GCSE (9-1)

Separate

Biology 1

### Topics common to Paper 1 and Paper 2

#### Topic 1 – Key concepts in biology

|  |  |  |
| --- | --- | --- |
| **Students should:** | | **Maths skills** |
| 1.1 | Explain how the sub-cellular structures of eukaryotic and prokaryotic cells are related to their functions, including:   1. animal cells – nucleus, cell membrane, mitochondria and ribosomes 2. plant cells – nucleus, cell membrane, cell wall, chloroplasts, mitochondria, vacuole and ribosomes 3. bacteria – chromosomal DNA, plasmid DNA, cell membrane, ribosomes and flagella   *a nucleus – controls the cell and its activities. Contains chromosomes which contain DNA. Cell membrane – Control what enters and leaves the cell Mitochondria – jelly-bean shaped structures in which respiration takes place  Ribosomes – make new proteins for the cell*  *b cell wall – is made of cellulose and supports and protects the cell. chloroplasts – contain chlorophyll, which traps energy transferred from the sun. The energy is used for photosynthesis  vacuole – stores cell sap and helps to keep the cell firm and rigid*  *c chromosomal DNA – one large loop of DNA which controls most of the cells activities plasmid DNA – smaller loops of DNA which controls a few of the cells activities flagella – spins round like a propeller so the bacterium can move.*  *See your revision guide for more info* |  |
| 1.2 | Describe how specialised cells are adapted to their function, including:   1. sperm cells;   acrosome –*the tip of the head contains a small vacuole called the acrosome. It contains enzymes that break down the substances in the egg cell’s jelly coat. This allows the sperm cell to burrow inside.*  haploid nucleus – *cells with only one copy of each chromosome*  tail – *waves from side to side, allowing the sperm cell to swim.*   1. egg cells;   nutrients in the cytoplasm- *supply the fertilized egg cell with energy and raw materials for the growth and development of the embryo*  changes in the cell membrane after fertilization – *after fertilisation, the cell membrane becomes hard to stop other sperm cells entering.*   1. ciliated epithelial cells   *See your revision guide for more info* |  |
| 1.3 | Explain how changes in microscope technology, including electron microscopy, have enabled us to see cell structures with more clarity and detail than in the past and increased our understanding of the role of sub-cellular structures and organelles egg   * *increased magnification* * *increased resolution*   *enabling us to see sub-cellular structures* |  |
| 1.4 | Demonstrate an understanding of number, size and scale, including the use of estimations and explain when they should be used   * *magnification is two lens’ together. I.e. Eyepiece lens x objective lens* * *scale bars are used to estimate sizes of cells/structures within cells.* | 1d 2h |
| 1.5 | Demonstrate an understanding of the relationship between quantitative units in relation to cells, including:   1. milli (10−3) 2. micro (10−6) 3. nano (10−9)   d pico (10−12)  **e calculations with numbers written in standard form**  i.e 0.0000002mm = 2 x 10-7 mm | 1b 2a 2h |
| 1.6 | *Core Practical: Investigate biological specimens using microscopes, including magnification calculations and labelled scientific drawings from observations*   * *know how to draw specimens seen under microscope; using a pencil, note magnification and field of view* * *know how to prepare a slide, remember; lowering a cover slip slowly and carefully means a slide is less likely to contain air bubbles* | 1d  2a, 2h 3b |
| 1.7 | Explain the mechanism of enzyme action including the active site and enzyme specificity. Active site is where the substrate of the enzyme fits. Different substances have different 3D shapes. |  |
| 1.8 | Explain how enzymes can be denatured due to changes in the shape of the active site. So substrate no longer fits enzyme, as enzyme now has a different shape active site. Only certain enzymes fit specific substrates e.g. lock and key mechanism. |  |
| 1.9 | Explain the effects of;  Temperature – *increases, increases speed, increases collisions, increases chance of substrate finding enzyme. If temperature gets too high, then the enzymes active site will change shape and the substrate will no longer fit. The temperature at which the enzyme and substrate binds the most is known as the optimum temperature, before the enzymes denatures.*  substrate concentration – *the higher the substrate concentration, the faster the reaction. This is because it’s more likely that the enzyme will meet up and react with a substrate molecule. This is only true up to a point. After that, there are so many substrate molecules that the enzymes have about as much as they can cope with (all the active sites are full) and adding more will make no difference*  pH on enzyme activity – *pH also affects enzymes. pH interferes with the bonds holding the enzyme together, therefore changing the shape of the active site. All enzymes have an optimum pH they work best at.* | 2c, 2f  4a, 4c |

