Keystone Biology Remediation

B3: Theory of Evolution

Assessment Anchors:

- to explain how natural selection can impact allele frequencies of a population (B.3.1.1)
- to describe the factors that can contribute to the development of a new species (e.g. isolating mechanisms, genetic drift, founder effect, migration) (B.3.1.2)
- to explain how genetic mutations may result in genotypic and phenotypic variations within a population (B.3.1.3)
- to interpret evidence supporting the theory of evolution (i.e. fossil, anatomical, physiological, embryological, biochemical, and universal genetic code) (B.3.2.1)
- to distinguish between the scientific terms: hypothesis, inference, law, theory, principle, fact, and observation (B.3.3.1)

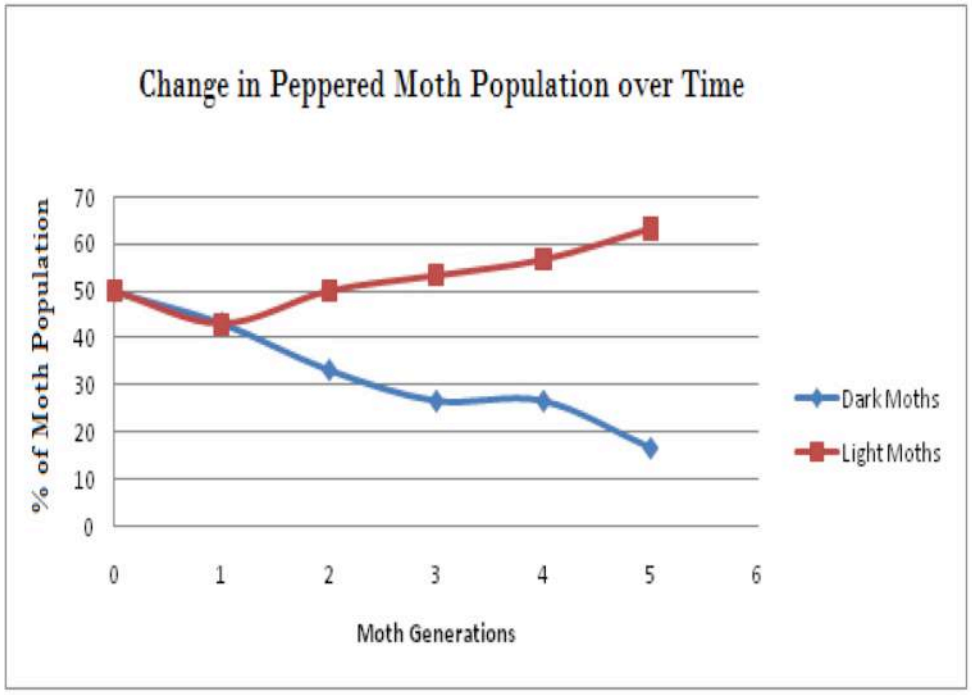
Unit Vocabulary:

allele frequency	genetic drift	observation
analogous structure	gradualism	principle
embryology	homologous structure	punctuated equilibrium
endosymbiosis	hypothesis	science
evolution	inference	speciation
extinction	isolating mechanism	species
fact	law	theory
fossils	migration (genetic)	vestigial structure
founder effect	natural selection	

Assessment Anchor: Explain how natural selection can impact allele frequencies of a population (B.3.1.1)

Evolution is a change is the **allele frequencies** of a population over time. The primary mechanism that drives evolution is **natural selection**. *Industrial melanism* is the term used to describe the adaptation of an organism is response to industrial pollution. One example of rapid industrial melanism occurred in the peppered moth, *Biston betularia*, in the area of Manchester, England from 1845 to 1890.

Before the Industrial Revolution, the trees in the forest around Manchester were light grayish-green due to the presence of lichens on their trunks. Almost all of the peppered moths that lived in the area were light with dark spots. Their coloring served as camouflage against the birds that were their predators. Lichens are very sensitive to pollution and died as a result of the sulfur dioxide being released into the air. As the Industrial Revolution progressed, the lichens living on the trees died revealing the dark bark on the trunks below. Over a period of 45 years, the peppered moth became a predominantly dark species, with only a few light-colored individuals remaining.

