
BEST STEPS GCSE:

Student Transitions to Enable Progress in Science

Biology

- *Provision of cell requirements*
- *Movement across membranes*
- *Interdependence and population change*
- *Role of microorganisms in decomposition*
- *Mitosis*
- *Antibodies*
- *Factors affecting phenotype*
- *Natural selection*

By Elizabeth Lupton



Welcome to **BEST STEPS**...

How to use the BEST STEPS GCSE resource:

BEST STEPS (Student Transitions to Enable Progress in Science) GCSE consists of a set of teaching progressions for biology, chemistry and physics. These use diagnostic questions from the Best Evidence Science Teaching (BEST) Project and GCSE examination questions to check student understanding of some key scientific concepts.

BEST STEPS GCSE facilitates an individualised approach by using formative assessment to identify the educational needs of students. This enables support to be provided to some students to address gaps in their understanding. Extension material may be offered to those students identified as having secure understanding, to ensure that they are not held back. Appropriate extension material could involve the application of understanding of a key concept to an unfamiliar context.

All GCSE subject content in this resource has been taken from the Department for Education subject guidelines (upon which all specifications in England are based), meaning that this resource is suitable for all GCSE specifications. The topics selected are studied by all students regardless of tier and are required for both combined science and triple science specifications. However, the science concepts developed are universal, so the resource can also be used to support students studying for equivalent qualifications in other countries.

Introducing the Best Evidence Science Teaching (BEST) resources:

Best Evidence Science Teaching (BEST) is a collection of free research evidence-informed resources for effective teaching of difficult ideas, embedded formative assessment and adaptive lesson planning. It is initially focused on science at ages 11-14, although new materials are now being written to extend BEST to support students aged 11-16.

Research evidence-informed progression toolkits for key concepts in science are available [free to download](#) from the BEST website.

Each progression toolkit includes:

- appropriately-sequenced learning steps;
- diagnostic questions that provide evidence of learning and of common misunderstandings; and
- response activities that promote purposeful practical work, metacognition and conceptual progression.

If you are unfamiliar with the BEST resources, a short introduction [may be downloaded](#) from the BEST website here. You may also find it helpful to watch an introductory webinar on the project - "Introduction to Best Evidence Science Teaching (BEST)" - which can be found in the "Secondary (11-19) science education" section [here on the ASE website](#).



Welcome to **BEST STEPS...**

Guidance on each key concept, research summaries, more diagnostic questions and accompanying response activities may be downloaded from:
<https://www.stem.org.uk/best-evidence-science-teaching>

How to use the BEST STEPS GCSE resource:

The eight topics may be used in any order so use the topics in the order that works best for your students. The resource provides a sequence of three questions for each topic, which together develop conceptual understanding of a key concept. Give your students the introductory question to start with. If students are successful, give them the next question. If students have not grasped the introductory level idea, provide additional material or teaching that will develop their understanding, before continuing to the next question in the progression. Use the final GCSE question to check that your students can apply their conceptual understanding at GCSE level.

How to navigate the Best Evidence Science Teaching (BEST) resources

For your convenience, the BEST diagnostic questions used in these progressions are hyperlinked from each topic page - just click on the question image.

The BEST resources are categorised into “big ideas”, with the “big ideas” in biology being:

- *The cellular basis of life (BCL)*
- *Heredity and life cycles (BHL)*
- *Organisms and their environments (BOE)*
- *Variation, adaptation and evolution (BVE)*
- *Health and disease (BHD)*

Use the three letter codes to help you navigate the full set of resources [on the BEST website](#). Here you will find response activities for each diagnostic question used in used in BEST STEPS GCSE 11-14 subject maps and much more.

Using the GCSE questions

Clicking on the image of each GCSE question will bring up a word version of the question, guidance on how this can help to identify gaps in your students' understanding and the official mark scheme.

Acknowledgments

All BEST resources are free to download thanks to the support of the [Salters' Institute](#) and a partnership with [STEM Learning](#). ASE is grateful to [OCR](#) for permission to use its questions in this resource.



