

# ACE SCIENCE CONSIDERING SCIENTIFIC CONCEPTS THROUGH MODELS AND ANALOGIES

Below is a brief introduction to Considering Scientific Concepts through Models and Analogies plus contents.

Much of the science we teach cannot be seen, it is abstract. In order to understand it, most students need to be able to visualise it. If we use a familiar scenario that can be seen or experienced, this can give a starting point, on which students can build their new knowledge. Using real life situations can also motivate some students.

Learning scientific concepts is not a passive process, students must construct their own ideas and knowledge and through using models and analogies they can do this. Each student will visualise the model or analogy differently and so will have to make their own choices about how the model is similar to, or different from, the concept being considered. Models are not perfect and will all contain flaws. It is through identifying and considering these flaws that students' learning is embedded.

## THE TASKS

Are intended to be used as a qualitative summative assessment task, or as a stimulus for discussion on topics already covered in lessons. The tasks can be used to gauge the level of understanding of a topic students have achieved, or to help identify any misconceptions that have arisen. The tasks would be ideal for use as starter, main or plenary activities or homework part way into a topic.

The book contains over twenty easy to use, engaging tasks written specifically to help students embed difficult scientific concepts through considering models and analogies. The tasks use easily understood and everyday situations to encourage student engagement. The tasks will improve students' ability to consider abstract concepts and the strengths and weaknesses of analogies and models and will provide an excellent diagnostic resource to help identify misconceptions.

The tasks cover biology, chemistry and physics and each includes:

- **Teacher's Notes** This includes the National Curriculum link and an **ACE Learning Ladder** to be used as broad guidance on the understanding being demonstrated by students. Detailed guidance on how to use ACE Learning Ladders is provided.
- **Stimulus Sheet** that should be given to, or displayed for, students. The stimulus sheet is presented in a very open-ended way, so that students can have freedom to consider the model in their own way.
- **Discussion Starters** These are optional suggested sentence starters to help students consider how the model may represent the concept. If required these could be printed out and given to students. The sheet is editable, so questions can be removed or added, to suit the needs of given students or classes.

# ACE SCIENCE CONSIDERING SCIENTIFIC CONCEPTS THROUGH MODELS AND ANALOGIES

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### 1 Biology

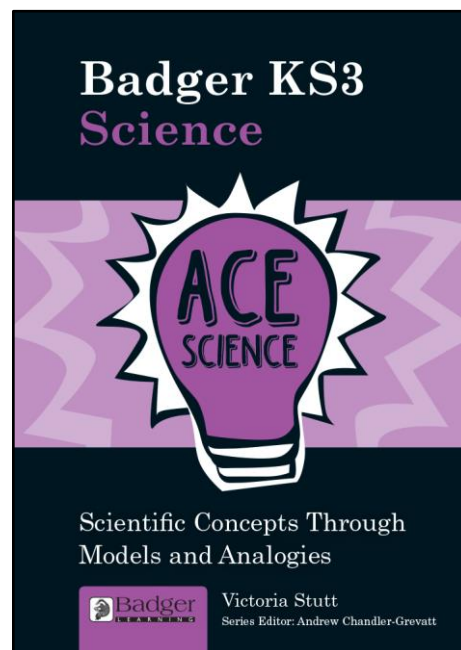
- 1 The Hierarchy of Cells
- 2 Substances Moving in and out of Cells
- 3 How the Lungs Work
- 4 Movement of Food through the Intestines
- 5 Getting Nutrients from Food
- 6 Interdependence in a Food Web
- 7 Natural Selection

### 2 Chemistry

- 1 Solids, Liquids and Gases
- 2 Atoms during Chemical Reactions
- 3 The Conservation of Mass
- 4 Dissolving
- 5 Catalysts
- 6 Reactivity of Metals and Carbon
- 7 The Structure of the Earth
- 8 Global Warming

