Edexcel Comb Sci Biology

Topic 1 – Key concepts in biology

Cells

1.1 Explain how the sub-cellular structures of eukaryotic and prokaryotic cells are related to their functions, including: a animal cells – nucleus, cell membrane, mitochondria and ribosomes b plant cells – nucleus, cell membrane, cell wall, chloroplasts, mitochondria, vacuole and ribosomes c bacteria – chromosomal DNA, plasmid DNA, cell membrane, ribosomes and flagella

1. How does the nucleus control the activities of an animal or plant cell?
2. How are mitochondria adapted for their role in releasing energy by aerobic respiration?
3. How do ribosomes contribute to the function of animal, plant and bacterial cells?
4. How are chloroplasts adapted for photosynthesis in plant cells?
5. How do the cell wall and vacuole help a plant cell maintain its shape?
6. How do chromosomal DNA, plasmid DNA, the cell membrane, ribosomes and flagella contribute to the functions of a bacterial cell?

1.2 Describe how specialised cells are adapted to their function, including: a sperm cells – acrosome, haploid nucleus, mitochondria and tail b egg cells – nutrients in the cytoplasm, haploid nucleus and changes in the cell membrane after fertilisation c ciliated epithelial cells

1. How is the acrosome of a sperm cell adapted for fertilisation?
2. Why does a sperm cell contain a haploid nucleus?
3. How are the mitochondria and tail of a sperm cell adapted for reaching an egg cell?
4. How are nutrients in the cytoplasm and the haploid nucleus of an egg cell adapted for its function?
5. How does the cell membrane of an egg cell change after fertilisation?
6. How are ciliated epithelial cells adapted to move substances along the surface of tissues?

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. How has microscope technology improved our ability to study cells?
2. Why can electron microscopes show greater detail than light microscopes?
3. How has electron microscopy increased our understanding of sub-cellular structures?
4. Why can electron microscopes be used to observe structures that are too small to resolve clearly with a light microscope?
5. How has increased resolution helped scientists understand the functions of cell organelles?
6. What is the relationship between the resolution of a microscope and the detail that can be observed in cells?

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

1. Why are estimations useful when measuring biological structures?
2. When should an estimate be used instead of an exact measurement in biology?
3. How can the size of a biological structure be estimated from a microscope image?
4. Why is it important to consider the scale of a biological structure when interpreting an image?
5. How can an order-of-magnitude estimate be used to check whether a calculated biological measurement is reasonable?
6. Why should calculated values for biological structures be checked against their expected size?

1.5 Demonstrate an understanding of the relationship between quantitative units in relation to cells, including: a milli (10–3) b micro (10–6) c nano (10–9) d pico (10–12) e calculations with numbers written in standard form

1. What does the prefix milli mean in powers of ten?
2. What does the prefix micro mean in powers of ten?
3. What does the prefix nano mean in powers of ten?
4. What does the prefix pico mean in powers of ten?
5. How many micrometres are there in one millimetre?
6. How can numbers written in standard form be multiplied or divided when calculating biological measurements?

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

1. How is the magnification of a biological specimen calculated from its image size and actual size?
2. What equation is used to calculate magnification when the image size and actual size are known?
3. Why must the units of image size and actual size be the same when calculating magnification?
4. What features should be included in a labelled scientific drawing of a biological specimen?
5. Why should scientific drawings use clear single lines rather than artistic shading?
6. How can observations from a microscope be used to produce an accurate labelled scientific drawing?

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

1. What is the active site of an enzyme?
2. How does a substrate interact with the active site of an enzyme?
3. Why is an enzyme specific to a particular substrate?
4. How does the shape of an enzyme's active site determine which substrate can bind?
5. What happens when an enzyme-substrate complex forms?
6. How does enzyme specificity allow enzymes to catalyse particular reactions?

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

1. What does it mean when an enzyme is denatured?
2. How can a change in temperature cause an enzyme to become denatured?
3. How can an extreme pH cause an enzyme to become denatured?
4. What happens to the active site when an enzyme is denatured?
5. Why can a denatured enzyme no longer bind effectively to its substrate?
6. Why is enzyme denaturation usually irreversible?

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

1. How does increasing temperature affect enzyme activity up to the optimum temperature?
2. Why does enzyme activity decrease rapidly above the optimum temperature?
3. How does increasing substrate concentration affect enzyme activity when enzyme concentration is fixed?

4. Why does enzyme activity eventually stop increasing when substrate concentration continues to increase?
5. How does pH affect the activity of an enzyme?
6. Why does each enzyme have an optimum pH?

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

1. How can the effect of pH on enzyme activity be investigated experimentally?
2. What variable should be changed when investigating the effect of pH on enzyme activity?
3. What measurements could be taken to determine the rate of an enzyme-controlled reaction?
4. Which variables should be controlled when investigating the effect of pH on enzyme activity?
5. Why should the same concentration of enzyme and substrate be used at each pH?
6. How can results from an investigation of pH and enzyme activity be used to determine the optimum pH?

1.11 Demonstrate an understanding of rate calculations for enzyme activity

1. How is the rate of an enzyme-controlled reaction calculated?
2. What equation can be used to calculate rate from the change in product concentration and time?
3. What units could be used for the rate of an enzyme-controlled reaction?
4. How would the rate change if the same amount of product were produced in half the time?
5. How can a graph of product formed against time be used to determine enzyme activity?
6. What does a steeper gradient on a product-against-time graph indicate about enzyme activity?

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. Why are enzymes important in the synthesis and breakdown of biological molecules?
2. Which smaller molecules are produced when carbohydrates are broken down by enzymes?
3. Which smaller molecules are produced when proteins are broken down by enzymes?
4. Which smaller molecules are produced when lipids are broken down by enzymes?

5. How do enzymes act as biological catalysts in the synthesis of carbohydrates, proteins and lipids?
6. Why would the synthesis and breakdown of biological molecules be too slow without enzymes?

