

## 5.1: Evidence for Evolution

**ESSENTIAL IDEA:** There is overwhelming evidence for the evolution of life on Earth.

### NATURE OF SCIENCE:

1. Looking for patterns, trends, and discrepancies--there are common features in the bone structure of vertebrate limbs despite their varied use.

### THEORY OF KNOWLEDGE:

Evolutionary history is an especially challenging area of science because experiments cannot be performed to establish past events or their causes. There are nonetheless scientific methods of establishing beyond reasonable doubt what happened in some cases. How do these methods compare to those used by historians to reconstruct the past?

### UNDERSTANDINGS, APPLICATIONS, and SKILLS

DCS Topic Code	Statement	Guidance
5.1U1	Evolution occurs when heritable characteristics of a species change.	
5.1U2	The fossil record provides evidence for evolution.	
5.1U3	Evolution of homologous structures by adaptive radiation explains similarities in structure when there are differences in function.	
5.1U4	Populations of a species can gradually diverge into separate species by evolution.	
5.1U5	Continuous variation across the geographical range of related populations matches the concept of gradual divergence.	

## 5.2: Natural Selection

**ESSENTIAL IDEA:** There is overwhelming evidence for the evolution of life on Earth.

**NATURE OF SCIENCE:**

Use theories to explain natural phenomena: the theory of evolution by natural selection can explain the development of antibiotic resistance in bacteria

**THEORY OF KNOWLEDGE:**

Natural selection is a theory. How much evidence is required to support a theory and what sort of counter evidence is required to refute it?

### UNDERSTANDINGS, APPLICATIONS, and SKILLS

DCS Topic Code	Statement	Guidance
5.2U1	Natural selection can only occur if there is variation amongst members of the same species.	
5.2U2	Mutation, meiosis, and sexual reproduction cause variation between individuals in a species.	
5.2U3	Adaptations are characteristics that make an individual suited to its environment and way of life.	Characteristics acquired during the lifetime of an individual are not heritable.
5.2U4	Species tend to produce more offspring than the environment can support.	
5.2U5	Individuals that are better adapted tend to survive and produce more offspring while the less well adapted tend to die or produce fewer offspring.	
5.2U6	Individuals that reproduce pass on characteristics to their offspring.	
5.2U7	Natural selection increases the frequency of characteristics that make individuals better adapted and decreases the frequency of other	

	characteristics leading to changes within the species.	
5.2A1	Changes in beaks of finches on Daphne Major	
5.2A2	Evolution of antibiotic resistance in bacteria	

### 5.3: Classification of biodiversity

**ESSENTIAL IDEA:** Species are named and classified using an internationally agreed system.

#### NATURE OF SCIENCE:

Cooperation and collaboration between groups of scientists--scientists use the binomial system to identify a species rather than the many different local names.

#### THEORY OF KNOWLEDGE:

The adoption of a system of binomial nomenclature is largely due to Swedish botanist and physician Carolus Linnaeus (1707-1778). Linnaeus also defined four groups of humans and the divisions were based on both physical and social traits. By 21st Century standards, his descriptions can be regarded as racist. How does the social context of scientific work affect the methods and findings of research? Is it necessary to consider the social context when evaluating ethical aspects of knowledge claims?

### UNDERSTANDINGS, APPLICATIONS, and SKILLS

DCS Topic Code	Statement	Guidance
5.3U1	The binomial system of names for species is universal among biologists and has been agreed and developed at a series of congresses.	
5.3U2	When species are discovered they are given scientific names using the binomial system.	
5.3U3	Taxonomists classify species using a hierarchy of taxa.	
5.3U4	All organisms are classified into three domains.	Archaea, eubacteria, and eukaryote should be used for the three domains. Members of these domains are referred to as archaeans, bacteria and eukaryotes.
5.3U5	The principal taxa for classifying eukaryotes are kingdom, phylum, class, order, family, genus, and species.	

5.3U6	In a natural classification, the genus and accompanying higher taxa consist of all the species that have evolved from one common ancestral species.	
5.3U7	Taxonomists sometimes reclassify groups of species when new evidence shows that a previous taxon contains species that have evolved from different ancestral species.	
5.3U8	Natural classifications help in identification of species and allow the prediction of characteristics shared by species within a group.	
5.3A1	Classification of one plant and one animal species from domain to species level	
5.3A2	Recognition of features of bryophyta, filicinophyta, coniferophyta and angiospermophyta	Students should know which plant phyla have vascular tissues.
5.3A3	Recognition of features of porifera, cnidaria, platyhelmintha, annelida, mollusca, arthropoda and chordata.	Focus on primary features that are most useful for distinguishing groups from each other.
5.3A4	Recognition of features of birds, mammals, amphibians, reptiles, and fish	
5.3S1	Construction of dichotomous keys for use in identifying specimens	Viruses are not classified as living.

#### 5.4: Cladistics

**ESSENTIAL IDEA:** The ancestry of groups of species can be deduced by comparing their base or amino acid sequences.

#### **NATURE OF SCIENCE:**

Falsification of theories with one theory being superseded by another--plant families have been reclassified as a result of evidence from cladistics.

#### **THEORY OF KNOWLEDGE:**

A major step forward in the study of bacteria was the recognition in 1977 by Carl Woese that Archaea have a separate line of evolutionary descent from bacteria. Famous scientists, including Luria and Mayr, objected to his division of the prokaryotes. To what extent is conservatism in science desirable?

#### UNDERSTANDINGS, APPLICATIONS, and SKILLS

DCS Topic Code	Statement	Guidance
5.4U1	A clade is a group of organisms that have evolved from a common ancestor.	
5.4U2	Evidence for which species are part of a clade can be obtained from the base sequences of a gene or the corresponding amino acid sequence of a protein.	
5.4U3	Sequence differences accumulate gradually so there is a positive correlation between the number of differences between two species and the time since they diverged from a common ancestor.	
5.4U4	Traits can be analogous or homologous	
5.4U5	Cladograms are tree diagrams that show the most probable sequence of divergence in clades.	

5.4U6	Evidence from cladistics has shown that classifications of some groups based on structure did not correspond with the evolutionary origins of a group or species.	
5.4A1	Cladograms including humans and other primates	
5.4A2	Reclassification of the figwort family using evidence from cladistics	
5.4S1	analysis of cladograms to deduce evolutionary relationships	