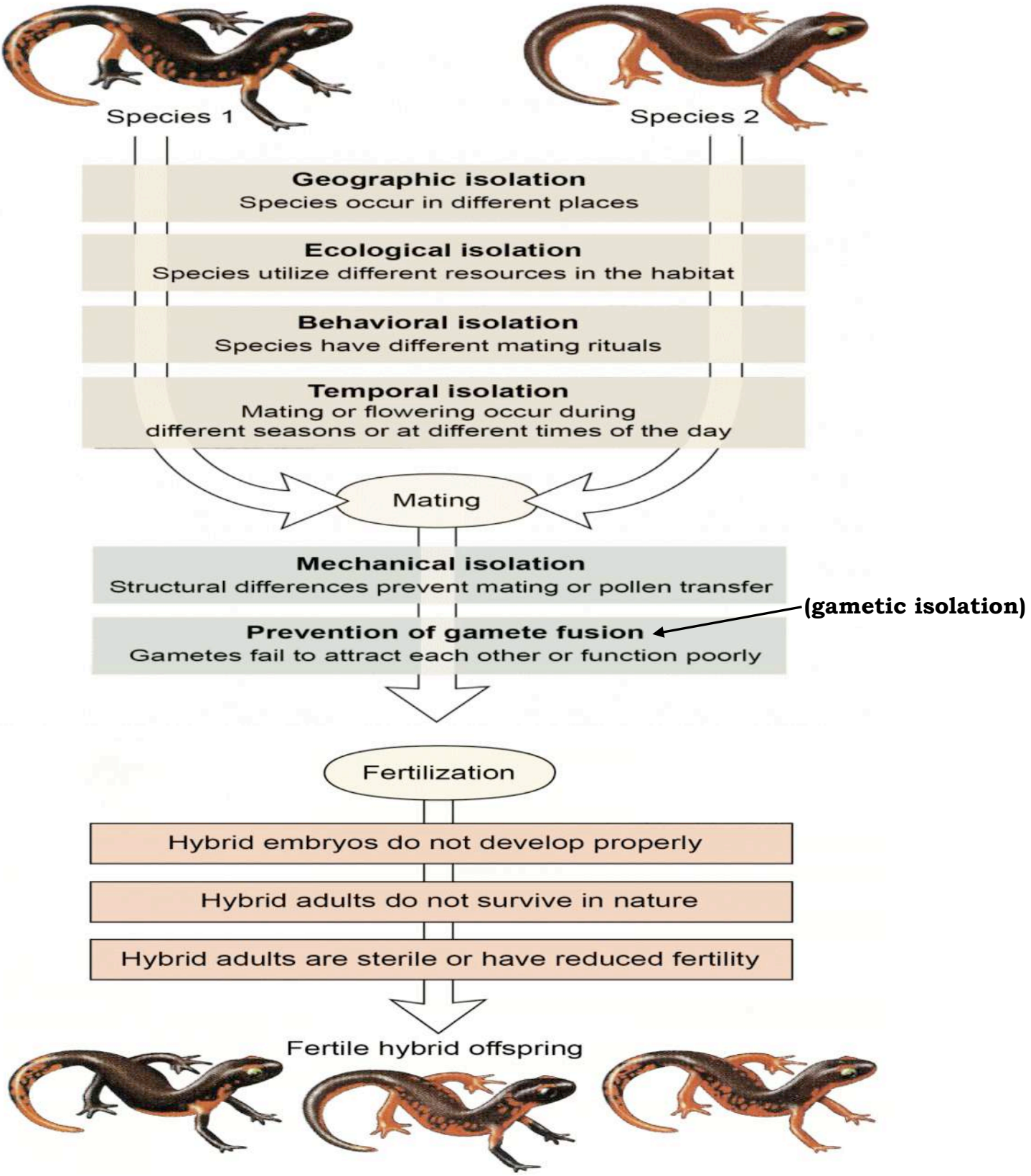


Principles of Natural Selection:

- Organisms produce more offspring than their environments can support. Not all individuals in a population survive.
- Individuals vary in phenotype. Some are better able to survive in their environment than others. (Some are more **fit**.)
- The more fit individuals will live longer, reproduce more, and pass on the beneficial alleles to their offspring.
- The ability of some organisms, with certain alleles, to survive and produce more offspring will lead to a change in **allele frequency** in the population. Over time, more individuals will have the "helpful" alleles.