Provision of cell requirements

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Introducing...

BEST Key concept BCL2.1: Working together

The cells of multicellular organisms are organised into tissues, organs and organ systems that work together to keep the cells alive.

Consolidating...

BEST Key concept BCL2.2: Supplying cells: the human circulatory, digestive and gas exchange system

Human life depends upon the tissues and organs of the circulatory, digestive and gas exchange systems working together to support the life processes of the cells from which we are made.

Securing...

GCSE Subject content: Human circulatory system

The human circulatory system is composed of the heart and blood vessels along with the gaseous exchange system. It enables cells to be provided with the substances required.

BEST STUDENT WORKSHEET

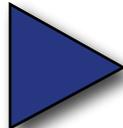
Cells, tissues and organs

The bodies of humans are made up of cells, tissues, organs and organ systems.

Read the information in the table.

Use evidence for each statement.

Statements	Can be made up of cells	Can be made up of tissues	Can be made up of organs	Can be made up of organ systems
1. Multicellular organs that make up the skeleton.				
2. Cells, tissues and organs are brought into the body.				
3. Tissues are made up of cells.				
4. Organs are made up of tissues.				
5. Some organs are made up of tissues.				
6. There are different organs.				

BEST STUDENT WORKSHEET

Brain cell

Oxygen



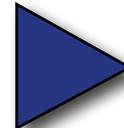
A human brain is made up of billions of cells. How can it be sure each cell gets oxygen to keep alive and function?

1. How does each cell in the brain get oxygen?

- It is made for each organ.
- It takes oxygen from the air.
- It takes oxygen from the lungs.
- It takes oxygen from the blood.

2. How does the oxygen get from the air to each cell?

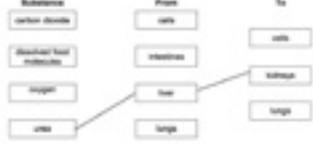
- The large airways bring air to the bronchioles.
- The circulatory system carries oxygen from air to the lungs to all cells in the body.
- Oxygen is made by photosynthesis.
- Oxygen is carried through the body to all of the cells.



1 The human circulatory system transports substances from place to place within the body. Use straight lines to complete the diagram showing where the listed substances are moved from and to in the human body.

Some boxes may have more than one line drawn to them. Two lines have been drawn for you.

Substance	From	To
Carbon dioxide	cells	cells
Glucose from the intestine	intestines	intestines
Oxygen	lungs	intestines
Water	lungs	lungs





Movement across membranes

Guidance on each key concept, research summaries, more diagnostic questions and accompanying response activities may be downloaded from: <https://www.stem.org.uk/best-evidence-science-teaching>

Introducing...

BEST Key concept BCL1.2:
Cells and cell structure

Organisms are made up of one or more cells, which have common structures that carry out life processes.

Consolidating...

BEST Key concept BCL 1.4:
Diffusion and the cell membrane

Molecules move through the cell cytoplasm by diffusion, and some molecules can enter and leave a cell by diffusing through the cell membrane.

Securing...

GCSE Subject content:
Movement across membranes

Substances are transported into and out of cells through diffusion, osmosis and active transport.

BEST Student worksheet

A single cell can...



The drawing shows a single cell.
Parts of the cell have been cut away so that you can see inside the cell and its structure.

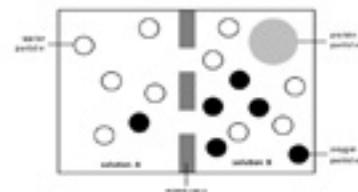
Look at the statements in the table.
Put a tick (✓) for each statement to show whether you think it's right or wrong.

Statements	I am sure this is right	I think this is right	I think this is wrong	I am sure this is wrong
1. A single cell can take in food and other substances.				
2. A single cell can get energy from food.				
3. A single cell can get rid of waste.				
4. A single cell can make new cells.				
5. A single cell can respond to its surroundings.				
6. A single cell is a living thing.				

BEST Student worksheet

Across the membrane

The diagram shows the particles of two solutions.
There is a selectively permeable membrane between the two solutions.



