion of cerebrum devoted to vision
Brain	Size	Increase size of brain relative to size of body
	Convolutions	Gradual increase in the number of folds in the surface of the cerebrum

	Cerebral cortex	Cerebral cortex making up an increasingly large proportion of the brain
Gestation		Increase length of time between fertilisation and birth
Development	Dependence	Increase length of time that the offspring are dependent on the parents
	Sexual maturity	Increasingly later development fo sexual maturity

The Apes (anatomical features)

- Well adapted **arboreal** lifestyle
- Brachiating (swing underneath from branch to branch
- Some mainly ground dwelling and quadrupedal (gorilla)
- Arms longer than legs
- No tail

Anatomical features of hominids (characteristics)

- Large cerebral cortex
- Reduced canines
- Highly sensitive skin
- Complex social behaviour
- Prominent no and chin
- Reduced eye ridges
- Short body hair which assist cooling
- Complex social behaviour

Anatomical features of bipedalism

- Position of foramen magnum = located more centrally under the skull, so that the skull is balanced on the spine
- Broad pelvis
- Legs angled inward which allows for stability and assists the positioning of the upper body over the centre of gravity
- Longer legs and shorter arms

Chapter 18

Adaptations to bipedalism

Structure	Adaptation	Advantage
Foramen magnum	Located centrally in the base of the cranium, allows for the skull the balance over the vertebral canal	Skull is better balanced/less neck muscles Brings centre of gravity over feet/upright posture
Jawbone	Small and non-protruding	Enables skull to balance on vertebral column
Vertebral column	Lumbar vertebrae is wedge shaped, producing an 'S' shaped curve	Brings the vertebral column directly under the centre of the skull
Pelvis	Broad/wide and shallow from top to bottom. Attachment of femur is wide apart	Provides support for abdominal organs Supports developing foetus during pregnancy Carrying angle increases due to the attachment of femur being wide apart, better for bipedal locomotion
Femur	Large head of femur	Contributes to carrying angle
Knee joint	Outer 'hinge' is larger and stronger	Takes weight off the body Knee is able to be straightened

Legs	Legs are longer than arms	Contributes to a low centre of gravity Carrying angle allows the weight of the body to be kept close to the central axis
Foot	Large heel bone and big toe supports the body. Has longitudinal and transverse arches	Increased weight bearing Weight distribution Forward movement

	Structure	Quadrupeds	Bipedal	Advantage
Skull	Foramen Magnum	Located at back of skull	Central at base of skull	Skull better balance Brings centre of gravity over feet
	Prognathism	Large prognathic jaw	Flat face	Skull better balance
	Neck muscles	Large neck muscles	Smaller muscles	Skull better balance so no need for large muscles
Vertebral column and pelvis	Lumber curve	'C' shaped	'S' shaped	Straightens to bring centre of gravity over feet Carry weight of upper body
	Pelvis	Longer and narrower for arborealism	Shorter, broader and more bowl shaped	for support of upper body and abdominal organs and supports foetus in development
Legs	Femur	No carrying angle so the weight is distributed inside femurs and there is side swaying	Carrying angle Enlarged femur head and hip socket	Distribute weight and bring to midline of body over feet Greater stability to carry weight of upper body, rotating when walking, and a striding gate instead of swaying
	Knee joints	Large strong inner hinge	Strong large outer hinge	Supports weight due to carrying angle
Feet	Arches	Longitudinal	Transvers and Longitudinal	Shock absorber Transfers weight from heel to big toe
	Big toe	Opposable with grasping ability	Non-opposable and robust	Carries weight and creates thrust when walking
CoG		High	Low	Greater stability
Other Features				
		Quadruped		**Bipedal**
Hand		Long fingers short thumb for power grip		Short fingers long thumb for precision grip
Brain		400-500cm^3 with a smaller cranium and space for a larger brow ridge		1350cm^3 with an increased cerebral cortex and cranium leading to decrease brow ridge and flatter face
Dentation		In a 'U' shape Large incisors and canines Diastema Chin not developed		Dental arcade shorter and parabolic Smaller canines and incisors No diastema Chin present
Skull		Rugged Prominent brow ridge Prognathic face Large zygomatic arches		Smooth and rounded Brow ridge reduced Flatter face Smaller zygomatic arches

Chapter 19

Robust: big and heavy
Gracile: small and has a slender body shape

Australopithecines

- Paranthropus robustus, Australopithecus afarensis and Australopithecus africanus

Australopithecus afarensis

- Lucy
- 40% skeletal muscle remains discovered which suggest bipedalism
- Gracile form
- **Flat nose, strongly projecting lower jaw and small canine teeth**

- Cranial capacity = 500cc – 1/3 size of modern human brain
- Long and strong arms with curved fingers adapted for climbing trees

Other Name	None
Time period	3.9 – 1.5 mya
Height	1 – 1.5 m
Where found	Eastern Africa
Skull	No chin No sagittal crest Low forehead Large, prominent brow ridge Prognathic Large zygomatic arch Jaw is half way between an ape and a human
Brain	500 cc
Dentition	'U' shaped dental arcade Smaller canines than apes Smaller incisors Thick enamel Diastema present
Skeleton	Sexual dimorphism Long arms, curved fingers, short thumb Toes - slightly curved bones

Australopithecus africanus

- Taung child
- **Rounder cranium, larger brain and smaller teeth** compared to Australopithecus afarensis
- Pelvis, femur and foot bones indicate bipedalism
- Shoulder and hand bones indicate they were adapted for climbing

