Paper 1:

B1 Cell Level Systems

B1.1 Cell Structures

B1.1a Describe how light microscopes and staining can be used to view cells

1. Name the three main parts of a light microscope used to illuminate, support and magnify a specimen.
2. State the functions of the lenses, stage and lamp in a light microscope.
3. Describe how a biological specimen is prepared using a microscope slide and cover slip.
4. Why are stains used when viewing colourless cells or specimens under a light microscope?
5. Explain how stains can help scientists distinguish between different cell structures or tissues.
6. State how the total magnification of a light microscope is calculated and calculate the magnification when a ×10 eyepiece lens and a ×40 objective lens are used.

B1.1b Explain how the main sub-cellular structures of eukaryotic cells (plants and animals) and prokaryotic cells are related to their functions

1. Explain the functions of the nucleus, genetic material and chromosomes in a eukaryotic cell.
2. Compare the location and arrangement of genetic material in eukaryotic and prokaryotic cells.
3. What are plasmids, where are they found and what type of information can they carry?
4. Explain how mitochondria are related to their function in cellular respiration.
5. Explain how chloroplasts are related to their function, including the role of chlorophyll.
6. Explain the functions of the cell membrane and ribosomes, including receptor molecules, the selective barrier and protein synthesis.

B1.1c Explain how electron microscopy has increased our understanding of sub-cellular structures

1. What is meant by the resolution of a microscope?
2. How does the resolution of a transmission electron microscope compare with the resolution of a light microscope?
3. Explain why a transmission electron microscope can reveal smaller sub-cellular structures than a light microscope.
4. State two sub-cellular structures that can be seen in greater detail using an electron microscope.
5. Compare the structures that may be visible in a light micrograph with those visible in an electron micrograph.
6. Explain how images produced by electron microscopes have increased scientists' understanding of the internal structure and organisation of cells.

B1.2 What happens in cells (and what do cells need)?

B1.2a Describe DNA as a polymer

1. What is DNA?
2. What is meant by the term polymer?
3. Explain why DNA is described as a polymer.
4. What smaller repeating units make up a DNA molecule?
5. Where is DNA found inside a eukaryotic cell?
6. Explain why DNA is important for living organisms.

B1.2b Describe DNA as being made up of two strands forming a double helix

1. How many strands make up a DNA molecule?
2. What is meant by the term double helix?
3. Describe the overall shape of a DNA molecule.
4. Explain how the two strands of DNA are arranged.
5. State the name given to the structure formed by the two DNA strands.
6. Explain why the double helix structure is important for storing genetic information.

B1.2c Describe experiments that can be used to investigate enzymatic reactions

1. What is an enzyme?

2. Describe a practical method that could be used to investigate the activity of an enzyme.
3. State the independent variable in an investigation of enzyme activity.
4. State the dependent variable that would be measured during an enzyme investigation.
5. Name two control variables that should be kept constant during an enzyme investigation.
6. Explain how the results of an enzyme investigation could be presented and analysed using tables, calculations or graphs.

B1.2d Explain the mechanism of enzyme action

1. Explain the role of enzymes in metabolism.
2. What is the active site of an enzyme?
3. Explain the lock and key hypothesis and how it describes enzyme specificity.
4. Describe how temperature and pH affect the rate of enzyme-controlled reactions.
5. Explain how substrate concentration and enzyme concentration affect the rate of enzyme-controlled reactions.
6. Explain why enzymes are described as biological catalysts, referring to the active site, enzyme specificity and the factors affecting enzyme activity.

B1.3 Respiration

B1.3a Describe cellular respiration as a universal chemical process, continuously occurring in all living cells that supply ATP

1. What is cellular respiration?
2. Why is cellular respiration described as a universal chemical process?
3. In which living cells does cellular respiration occur?
4. What molecule is supplied by cellular respiration to provide energy for cellular processes?
5. Explain why cells require a continuous supply of ATP.
6. Explain why cellular respiration must occur continuously, even when an organism is resting.

B1.3b Describe cellular respiration as an exothermic reaction

1. What is meant by an exothermic reaction?
2. Explain why cellular respiration is an exothermic reaction.
3. What happens to the energy released during cellular respiration?
4. How does the energy released during respiration benefit living organisms?

5. Compare an exothermic reaction with an endothermic reaction.
6. Give one example of evidence that shows energy is released during respiration.

B1.3c Compare the processes of aerobic and anaerobic respiration in plants/fungi and animals

1. Compare the conditions required for aerobic and anaerobic respiration.
2. State the reactants (substrates) used in aerobic respiration.
3. Compare the products formed during anaerobic respiration in animals with those formed in plants and fungi.
4. Which type of respiration produces the greatest yield of ATP? Explain your answer.
5. Complete a table comparing aerobic respiration, anaerobic respiration in animals, and anaerobic respiration in plants/fungi, including the conditions, substrates, products and ATP yield.
6. Explain why organisms carry out anaerobic respiration even though it produces much less ATP than aerobic respiration.

B1.3d Explain the importance of sugars in the synthesis and breakdown of carbohydrates

1. What is meant by the terms monomer and polymer?
2. Which monomers join together to form carbohydrates?
3. Explain how carbohydrates are synthesised from sugars.
4. Explain how carbohydrates are broken down into sugars.
5. Why is the synthesis and breakdown of carbohydrates important in living organisms?
6. Explain why carbohydrates are described as polymers.

