Subject Curriculum Overview - Biology A-Level

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
Year 12	Cell Structure, Mitosis and Biological Molecules	Biological Molecules continued Transport Across Membranes	Immune System Exchange with the Environment	DNA and Protein Synthesis	Genetic Diversity can arise from mutation and meiosis Genetic diversity and adaptation	Maths skills and maths assessment Practical skills Exam practice Homeostasis
Intent	Students study the ultrastructure of cells, with a focus on the structure and function of a range of organelles in both eukaryotic and prokaryotic organisms. They build on knowledge gained at KS4 and extend their understanding of how the organelles in cells work together to carry out a range of complex functions. Students will compare the main differences between prokaryotic and eukaryotic cells and link this to the endosymbiotic theory. Having studied the structure of cells, students link the functions of organelles such as the rough endoplasmic reticulum to the function of specialised cells. They gain an appreciation of how cells are specialised to carry out a range of specific functions with reference to the	Students will build on their knowledge of transport across membranes learnt at GCSE, through building a more complex understanding of how specific molecules are transported across membranes. Students will specifically study the different modes of transport including facilitated diffusion and its use of both carrier and channel proteins, co, and active transport and osmosis. They begin this section with a detailed study of the structure of the cell surface membrane, in terms of the fluid mosaic model, gaining an appreciation of the fluid nature of the cell surface membrane. Students study the effect of named variables on the permeability of membranes, such as the effect of alcohol or temperature on the leakage of	Students continue to develop their understanding of cellular processes, through the immune system topic. They look at what triggers an immune response, and then develop their understanding of both the humoral and cellular immune responses. Specifically: The role of helper T cells (TH cells) in stimulating cytotoxic T cells (TC cells), B cells and phagocytes. The role of other T cells is not required. The response of B lymphocytes to a foreign antigen, clonal selection and the release of monoclonal	Students look at the structure of chromosomes, and compare and contrast the structure of DNA and eukaryotic and prokaryotic cells in terms of association with histones, size and nature of the DNA molecule. The concept of the genome as the complete set of genes in a cell and of the proteome as the full range of proteins that a cell is able to produce is introduced. Students racell and build upon prior learning on protein synthesis. To develop a deeper understanding of these processes, students begin with the structure of molecules of messenger RNA (mRNA) and of transfer RNA (tRNA) so	Students will be taught the in-depth stages of meiosis and how it increases variation through independent segregation, crossing over and random fertilisation. This leads onto the concept of genetic diversity and how the stability of an ecosystem is affected by the diverse nature of the organism that lives there. Students will build on prior learning on evolution by looking at directional and stabilising selection, with examples of each. Students complete this topic with speciation, classification and phylogenetic trees. Students will explain observable phenomena such as evolution during this topic, with an exploration of the evidence	Students review and practice their maths skills including data interpretation in a range of contexts and styles, application of the principles of working scientifically, and carry out and practice statistical tests in this final half term. This is because these have been identified as areas of weaknesses in previous years. Any PAG catch ups can take place in this half term. Students continue to develop exam skills through the extended use of exam questions and papers to prepare them for the end of year mock. After the timetable roll over, students will learn about various homeostatic mechanisms, including the principles of homeostatic

