Human Biology (revised)
Higher

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National Course specification

Human Biology (revised) Higher

COURSE CODE C275 12

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Course structure

This Course has four mandatory Units. The mandatory Units are:

FH2K 12	*Human Cells* (Higher)	6 SCQF credits
FH2L 12	*Physiology and Health* (Higher)	6 SCQF credits
FH2M 12	*Neurobiology and Communication* (Higher)	3 SCQF credits
FH2N 12	*Immunology and Public Health* (Higher)	3 SCQF credits

Recommended entry

While entry is at the discretion of the centre, candidates would normally be expected to have attained a Biology National Qualification at SCQF level 5 or its equivalent

Progression

This Course or its Units may provide progression to:

- Advanced Higher Biology
- Life Science Courses at SCQF level 7

National Course specification: (cont)

COURSE Human Biology (revised) Higher

Credit value

The Higher Course in Human Biology (revised) is allocated 24 SCQF credit points at SCQF level 6*.

**SCQF points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

Each of the Units in this Course attracts 3 or 6 SCQF credits. Those attracting 6 credits would be 40 hours of programmed learning and those with 3 credits would be 20 hours of programmed learning. This Course includes 6 SCQF credits for 40 additional programmed hours which are not tied to any specific Unit. This may be used for induction, extending the range of learning and teaching approaches, support, consolidation, integration of learning and preparation for Course assessment.

Core Skills

Achievement of this Course gives automatic certification of the following:

Complete Core Skill	*Problem Solving* at SCQF level 6
Core Skill component	Using Graphical Information at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of the Unit specifications for this Course.

National Course specification: Course details (cont)

COURSE Human Biology (revised) Higher

Rationale

The Higher Human Biology Course provides a broad based integrated study of a selected range of biological topics which build on previous study. The Course content is set in contexts that are of particular significance and relevance to the human species.

The Course provides the opportunity for candidates to acquire a deeper understanding of cellular processes, physiological mechanisms, communication between organisms and the biology of populations as they apply to the human species. By setting these in human contexts relevant to candidates, opportunities arise naturally to develop capabilities associated with becoming successful candidates, confident individuals, responsible citizens and effective contributors.

The study of Higher Human Biology contributes to the candidate's scientific literacy by developing their skills of scientific experimentation, investigation and enquiry and skills for learning, life and work. These skills prepare candidates for life in the 21st century by enabling them to adapt their learning to new situations, solve problems, make decisions based on evidence and to evaluate the impact of science developments on their own health and well being, society and the environment.

By setting the acquisition of biological knowledge and skills in the context of Higher Human Biology a stimulating, relevant and enjoyable curriculum prepares candidates for further education, training or employment in areas associated with life sciences.

National Course specification: Course details (cont)

COURSE Human Biology (revised) Higher

Course content

The content of the Higher Human Biology Course develops Knowledge and Understanding, skills of scientific experimentation, investigation and enquiry and skills for learning, life and work. The Knowledge and Understanding and the skills associated with the Course content should be developed in contexts related to the content and explanatory notes in the tables of the Course specification. The suggested learning activities and approaches provide contexts in which science skills and Knowledge and Understanding can be developed and are not liable for assessment although they may provide contexts for assessment items. It is not intended that candidates should cover all of these suggested learning activities and approaches; rather a selection of these may be used along with other activities and approaches to best suit candidates' needs.

Knowledge and Understanding

Through study of the biology associated with the content statements and explanatory notes in the following tables candidates should be able to:

1 Demonstrate knowledge by making accurate statements about and describing the biology of human cells, processes, systems and relationships.
2 Apply their knowledge to new situations and when interpreting biological information and solving problems.
3 Demonstrate understanding by providing explanations and integrating different areas of knowledge.

Skills of scientific experimentation, investigation and enquiry

Practical work is essential in providing the contexts for the development of science skills. Through practical work candidates develop a deeper understanding of biological knowledge and acquire skills of:

1 Selecting and analysing relevant information from texts, tables, charts, keys, graphs and/or diagrams.
2 Presenting information appropriately in a variety of forms, including, extended writing, diagrams, tables and/or graphs.
3 Processing information accurately using calculations where appropriate. Calculations to include percentages, averages and/or ratios. Significant figures and units should be used appropriately.
4 Planning and designing experimental procedures to test given hypotheses or to illustrate particular effects. This could include identification of variables, controls and measurements or observations required.
5 Evaluating 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.
6 Drawing valid conclusions and giving explanations supported by evidence or justification. Conclusions should include reference to the overall pattern to readings or observations, trends in results or comment on the connection between variables and controls.
7 Making predictions and generalisations based on available evidence.

National Course specification: Course details (cont)

Course content (cont)

Skills for learning, life and work

By acquiring the knowledge, understanding and skills involved in the study of Human Biology candidates should develop capabilities that will enable them to be successful candidates, confident individuals, responsible citizens and effective contributors. By becoming scientifically literate individuals they should be able to communicate scientific knowledge by selecting and presenting relevant information. They should be able to analyse and interpret data to draw conclusions and to make predictions and generalisations. They should be able to solve problems through research, applying knowledge and through practical work in the field and laboratory. Planning and organising skills should be developed through practical work. The use of information technology should include interfacing equipment and data handling software. Candidates should be able to identify hazards, assess risk and suggest control measures and to make ethical decisions based on relevant information and the consequences of a course of action.

National Course specification: Course details (cont)

UNIT 1 — Human Cells

Introduction

Candidates will be familiar from previous study with the organisation of body cells into tissues, organs and systems. This Unit introduces 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, synthesized and recombined in the laboratory. These important advances in technology have led to the new science of bioinformatics and genomics with their implications for evolutionary relationships and 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 emphasized. 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.

National Course specification: Course details (cont)

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.

Candidates 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

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
1 Differentiation in Human cells (a) Stem cells	During embryological development the unspecialised cells of the early embryo differentiate into cells with specialised functions. Stem cells are relatively unspecialised cells that can continue to divide and can differentiate into specialised cells of one or more types. In the very early embryo, embryonic stem cells differentiate into all the cell types that make up the organism. Tissue (adult) stem cells replenish differentiated cells that need to be replaced and give rise to a more limited range of cell types. Tissue (adult) stem cells in the red bone marrow give rise to red blood cells, platelets and the various forms of phagocytes and lymphocytes. Once a cell becomes differentiated it only expresses the genes that produce the proteins 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).

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(b) Differentiation in somatic cells	Somatic cells form different types of body tissue. Epithelial cells cover the body surface and line body cavities, connective tissue includes blood, bone and cartilage cells, muscle cells form muscle tissue and nerve cells form nervous tissue. The body organs are formed from a variety of these tissues. 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.	
(c) Differentiation in germline cells	The nucleus of a germline cell can divide by mitosis to produce more germline cells or divide by meiosis to produce haploid gametes. Mutations that occur in germline cells will be passed to offspring whereas mutations in somatic cells will not.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(d) Research and therapeutic value of stem cells	Stem cell research provides information on how cell processes such as cell growth, differentiation and gene regulation work. Stem cells can also be used as model cells to study how diseases develop or for drug testing. The therapeutic uses of stem cells include bone marrow transplants, skin grafts for burns and stem cell grafts for cornea repair. 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). Case study on ethics of stem cell research and sources of stem cells. For example, embryo cells 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 reprogramme specialised cells to an embryonic state. Ethical issues could include: regulations on the use of embryo stem cells, the use of induced pluirpotent stem cells and the use of nuclear transfer techniques.
(e) Cancer cells	Cancer cells do not respond to regulatory signals and divide excessively to produce a mass of abnormal cells (a tumour). If the cancer cells fail to attach to each other they can spread through the body to form secondary tumours.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
2 Structure and function of DNA	The genotype of a cell is determined by the sequence of bases in its DNA.	
(a) Structure and replication of DNA	DNA is the molecule of inheritance and can direct its own replication.	
(i) Structure of DNA	Structure of a DNA nucleotide (deoxyribose sugar, phosphate and base). Nucleotides bond to form a sugar–phosphate backbone. Base pairs (adenine, thymine and guanine, cytosine,) held by weak hydrogen bonds forming a double helix. Double stranded antiparallel structure with deoxyribose and phosphate at 3' and 5' ends of each strand.	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.
(ii) Arrangement of DNA in chromosomes	Chromosomes consist of DNA tightly coiled and packaged with associated proteins.	
(iii) Replication of DNA	Prior to cell division, DNA polymerase replicates a DNA strand precisely using DNA nucleotides. DNA polymerase needs a primer to start replication.	Case study on Meselson and Stahl experiments on DNA replication.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	DNA unwinds to form two template strands. DNA polymerase adds complementary nucleotides to the deoxyribose (3') end of a DNA strand. This process occurs at several locations on a DNA molecule. DNA polymerase can only add nucleotides in one direction resulting in one strand being replicated continuously and the other strand replicated in fragments. Fragments of DNA are joined together by ligase.	
(b) Gene expression through protein synthesis	The phenotype is determined by the proteins produced as the result of gene expression, influenced by intra- and extracellular environmental factors. Only a fraction of the genes in a cell are expressed. Gene expression is controlled by the regulation of both transcription and translation. mRNA is transcribed from DNA in the nucleus and translated into proteins by ribosomes in the cytoplasm.	
(i) Structure and functions of RNA	Single strand, replacement of thymine with uracil and deoxyribose with ribose compared to DNA. mRNA carries a copy of the DNA code from the nucleus to the ribosome. rRNA and proteins form the ribosome. Each tRNA carries a specific amino acid.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(ii) Transcription of DNA into an RNA molecule	RNA polymerase moves along DNA unwinding 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). The introns of the primary transcript of mRNA are removed in RNA splicing.	Modelling transcription and translation using virtual and physical resources.
(iii) Translation of mRNA into a polypeptide	tRNA folds due to due to base pairing to form a triplet anticodon site and an attachment site for a specific amino acid. Triplet codons and anticodons of the genetic code. Start and stop codons. Codon recognition of incoming tRNA, peptide bond formation and exit of tRNA from the ribosome as polypeptide is formed.	
(iv) One gene, many proteins	A variety of proteins can be expressed from the same 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.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	Post translation protein structure modification by cutting and combining polypeptide chains or by adding phosphate or carbohydrate groups to the protein.	
(c) Genes and proteins in health and disease		
(i) Proteins	Proteins have a large variety of structures and shapes resulting in a wide range of functions. Amino acids are linked by peptide bonds to form polypeptides. Polypeptide chains fold to form the three dimensional shape of the protein. Chains are held together by hydrogen bonds and other interactions between the individual amino acids. In covering the functions of proteins reference should be made to the variety of proteins encountered in SCQF level five Courses.	Separation and identification of fish proteins by agarose gel electrophoresis. Investigation of the shape and structure of fibrous and globular proteins using RasMol or Protein Explorer software.
(ii) Mutations and genetic disorders	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.	Experiments investigating the effects of UV radiation on UV sensitive yeast.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Single gene mutations (point mutations/DNA sequence variations)	Single gene mutations involve the alteration of a DNA nucleotide sequence as a result of the substitution, insertion or deletion of nucleotides. Single-nucleotide substitutions include: missense (replacing one amino acid codon with another), nonsense (replacing an amino acid codon with a stop codon) and splice-site mutations (creating or destroying the codons for exon-intron splicing). Nucleotide insertions or deletions result in frameshift mutations or an expansion of a nucleotide sequence repeat.	Single gene mutation case studies: Sickle-cell disease (missense) PKU (missense) Beta (β) thalassemia (splice-site mutation) Duchenne muscular dystrophy (DMD) (nonsense) Tay-Sachs syndrome (frameshift insertion) Cystic fibrosis (frameshift deletion) Fragile X syndrome (nucleotide sequence repeat expansion) Huntingdon's disease (nucleotide sequence repeat expansion)
Altered protein structure and function in genetic disorders	The effect of missense, nonsense, splice-site, frameshift and nucleotide sequence repeat expansion mutations on the structure of the protein synthesised, its function and the effect of this on individuals.	
Altered chromosomal structure and genetic disorders	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 segment of a chromosome) or translocation (the rearrangement of chromosomal material involving two or more chromosomes). The substantial changes in chromosome mutations often make them lethal.	Chromosome mutation case studies: Cri-du-chat syndrome (deletion of part of the short arm of chromosome 5) Chronic myeloid leukemia (CML) (reciprocal translocation of a gene from chromosome 22 fused with a gene on chromosome 9) Familial Down's syndrome (in 5% of cases one parent has the majority of chromosome 21 translocated to chromosome 14)