B1.3e Explain the importance of amino acids in the synthesis and breakdown of proteins

1. What is meant by the terms monomer and polymer in relation to proteins?
2. What are the monomers that make up proteins?
3. Explain how amino acids are joined together to synthesise proteins.
4. Explain how proteins are broken down into amino acids.
5. Why are amino acids important for the growth and repair of living organisms?
6. Explain why proteins are described as polymers.

B1.3f Explain the importance of fatty acids and glycerol in the synthesis and breakdown of lipids

1. Name the molecules that join together to form a lipid.
2. Explain how fatty acids and glycerol are combined to synthesise lipids.
3. Explain how lipids are broken down into fatty acids and glycerol.
4. Why are lipids important in living organisms?
5. Compare the synthesis and breakdown of lipids with the synthesis and breakdown of carbohydrates.
6. Explain why fatty acids and glycerol are essential building blocks of lipids.

B1.4 Photosynthesis

B1.4a Describe photosynthetic organisms as the main producers of food and therefore biomass for life on Earth

1. What are photosynthetic organisms?
2. Give two examples of photosynthetic organisms.
3. Explain why photosynthetic organisms are described as the main producers of food.
4. What is meant by the term biomass?
5. Explain why most food chains depend on photosynthetic organisms.
6. Explain why life on Earth depends on photosynthetic organisms.

B1.4b Describe the process of photosynthesis

1. State the word equation for photosynthesis.
2. Identify the reactants and products of photosynthesis.
3. Explain why photosynthesis is described as a two-stage process.
4. Where in the cell does photosynthesis take place?
5. Explain the role of chloroplasts in photosynthesis.
6. Describe the process of photosynthesis from the entry of the reactants to the production of glucose and oxygen.

B1.4c Describe photosynthesis as an endothermic reaction

1. What is meant by an endothermic reaction?
2. Explain why photosynthesis is an endothermic reaction.
3. What is the source of energy for photosynthesis?
4. Compare an endothermic reaction with an exothermic reaction.
5. Explain what happens to light energy during photosynthesis.
6. Give one piece of evidence that shows photosynthesis requires an input of energy.

B1.4d Describe experiments to investigate photosynthesis

1. Describe how a plant can be tested for starch to investigate photosynthesis.
2. Why is part of a leaf covered with opaque material during a starch test?
3. Explain why a plant is destarched before investigating photosynthesis.
4. Describe the purpose of iodine solution in a photosynthesis investigation.
5. State what result would show that photosynthesis has occurred.
6. Explain how a starch test demonstrates the consequences of excluding light from a photosynthesising plant.

B1.4e Explain the effect of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis

1. Explain how increasing light intensity affects the rate of photosynthesis.
2. Explain how carbon dioxide concentration affects the rate of photosynthesis.
3. Explain how temperature affects the rate of photosynthesis.
4. Why does increasing one factor not always increase the rate of photosynthesis?
5. Predict what would happen to the rate of photosynthesis if light intensity, carbon dioxide concentration or temperature were reduced.
6. Explain how an investigation could be carried out to measure the effect of one factor on the rate of photosynthesis while keeping the other factors constant.

B1.4f Explain the interaction of temperature, light intensity and carbon dioxide concentration in limiting the rate of photosynthesis using graphs depicting the effects of the limiting factors

1. What is meant by a limiting factor?
2. Explain how light intensity can become the limiting factor for photosynthesis.
3. Explain how carbon dioxide concentration can become the limiting factor for photosynthesis.
4. Explain how temperature can become the limiting factor for photosynthesis.
5. Describe how a graph of photosynthesis changes when the limiting factor is increased and another factor becomes limiting.
6. Explain how graphs can be used to identify which factor is limiting the rate of photosynthesis under different conditions.

B2 Scaling Up

B2.1 Supplying the Cell

B2.1a Explain how substances are transported into and out of cells through diffusion, osmosis and active transport

1. Compare diffusion, osmosis and active transport.
2. Explain how concentration gradients affect the movement of substances during diffusion.
3. Explain how water moves by osmosis, using the term water potential.
4. Give one example of a substance transported by diffusion, one by osmosis and one by active transport.
5. Explain the direction of movement of substances during diffusion, osmosis and active transport.
6. Explain why active transport requires energy whereas diffusion and osmosis do not.

B2.1b Describe the process of mitosis in growth, including the cell cycle

1. What is the purpose of mitosis?
2. State the stages of the cell cycle in the correct order.
3. What happens during DNA replication?
4. Explain what happens to chromosomes during mitosis.
5. Explain how mitosis produces two genetically identical daughter cells.
6. Explain why mitosis is important for growth and repair in multicellular organisms.

B2.1c Explain the importance of cell differentiation

1. What is meant by cell differentiation?
2. Explain why cell differentiation allows organisms to become more efficient.
3. What is a specialised cell?
4. Give three examples of specialised cells and state one function of each.
5. Explain how cell differentiation produces specialised cells.
6. Explain why multicellular organisms require many different specialised cell types.

B2.1d Recall that stem cells are present in embryonic and adult animals, and meristems in plants

1. What is a stem cell?
2. Where are embryonic stem cells found?
3. Where are adult stem cells found?
4. Where are stem cells found in plants?
5. What is a meristem?
6. Compare the locations of stem cells in embryonic animals, adult animals and plants.

