

Biology

Big idea (age 11-14)

BVE: Variation, adaptation and evolution

What's the big idea?

There is a great diversity of organisms, living and extinct, with many similarities and differences between them. Differences between organisms cause species to evolve by natural selection of individuals better adapted to compete for limited resources when environmental conditions change, and the passing of advantageous heritable characteristics to subsequent generations. The diversity of organisms is the result of evolution by natural selection.

Key concepts

The big idea is developed through a series of **key concepts** at age 11-14, which have been organised into teaching topics as follows:

<p>Topic BVE1 Variation</p> <p>Key concepts:</p> <p>BVE1.1 Differences within species</p> <p>BVE1.2 Changes in species over time – fossil evidence</p>	<p>Topic BVE2 Classification</p> <p>Key concepts:</p> <p>BVE2.1 Identifying and classifying organisms</p>	<p>Topic BVE3 Evolution</p> <p>Key concepts:</p> <p>BVE3.1 Explaining evolution</p>
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The numbering gives some guidance about teaching order based on research evidence on learning pathways and effective sequencing of ideas. However, the teaching order can be tailored for different classes as appropriate.

Guidance notes

Students should be familiar with the ideas developed in key concept BHL1.1 *Heredity and genetic information* before exploring the key concepts of variation, adaptation and evolution.

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Learning progression

The science story associated with the big idea develops from age 5 to age 16, and could be summarised as follows:

Science story at age 5-11

Variation

There are many different kinds of organisms in the world, including animals, plants, fungi and bacteria. There are differences between animals and plants, and between different types of animals and different types of plants.

Many kinds of animals and plants that once lived have now died out and become extinct. We know about these organisms from fossils.

Classification

Similarities and differences between organisms enable us to classify them into groups. A species can be defined as a group of organisms that can breed to produce fertile offspring.

Adaptation and evolution

Different kinds of animals and plants live in different habitats that provide for their needs. Most organisms live in habitats to which they are adapted. Organisms that are poorly adapted to their environment may die out and become extinct.

Fossils provide evidence about organisms that lived and died tens of thousands to billions of years ago. There are similarities and differences in the features of fossilised organisms and organisms that are alive today.

The characteristics of groups of organisms change over time, and this is called evolution.

Science story at age 11-14

Variation

There is variation between individual organisms of the same species, which can be described as continuous or discontinuous. Variation can be caused by differences in the genome, lifestyle and interactions with the environment. Only variation caused by differences in the genome can be inherited.

The fossil record provides evidence that the characteristics of species change over time, and that many species that once existed are now extinct. The fossil record is incomplete, and there are limitations to the conclusions that can be drawn from it.

Classification

Keys can be used to identify organisms in the lab and in the field according to their observable characteristics.

Organisms can be classified into hierarchical groups based on observable common characteristics and differences.

Adaptation and evolution

There is competition between individuals of the same species for limited resources that are essential for survival.

Variation between individuals means that some individuals are better adapted to compete, and some are less well adapted. Individuals that are better adapted are more likely to survive to reproduce, and may pass on their advantageous characteristics to their offspring. This process of natural selection can cause the common characteristics of a species to change, and thus the species to evolve, over a number of generations.

The great diversity of organisms, living and extinct, is the result of evolution by natural selection.

Science story at age 14-16

Variation

There is usually genetic variation (differences in the coding and non-coding regions of the genome of individuals) within a population of a species. Differences can arise from genetic recombination (the production of offspring with different combinations of chromosomes than their parents) and from mutations that create genetic variants (differences in the sequence of bases).

Classification

Organisms can be classified into a hierarchical structure of groups, including domains, kingdoms and species.

Adaptation and evolution

Evolution occurs through the natural selection of genetic variants that give rise to phenotypes better adapted to their environment, which confer a competitive advantage. Thus, by natural selection, the proportion of individuals possessing beneficial genetic variants increases in subsequent generations.

Evolution by natural selection may result in the formation of new species. A new species can arise if the organisms in a population evolve to be so different from their ancestors that they could no longer mate with them to produce fertile offspring. Speciation is more likely to occur when two populations of an organism are isolated.

The theory of evolution by natural selection was developed to explain observations made by Darwin, Wallace and other scientists, including: the production of new varieties of plants and animals with beneficial characteristics by selective breeding (Darwin wondered whether a similar process of selection in nature could have created new species); fossils with similarities and differences to living species; and the different characteristics shown by isolated populations of the same species living in different ecosystems.

The development of the theory is an example of how scientists develop explanations. Darwin: made observations of the natural world; suggested natural selection to explain differences between fossils and living organisms, and between isolated populations; used ideas from Wallace and other scientists to improve his explanation; and shared his explanation with the scientific community. It also illustrates how scientists continue to test a proposed explanation by making new observations and collecting new evidence, and how if the explanation is able to explain these it can become widely accepted by the scientific community. New observation such as the spread of antibiotic resistance in bacteria can be explained using ideas about mutation, advantage and natural selection.

Most scientists accept the modern theory of evolution because it is the best explanation for many of our observations of the natural world. However, some people do not accept it either because they are unaware of (or do not understand) the evidence, or because it does not fit with their beliefs.