Unit 33: Understand the Principles of Animal Biology

Unit code: J/600/9389

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to provide learners with an understanding of the principles of animal biology. This unit is primarily aimed at learners within a centre-based setting looking to progress into the sector or to further education and training.

The aim of this unit is to develop the learner's knowledge and understanding of the structure and function of cells and tissues and their relationship with body systems. This will be developed through an understanding of the structure and function of skeletal systems and sensory organs and how these have been adapted to meet the needs of animals living in different environments.

Unit introduction

The focus of this unit is on the concepts of structure and function in the animal body. A background knowledge of animal biological systems is essential to help animal managers, animal technologists and veterinary nurses understand the situations they come across daily in their jobs. This ensures more effective animal management and health monitoring, including any malfunction or imbalance of the systems which has a negative effect on animals' wellbeing. The unit also covers how these biological systems have evolved, allowing animals to adapt to their environment.

Learners will be introduced to important aspects of cell biology. They will discover the functions of the main organelles within the cell, be introduced to the processes of cell division by mitosis and meiosis, and learn how the structure of cells relates to their functions in the animal body. They will explore how the structure of tissues relates to their functions within the body.

Learners will investigate components and functions of the animal skeleton and how skeletal systems have adapted to the environment in which the animal lives. They will also investigate the process of evolution and how it has influenced the design of the animal skeleton. Learners will study animal senses and the sensory organs of selected animal species. They will examine the structure and function of the sensory organs in relation to how the animal interacts with its external environment.

Learning outcomes

On completion of this unit a learner should:

1 Know the functions of the main animal cell organelles

2 Understand the structure and function of the main animal tissue types

3 Know the structure and function of animal skeletal systems

4 Know the structure and function of sensory organs in animals.

Unit content

1 Know the functions of the main animal cell organelles

Appearance and function: nucleus, mitochondria, rough and smooth endoplasmic reticulum, cytoskeleton, Golgi apparatus, lysosomes, plasma membrane, cilia, cell membrane

Cell division: role of chromosomes, purpose of mitosis (repair and growth) and meiosis (production of sex cells); stages of each type of cell division as follows: mitosis (interphase, prophase, prometaphase, metaphase, anaphase, telophase, cytokinesis); meiosis (prophase I, prometaphase I, metaphase I, anaphase I, telophase I, (cytokinesis may or may not occur), interphase II, prophase II, metaphase II, anaphase II, telophase II, cytokinesis)

2 Understand the structure and function of the main animal tissue types

Epithelial: structure, function and location of simple and stratified epithelia

Connective: structure, function and location of dense (regular and irregular), loose, supporting and fluid connective tissues

Nervous: structure and function of motor and sensory neurones (dendrites, dendron, cell body, axon, Schwann cells, myelin sheath, nodes of Ranvier, terminal knobs); saltatory conduction of action potential, synaptic action and purpose

Muscle: structure, function and location of cardiac, smooth and skeletal muscle (including fast and slow muscle); sliding filament theory of muscle contraction

3 Know the structure and function of animal skeletal systems

Skeletal structure: bones of the axial and appendicular skeleton; divisions of the vertebral column; limb bones, carpals and metacarpals, tarsals and metatarsals, phalanges; attachment of bones to one another (ligaments) and to muscle (tendons); basic structure, function and location of the following joint types: fibrous, cartilaginous and synovial (ball and socket, hinge, gliding and pivot)

Skeletal functions: locomotion, support, mineral storage, formation of blood cells, protection of internal organs

Environmental adaptations: evolution of mammalian adaptations to swimming, flying, running and hopping

4 Know the structure and function of sensory organs in animals

Sensory organs: eyes (sclera, cornea, pupil, iris, lens, ciliary body, retina (rod and cone cells), fovea, choroid, optic disc, optic nerve, medial and lateral rectus muscles); ears (auricle (pinna), tympanic membrane; malleus, incus, stapes, auditory ossicles; oval window, round window, cochlea, organ of Corti, cochlear nerve); nose, mouth, electroreceptors in fish; lateral line system; and tactile organs (eg skin, vibrissae)

