Unit 7A Cells

About the unit

In this unit pupils:
- learn that cells are the basic units of life and are organised into tissues from which organs are made
- explore cell structure and differences between plant and animal cells
- learn about some functions of cells

In scientific enquiry pupils:
- learn how observations made with a microscope helped ideas about the structure of living things to develop
- learn to use a microscope safely and effectively
- make observations using a microscope and record these in drawings
- compare and interpret information from microscopic observation
- draw conclusions from observations and explain these using scientific knowledge
- are introduced to the importance of sampling in biological investigations
- carry out an investigation into the growth of pollen tubes, controlling relevant variables and taking account of those which cannot be controlled

Much of this work involves the interpretation and analysis of visual information gathered from a variety of sources. The use of enlarged images and microprojection apparatus may support learning for pupils with visual impairment. Extra support may be required by pupils with poor manipulative skills, in preparing materials for microscopic examination, in the effective use of a microscope and when using a computer or other drawing aid to record their observations.

This unit is expected to take approximately 8 hours.

Where the unit fits in

This unit draws on ideas developed in the key stage 2 programme of study. It relates to unit 5A 'Keeping healthy' and unit 6B 'Micro-organisms' in the key stage 2 scheme of work.

The unit relates closely to unit 7B 'Reproduction' and unit 7D 'Variation and classification'. It provides an introduction to ideas and experimental techniques which pupils may not have encountered in the key stage 2 scheme of work.

It provides the foundation for work on cells in all year 8 and year 9 units.

Expectations

At the end of this unit

in terms of scientific enquiry

most pupils will: describe some earlier ideas about the structure of living things and relate these to evidence from microscope observations; make observations using a microscope and record them in simple drawings; suggest a question about pollen tubes that can be investigated and use an appropriate sample; present results in an appropriate graph, explaining what these show

some pupils will not have made so much progress and will: relate drawings to observations made using a microscope and describe what they found out from their investigation

some pupils will have progressed further and will: explain how evidence from microscope observations changed ideas about the structure of living things; estimate sizes of specimens viewed under the microscope and justify the sample chosen in an investigation of pollen tubes

in terms of life processes and living things

most pupils will: identify and name features of cells and describe some differences between plant and animal cells; explain that growth occurs when cells divide and increase in size; describe how cells are grouped to form tissues

some pupils will not have made so much progress and will: recognise that all organisms are made from cells and name some parts of a cell

some pupils will have progressed further and will: recognise that viruses are not cells and describe how some cells in an organism are specialised to carry out particular functions

Prior learning

It is helpful if pupils know:
- the names and functions of some major organs in plants and animals
- about some of the life processes common to living things, *eg movement, growth, reproduction, nutrition*

Health and safety

Risk assessments are required for any hazardous activity. In this unit pupils:
- use a variety of stains for cells
- work with animal materials
- plan and carry out their own investigation

Model risk assessments used by most employers for normal science activities can be found in the publications listed in the *Teacher's guide*. Teachers need to follow these as indicated in the guidance notes for the activities, and consider what modifications are needed for individual classroom situations.

Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly:
- words relating to the structure of organisms, *eg organ, tissue, cell*
- more specialised words relating to cells, *eg membrane, cytoplasm, nucleus, chloroplast, vacuole*
- words with similar but distinct meanings, *eg membrane and skin*, or terms that they regularly interchange, *eg cell wall and membrane*
- words with different meanings in scientific and everyday contexts, *eg cell, wall, tissue*
- words and phrases relating to scientific enquiry, *eg variable, sample size, evaluate, magnification*

Through the activities pupils could:
- use skimming, scanning, highlighting and note taking as appropriate to different texts

