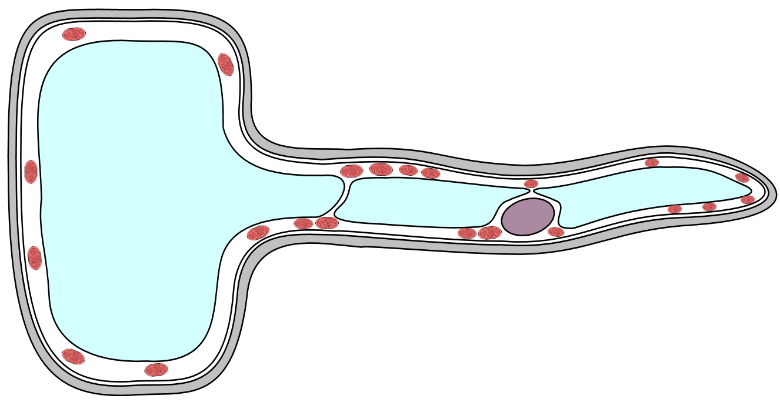
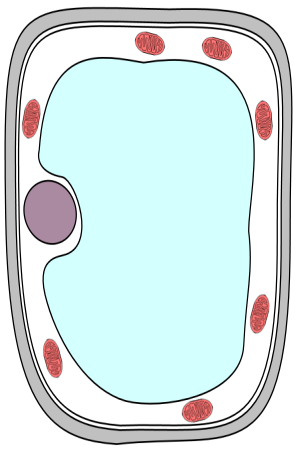
**Root hair cell**

The diagrams show two cells from the outside surface of a plant’s root.



cell A

cell B

soil

1. Which cell would be better at absorbing substances from the soil?

|  |  |
| --- | --- |
| **A** | Cell A would be better. |
| **B** | Cell B would be better. |
| **C** | They would be equally as good. |

1. How would you explain your answer to question 1?

|  |  |
| --- | --- |
| **A** | They are both touching the soil. |
| **B** | It reaches further into the soil. |
| **C** | It has a larger area of membrane for diffusion. |
| **D** | It has a flatter area of membrane for diffusion. |

*Biology > Big idea BCL: The cellular basis of life > Topic BCL1: Cells > Key concept BCL1.4: Diffusion and the cell membrane*

|  |
| --- |
| **Diagnostic question** |
| **Root hair cell** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Molecules move through the cell cytoplasm by diffusion, and some molecules can enter and leave a cell by diffusing through the cell membrane. |
| Observable learning outcome: | Apply ideas about diffusion through the cell membrane to explain why some cells have a larger surface area. |
| Question type: | Two-tier multiple choice |
| Key words: | cell, membrane, diffusion, adaptation, surface area |

|  |  |
| --- | --- |
| **B** | **BRIDGING**  This diagnostic question probes understanding of ideas that are usually taught at age 14-16, to build a bridge to later stages of learning. |

**What does the research say?**

Various researchers (e.g. Odom, 1995; Tomažič and Vidic, 2012; Oztas and Oztas, 2016) have described the use of two-tier multiple choice questions to diagnose students’ misconceptions related to diffusion in the context of cells. Students can struggle to understand and explain diffusion because of the need to visualise and think about processes at the molecular level (Sanger, Brecheisen and Hynek, 2001).

There is very little published research into students’ understanding of the concepts of surface area and surface-area-to-volume ratio and their implications for living and non-living systems (Taylor and Jones, 2013). Various school science curricula recognise size and scale as important crosscutting concepts in science (National Academy of Sciences, 2012; Department for Education, 2015).

Data from national examinations in the UK shows that students at age 16 struggle to explain why the shape of a root hair cell enables it to absorb substances from the soil more effectively (OCR, 2018). Commonly seen answers that did not provide sufficient explanation included that it could reach further into the soil and that it would anchor the plant in the soil more effectively.

**Ways to use this question**

Students should complete the questions individually. This could be a pencil and paper exercise, or you could use the PowerPoint presentation with an electronic voting system or mini white boards.

Although ideas about surface-area-to-volume ratio are not usually explored in depth with students until the ages of 14-16, younger students who are secure in their understanding that molecules of substances diffuse into and out of cells through the cell membrane should be able to apply what they know to reason that a larger area of membrane will enable more molecules to diffuse through. The answers to the questions will show you whether students are able to do this.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

1. B - Cell B would be better.
2. C - It has a larger area of membrane for diffusion.

**How to respond - what next?**

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs. Responses often work best when the activities involve paired or small group discussions, which encourage social construction of new ideas through dialogue.

Researchers have described constructivist approaches that enable students to build their own explanations of diffusion, which may help to develop students’ understanding and overcome misconceptions, including use group discussion and challenging students’ thinking (Christianson and Fisher, 1999). One possible approach may be to show students pictures or a video of microvilli in the human gut – microscopic projections of the cell membrane that massively increase the surface area for absorption of water and substances from food. Tell them that scientists estimate that the microvilli in the small intestine increase the surface to total area of 250 or more square meters (about the surface area of a tennis court), and ask them to discuss why this is useful.

**Acknowledgments**

Developed by Alistair Moore (UYSEG).

Images: mitochondria – Wikimedia Commons/Nevit (adapted by UYSEG); all other drawings – UYSEG

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