**Across the membrane**

The diagram shows the particles of two solutions.

There is a selectively permeable membrane between the two solutions.

**solution A**

**solution B**

membrane

water particle

protein particle

oxygen particle

1. Which statement is true?

|  |  |
| --- | --- |
| **A** | Protein particles can move through the membrane in both directions. |
| **B** | Protein particles can only move from solution A to solution B. |
| **C** | Protein particles can only move from solution B to solution A. |
| **D** | Protein particles **cannot** move through the membrane in either direction. |

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

|  |  |
| --- | --- |
| **A** | The membrane is permeable. |
| **B** | Protein particles are only found in solution B. |
| **C** | There is a concentration gradient. |
| **D** | Protein particles are too big to move through the membrane. |

Look at the diagram again.

protein particle

water particle

oxygen particle

**solution A**

**solution B**

membrane

1. Which statement is true?

|  |  |
| --- | --- |
| **A** | Water particles will move through the membrane in both directions. |
| **B** | Water particles will only move from solution A to solution B. |
| **C** | Water particles will only move from solution B to solution A. |
| **D** | Water particles will **not** move through the membrane in either direction. |

1. How would you explain your answer to question 3?

|  |  |
| --- | --- |
| **A** | There number of water particles in each solution is the same. |
| **B** | Solution B is much more concentrated. |
| **C** | Particles only move from higher concentration to lower concentration. |
| **D** | Water particles are small enough to move through the membrane. |

Look at the diagram again.

protein particle

water particle

oxygen particle

**solution A**

**solution B**

membrane

1. Which statement is true?

|  |  |
| --- | --- |
| **A** | Oxygen particles will move through the membrane in both directions. |
| **B** | Oxygen particles will only move from solution A to solution B. |
| **C** | Oxygen particles will only move from solution B to solution A. |
| **D** | Oxygen particles will **not** move through the membrane in either direction. |

1. How would you explain your answer to question 5?

|  |  |
| --- | --- |
| **A** | There is a concentration gradient. |
| **B** | There are more oxygen particles in solution B than in solution A. |
| **C** | Oxygen particles are small enough to move through the membrane. |
| **D** | Particles only move from higher concentration to lower concentration. |

Look at the diagram again.

protein particle

water particle

oxygen particle

**solution A**

**solution B**

membrane

1. Which statement is true?

|  |  |
| --- | --- |
| **A** | The **net** movement of oxygen particles will be from solution A to solution B. |
| **B** | The **net** movement of oxygen particles will be from solution B to solution A. |
| **C** | There will be no **net** movement of oxygen particles. |
| **D** | The **net** movement of oxygen particles will be in both directions. |

1. How would you explain your answer to question 7?

|  |  |
| --- | --- |
| **A** | Oxygen particles will only move from solution A to solution B. |
| **B** | Oxygen particles will only move from solution B to solution A. |
| **C** | Oxygen particles will move through the membrane in both directions. |
| **D** | Oxygen particles will move through the membrane in both directions but more will move from solution B to solution A. |

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

|  |
| --- |
| **Diagnostic question** |
| **Across the membrane** |

**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: | Explain the diffusion of particles through a selectively permeable membrane. |
| Question type: | Two-tier multiple choice |
| Key words: | membrane, selectively permeable, diffusion |

**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, including a series of questions known as the ‘Diffusion and Osmosis Diagnostic Test’ (DODT), as described by Odom and Barrow (1995).

These tests have revealed common misunderstandings about diffusion amongst students, including that:

* molecules move only in one direction, from an area of higher concentration to an area of lower concentration (a failure to understand the random movement of particles versus the concept of *net* movement);
* movement of particles stops after the concentration gradient between two areas has been equalised by diffusion (possibly because students interpret “no net movement” to mean “no movement of particles”).

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).

**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.

The answers to the questions will show you whether students understand the movement of particles across a selectively permeable membrane, including the idea that particles move in both directions and the concept of net movement due to a concentration gradient.

*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. D - Protein particles cannot move through the membrane in either direction.
2. D - Protein particles are too big to move through the membrane.
3. A - Water particles will move through the membrane in both directions.
4. D - Water particles are small enough to move through the membrane.
5. A - Oxygen particles will move through the membrane in both directions.
6. C - Oxygen particles are small enough to move through the membrane.
7. B - The net movement of oxygen particles will be from solution B to solution A.
8. D - Oxygen particles will move through the membrane in both directions but more will move from solution B to solution A.

Note: although some of the questions refer to the movement of water particles, students are not expected to understand anything about osmosis at this stage. They should answer these questions using their knowledge and understanding of the movement and diffusion of particles (assuming water is just like any other particle).

**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 to apply concepts they have been taught to make predictions (Christianson and Fisher, 1999). The following BEST ‘response activity’ facilitates these types of activities and could be used in follow-up to this diagnostic question:

* Response activity: PEOE – A cup of tea

**Acknowledgments**

Developed by Alistair Moore (UYSEG).

Images: UYSEG

**References**

Christianson, R. G. and Fisher, K. M. (1999). Comparison of student learning about diffusion and osmosis in constructivist and traditional classrooms. *International Journal of Science Education,* 21(6)**,** 687-698.

Odom, A. (1995). Secondary & college biology students' misconceptions about diffusion & osmosis. *The American Biology Teacher,* 57(7)**,** 409-415.

Odom, A. L. and Barrow, L. H. (1995). Development and application of a two-tier diagnostic test measuring college biology students' understanding of diffusion and osmosis after a course of instruction. *Journal of Research in Science Teaching,* 32(1)**,** 45-61.

Oztas, F. and Oztas, H. (2016). How do biology teacher candidates know particulate movements & random nature of matter and their effects to diffusion. *Journal of Education and Practice,* 7(29)**,** 189-194.

Sanger, M. J., Brecheisen, D. M. and Hynek, B. M. (2001). Can computer animations affect college biology students' conceptions about diffusion and osmosis? *The American Biology Teacher,* 63(2)**,** 104-109.

Tomažič, I. and Vidic, T. (2012). Future science teachers' understandings of diffusion and osmosis concepts. *Journal of Biological Education,* 46**,** 66-71.