SCQF level 6
Unit Specification

# Human Biology: Neurobiology and Immunology

## SCQF: level 6 (6 SCQF credit points)

## Unit code: J4A4 76

## Unit outline

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

Learners will apply these skills when considering the applications of neurobiology and immunology on our lives. This can be done by using a variety of approaches, including investigation and problem solving.

The Unit covers the key areas of divisions of the nervous system and neural pathways; the cerebral cortex; memory; the cells of the nervous system and neurotransmitters at synapses; non-specific body defences; specific cellular defences against pathogens; immunisation; and clinical trials of vaccines and drugs.

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

Learners who complete this Unit will be able to:

1 Apply skills of scientific inquiry and draw on knowledge and understanding of the key areas of this Unit to carry out an experiment/practical investigation
2 Draw on knowledge and understanding of the key areas of this Unit and apply scientific skills

This Unit is a free-standing Unit. The *Unit Support Notes* in the Appendix provide advice and guidance on delivery, assessment approaches and development of skills for learning, skills for life and skills for work. Exemplification of the standards in this Unit is given in *Unit Assessment Support*.

## Recommended entry

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

- National 5 Biology Course
- free-standing SCQF level 5 Biology Units

## Equality and inclusion

This Unit Specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence. For further information, please refer to the *Unit Support Notes.*

# Standards

## Outcomes and Assessment Standards

### Outcome 1

The learner will:

**1 Apply skills of scientific inquiry and draw on knowledge and understanding of the key areas of this Unit to carry out an experiment/practical investigation by:**

1.1 Planning an experiment/practical investigation
1.2 Following procedures safely
1.3 Making and recording observations/measurements correctly
1.4 Presenting results in an appropriate format
1.5 Drawing valid conclusions
1.6 Evaluating experimental procedures

### Outcome 2

The learner will:

**2 Draw on knowledge and understanding of the key areas of this Unit and apply scientific skills by:**

2.1 Making accurate statements
2.2 Solving problems

# Evidence Requirements for the Unit

Assessors should use their professional judgement, subject knowledge and experience, and understanding of their learners, to determine the most appropriate ways to generate evidence and the conditions and contexts in which they are used.

The key areas covered in this Unit are divisions of the nervous system and neural pathways; the cerebral cortex; memory; the cells of the nervous system and neurotransmitters at synapses; non-specific body defences; specific cellular defences against pathogens; immunisation; and clinical trials of vaccines and drugs.

The following table describes the evidence for the Assessment Standards. Exemplification of assessment is provided in *Unit Assessment Support*.

| **Assessment Standard** | **Evidence required** |
|---|---|
| Planning an experiment | The plan must include:<br><br>♦ a clear statement of the aim<br>♦ a hypothesis<br>♦ a dependent and independent variable<br>♦ variables to be kept constant<br>♦ measurements/observations to be made<br>♦ the equipment/materials<br>♦ a clear and detailed description of how the experiment/practical investigation should be carried out, including safety considerations |
| Following procedures safely | The learner must be seen to follow procedures safely. |
| Making and recording observations/measurements correctly | The raw data must be collated in a relevant format, for example a table. |
| Presenting results in an appropriate format | One format from: bar graph or line graph. |
| Drawing a valid conclusion | Must include reference to the aim and be supported by the results. |
| Evaluating experimental procedures | Provide one evaluative statement about the procedures used **and** suggest one improvement for the experiment.<br>**or**<br>Provide two evaluative statements about the procedures used.<br>**or**<br>Suggest two improvements for the experiment.<br><br>Appropriate justification must also be provided, whichever option is chosen. |

| Assessment Standard | Evidence required |
|---|---|
| Making accurate statements and solving problems | Achieve at least 50% of the total marks available in a holistic assessment.<br><br>A holistic assessment must include:<br><br>♦ an appropriate number of opportunities to make accurate statements for each key area of the Unit<br>♦ at least one opportunity to demonstrate each of the following problem-solving skills:<br>— make generalisations/predictions<br>— select information<br>— process information, including calculations, as appropriate<br>— analyse information |

# Assessment Standard thresholds

## Outcome 1

Learners are not required to show full mastery of the Assessment Standards to achieve Outcome 1. Instead, five out of the six Assessment Standards for Outcome 1 must be met to achieve a pass. Learners must be given the opportunity to meet all Assessment Standards.