Adaptations of sensory organs: link between lifestyle and the senses eg nocturnal, diurnal and crepuscular; digging and flying; predator and prey

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 identify cell components [SM]	**M1** identify the stages of mitosis and meiosis from unlabelled slides of cells	**D1** explain how the structure of different animal cell types relates to their functions in the body
P2 describe the functions of cell organelles [IE]		
P3 identify the stages of mitosis and meiosis [RL]		
P4 categorise different tissue types [IE]	**M2** describe the sliding filament theory of muscle contraction	**D2** compare the structure and function of sensory and motor neurones
P5 explain the structure of the main tissue types [IE]		
P6 explain the function of the main tissue types [IE]		
P7 identify the component parts of the animal skeletal system	**M3** describe the structure, function and location of joint types in the animal body	**D3** compare how evolution has influenced the design of the animal skeleton for selected species
P8 describe the functions of the animal skeletal system		
P9 describe adaptations of selected skeletal systems of animals living in different environments [IE, CT]		
P10 identify the sense organs in animals	**M4** explain the special sensory adaptations in selected species.	**D4** analyse the differences in sensory organs between selected predator and prey species.
P11 describe the structure of sense organs in selected animals		
P12 describe the function of sense organs in selected animals [IE]		

PLTS: This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Delivery of this unit will involve practical assessments and written assessments, visits to suitable collections and will link to work experience placements.

It would be beneficial if learners and supervisors were made aware of the requirements of this unit before doing any work-related activities so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to use microscopes to look at animal cells and they should ask for observation records and/or witness statements to be provided as evidence of this. Guidance on the use of observation records and witness statements is provided on the Edexcel website.

This unit could be delivered by combining theory and practical work in laboratories and the classroom. If dissections and/or microscope work are undertaken, health and safety issues must be emphasised and reinforced, personal protective equipment must be worn and risk assessments carried out before the activity. It would be useful for learners to carry out risk assessments themselves using a pro forma that would be used in an industrial setting.

An active approach to delivery is encouraged, so learners are engaged in their investigations of the relationship between structure and function in the animal body. For example, learners could make their own skeletons, cell organelles and other structures using simple household or modelling materials. Microscope/video projector combinations are an excellent aid to theory sessions on tissue structure and function. There are many internet resources available to guide learners through cell, tissue and organ structure and function, some of which are recommended in the indicative reading.

Learning outcomes 1 and 2 are directly linked and allow much scope for practical work. As well as diagrammatic representations, electron micrographs should be used to illustrate cell structure. Microscopes linked to digital cameras or video that can be projected and/or recorded should also be used. This can be carried out and linked to theory sessions to make the subject more relevant to learners. Visiting expert speakers could also add to the relevance of the subject for learners. For example, a veterinary pathologist could talk about their histology work, the situations they face and the methods they use.

Learning outcome 3 requires access to skeletons, either real or models. Learners are expected to name the main bones of the animal skeleton and there are various online skeleton games that can be used to motivate and engage learners. Examination of skeletal material should include annotation and drawing of various skeletal specimens. Delivery should include theory sessions on the processes of divergent and convergent evolution, concentrating on the pentadactyl limb of whales, bats and horses.

Learning outcome 4 could be delivered using formal lectures, practicals and independent learner research. Case studies of different animal species and the sensory organs they possess should be covered. Species analysed should include some with unusual sensory receptors, such as fish and their lateral line systems and/or the electric organs in some species, the bill of the duck-billed platypus, thermosensitive pits in some snake families (eg boidae) and the organs of special sense (eg the 'hammer' of the hammerhead shark). This learning outcome should include theory sessions on the mammalian eye and ear and, where possible, practical sessions viewing real body organs, but models could provide an alternative. Practicals may also include those looking at the function of the eye or ear using simple experiments (eg the blind spot, pupil shape in different animal species, colour detection in different animal species, hearing sensitivity experiments). Delivery should include materials covering a wide range of species with different lifestyles to highlight how an animal's way of life is reflected in its sensory adaptations, such as diurnal and nocturnal predators and the effects these lifestyles have on the structure of the eye.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives **an indication of the volume of learning it would take the average learner** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value**.

