Edexcel GCSE Triple Biology

Topic 1 – Key concepts in biology

1.1 Explain how the sub-cellular structures of eukaryotic and prokaryotic cells are related to their functions, including animal cells, plant cells and bacteria

1. Controls the activities of the cell and contains genetic material.
2. Site of aerobic respiration, releasing energy for cell processes.
3. Site of protein synthesis.
4. Chloroplasts absorb light energy for photosynthesis; the permanent vacuole contains cell sap and helps maintain turgor.
5. Supports the cell and helps maintain its shape.
6. Chromosomal DNA contains genetic information; plasmid DNA carries additional genes; the cell membrane controls movement of substances in and out; flagella allow movement.

1.2 Describe how specialised cells are adapted to their function, including sperm cells, egg cells and ciliated epithelial cells

1. The acrosome contains enzymes that help the sperm penetrate the egg cell.
2. Many mitochondria provide energy for movement of the sperm tail.
3. It contains one set of chromosomes so that the diploid chromosome number is restored at fertilisation.
4. The cytoplasm contains nutrients that support the early development of the embryo.
5. It changes so that no more sperm can enter the egg.
6. Cilia beat to move mucus and trapped particles towards the throat.

1.3 Explain how changes in microscope technology, including electron microscopy, have enabled us to see cell structures and organelles with more clarity and detail than in the past and increased our understanding of the role of sub-cellular structures

1. Improved technology increased magnification and resolution.

2. Electron microscopes have much greater resolving power.
3. Resolution is the ability to distinguish between two close objects as separate.
4. Greater resolution makes closely spaced structures easier to distinguish.
5. Electron microscopes have higher resolution, so they can show the internal structure of mitochondria in greater detail.
6. Seeing structures in greater detail helped scientists relate their structures to their functions.

1.4 Demonstrate an understanding of number, size and scale, including the use of estimations and explain when they should be used

1. An approximate value rather than an exact measurement.
2. They provide a useful value when exact measurement is difficult or unnecessary.
3. The power of ten that represents the approximate size of a measurement.
4. Compare the unknown object with the known object and use the scale to estimate its size.
5. It allows the relative sizes of structures to be understood correctly.
6. When an exact measurement is difficult, unavailable or unnecessary.

1.5 Demonstrate an understanding of the relationship between quantitative units in relation to cells, including milli, micro, nano, pico and calculations with numbers written in standard form

1. 10^-3.
2. 10^-6.
3. 10^-9.
4. 10^-12.
5. 4 µm.
6. 6 × 10^-3.

1.6 Core Practical: Investigate biological specimens using microscopes, including magnification calculations and labelled scientific drawings from observations

1. Magnification = image size ÷ actual size.
2. 10 mm = 10,000 µm; magnification = 10,000 ÷ 50 = ×200.
3. Actual size = 8 mm ÷ 400 = 0.02 mm = 20 µm.
4. Clear single lines, accurate proportions, labels with straight ruled lines and relevant structures.

5. It makes the drawing clear and avoids obscuring structures.
6. The units must be the same so the calculation gives the correct magnification.

1.7 Explain the mechanism of enzyme action including the active site and enzyme specificity

1. A biological catalyst that speeds up a reaction without being used up.
2. The region of an enzyme where the substrate binds.
3. An enzyme only works with a particular substrate or small range of substrates.
4. The substrate has a complementary shape to the enzyme's active site.
5. An enzyme-substrate complex forms and the reaction occurs.
6. Its complementary shape determines which substrate can bind.

1.8 Explain how enzymes can be denatured due to changes in the shape of the active site

1. Its active site has changed shape so the substrate can no longer bind effectively.
2. Excessive heat can change the bonds maintaining the enzyme's shape.
3. The substrate no longer fits the active site correctly.
4. The active site has changed shape.
5. Extreme pH can disrupt bonds in the enzyme and change the active site shape.
6. The enzyme's structure has been permanently altered.

1.9 Explain the effects of temperature, substrate concentration and pH on enzyme activity

1. Particles have more kinetic energy, so there are more successful collisions.
2. High temperature denatures the enzyme and changes the shape of its active site.
3. The rate increases until the enzymes become saturated.
4. All available active sites are occupied, so enzyme concentration becomes limiting.
5. Changes in pH can affect the bonds maintaining the enzyme's shape.
6. Activity decreases because the active site is altered and the enzyme may become denatured.

1.10 Core Practical: Investigate the effect of pH on enzyme activity

1. pH.
2. The amount of product formed or substrate broken down per unit time.

3. Temperature affects enzyme activity, so it must not become a confounding variable.
4. To make sure differences in rate are due to pH.
5. To make sure the amount of substrate available is the same.
6. The pH giving the highest reaction rate is the optimum pH.

1.11 Demonstrate an understanding of rate calculations for enzyme activity

1. Rate = change in amount ÷ time.
2. 24 ÷ 6 = 4 cm^3/min.
3. 40 ÷ 8 = 5 mg/min.
4. 15 ÷ 3 = 5 min.
5. 10 ÷ 20 = 0.5 cm^3/s.
6. It allows enzyme activity to be compared under different conditions.

1.12 Explain the importance of enzymes as biological catalysts in the synthesis of carbohydrates, proteins and lipids and their breakdown into sugars, amino acids and fatty acids and glycerol

1. They speed up reactions needed to build and break down biological molecules.
2. Sugars.
3. Amino acids.
4. Fatty acids and glycerol.
5. They make the reactions occur rapidly enough at suitable biological temperatures.
6. They speed up digestion so large molecules can be broken down into smaller molecules that can be absorbed.

1.13B Core Practical: Investigate the use of chemical reagents to identify starch, reducing sugars, proteins and fats

1. Iodine solution.
2. Brown/orange to blue-black.
3. Benedict's solution.
4. Blue to green, yellow, orange or brick-red, depending on the amount of reducing sugar.
5. Biuret solution; blue to lilac/purple.
6. Ethanol followed by water; a cloudy white emulsion forms.

1.14B Explain how the energy contained in food can be measured using calorimetry

1. The energy transferred from food to the surroundings, usually measured through the temperature rise of water.
2. Burning food releases chemical energy as thermal energy, which heats the water.
3. Mass of water, specific heat capacity of water and temperature change.
4. $\Delta E = mc\Delta T$.
5. Energy per gram = energy transferred ÷ mass of food burned.
6. Some energy is transferred to the surroundings instead of the water.

1.15 Explain how substances are transported into and out of cells, including by diffusion, osmosis and active transport

1. The net movement of particles from a higher concentration to a lower concentration.
2. Down the concentration gradient, from higher concentration to lower concentration.
3. The net movement of water through a partially permeable membrane from higher water potential to lower water potential.
4. Water moves from a more dilute solution to a more concentrated solution through a partially permeable membrane.
5. The movement of substances against a concentration gradient using energy from respiration.
6. Energy is required to move substances against the concentration gradient.

1.16 Core Practical: Investigate osmosis in potatoes

1. Concentration of the surrounding solution.
2. To make the starting masses and surface areas comparable.
3. To remove surface water that would affect the final mass.
4. Its mass increases.
5. Its mass decreases.
6. The concentration where there is no net change in mass is approximately the concentration of the cell sap.

1.17 Calculate percentage gain and loss of mass in osmosis

1. Percentage change = (change in mass ÷ original mass) × 100.
2. (1.0 ÷ 5.0) × 100 = 20% gain.
3. (2.0 ÷ 8.0) × 100 = 25% loss.
4. (0.8 ÷ 4.0) × 100 = 20% gain.
5. (2.5 ÷ 10.0) × 100 = 25% loss.

6. It allows results from different starting masses to be compared fairly.

Topic 2 – Cells and control

2.1 Describe mitosis as part of the cell cycle, including the stages interphase, prophase, metaphase, anaphase and telophase and cytokinesis

1. DNA is replicated so each chromosome has two copies of its genetic information.
2. Chromosomes condense and become visible; the nuclear membrane breaks down.
3. Chromosomes line up at the equator of the cell.
4. Sister chromatids are pulled to opposite poles.
5. New nuclear membranes form around the chromosomes at each pole.
6. Cytokinesis is division of the cytoplasm, producing two daughter cells.

2.2 Describe the importance of mitosis in growth, repair and asexual reproduction

1. It produces more body cells.
2. It produces new cells to replace damaged cells.
3. It replaces cells that are no longer functioning effectively.
4. It produces new organisms from one parent without fertilisation.
5. There is no fusion of gametes, so the offspring are genetically identical apart from mutations.
6. Mitosis.

2.3 Describe the division of a cell by mitosis as the production of two daughter cells, each with identical sets of chromosomes in the nucleus to the parent cell, and that this results in the formation of two genetically identical diploid body cells

1. Two.
2. It is the same as the parent cell.
3. DNA is replicated before division and the copies are separated equally.
4. Diploid cells.
5. They have identical sets of chromosomes.
6. So each daughter cell receives a complete identical set of chromosomes.

