Programme of study for Year 12 A level Biology

Autumn (1st term)	Autumn (2nd term)	Spring (1st term)	Spring (2nd Term)	Summer (1st term)	Summer (2nd term)
Other timescale: From: To:	Other timescale: From: To:	Other timescale: From: To:	Other timescale: From: To:	Other timescale: From: To:	Other timescale: From: To:
Topic / Big Question: Teacher 1: Introduction to Statistics at A level Biology, 3.1 Biological molecules part 1 Teacher 2: Introduction to Maths at A level Biology, 3.2: Cells: Cell Structure and Studying cells 3.2 Cells: All cells arise from other cells Skills (students should be able to do): AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures • AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures: • in a theoretical context • in a practical context • when handling qualitative data	Topic / Big Question: Teacher 1: 3.1 Biological molecules Part 2 Teacher 2: 3.2 Cells: Transport across cell membranes and Cell recognition and the immune system Skills (students should be able to do): AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures • AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures: • in a theoretical context • in a practical context • when handling qualitative data • when handling quantitative data	Topic / Big Question: Teacher 1: 3.4 Genetic information and Variation and relationships between organisms: Genetic information 3.3 Organisms exchange substances with their environment: Gas Exchange Teacher 2: 3.2 Cells: Cell recognition and the immune system Teacher 2: 3.4 Genetic information and Variation and relationships between organisms: Variation and relationships between organisms Skills (students should be able to do): AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures	Topic / Big Question: Teacher 1: 3.3 Organisms exchange substances with their environment: Gas Exchange Organisms exchange substances with their environment: Digestion and absorption Teacher 2: 3.4 Genetic information and Variation and relationships between organisms: Variation and relationships between organisms Skills (students should be able to do): AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures • AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:	Topic / Big Question: Teacher 1: 3.3 Organisms exchange substances with their environment: Digestion and absorption Teacher 2: 3.4 Genetic information and Variation and relationships between organisms: Species and Taxonomy Skills (students should be able to do): AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures • AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures: • in a theoretical context • in a practical context • when handling qualitative data	Topic / Big Question: Teacher 1: 3.3 Organisms exchange substances with their environment: Mass transport Teacher 2: 3.4 Genetic information and Variation and relationships between organisms: Biodiversity Skills (students should be able to do): AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures • AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures: • in a theoretical context • in a practical context • when handling qualitative data

• when handling quantitative data • AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to: • make judgements and reach conclusions • develop and refine practical design and procedures.	• AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to: • make judgements and reach conclusions • develop and refine practical design and procedures.	• AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures: • in a theoretical context • in a practical context • when handling qualitative data • when handling quantitative data • AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to: • make judgements and reach conclusions • develop and refine practical design and procedures.	• in a theoretical context • in a practical context • when handling qualitative data • when handling quantitative data • AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to: • make judgements and reach conclusions • develop and refine practical design and procedures.	• when handling quantitative data • AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to: • make judgements and reach conclusions • develop and refine practical design and procedures.	• when handling quantitative data • AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to: • make judgements and reach conclusions • develop and refine practical design and procedures.
Key Learning Outcomes (students should know): **Teacher 1:** **Introduction to statistics at A level Biology** Chi-squared test, Student's T-test Correlation coefficient, Standard deviation **3.1 Biological molecules:**	Key Learning Outcomes (students should know): **Teacher 1:** **3.1 Biological molecules:** 3.1.5 Nucleic acids are important information-carrying molecules (structures and functions) The semi-conservative replication of DNA (purpose and process) Evaluate the work of scientists in validating the	Key Learning Outcomes (students should know): **Teacher 1:** **3.4 Genetic information, variation and relationships between organisms** 3.4.2 DNA and protein synthesis (processes) **3.3 Organisms exchange substances with their environment**	Key Learning Outcomes (students should know): **Teacher 1:** **3.3 Organisms exchange substances with their environment:** 3.3.3 Digestion and absorption During digestion, large biological molecules are hydrolysed to smaller molecules that can be absorbed across cell membranes. Digestion in mammals of:	Key Learning Outcomes (students should know): **Teacher 1:** **3.3 Organisms exchange substances with their environment** 3.3.3 Digestion and absorption Mechanisms for the absorption of the products of digestion by cells lining the ileum of mammals, to include 3.3.4 Mass transport	Key Learning Outcomes (students should know): **Teacher 1:** **3.3 Organisms exchange substances with their environment** 3.3.4 Mass transport 5. Dissection of animal or plant respiratory system or mass transport system or of organ within such a system. 3.3.4.2 Mass transport in plants

