**5.4 Evolutionary Theory**

* Nothing in Biology makes sense except in light of Evolution!
* Evolution is about subtle, gradual & selectable change over time which \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the struggle to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_!
* The concept of biological evolution is one of the most important ideas ever supported by the application of scientific methods to the natural world
* The evolution of all organisms that live now & in the past is at the core of genetics, biochemistry, neurobiology, physiology & ecology.
* It also helps explain the emergence of new diseases, antibiotic resistance in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, agricultural resistance to pests, changes in the Earth’s atmosphere, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, cell machinery, etc

**Evolution**

* Evolution is about change in a pop., species or group of species
* ***Microevolution***: this is how a pop. of organisms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* ***Macroevolution***: this describes patterns of changes in groups of species \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  1. These patterns determine phylogeny (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)

**Lamarck’s Theory of Evolution**

* ***1) Law of Use & Disuse***
  1. Each body part possesses a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ which allows it to change in order to better fit its environment (USE)
     1. *Ie* Short necked Giraffe \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ its neck to reach a branch because it needs a long neck
  2. If a body part is not used it will begin to disappear (DISUSE)
     1. *Ie* Nocturnal animal (Bats) lose their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or aquatic organisms lose their \_\_\_\_\_\_\_\_\_
  3. Based on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ this law seems likely!
* Jean Baptiste Lamarck (1809)…
* ***2) Inheritance of Acquired Characteristics***
  1. Characteristics \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ will be passed onto the offspring
     1. Ie Permed/dyed hair will pass on to the children
     2. Ie Body builder has kids with big muscles
     3. Ie If you lost an arm in an accident your child will be missing the limb

**Problems with the Lamarckian view**

* Use & Disuse implies an organism can sense its needs & physically change to meet those needs ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***
  1. *I will never dunk a Basketball Ball*
* Acquired Characteristics can be inherited 🡪 ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***
  1. *Good hypothesis but not proven via test*
* Never confirmed by experiment ***POOR SCIENCE***

**How Darwin formed his theory!**

* Darwin considered 2 pieces of info when developing his theory of natural selection
  1. ***Thomas Malthus’ essay:***populations grow faster than the food supply which could support it (r or K?) 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  2. ***Selective Breeding (Artificial Selection):*** breeders select \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ already present in a population & breed to create desirable offspring for the specific trait

**Darwin’s Evidence**

* *See handout*
* Giraffes change due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Those innate traits may give an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* If you live long enough, you may pass them onto the next generation!

**Darwin’s Theory: 5 conditions for Natural Selection**

1) Organisms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ offspring

2) No 2 organisms are exactly alike (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)

3) Changes in the environment occur

4) The organism \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the new conditions will survive to reproduce

5) In time, the population will change due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Objections to Natural Selection**

* The Church of the day
  1. he was going to be a minister so even he disliked what he was thinking
* The belief that characteristics of parents blend in offspring leading to loss of variation & less to select from naturally
  1. Gregor Mendel’s work on peas proved \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Darwin used examples of artificial selection but never provided examples to show that natural selection works in nature.
* He could not explain what \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Today we can!

**Evolution**

* **Evolution**: *the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the genetic composition of populations*
* **Natural selection**: *populations of organisms can change over the generations if individuals having certain \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ leave more offspring than others (differential reproductive success)*
* **Evolutionary adaptations**: *a prevalence of inherited characteristics that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**Sources of Variation**

* **Mutations**: mutagenic agents cause \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ then proteins then form & structure
  1. Mutations are the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* New random combinations of genes occur due to **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* **Crossing over** in Prophase I
* **Independent assortment** of homologues
* **Diploidy**: having 2 copies of each gene allows the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ones to stay hidden
  1. Fatal recessive disease like sickle cell anemia *aa*-kills (a lethal combo) vs. *AA* or *Aa* who survive it

**Sources of Variation….**

* **Outbreeding**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ increases the possibility of creating new gene combos
* **Heterozygote advantage**: individual carries \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (*Aa*) for a trait is better fit to survive than an individual that is homozygous (*AA* or *aa*)
* **Hybrid vigour**: a hybrid offspring is stronger than the pure parent (less chance of getting a nasty recessive combo of genes) 🡪 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Evidence for Evolution (Review)**

**1) Fossil Records** (Paleontology)

* 1. Fossils reveal the existence of extinct species
  2. These ancestors look similar to modern species
  3. Fossils can be radioactively dated (1/2 life) to suggest great age
  4. Lots of gaps exist. WHY?
     1. Only hard parts fossilize

**2) Biogeography**

* Uses geography to describe the distribution of species
* Unrelated species in dif parts of the world look similar due to similar conditions
* Helps support the effect of nat. selection

**3) Comparative Embryology**

* Reveals similar stages of development among species
* Helps establish evolutionary relationships
* Gill slits in fish become middle ear parts & tonsils in us
* Tails exist in many species but it is rudimentary in us
* The closer organisms are related, on the ***phylogenetic tree***, the more similar the embryos of those organisms will be!
* **For example**, *crocodilia* & *aves* are more related than are *aves* & *mammalia*

**4) Comparative Anatomy (2 kinds)**

* This describes 2 kinds of structures that help ID the relationship between organisms
* ***i) HOMOLOGOUS Structures***
  1. Similar body parts due to evolution from a common ancestor
  2. Similar in structure & origin but not in function
  3. Ie forelimbs (see booklet pics)
* **ii) ANALOGOUS Structures**
  1. These body parts look alike because of natural selection to adapt to similar environments
  2. Not due to common ancestry
  3. Similar in function but not similar function or origin
* **5) Molecular Biology**
  1. Examines the amino acid & nucleotide sequences in Protein & DNA respectively
  2. Closely related species contain more common sequences than from those more distantly related
  3. **IE** Diabetics use insulin harvested from sheep & pigs
  4. Saliva, bile, digestive enzymes, hemoglobin in RBC
* **6) Vestigial Organs**
  1. Structures of the body that no longer serve a useful purpose but are similar to functional organs used in other organisms
  2. Over time the functional purpose has been lost
  3. **Examples in humans:**
     1. Appendix
     2. Tail vertebrae (100 cases exist in literature), Ear muscles
     3. Wisdom teeth (our faces are too short to allow room)
     4. Tonsils

**Types of Evolution**

* **Convergent evolution-** 
  1. 2 different species are completely unrelated!
  2. They develop similar form due to similar ecological roles (niche is the same)
  3. natural selection has shaped these analogous adaptations
* **Divergent evolution** 
  1. species from the same evolutionary branch (related)
  2. development of different forms
  3. due to different roles and adaptations
  4. ie: Darwin’s Finches