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

1. What is diffusion and how does it transport substances into or out of cells?
2. How does the concentration gradient affect the net movement of particles by diffusion?
3. What is osmosis?
4. How does osmosis differ from diffusion?
5. What is active transport and how does it differ from diffusion?
6. Why does active transport require energy from respiration?

1.16 Core Practical: Investigate osmosis in potatoes

1. How can potato cylinders be used to investigate osmosis experimentally?
2. What should be measured before and after placing potato cylinders in different concentrations of solution?
3. Why should potato cylinders be cut to the same size when investigating osmosis?
4. Which variable should be changed when investigating the effect of solution concentration on osmosis in potato tissue?
5. Which variables should be controlled when investigating osmosis using potato cylinders?
6. How can the results of a potato osmosis experiment be used to determine the concentration at which there is no net movement of water?

1.17 Calculate percentage gain and loss of mass in osmosis

1. What equation is used to calculate the percentage change in mass of a potato cylinder during osmosis?
2. How is percentage gain in mass calculated when the final mass is greater than the initial mass?
3. How is percentage loss in mass calculated when the final mass is less than the initial mass?
4. A potato cylinder increases in mass from 4.0 g to 5.0 g. What is its percentage gain in mass?
5. A potato cylinder decreases in mass from 5.0 g to 4.0 g. What is its percentage loss in mass?
6. Why is percentage change in mass useful when comparing osmosis results from potato cylinders of different starting masses?

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. What happens during interphase before a cell undergoes mitosis?
2. What happens to the chromosomes during prophase?
3. What happens to the chromosomes during metaphase?
4. What happens to the chromosomes during anaphase?
5. What happens to the chromosomes during telophase?
6. What is cytokinesis, and when does it occur in the cell cycle?

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

1. How does mitosis allow a multicellular organism to increase in size?
2. How does mitosis allow damaged tissues to be repaired?
3. Why is mitosis important in asexual reproduction?
4. Why are the cells produced by mitosis suitable for growth and tissue repair?
5. How does mitosis allow a single parent organism to produce genetically identical offspring by asexual reproduction?
6. Why must mitosis occur repeatedly during the growth of a multicellular organism?

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. How many daughter cells are produced when one diploid body cell undergoes mitosis?
2. How does the chromosome number of each daughter cell produced by mitosis compare with the parent cell?
3. Why are the daughter cells produced by mitosis genetically identical to each other?
4. Why are the daughter cells produced by mitosis genetically identical to the parent cell?
5. What does the term diploid mean when describing body cells produced by mitosis?
6. What must happen to the DNA before a diploid cell can divide by mitosis?

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

1. What is cancer?
2. What happens to cell division when a cell becomes cancerous?
3. How can changes in cells lead to uncontrolled cell division?
4. How can uncontrolled cell division result in the formation of a tumour?
5. Why is uncontrolled cell division harmful to the body?
6. How does uncontrolled cell division in cancer differ from normal cell division?

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

1. Which two processes contribute to growth in animals?
2. How does cell division contribute to growth in animals?
3. How does cell differentiation contribute to growth in animals?
4. Which three processes contribute to growth in plants?
5. How does cell elongation contribute to growth in plants?
6. How does cell differentiation contribute to growth in plants?

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

1. What is cell differentiation?
2. Why is cell differentiation important in multicellular organisms?
3. How does cell differentiation allow cells to become specialised?
4. Why do different cells need to become specialised for different functions?
5. How does differentiation contribute to the development of tissues and organs?
6. What would happen to the development of a multicellular organism if cells could not differentiate?

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

1. What information can a percentile chart provide when monitoring the growth of a child?
2. How can a child's height be monitored using a percentile chart?
3. How can a child's mass be monitored using a percentile chart?
4. What does it mean if a child's measurement follows approximately the same percentile over time?
5. What might a significant change in a child's position on a percentile chart indicate?
6. How can percentile charts be used to identify unusual patterns of growth?

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

1. What are embryonic stem cells?
2. What is the function of embryonic stem cells?
3. What is the function of stem cells found in animals after birth?
4. Why can animal stem cells produce different types of specialised cells?
5. What are meristems in plants?
6. How do meristems allow plants to produce new cells for growth?

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

1. What is one potential medical benefit of using stem cells?
2. How could stem cells be used to replace damaged or diseased cells?
3. Why could embryonic stem cells be useful in treating human diseases?
4. What is one ethical concern associated with obtaining embryonic stem cells?
5. What is one medical risk associated with using stem cells in patients?
6. Why might stem cell treatments require careful control to reduce the risk of unwanted cell division?

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. What is the function of a sensory receptor in the nervous system?
2. What is the function of a sensory neurone?
3. What is the function of a relay neurone, and where is it found?
4. What is the function of a motor neurone?
5. What are the functions of the axon, dendron and myelin sheath in a neurone?
6. How do neurotransmitters allow an electrical impulse to pass across a synapse?

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

1. What is a reflex action?
2. What is the correct pathway of a nerve impulse through a reflex arc?
3. What is the role of the sensory neurone in a reflex arc?
4. What is the role of the relay neurone in a reflex arc?
5. What is the role of the motor neurone in a reflex arc?
6. Why do reflex arcs allow responses to occur rapidly without conscious thought?

Topic 3 – Genetics

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 The stages of meiosis are not required

1. What is the role of meiotic cell division in sexual reproduction?
2. How many daughter cells are produced from one cell during meiosis?
3. How does the chromosome number of each daughter cell produced by meiosis compare with the original cell?
4. What is a haploid gamete?
5. Why are the four gametes produced by meiosis genetically different from each other?
6. How does meiosis produce gametes with half the normal chromosome number?

3.4 Describe DNA as a polymer made up of: a two strands coiled to form a double helix b strands linked by a series of complementary base pairs joined together by weak hydrogen bonds c nucleotides that consist of a sugar and phosphate group with one of the four different bases attached to the sugar

1. What is the overall structure of a DNA molecule?
2. How are the two strands of DNA held together?
3. What is meant by complementary base pairing in DNA?
4. Which bases are complementary in DNA?
5. What three components make up a DNA nucleotide?
6. How are nucleotides arranged to form a DNA molecule?