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(d) Human genomics		
(i) Sequencing DNA	The sequence of bases can be determined for individual genes and entire genomes.	Genome determination case studies including the human genome project and the comparison of individual genomes using single nucleotide polymorphisms (SNPs).
Bioinformatics	The enormous amount of data produced by DNA and protein sequencing can be managed and analysed using computer technology and shared over the internet. Identifying gene sequences by looking for coding sequences similar to known genes, start sequences or sequences lacking stop codons. Identifying base sequences that correspond to the amino acid sequence of a protein.	Bioinformatics case studies Use genome data to identify stop and start codons and known protein coding sequences.
Systematics	Comparison of human genome sequence data (and genomes of other species) provides information on evolutionary relationships and origins.	Case study on evolution of primates and bears using Geneious software.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Personalised medicine	Analysis of an individual's genome may lead to personalised medicine through understanding the genetic component of risk of disease. The importance of distinguishing between neutral and harmful mutations and the complex nature of many diseases. Pharmacogenetics and the use of genome information in the choice of effective drugs.	The information gained from DNA studies can provide information on the structure of the genes and proteins involved in 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).
(ii) Amplification and detection of DNA sequences		
Polymerase Chain Reaction (PCR)	The polymerase chain reaction (PCR) is a technique for the amplification of DNA *in vitro*. In PCR, primers are complementary to specific target sequences at the two ends of the region to be amplified. DNA is heated to separate the strands. Cooling allows primers to bind to target sequences. 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.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
DNA probes	Arrays of DNA probes are used to detect the presence of specific sequences in samples of DNA. Each probe is a short single stranded fragment of DNA that is 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 micoarrays manufactured from RNA transcripts.
Medical and forensic applications	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. DNA profiling allows the identification of individuals through comparison of regions of the genome with highly variable numbers of repetitive sequences of DNA.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
3 Cell metabolism	Metabolism encompasses the integrated and controlled pathways of enzyme catalysed reactions within a cell.	
(a) Metabolic pathways	Metabolic pathways involve biosynthetic processes (anabolism) and the breakdown of molecules (catabolism) to provide energy and building blocks. Synthetic pathways require the input of energy; pathways that break down molecules usually release energy. Metabolic pathways can have reversible and irreversible steps and alternative routes may exist that can bypass steps in a pathway.	
(i) Control of metabolic pathways	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. 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.
Enzyme action	The activity of enzymes depends on their flexible and dynamic shape. The affinity of substrate molecules for the active site of an enzyme and induced fit. 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.	Activation energy experiments, comparing heat, manganese dioxide and catalase action on hydrogen peroxide.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Regulation of metabolic pathways by the action of enzymes	The effects of substrate and end product concentration on the direction and rate of enzyme reactions. 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. Enzymes often act in groups or as multi-enzyme complexes. 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. Non competitive inhibition or stimulation of enzyme activity by the binding of molecules that change the shape of the active site. Competitive inhibition for the active site by molecules that resemble the substrate and its reversal by increasing substrate concentration. The control of metabolic pathways by feedback inhibition where an end product binds to an enzyme that catalyses a reaction early in the pathway.	Experiments on reaction rate with increasing substrate concentration. DNA and RNA polymerases are part of a multi-enzyme complexes. Investigate the inhibition of beta galactosidase by galactose and its reversal by increasing ONPG concentration. Experiments on product inhibition with phosphatase.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(b) Cellular respiration	The metabolic pathways of cellular respiration are central to metabolism. They yield energy and are connected to many other pathways. Glucose is broken down in a series of enzyme controlled steps. Hydrogen and high energy electrons are removed by dehydrogenase enzymes and used to yield ATP.	
(i) Transfer of energy via ATP	Adenosine triphosphate (ATP) is used to transfer the energy released from cellular respiration to synthetic pathways and other cellular processes where energy is required. The breakdown of ATP to ADP and phosphate releasing energy. The regeneration of ATP from ADP and phosphate using the energy released from cellular respiration. The phosphorylation of molecules to alter their reactivity.	Experiments on ATP dependant reactions, eg luciferase, luminescent reactions. Experiments using phosphorylated substrates, (eg glucose-1-phosphate) using suitable positive and negative controls in the design of an experiment.
(ii) Synthesis of ATP	To synthesise the bulk of its ATP requirements, a cell uses a source of high energy electrons to pump H ions across a membrane. The return flow of these ions rotates part of the membrane protein ATP synthase, catalysing the synthesis of ATP.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(iii) Metabolic pathways of cellular respiration		
Glycolysis	The breakdown of glucose to pyruvate during glycolysis. The phosphorylation of intermediates in glycolysis in an energy investment phase and the direct generation of ATP in an energy pay off stage. 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.	
Citric acid cycle	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 citric acid cycle with some generation of ATP, the release of carbon dioxide and the regeneration of oxaloacetate.	Experiments on inhibition of citric acid cycle with malonic acid and DCPIP as an indicator of dehydrogenase activity.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Electron transport chain	The electron transport chain as a collection of proteins attached to a membrane. At certain steps in the glycolytic and citric acid pathways, dehydrogenase enzymes remove hydrogen ions from the substrate along with associated high-energy electrons. These hydrogen ions and high-energy electrons are passed to the coenzymes NAD or FAD forming NADH or $FADH_2$. NADH and $FADH_2$ release the high-energy electrons to the electron transport chain where they cascade down 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. The final electron acceptor is oxygen, which combines with hydrogen ions and electrons to form water.	Experiments with yeast dehydrogenase, eg using resazurin.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Substrates for respiration	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.	Investigation of different sugars as respiratory substrates in yeast. Research different use of substrates during exercise and starvation.
Regulation of the pathways of cellular respiration	Phosphofructokinase activity can be inhibited by ATP and citric acid. These feedback mechanisms help to synchronise the activity of glycolysis and the citric acid cycle to ensure the cell conserves its resources by only producing ATP from cellular respiration when it is required.	
(iii) The creatine phosphate system	During strenuous activity muscle cells break down ATP releasing ADP and phosphate, along with energy. Creatine phosphate in the muscle cells breaks down to provide energy and phosphate to convert ADP to ATP by phosphorylation. This system sustains maximal muscle contraction for a short period of time, eg about a 100 metre sprint.	Case study: effects of creatine supplements on fitness and sporting performance.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	When demand for energy in muscles is low ATP produced by cellular respiration acts as a source of phosphate for the phosphorylation of creatine into creatine phosphate, which acts as a store of energy for the muscle tissue.	
(iv) Lactic acid metabolism	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 repayed when exercise is complete allows respiration to provide the energy to convert lactic acid back to pyruvic acid and glucose in the liver.	
(v) Types of skeletal muscle fibres	The two different types of skeletal muscle fibres are slow twitch (type 1) muscle fibres and fast twitch (type 2) muscle fibres.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	Slow twitch muscle fibres contract more slowly, but can sustain contractions for longer. These 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. Fast twitch muscle fibres contract more quickly, but cannot sustain contractions for as long as slow twitch muscle fibres. These 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.	Case study: comparison of the ratios of slow twitch muscle fibres to fast twitch muscle fibres amongst elite athletes in different sports. 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.

National Course specification: Course details (cont)

UNIT 2 — 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 candidates 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 cardio vascular disease helps to deepen understanding of the cardiovascular system as well as developing 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 candidates to consider their personal responsibility when making life style choices.

National Course Specification: Course details (cont)

Candidates 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

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
1 Reproduction		
(a) The reproductive organs, gametes and fertilisation	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.	
(b) Hormonal control of reproduction	Hormones control the onset of puberty, sperm production and the menstrual cycle.	
(i) Hormonal onset of puberty	The pituitary gland is stimulated to release follicle stimulating hormone (FSH) and luteinising hormone (LH)/interstitial cell stimulating hormone (ICSH) by a releaser hormone produced in the hypothalamus.	
(ii) Hormonal control of sperm production	FSH promotes sperm production and ICSH stimulates the production of testosterone. Testosterone also stimulates sperm production and activates the prostate gland and seminal vesicles. Negative feedback control of testosterone by FSH and ICSH.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(iii) Hormonal control of the menstrual cycle	The menstrual cycle lasts for 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 prevents 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.	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.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(c) The biology of controlling fertility	Infertility treatments and contraception are based on the biology of fertility.	
(i) Fertile periods	Cyclical fertility in females leading to a fertile period. Continuous fertility in males. Calculation of fertile periods and their use.	Case studies on infertility, its causes and treatment to include overcoming problems in sperm production and ovulation, predicting fertile periods, and surgical interventions.
(ii) Treatments for infertility		
Stimulating ovulation	Ovulation can be 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.	
Artificial insemination	Artificial insemination is particularly useful where the male has a low sperm count. Several samples of semen are collected over a period of time. If a partner is sterile a donor may be used.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Intracytoplasmic sperm injection (ICSI)	If mature sperm are defective or very low in number ICSI can be used. In this technique the head of the sperm is drawn into a needle and injected directly into the egg to achieve fertilisation.	
In vitro fertilisation (IVF)	Surgical removal of eggs from ovaries after hormone stimulation. The eggs are then mixed with sperm in a culture dish. The fertilised eggs are incubated until they have formed at least 8 cells and are then transferred to the uterus for implantation. Pre-implantation genetic screening can be used at this stage to identify genetic disorders and chromosome abnormalities.	Examine data on the success rate for *in vitro* fertilisation (IVF) and its effect on long term health.
(iii) Contraception	Biological basis of physical methods such as barrier methods, avoiding fertile periods, intra uterine devices and sterilisation procedures. Chemical contraceptives are based on combinations of synthetic hormones that mimic negative feedback preventing the release of FSH/LH, prevent implantation (‘morning after pills’) or cause thickening of cervical mucus (‘mini pill’).	Case studies on the biological basis of physical and chemical contraceptives.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(d) Ante- and postnatal screening	A variety of techniques can be used to monitor the health of the mother and developing fetus. Antenatal screening identifies the risk of a disorder so that further tests and a prenatal diagnosis can be offered	
(i) Antenatal care	Blood pressure, blood type and general health checks (including routine blood and urine tests).	Case study on ante-natal care to include the use of ultrasound images and biochemical tests.
Ultrasound imaging	A dating scan at 8-14 weeks determines the stage of pregnancy and due date. An anomaly scan at 18-20 weeks may detect serious physical problems. Dating scans are used with tests for marker chemicals which vary normally during pregnancy. Measuring a substance at the wrong time could lead to a false positive result.	View ultrasound images at different stages of pregnancy. View specialised ultrasound images.
Biochemical tests	The health of mother and fetus can be monitored by biochemical tests that detect the normal physiological changes of pregnancy. Medical conditions can be detected by a range of marker chemicals that indicate a condition but need not necessarily be part of the condition.	Examine data on altered blood biochemistry due to altered renal, liver and thyroid function; alterations to carbohydrate and calcium metabolism; and hormonal changes.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Diagnostic testing	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. Cells from an amniocentesis sample can be cultured to obtain sufficient cells to produce a karyoptype. Chorionic villus sampling (CVS) from the placenta 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.	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. Construct karyoptypes 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.
Rhesus antibody testing	Generally mothers show no immune response to their fetus although sensitisation to Rhesus antigens can occur. Anti Rhesus antibodies are given to Rhesus negative mothers after a potentially sensitising event and after birth.	
(ii) Postnatal screening		
Diagnostic testing for metabolic disorders	Screening for phenylketonuria (PKU), an inborn error of metabolism. Individuals with high levels of phenylalanine are placed on a restricted diet.	Newborn screening for other diseases such as galactosaemia, congenital hypothyroidism, amino acid disorders.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Genetic screening and counselling	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). Patterns of inheritance in autosomal recessive, autosomal dominant, incomplete dominance and sex-linked recessive single gene disorders.	Examine case studies of inherited conditions including single gene disorders, chromosome abnormalities and conditions influenced by multiple genes. Calculate probability of outcomes in single gene inherited conditions. Suitable examples include: albinism, Huntington's chorea, sickle cell, thalassaemia, haemophilia, muscular dystrophy.
Pre-implantation genetic diagnosis (PGD)	The use of IVF in conjunction with PGD to identify single gene disorders and chromosomal abnormalities.	Consider moral/ethical issues surrounding PGD.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
2 The Cardiovascular System	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.	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.
(a) The structure and function of blood vessels	The endothelium lining the central lumen of blood vessels is surrounded by layers of tissue that differ between arteries, capillaries and veins.	
	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 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.	Examine prepared slides of arteries and veins. Measure the degree of stretching in arteries and veins with weights.
	Capillaries allow exchange of substances with tissues.	Observe capillaries, eg. nail bed.
	Veins have an outer layer of connective tissue containing elastic fibres but a much thinner muscular wall than arteries. Function of valves.	Demonstrate the presence of valves in veins.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(i) The exchange of materials between tissue fluid and cells	Pressure filtration of fluids through capillary walls. Similarity of tissue fluid and blood plasma with the exception of plasma proteins. 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.	Case study on disorders of the lymphatic system. Suitable examples include the effect of kwashiorkor on fluid balance and elephantiasis.
(b) The structure and function of the heart		
(i) Cardiac function	The left and right ventricles pump the same volume of blood through the aorta and pulmonary artery. 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).	Measuring pulse rate in arteries using pulsometer. Calculate cardiac output under different conditions.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(ii) The cardiac cycle	During diastole blood returning to the atria flows into the ventricles. Atrial systole transfers the remainder of the blood through the atrioventricular (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.	Interpret graphs of pressure changes in heart and blood vessels. Use a stethoscope or listen to a recording of heart sounds.
(iii) The cardiac conducting system	The heart beat originates in the heart itself but is regulated by both nervous and hormonal control. The autorhythmic cells of the sinoatrial 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 atrioventricular node (AVN) and then through the ventricles. These impulses generate currents that can be detected by an electrocardiogram (ECG). The medulla regulates the rate of the SAN through the antagonistic action of the autonomic nervous system (ANS). Sympathetic accelerator nerves release adrenaline (epinephrine) and slowing parasympathetic nerves release acetylcholine.	Examine normal and abnormal ECGs.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(iv) Blood pressure	Blood pressure changes in the aorta during the cardiac cycle. Measurement of blood pressure using a sphygmomanometer. An inflatable cuff stops blood flow and 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 typical reading for a young adult is 120/70 mmHg. Hypertension is a major risk factor for many diseases including coronary heart disease.	Measure blood pressure using a digital sphygmomanometer.
(c) Pathology of cardio vascular disease (CVD)		
(i) Atherosclerosis	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 artheroma 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. Atherosclerosis is the root cause of various cardio vascular diseases including angina, heart attack, stroke and peripheral vascular disease.	Examine league tables for coronary heart disease worldwide. Examine trends in coronary heart disease over last 10 years.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(ii) Thrombosis	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 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. A thrombosis in a coronary artery may lead to a heart attack (myocardial infarction). A thrombosis in an artery in the brain may lead to a stroke. Cells are deprived of oxygen leading to death of the tissues.	Investigate the use of thrombolytic medications such as streptokinase and tissue plasminogen activator. Compare and contrast the use of antiplatelet and anticoagulants therapies. Investigate examples of bleeding disorders such as Von Willebrand disease and haemophilia A, B and C.
(iii) Peripheral vascular disorders	Peripheral vascular disease is narrowing of the arteries due to atherosclerosis of arteries other than those to the heart and brain. The arteries to the legs are most commonly affected. Pain is experienced in the leg muscles due to a limited supply of oxygen.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(iv) Cholesterol and atherosclerosis	A deep vein thrombosis (DVT) is a blood clot that forms in a deep vein most commonly in the leg. If the clot breaks off and travels through the bloodstream it may result in a pulmonary embolism. Most cholesterol is synthesised by the liver from saturated fats in the diet. Cholesterol is a component of cell membranes and a precursor for steroid synthesis. High-density lipoprotein (HDL) transports excess cholesterol from the body cells to the liver for elimination. This prevents accumulation of cholesterol in the blood. Low-density lipoprotein (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.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	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. 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 determine if the FH gene has been inherited and it can be treated with lifestyle modification and drugs.	Research data on the action of cholesterol reducing drugs. Investigate current views on the use of statins in treatment of patients at risk of CVD. Pedigree analysis of FH. Investigate treatments for FH.
(v) Blood glucose levels and vascular disease	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.	Investigate the symptoms associated with ‘microvascular disease’ and ‘macrovascular’.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Regulation of blood glucose	Regulation of blood glucose level by insulin and glucagon negative feedback. 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.	
Diabetes	A diabetic is unable to control their glucose levels. 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.	Analyse glucose tolerance curves of normal and diabetic subjects.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	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. 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 250–300ml of glucose solution.	
(vi) Obesity	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 squared) greater than 30 is used to indicate obesity. Accurate measurement of body fat requires the measurement of body density.	Compare measurement of body composition using different methods. For example using densitometry, skin fold thicknesses, bioelectrical impedance, waist-hip ratio and body mass index.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	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.	Perform simple measurements of body composition. Analyse data which illustrates the effect of exercise on body composition. Examine case histories using coronary heart disease risk calculators (eg Framingham index). Examine risk factors and remedial measures in treating cardiovascular disease.

