**Evolution Worksheet**

Name________________________

**Section A: Charles Darwin**

1. How did Lyell’s books influence Darwin? ______________________________________________________

2. How were the Galapagos Islands significant in Darwin’s evolutionary thought? ______________________

3. What is “descent with modification”? __________________________________________________________

4. Explain the process of natural selection. ______________________________________________________

5. How were Darwin’s thoughts different from Lamarck’s? ____________________________________________

6. How did Malthus’ essays influence Darwin? ______________________________________________________

7. What does “fittest” mean from an evolutionary perspective? _________________________________________

8. Why didn’t Darwin publish his findings soon after returning from his voyage? ______________________

9. Who was Alfred Wallace and what was his contribution to evolutionary thought? ____________________

**Section B: Natural Selection**

1. Which statement is correct? A) Natural selection acts on existing traits. OR B) Natural selection creates new genes. Explain your choice. ______________________________________________________

2. Identify if the following is an adaptation or an acquired trait. Adaptation is an inherited trait. An acquired trait is a learned behavior to an environmental change.
   a. Fiddler crabs can alter the shape or size of their claw by using it more. __________________________
   b. Camels have 3 eyelids to prevent sand from entering during a sand storm. ______________________
   c. Chameleons change their skin color to hide in their surroundings. _____________________________
   d. A rat’s hair was burned off and now has a different scent. ________________________________

3. Bob believes that giraffes have long necks because they have stretched their necks to try and reach food that is high in trees. Since the parent had stretched its neck, it passed the long neck on to its offspring. Who does Bob think like -- Lamarck or Darwin? ______________________________

4. Pandas developed longer wrists to better eat bamboo over time and in turn increase their chance of survival. This is an example of ___.
   a. fitness c. artificial selection
   b. adaptation d. comparative anatomy

5. Living things that are well adapted to their environment survive and reproduce. Those that are not well adapted don’t survive and reproduce. An adaptation is any characteristic that increases fitness, which is defined as the ability to survive and reproduce.
   a. Which mouse would biologists consider the fittest? ____________________________
   b. What adaptation increased the fitness of the mice? ______________________________

<table>
<thead>
<tr>
<th>Color of Fur</th>
<th>Black</th>
<th>Tan</th>
<th>Tan and Black</th>
<th>Cream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Death</td>
<td>2 months</td>
<td>8 months</td>
<td>4 months</td>
<td>2 months</td>
</tr>
<tr>
<td># of offspring</td>
<td>0</td>
<td>11</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Running Speed</td>
<td>8 m/min</td>
<td>6 m/min</td>
<td>7 m/min</td>
<td>5 min/m</td>
</tr>
</tbody>
</table>
6. A more complete definition of fitness is the ability to survive and produce offspring who can also survive and reproduce. Which lion would biologists consider the “fittest”? Explain why.

<table>
<thead>
<tr>
<th>Name of Lions</th>
<th>George</th>
<th>Dwayne</th>
<th>Spot</th>
<th>Tyreone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Death</td>
<td>13 years</td>
<td>16 years</td>
<td>12 years</td>
<td>10 years</td>
</tr>
<tr>
<td># of offspring</td>
<td>19</td>
<td>25</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td># cubs surviving to adulthood</td>
<td>15</td>
<td>14</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Adulthood</td>
<td>10 feet</td>
<td>8.5 feet</td>
<td>9 feet</td>
<td>9 feet</td>
</tr>
</tbody>
</table>

7. Charles Darwin accumulated a tremendous collection of facts to support the theory of evolution by natural selection. One of his difficulties, however, was the lack of an example over a short period of time. Although Darwin was unaware of it, examples of evolution, which might have helped to persuade people of his theory, were in the countryside of his native England. **Scenario:** The industrial revolution began in the middle of the eighteenth century. Since then, tons of soot has been deposited on the countryside around industrial areas. The soot discolored and generally darkened the surfaces of trees and rocks.
   a. Explain how the moth color increases or decreases their chances of survival depending on the environment.

8. A rare genetic variation for smaller body size exists in a population. The variation for smaller body size allows the organisms to use a resource that others cannot; it has no disadvantage. Choose the graph that shows how the distribution of body size in the population is likely to change after many generations.

9. A student explains how natural selection causes populations to change over time: Natural selection happens because individuals have to fight one another to get resources and find a mate. Only the strongest and fiercest individuals get to reproduce and pass on their alleles. That’s what “survival of the fittest” means. The teacher says, “What about sea sponges or oak trees? They can’t fight one another.” Construct an explanation of natural selection that applies to ALL living things.

10. There are two types of rabbits: those that strictly eat grass and those that strictly eat berries and flowers. A drought occurs one year and plants have difficulty producing extra flowers, berries, etc., but they are still green. The rabbits have had babies all year long, but many are eaten by foxes or hawks. Due to the drought, many have starved to death.
   a. Use evidence from the scenario to prove the components of natural selection.