Assessment Anchor: Describe the factors that can contribute to the development of a new species (e.g. isolating mechanisms, genetic drift, founder effect, migration) (B.3.1.2)

Isolating Mechanisms



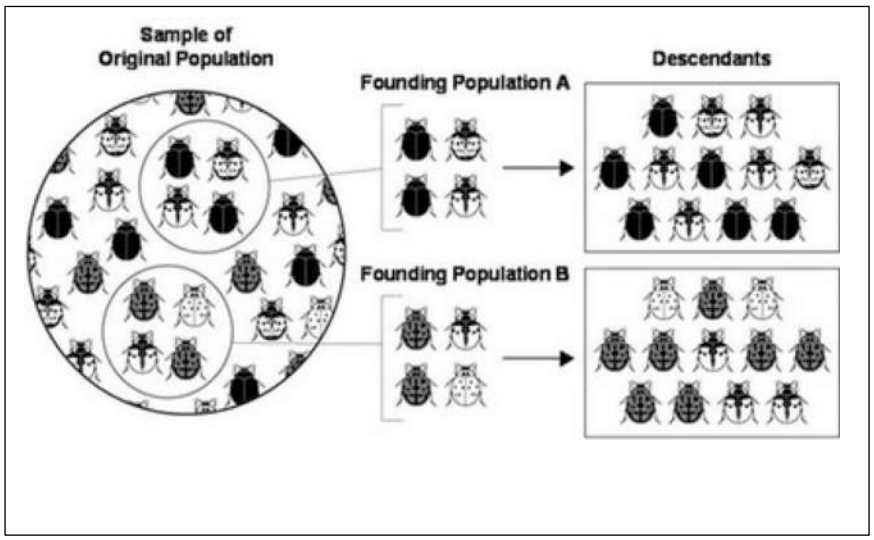
There are four basic mechanisms of evolutionary change:

1. **natural selection**: see B.3.1.1

2. **mutation**: see B.3.1.3

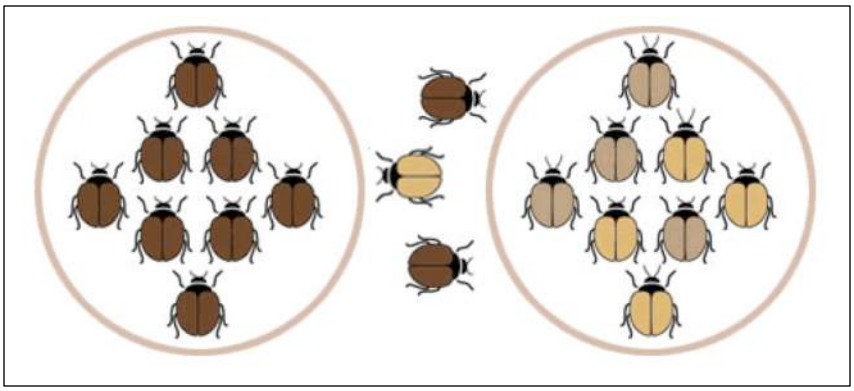
3. **genetic drift**: *random* changes in allele frequencies that occur in small populations due to *chance* events, an example of which is **founder effect**

   founder effect: genetic drift that occurs when a few individuals become isolated from a larger population, with the result that the new population's gene pool is not reflective of the original population