National Course specification: Course details (cont)

UNIT 3 — 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 candidates 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. Thus 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. Thus 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. In studying learning, the change in behaviour as a result of experience lends itself to experiential practical work.

National Course Specification: Course details (cont)

Candidates 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)

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
1 The nervous system	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) Divisions of the nervous system	The central nervous system (CNS) and the peripheral nervous system (PNS). The sensory and motor neurons of the somatic nervous system (SNS) control the voluntary movement of skeletal muscles. The autonomic nervous system (ANS) and homeostatic control through sensory neurons and motor neurons conducting involuntary impulses to smooth muscle, cardiac muscle and glands. The antagonistic action of the sympathetic 'fight or flight' and parasympathetic 'rest and digest' responses on heart rate, breathing rate, peristalsis and intestinal secretions.	
(b) Parts of the brain	The human brain is organised into three interconnected layers: the central core, the limbic system and the cerebral cortex.	
(i) The central core	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.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(ii) The limbic system	The limbic system processes information for memories and influences emotional and motivational states. It contains the hypothalamus which influences the hormone secretions of the pituitary and regulates homeostatic mechanisms such as the contraction of smooth muscle, body temperature and water balance.	Case studies investigating the role of the limbic system in regulating fear, anger, aggression, pleasure, pain, addiction, sexual behaviour, thirst or hunger.
(iii) Cerebral cortex	The cerebral cortex is the centre of conscious thought; it receives sensory information, coordinates voluntary movement, makes decisions, recalls memories and alters behaviour in the light of experience. Localisation of functions in sensory areas, motor areas and the association areas that deal with thought processes, language, personality, imagination and intelligence. The left cerebral hemisphere deals with information from the right visual field and controls the right side of the body and vice versa. The transfer of information through the corpus callosum and the action of the brain as an integrated whole.	Examine data on clinical observations of brain injuries and lesions, EEGs, brain scans and split brain studies as evidence of localisation of brain function. 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.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(e) Perception	Perception is the process by which the brain analyses and makes sense out of incoming sensory information. 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	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.
(ii) Perception of distance	Visual cues such as relative size, superimposition and relative height in field. Binocular disparity in judging distance. Perceptual constancy as objects become nearer and the viewing angle changes.	Analyse images of depth perception. Plan and design investigations using the Muller-Lyer illusion. Analyse the appearance of depth created by stereoscopes, 3D slide viewers and 3D movies.
(iii) Recognition	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.	Investigate the influence of perceptual set using ambiguous stimuli.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(d) Memory	Memory is the storage, retention and retrieval of information including past experiences, knowledge and thoughts. All information entering the brain passes through sensory memory and enters short term memory. Information is then transferred to long term memory or discarded.	
(i) Sensory memory	Sensory memory lasts a few seconds and retains all of the visual or auditory input.	
(ii) Short term memory	Memory span of short term memory (STM). Maintaining items in STM by rehearsal and loss of items from STM by displacement and decay. The serial position effect. Improvement of STM by 'chunking'. Working memory is an extension of STM. It is used to perform cognitive tasks involving information in the STM.	Design and carry out an investigation to determine the memory span for letters or numbers. Carry out an investigation on increasing memory span of STM by 'chunking' Carry out an investigation on the serial position effect.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(iii) Long term memory	The transfer of information from STM to long term memory (LTM) due to rehearsal, organisation and by the elaboration of meaning. Information is encoded either by repetition (shallow encoding) or linking it with previous memories (elaborative encoding). Retrieval is aided by the use of contextual cues which relate to the method of coding.	Carry out an investigation on the factors which improve retrieval from LTM. Case study on a memory disorder (eg Alzheimer's, stroke/brain injury, Aphasia, Amnesia, Wernicke-Korsakoff Syndrome)
(iv) Location of memory in the brain	Episodic memory, the memory of events and experiences, and semantic memory, the record of facts and concepts, are stored in the region of the cortex where the sensory information was first received and encoded. Procedural memories (skills) are linked to long term modifications in 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).
(e) The cells of the nervous system	Neurons receive and transmit electrical signals (impulses). Glial cells support and maintain interconnecting neurons.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(i) Neurons	Structure and function of neurons (dendrites, cell body and axons). Sensory, motor and inter neurons. Axons are surrounded by a myelin sheath which insulates the axon and increases the speed of impulse conduction from node to node. Myelination continues from birth to adolescence. 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 adult. Certain diseases destroy the myelin sheath causing a loss of coordination.	Examine suitable slides and photomicrographs of dendrites, cell body, axon and myelin sheath. Analyse causes, symptoms and treatments of polio, multiple sclerosis and Tay-Sachs disease.
(ii) Glial cells	Glial cells physically support neurons and produce the myelin sheath. They also maintain a homeostatic environment around the neurones and remove debris by phagocytosis.	
(f) Neurotransmitters	Neurotransmitters relay messages from nerve to nerve within and outwith the brain. Neurons connect with other neurons, muscles fibres and endocrine glands 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. The receptor determines whether the signal is excitatory or inhibitory.	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 neurones resulting in fully contracted skeletal muscles).

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	Neurotransmitters must be removed from the synaptic cleft to prevent continuous stimulation of post synaptic neurones. Neurotransmitters are removed by enzymes or re-uptake. 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.	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.
(i) Converging, diverging and reverberating neural pathways and plasticity of response	Converging neural pathways increase the sensitivity to excitatory or inhibitory signals. Diverging neural pathways influence several neurons at the same time. In a reverberating pathway neurones later in the pathway synapse with earlier ones sending the impulse back through the circuit. New neural pathways can be developed to create new responses, bypass areas of brain damage or to suppress reflexes or responses to sensory impulses creating a plasticity of response.	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 fine motor control, reverberating pathways in breathing and short term memory. 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). Examine brain injury case histories.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
		Investigate the ability of the brain to suppress reflexes or sensory impulses.
(ii) Neurotransmitters, mood and behaviour		
Endorphins	Endorphins are neurotransmitters that stimulate neurones 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.	Analyse data on the links between base endorphin levels and pain threshold, depression and appetite.
Dopamine and the reward pathway	The reward pathway involves neurones which secrete or respond to the neurotransmitter dopamine. The reward pathway is activated on engagement of beneficial behaviours, eg eating when hungry. Dopamine induces the feeling of pleasure and reinforces particular behaviours.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Neurotransmitter related disorders and their treatment	Many drugs used to treat neurotransmitter related disorders are similar to neurotransmitters. Agonists bind to and stimulate receptors mimicking the neurotransmitter. Antagonists bind to specific receptors blocking the action of the neurotransmitter. Other drugs inhibit the enzymes which degrade neurotransmitters or inhibit re-uptake.	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 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);

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
Mode of action of recreational drugs	Many recreational drugs affect neurotransmission in the reward circuit of the brain. Changes in neurochemistry alter mood, cognition, perception and behaviour. Recreational drugs may stimulate the release of neurotransmitters, imitate their action (agonists), block their binding (antagonists), and/or inhibit their re-uptake/enzymatic degradation.	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. Analyse data on the influence of alcohol on reaction time.
Drug addiction/tolerance	Sensitisation and desensitisation are thought to underlie drug addiction and tolerance. 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. Desensitisation is a decrease in the number and sensitivity of receptors as a result of exposure to drugs that are agonists and leads to drug tolerance.	Investigate genetic components of addiction. Examine drug rehabilitation programmes which combat physical tolerance (eg methadone and buprenorphine) and psychological dependency (eg counselling and cognitive-behavioural approaches).

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
2 Communication and social behaviour		
(a) The effect of infant attachment	Early infant attachment is important in laying the foundation for the future formation of stable relationships. Attachment becomes evident between 6 and 9 months. Measures of attachment in 'the strange situation'. Secure attachment and insecure attachment, responses of detachment, anger or inconsistent responses. Infants that form secure attachments are more likely to investigate their immediate environment helping the development of cognitive abilities. Humans have a long period of dependency on adults providing time for socialisation and learning to occur. As children develop different methods of control can influence social competence. Authoritative control (providing direction) generally results in greater social competence than authoritarian or permissive control.	Observe, measure and record infant behaviour (for example play, distress and proximity in the strange situation).