Resources

Resources include:
- secondary sources to explore cell structure and the variety of cell types in animals and plants, *eg CD-ROMs, internet, photographs at high magnification (which may be copied onto overhead transparencies (OHTs)), video clips, other literature*
- literature relating to Hooke's work on cells
- microscopes and/or bioviewers
- eyepiece graticules or strips of graticule photographs
- prepared slides showing human cheek cells and a range of human and plant cells, some of which illustrate cell specialisation
- materials for making model cells
- suitable plant material for microscope observation, *eg onion, tomato, potato, moss, filamentous green algae, fresh garlic roots, large flowers ripe with pollen and ovules*
- photographs or video clips of dividing cells and developing human embryos
- slides of pollen grains to illustrate developing pollen tubes

Out-of-school learning

Pupils could:
- visit libraries or museums to find out more about the importance of cells to our lives, *eg cancer as a disease resulting from cell malfunction, tissue grafting to repair burns*
- use the internet to examine images of cells, *eg www.cellsalive.com*
- read newspaper articles and watch television programmes relating to the topic
- find out about the history of the microscope, including the light microscope and electron microscope and their use in developing our understanding of the organisation of living things

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
What are living organisms made from?			
• that plants and animals contain organs • that tissues make up organs • to draw inferences from data	• Review pupils' knowledge of the organs of plants and humans, asking them to name, identify and show where these organs are found by using models and/or by labelling diagrams. Ask questions about the roles these organs play in the life of the organism, and the nature of important life processes. • Challenge pupils to consider what the organs of the body are made of, and introduce the idea of tissues. Show images of a range of organic structures, *eg on video, CD-ROM, OHT slides*. Ask pupils to make inferences about the structure of living things from this evidence.	• identify, locate and describe the functions of a range of plant and human organs • make suggestions about the structure of living things from microscope evidence • state that living things are made up of different types of tissue, which is made up from very small units	• This activity is intended to help teachers find out what pupils know and understand about the organisation of organs in plants and humans and about life processes. Teachers will need to bear this in mind when planning later activities.
How can using a microscope give us information about structure?			
• to use a microscope safely and effectively • to prepare simple specimens on a slide for observation using a microscope • to make observations using a microscope and to record these as drawings	• Ask pupils about using magnifying glasses and microscopes to make detailed observations, and find out what they understand about magnification. • Demonstrate the correct use of the microscope to make observations under low magnification. Help pupils to use a prepared slide of newsprint, *eg the letter 'e',* to practise placing and focusing slides. • Help pupils make slides of common objects, *eg sand, newsprint, tissue paper, hair.* Encourage them to record observations in clear drawings, *eg by showing them prepared drawings and asking them to identify what is clear and unclear in them*. Establish through questioning why it is important to include the level of magnification.	• prepare a specimen for microscopic observation, and correctly focus the microscope to view it • describe how the objects appear under low magnification • make careful drawings of the objects viewed	• Some pupils find it difficult to focus microscopes. It may be helpful to set up microscopes already focused on specimens or use bioviewers alongside microscopes. • Pupils with physical disability could be offered the opportunity to provide instructions to another pupil to demonstrate their knowledge and understanding about preparing specimens for microscopic observation. • Making measurements of cells can help pupils to develop an understanding of very small numbers. Eyepiece graticules, or strips of graticule photographs as cheaper alternatives, can be useful resources when making measurements. • Extension: some pupils may be ready to explore ways of measuring the size of objects observed, by measuring the diameter of the field of view and estimating size against this measure, or by devising their own method. ⚠ **Safety** – there is a risk from reflected sunlight when using daylight for mirror illumination with microscopes

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Learning objectives

Pupils should learn:

- to use skimming, scanning, highlighting and note taking as appropriate to different texts
- how ideas about the structure of living things have changed
- that plants and animals are made up of cells
- that plant and animal cells are similar in a number of respects, but have significant differences
- to make observations using a microscope

