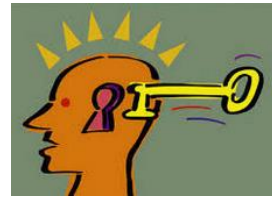
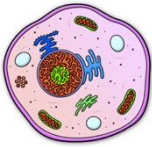




# Science



# Crucial Knowledge



# Biology



## Paper 1

Topic B1	Cell Biology
Topic B2	Organisation
Topic B3	Infection & Response
Topic B4	Bioenergetics

## Paper 2

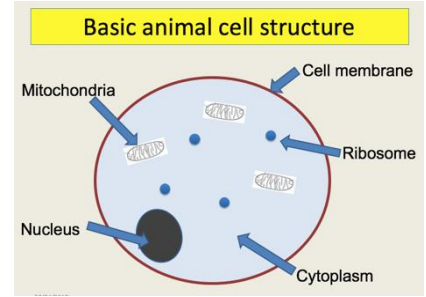
Topic B5	Homeostasis & Response
Topic B6	Inheritance, Variation & Evolution
Topic B7	Ecology

**Biology is the study of living things**



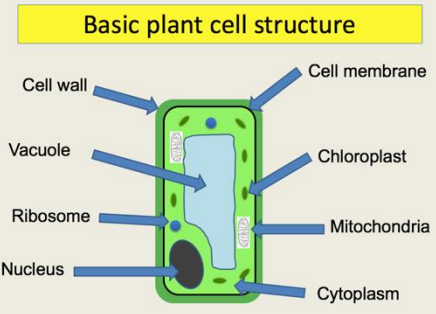
## Function of cell parts

- Nucleus – controls the cell, contains DNA
- Cell membrane – allows substances in and out of the cell
- Cell wall – for shape, structure, support. Made of cellulose in plants
- Mitochondria – aerobic respiration occurs here, to release energy from glucose
- Ribosomes – make protein
- Vacuole (plant only) – stores water and sap
- Chloroplast (plant only) – absorbs sunlight energy for photosynthesis
- Cytoplasm – liquid that fills the cell, chemical reactions occur here



## Magnification

- Microscopes are used to look at really small objects
- Magnification =  $\frac{\text{Image size}}{\text{Actual size}}$
- Magnification = eyepiece lens x objective lens



## Eukaryotic cells

- Have a nucleus. Eg. Animal cells, plant cells

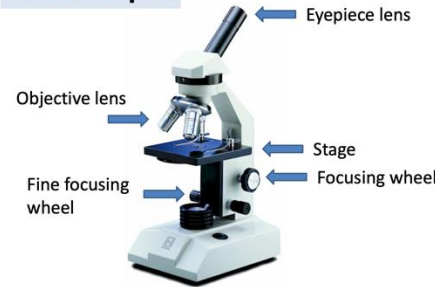
## Prokaryotic cells

- Do not have a nucleus. Eg. bacteria

## Stem cells

- Mainly found in the embryo. Some also found in bone marrow
- Can differentiate – this means turn into any other type of cell

## Microscopes



## The cell cycle

- Stage 1 – chromosomes and cell organelles copied
- Stage 2 – called mitosis. Chromosomes move to each end of the cell
- Stage 3 – called cytokinesis. Cell splits into two identical cells
- Cell cycle needed for growth and repair

## Diffusion

- Movement of particles
- From a high concentration to a low concentration

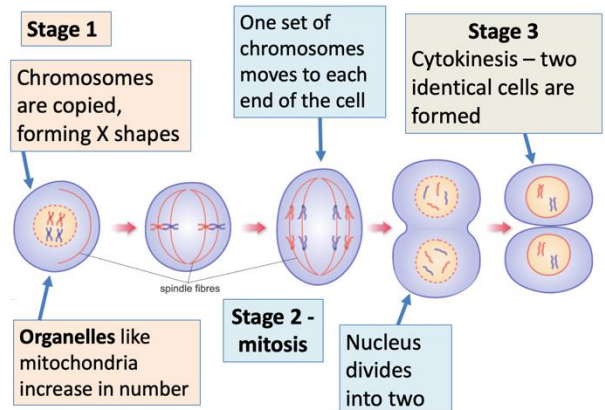
## Osmosis

- Movement of water
- From a high concentration to a low concentration
- Across a partially permeable membrane