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 1.10 *Core Practical: Investigate the effect of pH on enzyme activity*  *amylase is an enzyme which breaks starch 🡪 glucose*  *we can test for starch using iodine. If the iodine turns black then starch is present.* | 2c, 2f  4a, 4c |
| 1.11 Demonstrate an understanding of rate calculations for enzyme activity.  *e.g. At 30 degrees, 100g starch was broken down in 5 minutes. The mean rate of this reaction is 100/5 = 20g/minute at 30 degrees is the rate of this reaction.* | 1a, 1c |
| 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.  *Starch 🡪 ( amylase) 🡪 glucose*  *Proteins 🡪 ( protease ) 🡪 amino acids*  *Lipids 🡪 ( lipase ) 🡪 glycerol and fatty acids.* |  |
| 1.13B *Core Practical: Investigate the use of chemical reagents to identify starch, reducing sugars, proteins and fats.*  *Starch - iodine yellow 🡪 black*  *Sugars – equal volume benedicts solution, place in hot water bath. Know different colours of precipitation for amount of sugar present.*  *Proteins – biuret test. Add a few drops of potassium hydroxide solution pus 2 drops of copper sulphate solution. If no protein present it will stay blue. If protein present will turn purple.*  *Fats – ethanol emulsion test. Mix with ethanol and shaken, pour into water, shake again. Any fats present will precipitate out of the solution and show as a milky emulsion. The more lipid present, the milkier the colour will be.* |  |
| 1.14B Explain how the energy contained in food can be measured using calorimetry.  *We can burn the food. The amount of energy transferred from the burning the food is used to heat the water and increase the temperature.* | 1a  2a  see p20 GCSE Biology for more info |
| 1.15 Explain how substances are transported into and out of cells, including by;  diffusion *– is the net movement of particles from an area of higher concentration to an area of lower concentration*  osmosis – *is the net movement of water molecules across a partially permeable membrane from a region of higher water concentration to a region of lower water concentration.*  active transport- *is the movement of particles across a membrane against a concentration gradient using energy transferred during respiration* |  |
| 1.16 *Core Practical: Investigate osmosis in potatoes* | 1c  2b, 2f 4a, 4c |
| 1.17 Calculate percentage gain and loss of mass in osmosis   * *work out the difference between the mass of tissue at the start and at the end (final mass – initial mass)* * *divide the difference by the initial mass* * *multiply by 100*   *percentage change in mass= ((final mass – initial mass) / initial mass) x 100.*  *a negative answer is a percentage change in mass.* | 1a, 1c  4a, 4c |

