ESSENTIAL SKILLS

7-1. Explain how overproduction of offspring, competition and individual variation lead to natural selection.
7-2. List and describe five evidences for evolution.
7-3. Use evidence to describe how the five mechanisms of evolution lead to the evolution of a population.
7-4. Describe and provide an example of how a change in environmental conditions may lead to the formation of new species (speciation) or the extinction of existing species.

STUDY GUIDE

1. Explain how each of the following relate to Natural Selection:
   - Genetic Diversity – gives more options for nature to select from.
   - Overproduction of offspring – provides more variety and fight for survival; ensures that at least some of the offspring will survive.
   - Competition – fight for survival, better “fighters” survive and pass on their genes to the next generation.
   - Reproduction – can pass the “better” genes on to the next generation.
2. What is meant by Fitness in Biology? List at least 4 different environmental factors that affect a species “fitness” or survival.
   - Ability to survive AND reproduce. Those with “better” traits will be able to reproduce more. Survival depends on food, competition for mate, avoidance of predators, temperature, water, etc.
3. Why is “survival of the fittest” an incomplete description of natural selection? Survival of the fittest does not include the importance of reproduction. Without survival and reproduction, the population does not improve.
4. Why is it that an individual can not evolve; only populations can evolve? Evolution involves the change in gene pools over time, and an individual cannot change its genes. Populations can see a shift in the gene frequencies with each generation. This is genetic change, or evolution.
5. Explain how each of the following are used to support evolutionary relationships among species:
   - Fossils – evidence of previous life forms through time. Shows that life on Earth has changed in the past.
   - Biogeography – Looking at similar species of animals in different parts of the world. Provides evidence of how environmental factors drive evolution of different species.
   - Molecular Comparisons – DNA & Protein comparisons show relatedness. Changes in DNA accumulate over time.
   - Anatomical Comparisons – Homologous & Vestigial structures show modifications of the same basic body types. Indicates a common/shared ancestry, where the same genes for these structures were preserved in each developing species and passed on.
   - Embryological Development – Studying embryos show similar patterns of development among related species. The more closely related the species are, the longer their embryo develop ‘patterns’ each other. Very different species show great differences right away.
6. Why is it important for scientists to use more than one source of evidence to support evolutionary relationships? Give an example of many sources leading to the same conclusions about evolution.
   - Multiple evidences and repeatable results lead to accepted theories. Example: Whale evolution from land mammals = fossils, homologous structures, DNA evidence, embryology, biogeography all show the same evolutionary path.
7. How are fossils formed? Why are there so many species that cannot be found in the fossil record? What information about the fitness of specific traits can an extinction event tell us? (think environment) Fossils are formed in sedimentary rock, tar or ice. Most organisms decompose when they die and are not fossilized in these conditions. Organisms that are not well adapted to their environment may face extinction (the die off of a group of organisms).

8. How do scientists know the age of a fossil? Explain how the processes of relative dating and absolute/radioactive dating differ. Relative dating – based on layers of soil fossil is found. Absolute- uses chemical analysis of radioactive ½ life.

9. Explain and give examples of each of the following anatomical comparisons:
   - Homologous Structures – arm of a human and flipper of a dolphin. (same structure modified for different function). Shows each species has the same set of genes for these structures.
   - Vestigial Structures – pelvis and femur of a whale (useless, but functional in related species. Shows they have some of the same genes for these structures)
   - Analogous Structures – wing of a bee and wing of a bat (different structures that serve the same function). Show that environmental pressures can cause evolution of similar functions in unrelated species.

10. Compare and contrast Co-evolution, Convergent evolution, and Divergent evolution. Give specific examples of organisms that represent these patterns. Co = species evolve in response to eachother (parallel). Convergent = unrelated species evolve to be more similar (come together). Divergent = related species evolve to become less similar (move away).

11. How do vestigial structures and homologous structures show divergent evolution? How do analogous structures show convergent evolution? Vestigial & Homologous show how related structures have been modified to yield different functions. Analogous show how same environmental pressures can lead to similar external structure from different evolutionary paths (not modification of same part).

12. Explain the difference between gradualism vs. punctuated equilibrium.
   In gradualism, speciation occurs due to the slow accumulation of genetic differences in populations over time. Punctuated equilibrium describes speciation that occurs very rapidly and is then followed by a period of little to no change.

13. Explain how each of the following can lead to the evolution of a population.
   a. Mutation – introduces new genes
   b. Migration – causes new traits to enter a population or traits exit a population.
   c. Genetic Drift – small population can change due to random events (not natural selection)
   d. Nonrandom Mating – choice in mates leads to changes in populations or differences in genders.
   e. Natural Selection – survival of only a few members of the species leads to better traits surviving and reproducing.

14. What are Hardy-Weinberg’s assumptions for no evolutionary change? Explain what Hardy-Weinberg is actually looking at. (What does the equation show us?) Shows that genotype frequencies in a population are stable. Assuming – no mutation, no natural selection, no migration, large populations and random mating. If the gene frequencies change, then evolution is occurring!

15. How does the study of population genetics define evolution? What is the biological definition of a species? What is a population? A population is a group of a species that has the ability, due to location, to reproduce and can produce viable/fertile offspring. Population genetics studies the changes in gene/allele frequencies in a population.
16. What is evolution? What is the difference between micro-evolution and macro-evolution? Evolution is the genetic change in a population over time. Micro=small scale changes over short periods of time. Macro=large scale changes over large periods of time.

17. What is speciation? What are the 4 events that must occur for speciation to occur? Explain why each is so important. Formation of a new species due to isolation + natural selection + mutation. Isolation—separation from the other population so this population can change independently. Mutation—introduces new genes to the population that are unique. Natural selection—selects mutations and phenotypes (and their corresponding genotypes) that are best suited for the given environment.

18. What is the difference between Reproductive Isolation and Geographic Isolation? Give examples.

   Geographic: land barriers preventing inter-breeding of populations. Example: squirrels on east side of grand canyon vs. those on west side. Reproductive: behaviors preventing inter-breeding of populations. Example: Nocturnal vs. diurnal animals or insects.

19. Natural selection results in a variety of changes in a population. Explain the difference in the populations that occur among stabilizing selection, directional selection and disruptive selection.

   Stabilizing selection: average form of the phenotype has an advantage. Over time, the average form of the trait will become more common. Directional selection: one extreme form of the trait has an advantage; extreme form of the trait will become more common. Disruptive selection: both extreme forms of the trait have an advantage. Over time, the population will have a higher frequency of both extreme phenotypes.

20. Why is evolution beneficial for a species? Why is evolution beneficial for all life on Earth? Why is it beneficial for all humans to understand the Theory of Evolution? It is the mechanism in which all life on earth can change in response to an ever-changing world. It ensures that life will continue throughout a huge variety of changes. Humans need to understand how we are the source of evolutionary changes in many of our predators (bacteria & viruses). We are evolving stronger forms that could be dangerous to us.