B2.1e Describe the functions of stem cells in embryonic and adult animals, and meristems in plants

1. What is the function of embryonic stem cells?
2. What is the function of adult stem cells?
3. What is the function of meristems in plants?
4. Explain how stem cells contribute to development, growth and repair.
5. Explain why stem cells are able to produce a range of different cell types.
6. Compare the roles of embryonic stem cells, adult stem cells and plant meristems.

B2.1f Describe the difference between embryonic and adult stem cells in animals

1. Compare embryonic and adult stem cells.
2. Which type of stem cell can differentiate into the greatest variety of cell types?
3. Explain why embryonic stem cells have greater potential than adult stem cells.
4. State one similarity between embryonic and adult stem cells.
5. Give one example of a use for adult stem cells in the body.
6. Explain why embryonic stem cells are particularly important during early development.

B2.2 The Challenges of Size

B2.2a Explain the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area : volume ratio

1. What is meant by the term surface area : volume ratio?
2. Calculate the surface area, volume and surface area : volume ratio of a cube with sides measuring 3 cm.
3. Explain how the surface area : volume ratio changes as an organism increases in size.

4. Explain why cells in large multicellular organisms cannot obtain enough oxygen and nutrients by diffusion alone.
5. Explain why increasing diffusion distance reduces the efficiency of diffusion in large organisms.
6. Explain why multicellular organisms require specialised exchange surfaces and transport systems, making reference to surface area : volume ratio and diffusion distance.

B2.2b Describe some of the substances transported into and out of a range of organisms in terms of the requirements of those organisms

1. Name four substances that are transported into or out of living organisms.
2. Explain why oxygen is transported into animal cells.
3. Explain why carbon dioxide is transported out of animal cells.
4. Explain why water must be transported into and around living organisms.
5. Explain why dissolved food molecules are transported to cells throughout the body.
6. Compare the substances transported into and out of plants and animals, explaining why each substance is required.

B2.2b Describe some of the substances transported into and out of a range of organisms in terms of the requirements of those organisms

1. Name six substances that are transported into or out of living organisms.
2. Explain why oxygen is transported into animal cells.
3. Explain why carbon dioxide is transported out of animal cells.
4. Explain why water and dissolved food molecules must be transported around multicellular organisms.
5. Explain why mineral ions are transported into plants.
6. Explain why urea is transported out of the body and identify where it is produced.

B2.2c Describe the human circulatory system

1. What is the main function of the human circulatory system?
2. Explain the relationship between the circulatory system and the gaseous exchange system.
3. What is meant by a double circulatory system?
4. Describe the route taken by blood through the pulmonary and systemic circulations.
5. Explain why mammals require a double circulatory system.

6. Describe the arrangement of the blood vessels that make up the human circulatory system.

B2.2d Explain how the structure of the heart and the blood vessels are adapted to their functions

1. Name the four chambers of the mammalian heart.
2. Name the four main valves and the major blood vessels entering and leaving the heart.
3. Explain how cardiac muscle is adapted for its function.
4. Compare the structures of arteries, veins and capillaries, referring to wall thickness, lumen diameter and the presence of valves.
5. Explain why arteries, veins and capillaries each have different structural adaptations.
6. Explain how the adaptations of the heart and blood vessels allow blood to be transported efficiently around the body.

B2.2e Explain how red blood cells and plasma are adapted to their transport functions in the blood

1. Explain how red blood cells are adapted to transport oxygen.
2. Explain why red blood cells have a biconcave shape.
3. Explain why mature red blood cells do not contain a nucleus.
4. State the function of plasma.
5. Name four substances transported by plasma.
6. Explain how the adaptations of both red blood cells and plasma enable efficient transport throughout the body.

B2.2f Explain how water and mineral ions are taken up by plants, relating the structure of the root hair cells to their function

1. Explain how water enters a root hair cell.
2. Explain how mineral ions enter a root hair cell.
3. Describe three adaptations of root hair cells that make them efficient at absorbing water and mineral ions.
4. Explain why root hair cells have a large surface area.
5. Compare the uptake of water with the uptake of mineral ions into root hair cells.
6. Explain how the adaptations of root hair cells enable plants to absorb the substances needed for healthy growth.

B2.2g Describe the processes of transpiration and translocation

1. Define the term transpiration.

2. Define the term translocation.
3. Explain the role of the stomata during transpiration.
4. State the substances transported by the xylem during transpiration.
5. State the substances transported by the phloem during translocation.
6. Compare transpiration and translocation.

B2.2h Explain how the structure of the xylem and phloem are adapted to their functions in the plant

1. State the function of the xylem.
2. State the function of the phloem.
3. Describe two structural adaptations of xylem vessels that make them suitable for transporting water.
4. Describe two structural adaptations of phloem vessels that make them suitable for transporting dissolved sugars.
5. Compare the substances transported by xylem and phloem.
6. Explain how the adaptations of xylem and phloem allow transport throughout the plant.

B2.2i Explain the effect of a variety of environmental factors on the rate of water uptake by a plant

1. Explain why increasing light intensity increases the rate of water uptake.
2. Explain why increasing temperature increases the rate of water uptake.
3. Explain why increasing air movement (wind speed) increases the rate of water uptake.
4. A plant absorbs 2.4 cm^3 of water per hour at 20°C and 4.8 cm^3 per hour at 30°C. By what factor has the rate of water uptake increased?
5. During an investigation, the rate of water uptake is 1.5 cm^3/hour in still air and 3.6 cm^3/hour in windy conditions. Calculate the increase in the rate of water uptake.
6. Predict and explain what would happen to the rate of water uptake if a plant was placed in a dark, cool room with no wind.