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.

2. How would you explain your answer to question 1?
 A. The membrane is permeable.
 B. Protein particles can only travel in solution B.
 C. There is a concentration gradient.
 D. Protein particles are too big to move through the membrane.

4. Energy from cellular respiration can be used to transport molecules across cell membranes.
What is the name of this process?
Tick (✓) one box.
Active transport
Diffusion
Osmosis
Transpiration



Interdependence and population

Guidance on each key concept, research summaries, more diagnostic questions and accompanying response activities may be downloaded from: <https://www.stem.org.uk/best-evidence-science-teaching>

Introducing...

BEST Key concept BOE1.1: Food chains and food webs

Feeding relationships within a community of organisms can be modelled using food chain and food web diagrams.

Consolidating...

BEST Key concept BOE2.1: Ecosystem components and dynamics

The environmental conditions in different ecosystems, and in different parts of an ecosystem, affect and are affected by the organisms that live there.

Securing...

GCSE subject content: Levels of organisation within an ecosystem

Interdependence and competition are important in a community.

BEST STUDENT WORKSHEET

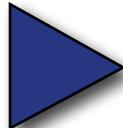
How many organisms?

Lucy made the food chain diagram.



4 chosen feeding relationships in Lucy's garden.

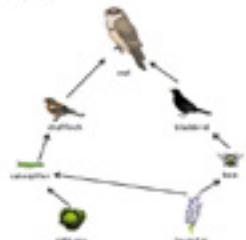
- How many caterpillars are there in Lucy's garden?
 - A. One
 - B. At least one
 - C. We cannot tell from the diagram.
- What is the best explanation for your answer to question 1?
 - A. Each stage in the food chain diagram is a population.
 - B. Each stage in the food chain diagram is an individual organism.
 - C. The diagram shows one caterpillar.
 - D. Lucy might not have counted all of the caterpillars.



BEST STUDENT WORKSHEET

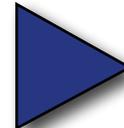
Through the food web

Look at the food web diagram.

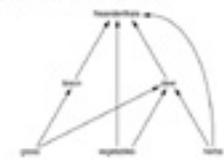


- Imagine if the Neanderthal died. Some children have suggested possible effects of the Neanderthal dying out. How do you feel about each suggestion?

Suggestion	I am sure this is right	I think this is right	I think this is wrong	I am sure this is wrong
1. The number of bees could decrease.				
2. The number of Neanderthals could decrease.				
3. The number of rabbits could decrease.				
4. The number of caterpillars could increase.				



4. The diagram shows part of a Neanderthal's food web.



The size of the deer population increases rapidly.

Explain what effect this could have on the size of the Neanderthal population.

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.....

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Role of microorganisms in decomposition

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Introducing...

**BEST Key concept BOE2.1:
Ecosystem components and dynamics**

The environmental conditions in different ecosystems, and in different parts of an ecosystem, affect and are affected by the organisms that live there.

Consolidating...

**BEST Key concept BOE2.1:
Ecosystem components and dynamics**

The environmental conditions in different ecosystems, and in different parts of an ecosystem, affect and are affected by the organisms that live there.

Securing...

**GCSE Subject content:
The principle of material cycling**

Microorganisms play a large role in the cycling of materials through an ecosystem.

BEST STUDENT WORKSHEET

Starter for ten



Write down the 10 things you think will happen when you throw off a log.

	Word
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

BEST STUDENT WORKSHEET

What happens next?



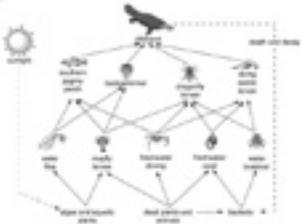
A dead tree is lying on the ground.

Part 1

Which statement best describes what will happen to the dead tree? (Choose **one**.)

- A. It will disappear.
- B. It will break down naturally.
- C. It will be broken down by insects crawling through it.
- D. It will be broken down by microorganisms.
- E. It will be broken down by fungi and bacteria.

