# Biology Revision E-Assessment

## CHAPTER 1: Cells

### Cell structure

- All living things are made of cells, which can either be prokaryotic or eukaryotic.
- Animal and plant cells are eukaryotic. They have:
    - Cell membrane
    - Cytoplasm
    - Nucleus containing DNA
- Bacterial cells are prokaryotic and are much smaller. They have a:
    - Cell wall
    - Cell membrane
    - Cytoplasm
    - Single circular strand of DNA and plasmids (small rings of DNA found in the
    - cytoplasm)
- The subcellular structures inside cells all have a specific function.

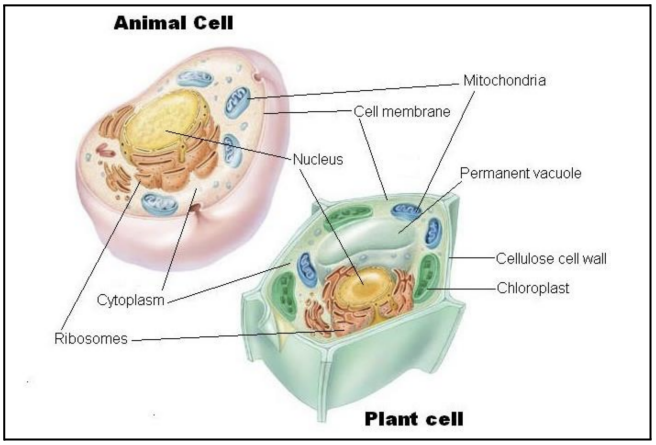
In animal and plant cells…

| Structure | Function |
|---|---|
| Nucleus | ● Contains DNA coding for a particular protein needed to build new cells.<br>● Enclosed in a nuclear membrane. |
| Cytoplasm | ● Liquid substance in which chemical reactions occur.<br>● Contains enzymes (biological catalysts, i.e. proteins that speed up the rate of reaction).<br>● Organelles are found in it |
| Cell membrane | ● Controls what enters and leaves the cell |
| Mitochondria | ● Where aerobic respiration reactions occur, providing energy for the cell |
| Ribosomes | ● Where protein synthesis occurs.<br>● Found on a structure called the rough endoplasmic reticulum. |

Only in plant cells…

| Structure | Function |
|---|---|
| Chloroplasts | ● Where photosynthesis takes place, providing food for the plant<br>● Contains chlorophyll pigment (which makes it green) which harvests the light needed for photosynthesis. |
| Permanent vacuole | ● Contains cell sap<br>● Found within the cytoplasm |

| | |
|---|---|
| | ● Improves cell's rigidity |
| Cell wall | ● Made from cellulose<br>● Provides strength to the cell |




- Bacterial cells are prokaryotic, so do not share as many similarities in the type of organelles as animal and plant cells do.

In bacterial cells…

| **Structure** | **Function** |
|---|---|
| Cytoplasm | Above |
| Cell membrane | Above |
| Cell wall | Made of a different compound - (peptidoglycan) |
| Single circular strand of DNA | As they have no nucleus, this floats in the cytoplasm |
| Plasmids | Small rings of DNA |

## Cell division

<u>Chromosomes</u>

The nucleus contains your genetic information.

- This is found in the form of **chromosomes**, which contain coils of DNA.
- A **gene** is a short section of DNA that codes for a protein and as a result, controls a characteristic- therefore each chromosome carries many genes.
- There are **23 pairs** of chromosomes in each cell of the body, as you inherit one from your mother and one from your father - resulting in 46 chromosomes in total in each cell.
- **Sex cells (gametes)** are the exception: there is half the number of chromosomes, resulting in 23 chromosomes in total in each gamete cell.

<u>The cell cycle</u>

- **The cell cycle** is a series of steps that the cell has to undergo in order to divide. Mitosis is a step in this cycle - the stage when the cell divides
- **Stage 1 (Interphase):** In this stage, the cell grows, organelles (such as ribosome and mitochondria) grow and increase in number, the synthesis of proteins occurs, DNA is replicated (forming the characteristic 'X' shape) and energy stores are increased.
- **Stage 2 (Mitosis):** The chromosomes line up at the equator of the cell and cell fibres pull each chromosome of the 'X' to either side of the cell.
    - Prophase, Metaphase, Anaphase, Telophase
- **Stage 3 (Cytokinesis):** Two identical daughter cells form when the cytoplasm and cell membranes divide

- Cell division by mitosis in multicellular organisms is important in their growth and development, and when replacing damaged cells. Mitosis is also a vital part of asexual reproduction, as this type of reproduction only involves one organism, so to produce offspring it simply replicates its own cells.

## Asexual reproduction

- The cells of the offspring produced by asexual reproduction is produced by mitosis from the parental cells.
- They contain the same genes as the parents.