### Topics for Paper 1

#### Topic 2 – Cells and control

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 2.1 Describe mitosis as part of the cell cycle, including the stages; **interphase** – In this phase the cell makes extra-sub-cellular cell parts (e.g. mitochondria). DNA replication also occurs, to make copies of all the chromosomes.  **Prophase** – *The nucleus starts to break down and spindle fibres appear.*  **Metaphase**- *the chromosomes are lined up on the spindle fibres across the middle of the cell.*  **Anaphase –** *The chromosome copies are separated and moved to ether end of the cell on the spindle fibres.*  **Telophase –** *A membrane forms around each set of chromosomes to form nuclei*  **Cytokinesis –** *A cell surface membrane forms to separate the two cells during cytokinesis. Cell walls form in plant cells* |  |
| 2.2 Describe the importance of mitosis in growth, repair and asexual reproduction.  *Organisms can reproduce using just one parent. This is asexual reproduction and produces offspring that are clones, which means their cells have the same chromosomes as the parent. So asexual reproduction relies on mitosis.*  *Normal cells divide only when they need to. Changes in cells can sometimes turn them into cancer cells, which divide uncontrollably.* |  |
| 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 ( 46 chromosomes )body cells. |  |
| 2.4 Describe cancer as the result of changes in cells that lead to uncontrolled cell division |  |
| * 1. Describe growth in organisms, including:      1. cell division and differentiation in animals      2. cell division, elongation and differentiation in plants   ***meristems*** *– a group of cells near the end of each shoot and root allows plants to continue growing throughout their lives. The cells divide rapidly by mitosis. Many of the cells produce and then increase in length (* ***elongation*** *), and* ***differentiate*** *into specialized cells that have different functions.* |  |
| * 1. Explain the importance of cell differentiation in the development of specialised cells.   *Although all animals develop from a single cell, not all the cells in their bodies are the same. New cells may change so they become specialized for different functions. This process that changes less specialized cells into more specialized ones is differentiation.* |  |
| * 1. Demonstrate an understanding of the use of percentiles charts to monitor growth   Percentage changes calculated using this formula;  (final value – starting value) x 100%  starting value | 1c  4a |
| 2.8 Describe the function of embryonic stem cells, stem cells in animals and meristems in plants.  *Stem cells – cells that can divide repeatedly over a long period of time to produce cells that then differentiate are called stem cells. In plants these cells are found in meristems.*  *Embryonic stem cells – the cells of an early stage embryo – have the ability to produce any type of specialized cell. Can replace old or damaged cells in human tissues. They can therefore offer a way of treating many different diseases caused by damaged cells.* | 1d |
| * 1. Discuss the potential benefits and risks associated with the use of stem cells in medicine.   Benefits – used for human transplants (i.e. bone marrow transplant)  Replace damaged cells (e.g. diabetes)  Risks – stem cells continuing to divide inside the body after they have replaced damaged cells causing cancer.  Risk of stem cells being rejected by the immune system of people they are put into. |  |
| 2.10B Describe the structures and functions of the brain including the cerebellum, cerebral hemispheres and medulla oblongata.  Cerebellum – responsible for muscle coordination and balance  Cerebral hemispheres – the cerebrum is the largest part of the brain. It is divided into two halves called the cerebral hemispheres. The right hemisphere controls muscle on the left side of the body and vice versa. Different parts of the cerebrum are responsible for different things including movement, intelligence, memory, language and vision.  Medulla oblongata – controls unconscious activities like breathing and your heart rate. |  |
| 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**  ***CT scanning –*** *uses x- rays to produce an image of the brain*  *Shows the main structures in the brain but doesn’t show the functions of them*  *Can show a diseased or damaged brain structure, but if the patient has lost some function, the function can also be worked out*  ***PET scanning -*** *uses radioactive chemicals to show which parts of the brain are active when the person is inside the scanner*  *Very detailed and can be used to investigate both the structure and the function in real time. Can show if areas of the brain are unusually inactive or active, so they are useful for studying disorders that change the brain’s activity* | 1d 2d |
| 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.**  *Hard to repair any damage to the nervous system.*  *Parts of the nervous system could be hard to access and therefore difficult to treat.*  *Problems in the nervous system may lead to permanent damage* |  |
| 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.  *Sensory receptors – found in the sense organs (eyes, ears and skin), contain receptor cells that detect stimuli i.e. skin contains receptor cells that detect the stimulus of temperature change*  *Sensory neurons – carries impulses from receptor cells towards the CNS*  *Relay neurones – short neurones that are found in the spinal cord, where they link motor and sensory neurones.*  *Motor neurons – carry impulses to effectors*  *Synapses – where one neurone meets another, when one impulse reaches an axon terminal, neurotransmitter is release which crosses a tiny gap to the effector neurone. This gap is the synapse*  *Neurotransmitters – released into synapse at neurone junctions.* | 2g 4a, 4c |
| 2.14 Explain the structure and function of a reflex arc including sensory, relay and motor neurones |  |