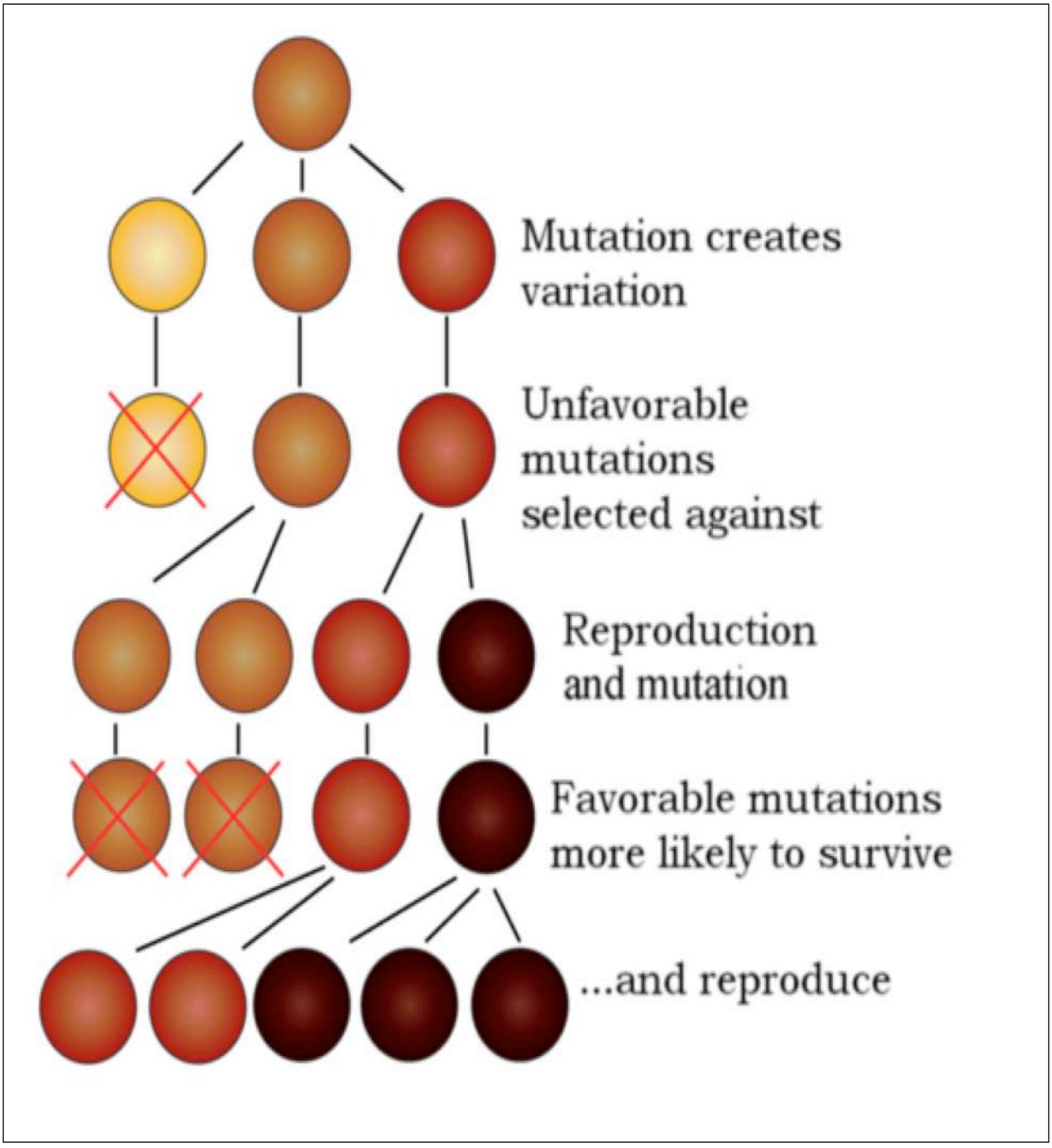
Compare Population A and Population B to the original population. The allele frequencies of the new populations are distinctly different than the original population. However, the reason for this is not natural selection, but simply the chance event that some alleles were not represented in the founding populations.

4. **gene flow** (**migration**): the movement of individuals into or out of a population. These individual bring their alleles with them possibly resulting in the gain or loss of particular alleles. This would affect the allele frequencies of a small population more than a large one.



