Objectives

B1.2 Describe how specialised cells are adapted to their function, including (a) sperm cells – acrosome, haploid nucleus, mitochondria and tail, (b) egg cells – nutrients in the cytoplasm, haploid nucleus and changes in the cell membrane after fertilisation, (c) ciliated epithelial cells.

B1.6 *Produce labelled scientific drawings from observations of biological specimens using microscopes.*

Maths requirements

2h Demonstrate an understanding of size and scale in relation to microscopy, including magnification calculations.

Learning outcomes

6th **SB1.2** Describe how sperm cells are adapted to their function.

6th **SB1.2** Describe how egg cells are adapted to their function.

6th **SB1.2** Describe how ciliated epithelial cells are adapted to their function.

7th **SB1.2** Draw conclusions about a cell's function from its adaptations.

Before starting, consider using rapid-fire quick questions to check and secure basic knowledge and understanding from recent lessons (examples are given in the Quick Quiz below). The quiz can be done as a whole class and should take no more than a couple of minutes.

You can also ask students to answer the Progression questions at the top of the Progression Check sheet and to score their confidence levels. This gives students their own baseline with which to measure their own learning during the lesson.

The **ALDS** presentation *SB1c Specialised cells objectives* contains the Objectives, Learning outcomes and Progression questions and allows confidence levels to be monitored. The Quick Quiz is available as the **ALDS** presentation *SB1c Quick Quiz*.

Quick Quiz

1. List three sub-cellular structures that are usually found in animal cells. (any three from: cell membrane, nucleus, mitochondria, ribosomes)
2. List three sub-cellular structures found in plant cells but not in animal cells. (large permanent vacuole, chloroplasts, cell wall)
3. Which cell structure controls what enters and leaves the cell? (cell membrane)
4. Which cell structure controls how the cell works? (nucleus)
5. In which cell structure does respiration mainly take place? (mitochondria)
6. Which plant cell structure contains chlorophyll? (chloroplast)
7. What is the function of the cell structure that contains chlorophyll? (to capture energy from light for photosynthesis/to produce glucose using photosynthesis)
8. Describe the function of the structure that surrounds plant cells, but not animal cells. (supports and protects the cell)
9. What is the function of ribosomes? (manufacture of proteins)
10. What are gametes? (sex cellsStarters

1. Adaptations

Write the word 'adaptation' on the board. Ask students to work in pairs or small groups to write down adaptations of three animal species, or, depending on the ability of the students, provide a list of species from

which they can select. Examples they may have studied in earlier work include polar bear, camel, eagle, shark; less familiar examples may include human, cat, snake. Encourage students to identify how their chosen adaptations help the animals to survive. Take examples from around the class, reinforcing the link between adaptation and environment to show the purpose of each adaptation. Then ask students to name as many different kinds of cells as they can think of in the human body. Then challenge students to suggest what is special about each kind of cell, though don't worry if answers are a little confused at this stage. What is important here is to get across the idea that different kinds of cell have different structures and different functions. This leads to the idea that the structures of different kinds of cells are adapted to their function.

2. Cell drawing

Provide students with mini-whiteboards or scrap paper, and challenge them to sketch the main features of different kinds of cells that have different functions related to cell structures with which they are familiar. Possible examples to give them are a cell that produces a lot of protein (contains many ribosomes), is able to move (e.g. sperm cell; contains many mitochondria to release energy for movement as well as having a tail for movement), plant leaf cell where a lot of photosynthesis takes place (contains many chloroplasts). Students should annotate their sketches to identify the features that are adaptations to their function. For each example, ask students to show what they have drawn and compare the key features. This should link structures with function.

Equipment

mini-whiteboards and markers, or scrap paper

Exploring

1. Specialised human cells

Students extend their experience in earlier topics by using a microscope to look at prepared slides of some specialised human cells. Display on the board a list of the specialised cells on the slides, but not in the order that the slides are labelled. You may need to indicate where to look for some of these in the tissues, e.g. epithelial cells line the edge of a tissue. A set of instructions for this practical is given on Worksheet SB1c.1.