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Introduction and overview of the unit.
Assessment of prior learning – concept maps.
Assignment 1: Cells (P1, P2, P3, M1, D1) Tutor introduces assignment brief.
Study of cell components and functions using diagrams and electron micrographs.
Personal study.
Cell division 1 – mitosis (function, stages and practical session on identifying each stage).
Cell division 2 – meiosis (function, stages and practical session on identifying each stage).
Personal study.
Individual support.
Section review.
Assignment 2: Animal Tissues (P4, P5, P6, M2, D2) Tutor introduces assignment brief.
Study of structure of different tissue types – introduction and practical histology session.
Personal study.
Study of structure and functions of epithelial, connective, nervous and muscle tissue.
Personal study.
Section review.
Individual support.
Assignment 3: Animal Senses (P10, P11, P12, M4, D4) Tutor introduces assignment brief.
Study sensory organ structure and function, including practical dissection if possible.
Personal study.
Sensory organ adaptations.
Personal study.
Section review.
Individual support.
Assignment 4: Animal Skeletal Systems (P7, P8, M3) Tutor introduces assignment brief.
Study of skeletal functions.
Skeletal structure – looking at various animals, model skeletons, online games and quizzes.
Joint structure and function.
Personal study.

Topic and suggested assignments/activities and/assessment
Skeletal adaptations.
Assignment 5: Skeletal Adaptations (P9, D3) Tutor introduces assignment brief.
Personal study.
Individual support.
Section review.
Unit review.

Assessment

For P1, learners are expected to identify animal cell organelles. Evidence for this could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector), an annotated poster or a project.

P2 could be assessed at the same time as P1, with learners describing the function of each organelle as they are labelled.

P3 requires learners to describe the stages of mitosis and meiosis as set out in the unit content. Evidence could be a poster or illustrated essay. Alternatively, P3 could be assessed alongside M1 in a practical situation.

P4, P5 and P6 require learners to explain the structure and function of the main tissue types in the animal body and to categorise the different tissue types. Practical sessions on tissue structure and function are an excellent way to assess learning for this area. This could be through microscopy practicals with learners generating evidence by drawing and annotating different tissues. Evidence could also be in the form of posters, computer-based research, leaflets and articles for hypothetical magazines. These criteria could also be assessed directly by the tutor during practical activities. If this format is used, suitable evidence from guided activities would be observation records completed by learners and the tutor.

P7 requires learners to identify the component parts of the skeletal system and valid evidence could be labelling a blank skeleton, model skeleton or virtual labelling exercises. If assessed through practical activities, observation records completed by learners and the tutor would be suitable evidence.

For P8, learners need to describe the functions of the skeletal system. This could be assessed at the same time as P7 with annotations including the functions of the skeleton. Alternatively, evidence could be part of an illustrated essay, report or hypothetical magazine article.

P9 requires descriptions of skeletal adaptations of animals living in different environments. Animals could be selected by tutors or through discussion with learners, but the animals must be adapted to contrasting environments, such as digging animals and flying animals.

For P10, learners need to identify the sensory organs in animals. An annotated poster or pictorial presentation could be used. Learners can label an animal of their choice, indicating the locations of all the sensory organs and the stimuli to which they are responsive. The animal species may be selected by the tutor or agreed through discussion with learners.

P11 and P12 could be assessed together, identifying the structure and function of the sensory organs. This could be through practical investigation, pictorial presentation or an illustrated essay and may also form part of the assessment for M4 and D4.

For M1, learners must identify the stages of mitosis and meiosis from unlabelled slides of cells at each stage. This could be carried out during a microscopy session, using photographs of slides or virtual slides. Observation records completed by learners and the tutor would be suitable evidence.

For M2, learners must describe the sliding filament theory of muscle contraction. Evidence for M2 could be a written account illustrated with suitable diagrams, posters and presentations, factsheets written and designed by learners or articles for hypothetical magazines.

For M3, learners must describe the structure, function and location of joint types in the animal body. All joint types given in the unit content must be covered. This may be partly through practical observations recorded by learners, alongside posters, presentations with notes or illustrated essays and reports.

