2016 Suite

OCR
Oxford Cambridge and RSA

Cambridge TECHNICALS LEVEL 3

APPLIED SCIENCE

Cambridge TECHNICALS 2016

Unit 8

Cell biology

T/507/6155

Guided learning hours: 60

Version 4 - September 2016 - black line indicates updated content

ocr.org.uk/science

LEVEL 3

UNIT 8: Cell biology

T/507/6165

Guided learning hours: 60

Essential resources required for this unit: Microscopes, haemacytometer and Coulter counter.

This unit is internally assessed and externally moderated by OCR.

UNIT AIM

Cell biology, or cytology, is the study of cells. As the cell is the basic unit of almost all living things, cytology is one of the most important areas of biological research.

This unit examines how these observations enable cytologists to reveal details of cell structure, their fine structure or ultrastructure, and how parts of the cell function and interact with each other. You will use cell counting techniques, along with staining techniques to identify types of cells, components within them, and products they make.

Cytology is important to the developmental biologist. Through the study of this unit, you will develop an understanding of cell division and differentiation, where they become adapted to fulfil specific roles. The unit examines how these processes occur, with genes being expressed in some specialist cells, but not in others.

The cells involved in differentiation are called stem cells. You will research the different types of stem cell and their potential to produce the different types of cells required. As part of this unit, you will have the opportunity to research and present a case study on the ground-breaking area of stem cell-based therapies. Some of the techniques are controversial, but they offer cell replacement therapies and regenerative medicine, and with this the possibility of the management or cure of diseases and conditions that are currently untreatable.

TEACHING CONTENT

The teaching content in every unit states what has to be taught to ensure that learners are able to access the highest grades.

Anything which follows an i.e. details what must be taught as part of that area of content. Anything which follows an e.g. is illustrative, it should be noted that where e.g. is used, learners must know and be able to apply relevant examples in their work, although these do not need to be the same ones specified in the unit content.

For internally assessed units you need to ensure that any assignments you create, or any modifications you make to an assignment, do not expect the learner to do more than they have been taught, but must enable them to access the full range of grades as described in the grading criteria.

Learning outcomes The Learner will:	Teaching content Learners must be taught:
1 Understand the functions of the plasma membrane and endomembrane systems	1.1 The movement of substances into and out of the cell i.e.: • passive movement (diffusion and facilitated diffusion), active transport, endocytosis and exocytosis. • the endomembrane systems in eukaryotic cells (synthesis, transport, packaging and secretion). • cell signalling (chemical signalling; electrical signalling).
2 Be able to use cytological techniques	2.1 How to use a light microscope to examine cells i.e.: • limits of light microscopy (magnification; resolution) • microscopical and differential staining techniques • immunohistochemistry (IHC) • extending the limits of light microscopy (oil immersion; confocal microscopy) 2.2 Cell counting techniques i.e.: • haemacytometer • Coulter counter
3 Understand the cell cycle and the importance of mitosis	3.1 Mitosis as the cell division leading to growth and repair i.e.: • the cell cycle (i.e. interphase [G_1, S and G_2]; stages of mitosis; and cytokinesis • the importance of mitosis (produces genetically identical cells; for asexual reproduction, growth and repair) • mechanisms that arrest cell division (checkpoints and clinical techniques)
4 Understand the process and significance of differentiation	4.1 Cell differentiation as the process by which a cell changes from one cell type to another i.e.: • undifferentiated cells (stem cells); production of specialised cells for cell turnover and cell repair • gene expression and repression

Learning outcomes The Learner will:	Teaching content Learners must be taught:
5 Understand the potential of stem cells in medical therapies	5.1 Stem cells, their function and potential use in modern medicine i.e.: • origin of stem cells for research and therapies (embryonic; adult; totipotency; pluripotency; multipotency; induced pluripotency) • stem cell research (model cells; disease development; drug testing) • stem cell therapies (scientific issues; moral and ethical issues; clinical studies)

