BEST
Best Evidence Science Teaching

Best Evidence Science Teaching (BEST) Introduction

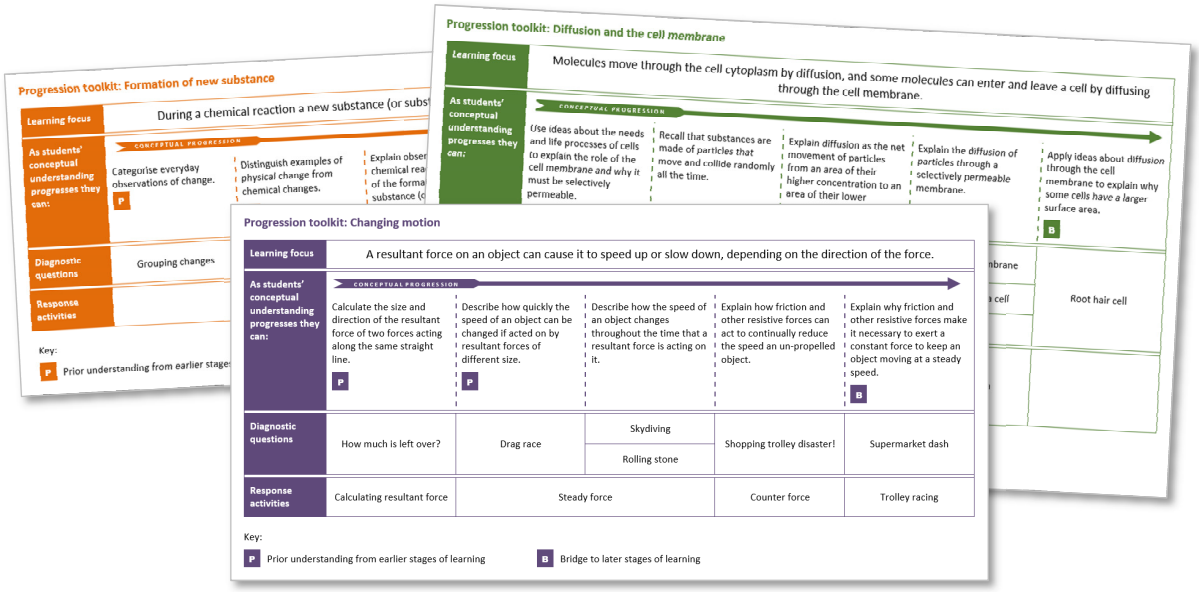
All resources FREE to download

The best teaching draws on the best evidence.

Best Evidence Science Teaching (BEST) is a large online collection of research evidence-informed resources for effective teaching of difficult ideas in science, embedded formative assessment and adaptive lesson planning. It is initially focussed on science at ages 11-14.

The resources are being developed by the *University of York Science Education Group* in collaboration with science teachers. Thanks to generous support from the *Salters' Institute* and *STEM Learning* we are providing **FREE** access to the resources to support science teaching.

PROGRESSION WITHOUT LEVELS



We've developed **progression toolkits** for key concepts in science, which provide:

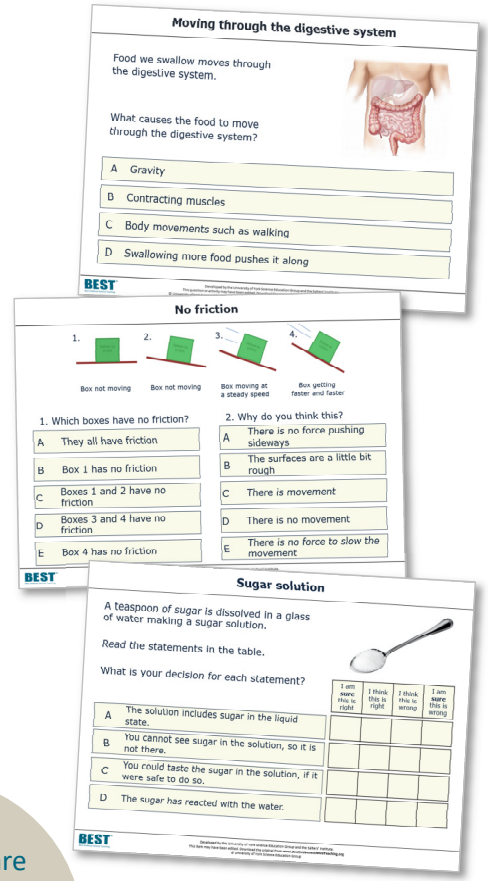
- appropriately-sequenced **learning outcomes**, developed from research on learning progressions
- **diagnostic questions** linked to the learning outcomes, developed from research on effective formative assessment, common preconceptions and common misunderstandings
- **response activities** linked to the diagnostic questions, developed from research on constructivist approaches that can help students to overcome misunderstandings and develop scientific understanding.