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 2.15B Explain the structure and function of the eye as a sensory receptor including the role of:  a the cornea and lens *refracts light into the eye, focusing it onto the retina*  b the iris – *controls how much light enters the pupil*  c rod and cone cells in the retina – *rod cells are more sensitive in dim light but can’t sense colour. Cone cells are sensitive to different colours but are not so good in dim light.* | 2c |
| 2.16B Describe defects of the eye including cataracts, long- sightedness, short-sightedness and colour blindness.  ***Cataracts*** *– a cloudy patch on the lens, which stops light from being able to enter the eye normally. People with cataracts are likely to have blurred vision. They may also experience colours looking less vivid and have difficulty seeing in bright light.*  ***Long-sightedness*** *– unable to focus on near objects. This occurs when the lens is the wrong shape and doesn’t bend light enough. Light from near objects is brought into focus behind the retina.*  ***Short sightedness*** *-*  ***Colour blindness*** *– people with colour blindness can’t tell the difference between certain colours. Caused when red or* green cones in the retina are not working properly. |  |
| 2.17B Explain how cataracts, long-sightedness and short-sightedness can be corrected  ***Cataracts*** *– can be treated by replacing the faulty lens with an artificial one.*  ***Long sightedness*** *– you can use glasses or contact lenses with a convex lens to correct it*  ***Short sightedness*** *– You can use glasses or contact lenses with a concave lens to correct it*  ***Colour Blindness –*** *There’s no cure for colour blindness at the moment because the cone cells can’t be replaced.* |  |

###### Use of mathematics

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 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.  *Asexual reproduction;*  *Advantages – produces lots of offspring quickly because the reproductive cycle is so fast*   * *Only one parent is needed – means organisms can reproduce* *whenever conditions are favourable, without having to wait for a mate.*   *Disadvantages – there’s no genetic variation between offspring in the population*   * *If the environment changes and conditions become unfavourable, the whole population may be affected.* |  |
| 3.2B Explain some of the advantages and disadvantages of sexual reproduction, including variation in the population, but the requirement to find a mate |  |
| 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. (just one set of chromosomes)  The stages of meiosis are not required |  |
| * 1. Describe DNA as a polymer made up of:      1. two strands coiled to form a double helix      2. strands linked by a series of complementary base pairs joined together by weak hydrogen bonds      3. nucleotides that consist of a sugar and phosphate group with one of the four different bases attached to the sugar.   *b A – T linked by two hydrogen bonds (REMEMBER; Adidas* ***T****rainers, come as a pair!). G-C are linked by 3 hydrogen bonds (REMEMBER;* ***G****alaxy* ***C****hocolate)* |  |
| 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. Explain how DNA can be extracted from fruit.  1. *Mash the fruit and put in a beaker containing a solution of detergent and salt. Mix well. The detergent will break down the cell membranes to release the DNA. The salt will make the DNA stick together.* 2. *Filter the mixture to get the froth and big, insoluble bits of cell out.* 3. *Gently add some ice cold alcohol to the filtered mixture.* 4. *The DNA will start to come out of solution as it’s not soluble in cold alcohol. It will appear as a stringy white precipitate (a solid) that can be carefully fished out with a glass rod.* |  |
| 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**  *See your revision guide for more info* |  |
| 8B Describe the stages of protein synthesis, including transcription and translation:  * + 1. **RNA polymerase binds to non-coding DNA located in front of a gene**     2. **RNA polymerase produces a complementary mRNA strand from the coding DNA of the gene**     3. **the attachment of the mRNA to the ribosome**     4. **the coding by triplets of bases (codons) in the mRNA for specific amino acids**     5. **the transfer of amino acids to the ribosome by tRNA f the linking of amino acids to form polypeptides** |  |
| 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**  *See your revision guide for more info* |  |
| 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.**  *Genetic variants can arise by mutations. A mutation is a rare, random change to an organisms’ DNA base sequence that can be inherited. If a mutation happens in a gene, it produces a genetic variant – a different version of the gene.* |  |

