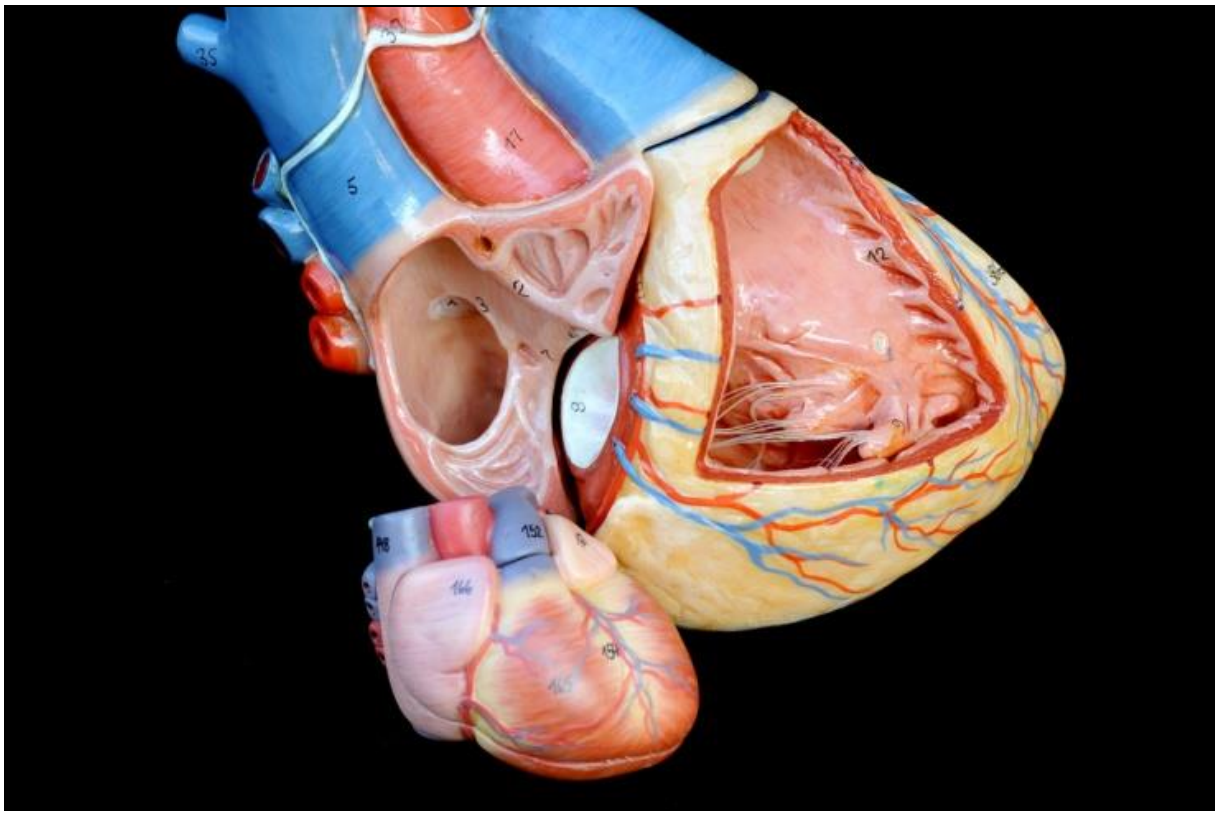
Course Support Notes

# Higher Human Biology Course Support Notes





Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

# Contents

# Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the Higher Human Biology Course. They are intended for teachers and lecturers who are delivering the Course and its Units. They should be read in conjunction with the *Course Specification*, the *Course Assessment Specification* and the *Unit Specifications* for the Units in the Course.

# General guidance on the Course

## Aims

As stated in the *Course Specification,* the aims of the Course are to enable learners to:

- develop and apply knowledge and understanding of human biology
- develop an understanding of human biology's role in scientific issues and relevant applications of human biology, including the impact these could make on society and the environment
- develop scientific inquiry and investigative skills
- develop scientific analytical thinking skills, including scientific evaluation, in a human biology context
- develop the use of technology, equipment and materials, safely, in practical scientific activities, including using risk assessments
- develop planning skills
- develop problem solving skills in a human biology context
- use and understand scientific literacy to communicate ideas and issues and to make scientifically informed choices
- develop the knowledge and skills for more advanced learning in biology
- develop skills of independent working

## Progression into this Course

Entry to this Course is at the discretion of the centre. However, learners would normally be expected to have attained some relevant skills and knowledge through prior experience.

Skills and knowledge developed through any of the following, while **not mandatory**, are likely to be helpful as a basis for further learning in this Course:

- Biology (National 5) Course

More detail is contained in the Biology Progression Framework. The Biology Progression Framework shows the development of the key areas throughout the suite of Courses.

# Skills, knowledge and understanding covered in the Course

Note: teachers and lecturers should refer to the *Course Assessment Specification* for mandatory information about the skills, knowledge and understanding to be covered in this Course.

# Progression from this Course

This Course or its components may provide progression for the learner to:

- Advanced Higher Biology or related areas
- further study, employment and/or training

# Hierarchies

**Hierarchy** is the term used to describe Courses and Units which form a structured sequence involving two or more SCQF levels.

It is important that any content in a Course and/or Unit at one particular SCQF level is not repeated if a learner progresses to the next level of the hierarchy. The skills and knowledge should be able to be applied to new content and contexts to enrich the learning experience. This is for centres to manage.

- Biology Courses from National 3 to Advanced Higher are hierarchical.
- Courses from National 3 to National 5 have Units with the same structure and titles.

National 5 gives equal progression to both Higher Biology and Higher Human Biology. Higher Biology and Higher Human Biology give equal progression to Advanced Higher Biology.

# Approaches to learning and teaching

The purpose of this section is to provide you with advice and guidance on learning and teaching. It is essential that you are familiar with the mandatory information within the Higher Human Biology *Course Assessment Specification*.

Teaching should involve an appropriate range of approaches to develop knowledge and understanding and skills for learning, life and work. This can be integrated into a related sequence of activities, centred on an idea, theme or application of Higher Human Biology, based on appropriate contexts, and need not be restricted to the Unit structure. Learning should be experiential, active, challenging and enjoyable, and include appropriate practical experiments/ activities and could be learner led. The use of a variety of active learning approaches is encouraged, including peer teaching and assessment, individual and group presentations, role-playing and game-based learning, with learner-generated questions.

When developing your Human Biology Course there should be opportunities for learners to take responsibility for their learning. Learning and teaching should build on learners' prior knowledge, skills and experiences. The Units and the key areas identified within them may be approached in any appropriate sequence, at the centre's discretion. The distribution of time between the various Units is a matter for professional judgement and is entirely at the discretion the centre. Each Unit is likely to require an approximately equal time allocation, although this may depend on the learners' prior learning in the different key areas.

Learning and teaching, within a class, can be organised, in a flexible way, to allow a range of learners' needs to be met and to ensure progression. The new qualifications provide improved continuity between the levels. Centres can, therefore, confidently continue to organise learning and teaching strategies, in ways appropriate for their learners.

Within a class, there may be learners capable of achieving at a higher level in some aspects of the Course. Where possible, they should be given the opportunity to do so. There may also be learners who are struggling to achieve in all aspects of the Course, and may only achieve at the lower level in some areas.

Teachers/lecturers need to consider the Course and Unit Specifications to identify the differences between Course levels. It may also be useful to refer to the Biology Progression Framework.

When delivering this Course to a group of learners, with some working towards different levels, it may be useful for teachers to identify activities covering common key areas and skills for all learners, and additional activities required for some learners. In some aspects of the Course, the difference between levels is defined in terms of a higher level of skill.

An investigatory approach is encouraged in Human Biology, with learners actively involved in developing their skills, knowledge and understanding by investigating a range of applications and issues relevant to human biology. A holistic approach should be adopted to encourage simultaneous development of learners' conceptual understanding and skills.

Where appropriate, investigative work/experiments, in Human Biology, should allow learners the opportunity to select activities and/or carry out extended study. Investigative and experimental work is part of the scientific method of working and can fulfil a number of educational purposes.

All learning and teaching should offer opportunities for learners to work collaboratively. Practical activities and investigative work can offer opportunities for group work, which should be encouraged.

Group work approaches can be used within Units and across Courses, where it is helpful to simulate real-life situations, share tasks and promote team working skills. However, there must be clear evidence for each learner to show that the learner has met the required assessment standards for the Unit or Course.

Laboratory work should include the use of technology and equipment that reflects current scientific use in Human Biology. Appropriate risk assessment must be undertaken.

Learners, especially at Higher, would be expected to contribute their own time in addition to programmed learning time.

Effective partnership working can enhance the science experience. Where feasible, locally relevant contexts should be studied, with visits where this is possible. Guest speakers from industry, further and higher education could be used to bring the world of human biology into the classroom.

Information and Communications Technology (ICT) can make a significant contribution to practical work in Higher Human Biology, in addition to the use of computers as a learning tool. Computer interfacing equipment can detect and record small changes in variables allowing experimental results to be recorded over long or short periods of time. Results can also be displayed in real time helping to improve understanding. Data logging equipment and video cameras can be set up to record data and make observations over periods of time longer than a class lesson that can then be downloaded and viewed for analysis.

Learning about Scotland and Scottish culture will enrich the learners' learning experience and help them to develop the skills for learning, life and work they will need to prepare them for taking their place in a diverse, inclusive and participative Scotland and beyond. Where there are opportunities to contextualise approaches to learning and teaching to Scottish contexts, teachers and lecturers should consider this.

Assessment should be integral to and improve learning and teaching. The approach should involve learners and provide supportive feedback. Self- and peer-assessment techniques should be encouraged, wherever appropriate. Assessment information should be used to set learning targets and next steps.

Suggestions for possible contexts and learning activities, to support and enrich learning and teaching, are detailed in the table below.

The **Mandatory Course key areas** are from the *Course Assessment Specification*. Activities in the **Suggested learning activities** are not mandatory. This offers examples of suggested activities, from which you could select a range

of suitable activities. It is not expected that all will be covered. Centres may also devise their own learning activities. **Exemplification of key areas** is not mandatory. It provides an outline of the level of demand and detail of the key areas.

In the Suggested Learning Activities, there are references to the use of case studies. These should be seen as a suggested approach to teaching and learning and not confused with the use of Case Study as a method of Course assessment. These case studies should make learning active, challenging and enjoyable and identify for the learner the Course content and skills that will be developed. Case studies should be developed in such a way that learners have the opportunity to select activities, where appropriate, and present the opportunity to pursue further study. Case studies need not necessarily be restricted to one Unit but could include human biology drawn from different Units.

# Human Cells

## Introduction

From previous study, learners will be familiar with the organisation of body cells into tissues, organs and systems. This Unit develops the concept of stem cells as being capable of dividing and differentiating into specialised cells. Although the Course does not cover all cells found in the body, the biology of the four types of somatic cells are represented throughout the Course. Emphasis is placed on the maintenance of the diploid number of chromosomes in the division of somatic cells and reduction division to the haploid number of chromosomes in gametes from germline cells. Consideration is given to the research and therapeutic value of stem cells and to uncontrolled division of cancer cells providing opportunity to look at wider social issues and the relevance of applied biological science.

This Unit recognises the central importance of DNA to cell processes. The structure and replication of DNA is now treated with a greater degree of clarity and accuracy than was the case in the previous Higher Human Biology Course. The emphasis is now on the expression of the genotype encoded by DNA into the phenotype of protein structure and function through the mechanisms of transcription and translation. This approach paves the way for a consideration of mutations and genetic disorders caused by alterations that change the expression of functioning proteins. DNA can now be sequenced, synthesised and recombined in the laboratory. These important advances in technology have led to the new science of bioinformatics and genomics with their implications for understanding evolutionary relationships and developing personalised medicine. The ability to replicate DNA in vitro has implications for fundamental research and for medical and forensic applications and provides opportunities for informed discussion of the associated social, moral and ethical issues facing society.

The control and regulation of metabolic pathways is essential to cell function. Metabolism should be seen as a network of connected and integrated pathways with reversible and irreversible steps and alternative routes. The role of genes in coding for enzymes that control and regulate pathways further demonstrates the central importance of DNA and the regulation of gene expression in the cell. At this level the importance of the flexible and dynamic shape of enzymes and the functioning of the active site should be emphasised. The importance of signal molecules on gene expression, regulatory molecules that influence enzyme shape and feedback inhibition should all be introduced. Cellular respiration lies at the heart of metabolism. The role of ATP in the transfer of energy in catabolic and anabolic reactions and in phosphorylating molecules should all be introduced. Glycolysis provides the opportunity to demonstrate reversible and irreversible steps on a pathway, phosphorylation, and the generation of ATP. The citric acid cycle is a suitable example of a cyclical set of enzyme-mediated reactions. There is no need to account for carbon atoms; it is the removal of hydrogen by dehydrogenase enzymes and the transfer of electrons to an electron transfer chain that is critical in the cell’s energy economy.

The wide range of respiratory substrates used for respiration demonstrates the connected and integrated nature of metabolic pathways. The relationship between metabolic pathways and sports performance is illustrated by the creatine phosphate system, the production of energy in the absence of oxygen and the types of skeletal muscle fibres.

Learners should have a clear understanding of the following areas of content from their previous learning:

- Tissues, organs and systems
- Cell division
- Cell ultrastructure and function
- Cell division and chromosomes
- Base sequence and base pairing of DNA
- Function of proteins
- Enzymes
- Summary equation for respiration
- ATP and energy

| Mandatory Course key areas | Suggested learning activities | Exemplification of key areas |
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| **1 Division and differentiation in human cells**<br>(a) Somatic cells divide by mitosis to form more somatic cells. | | |
| (b) Cellular differentiation is the process by which a cell develops more specialised functions by expressing the genes characteristic for that type of cell. | View audio visual resources on the origin of blood cells and their functions (red blood cells, platelets, phagocytes (eosinophils, neutrophils, basophils and monocytes) and lymphocytes (B-lymphocytes, T-lymphocytes and natural killer cells). | Once a cell becomes differentiated it only expresses the genes that produce the proteins characteristic for that type of cell. |
| (c) Stem cells — embryonic and tissue (adult) stem cells.<br>Stem cells are unspecialised somatic cells that can divide to make copies of themselves (self-renew) and/or differentiate into specialised cells. | | |
| Tissue (adult) stem cells are involved in the growth, repair and renewal of the cells found in that tissue. They are multipotent. | | Tissue stem cells are multipotent as they can make all of the cell types found in a particular tissue type. For example, blood (haematopoietic) stem cells can make all of the cell types in the blood. |
| The main body tissue types are epithelial, connective, muscle and nerve tissue.<br>The body organs are formed from a variety of these tissues. | | Development of tissue (adult) stem cells in bone marrow into red blood cells, platelets and the various forms of phagocytes and lymphocytes.<br>Epithelial cells cover the body surface and line body cavities, connective tissue |

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| | | includes blood, bone and cartilage cells, muscle cells form muscle tissue and nerve cells form nervous tissue. |
| The cells of the early embryo can make all of the differentiated cell types of the body. They are pluripotent.<br>When grown in the lab scientists call these embryonic stem cells. | | The inner cell mass cells of an early embryo (blastocyst stage) are pluripotent as they can make nearly all of the cell types in the body. These cells can self-renew, under the right conditions, in the lab. It is then they are termed embryonic stem cells. |
| (d) Germline cells divide by mitosis to produce more germline cells or by meiosis to produce haploid gametes. Mutations in germline cells are passed to offspring. | | During cell division the nucleus of a somatic cell divides by mitosis to maintain the diploid chromosome number. Diploid cells have 23 pairs of homologous chromosomes. |
| (e) Research and therapeutic uses of stem cells by reference to the repair of damaged or diseased organs or tissues. Stem cells can also be used as model cells to study how diseases develop or for drug testing. The ethical issues of stem cell use and the regulation of their use. | Case study on use of stem cells in repair of diseased or damaged organs (eg skin grafts, bone marrow transplantation and cornea repair).<br><br>Case study on ethics of stem cell research and sources of stem cells. For example, embryos used for research must not be allowed to develop beyond 14 days, around the time a blastocyst would be implanted in a uterus. Sources of stem cells include embryonic stem cells, tissue stem cells and attempts to reprogram specialised cells to an embryonic state (induced pluripotent stem cells [iPS]). | Stem cell research provides information on how cell processes such as cell growth, differentiation and gene regulation work. The therapeutic uses of stem cells should be exemplified by reference to the repair of diseased or damaged organs, eg corneal transplants and skin grafts for burns. |

