# Programme of study for Year 13 A Level Biology

| Autumn (1st term) | Autumn (2nd term) | Spring (1st term) | Spring (2nd Term) | Summer (1st term) | Summer (2nd term) |
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| Topic / Big Question:<br>**Teacher 1:**<br>**3.5 Energy transfer in and between organisms**<br>**Teacher 2:**<br>**3.6 Organisms respond to changes in their internal and external environments**<br>Skills (students should be able to do):<br>AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures<br>• AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:<br>• in a theoretical context<br>• in a practical context<br>• when handling qualitative data<br>• when handling quantitative data | Topic / Big Question:<br>**Teacher 1:**<br>**3.5 Energy transfer in and between organisms**<br>**Teacher 2:**<br>**3.6 Organisms respond to changes in their internal and external environments**<br>Skills (students should be able to do):<br>AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures<br>• AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:<br>• in a theoretical context<br>• in a practical context<br>• when handling qualitative data<br>• when handling quantitative data | Topic / Big Question:<br>**Teacher 1:**<br>**3.7 Genetics, populations, evolution and ecosystems**<br>**Teacher 2:**<br>**3.6 Organisms respond to changes in their internal and external environments**<br>Skills (students should be able to do):<br>AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures<br>• AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:<br>• in a theoretical context<br>• in a practical context<br>• when handling qualitative data<br>• when handling quantitative data<br>• AO3: Analyse, interpret and evaluate | Topic / Big Question:<br>**Teacher 1:**<br>**3.7 Genetics, populations, evolution and ecosystems**<br>**Teacher 2:**<br>**3.8 The Control of Gene expression**<br>Skills (students should be able to do):<br>AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures<br>• AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:<br>• in a theoretical context<br>• in a practical context<br>• when handling qualitative data<br>• when handling quantitative data | Topic / Big Question:<br>**Teacher 1:**<br>**3.7 Genetics, populations, evolution and ecosystems**<br>**Teacher 2:**<br>**3.8 The Control of Gene expression**<br>Skills (students should be able to do):<br>AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures<br>• AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:<br>• in a theoretical context<br>• in a practical context<br>• when handling qualitative data<br>• when handling quantitative data<br>• AO3: Analyse, interpret and evaluate | Revision and Public Exams |

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| • AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:<br>• make judgements and reach conclusions<br>• develop and refine practical design and procedures. | • AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:<br>• make judgements and reach conclusions<br>• develop and refine practical design and procedures. | scientific information, ideas and evidence, including in relation to issues, to:<br>• make judgements and reach conclusions<br>• develop and refine practical design and procedures. | • AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:<br>• make judgements and reach conclusions<br>• develop and refine practical design and procedures. | scientific information, ideas and evidence, including in relation to issues, to:<br>• make judgements and reach conclusions<br>• develop and refine practical design and procedures. | |
| Key Learning Outcomes (students should know):<br>**Teacher 1:**<br>**3.5.1 Photosynthesis**<br>The light-dependent reaction<br>The light-independent reaction<br>Identify environmental factors that limit the rate of photosynthesis evaluate data relating to common agricultural practices used to overcome the effect of these limiting factors<br>Required practical 7: Use of chromatography to investigate the pigments isolated from leaves of different plants, e.g., leaves from shade-tolerant and shade-intolerant plants | Key Learning Outcomes (students should know):<br>**Teacher 1:**<br>**3.5.2 Respiration**<br>Respiration produces ATP.<br>Stages of Glycolysis.<br>Aerobic respiration; Krebs cycle, chemiosomotic theory, other respiratory substrates include the breakdown products of lipids and amino acids, which enter the Krebs cycle<br>Required practical 9: Investigation into the effect of a named variable on the rate of respiration of cultures of single-celled organisms<br>**3.5.3 Energy and ecosystems**<br>How to measure biomass and its chemical energy store | Key Learning Outcomes (students should know):<br>**Teacher 1:**<br>**3.7.1 Inheritance**<br>The genotype<br>The phenotype<br><br>Alleles may be dominant, recessive or codominant.<br>In a diploid organism, the alleles at a specific locus may be either homozygous or heterozygous.<br>The use of fully labelled genetic diagrams to interpret, or predict, the results of:<br>-monohybrid and dihybrid crosses involving dominant, recessive and codominant alleles<br>- crosses involving sex-linkage, autosomal | Key Learning Outcomes (students should know):<br>**Teacher 1:**<br>**3.7.2 Populations**<br>Meaning of population.<br>The concepts of gene pool and allele frequency.<br>The Hardy–Weinberg principle provides a mathematical model, which predicts that allele frequencies will not change from generation to generation. The conditions under which the principle applies.<br>The frequency of alleles, genotypes and phenotypes in a population can be calculated using the Hardy–Weinberg equation<br>**3.7.3 Evolution may lead to speciation** | Key Learning Outcomes (students should know):<br>**Teacher 1:**<br>**3.7.4 Populations in ecosystems**<br>How the size of a population can be estimated using:<br>- randomly placed quadrats, or quadrats along a belt transect, for slow-moving or non-motile organisms<br>- the mark-release-recapture method for motile organisms. The assumptions made when using the mark-release-recapture method<br>Ecosystems are dynamic systems.<br>Primary succession, from colonisation by pioneer species to climax community. | |