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 3.11B Describe the work of Mendel in discovering the basis of genetics and recognise the difficulties of understanding inheritance before the mechanism was discovered.  *Three Important conclusions Mendel reached;*   1. *Characteristics in plants are determined by “hereditary units”* 2. *Hereditary units are passed on to offspring unchanged from both parents, one unit from each parent* 3. *Hereditary units can be dominant or recessive – if an individual has both the dominant and the recessive unit for a characteristic, the dominant characteristics will be expressed.* | 1c 2c, 2e |
| 3.12 Explain why there are differences in the inherited characteristics as a result of alleles |  |
| * 1. *Explain the terms: chromosome, gene, allele, dominant, recessive, homozygous, heterozygous, genotype, phenotype, gamete and zygote.*   *Chromosome – a thread like structure found in the nuclei of cells. Each chromosome contains one enormously long DNA molecule packed with proteins.*  *Gene- a section of DNA found in a chromosome which contains instructions for a specific protein*  *Allele – a different form of the same gene*  *Dominant – an allele that will always affect the phenotype*  *Recessive – an allele whose effect will not be seen if a dominant allele is present.*  *Homozygous – when both the alleles for a gene are the same in an organism*  *Heterozygous – when both alleles for a gene are different in an organism*  *Genotype – the alleles for a certain characteristic that are found in an organism*  *Phenotype – The characteristics produced by a certain set of alleles*  *Gamete – A haploid cell produced by meiosis used for sexual reproduction*  *Zygote – A fertilized egg cell.* |  |
| * 1. Explain monohybrid inheritance using genetic diagrams, Punnett squares and family pedigrees   *See your revision guide for more info* | 1c 2c, 2e  4a |
| * 1. Describe how the sex of offspring is determined at fertilisation, using genetic diagrams   *See your revision guide for more info* | 1c 2c, 2e  4a |
| * 1. Calculate and analyse outcomes (using probabilities, ratios and percentages) from monohybrid crosses and pedigree analysis for dominant and recessive traits   *See your revision guide for more info* | 1c 2c, 2e  4a |
| 3.17B Describe the inheritance of the ABO blood groups with reference to codominance and multiple alleles.  *Humans have four potential blood types. O, A, B and AB. The gene for blood type in humans has three different alleles. Io, Ia and Ib. Ia and Ib are codominant with each other. This means that when an individual has both of these alleles, then they will have the blood type AB – One allele isn’t dominant over the other.*  *However, Io is recessive. Therefore, if you get Ia with Io then you would have blood type A* | 1c 2c, 2e  4a |
| 3.18B **Explain how sex-linked genetic disorders are inherited**  ***-*** *a characteristic is sexed linked if the allele that codes for it is located on a sex chromosome i.e. X or Y*  *- Y is smaller than X and carries fewer genes*  *- Most genes on sex chromosomes are carried on the X chromosome.*  *- men therefore, only often have one allele for sex linked genes*  *more likely that women show recessive characteristics for sex-linked genes e.g. colour blindness* | 1c 2c, 2e  4a |
| 3.19 State that most phenotypic features are the result of multiple genes rather than single gene inheritance |  |
| * 1. Describe the causes of variation that influence phenotype, including:      1. genetic variation – different characteristics as a result of mutation and sexual reproduction      2. environmental variation – different characteristics caused by an organism’s environment (acquired characteristics) |  |
| * 1. Discuss the outcomes of the Human Genome Project and its potential applications within medicine   *So far project has helped to identify about 1800 genes related to disease.*  *Medical applications;*   * *Prediction and prevention of diseases* * *Testing and treatment for inherited disorders* * *New and better medicines* |  |
| 3.22 State that there is usually extensive genetic variation within a population of a species and that these arise through mutations |  |
| * 1. 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 |  |