GRADING CRITERIA

LO	Pass	Merit	Distinction
	The assessment criteria are the Pass requirements for this unit.	To achieve a Merit the evidence must show that, in addition to the Pass criteria, the candidate is able to:	To achieve a Distinction the evidence must show that, in addition to the pass and merit criteria, the candidate is able to:
1. Understand the functions of the plasma membrane and endomembrane systems	*P1: Describe the functions of the plasma membrane	M1: Explain the dynamic nature of endomembrane systems in a eukaryotic cell	D1: Explain the role of cell signalling pathways
2. Be able to use cytological techniques	*P2: Demonstrate the use of microscopical and differential staining techniques		D2: Demonstrate the use of a technique used to extend the limits of light microscopy
	*P3: Demonstrate the use of an appropriate cell counting technique		
3. Understand the cell cycle and the importance of mitosis	*P4: Describe the cell cycle, stages of mitosis and cytokinesis	M2: Explain the importance of mitosis	D3: Assess the importance of mechanisms that arrest cell division
4. Understand the process and significance of differentiation	*P5: Describe the process of differentiation in the embryo in producing specialised cells	M3: Explain the role of gene expression in differentiation	
5. Understand the potential of stem cells in medical therapies	*P6: Describe uses of stem cells in medicine	M4 Explain the laboratory techniques used in stem cell therapy.	

ASSESSMENT GUIDANCE

P1: Describe the functions of the plasma membrane
Having considered this in outline in Unit 1, learners will now consider the functions in more detail, in particular those related to transport of substances into and out of the cell. These must be discussed in terms of the nature of the substance to be transported, in conjunction with how the membrane functions as a partially permeable barrier, with movement of substances passively (diffusion and facilitated diffusion), by active transport, endocytosis and exocytosis.

M1: Explain the dynamic nature of endomembrane systems in a eukaryotic cell
Learners will have described the outline structure of the endomembrane system in eukaryotic cells – the endoplasmic reticulum (rough and smooth) and Golgi apparatus, and must now be introduced to the other components; lysosomes and vesicles. Their explanation needs to show an understanding of the functions of the endomembrane system, in the production of proteins and lipids, and their modification, packaging, transport and secretion. They need to appreciate that the system as observed with electron microscopy is not static, but a constantly changing, dynamic system. This is best done using a series of diagrams, a series of models or an animation.

D1: Explain the role of cell signalling pathways
Cells in organisms constantly communicate with each other. The plasma membrane forms the point of contact between other cells and the cell's environment. Learning could perhaps begin by considering that as multicellular organisms have evolved, mechanisms must also have developed to ensure that activities of cells must be coordinated.

Linking with the next section, learners should appreciate that different signalling pathways are used to control the life history of cells, from their birth during the process of cell division and proliferation, their differentiation into specific cell types to carry out different cell functions, and finally their death. In adults, cell signalling systems regulate a wide range of specific processes in adult cells, such as contraction, secretion, metabolism, tissue repair, information processing in neurones and sensory perception. Cell communication occurs through chemical, e.g. through neurotransmitters, hormones, growth factors, and electrical signalling, e.g. in the heart and brain.

Our increased understanding of cell signalling is giving scientists increased insight in defects responsible for many human diseases, and altered signalling is involved in many forms of cancer.

It is essential that learners give an overview of cell signalling pathways, for instance in a wall display, explaining their various roles, and not become focused on detail.

P2: Demonstrate the use of microscopical and differential staining techniques
In Unit 1: Science fundamentals, learners will have examined some animal and plant cells. They should now use microscopical and differential staining techniques to identify cells, organelles, inclusions and secretions. They could begin by using the Gram stain to identify a gram positive, e.g. *Bacillus subtilis*, and gram-negative bacteria, e.g. *Escherichia coli*. This should be linked back to cell wall and membrane structure. Learners should then proceed to use staining techniques to identify cell organelles, inclusions or secretions. These might include haematoxylin and eosin (haematoxylin for the nucleus; eosin for the cytoplasm), Alcian blue for mucopolysaccharides produced by mucus-secreting cells; Masson's trichrome stain for blood, smooth and striated muscle and mucus. The staining procedures are best carried out using paraffin wax sections and a worthwhile activity for learners might be to prepare permanent slides by fixing, dehydrating, embedding and sectioning before staining, then dehydrating and mounting.