### 3 Physics

- 1 Brownian Motion
- 2 Diffusion in a Liquid
- 3 Electrons in a Circuit
- 4 Resistance in Insulators
- 5 Energy Carried by Waves
- 6 Light through a Prism
- 7 Colour Filters



# 1

## BIOLOGY 1: TEACHER'S NOTES THE HIERARCHY OF CELLS

### NATIONAL CURRICULUM LINK

#### CELLS AND ORGANISATION

- the hierarchical organisation of multicellular organisms: from cells to tissues to organs to systems to organisms

### GUIDANCE ON THE ANALOGY

Student interpretation of the analogy can vary and still be correct. However, as a general guide, the individual police officers are representing individual cells. When they work together to carry out the same role this is representing tissues. When the units work together within a police force this is representing various tissues working together as an organ. When various police forces work together as the UK Police, this represents an organ system. The organism could be discussed as being similar to all the international police forces working together. Students should identify flaws in the analogy. For example, there not being the same number of organisation levels as within the body (which is five); the police officers are all the same in terms of their structure (ignoring differences in appearances and characteristics) whereas cells can have completely different structures to suit their roles (e.g. nerve cells and red blood cells); and the police officers within a unit may have slightly different roles, or attend different jobs, whereas all the cells in a tissue carry out the same function.

*Please refer to the generic guidance on pp 7–8 on how to use the following ACE Learning Ladder.*

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## BIOLOGY 1: TEACHER'S NOTES THE HIERARCHY OF CELLS

### ACE LEARNING LADDER

Performance	Students may:
<b>Advanced</b>	<ul style="list-style-type: none"> <li>• Explain in detail how the police force analogy explains the hierarchical organisation of cells.</li> <li>• Explain the limitations of the police force analogy compared to the actual hierarchical organisation of cells.</li> <li>• Explain how the analogy could be improved or suggest and explain your own model for hierarchical organisation of cells.</li> </ul>
<b>Confident</b>	<ul style="list-style-type: none"> <li>• Describe how the police force analogy represents the hierarchical organisation of cells.</li> <li>• Describe the differences between the police force analogy and the actual hierarchical organisation of cells.</li> <li>• Describe how the analogy could be improved.</li> </ul>
<b>Establishing</b>	<ul style="list-style-type: none"> <li>• Match the parts of the police force analogy to the key parts of the hierarchical organisation of cells.</li> <li>• State one problem with the analogy.</li> <li>• State how the analogy can be improved.</li> </ul>

# BIOLOGY 1: STIMULUS SHEET

## THE HIERARCHY OF CELLS

I am a police officer.  
My colleagues and I all  
make up the emergency  
response unit.  
Our job is to answer  
emergency calls.



I am a police officer too.  
My colleagues and I all  
work on the dog unit. We  
use dogs to find people  
and property.



All our units  
work together for  
Southtown Police  
Force. We protect  
the people of  
Southtown.

I am a police officer  
too. My colleagues  
and I work for the  
investigation unit  
as detectives.  
Our job is to solve  
serious crimes.



Southtown Police Force  
work alongside all the other  
Police Forces in the UK to  
protect the country. I think  
that all together we are like  
cells in the body. What do  
you think?

### POSSIBLE KEYWORDS TO USE:

cell, different, level, organ, organ system, organisation, role, similar, tissue

# 1

## BIOLOGY 1: DISCUSSION STARTERS THE HIERARCHY OF CELLS

### What does the analogy describe or explain?

- I think each police officer would represent...
- I think the special units (e.g. the dog unit) represent...
- All the police officers in each unit do the same job, this is important because...
- I think Southtown Police Force could represent...
- I think all the UK Police Forces together could represent...

### What are the limitations of the analogy?

- The analogy has four levels of organisation. This is/is not the same as in the body because...
- Using police officers as an analogy to explain how cells are arranged in the body is good because...
- Using police officers as an analogy to explain how cells are arranged in the body is not good because...

### How could the analogy be improved?

- The analogy could be improved by...
- I would adapt the analogy by ...
- A better analogy would be...
- I would improve the analogy by...