Possible teaching activities

- Show pupils evidence of the early observations made by Robert Hooke and others to illustrate how the development of the microscope changed the way in which scientists viewed the structure of living things. Ask pupils to find out how ideas developed. Provide opportunities for pupils to read different types of text, reminding them of ways of identifying key points, and to discuss findings in groups before reporting back to the whole class, *eg using flow charts or a series of annotated diagrams.*
- Introduce the term 'cell' and show pictures and/or three-dimensional models of a range of cell types from animals and plants. Help pupils to prepare slides of pieces of plant material, *eg leaf surface, petals, root, squash, potato and tomato scrapings, onion epidermis.* Establish that plant material is made of cells. Ask pupils to describe these cells.
- Provide opportunities for pupils to make their own slides of cheek cells as well as to observe prepared slides of human cells. Ask pupils to suggest ways in which these cells are similar to and different from plant cells. Demonstrate by drawing around a single cell in the photograph, or by drawing a cell which you can see and then showing this particular cell to a pupil, to help to focus their perception and observations.

Learning outcomes

Pupils:

- describe some earlier ideas about the structure of living things
- identify key points using an appropriate technique
- explain how evidence from microscope observations led to new ideas
- state that living things are made of microscopic units called cells
- draw the cells observed
- identify observable similarities and differences between cells
- make a generalisation about the differences, *eg in size, presence of thick outer wall*, between plant and animal cells

Points to note

- Much material relating to the development of our understanding of cells and the contributions made by the microscope is available on the internet. A search beginning with 'Robert+Hooke' may provide useful resources.
- Details of cell structure visible at higher magnification are not required, *eg mitochondria*.
- Pupils often have difficulty in recognising individual cells. Careful demonstration with the whole class, using a microprojector or an OHT of cell photographs, can help overcome this problem.
- Extension: some pupils could use moss to observe chloroplasts.

⚠ **Safety**
– a risk assessment may be required in relation to the types of stain that might be used
– allow pupils to use a cotton bud to take their own samples and dispose of the cotton bud safely. Check school/LEA risk assessments for cheek-cell sampling

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
What are cells like?			
• that plant and animal cells are similar in a number of respects • that plant and animal cells have a cell surface membrane which keeps the cell together and controls what enters and leaves • that cells have cytoplasm which occupies most of the cell • that cells have nuclei which control activities of the cell • that there are significant differences between plant and animal cells	• Show, and help pupils to make, three-dimensional models of plant and animal cells, *eg using small plastic bags filled with cellulose paste to represent cytoplasm, with suitable objects to represent the nucleus (plant cells can also be made if the bags are squeezed into boxes).* • Ask pupils to identify what plant and animal cells have in common and how they are different, and help them relate the models to cells they have observed, and to drawings, diagrams, and photographs of cells. Establish that the diagrams represent a 'view' of the cell from one aspect. • Provide pupils with secondary sources of information about cells, *eg CD-ROMs which allow virtual reality cell exploration, such as a voyage through a cell.* Ask them to produce an account, *eg 'My journey through a cell'*. Compare accounts of plant and animal cells to begin to identify differences between them. • Review the parts of the cells, with pupils identifying that plant and animal cells contain cytoplasm, cell membrane and nucleus, and that plant cells also have a cell wall, almost always a vacuole and often chloroplasts.	• relate the parts of model cells to diagrams and pictures of plant and animal cells • describe what plant and animal cells have in common • identify that plant cells have a cell wall and vacuole and may have chloroplasts, but that animal cells do not	• Making cell models is useful because it enables pupils to appreciate the 3-D structure of cells. However, models have limitations, *eg presenting a static rather than a dynamic model of the cell.* Pupils could discuss these. • Models of cells could also be prepared from different colours of modelling clay, with a central nucleus. These can be cut into sections to demonstrate different views. ⚠ **Safety** – it is best to use cellulose paste because wallpaper paste contains fungicide
Checking progress			
• to relate ideas about cells and cell structure	• Present pupils with a collection of pictures, models, CD-ROMs of specialised cells, *eg epithelial cell, root hair, pollen, palisade cell, neurone, sperm, egg, red blood cell*. Ask them to classify each cell as plant or animal in origin, giving reasons, and to label the parts of the cells which they can identify.	• classify cells as plant or animal in origin, giving reasons, and label parts of cells	
What do cells do?			
• that there are different types of cell, adapted for different functions • to use secondary sources of information	• Review with pupils pictures, models or CD-ROMs of some specialised cells, *eg epithelial cell, root hair, pollen, neurone, sperm, egg, red blood cell.* Provide information about the role of each type of cell and ask pupils to match these to each cell. • Show pupils how to use secondary sources to find out more about specialised cells in plants and animals, and how to present this information as a report on a cell type. Use this activity as an opportunity to emphasise that cells are dynamic systems rather than static structures.	• explain that different types of cell can be found in plants and animals, and that these cells carry out specialised functions • identify specialised features in different types of cell, and relate these to the function of a cell • find and present relevant information on a particular cell type	• Consideration of different types of cell in plants and animals is used to reinforce work on parts of cells, and on similarities and differences between cells in plants and animals. • At this stage pupils do not need to know about the structure of viruses. However, some pupils will find from secondary sources that they are not cells. • Pupils will have opportunities to relate cell adaptations to life processes in unit 7B 'Reproduction' and unit 9C 'Plants and photosynthesis'.