#### Topic 4 – Natural selection and genetic modification

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 4.1B Describe the work of Darwin and Wallace in the development of the theory of evolution by natural selection and explain the impact of these ideas on modern biology.  *Darwin came up with the theory of evolution by natural selection. He noticed that there was variation in members of the same species and that those with characteristics most suited to the environment were more likely to survive. He also noticed that characteristics could be passed on to offspring Wallace was working at the same time as Darwin. He also came up with the idea of natural selection, independently of Darwin.* |  |
| 4.2 Explain Darwin’s theory of evolution by natural selection  *1. Genetic variation*  *2. Environmental change*  *3. Natural selection*  *4. Inheritance*  *5. Evolution* |  |
| 4.3 Explain how the emergence of resistant organisms supports Darwin’s theory of evolution including antibiotic resistance in bacteria.  *1. Variation in the population of bacteria with some being resistant*  *2. Courses of antibiotics are unfinished*  *3. BY CHANCE resistant bacteria are not killed*  *4. These resistant bacteria survive and reproduce passing on their genes. Eventually, as more and more non-resistant bacteria are killed all the bacteria are resistant.* | 2c 4a |
| 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 Leakey’s discovery of fossils from 1.6 million years ago | 1a, 1b, 1c 4a |
| * 1. Describe the evidence for human evolution based on stone tools, including:      1. the development of stone tools over time      2. how these can be dated from their environment   *a looking at structural features of the tool or fossil. For example, simpler tools are likely to be older than more complex tools.*  *b using stratigraphy – the study of rock layers. Older rock layers are normally found below younger layers, so tools or fossils in deeper layers are usually older.*  *Stone tools are often found with carbon – containing material e.g. a wooden handle. Carbon -14 dating can be used to date this material* |  |
| 4.6B Describe how the anatomy of the pentadactyl limb provides scientists with evidence for evolution.  *A pentadactyl limb is a limb with five digits. You can see the pentadactyl limb in many species. In each, they have a similar bone structure, but usually a different function. The similarity in bone structure provides evidence that species with a pentadactyl limb have all evolved from a common ancestor.* |  |
| * 1. Describe how genetic analysis has led to the suggestion of the three domains rather than the five kingdoms classification method.   *Using RNA sequencing Woese found that some members of the prokaryote kingdom were not as closely related as first thought. He proposed that this kingdom should be split into two groups called archaea and bacteria.* |  |
| * 1. Explain selective breeding and its impact on food plants and domesticated animals   *Selective breeding is when humans artificially select the plants or animals that are going to breed so that the genes for particular characteristics remain in the population.*  *Organisms are selectively bred to develop features that are useful or attractive, for example;*   * *Animals that produce more meat or milk* * *Crops with disease resistance* * *Dogs with a good, gentle temperament* * *Plants that produce bigger fruit* |  |
| 4.9B Describe the process of tissue culture and its advantages in medical research and plant breeding programs.  *Tissue culture involves growing cells on an artificial growth medium.*  *This can be done with both plant and animal cells.*  *See your revision guide for step by step process in plants and animals.*  *The plants produced via tissue culture are also clones- genetically identical organisms. This means you can use tissue culture to create lines of clones all with the same beneficial features e.g. pesticide resistance.*  *Animal tissue culture is often used in medical research because it means you can carry out all kinds of experiments on tissues in isolation. E.g. you can investigate the effect of glucose on cells in the pancreas by growing pancreatic cells in culture.* |  |
| 4.10 Describe genetic engineering as a process which involves modifying the genome of an organism to introduce desirable characteristics |  |
| 4.11 **Describe the main stages of genetic engineering including the use of:**  **a restriction enzymes b ligase** sticky ends  1. **vectors**   *a restriction enzymes recognize specific sequences of DNA and cut the DNA at these points – the pieces of DNA are left with sticky ends where they have been cut.*  *b ligase enzymes are used to join two pieces of DNA together at their sticky ends.*  *d something that is used to transfer DNA into a cell. There are two sorts; plasmids and viruses* |  |
| 4.12B Explain the advantages and disadvantages of genetic engineering to produce GM organisms including the modification of crop plants, including the introduction of genes for insect resistance from *Bacillus thuringiensis* into crop plants.  *Bacillus thuringiensis (Bt) is a bacterium which produces a toxin that kills many of the insect larvae that are harmful to crops. The gene for the Bt toxin is inserted into crops, such as corn and cotton, which then produce the toxin in their stems and leaves – making them resistant to the insect pests.* |  |

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 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  *- if soils are poor, applying fertilisers is likely to be the best way to increase yields. Fertilisers contain minerals that are essential for plant growth e.g. nitrates and phosphates. However, excess fertilisers can cause problems in rivers and lakes through the process of eutrophication*  *- Biological control uses other organisms to reduce pest numbers. E.g. cane toads were introduced in Australia to eat beetles that were damaging crops. Biological control can have longer lasting effects than chemical pesticides and be less harmful to wildlife. However, introducing new organisms can also cause problems. E.g. the cane toad are now a pest themselves in Australia* | 2c 4a, 4c |
| 4.14 Evaluate the benefits and risks of genetic engineering and selective breeding in modern agriculture and medicine, including practical and ethical implications.  *See your revision guide for further info* | 2c 4a, 4c |