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| or leaves of different colours.<br>Required practical 8: Investigation into the effect of a named factor on the rate of dehydrogenase activity in extracts of chloroplasts.<br>**Teacher 2:**<br>**3.6 Organisms respond to changes in their internal and external environments**<br>Know the meanings of stimulus, receptor, stimulus, coordinator and effector.<br>Nerve cell and electrical impulses<br>Mammalian hormones<br>Specificity and mode of action.<br>Plants control their response using hormone-like growth substances.<br>**3.6.1 Stimuli, both internal and external, are detected and lead to a response**<br>**3.6.1.1 Survival and response**<br>The effect of different concentrations of indole acetic acid (IAA) on cell elongation. | Gross primary production<br>Net primary production<br>Calculations of the net production of consumers<br>Primary and secondary productivity is the rate of primary or secondary production, respectively.<br>Appreciate the ways in which production is affected by farming practices designed to increase the efficiency of energy transfer.<br>**3.5.4 Nutrient Cycles** exemplified by the nitrogen cycle and the phosphorus cycle.<br>Microorganisms role.<br>The role of saprobionts in decomposition.<br>The role of mycorrhizae.<br>The role of bacteria in the nitrogen cycle<br>The use of natural and artificial fertilisers and environmental issues arising: leaching and eutrophication.<br>**Teacher 2:**<br><br>**3.6.4 Homeostasis is the maintenance of a stable internal environment** | linkage, multiple alleles and epistasis Use of the chi-squared test to compare the goodness of fit of observed phenotypic ratios with expected ratios<br><br>**Teacher 2:**<br>**3.8 The Control of Gene expression**<br>**3.8.1 Alteration of the sequence of bases in DNA can alter the structure of proteins**<br>The different types of Gene mutations that might arise during DNA replication. How and why they occur and the impact on the encoded polypeptide.<br>**3.8 The Control of Gene expression**<br>**3.8.2 Gene expression is controlled by a number of features**<br>**3.8.2.1 Most of a cell's DNA is not translated**<br>Properties of Totipotent cells and how<br>cell specialisation occurs. Properties of pluripotent cells, | The process of Evolution through Natural selection<br>The effects of stabilising, directional and disruptive selection.<br>Evolution as a change in the allele frequencies in a population.<br>Reproductive separation of two populations<br>New species arise through speciation.<br>Allopatric and sympatric speciation.<br>The importance of genetic drift in causing changes in allele frequency in small populations.<br>**3.7.4 Populations in ecosystems**<br>Meaning of community and ecosystem. Within a habitat, a species occupies a niche governed by adaptation to both abiotic and biotic conditions.<br>An ecosystem supports a certain size of population of a species, called the carrying capacity. Factors affecting carrying capacity.<br><br>**Teacher 2:**<br>**3.8.2.3 Gene expression and cancer** | Conservation of habitats frequently involves management of succession.<br>Required practical 12: Investigation into the effect of a named environmental factor on the distribution of a given species<br><br>Revision and Intervention<br><br>**Teacher 2:**<br><br>**3.8.4.2 Differences in DNA** between individuals of the same species can be exploited for identification and diagnosis of heritable conditions, drug responses or health risks.<br>Genetic counselling and personalised medicine.<br>**3.8.4.3 Genetic fingerprinting** in the fields of forensic science, medical diagnosis, animal and plant breeding.<br><br>Revision and Intervention | |

