Evolution: Patterns and Diversity

Biology Lecture 9.1 – 9.7; Pages 221 - 234

Sect. 9.1: Living organisms Are Both Similar and Varied

Questions:

How did today's species come to be?

Do different species share similarities between them?

Recall:

- The same types of cells and molecules can form different organisms, eg, a daffodil vs. a pine tree, or a horse vs. a fruit fly.
- All organisms must obtain energy, reproduce, and interact with their environment.
- All organisms may appear differently, but share biological processes; a commonality.
- **Unity of Pattern** – similarities between living organisms.
- **Diversity** – the many differences between different species, "biodiversity".
- **Variability** – differences within a species, eg, much variability among house cats.

I. Biologists Observe Unity of Pattern in Different Organisms:

Some Evidence to Support Unity Of Pattern (evolution): (*See Figures 9.1 and 9.2, pgs 222 – 223)

- The **triplet sequences of bases** in DNA [eg, ATC] that encodes for a specific amino acid. There is only **one genetic code** for ALL organisms!
- All organisms are made of cells, and all cells function in a similar way. **The Cell Theory**.
- **Homology**: Vertebrate animals have backbones, and similar limb patterns, eg, whale limbs vs. bat limbs (skeletons).
- **Reproduction** and **Embryonic Development** processes are similar among organisms.

*** There is much diversity among life forms, but at the same time much unity in pattern!**

Sect. 9.2: All organisms Are Grouped Into Species

- Some organisms have more characteristics in common than others.
- **Species** – organisms that can (interbreed) mate, and reproduce.

I. What allows a species to remain distinct? *See figs. 9.3, 9.4, 9.5, and 9.6 on page 224-225

1. Behavioral, geographical, or physical differences may prevent one species mating with another.
   - **Reproductive isolation** – inability of one group to interbreed with another, eg an elephant cannot mate with a crab and produce offspring. Alaskan brown bear and polar bears have successfully mated in zoos, but not in the wild. WHY?
   - **Enviable offspring** – mating and offspring may result between to different sp. but the eggs soon die. eg, Bull Frogs and Leopard Frogs.
   - **Hydrid** – two sp. mate and produce live offspring, but the offspring are **sterile**. eg, a Mule is the sterile offspring of a horse and donkey. Exceptions to this in plant hybrids, eg, lemon-limes and tangelos). Wolf and dogs?

2. Sometimes organisms of the same species may not look like one another.
   - Not all dogs look alike, yet they all belong to the same species.
   - All dogs are **variations** of the same species. There are many intermediate breeds; differences among dogs.
   - **Variations** (differences) – occur among all individuals of sexually reproducing organisms.
   - **Geographic Location** - populations vary within a species depending on where they live. The environment can lead to variations. eg, Birds, Humans, and Indian Paintbrush

Sect. 9.3: Darwin Observed Variation Among Organisms

I. How does diversity and variation come about?

- **Charles Darwin; "**Father of Evolution" (1831's) – a naturalist who sailed around the world on the HMS *Beagle*. *See figure 9.8, page 226
- ***Naturalist*** – a scientist who studies natural history and biology of an area, eg, S. America
- **Galapagos islands** esp. influenced Darwin. He collected many island specimens.

Darwin Observed:

- A local islander told Darwin that he could tell which of the islands the tortoises came from based on the size & shape of their shell, and the length of their legs & neck.
- He saw variations among **finches**, esp. their beak size & shape. *See Figure 9.9, page 227.
- Darwin, Hooker and Gould sorted the finches into 13 different species and analyzed the data

Darwin Surmised:

- The finches must have originally come from S. America mainland, but why were the island finches so different from those found on the mainland?
- Why did the assortment of finches differ so much from island to island?

II. **Thomas Malthus** (1766 – 1834) – his writings influenced Darwin's own work.

- Malthus warned about the dangers of human overpopulation, that if humans continue to reproduce at the current rate, they would eventually deplete their food resources.
- Darwin applied Malthus' ideas to his work and concluded that most species have a **high reproductive potential**, but not all individuals reproduce; therefore, populations are kept in check in part because some individuals fail to have offspring.
- Darwin wondered: If the above was true, then what might affect the reproductive output of a species, and did it affect all individuals in the same way?

Sect. 9.4: Darwin Identified Selection as a Force in Evolution

- Darwin observed that animal breeders could accentuate desirable traits by carefully selecting animals for mating – ***artificial selection***. *See figure 9.10, page 228.

