CHAPTER 9: APPLICATION OF FORCES AND TRANSFER OF ENERGY

*For G3 syllabus Only

Contact force	Non-contact force
friction, elastic force, tension, normal contact force	magnetic force, gravitational force (weight)

Magnetic force

A magnet has two poles – a **north pole (N)** and a **south pole (S)**.

- **Like** poles **repel** each other
- **Unlike** poles **attract** each other

Friction

The force that **opposes motion between two surfaces in contact**. Friction can also take the form of air resistance and water resistance.

Positive effects of friction	Negative effects of friction
• Friction enable us to have a grip to hold things and walk e.g. friction between our hands and a pencil, friction between shoes and the ground. • Friction **slows** things down and enable them to stop e.g. friction between the bicycle and the wheel.	• Friction causes **wear and tear** e.g. friction between tyres and the road • Friction **reduce the speed** of objects e.g. water resistance acting on a swimmer

W = m x g

Weight = mass x gravitational field strength

(N) (kg) (on Earth ***g*** = 10 N/kg)

Mass	Weight
• the amount of matter in an object.	• the gravitational force acting on an object.
• SI unit: **kilogram** (kg)	• SI unit: **newton** (N)
• Remains constant regardless of location	• May change with location
• Measured with electronic or beam balance	• Measured with spring balance

Effects of forces

- change in the **state of rest or motion**
  - start an object moving
  - stop a moving object
  - change the speed of a moving object
  - change the direction of a moving object
- change the **size** and **shap**e of an object
- **turning effect** (e.g. spanners, levers)
- **pressure**

Pressure is the measure of the amount of **force** acting on **a unit area**.

$$P = \frac{F}{A}$$

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

SI unit : N/m^2 or pascal (Pa)

Pressure depends on **force** and **area in contact**.

How to **increase** pressure?

- **<u>Increase</u>** the force
- **<u>Decrease</u>** the area of contact
  e.g. sharp injection needle, small surface area of heel of high-heeled shoe, sharp knife

***Pressure in liquid**

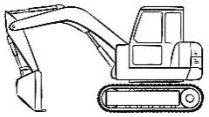
- The deeper the depth of the liquid, the higher the pressure.
- Application of liquid pressure on submarines and dams.

***Atmospheric pressure**

- Atmospheric pressure is 100 000 Pa at sea level.
- Drinking straws and suction cup are used by creating a difference in the air pressure inside the straws / suction cup and the surrounding atmospheric pressure.

How to **decrease** pressure?

- **<u>Decrease</u>** the force
- **<u>Increase</u>** the area of contact



e.g. the heavy weight of an excavator acts on the caterpillar tracks which have a **large contact area** with the ground. Therefore, the pressure on the ground is **low** and hence, the excavator does **<u>not</u>** sink into the muddy ground.

CHAPTER 9: APPLICATION OF FORCES AND TRANSFER OF ENERGY

*For G3 syllabus Only

*

Work is done when **energy is transferred** through the **application of force**.

THREE Conditions for Work to be done:

1. There is a force acting on an object.
2. The object moves.
3. The object moves in the direction of the force.

$$W = F \times d$$

Work = Force x Distance moved (in the direction of the force)

SI unit of Work: **joule (J)**

More work is done when:

1. the force applied is larger
2. the distance moved by the object in the **direction of the force** is larger

Different forms of energy

Kinetic Energy	Energy possessed by a moving object. The faster an object moves, the more kinetic energy it has.
Gravitational potential energy	Energy stored when an object is lifted above the surface of the Earth. The higher the object, the greater its gravitational potential energy.
Elastic potential energy	Energy stored when objects are stretched, compressed or bent.
Chemical potential energy	Energy stored in substances, such as food and fuels.

Principle of Conservation of Energy

- Energy cannot be created or destroyed.
- It can only be transferred from one form to another.
- The total amount of energy in an isolated system is constant.

Destructive Power of Forces in Nature

(Earthquakes, tsunamis, volcanic eruptions, tropical cyclones)

	Sources of Energy	Impact on Environment
1.	**Fossil fuels** Chemical potential energy → heat energy → kinetic energy (steam) → kinetic energy (turbine) → electrical energy	Releases air pollutants and greenhouse gases (e.g. carbon dioxide) which causes global warming which lead to climate change and more intense natural disasters.
2.	**Solar energy** Light energy → electrical energy	Production and disposal of solar panels produces toxic waste.
3	**Hydroelectric energy** Gravitational potential energy → kinetic energy (water) → kinetic energy (turbine) → electrical energy	Water floods areas behind the dam, killing plants and forcing animals to move. As fishes move, fishermen need to relocate.
4.	**Wind energy** Kinetic energy (wind) → kinetic energy (wind turbine) → electrical energy (generator)	Large plots of land must be cleared. Destruction of natural habitats hence potential loss of wildlife. Birds may collide into turbines. Noise pollution.
5.	**Geothermal energy** Heat energy → kinetic energy (steam) → kinetic energy (turbine) → electrical energy	Large areas of land need to be cleared, destroying wildlife habitats and affecting diversity of species. Traces of toxic elements may be drawn out from underground.
6.	**Biofuels** Chemical potential energy → heat energy → kinetic energy	Releases air pollutants when burnt.
7.	**Nuclear energy** Nuclear energy → heat energy → kinetic energy (steam) → kinetic (turbine) → electrical energy	Clean energy requiring less land. Potential risk to health & safety of nearby communities.

Transfer of Heat Energy

When two objects are in contact, heat energy is transferred from an object of higher temperature to an object of lower temperature.

S.I. unit of temperature: <u>kelvin (K)</u>

Expansion and Contraction in Solids, Liquids and Gases

Heating → Expansion	**Cooling → Contraction**
When temperature increases, particles gain energy and move further away from one another.	When temperature decreases, particles lose energy and move closer to one another.
Volume increases	Volume decreases
Mass remains unchanged	
Density decreases $\left(D = \frac{m}{V}\right)$	Density increases $\left(D = \frac{m}{V}\right)$

For the same rise in temperature:
Expansion of gas > liquid > solid

For the same fall in temperature:
Contraction of gas > liquid > solid

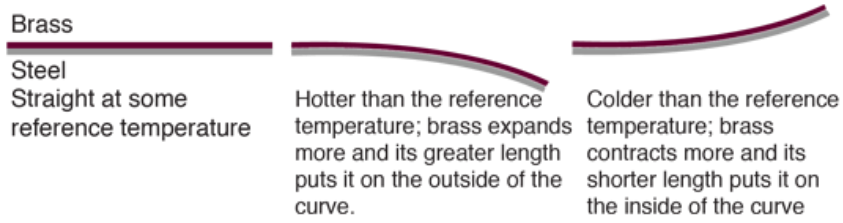
Applications of Expansion and Contraction

Effect	**Precaution**
Buckling of railway lines	Small gaps to allow for expansion
Cracking of concrete surfaces	
Snapping of overhead wires	Allow extra length of wire
Expansion/Contraction of bridges	One end of bridge is fixed while the other end is free to move over rollers
Bursting of pipes carrying hot water	'Expansion loops'

<u>Bimetallic strips</u>

Unequal expansion and contraction of two metals.