3.1.1 Monomers and polymers (structures, functions and properties) 3.1.2 Carbohydrates (structures, functions and properties) Biochemical tests using Benedict's solution for reducing sugars and non-reducing sugars and iodine/potassium iodide for starch. 3.1.3 Lipids (structures, functions and properties). The emulsion test for lipids. 3.1.4 Proteins 3.1.4.1 General properties of proteins (structures, functions and properties) The biuret test for proteins. 3.1.4.2 Many proteins are enzymes (structures, functions and properties) The induced-fit model of enzyme action. The specificity of enzymes The effects of factors on the rate of enzyme-controlled reactions – How models of enzyme action have changed over time 1. Investigation into the effect of a named variable	Watson–Crick model of DNA replication 3.1.6 ATP Structure, function and formation during photosynthesis, or during respiration 3.1.7 Water; importance, properties, functions 3.1.8 Inorganic ions Each type of ion has a specific role, depending on its properties. Recognise the role of ions **3.4 Genetic information, variation and relationships between organisms** 3.4.1 DNA, genes and chromosomes (structures and functions) **Teacher 2:** **3.2 Cells** 3.2.2 All cells arise from other cell Cell cycle stages Stages of mitosis including appearance and behaviour of chromosomes Division of the cytoplasm (cytokinesis) usually occurs, producing two new cells. Mitosis is a controlled process.	3.3.1 Surface area to volume ratio 3.3.2 Gas exchange **Teacher 2:** **3.2 Cells** 3. Production of a dilution series of a solute to produce a calibration curve with which to identify the water potential of plant tissue. 4. Investigation into the effect of a named variable on the permeability of cell-surface membranes. 3.2.4 Cell recognition and the immune system Each type of cell has specific molecules on its surface that identify -pathogens -cells from other organisms of the same species -abnormal body cells -toxins Definition of antigen. The effect of antigen variability on disease and disease prevention. Phagocytosis of pathogens. Destruction of ingested pathogens by lysozymes	-carbohydrates by amylases and membrane-bound disaccharidases - lipids by lipase, including the action of bile salts - proteins by endopeptidases, exopeptidases and membrane-bound dipeptidases **Teacher 2:** 3.4 Genetic information, variation and relationships between organisms Gene mutations and how due to the degenerate nature of the genetic code, not all base substitutions cause a change in the sequence of encoded amino acids. Mutagenic agents can increase the rate of gene mutation. Mutations in the number of chromosomes by chromosome non-disjunction during meiosis. Meiosis produces daughter cells that are genetically different from each other. The process of meiosis	Over large distances, efficient movement of substance to and from exchange surfaces is provided by mass transport 3.3.4.1 Mass transport in animals Structure and functions of haemoglobins in relation to the oxyhaemoglobin dissociation curve. The cooperative nature of oxygen binding. The effects of carbon dioxide concentration on the dissociation of oxyhaemoglobin (the Bohr effect). Animal adaptations to their environment by possessing different types of haemoglobin with different oxygen transport properties. The general pattern of blood circulation in a mammal. The gross structure of the human heart. Pressure and volume changes and associated valve movements during the cardiac cycle that maintain a unidirectional flow of blood. The structure of arteries, arterioles and veins in relation to their function.	Xylem as the tissue that transports water in the stem and leaves of plants. The cohesion-tension theory of water transport in the xylem. Phloem as the tissue that transports organic substances in plants. The mass flow hypothesis for the mechanism of translocation in plants. The use of tracers and ringing experiments to investigate transport in plants. - recognise correlations and causal relationships - interpret evidence from tracer and ringing experiments and to evaluate the evidence for and against the mass flow hypothesis **Teacher 2:** **3.4 Genetic information, variation and relationships between organisms** 3.4.6 Biodiversity within a community Biodiversity can relate to a range of habitats. Species richness is a measure of the number of different species in a community. An index of diversity and how to calculate it.