## Cell Specialisation

- Cells specialise by undergoing differentiation: a process that involves the cell gaining new sub-cellular structures in order for it to be suited to its role.
- Cells can either differentiate once early on or have the ability to differentiate their whole life (these are called stem cells).
- In animals, most cells only differentiate once, but in plants, many cells retain the ability.

<u>Examples of specialised cells in animals</u>

1. **Sperm cells:** specialised to carry the male's DNA to the egg cell (ovum) for successful reproduction
    - Streamlined head and long tail to aid swimming
    - Many mitochondria (where respiration happens) which supply the energy to allow the cell to move
    - The acrosome (top of the head) has digestive enzymes which break down the outer layers of the membrane of the egg cell

2. **Nerve cells:** specialised to transmit electrical signals quickly from one place in the body to another
    - The axon is long, enabling the impulses to be carried along long distances
    - Having lots of extensions from the cell body (called dendrites) means branched connections can form with other nerve cells
    - The nerve endings have many mitochondria which supply the energy to make special transmitter chemicals called neurotransmitters. These allow the impulse to be passed from one cell to another.

3. **Muscle cells:** specialised to contract quickly to move bones (striated muscle) or simply to squeeze (smooth muscle, e.g found in blood vessels so blood pressure can be varied), therefore causing movement
    - Special proteins (myosin and actin) slide over each other, causing the muscle to contract
    - Lots of mitochondria to provide energy from respiration for contraction
    - They can store a chemical called glycogen that is used in respiration by mitochondria

<u>Examples of specialised cells in plants</u>

1. **Root hair cells:** specialised to take up water by osmosis and mineral ions by active transport from the soil as they are found in the tips of roots
    - Have a large surface area due to root hairs, meaning more water can move in
    - The large permanent vacuole affects the speed of movement of water from the soil to the cell
    - Mitochondria to provide energy from respiration for the active transport of mineral ions into the root hair cell

2. **Xylem cells:** specialised to transport water and mineral ions up the plant from the roots to the shoots
    - Upon formation, a chemical called lignin is deposited which causes the cells to die. They become hollow and are joined end-to-end to form a continuous tube so water and mineral ions can move through
    - Lignin is deposited in spirals which helps the cells withstand the pressure from the movement of water

3. **Phloem cells:** specialised to carry the products of photosynthesis (food) to all parts of the plants
    - Cell walls of each cell form structures called sieve plates when they break down, allowing the movement of substances from cell to cell
    - Despite losing many sub-cellular structures, the energy these cells need to be alive is supplied by the mitochondria of the companion cells.

## Cell Differentiation

- To become specialised and be suited to its role, **stem cells** must undergo differentiation to form **specialised cells**.
- This involves some of their **genes being switched on or off** to produce different proteins, allowing the cell to acquire different sub-cellular substances to carry out a specific function.

- In animals, almost all cells differentiate at an early stage and then lose this ability. Most specialised cells can make more of the same cell by undergoing mitosis (the process that involves a cell dividing to produce 2 identical cells).
- Others such as red blood cells (which lose their nucleus) cannot divide and are replaced by adult stem cells (which retain their ability to undergo differentiation).
- In mature animals, cell division mostly only happens to repair or replace damaged cells, as they undergo little growth.

- In plants, many types of cells retain the ability to differentiate throughout life.
- They only differentiate when they reach their final position in the plant, but they can still re-differentiate when it is moved to another position.

## Stem cells

Stem cell research has the potential to treat diseases that are currently burdened with high health care costs—especially chronic conditions such as heart disease, Alzheimer's disease or diabetes, the costs of which threaten to cripple the healthcare system.

Types of stem cells

1. **Embryonic stem cells**
   - Form when an egg and sperm cell fuse to form a zygote
   - They can differentiate into any type of cell in the body
   - Scientists can clone these cells (though culturing them) and direct them to **differentiate into almost any cell in the body**
   - Treat a wide range of medical conditions
     - These could potentially be used to replace insulin-producing cells in those suffering from diabetes, new neural cells for diseases such as Alzheimer's, or nerve cells for those paralysed with spinal cord injuries.
   - Ethical and religious concerns with using embryos
   - But they also use embryos that would otherwise be discarded after in vitro fertilization procedures

2. **Adult stem cells**
   - If found in bone marrow they can form many types of cells including blood cells
   - Eliminates the need for using embryos.
   - Reduces the risk of immune rejection as the cells are a genetic match to the patient.
   - However, more limited differentiation potential than embryonic stem cells, meaning they can only differentiate into specific types of cells.
   - This limits their potential use in certain medical conditions.