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. What is meant by the genome of an organism?
2. What is a gene?
3. How is a gene related to a protein?
4. How does a gene differ from the entire genome?
5. Where are genes found?
6. Why can different sections of DNA code for different proteins?

3.6 Explain how DNA can be extracted from fruit

1. How can DNA be extracted from fruit?
2. Why is the fruit mashed or blended when extracting DNA?
3. Why is detergent added when extracting DNA from fruit?
4. Why is salt added when extracting DNA from fruit?

5. Why is the fruit mixture filtered during DNA extraction?
6. Why is cold ethanol or propanone added to the filtered fruit extract?

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

1. What is an allele?
2. Why can different alleles of the same gene produce differences in inherited characteristics?
3. How can two individuals inherit different alleles for the same gene?
4. How can different combinations of alleles cause variation in inherited characteristics?
5. Why can offspring inherit different combinations of alleles from their parents?
6. How do alleles contribute to genetic variation within a population?

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

1. What is a chromosome?
2. What is a gene?
3. What is an allele?
4. What is meant by a dominant allele?
5. What is meant by a recessive allele?
6. What is a homozygous genotype?
7. What is a heterozygous genotype?
8. What is meant by genotype?
9. What is meant by phenotype?
10. What is a gamete?
11. What is a zygote?
12. How does a zygote differ from a gamete?

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

1. What is a monohybrid cross?
2. How can a Punnett square be used to predict the genotypes of offspring?
3. How can a genetic diagram be used to show the inheritance of a single characteristic?
4. How can a family pedigree be used to show the inheritance of a characteristic?
5. How can a dominant allele affect the phenotype of a heterozygous individual?
6. How can a recessive phenotype be inherited from two heterozygous parents?

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

1. Which sex chromosomes are present in a human female?
2. Which sex chromosomes are present in a human male?
3. Which sex chromosomes can a human female's eggs contain?
4. Which sex chromosomes can a human male's sperm contain?
5. How is the sex of a human offspring determined at fertilisation?
6. What is the probability that a human offspring will be male or female?

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

1. How can probabilities be calculated from a monohybrid Punnett square?
2. How can the expected genotype ratio of offspring be determined from a genetic cross?
3. How can the expected phenotype ratio of offspring be determined from a genetic cross?
4. How can the probability of inheriting a recessive phenotype be calculated from a genetic cross?
5. How can percentages be used to express the expected outcomes of a monohybrid cross?
6. How can a pedigree be analysed to determine whether a characteristic is dominant or recessive?

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

1. What does polygenic inheritance mean?
2. Why are most phenotypic features not controlled by a single gene?
3. How can multiple genes contribute to a single phenotypic feature?
4. Why can polygenic characteristics show a wide range of phenotypes?
5. Give one example of a human characteristic that is influenced by multiple genes.
6. How does polygenic inheritance differ from single-gene inheritance?

3.20 Describe the causes of variation that influence phenotype, including: a genetic variation – different characteristics as a result of mutation and sexual reproduction b environmental variation – different characteristics caused by an organism's environment (acquired characteristics)

1. What is meant by variation within a population?
2. How can mutations cause genetic variation?
3. How can sexual reproduction produce genetic variation?

4. How can environmental factors cause variation in phenotype?
5. What is an acquired characteristic?
6. What is the difference between genetic variation and environmental variation?

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

1. What was the main aim of the Human Genome Project?
2. What did the Human Genome Project determine about human DNA?
3. How could information from the Human Genome Project improve the diagnosis of inherited diseases?
4. How could the Human Genome Project contribute to the development of personalised medicine?
5. How could knowledge of the human genome help identify genes associated with disease?
6. What are potential limitations or ethical concerns associated with using information from the human genome?

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

1. What is genetic variation?
2. Why is there usually extensive genetic variation within a population of a species?
3. How do mutations create new alleles?
4. Why can mutations increase the genetic variation within a population?
5. How can sexual reproduction contribute to the variation produced by mutations?
6. Why does genetic variation mean that individuals of the same species can have different genotypes?

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. What effect do most genetic mutations have on an organism's phenotype?
2. Why might a genetic mutation have no effect on the phenotype?
3. What effect can some genetic mutations have on an organism's phenotype?
4. How can a mutation have a small effect on phenotype?
5. Why can a single mutation rarely have a significant effect on phenotype?
6. Why do genetic mutations not always result in noticeable changes to an organism's characteristics?

Topic 4 – Natural selection and genetic modification

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

1. What is meant by evolution by natural selection?
2. Why is there variation between individuals within a population?
3. How does competition for limited resources affect individuals within a population?
4. How does natural selection cause individuals with advantageous characteristics to survive and reproduce more successfully?
5. How can advantageous alleles become more common in a population over many generations?
6. How does Darwin's theory of natural selection explain how species can change over time?

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

1. How can antibiotic resistance arise in a population of bacteria?
2. Why does an antibiotic kill susceptible bacteria but allow resistant bacteria to survive?
3. How does natural selection increase the proportion of antibiotic-resistant bacteria in a population?
4. Why does the use of antibiotics create a selection pressure on bacterial populations?
5. How does the emergence of antibiotic-resistant bacteria provide evidence supporting Darwin's theory of evolution?
6. Why can an antibiotic-resistant bacterial population become more common after repeated antibiotic use?

4.4 Describe the evidence for human evolution, based on fossils, including: a Ardi from 4.4 million years ago b Lucy from 3.2 million years ago c Richard Leakey's discovery of fossils from 1.6 million years ago

1. What is a fossil?
2. How can fossils provide evidence for human evolution?
3. What does the fossil evidence from Ardi, dating from about 4.4 million years ago, contribute to our understanding of human evolution?
4. What does the fossil evidence from Lucy, dating from about 3.2 million years ago, contribute to our understanding of human evolution?
5. What did Richard Leakey's discovery of fossils from about 1.6 million years ago contribute to the evidence for human evolution?
6. Why does a sequence of fossils from different time periods provide evidence for changes in human characteristics over time?