Used in thermostats, fire alarms etc.



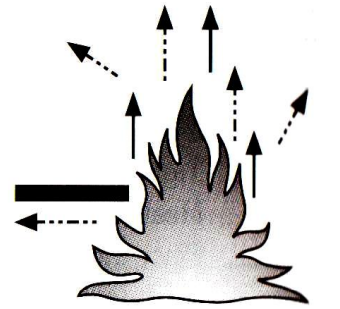
CHAPTER 10: TRANSFER OF HEAT ENERGY AND ITS EFFECTS *For G3 syllabus Only

<table>
<tr><th></th><th>Conduction</th><th colspan="2">Convection</th><th>Radiation</th></tr>
<tr><td>Definition</td><td>Conduction is the transfer of heat energy through a medium or material without the physical movement of the medium.</td><td colspan="2">Convection is the transfer of heat energy by convection currents in a fluid (liquid or gas), due to a difference in density.</td><td>Radiation is the transfer of heat energy, in the form of waves such as infrared radiation, without the aid of a medium.</td></tr>
<tr><td rowspan="2">Notes</td><td>Best in solids, then liquids, then gases.</td><td colspan="2" rowspan="2">In liquids and gases only.</td><td>In solids, liquids, gases and vacuum.</td></tr>
<tr><td>Metals are good conductors of heat as they have free electrons.</td><td>Heat from Sun reaches Earth by radiation.</td></tr>
<tr><td>Explanation</td><td>Particles gain heat and vibrate faster.
These particles collide with neighbouring particles, transferring energy and causing them to vibrate faster too.</td><td>When the water at the bottom of the flask is heated, it expands, becomes less dense and rises.
Since the upper region is cooler, it is denser and therefore sinks.
The difference in the densities of water in the different regions sets up a convection current.</td><td>The aircon cools the air on top. When the air is cooled, it contracts, becomes denser and sinks.
The warmer air at the bottom, being less dense, would rise.
The difference in densities of air in the different regions sets up a convection current which cools the whole room.</td><td>Rough, dull, black surfaces are good absorbers and emitters of heat.
Smooth, shiny, white surfaces are poor absorbers and emitters of heat.

Rate of emission and absorption of radiation is higher when
• Higher temperature
• Larger surface area</td></tr>
<tr><td>Applications</td><td>Conductors: Heating food in a frying pan
Insulators: Handle of frying pan, walls of buildings, double-glazed windows</td><td colspan="2">Cool a refrigerator, heat or cool a room, boil water in a kettle
Land and sea breeze</td><td>Vacuum flask
Shiny kettles
Black pipes on solar water heaters</td></tr>
</table>

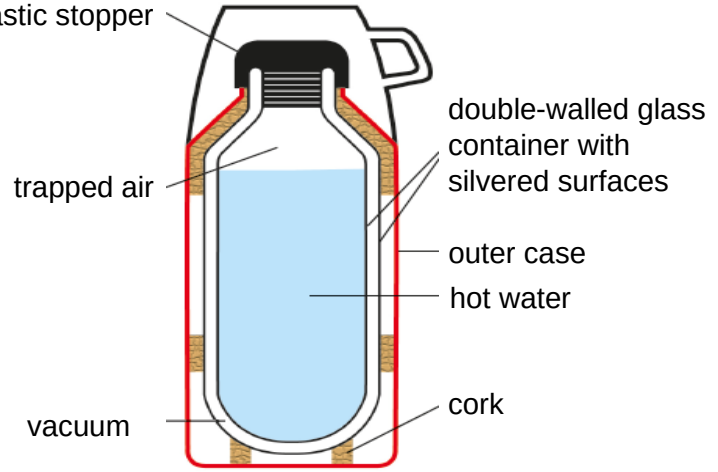
Why do metals conduct heat more quickly than non-metals?
Metals have free electrons. In metals, both the particles and the free electrons vibrate and collide, resulting in quicker transfer of thermal energy.

Using the particulate model of matter, suggest why liquids and gases are poorer thermal conductors than solids.
Particles in liquids and gases are further apart, hence they collide less frequently, resulting in a slower transfer of thermal energy.



Vacuum Flask

Feature	Reduces heat loss by	Explanation
Vacuum	conduction and convection	conduction and convection require a **medium** to take place
Silvered surfaces	radiation	silver surfaces are poor **emitters** of thermal energy
Trapped air	conduction	air is a poor thermal conductor
Plastic stopper	conduction	plastic is a poor thermal conductor
Glass walls	conduction	glass is a poor thermal conductor



CHAPTER 11: CHEMICAL CHANGES

Physical Changes	Chemical Changes (chemical reaction has taken place)
A change in which **no new substances** are formed	A change that leads to the formation of **new substance(s)**
Usually easily **reversible**	Usually **not easily reversed**. (Sometimes possible & may involve large amounts of energy)
e.g. • melting / freezing • boiling / evaporation • dissolving • magnetizing of iron	e.g. • combustion • thermal decomposition • oxidation (rusting & respiration) • neutralisation

Writing word equations

hydrogen + oxygen → water

reactants products

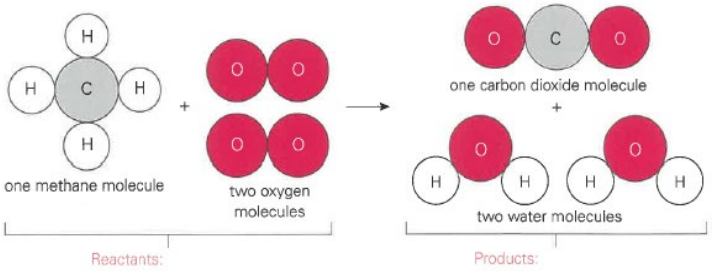
- An **arrow** (→) is used to represent the chemical change
- A plus sign (+) is used when there is more than one reactant / products

Chemical Reactions Involving Acids

- acid + alkali → salt + water
  [e.g. hydrochloric acid + sodium hydroxide → sodium chloride + water]
  [neutralisation]
- *acid + metal → salt + hydrogen
  [e.g. hydrochloric acid + magnesium → magnesium chloride + hydrogen]
  [Observation: bubbles + colourless odourless gas is produced]
  [Note: copper, silver and gold do not react with acids]
- *acid + carbonate → salt + water + carbon dioxide
  [e.g. hydrochloric acid + magnesium carbonate
  → magnesium chloride + water + carbon dioxide]
  [Observation: bubbles + colourless, odourless gas is produced]