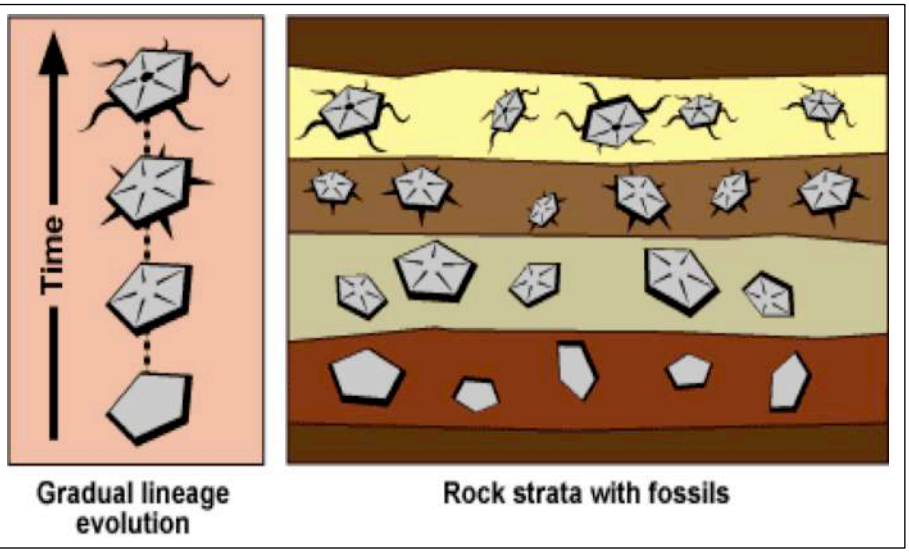
As individuals move from one population to another, new alleles are introduced into each population.

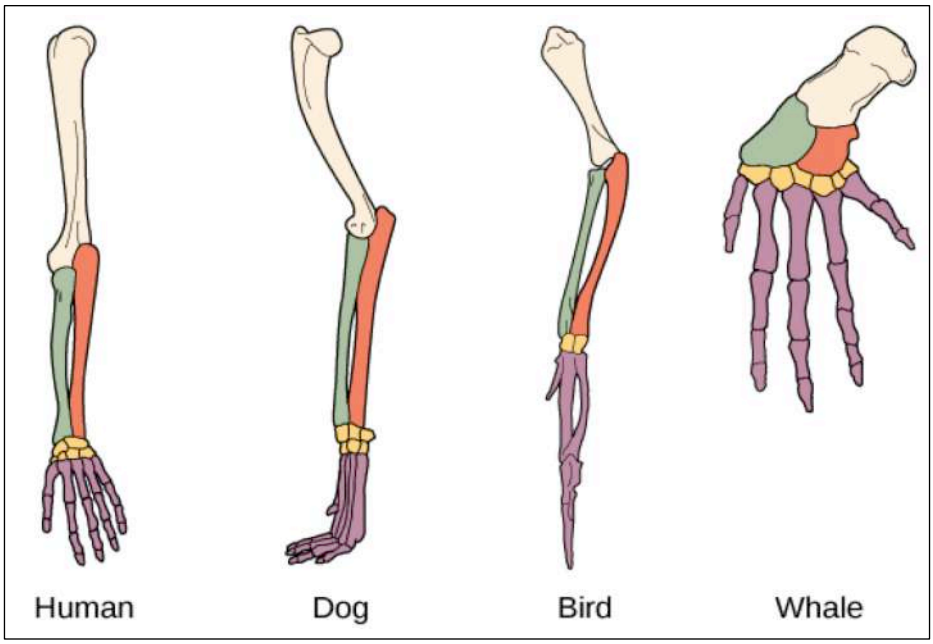
Assessment Anchor: Explain how genetic mutations may result in genotypic and phenotypic variations within a population (B.3.1.3)



Assessment Anchor: Interpret evidence supporting the theory of evolution (i.e. fossil, anatomical, physiological, embryological, biochemical, and universal genetic code) (B.3.2.1)

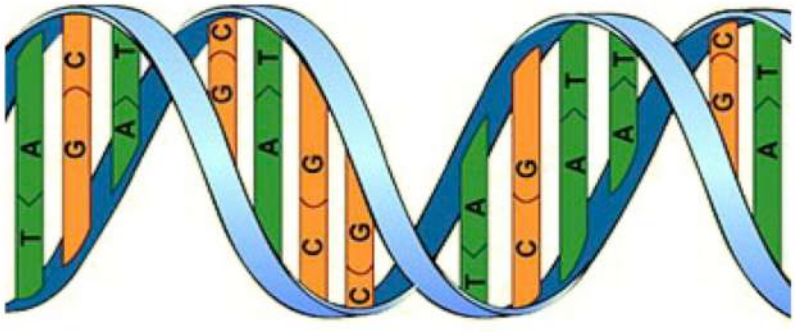
Fossils: are only formed under very specific circumstances where the organism or part of the organism is preserved (like in ice). Fossils can give us some indication of what the ancestors to current organisms looked like.