B2.2j Describe how a simple potometer can be used to investigate factors that affect the rate of water uptake

1. What is a potometer used to measure?
2. Describe how you would use a simple potometer to investigate the effect of light intensity on water uptake.
3. Explain why only one variable should be changed during a potometer investigation.
4. A bubble moves 36 mm in 9 minutes. Calculate the rate of water uptake in mm/min.

5. A plant shoot has a mass of 18.0 g before an investigation and 16.2 g afterwards. Calculate the percentage loss in mass.
6. A bubble moves 18 mm in 6 minutes at 20°C and 42 mm in 6 minutes at 30°C. Calculate the rate of water uptake at each temperature and identify which temperature resulted in the greater rate.

B3: Organism Level Systems

B3.1 Coordination and Control – The Nervous System

B3.1a Describe the structure of the nervous system

1. State the function of the central nervous system (CNS).
2. State the function of the brain in the nervous system.
3. State the function of the spinal cord.
4. State the function of a sensory neurone.
5. State the function of a relay neurone.
6. State the function of a motor neurone.

B3.1b Explain how the components of the nervous system can produce a coordinated response

1. Define the term stimulus.
2. Define the term receptor.
3. Define the term effector.
4. Explain the role of receptors in producing a coordinated response.
5. Explain the role of effectors in producing a coordinated response.
6. A person accidentally steps on a sharp drawing pin. Describe how the nervous system produces a coordinated response from the moment the stimulus is detected until the muscles contract.

B3.1c Explain how the structure of a reflex arc is related to its function

1. Define the term reflex action.
2. State the correct order of structures in a reflex arc.
3. Explain why reflex actions are usually faster than voluntary actions.
4. A person touches a hot pan and immediately removes their hand. Explain why this response is a reflex action.
5. Explain how a relay neurone helps a reflex arc to function.

6. A reflex response takes 0.15 s, while a voluntary response takes 0.48 s. Calculate how much faster the reflex response is than the voluntary response.

B3.2 Coordination and Control – The Endocrine System

B3.2a Describe the principles of hormonal coordination and control by the human endocrine system

1. Define the term hormone.
2. Explain why hormones are described as chemical messengers.
3. State where hormones are produced in the endocrine system.
4. State how hormones are transported around the body.
5. Define the term receptor.
6. Explain why a hormone affects only particular target cells or organs.

B3.2b Explain the roles of thyroxine and adrenaline in the body

1. Name the endocrine gland that produces thyroxine.
2. State the role of thyroxine in controlling metabolic rate.
3. Explain how negative feedback controls the release of thyroxine.
4. Name the endocrine gland that produces adrenaline.
5. Describe the effects of adrenaline on the body during a fight-or-flight response.
6. Explain how the effects of adrenaline increase a person's chances of survival in a dangerous situation.

B3.2c Describe the role of hormones in human reproduction including the control of the menstrual cycle

1. State the role of follicle stimulating hormone (FSH) in female reproduction.
2. State the role of oestrogen in the menstrual cycle.
3. State the role of progesterone in the menstrual cycle.
4. State the role of testosterone in male reproduction.
5. Explain how oestrogen and progesterone prepare the uterus for pregnancy.
6. Explain how hormones control the menstrual cycle.

B3.2d Explain the interactions of FSH, LH, oestrogen and progesterone in the control of the menstrual cycle

1. State the role of luteinising hormone (LH) in the menstrual cycle.
2. Explain how follicle stimulating hormone (FSH) and oestrogen interact during the menstrual cycle.
3. Explain how oestrogen affects the release of FSH and LH.
4. Explain how progesterone affects the release of FSH and LH.
5. Describe the sequence of hormonal changes that leads to ovulation.
6. Explain how FSH, LH, oestrogen and progesterone work together to control the menstrual cycle.

B3.2e Explain the use of hormones in contraception and evaluate hormonal and non-hormonal methods of contraception

1. State one example of a hormonal method of contraception.
2. State one example of a non-hormonal method of contraception.
3. Explain how hormonal contraception prevents pregnancy.
4. Explain how a non-hormonal method of contraception prevents pregnancy.
5. Compare the effectiveness of hormonal and non-hormonal methods of contraception.
6. Evaluate the advantages and disadvantages of hormonal and non-hormonal methods of contraception.

B3.2f Explain the use of hormones in modern reproductive technologies to treat infertility

1. Define the term infertility.
2. State how hormones are used to stimulate egg maturation during fertility treatment.
3. Explain how hormones can increase the chances of pregnancy during fertility treatment.
4. State one modern reproductive technology used to treat infertility.
5. Explain how hormone treatment is used alongside modern reproductive technologies.
6. Explain why hormone treatments can be effective in treating infertility.

B3.3 Maintaining Internal Environments

B3.3a Explain the importance of maintaining a constant internal environment in response to internal and external change

1. Define the term homeostasis.
2. State why living organisms need to maintain a constant internal environment.
3. State two examples of internal conditions controlled by homeostasis.
4. Explain how changes in the external environment can affect the body's internal environment.
5. Explain why enzymes and other metabolic reactions require a constant internal environment.
6. Explain why maintaining homeostasis is essential for survival.