## Active transport

- Movement of mineral ions
- From a low concentration to a high concentration
- Requires an input of energy

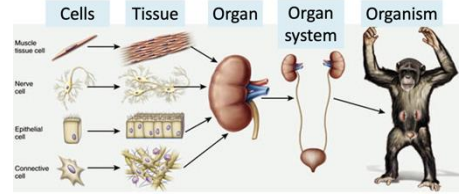
## The cell cycle





**Organisation**

- Cells are the basic building blocks of all living organisms
- Tissues are groups of cells with a similar structure and function
- Organs are groups of tissues performing specific functions
- Organs are grouped into organ systems, which work together to form organisms

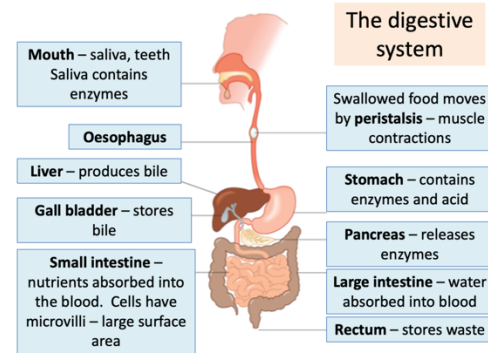


**Food tests – reagents (chemicals) needed and colour change**

- Glucose – Benedict’s reagent, blue → green → orange → red
- Starch – Iodine, orange → blue-black
- Protein – Biuret reagent, blue → purple
- Lipids – ethanol, clear → cloudy

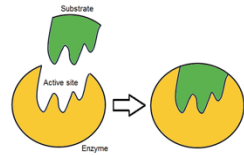
**Digestive system - bile**

- Bile is made in the liver and stored in the gall bladder
- Bile is alkaline to neutralize hydrochloric acid from the stomach
- Bile emulsifies fat to form small droplets which increases the surface area



**Enzymes**

- Enzymes work by the lock and key method - special shape is called the active site
- Active site can be changed by high temperatures and extremes of pH
- An enzyme with a damaged active site is denatured



Name of enzyme	Where made in the body	Breaks down → into
Amylase	Salivary glands, pancreas, small intestine	Starch → glucose
Protease	Stomach, pancreas, small intestine	Protein → amino acids
Lipase	Pancreas, small intestine	Lipids → fatty acids + glycerol

**Structure of the blood**

- Red blood cells – contain haemoglobin to carry oxygen, bi-concave shape for large surface area
- White blood cells – defends against pathogens
- Platelets – cause blood to clot
- Plasma – liquid part of the blood, carries CO<sub>2</sub>, hormones, urea and nutrients

**The heart**

- Right side carries deoxygenated blood
- Right side pumps blood to the lungs to collect oxygen
- Left side carries oxygenated blood
- Left side thicker to pump blood all around the body
- Heart has 4 chambers
- Pacemaker cells are found in the right atrium



**Blood vessels**

- Arteries – thick muscular walls, blood under high pressure, takes blood away from the heart
- Veins – large lumen, lower pressure, valves prevent backflow of blood, takes blood to the heart
- Capillaries – one cell thick to allow diffusion of oxygen and nutrients into cells and CO<sub>2</sub> out of cells

**Heart disease (CHD = coronary heart disease)**

- Layers of fatty material build up inside arteries, reducing flow of blood and oxygen
- Stents used to keep the arteries open
- Statins (a medicine) used to reduce build up of fatty material
- Faulty heart valves can be replaced with biological or mechanical valves

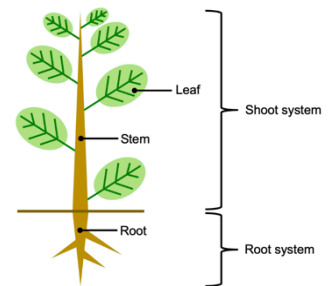
**The lungs**

- Air enters the lungs via the trachea (windpipe) and bronchi
- Alveoli are tiny air sacs surrounded by capillaries
- Alveoli have large surface area and thin walls to allow diffusion of gases