## Outcome 2

Learners are assessed using a holistic assessment that assesses Assessment Standards 2.1 and 2.2. To gain a pass for Outcome 2, learners must achieve 50% or more of the total marks available in the assessment.

## Transfer of evidence

Evidence for the achievement of Outcome 1 for this Unit can be used as evidence for the achievement of Outcome 1 in the SCQF level 6 Units: Human Biology: Human Cells (J4A3 76) and Human Biology: Physiology and Health (J4A5 76).

Evidence for the achievement of Outcome 2 for this Unit is **not** transferable between the SCQF level 6 Units: Human Biology: Human Cells (J4A3 76) and Human Biology: Physiology and Health (J4A5 76).

## Re-assessment

SQA's guidance on re-assessment is that there should only be one or, in exceptional circumstances, two re-assessment opportunities. Re-assessment must be carried out under the same conditions as the original assessment.

## Outcome 1

Learners can re-draft their original Outcome 1 report or carry out a new experiment/practical investigation.

## Outcome 2

Learners must have a full re-assessment opportunity, ie a holistic assessment. To achieve Outcome 2, learners must achieve 50% of the total marks available in the re-assessment.

# Development of skills for learning, skills for life and skills for work

It is expected that learners will develop broad, generic skills through this Unit. The skills that learners will be expected to improve on and develop through the Unit are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and drawn from the main skills areas listed below. These must be built into the Unit where there are appropriate opportunities.

**1 Literacy**

1.2 Writing

**2 Numeracy**

2.1 Number processes
2.2 Money, time and measurement
2.3 Information handling

**5 Thinking skills**

5.3 Applying
5.4 Analysing and evaluating
5.5 Creating

Amplification of these is given in SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work*. The level of these skills should be at the same SCQF level of the Unit and be consistent with the SCQF level descriptor. Further information on building in skills for learning, skills for life and skills for work is given in the Appendix: *Unit Support Notes*.

# Appendix: Unit Support Notes

## Introduction

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

- *Unit Assessment Support*

## Developing skills, knowledge and understanding

Teachers and lecturers are free to select the skills, knowledge, understanding and contexts that are most appropriate for delivery in their centres.

# Approaches to learning and teaching

| Neurobiology and immunology | | |
|---|---|---|
| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **1 Divisions of the nervous system and neural pathways**<br>(a) Structure of the central nervous system (CNS) and the peripheral nervous system (PNS)<br><br>The somatic nervous system contains sensory and motor neurons.<br><br>The autonomic nervous system (ANS) consists of the sympathetic and parasympathetic systems.<br><br>The antagonistic actions of the sympathetic and parasympathetic systems on heart rate, breathing rate, peristalsis and intestinal secretions | The CNS consists of the brain and the spinal cord. The PNS consists of the somatic nervous system (SNS) and the autonomic nervous system (ANS).<br><br>Sensory neurons take impulses from sense organs to the CNS. Motor neurons take impulses from the CNS to muscles and glands.<br><br>The sympathetic system speeds up heart rate and breathing rate while slowing down peristalsis and production of intestinal secretions. The parasympathetic system changes these in the opposite way. | |
| (b) Structure and function of converging, diverging and reverberating neural pathways | In a converging neural pathway, impulses from several neurons travel to one neuron. This increases the sensitivity to excitatory or inhibitory signals. | Study examples of neural pathways such as:<br><br>♦ the convergence of neurons from rods in the retina so increasing sensitivity to low |

| Neurobiology and immunology | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| | In a diverging neural pathway, impulses from one neuron travel to several neurons so affecting more than one destination at the same time.<br><br>In a reverberating pathway, neurons later in the pathway link with earlier neurons, sending the impulse back through the pathway. This allows repeated stimulation of the pathway. | levels of illumination through summation<br>♦ the divergence of motor neurons, which allows fine motor control of fingers<br><br>♦ the use of reverberating pathways in repetitive activities, such as breathing |
| **2 The cerebral cortex**<br>(a) The cerebral cortex is the centre of conscious thought. It also recalls memories and alters behaviour in the light of experience.<br><br>There is localisation of brain functions in the cerebral cortex. It contains sensory areas, motor areas and association areas. There are association areas involved in language processing, personality, imagination and intelligence. | There is no requirement to know the locations of these areas in the brain. | Examine data on clinical observations of brain injuries, lesions and EEGs. Examine brain scans as evidence of localisation of brain function.<br><br>Study brain images produced using PET and fMRI techniques that highlight active regions of the brain. |