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(b) The effect of communication		
(i) Non-verbal communication	Non-verbal communication is important in the formation of relationships between individuals. Non-verbal communication can signal attitudes and emotions as well as acting as an aid to verbal communication.	Analyse silent video clips for the six main types of facial expression (happiness, sadness, disgust, fear, anger and surprise). Measure non-verbal communication in video clips by observing and recording, for example, facial expression, eye contact, touching, tone of voice and physical proximity.
(ii) Verbal communication	Language uses symbols to represent information and enables it to be organised into categories and hierarchies thus accelerating learning and intellectual development. The ability of humans to communicate verbally has resulted in the transmission of knowledge, development of culture and social evolution.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(c) The effect of experience	Learning is a change in behaviour as a result of experience.	Design and carry out an investigation on learning using a finger maze.
(i) The effect of practice on motor skills	The repeated use of a motor skill results in a motor pathway being established.	
(ii) Imitation	A great deal of human behaviour is learned by observing and imitating the behaviour of others.	Design and carry out an investigation on the speed of performance of a task by following instructions and by imitation.
(iii) Reinforcement, shaping and extinction of behaviour as seen in trial and error learning	Behaviour patterns that have positive consequences for the individual are likely to be repeated and so become reinforced. Shaping is the rewarding of behaviour that approximates to the desired behaviour. If behaviour patterns are not rewarded, they are likely to disappear (extinction).	Case studies of rewarded behaviour, unrewarded behaviour and shaping in learning.
(iv) 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).	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(d) The effect of group behaviour and social influence		
(i) Social facilitation	Increased performance in competitive situations.	
(ii) Deindividuation	Loss of personal identity in a group leading to diminished restraints on behaviour. Deindividuation 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.	
Influences that change beliefs: internalisation and identification	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.

National Course specification: Course details (cont)

UNIT 4 — 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. Candidates 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).

Candidates 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)

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
1 The immune system	The human body has the capacity to protect itself against pathogens, some toxins and cancer cells through the immune system.	
(a) Non-specific defences		
(i) Physical and chemical defences	Epithelial cells on the body surface and cavity linings form a physical barrier and produce secretions that defend against infection.	
(ii) Inflammatory response	Release of histamine by mast cells causes vasodilation and increased capillary permeability. The increased blood flow and the secretion of cytokines results in the accumulation of phagocytes and the delivery of antimicrobial proteins and clotting elements to the site of infection.	
(iii) Non-specific cellular responses	A variety of specialised white blood cells provide protection against pathogens. Phagocytes recognise surface antigen molecules on pathogens and destroy them by phagocytosis. Natural killer (NK) cells induce the pathogen to produce self destructive enzymes in apoptosis. Phagocytes and NK cells release cytokines which stimulate the specific immune response.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(b) Specific cellular defences		
(i) Immune surveillance	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.	
(ii) Clonal selection theory	The body has a large number of lymphocytes each with a single type of membrane receptor specific for one antigen. When a receptor is activated by the binding of an antigen, the lymphocyte repeatedly divides resulting in a clonal population of lymphocytes.	
(iii) T and B lymphocytes	Lymphocytes respond specifically to antigens on foreign cells, cells infected by pathogens and toxins released by pathogens.	
Recognition of self and non self	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. Failure in regulation of the immune system leads to a T lymphocyte immune response to self cells (auto immune disease). Allergy is a hypersensitive B lymphocyte response to an antigen that is normally harmless.	ABO and Rh blood typing. 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). Case studies on hay fever, anaphylactic shock and allergic asthma.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
T lymphocytes	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.	
B lymphocytes	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.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(iv) Memory cells (immunological memory)	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.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
2 Infectious diseases and immunity	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.	
(a) The transmission of infectious diseases	Infectious diseases are caused by pathogens such as viruses, bacteria, fungi, protozoa and multicellular parasites. Infectious diseases are transmitted by direct physical contact, water, food, body fluids, inhaled air or vector organisms. The transmission of infectious disease can be 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 the control of vectors.	Case study: comparison of the transmission methods of different pathogens, eg measles (air borne), HIV (body fluids) and cholera (water or food).
Epidemiology of infectious diseases	Epidemiologists study the outbreak and pattern of infectious diseases to determine the factors which affect the spread of infectious disease. The spread of infectious diseases are classified as: sporadic (occasional occurrence), endemic (regular cases occurring in an area), epidemic (unusually high number of cases in an area) or pandemic (a global epidemic).	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	Based on epidemiological studies control measures can be considered that include preventing transmission, drug therapy, immunisation or a combination of these.	
(b) Active immunisation and vaccination	Active immunity can be developed by vaccination with antigens from infectious pathogens. 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. These agents induce a primary immune response and immunological memory in the individual but not disease symptoms.	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).
Vaccine clinical trials	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 receives the vaccine, while the second group receives a placebo control to ensure valid comparisons.	

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
	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.	
Herd immunity	If a large percentage of a population are immunised, non-immune individuals are protected as there is a lower probability that they will come into contact with infected individuals. This herd immunity is important in reducing the spread of diseases and in protecting vulnerable and non-vaccinated individuals. 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.
Public health medicine	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).	Comparison of the estimated herd immunity thresholds for vaccine preventable diseases.

National Course specification: Course details (cont)

Content	Notes	Suggested learning activities and approaches
(c) Evasion of specific immune responses by pathogens	Many pathogens have evolved mechanisms that evade the specific immune system which has consequences for vaccination strategies.	
Antigenic variation	Some pathogens can change their antigens avoiding the effect of immunological memory. 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.	Use bioinformatics software to study the DNA sequence/protein differences between different types and strains of influenza viruses.
Direct attack on the immune system	The absence or failure of some component of the immune system results in increased susceptibility to infection. HIV attacks lymphocytes and is the major cause of acquired immunodeficiency in adults. Tuberculosis (TB) survives within phagocytes and avoids immune detection.	Case study on HIV including the public health measures and drug therapies for its control.

Assessment

To achieve the Course award the candidate must achieve the Units as well as pass the Course assessment. The candidate's grade is based on the Course assessment.

Assessment objectives

Candidates will be assessed on their Knowledge and Understanding of the content column and notes column in the tables for each Unit. The suggested learning activities and approaches column in the tables for each Unit provides advice and suggests contexts and activities for learning and will not be liable for sampling in assessment.

Candidates will be assessed on their skills of scientific experimentation, investigation and enquiry and skills for learning, life and work. These skills should be developed in contexts related to the content and notes columns in the tables for each Unit.

Advice on developing the capabilities associated with knowledge, understanding and skills is given in the section G*uidance on Learning and Teaching Approaches for this Course* (page 77).

Unit assessment

Unit assessment will be a closed-book test with items based on the statement of standards for each Unit and a report of one experimental activity set in the context of the Unit based on the statement of standards. Only one report of an experimental activity is required to meet the Course specification for Higher Human Biology. This report can then be used as evidence of the statement of standards for the other Units of the Course. The report can be in the format of a traditional lab report or alternatives such as a conference poster, scientific paper, Power Point presentation, video presentation or web page that cover the Performance Criteria.

Further details about Unit assessment for this Course can be found in the Unit specifications and the National Assessment Bank (NAB) materials.

Course assessment

The external Course assessment will be based on the Knowledge and Understanding, skills of scientific experimentation, investigation and enquiry and skills for learning, life and work described in the Course content.

The examination will consist of one paper of 2 hours 30 minutes with a total of 130 marks. The paper will consist of three sections:

National Course specification: Course details (cont)

Section A

This section will contain 30 multiple-choice questions. Between 9 and 11 of these will test science skills and skills for learning, life and work, the remainder will test Knowledge and Understanding. Section A will have an allocation of 30 marks. Candidates will be expected to answer all the questions.

Section B

This section will contain structured questions and data handling questions with an allocation of 80 marks. Between 25 and 30 marks will test science skills and skills for learning, life and work, the remainder will test Knowledge and Understanding. Candidates will be expected to answer all the questions.

Section C

This section will consist of four extended response questions to test the candidate's ability to select, organise and present relevant knowledge. Section C will have an allocation of 20 marks and will include:

- two structured extended response questions each with an allocation of 10 marks. Candidates will be expected to answer one of these questions.
- two open extended response questions for 10 marks (1 mark for relevance, 1 mark for coherence and 8 marks for Knowledge and Understanding). Candidates will be expected to answer one of these questions.

Further details of the Course assessment are given in the Course Assessment specification and in the Specimen Question Paper.

Complexity of data

The following advice is intended as general guidelines in setting the complexity of data to be used in science skills Problem Solving questions.

At Higher, typically two sources of data (text, tables, charts, keys, diagrams or graphs) should be provided from which the problem has to be solved. It is, however, recognised that extracting data from one source could be more demanding than extracting data from two sources for example, depending on the nature of the data.

Where there are not two separate sources of data, the provided data should normally have two to three patterns, trends, conditions, variables or sets of results from which information has to be selected and presented, or which have to be used as sources of evidence for conclusions, explanations, predictions or generalisations. The analysis of data should involve comparisons between two or more of these sets of data.

The planning, designing and evaluation of experimental procedures should involve one to two of the following: purpose, one or two treatments, adequate controls, limitations of equipment, sources of error and possible improvements as appropriate.

National Course specification: Course details (cont)

Link between Unit and Course assessment/added value

Course assessment requires candidates to demonstrate abilities beyond Unit assessment by:

- retaining knowledge and skills over an extended period of time
- integrating Knowledge and Understanding and skills from different Units
- applying knowledge, understanding and skills in contexts less familiar and more complex than in the component Units.

National Course specification: Course details (cont)

Grade Descriptions at A and C

The candidate's grade will be based on the total score obtained from the Course assessment. The descriptions below indicate the nature of achievement required for an award at Grade C and Grade A in the Course.

For an award at Grade C, candidates should be able to:

- retain knowledge and skills over an extended period of time
- integrate Knowledge and Understanding, science skills and skills for learning life and work acquired across component Units
- apply Knowledge and Understanding, science skills and skills for learning life and work in contexts similar to those in the component Units.

For an award at Grade A, candidates should be able to:

- retain an extensive range of knowledge and skills over an extended period of time
- integrate an extensive range of Knowledge and Understanding, science skills and skills for learning life and work acquired across component Units
- apply Knowledge and Understanding, science skills and skills for learning life and work in contexts less familiar and more complex than in the component Units.

Estimates and appeals

Detailed advice and guidance is issued to centres in the publication *Estimates, Absentees and Assessment Appeals: Guidance on Evidence Requirements.*

Estimates

In preparing estimates, evidence must take account of performance across the Course and must be judged against the Grade Descriptions. Further advice on the preparation of estimates is given in the Course Assessment specification.

Appeals

Evidence to support appeals for the Course must show sufficient breadth of coverage of the content, cover each of the seven science skills areas and must relate to the Course grade descriptions at A and C. Approximately 30% of the assessment items in the evidence to support appeals should relate to the Course grade descriptions at A to ensure that candidates who are graded at A are gaining marks in A grade items.

The evidence to support appeals should reflect the structure of the Course Assessment specification and the standards set out in the Specimen Question Paper. Centres must ensure that the instrument of assessment has not been seen previously by candidates.

An analysis of the evidence to support appeals showing the content and skills covered by assessment items along with marking instructions with cut off scores should be included with ***all*** evidence submitted in support of an appeal.

National Course specification: Course details (cont)

Quality Assurance

All National Courses are subject to external marking and/or verification. Externals Markers, visiting Examiners and Verifiers are trained by SQA to apply national standards.

The Units of all Courses are subject to internal verification and may also be chosen for external verification. This is to ensure that national standards are being applied across all subjects.

Courses may be assessed by a variety of methods. Where marking is undertaken by a trained Marker in their own time, Markers meetings are held to ensure that a consistent standard is applied. The work of all Markers is subject to scrutiny by the Principal Assessor.

To assist centres, External Assessment and Internal Assessment reports are published on SQA's website **www.sqa.org.uk**.

National Course specification: Course details (cont)

Guidance on learning and teaching approaches for this Course

In delivering the Course, teachers should be building on candidates' previously acquired knowledge and skills. Candidates' experiences should include a variety of approaches to develop Knowledge and Understanding, science skills and skills for learning life and work. Where possible these experiences should be integrated into a related sequence of activities centered on an idea, theme or application of biology based on contexts related to the Course content. Such case studies should make learning active, challenging and enjoyable and identify for the candidate the Course content and skills that will be developed. Case studies should be developed in such a way that candidates 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 biology drawn from different Units. Advice on the capabilities that could be included in such case studies to develop the knowledge, understanding and skills of the Course content is provided below.

Practical experimental work is a key part of the scientific method of working and as such is an essential component of Biology Courses. In addition to being part of the way scientists work, practical work can fulfill a number of educational purposes including:

- Developing Problem Solving skills and analytical thinking
- Working collaboratively and thinking independently
- Illustrating concepts as an aid to understanding
- Developing experimental designs that are valid and reliable
- Testing hypotheses and drawing conclusions based on evidence
- Generating data for subsequent analysis
- Developing competence in practical techniques

Information and Communication Technology (ICT) makes a significant contribution to practical work in 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 short periods of time completing experiments in class 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 which can then be subsequently downloaded and viewed for analysis. Developments in the mapping and analysing of DNA sequences and bioinformatics have made computing an essential tool in scientific investigations of personalised medicine, inheritance and human evolution.