	organelles and structure of the cell. Students move onto studying the ways in which we study cells, through the use of both electron and light microscopes. Students develop their skills in microscopy, through the use of a stage micrometer to calibrate and measure the size of cells. Students also learn about how the functions of specific organelles are derived through the use of centrifugation, and use a bench centrifuge to understand the technique further. Students will move onto look at the stages of mitosis, calculate the mitotic index, and explain what happens during binary fission.	pigment from beetroot tissue. Students' practical skills develop through the use of new instrumentation such as a colorimeter, which they use to produce a calibration curve. Having become familiar with the mode of transport, students will interpret and analyse graphical data to suggest which mode of transport is being used, justifying their choices. Through practicals, students will investigate the effect of a named variable on osmosis.	antibodies (the humoral response). • Definition of antibody. • Antibody structure. • The formation of an antigen-antibody complex, leading to the destruction of the antigen, limited to agglutination and phagocytosis of bacterial cells. • The roles of plasma cells and of memory cells in producing primary and secondary immune responses. Students apply their knowledge of the immune system when they study the effect of HIV, the effect of and effectiveness of vaccines, including herd immunity, passive and active and factors that affect the success of vaccination programmes, and the uses of monoclonal antibodies, including any associated ethical issues. Students develop practical skills when working with microorganisms and aseptic techniques.	that they can relate these to the roles that they carry out. Students must be able to describe the process of transcription including the role of helicase, RNA polymerase and m RNA. Distinguish between transcription in eukaryotic cells and prokaryotic cells. • In prokaryotes, transcription results directly in the production of mRNA from DNA. • In eukaryotes, transcription results in the production of pre-mRNA; this is then spliced to form mRNA. Once transcription has been completed, students learn that translation as the production of polypeptides from the sequence of codons carried by mRNA. The roles of ribosomes, tRNA and ATP. Students should be able to: • relate the base sequence of nucleic acids to the amino acid sequence of polypeptides, when provided with suitable data about the genetic code • interpret data from experimental work investigating the role of nucleic acids	collected to support scientific claims. Students move onto classification and taxonomy, and biodiversity to include the following: Courtship behaviour as a necessary precursor to successful mating. The role of courtship in species recognition. A phylogenetic classification system attempts to arrange species into groups based on their evolutionary origins and relationships. It uses a hierarchy in which smaller groups are placed within larger groups, with no overlap between groups. Each group is called a taxon (plural taxa) Species richness is a measure of the number of different species in a community. An index of diversity describes the relationship between the number of species in a community and the number of individuals in each species. Calculation of an index of diversity (d) from the formula d = N N − 1 n n − 1 where N = total number of organisms of all species and n = total number of organisms of each species. Farming techniques reduce biodiversity. The balance	regulation, how glucose levels are regulated, and the role of hormones such as adrenaline, glucagon and insulin in maintaining internal conditions. Students distinguish between hormones that require secondary messengers in terms of the second messenger model of adrenaline and glucagon action, involving adenylate cyclase, cyclic AMP (cAMP) and protein kinase: Students also study the regulation of water and salts by the kidney. This includes: Osmoregulation as control of the water potential of the blood. The roles of the hypothalamus, posterior pituitary and antidiuretic hormone (ADH) in osmoregulation. The structure of the nephron and its role in: • the formation of glomerular filtrate • reabsorption of glucose and water by the proximal convoluted tubule • maintaining a gradient of sodium ions in the medulla by the loop of Henle • reabsorption of water by the distal convoluted tubule and collecting ducts. This topic links to GCSE content on glucose regulation and is therefore a

					between conservation and farming. Genetic diversity within, or between species, can be made by comparing: • the frequency of measurable or observable characteristics • the base sequence of DNA • the base sequence of mRNA • the amino acid sequence of the proteins encoded by DNA and mRNA. Students conclude by using a sampling technique to investigate the effect of a named variable on a species.	suitable first A Level topic to begin with. Students recall the causes and consequences of type 1 and 2 diabetes and complete a PAG to determine the glucose concentration in an unknown sample.
Rationale	The structure and function of cells forms the basis of understanding almost all other concepts related to living things. This topic is therefore placed at the start of the year, so that subsequent knowledge builds upon it. For similar reasons, biological molecules underpin the basis of many cellular processes, hence this is the first topic to be covered here.	Once students have studied the structure of cells, they are ready to extend their knowledge of the various transport systems across cell membranes and a detailed study of the structure of cell surface membranes. This topic has clear links with future topics such as cell recognition and the immune system, hence it is placed near the beginning of the course.	The immune system directly links to cellular structure as pupils interpret how cells of the immune system recognise foreign cells and through receptor proteins and distinguish between phagocytic and cellular responses involving T and B cells.	The structure of DNA is learnt during the biological molecules topic, linking directly to transcription and protein synthesis. Pupils need to be familiar with the DNA in order to appreciate how DNA helicase and RNA polymerase are involved in the production of an m RNA strand. This topic also links to the primary structure of proteins learnt during biological molecules in term one.	The structure of DNA, cell division, mitosis and protein synthesis have direct links with genetic diversity due to mutations and meiosis. This therefore is placed near the end of the sequence of lessons so that the prior learning has taken place. The idea that mutations can lead to changes in genotype and phenotype links directly to adaptations and natural selection, it therefore makes sense to have this topic near the end of the year. Biodiversity and classification are well placed here as they link to	This half term is all about preparing students for success in any summative assessments, filling any gaps in knowledge or understanding and developing much needed skills that will increase their attainment in the subject. This is best placed at the end of the year, when they have visited all of the key theoretical and practical concepts at once, and can extend and deepen them through further practice at the end of the year. The homeostasis topic links directly to prior learning during GCSE on glucose regulation and is therefore a