B3.3b Explain how insulin controls blood sugar levels in the body

1. Name the organ that produces insulin.
2. State when insulin is released into the bloodstream.
3. Explain how insulin lowers blood glucose concentration.
4. State what happens to excess glucose after insulin is released.
5. Explain why blood glucose concentration must be kept within a narrow range.
6. Explain how insulin helps maintain homeostasis.

B3.3c Explain how glucagon interacts with insulin to control blood sugar levels in the body

1. State when glucagon is released into the bloodstream.
2. Name the organ that produces glucagon.
3. Explain how glucagon increases blood glucose concentration.
4. Explain how insulin and glucagon have opposite effects on blood glucose concentration.
5. Explain how insulin and glucagon work together to maintain a constant blood glucose concentration.
6. Explain why the interaction between insulin and glucagon is an example of homeostasis.

B3.3d Compare type 1 and type 2 diabetes and explain how they can be treated

1. State the cause of type 1 diabetes.
2. State the cause of type 2 diabetes.
3. Compare type 1 diabetes with type 2 diabetes.
4. State one treatment used for type 1 diabetes.
5. State two treatments used for type 2 diabetes.
6. Explain why the treatment for type 1 diabetes differs from the treatment for type 2 diabetes.

Paper 2:

Topic B4: Community level systems

B4.1 Ecosystems

B4.1a — recall that many different materials cycle through the abiotic and biotic components of an ecosystem

1. What is meant by the abiotic and biotic components of an ecosystem?
2. What does it mean for a material to cycle through the abiotic and biotic components of an ecosystem?
3. What happens to materials when they move from the abiotic components into living organisms?
4. What happens to materials when they move from biotic components back into the abiotic environment?
5. What are two examples of materials that cycle through ecosystems?
6. Why must materials such as carbon and nitrogen be continually recycled within ecosystems?

B4.1b — explain the role of microorganisms in the cycling of materials through an ecosystem

1. What role do microorganisms play in the cycling of materials through an ecosystem?
2. What is decomposition, and what types of material are decomposed by microorganisms?
3. How do microorganisms act as decomposers in an ecosystem?
4. How does decomposition return materials from dead organisms and waste to the abiotic environment?
5. How could you investigate the range of ecosystems and identify examples of microorganisms that act as decomposers within them?
6. Why are microorganisms acting as decomposers essential for the continued cycling of materials through an ecosystem?

B4.1c — explain the importance of the carbon cycle and the water cycle to living organisms

1. Why is the carbon cycle important to living organisms?

2. What are the main stages by which carbon is transferred between living organisms and the environment?
3. Why is the water cycle important to living organisms?
4. What are the main stages of the water cycle?
5. How do the carbon and water cycles help maintain habitats and freshwater supplies?
6. How do the carbon and water cycles contribute to the flow of nutrients through ecosystems?

B4.1d — describe different levels of organisation in an ecosystem from individual organisms to the whole ecosystem

1. What is meant by an individual organism in an ecosystem?
2. What is a population, and how is it different from an individual organism?
3. What is a community, and how is it different from a population?
4. What is an ecosystem, and how does it include both biotic and abiotic components?
5. What is the correct order of organisation from an individual organism to the whole ecosystem?
6. How does the number of organisms change as you move from an individual organism to a population, community and ecosystem?

B4.1e — explain how abiotic and biotic factors can affect communities

1. How can temperature and light intensity affect the organisms present in a community?
2. How can moisture level and soil pH affect the distribution and abundance of organisms in a community?
3. How can predators affect the size and distribution of populations within a community?
4. How can the availability of food affect populations within a community?
5. How can sampling techniques be used to identify and investigate biotic factors in an ecosystem?
6. How could you investigate the effect of an abiotic or biotic factor on the distribution and abundance of organisms in an ecosystem?

B4.1f — describe the importance of interdependence and competition in a community

1. What is meant by interdependence between organisms in a community?
2. How does predation demonstrate interdependence between organisms?
3. What is mutualism, and how does it demonstrate interdependence?
4. What is parasitism, and how does it demonstrate interdependence?

5. Why is interdependence important for the survival of organisms within a community?
6. Why do organisms compete with one another, and which resources can they compete for?

B5: Genes, inheritance and selection

B5.1 Inheritance

B5.1a — explain the following terms: gamete, chromosome, gene, allele/variant, dominant, recessive, homozygous, heterozygous, genotype and phenotype

1. What is a gamete, and how does its genetic content differ from that of a body cell?
2. What are a chromosome, gene and allele/variant, and how are these terms related?
3. What is the difference between a dominant allele and a recessive allele?
4. What is the difference between a homozygous genotype and a heterozygous genotype?
5. What is the difference between an organism's genotype and its phenotype?
6. How can the alleles inherited by an offspring be used to determine its phenotype?

B5.1b — describe the genome as the entire genetic material of an organism

1. What is meant by the term genome?
2. What does an organism's genome consist of?
3. How is the genome related to the chromosomes of an organism?
4. How does a genome differ from an individual gene?
5. Why can the genome be described as the entire genetic material of an organism?
6. Why is an organism's genome important in determining its characteristics?

B5.1c — describe that the genome, and its interaction with the environment, influence the development of the phenotype of an organism

1. How does an organism's genome influence the development of its phenotype?
2. How can environmental factors influence an organism's phenotype?