4. Look at the food web.



When a platypus dies it decomposes. The decomposing platypus helps the other organisms in this food web. Use the food web to explain how.

[2]



Mitosis

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Introducing...

BEST Key concept BHL 2.2: Life cycles

Plants and animals go through a series of changes during their lifetime, including stages of growth, development and reproduction to make new plants and animals; together these stages can be described as a life cycle.

Consolidating...

BEST Key concept BHL2.1: Growth

The process of growth takes place in all living multicellular organisms when existing cells divide to make new cells.

Securing...

GCSE Subject content: Growth and development of cells

Growth occurs as a result of mitosis, which is a part of the cell cycle.

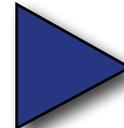
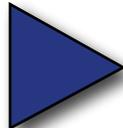
BEST Best Evidence Science Teaching

Plant growth

The picture shows a plant growing.

What do you think makes the growth happen?

- A. Division of cells.
- B. Multiplication of cells.
- C. Enlargement of cells.
- D. Enlargement and division of cells.



BEST Best Evidence Science Teaching

Cell division

New cells are made from existing cells. This is called cell division.

Which diagram best represents cell division?

6. The cell cycle consists of two stages, cell growth and cell division.

Put ticks (✓) in four boxes to indicate when the processes occur.

Process	Cell growth	Cell division
nucleus splits into two	<input type="checkbox"/>	<input type="checkbox"/>
numbers of organelles increase	<input type="checkbox"/>	<input type="checkbox"/>
chromosomes are copied	<input type="checkbox"/>	<input type="checkbox"/>
copies of the chromosomes separate	<input type="checkbox"/>	<input type="checkbox"/>



Antibodies

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Introducing...

BEST Key concept BHD1.2: Disease

The good health of organisms can be compromised by infectious and non-infectious diseases, which can be caused by germs, lifestyle, environment, or information in the genome.

Consolidating...

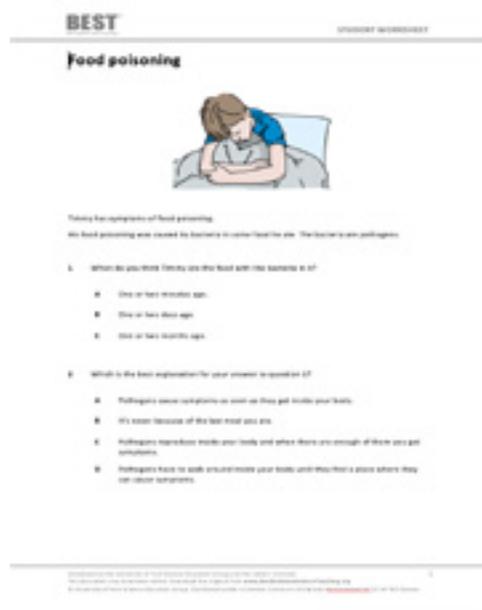
BEST Key concept BHD3.1: Pathogens

The health of humans, other animals and plants can be affected by infection with pathogens, including viruses and some bacteria and fungi.

Securing...

GCSE Subject content: Communicable diseases

The immune system of the human body has an important role in defence against disease.





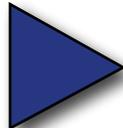
Factors affecting phenotype

Guidance on each key concept, research summaries, more diagnostic questions and accompanying response activities may be downloaded from: <https://www.stem.org.uk/best-evidence-science-teaching>

Introducing...

BEST Key concept BHL 1.1: Hereditary and genetic information

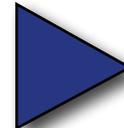
Similarities and differences between family members can be explained by the passing of genetic information from one generation to the next and the effects of the interaction of organisms with their environment.



Consolidating...