The **ALDS** presentation *SB1c Scientific drawing* shows photos of cells as viewed under a light microscope. The presentation then gives some good and poor examples of cell drawings. There are two fully illustrated examples to start with. The presentation then includes two more examples of cell photos and the sort of drawings that students would be expected to produce from those photos. You may wish to show students the photos first and ask them to draw the cells before revealing the drawings. Skills Sheet UE3 could be used to remind students of the correct way of using a microscope. Depending on time available, students could work in pairs or small groups to share work, so that they study all the slides.

Suitable slides include: human sperm cells, human egg cell, ciliated cells lining the oviduct, epithelial tissue of small intestine showing microvilli. Cover any details of what the slides show, so they are not visible to students, and label the slides starting with 'slide A'.

Note that further examples of specialised cells will be studied later, such as those in the topics on differentiation in animal and plant cells.

Support: Display one of the slides on the board using a digital microscope. Discuss with students which features of the cell are typical of all animal cells and which are specialised. Ask them to decide which cell in the list on the board the slide shows, and to explain their choice. Then demonstrate how to draw one cell from the slide clearly, and label one or two specialised features on your drawing. Remind students of how to measure the actual size of a cell on the slide and to calculate how much larger the drawing is. Extend this to adding a scale bar or a magnification to the drawing, to show the size of the cell. Students should then attempt a slide on their own. For the 'Considering your results' section of the worksheet, you may need to remind students of the functions of the different types of cell, and use class discussion to associate these with the special features of each cell.

Stretch: Include examples of unfamiliar cells that have similar adaptations to those listed above, such as sperm cells of ferns, ciliated cells from the trachea, fat cell (where lipids are stored for future use as an energy supply), liver cell (containing many mitochondria for releasing energy for other processes including synthesis and breakdown of many substances), root hair cells of plants (large surface area for absorption). When students have completed the sheet, you may need to help them fill gaps in their knowledge about the function of some of the cells.

⚠ Safety

Handle slides and microscopes with care.

Expected results

Adaptations of cells in slides suggested: a sperm cell has a tail that helps it move through the female reproductive system to reach the egg for fertilisation; an egg cell has a large amount of food in the cytoplasm to provide energy for cell division and growth after fertilisation; some epithelial cells have cilia on their surface, to move substances along the tube that the cells line; villi in the small intestine are covered in epithelial cells that have microvilli (brush border) that increase the surface area for absorption of digested food.

Course resources

ALDS: Presentation *SB1c Scientific drawing*

AAP: Skills Sheet UE 3. Worksheet SB1c.1

Equipment

prepared and labelled slides of human cells and tissues (see above for suitable examples), light microscope and light source, transparent ruler

2. Structure and function

Worksheet SB1c.2 is a cut-and-paste sheet on the structure and function of some of the specialised cells met in this topic. For most students, cut off the bottom table of explanatory notes.

Support: Leave the bottom table of statements on the sheet and explain that these should be used to help answer question 3 on the sheet.

Stretch: Ask students to identify at least three key features of each of the following cells, and to explain how each feature supports the function of the cell: sperm cell, egg cell, ciliated epithelial cell, epithelial cell from the small intestine with microvilli, muscle cell, root hair cell, plant leaf (palisade) cell.

Course resources

AAP: Worksheet SB1c.2

Explaining

1. Student Book SB1c Specialised cells

Work through the Student Book pages, answering the questions. Note that a wider range of cell types is covered in this topic than simply sperm, egg and ciliated epithelial cells. This is to provide links to examples of other types that will be covered in more detail later in the course.

The **ALDS** presentation *SB1c Scientific drawing* shows photos of cells and drawings made from those cells (see Exploring 1).

Support: Students may need help remembering the difference between haploid and diploid. Work with them to think up a simple mnemonic that will help, such as **HA**ploid cells have **HA**lf the normal chromosome number. They may also struggle with the link between surface area and rate of absorption. If so, use visual representations to support this such as in Explaining 2, or by using two sizes of sieve with the same mesh to show how quickly the same amount of powder (e.g. flour) can be sieved through it.