4	Learning objectives	Possible teaching activities	Learning outcomes	Points to note
	Pupils should learn:		Pupils:	
	• that cells form tissues, and tissues form organs • to name some important tissues in plants and humans • to explain the organisation of tissues, using a model	• Introduce the concept of a tissue, naming examples relating to specialised cells previously observed. Use the analogy of a house to explain the organisation of tissues, showing that different materials are used to make different parts, and that these parts make the whole. Help pupils to model this, using building sets to make the equivalent of tissues, and using these to build a house or an organ of their choice. • Show pupils a dissection, *eg of a hen's leg*, to illustrate the different types of tissue in a complex structure. • Show pupils a privet leaf as an example of a plant organ, explaining that it is made from different types of cell organised into tissues. • As an alternative some pupils could provide cartoons or drawings to show and explain how various tissues make up an organ.	• name some examples of tissues from plants and humans • relate the different parts of a model to the cells and tissues making up an organ in a living organism	• At this stage, pupils are introduced to the idea of hierarchical organisation of cells into tissues and organs. They do not need to know details of structure and function of tissues. • Extension: pupils may be familiar with the idea of tissue grafting, or bone marrow transplants. They could be asked to find out more about these. • Extension: pupils could observe prepared slides, *eg of a transverse section of a privet leaf,* identifying the occurrence and distribution of different cell types and tissues, and relating this to the structure of the leaf as an organ. ⚠ **Safety** – disinfect the bench after the dissection
	How are new cells made?			
	• that cells can make new cells by dividing • that growth occurs when new cells are made and increase in size • that cell division begins with division of the nucleus	• Ask pupils how they think new cells are made, and discuss different ideas that may arise. • Provide plant material to illustrate active cell division, *eg filamentous green algae, budding yeast, broad bean roots*, for microscope examination under low magnification. Ask pupils to suggest how they might identify cells that are making new cells, and to locate and identify cells that may have recently divided, giving reasons. • Using these observations and secondary sources of evidence, *eg photographs or video images of dividing cells,* help pupils to sequence photographs of cell division. Prompt them with questions, *eg Why does the nucleus divide first?* Consolidate by providing pupils with diagrams of the same process to sequence and annotate.	• explain that growth of living things occurs by cells dividing to make new cells, and these cells increasing in size • represent the process of cell division as a sequence that begins with division of the nucleus	• Check plant material before the lesson to ensure examples of dividing cells can be observed. Filamentous green algae collected from a pond provide evidence of recently divided cells, about half the size of the typical cell in the filament. • As an alternative, use prepared slides which show dividing cells. • Details of cell division are not required. Mitosis forms part of the key stage 4 programme of study.