CONSERVATION OF MASS

- Chemical reactions involve a **rearrangement of atoms** which are **not created or destroyed**.
- The **total number of atoms** before and after the reaction is balanced (**remains the same**).
- Hence **mass is conserved** during a chemical change.
  mass of the reactants = mass of products



Reactants:
No. of C = 1
No. of H = 4
No. of O = 4

Products:
No. of C = 1
No. of H = 4
No. of O = 4

TYPES OF CHEMICAL CHANGES

- **Combustion** (reactant combines with oxygen; heat + light given out; oxygen and heat needed)
  carbon + oxygen → carbon dioxide
- **Thermal Decomposition**
  (substance breaks down upon heating)
  heat
  calcium carbonate → calcium oxide + carbon dioxide
- **Oxidation** (substance gains oxygen)
  - Respiration
    [glucose + oxygen → carbon dioxide + water]
  - Fruits turning brown
  - Rusting
    [iron + oxygen + water → iron oxide (rust)]
- **Neutralisation**
  acid + alkali → salt + water

* Optional for NA

Chemical Changes that Benefit:

- cooking
- respiration

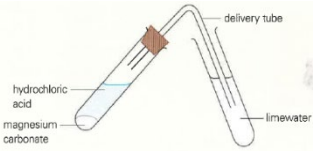
Chemical Changes that causes harm:

- rusting
- tooth decay
- burning (combustion – release of greenhouse gases that contribute to global warming)

Test for Gases

- **Hydrogen** – Lighted splint extinguishes with a pop.

- **Carbon dioxide** – white precipitate is formed when the gas is bubbled through limewater.



CHAPTER 11: CHEMICAL CHANGES

Indicators change colours in acids or alkalis.

Indicator	Acid	Neutral	Alkali
red litmus paper	remains red	no effect	turns blue
blue litmus paper	turns red	no effect	remains blue
universal indicator	red	green	blue / violet
methyl orange	red	yellow	yellow
bromothymol blue	yellow	green	blue
red cabbage	red	blue	green

Applications of Neutralisation

acid + alkali → salt + water
to bring to pH 7

- Antacids neutralise excess acid in the stomach
- Toothpaste neutralises acid that can cause tooth decay
- Soil if too acidic, can be neutralised (e.g. by calcium oxide)

How Chemical Changes Occur

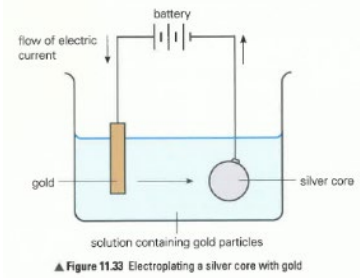
(e.g. of irreversible chemical reactions)

- mixing (e.g. neutralisation)
  - acid + alkali (neutralisation)
- heating (e.g. combustion and thermal decomposition)
  - combustion of coal / petrol
  - thermal decomposition (e.g. of sugar and calcium carbonate)
    - thermal decomposition of carbonates produces carbon dioxide gas
- exposure to light
  - e.g. fading of clothes and photographs
  - e.g. photosynthesis

carbon dioxide + water $\xrightarrow[\text{chlorophyll}]{\text{light energy}}$ glucose + oxygen

- oxidation (interaction with oxygen)
  - e.g. rusting
  - e.g. respiration
  - e.g. browning of fruits

- *using an electric current.
  - Electroplating (of medals, medical instruments etc.)
  - electrolysis



▲ Figure 11.33 Electroplating a silver core with gold

Universal Indicator

	ACIDIC							NEUTRAL	ALKALINE						
pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
colour	**r**ed			**o**range	light orange	**y**ellow	light green	**g**reen		dark green			**b**lue	**i**ndigo	**v**iolet
example		stomach acid	lemon juice	vinegar	honey	coffee	milk	pure water	sea water	tooth-paste	baking soda; antacid	ammonia	soapy water	bleach	drain cleaner

CHAPTER 12: INTERACTIONS WITHIN ECOSYSTEMS

* Optional for NA

MAN's NEGATIVE IMPACT ON THE ENVIRONMENT

1. **Waste food** → waste water, energy and minerals to produce food
2. **Waste electricity** → Burning more fossil fuels → more CO_2 → Climate change
3. **Waste water** → Deplete resource
4. **Excessive waste** → Pollution of air, land, water

CONSEQUENCE → Increased effects of climate change
(e.g. rising sea levels, floods, droughts, more frequent and stronger storms)

CONSERVING THE ENVIRONMENT - HOW?

5. ↓**use of fossil fuels** → walk, cycle, public transport, use less electricity, energy efficient models.
6. ↓**consumption** (Reduce, Reuse, Recycle) → less wood and paper use.
7. ↓**deforestation** → more trees to take in CO_2 during photosynthesis.
8. *some cultures practise sustainable living
    - they do not take more than what they need from their environment
    - they are respectful and appreciative of what nature has provided
    - they ensure natural resources are not overly used.
    - e.g.
        - Tight controls of no. of salmon caught and eaten each year by Canadian natives.
        - Use of banana leaves for packaging to reduce plastic.

PHYSICAL FACTORS & THEIR IMPORTANCE

Air	oxygen is needed for respiration to release energy carbon dioxide is needed for photosynthesis
Water	all living things need water to survive
Temperature	A suitable temperature is needed for enzymes to function.
Light	Light is needed for photosynthesis to make food. Animals also rely on plants for food. Light is also needed for animals to see.
Minerals	Mineral salts are needed for healthy plant growth.
pH	Acidity and alkalinity of soil and water affects plants and animals.

* survival of organisms may be negatively impacted if physical factors are not optimal.

WHY CONSERVE?

- Earth's (natural) resources last long enough for future needs
- Reduce greenhouse gas (e.g. CO_2) emmission hence decrease the rate of climate change
- Maintains the stability of the ecosystem.

INTERACTIONS WITHIN AN ECOSYSTEM

Organism

↓

Population — Organisms of the same kind/species living in the same environment.

↓

Community — Different populations of plants and animals living and interacting in a particular environment

↓

Ecosystem — Interactions between a community (living things) and its physical environment.

*Habitat: place where an organism lives

ADAPTATIONS

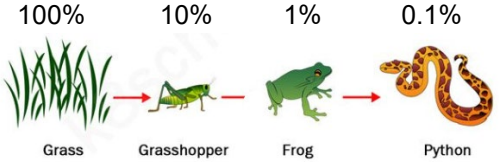
- Structural adaptations are physical traits that enable organisms to better survive in their environment.
- Behavioural adaptations are behaviours carried out that allows the organism to better survive in its environment.