3. How does the interaction between an organism's genome and its environment affect its phenotype?
4. What is discontinuous variation, and what is an example of it?
5. What is continuous variation, and what are two examples?
6. How do discontinuous and continuous variation differ?

B5.1d — recall that all variants arise from mutations, and that most have no effect on the phenotype, some influence phenotype and a very few determine phenotype

1. What is a mutation, and how can it produce a new genetic variant?
2. What effect do most genetic variants have on an organism's phenotype?
3. How can some genetic variants influence an organism's phenotype?
4. What does it mean when a genetic variant determines an organism's phenotype?
5. Why do most mutations have no effect on the phenotype?
6. What are the three possible effects that a mutation can have on an organism's phenotype?

B5.1e — explain the terms haploid and diploid

1. What is meant by the term haploid?
2. What is meant by the term diploid?
3. How does the chromosome number of a haploid cell compare with that of a diploid cell?
4. Which cells in humans are haploid?
5. Which cells in humans are diploid?
6. Why must gametes be haploid?

B5.1f — explain the role of meiotic cell division in halving the chromosome number to form gametes

1. What is the role of meiotic cell division in the formation of gametes?
2. How does meiosis halve the chromosome number when forming gametes?
3. Why must meiosis produce haploid gametes from diploid cells?
4. How does the fusion of two haploid gametes restore the diploid chromosome number?
5. How does meiosis provide a source of genetic variation?
6. How does meiosis help maintain the diploid chromosome number between generations?

B5.1g — explain single gene inheritance in the context of homozygous and heterozygous crosses involving dominant and recessive genes

1. What is meant by single gene inheritance?
2. What is the difference between a homozygous dominant, homozygous recessive and heterozygous genotype?
3. How does a dominant allele affect the phenotype of a heterozygous organism?
4. How does a recessive allele affect the phenotype when an organism is heterozygous?
5. How can the probability of a particular phenotype be predicted from a genetic cross?
6. How could a coin toss or die roll be used to investigate probability in genetic inheritance?

B5.1h — predict the results of single gene crosses

1. What is a Punnett square used to predict in a single gene cross?
2. How are the possible gametes from each parent represented in a Punnett square?
3. How can a Punnett square be used to determine the possible genotypes of offspring?
4. How can the possible phenotypes of offspring be determined from a Punnett square?
5. How can the probability of an offspring having a particular phenotype be calculated from a Punnett square?
6. How would you use a Punnett square to predict the results of a cross between two heterozygous organisms?

B5.1i — describe sex determination in humans using a genetic cross

1. Which sex chromosomes are normally present in a human female?
2. Which sex chromosomes are normally present in a human male?
3. Which sex chromosome does a human egg normally contain?
4. Which sex chromosomes can a human sperm contain?
5. How does fertilisation determine whether a human embryo is genetically XX or XY?
6. How can a Punnett square be used to predict the probability of a human offspring being XX or XY?

B5.1j — recall that most phenotypic features are the result of multiple genes rather than single gene inheritance

1. What is meant by multiple gene inheritance?
2. Why are most phenotypic features determined by multiple genes rather than a single gene?
3. How can multiple genes contribute to continuous variation?

4. Why can characteristics such as height and weight show a wide range of phenotypes?
5. How does multiple gene inheritance differ from single gene inheritance?
6. Why is it important to consider multiple genes when explaining most phenotypic features?

B5.2 Natural selection and evolution

B5.2a — state that there is usually extensive genetic variation within a population of a species

1. What is meant by genetic variation within a population?
2. What is the difference between genetic variation and environmental variation?
3. Why can individuals of the same species have different alleles?
4. How can different alleles produce differences in the characteristics of individuals within a population?
5. Why is genetic variation within a population necessary for natural selection to occur?
6. What is the relationship between genetic variation and the ability of a population to adapt to environmental changes?

B5.2b — describe the impact of developments in biology on classification systems

1. What is a classification system used for?
2. What is a natural classification system?
3. What is an artificial classification system?
4. What is the main difference between natural and artificial classification systems?
5. What is molecular phylogenetics?
6. How has DNA sequencing improved the classification of organisms and the identification of evolutionary relationships?

B5.2c — explain how evolution occurs through the natural selection of variants that have given rise to phenotypes best suited to their environment

1. What is a mutation?
2. How can mutations produce new genetic variants?
3. How can genetic variants produce different phenotypes within a population?

4. What happens to organisms with phenotypes that are better suited to their environment?
5. How does natural selection cause advantageous variants to become more common in a population?
6. How does natural selection lead to evolution over successive generations?

B5.2d — 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 new species

1. What is meant by evolution?
2. What changes in a population during evolution?
3. How does natural selection cause the inherited characteristics of a population to change over time?
4. Why can advantageous inherited characteristics become more common over successive generations?
5. How can populations become sufficiently different through evolutionary change to form new species?
6. What is meant by the formation of a new species?

B5.2e — describe the evidence for evolution

1. What is a fossil?
2. How do fossils provide evidence that organisms have changed over time?
3. What can differences between fossils from different geological periods show about evolution?
4. How does antibiotic resistance in bacteria provide evidence for evolution?
5. How does natural selection cause antibiotic-resistant bacteria to become more common in a population?
6. What does the evolution of antibiotic resistance demonstrate about changes in inherited characteristics over generations?