on the rate of an enzyme-controlled reaction. **Teacher 2:** **Introduction to Maths at A level Biology** Perform maths skills including: -converting between units, standard form, and prefixes, -using significant figures -rearranging formulae -magnification calculations -calculating percentages, errors, and uncertainties -drawing and interpreting line graphs. **3.2 Cells** 3.2.1 Cell structure The structure of eukaryotic cells; structure and function of: -cell-surface membrane - nucleus (containing chromosomes, consisting of protein-bound, linear DNA, and one or more nucleoli) - mitochondria - chloroplasts (in plants and algae) - Golgi apparatus and Golgi vesicles - lysosomes (a type of Golgi vesicle that releases lysozymes)	Uncontrolled cell division can lead to cancers. Cancer treatments are directed at controlling the rate of cell division. Binary fission in prokaryotic cells Viral replication process 2. Preparation of stained squashes of cells from plant root tips; setup and use of an optical microscope to identify the stages of mitosis in these stained squashes and calculation of a mitotic index. 3.2.3 Transport across cell membranes The basic structure of all cell membranes. The arrangement and any movement of phospholipids, proteins, glycoproteins and glycolipids in the fluid-mosaic model of membrane structure. Cholesterol function 3.2.3 Transport across cell membranes; Movement across membranes occurs by:	The response of T lymphocytes to a foreign antigen (the cellular response). The response of B lymphocytes to a foreign antigen, clonal selection and the release of monoclonal antibodies (the humoral response). Definition of antibody. 3.4 Genetic information, variation and relationships between organisms 3.4.3 Genetic diversity can arise as a result of mutation or during meiosis	3.4.4 Genetic diversity and adaptation. Genetic diversity as the number of different alleles of genes in a population. Genetic diversity is a factor enabling natural selection to occur. The principles of natural selection in the evolution of populations. Directional selection, exemplified by antibiotic resistance in bacteria, and stabilising selection, exemplified by human birth weights. Natural selection results in species that are better adapted to their environment. These adaptations may be anatomical, physiological or behavioural. 6. Use of aseptic techniques to investigate the effect of antimicrobial substances on microbial growth.	The structure of capillaries and the importance of capillary beds as exchange surfaces. The formation of tissue fluid and its return to the circulatory system. **Teacher 2:** **3.4 Genetic information, variation and relationships between organisms** 3.4.5 Species and taxonomy Two organisms belong to the same species if they are able to produce fertile offspring. 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). One hierarchy comprises the taxa: domain, kingdom, phylum, class, order, family, genus and species.	Farming techniques reduce biodiversity. The balance between conservation and farming. 3.4.7 Investigating diversity 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 Quantitative investigations of variation within a species involve: - collecting data from random and systematic samples - calculating a mean value of the collected data and the standard deviation of that mean - interpreting mean values and their standard deviations.

- ribosomes - rough endoplasmic reticulum and smooth endoplasmic reticulum - cell wall (in plants, algae and fungi) - cell vacuole (in plants). In complex multicellular organisms, eukaryotic cells become specialised for specific functions. Specialised cells are organised into tissues, tissues into organs and organs into systems Prokaryotic cells differ from eukaryotic cells in having: - cytoplasm that lacks membrane-bound organelles - smaller ribosomes - no nucleus; instead they have a single circular DNA molecule that is free in the cytoplasm and is not associated with proteins - a cell wall that contains murein, a glycoprotein. In addition, many prokaryotic cells have: - one or more plasmids - a capsule surrounding the cell 3.2.1.3 Methods of studying cells	-simple diffusion (involving limitations imposed by the nature of the phospholipid bilayer) -facilitated diffusion (involving the roles of carrier proteins and channel proteins) - osmosis (explained in terms of water potential) - active transport (involving the role of carrier proteins and the importance of the hydrolysis of ATP) -co-transport (illustrated by the absorption of sodium ions and glucose by cells lining the mammalian ileum) - Adaptations of cells for rapid transport across their membranes - How factors affect the rate of movement across cell membranes			Binomial system Appreciate that advances in immunology and genome sequencing help to clarify evolutionary relationships between organisms.	