BEST Key concept BHL 1.2: The structure and function of the genome

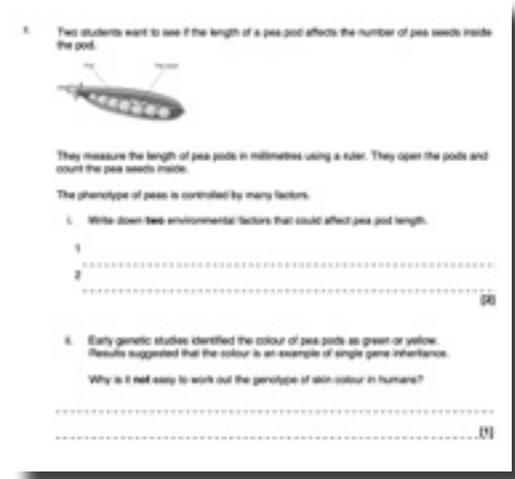
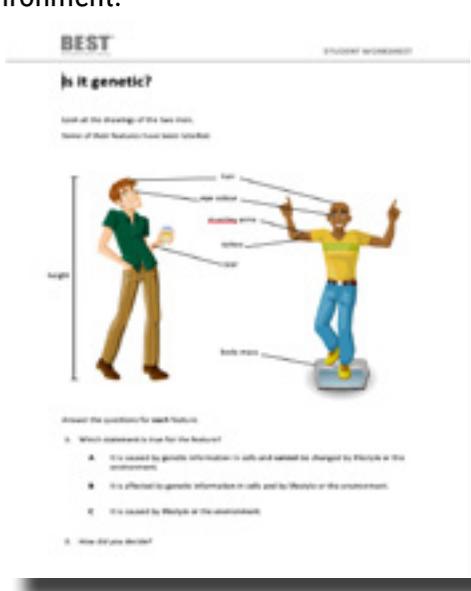
The structure and function of organisms depend on proteins made by cells using instructions stored in the DNA of the genome.



Securing...

GCSE Subject content: The genome and gene expression

The genome and its interaction with the environment influence the phenotype of an organism.





Natural selection

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Introducing...

BEST Key concept BVE1.1: Differences within species

There is variation between individuals of the same species, caused by differences in the genomes, lifestyles and environments of the individuals.

Consolidating...

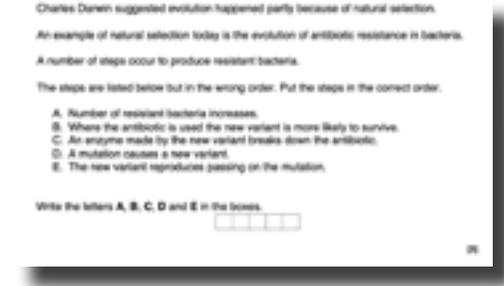
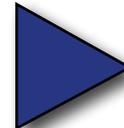
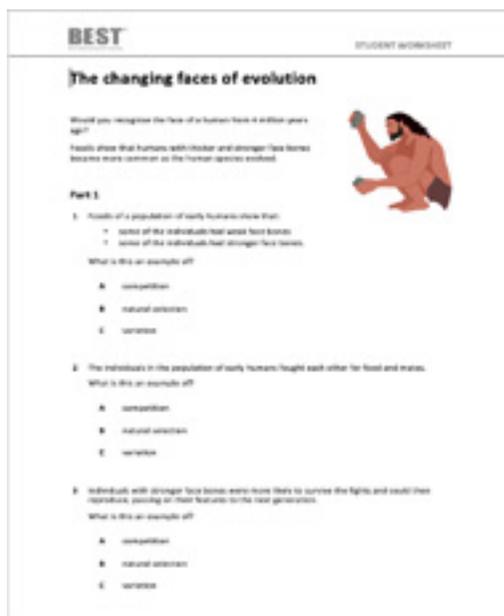
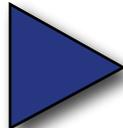
BEST Key concept BVE3.1: Adaptation and evolution

The characteristics of a species can change over generations as advantageous adaptations become more common; this is evolution, and can be explained by a process of natural selection.

Securing...

GCSE Subject content: Variation and evolution

Evolution is the change in inherited characteristics of a population over time through a process of natural selection (this process may result in the formation of a new species).



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