2.4 Describe cancer as the result of changes in cells that lead to uncontrolled cell division

1. A disease caused by uncontrolled cell division.
2. Cell division becomes uncontrolled.
3. Mutations can affect genes controlling cell division.
4. A mass of abnormally dividing cells can form a tumour.
5. Normal cell division is controlled; cancerous cell division is uncontrolled.
6. They can invade and damage surrounding tissues.

2.5 Describe growth in organisms, including cell division and differentiation in animals and cell division, elongation and differentiation in plants

1. Cell division increases cell number.
2. A process in which cells become specialised.
3. Differentiation produces specialised cells needed for different tissues and functions.
4. Cell division increases cell number.
5. Cells increase in length, increasing the size of the plant.
6. Cells become specialised for different plant functions.

2.6 Explain the importance of cell differentiation in the development of specialised cells

1. The process by which cells become specialised.
2. It allows multicellular organisms to develop different cell types.
3. Different genes are expressed so cells develop different structures and functions.
4. Their structures allow them to perform particular functions efficiently.
5. Groups of specialised cells form tissues.
6. It would not have the range of specialised cells needed for different functions.

2.7 Demonstrate an understanding of the use of percentiles charts to monitor growth

1. To compare an individual's growth with a reference population.
2. Plot the child's measurements against age.
3. About 50% of children are below that measurement and 50% are above it.
4. It may indicate a change in the pattern of growth.
5. Measurements far outside the usual range or unusual changes in position can be identified.
6. It shows the pattern and rate of growth over time.

2.8 Describe the function of embryonic stem cells, stem cells in animals and meristems in plants

1. An unspecialised cell from an early embryo that can differentiate into many cell types.
2. They have the ability to differentiate into many different specialised cells.
3. They replace and repair damaged or worn-out cells.
4. At regions of active plant growth, such as root and shoot tips.
5. They divide to produce new cells for plant growth.
6. They produce cells that elongate and differentiate.

2.9 Discuss the potential benefits and risks associated with the use of stem cells in medicine

1. They can replace damaged or diseased cells.
2. They could replace damaged nervous tissue and restore some function.
3. They could replace insulin-producing cells.
4. They may cause unwanted immune responses or uncontrolled growth.
5. Uncontrolled division can produce tumours.
6. Embryos are destroyed when embryonic stem cells are obtained, raising ethical concerns.

2.10B Describe the structures and functions of the brain including the cerebellum, cerebral hemispheres and medulla oblongata

1. Controls coordination, balance and fine movement.
2. Responsible for conscious thought, memory, intelligence and voluntary actions.
3. Controls involuntary functions such as breathing and heart rate.
4. Cerebellum.
5. Cerebral hemispheres.
6. Medulla oblongata.

2.11B Explain how the difficulties of accessing brain tissue inside the skull can be overcome by using CT scanning and PET scanning to investigate brain function

1. The skull protects the brain and direct access would damage tissue.
2. It provides detailed images of structures inside the skull.
3. X-rays are taken from different angles and combined to produce cross-sectional images.
4. It shows areas of brain activity.

5. A radioactive tracer is taken up more in active areas and detected by the scanner.
6. They allow the brain to be investigated without directly accessing the tissue.

2.12B Explain some of the limitations in treating damage and disease in the brain and other parts of the nervous system, including spinal injuries and brain tumours

1. The brain is complex and damaged neurones are difficult to replace.
2. Damage can prevent electrical signals travelling between the brain and body.
3. The tumour may be close to important brain tissue.
4. Healthy tissue may be damaged during surgery.
5. Neurones have limited ability to regenerate and reconnect correctly.
6. Removing the tumour may damage areas responsible for essential functions.

2.13 Explain the structure and function of sensory receptors, sensory neurones, relay neurones in the CNS, motor neurones and synapses in the transmission of electrical impulses, including the axon, dendron, myelin sheath and the role of neurotransmitters

1. Detect a stimulus.
2. Carry electrical impulses from receptors to the CNS.
3. Connect sensory neurones to motor neurones within the CNS.
4. Carry impulses from the CNS to effectors.
5. Insulates the axon and increases the speed of impulse transmission.
6. Neurotransmitters diffuse across the synaptic gap and bind to receptors on the next neurone, triggering an electrical impulse.

2.14 Explain the structure and function of a reflex arc including sensory, relay and motor neurones

1. A rapid, automatic response to a stimulus.
2. Receptor → sensory neurone → relay neurone → motor neurone → effector.
3. Carries the impulse from the receptor to the CNS.
4. Passes the impulse from the sensory neurone to the motor neurone.
5. Carries the impulse from the CNS to the effector.
6. The pathway is short and the response does not require conscious thought.

2.15B Explain the structure and function of the eye as a sensory receptor including the role of the cornea and lens, the iris, and rod and cone cells in the retina

1. Refracts light as it enters the eye.
2. Focuses light onto the retina.
3. Controls the size of the pupil and therefore the amount of light entering the eye.
4. Work in low light and detect light intensity.
5. Detect colour and work best in brighter light.
6. Rods detect light intensity and cones detect different wavelengths of visible light.

2.16B Describe defects of the eye including cataracts, long-sightedness, short-sightedness and colour blindness

1. Clouding of the lens.
2. Vision becomes blurred or cloudy.
3. Difficulty seeing nearby objects clearly; the image forms behind the retina.
4. Difficulty seeing distant objects clearly; the image forms in front of the retina.
5. A condition in which some colours are difficult to distinguish.
6. Some cone cells or their pigments do not function normally.

2.17B Explain how cataracts, long-sightedness and short-sightedness can be corrected

1. Replace the cloudy lens with an artificial lens.
2. A convex lens converges light before it enters the eye.
3. A concave lens diverges light before it enters the eye.
4. It increases convergence so the image moves onto the retina.
5. It reduces convergence so the image moves back onto the retina.
6. On the retina.

Topic 3 – Genetics

3.1B Explain some of the advantages and disadvantages of asexual reproduction, including the lack of need to find a mate, a rapid reproductive cycle, but no variation in the population

1. Reproduction involving one parent and no fusion of gametes.

2. Only one parent is required.
3. No mating or fertilisation is needed, so offspring can be produced quickly.
4. They are produced by mitosis from one parent and are genetically identical apart from mutations.
5. A change in the environment could affect most or all individuals in the same way.
6. Advantage: rapid reproduction without finding a mate. Disadvantage: little or no genetic variation.

3.2B Explain some of the advantages and disadvantages of sexual reproduction, including variation in the population, but the requirement to find a mate

1. Reproduction involving the fusion of male and female gametes.
2. Gametes from two parents combine genetic information.
3. Some individuals may have characteristics better suited to the changed environment.
4. Gametes from two organisms must meet and fuse.
5. Finding a mate and producing gametes takes time and energy.
6. Advantage: genetic variation. Disadvantage: a mate is required and reproduction can be slower.

3.3 Explain the role of meiotic cell division, including the production of four daughter cells, each with half the number of chromosomes, and that this results in the formation of genetically different haploid gametes

1. Produces gametes for sexual reproduction.
2. Four.
3. It has half the chromosome number.
4. A gamete is haploid, while a body cell is diploid.
5. Chromosome combinations and crossing over create genetic variation.
6. Haploid cells.

3.4 Describe DNA as a polymer made up of two strands coiled to form a double helix, complementary base pairs joined by weak hydrogen bonds, and nucleotides consisting of a sugar, phosphate group and base

1. A double helix.
2. Weak hydrogen bonds between complementary bases.
3. Adenine, thymine, cytosine and guanine.
4. A pairs with T; C pairs with G.

5. A sugar, phosphate group and base.
6. Nucleotides join through their sugar and phosphate groups to form the strand.

3.5 Describe the genome as the entire DNA of an organism and a gene as a section of a DNA molecule that codes for a specific protein

1. The entire DNA of an organism.
2. A section of DNA that codes for a specific protein.
3. The gene contains the base sequence that determines the amino acid sequence of the protein.
4. The genome contains all the organism's DNA; a gene is one section of that DNA.
5. In the DNA of the cells.
6. They contain different base sequences that specify different amino acid sequences.

3.6 Explain how DNA can be extracted from fruit

1. It breaks down cell membranes.
2. It helps separate DNA from proteins and other cell material.
3. It breaks up the tissue and releases cell contents.
4. To remove larger solid pieces while allowing dissolved material through.
5. DNA is insoluble in cold ethanol, so it precipitates out.
6. A white, cloudy or stringy material.

3.7B Explain how the order of bases in a section of DNA decides the order of amino acids in the protein and that these fold to produce specifically shaped proteins such as enzymes

1. The base sequence is read in groups that specify the order of amino acids.
2. The amino acid sequence determines how the protein folds and therefore its three-dimensional shape.
3. It can change the amino acid sequence.
4. The active site must have a specific shape to bind the substrate.
5. Interactions between amino acids cause the protein to fold into a particular shape.
6. A changed protein shape can alter its activity.

3.8B Describe the stages of protein synthesis, including transcription and translation

1. Copying the base sequence of a gene into mRNA.
2. Separates the DNA strands and joins complementary RNA nucleotides.
3. An mRNA molecule.
4. A ribosome.
5. They are three-base sequences that specify amino acids.
6. It carries amino acids to the ribosome and matches them to the codons.

