EVOLUTION

The differences in living things on Earth may be better understood through the study of **evolution**- the gradual change in the characteristics of a species over time.

Charles Darwin is considered to be the founder of modern evolutionary theory. He described natural selection as a mechanism for change. When organisms with favorable characteristics for a particular environment survive, they are able to reproduce and pass on the helpful variations to the next generation. If an organism has a less favorable variation, it is less likely to survive and therefore less likely to reproduce. Each new generation will have more individuals with the helpful traits, and fewer individuals with harmful traits. There is a variety of evidence that supports the theory of evolution.

DNA and Amino Acid Sequences

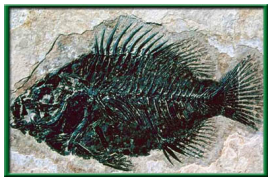
By comparing DNA and amino acid sequences, scientists can determine whether or not organisms are closely related. Close relatives share more similarities in DNA and amino acids than do distant relatives. For example, the table below shows the similarities and differences in several species of insects. Based on the data, the screwworm fly and the silkworm moth are the least genetically related because they show differences in composition of 4 amino acids (cysteine, glutamic acid, glycine, and valine).

Amino Acid Composition of Cytochrome c in Some Organisms

Amino Acid	Fruit Fly	Screwworm Fly	Hornworm Moth	Silkworm Moth
Alanine	10%	10%	10%	10%
Arginine	4%	4%	4%	4%
Aspartic acid	6%	6%	6%	6%
Cysteine	6%	6%	6%	4%
Glutamic acid	12%	12%	8%	8%
Glycine	4%	2%	4%	4%
Valine	2%	1%	4%	6%

Fossils

Fossils are remains of once-living things that are preserved in Earth's layered (sedimentary) rocks. The oldest fossils are bacteria that lived on Earth about 3.8 billion years ago. Although the fossil record is not complete, the general pathway of evolution (change) can be followed.



Anatomical Similarities

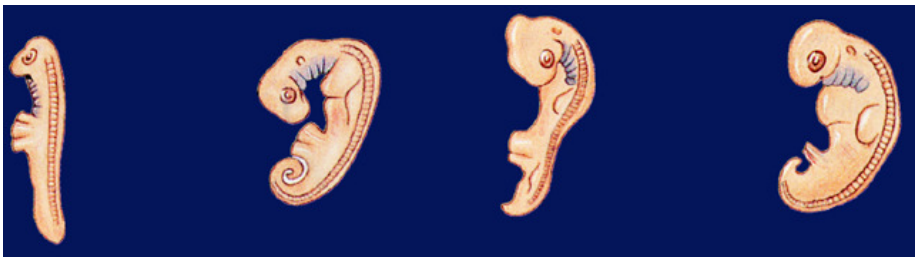
Sometimes structures of different organisms look the same, even if they have different jobs. These structures are called **homologous structures**. For example, the "arms" of a whale, crocodile, and bird are used for different things but look a lot alike. This suggests that the organisms may share a distant common ancestor.

Whale Crocodile Bird

Sometimes organisms have structures that no longer have a job (these structures are called **vestigial structures**). For example, we have an appendix that serves no obvious function now, but may have had a job in a distant ancestor of humans. This provides evidence that structures change over time.

Physiological Adaptations (changes in how an organism works/ breaks down substances)
If a bacterium has a mutation that allows it to break down an antibiotic (a chemical that would otherwise kill it), this physiological change will allow it to survive better then another bacterium without this helpful mutation. If the bacterium is better able to survive an antibiotic, it is also more likely to reproduce and pass on this ability to break down antibiotics (antibiotic resistance).

Embryology
Studying organisms in their earliest forms of development also helps scientists see similarities and possible relationships between organisms. For example, embryos of fish, reptiles, birds, and mammals look very similar. This pattern indicates evolutionary relationships among these species.



Fish Reptile Bird Mammal

Practice

1. Evolutionary relationships can be established by examining molecules such as the protein hemoglobin. Which process is responsible for making protein molecules?
   A. translation
   B. replication
   C. photosynthesis
   D. mitosis

2. _____ _____ are structures seen in different organisms that look the same, even if they have different jobs.

3. Antibiotic resistance illustrates natural selection because if a bacterium is better able to survive an antibiotic, it is also more likely to…
_____.

Animal					
	A	B	C	D	E
Horse	gln	pro	phe	thr	thr
Chicken	gln	glu	phe	ser	thr
Tuna	gln	glu	phe	ser	thr
Frog	gln	ala	phe	glu	thr
Human	gln	pro	tyr	ser	thr
Shark	gln	gln	phe	ser	thr
Turtle	gln	glu	ser	ser	thr
Monkey	gln	pro	tyr	ser	thr
Rabbit	gln	ile	phe	ser	thr

The table above shows a portion of an amino acid sequence found in cytochrome c (a protein used for cellular respiration).

4. Compare the amino acid sequence of human cytochrome C with that of the other 8 vertebrates. For each vertebrate, count the number of amino acids that differ from those in the human and write the number in the table to the right.

Species	Number of Differences
	0
Horse	
Chicken	
Tuna	
Frog	
Shark	
Turtle	
Monkey	
Rabbit	

5. Based on this information, which vertebrate do you think is most closely related to humans and why?

6. Based on this information, which vertebrate do you think is least related to humans and why?

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7. If fossils were found in Layer C (sandstone) and Layer A (slate and siltstone), which fossil would be older and why?