**Focus Topics for Unit 7: Natural Selection**

**Hardy Weinberg Problems:** See Goldfish Lab and homework for examples.

**Types of Natural Selection:**

-**Artificial Selection:** The process by which species are modified by humans. Example: Selective breeding for milk or meat production; development of dog breeds. Example: dogs, pigeons, cattle, horses etc.

-**Sexual Selection:** The choosing of a mate by specific characteristics that may not be beneficial to the population. Example: Peacocks tails.

---**Directional Selection:** Shifts the frequency curve for variations in some phenotypic character in one direction or another. From rare to average. Example: Average size of black bears in Europe increases in ice ages, decreases in warmer periods

 ---**Disruptive Selection:** Favors variants of opposite extremes over intermediate individuals.

Example: Peppered moths: One of the most studied examples of disruptive selection is the case of ​London's peppered moths. In rural areas, the peppered moths were almost all a very light color. However, these same moths were very dark in color in industrial areas. Very few medium-colored moths were seen in either location. The darker-colored moths survived predators in the industrial areas by blending in with the polluted surroundings. The lighter moths were seen easily by predators in industrial areas and were eaten. The opposite happened in rural areas. The medium-colored moths were easily seen in both locations and were therefore very few of them left after disruptive selection. ​​

Additional Example: Oysters: Light- and dark-colored oysters could also have a camouflage advantage as opposed to their medium-colored relatives. Light-colored oysters would blend into the rocks in the shallows, and the darkest would blend better into the shadows. The ones in the intermediate range would show up against either backdrop, offering those oysters no advantage and make them easier prey. Thus, with fewer of the medium individuals surviving to reproduce, the population eventually has more oysters colored to either extreme of the spectrum.

 ---**Stabilizing Selection:** Acts against extreme phenotypes. Favors the more common intermediate variants. Maintains the “status quo”. Example: 3 – 4 kg. average for human births

**Evidences of Evolution:**

**-Fossil Record:** Fossils provide evidence for the theory of evolution. Fossils are remains or traces of organisms from the past. They are found in sedimentary rock. Paleontology is the study of fossils. Fossils show that evolutionary changes have occurred over time and the origin of major new groups of organisms. Darwin’s theory of evolution through natural selection explains the succession of forms in the fossil record. Transitional fossils have been found that link ancient organism to modern species, just as Darwin’s theory predicts.

-**Artificial Selection:** the ability to create new breeds and species within a generation demonstrates evolution in action. Examples: dogs, pigeons, bacterial resistance.

-**Anatomical Evidence:**

 ----**Homologous Structure:** -Homologous structures are anatomical signs of evolution. Examples: Forelimbs of mammals that are now used for a variety of purposes, such as flying in bats or swimming in whales, but were present and used in a common ancestor for walking.

 ----**Analogous Structure:** Solving a similar problem with a similar solution. Example: Wings of butterfly and bird.

 ----**Convergent Evolution:** Similar animals due to similar environments and not because of a common ancestor with those traits. Convergent evolution explains why distantly related species can resemble one another. Convergent evolution has taken place when two organisms developed similarities as they adapted to similar environmental challenges-not because they evolved from a common ancestor. The likenesses that result from convergent evolution are considered analogous rather than homologous. Think of it like this: Similar problems have similar solutions. Here are some examples:

 The torpedo shapes of a penguin, dolphin, and shark are the solution to movement through an aqueous environment. Also, Sugar gliders (marsupial mammals) and flying squirrels (eutherian mammals) occupy similar niches and their respective habitats.

 **-Comparative DNA and Protein structures:**

**-Embryonic homologies**: Comparison of early stages of animal development reveals many anatomical homologies in embryos that are not visible in adult organisms. Examples: All vertebrate embryos have a post-anal tail and pharyngeal pouches.

**-Vestigial organs** are structure so marginal, if any, importance to the organism. They are remnants of structures that served important functions in the organisms’ ancestors. Example: Remnants of the pelvis and leg bones are found in some snakes.

**-Molecular homologies** are shared characteristics on the molecular level. Examples: all life-forms use the same genetic language of DNA and RNA. Amino acid sequences coding for hemoglobin in primate species shows great similarity, thus indicating a common ancestor.

**-Biogeography:** The geographic distribution of species. Species in a discrete geographic area tend to be more closely related to each other than to species in distant geographic areas. Example: In South America, desert animals are more closely related to local animals in other habitats than they are to the desert animals of Asia. This reflects evolution, not creation.

-**Continental drift** and the break-up of Pangaea can explain the similarity of species on continents that are distant today.

-**Endemic species** are found at a certain geographic location and nowhere else. Example: Marine iguanas are endemic to the Galapagos.

**Primate-human chromosomal differences:**

-Humans have 46 chromosomes. Orangutan, gorilla, and chimpanzee have 48 chromosomes. Hypothesis: Change in chromosome number? If these organisms share a common ancestor, then is there evidence in the genome for this change in chromosome number. Testable prediction: If common ancestor had 48 chromosomes (24 pairs), then humans carry a fused chromosome (23 pairs). Findings: “Chromosome 2 is unique to the human lineage of evolution, having emerged as a result of head-to-head fusion of two chromosomes that remained separate in other primates.

**5 Agents of Evolutionary change**

-**Mutation** is a change in an organism’s DNA. Mutation at a given gene locus is very rare, but mutations at all gene loci can have a big impact. Chromosomal Mutations=Additions; Deletions; Inversions, Translocations. Point Mutations- Substitutions & Frame Shift Mutations

-**Gene Flow:** A population may gain or lose alleles by gene flow. Gene flow is genetic exchange due to the migration of fertile individuals or gametes between populations. Sexual selection is a form of natural selection in which individuals with certain traits inherited characteristics are more likely than other individuals to obtain mates. It can result in sexual dimorphism, a difference between the ornamentation, and behavior. The migration of people from Europe to South America with the discovery of the new world changed the allelic frequency of many populations.