3.9B Describe how genetic variants in the non-coding DNA of a gene can affect phenotype by influencing the binding of RNA polymerase and altering the quantity of protein produced

1. DNA that does not directly code for the amino acid sequence of a protein.
2. It can make RNA polymerase bind more or less effectively.
3. It can increase or decrease the rate of transcription.
4. More or less mRNA may be produced, leading to more or less protein.
5. Proteins affect cell processes and characteristics.
6. It can change the amount of protein produced without changing the protein's amino acid sequence.

3.10B Describe how genetic variants in the coding DNA of a gene can affect phenotype by altering the sequence of amino acids and therefore the activity of the protein produced

1. DNA containing the sequence that codes for a protein.
2. It can change the base sequence and therefore the amino acid sequence.
3. The altered amino acid sequence can change protein folding.
4. The altered shape can change how well the protein functions.
5. A changed protein can alter a characteristic.
6. It could alter the active site so the enzyme works less effectively or not at all.

3.11B Describe the work of Gregor Mendel in discovering the basis of genetics and recognise the difficulties of understanding inheritance before the mechanism was discovered

1. Pea plants.
2. Characteristics are inherited through discrete factors, now understood as genes and alleles.
3. They have clear contrasting characteristics and can be cross-pollinated.
4. Genes, chromosomes and DNA had not yet been discovered.
5. Different inherited factors could be followed through generations.
6. The mechanism of inheritance was not understood and the significance of his work was not recognised at the time.

3.12 Explain why there are differences in the inherited characteristics as a result of alleles

1. Different forms of the same gene.
2. They can contain different base sequences and therefore influence characteristics differently.
3. One allele comes from each parent.
4. They can inherit different allele combinations from their parents.
5. It mixes genetic information from two parents and creates new allele combinations.
6. Different allele combinations can lead to different phenotypes.

3.13 Explain the terms chromosome, gene, allele, dominant, recessive, homozygous, heterozygous, genotype, phenotype, gamete and zygote

1. A long DNA molecule containing many genes.
2. A section of DNA coding for a specific protein.
3. A different form of a gene.
4. A dominant allele is expressed when present; a recessive allele is only expressed when no dominant allele is present.
5. Homozygous means two identical alleles; heterozygous means two different alleles.
6. Genotype = allele combination; phenotype = observable characteristics; gamete = haploid sex cell; zygote = diploid cell formed by fertilisation.

3.14 Explain monohybrid inheritance using genetic diagrams, Punnett squares and family pedigrees

1. A genetic cross involving one gene.
2. The possible allele combinations of offspring.
3. Combine the alleles from the two parents in the possible gametes.
4. Determine the characteristic associated with each genotype.
5. Capital letter for dominant allele and corresponding lowercase letter for recessive allele.
6. It shows how a characteristic may be inherited through a family.

3.15 Describe how the sex of offspring is determined at fertilisation, using genetic diagrams

1. XX.
2. XY.
3. X.

4. X or Y.
5. An X sperm gives XX; a Y sperm gives XY.
6. 50% genetically female and 50% genetically male, assuming equal probability.

3.16 Calculate and analyse outcomes using probabilities, ratios and percentages from monohybrid crosses and pedigree analysis for dominant and recessive traits

1. Number of favourable outcomes ÷ total possible outcomes.
2. Count the relevant offspring in the Punnett square and express as a fraction, ratio or percentage.
3. 3 dominant : 1 recessive.
4. 1 AA : 2 Aa : 1 aa.
5. 25%.
6. Look at the pattern of affected and unaffected individuals across generations.

3.17B Describe the inheritance of the ABO blood groups with reference to codominance and multiple alleles

1. I^A, I^B and i.
2. More than two alleles exist for the same gene in the population.
3. I^A and I^B.
4. AB.
5. A.
6. O.

3.18B Explain how sex-linked genetic disorders are inherited

1. A disorder caused by an allele on a sex chromosome, usually the X chromosome.
2. Males have only one X chromosome, so a recessive allele on it is expressed.
3. His X chromosome comes from his mother.
4. She has one normal dominant allele and one recessive allele.
5. A carrier mother can pass the recessive X-linked allele to her son.
6. A son receives the Y chromosome from his father.

3.19 State that most phenotypic features are the result of multiple genes rather than single gene inheritance

1. Several genes contribute to the characteristic.
2. Most characteristics depend on the combined effects of many genes.

3. Height.
4. Different combinations of alleles produce many possible phenotypes.
5. Different allele combinations contribute small effects to height.
6. Polygenic inheritance involves many genes; single-gene inheritance mainly involves one gene.

3.20 Describe the causes of variation that influence phenotype, including genetic and environmental variation

1. Differences in DNA or allele combinations between individuals.
2. Mutations create new DNA sequences and potentially new alleles.
3. It creates new combinations of alleles.
4. Variation caused by differences in environmental conditions.
5. Factors such as diet, temperature and lifestyle can affect characteristics.
6. Height.

3.21 Discuss the outcomes of the Human Genome Project and its potential applications within medicine

1. To determine the sequence of bases in human DNA and identify genes.
2. Information about the base sequence and location of human genes.
3. Scientists can compare genomes to identify genetic variants associated with disease.
4. It can help identify genetic mutations linked to disorders.
5. Treatment can be tailored according to a person's genetic information.
6. Privacy or discrimination based on genetic information.

3.22 State that there is usually extensive genetic variation within a population of a species and that these arise through mutations

1. Differences in alleles and DNA between individuals in the same population.
2. A change in the DNA base sequence.
3. A mutation can produce a new DNA sequence that forms a new allele.
4. Each new allele adds to the genetic differences within the population.
5. It combines alleles from two parents to form different offspring.
6. Variation increases the chance that some individuals can survive environmental change.

3.23 State that most genetic mutations have no effect on the phenotype, some mutations have a small effect on the phenotype and, rarely, a single mutation will significantly affect the phenotype

1. They may occur in non-coding DNA or not change the protein's function.
2. They may slightly alter protein function.
3. A mutation can greatly alter an important protein or its production.
4. It can change the DNA sequence used to produce the protein.
5. A major change in protein function can significantly alter a characteristic.
6. Different genes have different functions and different DNA changes have different effects.

Topic 4 – Natural selection and genetic modification

4.1B Describe the work of Charles Darwin and Alfred Wallace in the development of the theory of evolution by natural selection and explain the impact of these ideas on modern biology

1. He developed the theory of evolution by natural selection.
2. He independently developed the theory of natural selection and communicated his ideas alongside Darwin.
3. Variation within populations and observations of organisms in different environments helped Darwin develop the theory.
4. It explains how populations change over generations and is a central idea in modern biology.
5. Both independently developed ideas about natural selection.
6. It replaced the idea that species were fixed and showed that populations change over time through natural selection.

4.2 Explain Charles Darwin's theory of evolution by natural selection

1. Individuals with advantageous inherited characteristics are more likely to survive and reproduce.
2. Mutations and sexual reproduction create genetic variation.
3. They are better adapted to the environment, so they are more likely to survive and reproduce.
4. They are passed to offspring during reproduction.
5. Their alleles become more common over successive generations.
6. Accumulated genetic differences can become large enough for populations to become reproductively isolated.

4.3 Explain how the emergence of resistant organisms supports Charles Darwin's theory of evolution including antibiotic resistance in bacteria

1. A mutation can produce a resistance allele.
2. Susceptible bacteria are killed or inhibited, while resistant bacteria survive.
3. The antibiotic creates selection pressure by favouring resistant bacteria.
4. Resistant bacteria survive and reproduce, passing the allele to offspring.
5. It shows that advantageous inherited characteristics become more common through natural selection.
6. Unnecessary use increases selection for resistant bacteria.

4.4 Describe the evidence for human evolution, based on fossils, including Ardi, Lucy and Richard Leakey's discoveries

1. The preserved remains or traces of past organisms.
2. It provides evidence about an early human ancestor living about 4.4 million years ago.
3. It provides evidence about an early hominin living about 3.2 million years ago.
4. They provided evidence of early human ancestors and changes in human anatomy over time.
5. Different features at different ages show changes in organisms over time.
6. Fossils from different periods show that human ancestors have changed over time.

4.5 Describe the evidence for human evolution based on stone tools

1. Increasingly complex tools suggest increasing skill and changes in behaviour over time.
2. They generally became more complex and better made.
3. They suggest increased intelligence, skill and behavioural development.
4. By examining the rock layers or deposits in which they are found and using dating methods.
5. Lower rock layers are generally older than higher layers.
6. It provides evidence about the development of human behaviour over time.

4.6B Describe how the anatomy of the pentadactyl limb provides scientists with evidence for evolution

1. A limb with five digits based on a common skeletal pattern.

2. The same basic arrangement of bones.
3. Many vertebrates, including mammals, birds, reptiles and amphibians.
4. Similar structures suggest that the organisms may have inherited them from a common ancestor.
5. The bones have been modified for different functions.
6. Evidence for common ancestry and divergent evolution.