4.5 Describe the evidence for human evolution based on stone tools, including: a the development of stone tools over time b how these can be dated from their environment

1. How can stone tools provide evidence for human evolution?
2. How did the design and complexity of stone tools change over time?
3. What can increasingly sophisticated stone tools suggest about the development of human abilities?
4. How can the development of stone tools be used to provide evidence for human evolution?
5. How can the environment surrounding a stone tool be used to determine its age?
6. Why is dating stone tools important when using them as evidence for human evolution?

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

1. What is meant by classification in biology?
2. What are the three domains used to classify organisms?
3. What evidence from genetic analysis led scientists to propose the three-domain system?
4. How did genetic analysis challenge the traditional five-kingdom classification system?
5. Why is genetic information useful when determining evolutionary relationships between organisms?
6. How does the three-domain system differ from the five-kingdom classification system?

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

1. What is selective breeding?
2. What steps are involved in selectively breeding organisms with desirable characteristics?
3. How can selective breeding produce food plants with desirable characteristics?
4. How can selective breeding produce domesticated animals with desirable characteristics?
5. Why can selective breeding increase the frequency of desirable alleles in a population?
6. What are potential disadvantages of selective breeding, including reduced genetic variation and inherited health problems?

4.10 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 genetic engineering?
3. Why is a gene introduced into an organism during genetic engineering?
4. How can genetic engineering introduce a desirable characteristic into an organism?
5. How does genetic engineering differ from selective breeding?
6. Give one example of a desirable characteristic that could be introduced using genetic engineering.

4.11 Describe the main stages of genetic engineering including the use of: a restriction enzymes b ligase c sticky ends d vectors

1. What is the role of a restriction enzyme in genetic engineering?
2. What are sticky ends and why are they useful in genetic engineering?
3. What is the role of DNA ligase in genetic engineering?
4. What is a vector and why is it used in genetic engineering?
5. What are the main stages involved in transferring a desired gene into an organism using genetic engineering?
6. How do restriction enzymes, sticky ends, ligase and vectors work together during genetic engineering?

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

1. What is one benefit of genetic engineering in modern agriculture?
2. What is one potential risk of genetic engineering in agriculture?
3. What is one medical benefit of genetic engineering?
4. What is one potential practical or ethical concern associated with genetic engineering?
5. What are the benefits and risks of selective breeding in agriculture?
6. How should practical, environmental and ethical factors be considered when evaluating genetic engineering and selective breeding?

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. How does the World Health Organization define health?
2. What three aspects of well-being are included in the WHO definition of health?
3. Why does being free from disease not necessarily mean that a person is healthy?
4. What is meant by physical well-being?
5. What is meant by mental and social well-being?
6. Why is health considered more than simply the absence of disease or infirmity?

5.2 Describe the difference between communicable and non-communicable 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. Why can communicable diseases be transmitted between individuals?
5. Give one example of a communicable disease and one example of a non-communicable disease.
6. Why are non-communicable diseases not spread from person to person?

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

1. Why can having one disease increase a person's susceptibility to another disease?
2. How can one disease weaken the immune system?
3. Why can damage caused by one disease make it easier for another pathogen to cause disease?
4. How can HIV infection increase susceptibility to other diseases?
5. Why are people with weakened immune systems more likely to develop infections?
6. How does the presence of one disease affect the body's ability to defend itself against other diseases?

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

1. What is a pathogen?
2. Which four types of pathogen are included in the Edexcel specification?
3. How do pathogens cause disease?
4. How are viruses different from bacteria as pathogens?
5. How can fungi cause disease?
6. How can protists cause disease?

5.5 Describe some common infections, including: a cholera (bacteria) causes diarrhoea b tuberculosis (bacteria) causes lung damage c Chalara ash dieback (fungi) causes leaf loss and bark lesions d malaria (protists) causes damage to blood and liver e HIV (virus) destroys white blood cells, leading to the onset of AIDS

1. Which type of pathogen causes cholera and what symptom does cholera cause?
2. Which type of pathogen causes tuberculosis and what damage can tuberculosis cause?
3. Which type of pathogen causes Chalara ash dieback and what symptoms does it cause in ash trees?
4. Which type of pathogen causes malaria and what tissues can malaria damage?
5. Which type of pathogen causes HIV and what cells does HIV destroy?
6. How can destruction of white blood cells by HIV lead to the onset of AIDS?

5.6 Explain how pathogens are spread and how this spread can be reduced or prevented, including: a cholera (bacteria) – water b tuberculosis (bacteria) – airborne c Chalara ash dieback (fungi) – airborne d malaria (protists) – animal vectors

1. How is cholera transmitted and how can its spread be reduced?
2. How is tuberculosis transmitted and how can its spread be reduced?
3. How is Chalara ash dieback transmitted and how can its spread be reduced?
4. How is malaria transmitted and what type of organism acts as its vector?
5. What is meant by an animal vector in the transmission of disease?
6. How do clean water, reducing airborne transmission and controlling vectors help prevent the spread of pathogens?

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

1. What is a sexually transmitted infection?
2. How is Chlamydia transmitted?
3. How is HIV transmitted as a sexually transmitted infection?
4. How can the spread of Chlamydia be reduced or prevented?
5. How can the sexual transmission of HIV be reduced or prevented?
6. Why can barrier contraception reduce the transmission of some sexually transmitted infections?

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

including mucus, cilia and skin b chemical defence, including lysozymes and hydrochloric acid

1. How does the skin act as a physical barrier against pathogens?
2. How does mucus help protect the body from pathogens?
3. How do cilia help prevent pathogens from reaching the lungs?
4. How does hydrochloric acid protect the body from pathogens?
5. What are lysozymes and how do they help defend the body against pathogens?
6. How do physical barriers and chemical defences work together to prevent pathogens entering and surviving in the body?