M4 requires learners to explain the sensory adaptations of selected species. Two species with different sensory adaptations should be chosen by the tutor or through discussion with learners. Learners need to both identify the sensory adaptation and explain its advantage to the animals. Evidence could be posters, written assignments, information packs written and designed by learners, or articles for hypothetical magazines.

For D1, learners must explain how the structure of different animal cell types relates to their functions in the body. Learners should use as diverse an array of cell types as possible, using examples of cells from around the body, rather than from just one tissue. Diagrams will complement written material. The relationship between cell structure and function must be shown clearly. This criterion could be assessed through microscopy practicals to generate drawings of different cell types, together with written work to explain in more detail the relationship between cell structure and function. Alternatively, posters (possibly with class presentations), presentations, factsheets and articles are all excellent evidence.

For D2, learners must compare the structure and function of both sensory and motor neurones in terms of their differing functions. This may be assessed alongside P4, P5, P6 and M2 as part of a project or presentation. Evidence could be in the form of annotated posters.

For D3, learners must compare how evolution has influenced the design of the animal skeleton for selected species. Tutors should identify the species or agree these through discussion with learners. It is expected that learners will provide evidence covering at least three contrasting animals. Diagrams and pictures of skeletons could be used to supplement written material. Learners should show clearly how through evolution animal skeletal design has adapted according to the ecological niche they fill and the habitat they live in, for example the cetacea. Investigating animals returning to an aquatic environment from land (such as the cetacea), as well as animals evolving to exploit the aerial environment (such as birds and bats), provides excellent opportunities to gain evidence to meet this criterion. The design of the skull and jaws and how this relates to diet also offers an excellent opportunity to gain evidence. Learners may use examples of animals from any of the five vertebrate classes according to their interests, including extinct animals (such as pterosaurs and dinosaurs).

For D4, learners must analyse how the anatomy of the sensory organs differs in selected predator and prey species. Tutors should identify the species or agree them through discussion with learners. Where possible, to ensure fairness of assessment, the size and complexity of the tasks should be the same for all learners. It is expected that, as a minimum, learners will provide evidence covering at least two different species. This could be assessed using video cameras to make video documentaries about the sensory systems of a range of animals, highlighting how they are influenced by the animal's environment and status as predator or prey. Evidence could also be posters, written articles and/or presentations. Practical observations of animals are to be encouraged in the assessment process.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1, D1	Cells	You work as a zoo educational assistant. You are putting together a project to tell other learners about the structure and function of animal cells. You should include a labelled, ideal animal cell, linking each structure to its function and introduce the processes of cell division by mitosis and meiosis. For a merit grade, you should identify the stages of mitosis and meiosis. For a distinction grade, you need to include a section describing how cells are specialised for their functions within the animal body.	Written. Practical.
P4, P5, P6, M2, D2	Animal Tissues	Using an illustrated essay or series of illustrated factsheets (which may use diagrams from practical sessions), you need to describe the structure and function of epithelial, connective, muscle and nervous tissue. An introduction is required, explaining what tissues are and why there are different types. You may include any drawings you have made in practical sessions if you feel they illustrate your points. For a merit grade, you should describe the sliding filament theory of muscle contraction within your description of muscle tissue. For a distinction grade, you should compare and contrast the structure of sensory and motor neurones and relate this to their functions.	Written. Practical element.
P7, P8, M3	Animal Skeletal Systems	Label the blank diagram of the skeleton for your selected animal and write a paragraph describing the functions of the skeleton. For a merit grade, indicate the location of the main joint types on the skeleton and write a short report on the function and structure of each joint type you have labelled.	Written.
P9, D3	Skeletal Adaptations	You are writing a feature article for the magazine *Skeletons Today!*. Describe the skeletal adaptations of two animals that live in contrasting environments. For a distinction grade, you should cover a total of three animals and discuss the adaptation of their skeleton design to the habitat they live in and the ecological niche they inhabit. Your editor will need you to provide a range of diagrams, photographs or pictures to illustrate your piece.	Written.
P10, P11, P12, M4, D4	Animal Senses	Section 1 of the project should introduce the animal senses by labelling a picture of the selected species with its sense organs. Section 2 should be a more detailed look at the structure and function of those senses and should include labelled diagrams of the eye and ear (these may be from practical sessions). For a merit grade, you need to describe the special sensory adaptations of two animals, explaining how the differences are linked with the animals' lifestyles. For a distinction grade, you should analyse one predator and one prey species (though they do not necessarily have to be linked), discussing the sensory advantages each has for its status as predator or prey.	Written. Practical.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