4.7 Describe how genetic analysis has led to the suggestion of the three domains rather than the five kingdoms classification method

1. Organising organisms into groups based on shared characteristics and evolutionary relationships.
2. Bacteria, Archaea and Eukarya.
3. Prokaryotae, Protoctista, Fungi, Plantae and Animalia.
4. DNA and molecular comparisons revealed relationships that were not clear from physical characteristics alone.
5. More similar DNA sequences suggest a more recent common ancestor.
6. Genetic differences support the separation of organisms into three major evolutionary groups.

4.8 Explain selective breeding and its impact on food plants and domesticated animals

1. Choosing parents with desired characteristics and breeding them.
2. Select parents with desired traits, breed them, select offspring with the trait and repeat over generations.
3. Breed cattle that produce the most milk and repeatedly select high-producing offspring.
4. Select plants with desirable traits such as high yield and breed them over generations.
5. Individuals carrying the desirable alleles are more likely to be selected as parents.
6. Reduced genetic variation and increased risk of inherited health problems or disease.

4.9B Describe the process of tissue culture and its advantages in medical research and plant breeding programmes

1. Growing cells or tissues in a controlled nutrient medium.
2. Plant cells divide and form new plants genetically identical to the parent.
3. Many plant cells retain the ability to divide and differentiate.
4. Small pieces of tissue can produce many plants in a short time.

5. It can provide cells or tissues for controlled studies of biological processes and diseases.
6. Large numbers of genetically identical plants with desirable characteristics can be produced quickly.

4.10 Describe genetic engineering as a process which involves modifying the genome of an organism to introduce desirable characteristics

1. Deliberately modifying an organism's DNA to introduce a desired characteristic.
2. To introduce a gene that gives a desirable characteristic.
3. Isolate the desired gene and insert it into the recipient organism's DNA using a suitable vector.
4. The organism expresses the introduced gene and develops the desired trait.
5. Genetic engineering directly changes DNA; selective breeding selects existing variation.
6. An organism whose genetic material has been altered using genetic engineering.

4.11 Describe the main stages of genetic engineering including the use of restriction enzymes, ligase, sticky ends and vectors

1. It cuts DNA at specific base sequences.
2. Short single-stranded sections of DNA left after cutting.
3. They can pair with complementary sticky ends on another DNA molecule.
4. It joins DNA fragments together.
5. A carrier used to transfer a gene into a host cell, such as a plasmid.
6. Isolate the desired gene, cut DNA with restriction enzymes, join the gene into a vector using ligase, then transfer the vector into the host cell.

4.12B Explain the advantages and disadvantages of genetic engineering to produce GM organisms including the introduction of genes for insect resistance from Bacillus thuringiensis into crop plants

1. Reduced crop damage and increased yield.
2. The Bt gene codes for a protein that is toxic to certain insect pests.
3. Fewer chemical insecticides may be needed.
4. The gene or its effects could affect non-target organisms or biodiversity.
5. GM crops may be expensive to develop, and there may be concerns about consumer acceptance.

6. Benefits, environmental risks, safety, economic effects and ethical concerns must all be considered.

4.13B Explain the advantages and disadvantages of agricultural solutions to the demands of a growing human population, including use of fertilisers and biological control

1. They provide mineral ions needed for plant growth.
2. They replace mineral ions in the soil, increasing plant growth and yield.
3. Using one organism to control the population of another organism, such as a pest.
4. A biological control organism reduces the pest population.
5. Nutrient pollution and eutrophication can occur.
6. Advantage: reduces chemical pesticide use. Disadvantage: the control organism may affect non-target species or become difficult to control.

4.14 Evaluate the benefits and risks of genetic engineering and selective breeding in modern agriculture and medicine, including practical and ethical implications

1. It can introduce desirable traits such as pest resistance or improved yield.
2. Possible environmental effects, such as effects on non-target species or biodiversity.
3. It can increase useful characteristics in crops and livestock.
4. Reduced genetic variation can increase inherited disorders and disease susceptibility.
5. It can produce useful proteins or treatments for disease.
6. Safety, cost, effectiveness, environmental impact, animal welfare, consent and ethical concerns.

Topic 5 – Health, disease and the development of medicines

5.1 Describe health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, as defined by the World Health Organization (WHO)

1. Health is a state of complete physical, mental and social well-being, not merely the absence of disease or infirmity.
2. Being physically healthy and functioning normally.

3. Having good psychological and emotional well-being.
4. Being able to interact and function positively within society.
5. A person may have no disease but still have poor physical, mental or social well-being.
6. World Health Organization (WHO).

5.2 Describe the difference between communicable and non-communicable diseases

1. A disease that can be transmitted between organisms.
2. A disease that cannot be transmitted between organisms.
3. Through pathogens by routes such as droplets, contaminated food or water, direct contact or vectors.
4. They are not caused by transmissible pathogens.
5. Tuberculosis.
6. Cancer.

5.3 Explain why the presence of one disease can lead to a higher susceptibility to other diseases

1. It may weaken the immune system or damage body defences.
2. It can reduce the body's ability to destroy pathogens.
3. Fewer white blood cells are available to respond to pathogens.
4. HIV attacks immune cells, weakening the immune system.
5. The body is less able to detect and destroy pathogens.
6. One disease can weaken defences, making another infection more likely.

5.4 Describe a pathogen as a disease-causing organism, including viruses, bacteria, fungi and protists

1. An organism that causes disease.
2. A bacterium that causes disease.
3. A virus that causes disease.
4. A fungus that causes disease.
5. A protist that causes disease.
6. Viruses, bacteria, fungi and protists.

5.5 Describe some common infections, including cholera, tuberculosis, Chalara ash dieback, malaria, HIV, stomach ulcers caused by Helicobacter and Ebola

1. Bacterium; severe diarrhoea and dehydration.
2. Bacterium; it can damage the lungs.

3. Fungus; it causes lesions and dieback of ash trees.
4. Protist; it can damage red blood cells and the liver.
5. Virus; it destroys helper T cells.
6. Helicobacter pylori; Ebola is caused by a virus.

5.6 Explain how pathogens are spread and how this spread can be reduced or prevented

1. Through contaminated food or water.
2. In droplets from coughs and sneezes.
3. Through infected plants, spores or movement of infected plant material.
4. By mosquitoes acting as vectors.
5. Through close contact and contaminated food or other routes of transmission.
6. Through contact with infected blood or body fluids.

5.7B Describe the lifecycle of a virus, including lysogenic and lytic pathways

1. It attaches to a receptor and enters or injects its genetic material into the host cell.
2. The viral genome is copied using the host cell's machinery.
3. Viral components are produced and new viruses form; the host cell eventually bursts.
4. Viral DNA becomes incorporated into the host DNA and is copied when the host cell divides.
5. It becomes part of the host cell's DNA.
6. A trigger can activate the viral DNA, causing it to enter the lytic pathway.

5.8 Explain how sexually transmitted infections (STIs) are spread and how this spread can be reduced or prevented, including Chlamydia and HIV

1. An infection mainly spread through sexual contact.
2. Through sexual contact with an infected person.
3. Through infected blood, semen, vaginal fluids or breast milk, including sexual contact.
4. They act as a barrier that reduces contact with infected body fluids.
5. Infected people can be identified and treated, reducing transmission.
6. Reducing exposure to infected blood and other body fluids reduces transmission.

5.9B Describe how some plants defend themselves against attack from pests and pathogens by physical barriers, including the leaf cuticle and cell wall

1. It forms a waxy waterproof barrier.
2. It reduces the ability of pathogens to enter the leaf.
3. It provides a strong barrier around the plant cell.
4. It is strong and difficult for pathogens to penetrate.
5. They prevent or reduce pathogen entry before infection is established.
6. The leaf cuticle and cell wall.

5.10B Describe how plants defend themselves against attack from pests and pathogens by producing chemicals, some of which can be used to treat human diseases or relieve symptoms

1. They produce chemicals that repel or harm pests.
2. They produce chemicals that inhibit or kill pathogens.
3. Some have useful biological effects in humans.
4. They can be developed into medicines.
5. They can reduce symptoms by affecting biological processes causing them.
6. It reduces damage and increases the chance of survival and reproduction.

5.11B Describe different ways plant diseases can be detected and identified, in the lab and in the field

1. To avoid confusing disease with a non-infectious cause such as mineral deficiency.
2. Clusters or patterns of affected plants can suggest how a disease is spreading.
3. Symptoms such as leaf spots, discolouration, wilting or lesions.
4. Tests can detect the pathogen or its genetic material.
5. Field observations provide context and laboratory tests provide more specific evidence.
6. Visual symptoms, distribution patterns, laboratory testing and molecular or genetic tests.

5.12 Describe how the physical barriers and chemical defences of the human body provide protection from pathogens

1. It forms a physical barrier preventing pathogens from entering.
2. It traps pathogens and particles.
3. They move mucus and trapped pathogens away from the lungs.

4. It breaks down bacterial cell walls.
5. It provides an acidic environment that kills many pathogens.
6. Skin, mucus, cilia, lysozyme and hydrochloric acid.

