Honors Biology – Unit 3 – Chapter 13
"HOW POPULATIONS EVOLVE"

1.   Jean-Baptiste de LaMarck: a desire to change, use and disuse, acquired traits

2.   Charles Darwin: "On the Origin of Species by Means of Natural Selection"

3.   Darwin's finches: South America vs. Galapagos Islands

4.   fitness: the ability of successfully reproduce and produce fertile offspring

5.   Darwin's 5 steps of natural selection:

   • genetic variation
   • overproduction of offspring
   • fitness
   • genetic change
   • adaptation

6.   examples of natural selection:

   • giraffes
   • finches
   • drug-resistant bacteria
   • pesticide-resistant insects
   • the peppered moth

7.   evidence for evolution:

   • fossils and rock layers (principle of superposition)
   • homologous structures
   • vestigial organs
   • comparative embryology
   • molecular data

8.   evolution WITHOUT natural selection

   • founder effect, bottleneck effect, artificial selection

9.   directional selection vs. stabilizing selection vs. disruptive selection

10.   Hardy-Weinberg equilibrium: $p^2 + 2pq + q^2 = 1$

Honors Biology – Unit 3 – Chapter 14
"THE ORIGIN OF SPECIES"

1.   biological species concept

2.   5 reproductive (PRE-ZYGOTIC) barriers:

   • temporal isolation
   • habitat isolation
   • behavioral isolation
   • mechanical isolation
   • gametic isolation

3.   3 developmental (POST-ZYGOTIC) barriers:

   • reduced hybrid viability
   • reduced hybrid fertility
   • hybrid breakdown

Honors Biology – Chapters 13 & 14 Word Roots
"HOW POPULATIONS EVOLVE" & "THE ORIGIN OF SPECIES"

allo- = other; **-patri** = father (*allopatric speciation:* the formation of new species in populations that are geographically isolated from one another)

bio- = life; **geo-** = the Earth (*biogeography:* the study of the past and present distribution of organisms)

homo- = like, resembling (*homologous structures:* structures in different species that are similar because of common ancestry; *homology:* similarity in characteristics resulting from a shared ancestry)

micro- = small (*microevolution:* a change in a population's gene pool over generations)

muta- = change (*mutation:* a change in the nucleotide sequence of an organism's DNA)

paleo- = ancient (*paleontologist:* a scientist who studies fossils)

post- = after; **zygo-** = fertilized cell (*postzygotic barrier:* any of several reproductive barriers that prevent hybrid zygotes produced by two different species from developing into viable, fertile adults)

pre- = before; **zygo-** = fertilized cell (*prezygotic barrier:* any of several reproductive barriers that impede mating between species or hinder fertilization if mating between two species is attempted)

sym- = together; **-patri** = father (*sympatric speciation:* the formation of new species in populations that live in the same geographic area)

vestigi- = trace (*vestigial organs:* a structure of marginal or no importance to an organism that is the historical remnant of structures that had important functions in ancestors)

HONORS BIOLOGY – UNIT 3 – CHAPTERS 13 & 14 NOTES

HOW POPULATIONS EVOLVE & THE ORIGIN OF SPECIES

Jean Baptiste de Lamarck
- first major theory of evolution
- based on 3 principles:
    - a desire to change = if an animal wants or needs to change its body, then it does
    - use and disuse = if a part of an animal isn't used, then it shrinks and disappears; if it is used a lot, then it grows bigger, stronger, or more numerous
    - acquired traits = traits that an animal receives during its lifetime will be passed to its offspring
- WHAT IS WRONG WITH LAMARCK'S THEORY? (EVERYTHING!)

Charles Darwin
- a naturalist from England
- first voyage at 22 years old
- sailed to the Galapagos Islands off the coast of Ecuador (South America)
- most famous book was "On the Origin of Species by Means of Natural Selection" (1859)

Darwin's Research
- He collected several species of birds (finches)
- Each bird had a specialized way of catching food in its beak
- All the birds on the islands resembled one particular bird on South America
- HOW COME SOME OF THE BIRDS HAVE DIFFERENT TRAITS?
- WHY DID THE ISLAND FINCHES RESEMBLE THOSE ON SOUTH AMERICA?
- The finches must have changed throughout time in order to survive.
- They evolved different traits in response to the different environments on the islands.
- In the case of their beaks, the environmental factor was food availability.