| Neurobiology and immunology | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| (b) Information from one side of the body is processed in the opposite side of the cerebrum.<br><br>Transfer of information between the cerebral hemispheres occurs through the corpus callosum. | The left cerebral hemisphere deals with information from the right visual field and controls the right side of the body and vice versa. | Examine responses produced by split-brain patients when asked to complete tasks. |
| **3 Memory**<br>(a) Memory involves encoding, storage and retrieval of information.<br><br>All information entering the brain passes through sensory memory and enters short-term memory (STM). Information is then either transferred to long-term memory (LTM) or is discarded. | Memories include past experiences, knowledge and thoughts. | |
| (b) Sensory memory retains all the visual and auditory input received for a few seconds. | Only selected images and sounds are encoded into short-term memory. | |
| (c) Short-term memory (STM)<br>STM has a limited capacity and holds information for a short time. The capacity of STM can be improved by 'chunking'.<br><br>STM can also process data, to a limited | Memory span, the serial position effect, maintaining items by rehearsal and loss of items by displacement and decay | Carry out experiments to determine an individual's memory span for letters or numbers.<br><br>Carry out experiments to show how the memory span of STM can be increased by |

| Neurobiology and immunology | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| extent, as well as store it. This 'working memory model' explains why the STM can perform simple cognitive tasks. | | 'chunking'.<br><br>Carry out experiments to illustrate the serial position effect and how it can be disrupted by distraction tasks. |
| (d) Long-term memory (LTM)<br>LTM has an unlimited capacity and holds information for a long time.<br><br>The transfer of information from STM to LTM by rehearsal, organisation and elaboration<br><br>Retrieval is aided by the use of contextual cues. | Rehearsal is regarded as a shallow form of encoding information into LTM. Elaboration is regarded as a deeper form of encoding,which leads to improved information retention.<br><br>Contextual cues relate to the time and place when the information was initially encoded into LTM. | Carry out experiments to show that organisation and elaboration improve retrieval from LTM.<br><br>Research memory disorders, such as Alzheimer's disease and amnesia. |
| **4 The cells of the nervous system and neurotransmitters at synapses**<br>(a) Structure and function of neurons — dendrites, cell body and axons<br><br>Structure and function of myelin sheath | Axons are surrounded by a myelin sheath, which insulates the axon and increases the speed of impulse conduction. | Examine slides and photomicrographs of neurons. |

| Neurobiology and immunology | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| Myelination continues from birth to adolescence.<br><br>Certain diseases destroy the myelin sheath, causing a loss of co-ordination.<br><br>Glial cells produce the myelin sheath and support neurons. | Responses to stimuli in the first two years of life are not as rapid or co-ordinated as those of an older child or adult.<br><br>No requirement to know names of diseases. | Carry out research into multiple sclerosis (MS). |
| (b) Neurotransmitters at synapses<br><br>Chemical transmission at the synapse by neurotransmitters — vesicles, synaptic cleft and receptors<br><br>The need for removal of neurotransmitters by enzymes or reuptake to prevent continuous stimulation of postsynaptic neurons | Neurons connect with other neurons or muscle fibres at a synaptic cleft. Neurotransmitters relay impulses across the synaptic cleft.<br><br>Neurotransmitters are stored in vesicles in the axon endings of the presynaptic neuron. They are released into the cleft on arrival of an impulse. They diffuse across the cleft and bind to receptors on the membrane of the postsynaptic neuron. | Examine how acetylcholine and norepinephrine (noradrenaline) are removed from the synaptic cleft. |

| Neurobiology and immunology | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| Receptors determine whether the signal is excitatory or inhibitory.<br><br>Synapses can filter out weak stimuli arising from insufficient secretion of neurotransmitters.<br><br>Summation of a series of weak stimuli can release enough neurotransmitter to trigger an impulse. | <br><br>A minimum number of neurotransmitter molecules must attach to receptors in order to reach the threshold on the postsynaptic membrane to transmit the impulse.<br><br>Convergent neural pathways can release enough neurotransmitter molecules to reach threshold and trigger an impulse. | |
| (c) Neurotransmitter effects on mood and behaviour<br><br>The functions of endorphins<br><br>Endorphin production increases in response to severe injury, prolonged and continuous exercise, stress and certain foods.<br><br>The function of dopamine | <br><br>Endorphins are neurotransmitters that stimulate neurons involved in reducing the intensity of pain.<br><br>Increased levels of endorphins are also linked to the feelings of pleasure obtained from activities, such as eating, sex and prolonged exercise.<br><br>Dopamine is a neurotransmitter that induces feelings of pleasure and reinforces particular behaviour by activating the reward pathway | <br><br>Analyse data on the link between an individual's endorphin levels and their pain threshold. |