DIAGNOSE MISUNDERSTANDINGS

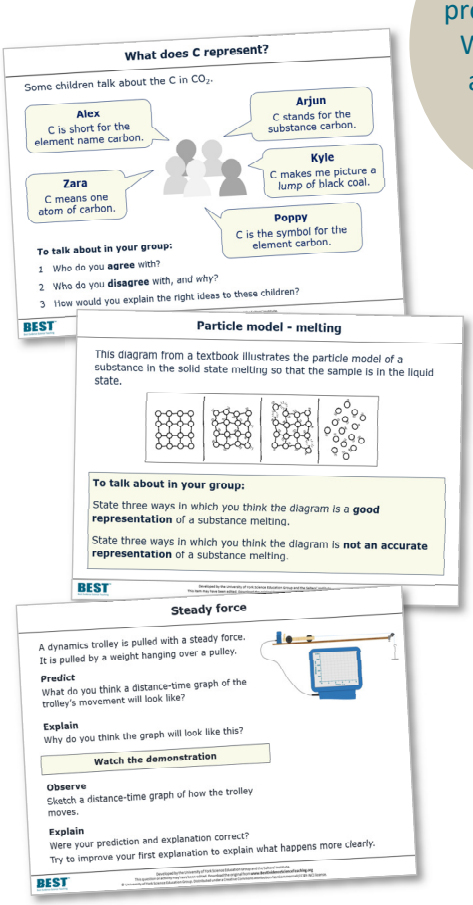
Each progression toolkit includes research-informed **diagnostic questions** to help you to quickly and easily collect:

- evidence of preconceptions and misunderstandings, which may form barriers to developing scientific understanding
- evidence of what your students know, understand and can do
- evidence of where your students are in their conceptual progression.

Innovative formats such as confidence grids provide rich evidence about what your students are thinking. This evidence can be used formatively to decide what happens next.



All resources are provided in editable Word documents and PowerPoint presentations



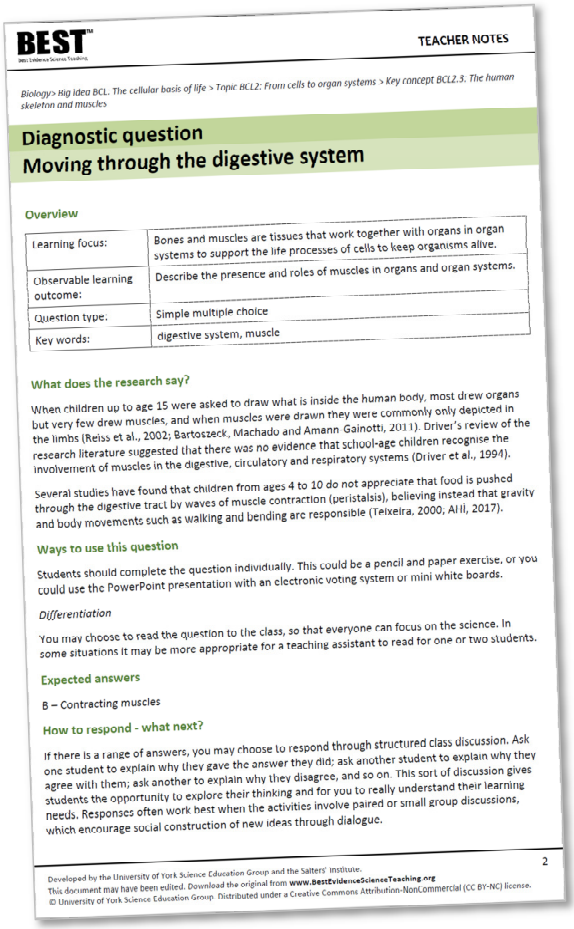
ENCOURAGE METACOGNITION AND MEANING-MAKING

Each progression toolkit also includes research-informed **response activities** to challenge misunderstandings and help students to overcome barriers to conceptual development.

These activities facilitate metacognition and encourage meaning-making through:

- dialogue and group discussions
- using and critiquing models
- purposeful practical work.

Formats such as predict-explain-observe-explain help to challenge students' thinking.



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TEACHER NOTES

Biology> Big idea BCL. The cellular basis of life > Topic BCL2: From cells to organ systems > Key concept BCL2.3. The human skeleton and muscles

Diagnostic question
Moving through the digestive system

Overview

Learning focus:	Bones and muscles are tissues that work together with organs in organ systems to support the life processes of cells to keep organisms alive.
Observable learning outcome:	Describe the presence and roles of muscles in organs and organ systems.
Question type:	Simple multiple choice
Key words:	digestive system, muscle

What does the research say?

When children up to age 15 were asked to draw what is inside the human body, most drew organs but very few drew muscles, and when muscles were drawn they were commonly only depicted in the limbs (Reiss et al., 2002; Bartoszeck, Machado and Amann-Gainotti, 2011). Driver's review of the research literature suggested that there was no evidence that school-age children recognise the involvement of muscles in the digestive, circulatory and respiratory systems (Driver et al., 1994).

Several studies have found that children from ages 4 to 10 do not appreciate that food is pushed through the digestive tract by waves of muscle contraction (peristalsis), believing instead that gravity and body movements such as walking and bending are responsible (Teixeira, 2000; AHI, 2017).

