

# A Level Biology Syllabus

## Exam board: AQA

**What will I learn?** You will learn about a variety of areas some details of which are below and full details in your course outline and specification ticksheet for each topic.

### AS and A Level course

#### Topic 1 – Biological Molecules

All life on Earth shares a common chemistry. This provides indirect evidence for evolution.

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. They also form structural components in plasma membranes and cell walls. Lipids have many uses, including the bilayer of plasma membranes, certain hormones and as respiratory substrates. Proteins form many cell structures. They are also important as enzymes, chemical messengers and components of the blood. Nucleic acids carry the genetic code for the production of proteins. The genetic code is common to viruses and to all living organisms, providing evidence for evolution.

The most common component of cells is water; hence our search for life elsewhere in the universe involves a search for liquid water

#### Topic 2 - Cells

All life on Earth exists as cells. These have basic features in common. Differences between cells are due to the addition of extra features. This provides indirect evidence for evolution. All cells arise from other cells, by binary fission in prokaryotic cells and by mitosis and meiosis in eukaryotic cells.

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. Some of these are involved in cell signalling – communication between cells. Others act as antigens, allowing recognition of 'self' and 'foreign' cells by the immune system. 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.

#### Topic 3 - Organism Exchange

The internal environment of a cell or organism is different from its external environment. The exchange of substances between the internal and external environments takes place at exchange surfaces. To truly enter or leave an organism, most substances must cross cell plasma membranes.

In large multicellular organisms, the immediate environment of cells is some form of tissue fluid. 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. 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.

Mass transport maintains the final diffusion gradients that bring substances to and from the cell membranes of individual cells. It also helps to maintain the relatively stable environment that is tissue fluid.

#### Topic 4 – Genetic information and relationships between organisms

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.

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. A gene is a section of DNA located at a particular site on a DNA molecule, called its locus. The base sequence of each gene carries the genetic code that determines the sequence of amino acids during protein synthesis. The genetic code is the same in all organisms, providing indirect evidence for evolution. Genetic diversity within a species can be caused by gene mutation, chromosome mutation or random factors associated with meiosis and fertilisation. This genetic diversity is acted upon by natural selection, 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. Biodiversity within a community can be measured using species richness and an index of diversity.

## **A Level course**

The A Level course includes Topics 1 to 4 but then also includes four more topics. The assessment details are also included.

### **Topic 5 – Energy transfers in and between organisms**

Life depends on continuous transfers of energy. In photosynthesis, light is absorbed by chlorophyll and this is linked to the production of ATP. In respiration, various substances are used as respiratory substrates. The hydrolysis of these respiratory substrates is linked to the production of ATP. 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. 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.

In communities, the biological molecules produced by photosynthesis are consumed by other organisms, including animals, bacteria and fungi. Some of these are used as respiratory substrates by these consumers. Photosynthesis and respiration are not 100% efficient. The transfer of biomass and its stored chemical energy in a community from one organism to a consumer is also not 100% efficient.

### **Topic 6 – Organisms respond to changes in their internal and external environments**

A stimulus is a change in the internal or external environment. A receptor detects a stimulus. A coordinator formulates a suitable response to a stimulus. An effector produces a response. Receptors are specific to one type of stimulus. Nerve cells 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.

In contrast, mammalian hormones stimulate their target cells via the blood system. They are specific to the tertiary structure of receptors on their target cells and produce responses that are usually slow, long-lasting and widespread. Plants control their response using hormone-like growth substances.

### **Topic 7 – Genetics, populations, evolution and ecosystems**

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 ancestry can explain the similarities between all living organisms, such as common chemistry (eg all proteins made from the same 20 or so amino acids), physiological pathways (eg anaerobic respiration), cell structure, DNA as the genetic material and a 'universal' genetic code. The individuals of a species share the same genes but (usually) different combinations of alleles of these genes. An individual inherits alleles from their parent or parents.

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. 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.

If a population becomes isolated from other populations of the same species, there will be no gene flow between the isolated population and the others. This may lead to the accumulation of genetic differences in the isolated population, compared with the other populations. These differences may ultimately lead to organisms in the isolated population becoming unable to breed and produce fertile offspring with organisms from the other populations. This reproductive isolation means that a new species has evolved. 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. Populations within communities are also affected by, and in turn affect, the abiotic (physicochemical) factors in an ecosystem.

### **Topic 8 – The control of gene expression**

Cells are able to control their metabolic activities by regulating the transcription and translation of their genome. Although the cells within an organism carry the same genetic code, they translate only part of it. In multicellular organisms, this control of translation enables cells to have specialised functions, forming tissues and organs. There are many factors that control the expression of genes and, thus, the phenotype of organisms. Some are external, environmental factors, others are internal factors. The expression of genes is not as simple as once thought, with epigenetic regulation of transcription being increasingly recognised as important.