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| Gravitropism and phototropism<br>Taxes and kineses<br>The protective effect of a simple reflex, exemplified by a three-neurone simple reflex.<br>Required practical 10: Investigation into the effect of an environmental variable on the movement of an animal using either a choice chamber or a maze.<br>**3.6.1. Receptors**<br>Structure and function of Pacinian corpuscle; generator potential.<br>The human retina; differences in sensitivity to light, sensitivity to colour and visual acuity<br>**3.6.1. Control of heart rate**<br>Myogenic stimulation of the heart and transmission of a subsequent wave of electrical activity. The roles of the sinoatrial node (SAN), atrioventricular node (AVN) and Purkyne tissue in the bundle of His.<br>The roles and locations of chemoreceptors and pressure receptors and the roles of the autonomic | **Homeostasis in mammals involves physiological control systems that maintain the internal environment within restricted limits.**<br><br>**3.6.4.1 Principles of homeostasis and negative feedback**<br>The importance of maintaining a stable core temperature, stable blood pH, stable blood glucose concentration<br>Negative feedback restores systems to their original level.<br><br>**3.6.4.2 Control of blood glucose concentration**<br>The role of the liver in glycogenesis, glycogenolysis and gluconeogenesis.<br>The action of insulin<br>The action of glucagon<br>The role of adrenaline<br>The second messenger model of adrenaline and glucagon action, involving adenylate cyclase, cyclic AMP (cAMP) and protein kinase.<br>The causes of types I and II diabetes and their control by insulin and/or manipulation of the diet.<br>Required practical 11: Production of a dilution | multipotent and unipotent cells<br>Use of pluripotent cells in treating human disorders.<br>**3.8.2.2 Regulation of transcription and translation**<br><br>Epigenetic control of gene expression in eukaryotes.<br><br>Epigenetics involves heritable changes in gene function, without changes to the base sequence of DNA.<br><br>Epigenetics and the development and treatment of disease, especially cancer.<br><br>Translation of the mRNA produced from target genes can be inhibited by RNA interference (RNAi). | The main characteristics of benign and malignant tumours.<br>Factors effecting the development of tumours<br>3.8.3 Using genome projects<br>Determining the genome and the proteome of the organism and the applications.<br>**3.8.4 Gene technologies**<br>**3.8.4.1 Recombinant DNA technology**<br>Production and amplification of DNA fragments (PCR)<br>The use of marker genes to detect genetically modified (GM) cells or organisms. | | |

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| nervous system and effectors in controlling heart rate.<br>**3.6.2 Nervous coordination**<br>**3.6.2.1 Nerve impulses**<br>The structure of a myelinated motor neurone.<br>The establishment of a resting potential and the generation of an action potential.<br>The passage of an action potential along non-myelinated and myelinated axons<br>The nature and importance of the refractory period.<br>Factors affecting the speed of conductance: myelination and saltatory conduction; axon diameter; temperature.<br>**3.6.2.2 Synaptic transmission**<br>The detailed structure of a synapse and of a neuromuscular junction.<br>The sequence of events involved in transmission across a cholinergic<br>**3.6.3 Skeletal muscles are stimulated to contract by nerves and act as effectors**<br>Muscles act in antagonistic pairs | series of a glucose solution and use of colorimetric techniques to produce a calibration curve with which to identify the concentration of glucose in an unknown 'urine' sample<br>**3.6.4.3 Control of blood** water potential<br>Osmoregulation. The roles of the hypothalamus, posterior pituitary and antidiuretic hormone (ADH) in osmoregulation.<br>The structure of the nephron and its role | | | | |