P3 Demonstrate the use of an appropriate cell counting technique
Learners should demonstrate skills in cell counting using a haemacytometer. The use of a yeast cell suspension is recommended. With a drop of methylene blue solution, the task could assume an applied context. Some brewers use this technique to assess yeast cell viability (viable cells will be colourless, dead cells, blue). An optimum concentration of yeast cells should be used to give a countable number of cells (25-100) per large square (1 mm x 1 mm).

D2: Demonstrate the use of a technique used to extend the limits of light microscopy
This should begin with learners using oil immersion techniques to observe cells under high power, overcoming the limitations explained in P3. Candidates should go on to research a range of microscopical techniques, including different optical systems and confocal microscopy, which will extend the limits of microscopy. These could be compared with the advantages conveyed by electron microscopy (Unit 2).

P4: Describe the cell cycle, stages of mitosis and cytokinesis
Following the teaching of the stages, learners can demonstrate their understanding of the processes on the work bench, assembling poppet beads as chromosomes (different colours can be added to illustrate genes), string as spindle fibres, and a board marker to illustrate degradation and then re-formation of the nucleus. Some learners may wish to draw and animate sequences to illustrate the process.

M2: Explain the importance of mitosis
This criterion should build on the principles developed at Key Stage 4, i.e. for mitosis, its importance in producing genetically identical cells for asexual reproduction, growth and repair. This will link with LO1 in Unit 8: Genetics; with the importance of meiosis in halving the chromosome number in gamete formation and leading to genetic variation in sexual reproduction.

These explanations will require the use of some extended prose to be provide sufficient detail.

D3: Assess the importance of mechanisms that arrest cell division
Learners should consider a cell's use of checkpoints during the cell cycle, potential halting points that ensure proper cell division. They should discuss the timing of checkpoints in mitosis and how these have been linked with cancer. Certain medication can introduce stopping points, and learners should assess how these are important in many cancer therapies, e.g. the taxol group and the vinca alkaloids and their effect on the mitotic spindle. Toxicity, tumour types affected, and their unpredictability are all considerations and learners could examine how new strategies are being researched. Environmental factors – either natural or induced by chemicals or radiation – can also be important in cell cycle arrest in certain organisms, leaving the organism in a type of suspended animation until conditions become more favourable.

The recommended approach is that learners produce a formal report or webpages to address the criterion.

P5: Describe the process of differentiation in the embryo in producing specialised cells
Learners need to know that in animals, cells that can differentiate into other cell types are called stem cells, and they need to distinguish between totipotent, pluripotent, multipotent and unipotent stem cells. In plants, cells capable of differentiation are called meristematic cells.

M3: Explain the role of gene expression in differentiation
Learners need to appreciate that the changes that occur during differentiation are the result of regulated gene expression, the process by which the information in the DNA is transcribed into messenger RNA, for protein synthesis (which is dealt with in detail in Unit 1: Science fundamentals), and not to any loss of a cell's DNA. Cell-extrinsic factors are involved, i.e. cell signalling, with growth factors conveying information from one cell to another during the process.

Cell-extrinsic factors involve factors that modify chromatin (DNA and associated histone proteins); these factors are known as epigenetic as they don't affect the primary DNA sequence.

P6: Describe uses of stem cells in medicine

It should be emphasised to learners, that stem cell therapies are not new; in 1968, doctors performed the first successful bone marrow transplant. Stem cell transplants have been/are used in the treatment of various cancers (leukaemia, lymphoma, myeloma) and following chemo- or radiotherapy for many years before possible treatment of degenerative diseases.

M4 Explain the laboratory techniques used in stem cell therapy

Learners should know that not all stem cells come from embryos but also can be taken from tissue stem cells: found in our bodies all our lives and induced pluripotent stem cells, or 'reprogrammed' stem cells: similar to embryonic stem cells but made from adult specialised cells using a laboratory technique discovered in 2006.