Humans are learning how to control the expression of genes by altering the epigenome, and how to alter genomes and proteomes of organisms. This has many medical and technological applications. Consideration of cellular control mechanisms underpins 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.

## How will I be assessed? AS Levels (please see further down for full A Level)

There are three exams at the end of the two years for A-level, all of which are two hours long. At least 15% of the marks for A-level Biology are based on what you learned in your practicals.

The AS has two exams at the end of the year. Both are 1 hour 30 minutes long.

### Practicals

Biology, like all sciences, is a practical subject. Throughout the course you will carry out practical activities including:

- using microscopes to see cell division
- dissection of animal or plant systems
- aseptic technique to study microbial growth
- investigating activity within cells
- investigating distributions of species in the environment.

These practicals will give you the skills and confidence needed to investigate the way living things behave and work. It will also ensure that if you choose to study a Biology-based subject at university, you'll have the practical skills needed to carry out successful experiments in your degree.

### Assessment objectives

The exams will measure how students have achieved the following assessment objectives.

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.

### Weighting of assessment objectives for AS Biology

| Assessment objectives (AOs)     | Component weightings (approx %) |         | Overall weighting (approx %) |
|---------------------------------|---------------------------------|---------|------------------------------|
|                                 | Paper 1                         | Paper 2 |                              |
| AO1                             | 47–51                           | 33–37   | 35–40                        |
| AO2                             | 35–39                           | 41–45   | 40–45                        |
| AO3                             | 13–17                           | 21–25   | 20–25                        |
| Overall weighting of components | 50                              | 50      | 100                          |

10% of the overall assessment of AS Biology will contain mathematical skills equivalent to Level 2 or above.

At least 15% of the overall assessment of AS Biology will assess knowledge, skills and understanding in relation to practical work.

## Assessments

| Paper 1  | + | Paper 2   | + | Paper 3  |
|--|---|---|---|--|
| <b>What's assessed</b> <ul style="list-style-type: none"> <li>Any content from topics 1–4, including relevant practical skills</li> </ul>                                |   | <b>What's assessed</b> <ul style="list-style-type: none"> <li>Any content from topics 5–8, including relevant practical skills</li> </ul>                           |   | <b>What's assessed</b> <ul style="list-style-type: none"> <li>Any content from topics 1–8, including relevant practical skills</li> </ul>  |
| <b>Assessed</b> <ul style="list-style-type: none"> <li>written exam: 2 hours</li> <li>91 marks</li> <li>35% of A-level</li> </ul>  |   | <b>Assessed</b> <ul style="list-style-type: none"> <li>written exam: 2 hours</li> <li>91 marks</li> <li>35% of A-level</li> </ul>                                   |   | <b>Assessed</b> <ul style="list-style-type: none"> <li>written exam: 2 hours</li> <li>78 marks</li> <li>30% of A-level</li> </ul>  |
| <b>Questions</b> <ul style="list-style-type: none"> <li>76 marks: a mixture of short and long answer questions</li> <li>15 marks: extended response questions</li> </ul> |   | <b>Questions</b> <ul style="list-style-type: none"> <li>76 marks: a mixture of short and long answer questions</li> <li>15 marks: comprehension question</li> </ul> |   | <b>Questions</b> <ul style="list-style-type: none"> <li>38 marks: structured questions, including practical techniques</li> <li>15 marks: critical analysis of given experimental data</li> <li>25 marks: one essay from a choice of two titles</li> </ul> |

Assessment objectives (AOs) are set by Ofqual and are the same across all AS and A-level Biology specifications and all exam boards.

The exams will measure how students have achieved the following assessment objectives.

- 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.

## Weighting of assessment objectives for A-level Biology

| Assessment objectives (AOs)     | Component weightings (approx %) |         |         | Overall weighting (approx %) |
|---------------------------------|---------------------------------|---------|---------|------------------------------|
|                                 | Paper 1                         | Paper 2 | Paper 3 |                              |
| AO1                             | 44–48                           | 23–27   | 28–32   | 30–35                        |
| AO2                             | 30–34                           | 52–56   | 35–39   | 40–45                        |
| AO3                             | 20–24                           | 19–23   | 31–35   | 25–30                        |
| Overall weighting of components | 35                              | 35      | 30      | 100                          |

10% of the overall assessment of A-level Biology will contain mathematical skills equivalent to Level 2 or above.

At least 15% of the overall assessment of A-level Biology will assess knowledge, skills and understanding in relation to practical work.