I. Darwin Suggested:

- Darwin hypothesized that a process similar to artificial selection might affect organisms in their natural environment.
- In nature, the animals that reproduced were somehow "selected by the environment". Individuals with characteristics that helped them survive in their environment could produce more offspring than individuals that did not have such characteristics.
- Darwin called this process – ***natural selection.***
- **Adaptations** – the characteristics that enable members of a species to survive and reproduce more frequently; adaptations are part of the variations in a population.
  *See adaptation examples.

Question:

What are some adaptations that you have noticed in plants or animals?

II. Two 19th Century Explanations for How Species Change and Variations are Passed On:

A. Natural Selection Acts on Variations – Charles Darwin's Ho. in England

- Darwin proposed that variations in a species appear randomly and without "design".
- If a new variation allows its bearer to produce more offspring, the trait will spread to future generations.

Example: Long-necked giraffes. Natural selection says that giraffes that happen to be born with longer necks have a greater advantage for obtaining food. These giraffes have more "fit genes"; greater reproductive success. The genes for long necks are passed on to the next generation

B. Acquired Characteristics – Jean Lamarck's Ho. in France

- He argued that some "force" causes an organism to generate new structures or organs [in its lifetime] to meet its biological needs.
- Once formed, the structures continue to develop through use, and the development attained by the parents is passed onto the offspring. - ***Acquired Characteristics*.**
- Today, we know that acquired characteristics of an organism are NOT passed on to the offspring.

Example: Long-necked giraffes. Lamarkian thinking implies that stretching the neck to reach the leaves elongates the neck. This elongated neck acquired in its lifetime is then passed on to the next generation. All giraffes born to this individual will have long necks.

Sect. 9.5: Darwin's Theory Changed Biology

Darwin developed his theory during a time when the prevailing scientific opinions were very different. He lacked conclusive data to support his ideas. The study of genes would have been helpful, but little was known about it then! Not having much proof and the storm of controversy led Darwin to be reluctant about presenting his ideas.

- 1855 Darwin received a paper from Alfred Wallace (in Indonesia) which was a sketchy outline of the principles of natural selection. Both Darwin and Wallace presented their papers @ scientific meetings, but Darwin was given the credit. Darwin's ideas were extensive and well thought-out. The best developed and supported gets the most credit.
- Darwin published his ideas in a book, *The Origin of Species by Means of Natural Selection*; 1859.
- Darwin's theory of natural selection has been supported by thousands of biologists.
- Examples of natural selection in nature can be seen in the Peppered Moth experiment. Fig 9.11 and in penicillin-resistant bacteria experiment Fig. 9.12.
- Extensive fieldwork and experiments continue to support Darwin's theory of evolution by natural selection; it is the corner stone of modern biology.

The question is, not *whether evolution occurs*, but *how it occurs*, and *how rapidly it occurs*.

Section 9.6 – 9.7: Evolution and Genetics

I. Mendel's discoveries showed how variations could be inherited: "variations passed onto the offspring"

* Darwin's original ideas have been greatly modified
and expanded in the 20th century.

Evolution - a change in a species through time. *But, what type of change?*

* Darwin knew:

a) only inherited traits have affect the evolutionary process.

b) variations that are not passed on DO NOT lead to changes in a species.

II. Three major Sources of Variability required for Evolution:

1) *Mutations* - changes in the DNA sequence can be beneficial as well as harmful; some have no effect at all.

* 1 in a billion replications are miscopied (in humans)!

* *Mutations* have been occuring (in pops.) for huge periods of time, *producing variations for natural selection to operate*.

* Mutations create new genes , adding to the *gene pool*.

* *Gene Pool* - all the alleles in a population. e.g. the human gene pool

2) *Sexual reproduction* produces a diploid (2n) zygote with genetic variability!

RECALL:

During meiosis Homologous Chromosomes move close together and twist around each other and exchange genetic info (DNA) = this phenomenon is called ... Crossing Over of chromosomes.

- Crossing Over = ensures a new combo. of genes in the offspring, i.e. Genetic recombination!!
- Occurs at random anywhere on the chromosome, (2-3X/meiosis)

3) *Crossing Over of chromosomes* ensures Genetic Recombination during meiosis.

*Ensures a new combo. of genes added to the gene pool!

* New combos of genes on Chromosomes are carried in the gametes!

* 1/64 trillion chance that your parents could make a "clone" of you!