

Unit title: Cell Biology

Unit code: **T/601/0215**

Level: **4**

Credit value: **15**

Aim

This unit provides an understanding of the structure of a cell and how the cell functions, divides, differentiates and adopts a position in order to perform a specialist role in the multicellular organism. Learners also develop skills necessary for growing cells in culture.

Unit abstract

Understanding the cell, and the role and function of the cell in the multicellular organism, are of fundamental importance in understanding biology and related disciplines.

This unit will enable learners to appreciate the cell as the basic unit of life. Learners will examine the structure and function of the organelles of the cell. Familiarity with the internal structure of the cell and the variety of cell types will be enhanced through the use of microscopy and electron micrographs. The importance of the cell membrane in controlling the internal environment of the cell and in communication will be emphasised. The process of internalisation into the cell and secretion from the cell will be explored.

The unit enables learners to understand how cells develop and arrange themselves in order to perform specialist roles in the multicellular organism. The different factors contributing to the developmental and differentiation of a cell into an overtly specialised cell type will be emphasised.

The unit also enables learners to examine the life cycle of a cell and how knowledge of the cell cycle can be utilised to grow cells in culture. The unit provides opportunities for learners to grow cells in culture and to appreciate the importance of cell culture as a valuable tool in diagnostic research. Integral to the practical investigations into cell culture is the need to work safely and accurately, adhering to laboratory safety guidelines and protocols.

Learning outcomes

On successful completion of this unit a learner will:

- 1 Understand the structural features of eukaryotic and prokaryotic cells
- 2 Understand cellular diversity
- 3 Understand the growth and development of cells
- 4 Be able to grow cells in culture.

Unit content

1 Understand the structural features of eukaryotic and prokaryotic cells

Structure and role: nucleus; mitochondria; chloroplasts; endoplasmic reticulum; Golgi body; peroxisomes; lysosomes; cilia; flagella; cytoskeleton; examination of electron and light micrographs

Membrane structure and function: Singer and Nicolson model; properties and composition of lipid bilayer; fluidity of lipid bilayer; membrane proteins; differential permeability; membrane transport; ion gradients

Interdependence: protein sorting; vesicular transport; secretory pathways; ingestion pathways; energy requirements

2 Understand cellular diversity

Cell types: differences in structure e.g. epithelial cells, secretory cells, nerve cells, muscle cells, specialised plant cells

Function of cells: tissue group e.g. protection, transport, secretion, excretion, absorption, electrochemical signalling, movement, transport

Observation: tissue sectioning and staining; use of the light microscope; examination of electron micrographs

Tissue types: epithelial; connective; muscular; nervous

3 Understand the growth and development of cells

Mitosis and meiosis: prophase; metaphase; anaphase; telophase; spindle formation; generation of genetic diversity

Cell division cycle: G₀; G₁; S; G₂; control points; cell size; apoptosis and tumour formation

Cell division cycle control: maturation promoting factor (MPF); protein kinases; cyclins; growth factors

Growth and differentiation: germ layers; cleavage; gastrulation; cell junctions; foetal tissue development; cell adhesion molecules; foetal tissue development; stem cells; pluripotent cells; differential gene expression

4 Be able to grow cells in culture

Culture methods: plant and animal cultures e.g. cell lines and cell strains, batch culture, continuous culture, primary tissue culture

Factors: pH; temperature; media type; oxygen tension; water potential; nutritional requirements

Preparation: selective cell culture media; sub-culture; aseptic techniques

Growth: experimental data e.g. mean generation time, growth rate constant, measurement of population growth by cell number, mass and optical density

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
LO1 Understand the structural features of eukaryotic and prokaryotic cells	1.1 discuss the structural features of prokaryotic and eukaryotic cells 1.2 explain the role of subcellular organelles in the cell 1.3 relate the structure of membranes to their function 1.4 explain the interdependence of subcellular organelles
LO2 Understand cellular diversity	2.1 examine a range of cell types to identify differences in structure 2.2 illustrate the function of cells belonging to specific tissue groups 2.3 undertake observation of different types of tissues
LO3 Understand the growth and development of cells	3.1 compare the processes of mitosis and meiosis 3.2 explain the events of the cell division cycle 3.3 explain the control of the cell division cycle 3.4 explain how multicellular organisms develop by a process of growth and differentiation
LO4 Be able to grow cells in culture	4.1 safely use methods for the growth of cell cultures 4.2 determine factors affecting growth of cells in culture 4.3 prepare and maintain cell cultures using appropriate techniques 4.4 estimate the growth of cells in culture using experimental data.