National Course specification: Course details (cont)

Knowledge and Understanding

The following capabilities related to demonstrating knowledge, applying knowledge and demonstrating understanding should be developed in Course work.

1 Demonstrating knowledge

Candidates should be able to:

- Make accurate statements about the processes, systems and relationships of human biology
- Use biological terms, symbols, abbreviations and units correctly
- Describe the properties and structure and function of the human organism
- Describe the properties of human biological processes and systems.

2 Applying knowledge

Candidates should be able to:

- Use knowledge when interpreting biological information in textual, tabular or graphical forms
- Use a relationship, equation or formula to find a qualitative or quantitative solution to a biological problem
- Use existing knowledge in new situations
- Appreciate and understand the impact of science and technology on everyday life
- Make and justify personal decisions about things that involve biological science.

3 Demonstrating understanding

Candidates should be able to:

- Demonstrate understanding of the properties and structure and function of organisms
- Demonstrate understanding of the properties of and relationships in biological processes, systems and cycles
- Give examples to illustrate a concept or relationship or to support an observation, hypothesis or point of view
- Explain an observation or phenomenon demonstrating understanding of the underlying concept, principle or theory
- Use knowledge to demonstrate understanding of cause and effect
- Combine knowledge with evidence from observation, experience and investigation to provide explanations, formulate hypotheses and make predictions about the effects of change on biological systems and processes
- Integrate knowledge in different areas of human biology.

National Course specification: Course details (cont)

Skills of scientific experimentation, investigation and enquiry

Candidates should acquire scientific skills through a series of learning experiences, investigations and experimental work set in the contexts described in the content statements and supplementary notes of the Course specification. 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 analyzing 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 candidates' learning. Further details on the skills that should be developed in Course work are given below.

1 Selecting Information

Select and analyse relevant information from texts, tables, charts, keys, graphs and/or diagrams.

The study of biology involves dealing with written and visual information. Candidates will often deal with more complex information than they can produce.

Candidates 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.

National Course specification: Course details (cont)

2 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

Candidates 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

Candidates 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 candidates 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.

3 Processing Information

Process information accurately using calculations where appropriate.

Candidates 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. Candidates should 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
- use software packages to carry out statistical and other data handling processes.

4 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

Candidates 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

Candidates 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 individuals, other 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.

National Course specification: Course details (cont)

5 Evaluating

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.

Candidates 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.

6 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.

Candidates 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.

7 Making predictions and generalisations

Make predictions and generalisations based on available evidence.

Candidates should be able to:

- predict the outcome in experimental situations from supplied information
- make generalisations from a range of biological information
- use modeling 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.

National Course specification: Course details (cont)

Skills for learning, life and work

As a result of their study of human biology candidates should have the opportunity to and further develop their capabilities to:

- Use their literacy, communication and numeracy skills to demonstrate their Knowledge and Understanding of biology
- Solve problems by thinking creatively, working with others and planning and managing tasks related to biological laboratory and field work
- Develop competence in the use of laboratory and fieldwork equipment and the use of information and communication technology
- Identify hazards, assess their risk in different situations and suggest control measures
- Make ethical decisions based on researching relevant information and a consideration of the consequences for different courses of action.

Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

History of changes

Version	Description of change	Date

National Unit specification: general information

Unit title: Human Cells (SCQF level 6)

Unit code: FH2K 12

Superclass: RH

Publication date: March 2011

Source: Scottish Qualifications Authority

Version: 01

Summary

This Unit is a mandatory Unit of the Human Biology (revised) Higher Course and has been designed to be taken as part of that Course. It can also be taken as a free-standing Unit.

This Unit seeks to develop Knowledge and Understanding, Problem Solving and practical skills related to differentiation in human cells, structure and function of DNA and cell metabolism.

Successful candidates will be able to describe and explain aspects of the biology of human cells and apply their knowledge in new situations and when interpreting related biological information. They will be able to collect, analyse and present scientific data and information; plan, design and carry out practical work; draw conclusions, evaluate and make predictions and generalisations based on scientific evidence. They will be able to write a scientific report on an experimental activity related to human cells that they have carried out.

This Unit is suitable for candidates who have studied cell biology as part of a Course or Unit at SCQF level 5.

Outcomes

1 Demonstrate Knowledge and Understanding related to human cells.
2 Solve problems related to human cells using scientific skills.
3 Collect and analyse information related to human cells by experiment.

Recommended entry

While entry is at the discretion of the centre, candidates would normally be expected to have attained a Biology National Qualification at SCQF level 5 or its equivalent.

General information (cont)

Credit points and level

1 SQA credit at SCQF level 6: (6 SCQF credit points at SCQF level 6*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

Core Skills

Achievement of this Unit gives automatic certification of the following:

Complete Core Skill *Problem Solving* at SCQF level 6

Core Skill component Using Graphical Information at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

National Unit specification: statement of standards

Unit title: Human Cells (SCQF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Outcome 1

Demonstrate Knowledge and Understanding related to human cells.

Performance Criteria

(a) Make accurate statements and give clear descriptions about the biology of human cells.
(b) Apply relevant knowledge of human cells in new situations and appreciate its significance when interpreting biological information.
(c) Explain the biology of human cells with reasons or supporting evidence.

Outcome 2

Solve problems related to human cells using scientific skills.

Performance Criteria

(a) Select and present relevant information in an appropriate format.
(b) Process information accurately using calculations where appropriate.
(c) Draw valid conclusions and give explanations supported by evidence.
(d) Plan, design and evaluate experimental procedures appropriately.
(e) Make predictions and generalisations based on evidence.

Outcome 3

Collect and analyse information related to human cells by experiment.

Performance Criteria

(a) Participate actively in the collection of information by experiment.
(b) Describe the experimental procedures accurately.
(c) Record relevant measurements and observations in an appropriate format.
(d) Analyse and present the recorded experimental information in an appropriate format.
(e) Draw valid conclusions.
(f) Evaluate the experimental procedures with supporting argument.

National Unit specification: statement of standards (cont)

Unit title: Human Cells (SCQF level 6)

Evidence Requirements for this Unit

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

The standard to be applied and the breadth of coverage are illustrated in the National Assessment Bank items available for this Unit. If a centre wishes to design its own assessments for this Unit they should be of a comparable standard.

Evidence of an appropriate level of achievement must be generated from a closed-book instrument of assessment under controlled conditions covering the Performance Criteria for Outcome 1 and Outcome 2 set in the context of differentiation in human cells, structure and function of DNA and cell metabolism, with a time limit of 45 minutes.

In the evidence for planning and designing experimental procedures in Outcome 2 PC (d) candidates must be able to develop and justify a hypothesis to be investigated or the aim of an experiment.

A report of one experiment is required covering the Performance Criteria for Outcome 3 set in the context of differentiation in human cells, structure and function of DNA or cell metabolism. The report can be in the format of a traditional lab report or alternative that covers the Performance Criteria for the Unit including conference poster format, scientific paper format, Power Point presentation, video presentation or web page.

The teacher/lecturer responsible must attest that the report is the individual work of the candidate derived from active participation in an experiment in which the candidate plans the experiment; decides how it is managed; identifies and obtains the necessary resources, some of which must be unfamiliar; and carries out the experiment. Depending on the activity, the collection of the information may be group work.

Evidence submitted in support of attainment of PC (d) must be in the format of a table or graph(s) as appropriate. Conclusions drawn should be justified by reference to supporting evidence and comment on trends or patterns and/or connections between variables and controls.

The evaluation should cover all stages of the experiment, including the initial analysis of the situation and planning and organising the experimental procedure. In carrying out the experiment candidates should consider modifying procedures and respond to sources of error.

National Unit specification: support notes

Unit title: Human Cells (SCQF level 6)

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

1 Differentiation in Human cells

(a) Stem cells
(b) Differentiation in somatic cells
(c) Differentiation in germline cells
(d) Research and therapeutic value of stem cells
(e) Cancer cells

2 Structure and function of DNA

(a) Structure and replication of DNA:
  (i) Structure of DNA
  (ii) Arrangement of DNA in chromosomes
  (iii) Replication of DNA
(b) Gene expression through protein synthesis:
  (i) Structure and functions of RNA
  (ii) Transcription of DNA into an RNA molecule
  (iii) Translation of mRNA into a polypeptide
  (iv) One gene, many proteins
(c) Genes and proteins in health and disease:
  (i) Proteins
  (ii) Mutations and genetic disorders
    Single gene mutations (point mutations/DNA sequence variations)
    Altered protein structure and function in genetic disorders
    Altered chromosomal structure and genetic disorders
(d) Human genomics:
  (i) Sequencing DNA
    Bioinformatics
    Systematics
    Personalised medicine
  (ii) Amplification and detection of DNA sequences
    Polymerase Chain Reaction (PCR)
    DNA probes
    Medical and forensic applications

National Unit specification: support notes (cont)

Unit title: Human Cells (SCQF level 6)

3 Cell metabolism

(a) Metabolic pathways:
  (i) Control of metabolic pathways
    Enzyme action
    Regulation of metabolic pathways by the action of enzymes

(b) Cellular respiration:
  (i) Transfer of energy via ATP
    Synthesis of ATP
  (ii) Metabolic pathways of cellular respiration
    Glycolysis
    Citric acid cycle
    Electron transport chain
    Substrates for respiration
    Regulation of the pathways of cellular respiration
  (iii) The creatine phosphate system
  (iv) Lactic acid metabolism
  (v) Types of skeletal muscle fibres

Further guidance on the content and context for this Unit is provided in the Course content tables for Human Cells in the Course specification for Human Biology (revised) Higher. The suggested learning activities and approaches column in these tables provides contexts in which the Knowledge and Understanding and skills of this Unit can be developed and are not liable for assessment although they may provide contexts for assessment items.

Guidance on learning and teaching approaches for this Unit

Guidance on learning and teaching approaches for this Unit are provided in the guidance on learning and teaching approaches in the Course specification for Human Biology (revised) Higher.

Opportunities for developing Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the support notes of this Unit specification. The guidance on learning and teaching approaches for this Unit provided in the Course specification for Human Biology (revised) Higher highlights opportunities to develop Using Number when processing information and Oral and Written Communication when presenting information. In addition the guidance on learning and teaching approaches highlights opportunities to develop *Working with Others* when carrying out practical experimental work and in using *Information and Communication Technology* in practical experimental work and for data analysis.

Guidance on approaches to assessment for this Unit

A holistic approach is taken to assessment, ie Outcomes 1 and 2 are assessed by an integrated end of Unit test with questions covering all the Performance Criteria for Knowledge and Understanding and Problem Solving.

National Unit specification: support notes (cont)

Unit title: Human Cells (SCQF level 6)

Outcome 1

Test items should be constructed to allow candidates to meet all of the Performance Criteria in the context of differentiation in human cells, structure and function of DNA or cell metabolism.

Outcome 2

Test items should be constructed to allow candidates to generate evidence relating to the Performance Criteria as follows:

(a) Selecting and presenting information:
- sources of information to include: texts, tables, charts, keys, graphs and diagrams
- formats of presentation to include: written summaries, extended writing, tables and graphs.

(b) Calculations to include: percentages, averages, ratios. Significant figures and units should be used appropriately.

(c) Conclusions drawn should include some justification, and explanations should be reported by evidence. Conclusions could contain a comment on trends or patterns and/or connections between variables and controls.

(d) Candidates could plan and design procedures to test given hypotheses or to illustrate particular effects. This could include identification of variables, controls and measurements or observations required. The evaluation of given experimental procedures may include situations which are unfamiliar to candidates and could test the candidates' ability to comment on the purpose of approach or the suitability of given experimental procedures. Candidates could comment on the limitations of the set-up, apparatus, suggested measurements or observations, limitations of equipment, appropriateness of controls, sources of error and possible improvements.

(e) Candidates could make predictions and generalisations from given experimental results or, given situations, predict what the results might be.

Outcome 3

Type of experimental activity

The teacher/lecturer should ensure that the experimental activity to be undertaken in connection with Outcome 3 affords opportunity for the candidate to demonstrate the ability to undertake the planning and organising of an experimental activity at an appropriate level of demand. The activity must relate to the Course content and candidates should be made aware of the range of skills which must be demonstrated to ensure attainment of Outcome 3.

Assessment of Outcome 3

Candidates are only required to produce one report for Outcome 3 in relation to the contents and notes specified for Human Biology (revised) Higher. This report can then be used as evidence for Outcome 3 for the other Units of the Course.

National Unit specification: support notes (cont)

Unit title: Human Cells (SCQF level 6)

In relation to PC (a), the teacher/lecturer checks by observation that the candidate participates in the collection of the experimental information by playing an active part in planning the experiment, deciding how it will be managed, identifying and obtaining resources (some of which must be unfamiliar to the candidate), and carrying out the experiment.