5.13 Explain the role of the specific immune system of the human body in defence against disease

1. Specific lymphocytes recognise antigens and begin an immune response.
2. Molecules on the surface of pathogens that are recognised by the immune system.
3. Specific lymphocytes produce antibodies complementary to the antigen.
4. They remain in the body and respond rapidly if the same pathogen enters again.
5. Memory lymphocytes are already present and quickly produce a stronger response.
6. They allow a rapid secondary response that can prevent illness.

5.14 Explain the body's response to immunisation using an inactive form of a pathogen

1. The process of making a person immune using a vaccine.
2. It provides antigens without causing the full disease.
3. The antigens trigger a specific immune response.
4. Specific antibody-producing cells are activated and antibodies are produced.
5. They provide long-term immune memory.
6. Memory lymphocytes recognise the pathogen and produce a rapid antibody response.

5.15B Discuss the advantages and disadvantages of immunisation, including the concept of herd immunity

1. Protection of a population when enough people are immune to reduce disease transmission.
2. There are fewer susceptible people for the pathogen to infect.
3. Reduced transmission lowers the chance of exposure.
4. It reduces the spread and incidence of communicable disease.
5. Some people may experience side effects or, rarely, serious reactions.
6. High vaccination coverage reduces transmission and the size of outbreaks.

5.16 Explain that antibiotics can only be used to treat bacterial infections because they inhibit cell processes in the bacterium but not the host organism

1. They target bacterial cell processes, such as cell wall synthesis, that can be disrupted without normally damaging human cells.
2. Viruses do not have the bacterial cell structures or processes targeted by antibiotics.
3. Processes or structures such as bacterial cell wall synthesis or bacterial protein synthesis.
4. The targets are different from those in human cells.
5. The virus is unaffected by antibacterial drugs.
6. To reduce unnecessary selection for antibiotic-resistant bacteria.

5.17B Explain the aseptic techniques used in culturing microorganisms in the laboratory

1. To kill microorganisms and sterilise the medium and equipment.
2. To prevent unwanted microorganisms contaminating the culture.
3. To transfer microorganisms without introducing contaminants.
4. To reduce contamination from the air and surroundings.
5. It prevents unwanted microorganisms entering the culture.
6. To maintain a pure culture and protect against contamination.

5.18B Core Practical: Investigate the effects of antiseptics, antibiotics or plant extracts on microbial cultures

1. Place measured amounts of the substances onto a microbial culture and compare the areas where growth is inhibited.
2. It shows that microbial growth has been inhibited.
3. A larger clear zone indicates greater antimicrobial effectiveness.
4. So differences in results can be linked to the antimicrobial rather than concentration.
5. To prevent contamination and protect the investigator.
6. They allow a mean to be calculated and reduce the effect of random error.

5.19B Calculate cross-sectional areas of bacterial cultures and clear agar jelly using πr^2

1. Area = πr^2.
2. The radius.
3. Radius = diameter ÷ 2.
4. Area = $\pi \times 5^2 = 78.5$ mm^2.

5. The equation uses radius squared.
6. Larger area generally indicates greater antimicrobial effectiveness.

5.20 Describe that the process of developing new medicines, including antibiotics, has many stages, including discovery, development, preclinical and clinical testing

1. Finding a substance that may have a useful biological effect.
2. Refining and testing the substance to produce a suitable medicine.
3. Testing for safety, toxicity and effectiveness using cells, tissues and organisms before human trials.
4. Testing safety and effectiveness in humans.
5. To ensure they are safe and work effectively.
6. Discovery → development → preclinical testing → clinical testing.

5.21B Describe the production of monoclonal antibodies

1. Lymphocytes.
2. They do not divide indefinitely in culture.
3. A cell made by fusing a lymphocyte with a tumour cell.
4. Fuse a lymphocyte producing the desired antibody with a tumour cell.
5. They can divide repeatedly while producing the same antibody.
6. They divide repeatedly and all the cells produce the same antibody.

5.22B Explain the use of monoclonal antibodies

1. They bind to pregnancy hormones so a test can detect them.
2. They can bind to substances associated with clots and carry a detectable marker.
3. They can bind to antigens found on cancer cells.
4. They can deliver toxic substances or radioactive material to cancer cells.
5. They bind to specific antigens on particular cells.
6. They can target specific cells while reducing damage to nearby healthy tissue.

5.23 Describe that many non-communicable human diseases are caused by the interaction of a number of factors

1. A disease that cannot be transmitted between organisms.
2. Different risk factors can act together to increase disease risk.
3. Non-communicable disease.
4. For example, lung and colorectal cancer can involve several risk factors.
5. Poor diet can increase disease risk through effects such as obesity or nutrient deficiency.

6. Cardiovascular disease, many cancers, and some liver and lung diseases.

5.24 Explain the effect of lifestyle factors on non-communicable diseases at local, national and global levels

1. BMI = mass ÷ height².
2. A high body mass relative to height.
3. Healthy diet and regular exercise reduce the risk of obesity.
4. An inadequate or unbalanced diet can lead to nutrient deficiencies or excess energy intake.
5. It increases the risk of liver damage and liver disease.
6. It damages the cardiovascular system and increases the risk of cardiovascular disease.

5.25 Evaluate some different treatments for cardiovascular disease, including life-long medication, surgical procedures and lifestyle changes

1. Drugs can lower blood pressure, reduce cholesterol or reduce clot formation.
2. Procedures such as stents, angioplasty or bypass surgery can improve blood flow.
3. Improving diet, increasing exercise and stopping smoking can reduce risk.
4. It can control risk factors without invasive surgery.
5. Advantage: can restore blood flow. Risk: complications and damage during surgery.
6. Lifestyle changes can reduce underlying risk factors and improve the effectiveness of other treatments.

Topic 6 – Plant structures and their functions

6.1 Describe photosynthetic organisms as the main producers of food and therefore biomass

1. They make organic food molecules using photosynthesis and form the base of most food chains.
2. They produce food and biomass that can be transferred to consumers.
3. They use light energy to convert carbon dioxide and water into glucose.
4. Glucose can be used to make larger biological molecules and plant tissues.
5. The mass of living biological material.

6. Consumers obtain biomass and energy by feeding on them directly or indirectly.

6.2 Describe photosynthesis in plants and algae as an endothermic reaction that uses light energy to react carbon dioxide and water to produce glucose and oxygen

1. Carbon dioxide + water → glucose + oxygen.
2. It takes in energy from the surroundings.
3. Light energy.
4. Carbon dioxide and water.
5. Glucose and oxygen.
6. The Sun.

6.3 Explain the effect of temperature, light intensity and carbon dioxide concentration as limiting factors on the rate of photosynthesis

1. It increases the rate until another factor becomes limiting or the temperature becomes too high.
2. More light energy is available for photosynthesis.
3. More carbon dioxide is available for the photosynthetic reactions.
4. The rate reaches a plateau because another factor becomes limiting.
5. A factor that limits the rate of photosynthesis when it is in shortest supply.
6. Each can become the factor that limits the rate when the others are sufficient.

6.4 Explain the interactions of temperature, light intensity and carbon dioxide concentration in limiting the rate of photosynthesis

1. Another factor, such as carbon dioxide concentration or temperature, may be limiting.
2. Another factor, such as light intensity or temperature, may be limiting.
3. The factors affect the same process and the limiting factor can change depending on conditions.
4. Increasing one factor may increase the rate until another factor becomes limiting.
5. The rate remains low because temperature is limiting.
6. Another factor may already be limiting the process.

6.5 Core Practical: Investigate the effect of light intensity on the rate of photosynthesis

1. Place an aquatic plant at different distances from a light source and measure the photosynthesis rate.
2. Count bubbles of oxygen or measure oxygen volume produced per unit time.
3. Light intensity, usually changed by varying the distance from the light source.
4. Temperature, carbon dioxide concentration, plant species and amount of plant.
5. Light intensity depends on distance from the source.
6. To calculate a mean and identify anomalous results.

6.6 Explain how the rate of photosynthesis is directly proportional to light intensity and inversely proportional to the distance from a light source, including the use of the inverse square law calculation

1. It is directly proportional when light intensity is the limiting factor.
2. Light intensity decreases as distance increases.
3. It becomes one quarter as great.
4. Light intensity $\propto 1 \div \text{distance}^2$.
5. It becomes one ninth as great.
6. Calculate relative light intensity using $1 \div \text{distance}^2$ and compare the corresponding rates.

6.7 Explain how the structure of the root hair cells is adapted to absorb water and mineral ions

1. It increases surface area and contact with soil water.
2. A large surface area increases the rate of absorption.
3. It gives a short diffusion path for water.
4. They are absorbed by active transport when their concentration is lower in the soil than in the root cells.
5. Active transport of mineral ions requires energy.
6. Long extension, large surface area, thin surface and many mitochondria adapt the cell for absorption.

6.8 Explain how the structures of the xylem and phloem are adapted to their function in the plant, including: a lignified dead cells in xylem transporting water and minerals through the plant b living cells in phloem using energy to transport sucrose around the plant

1. They form long hollow tubes with no end walls and lignified walls, allowing water and mineral ions to move through them.
2. The absence of cell contents leaves a continuous pathway.
3. It strengthens the vessels and prevents them collapsing.
4. Living phloem cells are arranged in tubes and transport sucrose around the plant.
5. Active translocation of sucrose requires energy.
6. Xylem is made of dead lignified cells and carries water and minerals; phloem is living tissue and carries sucrose.