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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| | in the brain.<br><br>The reward pathway involves neurons, which secrete or respond to dopamine.<br><br>The reward pathway is activated when an individual engages in a behaviour that is beneficial to them, for example eating when hungry. | |
| (d) Neurotransmitter-related disorders and their treatment<br><br>Many drugs used to treat neurotransmitter-related disorders are agonists or antagonists. | Agonists are chemicals that bind to and stimulate specific receptors, mimicking the action of a neurotransmitter at a synapse.<br><br>Antagonists are chemicals that bind to specific receptors, blocking the action of a neurotransmitter at a synapse. | Carry out research on the agonistic action of morphine, which leads to pain relief.<br><br>Carry out research on the antagonistic action of strychnine, a poison. |
| Other drugs act by inhibiting the enzymes that degrade neurotransmitters or by inhibiting reuptake of the neurotransmitter at the synapse, causing an enhanced effect. | | Examine the use of cholinesterase inhibitors in the treatment of Alzheimer's disease.<br><br>Examine the use of serotonin reuptake inhibitors in the treatment of depression. |

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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| (e) Mode of action of recreational drugs<br><br>Recreational drugs can also act as agonists or antagonists.<br><br>Recreational drugs affect neurotransmission at synapses in the brain, altering an individual's mood, cognition, perception and behaviour.<br><br>Many recreational drugs affect neurotransmission in the reward pathway of the brain.<br><br>Drug addiction is caused by repeated use of drugs that act as antagonists.<br><br>Drug tolerance is caused by repeated use of drugs that act as agonists. | Antagonists block specific receptors causing the nervous system to increase both the number and sensitivity of these receptors. This sensitisation leads to addiction, where the individual craves more of the drug.<br><br>Agonists stimulate specific receptors causing the nervous system to decrease both the number and sensitivity of these receptors. This desensitisation leads to drug tolerance, where the individual must take more of the drug to get an effect. | Carry out research into the mode of action of recreational drugs, such as cocaine, cannabis, MDMA, nicotine and alcohol. |

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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **5 Non-specific body defences**<br>(a) Physical and chemical defences<br><br>Epithelial cells form a physical barrier.<br><br>Chemical secretions are produced against invading pathogens. | Closely packed epithelial cells are found in the skin and inner linings of the digestive and respiratory systems.<br><br>Secretions include tears, saliva, mucus and stomach acid.<br><br>A pathogen is a bacterium, virus or other organism that can cause disease. | |
| (b) The inflammatory response | Histamine is released by mast cells causing vasodilation and increased capillary permeability. The increased blood flow leads to an accumulation of phagocytes and clotting elements at the site of infection. | |
| (c) Phagocytes<br><br>Phagocytes recognise pathogens and destroy them by phagocytosis.<br><br>Phagocytes release cytokines, which attract more phagocytes to the site of infection. | Phagocytosis involves the engulfing of pathogens and their destruction by digestive enzymes contained in lysosomes.<br><br>Cytokines are protein molecules that act as a signal to specific white blood cells causing them to accumulate at the site of infection. | |

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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **6 Specific cellular defences against pathogens**<br>(a) Lymphocytes<br><br>Lymphocytes are the white blood cells involved in the specific immune response.<br><br>Lymphocytes respond to specific antigens on invading pathogens.<br><br>Antigens are molecules, often proteins located on the surface of cells that trigger a specific immune response.<br><br>There are two types of lymphocytes — B lymphocytes and T lymphocytes.<br><br>B lymphocytes produce antibodies against antigens, and this leads to the destruction of the pathogen.<br><br>B lymphocytes can respond to antigens on substances that are harmless to the body, for example pollen. This hypersensitive response is called an allergic reaction. | Lymphocytes have a single type of membrane receptor, which is specific for one antigen. Antigen binding leads to repeated lymphocyte division resulting in the formation of a clonal population of identical lymphocytes.<br><br>Antibodies are Y-shaped proteins that have receptor binding sites specific to a particular antigen on a pathogen. Antibodies become bound to antigens, inactivating the pathogen. The resulting antigen-antibody complex can then be destroyed by phagocytosis. | Carry out research into the causes, symptoms and treatment of hay fever, anaphylactic shock and allergic asthma. |