Level 2	Level 3
Understand the Basic Principles of Animal Biology	Understand Animal Anatomy and Physiology
	Undertake an Investigative Project in the Land-based Sector

Essential resources

Access to laboratories, animal organs and observation of veterinary postmortems and operations may enhance delivery of this unit.

internet access is essential but should be guided to avoid confusion when higher level resources or contentious issues, such as creationist websites, are encountered. While these are useful for lively debate, the process of accepting scientific theories using evidence must be stressed at all times. When researching, learners will also need access to a range of information which may require use of inter library loans or visits to collections.

Employer engagement and vocational contexts

Learners within veterinary laboratories could be present at operations and postmortems to see the links between structure and function within the animal body. Work experience within animal collections may allow first-hand observation of animal adaptations, both skeletal and sensory.

Indicative reading for learners

Textbooks

Aspinall V and O'Reilly M – *Introduction to Veterinary Anatomy and Physiology* (Butterworth-Heinemann, 2004) ISBN 9780750687829

Boden E – *Black's Veterinary Dictionary, 21st Edition* (A&C Black Publishers, 2005) ISBN 9780713663624

Boyle M and Senior K – *Biology* (Collins Educational, 2008) ISBN 978- 0007267453

Jones A, Reed B and Weyers J – *Practical Skills in Biology* (Prentice Hall, 2002) ISBN 9780130451415

Kent M – *Advanced Biology* (Oxford University Press, 2000) ISBN 9780199141951

Lane D and Cooper B – *Veterinary Nursing, Third Edition* (Butterworth-Heinemann, 2003) ISBN 9780750655255

Pond K and Pond W – *Introduction to Animal Science* (J Wiley & Sons Inc, 2000) ISBN 978- 0471170945

Toole G and Toole S – *New Understanding Biology for Advanced Level* (Nelson Thornes, 1999) ISBN 9780748739578

Williams G – *Advanced Biology for You* (Nelson Thornes, 2000) ISBN 978-0748752980

Journals

Animal Science

Biologist

Biological Sciences Review

New Scientist

Websites

www.cellsalive.com	Cells Alive
www.darwin-online.org.uk	Complete Works of Darwin online
www.defra.gov.uk	Department for Environment, Food and Rural Affairs
www.hsegov.uk	Health and Safety Executive
www.keyskill.com	Key Skill Company
www.purchon.com/biology/animal.htm	Gondar Design Science
www.wellcometreeoflife.org	Wellcome Trust Tree of Life

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

Skill	When learners are ...
Independent enquirers	researching structure/function relationships of cell organelles, tissues, sensory organs and skeletal systems analysing and evaluating information to support conclusions about biological structures and their functions
Creative thinkers	investigating the theory of evolution and adaptation
Reflective learners	evaluating personal performance when identifying the stages in mitosis and meiosis
Self-managers	organising time and resources for identifying cell components.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	planning and carrying out research analysing and evaluating information supporting conclusions they have drawn
Creative thinkers	questioning assumptions made about natural selection
Reflective learners	assessing themselves and others in presentations
Team workers	collaborating with others to give presentations
Self-managers	organising time and resources to carry out research and tasks.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching links between structure and function, and special sensory adaptations
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	producing written assignments using ICT
Bring together information to suit content and purpose	producing written assignments
Present information in ways that are fit for purpose and audience	producing written assignments, presentations and videos using ICT programs and digital media
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	presenting information to other learners and/or tutors discussing scientific theories (natural selection, evolution, adaptation)
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching books for information
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	completing assignments.