#### Topic 5 – Health, disease and the development of medicines

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 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) |  |
| 5.2 Describe the difference between communicable and non-communicable diseases  *communicable – can be spread from person to person*  *non-communicable – cannot be spread from person to person* |  |
| 5.3 Explain why the presence of one disease can lead to a higher susceptibility to other diseases  *Your body is already weakened by the disease present, so it is less able to fight any other diseases.* | 2c, 2d, 2g  4a, 4c |
| 5.4 Describe a pathogen as a disease-causing organism, including viruses, bacteria, fungi and protists |  |
| * 1. Describe some common infections, including: a cholera (bacteria) causes diarrhea      1. tuberculosis (bacteria) causes lung damage      2. Chalara ash dieback (fungi) causes leaf loss and bark lesions      3. malaria (protists) causes damage to blood and liver      4. HIV (virus) destroys white blood cells, leading to the onset of AIDS      5. stomach ulcers caused by Helicobacter (bacteria) g Ebola (virus) causes hemorrhagic fever |  |
| * 1. Explain how pathogens are spread and how this spread can be reduced or prevented, including:      1. cholera (bacteria) – water      2. tuberculosis (bacteria) – airborne      3. Chalara ash dieback (fungi) – airborne d malaria (protists) – animal vectors  1. stomach ulcers caused by Helicobacter (bacteria) – oral transmission 2. Ebola (virus) – body fluids |  |
| 5.7B Describe the lifecycle of a virus, including lysogenic and lytic pathways  *lytic pathway;*  *virus attaches itself to a specific host cell and injects its genetic material into the cell.*  *The virus uses proteins and enzymes in the host cell to replicate its genetic material and produce the components of new viruses*  *The viral components assemble*  *The host cell splits open, releasing the new viruses, which infect more cells*  *lysogenic pathway;*  *The injected genetic material is incorporated into the genome of the host cell*  *The viral genetic material gets replicated along with the host DNA every time the host cell divides – but the virus is dormant and no new viruses are made.*  *Eventually a trigger causes the viral genetic material to leave the genome and enter the lytic pathway.* |  |
| * 1. Explain how sexually transmitted infections (STIs) are spread and how this spread can be reduced or prevented, including:      1. *Chlamydia* (bacteria)      2. HIV (virus)   *a can only reproduce inside host cells. spread by sexual contact. The spread of chlamydia can be reduced by wearing a condom when having sex, screening individuals so they can be treated for the infection or avoiding sexual contact.*  *b HIV is spread by bodily fluids (e.g. blood, semen, vaginal fluids). One of the main ways to prevent its spread is to use a condom when having sex. Drug users should also avoid sharing needles. Medication can reduce the risk of an infected person passing on the virus on to others during sex so screening and proper treatment are also important.* |  |
| 5.9B Describe how some plants defend themselves against attack from pests and pathogens by physical barriers, including the leaf cuticle and cell wall.  *Most plant leaves and stems have a waxy cuticle, which provides a barrier to stop pathogens entering them or pests from damaging them. It may also stop water collecting on the leaf, which could reduce the risk of infection by pathogens that are transferred between plants in water.*  *Plant cells themselves are surrounded by cell walls made from cellulose. These form a physical barrier against pathogens that make it past the waxy cuticle.* |  |
| 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.  *Plants can produce chemicals that help prevent damage to the plant. For example, they produce chemicals called antiseptics, which kill bacterial and fungal pathogens. They also produce chemicals to deter pests (e.g. insects) from feeding on their leaves. Some of these chemicals can be used as drugs to treat human diseases or relieve symptoms. E.g. quinine comes from the bark of the cinchona tree. For years it was the main treatment for malaria.* | 5c |