Structural Adaptations
claws
teeth
fur
breathing roots

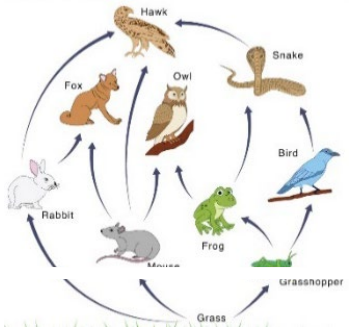
Behavioural Adaptations
birds migrate
cobra lifting head
mudskipper burrowing
kacang putih moth larvae rolls up the leaf

CHAPTER 12: INTERACTIONS WITHIN ECOSYSTEMS

FOOD CHAIN (→ represents transfer of energy and nutrients)



producer	primary consumer	secondary consumer	tertiary consumer



Food Web

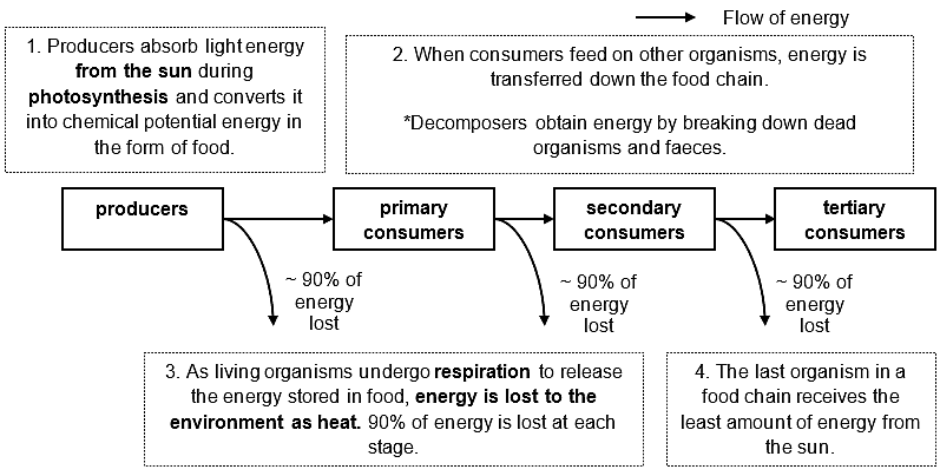
- shows how one or more food chains are interconnected.
- consists of several food chains.

INTERRELATIONSHIPS IN ECOSYSTEMS

Interrelationship	Example
predator-prey relationship (Predators hunt and kill their prey)	sea eagle / fish
parasitism (Parasite obtains food & nutrients & harms the host but does not kill it.)	round worm / human
mutualism (Two or more organisms support or benefit one another e.g. protection in exchange for food)	clown fish / anemone scale insects / weaver ant

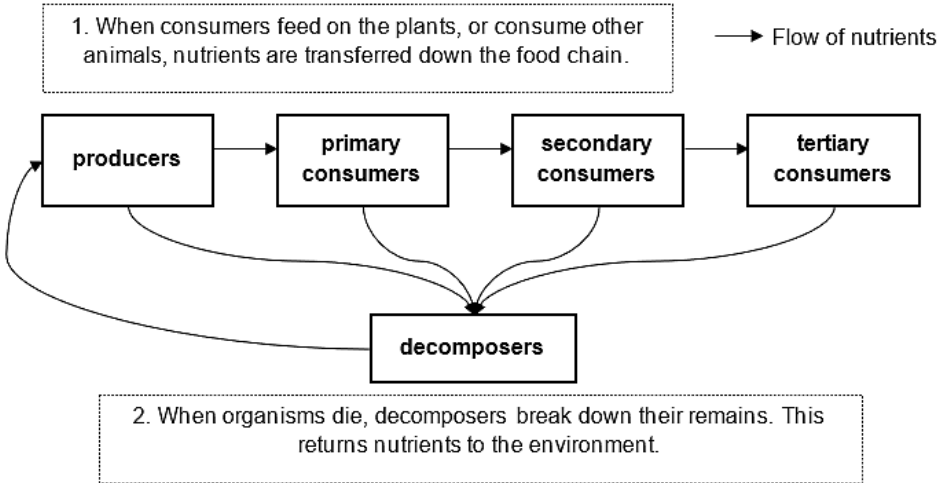
Flow of energy

- The ultimate source of energy is the **Sun**.



- The energy lost as heat cannot be re-used by the producers for photosynthesis.
- Thus, the flow of energy in an ecosystem is **non-cyclical.**

Flow of nutrients **

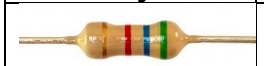
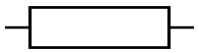
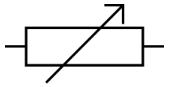
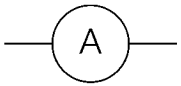
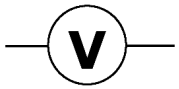


- **Decomposers** break down the remains of dead organisms, or waste products such as as faeces. This returns nutrients to the environment, which can be re-used by living organisms.
- Without decomposers, nutrients found in organisms and waste will be not returned to the environment.

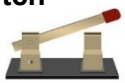
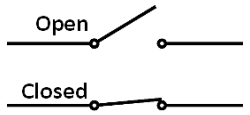
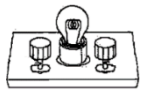
CHAPTER 13: ELECTRICAL SYSTEMS

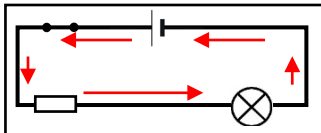
	Description	Symbol	SI unit	Measuring instrument
current	The rate at which electric charge flows.	I	ampere (A)	ammeter
potential difference (voltage)	The amount of energy needed to move a unit charge from one point in an electric circuit to another.	V	volt (V)	voltmeter
resistance	A measure of how much an electrical component opposes the flow of electric current.	R	ohm (Ω)	

Additional components of an electrical system

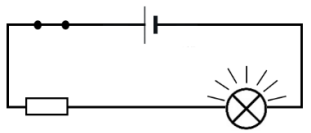
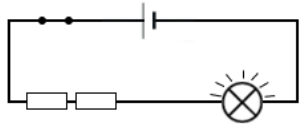
Circuit symbol	Circuit symbol	Circuit symbol
 **fixed resistor**		• Adding a resistor in series increases resistance and decreases the current flowing through the circuit . • Fixed resistor: fixed resistance • Variable resistor: range of resistance
 **variable resistor (rheostat)**		
 **ammeter**		• Measures the current flowing through a circuit. • Connection: In series within a circuit • Negative terminal of the ammeter connected to the negative terminal of cell
 **voltmeter**		• Measures the potential difference between two points in a circuit/ across an electrical component. • Connection: In parallel to the electrical component • Negative terminal of the voltmeter connected to the negative terminal of the battery

Basic components of an electrical system.