5.13 Explain the role of the specific immune system of the human body in defence against disease, including: a exposure to pathogen b the antigens trigger an immune response which causes the production of antibodies c the antigens also trigger production of memory lymphocytes d the role of memory lymphocytes in the secondary response to the antigen

1. What happens when the body is exposed to a pathogen for the first time?
2. What are antigens and how do they trigger an immune response?
3. How do lymphocytes respond to antigens on a pathogen?
4. What are memory lymphocytes?
5. How do memory lymphocytes produce a faster secondary immune response?
6. Why does the secondary response usually produce antibodies more quickly than the primary response?

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

1. What is immunisation?
2. Why is an inactive form of a pathogen used during immunisation?
3. How does an inactive pathogen stimulate an immune response?
4. How does immunisation lead to the production of memory lymphocytes?
5. Why can a person respond more rapidly to the real pathogen after immunisation?
6. How does immunisation help protect an individual from developing a disease?

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. Why are antibiotics used to treat bacterial infections?
2. Why are antibiotics not effective against viral infections?
3. How do antibiotics affect processes in bacterial cells?

4. Why can antibiotics inhibit bacterial cell processes without normally damaging human cells?
5. Why would taking antibiotics to treat a viral infection be ineffective?
6. How does the difference between bacterial and human cells allow antibiotics to treat bacterial infections?

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

1. What are the main stages involved in developing a new medicine?
2. What happens during the discovery stage of medicine development?
3. What is meant by the development stage of medicine development?
4. What is the purpose of preclinical testing when developing a new medicine?
5. What is the purpose of clinical testing when developing a new medicine?
6. Why must a new medicine undergo several stages of testing before it can be widely used?

5.23 Describe that many non-communicable human diseases are caused by the interaction of a number of factors, including cardiovascular diseases, many forms of cancer, some lung and liver diseases and diseases influenced by nutrition

1. What is a non-communicable disease?
2. Why are many non-communicable diseases caused by several interacting factors?
3. Which types of disease can be influenced by multiple risk factors?
4. How can cardiovascular disease be influenced by several different factors?
5. How can lifestyle and environmental factors interact to increase the risk of cancer?
6. Why is it difficult to identify one single cause for many non-communicable diseases?

5.24 Explain the effect of lifestyle factors on non-communicable diseases at local, national and global levels, including: a exercise and diet on obesity and malnutrition, including BMI and waist : hip calculations, using the BMI equation: mass (kg) / height (m)^2 b alcohol on liver diseases c smoking on cardiovascular diseases

1. How can exercise and diet affect the risk of obesity?
2. How can inadequate nutrition lead to malnutrition?
3. How is BMI calculated?
4. How can waist-to-hip ratio be used when assessing health risks?
5. How can excessive alcohol consumption increase the risk of liver disease?

6. How can smoking increase the risk of cardiovascular disease?

5.25 Evaluate some different treatments for cardiovascular disease, including: a life-long medication b surgical procedures c lifestyle changes

1. What are the potential benefits of using lifelong medication to treat cardiovascular disease?
2. What are the potential disadvantages of lifelong medication for cardiovascular disease?
3. What are the potential benefits and risks of surgical procedures for cardiovascular disease?
4. How can lifestyle changes help prevent or manage cardiovascular disease?
5. Why might lifestyle changes be preferred to some medical treatments for cardiovascular disease?
6. How should the advantages and disadvantages of medication, surgery and lifestyle changes be evaluated when treating cardiovascular disease?

Topic 6 – Plant structures and their functions

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

1. What are photosynthetic organisms?
2. Why are photosynthetic organisms described as producers?
3. Why are photosynthetic organisms the main producers of food in ecosystems?
4. How do photosynthetic organisms produce biomass?
5. Why is photosynthesis important for providing food for other organisms?
6. How does the production of biomass by photosynthetic organisms support food chains?

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. What is photosynthesis?
2. Which two raw materials are required for photosynthesis?
3. What products are produced during photosynthesis?
4. Why is photosynthesis described as an endothermic reaction?
5. What form of energy is required for photosynthesis?
6. Where do plants obtain the carbon dioxide and water required for photosynthesis?

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

1. What is meant by a limiting factor in photosynthesis?
2. How does light intensity affect the rate of photosynthesis when light is a limiting factor?
3. How does carbon dioxide concentration affect the rate of photosynthesis when carbon dioxide is a limiting factor?
4. How does temperature affect the rate of photosynthesis?
5. Why does increasing one limiting factor eventually stop increasing the rate of photosynthesis?
6. How can temperature, light intensity and carbon dioxide concentration each limit the rate of photosynthesis?

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

1. Why can more than one factor limit the rate of photosynthesis at the same time?
2. How does the effect of increasing light intensity depend on the availability of carbon dioxide?
3. How does the effect of increasing carbon dioxide concentration depend on light intensity?
4. Why does increasing temperature only increase the rate of photosynthesis within a suitable temperature range?
5. How can changing one environmental factor reveal another limiting factor?
6. How do temperature, light intensity and carbon dioxide concentration interact to determine the rate of photosynthesis?

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

1. How could you investigate the effect of light intensity on the rate of photosynthesis in a plant?
2. What variable should be changed when investigating the effect of light intensity on photosynthesis?
3. What measurement could be used to determine the rate of photosynthesis in an aquatic plant?
4. Which variables should be controlled when investigating the effect of light intensity on photosynthesis?
5. Why should the temperature and carbon dioxide concentration be kept constant when investigating light intensity?
6. How could repeated measurements improve the reliability of an investigation into the effect of light intensity on photosynthesis?

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. How does the rate of photosynthesis change when light intensity increases, if light intensity is the limiting factor?
2. What does it mean for the rate of photosynthesis to be directly proportional to light intensity?
3. How does the intensity of light change as the distance from a light source increases?
4. What does it mean for light intensity to be inversely proportional to the square of the distance from a light source?
5. A plant is moved from 20 cm to 40 cm from a light source. By what factor does the light intensity change?
6. How can the inverse square law be used to calculate changes in light intensity when the distance from a light source changes?