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| (f) Cancer cells divide excessively to produce a mass of abnormal cells (called a tumour). These cells do not respond to regulatory signals and may fail to attach to each other. If the cancer cells fail to attach to each other they can spread through the body to form secondary tumours. | Ethical issues could include regulations on the use of human embryos and the use of iPS cells. | |
| **2 Structure and replication of DNA**<br>(a) Structure of DNA — nucleotides contain deoxyribose sugar, phosphate and base. DNA has a sugar–phosphate backbone, complementary base pairing — adenine with thymine and guanine with cytosine. The two DNA strands are held together by hydrogen bonds and have an antiparallel structure, with deoxyribose and phosphate at 3' and 5' ends of each strand.<br><br>(b) Chromosomes consist of tightly coiled DNA and are packaged with associated proteins.<br><br>(c) Replication of DNA by DNA polymerase and primer. DNA is unwound and unzipped to form two template strands. DNA | Case study examining the experimental evidence of the bacterial transformation experiments of Griffiths and identification of DNA as the transforming agent by Avery, phage experiments of Hershey and Chase, Chargaff's base ratios and the X-ray crystallography of Wilkins and Franklin. Watson and Crick's double helix model as an evidence based conclusion.<br><br>Case study on Meselson and Stahl experiments on DNA replication. | All cells store their genetic information in the base sequence of DNA. The genotype is determined by the sequence of DNA bases. DNA is the molecule of inheritance and can direct its own replication.<br><br>Prior to cell division, DNA is replicated by a DNA polymerase. This process occurs at several locations on a DNA molecule. |

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| polymerase needs a primer to start replication and can only add complementary DNA nucleotides to the deoxyribose (3') end of a DNA strand. This results in one strand being replicated continuously and the other strand replicated in fragments which are joined together by ligase.<br><br>**3 Gene expression**<br>(a) Phenotype is determined by the proteins produced as the result of gene expression. Only a fraction of the genes in a cell are expressed. Gene expression is influenced by intra- and extra-cellular environmental factors. Gene expression is controlled by the regulation of both transcription and translation.<br><br>(b) Structure and functions of RNA.<br>RNA is single stranded, contains uracil instead of thymine and ribose instead of deoxyribose sugar. Messenger RNA (mRNA) carries a copy of the DNA code from the nucleus to the ribosome. Ribosomal RNA (rRNA) and proteins form the ribosome. Each transfer RNA (tRNA) carries a specific amino acid.<br><br>(c) Transcription of DNA into primary and mature RNA transcripts in the nucleus. This should include the role of RNA polymerase | Modelling transcription and translation using virtual and physical resources. | mRNA is transcribed from DNA in the nucleus and translated into proteins by ribosomes in the cytoplasm. RNA |

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| and complementary base pairing.<br>The introns of the primary transcript of mRNA are non-coding and are removed in RNA splicing. The exons are coding regions and are joined together to form mature transcript. This process is called RNA splicing.<br><br>(d) Translation of mRNA into a polypeptide by tRNA at the ribosome. tRNA folds due to base pairing to form a triplet anticodon site and an attachment site for a specific amino acid. Triplet codons on mRNA and anticodons translate the genetic code into a sequence of amino acids. Start and stop codons exist. Codon recognition of incoming tRNA, peptide bond formation and exit of tRNA from the ribosome as polypeptide is formed.<br><br>(e) Different proteins can be expressed from one gene as a result of alternative RNA splicing and post-translational modification. Different mRNA molecules are produced from the same primary transcript depending on which RNA segments are treated as exons and introns. Post-translation protein structure modification by cutting and combining polypeptide chains or by adding phosphate or carbohydrate groups to the protein. | | polymerase moves along DNA unwinding and unzipping the double helix and synthesising a primary transcript of RNA by complementary base pairing. Genes have introns (non-coding regions of genes) and exons (coding regions of genes). |

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| **4 Genes and proteins in health and disease**<br>(a) Proteins are held in a three dimensional shape by peptide bonds, hydrogen bonds, interactions between individual amino acids. Polypeptide chains fold to form the three dimensional shape of the protein. | Separation and identification of fish proteins by agarose gel electrophoresis.<br><br>Investigation of the shape and structure of fibrous and globular proteins using RasMol or Protein Explorer software. | Proteins have a large variety of structures and shapes resulting in a wide range of functions.<br>Amino acids are linked by peptide bonds to form polypeptides. |
| (b) Mutations result in no protein or a faulty protein being expressed. | Experiments investigating the effects of UV radiation on UV sensitive yeast. | Genetic disorders are caused by changes to genes or chromosomes that result in the proteins not being expressed or the proteins expressed not functioning correctly. |
| Single gene mutations involve the alteration of a DNA nucleotide sequence as a result of the substitution, insertion or deletion of nucleotides. Nature of single-nucleotide substitutions including: missense, nonsense and splice-site mutations. Nucleotide insertions or deletions result in frame-shift mutations or an expansion of a nucleotide sequence repeat.<br>The effect of these mutations on the structure and function of the protein synthesised and the resulting effects on health. | Single gene mutation case studies:<br>Sickle-cell disease (missense)<br>PKU (missense)<br>Beta (β) thalassemia (splice-site mutation)<br>Duchenne muscular dystrophy (DMD) (nonsense)<br>Tay-Sachs syndrome (frameshift insertion)<br>Cystic fibrosis (frameshift deletion)<br>Fragile X syndrome (nucleotide sequence repeat expansion)<br>Huntingdon's disease (nucleotide sequence repeat expansion) | Missense (replacing one amino acid codon with another), nonsense (replacing an amino acid codon with a premature stop codon — no amino acid is made and the process stops) and splice-site mutations (creating or destroying the codons for exon-intron splicing). |
| Chromosome structure mutations — deletion; duplication; translocation.<br>The substantial changes in chromosome mutations often make them lethal. | Chromosome mutation case studies:<br>Cri-du-chat syndrome (deletion of part of the short arm of chromosome 5)<br>Chronic myeloid leukaemia (CML) | The structure of a chromosome can be altered. These mutations can take the form of a deletion (loss of a segment of a chromosome), duplication (repeat of a |

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| | (reciprocal translocation of a gene from chromosome 22 fused with a gene on chromosome 9)<br>Familial Down's syndrome (in 5% of cases one parent has the majority of chromosome 21 translocated to chromosome 14). | segment of a chromosome) or translocation (the rearrangement of chromosomal material involving two or more chromosomes). |
| **5 Human genomics**<br>(a) Sequencing DNA.<br>Bioinformatics is the use of computer technology to identify DNA sequences. | Genome determination case studies including the human genome project and the comparison of individual genomes using single nucleotide polymorphisms (SNPs).<br><br>Bioinformatics case studies.<br><br>Use genome data to identify stop and start codons and known protein coding sequences. | The sequence of bases can be determined for individual genes and entire genomes.<br><br>The enormous amount of data produced by DNA and protein sequencing can be managed and analysed using computer technology and shared over the internet. Computer programs can be used to identify gene sequences by looking for coding sequences similar to known genes, start sequences or sequences lacking stop codons. Computer programs can be used to identify base sequences that correspond to the amino acid sequence of a protein. |
| Systematics compares human genome sequence data and genomes of other species to provide information on evolutionary relationships and origins. | Case study on evolution of primates and bears using Geneious software. | |
| Personalised medicine is based on an individual's genome. Analysis of an individual's genome may lead to | The information gained from DNA studies can provide information on the structure of the genes and proteins involved in disease. | The importance of distinguishing between neutral and harmful mutations and the complex nature of many diseases. |

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| personalised medicine through understanding the genetic component of risk of disease. | Rational drug design synthesises specific drugs that will bind to these proteins or prevent their synthesis by binding to a specific region of DNA preventing transcription or by binding to mRNA preventing translation, for example interfering RNA (RNAi). | Pharmacogenetics and the use of genome information in the choice of effective drugs. |
| (b) Amplification and detection of DNA sequences. | | |
| Polymerase Chain Reaction (PCR) amplification of DNA using complementary primers for specific target sequences. DNA heated to separate strands then cooled for primer binding. Heat-tolerant DNA polymerase then replicates the region of DNA. Repeated cycles of heating and cooling amplify this region of DNA. | Case study on the use and application of PCR including practical using thermal cycler or water baths. | The polymerase chain reaction (PCR) is a technique for the amplification of DNA *in vitro*.<br><br>In PCR, primers are complementary to specific target sequences at the two ends of the region to be amplified.<br>Cooling allows primers to bind to target sequences. |
| Arrays of DNA probes are used to detect the presence of specific sequences in samples of DNA. The probes are short single stranded fragments of DNA that are complementary to a specific sequence. Fluorescent labelling allows detection. | Case studies on the medical uses of DNA probes in: detecting single gene mutations, genotype microarrays and gene expression microarrays manufactured from RNA transcripts. | |
| Applications of DNA profiling allow the identification of individuals through comparison of regions of the genome with highly variable numbers of repetitive | DNA fingerprinting (Alec Jeffreys). | By screening a cell sample from a patient for the presence or absence of a particular sequence, a diagnosis of disease status or risk of disease onset can be made. |

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| sequences of DNA. | | |
| **6 Metabolic pathways**<br>(a) Anabolic pathways require energy and involve biosynthetic processes. Catabolic pathways release energy and involve the breakdown of molecules. These pathways can have reversible and irreversible steps and alternative routes. | | Metabolism encompasses the integrated and controlled pathways of enzyme catalysed reactions within a cell.<br><br>Metabolic pathways may exist that can bypass steps in a pathway. |
| (b) Control of metabolic pathways — presence or absence of particular enzymes and the regulation of the rate of reaction of key enzymes within the pathway. Regulation can be controlled by intra and extracellular signal molecules. | Enzyme induction experiments such as ONPG and lactose metabolism in *E. coli* and PGlo experiments. | Metabolic pathways are controlled by the presence or absence of particular enzymes in the metabolic pathway and through the regulation of the rate of reaction of key enzymes within the pathway. Genes for some enzymes are continuously expressed. These enzymes are always present in the cell and their control involves regulation of their rate of reaction. Most metabolic reactions are reversible and the presence of a substrate or the removal of a product will drive a sequence of reactions in a particular direction. |
| Induced fit and the role of the active site of enzymes including shape and substrate affinity. Activation energy.<br><br>The effects of substrate and end product concentration on the direction and rate of enzyme reactions. Enzymes often act in | Activation energy experiments, comparing heat, manganese dioxide and catalase action on hydrogen peroxide.<br><br>Experiments on reaction rate with increasing substrate concentration. | The role of the active site in orientating reactants, lowering the activation energy of the transition state and the release of products with low affinity for the active site. |

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| groups or as multi-enzyme complexes. | DNA and RNA polymerases are part of multi-enzyme complexes. | |
| Control of metabolic pathways through competitive (binds to active site), non-competitive (changes shape of active site) and feedback inhibition (end product binds to an enzyme that catalyses a reaction early in the pathway). | Investigate the inhibition of beta galactosidase by galactose and its reversal by increasing ONPG concentration.<br><br>Experiments on product inhibition with phosphatase. | Competitive inhibition can be reversed by increasing substrate concentration. |
| **7 Cellular respiration**<br>(a) Glucose broken down, removal of hydrogen ions and electrons by dehydrogenase enzymes releasing ATP. | | The metabolic pathways of cellular respiration are central to metabolism. They yield energy and are connected to many other pathways. |
| (b) The role of ATP in the transfer of energy and the phosphorylation of molecules by ATP. | Experiments on ATP dependent reactions, eg luciferase, luminescent reactions.<br><br>Experiments using phosphorylated substrates, (eg glucose-1-phosphate) using suitable positive and negative controls in the design of an experiment. | ATP is used to transfer energy to synthetic pathways and other cellular processes where energy is required. |
| (c) Metabolic pathways of cellular respiration. The breakdown of glucose to pyruvate in the cytoplasm in glycolysis, and the progression pathways in the presence or absence of oxygen (fermentation). The phosphorylation of intermediates in glycolysis in an energy investment phase and the direct generation | Experiments with yeast dehydrogenase | The first phosphorylation leads to a product that can continue to a number of pathways and the second phosphorylation, catalysed by phosphofructokinase, is an irreversible reaction leading only to the glycolytic pathway. Pyruvate progresses to the citric acid cycle if oxygen is available. |

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| of ATP in an energy pay-off stage. The role of the enzyme phosphofructokinase in this pathway. | | |
| The formation of citrate. Pyruvate is broken down to an acetyl group that combines with coenzyme A to be transferred to the citric acid cycle as acetyl coenzyme A. Acetyl (coenzyme A) combines with oxaloacetate to form citrate followed by the enzyme mediated steps of the cycle. This cycle results in the generation of ATP, the release of carbon dioxide and the regeneration of oxaloacetate in the matrix of the mitochondria. | Experiments on inhibition of citric acid cycle with malonic acid and DCPIP as an indicator of dehydrogenase activity. | |
| Dehydrogenase enzymes remove hydrogen ions and electrons which are passed to the coenzymes NAD or FAD to form NADH or $FADH_2$ in glycolysis and citric acid pathways. NADH and $FADH_2$ release the high-energy electrons to the electron transport chain on the mitochondrial membrane and this results in the synthesis of the bulk of the ATP. | Experiments with yeast dehydrogenase, eg using resazurin. | The electron transport chain as a collection of proteins attached to a membrane. NADH and $FADH_2$ release the high-energy electrons to the electron transport chain where they pass along the chain, releasing energy. The energy is used to pump H ions across the inner mitochondrial membrane. The return flow of H ions drives ATP synthase and produces the bulk of the ATP generated by cellular respiration. |
| (d) ATP synthesis — high energy electrons are used to pump hydrogen ions across a membrane and flow of these ions back through the membrane synthesises ATP using the membrane protein ATP synthase. | | The return flow of these ions rotates part of the membrane protein ATP synthase, catalysing the synthesis of ATP. |

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| The final electron acceptor is oxygen, which combines with hydrogen ions and electrons to form water. | | |
| Substrates for respiration.<br>The role of starch, glycogen, other sugar molecules, amino acids and fats in the respiratory pathway. | Investigation of different sugars as respiratory substrates in yeast.<br><br>Research different use of substrates during exercise and starvation. | Starch and glycogen are broken down to glucose for use as a respiratory substrate. Other sugar molecules can be converted to glucose or glycolysis intermediates for use as respiratory substrates. Proteins can be broken down to amino acids and converted to intermediates of glycolysis and the citric acid cycle for use as respiratory substrates. Fats can also be broken down to intermediates of glycolysis and the citric acid cycle. |
| Regulation of the pathways of cellular respiration by feedback inhibition — regulation of ATP production, by inhibition of phosphofructokinase by ATP and citrate, synchronisation of rates of glycolysis and citric acid cycle. | | The cell conserves its resources by only producing ATP when required.<br>ATP supply increases with increasing rates of glycolysis and the citric acid cycle, and decreases when these pathways slow down. If the cell produces more ATP than it needs, the ATP inhibits the action of phosphofructokinase slowing the rate of glycolysis. The rates of glycolysis and the citric acid cycle are synchronised by the inhibition of phosphofructokinase by citrate. If citrate accumulates, glycolysis slows down and when citrate consumption increases glycolysis increases the supply of acetyl groups to the citric acid cycle. |

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| **8 Energy systems in muscle cells**<br>(a) Creatine phosphate breaks down to release energy and phosphate that is used to convert ADP to ATP at a fast rate. This system can only support strenuous muscle activity for around 10 seconds, when the creatine phosphate supply runs out. It is restored when energy demands are low. | Case study: effects of creatine supplements on fitness and sporting performance. | During strenuous muscle activity the cell rapidly breaks down its reserves of ATP to release energy. Muscle cells have an additional source of energy in creatine phosphate that can be used to replenish ATP pools during rigorous bouts of exercise. This system can only support strenuous muscle activity for around 10 seconds, when the creatine phosphate supply runs out. When muscle energy demand is low, ATP from cellular respiration is used to restore the levels creatine phosphate. |
| (b) Lactic acid metabolism. Oxygen deficiency, conversion of pyruvate to lactic acid, muscle fatigue, oxygen debt. | | During vigorous exercise, the muscle cells do not get sufficient oxygen to support the electron transport chain. Under these conditions, pyruvate is converted to lactic acid. This conversion involves the transfer of hydrogen from the NADH produced during glycolysis to pyruvic acid to produce lactic acid. This regenerates the NAD needed to maintain ATP production through glycolysis. Lactic acid accumulates in muscle causing fatigue. Oxygen debt repaid when exercise is complete allows respiration to provide the energy to convert lactic acid back to pyruvic acid and glucose in the liver. |

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| (c) Types of skeletal muscle fibres<br>Differences between slow twitch and fast twitch muscle fibres.<br><br>Slow twitch (Type 1) muscle fibres contract more slowly, but can sustain contractions for longer and so are good for endurance activities.<br><br>Fast twitch (Type 2) muscle fibres contract more quickly, over short periods, so are good for bursts of activity. | Case study: comparison of the ratios of slow twitch muscle fibres to fast twitch muscle fibres amongst elite athletes in different sports. | Slow twitch muscle fibres are good for endurance activities like long distance running, cycling or cross-country skiing. Slow twitch muscle fibres rely on aerobic respiration to generate ATP and have many mitochondria, a large blood supply and a high concentration of the oxygen storing protein myoglobin. The major storage fuel of slow twitch muscles fibres is fats.<br><br>Fast twitch muscle fibres are good for activities like sprinting or weightlifting. Fast twitch muscle fibres can generate ATP through glycolysis only and have few mitochondria and a lower blood supply than slow twitch muscle fibres. The major storage fuels of fast twitch muscles fibres are glycogen and creatine phosphate.<br>Most human muscle tissue contains a mixture of both slow and fast twitch muscle fibres. Athletes show distinct patterns of muscle fibres that reflect their sporting activities. |

# Physiology and Health

## Introduction

Much of our knowledge of human physiology is based upon research activity related to human health. This Unit focuses on reproduction and the cardiovascular system, two areas where biological research and knowledge is of particular significance and relevance to the human species.

