

# AQA Additional Science - Biology

## 11.1 What are animals and plants built from?

- All living things are made up of cells. The structures of different types of cells are related to their functions.
- Relate the structure of different types of cells to their function in a tissue or an organ.
- Most human cells, like most other animal cells have the following parts:
- A nucleus which controls the activities of the cell
- Cytoplasm in which most of the chemical reactions take place
- A cell membrane which controls the passage of substances in and out of the cell
- Mitochondria, which is where most energy is released in respiration
- Ribosomes, which is where protein synthesis occurs.
- Plant cells also have a cell wall which strengthens the cell. Plant cells often have:
- Chloroplasts which absorb light energy to make food
- A permanent vacuole filled with cell sap.
- The chemical reactions inside cells are controlled by enzymes.
- Cells may be specialised to carry out a particular function.

## 11.2 How do dissolved substances get into and out of cells?

- To get into or out of cells, dissolved substances have to cross the cell membranes.
- Dissolved substances can move into and out of cells by diffusion and osmosis.
- Diffusion is the spreading of the particles of a gas, or of any substance in solution, resulting in a net movement from a region where they are of a higher concentration. The greater the difference in concentration, the faster the rate of diffusion.
- Oxygen required for respiration passes through cell membranes by diffusion.
- Water often moves across boundaries by osmosis. Osmosis is the diffusion of water from a dilute to a more concentrated solution through a partially permeable membrane that allows the passage of water molecules.
- Differences in the concentrations of the solutions inside and outside a cell cause water to move into or out of the cell by osmosis.

## 11.3 How do plants obtain the food they need to live and grow?

- Green plants use light energy to make their own food. They obtain the raw materials they need to make this food from the air and the soil.
- Interpret data showing how factors affect the rate of photosynthesis and evaluate the benefits of artificially manipulating the environment in which plants are grown.
- Photosynthesis is summarised by the equation:  
$$\text{Carbon dioxide} + \text{water} (+ \text{light energy}) \rightarrow \text{glucose} + \text{oxygen}$$
- During photosynthesis:
- Light energy is absorbed by a green substance called chlorophyll which is found in chloroplasts in some plant cells
- This energy is used by converting carbon dioxide and water into sugar (glucose)
- Oxygen is released as a by-product.
- The rate of photosynthesis may be limited by:
  - Low temperature
  - Shortage of carbon dioxide
  - Shortage of light.

- Light, temperature and the availability of carbon dioxide interact and in practice any one of them may be the factor that limits photosynthesis.
- 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.
- Plant roots absorb mineral salts including nitrates needed for healthy growth. For healthy growth plants need mineral ions including:
  - Nitrate – for producing amino acids which are then used to form proteins
  - Magnesium – which is needed for chlorophyll production.
- The symptoms shown by plants growing in conditions where mineral ions are deficient include:
  - Stunted growth if nitrate ions are deficient
  - Yellow leaves if magnesium ions are deficient.

#### 11.4 What happens to energy and biomass at each stage in a food chain?

- By observing the numbers and sizes of the organisms in food chains we can find out what happens to energy and biomass as it passes along the food chain.
- Interpret pyramids of biomass and construct them from appropriate information
- Evaluate the positive and negative effects of managing food production and distribution, and to be able to recognise that practical solutions to human needs may require compromise between competing priorities.
- Radiation from the Sun is the source of energy for most communities of living organisms. Green plants capture a small part of the solar energy which reaches them. This energy is stored in the substances which make up the cells of the plants.
- The mass of living material (biomass) at each stage in a food chain is less than it was at the previous stage. The biomass at each stage can be drawn to scale and shown as a pyramid of biomass.
- At each stage in a food chain, less material and less energy are contained in the biomass of the organisms. This means that the efficiency of food production can be improved by reducing the number of stages in food chains.
- The efficiency of food production can also be improved by restricting energy loss from food animals by limiting their movement and by controlling the temperature of their surroundings.
- The amounts of material and energy contained in the biomass of organisms is reduced at each successive stage in a food chain because:
  - Some materials and energy are always lost in the organisms' waste materials
  - Respiration supplies all the energy needs for living processes, including movement. Much of this energy is eventually lost as heat to the surroundings
  - These losses are especially large in mammals and birds whose bodies must be kept at a constant temperature, which is usually higher than that of their surroundings.