Stretch: Ask students to suggest other cells that have particular adaptations, such as: many mitochondria (any cell that requires a lot of energy, e.g. muscle cell, rapidly dividing cells), many ribosomes (any cell that produces a lot of protein, e.g. enzyme-producing cells, dividing muscle cells, hormone-producing cells), large surface area (any cell where transfer of molecules across the cell membrane is important, e.g. root hair cells in plants, red blood cells).

Course resources

ALDS: Presentation *SB1c Scientific drawing*

SB: Student Book *SB1c Specialised cells*

2. Effect of surface area demonstration

Prepare two equal lengths (approximately 12 cm) of Visking tubing by wetting to make them pliable, then tie a knot close to one end of each tube. Measure a small amount (e.g. 3 cm^3) of concentrated sucrose solution into one tube. Exclude as much air as possible from the tube, then roll the tube up from the open end until it is about 4 cm long from knot to rolled part. Hold the rolled-up part with a paperclip, being careful not to pierce the tubing. Repeat the filling, rolling and closing of the second tube, but this time leave 8 cm between the knot and the rolled part. Wash off any solution that has spilt onto the outside of each tube, and dry gently. Then measure and record the mass of each tube.

Place both tubes into a large beaker of distilled water, and explain that water is able to cross the tubing membrane from the water in the beaker into the solution. (Unless students have already learnt about osmosis, ignore the fact that some water molecules will move from the solution into the water.) Ask students to predict how the mass of the tubes will change over time, and whether they will change in the same way or be different. They should try to give a reason for their predictions.

After five minutes, remove the tubes from the water, carefully dry them and measure their masses again. The longer tube should have increased in mass more than the shorter one, due to the larger surface area over which water can be absorbed. If results are not obvious enough, place the tubes back into the water for another five minutes and then measure again.

Support: Prompt students to think about the difference in area of tubing in contact with the water in the beaker, to help them link that to the difference in amount of water absorbed into each tube.

Stretch: Challenge students to apply what they have seen in the demonstration to explain the importance of microvilli on cells lining the small intestine.

Equipment

For the teacher: two 12 cm lengths of Visking tubing, 6 cm^3 concentrated (e.g. 5%) sucrose solution, two large paperclips, paper towels, wash bottle of water (to wash tubes), large beaker of distilled water, balance

Checkpoint

Ask students to complete the Assessment and Feedback sections of the Progression Check sheet for this topic. Or revisit the Progression questions on Student Book *SB1c Specialised cells* and assess whether students feel more confident about answering them. Less confident students should use the 'Strengthen' activity. Students who demonstrate good understanding should move on to the 'Extend' activity.

Strengthen

Question 1 on Worksheet SB1c.3 provides scaffolding for question S1 in the Student Book. The remaining question reinforces other key ideas in this topic.

Check that weaker students understand the questions on the worksheet before encouraging them to complete the answers in pairs or small groups.

Other students can work in pairs or small groups to answer question S1 in the Student Book first and then answer question 1 on the worksheet. They should compare their answers to questions 1 and S1 before completing the sheet.

When students have completed the questions, check which students have difficulty with which questions and use the level of problem to identify any areas for revisiting before moving on to the next topic.

Extend

Ask students to work in pairs to discuss question E1 in the Student Book. The pairs then join into fours to discuss their responses before working through question 1 on Worksheet SB1c.4. They can then compare their answers with their original answers to E1. Students then return to their pairs to complete the worksheet collaboratively. The remaining questions on the worksheet cover other areas of learning in this topic.

Course resources

AAP: Worksheet SB1c.4

Reflect

Ask students to answer the exam-style question at the bottom of *SB1c Specialised cells* in the Student Book.

Homework

Homework 1

Worksheet SB1c.5 is suitable for homework and contains straightforward questions about this topic.

Support: Check that students understand the questions before asking them to complete the worksheet.

Course resources

AAP: Worksheet SB1c.5

Homework 2

Worksheet SB1c.6 is suitable for homework and contains more challenging questions about this topic.

Stretch: Students complete the Extra challenge questions at the end of the sheet.

Course resources

AAP: Worksheet SB1c.6