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| Gross and microscopic structure of skeletal muscle. The ultrastructure of a myofibril.<br>The roles of actin, myosin, calcium ions and ATP in myofibril contraction.<br>The roles of calcium ions and tropomyosin in the cycle of actinomyosin bridge formation.<br>The roles of ATP and phosphocreatine in muscle contraction.<br>The structure, location and general properties of slow and fast skeletal muscle fibres. | | | | | |
| Autumn Term – centrally planned, standardised and teacher marked piece(s) of work<br>3.4 Genetic information and Variation Linear test<br>3.6 Chapter 14 linear test<br>3.5 Energy transfer in and between organisms linear test<br>Assessed Essay on importance of ions | | Spring Term – centrally planned, standardised and teacher marked piece(s) of work<br>Mock exams covering:<br>3.5 Energy transfer in and between organisms<br>3.6 Organisms respond to changes in their internal and external environments, 3.7 Genetics, populations, evolution and ecosystems, 3.8 The Control of Gene expression.<br>3.7 Linear exam on Inheritance, variation, evolution<br>3.8 Linear exam on Gene expression | | Public Exams | |
| **Building understanding: Rationale / breakdown for your sequence of lessons:**<br>**Teacher 1:**<br>3.5 Energy transfers in and between organisms<br>- Life depends on continuous transfers of energy.<br>- In photosynthesis, light is absorbed by chlorophyll and this is linked to the production of ATP which was studied in year 12. | | **Building understanding: Rationale / breakdown for your sequence of lessons:**<br>**Teacher 1:**<br>3.7 Genetics, populations, evolution and ecosystems<br>- The theory of evolution underpins modern Biology. All new species arise from an existing species. This results in different species sharing a common ancestry, as represented in phylogenetic classification. Common | | | |

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| - In respiration, various substances are used as respiratory substrates, these were covered in Biological molecules. The hydrolysis of these respiratory substrates is linked to the production of ATP, hydrolysis was also covered in year 12.<br>- In both respiration and photosynthesis, ATP production occurs when protons diffuse down an electrochemical gradient through molecules of the enzyme ATP synthase, embedded in the membranes of cellular organelles. This links back to inorganic ions in biological molecules.<br>- The process of photosynthesis is common in all photoautotrophic organisms and the process of respiration is common in all organisms, providing indirect evidence for evolution which is studied in the summer term.<br>- In communities, the biological molecules (studied in year 12) produced by photosynthesis are consumed by other organisms, including animals, bacteria and fungi. Some of these are used as respiratory substrates by these consumers.<br>**Teacher 2:**<br>3.6 Organisms respond to changes in their internal and external environments<br>-Nerve cells were covered in specialised cells in year 12. They pass electrical impulses along their length. A nerve impulse is specific to a target cell only because it releases a chemical messenger directly onto it, producing a response that is usually rapid, short-lived and localised.<br>- In contrast, mammalian hormones stimulate their target cells via the blood system. They are specific to the tertiary structure of receptors (covered in Biological molecules year 12) on their target cells (covered in cell signalling year 12) and produce responses that are usually slow, long-lasting and widespread. | ancestry can explain the similarities between all living organisms, such as common chemistry (e.g. all proteins made from the same 20 or so amino acids which links back to biological molecules and genetic variation form year 12), physiological pathways (e.g. anaerobic respiration), cell structure (as studied in year 12), DNA as the genetic material and a 'universal' genetic code (as studied in genetic variation Year 12).<br>- A species exists as one or more populations. There is variation in the phenotypes of organisms in a population, due to genetic and environmental factors (this links back to concepts from Genetic variation topic from year 12). Two forces affect genetic variation in populations: genetic drift and natural selection. Genetic drift can cause changes in allele frequency in small populations. Natural selection occurs when alleles that enhance the fitness of the individuals that carry them rise in frequency. A change in the allele frequency of a population is evolution (this also links back to Antibiotic resistance in bacteria from the year 12 variation topic.<br>- Populations of different species live in communities. Competition occurs within and between these populations for the means of survival. Within a single community, one population is affected by other populations, the biotic factors, in its environment (This topic links back to concepts in Biodiversity taught in year 12). Populations within communities are also affected by, and in turn affect, the abiotic (physicochemical) factors in an ecosystem.<br>**Teacher 2:**<br>3.8 The Control of Gene expression<br>- Cells are able to control their metabolic activities by regulating the transcription and translation of their genome (this links back to specialised cells taught in year 12). Although the cells within an organism carry the same coded genetic information, they translate only part of it. In multicellular organisms, this control of translation enables cells to have specialised functions, forming tissues and organs (year 12 topic provides the foundation concepts for this). | |