Candidates should provide a report with an appropriate title. The report should relate to the Performance Criteria as follows:

(b)	The experimental procedures are described accurately.	A clear statement of the aim of the experiment. A few brief concise sentences including as appropriate: ♦ a labelled diagram or brief description of apparatus or ♦ instruments used ♦ how the independent variable was altered ♦ control measure used ♦ how measurements were taken or observations made. There is no need for a detailed description. The use of the impersonal passive voice is to be encouraged as an example of good practice but this is not mandatory for meeting the Performance Criteria.
(c)	Relevant measurements and observations are recorded in an appropriate format.	Readings or observations (raw data) must be recorded in a clear table with correct headings, appropriate units and results/readings entered correctly.
(d)	Recorded experimental information is analysed and presented in an appropriate format.	Data should be analysed and presented in tabular, graphical format or as a scatter diagram or equivalent, as appropriate: ♦ For a tabular presentation this may be an extension of the table used for PC (c) above, and must include: suitable headings and units showing averages or other appropriate computations ♦ For a graphical presentation this must include: data presented as a histogram, bar chart, connected points or line of best fit as appropriate, with suitable scales and axes labelled with variable and units and with data correctly plotted.

(e)	Conclusions drawn are valid.	Conclusions should use evidence from the experiment and relate back to the aim of the experiment. At least one of the following should be included: ♦ overall pattern to readings or observations (raw data) ♦ trends in analysed information or results ♦ connection between variables and controls.
(f)	The experimental procedures are evaluated with supporting argument.	The evaluation could cover all stages of the activity including preparing for the activity, analysis of the activity and the results of the activity. The evaluation must include supporting argument in at least one of the following: ♦ effectiveness of procedures ♦ control of variables ♦ limitations of equipment ♦ possible sources of error ♦ possible improvements.

The bullet points under each Performance Criterion give an indication of what should be addressed to achieve a pass. The relevance of the bullet points will vary according to the experiment. These bullet points are intended as helpful guidance. The decision of pass or fail is to be made by the professional judgement of the presenting centre (subject to external verification) against the Performance Criteria. It is appropriate to support candidates in producing a report to meet the Performance Criteria. re-drafting of a report after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment. Redrafting and resubmission is only required for the specific performance criterion identified in need of further attention, ie the entire report does not need to be rewritten.

Conditions required to complete the report

Candidates may complete their work outwith class time provided reasonable measures are taken to ensure that the report is the individual work of the candidate. Teachers and lecturers may wish candidates to write up reports under their direct supervision so that they can provide appropriate advice and support. However, they may feel confident that any redrafting required need not be undertaken under such close supervision as it will be evident in the candidate's response that it is his or her unaided work. Under such circumstances it would be acceptable for such redrafting to take place outwith class time.

National Unit specification: support notes (cont)

Unit title: Human Cells (SCQF level 6)

Use of IT

Candidates may, if they wish, present their reports in a word-processed format. Candidates may use Excel (or any other suitable data analysis software) when tackling Outcome 3. However, candidates must not be given a spreadsheet with pre-prepared column headings nor formulae, as they are being assessed on their ability to enter quantities and units into a table and to make decisions about appropriate scales and labels on graph axes. The use of clip art or images captured by digital camera may also be used in recording details of experimental methods.

Transfer of evidence

Candidates may transfer evidence for Outcome 3 from one level to the one below provided the experiment is in the context of the Course concerned. Candidates, who are repeating a Course, may carry forward evidence of an appropriate standard, generated in a previous year.

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003), SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

History of changes

Version	Description of change	Date

National Unit specification: general information

Unit title: Physiology and Health (SCQF level 6)

Unit code: FH2L 12

Superclass: RH

Publication date: March 2011

Source: Scottish Qualifications Authority

Version: 01

Summary

This Unit is a mandatory Unit of the Human Biology (revised) Higher Course and has been designed to be taken as part of that Course. It can also be taken as a free-standing Unit.

This Unit seeks to develop Knowledge and Understanding, Problem Solving and practical skills related to reproduction and the cardiovascular system.

Successful candidates will be able to describe and explain aspects of physiology and health and apply their knowledge in new situations and when interpreting related biological information. They will be able to collect, analyse and present scientific data and information; plan, design and carry out practical work; draw conclusions, evaluate and make predictions and generalisations based on scientific evidence. They will be able to write a scientific report on an experimental activity related to physiology and health that they have carried out.

This Unit is suitable for candidates who have studied cells, inheritance, homeostasis, and the reproductive, endocrine and circulatory systems as part of a Course or Unit at SCQF level 5.

Outcomes

1 Demonstrate Knowledge and Understanding related to physiology and health.
2 Solve problems related to physiology and health using scientific skills.
3 Collect and analyse information related to physiology and health by experiment.

Recommended entry

While entry is at the discretion of the centre, candidates would normally be expected to have attained a Biology National Qualification at SCQF level 5 or its equivalent.

General information (cont)

Credit points and level

1 SQA credit(s) at SCQF level 6: (6 SCQF credit points at SCQF level 6*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

Core Skills

Achievement of this Unit gives automatic certification of the following:

Complete Core Skill *Problem Solving* at SCQF level 6

Core Skill component Using Graphical Information at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

National Unit specification: statement of standards

Unit title: Physiology and Health (SCQF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Outcome 1

Demonstrate Knowledge and Understanding related to physiology and health.

Performance Criteria

(a) Make accurate statements and give clear descriptions about physiology and health.
(b) Apply relevant knowledge of physiology and health in new situations and appreciate its significance when interpreting biological information.
(c) Explain the biology of physiology and health with reasons or supporting evidence.

Outcome 2

Solve problems related to physiology and health using scientific skills.

Performance Criteria

(a) Select and present relevant information in an appropriate format.
(b) Process information accurately using calculations where appropriate.
(c) Draw valid conclusions and give explanations supported by evidence.
(d) Plan, design and evaluate experimental procedures appropriately.
(e) Make predictions and generalisations based on evidence.

Outcome 3

Collect and analyse information related to physiology and health by experiment.

Performance Criteria

(a) Participate actively in the collection of information by experiment.
(b) Describe the experimental procedures accurately.
(c) Record relevant measurements and observations in an appropriate format.
(d) Analyse and present the recorded experimental information in an appropriate format.
(e) Draw valid conclusions.
(f) Evaluate the experimental procedures with supporting argument.

National Unit specification: statement of standards (cont)

Unit title: Physiology and Health (SCQF level 6)

Evidence Requirements for this Unit

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

The standard to be applied and the breadth of coverage are illustrated in the National Assessment Bank items available for this Unit. If a centre wishes to design its own assessments for this Unit they should be of a comparable standard.

Evidence of an appropriate level of achievement must be generated from a closed-book instrument of assessment under controlled conditions covering the Performance Criteria for Outcome 1 and Outcome 2 set in the contexts of reproduction and the cardiovascular system, with a time limit of 45 minutes.

In the evidence for planning and designing experimental procedures in Outcome 2 PC (d) candidates must be able to develop and justify a hypothesis to be investigated or the aim of an experiment.

A report of one experiment is required covering the Performance Criteria for Outcome 3 set in the contexts of reproduction and the cardiovascular system. The report can be in the format of a traditional lab report or alternative that covers the Performance Criteria for the Unit including conference poster format, scientific paper format, Power Point presentation, video presentation or web page.

The teacher/lecturer responsible must attest that the report is the individual work of the candidate derived from active participation in an experiment in which the candidate plans the experiment; decides how it is managed; identifies and obtains the necessary resources, some of which must be unfamiliar; and carries out the experiment. Depending on the activity, the collection of the information may be group work.

Evidence submitted in support of attainment of PC (d) must be in the format of a table or graph(s) as appropriate. Conclusions drawn should be justified by reference to supporting evidence and comment on trends or patterns and/or connections between variables and controls.

The evaluation should cover all stages of the experiment, including the initial analysis of the situation and planning and organising the experimental procedure. In carrying out the experiment candidates should consider modifying procedures and respond to sources of error.

National Unit specification: support notes

Unit title: Physiology and Health (SCQF level 6)

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

1 Reproduction

(a) The reproductive organs, gametes and fertilisation
(b) Hormonal control of reproduction:
  (i) Hormonal onset of puberty
  (ii) Hormonal control of sperm production
  (iii) Hormonal control of the menstrual cycle
(c) The biology of controlling fertility:
  (i) Fertile periods
  (ii) Treatments for infertility
    Stimulating ovulation
    Artificial insemination
    Intracytoplasmic sperm injection (ICSI)
    In vitro fertilisation (IVF)
  (iii) contraception
(d) Ante- and post natal screening:
  (i) Antenatal care
    Ultrasound imaging
    Biochemical tests
    Diagnostic testing
    Rhesus antibody testing
  (ii) Postnatal screening
    Diagnostic testing for metabolic disorders
    Genetic screening and counselling
    Pre-implantation genetic diagnosis (PGD)

2 The Cardiovascular System

(a) The structure and function of blood vessels:
  (i) The exchange of materials between tissue fluid and cells
(b) The structure and function of the heart:
  (i) Cardiac function
  (ii) The cardiac cycle
  (iii) The cardiac conducting system
  (iv) Blood pressure
(c) Pathology of cardio vascular disease:
  (i) Atherosclerosis
  (ii) Thrombosis
  (iii) Peripheral vascular disorders
  (iv) Cholesterol and atherosclerosis

(v) Blood glucose levels and vascular disease
Regulation of blood glucose
Diabetes
(vi) Obesity

Further guidance on the content and context for this Unit is provided in the Course content tables for Physiology and Health in the Course specification for Human Biology (revised) Higher. The suggested learning activities and approaches column in these tables provides contexts in which the Knowledge and Understanding and skills of this Unit can be developed and are not liable for assessment although they may provide contexts for assessment items.

Guidance on learning and teaching approaches for this Unit

Guidance on learning and teaching approaches for this Unit are provided in the guidance on learning and teaching approaches in the Course specification for Human Biology (revised) Higher.

Opportunities for developing Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the support notes of this Unit specification. The guidance on learning and teaching approaches for this Unit provided in the Course specification for Human Biology (revised) Higher highlights opportunities to develop Using Number when processing information and Oral and Written Communication when presenting information. In addition the guidance on learning and teaching approaches highlights opportunities to develop *Working with Others* when carrying out practical experimental work and in using *Information and Communication Technology* in practical experimental work and for data analysis.

Guidance on approaches to assessment for this Unit

A holistic approach is taken to assessment, ie Outcomes 1 and 2 are assessed by an integrated end of Unit test with questions covering all the Performance Criteria for Knowledge and Understanding and Problem Solving.

Outcome 1

Test items should be constructed to allow candidates to meet all of the Performance Criteria in the context of reproduction and the cardiovascular system.

National Unit specification: support notes (cont)

Unit title: Physiology and Health (SCQF level 6)

Outcome 2

Test items should be constructed to allow candidates to generate evidence relating to the Performance Criteria as follows:

(a) Selecting and presenting information:
- sources of information to include: texts, tables, charts, graphs, keys and diagrams
- formats of presentation to include: written summaries, extended writing, tables and graphs.

(b) Calculations to include: percentages, averages, ratios. Significant figures and units should be used appropriately.

(c) Conclusions drawn should include some justification, and explanations should be reported by evidence. Conclusions could contain a comment on trends or patterns and/or connections between variables and controls.

(d) Candidates could plan and design procedures to test given hypotheses or to illustrate particular effects. This could include identification of variables, controls and measurements or observations required. The evaluation of given experimental procedures may include situations which are unfamiliar to candidates and could test the candidates' ability to comment on the purpose of approach or the suitability of given experimental procedures. Candidates could comment on the limitations of the set-up, apparatus, suggested measurements or observations, limitations of equipment, appropriateness of controls, sources of error and possible improvements.

(e) Candidates could make predictions and generalisations from given experimental results or, given situations, predict what the results might be.

Outcome 3

Type of experimental activity

The teacher/lecturer should ensure that the experimental activity to be undertaken in connection with Outcome 3 affords opportunity for the candidate to demonstrate the ability to undertake the planning and organising of an experimental activity at an appropriate level of demand. The activity must relate to the Course content and candidates should be made aware of the range of skills which must be demonstrated to ensure attainment of Outcome 3.

Assessment of Outcome 3

Candidates are only required to produce one report for Outcome 3 in relation to the contents and notes specified for Human Biology (revised) Higher. This report can then be used as evidence for Outcome 3 for the other Units of the Course.

In relation to PC (a), the teacher/lecturer checks by observation that the candidate participates in the collection of the experimental information by playing an active part in planning the experiment, deciding how it will be managed, identifying and obtaining resources (some of which must be unfamiliar to the candidate), and carrying out the experiment.