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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| T lymphocytes destroy infected body cells by recognising antigens of the pathogen on the cell membrane and inducing apoptosis. Apoptosis is programmed cell death.<br><br>T lymphocytes can normally distinguish between self-antigens on the body's own cells and non-self-antigens on infected cells.<br><br>Failure of the regulation of the immune system leads to T lymphocytes responding to self-antigens. This causes autoimmune diseases. | T lymphocytes attach onto infected cells and release proteins. These proteins diffuse into the infected cells causing production of self-destructive enzymes that cause cell death. The remains of the cell are then removed by phagocytosis.<br><br>In autoimmunity, the T lymphocytes attack the body's own cells. This causes autoimmune diseases, such as type 1 diabetes and rheumatoid arthritis. | Carry out research into the causes, symptoms and treatment of type 1 diabetes and rheumatoid arthritis. |
| (b) Some of the cloned B and T lymphocytes survive long-term as memory cells. When a secondary exposure to the same antigen occurs, these memory cells rapidly give rise to a new clone of specific lymphocytes. These destroy the invading pathogens before the individual shows symptoms.<br><br>The human immunodeficiency virus (HIV) attacks and destroys T lymphocytes. HIV causes depletion of T lymphocytes, which leads to the development of AIDS (acquired immune deficiency syndrome). | During the secondary response, antibody production is greater and more rapid than during the primary response.<br><br>Individuals with AIDS have a weakened immune system and so are more vulnerable to opportunistic infections. | Examine public health measures and drug therapies used in the control of HIV. |

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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **7 Immunisation**<br>(a) Vaccination<br><br>Immunity can be developed by vaccination using antigens from infectious pathogens, so creating memory cells.<br><br>Antigens are usually mixed with an adjuvant when producing the vaccine. | <br><br>The antigens used in vaccines can be inactivated pathogen toxins, dead pathogens, parts of pathogens and weakened pathogens.<br><br>An adjuvant is a substance that makes the vaccine more effective, so enhancing the immune response. | <br><br>Research the form of antigen used in vaccines for diseases, such as tetanus, polio, HPV, measles and rubella. |
| (b) Herd immunity<br><br>Herd immunity occurs when a large percentage of a population is immunised. Establishing herd immunity is important in reducing the spread of diseases.<br><br>Non-immune individuals are protected as there is a lower probability they will come into contact with infected individuals.<br><br>The herd immunity threshold depends on the type of disease, the effectiveness of the vaccine and the density of the population. | | <br><br><br><br><br><br>Compare the herd immunity thresholds for various vaccine-preventable diseases. |

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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| Mass vaccination programmes are designed to establish herd immunity to a disease.<br><br>Difficulties can arise when widespread vaccination is not possible due to poverty in the developing world, or when vaccines are rejected by a percentage of the population in the developed world. | | Study the success of mass vaccination programmes for tuberculosis (TB), polio and smallpox. |
| (c) Antigenic variation<br><br>Some pathogens can change their antigens. This means that memory cells are not effective against them.<br><br>Role and impact of antigenic variation in influenza | Antigenic variation occurs in the influenza virus, explaining why it remains a major public health problem and why individuals who are at risk need to be vaccinated every year. | Use digital resources to study the DNA sequence and/or protein differences between different strains of the influenza virus. |
| **8 Clinical trials of vaccines and drugs**<br>Vaccines and drugs are subjected to clinical trials to establish their safety and effectiveness before being licensed for use.<br><br>The design of clinical trials to test vaccines | Subjects in clinical trials are divided into | |

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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| and drugs involves randomised, double-blind and placebo-controlled protocols. | groups in a randomised way to reduce bias in the distribution of characteristics, such as age and gender. In a double-blind trial, neither the subjects nor the researchers know which group subjects are in to prevent biased interpretation of the results. One group of subjects receives the vaccine or drug, while the second group receives a placebo-control to ensure valid comparisons. | |
| The importance of group size in reducing experimental error and establishing statistical significance | 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. | Examine graphs of clinical trial results to show how error bars are used to determine significant differences between mean results. |

# Administrative information

**Published:** June 2020 (version 1.0)

**Superclass:** RH

## History of changes to National Unit Specification

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