EVIDENCE FOR EVOLUTION

(Refer to Nelson Biology 12: Chapter 11/13)

Many lines of evidence indicate that evolution has occurred, and that natural selection is the chief mechanism driving changes in the characteristics of species over time. This evidence includes:

1. FOSSILS

Fossils of ancient organisms are simpler in form than modern organisms. Sequences of fossils have been discovered that show a graded, gradual series of changes in form as one progresses through layers of sediment or volcanic ash. The oldest fossils (hence oldest organisms) are in the deepest layers and moving up through the layers (or strata) organisms become increasingly complex and recent.

- pp. 511-513

2. COMPARATIVE ANATOMY

Organisms thought to be related through a common ancestor show many similar anatomical structures.

i) **homologous structures (homology)**

– similarity in one or more body parts in different organisms, that is attributable to descent from a common ancestor

- body parts may differ in their function but retain similar anatomy

ie. vertebrate "pentadactyl" (5-finger) forelimb

- human (grasping), bat (flying), penguin (swimming), amphibian (walking)
– Fig. 2, pg. 523

ii) **analogous structures**

- structures that have similar functions and superficial appearance but very different anatomy, such as the flippers of sharks, penguins, and porpoises

– the similarities are due to similar selective pressures but do not demonstrate any recent common ancestry (morphological convergence)

ie. flippers of penguin, porpoise, and shark

- shark never left the water, whereas penguins are descended from 4-legged ancestor that evolved into birds and porpoises descended from 4-legged vertebrates that evolved into mammals, which later returned to the seas

iii) **vestigial structures**

- structures with no current function, but which are homologous to functional structures in related organisms

ie. human appendix, tail bone, ear muscles
rudimentary leg bones/pelvic girdle in snakes

– Fig. 4 pg. 524

3. COMPARATIVE EMBRYOLOGY

Embryological studies also support the theory of evolution. All vertebrate embryos proceed through strikingly similar stages of development. This is because all vertebrate embryos inherit the same basic genetic plan for development.

– fish, turtles, chickens, mice, and humans all develop tails and gill arches early in embryonic development; not all maintain these structures in life, however

– presumably, the more similar the stages, the more related the organisms

– Fig. 3, pg. 524

4. **COMPARATIVE BIOCHEMISTRY/ GENETIC EVIDENCE**

A recent development in evolutionary biology is the ability to measure genetic and biochemical similarities. Similarities in chromosome structure, sequences of amino acids in proteins, and similarity in DNA composition all support the notion of descent of related species through evolution from common ancestors.

i) **nucleic acid comparisons**

- the more closely related the organisms, the more similar the sequences of DNA or RNA

ie. studies show that the red panda, giant panda, and brown bear are all descended from a common ancestor since their DNA is quite similar; and since the DNA of the giant panda is more similar to the brown bear than to the red panda, the giant panda is more closely related to the brown bear

ie. a human and a chimpanzee (a type of ape) have ~98% identical DNA; this suggests a very close relation between humans and chimps *(scientists are becoming convinced that humans are actually a type of ape and may be more closely related to chimps than chimps are to gorillas!)*

- Fig. 6, pg. 611

ii) **amino acid comparisons**

- if species have the same gene sequences, the amino acid sequences (hence proteins) should be conserved
- if few mutations have occurred, few differences in the amino acid sequences occur and species are more closely related

ie. Cytochrome C (protein component of electron transport chain)

- highly conserved sequence occurring in bacteria to corn plants to humans
- between humans and chimps (0 diff.), humans and chicken (18 diff.), humans and turtles (19 diff.) , humans and yeasts (56 diff.)
- Fig. 4, pg. 610

ie. Hemoglobin

- Fig. 5, pg. 611

4. **ARTIFICIAL SELECTION**

Rapid, heritable changes have been produced in domestic animals and plants by selectively breeding organisms with desired features. If differences as vast as those occurring between the Chihuahua and the Great Dane can be produced in a few thousand year of artificial selection by humans, it seems likely that much larger changes could occur in hundreds of millions of years.
- pg. 525

5. **INDUSTRIAL MELANISM**

Both natural and human activities may drastically change the environment over short periods of time. Significant changes in the characteristics of species have been observed in response to these environmental changes. A well-studied example is the evolution of black colouration among peppered moths in response to darkening of their environment by industrial pollutants.