					previous learning on protein synthesis and evolution well.	suitable first A Level topic to begin with. It will link into the next topic on respiration in which students learn about the Krebs cycle and how non carbohydrate substances can be used to generate ATP.
Year 13	Stimuli and Response Energy systems in Ecosystems- Respiration	Energy systems in ecosystems- Photosynthesis Genetics, populations, evolution, speciation and ecosystems	Control of gene expression & gene technologies Populations in ecosystems	Complete any PAG or catch-up of Spring 1 Essay Prep + Maths Work	Exam Preparation	
Intent	Students will begin to learn how organisms respond to the environment. They will understand what is meant by the key definitions: Stimulus, effector and response. They will look specifically at the nervous system wherein they will learn how nerve cells are involved in stimulus response by passing electrical impulses along their length. They will be able to explain that a nerve impulse is specific to a target cell only because it releases a chemical messenger directly onto it, producing a response	Students will aim to understand that in photosynthesis, light is absorbed by chlorophyll and this is linked to the production of ATP. Students could devise and carry out experiments to investigate the effect of named environmental variables on the rate of photosynthesis using aquatic plants, algae or immobilised algal beads. Students will need to know and be able to explain the light-dependent reaction and the light-independent reaction in detail. Students should be able to:	Gene mutations might arise during DNA replication. They include addition, deletion, substitution, inversion, duplication and translocation of bases. Gene mutations occur spontaneously. The mutation rate is increased by mutagenic agents. Mutations can result in a different amino acid sequence in the encoded polypeptide. Students move on to learn about the key differences and applications of different stem cells to	Any PAG catch ups can take place in this half term. Students are prepared for the 25 mark essay in paper 3 during this term. They have acquired sufficient breadth and depth of knowledge and understanding to write essays as per the guidance set by the exam board.	Students continue to develop exam skills through the extended use of exam questions and papers to prepare them for the end of year exams.	

	that is usually rapid, short-lived and localised. Furthermore, they will be able to make reference to some examples, such as in flowering plants where specific growth factors move from growing regions to other tissues, where they regulate growth in response to directional stimuli as well as making reference to the Pacinian corpuscle as an example of a receptor. Students will implement and apply their understanding of response to stimuli by designing and carrying out investigations into the effects of indoleacetic acid on root growth in seedlings. Students could also carry out investigations into: • The sensitivity of temperature receptors in human skin • Habituation of touch receptors in human skin • Resolution of touch receptors in human skin. _____ Students will begin to look into what respiration is wherein various substances are used as respiratory substrates. They will be made aware of the notion that hydrolysis of these	• 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. For this, they will also be applying this information through two practicals: The first is looking at the use of chromatography to investigate the pigments isolated from leaves of different plants, eg, leaves from shade-tolerant and shade-intolerant plants or leaves of different colours. The second will be investigating the effect of a named factor on the rate of dehydrogenase activity in extracts of chloroplasts. During the inheritance topic, students learn about a range of factors that affect patterns of inheritance such as codominance, dihybrid crosses and epistasis. This builds directly on content learnt on monohybrid inheritance. Inheritance includes: monohybrid and dihybrid crosses involving dominant, recessive and codominant alleles • crosses involving sex-linkage, autosomal linkage, multiple alleles and	include: totipotent, pluripotent and unipotent stem cells. The final topic extends students' understanding of genetics through the study of the control of gene expression. This includes: In eukaryotes, transcription of target genes can be stimulated or inhibited when specific transcriptional factors move from the cytoplasm into the nucleus. The role of the steroid hormone, oestrogen, in initiating transcription. Epigenetic control of gene expression in eukaryotes. Epigenetics involves heritable changes in gene function, without changes to the base sequence of DNA. These changes are caused by changes in the environment that inhibit transcription by: • increased methylation of the DNA or • decreased acetylation of associated histones. The relevance of epigenetics on the			

