GCSE (9-1)

Combined

Biology 2

### 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 |  |
| 1.2 | Describe how specialised cells are adapted to their function, including:   1. sperm cells – acrosome, haploid nucleus, mitochondria and tail 2. egg cells – nutrients in the cytoplasm, haploid nucleus and changes in the cell membrane after fertilisation 3. ciliated epithelial cells |  |
| 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 |  |
| 1.4 | Demonstrate an understanding of number, size and scale, including the use of estimations and explain when they should be used | 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** | 1b 2a 2h |
| 1.6 | *Core Practical: Investigate biological specimens using microscopes, including magnification calculations and labelled scientific drawings from observations* | 1d  2a, 2h 3b |
| 1.7 | Explain the mechanism of enzyme action including the active site and enzyme specificity |  |
| 1.8 | Explain how enzymes can be denatured due to changes in the shape of the active site |  |
| 1.9 | Explain the effects of temperature, substrate concentration and pH on enzyme activity | 2c, 2f  4a, 4c |

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| **Students should:** | **Maths skills** |
| 1.10 *Core Practical: Investigate the effect of pH on enzyme activity* | 2c, 2f  4a, 4c |
| 1.11 Demonstrate an understanding of rate calculations for enzyme activity | 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 |  |
| 1.13B *Core Practical: Investigate the use of chemical reagents to identify starch, reducing sugars, proteins and fats* |  |
| 1.14B Explain how the energy contained in food can be measured using calorimetry | 1a  2a |
| 1.15 Explain how substances are transported into and out of cells, including by diffusion, osmosis and active transport |  |
| 1.16 *Core Practical: Investigate osmosis in potatoes* | 1c  2b, 2f 4a, 4c |
| 1.17 Calculate percentage gain and loss of mass in osmosis | 1a, 1c  4a, 4c |

### Topics for Paper 2

#### Topic 6 – Plant structures and their functions

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| **Students should:** | **Maths skills** |
| 6.1 Describe photosynthetic organisms as the main producers of food and therefore biomass  *Energy that is stored in the organism’s biomass (food for the next trophic level in a food chain) works its way through the food chain*  kkd  jdj |  |
| 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  *Endothermic reactions take in heat energy from the surroundings.*  *carbon dioxide + water —> glucose + oxygen* |  |
| 6.3 Explain the effect of temperature, light intensity and carbon dioxide concentration as limiting factors on the rate of photosynthesis  *Temperature – as temperature increases so does the rate of photosynthesis as the as the enzymes work more quickly. If the plant gets too hot the enzyme becomes denatures and photosynthesis slows down.*  *Light intensity – as light intensity increases so does the rate of photosynthesis as the light needs to be absorbed by the chlorophyll until another factor becomes limiting.*  *Carbon dioxide – as the concentration as carbon dioxide increases so does the rate of photosynthesis as carbon dioxide is a raw material for the reaction, until another factor becomes limiting.* | 2c, 2d, 2g 4a, 4c |
| 6.4 **Explain the interactions of temperature, light intensity and carbon dioxide concentration in limiting the rate of photosynthesis**  *When the graph levels off, another factor is responsible for the rate of reaction and prevents photosynthesis happening any quicker.* | 4b, 4c, 4d |
| 6.5 *Core Practical: Investigate the effect of light intensity on the rate of photosynthesis* | 2c, 2f, 2g  4a, 4c |
| 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**  *Directly proportional – as temperature and carbon dioxide concentration increase so does photosynthesis (until a certain point).*  *Inversely proportional – as light intensity increase, the rate of photosynthesis decreases (until a certain point).*  *Light intensity = 1 / distance2* | 2g 3a, 3b  4a, 4b, 4c, 4d |
| 6.7 Explain how the structure of the root hair cells is adapted to absorb water and mineral ions  *Millions of tiny hairs – increase surface area to increase the rate of absorption*  *Water is absorbed by osmosis.*  *Mineral ions are absorbed by active transport.* |  |
| * 1. Explain how the structures of the xylem and phloem are adapted to their function in the plant, including:      1. lignified dead cells in xylem transporting water and minerals through the plant      2. living cells in phloem using energy to transport sucrose around the plant   *a xylem – no end walls between the dead cells to allow the flow of water and minerals*  *b phloem – small pores in the end walls to allow the flow of sucrose* |  |
| * 1. Describe how water and mineral ions are transported through the plant by transpiration, including the structure and function of the stomata   *Stomata – pores in the leaf that allow CO2 and O2 to diffuse in and out. Guard cells surround the pore to control flow. When the guard cells are turgid the stomata are open, when the guard cells are flaccid the stomata close.*  *Transpiration is caused by the evaporation and diffusion of water from the plants surface, this causes a slight water shortage so water and dissolved mineral ions are drawn up from the roots.* |  |
| * 1. Describe how sucrose is transported around the plant by translocation   *Translocation requires energy as the sucrose can travel in both directions. This happens between where these substances are made (the****sources****) and where they are used or stored (the****sinks****).* |  |
| 6.11B Explain how the structure of a leaf is adapted for photosynthesis and gas exchange  *cuticle - protects against water loss*  *upper epidermis – transparent to allow light through*  *palisade mesophyll - contains lots of chloroplast for photosynthesis*  *spongy mesophyll – contains air spaces to increase the rate of gas exchange*  *xylem - transports water and minerals to the leaves*  *phloem - transports sucrose around the plant*  *stomata – open and close to control gas exchange* | 2d  5c |
| 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  *Light intensity – the brighter the light, the greater the transpiration rate. Stomata close when it is dark as there is no photosynthesis so no need to let carbon dioxide in so very little water can escape.*  *Air movement – the better the air flow, the greater the transpiration rate. Poor wind flow means water surrounds the leaf and doesn’t move so there is a high concentration of water inside and outside the leaf. This slows the rate of diffusion.*  *Temperature – the warmer it is, the greater the transpiration rate. When it is warm the particles have more energy to evaporate and diffuse out of the leaf.* | 1a, 1c 2b, 2c  4a, 4b, 4c, 4d |
| 6.13 Demonstrate an understanding of rate calculations for transpiration  *Rate = distance moved / time taken* | 1a, 1c 2b, 2c  4a, 4b, 4c, 4d |