**Plant tissues**

- Epidermal tissues (top and bottom layers)
- Palisade mesophyll (where most photosynthesis happens)
- Spongy mesophyll (contains air spaces for diffusion of gases)
- Xylem and phloem
- Meristem tissue found at the growing tips of shoots and roots
- The leaf is a plant organ

Plant organs



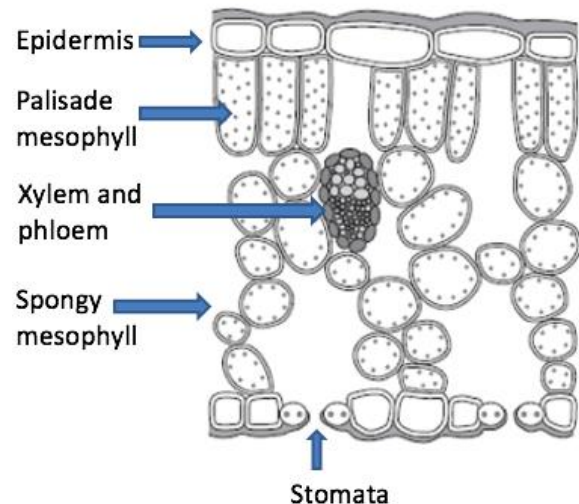
**Plant structures**

- Root hair cells have a large surface area to allow absorption of water and mineral ions
- Xylem vessels transport water and mineral ions from roots to leaves
- Phloem tubes transport sugars around plants
- Movement of sugars in plants is called translocation
- Stomata and guard cells in leaves control gas exchange and water loss

**Transpiration**

- Movement of water through a plant
- Water enters through root hair cells
- Factors that increase rate of transpiration include:
  - Increasing temperature
  - Increasing air movement
  - Increasing light intensity
  - Reducing humidity

Structure of a leaf





## Pathogens

- Pathogens are microorganisms that cause infectious disease. There are 4 types.
- Bacteria – reproduce rapidly and may produce toxins that damage tissues and make us feel ill
- Virus – live and reproduce inside cells
- Fungi
- Protists

Disease	Pathogen that causes it	How it is spread
Salmonella	Bacteria	Under cooked food
Gonorrhoea	Bacteria	Sexual contact
Measles	Virus	Airborne
HIV	Virus	Sexual contact, sharing needles
Tobacco mosaic virus	Virus	Direct contact
Rose black spot	Fungus	Airborne or through water
Malaria	Protist	Mosquito vector

## Human defence systems

- Physical barriers STOP pathogens (skin, mucus, ciliated cells)
- Chemical barriers KILL pathogens (stomach acid, enzymes in tears)

## White blood cells

- Phagocytes – engulf and digest pathogens
- Lymphocytes – produce antibodies
- Other white blood cells produce antitoxins to neutralize toxins

## Vaccination

- Introducing small quantities of dead or inactive pathogens
- Stimulates white blood cells to produce antibodies
- If the same pathogen re-enters the body the white blood cells quickly produce the correct antibodies

## Antibiotics and other drugs

- Antibiotics only kill bacteria
- The heart drug digitalis comes from foxgloves (a plant)
- Aspirin comes from willow (a plant)
- Penicillin comes from a fungus



## Photosynthesis

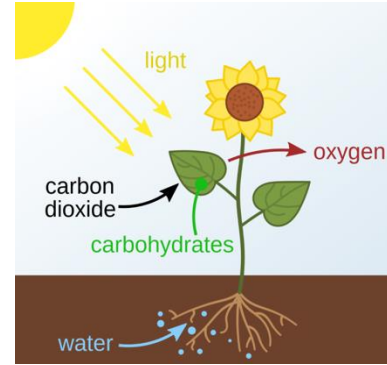
- Plants make their own food by photosynthesis
- Plants take in carbon dioxide through the leaves
- Plants take in water through the roots
- Plants absorb sunlight energy through the chloroplasts (in the leaf cells)
- Glucose and oxygen are produced by photosynthesis
- Photosynthesis word equation:



- Photosynthesis symbol equation:



- Photosynthesis is an endothermic reaction



## Limiting factors of photosynthesis

- Temperature
- Light intensity
- Carbon dioxide concentration

## Uses of glucose produced by photosynthesis

- Respiration
- Converted into starch for storage
- Used to produce fat or oil for storage, cellulose and amino acids

## Respiration

- Respiration is a chemical reaction that releases energy from glucose
- Living things use this energy to grow, move, keep warm and reproduce
- Aerobic respiration uses oxygen
- Anaerobic respiration occurs without the use of oxygen
- Aerobic respiration word equation:



- Anaerobic respiration word equation:



## Response to exercise

- Heart rate and breathing rate increase to supply muscles with more oxygenated blood
- If not enough oxygen is supplied lactic acid builds up

## Metabolism

- Metabolism is the sum of all the reactions in a cell or in the body
- Metabolism includes:
  - Conversion of glucose to starch, glycogen and cellulose
  - Formation of lipid molecules
  - Use of glucose to form amino acids and then proteins
  - Respiration
  - Breakdown of excess protein to form urea for excretion

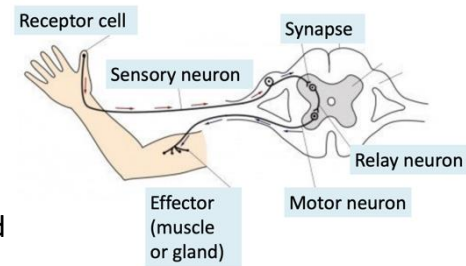


## Homeostasis

- Homeostasis is the regulation of internal conditions in the body
- Internal conditions that need to be kept constant include blood glucose levels, temperature and water levels

## The central nervous system (CNS)

- The CNS is made up of the brain and spinal cord
- Receptor cells are special cells found in sense organs, eg. eyes, nose
- A stimulus is anything a living organism is sensitive to, eg. light, sound
- Receptor cells detect a stimulus and create an impulse
- The impulse travels as an electrical signal along a sensory neuron
- Motor neurons send a message to an effector (muscle or gland)
- Reflex actions do not involve the conscious part of the brain
- A synapse is the gap between two neurons



## Hormones

- A hormone is a chemical messenger released by an endocrine gland
- Hormones are carried in the blood to a target organ
- Hormones are slower than the nervous system but effects last for longer

## Endocrine glands and the hormones produced

- Pituitary gland – FSH, LH
- Pancreas – insulin and glucagon (control blood glucose levels)
- Thyroid – thyroxine (regulates metabolic rate)
- Adrenal glands – adrenaline
- Ovary – oestrogen and progesterone
- Testes – testosterone

## Type 1 diabetes

- Pancreas does not make insulin
- Have to inject insulin

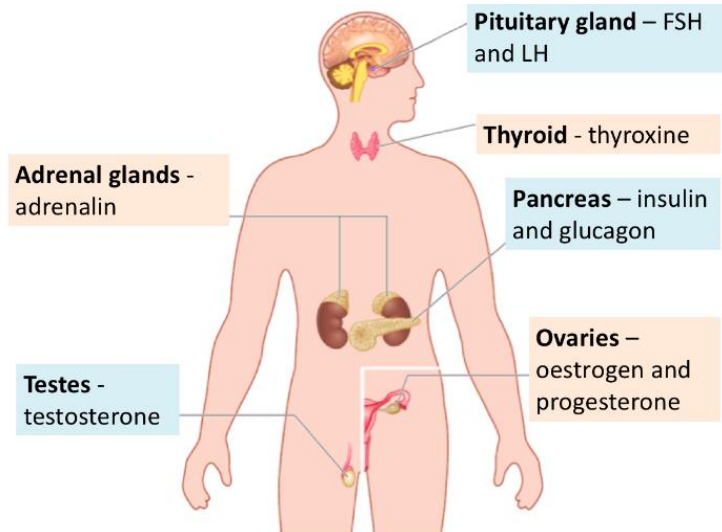
## Type 2 diabetes

- Cells do not respond to insulin
- Managed by diet and exercise
- Obesity is a risk factor

## The menstrual cycle

- The menstrual cycle takes place approximately every 28 days
- FSH causes maturation of an egg in the ovary
- LH stimulates the release of the egg (ovulation)
- Oestrogen and progesterone are involved in maintaining the uterus lining