Guidance

Links

This unit has particular links with the following units within this qualification:

- *Unit reference number L/601/0219: Laboratory Techniques for Applied Biology*
- *Unit reference number F/601/0220: Analysis of Scientific Data and Information*
- *Unit reference number F/601/0217: Biochemistry of Macromolecules and Metabolic Pathways*
- *Unit reference number J/601/0218: Physiology of Cellular Systems in Animals*
- *Unit reference number L/601/0222: Laboratory Management*
- *Unit reference number Y/601/0224: Neurophysiology and Homeostatic Control of the Human Body*
- *Unit reference number D/601/0225: Molecular Biology and Genetics*
- *Unit reference number M/601/0228: The Immune Response*
- *Unit reference number M/601/0231: Infectious Diseases*
- *Unit reference number K/601/0227: Pharmacological Principles of Drug Actions*

Essential requirements

Delivery

Delivery must emphasise the relationship between the structure and function of a cell and its position and function in the whole organism. How a cell type or tissue obtains its final position in the whole organism must be demonstrated.

The development of appropriate laboratory skills, especially in the correct use of a microscope, must be encouraged whenever possible. Prepared slides and electron micrographs are required for delivery of learning outcomes 1 and 2. Prepared slides and digital presentations are needed to illustrate the processes of cleavage and gastrulation in learning outcome 3.

Tutors must emphasise the importance of health and safety throughout the delivery and assessment of learning outcome 4 (growth of cells in culture). Learners must understand the importance of adhering to laboratory health and safety guidelines when working with immortalised cells and live tissue. Practical tasks and activities relating to cell culture must include risk analyses consistent with COSHH guidelines.

Assessment

Learning outcome 1 involves gaining knowledge of the structure and function of the cell and it is essential that learners demonstrate this knowledge. Learners must carry out, and provide evidence for, the microscopic examination of cells.

Learning outcome 2 involves understanding the variety of cell types and their functions and how cells arrange themselves into tissues. Evidence is likely to be in written form and will include laboratory studies, such as a histological stain and the microscopic examination of tissues. General reviews can also be used in conjunction with laboratory studies as evidence.

Learning outcome 3 involves understanding the cell cycle and how cells obtain their final position and function in the complete adult multicellular organism. Evidence may be in written form and will include microscopic examination of cells undergoing mitosis, meiosis, cleavage and gastrulation. Evidence for cell division, the cell cycle and apoptosis can be integrated with evidence for learning outcome 4.

Learning outcome 4 involves learners carrying out laboratory investigations, selecting appropriate methods in a laboratory situation, growing and maintaining cells in culture and calculating the growth rate of a culture of cells. Techniques used will depend on the equipment available in the centre. Learners must provide evidence of preparing culture media, growing and maintaining cells in culture and measuring the growth of a population of cells.

Resources

Learners will require access to light microscopes. Prepared slides and electron micrographs are essential for the delivery of learning outcomes 1, 2 and 3. Biosets provide a cost effective alternative to glass slides. Each bioset normally contains a strip containing eight pre-prepared slide images and can be viewed under a bioviewer. Many biosets contain workbooks which may be used in the delivery and assessment of learning outcomes 1, 2 and 3. Biosets and bioviewers are available from a range of distributors.

Learners will also require access to immortalised cells. Ideally, a laminar flow hood should be available for cell culture. However, if this is not available, cell culture may be attempted in a suitable environment using good aseptic techniques in a fume cupboard or on a sterilised laboratory bench.

Learners will need access to appropriate laboratory facilities, tutorial support and library resources.

Employer engagement and vocational contexts

Understanding the cell and its function in the multicellular organism is of fundamental importance in understanding biology and related disciplines. Learners will have opportunities to grow cells in culture and to appreciate the importance of cell culture as a valuable tool in diagnostic research. Learners will benefit from visits to industrial cell culture facilities to observe the practical applications of cell culture in operation. Learners would also benefit from visits to centres with electron and confocal microscope facilities.

Industry links, work placements and visits from personnel with technical expertise in developmental biology and cell culture would enhance delivery of this unit.