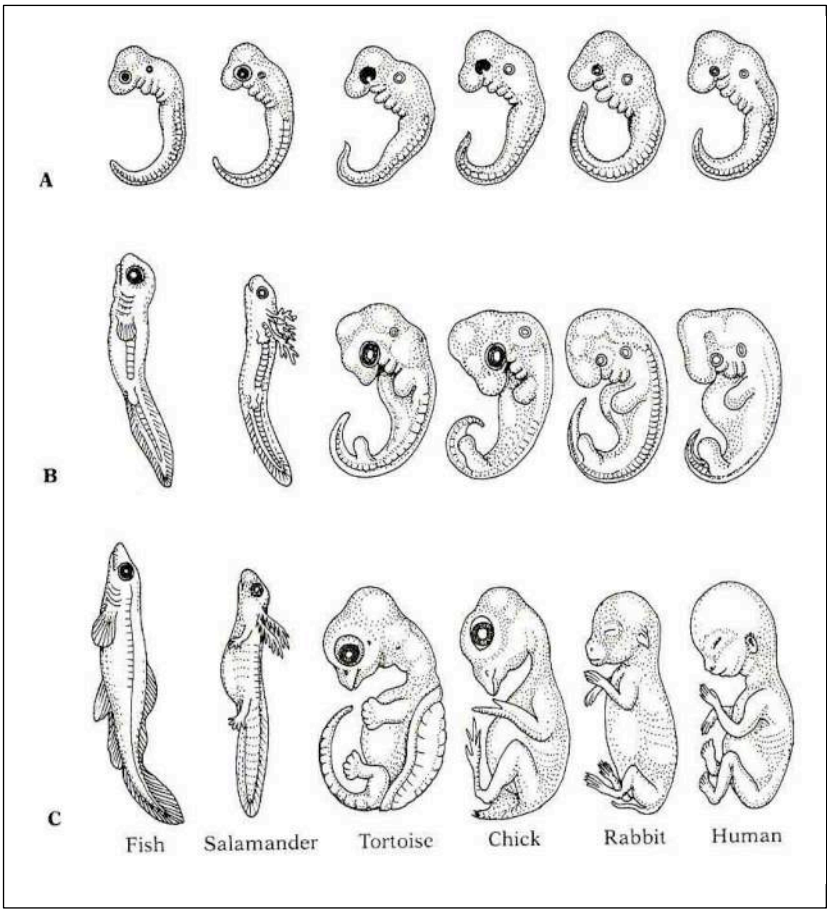




Similarities in **anatomical structures** (**homologous structures**) provide evidence for common ancestry. Similarities and differences in homologous structures help scientists group organisms according to how recently they shared a common ancestor.

Universal genetic code: All living things have a genetic code composed of the same four nucleotides. Comparing similarities and differences can help scientists determine how closely related two organisms are.