3. **Meristems in plants**
   - Found in root and shoot tips
   - They can differentiate into any type of plant, and have this ability throughout the life of the plant
   - They can be used to make clones of the plant- this may be necessary if the parent plant has certain desirable features (such as disease resistance), for research or to save a rare plant from extinction

- **Therapeutic cloning** involves an embryo being produced with the same genes as the patient.
  - The embryo produced could then be harvested to obtain the embryonic stem cells.
  - These could be grown into any cells the patient needed, such as new tissues or organs.
  - The advantage is that they would not be rejected as they would have the exact same genetic make-up as the individual.

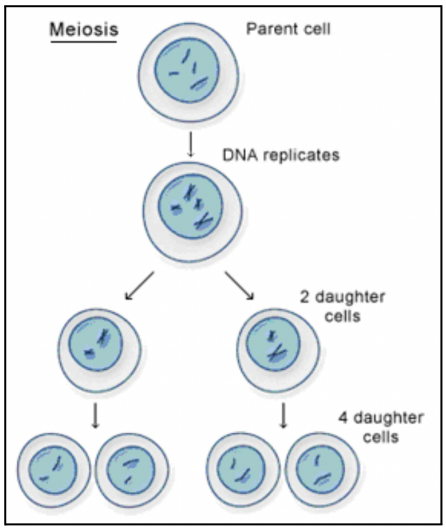
**Benefits vs problems of research with stem cells**

| Benefits | Problems |
|---|---|
| Can be used to replace damaged or diseased body parts. | We do not completely understand the process of differentiation, so it is hard to control stem cells to form the cells we desire. |
| Unwanted embryos from fertility clinics could be used as they would otherwise be discarded | Removal of stem cells results in the destruction of the embryo. |
| Research into the process of differentiation | People may have religious or ethical objections as it is seen as interference with the natural process of reproduction. |
| | If the growing stem cells are contaminated with a virus, an infection can be transferred to the individual. |
| | Money and time could be better spent into other areas of medicine. |

## Sexual reproduction

Gamete formation

- Gametes are sex cells (sperm and egg cells).
- Sperm formed in the testes.
- Egg cells are formed in the ovaries.
- A cell containing a full set of chromosomes (chromosomes in pairs) divides to form cells with half the number set of chromosomes (a single set):
    - Meiosis occurs:
        - Copies of the chromosomes are made.
        - The nucleus divides twice to form 4 nuclei.
        - Then the cell divides twice to form four gametes.
        - Each has a single set of chromosomes.




## Variation

<u>Asexual reproduction leads to very little variation:</u>

- Organisms that reproduce asexually create new individuals by mitosis.
- They are genetically identical to the parent.
- They may develop differently due to differences in their environment.

<u>Sexual reproduction leads to much more variation:</u>

- Meiosis ensures that all gametes contain the same genes, but have a different selection of alleles.
- Also, it is random which sperm fertilises which egg.
- Therefore all individuals (except for identical twins) produced sexually are genetically different.

## Inheritance

- Each gene may have different forms called **alleles**.
    - Eg. There is a gene for eye colour. Everyone has 2 copies of this gene. Alleles for eye colour may be blue, brown, green etc.
    - Therefore each person may have 2 different alleles for eye colour.
- When we are conceived, we receive one copy of each gene from each parent.
- Therefore we have two copies of every gene, but they may be 2 different alleles.
- Different combinations of alleles may lead to differences in the characteristic.
    - An allele, which controls the development of a characteristic when it is present on only one of the chromosomes, is a **dominant** allele.
    - An allele, which controls the development of characteristics only if the dominant allele is not present, is a recessive allele.
- **Phenotype** is a description of how a characteristic is expressed. This can be influenced by genetic or environmental factors.
- **Genotype** is a description of the alleles an individual possesses for a characteristic.
    - A **homozygous** genotype has 2 identical alleles.
    - A **heterozygous** genotype has two different alleles for a gene.