6.9 Explain how water and mineral ions are transported through the plant by transpiration, including the structure and function of the stomata

1. Loss of water vapour from leaves.
2. Water loss creates a pull that draws water up through the xylem.
3. Water moves upward through the xylem as part of the transpiration stream.
4. They allow gas exchange and control water vapour loss.
5. Water evaporates from leaf cells and diffuses out through the stomata.
6. Guard cells open and close the stomata, controlling gas exchange and water vapour loss.

6.10 Describe how sucrose is transported around the plant by translocation

1. Movement of sucrose through the phloem.
2. Sucrose.
3. Between sources and sinks around the plant.
4. It supplies cells with sugars needed for respiration, growth and storage.
5. Phloem.
6. Water is mainly transported upward in xylem, while sucrose can be transported from sources to sinks in phloem.

6.11B Explain how the structure of a leaf is adapted for photosynthesis and gas exchange

1. It provides a large surface area for absorbing light.
2. They contain many chloroplasts and are near the upper surface where light intensity is high.
3. Gases have a short diffusion distance.
4. They allow carbon dioxide to enter and oxygen and water vapour to leave.
5. They provide a large internal surface area for gas diffusion.

6. Large surface area, thin structure, chloroplast-rich palisade cells, stomata and air spaces all improve photosynthesis and gas exchange.

6.12 Explain the effect of environmental factors on the rate of water uptake by a plant, to include light intensity, air movement and temperature

1. It increases.
2. It increases.
3. It usually increases.
4. It removes water vapour from around the leaf, maintaining a concentration gradient.
5. It increases evaporation and diffusion of water vapour.
6. Greater light intensity, air movement and temperature generally increase water uptake by increasing transpiration.

6.13 Demonstrate an understanding of rate calculations for transpiration

1. Rate of water loss = amount of water lost ÷ time.
2. 6 ÷ 3 = 2 cm^3/hour.
3. 0.8 ÷ 20 = 0.04 g/min.
4. It determines the unit and value of the rate.
5. Measure the decrease in mass over a known time and divide by time.
6. Amount of water lost and time taken.

6.14B Explain how plants are adapted to survive in extreme environments including the effect of leaf size and shape, the cuticle and stomata

1. It reduces surface area and therefore water loss.
2. A suitable shape can reduce exposed surface area and water loss.
3. It reduces evaporation of water from the leaf.
4. Fewer or sunken stomata reduce water loss.
5. Fewer stomata reduce the pathways for water vapour to leave.
6. They reduce water loss while allowing enough gas exchange for survival.

6.15B Explain how plant hormones control and coordinate plant growth and development, including the role of auxins in phototropisms and gravitropisms

1. They act as chemical messengers controlling growth and development.
2. Growth response to light.

3. Auxin accumulates on the shaded side of the shoot and stimulates greater cell elongation there, causing bending towards light.
4. Growth response to gravity.
5. Auxin causes roots to grow downwards by affecting cell elongation.
6. Auxin distribution causes unequal growth on different sides of shoots and roots.

6.16B Describe the commercial uses of auxins, gibberellins and ethene in plants, including: a auxins in weedkillers and rooting powders b gibberellins in germination, fruit and flower formation and the production of seedless fruit c ethene in fruit ripening

1. Selective auxin weedkillers cause rapid abnormal growth in weeds.
2. Auxins stimulate root formation in cuttings.
3. They can stimulate germination.
4. They can promote fruit and flower formation and produce seedless fruit.
5. It is used to control and speed up fruit ripening.
6. Auxins: weedkillers and rooting powders; gibberellins: germination, fruit and flower formation and seedless fruit; ethene: fruit ripening.

Topic 7 – Animal coordination, control and homeostasis

7.1 Describe where hormones are produced and how they are transported from endocrine glands to their target organs, including the pituitary gland, thyroid gland, pancreas, adrenal glands, ovaries and testes

1. In endocrine glands.
2. In the blood.
3. It releases hormones that control other endocrine glands and body processes.
4. It produces thyroxine, which affects metabolic rate.
5. Pancreas: insulin and glucagon; adrenal glands: adrenalin; ovaries: oestrogen and progesterone; testes: testosterone.
6. Target organs contain cells that respond to particular hormones, producing specific effects.

7.2 Explain that adrenalin is produced by the adrenal glands to prepare the body for fight or flight, including: a increased heart rate b increased blood pressure c increased blood flow to the muscles d raised blood sugar levels by stimulating the liver to change glycogen into glucose

1. Adrenal glands.
2. It prepares the body for rapid action.
3. It increases heart rate.
4. It increases blood pressure.
5. It increases blood supply to the muscles.
6. It stimulates the liver to convert glycogen into glucose, increasing blood glucose concentration.

7.3 Explain how thyroxine controls metabolic rate as an example of negative feedback, including: a low levels of thyroxine stimulates production of TRH in hypothalamus b this causes release of TSH from the pituitary gland c TSH acts on the thyroid to produce thyroxine d when thyroxine levels are normal thyroxine inhibits the release of TRH and the production of TSH

1. It controls the rate of metabolism.
2. TRH production increases.
3. It stimulates release of TSH.
4. It stimulates the thyroid gland to produce thyroxine.
5. Thyroxine inhibits TRH release and TSH production.
6. The response reduces the original change and returns thyroxine levels towards normal.

7.4 Describe the stages of the menstrual cycle, including the roles of the hormones oestrogen and progesterone, in the control of the menstrual cycle

1. The uterus lining is shed.
2. The lining thickens.
3. It stimulates repair and thickening of the uterus lining.
4. An egg is released from the ovary.
5. It maintains the uterus lining.
6. Progesterone levels fall.

7.5 Explain the interactions of oestrogen, progesterone, FSH and LH in the control of the menstrual cycle, including the repair and maintenance of the uterus wall, ovulation and menstruation

1. It stimulates an ovarian follicle to mature and begin producing oestrogen.
2. It helps repair and thicken the uterus lining.
3. High oestrogen reduces FSH and causes an increase in LH leading to ovulation.
4. A rise in LH causes ovulation.
5. It maintains the uterus lining.
6. Falling progesterone and oestrogen levels cause the lining to break down, resulting in menstruation.

7.6 Explain how hormonal contraception influences the menstrual cycle and prevents pregnancy

1. It changes hormone levels to prevent ovulation and reduce the chance of fertilisation.
2. Hormones suppress the release of FSH and LH.
3. They reduce FSH and LH production.
4. It can make the uterus lining less suitable for implantation.
5. Some hormonal methods thicken cervical mucus.
6. They make ovulation, fertilisation and implantation less likely.

7.7 Evaluate hormonal and barrier methods of contraception

1. A method that uses hormones to prevent pregnancy.
2. A method that physically prevents sperm reaching the egg.
3. It suppresses FSH and LH, preventing ovulation.
4. It acts as a physical barrier preventing sperm entering the female reproductive tract.
5. They are generally more effective when used correctly and do not require use at the time of intercourse for some methods.
6. Barrier methods do not alter hormone levels and condoms also reduce STI transmission, but they must be used correctly each time.

7.8 Explain the use of hormones in Assisted Reproductive Technology (ART) including IVF and clomifene therapy

1. They stimulate and control egg development and ovulation.
2. Hormones stimulate the ovaries to mature several follicles.

3. Fertilisation occurs outside the body and an embryo is transferred to the uterus.
4. To control the timing of egg maturation and ovulation.
5. It is used to stimulate ovulation in women who do not ovulate normally.
6. It stimulates release of FSH and LH, encouraging ovulation.

7.9 Explain the importance of maintaining a constant internal environment in response to internal and external change

1. Keeping conditions inside the body within narrow limits.
2. Cells and enzymes need stable conditions to function effectively.
3. It can cause the internal temperature to rise or fall.
4. It can affect cell respiration and enzyme activity.
5. It changes water balance and cell function.
6. Homeostasis is the maintenance of a stable internal environment and is essential for normal cell function.

7.10B Explain the importance of homeostasis, including: a thermoregulation – the effect on enzyme activity b osmoregulation – the effect on animal cells

1. Maintenance of a stable internal environment.
2. Enzymes work best within a narrow temperature range.
3. They can denature.
4. Control of water concentration.
5. It prevents cells gaining or losing too much water.
6. They may swell and burst or shrink, depending on the surrounding water concentration.

7.11B Explain how thermoregulation takes place, with reference to the function of the skin, including: a the role of the dermis b the role of the epidermis c the role of the hypothalamus

1. It contains blood vessels, sweat glands and temperature receptors involved in heat loss.
2. It forms the outer protective layer of the skin.
3. It monitors body temperature and coordinates responses.
4. Temperature receptors provide information about body temperature to the hypothalamus.
5. It changes blood flow and sweating to control heat loss.
6. The hypothalamus detects changes and coordinates responses in the skin, while the dermis contains structures that produce heat loss and the epidermis provides protection.