#### Topic 7 – Animal coordination, control and homeostasis

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| **Students should:** | **Maths skills** |
| 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  *Pituitary Gland – many hormones*  *Thyroid Gland - thyroxine*  *Adrenal Gland - adrenaline*  *Pancreas - insulin*  *Ovaries - oestrogen*  *Testes - testosterone* |  |
| Explain that adrenalin is produced by the adrenal glands to prepare the body for fight or flight, including:  * + 1. **increased heart rate**     2. **increased blood pressure**     3. **increased blood flow to the muscles**     4. **raised blood sugar levels by stimulating the liver to change glycogen into glucose**   *Adrenaline activates processes that supply oxygen and glucose to cells to prepare for fight or flight.* | 2c 4a, 4c |
| * 1. **Explain how thyroxine controls metabolic rate as an example of negative feedback, including:**      1. **low levels of thyroxine stimulate production of TRH in hypothalamus**      2. **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**  *Negative feedback is a reaction that causes a decrease in function. It occurs in response to some kind of stimulus e.g. thyroxine levels.* | 2c 4a, 4c |
| * 1. Describe the stages of the menstrual cycle, including the roles of the hormones oestrogen and progesterone, in the control of the menstrual cycle   *Oestrogen – stimulates LH to thicken lining wall*  *Progesterone – inhibits FSH and LH to maintain the lining wall* | 4a |
| * 1. **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**   *FSH*  *The hormone FSH is secreted by the pituitary gland. FSH makes two things happen:*  *it causes an egg to mature in an ovary*  *it stimulates the ovaries to release the hormone oestrogen*  *Oestrogen*  *The hormone oestrogen is secreted by the ovaries. Oestrogen makes two things happen:*  *it stops FSH being produced - so that only one egg matures in a cycle*  *it stimulates the pituitary gland to release the hormone LH*  *LH*  *The hormone LH causes the mature egg to be released from the ovary.* | 4a, 4c |
| * 1. Explain how hormonal contraception influences the menstrual cycle and prevents pregnancy   *Oestrogen – prevents egg release*  *Progesterone – stimulates cervical mucus to prevent sperm* |  |
| * 1. Evaluate hormonal and barrier methods of contraception   Hormonal (pill, injection) –  + more effective, don’t have to stop and thick each time   * Side effects, no protection from STIs   Barrier (condom, diaphragm) | 2c, 2d  4a |
| * 1. **Explain the use of hormones in Assisted Reproductive Technology (ART) including IVF and clomifene therapy**   *IVF – FSH and LH are given before egg collection to stimulate egg production*  *Clomifene – causes more FSH and LH stimulate egg maturation and ovulation* |  |
| * 1. Explain the importance of maintaining a constant internal environment in response to internal and external change   *Cells need the right conditions in order to function properly, including the right conditions for enzyme action.* |  |