	respiratory substrates is linked to the production of ATP. Students will look specifically at how ATP production occurs when protons diffuse down an electrochemical gradient through molecules of the enzyme ATP synthase, embedded in the membranes of cellular organelles. There will be specific focus on the stages of respiration which will include the following: Glycolysis is the first stage of anaerobic and aerobic respiration. It occurs in the cytoplasm and is an anaerobic process. Glycolysis involves the following stages: • Phosphorylation of glucose to glucose phosphate, using ATP • Production of triose phosphate • Oxidation of triose phosphate to pyruvate with a net gain of ATP and reduced NAD. If respiration is aerobic, pyruvate from glycolysis enters the mitochondrial matrix by active transport:	epistasis. Use of the chi-squared (2) test to compare the goodness of fit of observed phenotypic ratios with expected ratios. This links in with the Hardy Weinberg principle in which students learn about how to estimate the frequency of different genotypes within a population. Students will learn that: 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. The frequency of alleles, genotypes and phenotypes in a population can be calculated using the Hardy–Weinberg equation: p2 + 2pq + q2 = 1 where p is the frequency of one (usually the dominant) allele and q is the frequency of the other (usually recessive) allele of the gene. Students move onto natural selection and the causes of speciation: The effects of stabilising, directional and disruptive selection. Evolution as a change in the allele frequencies in a population. Reproductive separation of two populations can result in the accumulation of difference	development and treatment of disease, especially cancer. In eukaryotes and some prokaryotes, translation of the mRNA produced from target genes can be inhibited by RNA interference (RNAi). The application of genome projects concludes the concept of understanding genetics and its importance through the use of genome projects: Recombinant DNA technology includes the following: Fragments of DNA can be produced by several methods, including: • conversion of mRNA to complementary DNA (cDNA), using reverse transcriptase • using restriction enzymes to cut a fragment containing the desired gene from DNA • creating the gene in a ‘gene machine’. Fragments of DNA can be amplified by in vitro and in vivo techniques. The principles of the polymerase chain			

	• Pyruvate is oxidised to acetate, producing reduced NAD in the process • Acetate combines with coenzyme A in the link reaction to produce acetylcoenzyme A • Acetylcoenzyme A reacts with a four-carbon molecule, releasing coenzyme A and producing a six-carbon molecule that enters the Krebs cycle • In a series of oxidation-reduction reactions, the Krebs cycle generates reduced coenzymes and ATP by substrate-level phosphorylation, and carbon dioxide is lost • Synthesis of ATP by oxidative phosphorylation is associated with the transfer of electrons down the electron transfer chain and passage of protons across inner mitochondrial membranes and is catalysed by ATP synthase embedded in these membranes (chemiosmotic theory) • Other respiratory substrates include the breakdown products of lipids and amino acids, which enter the Krebs cycle.	in their gene pools. New species arise when these genetic differences lead to an inability of members of the populations to interbreed and produce fertile offspring. In this way, new species arise from existing species. Allopatric and sympatric speciation.The importance of genetic drift in causing changes in allele frequency in small populations.	reaction (PCR) as an in vitro method to amplify DNA fragments. The culture of transformed host cells as an in vivo method to amplify DNA fragments. • The addition of promoter and terminator regions to the fragments of DNA. • The use of restriction endonucleases and ligases to insert fragments of DNA into vectors. Transformation of host cells using these vectors. • The use of marker genes to detect genetically modified (GM) cells or organisms.			

Rationale	Respiration is an important biological process that is common to all living things. Students will be able to grasp the finer details of this topic having studied biological molecules such as glucose in year 1 and the structure and function of the mitochondria, in addition to the generation of ATP form inorganic phosphate and ADP. This topic has specific links to the previous topic on homeostasis and should therefore be taught straight after it.	Students will have a wider appreciation of the dynamics that are involved in ecosystems and therefore the topic on populations is well suited here. Inheritance builds on the principles learnt at GCSE whilst developing further through the study of inheritance in a range of challenging contexts. For this reason this topic is well placed after respiration and photosynthesis when students have had a chance to look the depth required at A2.	The year concludes with some very high level concepts in the control of gene expression and gene technologies. Students will need the foundation of knowledge that they have built in many previous topics in order two access these final two topics appropriately, hence this is well placed at the end of the year.	Students have acquired sufficient breadth and depth of knowledge and understanding to write essays as per the guidance set by the exam board.	s	