# CHAPTER 2: Tissues, Organs and Organ Systems

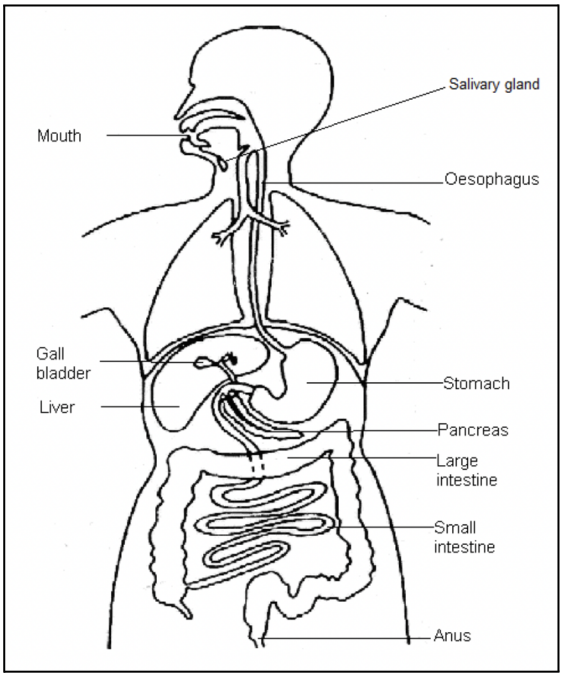
## Multicellular organisms

- Large multicellular organisms develop systems for exchanging materials.
- During the development of a multicellular organism, cells differentiate so that they can perform different functions.
- **Tissue** - a group of (similar) cells that work together to perform the same function
- **Organ** - A group of tissues or cells that work together to perform different functions
    - One organ may contain several tissues.

## Animal organs

- The stomach is an organ that contains:
    - muscular tissue, to churn the contents
    - glandular tissue, to produce digestive juices
    - epithelial tissue, to cover the outside and the inside of the stomach.

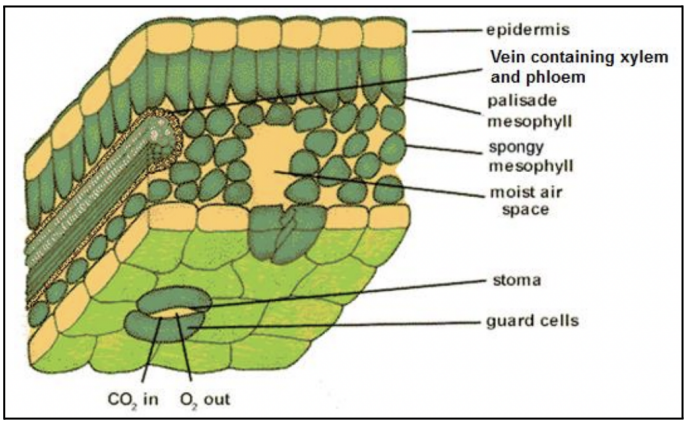
- The digestive system is one example of a system in which humans and other mammals exchange substances with the environment.
- The digestive system includes:
    - glands, such as the pancreas and salivary glands, which produce digestive juices
    - the stomach and small intestine, where digestion occurs
    - the liver, which produces bile
    - the small intestine, where the absorption of soluble food occurs
    - the large intestine, where water is absorbed from the undigested food, producing faeces.




## Plant organs

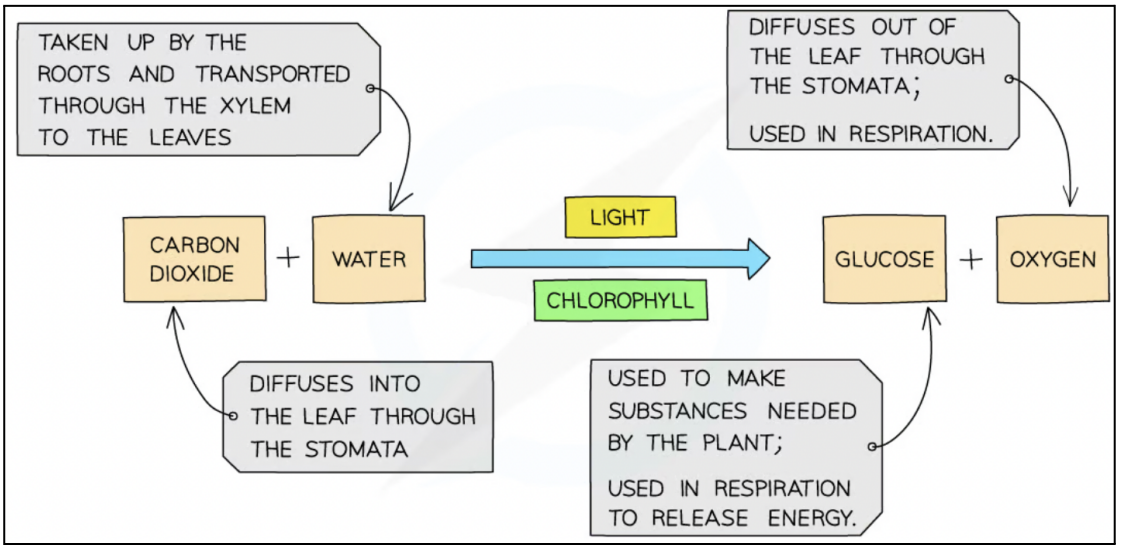
- Plant organs include stems, roots and leaves.
- Examples of plant tissues include:
    - epidermal tissues, which cover the plant

- mesophyll, which carries out photosynthesis
- xylem and phloem, which transport substances around the plant.