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| 7.13 Explain how the hormone insulin controls blood glucose concentration  *High levels of glucose causes the release of insulin, glucose is moved from the blood into liver and muscle cells.* |  |
| * 1. **Explain how blood glucose concentration is regulated by glucagon**   *Low levels of insulin causes the release of glucagon which is broken down into glucose in the liver and released into the blood.* |  |
| * 1. Explain the cause of type 1 diabetes and how it is controlled   *The pancreas produces little or no insulin, it is controlled by injecting insulin (insulin therapy)* |  |
| * 1. Explain the cause of type 2 diabetes and how it is controlled   *The pancreas doesn’t produce enough insulin or the person becomes resistant to the effects. It is controlled by eating a healthy diet, exercise, losing weight medication or injecting insulin.* |  |
| 7.17 Evaluate the correlation between body mass and type 2 diabetes including waist:hip calculations and BMI, using the BMI equation:  weight (kg)  BMI   height (m)2 | 1a, 1c, 2c 2e, 3a |

#### Topic 8 – Exchange and transport in animals

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| **Students should:** | | **Maths skills** |
| 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  *Oxygen – needed for respiration*  *Carbon dioxide – removed as a waste product*  *Water – dissolve food/minerals*  *Urea – removed as a waste product* |  |
| 8.2 | Explain the need for exchange surfaces and a transport system in multicellular organisms including the calculation of surface area : volume ratio  *Total area/total volume to get n:1 ratio* | 1a, 1c 5c |
| 8.3 | Explain how alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries  *Small SA:V ratio as it would be difficult to supply the entire volume*  *Millions of alveoli to increase surface area, a good supply of blood and moist, thin walls increase efficiency* |  |
| 8.6 | Explain how the structure of the blood is related to its function:   1. red blood cells (erythrocytes) 2. white blood cells (phagocytes and lymphocytes) c plasma   d platelets  *red blood cells (erythrocytes) – large surface area, biconcave shape, no nucleus to carry maximum oxygen*  *white blood cells (phagocytes and lymphocytes) – engulf bacteria/ release antibodies to fight infection*  *plasma – fluid that carries blood cells and other substances*  *platelets - no nucleus to help clotting* | 1b 2h |
| 8.7 | Explain how the structure of the blood vessels is related to their function  *Arteries carry oxygenated blood away from the hearth under high pressure – strong, elastic, thick walls*  *Veins carry deoxygenated blood towards the heart under low pressure – contain valves, large lumen*  *Capillaries allow exchange of substances – one cell thick, permeable (allow substance in and out), very narrow* | 1a |
| 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  *Right atrium – receives deoxygenated blood from the body*  *Left atrium – receives oxygenated blood from the lungs*  *Right ventricle – pumps deoxygenated blood to the lungs*  *Left ventricle – pumps oxygenated blood around the body so* ***has very thick walls***  *Vena cava – carries deoxygenated blood*  *Pulmonary artery – carries blood towards the lungs*  *Pulmonary vein – carries blood away from the lungs*  *Aorta – pumps blood around the whole 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  *Exothermic – releases energy as heat*  *Aerobic respiration*  *Glucose + oxygen -> carbon dioxide + water*  *Anaerobic respiration*  *Glucose -> lactic acid* |  |
| 8.10 | Compare the process of aerobic respiration with the process of anaerobic respiration  *Aerobic – requires oxygen, produces carbon dioxide and water*  *Anaerobic – doesn’t require oxygen, produces lactic acid or ethanol and carbon dioxide, less efficient* |  |
| 8.11 | *Core Practical: Investigate the rate of respiration in living organisms* | 1a 2a, 2c, 2f  4a, 4c |
| 8.12 | Calculate heart rate, stroke volume and cardiac output, using | 1a |
|  | the equation cardiac output = stroke volume × heart rate | 2a, 2c |
| 3a, 3b |
| 4a, 4c |

