

BIOLOGY

B1. Cells

B1.1 Know and understand the structure and function of the main sub-cellular components of both animal and plant eukaryotic cells to include:

- a. cell membrane
- b. cytoplasm
- c. nucleus
- d. mitochondrion
- e. cell wall (plant only)
- f. chloroplast (plant only)
- g. vacuole (plant only)

B1.2 Know and understand the structure and function of the main sub-cellular components of prokaryotic cells (bacteria) to include:

- a. cell membrane
- b. cytoplasm
- c. cell wall
- d. chromosomal DNA/no 'true' nucleus
- e. plasmid DNA

B1.3 Know and understand the levels of organisation as: cells to tissues to organs to organ systems.

B2. Movement across membranes

B2.1 Know and understand the processes of diffusion, osmosis and active transport, including examples in living and non-living systems.

B3. Cell division and sex determination

B3.1 Mitosis and the cell cycle:

- a. Know and understand that the cell cycle includes interphase (the cell grows and DNA is copied) and mitosis (division leading to two daughter cells that have the same number of chromosomes so are genetically identical to each other and the parental cell).
- b. Know and understand the role of mitosis in growth by increasing cell numbers, repair of tissues, replacement of worn out cells and asexual reproduction.
- c. Understand that cancer is the result of changes in cells that lead to uncontrolled growth and division.

- B3.2 Meiosis and the cell cycle:
- Know and understand the cell cycle includes interphase (the cell grows and DNA is copied) and meiosis (division that produces daughter cells, known as gametes, in which the chromosome number is halved from diploid to haploid so they have a single set of chromosomes). Each daughter cell will be genetically different.
 - Know and understand the role of meiosis in reducing the chromosome number and that the full chromosome complement is restored at fertilisation.
- B3.3 Asexual and sexual reproduction:
- Know and understand that asexual reproduction involves one parent and that offspring are genetically identical when no mutations occur.
 - Know and understand that sexual reproduction involves two parents and that offspring are genetically different in relation to each other and the parents, leading to (increased) variation.
- B3.4 Sex determination:
- Know that, in most mammals including humans, females are XX and males are XY.
 - Be able to establish the sex and ratio of offspring using genetic diagrams.

B4. Inheritance

- B4.1 Know the nucleus as a site of genetic material/chromosomes/genes in plant and animal cells.
- B4.2 Know and understand the following genetic terms:
- gene
 - allele
 - dominant
 - recessive
 - heterozygous
 - homozygous
 - phenotype
 - genotype
 - chromosome
- B4.3 Monohybrid crosses:
- Use and interpret genetic diagrams to depict monohybrid (single gene) crosses.
 - Use family trees/pedigrees.
 - Express outcome as ratios, numbers, probabilities or percentages.
 - Understand the concept of inherited conditions.
 - Know that most phenotypic features are the result of multiple genes rather than a single gene inheritance.

B5. DNA

B5.1 Understand that:

- a. the genome is the entire genetic material (DNA) of an organism.
- b. chromosomes contain DNA.

B5.2 Describe the structure of DNA:

- a. Know that DNA is a polymer made up of two strands forming a double helix.
- b. Know that DNA is made from four different nucleotides, each consisting of a common sugar and phosphate group along with one of four different bases attached to the sugar.
- c. Know the complementary pairs of bases – adenine (A) with thymine (T), guanine (G) with cytosine (C) – and that the sequence of these bases is the genetic code.

B5.3 Protein synthesis:

- a. Know and understand that genes carry the code for proteins.
- b. Know and understand that the genetic code is 'read' as triplets, and that each triplet codes for an amino acid.
- c. Understand that protein synthesis involves the production of proteins from amino acids.

B5.4 Gene mutations:

- a. Understand that a mutation is a change in the DNA.
- b. Know that most mutations have no effect on the phenotype, some will have a small effect, whilst occasionally others will determine the phenotype.

B6. Gene technologies

B6.1 Genetic engineering:

- a. Understand the process of genetic engineering to include:
 - i. taking a copy of a gene from (DNA/chromosomes of) one organism.
 - ii. insertion of that gene into the DNA of another organism.
 - iii. the roles of restriction enzymes and ligases.
- b. Recall examples of genetic engineering in different cell types.
- c. Explain the benefits and risks of using genetic engineering in medical applications.

B6.2 Stem cells:

- a. Know that embryonic stem cells can give rise to any cell type.
- b. Know that cells lose this ability as an animal matures.
- c. Know the functions of stem cells including adult stem cells.
- d. Explain the benefits and risks of using stem cells in medical applications.

B6.3 Selective breeding:

- a. Understand the impact of selective breeding on domesticated animals.

B7. Variation

B7.1 Natural selection and evolution:

- a. Know that there is usually extensive genetic variation within a population of a species.
- b. Describe evolution as a change in the inherited characteristics of a population over time through a process of natural selection which may result in the formation of a new species.
- c. Explain how evolution can occur through natural selection of variants that give rise to phenotypes best suited to their environment.
- d. Understand antibiotic resistance and that it is an example of evolution through natural selection.