Component	Circuit Symbol
cell 	
switch  (open)  (closed)	
wire 	
electrical device (e.g. bulb) 	
electric charge	



When the switch is closed, current flows from the positive terminal to the negative terminal of the cell.

Adding **a resistor in series** increases the overall resistance of the circuit,and **decreases the current flowing** through it. This causes the brightness of the bulb to decrease.

Calculations within a circuit

$V = IR$

$I_1 = I_2 = I_3 = I_4 = ...$

$V_{EMF} = V_1 + V_2 + V_3 + ...$

$R_T = R_1 + R_2 + R_3 + ...$

V: potential difference
I: current
R: resistance

CHAPTER 13: ELECTRICAL SYSTEMS

Applications of the effects of an electric current		
Effect		**Application**
Chemical	Electrical current is passed through chemical solutions resulting in a chemical change.	**Electroplating household objects** (shiny appearance and more resistant to scratches and corrosion.) **Electroplating medical instruments** 1. protective layer of metal to minimise damages and lengthen their lifespan 2. with antimicrobial metals to minimize infections **Electroplating implants** (with titanium to reduce the risk of infection and rejection by the body)
Heating	In heating element - electrical energy converted to heat energy.	• Household appliances (e.g. hairdryer, kettle, toaster) • Infant incubator • Sterilisers
Magnetic	Electric current passed through a coil of wire forming a temporary magnet	• Magnetic resonance imaging (MRI) • Electric bell • Robot-assisted surgery (controlling the electric current → suitable force to be applied on the patient)

Electrical hazards	
Dangerous situation	**Hazard**
Electrical appliance/plug in contact with water (a good conductor of electricity).	**Electric shock**
Tampering/playing with power sockets	
Damaged / frayed wires	
Overloading of electrical sockets → overheating	**Electrical fire**
Faulty electrical appliance	

Power & Electrical Consumption

Power is the amount of electrical energy used for conversion to other forms of energy per unit time.

- SI unit: **Watt (W)**
- 1 Watt = 1 Joule of electrical energy is converted in one second.
- 1000 W = 1 kW

***Electrical Energy Consumption**

Electrical energy (kWh) = power (kW) × time (h)

***Total Cost of Electricity**

total cost = electrical energy consumption × cost of electricity per kWh

convert to correct units before calculating

Conserving electricity

Electrical appliances with high electrical consumption

- Air conditioner
- Refrigerator
- Water heaters
- Oven

Ways to conserve electricity

1. Buy energy-efficient electrical appliances
2. Switch off the air conditioner after a short while and switch to a fan
3. Use the air conditioner at 25 °C.
4. Switch off water heaters when not in use

Switch off power sockets to reduce standby power

Safety devices

Fuse

- Protects electrical appliances from excess current.
- The wire in a fuse melts when current flowing through the appliance is larger than its current rating. → The circuit becomes open and current cannot flow through.

Circuit breaker

- Protects from electric shocks
- When current flowing through a circuit is too high, switches in the circuit breaker trip, opening the circuit, and stops current from flowing through.

CHAPTER 14: HUMAN DIGESTIVE SYSTEM

HUMAN DIGESTIVE SYSTEM

The human digestive system helps to break down large, complex, and insoluble food into small, soluble molecules to be absorbed into the blood / body cells.

Bacteria

Harmful – cause food poisoning

Beneficial – fight diseases, absorb nutrients and mineral salts, produce enzymes, vitamins and amino acids.

	Physical digestion	Chemical digestion
Definition	Food is broken down into smaller pieces to increase their surface area to volume ratio.	Large food molecules are broken down into small, soluble molecules that can be absorbed into the blood.
Location	mouth – chewing stomach - churning	Enzymes in the • mouth • stomach • small intestines

	Enzyme	Reaction
Mouth	Carbohydrase (e.g. amylase)	Starch → Partially digested carbohydrates
Stomach	Protease	Proteins → Partially digested proteins
Small Intestine	Carbohydrase	Starch → Partially digested carbohydrates Partially digested carbohydrates → **Simple sugars**
	Protease	Proteins → Partially digested proteins Partially digested proteins → **Amino acids**
	Lipase	Fats → **Fatty acids + Glycerol**

Diabetes

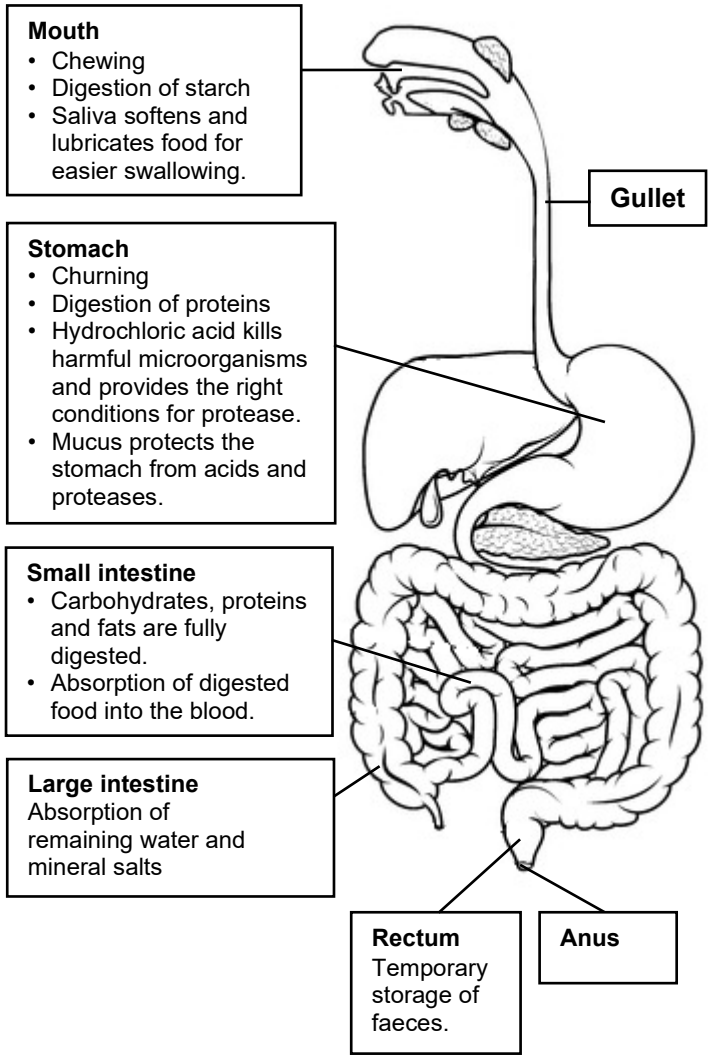
Blood sugar level is too high due to insufficient insulin or inability to respond to insulin.