Ways to use this question

Students should complete the question 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.

Differentiation

You may choose to read the question 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

B – Contracting muscles

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.

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Developed by the University of York Science Education Group and the Salters' Institute.
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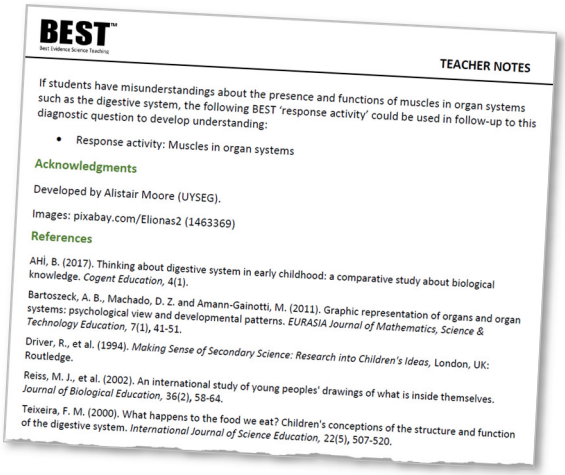

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TEACHER NOTES

If students have misunderstandings about the presence and functions of muscles in organ systems such as the digestive system, the following BEST 'response activity' could be used in follow-up to this diagnostic question to develop understanding:

- Response activity: Muscles in organ systems

Acknowledgments

Developed by Alistair Moore (UYSEG).

Images: pixabay.com/Elionas2 (1463369)

References

AHI, B. (2017). Thinking about digestive system in early childhood: a comparative study about biological knowledge. *Cogent Education*, 4(1).

Bartoszeck, A. B., Machado, D. Z. and Amann-Gainotti, M. (2011). Graphic representation of organs and organ systems: psychological view and developmental patterns. *EURASIA Journal of Mathematics, Science & Technology Education*, 7(1), 41-51.

Driver, R., et al. (1994). *Making Sense of Secondary Science: Research into Children's Ideas*, London, UK: Routledge.

Reiss, M. J., et al. (2002). An international study of young peoples' drawings of what is inside themselves. *Journal of Biological Education*, 36(2), 58-64.

Teixeira, F. M. (2000). What happens to the food we eat? Children's conceptions of the structure and function of the digestive system. *International Journal of Science Education*, 22(5), 507-520.

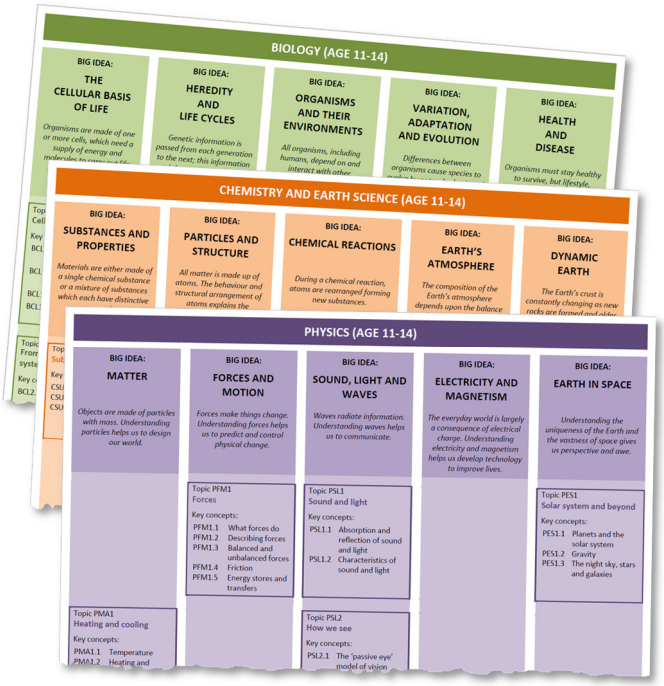
DEVELOP EVIDENCE-BASED PRACTICE

Each resource in the **Best Evidence Science Teaching (BEST)** collection includes short teacher notes that summarise the research evidence that has informed the design of the item, with full references should you wish to read more.

BUILD THE BIG IDEAS OF SCIENCE

The **Best Evidence Science Teaching (BEST)** resources are focussed on universal key concepts in science, so they can be incorporated into your existing schemes of learning.

We've also developed **subject maps** from research on learning progressions. These show how the key concepts fit into familiar teaching topics, and how they link together to build understanding of the **big ideas** of science education.



DON'T JUST TAKE OUR WORD FOR IT!

The UK-based **Education Endowment Foundation** published a guidance report in 2018 titled 'Improving Secondary Science'.

This report cites **Best Evidence Science Teaching (BEST)** as a good source of:

- diagnostic questions
- activities that promote metacognitive talk and dialogue.

To download our poster showing how **Best Evidence Science Teaching (BEST)** can help you implement the seven main recommendations of the report, go to:

www.BestEvidenceScienceTeaching.org

And we've been a hit on Twitter too…

@BestEvSciTeach

Hundreds of resources already available. New topics added every month.
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