National Unit specification: support notes (cont)

Unit title: Physiology and Health (SCQF level 6)

Candidates should provide a report with an appropriate title. The report should relate to the Performance Criteria as follows:

(b)	The experimental procedures are described accurately.	A clear statement of the aim of the experiment. A few brief concise sentences including as appropriate: ♦ a labelled diagram or brief description of apparatus or ♦ instruments used ♦ how the independent variable was altered ♦ control measure used ♦ how measurements were taken or observations made. There is no need for a detailed description. The use of the impersonal passive voice is to be encouraged as an example of good practice but this is not mandatory for meeting the Performance Criteria.
(c)	Relevant measurements and observations are recorded in an appropriate format.	Readings or observations (raw data) must be recorded in a clear table with correct headings, appropriate units and results/readings entered correctly.
(d)	Recorded experimental information is analysed and presented in an appropriate format.	Data should be analysed and presented in tabular, graphical format or as a scatter diagram or equivalent, as appropriate: ♦ For a tabular presentation this may be an extension of the table used for PC (c) above, and must include: suitable headings and units showing averages or other appropriate computations ♦ For a graphical presentation this must include: data presented as a histogram, bar chart, connected points or line of best fit as appropriate, with suitable scales and axes labelled with variable and units and with data correctly plotted.
(e)	Conclusions drawn are valid.	Conclusions should use evidence from the experiment and relate back to the aim of the experiment. At least one of the following should be included: ♦ overall pattern to readings or observations (raw data) ♦ trends in analysed information or results ♦ connection between variables and controls.

(f)	The experimental procedures are evaluated with supporting argument.	The evaluation could cover all stages of the activity including preparing for the activity, analysis of the activity and the results of the activity. The evaluation must include supporting argument in at least one of the following: ♦ effectiveness of procedures ♦ control of variables ♦ limitations of equipment ♦ possible sources of error ♦ possible improvements.

The bullet points under each performance criterion give an indication of what should be addressed to achieve a pass. The relevance of the bullet points will vary according to the experiment. These bullet points are intended as helpful guidance. The decision of pass or fail is to be made by the professional judgement of the presenting centre (subject to external verification) against the Performance Criteria. It is appropriate to support candidates in producing a report to meet the Performance Criteria. Re-drafting of a report after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment. Redrafting and resubmission is only required for the specific performance criterion identified in need of further attention, ie the entire report does not need to be rewritten.

Conditions required to complete the report

Candidates may complete their work outwith class time provided reasonable measures are taken to ensure that the report is the individual work of the candidate. Teachers and lecturers may wish candidates to write up reports under their direct supervision so that they can provide appropriate advice and support. However, they may feel confident that any redrafting required need not be undertaken under such close supervision as it will be evident in the candidate's response that it is his or her unaided work. Under such circumstances it would be acceptable for such redrafting to take place outwith class time.

Use of IT

Candidates may, if they wish, present their reports in a word-processed format. Candidates may use Excel (or any other suitable data analysis software) when tackling Outcome 3. However, candidates must not be given a spreadsheet with pre-prepared column headings nor formulae, as they are being assessed on their ability to enter quantities and units into a table and to make decisions about appropriate scales and labels on graph axes. The use of clip art or images captured by digital camera may also be used in recording details of experimental methods.

National Unit specification: support notes (cont)

Unit title: Physiology and Health (SCQF level 6)

Transfer of evidence

Candidates may transfer evidence for Outcome 3 from one level to the one below provided the experiment is in the context of the Course concerned. Candidates, who are repeating a Course, may carry forward evidence of an appropriate standard, generated in a previous year.

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003), SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

History of changes

Version	Description of change	Date

National Unit specification: general information

Unit title: Neurobiology and Communication (SCQF level 6)

Unit code: FH2M 12

Superclass: RH

Publication date: March 2011

Source: Scottish Qualifications Authority

Version: 01

Summary

This Unit is a mandatory Unit of the Human Biology (revised) Higher Course and has been designed to be taken as part of that Course. It can also be taken as a free-standing Unit.

This Unit seeks to develop Knowledge and Understanding, Problem Solving and practical skills related to the human nervous system and communication and social behaviour.

Successful candidates will be able to describe and explain aspects of neurobiology and communication and apply their knowledge in new situations and when interpreting related biological information. They will be able to collect, analyse and present scientific data and information; plan, design and carry out practical work; draw conclusions, evaluate and make predictions and generalisations based on scientific evidence. They will be able to write a scientific report on an experimental activity related to neurobiology and communication that they have carried out.

This Unit is suitable for candidates who have studied the senses and reflex arc of the nervous system as part of a Course or Unit at SCQF level 5.

Outcomes

1 Demonstrate Knowledge and Understanding related to neurobiology and communication.
2 Solve problems related to neurobiology and communication using scientific skills.
3 Collect and analyse information related to neurobiology and communication by experiment.

General information (cont)

Recommended entry

While entry is at the discretion of the centre, candidates would normally be expected to have attained a Biology National Qualification at SCQF level 5 or its equivalent.

Credit points and level

0.5 SQA credit at SCQF level 6: (3 SCQF credit points at SCQF level 6*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

Core Skills

Achievement of this Unit gives automatic certification of the following:

Complete Core Skill	*Problem Solving* at SCQF level 6
Core Skill component	Using Graphical Information at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

National Unit specification: statement of standards

Unit title: Neurobiology and Communication (SCQF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Outcome 1

Demonstrate Knowledge and Understanding related to neurobiology and communication.

Performance Criteria

(a) Make accurate statements and give clear descriptions about neurobiology and communication.
(b) Apply relevant knowledge of neurobiology and communication in new situations and appreciate its significance when interpreting biological information.
(c) Explain the biology of neurobiology and communication with reasons or supporting evidence.

Outcome 2

Solve problems related to neurobiology and communication using scientific skills.

Performance Criteria

(a) Select and present relevant information in an appropriate format.
(b) Process information accurately using calculations where appropriate.
(c) Draw valid conclusions and give explanations supported by evidence.
(d) Plan, design and evaluate experimental procedures appropriately.
(e) Make predictions and generalisations based on evidence.

Outcome 3

Collect and analyse information related to neurobiology and communication by experiment.

Performance Criteria

(a) Participate actively in the collection of information by experiment.
(b) Describe the experimental procedures accurately.
(c) Record relevant measurements and observations in an appropriate format.
(d) Analyse and present the recorded experimental information in an appropriate format.
(e) Draw valid conclusions.
(f) Evaluate the experimental procedures with supporting argument.

National Unit specification: statement of standards (cont)

Unit title: Neurobiology and Communication (SCQF level 6)

Evidence Requirements for this Unit

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

The standard to be applied and the breadth of coverage are illustrated in the National Assessment Bank items available for this Unit. If a centre wishes to design its own assessments for this Unit they should be of a comparable standard.

Evidence of an appropriate level of achievement must be generated from a closed-book instrument of assessment under controlled conditions covering the Performance Criteria for Outcome 1 and Outcome 2 set in the context of the nervous system and communication and social behaviour, with a time limit of 45 minutes.

In the evidence for planning and designing experimental procedures in Outcome 2 PC (d) candidates must be able to develop and justify a hypothesis to be investigated or the aim of an experiment.

A report of one experiment is required covering the Performance Criteria for Outcome 3 set in the context of the nervous system and communication and social behaviour. The report can be in the format of a traditional lab report or alternative that covers the Performance Criteria for the Unit including conference poster format, scientific paper format, Power Point presentation, video presentation or web page.

The teacher/lecturer responsible must attest that the report is the individual work of the candidate derived from active participation in an experiment in which the candidate plans the experiment; decides how it is managed; identifies and obtains the necessary resources, some of which must be unfamiliar; and carries out the experiment. Depending on the activity, the collection of the information may be group work.

Evidence submitted in support of attainment of PC (d) must be in the format of a table or graph(s) as appropriate. Conclusions drawn should be justified by reference to supporting evidence and comment on trends or patterns and/or connections between variables and controls.

The evaluation should cover all stages of the experiment, including the initial analysis of the situation and planning and organising the experimental procedure. In carrying out the experiment candidates should consider modifying procedures and respond to sources of error.

National Unit specification: support notes

Unit title: Neurobiology and Communication (SCQF level 6)

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 20 hours.

Guidance on the content and context for this Unit

1 The nervous system

(a) Divisions of the nervous system:
(b) Parts of the brain
  (i) The central core
  (ii) The limbic system
  (iii) Cerebral cortex
(c) Perception:
  (i) Segregation of objects
  (ii) Perception of distance
  (iii) Recognition
(d) Memory:
  (i) Sensory memory
  (ii) Short term memory
  (iii) Long term memory
  (iv) Location of memory in the brain
(e) The cells of the nervous system:
  (i) Neurons
  (ii) Glial cells
(f) Neurotransmitters:
  (i) Converging, diverging and reverberating neural pathways and plasticity of response
  (ii) Neurotransmitters, mood and behaviour
    Endorphins
    Dopamine and the reward pathway
    Neurotransmitter related disorders and their treatment
    Mode of action of recreational drugs
    Drug addiction/tolerance

2 Communication and social behaviour

(a) The effect of infant attachment
(b) The effect of communication:
  (i) Non-verbal communication
  (ii) Verbal communication
(c) The effect of experience:
  (i) The effect of practice on motor skills
  (ii) Imitation
  (iii) Reinforcement, shaping and extinction of behaviour as seen in trial and error learning
  (iv) Generalisation and discrimination

(d) The effect of group behaviour and social influence:
  (i) Social facilitation
  (ii) Deindividuation
  (iii) Influences that change beliefs: internalisation and identification

Further guidance on the content and context for this Unit is provided in the Course content tables for neurobiology and communication in the Course specification for Human Biology (revised) Higher. The suggested learning activities and approaches column in these tables provides contexts in which the Knowledge and Understanding and skills of this Unit can be developed and are not liable for assessment although they may provide contexts for assessment items.

Guidance on learning and teaching approaches for this Unit

Guidance on learning and teaching approaches for this Unit are provided in the guidance on learning and teaching approaches in the Course specification for Human Biology (revised) Higher.

Opportunities for developing Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the support notes of this Unit specification. The guidance on learning and teaching approaches for this Unit provided in the Course specification for Human Biology (revised) Higher highlights opportunities to develop Using Number when processing information and Oral and Written Communication when presenting information. In addition the guidance on learning and teaching approaches highlights opportunities to develop *Working with Others* when carrying out practical experimental work and in using *Information and Communication Technology* in practical experimental work and for data analysis.

Guidance on approaches to assessment for this Unit

A holistic approach is taken to assessment, ie Outcomes 1 and 2 are assessed by an integrated end of Unit test with questions covering all the Performance Criteria for Knowledge and Understanding and Problem Solving.

Outcome 1

Test items should be constructed to allow candidates to meet all of the Performance Criteria in the context of the nervous system and communication and social behaviour.

National Unit specification: support notes (cont)

Unit title: Neurobiology and Communication (SCQF level 6)

Outcome 2

Test items should be constructed to allow candidates to generate evidence relating to the Performance Criteria as follows:

(a) Selecting and presenting information:
- sources of information to include: texts, tables, charts, graphs, keys and diagrams
- formats of presentation to include: written summaries, extended writing, tables and graphs.

(b) Calculations to include: percentages, averages, ratios. Significant figures and units should be used appropriately.

(c) Conclusions drawn should include some justification, and explanations should be reported by evidence. Conclusions could contain a comment on trends or patterns and/or connections between variables and controls.

(d) Candidates could plan and design procedures to test given hypotheses or to illustrate particular effects. This could include identification of variables, controls and measurements or observations required. The evaluation of given experimental procedures may include situations which are unfamiliar to candidates and could test the candidates' ability to comment on the purpose of approach or the suitability of given experimental procedures. Candidates could comment on the limitations of the set-up, apparatus, suggested measurements or observations, limitations of equipment, appropriateness of controls, sources of error and possible improvements.

(e) Candidates could make predictions and generalisations from given experimental results or, given situations, predict what the results might be.

Outcome 3

Type of experimental activity

The teacher/lecturer should ensure that the experimental activity to be undertaken in connection with Outcome 3 affords opportunity for the candidate to demonstrate the ability to undertake the planning and organising of an experimental activity at an appropriate level of demand. The activity must relate to the Course content and candidates should be made aware of the range of skills which must be demonstrated to ensure attainment of Outcome 3.

Assessment of Outcome 3

Candidates are only required to produce one report for Outcome 3 in relation to the contents and notes specified for Human Biology (revised) Higher. This report can then be used as evidence for Outcome 3 for the other Units of the Course.

In relation to PC (a), the teacher/lecturer checks by observation that the candidate participates in the collection of the experimental information by playing an active part in planning the experiment, deciding how it will be managed, identifying and obtaining resources (some of which must be unfamiliar to the candidate), and carrying out the experiment.

