**Cytoplasm – a particle model**

The cytoplasm in a cell is made up of particles.

Imagine you could see the particles.

Which diagram and description best matches what you would see?

|  |  |
| --- | --- |
| **A** | **B** |
|  |  |
| Particles not moving | Particles not moving |
|  |  |
| **C** | **D** |
|  |  |
| Particles moving freely | Particles moving freely |
|  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Cytoplasm – a particle model** |

**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: | Recall that substances are made of particles that move and collide randomly all the time. |
| Question type: | Simple multiple choice |
| Key words: | cell, cytoplasm, diffusion, particle |

**What does the research say?**

Explaining diffusion requires a secure understanding of concepts from chemistry and physics, including the particulate nature of matter and the behaviour of particles in solutions. Students can struggle to understand and explain diffusion because of the need to visualise and think about the process at the molecular level (Sanger, Brecheisen and Hynek, 2001).

Johnson (1998) summarises research in which it was found that even students who appreciate that a substance is made up of particles showed very little appreciation of the intrinsic, random movement of particles. In addition, they commonly had misunderstandings about the spacing between the particles of a substance in the liquid state – typically choosing to depict the particles as too far apart, somewhere between that of the solid and gas states. This misunderstanding could be introduced or reinforced by textbook diagrams in which the spacing is shown incorrectly.

Odom (1995) has defined a list of knowledge statements required for understanding diffusion in the context of cells, which begins with the following three ideas:

1. All particles are in constant motion.
2. Diffusion involves the movement of particles.
3. Diffusion results from the random motion and/or collisions of particles (ions or molecules).

…as pre-requisites for the development of understanding that diffusion is the net movement of particles as a result of a concentration gradient.

**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 passive but important role of the cell membrane in controlling which substances can diffuse into and out of a cell, and the meaning of the term “selectively permeable”.

*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**

The correct answer is C.

Both options C and D correctly describe the intrinsic motion of the particles, but in D the particles are depicted as being too far apart (more representative of a gas than a liquid).

**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.

A number of 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 group discussion (Christianson and Fisher, 1999) and drawing (Wilkerson-Jerde, Gravel and Macrander, 2015).

If students have misunderstandings about the particulate nature of cell cytoplasm, the following BEST ‘response activity’ facilitates the building of understanding through drawing and group discussion, and could be used in follow-up to this diagnostic question:

* Response activity: Drawing cytoplasm

If students have misunderstandings about the arrangement, spacing and motion of particles in substances, a range of diagnostic questions and response activities to further probe and develop students’ understanding are provided in the following BEST key concepts:

* Key concept: CPS1.1 *Particle model for the solid, liquid and gas states*
* Key concept: CPS1.2 *Particles in solutions*

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Images: ASK/Philip Johnson

**References**

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