## CHAPTER 3: Photosynthesis

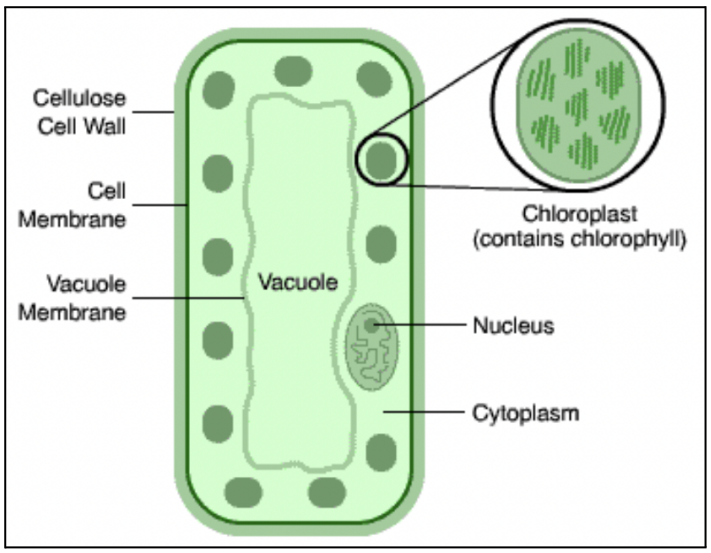
- Green plants make the carbohydrate glucose from the raw materials carbon dioxide and water
- At the same time oxygen is made and released as a waste product
- The reaction requires energy which is obtained by the pigment chlorophyll trapping light from the Sun
- So photosynthesis can be defined as the process by which plants manufacture carbohydrates from raw materials using energy from light
- It can be summed up in the following equation:
  - 6CO2 + 6H2= —> C6H12O6 + 6O2




<u>Where does photosynthesis happen?</u>

- Leaves are the main site of photosynthesis.
- Photosynthesis mainly occurs in the mesophyll cells.
- These cells contain lots of chloroplasts.
- Chloroplasts contain chlorophyll.

<u>A palisade mesophyll cell</u>




## Factors that limit the rate of photosynthesis

1. **Temperature**

A low temperature will limit the rate as the molecules will move less and therefore the reaction happens slower

2. **Carbon dioxide**

A shortage of $CO_2$ will limit the rate as fewer molecules will be available for the reaction.

3. **Light intensity**

A shortage of light means there is less energy to power the reaction.

<u>Limiting factors explained:</u>

- Light, temperature and the availability of carbon dioxide interact and in practice, any one of them may be the factor that limits photosynthesis.
- If one of these factors is closest to its minimum value it will limit the rate.
- Increasing this factor will increase the rate.
- The rate will continue to increase until another factor becomes limiting.
- Any further increase in the original factor will now not increase the rate.
- With no limiting factors, increasing a factor above a certain level will not increase the rate.
- All chlorophyll molecules are being used.

## Farming practices

- Farmers artificially manipulate the environment in which they grow plants.
    - They grow plants in greenhouses or in polythene tunnels.
    - They can control the temperature in greenhouses using heaters and ventilation.
    - They can artificially increase carbon dioxide levels.
    - They can control the light using fluorescent lamps.
- By doing all of this, their plants grow faster and certain plants can be grown in this country out of their natural growing season. Eg tomatoes can be grown all year round.
- Therefore, they increase their profits.

### How do plants and algae use glucose?

- The glucose produced in photosynthesis may be converted into insoluble starch for storage
- Plant cells use some of the glucose produced during photosynthesis for respiration.
- Some glucose in plants and algae is used:
    - to produce fat or oil for storage
    - to produce cellulose, which strengthens the cell wall
    - to produce proteins:
        - To produce proteins, plants also use nitrate ions that are absorbed from the soil.

## CHAPTER 4: Respiration

Definition

- Aerobic respiration - uses oxygen
- Anaerobic respiration - uses no oxygen
- All chemical reactions inside cells are controlled by enzymes

### Aerobic respiration

- Glucose reacts with oxygen, producing $CO_2$ and $H_2O$ as waste products
- This takes place in animals and plants
    - Word equation: Glucose + Oxygen —---> Carbon dioxide + Water + Energy
    - Chemical equation: $C_6H_{12}O_6 + 6O_2$ —---> $6CO_2 + 6H_2O$
- Respiration actually involves a series of many small reactions.
- Each reaction is controlled by an enzyme.
- Organisms need energy for things like:
    - Growth
    - Movement
    - Reproduction
    - Repair/maintenance