National Unit specification: support notes (cont)

Unit title: Neurobiology and Communication (SCQF level 6)

Candidates should provide a report with an appropriate title. The report should relate to the Performance Criteria as follows:

(b)	The experimental procedures are described accurately.	A clear statement of the aim of the experiment. A few brief concise sentences including as appropriate: ♦ a labelled diagram or brief description of apparatus or ♦ instruments used ♦ how the independent variable was altered ♦ control measure used ♦ how measurements were taken or observations made. There is no need for a detailed description. The use of the impersonal passive voice is to be encouraged as an example of good practice but this is not mandatory for meeting the Performance Criteria.
(c)	Relevant measurements and observations are recorded in an appropriate format.	Readings or observations (raw data) must be recorded in a clear table with correct headings, appropriate units and results/readings entered correctly.
(d)	Recorded experimental information is analysed and presented in an appropriate format.	Data should be analysed and presented in tabular, graphical format or as a scatter diagram or equivalent, as appropriate: ♦ For a tabular presentation this may be an extension of the table used for PC (c) above, and must include: suitable headings and units showing averages or other appropriate computations ♦ For a graphical presentation this must include: data presented as a histogram, bar chart, connected points or line of best fit as appropriate, with suitable scales and axes labelled with variable and units and with data correctly plotted.
(e)	Conclusions drawn are valid.	Conclusions should use evidence from the experiment and relate back to the aim of the experiment. At least one of the following should be included: ♦ overall pattern to readings or observations (raw data) ♦ trends in analysed information or results ♦ connection between variables and controls.

(f)	The experimental procedures are evaluated with supporting argument.	The evaluation could cover all stages of the activity including preparing for the activity, analysis of the activity and the results of the activity. The evaluation must include supporting argument in at least one of the following: ♦ effectiveness of procedures ♦ control of variables ♦ limitations of equipment ♦ possible sources of error ♦ possible improvements.

The bullet points under each performance criterion give an indication of what should be addressed to achieve a pass. The relevance of the bullet points will vary according to the experiment. These bullet points are intended as helpful guidance. The decision of pass or fail is to be made by the professional judgement of the presenting centre (subject to external verification) against the Performance Criteria. It is appropriate to support candidates in producing a report to meet the Performance Criteria. Re-drafting of a report after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment. Redrafting and resubmission is only required for the specific performance criterion identified in need of further attention, ie the entire report does not need to be rewritten.

Conditions required to complete the report

Candidates may complete their work outwith class time provided reasonable measures are taken to ensure that the report is the individual work of the candidate. Teachers and lecturers may wish candidates to write up reports under their direct supervision so that they can provide appropriate advice and support. However, they may feel confident that any redrafting required need not be undertaken under such close supervision as it will be evident in the candidate's response that it is his or her unaided work. Under such circumstances it would be acceptable for such redrafting to take place outwith class time.

Use of IT

Candidates may, if they wish, present their reports in a word-processed format. Candidates may use Excel (or any other suitable data analysis software) when tackling Outcome 3. However, candidates must not be given a spreadsheet with pre-prepared column headings nor formulae, as they are being assessed on their ability to enter quantities and units into a table and to make decisions about appropriate scales and labels on graph axes. The use of clip art or images captured by digital camera may also be used in recording details of experimental methods.

National Unit specification: support notes (cont)

Unit title: Neurobiology and Communication (SCQF level 6)

Transfer of evidence

Candidates may transfer evidence for Outcome 3 from one level to the one below provided the experiment is in the context of the Course concerned. Candidates, who are repeating a Course, may carry forward evidence of an appropriate standard, generated in a previous year.

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003), SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

History of changes

Version	Description of change	Date

National Unit specification: general information

Unit title: Immunology and Public Health (SCQF level 6)

Unit code: FH2N 12

Superclass: RH

Publication date: March 2011

Source: Scottish Qualifications Authority

Version: 01

Summary

This Unit is a mandatory Unit of the Human Biology (revised) Higher Course and has been designed to be taken as part of that Course. It can also be taken as a free-standing Unit.

This Unit seeks to develop Knowledge and Understanding, Problem Solving and practical skills related to the immune system and infectious diseases and immunity.

Successful candidates will be able to describe and explain aspects of the immune system and infectious diseases and immunity and apply their knowledge in new situations and when interpreting related biological information. They will be able to collect, analyse and present scientific data and information; plan, design and carry out practical work; draw conclusions, evaluate and make predictions and generalisations based on scientific evidence. They will be able to write a scientific report on an experimental activity related to immunology and public health that they have carried out.

This Unit is suitable for candidates who have studied diseases and defences against diseases as part of a Course or Unit at SCQF level 5.

Outcomes

1 Demonstrate Knowledge and Understanding related to immunology and public health.
2 Solve problems related to immunology and public health using scientific skills.
3 Collect and analyse information related to immunology and public health by experiment.

Recommended entry

While entry is at the discretion of the centre, candidates would normally be expected to have attained a Biology National Qualification at SCQF level 5 or its equivalent.

General information (cont)

Credit points and level

0.5 SQA credit(s) at SCQF level 6: (3 SCQF credit points at SCQF level 6*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

Core Skills

Achievement of this Unit gives automatic certification of the following:

Complete Core Skill	*Problem Solving* at SCQF level 6
Core Skill component	Using Graphical Information at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

National Unit specification: statement of standards

Unit title: Immunology and Public Health (SCQF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Outcome 1

Demonstrate Knowledge and Understanding related to immunology and public health.

Performance Criteria

(a) Make accurate statements and clear descriptions of immunology and public health.
(b) Apply relevant knowledge of immunology and public health in new situations and appreciate its significance when interpreting biological information.
(c) Explain the biology of immunology and public health with reasons or supporting evidence.

Outcome 2

Solve problems related to immunology and public health using scientific skills.

Performance Criteria

(a) Select and present relevant information in an appropriate format.
(b) Process information accurately using calculations where appropriate.
(c) Draw valid conclusions and give explanations supported by evidence.
(d) Plan, design and evaluate experimental procedures appropriately.
(e) Make predictions and generalisations based on evidence.

Outcome 3

Collect and analyse information related to immunology and public health by experiment.

Performance Criteria

(a) Participate actively in the collection of information by experiment.
(b) Describe the experimental procedures accurately.
(c) Record relevant measurements and observations in an appropriate format.
(d) Analyse and present the recorded experimental information in an appropriate format.
(e) Draw valid conclusions.
(f) Evaluate the experimental procedures with supporting argument.

National Unit specification: statement of standards (cont)

Unit title: Immunology and Public Health (SCQF level 6)

Evidence Requirements for this Unit

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

The standard to be applied and the breadth of coverage are illustrated in the National Assessment Bank items available for this Unit. If a centre wishes to design its own assessments for this Unit they should be of a comparable standard.

Evidence of an appropriate level of achievement must be generated from a closed-book instrument of assessment under controlled conditions covering the Performance Criteria for Outcome 1 and Outcome 2 set in the context of the immune system and infectious diseases and immunity, with a time limit of 45 minutes.

In the evidence for planning and designing experimental procedures in Outcome 2 PC (d) candidates must be able to develop and justify a hypothesis to be investigated or the aim of an experiment.

A report of one experiment is required covering the Performance Criteria for Outcome 3 set in the context of the immune system and infectious diseases and immunity. The report can be in the format of a traditional lab report or alternative that covers the Performance Criteria for the Unit including conference poster format, scientific paper format, Power Point presentation, video presentation or web page.

The teacher/lecturer responsible must attest that the report is the individual work of the candidate derived from active participation in an experiment in which the candidate plans the experiment; decides how it is managed; identifies and obtains the necessary resources, some of which must be unfamiliar; and carries out the experiment. Depending on the activity, the collection of the information may be group work.

Evidence submitted in support of attainment of PC (d) must be in the format of a table or graph(s) as appropriate. Conclusions drawn should be justified by reference to supporting evidence and comment on trends or patterns and/or connections between variables and controls.

The evaluation should cover all stages of the experiment, including the initial analysis of the situation and planning and organising the experimental procedure. In carrying out the experiment candidates should consider modifying procedures and respond to sources of error.

National Unit specification: support notes

Unit title: Immunology and Public Health (SCQF level 6)

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 20 hours.

Guidance on the content and context for this Unit

1 The Immune system

(a) Non-specific defences:
  (i) Physical and chemical defences
  (ii) Inflammatory response
  (iii) Non-specific cellular responses

(b) Specific cellular defences:
  (i) Immune surveillance
  (ii) Clonal selection theory
  (iii) T and B lymphocytes
    Recognition of self and non self
    T lymphocytes
    B lymphocytes
  (iv) Memory cells (immunological memory)

2 Infectious diseases and immunity

(a) The transmission of infectious diseases:
  (i) Epidemiology of infectious diseases

(b) Active immunisation and vaccination:
  (i) Vaccine clinical trials
  (ii) Herd immunity
  (iii) Public health medicine

(c) Evasion of specific immune responses by pathogens:
  (i) Antigenic variation
  (ii) Direct attack on the immune system

Further guidance on the content and context for this Unit is provided in the Course content tables for immunology and public health in the Course specification for Human Biology (revised) Higher. The suggested learning activities and approaches column in these tables provides contexts in which the Knowledge and Understanding and skills of this Unit can be developed and are not liable for assessment although they may provide contexts for assessment items.

Guidance on learning and teaching approaches for this Unit

Guidance on learning and teaching approaches for this Unit are provided in the guidance on learning and teaching approaches in the Course specification for Human Biology (revised) Higher.

National Unit specification: support notes (cont)

Unit title: Immunology and Public Health (SCQF level 6)

Opportunities for developing Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the support notes of this Unit specification. The guidance on learning and teaching approaches for this Unit provided in the Course specification for Human Biology (revised) Higher highlights opportunities to develop Using Number when processing information and Oral and Written Communication when presenting information. In addition the guidance on learning and teaching approaches highlights opportunities to develop *Working with Others* when carrying out practical experimental work and in using *Information and Communication Technology* in practical experimental work and for data analysis.

Guidance on approaches to assessment for this Unit

A holistic approach is taken to assessment, ie Outcomes 1 and 2 are assessed by an integrated end of Unit test with questions covering all the Performance Criteria for Knowledge and Understanding and Problem Solving.

Outcome 1

Test items should be constructed to allow candidates to meet all of the Performance Criteria in the context of the immune system and infectious diseases and immunity.

Outcome 2

Test items should be constructed to allow candidates to generate evidence relating to the Performance Criteria as follows:

(a) Selecting and presenting information:
- sources of information to include: texts, tables, charts, keys, graphs and diagrams
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(b) Calculations to include: percentages, averages, ratios. Significant figures and units should be used appropriately.

(c) Conclusions drawn should include some justification, and explanations should be reported by evidence. Conclusions could contain a comment on trends or patterns and/or connections between variables and controls.

(d) Candidates could plan and design procedures to test given hypotheses or to illustrate particular effects. This could include identification of variables, controls and measurements or observations required. The evaluation of given experimental procedures may include situations which are unfamiliar to candidates and could test the candidates' ability to comment on the purpose of approach or the suitability of given experimental procedures. Candidates could comment on the limitations of the set-up, apparatus, suggested measurements or observations, limitations of equipment, appropriateness of controls, sources of error and possible improvements.

(e) Candidates could make predictions and generalisations from given experimental results or, given situations, predict what the results might be.

National Unit specification: support notes (cont)

Unit title: Immunology and Public Health (SCQF level 6)

Outcome 3

Type of experimental activity

The teacher/lecturer should ensure that the experimental activity to be undertaken in connection with Outcome 3 affords opportunity for the candidate to demonstrate the ability to undertake the planning and organising of an experimental activity at an appropriate level of demand. The activity must relate to the Course content and candidates should be made aware of the range of skills which must be demonstrated to ensure attainment of Outcome 3.

Assessment of Outcome 3

Candidates are only required to produce one report for Outcome 3 in relation to the contents and notes specified for Human Biology (revised) Higher. This report can then be used as evidence for Outcome 3 for the other Units of the Course.

In relation to PC (a), the teacher/lecturer checks by observation that the candidate participates in the collection of the experimental information by playing an active part in planning the experiment, deciding how it will be managed, identifying and obtaining resources (some of which must be unfamiliar to the candidate), and carrying out the experiment.

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(f)	The experimental procedures are evaluated with supporting argument.	The evaluation could cover all stages of the activity including preparing for the activity, analysis of the activity and the results of the activity. The evaluation must include supporting argument in at least one of the following: ♦ effectiveness of procedures ♦ control of variables ♦ limitations of equipment ♦ possible sources of error ♦ possible improvements.

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History of changes

Version	Description of change	Date