The principles and limitations of optical microscopes, transmission electron microscopes and scanning electron microscopes. 3.2.1.3 Methods of studying cells Measuring the size of an object viewed with an optical microscope. The difference between magnification and resolution. Use of the formula: Principles of cell fractionation and ultracentrifugation as used to separate cell components.					
End of term 1 assessment to cover: 3.1 Biological molecules and 3.2 Cells		End of term 2 assessment to cover: 3.1 Biological molecules, 3.2 Cells, 3.3 Organisms exchange substances with their environment and 3.4 Genetic information, variation and relationships between organisms		End of year assessment to cover: 3.1 Biological molecules, 3.2 Cells, 3.3 Organisms exchange substances with their environment and 3.4 Genetic information, variation and relationships between organisms	
Building understanding: Rationale / breakdown for your sequence of lessons: **Introduction to Statistics at A Level Biology:** This is a short sequence of lessons designed to give students a greater appreciation of how to correctly prepare experiments, verify conclusions and properly interpret results. These skills underpin everything they will study on the course and so are		**Building understanding: Rationale / breakdown for your sequence of lessons:** **Biological molecules:** **3.4 Genetic information, variation and relationships between organisms** Having recently finished studying the structure and function of DNA, students have the foundations to understand that genes are sections of DNA located at a particular site on a DNA molecule, called its locus.		**Building understanding: Rationale / breakdown for your sequence of lessons:** **3.3 Organisms exchange substances with their environment** Understanding the process of digestion and absorption builds upon the study of intestinal epithelial cells done with Teacher 2 earlier on in the year. This provides an understanding of their adaptations for the absorption process.	

taught explicitly and then revisited regularly over the rest of the topics and required practical's.

Biological molecules:

All life on Earth shares a common chemistry. These biological molecules are the basis of all the structures and chemical reactions that are taught later on in the course and so a solid understanding of them is an essential foundation. This provides indirect evidence for evolution which is a topic that is taught in year 13.

Despite their great variety, the cells of all living organisms contain only a few groups of carbon-based compounds that interact in similar ways. Carbohydrates are commonly used by cells as respiratory substrates; this allows students to understand respiration in year 13. They also form structural components in plasma membranes and cell walls which is taught in Autumn 2.

Lipids have many uses, including the bilayer of plasma membranes taught in Autumn 2, and certain hormones as taught in year 13 and as respiratory substrates, as also taught in year 13.

Proteins form many cell structures. They are also important as enzymes (comes up throughout year 12 and 13 eg in respiration and photosynthesis), chemical messengers (Hormones topic in Year 13) and components of the blood (mass transport later in year 12). Nucleic acids carry the genetic code for the production of proteins. The genetic code is common to viruses and to all living organisms (Provides the basis upon which to learn variation through mutations), providing evidence for evolution which is taught in year 13.

The most common component of cells is water; hence our search for life elsewhere in the universe involves a search for liquid water (students develop this idea when studying photosynthesis in year 13).

Understanding the properties of water is essential in order to understand how water is transported within organisms- a topic taught later on in year 12.

They are also able to apply their understanding of nucleotide bases to understand that the base sequence of each gene carries the coded genetic information that determines the sequence of amino acids during protein synthesis. The genetic code used is the same in all organisms, providing indirect evidence for evolution which is studied in year 13.

3.3 Organisms exchange substances with their environment

The exchange of substances between the internal and external environments takes place at exchange surfaces which contain specialised cells studied previously in the cells topic. To truly enter or leave an organism, most substances must cross cell plasma membranes (as taught earlier by teacher 2 in transport across membranes). Most cells are too far away from exchange surfaces, and from each other, for simple diffusion alone to maintain the composition of tissue fluid within a suitable metabolic range so there is a need for organ systems (a concept studied in the specialised cells topics earlier this year).

3.2 Cells

Cell-surface membranes contain embedded proteins which act as antigens, allowing recognition of 'self' and 'foreign' cells by the immune system 9this links back to work on structure of cell membranes done last term).