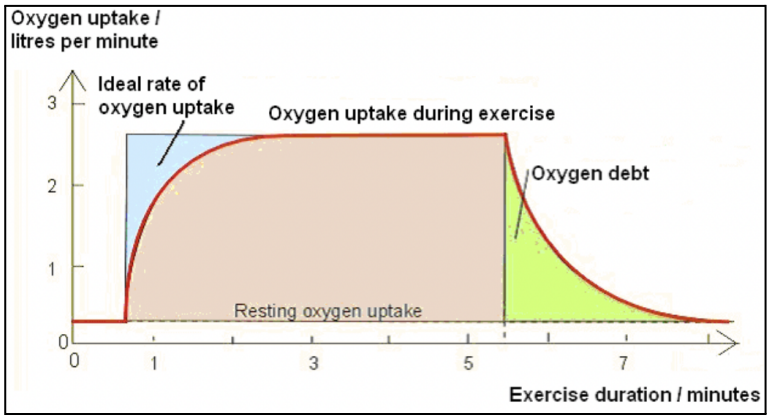
### Anaerobic respiration

- During exercise if insufficient oxygen is reaching the muscles they use anaerobic respiration to obtain energy.
- Anaerobic respiration is the incomplete breakdown of glucose and produces lactic acid.
- As the breakdown of glucose is incomplete, much less energy is released than during aerobic respiration.

glucose —---------> lactic acid + small amount of energy released

- However, lactic acid is poisonous. We can only tolerate small amounts in our bodies.
- If muscles are subjected to long periods of vigorous activity they become fatigued, ie they stop contracting efficiently.
- One cause of muscle fatigue is the build-up of lactic acid in the muscles.
- Blood flowing through the muscles removes the lactic acid.
- During and after exercise, we breathe heavily to take in extra oxygen to oxidise the lactic acid:

lactic acid + oxygen —---------> carbon dioxide + water




## CHAPTER 5: Classification

- **Classification** - the scientific differentiation between evolutionary stages of organisms
    - Organising living things into groups

- **Linnaeun system** (generic to specific)
    - Kingdom
    - Phylum
    - Class
    - Order
    - Family
    - Genus
    - Species

- **Binomial naming system**
    - Part 1: Genus
    - Part 2: Species
    - Written in italics

- **Modern classification system**
    - Three domain system
    - Archaea
        - Primitive prokaryotes that live in extreme conditions (archaebacteria)
    - Bacteria
        - Typical prokaryotes that lack membrane-bound organelles (eubacteria)
    - Eukarya
        - Contain eukaryotic organisms

### Natural selection

- Organisms with traits better-suited to their environment survive and reproduce more often

    - Causes species to evolve over time
- **Adaptation** - a trait that helps a population survive (Giraffe's long neck).
- **Population** - group organisms of the same species living in a particular area at the same time
- **Overproduction of offspring** - organisms produce more offspring than need to sustain the population.
- **Genetic Variation** - organisms have different genes and traits.
- **Struggle To Survive** - starvation, disease, and predators all make it a struggle for organisms to survive.
- **Successful reproduction** - the best adapted to their environment are likely to have many offspring that survive.
- **Selective Breeding** - the process by which humans breed other animals and plants for particular traits (also called artificial selection).

## CHAPTER 6: Food chains and Food webs

- An ecosystem is an ensemble of species and plants coexisting in a habitat
- The biodiversity and distribution of organisms within an ecosystem are due to both **biotic (living thing)** and **abiotic (non-living)** factors.
- These factors affect **decomposition.**

Examples of abiotic factors

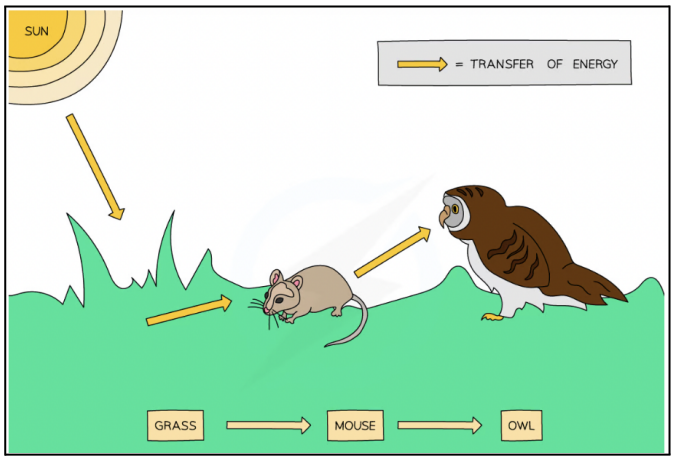
- Light intensity
- PH level
- Soil moisture
- Temperature