Topic B6: Global challenges

B6.1 Monitoring and maintaining the environment

B6.1a — explain how to carry out a field investigation into the distribution and abundance of organisms in a habitat and how to determine their numbers in a given area

1. What is meant by the distribution of organisms within a habitat?

2. What is meant by the abundance of organisms within a habitat?
3. How can random sampling using quadrats be used to investigate the distribution and abundance of organisms?
4. How can a transect be used to investigate changes in the distribution of organisms across a habitat?
5. How can pooters, nets and keys be used to sample and identify organisms during a field investigation?
6. How can scaling-up methods and capture-recapture be used to estimate the number of organisms in a given area or population?

B6.1b — describe both positive and negative human interactions within ecosystems and explain their impact on biodiversity

1. What is meant by biodiversity?
2. What are two positive ways in which humans can interact with ecosystems?
3. What are two negative ways in which humans can interact with ecosystems?
4. How can changes in land use threaten biodiversity?
5. How can hunting threaten individual species and biodiversity?
6. How can conservation of individual species and selected habitats help maintain biodiversity?

B6.1c — explain some of the benefits and challenges of maintaining local and global biodiversity

1. What are two benefits of maintaining biodiversity?
2. Why is maintaining biodiversity important for ecosystems?
3. Why can it be difficult to gain agreements for conservation schemes?
4. Why is monitoring conservation schemes important?
5. What is ecotourism?
6. How can ecotourism benefit biodiversity and local communities?

B6.2 Feeding the human race

B6.2a — explain the impact of the selective breeding of food plants and domesticated animals

1. What is selective breeding?
2. How is selective breeding used to produce food plants with desirable characteristics?
3. How is selective breeding used to produce domesticated animals with desirable characteristics?

4. What desirable characteristics might be selected for in food plants?
5. What desirable characteristics might be selected for in domesticated animals?
6. How can selective breeding affect the characteristics of food plants and domesticated animals?

B6.2b — describe genetic engineering as a process which involves modifying the genome of an organism to introduce desirable characteristics

1. What is genetic engineering?
2. What is modified during the process of genetic engineering?
3. How does genetic engineering introduce a desirable characteristic into an organism?
4. What is meant by a desirable characteristic in genetic engineering?
5. How does genetic engineering differ from selective breeding?
6. Why can genetic engineering introduce characteristics that would be difficult to obtain through selective breeding?

B6.2c — describe the main steps in the process of genetic engineering

1. What is the role of restriction enzymes in genetic engineering?
2. What are sticky ends?
3. What is the role of ligase in genetic engineering?
4. What is a vector, and why can plasmids be used as vectors?
5. How is a desired gene inserted into a plasmid and transferred into a host bacterium?
6. How are antibiotic resistance markers used to select bacteria that have taken up the genetically engineered plasmid?

B6.2d — explain some of the possible benefits and risks of using gene technology in modern agriculture

1. What are two potential benefits of using gene technology in modern agriculture?
2. How could genetic engineering increase crop yields?
3. How could genetic engineering improve crop resistance to pests or disease?
4. What are two potential risks of using gene technology in modern agriculture?
5. What practical considerations should be considered when using genetically modified organisms in agriculture?

6. What ethical considerations should be considered when using genetically modified organisms in agriculture?

B6.3 Monitoring and maintaining health

B6.3a — describe the relationship between health and disease

1. What is meant by health?
2. What is meant by disease?
3. How can disease affect the health of an individual?
4. How can poor health increase the likelihood of disease?
5. How can disease affect the normal functioning of the body?
6. Why can health and disease be considered closely related?

B6.3b — describe different types of diseases

1. What is a communicable disease?
2. What is a non-communicable disease?
3. How are communicable diseases different from non-communicable diseases?
4. How are communicable diseases transmitted between individuals?
5. Why are non-communicable diseases not normally transmitted between individuals?
6. Give one example of a communicable disease and one example of a non-communicable disease.

B6.3c — describe the interactions between different types of disease

1. How does HIV affect the immune system?
2. How can HIV increase a person's susceptibility to other diseases?
3. What is tuberculosis?
4. How can HIV and tuberculosis interact within an infected person?
5. What is the relationship between HPV infection and cervical cancer?
6. How can infection with HPV increase the risk of developing cervical cancer?

B6.3d — explain how communicable diseases (caused by viruses, bacteria, protists and fungi) are spread in animals and plants

1. What are the four types of pathogen that can cause communicable diseases?
2. How can viruses spread between animals and plants?

3. How can bacteria spread between animals and plants?
4. How can protists and fungi spread between animals and plants?
5. How can the number of pathogens and number of infected cases be used as measures of the spread of a communicable disease?
6. How can the number of infected cases be estimated when monitoring the spread of a communicable disease?

B6.3e — explain how the spread of communicable diseases may be reduced or prevented in animals and plants

1. How can detecting an antigen help identify a communicable disease?
2. How can DNA testing be used to detect a communicable disease?
3. How can visual identification be used to detect disease in plants?
4. How can early detection of a communicable disease help reduce its spread?
5. How can the number of infected cases be used to assess whether measures are reducing the spread of a disease?
6. What measures can be used to reduce or prevent the spread of communicable diseases in animals and plants?