#### 11.5 What happens to the waste material produced by plants and animals?

- Many trees shed their leaves each year and most animals produce droppings at least once a day. All plants and animals also eventually die. Microbes play an important part in decomposing this material so that it can be used again by plants. The same material is recycled over and over.
- Living things remove materials from the environment for growth and other processes. These materials are returned to the environment either in waste materials or when living things die and decay.
- Materials decay because they are broken down (digested) by micro-organisms. Microorganisms digest materials faster in warm, moist conditions. Many microorganisms are also more active when there is plenty of oxygen.
- The decay process releases substances which plants need to grow.

- In a stable community, the processes which remove materials are balanced by processes which return materials. The materials are constantly cycled.
- The constant cycling of carbon is called the carbon cycle. In the carbon cycle:
  - Carbon dioxide is removed from the environment by green plants for photosynthesis.
  - The carbon from the carbon dioxide is used to make carbohydrates, fats and proteins which make up the body of plants.
  - Some of the carbon dioxide is returned to the atmosphere when green plants respire
  - When green plants are eaten by animals and these animals are eaten by other animals, some of the carbon becomes part of the fats and proteins which make up their bodies
  - When animals respire some of this carbon becomes carbon dioxide and is released into the atmosphere
  - When plants and animals die, some animals and microorganisms feed on their bodies. Carbon is released into the atmosphere as carbon dioxide when these organisms respire
  - By the time the microorganisms and detritus feeders have broken down the waste products and dead bodies of organisms in ecosystems and cycled the materials as plant nutrients, all the energy originally captured by green plants has been transferred.

### 11.6 What are enzymes and what are some of their functions?

- Enzymes are biological catalysts that have many functions both inside and outside cells.
- Evaluate the advantages and disadvantages of using enzymes in home and industry.
- Catalysts increase the rate of chemical reactions. Biological catalysts are called enzymes.
- Enzymes are protein molecules made up of long chains of amino acids. These long chains are folded to produce a special shape which enables other molecules to fit into the enzyme. This shape is vital for the enzyme's function. High temperatures destroy this special shape. Different enzymes work best at different pH values.
- Enzymes inside living cells catalyse processes such as respiration, protein synthesis and photosynthesis.
- During aerobic respiration (respiration which uses oxygen) chemical reactions occur which:
  - use glucose (a sugar) and oxygen
  - release energy.
- Most of the reactions in aerobic respiration take place inside mitochondria.
- Aerobic respiration is summarised by the equation:  $\text{Glucose} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water} (+ \text{energy})$
- The energy that is released during respiration is used:
  - to build up larger molecules using smaller ones
  - in animals, to enable muscles to contract
  - in mammals and birds, to maintain a steady body temperature in colder surroundings
  - in plants, to build up sugars, nitrates and other nutrients into amino acids which are then built up into proteins.
- Enzymes inside living cells catalyse the reactions that build up amino acids and proteins.
- Some enzymes work outside the body cells. The digestive enzymes are produced by specialised cells in glands and in the lining of the gut. The enzymes then pass out of the cells into the gut where they come into contact with food molecules. They catalyse the breakdown of large molecules into smaller molecules:
  - The enzyme amylase is produced in the salivary glands, the pancreas and the small intestine. This enzyme catalyses the breakdown of starch into sugars in the mouth and small intestine
  - Protease enzymes are produced by the stomach, the pancreas and the small intestine. These enzymes catalyse the breakdown of proteins into amino acids in the stomach and the small intestine

- lipase enzymes are produced by the pancreas and small intestine. These enzymes catalyse the breakdown of lipids (fats and oils) into fatty acids and glycerol in the small intestine
- the stomach also produces hydrochloric acid. The enzymes in the stomach work most effectively in these acid conditions
- the liver produces bile which is stored in the gall bladder before being released into the small intestine. Bile neutralises the acid that was added to food in the stomach. This provides alkaline conditions in which enzymes in the small intestine work most effectively.
- Some microorganisms produce enzymes which pass out of the cells. These enzymes have many uses in the home and in industry.
- In the home, biological detergents may contain protein-digesting and fat-digesting enzymes (proteases and lipases).
- In industry:
  - Proteases are used to 'pre-digest' the protein in some baby foods
  - carbohydrases are used to convert starch into sugar syrup
  - isomerase is used to convert glucose syrup into fructose syrup, which is much sweeter and therefore can be used in smaller quantities in slimming foods.