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| | -Consideration of cellular control mechanisms underpin the content of this section. Students who have studied it should develop an understanding of the ways in which organisms and cells control their activities. This should lead to an appreciation of common ailments resulting from a breakdown of these control mechanisms and the use of DNA technology in the diagnosis and treatment of human diseases (This links to the hereditary conditions taught in the Genetics topic taught by teacher 1. | |
| Home – Learning:<br>Flip learning; students complete notes from their textbook for homework and answer the questions on each double page spread. Students will have standardised topic workbooks for each topic to complete as part of their home learning. Students will also be asked to complete various essays as part of their home learning. They will redraft and improve upon their essays from their end of year 12 exams. | Home – Learning:<br>Flip learning; students complete notes from their textbook for homework and answer the questions on each double page spread. Students will have standardised topic workbooks for each topic to complete as part of their home learning. Students will also be asked to complete various essays as part of their home learning for example 'the importance of ATP'. | Home – Learning:<br>Flip learning; students complete notes from their textbook for homework and answer the questions on each double page spread. Students will have standardised topic workbooks for each topic to complete as part of their home learning. Students will also be asked to complete various essays as part of their home learning for example 'the importance of membranes'. |
| Reading / High Quality Text:<br>Literacy support is provided through scaffolding for the essay questions; using PEEL approach (Point, Explanation, Example, Link back to question) in order to support students in the development of their extended writing skills. Students are also taught to read for purpose by underlining key command words in exam questions. Students are regularly set pre-learning which involves outside reading and note taking, thereby supporting their reading and comprehension skill development.<br>Suggested outside reading:<br>Magazines:<br>Biological Sciences Review magazine (Available in 6th form library)<br>Nature<br>New Scientist<br>BBC Science Focus<br>Scientific America<br><br>Organisations & Websites<br>Natural History Museum : www.nhm.ac.uk<br>Science Museum : www.sciencemuseum.org.uk<br>The Royal Society : royalsociety.org<br>Royal Society of Biologists : rsb.org.uk | | |

www.arkive.org
www.ted.com
https://ed.ted.com/lessons?category=science-technology
www.thenakedscientists.com
www.nuffieldfoundation.org/practical-biology
www.youtube.com/user/Kurzgesagt
www.youtube.com/user/thehealthcaretriage
www.youtube.com/user/Kurzgesagt

- Nature and New Scientist magazines (articles are often posted on social media).
- The Chemistry of Life - Steven Jones.
- Language of the Genes and Almost Like a Whale - Steven Jones.
- Genome - Matt Ridley.
- The Wisdom of the Genes - Christopher Wills.
- Darwin's Dangerous Idea - Daniel Dennett.
- The Selfish Gene and The Extended Phenotype - Richard Dawkins.
- Virolution - Frank Ryan.
- Life Ascending - Nick Lane.
- The Revenge of Gaia - James Lovelock.
- 50 Genetic Ideas You Really Need to Know - Mark Henderson.
- Zoobiquity - Barbara Natterson-Horowitz and Kathryn Bowers.
- Creation: The Origin of Life - Adam Rutherford.
- Maths Skills for A level Biology.

Numeracy:
Standard Form –to read standard form and convert into and from standard form. Also understanding the actual size of particular organelles. For instance, a mitochondrion would be measured in micrometres where as a virus would be measured in nanometres.
Powers and indices – Understanding and manipulating powers.
Shapes – to calculate the area, perimeter and volume of shapes such as cones and spheres.
Units – As well as micrometres and nanometres; how to convert from one unit to another so grams to kilograms for instance.
Statistical Tests – to interpret the results of a statistical test when given the formulas and the variables. Understanding the significance of a test result and why that test was selected.
Graphs and Data – Different types of graphs and data questions. How to read and construct a histogram as well as interpret bar charts, line graphs, scatter graphs.
Algebra in A Level Biology – Understanding and using the Hardy-Weinberg principle calculations which requires algebra skills. Other types of algebra questions will be limited to basic rearrangements and substitutions.

Enrichment / opportunities to develop cultural capital (including careers, WRL and SMSC):

Enrichment workshops, lectures and visits will be organised as part of the science week programme. Subscription to Biological Sciences Review magazine, which students are referred to for outside reading.