7.12B Explain how thermoregulation takes place, with reference to: a shivering b vasoconstriction c vasodilation

1. Rapid muscle contractions release heat.
2. Narrowing of blood vessels near the skin.
3. Less blood flows near the surface, reducing heat loss.
4. Widening of blood vessels near the skin.
5. More blood flows near the surface, increasing heat loss.
6. They reduce or increase heat loss to keep body temperature near normal.

7.13 Explain how the hormone insulin controls blood glucose concentration

1. Pancreas.
2. It increases.
3. It causes cells to take up more glucose and stimulates glycogen formation.
4. It increases uptake of glucose by cells.
5. It stimulates glucose to be converted into glycogen for storage.
6. It lowers blood glucose when it rises above the normal range.

7.14 Explain how blood glucose concentration is regulated by glucagon

1. Pancreas.
2. It increases.
3. It stimulates the liver to break down glycogen to glucose.
4. It causes glycogen to be converted into glucose.
5. Insulin lowers blood glucose; glucagon raises it.
6. It prevents blood glucose concentration becoming too low.

7.15 Explain the cause of type 1 diabetes and how it is controlled

1. The immune system destroys insulin-producing cells in the pancreas.
2. The cells producing insulin are destroyed.
3. It causes blood glucose concentration to rise.
4. Insulin injections, monitoring blood glucose, diet and exercise.
5. To adjust insulin treatment and avoid dangerously high or low glucose levels.
6. It replaces the insulin the body cannot produce adequately.

7.16 Explain the cause of type 2 diabetes and how it is controlled

1. Body cells become less responsive to insulin, often linked to genetic factors and obesity.

2. Reduced sensitivity of cells to insulin.
3. Blood glucose concentration remains too high.
4. A healthy diet can help reduce excess body mass and improve blood glucose control.
5. It can improve insulin sensitivity and help control blood glucose.
6. Drugs can improve insulin action or reduce blood glucose concentration.

7.17 Evaluate the correlation between body mass and type 2 diabetes including waist:hip calculations and BMI, using the BMI equation

1. Greater body mass, particularly excess body fat, is associated with increased risk.
2. A measure comparing body mass with height.
3. BMI = mass in kg ÷ height in m^2.
4. Waist-to-hip ratio = waist circumference ÷ hip circumference.
5. They can indicate body fat distribution and help assess disease risk.
6. BMI does not distinguish fat from muscle and does not directly measure body fat distribution.

7.18B Describe the structure of the urinary system

1. Kidneys, ureters, bladder and urethra.
2. Filter the blood and produce urine.
3. Carry urine from the kidneys to the bladder.
4. Stores urine.
5. Carries urine out of the body.
6. Kidneys → ureters → bladder → urethra → outside the body.

7.19B Explain how the structure of the nephron is related to its function in filtering the blood and forming urine including: a filtration in the glomerulus and Bowman's capsule b selective reabsorption of glucose c reabsorption of water

1. The functional unit of the kidney.
2. In the glomerulus and Bowman's capsule.
3. Small molecules and water are forced out of the blood into the filtrate.
4. In the proximal convoluted tubule.
5. Glucose is useful and normally needs to be returned to the blood.
6. Water is reabsorbed by osmosis from the filtrate into the blood.

7.20B Explain the effect of ADH on the permeability of the collecting duct in regulating the water content of the blood

1. It is produced in the hypothalamus and released by the pituitary gland.
2. ADH levels increase.
3. It increases the permeability of the collecting duct.
4. More water is reabsorbed into the blood.
5. Urine volume decreases and urine becomes more concentrated.
6. ADH levels decrease.

7.21B Describe the treatments for kidney failure, including kidney dialysis and organ donation

1. The kidneys can no longer adequately filter the blood and regulate water and ion balance.
2. It removes waste substances and excess water from the blood.
3. Urea and excess ions or water.
4. It is time-consuming, requires regular treatment and can restrict lifestyle.
5. A healthy donated kidney takes over the filtration function.
6. Advantage: can restore kidney function without repeated dialysis.
   Disadvantage: rejection and lifelong treatment may be required.

7.22B State that urea is produced from the breakdown of excess amino acids in the liver

1. Liver.
2. Excess amino acids.
3. They cannot be stored, so they are broken down.
4. Excess amino acids cannot be stored in the same way as glucose or fat.
5. Their amino groups are removed by deamination.
6. Kidneys.

Topic 8 – Exchange and transport in animals

8.1 Describe the need to transport substances into and out of a range of organisms, including oxygen, carbon dioxide, water, dissolved food molecules, mineral ions and urea

1. They are too large to rely on diffusion alone over long distances.
2. Oxygen is needed for aerobic respiration.
3. It is produced by respiration and must be removed to prevent harmful accumulation.
4. They are needed for metabolism and other cell processes.

5. They provide nutrients and energy sources for cells.
6. Urea is a waste product that must be removed because it is toxic at high concentrations.

8.2 Explain the need for exchange surfaces and a transport system in multicellular organisms including the calculation of surface area : volume ratio

1. To provide a large area for rapid exchange of substances.
2. To move substances between exchange surfaces and cells.
3. A large surface area compared with volume gives more area for exchange per unit volume.
4. Surface area : volume ratio = surface area ÷ volume.
5. As size increases, surface area : volume ratio decreases.
6. Diffusion distances become too large and the surface area : volume ratio becomes too small.

8.3 Explain how alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries

1. There are many alveoli, giving a large surface area.
2. The wall is one cell thick, giving a short diffusion distance.
3. Continuous blood flow removes oxygen and brings carbon dioxide, maintaining a concentration gradient.
4. Ventilation replaces air, maintaining concentration gradients.
5. Oxygen diffuses down its concentration gradient from the alveoli into the blood.
6. Carbon dioxide diffuses down its concentration gradient from the blood into the alveoli.

8.4B Describe the factors affecting the rate of diffusion, including surface area, concentration gradient and diffusion distance

1. It increases the rate.
2. It increases the rate.
3. It decreases the rate.
4. More particles can cross the surface at the same time.
5. There is a greater difference in concentration between the two sides.
6. Particles travel a shorter distance.

8.5B Calculate the rate of diffusion using Fick's law: surface area concentration difference diffusion thickness of membrane rate of × α

1. Surface area and concentration difference.
2. Membrane thickness.
3. It doubles.
4. It doubles.
5. It halves.
6. Rate $\propto$ (surface area × concentration difference) ÷ membrane thickness.

8.6 Explain how the structure of the blood is related to its function: a red blood cells (erythrocytes) b white blood cells (phagocytes and lymphocytes) c plasma d platelets

1. They are biconcave, have no nucleus and contain haemoglobin, giving a large surface area for oxygen transport.
2. They can change shape and engulf pathogens by phagocytosis.
3. They have receptors that recognise antigens and produce specific antibodies.
4. It transports dissolved substances such as nutrients, hormones, carbon dioxide and urea.
5. They help blood clot to prevent blood loss and entry of pathogens.
6. Each component has structures adapted for transport, defence or clotting.

8.7 Explain how the structure of the blood vessels is related to their function

1. Thick muscular and elastic walls withstand high pressure.
2. They have thin walls, a large lumen and valves to help return blood at low pressure.
3. They prevent blood flowing backwards.
4. They are very narrow and have walls one cell thick.
5. They provide a short diffusion distance.
6. Arteries have thick walls and small lumens; veins have thinner walls, larger lumens and valves; capillaries have one-cell-thick walls.

8.8 Explain how the structure of the heart and circulatory system is related to its function, including the role of the major blood vessels, the valves and the relative thickness of chamber walls

1. Muscular chambers contract to pump blood and valves maintain one-way flow.
2. Arteries carry blood away from the heart, veins return blood and the pulmonary vessels carry blood to and from the lungs.
3. They prevent backflow.

4. It pumps blood to the whole body at high pressure.
5. The atria only push blood into the ventricles, so they need less force.
6. The left and right sides are separated, and the pulmonary and systemic circuits keep oxygenated and deoxygenated blood apart.

8.9 Describe cellular respiration as an exothermic reaction which occurs continuously in living cells to release energy for metabolic processes, including aerobic and anaerobic respiration

1. A series of reactions that release energy from glucose.
2. It releases energy to the surroundings.
3. Cells need a continuous energy supply for metabolic processes.
4. It powers processes such as active transport, movement, growth and synthesis.
5. Respiration using oxygen to release energy from glucose.
6. Respiration without oxygen.

8.10 Compare the process of aerobic respiration with the process of anaerobic respiration

1. Aerobic respiration uses oxygen and releases more energy; anaerobic respiration occurs without oxygen and releases less energy.
2. Aerobic respiration.
3. Aerobic respiration.
4. Carbon dioxide and water.
5. Lactic acid.
6. Oxygen cannot be supplied quickly enough to meet the muscles' energy demand.

8.11 Core Practical: Investigate the rate of respiration in living organisms

1. Measure oxygen uptake or carbon dioxide production over time, for example using a respirometer.
2. Change in gas volume or pressure over time.
3. Temperature affects respiration rate.
4. It shows whether changes are due to respiration rather than apparatus effects.
5. Rate = change in measurement ÷ time.
6. Temperature, amount of organism, species, food availability and apparatus conditions.