Symptoms

- Slow healing wounds
- Constant hunger
- Frequent urination
- Tingling or numbness in hands and feet
- Unexplained weight loss
- Blurred vision

Ways to reduce risk

- Regular health screenings
- Healthy and balanced diet [more whole grains, fruit, vegetables and lean meat][avoid foods with high sugar, high salt and saturated fats]
- Regular exercise
- Avoid smoking & alcohol



End Products of Digestion

- **Simple sugars** are used during **respiration** to release **energy**.
- **Amino acids** are used for **growth** and **tissue repair**.
- **Fatty acids** and **glycerol** are used to make fats.

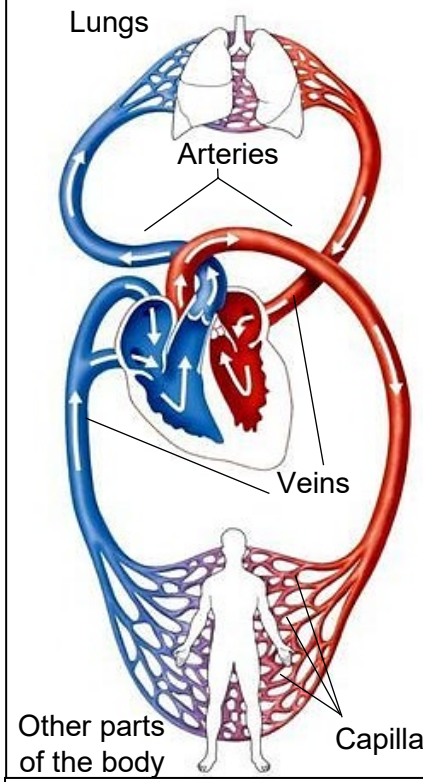
CHAPTER 15: TRANSPORT IN LIVING THINGS

(G3 only) **Multicellular** organisms require transport systems to efficiently and quickly transport substances [like oxygen, nutrients and waste] within the organism. This prevents cells from starving or being poisoned by their own waste products as relying on diffusion alone

The transport system consists of 3 main components:
1. **Heart**: pumps blood
2. **Blood vessels**
3. **Blood**

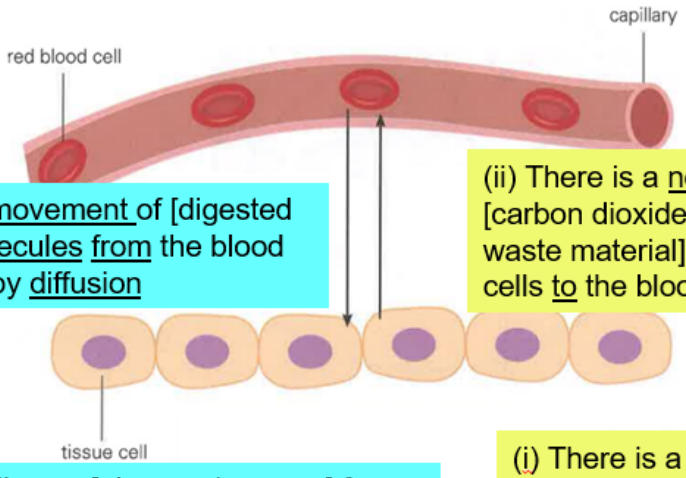
The **red blood cell transports oxygen** from the lungs to different parts of the body.

Plasma transports water and **dissolved substances** such as mineral salts, digested food, waste)



Diffusion in humans

(1) There is a higher concentration of [digested food / oxygen] in the blood than in the tissue cells.



(iii) The carbon dioxide / waste materials are transported away in the blood

(2) There is a net movement of [digested food / oxygen] molecules from the blood to the tissue cells by diffusion

(ii) There is a net movement of [carbon dioxide molecules / waste material] from the tissue cells to the blood by diffusion

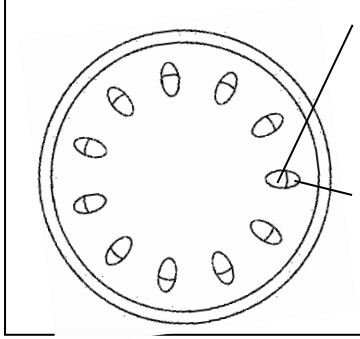
(3) The tissue cells use [glucose / oxygen] for respiration to release energy.

(i) There is a higher concentration of [carbon dioxide / waste materials] in the tissue cells than in the blood.

Arteries carry blood **away from the heart**.

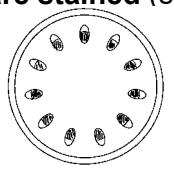
Veins carry blood **towards the heart**.

Capillaries act as the **site of substance exchange**.

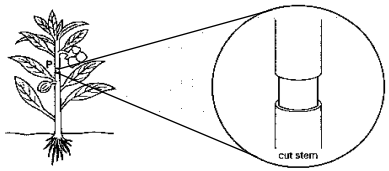


(G3 only) **Xylem**
Transports **water and mineral salts from the roots** to all parts of the plant in an **upward direction**.
(G3 only) **Phloem**
Transports manufactured **food** (sugar) **from leaves** to all parts of the plant in both **upward and downward directions**.

(G3 only) A stalk of flower was placed in a beaker of **red dye**. After some time, a cross-section will show that the **xylems are stained** (shaded areas).



Removing the **outer** layer of a plant stem **removes its phloem**. This results in **bulging above and below** where the stem is cut due to accumulation of sugars.



cut stem

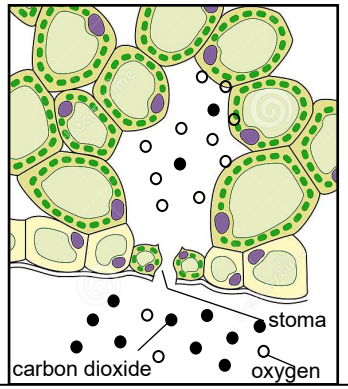
Removing the **inner** layer removes the **xylem**, causing the **plant to die** as other parts of the plant cannot receive water.

Diffusion: the **net** movement of particles from a region of higher **concentration** to a region of lower concentration.