## The endocrine system





## Sexual and asexual reproduction

- Gametes (sex cells) in animals – sperm and egg. In humans these contain 23 chromosomes
- Gametes in flowering plants – pollen and egg
- Asexual reproduction requires only 1 parent and leads to identical offspring (clones)
- Sexual reproduction requires 2 parents and leads to variation

## Meiosis

- Cells in ovaries and testes divide by meiosis to form gametes
- Cells divide twice to form four gametes
- Gametes are all genetically different and have half the number of chromosomes

## DNA and the genome

- DNA is a double helix structure, with 4 base pairs (A-T, C-G)
- A gene is a small section of DNA
- The genome of an organism is the entire genetic material

## Inheritance

- Alleles are different forms of the same gene
- Genotype is the genes in an organism eg. Bb
- Phenotype is the physical characteristic eg. White flowers
- Dominant alleles are always expressed
- Bb = heterozygous                      BB and bb = homozygous
- Male chromosomes are XY                      Female chromosomes are XX
- Polydactyly (having extra fingers or toes) is caused by a dominant allele
- Cystic fibrosis (a disorder of cell membranes) is caused by a recessive allele



A Punnet square

possible gametes	t	t
T	Tt	Tt
T	Tt	Tt

## Evolution

- A change in the environment causes competition
- Random mutations in organisms' DNA mean there is variation
- The best adapted organisms survive, reproduce and pass on their genes
- Evidence for evolution is found in the fossil record

## Selective breeding

- Desired characteristics are selected, these animals or plants are bred together
- Offspring that show the desired characteristic are bred together

## Genetic engineering

- A process which involves modifying the genome of an organism by introducing a gene from another organism

## Classification

- Three domain system – archaea, bacteria and eukaryote
- All organisms have a binomial name eg. Humans are *Homo sapiens*



**Abiotic factors**

- Non-living factors that affect a community

**Biotic factors**

- Living factors which can affect a community

**Sampling techniques - Quadrats**

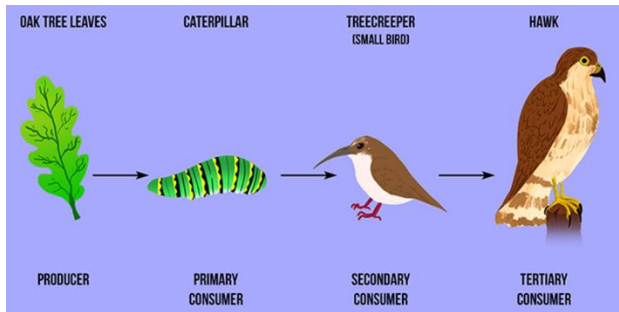
- Quadrat – a hollow square frame
- Place randomly in the area you wish to sample
- Count up the number of organisms
- Repeat many times and find the mean
- Multiply the mean by the number of quadrats that will fit into the area

**Adaptations of organisms**

- Structural – physical features. Eg. Thick fur, spiky leaves
- Behavioural – things organisms do to survive. Eg. Hide from predators
- Functional – things that help an organism survive. Eg. Photosynthesis in plants

**Food chains**

- Always start with a producer – usually a green plant or alga which makes glucose by photosynthesis
- The arrows in a food chain show the flow of energy
- Producer → primary consumer → secondary consumer → tertiary consumer



**Carbon cycle – 4 key processes**

- Respiration – organisms release CO<sub>2</sub>
- Photosynthesis – plants take in CO<sub>2</sub>
- Decomposers – release CO<sub>2</sub> by respiration
- Combustion – burning fossil fuels releases CO<sub>2</sub>

**Biodiversity**

- The variety of all different species of organisms
- Ways to increase biodiversity:
  - Breeding programmes for endangered species
  - Reduction of deforestation
  - Recycling resources

Abiotic factors (non-living)	Biotic factors (living)
Light intensity	Availability of food
Temperature	Predators
Water levels	Pathogens
Soil pH	
Wind intensity	
O <sub>2</sub> and CO <sub>2</sub> levels	

**The carbon cycle**