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

1. What is the function of a root hair cell?
2. How does the long extension of a root hair cell help it absorb water and mineral ions?
3. How does the large surface area of root hair cells help water uptake?
4. How does the thin cell wall of a root hair cell help water enter the cell?
5. How are mineral ions absorbed by root hair cells when their concentration is lower in the soil than inside the cell?
6. How is the structure of a root hair cell adapted for efficient absorption of water and mineral ions?

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. What is the function of xylem tissue?
2. How are xylem vessels adapted to transport water and mineral ions?
3. Why does lignin strengthen xylem vessels?
4. What is the function of phloem tissue?
5. Why do phloem cells require energy to transport sucrose?
6. How do the structures of xylem and phloem differ in relation to their functions?

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

1. What is transpiration?
2. How does water loss from leaves contribute to the movement of water through a plant?
3. How are mineral ions transported through a plant with water?
4. What are stomata?
5. How do stomata control the movement of gases and water vapour into and out of a leaf?
6. How does transpiration result in water and mineral ions being transported from the roots to the leaves?

6.10 Describe how sucrose is transported around the plant by translocation

1. What is translocation?
2. Which substance is transported around a plant by translocation?
3. Which plant tissue transports sucrose by translocation?
4. Why does a plant need to transport sucrose from its leaves to other parts of the plant?
5. How can sucrose be transported from a source to a sink in a plant?
6. How does translocation differ from the transport of water and mineral ions in plants?

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. How does increasing light intensity affect the rate of water uptake by a plant?
2. Why can increased light intensity increase the rate of water uptake by a plant?
3. How does increased air movement affect the rate of water uptake by a plant?
4. Why can increased air movement increase the rate of water uptake by a plant?
5. How does temperature affect the rate of water uptake by a plant?
6. How do light intensity, air movement and temperature affect water uptake through their effects on transpiration?

6.13 Demonstrate an understanding of rate calculations for transpiration

1. How is the rate of transpiration calculated from a change in mass over a given time?
2. A plant loses 6 g of water in 30 minutes. What is its average rate of water loss in g/min?
3. A plant loses 12 g of water over 2 hours. Calculate its average rate of water loss in g/hour.

4. A plant loses 0.8 g of water in 20 minutes. Calculate its rate of water loss in g/min.
5. A plant loses 9 g of water in 3 hours. Calculate its average rate of water loss in g/hour.
6. Why is calculating the rate of water loss more useful than simply measuring the total mass of water lost when comparing transpiration in different plants?

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. What is a hormone, and how are hormones transported from endocrine glands to their target organs?
2. Where is the pituitary gland located, and what is its role as an endocrine gland?
3. Which hormone-producing gland is located in the neck, and what is its main hormone?
4. Which hormones are produced by the pancreas, and what process do they regulate?
5. Where are the adrenal glands located, and what hormone associated with the fight-or-flight response do they produce?
6. Which hormones are produced by the ovaries and testes?

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. Which glands produce adrenalin, and why is adrenalin released during a fight-or-flight response?
2. How does adrenalin affect heart rate and blood pressure during a fight-or-flight response?
3. How does adrenalin increase blood flow to the muscles during a fight-or-flight response?
4. How does adrenalin increase blood glucose concentration during a fight-or-flight response?
5. What substance stored in the liver is converted into glucose when adrenalin raises blood glucose concentration?

6. Explain how the effects of adrenalin prepare the body for vigorous physical activity.

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. What is the role of thyroxine in controlling metabolic rate?
2. What happens to TRH production when thyroxine levels in the blood are low?
3. How does TRH cause the production of thyroxine to increase?
4. What is the role of TSH in controlling thyroxine production?
5. What happens to TRH and TSH production when thyroxine levels return to normal?
6. Explain how thyroxine provides an example of negative feedback.

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. What happens to the uterus lining during menstruation?
2. What happens to the uterus lining during the part of the menstrual cycle when it is repaired and thickened?
3. What is ovulation, and approximately when does it occur during the menstrual cycle?
4. What is the role of oestrogen in the menstrual cycle?
5. What is the role of progesterone in the menstrual cycle?
6. What causes the uterus lining to break down during menstruation?

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. What is the role of FSH in the menstrual cycle?
2. How does FSH stimulate the production of oestrogen during the menstrual cycle?
3. How does oestrogen affect FSH production and the uterus lining?
4. What is the role of LH in causing ovulation?
5. How does progesterone maintain the uterus lining after ovulation?
6. Explain how changes in oestrogen, progesterone, FSH and LH control the menstrual cycle.

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

1. How does hormonal contraception prevent pregnancy?
2. How can hormonal contraceptives containing oestrogen and progesterone prevent ovulation?
3. How does hormonal contraception affect FSH and LH levels?
4. How can hormonal contraception make it more difficult for sperm to reach an egg?
5. How can hormonal contraception affect the uterus lining?
6. Explain how hormonal contraception reduces the probability of fertilisation and pregnancy.

7.7 Evaluate hormonal and barrier methods of contraception

1. What is a hormonal method of contraception, and how does it prevent pregnancy?
2. What is a barrier method of contraception, and how does it prevent pregnancy?
3. What are the advantages of hormonal contraception compared with barrier contraception?
4. What are the disadvantages of hormonal contraception compared with barrier contraception?
5. Which type of contraception can also reduce the risk of sexually transmitted infections?
6. How should the effectiveness, side effects, convenience and protection against STIs be considered when evaluating contraceptive methods?

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

1. What is assisted reproductive technology (ART), and why may hormones be used during ART?
2. How are hormones used during IVF to stimulate the development of multiple eggs?
3. What happens to an egg and sperm during IVF before the resulting embryo is transferred to the uterus?
4. What is the purpose of transferring an embryo into the uterus during IVF?
5. How does clomifene therapy increase the chance of ovulation?
6. Explain how hormones can be used in IVF and clomifene therapy to increase the chance of pregnancy.

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

1. What is meant by maintaining a constant internal environment?
2. Why must organisms maintain a constant internal environment?