8.12 Calculate heart rate, stroke volume and cardiac output, using the equation cardiac output = stroke volume × heart rate

1. Number of heart beats per minute.
2. Volume of blood pumped by the heart in one beat.
3. Volume of blood pumped by the heart per minute.
4. Cardiac output = stroke volume × heart rate.
5. It increases.
6. It increases.

Topic 9 – Ecosystems and material cycles

9.1 Describe the different levels of organisation from individual organisms, populations, communities, to the whole ecosystem

1. An individual living thing.
2. All organisms of one species living in an area.
3. All the populations of different species living together in an area.
4. A community and the abiotic environment interacting.
5. A population contains one species; a community contains many species.
6. Organism → population → community → ecosystem.

9.2 Explain how communities can be affected by abiotic and biotic factors, including: a temperature, light, water, pollutants b competition, predation

1. It affects enzyme activity, survival and reproduction.
2. It affects photosynthesis and the organisms that can survive.
3. It affects the availability of water for organisms.
4. They can damage or kill organisms and reduce population sizes.
5. Competition for resources can reduce population size.
6. Predators reduce prey populations and can affect population balance.

9.3 Describe the importance of interdependence in a community

1. Organisms depend on other organisms for resources or survival.
2. They rely on food, pollination, shelter, reproduction or other interactions.
3. Changes in one population can alter food availability or competition for others.
4. Interactions between populations can help maintain a balance.

5. Other populations may increase or decrease.
6. Food webs and other dependencies link populations together.

9.4 Describe how the survival of some organisms is dependent on other species, including parasitism and mutualism

1. A relationship where one organism benefits and the host is harmed.
2. It obtains nutrients or another resource from the host.
3. It can weaken the host and reduce its survival or reproduction.
4. A relationship where both organisms benefit.
5. Both gain an advantage such as food, protection or transport.
6. The relationship may provide an essential resource that neither organism can obtain as effectively alone.

9.5 Core Practical: Investigate the relationship between organisms and their environment using field-work techniques, including quadrats and belt transects

1. It is placed over an area to sample organisms and estimate abundance or distribution.
2. To avoid bias and give every location an equal chance of being sampled.
3. A series of quadrats is placed along a line to show changes across the habitat.
4. To obtain more representative data.
5. Compare abundance at different positions along the gradient.
6. Number of organisms, percentage cover, frequency or abundance at different locations.

9.6 Explain how to determine the number of organisms in a given area using raw data from field-work techniques, including quadrats and belt transects

1. Calculate the mean number per quadrat and scale it up to the total habitat area.
2. Mean = total number of organisms counted ÷ number of quadrats.
3. Mean organisms per quadrat × number of quadrats that would cover the habitat.
4. Population density = number of organisms ÷ area sampled.
5. Compare counts or percentage cover at different positions along the transect.
6. It reduces the effect of random variation and gives a more representative sample.

9.7B Explain how some energy is transferred to less useful forms at each trophic level and that this affects the number of organisms at each trophic level, limits the length of a food chain and determines the shape of a pyramid of biomass in an ecosystem

1. Energy is lost through respiration, movement, heat and waste at each level.
2. It is dissipated mainly as thermal energy through respiration, and energy is lost in waste and uneaten material.
3. Less available energy means less biomass can be supported.
4. There is progressively less energy available at higher trophic levels.
5. Biomass decreases at higher trophic levels.
6. Less energy and biomass are available to support organisms at higher levels.

9.8B Calculate the efficiency of energy transfers between trophic levels and percentage calculations of biomass

1. Efficiency = energy transferred to next level ÷ energy entering the level × 100.
2. Percentage change = change ÷ original × 100.
3. Divide energy transferred out by energy transferred in and multiply by 100.
4. (200 ÷ 2000) × 100 = 10%.
5. (50 ÷ 500) × 100 = 10%.
6. Energy is lost through respiration, movement, waste, death and uneaten material.

9.9 Explain the positive and negative human interactions within ecosystems and their impacts on biodiversity, including: a fish farming b introduction of non-indigenous species c eutrophication

1. It provides a controlled source of fish for food.
2. Waste, disease and escaped fish can affect natural ecosystems and biodiversity.
3. It may compete with native species, prey on them or introduce disease.
4. It may have no natural predators or competitors and spread rapidly.
5. Nutrient enrichment of water caused by substances such as nitrates and phosphates.
6. It can cause algal blooms, followed by oxygen depletion and death of aquatic organisms.

9.10 Explain the benefits of maintaining local and global biodiversity, including the conservation of animal species and the impact of reforestation

1. The variety of different species and genetic variation.
2. It increases ecosystem stability and provides resources and ecosystem services.
3. It prevents species extinction and maintains food webs.
4. It provides genetic resources, ecosystem services and resilience to environmental change.
5. It creates habitats and increases the number of species that can survive.
6. It can absorb carbon dioxide, reduce soil erosion and restore habitats.

9.11B Describe the biological factors affecting levels of food security, including: a increasing human population b increasing animal farming and the increased meat and fish consumption c the impact of new pests and pathogens d environmental change caused by human activity e sustainability issues, e.g. use of land for biofuel production and the cost of agricultural inputs

1. More people require more food.
2. It uses large amounts of land, water and feed.
3. Increased demand can place greater pressure on food resources and ecosystems.
4. They can reduce crop or livestock yields.
5. Climate change, pollution, deforestation and habitat destruction can reduce agricultural productivity.
6. Land used for biofuels may not be available for food, while expensive fertilisers, fuel or pesticides can increase food production costs.

9.12 Describe how different materials cycle through the abiotic and biotic components of an ecosystem

1. A non-living part of an ecosystem.
2. A living part of an ecosystem.
3. Through processes such as feeding, excretion, decomposition and gas exchange.
4. The supply of materials is finite within an ecosystem.
5. Photosynthesis, respiration, feeding, excretion and decomposition.
6. They return nutrients and other materials to organisms and the environment.

9.13 Explain the importance of the carbon cycle, including the processes involved and the role of microorganisms as decomposers

1. It recycles carbon between organisms and the atmosphere and provides carbon for biological molecules.
2. Plants absorb carbon dioxide during photosynthesis.
3. Organisms release carbon dioxide during respiration.
4. Burning fuels or biomass releases carbon dioxide.
5. They break down dead organisms and waste.
6. Decomposers break down organic material and release carbon dioxide through respiration, returning carbon compounds to the environment.

9.14 Explain the importance of the water cycle, including the processes involved and the production of potable water in areas of drought including desalination

1. It recycles water needed by living organisms and ecosystems.
2. Liquid water changes to water vapour.
3. Water vapour cools and forms liquid droplets.
4. Rain or other forms of precipitation return water to the surface.
5. Remove dissolved salts from seawater to produce freshwater.
6. It provides an additional source of freshwater where natural supplies are insufficient.

9.15 Explain how nitrates are made available for plant uptake, including the use of fertilisers, crop rotation and the role of bacteria in the nitrogen cycle

1. They are needed to make amino acids and proteins.
2. They add nitrate ions or compounds that provide them to the soil.
3. Growing legumes increases nitrogen fixation, improving soil nitrogen for later crops.
4. They convert nitrogen between different compounds in the nitrogen cycle.
5. They convert atmospheric nitrogen into nitrogen compounds that can enter the soil.
6. They make nitrogen compounds available in forms plants can absorb.

9.16B Evaluate the use of indicator species as evidence to assess the level of pollution, including: a polluted water – bloodworm, sludgeworm b clean water – freshwater shrimps, stonefly c air quality – different species of lichen, blackspot fungus on roses

1. Organisms whose presence or absence indicates particular environmental conditions.
2. Bloodworms and sludgeworms.
3. Freshwater shrimps and stoneflies.
4. Different lichen species vary in their tolerance to air pollution.
5. Its presence or absence can indicate air pollution levels.
6. They provide biological evidence of environmental conditions over time.

9.17B Explain the effects of temperature, water content and oxygen availability on the rate of decomposition in food preservation

1. Lower temperature slows enzyme activity and microbial growth.
2. Lower water availability reduces microbial activity and slows decomposition.
3. Less oxygen can reduce aerobic microbial respiration and slow decomposition.
4. Microorganisms and enzymes work more slowly at lower temperatures.
5. Microorganisms have less available water for growth and activity.
6. Many decomposers require oxygen for aerobic respiration.

9.18B Explain the effects of temperature, water content and oxygen availability on the rate of decomposition in composting

1. Increasing temperature within a suitable range increases decomposition rate.
2. Too little water slows decomposition; sufficient moisture allows decomposers to function.
3. More oxygen supports aerobic decomposers.
4. Microorganisms become more active at suitable higher temperatures.
5. Water is needed for cell processes and microbial activity.
6. Aerobic decomposers require oxygen for respiration and efficient decomposition.

9.19B Calculate rate changes in the decay of biological material

1. Rate of decay = change in mass ÷ time.
2. Change in mass and time taken.
3. Divide the mass lost by the time taken.
4. 30 ÷ 10 = 3 g/day.
5. 48 ÷ 12 = 4 g/hour.
6. Calculate rates using the same units and compare the values.