Feedback to learners: you can discuss work-in-progress towards summative assessment with learners to make sure it's being done in a planned and timely manner. It also provides an opportunity for you to check the authenticity of the work. You must intervene if you feel there's a health and safety risk.

Learners should use their own words when producing evidence of their knowledge and understanding. When learners use their own words it reduces the possibility of learners' work being identified as plagiarised. If a learner does use someone else's words and ideas in their work, they must acknowledge it, and this is done through referencing. Just quoting and referencing someone else's work will not show that the learner knows or understands it. It has to be clear in the work how the learner is using the material they have referenced to inform their thoughts, ideas or conclusions.

For more information about internal assessment, including feedback, authentication and plagiarism, see the centre handbook. Information about how to reference is in the OCR Guide to Referencing available on our website: http://www.ocr.org.uk/i-want-to/skills-guides/.

SYNOPTIC LEARNING AND ASSESSMENT

It will be possible for learners to make connections between other units over and above the unit containing the key tasks for synoptic assessment. Please see Section 6 of the Qualification Handbook for more details. We have indicated in the unit where these links are with an asterisk.

Name of other unit and related LO	This unit:
Unit 1 Science fundamentals LO3 Understand cell organisation and structures	LO1 Understand the functions of the plasma membrane and endomembrane systems (P1) LO2 Be able to use key cytological techniques (P2, P3) LO3 Understand the cell cycle and the importance of mitosis (P4) LO4 Understand the process and significance of differentiation (P5) LO5 Understand the potential of stem cells in medical therapies (P6)

Name of other unit and related LO	This unit:
Unit 2 Laboratory techniques LO4 Be able to examine and record features of biological samples	LO2 Be able to use key cytological techniques (P2, P3)
Unit 3 Scientific analysis and reporting LO2 Be able to use graphical techniques to analyse data LO4 Be able to analyse and evaluate the quality of data LO5 Be able to draw justified conclusions from data LO6 Be able to use modified, extended or combined laboratory techniques in analytical procedures LO7 Be able to record, report on and review scientific analyses	LO2 Be able to use key cytological techniques (P2, P3)
Unit 4 Human physiology LO1. Understand the structure and functions of the digestive system	LO1 Understand the functions of the plasma membrane and endomembrane systems (P1)
Unit 5 Genetics LO1. Understand the importance of meiosis	LO3 Understand the cell cycle and the importance of mitosis (P4) LO4 Understand the process and significance of differentiation (P5) LO5 Understand the potential of stem cells in medical therapies (P6)
Unit 6 Control of hazards in the laboratory LO1 Understand the types of hazard that may be encountered in a laboratory LO2 Be able to use health and safety procedures to minimise the risk presented by hazards in a laboratory	LO2 Be able to use key cytological techniques (P2, P3)
Unit 7 Human nutrition LO1 Understand human nutritional requirements in the maintenance of health LO2 Be able to calculate nutritional requirements to maintain energy for different levels of activity LO3 Understand conditions relating to dietary needs	LO1 Understand the functions of the plasma membrane and endomembrane systems (P1)

Name of other unit and related LO	This unit:
Unit 10 Testing consumer products LO2 Understand how product testing determines the development of consumer products	LO2 Be able to use key cytological techniques (P2, P3)
Unit 18 Microbiology LO1 Be able to classify and identify microorganisms	LO1 Understand the functions of the plasma membrane and endomembrane systems (P1) LO2 Be able to use key cytological techniques (P2, P3) LO3 Understand the cell cycle and the importance of mitosis (P4) LO4 Understand the process and significance of differentiation (P5)

To find out more
ocr.org.uk/science
or call our Customer Contact Centre on **02476 851509**

Alternatively, you can email us on **vocational.qualifications@ocr.org.uk**

LLOYD'S REGISTER · LRQA
ISO 9001
UKAS MANAGEMENT SYSTEMS
001

A DIVISION OF CAMBRIDGE ASSESSMENT

OCR
Oxford Cambridge and RSA