### 11.7 How do our bodies keep internal conditions constant?

- Humans need to remove waste products from their bodies to keep their internal environment relatively constant.
- Evaluate the data from the experiments by Banting and Best which led to the discovery of insulin
- Evaluate modern methods of treating diabetes.
- Waste products which have to be removed from the body include:
  - Carbon dioxide produced by respiration – most of this leaves the body via the lungs when we breathe out
  - Urea produced in the liver by the breakdown of excess amino acids – this is removed by the kidneys in the urine, which is temporarily stored in the bladder.
- Internal conditions which are controlled include the water content of the body, the ion content of the body, temperature and blood sugar levels.
- If the water or ion content of the body is wrong, too much water may move into or out of the cells and damage them. Water and ions enter the body when we eat and drink.
- Sweating helps to cool the body. More water is lost when it is hot, and more water has to be taken as drink or in food to balance this loss.
- Body temperature is monitored and controlled by the thermoregulatory centre in the brain. This centre has receptors sensitive to the temperature of blood flowing through the brain.
- Also temperature receptors in the skin send impulses to the centre giving information about skin temperature.
- If the core body temperature is too high:
  - Blood vessels supplying the skin capillaries dilate so that more blood flows through the capillaries and more heat is lost
  - Sweat glands release more sweat which cools the body as it evaporates.
- If the core body temperature is too low:
  - Blood vessels supplying the skin capillaries constrict to reduce the flow of blood through the capillaries
  - Muscles may 'shiver' – their contraction needs respiration which releases some energy as heat.
- The blood glucose concentration of the body is monitored and controlled by the pancreas. The pancreas produces the hormone insulin which allows glucose to move from the blood into the cells.

- Diabetes is a disease in which a person's blood glucose concentration may rise to a fatally high level because the pancreas does not produce enough of the hormone insulin. Diabetes may be treated by careful attention to diet and by injecting insulin into the body.

### 11.8 Which human characteristics show a simple pattern of inheritance?

- What sex human beings are, and whether or not they inherit certain diseases, show a very simple pattern of inheritance.
- Explain why Mendel proposed the idea of separately inherited factors and why the importance of this discovery was not recognised until after his death
- Interpret genetic diagrams
- Make informed judgements about the social and ethical issues concerning the use of stem cells from embryos in medical research and treatments
- Make informed judgements about the economic, social and ethical issues concerning embryo screening that they have studied or from information that is presented to them
- Predict and/or explain the outcome of crosses between individuals for each possible combination of dominant and recessive alleles of the same gene to construct genetic diagrams.
- In body cells the chromosomes are normally found in pairs. Body cells divide by mitosis to produce additional cells during growth or to produce replacement cells. Body cells have two sets of genetic information; sex cells (gametes) have only one set.
- Cells in reproductive organs – testes and ovaries in humans - divide to form gametes.
- The type of cell division in which a cell divides to form gametes is called meiosis.
- When a cell divides to form gametes
  - Copies of the chromosomes are made
  - Then the cell divides twice to form four gametes, each with a single set of chromosomes.
- When gametes join at fertilisation, a single body cell with new pairs of chromosomes is formed. A new individual then develops by this cell repeatedly dividing by mitosis.
- Most types of animal cells differentiate at an early stage whereas many plant cells retain the ability to differentiate throughout life.
- In mature animals, cell division is mainly restricted to repair and replacement. Cells from human embryos and adult bone marrow, called stem cells, can be made to differentiate into many different types of cells e.g. nerve cells. Treatment with these cells may help conditions such as paralysis.
- The cells of the offspring produced by asexual reproduction are produced by mitosis from the parental cells. They contain the same genes as the parents.
- Sexual reproduction gives rise to variation because, when gametes fuse, one of each pair of alleles comes from each parent.
- In human body cells, one of the 23 pairs of chromosomes carries the genes which determine sex. In females the sex chromosomes are the same (XX) in males the sex chromosomes are different (XY).
- Some characteristics are controlled by a single gene. Each gene may have different forms called alleles.
- 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.
- Chromosomes are made up of large molecules of DNA (deoxyribose nucleic acid). A gene is a small section of DNA.
- Each gene codes for a particular combination of amino acids which make a specific protein.
- Each person (apart from identical twins) has unique DNA. This can be used to identify individuals in a process known as DNA fingerprinting.

- Some disorders are inherited:
  - Huntington's disease – a disorder of the nervous system – is caused by a dominant allele of a gene and can therefore be passed on by only one parent who has the disorder
  - Cystic fibrosis – a disorder of cell membranes – must be inherited from both parents. The parents may be carriers of the disorder without actually having the disorder themselves. It is caused by a recessive allele of a gene and can therefore be passed on by parents, neither of whom has the disorder.
- Embryos can be screened for the alleles that cause these and other genetic disorders.