Diffusion in plants in the day (as photosynthesis occurs)

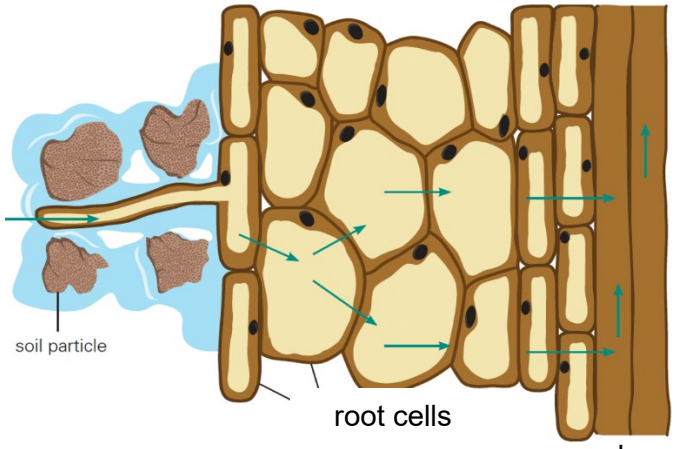
Oxygen:

There is a higher concentration of oxygen in the leaf than in the surrounding air. There is a net movement of oxygen molecules out of the leaf through the stomata by diffusion.



Carbon dioxide:

There is a higher concentration of carbon dioxide in the surrounding air than inside the leaf. There is a net movement of carbon dioxide molecules into the leaf through the stomata by diffusion.



Diffusion in plants (roots)

1. There is a higher concentration of mineral salts in the soil solution than in the root cells.
2. There is a net movement of dissolved mineral salts from the soil solution into the root cells by diffusion.
3. Mineral salts are transported to the rest of the plants through the xylem

Osmosis in plants (roots)

Osmosis is the **net** movement of **water molecules** from a region of higher **water potential** to a region of lower water potential through a partially permeable membrane.

1. There is a higher water potential in the soil solution than in the root cell.
2. There is a net movement of water molecules entering the root cell by osmosis through the partially permeable cell membrane.
3. (G3 only) Water moves from cell to cell via osmosis into the xylem where it is transported to the rest of the plant.

Drug abuse

Body system	Effect
Nervous system	• Poor balance and coordination • Slower reaction • Insomnia • Anxiety, irritability • Hallucination, memory loss
Circulatory system	• Irregular heartbeat, increased heart rate • Increased blood pressure • Increased risk of heart attack and stroke
Respiratory system	• Lung cancer • Emphysema
Digestive system	• Nausea • Increased risk of mouth and throat cancer • Stomach ulcer • Liver damage
Sexual reproductive system	• Infertility

Ethical considerations for organ transplant

1. Respect for persons
   - Donor consent
     - Is the donor able to make their decision willingly?
     - Has the donor been given full information about the donation to make their decision?
2. Justice (Fairness)
   - Priority for allocation
     - What criteria is used to ensure fairness in allocation?
3. Minimal harm and maximised benefits
   - Are there alternative treatments?
   - What decisions increase the patients' chances of survival?
   - To what extent will the patients' quality of life be enhanced?
   - How many dependents' do the patients have?