Examples of abiotic factors

- Competition for environmental resources
- Grazing
- Predation
- Diseases
- Food availability

| Term | Definition |
|---|---|
| **Producers** | Organisms that produce their organic nutrients usually using energy from sunlight. Plants are producers as they carry out photosynthesis to make glucose. |
| **Herbivore** | An animal that gets its energy by eating plants |
| **Carnivore** | An animal that gets its energy by eating other animals |
| **Primary consumers** | Herbivores - they feed on producers (plants) |

| | |
|---|---|
| **Secondary consumers** | Predators that feed on primary consumers |
| **Tertiary consumers** | Predators that feed on secondary consumers |
| **Decomposers** | Bacteria and fungi that get their energy from feeding off dead and decaying organisms and undigested waste (such as faeces) by secreting enzymes to break them down |

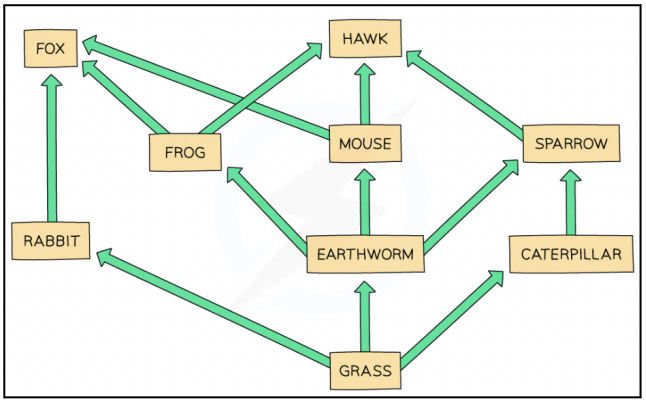



- A food chain shows the transfer of energy from one organism to the next, starting with a producer
- The source of all energy in a food chain is **light energy from the Sun**
- The arrows in a food chain show the **transfer of energy** from one trophic level to the next
- Energy is transferred from one organism to another by ingestion (eating)
- In the food chain above:

| Position in food chain | Organisms | Explanation |
|---|---|---|
| Producer | Grass seed | Makes its own food using photosynthesis |
| Primary consumer | Vole | Eats the producer |
| Secondary consumer | Barn owl | Eats the primary consumer |

**Food Webs**

- A food web is a network of interconnected food chains
- Food webs are more realistic ways of showing connections between organisms within an ecosystem as **animals rarely exist on just one type of food source**




- Food webs give us a lot more information about the transfer of energy in an ecosystem
- They also show **interdependence** - how the change in one population can affect others within the food web
- For example, in the food web above, if the **population of earthworms decreased:**
    - The population of **grass plants would increase** as there are now fewer species feeding off them
    - The populations of **frogs and mice would decrease significantly** as earthworms are their only food source
    - The population of **sparrows would decrease slightly** as they eat earthworms but also have another food source to rely on (caterpillars)
- Most of the changes in populations of animals and plants happen as a result of **human impact** - either by **overharvesting of food species** or by the **introduction of foreign species to a habitat**
- Due to interdependence, these can have **long-lasting knock-on effects** to organisms throughout a food chain or web

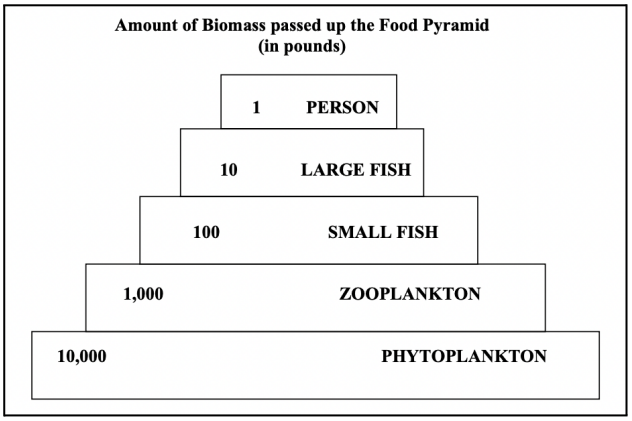
### Pyramid of energy

- Energy is passed between **trophic levels**, although this process is highly inefficient due to a variety of reasons:
    - Not all animal and plant material can be digested to gain energy from, e.g. fur and bones.
    - **Energy is lost** through excretion and decay.
    - Energy is used in other processes, e.g. movement and keeping warm.

- This means that organisms **later on in the food chain gain less energy from their food** than organisms earlier on, as energy is lost at each level.
- Consequently, organisms later in the food chain must eat a larger amount to gain enough energy for survival.
- For this reason, there are usually not more than five trophic levels as too much energy would be lost to sustain another.
- This is also why it is more efficient for humans to eat plants rather than animals, as there are more stages in the food chain if animals are present.

- **A pyramid of numbers** can be used to show the number of organisms in each trophic level.
- This is similar to a **pyramid of biomass**, which measures the total biomass of all the organisms at each level.