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 5.11B **Describe different ways plant diseases can be detected and identified, in the lab and in the field including the elimination of possible environmental causes, distribution analysis of affected plants, observation of visible symptoms and diagnostic testing to identify pathogens.** | 2d 4c 5c  See p57 of biology revision guide |
| * 1. Describe how the physical barriers and chemical defenses of the human body provide protection from pathogens, including:      1. physical barriers, including mucus, cilia and skin      2. chemical defense, including lysozymes and hydrochloric acid   *a skin acts as a barrier to pathogens and if it gets damaged, blood clots quickly seal cuts and keep microorganisms out. Hairs and mucus in your nose trap particles that could contain pathogens. Cells in your trachea and bronchi have cilia. These are hair-like structures which waft the mucus up to the back of the throat where it can be swallowed.*  *b The stomach produces hydrochloric acid. This kills most pathogens that are swallowed. The eyes produce a chemical called lysozyme ( in tears) which kills bacteria on the surface of the eye.* | 5c |
| * 1. Explain the role of the specific immune system of the human body in defense against disease, including:      1. exposure to pathogen      2. the antigens trigger an immune response which causes the production of antibodies      3. the antigens also trigger production of memory lymphocytes      4. the role of memory lymphocytes in the secondary response to the antigen |  |
| * 1. Explain the body’s response to immunisation using an inactive form of a pathogen.   2. *Immunisation involves injecting dead or inactive pathogens into the body. These are antigenic (carry antigens) so even though they’re harmless, your body makes antibodies to destroy them. The antigens trigger memory lymphocytes to be made. So, if live pathogens of the same type get into the body there will already be memory lymphocytes that can cause a fast secondary immune response. This means that you’re less likely to get the disease.* | 2c, 2g  4a, 4c |
| 5.15B Discuss the advantages and disadvantages of immunisation, including the concept of herd immunity.  Advantages;   * *Prevention of large outbreaks of disease (epidemics).* * *Even people who aren’t immunized are unlikely to catch the disease because there are fewer people to pass it on. – this is known as “herd immunity”.* * *Some diseases have virtually been wiped out by immunization programs*   Disadvantages;   * *Immunization doesn’t always work* * You can sometimes have a bad reaction to a vaccine | 2d, 2g  4a, 4c |
| 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 | 5c |
| 5.17B Explain the aseptic techniques used in culturing microorganisms in the laboratory, including the use of an autoclave to prepare sterile growth medium and petri dishes, the use of sterile inoculating loops to transfer microorganisms and the need to keep petri dishes and culture vials covered  *See your revision guide for more info* |  |
| 5.18B *Core Practical: Investigate the effects of antiseptics, antibiotics or plant extracts on microbial cultures* | 1a 2c, 2f  5c |
| 5.19B Calculate cross-sectional areas of bacterial cultures and clear agar jelly using *r2* | 1a 2c  5c |
| 5.20 Describe that the process of developing new medicines, including antibiotics, has many stages, including discovery, development, preclinical and clinical testing | 5c  See p 62 biology revision guise |

|  |  |
| --- | --- |
| **Students should:** | **Maths skills** |
| 1B Describe the production of monoclonal antibodies, including:  * + 1. **use of lymphocytes which produce desired antibodies but do not divide**     2. **production of hybridoma cells**     3. **hybridoma cells produce antibodies as they divide** |  |
| * 1. 2B **Explain the use of monoclonal antibodies, including: a in pregnancy testing**      1. **in diagnosis including locating the position of blood**   **clots and cancer cells and in treatment of diseases including cancer**   * + 1. **the advantages of using monoclonal antibodies to target specific cells compared to drug and radiotherapy treatments** |  |
| 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. Explain the effect of lifestyle factors on non-communicable diseases at local, national and global levels, including:      1. exercise and diet on obesity and malnutrition, including BMI and waist : hip calculations, using the BMI equation:   weight (kg)  BMI   height (m)2   * + 1. *alcohol on liver diseases*     2. *smoking on cardiovascular diseases*     *a wait-to-hip ratio = waist circumference / hip circumference* | 1a, 1c 2c, 2d, 2g  3b 4a, 4c |
| 5.25 Evaluate some different treatments for cardiovascular disease, including:  a life-long medication b surgical procedures  c lifestyle changes  *a statins , anticoagulants and antihypertensive*  *b balloon angioplasty, stent and heart by-pass*  *c healthy balanced diet, lose weight, reduce smoking, exercise regularly.* | 1c, 1d 2c  4a, 4c |