Interactions between different types of cell are involved in disease, recovery from disease and prevention of symptoms occurring at a later date if exposed to the same antigen, or antigen-bearing pathogen (Students have considered lymphocyte structure and function in the prior study of specialised cells).

3.4 Genetic information, variation and relationships between organisms

In large organisms, exchange surfaces are associated with mass transport systems that carry substances between the exchange surfaces and the rest of the body and between parts of the body which is underpinned by the concept of surface area to volume ratio which was taught earlier this year. Mass transport maintains the final diffusion gradients that bring substances to and from the cell membranes of individual cells (as explained in transport across membranes). It also helps to maintain the relatively stable environment that is tissue fluid, which starts to support the development of homeostasis concepts for study in year 13.

3.4 Genetic information, variation and relationships between organisms

This genetic diversity is acted upon by natural selection (which gives students the basis for their study of evolution next year), resulting in species becoming better adapted to their environment.

-Variation within a species can be measured using differences in the base sequence of DNA or in the amino acid sequence of proteins (the foundations for this were taught in Biological molecules at the start of the year).

- Biodiversity within a community can be measured using species richness and an index of diversity, this topic involves field work which gives students a strong foundation for their ecology unit and required practical in year 13.

Students should be able to relate the structure of proteins to properties of proteins named throughout the specification in year 12 and 13. Students should appreciate that enzymes catalyse a wide range of intracellular and extracellular reactions that determine structures and functions from cellular to whole-organism level eg photosynthesis and respiration in year 13. **Introduction to Maths at A Level Biology:** This is a short sequence of lessons designed to reinforce the foundation maths skills students need to access the A Level Biology course fully. For example; calculating magnification of cells, converting between units, rounding off answers properly, rearranging formulae, calculating uncertainties and errors, and choosing the most appropriate ways of displaying data. These skills are taught explicitly and then revisited regularly over the rest of the topics and required practical's. **3.2 Cells** All life on Earth exists as cells, therefore to progress further in the study of Biology, a sound understanding of the basic building blocks is required which is why it is the first topic taught. These have basic features in common. Differences between cells are due to the addition of extra features. This provides indirect evidence for evolution which is studied in year 13. Cells are the building blocks of tissues, organs and systems covered in the Exchange and transport topic taught later on in year 12. All cells arise from other cells, by binary fission in prokaryotic cells and by mitosis and meiosis in eukaryotic cells (the later which is taught later on in year 12 during the Variation topic). Cells may be adapted for rapid transport across their internal or external membranes by an increase in surface area of, or by an increase in the number of protein channels and carrier molecules in, their	Biological diversity – biodiversity – is reflected in the vast number of species of organisms, in the variation of individual characteristics within a single species and in the variation of cell types within a single multicellular organism (building on their study of genes from last term). - Differences between species reflect genetic differences. Differences between individuals within a species could be the result of genetic factors, of environmental factors, or a combination of both. - Genetic diversity within a species can be caused by gene mutation (building on their understanding of the structure of genes from last term), chromosome mutation (building on their study of chromosome structure last term) or random factors associated with meiosis and fertilisation.	

membranes (Specialisations of cells was covered last term and is the foundation to understand this). -explain the adaptations of specialised cells in relation to the rate of transport across their internal and external membranes The subsequent destruction of ingested pathogens by lysozymes (which were studied in the organelles sections of cell structure topic). All cells have a cell-surface membrane and, in addition, eukaryotic cells have internal membranes. The basic structure of these plasma membranes is the same and enables control of the passage of substances across exchange surfaces by passive or active transport. Cell-surface membranes contain embedded proteins (structural proteins studied last term with teacher 1). Some of these are involved in cell signalling – communication between cells.		
Home – Learning: Home learning will be set from the resources in the topic folder. 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 water'.	Home – Learning: Home learning will be set from the resources in the topic folder. 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 diffusion'.	Home – Learning: Home learning will be set from the resources in the topic folder. 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 nucleic acids and their derivatives'
Reading / literacy: 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.		
Numeracy: 10% of the A level biology exams are assessed via mathematical questions including the main key areas below: 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 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. Enrichment day visit to Natural History Museum. Subscription to Biological Sciences Review magazine, which students are referred to for outside reading. Where possible students will be given the opportunity to attend an A level Biology field trip.