3. Which internal conditions are commonly regulated to maintain a constant internal environment?
4. How can changes in the external environment affect the internal conditions of an organism?
5. What is homeostasis?
6. Explain why homeostasis is important for the correct functioning of cells and enzymes.

7.13 Explain how the hormone insulin controls blood glucose concentration

1. What causes the pancreas to release insulin?
2. What effect does insulin have on blood glucose concentration?
3. How does insulin cause body cells to take up more glucose from the blood?
4. How does insulin affect the conversion of glucose into glycogen in the liver and muscles?
5. What happens to blood glucose concentration when insulin is released?
6. Explain how insulin helps return a high blood glucose concentration to a normal level.

7.14 Explain how blood glucose concentration is regulated by glucagon

1. What causes the pancreas to release glucagon?
2. What effect does glucagon have on blood glucose concentration?
3. How does glucagon affect glycogen stored in the liver?
4. What happens to blood glucose concentration when glucagon is released?
5. How do insulin and glucagon have opposite effects on blood glucose concentration?
6. Explain how glucagon helps return a low blood glucose concentration to a normal level.

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

1. What causes type 1 diabetes?
2. Why can a person with type 1 diabetes have a high blood glucose concentration?
3. Why does the immune system cause a lack of insulin in type 1 diabetes?
4. How is type 1 diabetes controlled using insulin?
5. How can a person with type 1 diabetes adjust insulin treatment to help control blood glucose concentration?
6. Explain why people with type 1 diabetes require insulin to regulate their blood glucose concentration.

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

1. What is the main cause of type 2 diabetes?
2. What is meant by insulin resistance in type 2 diabetes?
3. Why can blood glucose concentration remain high in a person with type 2 diabetes?
4. How can changes to diet and exercise help control type 2 diabetes?
5. What medicines may be used to help control type 2 diabetes?
6. Explain how type 2 diabetes can be controlled through lifestyle changes and, when necessary, medication.

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

1. What does BMI measure, and how is BMI calculated from body mass and height?
2. A person has a mass of 80 kg and a height of 1.60 m. Calculate their BMI.
3. A person has a mass of 72 kg and a height of 1.80 m. Calculate their BMI.
4. How can waist-to-hip ratio be calculated?
5. Why can a higher body mass or waist-to-hip ratio be associated with an increased risk of type 2 diabetes?
6. Explain why a correlation between body mass and type 2 diabetes does not necessarily prove that body mass alone causes the disease.

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. Why do multicellular organisms need transport systems to move substances around their bodies?
2. Which gas must be transported to cells for aerobic respiration?
3. Which waste gas produced by aerobic respiration must be transported away from cells?
4. Why must water and dissolved food molecules be transported to cells?
5. Why do organisms need to transport mineral ions to their cells?
6. Why must urea be transported away from cells?

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

1. Why do multicellular organisms require specialised exchange surfaces for efficient movement of substances?
2. Why does a small surface area to volume ratio make exchange by diffusion less efficient in a multicellular organism?

3. Calculate the surface area : volume ratio of a cube with a surface area of 150 cm^2 and a volume of 125 cm^3.
4. Calculate the surface area : volume ratio of a cube with a surface area of 600 mm^2 and a volume of 1000 mm^3.
5. Why does increasing the size of an organism generally decrease its surface area to volume ratio?
6. Why do multicellular organisms require transport systems in addition to exchange surfaces?

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

1. How does the large surface area of the alveoli increase the rate of gas exchange?
2. How does the thin wall of an alveolus increase the rate of diffusion between the air and blood?
3. Why does the extensive blood supply surrounding the alveoli help maintain a concentration gradient for oxygen?
4. How does ventilation of the lungs help maintain a concentration gradient between alveolar air and the blood?
5. In which direction does oxygen diffuse between the alveoli and surrounding capillaries, and why?
6. In which direction does carbon dioxide diffuse between the blood and alveoli, and why?

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. How is the biconcave shape of a red blood cell adapted for transporting oxygen?
2. How does the absence of a nucleus in a red blood cell increase its ability to transport oxygen?
3. What are the roles of phagocytes and lymphocytes in defending the body against pathogens?
4. How are phagocytes adapted to engulf and destroy pathogens?
5. What substances are transported in blood plasma?
6. How are platelets adapted to their role in blood clotting?

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

1. How is the thick muscular wall of an artery adapted to withstand high blood pressure?
2. How does the narrow lumen of an artery help maintain high blood pressure?

3. How is the thin wall of a capillary adapted for efficient exchange of substances with tissues?
4. Why are capillaries arranged as extensive networks around body tissues?
5. How are veins adapted to carry blood back to the heart at relatively low pressure?
6. What is the function of valves in veins, and why are they necessary?

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. Why is the wall of the left ventricle thicker than the wall of the right ventricle?
2. What is the function of the valves in the heart?
3. What is the function of the septum separating the left and right sides of the heart?
4. Which major blood vessel carries oxygenated blood from the heart to the body, and which chamber pumps this blood?
5. Which major blood vessel carries deoxygenated blood from the body to the heart?
6. Why does the circulatory system transport blood through the lungs before it reaches the rest of the body?

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. Why is cellular respiration described as an exothermic reaction?
2. Where does cellular respiration occur in living cells?
3. Why must cellular respiration occur continuously in living cells?
4. What is the main purpose of the energy released during cellular respiration?
5. What substances are used and produced during aerobic respiration?
6. What is the difference between aerobic and anaerobic respiration in terms of oxygen availability?

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

1. What are the reactants and products of aerobic respiration?
2. What is the product of anaerobic respiration in human muscle cells?
3. Why does anaerobic respiration release less energy than aerobic respiration?
4. What is produced during anaerobic respiration in yeast?
5. Why may muscle cells use anaerobic respiration during vigorous exercise?

6. What is the main difference between aerobic and anaerobic respiration regarding the use of oxygen?

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

1. How could you investigate the rate of respiration in germinating seeds by measuring the uptake of oxygen?
2. Why could a respirometer be used to investigate the rate of respiration in germinating seeds?
3. What variable could be changed to investigate its effect on the rate of respiration in a respirometer?
4. Why should a control be included when investigating the rate of respiration in living organisms?
5. How could the rate of respiration be calculated from measurements of oxygen uptake over time?
6. Why should temperature be controlled when investigating the rate of respiration in living organisms?