5	Learning objectives	Possible teaching activities	Learning outcomes	Points to note
	Pupils should learn:		Pupils:	
	• that cells have nuclei containing the information that is transferred from one generation to the next • that in plants, pollen and ovule are specialised cells which enable information to be transferred from one generation to the next • that at fertilisation, nuclei from pollen and ovule fuse to make a new and unique individual	• Ask pupils what they remember about pollination and sexual reproduction in plants. Extend their ideas about pollen and ovule by establishing that these are the male and female reproductive cells of plants, and help them to observe pollen and ovules under the microscope at low magnification. Describe the process of fertilisation in plants as the transmission of information within a nucleus of the pollen grain to the ovule, and the combination of the nuclei of ovule and pollen grain to form a new cell. Prepare slides of pollen grains, *eg from lilies,* in 10% sugar solution and help pupils to observe the growth of pollen tubes. Establish that the new cell grows to form a seed, making new cells by division.	• explain the process of fertilisation in flowering plants as the transfer of information within nuclei from parents to offspring • distinguish between the processes of pollination and fertilisation in flowering plants • make drawings to illustrate the sequence of events during fertilisation in plants	• Pupils should be familiar with sexual reproduction in plants and with flower structure from work at key stage 2. • Details of fertilisation in flowering plants are not required at this stage. Fertilisation in plants and animals will be revisited in unit 9A 'Inheritance and selection' and fertilisation in humans is described in unit 7B 'Reproduction'. • Pollen and ovules are easily observed in any simple flower with large stamens and ovaries, *eg wallflower, daffodil, godetia, nasturtium, tulip*. A range of flowers from the same species will provide pollen at different stages of maturity.
	What causes pollen tubes to grow?			
	• how to frame a question that can be investigated • about the importance of sample size and the number of observations in biological investigations • to identify trends shown in graphs • to evaluate the strength of the evidence	• Remind pupils of their observations of pollen tubes and explain that they are going to find the sugar concentration that is best for pollen tube growth. Help them to frame a question for investigation. Suggest an appropriate range of sugar concentrations and discuss with pupils the control of variables and the sort of observations which would provide the information needed to answer the question. • Explain issues relating to sampling in biological investigations, *eg sufficient sample size to account for variables that cannot be controlled or to provide reliable data.* • Help pupils to collect and present data relating to the number of germinated grains, in a sample of approximately 20, from each sugar concentration. • Ask pupils to produce an account of their investigation in which the importance of sampling is clearly explained.	• identify a suitable question • explain why they needed to use a particular number of pollen grains, *eg 20 grains at each concentration* • make accurate observations and record these appropriately • draw an appropriate graph of data collected • use the graph to identify trends and make generalisations • compare graphs produced by different groups, and use these to evaluate the strength of evidence	• This investigation provides an opportunity to help pupils understand the importance of sampling in biological investigations. A suitable approach involves preparing slides of pollen in a range of sugar concentrations, observing, *eg 20 pollen grains from each slide,* and counting how many of these have germinated. The use of 20 pollen grains should enable a conclusion to be drawn about the optimum concentration for the process. However, within each 20 grains there will be differences arising from variables that cannot be controlled, *eg the genetic make-up of the grain*. In smaller samples these differences may mask the effect of the different concentrations of sugar. ⚠ **Safety** – pupils' plans must be checked for health and safety, before practical work begins

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
Reviewing work			
• about types of cells, their functions and organisation into tissues and organs • to relate ideas about cell division to growth	• Provide images or video sequences of different specialised cells and of division and growth, *eg early stages of a human embryo,* together with short descriptions, and ask pupils, in groups, to match image and description. Discuss with them the examples that they have difficulty agreeing on. Ask them to use their work to help them make a summary sheet about the unit.	• identify different types of cell and describe their roles • explain that growth occurs as a result of cell division and increase in size	