- A pyramid of biomass tends to have a true pyramid shape as biomass is lost at each level which corresponds to the energy lost.
- It is more useful as it gives an indication of the amount of energy being passed on at each stage of the food chain.




Human impact on food chains:
Humans alter food webs through over-harvesting food species and introducing foreign species to habitats. Over-harvesting will damage food chains as other organisms which consume these organisms will not have enough food to survive, meaning that many of them will die. Introducing foreign species may have the same effect as there is now competition for resources, which could damage existing species by interfering with the food chain.

An example of this is cane toads, which were introduced to Australia to eat pests. Due to their toxic skin, they have destroyed many native species and damaged habitats, especially water habitats, where the biodiversity has been reduced. This has had a negative effect on the bird population which preyed on animals living in these areas. This shows that when one trophic level is damaged, all that follow are also impacted as the amount of food for them decreases.

## Population size

Key words
- **Population** - A group of organisms of the same species living together in one habitat.
- **Community** - Populations of many different species living together in one ecosystem make up a community.
- **Ecosystem** - A system in a specific area which contains a variety of living organisms which work together within the environment.

Factors affecting rate of population growth:
- **Food supply** - if there is a large amount of food, organisms can breed more successfully.
    - If there is a food shortage, there is a higher death rate which results in slow or negative population growth.
- Predation - organisms which have lots of predators will have a slower rate of population growth as more will be killed by predators.

- Disease - disease can reduce the population by killing organisms. In densely populated areas, the disease can spread quickly, thus a large proportion of the population may be wiped out.

Human population growth:
Over the last 250 years, the human population has risen from just over 1 billion to 7.6 billion. There are many social and economic implications for this. Due to the massive demand for resources and space, deforestation occurs, and a high amount of fossil fuels are burnt. This leads to global warming and also damages habitats. Rapid population growth also puts a strain on services such as healthcare and education, meaning that many people cannot access these services, which lowers their quality of life.

## CHAPTER 7: Nutrition

- A nutrient is a substance which is needed for growth, repair, and metabolism.
- The four main nutrients are:
    - Carbohydrates
    - Proteins
    - Lipids
    - Fibres

### Carbohydrates

- Compounds found in living things
- They are molecules made up of carbon, hydrogen and oxygen..
- Important source of energy (starchy and sugary foods)

- Simple carbohydrates are sugars.
- Provides a rapid source of energy, but the person soon feels hungry again
    - Glucose - monosaccharide
    - Sucrose - disaccharide
    - Trisaccharide
- Polysaccharides are a long chain of monosaccharides are a long chain of monosaccharides
- Held together by a glycosidic bond
    - Amylose - polysaccharides

### Proteins

- Proteins are large molecules made up of small units of amino acids
    - Amino acids are linked by peptide bonds
    - Peptide bonds are broken down by water

- Important functions of proteins:
    - Growth and maintenance
    - Causes biochemical reactions
    - Acts as a messenger
    - Provides structure
    - Maintains proper pH

    - Balances fluids
    - Boosts immune health
    - Transports and stores nutrients

- Enzymes are proteins that aid the biochemical reactions that take place within and outside of your cells.
- Body functions that depend on enzymes include:
    - Digestion
    - Energy production
    - Blood clotting
    - Muscle Contraction

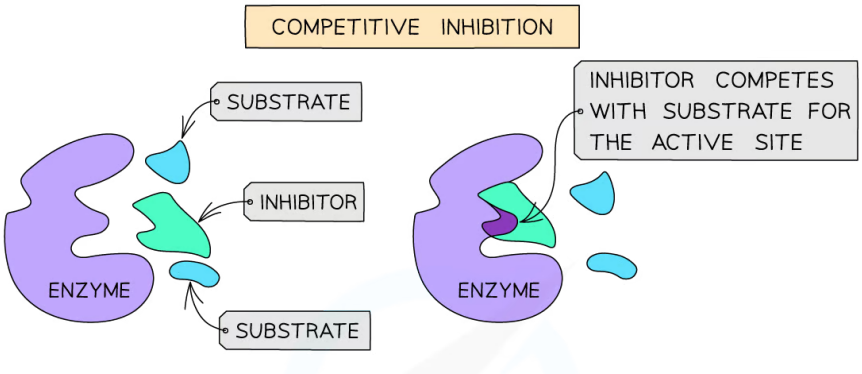
An enzyme is a biological molecule that is able to speed up a reaction

Substrates are the molecules that an enzyme act upon and have binding sites for specific enzymes.

An enzyme's activity can be reduced or stopped by a reversible inhibitor

There are two types of enzymes:

**Competitive inhibition**: similar shape as substrate and compete for the active site




**Non-competitive inhibition:** bind to the enzyme at an alternative site (allosteric site), which alters the shape of the active site (prevents substrate from binding)