B7.2 Sources of variation:

- a. Understand that variation can be genetic/inherited, resulting in a range of phenotypes.
- b. Understand that variation can also be environmental, which affects a range of phenotypes.

B8. Enzymes

B8.1 Understand that enzymes are biological catalysts.

B8.2 Understand the mechanism of enzyme action including the active site and enzyme specificity.

B8.3 Understand the factors affecting the rate of enzyme action:

- a. temperature
- b. pH

B8.4 Know the role of the amylases, proteases and lipases in digestion.

B9. Animal physiology

B9.1 Respiration:

- a. Understand the process of cellular respiration.
- b. Understand the process of aerobic respiration, including the word equation.
- c. Understand the process of anaerobic respiration in animals, including the word equation.

B9.2 Organ systems:

- a. Nervous system:
 - i. Understand that the central nervous system comprises the brain and spinal cord.
 - ii. Explain the structure and function of sensory neurones, relay neurones, motor neurones, synapses and the reflex arc.
- b. Respiratory system:
 - i. Explain the structure and function of the respiratory (breathing) system, including the structure of the thorax.
 - ii. Understand the processes of ventilation and gas exchange.
 - iii. Understand the importance of a high surface area : volume ratio for the gas exchange process.
- c. Circulatory system:
 - i. Understand the structure and function of the circulatory system, including the heart, heart rate and ECGs, and the blood vessels (arteries, veins and capillaries).
 - ii. Understand the composition and function of the blood (red blood cells carry oxygen; white blood cells are involved in antibody production and phagocytosis; platelets are involved in blood clotting; and plasma is involved both in the transport of blood components and other dissolved substances including hormones, antibodies, urea and carbon dioxide, and in the distribution of heat).
 - iii. Understand the relationship with the gaseous exchange system.
 - iv. Understand the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area : volume ratio.
- d. Digestive system:
 - i. Understand the structure and function of the digestive system.
 - ii. Understand the processes of peristalsis, digestion, absorption and egestion.
- e. Excretory system:
 - i. Understand the structure and function of the excretory system, including the kidney and the nephron.
 - ii. Understand the role of the kidneys in homeostasis.

B9.3 Homeostasis:

- a. Know that homeostasis is the maintenance of a constant internal environment, and appreciate its importance.
- b. Understand the concept of negative feedback.
- c. Understand the regulation of blood glucose levels, including the role of insulin and glucagon.
- d. Understand type 1 and type 2 diabetes, and how type 1 diabetes can be treated.
- e. Understand the regulation of water content (including ADH) and the regulation of temperature.

B9.4 Hormones:

- a. Recall that hormones are released from specific endocrine glands and travel in the blood to their target structures.
- b. Explain the roles of thyroxine and adrenaline in the body, including thyroxine as an example of a negative feedback system.
- c. Describe the role of hormones in human reproduction including:
 - i. those in the menstrual cycle (FSH, LH, oestrogen and progesterone)
 - ii. those in contraception, and the differences between hormonal and non-hormonal forms of contraception.

B9.5 Disease and body defence:

a. Communicable diseases:

- i. Know that communicable diseases are caused by pathogenic bacteria, viruses, protists and fungi.
- ii. Understand the transmission routes of sexually transmitted infections, including the effect on the immune system of HIV which results in AIDS.
- iii. Understand the treatment of disease, including the use of antibiotics, vaccines (role of dead and inactive pathogens, antibody production and formation of memory cells) and techniques to prevent the spread of pathogens including HIV.
- iv. Understand the process of discovery and development of new medicines including pre-clinical and clinical testing.

b. Non-communicable diseases:

- i. Know that the following diseases are caused by the interaction of many factors: cardiovascular disease, many forms of cancer, some lung and liver diseases and diseases influenced by nutrition, including type 2 diabetes.
- ii. Know that cardiovascular disease can be treated/managed using life-long medication (including statins, anti-coagulants and anti-hypertensive drugs), surgical procedures (including stents and bypass for coronary heart disease), and lifestyle changes (including reducing smoking, more exercise and a balanced diet).

B10. Ecosystems

B10.1 Levels of organisation in an ecosystem:

- a. Describe the organisation of levels within an ecosystem from individuals through to populations, and from communities through to ecosystems.
- b. Understand that communities are affected by abiotic and biotic factors.
- c. Appreciate the factors that can cause a population to change in size.
- d. Describe the importance of interdependence in ecosystems (relating to predation, mutualism and parasitism) and of competition in a community.
- e. Know and understand that photosynthetic organisms are the primary producers of food in an ecosystem, and therefore biomass.

B10.2 Material cycling:

- a. Explain the importance of the carbon cycle to include the following processes:
 - i. photosynthesis
 - ii. respiration
 - iii. combustion
 - iv. decomposition
- b. Understand the importance of the water cycle to living organisms.