GCSE (9-1)

Combined

Biology 1

### Topics common to Paper 1 and Paper 2

#### Topic 1 – Key concepts in biology

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| **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*  *See your revision guide for more info* | 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 |

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| **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.* |  |
| 1.15 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* | 1a  2a  see p18 GCSE for more info |
| 1.16 *Core Practical: Investigate osmosis in potatoes*  *See your revision guide for more info* |  |
| 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.* | 1c  2b, 2f 4a, 4c |

### Topics for Paper 1

#### Topic 2 – Cells and control

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| **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.* |  |
| 2.13 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.* |  |
| 2.14 Explain the structure and function of a reflex arc including sensory, relay and motor neurones | 1d 2d |

#### Topic 3 – Genetics

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| **Students should:** | **Maths skills** |
| 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.* |  |

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| **Students should:** | **Maths skills** |
| 3.12 Explain why there are differences in the inherited characteristics as a result of alleles  *See your revision guide for more info* |  |
| * 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.* |  |
| 3.14 Explain monohybrid inheritance using genetic diagrams, Punnett squares and family pedigrees  *See your revision guide for more info* | 1c 2c, 2e  4a |
| 3.15 Describe how the sex of offspring is determined at fertilisation, using genetic diagrams  *See your revision guide for more info* | 1c 2c, 2e  4a |
| 3.16 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 |
| 3.19 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

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| **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* |  |
| * 1. Describe how genetic analysis has led to the suggestion of the three domains rather than the five kingdoms classification method.   *Using DNA 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* |  |
| 4.10 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* |  |

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| **Students should:** | **Maths skills** |
| 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

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| **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 diarrhoea      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 haemorrhagic 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 |  |
| * 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.* |  |

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| **Students should:** | **Maths skills** |
| * 1. Describe how the physical barriers and chemical defences of the human body provide protection from pathogens, including:      1. physical barriers, including mucus, cilia and skin      2. chemical defence, 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 defence 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.   *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 |
| 5.16 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 |
| 5.20 Describe that the process of developing new medicines, including antibiotics, has many stages, including discovery, development, preclinical and clinical testing | 5c  See p 43 biology revision guise |

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| **Students should:** | **Maths skills** |
| 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  *See your revision guide for more info* |  |
| * 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 antihypertensives*  *b balloon angioplasty, stent and heart by-pass*  *c healthy balanced diet, lose weight, reduce smoking, exercise regularly.* | 1c, 1d 2c  4a, 4c |

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