The study of reproduction provides a good and clear opportunity to develop understanding of the mechanisms of hormonal control including releaser hormones, stimulation and inhibition, feedback control, multiple effects of hormones, cyclical and non-cyclical activity. Deeper understanding of these principles can be developed by studying the application of these principles to managed conception, contraception and infertility treatments. By taking an approach analogous to 'the patient's journey' the Unit proceeds to an understanding of the biological principles of marker diagnostic tests (including false positives), assessing risk and the genetic testing that underpins ante- and postnatal screening. By exploring physiology in these health-related contexts opportunities arise naturally to discuss in an informed way social, moral and ethical issues that relate to being a responsible citizen and an informed contributor to society.

Study of the cardiovascular system allows learners the opportunity to examine epithelial, connective and muscle tissue. Such a study will also include the movement of materials in and out of cells as well as the circulation of blood, tissue fluid and lymph. The physiological measurements involved in monitoring heart function, the cardiac cycle and blood pressure require the development of analytical skills related to understanding graphical data in applied real-life contexts. The pathology of cardiovascular disease helps to deepen understanding of the cardiovascular system as well as to develop biological concepts such as reaction cascades and the activation of enzymes when required in applied contexts that are of particular significance to health in Scotland. Homeostatic mechanisms can be explored through study of regulation of blood cholesterol and blood glucose, factors in the onset of atherosclerosis, diabetes and obesity. As well as reflecting on the significance of these conditions for our society and contributing to evidence-based decisions associated with them as citizens, they afford the opportunity for learners to consider their personal responsibility when making lifestyle choices.

Learners should have a clear understanding of the following areas of content from their previous learning:

- Reproduction
- Endocrine system
- Immune system
- Inheritance
- Circulatory system
- Movement across cell membrane
- Homeostasis

| Mandatory Course key areas | Suggested learning activities | Exemplification of key areas |
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| **1 The structure and function of reproductive organs and gametes and their role in fertilisation**<br>(a) Gamete production in the testes. The roles of seminiferous tubules, interstitial cells, testosterone, prostate gland and seminal vesicles.<br><br>(b) Gamete production in the ovaries to include maturation of ova and the development of a follicle.<br><br>(c) Site of fertilisation in the oviduct and zygote formation.<br><br>**2 Hormonal control of reproduction**<br>(a) Hormonal onset of puberty.<br>Pituitary gland is stimulated to release follicle stimulating hormone (FSH),luteinising hormone (LH) or interstitial cell stimulating hormone (ICSH) by a releaser hormone produced in the hypothalamus<br><br>(b) Hormonal control of sperm production.<br>FSH promotes sperm production and ICSH stimulates the production of testosterone. Testosterone also stimulates sperm | | Gametes are produced from germline cells. Testes produce sperm in the seminiferous tubules and testosterone in the interstitial cells. The prostate gland and seminal vesicles secrete fluids that maintain the mobility and viability of the sperm. The ovaries contain immature ova in various stages of development. Each ovum is surrounded by a follicle that protects the developing ovum and secretes hormones. Mature ova are released into the oviduct where they may be fertilised by sperm to form a zygote.<br><br>Hormones control the onset of puberty, sperm production and the menstrual cycle. |

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| production and activates the prostate gland and seminal vesicles. Negative feedback control of testosterone by FSH and ICSH.<br><br>(c) Hormonal control of the menstrual cycle. Development of a follicle and the endometrium in the uterus.<br>Roles of FSH, LH, oestrogen and progesterone in the menstrual cycle. Development of a follicle, the corpus luteum and the endometrium. Follicular and luteal phases. Blastocyst implantation. Negative feedback control through pituitary gland, FSH and progesterone, leading to menstruation. | Construct charts to illustrate the changes in the female body during the menstrual cycle. Identify the fertile period from data on timing of menstruation, body temperature, cervical mucus and life span of sperm and egg. | The menstrual cycle takes approximately 28 days with the first day of menstruation regarded as day one of the cycle. FSH stimulates the development of a follicle and the production of oestrogen by the follicle in the follicular phase. Oestrogen stimulates proliferation of the endometrium preparing it for implantation and affects the consistency of cervical mucus making it more easily penetrated by sperm. Peak levels of oestrogen stimulate a surge in the secretion of LH which triggers ovulation. In the luteal phase the follicle develops into a corpus luteum and secretes progesterone. Progesterone promotes further development and vascularisation of the endometrium preparing it to receive a blastocyst if fertilisation occurs. The negative feedback effect of the ovarian hormones on the pituitary gland and the secretion of FSH and LH prevent further follicles from developing. The lack of LH leads to degeneration of the corpus luteum with a subsequent drop in progesterone levels leading to menstruation. |

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| **3 The biology of controlling fertility**<br>(a) Infertility treatments and contraception are based on the biology of fertility. Risks and ethics associated with fertility treatments.<br><br>(b) Fertile periods.<br>Cyclical fertility in females leading to a fertile period. Continuous fertility in males. Calculation of fertile periods and their use.<br><br>(c) Treatments for infertility.<br>Stimulating ovulation. Ovulation stimulated by drugs that prevent the negative feedback effect of oestrogen on FSH secretion. Other ovulatory drugs mimic the action of FSH and LH. These drugs can cause super ovulation that can result in multiple births or be used to collect ova for in vitro fertilisation (IVF) programmes.<br><br>Artificial insemination. Several samples of semen are collected over a period of time. Artificial insemination is particularly useful where the male has a low sperm count. If a partner is sterile a donor may be used.<br><br>Intra-cytoplasmic sperm injection (ICSI).<br>If mature sperm are defective or very low in number ICSI can be used — the head of the sperm is drawn into a needle and injected | Case studies on infertility, its causes and treatment to include overcoming problems in sperm production and ovulation, predicting fertile periods, and surgical interventions. | |

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| directly into the egg to achieve fertilisation.<br><br>In vitro fertilisation (IVF).<br>Surgical removal of eggs from ovaries after hormone stimulation. Incubation of zygotes and uterine implantation. Pre-implantation genetic diagnosis (PGD). The use of IVF in conjunction with PGD to identify single gene disorders and chromosomal abnormalities. | Examine data on the success rate for *in vitro* fertilisation (IVF) and its effect on long-term health. | The eggs are mixed with sperm in a culture dish. The fertilised eggs are incubated until they have formed at least eight cells and are then transferred to the uterus for implantation. |
| (d) Contraception — physical and chemical methods of contraception.<br>Biological basis of physical methods. Chemical contraceptives are based on combinations of synthetic hormones that mimic negative feedback preventing the release of FSH/LH. | Case studies on the biological basis of physical and chemical contraceptives. | Physical methods such as barrier methods, avoiding fertile periods, intra uterine devices and sterilisation procedures. Some prevent implantation ('morning-after pills') or cause thickening of cervical mucus ('progesterone-only pill'). |
| **4 Ante- and postnatal screening**<br>(a) Antenatal screening identifies the risk of a disorder so that further tests and a prenatal diagnosis can be offered.<br><br>Ultrasound imaging.<br>Anomaly scans may detect serious physical problems. Dating scans, for pregnancy stage and due date, are used with tests for marker chemicals which vary normally during pregnancy. | Case study on antenatal care to include the use of ultrasound images and biochemical tests.<br><br>View ultrasound images at different stages of pregnancy.<br><br>View specialised ultrasound images. | A variety of techniques can be used to monitor the health of the mother and developing fetus.<br><br>Measuring a substance at the wrong time could lead to a false positive result. |
| Biochemical tests to detect the normal | Examine data on altered blood biochemistry due to altered renal, liver and thyroid | Blood pressure, blood type and general health checks (including routine blood and |

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| physiological changes of pregnancy.<br><br>Diagnostic testing<br>Amniocentesis and chorionic villus sampling (CVS) and the advantages and disadvantages of their use. Cells from samples can be cultured to obtain sufficient cells to produce a karyotype to diagnose a range of conditions.<br><br>Rhesus antibody testing.<br>Anti-rhesus antibodies are given to rhesus-negative mothers after a sensitising event or after birth<br><br>(b) Postnatal screening.<br>Individuals with high levels of phenylalanine are placed on a restricted diet. | function; alterations to carbohydrate and calcium metabolism; and hormonal changes.<br><br>Examine data on the risks associated with testing for Down's syndrome. Blood test for alpha-fetoprotein (AFP) and subsequent test for the 'marker' nuchal translucency by ultrasound. If the results indicate a high risk of Down's syndrome further diagnostic tests with more risk may be offered.<br><br>Construct karyotypes of fetal material which indicate a variety of genetic disorders. Suitable examples include: Down's trisomy, Edwards trisomy, Klinefelter's/Turner's syndromes, Familial Down's, Fragile X, Cri-du-chat.<br><br>New-born screening for other diseases such | urine tests).<br><br>Medical conditions can be detected by a range of marker chemicals that indicate a condition but need not necessarily be part of the condition.<br>As a result of routine screening or for individuals in high risk categories, further tests may be offered. In deciding to proceed with these tests, the element of risk will be assessed as will the decisions the individuals concerned are likely to make if a test is positive. Tests may include amniocentesis and CVS from the placenta. CVS can be carried out earlier in pregnancy than amniocentesis. Although it has a higher risk of miscarriage CVS karyotyping can be performed on the fetal cells immediately.<br><br>Generally mothers show no immune response to their fetus although sensitisation to Rhesus antigens can occur. |

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| Diagnostic testing for metabolic disorders, including phenylketonuria (PKU), an inborn error of metabolism.<br><br>The use of pedigree charts to analyse patterns of inheritance in genetic screening and counselling. Patterns of inheritance in autosomal recessive, autosomal dominant, incomplete dominance and sex-linked recessive single gene disorders.<br>. | as galactosaemia, congenital hypothyroidism, amino acid disorders.<br><br>Examine case studies of inherited conditions including single gene disorders, chromosome abnormalities and conditions influenced by multiple genes.<br><br>Calculate probability of outcomes in single gene inherited conditions. Suitable examples include: albinism, Huntington's chorea, sickle cell, thalassaemia, haemophilia, muscular dystrophy.<br><br>Consider moral/ethical issues surrounding PGD. | Draw, analyse and interpret pedigree charts over three generations to follow patterns of inheritance in genetic disorders using standardised human pedigree nomenclature and symbols (sex, matings, siblings, affected individuals, twins, heterozygotes, carrier of sex-linked allele and deceased). |
| **5 The structure and function of arteries, capillaries and veins**<br><br>(a) The structure and function of arteries, capillaries and veins to include endothelium, central lumen, connective tissue, elastic fibres, smooth muscle and valves. The role of vasoconstriction and vasodilation in controlling blood flow. | Study the circulation of the blood through the body including the coronary arteries, carotid artery, jugular vein, hepatic artery, hepatic vein, hepatic portal vein, renal artery and renal vein.<br><br>Examine prepared slides of arteries and veins. Measure the degree of stretching in arteries and veins with weights.<br><br>Observe capillaries eg nail bed.<br><br>Demonstrate the presence of valves in veins. | Blood circulates from the heart through the arteries to the capillaries to the veins and back to the heart. Decrease in blood pressure as blood moves away from the heart.<br><br>The endothelium lining the central lumen of blood vessels is surrounded by layers of tissue.<br><br>Arteries have an outer layer of connective tissue containing elastic fibres and a middle layer containing smooth muscle with more elastic fibres. The elastic walls of the |

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| | | arteries stretch and recoil to accommodate the surge of blood after each contraction of the heart. The smooth muscle can contract or relax causing vasoconstriction or vasodilation to control blood flow. Capillaries allow exchange of substances with tissues.<br>Veins have an outer layer of connective tissue containing elastic fibres but a much thinner muscular wall than arteries. Function of valves. |
| (b) The exchange of materials between tissue fluid and cells through pressure filtration and the role of lymph vessels. Similarity of tissue fluid and blood plasma with the exception of plasma proteins. | Case study on disorders of the lymphatic system. Suitable examples include the effect of kwashiorkor on fluid balance and elephantiasis. | Pressure filtration of fluids through capillary walls. Tissue fluid supplies cells with glucose, oxygen and other substances. Carbon dioxide and other metabolic wastes diffuse out of the cells and into the tissue fluid to be excreted. Much of the tissue fluid returns to the blood. Lymphatic vessels absorb excess tissue fluid and return the lymph fluid to the circulatory system. |
| **6 The structure and function of the heart**<br>(a) Cardiac function and cardiac output. Definition of cardiac output and its calculation. | Measuring pulse rate in arteries using pulsometer. Calculate cardiac output under different conditions. | The volume of blood pumped through each ventricle per minute is the cardiac output. Cardiac output is determined by heart rate and stroke volume (CO = HR x SV). The left and right ventricles pump the same volume of blood through the aorta and pulmonary artery. |

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| (b) The cardiac cycle to include the functions atrial systole, ventricular systole, diastole. Effect of pressure changes on atrio-ventricular (AV) and semi lunar (SL) valves. Blood flow through the heart and its associated blood vessel | Interpret graphs of pressure changes in heart and blood vessels.<br><br>Use a stethoscope or listen to a recording of heart sounds. | During diastole blood returning to the atria flows into the ventricles. Atrial systole transfers the remainder of the blood through the atrio-ventricular (AV) valves to the ventricles. Ventricular systole closes the AV valves and pumps the blood out through the semi lunar (SL) valves to the aorta and pulmonary artery. In diastole the higher pressure in the arteries closes the SL valves. The opening and closing of the AV and SL valves are responsible for the heart sounds heard with a stethoscope. |
| (c) The structure and function of cardiac conducting system including nervous control. Control of contraction and timing by cells of the sino-atrial node (SAN) and transmission to the atrio-ventricular node (AVN). Location of the SAN and AVN in the heart. Interpretation of electrocardiograms (ECG). The medulla regulates the rate of the SAN through the antagonistic action of the autonomic nervous system (ANS). Sympathetic accelerator nerves release nor-adrenaline (nor-epinephrine) and slowing parasympathetic nerves release acetylcholine. | Examine normal and abnormal ECGs. | The heart beat originates in the heart itself but is regulated by both nervous and hormonal control. The auto-rhythmic cells of the sino-atrial node (SAN) or pacemaker set the rate at which cardiac muscle cells contract. The timing of cardiac cells contracting is controlled by the impulse from the SAN spreading through the atria and then travelling to the atrio-ventricular node (AVN) and then through the ventricles. These impulses generate currents that can be detected by an electrocardiogram (ECG). |
| (d) Blood pressure changes, in response to | Measure blood pressure using a digital | An inflatable cuff stops blood flow and |