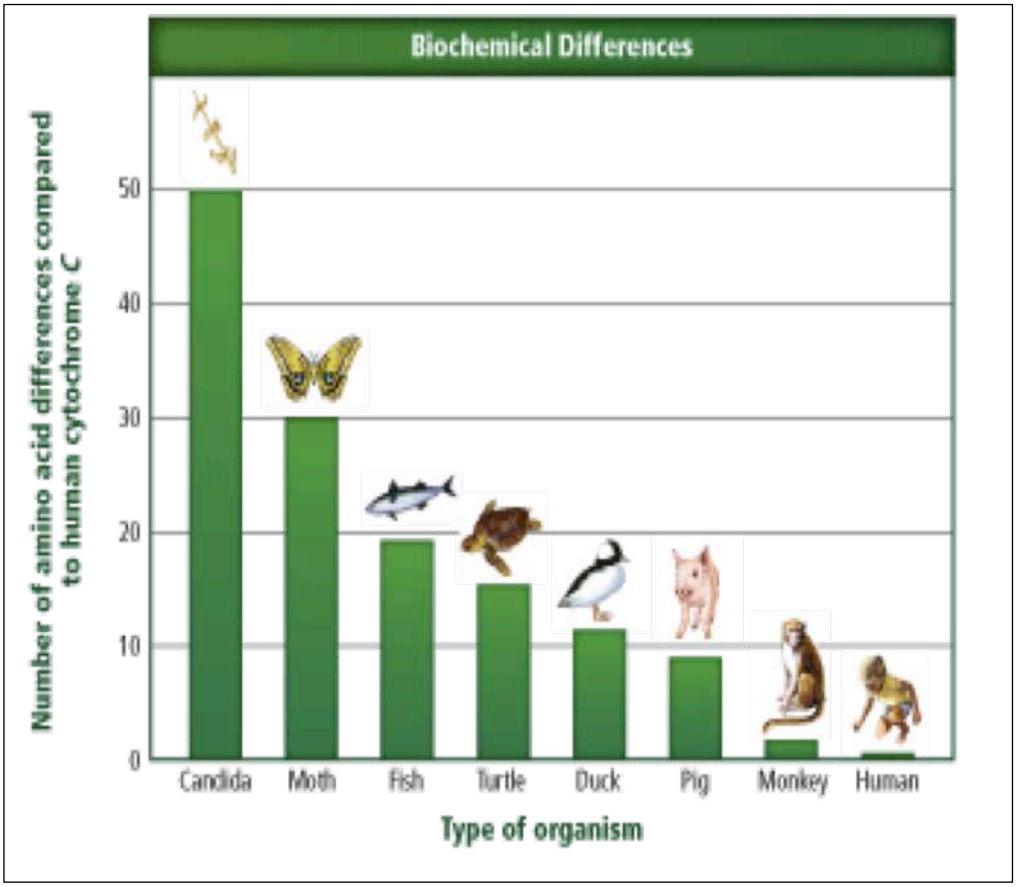




Comparative Embryology: An embryo is an early, pre-birth stage of an organism's development. Scientists have found that vertebrate embryos exhibit homologous structures during certain phases of development but become totally different structure in the adult forms.

Vertebrate embryos all have a tail and paired structures called pharyngeal pouches. In fish, these pouches develop into gills. In reptiles, birds, and mammals, these structures become part of the ears, jaws, and throat. Although the adult forms differ, the shared features in the embryos suggest that vertebrates evolved from a shared ancestor.

Comparative Biochemistry: Scientists also look to similarities in protein structure as a tool to identify how closely related two organisms might be. The table to the right compares the amino acids sequence in several different organisms to that of a human protein called cytochrome C. The more similarities in the molecules, the more recently the organisms shared a common ancestor.



Assessment Anchor: Distinguish between the scientific terms: hypothesis, inference, law, theory, principle, fact, and observation (B.3.3.1)

Hypothesis: a testable explanation for observations and data

Example: Scientist have observed a species of bird that feeds on the seeds contained in pinecones and proposed that the shape of their beak allows them to open tough pine cones. They hypothesized that if they changed the shape of their beaks, (It doesn't hurt them; there are no nerve endings and it grows back like fingernails.) then they would be able to open fewer closed pinecones. This hypothesis is testable.

Inference: a conclusion drawn from an observation

Example: The beak of the large ground finch is adapted for crushing large, tough seeds. (A conclusion based on the observation that the beak of the large ground finch is quite large.)

Law: describes or summarizes observations, but does not explain them (may be in the form of a mathematical formula)

Example: The law of superposition states that in undisturbed layers of bedrock, a rock layer will be younger than the layer below it and older than the layer above it. The law does not explain why this is the case – it simply describes the relationship between the relative position of a rock layer and its age.

Theory: an explanation of a broad range of observations and provides a framework that scientists can use to analyze and make predictions about the natural world

Example: The theory of evolution explains why we observe so many species on Earth, why different species in different parts of the world are so similar, and why the species found on Earth have changed over time. Data and evidence support the theory of evolution.

Principle: a concept based on scientific laws and rule that are agreed upon by the scientific community.

Example: The Hardy-Weinberg principle states that, if certain conditions apply for a population, the allele frequencies in that population will not change. This principle is based, in part, on the Hardy-Weinberg law, an equation that describes the frequencies of two alleles of a gene in a population.

Fact: a statement or piece of information that is accepted to be true

Example: Charles Darwin collected much of the information upon which he based his theory of evolution when he visited the Galapagos Islands. The Galapagos Islands are located 600 miles off the western coast of South America.

Observation: made with the senses and can be enhanced with the use of tools such as microscopes and measuring equipment

Example: Two of the species of finches found on the Galapagos Islands have beaks with the same general shape.