-**Nonrandom Mating:** If mating is non-random, specific traits can become biased in the allele frequency causing evolution.

-**Genetic drift** is the chance fluctuation of a small population due to chance

----**Bottleneck Effect:** Disasters reduce the size of a population dramatically, killing victims unselectively. Result: The small surviving population is unlikely to be representative of the original population in its genetic makeup. Some alleles may be lost

---- **Founder effect** results when a few individuals from a larger population colonize a new, isolated habitat. The new population is unlikely to be representative of the original population

**-Natural Selection:** Populations consist of varied individuals, with some variations of individuals leaving more offspring than others. Darwinian fitness: the relative contribution an individual makes to the gene pool of the next generation. “survival of the fittest”

 ---**Directional Selection:** Shifts the frequency curve for variations in some phenotypic character in one direction or another. From rare to average. Example: Average size of black bears in Europe increases in ice ages, decreases in warmer periods

 ---**Disruptive Selection:** Favors variants of opposite extremes over intermediate individuals.

Example: Peppered moths: One of the most studied examples of disruptive selection is the case of ​London's peppered moths. In rural areas, the peppered moths were almost all a very light color. However, these same moths were very dark in color in industrial areas. Very few medium-colored moths were seen in either location. The darker-colored moths survived predators in the industrial areas by blending in with the polluted surroundings. The lighter moths were seen easily by predators in industrial areas and were eaten. The opposite happened in rural areas. The medium-colored moths were easily seen in both locations and were therefore very few of them left after disruptive selection. ​​

Additional Example: Oysters: Light- and dark-colored oysters could also have a camouflage advantage as opposed to their medium-colored relatives. Light-colored oysters would blend into the rocks in the shallows, and the darkest would blend better into the shadows. The ones in the intermediate range would show up against either backdrop, offering those oysters no advantage and make them easier prey. Thus, with fewer of the medium individuals surviving to reproduce, the population eventually has more oysters colored to either extreme of the spectrum.

 ---**Stabilizing Selection:** Acts against extreme phenotypes. Favors the more common intermediate variants. Maintains the “status quo”. Example: 3 – 4 kg. average for human births

**Heterozygote advantage** (sickle cell)-carriers are less likely to get malaria than homozygous normal individuals.

Earths Early conditions and Hypothesis of how life may have began

-**Extra-terrestrial Origin**

Was the original source of organic (carbon) materials comets & meteorites striking early Earth?

-**Spontaneous Abiotic Origin**

Did life evolve spontaneously from inorganic molecules?

-**Origin of Genetics**: RNA is likely first genetic material as it serves multiple functions:

-encodes information (self-replicating),

-produces enzymes,

-regulatory molecule,

-transport molecule (tRNA, mRNA)

- it makes inheritance possible

-makes natural selection & evolution possible

-**Oxygen** in the atmosphere allowed species to utilize cellular respiration and the production of more ATP and energy for the organism. Additional evolution was now available and unrestrained. It helped develop the eukaryotic cell and multicellular organisms.

**Pre/Post-reproduction Barriers**

**Pre-reproduction Barriers:**

**-Geographic isolation:** Species occur in different areas due to a physical barrier. It also known as allopatric speciation. All other barriers are sympatric speciation. Example: Harris’s antelope squirrel inhabits the canyon’s south rim (L). Just a few miles away on the north rim (R) lives the closely related white-tailed antelope squirrel.

**-Ecological isolation:** Species occur in same region, but occupy different habitats so rarely encounter each other. Example: 2 species of garter snake, Thamnophis, occur in same area, but one lives in water & other is terrestrial. Another example: lions & tigers could hybridize, but they live in different habitats: lions in grasslands, tigers in rainforest.

**-Temporal isolation:** Species that breed during different times of day, different seasons, or different years cannot mix gametes. Eastern spotted skunk (L) & western spotted skunk (R) overlap in range but eastern mates in late winter & western mates in late summer.

**-Behavioral isolation:** Unique behavioral patterns & rituals isolate species which identifies members of species. They attract mates of same species by courtship rituals, mating calls. Example: Blue footed boobies mate only after a courtship display unique to their species

**-Mechanical isolation:** Morphological differences can prevent successful mating. Even in closely related species of plants, the flowers often have distinct appearances that attract different pollinators. 2 species of monkey flower differ greatly in shape & color, therefore cross-pollination does not happen. For many insects, male & female sex organs of closely related species do not fit together, preventing sperm transfer.

**-Gametic isolation:** Sperm of one species may not be able to fertilize eggs of another species. Mechanisms include biochemical barrier so sperm cannot penetrate egg. receptor recognition: lock & key between egg & sperm. There may be chemical incompatibility where sperm cannot survive in female reproductive tract. Example: Sea urchins release sperm & eggs into surrounding waters where they fuse & form zygotes. Gametes of different species— red & purple —are unable to fuse.

**Post-reproduction barriers:**

-The mating of two different species can produce hybrids that are not viable or sterile. Genes of different parent species may interact & impair the hybrid’s development. Even if hybrids are vigorous, they may be sterile. Chromosomes of parents may differ in number or structure & meiosis in hybrids may fail to produce normal gametes. Hybrids may be fertile & viable in first generation, but when they mate offspring are feeble or sterile