Paranthropus robustus

- 1.8-1.2 million years ago
- Large megadont cheek teeth with thick enamel
- Focused their chewing in the back of the jaw
- **Large zygomatic arches** (cheek bones) which allow the passage of large chewing muscles to attach to the jaw
- **Sagittal crest** which provided a large area to anchor chewing muscle to the skull

Homo habilis

- First species to make tools (handy man)
- **Taller with longer femurs and larger brain** in comparison to Australopithecines
- **Smaller teeth** = change in diet (meat) which increased brain size
- Bulge in speech producing area of brain = development of language
- May have existed alongside Paranthropus Robustus
- Hands were more robust compared to Homosapiens which suggest tree climbing is still prominent

Homo erectus or (Homo ergaster)

- Larger brain than Homo Habilis
- Footprints in Africa = big tie was parallel to other toes
- Evidence of fire use – **advantages**
  -light
  -kept predators away
  -cooking became more important = softened meat, killed parasites, detoxify plant foods

- Increased group hunting
- They modified the environment (environment is no longer a selective agent)
  -expansion of areas occupied
  -building shelters
  -tool and fire use

Homo neanderthalensis

- Cranial capacity = 1485cm^3
- Heavy brow ridge remain
- Probable that Neanderthals and Sapiens lived alongside each other
- Extinct = Homosapiens outcompeted directly in contact and indirectly in hunting and gathering resources

Homosapiens

Feature	**Description**
Prognathism	- Flatter face
Brow ridge	- No brow ridge present
Sagittal crest	- No sagittal crest present
Dentition	- Smaller teeth
Legs	- Longer femurs which slope towards knee

- "Cro-Magnon"
- Cranial capacity = 1350 cm^3
- Flatter faces
- No brow ridges
- No sagittal crest
- Smaller teeth
- Broader hips
- Longer femurs which slope towards knee

Cultural Evolution

Evolution of behaviour

- Natural History intelligence
- Social Intelligence
- Technical Intelligence
- Creating artefacts and images with symbolic meanings
- Advanced planning and communication

Homo Habilis/Australopithecines

Culture		
Food	Generalised diet – maybe some meat – lead to increased brain size	
Tools	Oldowan stone tool kit (2.6 – 1.7 mya) • Cores, flakes, hammers, choppers, scrapers, spheroids, polyhedrons • Pebble stone tools	Uses – cutting and scraping meat of prey

Homo Erectus

Culture	
Food	Generalised Diet – some meat; **first hunters** (possible cannibalism)
Fire	Harden spears and burning animal bones
Speech	First form of speech production due to Broca's and Wernicke's area

Cognition	Development in hunting technique which indicates **thinking** and **communication**	
Shelter	Control fire so could move to colder climates	
Art	Possible rituals and sculpting	
Tools	Acheulian (1.7 mya – 200 000 ya) • Hand axes = **tear drop shape**, cleavers, picks and cores • Cattleman – increased dispersal of species • Use of fire -remain active at night -cooking with fire -make better weapons and tools -protection from predators -warmth for themslves	Uses – cooking, warmth, protection, constructing shelter, hunting, killing animals

Homo Neanderthalensis

Culture		
Food	Generalised diet – reliance on meat (some evidence of cannibalism)	
Fire	Extensive use – heaths common	
Shelter	Extensive use of caves; clothing inferred	
Art	Clothing and needles; buttons; ivory beads, evidence of bone flute and necklace, cave paintings (pass on knowledge or invoke animal spirits for luck during hunting)	
Religion	Death awareness: Buried the dead: • Bodies with flowers, food, tools, medicinal plants, ochre pigment, animal bones, complex rituals and beliefs • Buried with body aligned east-west with head facing south (creates closer spiritual bonds within the group, leading to better cooperation and group cohesion) • **First species that buried their dead, therefore they believe in an after life** Looked after sick and injured; able to offer things for/to the clan other than physical work	
Tools	Mousterian Tools (200000 – 35 000 ya) • **Stone flakes** = enabled those living in colder climates to make clothes • **Axes** = with wooden handles • **Scraping tools** = for preparing animal hides have been found at Neanderthal sites • **Flint** became a preferred material to produce stone stools • **Levallois** method involved core and striking off a large oval flake	Uses - Hunting, protection, making clothing, carvings. Cutting, scraping, piercing and gouging

Homo sapiens

Culture	
Food	Generalised diet – omnivorous
Shelter	Extensive use of caves with development of tents/huts • caves with hearths, limestone, mammoth bones • tents made of mammoth bones with skins
Art	Modern language (6000 ya) – finger painting in limestone (24 000 ya) Figurines, pendants, shells, needles Symbols, flutes and paintings in caves (30 000ya)
Agricultural evolution/Neolithic revolution	**Fertile crescent** running from Egypt to the Persian Gulf (10000 ya) • cattle, goats, sheep and pigs all have their origins as farmed animals here • **7000** years ago, agriculture became established in China

Religion	Burials, cremations (with tools, weapons, organs; idols worships) – last 10 000 yrs	
Cognition	• Can create artefacts and images with symbolic meanings as a means of communication	
Tools	Aurignacian (40 000 – 26 000 ya) – upper paleolithic • Scrapers, blades, points, knives, burins, bone points, ivory pendants • **Blade tools**	Uses - Fishing, hunting, protection, building shelters, making clothing, harvesting
	Solutrean (22 000 – 19 000 ya) • Innovations in design of blades and points • **Laurel leaf points blade**	
	Magdalenian (18 000 – 12 000 ya) • Increase in needles, fishhooks, harpoons, snow shoes, nets, weights, bows and arrows and atlas (spear throwers) • **Bone and antler tools** • **Use of burin to shape bone, antler and ivory into tools**	