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| cardiac cycle, and its measurement.<br>Blood pressure changes in the aorta during the cardiac cycle. Measurement of blood pressure using a sphygmomanometer. A typical reading for a young adult is 120/70 mmHg. Hypertension is a major risk factor for many diseases including coronary heart disease.<br><br>**7 Pathology of cardio vascular disease (CVD)** | sphygmomanometer. | deflates gradually. The blood starts to flow (detected by a pulse) at systolic pressure. The blood flows freely through the artery (and a pulse is not detected) at diastolic pressure. |
| (a) Process of atherosclerosis, its effect on arteries and blood pressure and its link to cardiovascular diseases (CVD). | Examine league tables for coronary heart disease worldwide.<br><br>Examine trends in coronary heart disease over last 10 years. | Atherosclerosis is the accumulation of fatty material (consisting mainly of cholesterol), fibrous material and calcium forming an atheroma or plaque beneath the endothelium. As the atheroma grows the artery thickens and loses its elasticity. The diameter of the artery becomes reduced and blood flow becomes restricted resulting in increased blood pressure.<br>Atherosclerosis is the root cause of various cardio vascular diseases including angina, heart attack, stroke and peripheral vascular disease. |
| (b) Thrombosis— Events leading to a myocardial infarction (MI) or stroke.<br><br>Endothelium damage, clotting factors and the role of prothrombin, thrombin, fibrinogen and fibrin. Thrombus formation and formation and | Investigate the use of thrombolytic medications such as streptokinase and tissue plasminogen activator.<br><br>Compare and contrast the use of antiplatelet and anticoagulants therapies. | Atheromas may rupture damaging the endothelium. The damage releases clotting factors that activate a cascade of reactions resulting in the conversion of the enzyme prothrombin to its active form thrombin. Thrombin then causes molecules of the |

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| effects of an embolus.<br><br>(c) Causes of peripheral vascular disorders including narrowing of arteries due to atherosclerosis, deep vein thrombosis (DVT) and pulmonary embolism due to blood clots.<br><br>(d) Control of cholesterol levels and familial hypercholesterolaemia.<br>Cholesterol synthesis and its function in the cell membrane and in steroid synthesis.<br>Roles of high density lipoproteins (HDL) and | Investigate examples of bleeding disorders such as Von Willebrand disease and haemophilia A, B and C. | plasma protein fibrinogen to form threads of fibrin. The fibrin threads form a meshwork that clots the blood, seals the wound and provides a scaffold for the formation of scar tissue. The formation of a clot (thrombus) is referred to as thrombosis. In some cases a thrombus may break loose forming an embolus and travel through the bloodstream until it blocks a blood vessel.<br>A thrombosis in a coronary artery may lead to a heart attack (MI). A thrombosis in an artery in the brain may lead to a stroke. Cells are deprived of oxygen leading to death of the tissues<br><br>Peripheral vascular disease is narrowing of the arteries due to atherosclerosis of arteries other than those of the heart or brain. The arteries to the legs are most commonly affected. Pain is experienced in the leg muscles due to a limited supply of oxygen. A DVT is a blood clot that forms in a deep vein most commonly in the leg, and can break off and result in a pulmonary embolism.<br><br>Cholesterol is synthesised by all cells, although 25% of total production takes place in the liver. A diet high in saturated fats or cholesterol causes an increase in cholesterol levels in the blood. Cholesterol |

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| low density lipoproteins (LDL). LDL receptors, negative feedback control and atheroma formation. Ratios of HDL to LDL in maintaining health, the benefits of physical activity and a low fat diet. Reducing blood cholesterol through prescribed medications. | | is a component of cell membranes and a precursor for steroid synthesis. HDL transports excess cholesterol from the body cells to the liver for elimination. This prevents accumulation of cholesterol in the blood. LDL transports cholesterol to body cells. Most cells have LDL receptors that take LDL into the cell where it releases cholesterol. Once a cell has sufficient cholesterol a negative feedback system inhibits the synthesis of new LDL receptors and LDL circulates in the blood where it may deposit cholesterol in the arteries forming atheromas. A higher ratio of HDL to LDL will result in lower blood cholesterol and a reduced chance of atherosclerosis. |
| | Research data on the action of cholesterol reducing drugs.<br><br>Investigate current views on the use of statins in treatment of patients at risk of CVD. | Regular physical activity tends to raise HDL levels, dietary changes aim to reduce the levels of total fat in the diet and to replace saturated with unsaturated fats. Drugs such as statins reduce blood cholesterol by inhibiting the synthesis of cholesterol by liver cells. |
| Genetic screening of familial hypercholesterolaemia (FH) and its treatments. | Pedigree analysis of FH.<br>Investigate treatments for FH. | Familial hypercholesterolaemia (FH) due to an autosomal dominant gene predisposes individuals to developing high levels of cholesterol. FH genes cause a reduction in the number of LDL receptors or an altered receptor structure. Genetic testing can |

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| | | determine if the FH gene has been inherited and it can be treated with lifestyle modification and drugs. |
| **8 Blood glucose levels and obesity**<br>(a) Chronic elevated blood glucose levels leads to atherosclerosis and blood vessel damage. | Investigate the symptoms associated with 'microvascular disease' and 'macrovascular'. | Chronic elevation of blood glucose levels leads to the endothelium cells taking in more glucose than normal damaging the blood vessels. Atherosclerosis may develop leading to cardio vascular disease, stroke or peripheral vascular disease. Small blood vessels damaged by elevated glucose levels may result in haemorrhage of blood vessels in the retina, renal failure or peripheral nerve dysfunction. |
| Pancreatic receptors and the role of hormones in negative feedback control of blood glucose through insulin, glucagon and adrenaline (epinephrine). | | Pancreatic receptors respond to high blood glucose levels by causing secretion of insulin. Insulin activates the conversion of glucose to glycogen in the liver decreasing blood glucose concentration. Pancreatic receptors respond to low blood glucose levels by producing glucagon. Glucagon activates the conversion of glycogen to glucose in the liver increasing blood glucose level. During exercise and fight or flight responses glucose levels are raised by adrenaline (epinephrine) released from the adrenal glands stimulating glucagon secretion and inhibiting insulin secretion. |

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| Diagnosis, treatments and role of insulin in type 1 and type 2 diabetes. | Analyse glucose tolerance curves of normal and diabetic subjects. | Vascular disease can be a chronic complication of diabetes. Type 1 diabetes usually occurs in childhood. Type 2 diabetes or adult onset diabetes typically develops later in life and occurs mainly in overweight individuals. A person with type 1 diabetes is unable to produce insulin and can be treated with regular doses of insulin. In type 2 diabetes individuals produce insulin but their cells are less sensitive to it. This insulin resistance is linked to a decrease in the number of insulin receptors in the liver leading to a failure to convert glucose to glycogen. In both types of diabetes individual blood glucose levels will rise rapidly after a meal and the kidneys are unable to cope resulting in glucose being lost in the urine. Testing urine for glucose is often used as an indicator of diabetes.<br><br>The glucose tolerance test is used to diagnose diabetes. The blood glucose levels of the individual are measured after fasting and two hours after drinking 250–300 ml of glucose solution. |
| (b) Obesity linked to cardiovascular disease and diabetes.<br>Definition and characterisation of obesity. Body fat, body density measurements and BMI calculations. Role of exercise and diet in | Compare measurement of body composition using different methods. For example using densitometry, skin fold thicknesses, bioelectrical impedance, waist-hip ratio and body mass index. | Obesity is a major risk factor for cardiovascular disease and type 2 diabetes. Obesity is characterised by excess body fat in relation to lean body tissue (muscle). A body mass index (weight divided by height |

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| reducing obesity and CVD. | Perform simple measurements of body composition.<br><br>Analyse data which illustrates the effect of exercise on body composition.<br><br>Examine case histories using coronary heart disease risk calculators (eg Framingham index).<br><br>Examine risk factors and remedial measures in treating cardiovascular disease. | squared) greater than 30 is used to indicate obesity. Accurate measurement of body fat requires the measurement of body density. Obesity is linked to high fat diets and a decrease in physical activity. The energy intake in the diet should limit fats and free sugars as fats have a high calorific value per gram and free sugars require no metabolic energy to be expended in their digestion. Exercise increases energy expenditure and preserves lean tissue. Exercise can help to reduce risk factors for CVD by keeping weight under control, minimising stress, reducing hypertension and improving HDL blood lipid profiles. |

# Neurobiology and Communication

## Introduction

The human species has a particularly well developed brain and nervous system which has enabled the species to develop highly sophisticated behaviours including communication skills that allow the transmission of knowledge, development of culture and social evolution. The study of the nervous system in humans also allows learners to gain an insight into the biological basis of psychology, further widening their scientific experience.

The approach taken to the nervous system is based more on its function than structure. The system as a whole is seen as collecting and analysing information and making voluntary and involuntary responses. The brain is viewed as having three concentric functional layers (the central core, limbic system and cerebral cortex) rather than its detailed structured anatomy. Although localisation of function in the brain is included, reflecting the advances made in imaging technology, emphasis should be placed on the brain functioning as a whole. Areas such as perception and memory support such an approach and create good opportunities for practical work including, in particular, the principles of experimental design.

Communication between neurons is studied from the point of view of the mechanism of transmission at the synapse and its regulation of the flow of impulses rather than the biology of the impulse mechanism. A variety of functions of the nervous system can be created by establishing neural pathways with differing characteristics. The links between neurotransmitters and behaviour are examined as is the use of chemicals that can act like neurotransmitters in the treatment of some disorders. The mechanism of recreational drugs that influence neurotransmission is also explored providing a deeper understanding of the risks involved in their use. As a consequence, opportunities will arise to consider issues of personal and social responsible citizenship.

The degree of communication of which humans are capable has led to complex and sophisticated social behaviours. A scientific approach to behaviour should be taken employing practical ethological approaches to studying infant attachment, non-verbal communication, group behaviour and social influence. Studying learning, the change in behaviour as a result of experience, lends itself to experiential practical work.

Learners should have a clear understanding of the following areas of content from their previous learning:

- Senses
- Reflex arc
- Structure of the nervous system
- Drug education (PSE)

| Mandatory Course key areas | Suggested learning activities | Exemplification of key areas |
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| **1 Divisions of the nervous system and parts of the brain** | | The nervous system analyses sensory information from the body and the external environment stores some aspects and makes decisions regarding appropriate responses and behaviours. It makes motor responses by initiating muscular contractions or glandular secretions. |
| (a)Structures and functions of the central nervous system (CNS). | | Sensory and motor neurons of the somatic nervous system (SNS) control the voluntary movement of skeletal muscles. Homeostatic control through sensory neurons and motor neurons conducting involuntary impulses to smooth muscle, cardiac muscle and glands. |
| (b) Structures and functions of the peripheral nervous system (PNS) to include the autonomic nervous system (ANS) and the somatic nervous system (SNS). The antagonistic action of the sympathetic and parasympathetic systems on heart rate, breathing rate and digestive processes. | | Sympathetic 'fight or flight' and parasympathetic 'rest and digest' responses on heart rate, breathing rate, peristalsis and intestinal secretions. |
| (c) The functions of the medulla and cerebellum in the central core of the brain. | | The central core contains the medulla that regulates the basic life processes of breathing, heart rate, arousal and sleep and the cerebellum which is responsible for controlling balance, posture and movement. |

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| (d) The functions of the limbic system | Case studies investigating the role of the limbic system in regulating fear, anger, aggression, pleasure, pain, addiction, sexual behaviour, thirst or hunger. | Functions include processing information for memories and influencing emotional and motivational states. |
| (e) The functions of the cerebral cortex in receiving sensory information, coordinating voluntary movement and making decisions in the light of experience. | Examine data on clinical observations of brain injuries and lesions, EEGs, brain scans and split brain studies as evidence of localisation of brain function. | Cerebral cortex is the centre of conscious thought; it also recalls memories and alters behaviour in the light of experience. |
| (f) Localisation of brain functions to include sensory areas, motor areas and the association areas concerning language, personality, imagination and intelligence. Information from one side of the body is processed in the opposite side of the cerebrum, transfer of information occurs through the corpus callosum. | Examine brain images using PET and fMRI techniques that highlight active regions of the brain: PET highlights areas with an increased demand for glucose and oxygen. fMRI detects changes in blood flow and offers an anatomical and functional brain image. | Some association areas deal with thought processes., The left cerebral hemisphere deals with information from the right visual field and controls the right side of the body and vice versa. |
| **2 Perception** and memory<br>(a) Perception is the process by which the brain analyses and makes sense out of incoming sensory information. The three areas of perception involve segregation of objects, perception of distance and recognition. | | Perception allows us to segregate objects from one another and their background, recognise what they are and to judge their distance from us. |
| (i) Segregation of objects.<br>Perceptual organisation into figure and ground. Perceptual organisation of stimuli into coherent patterns. | Analyse reversible figure and ground images. Carry out experiments on the grouping of stimuli by proximity, similarity, closure, orientation or simplicity. | |

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| Visual cues such as relative size, superimposition and relative height in field.<br><br>(ii) Perception of distance.<br>Binocular disparity in judging distance.<br>Perceptual constancy as objects become nearer and the viewing angle changes.<br><br>(iii) Recognition.<br>The importance of shape rather than detail in the recognition of objects. Matching perceived shapes to shape descriptions stored in memory and the role of inference in recognition. The influence of perceptual set where past experience, context or expectation influences the way a stimulus is perceived.<br><br>(b) Memory involves storage, retention and retrieval of information.<br>Memories include past experiences, knowledge and thoughts.<br>All information entering the brain passes through sensory memory and enters short-term memory. Information is then transferred to long-term memory (LTM) or discarded.<br><br>(i) Sensory memory. This lasts a few seconds and retains all of the visual or auditory input. | Analyse images of depth perception.<br>Plan and design investigations using the Muller-Lyer illusion.<br>Analyse the appearance of depth created by stereoscopes, 3D slide viewers and 3D movies.<br><br>Investigate the influence of perceptual set using ambiguous stimuli. | Working memory is an extension of STM used to perform cognitive tasks. |

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| (ii) Short-term memory (STM).<br>This includes memory span, the serial position effect, maintaining items by rehearsal and loss of items by displacement and decay. Improvement of STM by 'chunking'. | Design and carry out an investigation to determine the memory span for letters or numbers.<br>Carry out an investigation on increasing memory span of STM by 'chunking'<br>Carry out an investigation on the serial position effect. | |
| (iii) Long-term memory (LTM).<br>The transfer of information from STM to LTM due to rehearsal, organisation and elaboration. Information is encoded using shallow encoding or elaborative encoding. Retrieval is aided by the use of contextual cues. | Carry out an investigation on the factors which improve retrieval from LTM.<br><br>Case study on a memory disorder (eg Alzheimer's, stroke/brain injury, Aphasia, Amnesia, Wernicke-Korsakoff Syndrome). | Repetition (shallow encoding) and previous memories (elaborative encoding). Contextual cues relate to the method of coding. |
| (iv) Location of memory in the brain.<br>Episodic and semantic memories are stored in the cortex. Procedural memories (skills) are linked to the motor cortex. Emotional memories involve links between the cortex and the limbic system. Spatial memory is located in the limbic system. | Analyse data on the mode of action of memory enhancing drugs (smart drugs). | Episodic memory (the memory of events and experiences) and semantic memory (the record of facts and concepts). Episodic and semantic memory are stored in the region of the cortex where the sensory information was first received and encoded. |
| **3 The cells of the nervous system and neurotransmitters at synapses**<br>(a) Structure and function of neurons to include dendrites, cell body and axons. Sensory, motor and inter neurons. Structure and function of myelin sheath in increasing the speed of impulse conduction. Myelination | Examine suitable slides and photomicrographs of dendrites, cell body, axon and myelin sheath.<br><br>Analyse causes, symptoms and treatments | Axons are surrounded by a myelin sheath which insulates the axon and increases the speed of impulse conduction from node to node. As a result responses to stimuli in the first two years of life are not as rapid or coordinated as those of an older child or |