B6.3f — describe a minimum of one common human infection, one plant disease and sexually transmitted infections in humans including HIV/AIDS

1. What is one example of a common human viral infection, and which type of pathogen causes it?
2. What is one example of a common human bacterial infection, and which type of pathogen causes it?
3. What is one example of a common human fungal infection, and which type of pathogen causes it?
4. What is tobacco mosaic virus (TMV), and what type of pathogen causes it?
5. What are barley powdery mildew and crown gall disease, and which pathogens cause them?
6. What is HIV/AIDS, and how is HIV transmitted as a sexually transmitted infection?

B6.3g — explain how white blood cells and platelets are adapted to their defence functions in the blood

1. What role do white blood cells play in defending the body against pathogens?
2. What are the three main defence functions of white blood cells?
3. How do white blood cells destroy pathogens by phagocytosis?

4. How do antibodies and antitoxins help defend the body against pathogens?
5. What role do platelets play in the defence of the body?
6. How are platelets adapted to help prevent pathogens entering the body through damaged blood vessels?

B6.3h — describe the non-specific defence systems of the human body against pathogens

1. What is meant by a non-specific defence system?
2. How does the skin act as a non-specific defence against pathogens?
3. How do hairs and mucus in the respiratory system help defend against pathogens?
4. How do cilia help prevent pathogens entering the lungs?
5. How does hydrochloric acid in the stomach help defend against pathogens?
6. How does blood clotting help prevent pathogens entering the body through wounds?

B6.3i — explain the role of the immune system of the human body in defence against disease

1. What is the role of the immune system in defending the body against disease?
2. How do white blood cells recognise pathogens?
3. How do antibodies help destroy or neutralise pathogens?
4. How do antitoxins help defend the body against pathogens?
5. How can antibodies provide immunity against a specific pathogen?
6. Why is the immune response specific to particular pathogens?

B6.3j — explain the use of vaccines and medicines in the prevention and treatment of disease

1. How do vaccines help prevent communicable diseases?
2. How does vaccination lead to the production of antibodies and memory cells?
3. What is the difference between an antibiotic and an antiviral?
4. Why are antibiotics effective against bacteria but not viruses?
5. What are antiseptics, and how are they used to prevent infection?
6. How are antibiotics, antivirals and antiseptics used in the prevention or treatment of disease?

B6.3k — describe the processes of discovery and development of potential new medicines

1. What is the purpose of preclinical testing when developing a new medicine?
2. What is the purpose of clinical testing when developing a new medicine?
3. What is investigated during preclinical testing of a potential new medicine?
4. What is investigated during clinical testing of a potential new medicine?
5. Why must a potential new medicine be tested for safety and effectiveness before it is widely used?
6. Why are aseptic techniques used when investigating the growth of bacterial cultures?

B6.3l — recall that many non-communicable human diseases are caused by the interaction of a number of factors

1. What is a non-communicable disease?
2. Why can many non-communicable diseases be caused by the interaction of several factors?
3. What are cardiovascular diseases?
4. Which types of cancer are examples of non-communicable diseases?
5. Which lung and liver diseases are examples of non-communicable diseases in this specification?
6. Which non-communicable diseases can be influenced by nutrition?

B6.3m — evaluate some different treatments for cardiovascular disease

1. What lifestyle changes can be used to treat cardiovascular disease?
2. What medical treatments can be used to treat cardiovascular disease?
3. What surgical treatments can be used to treat cardiovascular disease?
4. How can lifestyle changes reduce the risk or effects of cardiovascular disease?
5. What are the benefits of using medical treatments for cardiovascular disease?
6. What are the benefits and risks of using surgical treatments for cardiovascular disease?

B6.3n — analyse the effect of lifestyle factors on the incidence of non-communicable diseases at local, national and global levels

1. What is meant by the incidence of a disease?
2. How can exercise affect the incidence of non-communicable diseases?
3. How can diet affect the incidence of non-communicable diseases?
4. How can alcohol consumption affect the incidence of non-communicable diseases?

5. How can smoking affect the incidence of non-communicable diseases?
6. Why can the incidence of non-communicable diseases differ between local, national and global populations?

B6.3o — describe cancer as the result of changes in cells that lead to uncontrolled growth and division

1. What is cancer?
2. What changes occur in cells that can lead to cancer?
3. What is meant by uncontrolled cell growth?
4. What is meant by uncontrolled cell division?
5. How can uncontrolled growth and division lead to the formation of a tumour?
6. How does cancer differ from normal cell growth and division?

B6.3p — discuss potential benefits and risks associated with the use of stem cells in medicine

1. What are stem cells?
2. How can stem cells be used in tissue transplantation?
3. What is one potential benefit of using stem cells in medicine?
4. What is one potential risk of using stem cells in medicine?
5. Why can tissue rejection occur after a transplant?
6. How can tissue rejection affect the success of stem cell treatments?

B6.3q — explain some of the possible benefits and risks of using gene technology in medicine

1. What is gene technology?
2. What is one potential benefit of using gene technology in medicine?
3. How could gene technology be used to treat or prevent disease?
4. What is one potential risk of using gene technology in medicine?
5. What practical considerations should be considered when using gene technology in medicine?
6. What ethical considerations should be considered when using gene technology in medicine?

B6.3r — discuss the potential importance for medicine of our increasing understanding of the human genome

1. What is the human genome?
2. How could knowledge of the human genome help predict the likelihood of developing particular diseases?

3. How could knowledge of the human genome help doctors select treatments for diseases?
4. What are genome-targeted drugs?
5. How could drugs targeted to specific genomes improve the treatment of disease?
6. Why could increasing understanding of the human genome be important for the future of medicine?