#### Topic 9 – Ecosystems and material cycles

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| **Students should:** | | **Maths skills** |
| 9.1 | Describe the different levels of organisation from individual organisms, populations, communities, to the whole ecosystem  *Individual – single organism*  *Population – all organism of the same species in a habitat*  *Community – all the different species in a habitat*  *Ecosystem – all the organisms and abiotic factors* |  |
| 9.2 | Explain how communities can be affected by abiotic and biotic factors, including:   1. temperature, light, water, pollutants 2. competition, predation   *abiotic – non-living biotic - living*  *a migration, shade, water logging/drought, sulfur dioxide*  *b competition for light, food, space, mates and water. Reducing predators increases number of prey* | 4a, 4c |
| 9.3 | Describe the importance of interdependence in a community  *A change in one species can affect other in the community* |  |
| 9.4 | Describe how the survival of some organisms is dependent on other species, including parasitism and mutualism  *Parasitism – organisms takes what it needs but the host doesn’t benefit*  *Mutualism – both organism benefit* |  |
| 9.5 | *Core Practical: Investigate the relationship between organisms and their environment using field-work techniques, including quadrats and belt transects* | 1c, 1d,  2b, 2c, 2d, 2f, 2g,  4a, 4c |
| 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. *mark out the line* 2. *place quadrats at regular intervals* 3. *find the mean number or organisms per quadrat* 4. *1/size of quadrat x mean number per quadrat* 5. *mean number per m2 x total area* | 1c, 1d 2b, 2c, 2d, 2g  4a, 4c |
| 9.9 | Explain the positive and negative human interactions within ecosystems and their impacts on biodiversity, including:   1. fish farming 2. introduction of non-indigenous species c eutrophication   *fish farming*  *negative - waste leaks into open water, parasites, predators trapped in the nets, invasive species introduces*  *introduction of non-indigenous (not naturally found) species*  *negative – completion, decreased biodiversity, new diseases*  *eutrophication (nitrates)*  *negatives – death of organisms due to increase algae growth causing sunlight to be blocked out for other organisms, reduced photosynthesis, reduced oxygen levels* | 2c, 2g 4a, 4c |
| 9.10 | Explain the benefits of maintaining local and global biodiversity, including the conservation of animal species and the impact of reforestation  *Protects human food supply*  *Ensures minimal damage to food chains*  *Provides future medicines*  *Cultural aspects – species may be important to a countries heritage*  *Ecotourism*  *Provides new jobs* |  |

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| **Students should:** | **Maths skills** |
| * 1. Describe how different materials cycle through the abiotic and biotic components of an ecosystem   *Carbon, oxygen and nitrogen are found in complex compounds that are eaten by organisms. When the organism dies, the materials are returned to the soil/air.* |  |
| * 1. Explain the importance of the carbon cycle, including the processes involved and the role of microorganisms as decomposers   *See page 71 (H/F) Carbon, oxygen and nitrogen are found in complex compounds that are eaten by organisms. When the organism dies, the materials are returned to the soil/air.* |  |
| * 1. Explain the importance of the water cycle, including the processes involved and the production of potable water in areas of drought including desalination   *See page 72 (H/F)*  *Desalination – the removal of salt*  *A 1. Boil the water 2. Condense the steam leaving the salt at the bottom*  B Reverse osmosis – salt moves from high conc to low conc across a partially permeable membrane  B |  |
| * 1. 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   *See page 73 (H/F)*  *Fertilisers – recycles nutrients through decomposition of materials*  *Crop rotation – different crops are planted in the field each year including a nitrogen fixing crop*  *Bacteria – nitrogen fixing (nitrogen from air into nitrogen-containing ions), decomposers (decompose urea into ammonia), nitrifying (turn ammonia unto nitrites then nitrates), denitrifying (turn nitrates back into nitrogen gas)* |  |