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| continues from birth to adolescence.<br>Glial cells.<br>Physically support neurons and produce the myelin sheath. They also maintain a homeostatic environment around the neurons and remove debris by phagocytosis. | of polio, multiple sclerosis and Tay-Sachs disease. | adult. Certain diseases destroy the myelin sheath causing a loss of coordination. |
| (b) Neurotransmitters at synapses.<br>Chemical transmission at the synapse by neurotransmitters to include vesicles, synaptic cleft and receptors. The need for removal of neurotransmitters by enzymes or reuptake to prevent continuous stimulation of post-synaptic neurons.<br>Receptors determine whether the signal is excitatory or inhibitory. Synapses can filter out weak stimuli arising from insufficient secretion of neurotransmitters. Summation of a series of weak stimuli can trigger enough neurotransmitter to fire an impulse. | Examine data on the action of curare (a muscle relaxant and agonist that binds to acetylcholine receptors) and strychnine (a poison and antagonist that binds to receptors that inhibit motor neurons resulting in fully contracted skeletal muscles).<br><br>Suitable examples to illustrate the mode of action of neurotransmitters include: Serotonin binding to its receptor is excitatory, GABA binding to its receptor is inhibitory, dopamine can exert an excitatory or an inhibitory effect depending on the type of receptor. Acetylcholine is removed by enzymatic degradation and norepinephrine (noradrenaline) by reabsorption. | Neurotransmitters relay messages from nerve to nerve within and out with the brain. Neurons connect with other neurons, muscle fibres and endocrine at a synaptic cleft. Neurotransmitters are stored in vesicles and released into the cleft on arrival of an impulse. They diffuse across the cleft and bind to receptors on nerve endings. |
| (c) Function of converging, diverging and reverberating neural pathways.<br>Plasticity of response is created when new neural pathways are developed to create new responses, bypass areas of brain damage, to suppress reflexes or responses | Investigate suitable examples of pathways include: convergence of neurons from the rods in the retina increasing sensitivity to low levels of illumination through summation, divergence of motor neurons in | Converging neural pathways increase the sensitivity to excitatory or inhibitory signals. Diverging neural pathways influence several neurons at the same time.<br>Reverberating pathway neurons later in the pathway synapse with earlier ones sending |

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| to sensory impulses. | fine motor control, reverberating pathways in breathing and short-term memory.<br>Analyse data on the neural development of rat brains in stimulating and deprived environments. Analyse data on brain development and sensory deprivation (eg blind cats and feral children).<br>Examine brain injury case histories.<br>Investigate the ability of the brain to suppress reflexes or sensory impulses. | the impulse back through the circuit. |
| (d) Neurotransmitters, mood and behaviour.<br>The functions of endorphins and dopamine.<br>Endorphins are neurotransmitters that stimulate neurons involved in reducing the intensity of pain. Increased levels are also connected with euphoric feelings, appetite modulation and release of sex hormones. Endorphin production increases in response to severe injury, prolonged and continuous exercise, stress and certain foods.<br><br>Dopamine induces the feeling of pleasure and reinforces particular behaviour in the reward pathway. | Analyse data on the links between base endorphin levels and pain threshold, depression and appetite. | The reward pathway involves neurons which secrete or respond to the neurotransmitter dopamine. The reward pathway is activated on engagement of beneficial behaviours, eg eating when hungry. |
| Neurotransmitter related disorders and their treatment.<br>Agonists bind to and stimulate receptors mimicking the neurotransmitter. Antagonists bind to specific receptors blocking the action of the neurotransmitter. Other drugs inhibit | Suitable case studies include Alzheimer's (loss of brain cells that synthesise acetylcholine and the use of cholinesterase inhibitors); Parkinson's (loss of dopamine synthesising neurons and the use of L-dopa | Many drugs used to treat neurotransmitter related disorders are similar to neurotransmitters. |

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| the enzymes which degrade neurotransmitters or inhibit re-uptake.<br><br>(e) Mode of action of recreational drugs.<br>Can mimic neurotransmitters. Changes in neurochemistry alter mood, cognition, perception and behaviour.<br>Many recreational drugs affect neurotransmission in the reward circuit of the brain.<br><br>Drug addiction/tolerance.<br>Sensitisation is an increase in the number and sensitivity of neurotransmitter receptors as a result of exposure to drugs that are antagonists and leads to addiction.<br>Desensitisation is a decrease in the number and sensitivity of receptors as a result of | crossing the blood brain barrier, monamine oxidase inhibitors and the potential use of adult stem cells); schizophrenia (overactive dopamine system and the use of dopamine antagonists); generalised anxiety disorders (imbalance in serotonin and norepinephrin and the use of GABA agonists and beta blockers); depression (low levels of serotonin and norepinephrin re-uptake inhibitors and monoamine oxidase enzyme inhibitors).<br><br>Suitable case studies include: cocaine blocking dopamine re-uptake channels, cannabis binding to cannabinoid receptors, the synthetic hallucinogen MDMA (ecstasy) stimulating serotonin levels and inhibiting its re-uptake, alcohol binding to GABA receptors and elevating dopamine levels, nicotine activating nicotinic receptors increasing the levels of dopamine, serotonin and epinephrine.<br>Analyse data on the influence of alcohol on reaction time.<br><br>Investigate genetic components of addiction.<br><br>Examine drug rehabilitation programmes which combat physical tolerance (eg methadone and buprenorphine) and | Recreational drugs may stimulate the release of neurotransmitters, imitate their action (agonists), block their binding (antagonists), and/or inhibit their re-uptake/enzymatic degradation. |

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| exposure to drugs that are agonists and leads to drug tolerance. | psychological dependency (eg counselling and cognitive-behavioural approaches). | |
| **4 Communication and social behaviour**<br>(a) The effect of infant attachment.<br>Infant attachment studies.<br>Early infant attachment is important in laying the foundation for the future formation of stable relationships. Secure attachment and insecure attachment, responses of detachment, anger or inconsistent responses.<br><br>Socialisation and learning.<br>Humans have a long period of dependency on adults providing time for socialisation and learning to occur. Authoritative control generally results in greater social competence than permissive control.<br><br>(b) The effect of communication.<br>The importance of non-verbal communication in the formation of relationships between individuals and how it can signal attitudes and emotions as well as acting as an aid to verbal communication.<br><br>Verbal communication is used in the transmission of knowledge, development of culture and social evolution. | Observe, measure and record infant behaviour (for example play, distress and proximity in the strange situation).<br><br>Analyse silent video clips for the six main types of facial expression (happiness, sadness, disgust, fear, anger and surprise).<br>Measure non-verbal communication in video clips by observing and recording, for example, facial expression, eye contact, touching, tone of voice and physical proximity. | Attachment becomes evident between 6 and 9 months. Measures of attachment in 'the strange situation'. Infants that form secure attachments are more likely to investigate their immediate environment helping the development of cognitive abilities.<br><br>As children develop, different methods of control can influence social competence.<br><br>Language uses symbols to represent |

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| | | information and enables it to be organised into categories and hierarchies thus accelerating learning and intellectual development. |
| (c) The effect of experience.<br>Learning is a change in behaviour as a result of experience.<br><br>The repeated use of a motor skill results in a motor pathway being established.<br>Human behaviour may be learned by observation and imitation.<br><br>Reinforcement, shaping and extinction of behaviour as seen in trial and error learning. | Design and carry out an investigation on learning using a finger maze.<br><br>Design and carry out an investigation on the speed of performance of a task by following instructions and by imitation.<br><br>Case studies of rewarded behaviour, unrewarded behaviour and shaping in learning. | Reinforcement is when behaviour patterns that have positive consequences for the individual are likely to be repeated. Shaping is the rewarding of behaviour that approximates to the desired behaviour. Extinction happens when behaviour patterns are not rewarded and so are likely to disappear. |
| Generalisation and discrimination. | | Generalisation and discrimination may result in, for example, a child who has been bitten by a dog to fear all dogs (generalisation) or only to fear large dogs (discrimination). |
| (d) The effect of group behaviour and social influence.<br><br>Social facilitation. | | |

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| Increased performance in competitive/audience situations.<br><br>De-individuation.<br>Loss of personal identity in a group leading to diminished restraints on behaviour.<br><br>Internalisation is the changing of beliefs as a result of persuasion. Identification is the changing of beliefs to be like an admired influencing source. | Examine and discuss strategies of persuasion and identifying with respected or admired individuals used in drug education and advertising. | De-individuation is often used to explain the anti-social behaviour of some groups which would not be shown by individuals from these groups on their own. |

# Immunology and Public Health

## Introduction

Mammals have well developed immune systems. As a consequence of living in densely populated groups, humans are particularly liable to transmitted diseases. To manage these hazards humans have developed public health measures and immunisation programmes.

A key function of the immune system is to recognise pathogens, some toxins and cancer cells as foreign, and to create a response to them. The immune system may also produce allergic responses to harmless foreign materials. Defence responses include general non-cellular and cellular responses including phagocytosis and natural killer cells. Key aspects of the specific cellular immune response include immune surveillance and clonal selection theory. Emphasis should be placed on the role of cytokines, antigen-presenting cells and memory cells in the function of T- and B-lymphocytes.

Emphasis is placed on the control of infectious disease by public health measures. Control of transmission of infectious diseases depends on an understanding of disease biology and the epidemiology of disease. The principles of active immunisation and vaccination should be considered using appropriate examples. A study of clinical trials for vaccines should be used to consider the design of such trials to ensure the elimination of bias, valid comparisons and minimisation of experimental error by using randomised, double blind, placebo controlled protocols. A study of herd immunity and public health policy allows aspects of population biology to be considered. Learners can have the opportunity to consider evidence-based decision making on public health policy issues related to the challenges to disease control presented by antigenic variation (eg annual influenza vaccination programme) and pathogens that attack the immune system (eg HIV and tuberculosis).

Learners should have a clear understanding of the following areas of content from their previous learning:

- Defences against disease (phagocytosis, antibodies, vaccination)
- Diseases (viruses, bacteria, fungi, parasites)
- Hygiene (personal, sexual, food, water)

| Mandatory Course key areas | Suggested learning activities | Exemplification of key areas |
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| **1 Non-specific defences**<br>(a) Physical and chemical defences. Epithelial cells form a physical barrier and produce secretions against infection.<br><br>(b) Inflammatory response to include release of histamine by mast cells causing vasodilation and increased capillary permeability. The increased blood flow and secretion of cytokines leads to an accumulation of phagocytes and the delivery of antimicrobial proteins and clotting elements to the site of infection.<br><br>(c) Phagocytes and apoptosis by natural killer (NK) cells.<br>Phagocytes and NK cells release cytokines which stimulate the specific immune response. Phagocytes recognise surface antigen molecules on pathogens and destroy them by phagocytosis. NK cells induce the viral infected cells to produce self-destructive enzymes in apoptosis.<br><br>**2 Specific cellular defences**<br>(a) Immune surveillance. | | The human body has the capacity to protect itself against pathogens, some toxins and cancer cells through the immune system.<br><br>A variety of specialised white blood cells provide protection against pathogens. |

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| A range of white blood cells constantly circulate monitoring the tissues. If tissues become damaged or invaded, cells release cytokines which increase blood flow resulting in specific white blood cells accumulating at the site of infection or tissue damage.<br><br>(b) Clonal selection theory.<br>Lymphocytes have a single type of membrane receptor specific for one antigen. Antigen binding leads to repeated lymphocyte division resulting in a clonal population of lymphocytes.<br><br>(c) T and B lymphocytes.<br>Lymphocytes respond specifically to antigens on foreign cells, cells infected by pathogens and toxins released by pathogens.<br>T-lymphocytes have specific surface proteins that allow them to distinguish between the surface molecules of the body's own cells and cells with foreign molecules on their surface.<br>Immune system regulation failure leads to T-lymphocyte immune response to self antigens (auto immune disease).<br>Allergy is a hypersensitive B lymphocyte response to an antigen that is normally harmless. | ABO and Rh blood typing.<br>Case studies on: Rheumatoid arthritis (cells in the joints produce cytokines that promote an immune response), Type 1 diabetes (T-cells attack insulin producing cells), multiple sclerosis (T-cells attack antigens on the myelin sheath).<br>Case studies on hay fever, anaphylactic shock and allergic asthma. | |

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| T-lymphocytes.<br>One group of T lymphocytes destroy infected cells by inducing apoptosis. Another group of T lymphocytes secrete cytokines that activate B lymphocytes and phagocytes. When pathogens infect tissue, some phagocytes capture the pathogen and display fragments of its antigens on their surface. These antigen presenting cells activate the production of a clone of T lymphocytes that move to the site of infection under the direction of cytokines.<br><br>B lymphocytes.<br>Each B lymphocyte clone produces a specific antibody molecule that will recognise a specific antigen surface molecule on a pathogen or a toxin. Antigen-antibody complexes may inactivate a pathogen or toxin or render it more susceptible to phagocytosis. In other cases the antigen-antibody complex stimulates a response which results in cell lysis. B lymphocytes activated by antigen presenting cells and T lymphocytes produce a clone of B lymphocytes that secrete antibodies into the lymph and blood where they make their way to the infected area. | | |

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| (d) Immunological memory.<br>Some T and B lymphocytes produced in response to antigens by clonal selection survive long-term as memory cells. A secondary exposure to the same antigen rapidly gives rise to a new clone of lymphocytes producing a rapid and greater immunological response. | | |
| **3 The transmission and control of infectious diseases**<br>(a) Infectious diseases caused by pathogens, transmitted by direct physical contact, water, food, body fluids, inhaled air or vector organisms and controlled by quarantine, antisepsis, individual responsibility (good hygiene, care in sexual health and appropriate storage/handling of food), community responsibility (quality water supply, safe food webs and appropriate waste disposal systems) and vector control.<br><br>(b) Epidemiological studies of infectious diseases.<br>Description of spread to include sporadic (occasional occurrence), endemic (regular cases occurring in an area), epidemic (unusually high number of cases in an area) or | Case study: comparison of the transmission methods of different pathogens, eg measles (air borne), HIV (body fluids) and cholera (water or food). | Due to its role in maintaining health and combating infectious diseases on a global level, the immune system is at the centre of much of the research in public health. Infectious diseases are caused by pathogens such as viruses, bacteria, fungi, protozoa and multicellular parasites.<br><br>Epidemiologists study the outbreak and pattern of infectious diseases to determine the factors which affect the spread of infectious disease. Based on epidemiological studies control measures can be considered. |

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| pandemic (a global epidemic). Control measures to include preventing transmission, drug therapy, immunisation or a combination of these.<br><br>**4 Active immunisation and vaccination and the evasion of specific immune response by pathogens**<br>(a) Active immunity can be developed by vaccination with antigens from infectious pathogens, so creating an immunological memory. Antigens from infectious pathogens, usually mixed with an adjuvant to enhance the immune response, include inactivated pathogen toxins, dead pathogens, parts of pathogens and weakened pathogens.<br><br>The design of vaccine clinical trials including randomised, double-blind and placebo-controlled protocols. Importance of group size to reduce experimental error and statistical significance. | Suitable examples of antigens include: inactivated pathogen toxins (tetanus and diphtheria), dead pathogens (polio and hepatitis A), parts of pathogens (HPV and hepatitis B) and weakened pathogens (measles, mumps and rubella). | Vaccines are subjected to clinical trials in the same way as other pharmaceutical medicines to establish their safety and efficacy before being licensed for use. Clinical trials use randomised, double-blind, placebo-controlled protocols. Subjects are split into groups in a randomised way in which neither the subjects nor the researchers know which group they are in to eliminate bias. One group of subjects |

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| | | receives the vaccine, while the second group receives a placebo control to ensure valid comparisons. At the end of the trial, results from the two groups, which must be of a suitable size to reduce the magnitude of experimental error are compared to determine whether there are any statistically significant differences between the groups. |
| The importance of herd immunity in infectious disease control.<br>Herd immunity occurs when a large percentage of a population are immunised. Non-immune individuals are protected as there is a lower probability they will come into contact with infected individuals.<br>The herd immunity threshold depends on the disease, the efficacy of the vaccine and the contact parameters for the population. | Case study: Mass vaccination programmes (TB, polio, smallpox) and the eradication of diseases. | This herd immunity is important in reducing the spread of diseases and in protecting vulnerable and non-vaccinated individuals. |
| Public health immunisation programmes.<br>Establishing herd immunity to a number of diseases. Difficulties when widespread vaccination is not possible due to malnutrition, poverty or vaccine rejected by a percentage of the population. | Comparison of the estimated herd immunity thresholds for vaccine preventable diseases. | In most countries, policy in public health medicine is to establish herd immunity to a number of diseases. Difficulties can arise when widespread vaccination is not possible due to malnutrition and poverty (the developing world), or when vaccines are rejected by a percentage of the population (the developed world). |
| (b) Many pathogens have evolved | | |

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| mechanisms that evade the specific immune system which has consequences for vaccination strategies.<br><br>Antigenic variation.<br>Some pathogens can change their antigens avoiding the effect of immunological memory. Role and impact in diseases like malaria, trypanosomiasis and influenza.<br><br>Direct attack on the immune system.<br>HIV attacks lymphocytes which is the major cause of AIDS.<br>Tuberculosis (TB) survives within phagocytes and avoids immune detection. | Use bioinformatics software to study the DNA sequence/protein differences between different types and strains of influenza viruses.<br><br>Case study on HIV including the public health measures and drug therapies for its control. | Antigenic variation occurs in diseases like malaria and trypanosomiasis and is one of the reasons why they are still so common in many parts of the world. Antigenic variation also occurs in the influenza virus explaining why it remains a major public health problem and why at risk individuals require to be vaccinated every year.<br><br>The absence or failure of some component of the immune system results in increased susceptibility to infection. HIV is the major cause of acquired immunodeficiency in adults. |

# Developing skills for learning, skills for life and skills for work

Learners are expected to develop broad generic skills as an integral part of their learning experience. The *Course Specification* lists the skills for learning, skills for life and skills for work that learners should develop through this Course. These are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and must be built into the Course where there are appropriate opportunities. The level of these skills will be appropriate to the level of the Course.