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

1. A person's heart beats 72 times per minute. Calculate their heart rate in beats per minute.
2. A person's heart pumps 70 cm^3 of blood per beat at a heart rate of 75 beats per minute. Calculate their cardiac output in cm^3 per minute.
3. A person's cardiac output is 5,600 cm^3 per minute and their heart rate is 80 beats per minute. Calculate their stroke volume.
4. A person's stroke volume is 90 cm^3 and their heart rate is 65 beats per minute. Calculate their cardiac output in cm^3 per minute.
5. A person's cardiac output is 7,200 cm^3 per minute and their stroke volume is 80 cm^3 per beat. Calculate their heart rate.
6. An athlete has a stroke volume of 120 cm^3 and a heart rate of 150 beats per minute during exercise. Calculate their cardiac output in dm^3 per minute.

Topic 9 – Ecosystems and material cycles

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

1. What is an organism in an ecosystem?
2. What is a population?
3. What is a community?
4. What is an ecosystem?
5. What is the difference between a population and a community?

6. What is the correct order of ecological organisation from the smallest level to the largest: organism, population, community and ecosystem?

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

1. What is an abiotic factor, and how can temperature affect the organisms in a community?
2. How can light intensity affect the distribution and abundance of organisms in a community?
3. How can water availability affect the distribution and abundance of organisms in a community?
4. How can pollutants affect the organisms within a community?
5. How can competition between organisms affect the size of populations within a community?
6. How can predation affect the population sizes of predator and prey species within a community?

9.3 Describe the importance of interdependence in a community

1. What is meant by interdependence between organisms in a community?
2. Why are organisms in a community often dependent on other species for their survival?
3. How can a reduction in the population of one species affect other species in the same community?
4. How can changes in prey abundance affect a predator population?
5. Why can the removal of one species have effects throughout a community?
6. How does interdependence contribute to the stability of a community?

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

1. What is parasitism?
2. How does a parasite benefit from its relationship with a host?
3. How can parasitism negatively affect the survival of the host organism?
4. What is mutualism?
5. How do both organisms benefit from a mutualistic relationship?
6. Why can the survival of some organisms depend on maintaining a mutualistic relationship with another species?

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

1. How can a quadrat be used to investigate the distribution of organisms in a habitat?

2. Why should quadrats be placed randomly when investigating the distribution of plants in a habitat?
3. How can a belt transect be used to investigate how the distribution of organisms changes across a habitat?
4. Why should several quadrats be used when investigating the abundance of organisms in a habitat?
5. How could you investigate the effect of distance from a river on the distribution of a plant species using a belt transect?
6. What measurements could be recorded in quadrats placed along a belt transect to investigate the relationship between an organism and its environment?

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. How can the mean number of organisms per quadrat be calculated from raw quadrat data?
2. A researcher counts 8, 12, 10, 14 and 6 daisies in five quadrats. Calculate the mean number of daisies per quadrat.
3. A researcher records an average of 15 plants per 1 m^2 quadrat. Estimate the number of plants in a 200 m^2 field.
4. Why is the total area sampled important when estimating the population size of organisms?
5. A researcher counts 24 organisms in ten 0.5 m^2 quadrats. Estimate the number of organisms in a 100 m^2 habitat.
6. How can data from quadrats placed along a belt transect be used to determine how the number of organisms changes across a habitat?

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. How can fish farming have positive effects on human food supplies and reduce pressure on wild fish populations?
2. How can fish farming negatively affect biodiversity in aquatic ecosystems?
3. Why can introducing a non-indigenous species reduce biodiversity in an ecosystem?
4. How can a non-indigenous species affect native species through competition or predation?
5. How can fertilisers containing nitrates and phosphates cause eutrophication?
6. How can eutrophication lead to the death of aquatic organisms and a reduction in biodiversity?

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

1. What is biodiversity?
2. Why is maintaining biodiversity important for the stability of ecosystems?
3. How can conserving endangered animal species help maintain biodiversity?
4. How can reforestation increase biodiversity?
5. How can maintaining biodiversity provide resources that are useful to humans?
6. Why can reforestation have benefits for both biodiversity and the environment?

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

1. What is meant by a material cycle in an ecosystem?
2. What are the biotic components of an ecosystem?
3. What are the abiotic components of an ecosystem?
4. How do materials move between organisms and the non-living environment?
5. Why must materials such as carbon, water and nitrogen be continually recycled through ecosystems?
6. How do decomposers contribute to the cycling of materials between biotic and abiotic components of an ecosystem?

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

1. Why is the carbon cycle important to living organisms?
2. How does photosynthesis transfer carbon dioxide from the atmosphere into living organisms?
3. How does respiration return carbon dioxide to the atmosphere?
4. How does combustion of fossil fuels transfer carbon from fossil fuels into atmospheric carbon dioxide?
5. How do microorganisms act as decomposers in the carbon cycle?
6. How does decomposition return carbon from dead organisms and waste materials to the atmosphere?

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. Why is the water cycle important to living organisms and ecosystems?
2. What processes transfer water from the Earth's surface into the atmosphere during the water cycle?

3. How does water return from the atmosphere to the Earth's surface?
4. How can water from the environment be treated to produce potable water?
5. Why can desalination be used to produce potable water in areas affected by drought?
6. How does desalination remove dissolved salts from seawater to produce potable water?

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. Why do plants need nitrate ions?
2. How do nitrogen-fixing bacteria contribute to making nitrogen compounds available in soil?
3. How do nitrifying bacteria help make nitrate ions available for plant uptake?
4. How can fertilisers increase the availability of nitrate ions for plants?
5. How does crop rotation with leguminous plants increase the nitrate content of soil?
6. Why are bacteria essential for making nitrogen compounds available to plants in the nitrogen cycle?