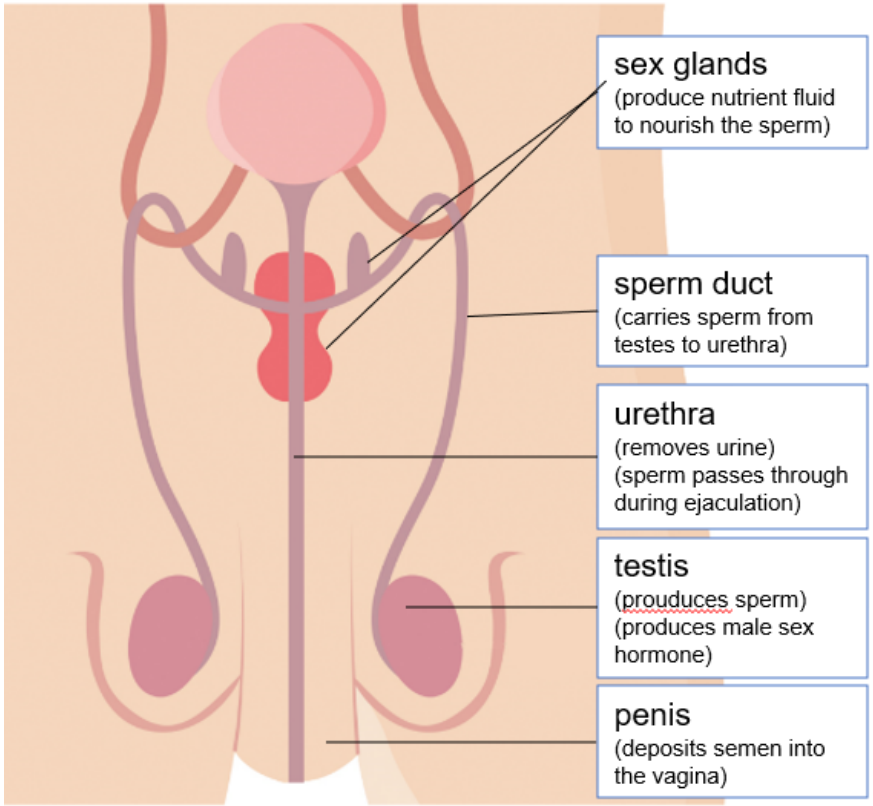
CHAPTER 16: HUMAN SEXUAL REPRODUCTIVE SYSTEMS

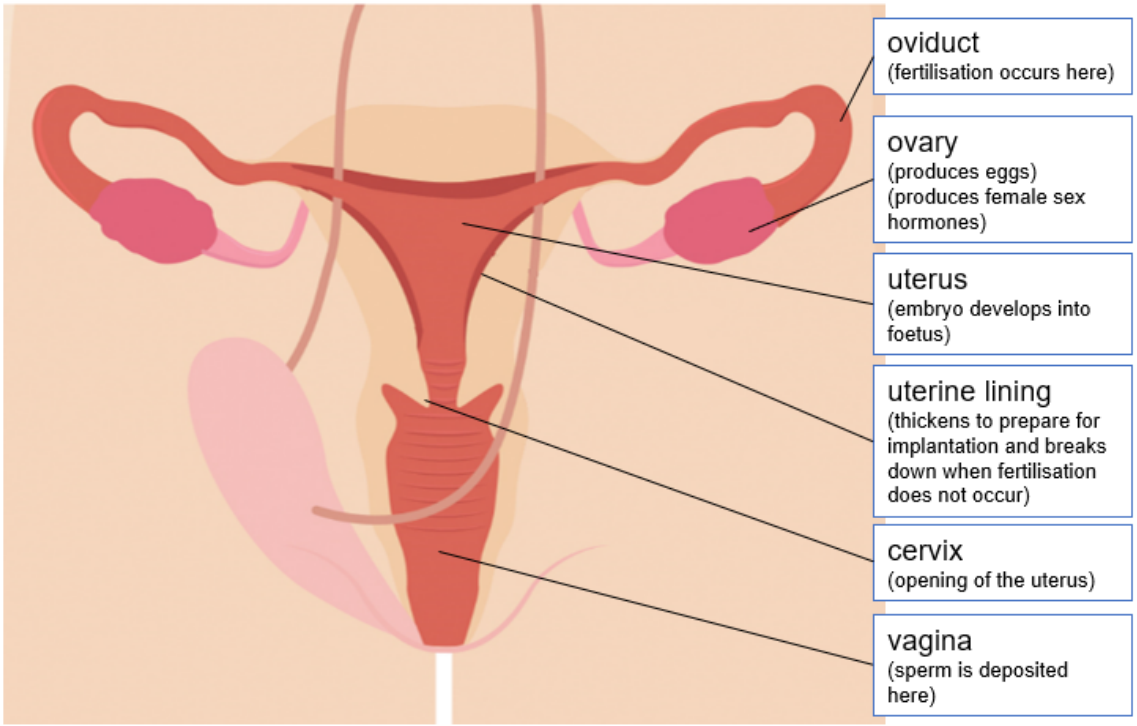
Sexual Reproduction

Fertilisation occurs when the nucleus of the sperm cell fuses with the nucleus of the egg cell.

The offspring contains **genetic** material (DNA) from **both** of its parents.

- (G3 only) Each individual inherits genetic material from the nucleus of an egg and the sperm in a unique combination. Hence, offspring possess a unique mix of traits from both their parents. Therefore, there are similarities and differences between individuals, their parents, and their siblings.





Puberty

- Physical changes that occur as the body matures sexually during early adolescence.
- Begins when certain hormones are produced by the body.
  - **Hormones** are chemicals found in small amounts in the blood that control different activities in many organ systems.

Male

- Increase in height and weight.
- Facial, armpit and pubic hair appears.
- Voice deepens
- Muscle strength increases
- Production of sperm begins.

Female

- Increase in height and weight.
- Armpit and pubic hair appears.
- Breasts develop
- Hips become broader and rounder.
- Maturation of eggs begin.
- Menstruation begins

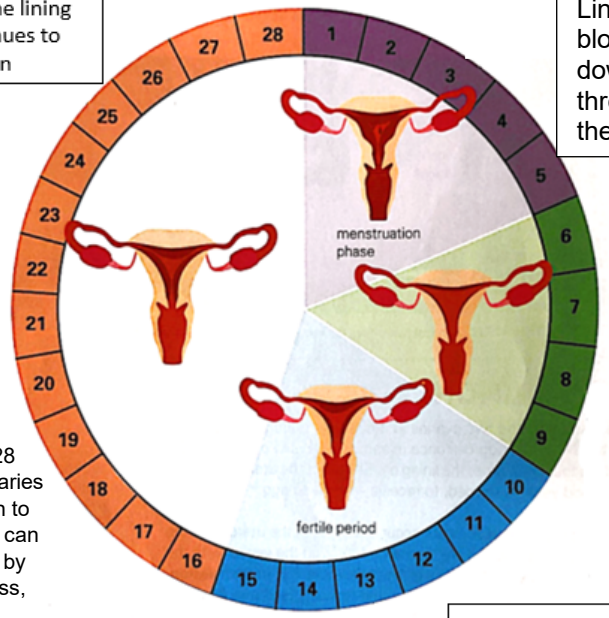
CHAPTER 16: HUMAN SEXUAL REPRODUCTIVE SYSTEMS

Sperm is produced in the **testes**. During sexual intercourse, sperm travels along the sperm ducts to the urethra. Nutrient fluid from the sex glands are mixed with sperm to form **semen**. Ejaculation is the process in which semen leaves the male reproductive system.

The penis deposits semen in the vagina. The sperm cells swim through the cervix past the uterus and into the oviduct.

The ovary releases an egg cell during **ovulation**. If **fertilisation** occurs in the oviduct, the fertilised egg develops into an **embryo** and will travel to the uterus and be **implanted** in the uterus wall.

During birth, contractions of the uterus, which is a muscular organ, pushes the baby past the cervix and out through the vagina.



Day 16-28
Uterine lining continues to thicken

Day 1-5: Menstruation
Lining of uterus and the blood vessels break down, and expelled through the vagina with the unfertilised egg.

Day 6-9
Uterus lining thickens with many blood vessels to prepare for implantation if fertilisation occurs.

Note: The 28 day cycle varies from person to person and can be affected by stress, illness, and diet.

Sperm survives 3-5 days. Egg survives 1 day

Day 14: ovulation
The ovary released a mature egg into the oviduct.

Day 10-15
Fertile period.
Sexual intercourse likely to result in pregnancy.

Substance abuse

Substance abuse can disrupt the function of the human reproductive system.

- Babies may be born premature or with a low birth weight. Thus they may be underdeveloped.
- Smoking may affect the development of the foetus' heart, lungs and brain.
- Alcohol and drug abuse (e.g. heroin, cocaine, cannabis, 'ice') can lead to physical, intellectual, and behavioural challenges in the child (e.g. learning and attention difficulties)

Temporary Birth Control (reversibly disrupt function of the sexual reproductive system)

- Rhythm method (unreliable)
- Condom: prevents sperm from entering the uterus
- Spermicide: kills sperm
- Intra-uterine device (IUD): prevents sperm from fertilising an egg and prevents an embryo from being implanted.
- Birth control pills: disrupt ovulation
- Diaphragm: covers cervix; prevents sperm from entering the uterus

Permanent Birth Control (irreversibly disrupt the function of the sexual reproductive system)

- Tubal ligation: surgically cut and tie oviducts
- Vasectomy: surgically cut and tie sperm ducts

Abstinence and **avoiding premarital sex** is advisable. **Abortion** is a deliberate termination of pregnancy and is illegal after the sixth month. Abortion has health risks of damaged uterus and infection. It is not a form of birth control.

Sexually Transmitted Infections (STIs)

Bacterial: Syphilis, gonorrhoea
Viral: Human Immunodeficiency Virus (HIV) → AIDS
Antibiotics can treat bacterial infections but have no effect on viruses.
STIs may also be transmitted through blood transfusion, sharing of contaminated needles during injections, body piercing and tattooing and from mother to infant during childbirth or breast-feeding.

*Growth in World Population

- Medical advancement
- Improved transportation
- Increased food production
- Improved sanitisation