For this Course, it is expected that the following skills for learning, skills for life and skills for work will be significantly developed:

**Literacy**
Writing means the ability to create texts which communicate ideas, opinions and information, to meet a purpose and within a context. In this context, 'texts' are defined as word-based materials (sometimes with supporting images) which are written, printed, Braille or displayed on screen. These will be technically accurate for the purpose, audience and context.

**1.2 Writing**
Learners develop the skills to effectively communicate key areas of human biology, make informed decisions and describe, clearly, human biology issues in written media. Learners will have the opportunity to communicate applied knowledge and understanding throughout the Course, with an emphasis on applications and environmental/ethical/social impacts.

There will be opportunities to develop the literacy skills of listening and reading, when gathering and processing information in human biology.

**Numeracy**
This is the ability to use numbers in order to solve problems by counting, doing calculations, measuring, and understanding graphs and charts. This is also the ability to understand the results. Learners will have opportunities to extract, process and interpret information presented in numerous formats including tabular and graphical. Practical work will provide opportunities to develop time and measurement skills.

**2.1 Number processes**
Number processes means solving problems arising in everyday life through carrying out calculations, when dealing with data and results from experiments/investigations and everyday class work, making informed decisions based on the results of these calculations and understanding these results.

**2.2 Money, time and measurement**
This means using and understanding time and measurement to solve problems and handle data in a variety of biology contexts, including practical and investigative.

**2.3 Information handling**
Information handling means being able to interpret human biology data in tables, charts and other graphical displays to draw sensible conclusions throughout the Course. It involves interpreting the data and considering its reliability in making reasoned deductions and informed decisions. It also involves an awareness and understanding of the chance of events happening.

**Thinking skills**
This is the ability to develop the cognitive skills of remembering and identifying, understanding and applying. The Course will allow learners to develop skills of applying, analysing and evaluating. Learners can analyse and evaluate practical work and data by reviewing the process, identifying issues and forming valid conclusions. They can demonstrate understanding and application of key areas and explain and interpret information and data.

**5.3 Applying**
Applying is the ability to use existing information to solve human biology problems in different contexts, and to plan, organise and complete a task such as an investigation.

**5.4 Analysing and evaluating**
Analysis is the ability to solve problems in biology and make decisions that are based on available information.
It may involve the review and evaluation of relevant information and/or prior knowledge to provide an explanation.
It may build on selecting and/or processing information, so is a higher skill.

**5.5 Creating**
This is the ability to design something innovative or to further develop an existing thing by adding new dimensions or approaches. Learners can demonstrate their creativity, in particular, when planning and designing human biology experiments or investigations. Learners have the opportunity to be innovative in their approach. Learners also have opportunities to make, write, say or do something new.

In addition, learners will also have opportunities to develop working with others and citizenship.

**Working with others**
Learning activities provide many opportunities, in all areas of the Course, for learners to work with others. Practical activities and investigations, in particular, offer opportunities for group work, which is an important aspect of human biology and should be encouraged.

**Citizenship**
Learners will develop citizenship skills, when considering the applications of human biology on our lives, as well as environmental and ethical implications.

# Approaches to assessment

Assessment should cover the mandatory skills, knowledge and understanding of the Course. Assessment should be integral to and improve learning and teaching. The approach should involve learners and provide supportive feedback. Self- and peer-assessment techniques should be used, whenever appropriate.

See the *Unit Support Notes* for guidance on approaches to assessment of the Units of the Course.

# Skills of scientific experimentation, investigation and enquiry

Learners should acquire scientific skills through a series of learning experiences, investigations and experimental work. These skills should be developed throughout the Course using a variety of case studies, practical activities and other learning experiences, as appropriate. Some activities and experiences will lend themselves to developing particular skills more than others. For example, some practical activities will be particularly suitable for developing planning and designing skills, some for presenting and analysing data skills, and others for the skill of drawing conclusions. In selecting appropriate activities and experiences, teachers and lecturers should identify which skills are best developed in each activity to ensure the progressive development of all skills and to support learners' learning. Further details on the skills that should be developed in Course work are given below.

### Selecting information

Select and analyse relevant information from texts, tables, charts, keys, graphs and/or diagrams. The study of human biology involves dealing with written and visual information. Learners will often deal with more complex information than they can produce. Learners should be able to:

- work with quantitative and qualitative data, discrete and continuous data and sampled data
- deal with experimental data presented in tables, pie and bar charts, line graphs, lines of best fit, graphs with semi-logarithmic scales, graphs with error bars and information presented as box plots
- analyse and interpret typically two interconnected tables, charts, keys, graphs or diagrams or a single source of graphical information with two to three patterns, trends, conditions, variables or sets of results
- deal with statistical concepts such as the mean, range and standard deviation of data and statistically significant differences (as shown by error bars in graphs and plus and minus values in tables of results)
- deal with text to analyse its content, select appropriate information, identify and evaluate evidence, explain relationships, draw conclusions and display related knowledge
- use computers and software applications to search and retrieve relevant information

## Presenting information

Present information appropriately in a variety of forms, including summaries and extended text, flow charts, keys, diagrams, tables and/or graphs.

(a) Representing data. Learners should be able to:

- present variables from experimental or other data in an appropriate form including tables, charts, keys, graphs and diagrams
- distinguish between dependant and independent variables

(b) Communication. Learners should be able to:

- select, organise and present relevant information, including presenting alternative points of view, on a biological issue
- produce scientific reports which describe experimental procedures, record relevant observations and measurements, analyse and present results, draw conclusions and evaluate procedures with supporting argument
- produce extended text presenting relevant ideas clearly, coherently and logically using specialist vocabulary where appropriate
- use word processing and graphics packages, spreadsheets and other data handling software.

(c) Oral communication. Through discussion and presentations learners should be able to:

- convey information clearly and logically using specialist vocabulary where appropriate
- use images including charts, models, graphs, diagrams, illustrations or video in conveying information
- respond to others by answering questions, clarifying points, contributing points of view and asking questions to clarify or explore in greater depth.

## Processing information

Process information accurately using calculations where appropriate. Learners should be able to:

- perform calculations involving whole numbers, decimals and fractions
- calculate ratios and percentages including percentage increase and decrease
- round answers to an appropriate degree of accuracy (eg to two decimal places or three significant figures)
- deal with a range of units in accordance with Society of Biology recommendations. Learners will be expected to be able to convert between, eg, µg and mg
- deal with calculations involving negative numbers, numbers represented by symbols and scientific notation
- work with data to find the mean and range of the data
- calculate genetic ratios based on probability
- substitute numerical values into equations and changing the subject of an equation
- use software packages to carry out statistical and other data handling processes

## Planning, designing and carrying out

Plan, design and carry out experimental procedures to test given hypotheses or to illustrate particular effects. This could include identification of variables, controls and measurements or observations required.

(a) Planning and designing. Learners should be able to:

- state the aim of an investigation
- suggest a hypotheses for investigation based on observation of biological phenomena
- plan experimental procedures and select appropriate techniques
- suggest suitable variables that could be investigated in a given experimental set up
- identify dependent and independent variables in an investigation
- decide on the experimental designs required to ensure the validity of experimental procedures
- decide on the measurements and observations required to ensure reliable results
- modify procedures in the light of experience

(b) Carrying out. Learners should be able to:

- identify component tasks in practical work and plan a procedure (to include timings and allocation of tasks where appropriate)
- identify, obtain and organise the resources required for practical work
- carry out work in a methodical and organised way with due regard for safety and with appropriate consideration for the well-being of organisms and the environment where appropriate
- follow procedures accurately
- make and record observations and measurements accurately
- capture experimental data electronically using a range of devices
- modify procedures and respond to sources of error.

## Evaluating experimental procedures

Evaluate experimental procedures by commenting on the purpose or approach, the suitability and effectiveness of procedures, the control of variables, the limitations of equipment, possible sources of error and/or suggestions for improvement. Learners should be able to:

- identify and comment on variables that are not controlled in experimental situations and distinguish between dependent and independent variables
- identify sources of error in measurements and observations
- identify and comment on the reliability of results
- identify and comment on the validity of experimental designs
- suggest possible improvements to experimental set ups
- use observations and collected data to make suggestions for further work

## Drawing conclusions

Draw valid conclusions and give explanations supported by evidence or justification. Conclusions should include reference to the aim of the experiment, overall pattern to readings or observations, trends in results or comment on the connection between variables and controls. Learners should be able to:

- analyse and interpret experimental data to select relevant information from which conclusions can be drawn
- state the results of the investigation
- draw conclusions on the relationships between the dependent and independent variables
- take account of controls when drawing conclusions
- analyse and interpret experimental data to identify patterns, trends and rates of change

### Making predictions and generalisations

Make predictions and generalisations based on available evidence. Learners should be able to:

- predict the outcome in experimental situations from supplied information
- make generalisations from a range of biological information
- use modelling and simulation software to test predictions and answer questions related to biological and experimental phenomena
- use evidence to support a personal decision or point of view on a current scientific, technological, environmental or health issue

See the *Unit Support Notes* for guidance on approaches to assessment of the Units of the Course.

# Added value

At Higher, the added value will be assessed in the Course assessment.

Information given in the *Course Specification* and the *Course Assessment Specification* about the assessment of added value is mandatory.

If this Unit is being taken as part of the Higher Human Biology Course, the learner will be required to draw on, extend and apply the skills and knowledge they have developed during this Unit within the *Course Assessment* (Question Paper and Assignment).

# Preparation for Course assessment

Each Course has additional time which may be used at the discretion of the teacher or lecturer to enable learners to prepare for Course assessment. This time may be used near the start of the Course and at various points throughout the Course for consolidation and support. It may also be used for preparation for Unit assessment, and towards the end of the Course, for further integration, revision and preparation and/or gathering evidence for Course assessment.

During delivery of the Course, opportunities should be found:

- for identification of particular aspects of work requiring reinforcement and support
- to practise skills of scientific inquiry and investigation in preparation for the Assignment
- to practise question paper techniques

# Combining assessment across Units

If an integrated approach to Course delivery is chosen then there may be opportunities for combining assessment across Units. If this approach is used, then it is necessary to be able to track evidence for individual Outcomes and Assessment Standards.

**Transfer of Evidence:**
Evidence for the achievement of Outcome 1 and Assessment Standard 2.2 for one Unit can be used as evidence of the achievement of Outcome 1 and Assessment Standard 2.2 in the other Units of this Course.

# Equality and inclusion

The following should be taken into consideration:

| Situation | Reasonable adjustment |
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| Carrying out practical activities. | Use could be made of practical helpers for learners with:<br>♦ physical disabilities, especially manual dexterity, when carrying out practical activities<br>♦ visual impairment who have difficulty distinguishing colour changes or other visual information |
| Reading, writing and presenting text, symbolic representation, tables, graphs and diagrams. | Use could be made of ICT, enlarged text, alternative paper and/or print colour and/or practical helpers for learners with visual impairment, specific learning difficulties and physical disabilities. |
| Process information using calculations. | Use could be made of practical helpers for learners with specific cognitive difficulties (eg dyscalculia). |
| Draw a valid conclusion, giving explanations and making generalisation/predictions. | Use could be made of practical helpers for learners with specific cognitive difficulties or autism. |

As far as possible, reasonable adjustments should be made for the Question Paper and/or Assignment, where necessary. All adjustments currently available for the Question Paper would be available for Component 1. Learners will have a choice of Assignment topic for Component 2, for which reasonable adjustments can be made. This includes the use of 'practical helpers', readers, scribes, adapted equipment or assistive technologies.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Course Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Course.

It is important that centres are aware of and understand SQA's assessment arrangements for disabled learners, and those with additional support needs, when making requests for adjustments to published assessment arrangements. Centres will find more guidance on this in the series of publications on Assessment Arrangements on SQA's website: www.sqa.org.uk/sqa/14977.html.

# Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications are available on SQA's website at: www.sqa.org.uk/sqa//14977.html.
- *Building the Curriculum 3: A framework for Learning and Teaching*
- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
- *Building the Curriculum 5: A framework for assessment*
- Course Specifications
- Design Principles for National Courses
- *Guide to Assessment* (June 2008)
- Principles and practice papers for sciences curriculum area
- Science: A Portrait of current practice in Scottish Schools (2008)
- *SCQF Handbook: User Guide* (published 2009) and SCQF level descriptors (reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*

# Administrative information

**Published:** May 2015 (version 2.1)

## History of changes to Course Support Notes

| Course details | Version | Description of change | Authorised by | Date |
|---|---|---|---|---|
| | 2.0 | Major changes to Mandatory knowledge and Exemplification of key areas. Amendments to "Division and differentiation in human cells" due to scientific advances<br>The original Assessment Standards 2.2 and 2.3 have been removed, and the original Assessment Standard 2.4 therefore becomes 2.2 | Qualifications Development Manager | June 2014 |
| | 2.1 | Minor typographical changes made. | Qualifications Manager | May 2015 |
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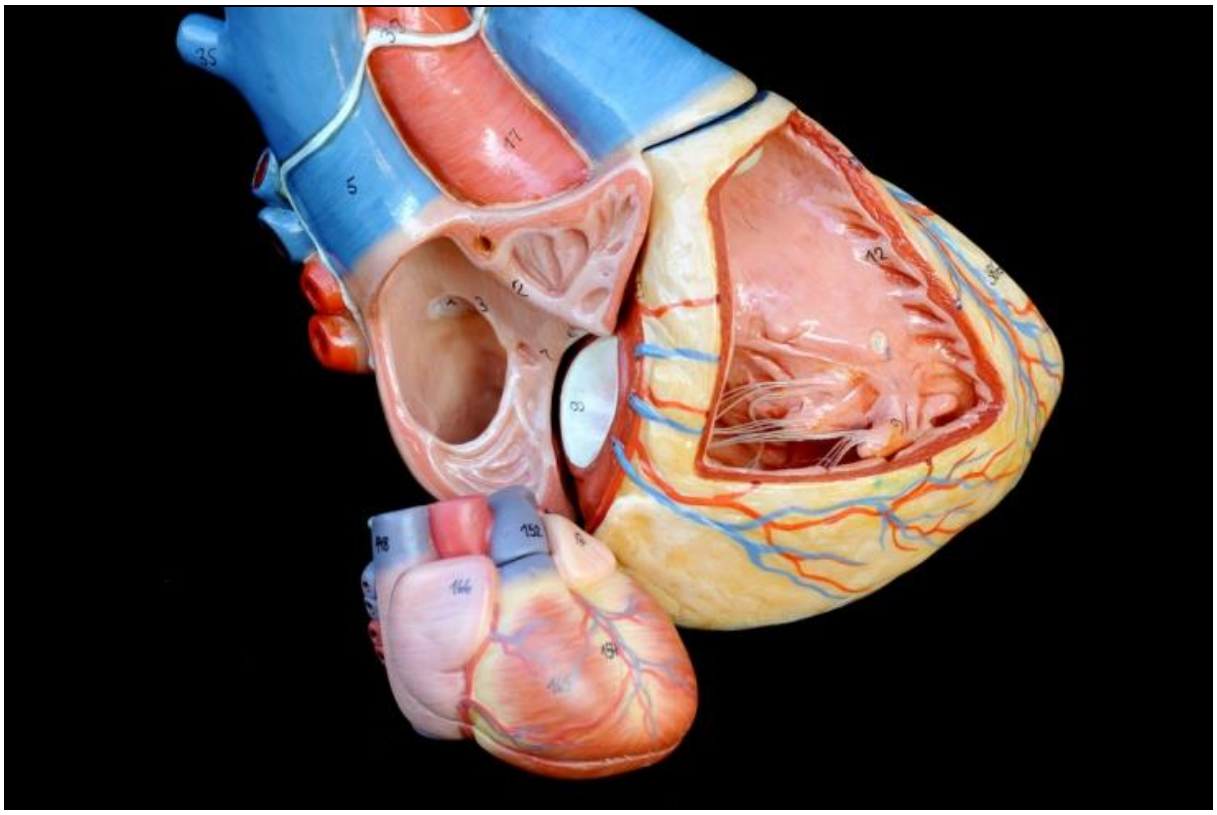
Unit Support Notes

# Unit Support Notes — Human Biology: Human Cells (Higher)





Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

# Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the Human Biology: Human Cells (Higher) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- the *Unit Specification*
- the *Course Specification*
- the *Course Assessment Specification*
- the *Course Support Notes*
- appropriate assessment support materials

# General guidance on the Unit

## Aims

The general aim of this Unit is to develop skills of scientific inquiry, investigation and analytical thinking, along with knowledge and understanding of human cells.

Learners will apply these skills when considering the applications of human cells on our lives, as well as the implications on society/the environment. This can be done by using a variety of approaches, including investigation and problem solving.

The Unit covers the key areas of:

- Division and differentiation in human cells
- Structure and replication of DNA
- Gene expression
- Genes and proteins in health and disease
- Human genomics.
- Metabolic pathways
- Cellular respiration
- Energy systems in muscle cells

Learners will research issues, apply scientific skills and communicate information related to their findings, which will develop skills of scientific literacy.

## Progression into this Unit

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained the skills, knowledge and understanding required by the following or equivalent qualifications and/or experience:

- National 5 Biology Course

## Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the Higher Human Biology *Course Support Notes*.

If this Unit is being delivered on a free-standing basis, teachers and lecturers should cover the mandatory skills and key areas in ways which are most appropriate for delivery in their centres.

## Progression from this Unit

This Unit may provide progression to:

- other qualifications in Biology or related areas
- further study, employment and/or training

# Approaches to learning and teaching

Approaches to learning and teaching and suggested learning activities are covered in the *Course Support Notes*.

## Developing skills for learning, skills for life and skills for work

Information about developing skills for learning, skills for life and skills for work in this Unit, is given in the relevant *Course Support Notes*.

## Approaches to assessment and gathering evidence

The purpose of this section is to give advice on approaches to assessment for the Unit. There will be other documents produced for centres to provide exemplification of assessments and guidance on how to write them.

Approaches to the assessment of a Unit when it forms part of a Course may differ from approaches to assessing the same Unit when it is not being delivered as part of a Course. If an integrated approach to Course delivery is chosen, then there may be opportunities for combining assessment across Units.

Assessments must be valid, reliable and fit for purpose for the subject and level, and should fit in with learning and teaching approaches.

Unit assessment should support learning and teaching and, where possible, enable personalisation and choice for learners in assessment methods and processes. Teachers and lecturers should select the assessment methods they believe are most appropriate, taking into account the needs of their learners and the requirements of the Unit.

There is no mandatory order for delivery of the Outcomes. These should be overtaken throughout the Unit and are an integral part of learning and teaching. The table below gives guidance and advice on possible approaches to assessment and gathering evidence:

| **Strategies for gathering evidence** |
| --- |
| There may be opportunities in the day-to-day delivery of the Units in a Course to observe learners providing evidence, which satisfies completely, or partially, a Unit or Units. This is naturally occurring evidence and can be recorded as evidence for an Outcome or parts of an Outcome. In some cases, additional evidence may also be required to supplement and confirm the naturally occurring evidence.<br><br>Approaches to assessment might cover the whole Unit or be combined across Outcomes. A holistic approach can enrich the assessment process for the |

learner by bringing together different Outcomes and/or Assessment Standards. If a holistic approach is used, then it is necessary to be able to track individual Assessment Standard evidence.

Strategies for gathering evidence and ensuring that the learners' work is their own could include:

- personal interviews during which the teacher or lecturer can ask additional questions about completed work
- an oral presentation on their work
- writing reports in supervised conditions
- checklists to record the authenticity
- supplementary sources of evidence, such as witness testimony, film or audio clips

Evidence can be gathered from classwork, experiments, investigations and/or research carried out in this Unit. It can be obtained using one or more of the strategies outlined above or by alternative methods, which could include a test of knowledge, understanding and skills.

# Equality and inclusion

The *Course Support Notes* provide full information on equality and inclusion for this Unit.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Unit Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Unit.

Alternative approaches to Unit assessment to take account of the specific needs of learners can be used. However, the centre must be satisfied that the integrity of the assessment is maintained and that the alternative approaches to assessment will, in fact, generate the necessary evidence of achievement.

# Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications on SQA's website: http://www.sqa.org.uk/sqa/14976.html
- *Building the Curriculum 3: A framework for Learning and Teaching*
- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
- *Building the Curriculum 5: A framework for assessment*
- Course Specifications
- Design Principles for National Courses
- *Guide to Assessment* (June 2008)
- *Principles and practice papers for curriculum areas*
- Science: A Portrait of current practice in Scottish Schools (2008)
- *Research Report 4 — Less is More: Good Practice in Reducing Assessment Time*
- *Coursework Authenticity — a Guide for Teachers and Lecturers*
- *SCQF Handbook: User Guide (published 2009)* and SCQF level descriptors (reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*
- SQA Guidelines on e-assessment for Schools
- SQA Guidelines on Online Assessment for Further Education
- SQA e-assessment web page: www.sqa.org.uk/sqa/5606.html

# Administrative information

**Published:** May 2015 (version 1.1)

## History of changes to Unit Support Notes

| Unit details | Version | Description of change | Authorised by | Date |
|---|---|---|---|---|
| | 1.1 | Footer added. | Qualifications Manager | May 2015 |
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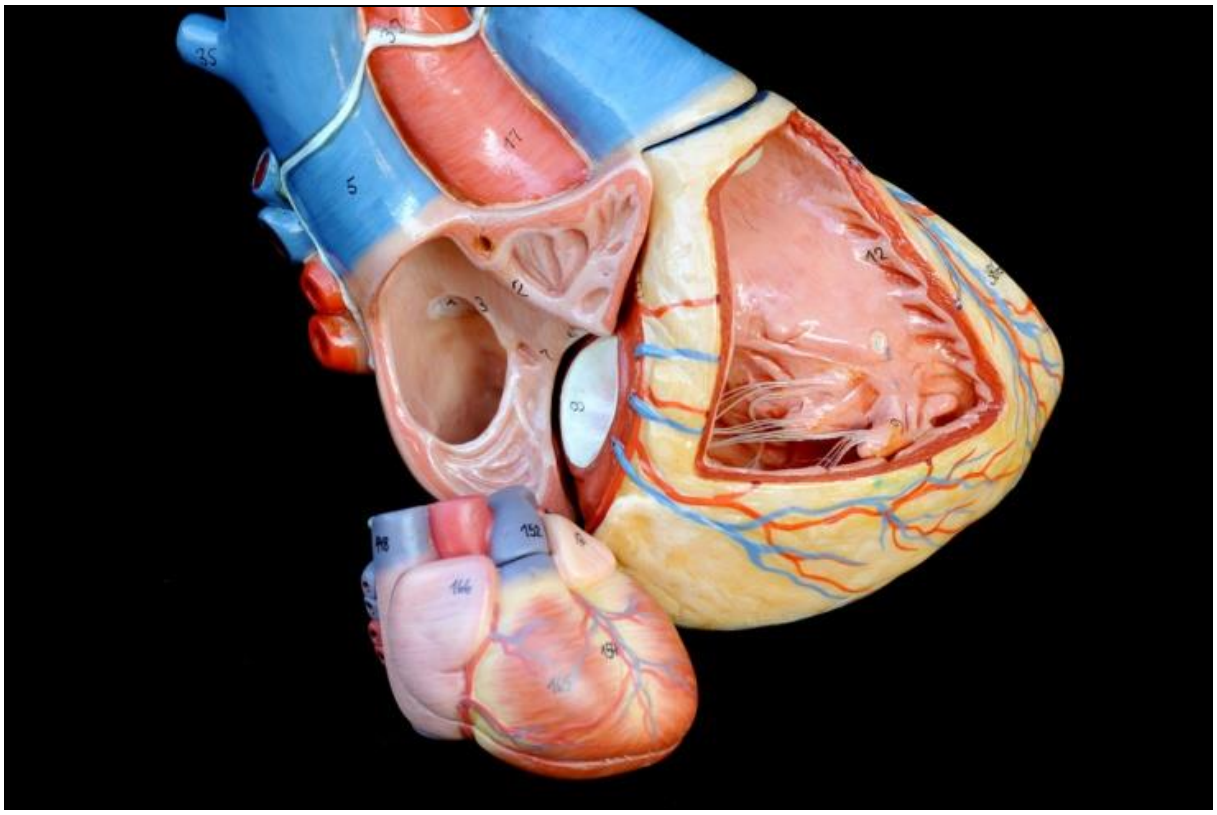
Unit Support Notes

# Unit Support Notes — Human Biology: Physiology and Health (Higher)





Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

# Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the Human Biology: Physiology and Health (Higher) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- the *Unit Specification*
- the *Course Specification*
- the *Course Assessment Specification*
- the *Course Support Notes*
- appropriate assessment support materials

# General guidance on the Unit

## Aims

The general aim of this Unit is to develop skills of scientific inquiry, investigation and analytical thinking, along with knowledge and understanding of physiology and health.

Learners will apply these skills when considering the applications of physiology and health on our lives, as well as the implications on the environment/society. This can be done by using a variety of approaches, including investigation and problem solving.

The Unit covers the key areas of:

- The structure and function of reproductive organs and gametes and their role in fertilisation
- Hormonal control of reproduction
- The biology of controlling fertility
- Ante- and postnatal screening
- The structure and function of arteries, capillaries and veins
- The structure and function of the heart
- Pathology of cardio vascular disease (CVD)
- Blood glucose levels and obesity

Learners will research issues, apply scientific skills and communicate information related to their findings, which will develop skills of scientific literacy.

## Progression into this Unit

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained the skills, knowledge and understanding required by the following or equivalent qualifications and/or experience:

- National 5 Biology Course

## Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the Higher Human Biology *Course Support Notes*.

If this Unit is being delivered on a free-standing basis, teachers and lecturers should cover the mandatory skills and key areas in ways which are most appropriate for delivery in their centres.

## Progression from this Unit

This Unit may provide progression to:

- other qualifications in Biology or related areas
- further study, employment and/or training

# Approaches to learning and teaching

Approaches to learning and teaching and suggested learning activities are covered in the *Course Support Notes*.

## Developing skills for learning, skills for life and skills for work

Information about developing skills for learning, skills for life and skills for work in this Unit, is given in the relevant *Course Support Notes*.

## Approaches to assessment and gathering evidence

The purpose of this section is to give advice on approaches to assessment for the Unit. There will be other documents produced for centres to provide exemplification of assessments and guidance on how to write them.

Approaches to the assessment of a Unit when it forms part of a Course may differ from approaches to assessing the same Unit when it is not being delivered as part of a Course. If an integrated approach to Course delivery is chosen, then there may be opportunities for combining assessment across Units.

Assessments must be valid, reliable and fit for purpose for the subject and level, and should fit in with learning and teaching approaches.

Unit assessment should support learning and teaching and, where possible, enable personalisation and choice for learners in assessment methods and processes. Teachers and lecturers should select the assessment methods they believe are most appropriate, taking into account the needs of their learners and the requirements of the Unit.

There is no mandatory order for delivery of the Outcomes. These should be overtaken throughout the Unit and are an integral part of learning and teaching.

The table below gives guidance and advice on possible approaches to assessment and gathering evidence:

| **Strategies for gathering evidence** |
| --- |
| There may be opportunities in the day-to-day delivery of the Units in a Course to observe learners providing evidence, which satisfies completely, or partially, a Unit or Units. This is naturally occurring evidence and can be recorded as evidence for an Outcome or parts of an Outcome. In some cases, additional evidence may also be required to supplement and confirm the naturally occurring evidence. |

Approaches to assessment might cover the whole Unit or be combined across Outcomes. A holistic approach can enrich the assessment process for the learner by bringing together different Outcomes and/or Assessment Standards. If a holistic approach is used, then it is necessary to be able to track individual Assessment Standard evidence.

Strategies for gathering evidence and ensuring that the learners' work is their own could include:

- personal interviews during which the teacher or lecturer can ask additional questions about completed work
- an oral presentation on their work
- writing reports in supervised conditions
- checklists to record the authenticity
- supplementary sources of evidence, such as witness testimony, film or audio clips

Evidence can be gathered from classwork, experiments, investigations and/or research carried out in this Unit. It can be obtained using one or more of the strategies outlined above or by alternative methods, which could include a test of knowledge, understanding and skills.

# Equality and inclusion

The *Course Support Notes* provide full information on equality and inclusion for this Unit.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Unit Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Unit.

Alternative approaches to Unit assessment to take account of the specific needs of learners can be used. However, the centre must be satisfied that the integrity of the assessment is maintained and that the alternative approaches to assessment will, in fact, generate the necessary evidence of achievement.

# Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications on SQA's website: http://www.sqa.org.uk/sqa/14976.html
- *Building the Curriculum 3: A framework for Learning and Teaching*
- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
- *Building the Curriculum 5: A framework for assessment*
- Course Specifications
- Design Principles for National Courses
- *Guide to Assessment* (June 2008)
- *Principles and practice papers for curriculum areas*
- Science: A Portrait of current practice in Scottish Schools (2008)
- *Research Report 4 — Less is More: Good Practice in Reducing Assessment Time*
- *Coursework Authenticity — a Guide for Teachers and Lecturers*
- *SCQF Handbook: User Guide (published 2009)* and SCQF level descriptors (reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*
- SQA Guidelines on e-assessment for Schools
- SQA Guidelines on Online Assessment for Further Education
- SQA e-assessment web page: www.sqa.org.uk/sqa/5606.html

# Administrative information

**Published:** May 2015 (version 1.1)

## History of changes to Unit Support Notes

| Unit details | Version | Description of change | Authorised by | Date |
|---|---|---|---|---|
| | 1.1 | Footer amended to show correct Unit title. | Qualifications Manager | May 2015 |
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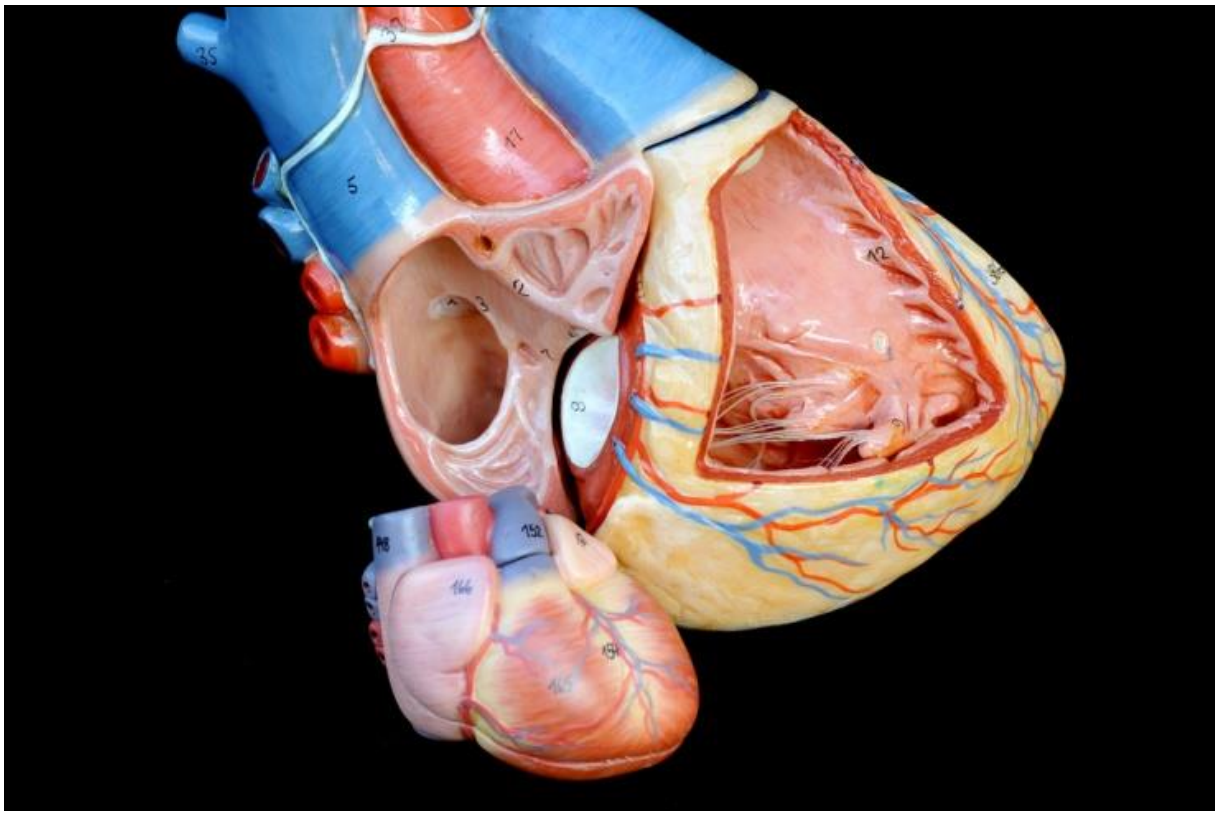
Unit Support Notes

# Unit Support Notes — Human Biology: Neurobiology and Communication (Higher)





Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

# Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the Human Biology: Neurobiology and Communication (Higher) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- the *Unit Specification*
- the *Course Specification*
- the *Course Assessment Specification*
- the *Course Support Notes*
- appropriate assessment support materials

# General guidance on the Unit

## Aims

The general aim of this Unit is to develop skills of scientific inquiry, investigation and analytical thinking, along with knowledge and understanding of neurobiology and communication.

Learners will apply these skills when considering the applications of neurobiology and communication on our lives, as well as the implications on society/the environment. This can be done by using a variety of approaches, including investigation and problem solving.

The Unit covers the key areas of:

- Divisions of the nervous system and parts of the brain
- Perception and memory
- The cells of the nervous system and neurotransmitters at synapses
- Communication and social behaviour

Learners will research issues, apply scientific skills and communicate information related to their findings, which will develop skills of scientific literacy.

## Progression into this Unit

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained the skills, knowledge and understanding required by the following or equivalent qualifications and/or experience:

- National 5 Biology Course

## Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the Higher Human Biology *Course Support Notes*.

If this Unit is being delivered on a free-standing basis, teachers and lecturers should cover the mandatory skills and key areas in ways which are most appropriate for delivery in their centres.

## Progression from this Unit

This Unit may provide progression to:

- other qualifications in Biology or related areas
- further study, employment and/or training

# Approaches to learning and teaching

Approaches to learning and teaching and suggested learning activities are covered in the *Course Support Notes*.

## Developing skills for learning, skills for life and skills for work

Information about developing skills for learning, skills for life and skills for work in this Unit, is given in the relevant *Course Support Notes*.

## Approaches to assessment and gathering evidence

The purpose of this section is to give advice on approaches to assessment for the Unit. There will be other documents produced for centres to provide exemplification of assessments and guidance on how to write them.

Approaches to the assessment of a Unit when it forms part of a Course may differ from approaches to assessing the same Unit when it is not being delivered as part of a Course. If an integrated approach to Course delivery is chosen, then there may be opportunities for combining assessment across Units.

Assessments must be valid, reliable and fit for purpose for the subject and level, and should fit in with learning and teaching approaches.

Unit assessment should support learning and teaching and, where possible, enable personalisation and choice for learners in assessment methods and processes. Teachers and lecturers should select the assessment methods they believe are most appropriate, taking into account the needs of their learners and the requirements of the Unit.

There is no mandatory order for delivery of the Outcomes. These should be overtaken throughout the Unit and are an integral part of learning and teaching.

The table below gives guidance and advice on possible approaches to assessment and gathering evidence:

**Strategies for gathering evidence**

There may be opportunities in the day-to-day delivery of the Units in a Course to observe learners providing evidence, which satisfies completely, or partially, a Unit or Units. This is naturally occurring evidence and can be recorded as evidence for an Outcome or parts of an Outcome. In some cases, additional evidence may also be required to supplement and confirm the naturally occurring evidence.

Approaches to assessment might cover the whole Unit or be combined across Outcomes. A holistic approach can enrich the assessment process for the learner by bringing together different Outcomes and/or Assessment Standards. If a holistic approach is used, then it is necessary to be able to track individual Assessment Standard evidence.

Strategies for gathering evidence and ensuring that the learners' work is their own could include:

- personal interviews during which the teacher or lecturer can ask additional questions about completed work
- an oral presentation on their work
- writing reports in supervised conditions
- checklists to record the authenticity
- supplementary sources of evidence, such as witness testimony, film or audio clips

Evidence can be gathered from classwork, experiments, investigations and/or research carried out in this Unit. It can be obtained using one or more of the strategies outlined above or by alternative methods, which could include a test of knowledge, understanding and skills.

# Combining assessment within Units

See *Course Support Notes*.

# Equality and inclusion

The *Course Support Notes* provide full information on equality and inclusion for this Unit.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Unit Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Unit.

Alternative approaches to Unit assessment to take account of the specific needs of learners can be used. However, the centre must be satisfied that the integrity of the assessment is maintained and that the alternative approaches to assessment will, in fact, generate the necessary evidence of achievement.

# Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications on SQA's website: http://www.sqa.org.uk/sqa/14976.html
- *Building the Curriculum 3: A framework for Learning and Teaching*
- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
- *Building the Curriculum 5: A framework for assessment*
- Course Specifications
- Design Principles for National Courses
- *Guide to Assessment* (June 2008)
- *Principles and practice papers for curriculum areas*
- Science: A Portrait of current practice in Scottish Schools (2008)
- *Research Report 4 — Less is More: Good Practice in Reducing Assessment Time*
- *Coursework Authenticity — a Guide for Teachers and Lecturers*
- *SCQF Handbook: User Guide (published 2009)* and SCQF level descriptors (to be reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*
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- SQA e-assessment web page: www.sqa.org.uk/sqa/5606.html

# Administrative information

**Published:** May 2015 (version 1.1)

## History of changes to Unit Support Notes

| Unit details | Version | Description of change | Authorised by | Date |
|---|---|---|---|---|
| | 1.1 | Developing skills for learning, skills for life and skills for work section amended to be in line with all other Units.<br>Title page amended to show correct Unit title. | Qualifications Manager | May 2015 |
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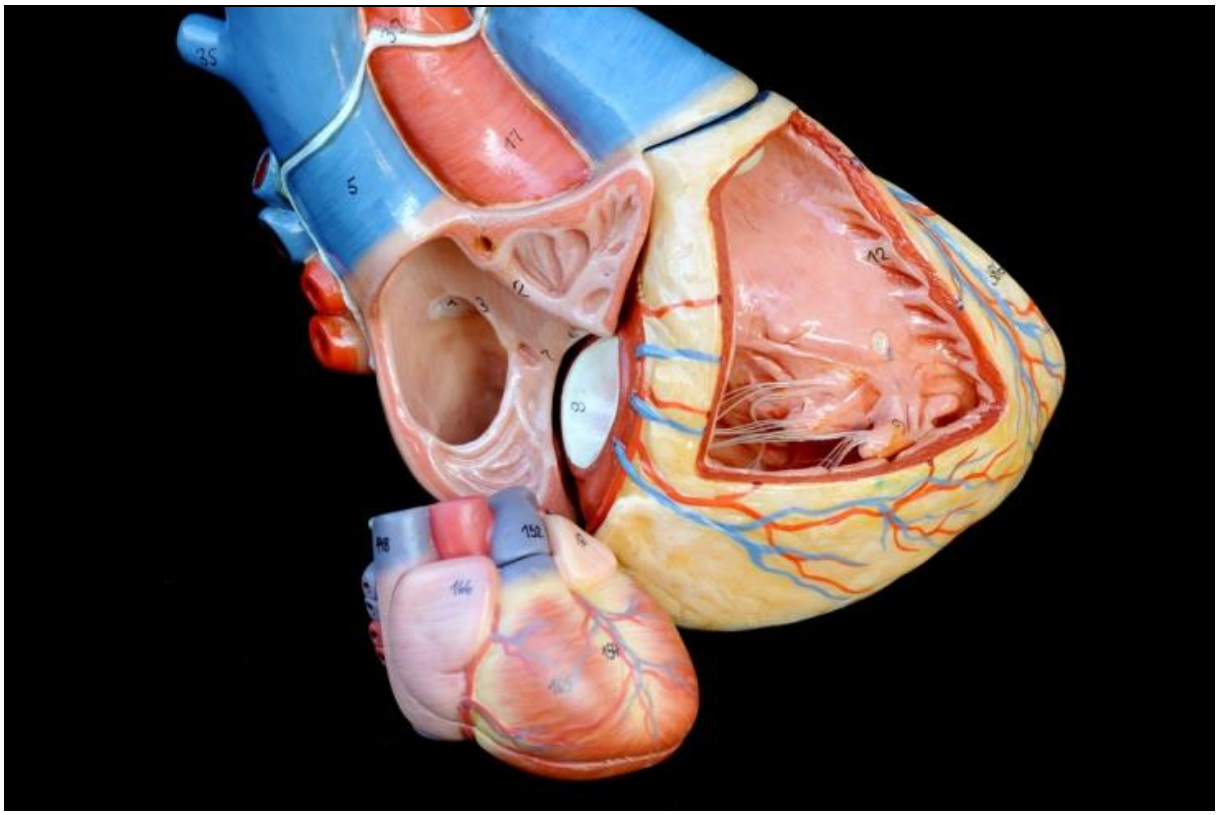
Unit Support Notes

# Unit Support Notes — Human Biology: Immunology and Public Health (Higher)





Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

# Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the Human Biology: Immunology and Public Health (Higher) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- the *Unit Specification*
- the *Course Specification*
- the *Course Assessment Specification*
- the *Course Support Notes*
- appropriate assessment support materials

If the *Unit Support Notes* have been developed for a Unit which is not part of a Course, then it is only necessary to read them in conjunction with the *Unit Specification*.

# General guidance on the Unit

## Aims

The general aim of this Unit is to develop skills of scientific inquiry, investigation and analytical thinking, along with knowledge and understanding of immunology and public health.

Learners will apply these skills when considering the applications of immunology and public health on our lives, as well as the implications on society/the environment. This can be done by using a variety of approaches, including investigation and problem solving.

The Unit covers the key areas of:

- Non-specific defences
- Specific cellular defences
- The transmission and control of infectious diseases
- Active immunisation and vaccination and the evasion of specific immune responses by pathogens

Learners will research issues, apply scientific skills and communicate information related to their findings, which will develop skills of scientific literacy.

## Progression into this Unit

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained the skills, knowledge and understanding required by the following or equivalent qualifications and/or experience:

- National 5 Biology Course

## Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the Higher Human Biology *Course Support Notes*.

If this Unit is being delivered on a free-standing basis, teachers and lecturers should cover the mandatory skills and key areas in ways which are most appropriate for delivery in their centres.

## Progression from this Unit

This Unit may provide progression to:

- Other qualifications in Biology or related areas
- Further study, employment and/or training

# Approaches to learning, teaching and assessment

Approaches to learning and teaching and suggested learning activities are covered in the *Course Support Notes*.

## Developing skills for learning, skills for life and skills for work

Information about developing skills for learning, skills for life and skills for work in this Unit, is given in the relevant *Course Support Notes*.

## General guidance on assessment

The purpose of this section is to give advice on approaches to assessment for the Unit. There will be other documents produced for centres to provide exemplification of assessments and guidance on how to write them.

Approaches to the assessment of a Unit when it forms part of a Course may differ from approaches to assessing the same Unit when it is not being delivered as part of a Course. If an integrated approach to Course delivery is chosen, then there may be opportunities for combining assessment across Units.

Assessments must be valid, reliable and fit for purpose for the subject and level, and should fit in with learning and teaching approaches.

Unit assessment should support learning and teaching and, where possible, enable personalisation and choice for learners in assessment methods and processes. Teachers and lecturers should select the assessment methods they believe are most appropriate, taking into account the needs of their learners and the requirements of the Unit.

There is no mandatory order for delivery of the Outcomes. These should be overtaken throughout the Unit and are an integral part of learning and teaching.

The table below gives guidance and advice on possible approaches to assessment and gathering evidence:

| **Strategies for gathering evidence** |
| --- |
| There may be opportunities in the day-to-day delivery of the Units in a Course to observe learners providing evidence, which satisfies completely, or partially, a Unit or Units. This is naturally occurring evidence and can be recorded as evidence for an Outcome or parts of an Outcome. In some cases, additional evidence may also be required to supplement and confirm the naturally occurring evidence.<br><br>Approaches to assessment might cover the whole Unit or be combined across Outcomes. A holistic approach can enrich the assessment process for the learner by bringing together different Outcomes and/or Assessment Standards. If a holistic approach is used, then it is necessary to be able to track individual Assessment Standard evidence.<br><br>Strategies for gathering evidence and ensuring that the learners' work is their own could include:<br><br>♦ personal interviews during which the teacher or lecturer can ask additional questions about completed work<br>♦ an oral presentation on their work<br>♦ writing reports in supervised conditions<br>♦ checklists to record the authenticity<br>♦ supplementary sources of evidence, such as witness testimony, film or audio clips<br><br>Evidence can be gathered from classwork, experiments, investigations and/or research carried out in this Unit. It can be obtained using one or more of the strategies outlined above or by alternative methods, which could include a test of knowledge, understanding and skills. |

# Equality and inclusion

The *Course Support Notes* provide full information on equality and inclusion for this Unit.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in this document is designed to sit alongside these duties but is specific to the delivery and assessment of the Unit.

Alternative approaches to Unit assessment to take account of the specific needs of learners can be used. However, the centre must be satisfied that the integrity of the assessment is maintained and that the alternative approach to assessment will, in fact, generate the necessary evidence of achievement.

# Appendix 1: Reference documents

The following reference documents will provide useful information and background.

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- *Building the Curriculum 4: Skills for learning, skills for life and skills for work*
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- *Research Report 4 — Less is More: Good Practice in Reducing Assessment Time*
- *Coursework Authenticity — a Guide for Teachers and Lecturers*
- *SCQF Handbook: User Guide (published 2009)* and SCQF level descriptors (reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- *SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*
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- SQA Guidelines on Online Assessment for Further Education
- SQA e-assessment web page: www.sqa.org.uk/sqa/5606.html

# Administrative information

**Published:** June 2014 (version 1.0)

## History of changes to Unit Support Notes

| Unit details | Version | Description of change | Authorised by | Date |
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