Darwin's Theory of Evolution
- definition of evolution = change in species over time
- natural selection = organisms with traits well suited to an environment are more likely to survive and produce more offspring
- FITNESS = the ability to successfully reproduce and produce fertile offspring
- Reproduction is the most important thing in life according to Darwin

5 Steps of Natural Selection
1.   GENETIC VARIATION
       Every species contains differences in DNA
       EX: Some giraffes have longer necks and some have shorter necks.
2.   OVERPRODUCTION OF OFFSPRING
       Organisms often produce more offspring than can survive.
       EX: The giraffes produce a lot of offspring.
3.   FITNESS
       Only some individuals survive and reproduce.
       EX: Tall giraffes could reach the food. They survived and reproduced.
          Short giraffes could not reach the food. They died and did not reproduce.
4.   GENETIC CHANGE
       Natural selection changes the % of genes in the population.
       EX: The "tall" gene becomes more common. The "short" gene becomes less common.
5.   ADAPTATION
       Species adapt to the environment. Some genes are more favored than others.
       EX: Most of the giraffes in the population are taller. The shorter ones were unable to survive.

Examples of Natural Selection (Classwork)
EX: Darwin's Finches (only food sources are nuts, fruits, and seeds)
      1.   There are birds with short, fat beaks and long, thin beaks.
      2.   _____
      3.   _____
             _____
      4.   _____
      5.   _____
EX: Drug-Resistant Bacteria
      1.   Some bacteria are killed by antibiotics and some are not.
      2.   _____
      3.   _____
             _____
      4.   _____
      5.   _____
EX: Pesticide-Resistant Insects
      1.   Some insects are killed by pesticides and some are not.
      2.   _____
      3.   _____
             _____
      4.   _____
      5.   _____
EX: The Peppered Moths (the trees have been covered with soot)
      1.   There are light and dark peppered moths.
      2.   _____
      3.   _____
             _____
      4.   _____
      5.   _____

Proof of Evolution
1.	Homologous Structures = similar bone structures found in closely related animals
	EX: human arm, bird wing, whale flipper
2.	Vestigial Organ = an organ that is no longer used by an animal
	EX: human appendix, coccyx (tail bone), wisdom teeth
3.	Molecular Data = comparing similar DNA or proteins sequences of different animals
	EX: humans and chimpanzees have 98.4% DNA similarities
4.	Comparative Embryology = animals that are closely related have similar features
	during development (before they are born)
	EX: human embryos have gill-like slits (humans evolved from fish)
	EX: human embryos have a "tail" (humans evolved from primates)
5.	Fossils = remnants of animals from the past
	EX: Archaeopteryx = fossil that proves that birds evolved from dinosaurs

Evolution Without Natural Selection
1.	Founder Effect = when a small group is separated from a large population, the small
		group will have a different % of genes than the original (larger) group
	EX:	Carolina and Dimetri are swept away by a storm to a deserted island.
		All the offspring will be tall.
2.	Bottleneck Effect = when a storm or natural disaster randomly destroys most of a
		population, the survivors that are left to reproduce may not have the same genetic
		qualities as the original (larger) group
	EX:	A storm destroys everyone except Carlos, Kristia, Danilo, Charbel, and Carolina.
		All the offspring will be Spanish.
3.	Artificial Selection = when humans determine which organisms are going to mate.
	EX:	farmers planting the seeds from the best crops
	EX:	dog/horse breeders

Species Concept
-	Organisms of the same species are able to mate and produce fertile offspring.
-	If they can't mate together, then they are different species!
-	EX: horse + donkey → mule (not a species because it is sterile)

5 Pre-Zygotic Reproductive Barriers
1.	Habitat Isolation = species are separated based on where they live
2.	Temporal Isolation = species are separated based on when they mate
	(time of day or mating seasons)
3.	Behavioral Isolation = species are separated based on differences in mating rituals
4.	Mechanical Isolation = species are separated based on incompatible reproductive organs
5.	Gametic Isolation = species are separated based on incompatible gametes (eggs + sperm)

3 Post-Zygotic Reproductive Barriers
1.	Reduced Hybrid Viability = hybrid fails to develop or reach "puberty"
2.	Reduced Hybrid Fertility = hybrid reaches "puberty" but can't make functional gametes
3.	Hybrid Breakdown = hybrid produces offspring, but the offspring are weak or infertile

<u>3 Modes of Natural Selection</u>

1.   Directional Selection: one extreme trait is favored
          EX: - Trait: speed of wolves
                - Evolution favors faster wolves
                - Graph is shifted to the left or right

2.   Stabilizing Selection: the middle form of the trait is favored
          EX: - Trait: human birth weight
                - Evolution favors medium birth weight
                - Graph produces a thinner bell curve

3.   Diversifying Selection: both extreme traits are equally favorable, but not the middle trait
          EX: - Trait: type of beak (Darwin's finches)
                - Evolution favors short/fat beaks (for eating nuts and fruit) as well as long/thin
                  beaks (for eating worms and insects), but not medium-sized beaks
                - Graph produces an upside-down bell curve