11. The artic fox has adapted to its environment in a number of ways. Its fur turns white in winter and it does not begin to shiver until temperatures plunge below 10°F. Global warming is likely to bring many changes. Overtime, the artic fox will have to adapt to this change. Which adaptation is MOST LIKELY to occur?
   a. Its paw pad may thicken.       C. Its fur may stay white longer.
   b. Its tail may have thinner fur.  D. Its ears may be shorter and rounder.
12. Use the checklist to determine if the following examples are a result of natural selection.

a. Bighorn sheep live in the Canadian Rocky Mountains. The horns grow throughout their lives, but mostly before age 5. Male sheep reach reproductive age when they are about 2-3 years old and live for an average of 11 years. Bighorn sheep attract many hunters who like to harvest the rams with the biggest horns. Since 1970s, scientists have studied the effects of hunting on the bighorn sheep population. When researchers measured the lengths of the horns of rams and their sons, they saw a correlation – rams with longer horns had offspring with longer horns, while rams with smaller horns had offspring with smaller horns. In over 30 years, the average horn length has decreased by 20 cm.

<table>
<thead>
<tr>
<th>Checklist</th>
<th>Yes or No?</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change Over time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genetic Variation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heritability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproductive Advantage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is it Natural Selection?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. The small freshwater snail, *Physella virgata*, lives in streams. Sometimes crayfish live in these streams, and they eat the smaller snails. Scientists measured the shells of snails living in streams with and without crayfish. They found that the snails were larger in the streams with crayfish. To test whether the shell length is heritable, scientists collected snails from two streams: one with crayfish and one without. Keeping the snail populations separate, they let them mate and raised the offspring in two different types of water. The data collected from the experiment is below.

<table>
<thead>
<tr>
<th>Offspring of parents that lived with no crayfish.</th>
<th>Offspring of parents that lived with crayfish.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water from stream with no crayfish</td>
<td>5.8 mm</td>
</tr>
<tr>
<td></td>
<td>5.9 mm</td>
</tr>
<tr>
<td>Water from stream with crayfish</td>
<td>10.1 mm</td>
</tr>
<tr>
<td></td>
<td>9.9 mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Checklist</th>
<th>Yes or No?</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
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<td></td>
</tr>
<tr>
<td>Heritability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproductive Advantage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is it Natural Selection?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Section C: What's happening to the Spotted Salamanders?**

*Background:* A fatal genetic disease has been observed in a population of Spotted salamanders commonly found throughout Georgia. You are a wildlife biologist who has been charged with monitoring changes in the population. You have determined that the fatal disease is the result of a recessive trait and that the affected salamanders typically die in their second year of life. Male and female salamanders are equally likely to be affected by the disease. This exercise simulates the change in allele frequencies under selection.

*Procedure:* The container/bag will contain the “gene pool” consisting of 50 red and 50 white beads. Without looking, withdraw 2 beads from the container/bag. Tally the beads’ colors (red-red, red-white, or white-white) in the table below, and return the two beads to the container/bag. Thoroughly mix the beads. Continue withdrawing beads two at a time, tallying their colors, and returning the beads to the container/bag, until you have drawn 50 pairs of beads. Find the frequency of each color combination using the following formula:

Frequency of a color combination (%) = number drawn of the combination / 50 x 100
Now you will simulate the removal of individuals with the fatal white/white gene pair from the population. Determine the total number of white beads you withdrew in white/white pairs. Remove this number of white beads from the gene pool and replace them with red beads from the bag of extra red beads. For example, if you drew 13 white/white pairs, replace 26 white beads with 26 red beads. From the new “gene pool”, randomly draw another 50 pairs of beads, tally their color combinations as before, and return them to the bag before you draw the next set.

<table>
<thead>
<tr>
<th>Generation 2</th>
<th>Red-red</th>
<th>Red-white</th>
<th>White-white</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color combination tally</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of pairs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Questions:**
1. What happened to the frequency of the red allele and the white allele?
2. Explain how the spotted salamander population is experiencing natural selection.

**Section D: Outcomes of Selection**

1. Which of the following is most likely to have caused the change in the population shown in the graphs?
   a. a new predator prefers dark-tan crabs
   b. a new predator prefers light-tan crabs
   c. a new beach color makes medium-tan crabs the least visible
   d. a new beach color makes medium-tan crabs the most visible

2. What outcome of natural selection is shown in Graph B?

3. Identify the type of selection: directional selection, stabilizing selection, disruptive selection
   a. ____________________ Birds with bigger, thicker beaks can feed more easily on larger, harder seeds. A food shortage causes the supply of small and medium seeds to run low, leaving only larger seeds. Birds with bigger beaks show greater fitness than birds with smaller beaks.
   b. ____________________ The orange and black pattern of a Monarch butterfly serves as a warning to sharp-eyed birds that the Monarch is poisonous. Individuals with the brightest color pattern were more likely to warn off birds and survive to reproduce than those with a dull or medium color pattern. Over many generations, the population became more brightly-colored.
   c. ____________________ In birds, feather color among males is more likely to attract a mate, but also more likely to attract a predator. Over time and many generations, the highest frequency color is for males with medium colors, while males with very dull colors and males with very bright colors become increasingly rare.
   d. ____________________ A population of birds lives in an area where plants with medium sized seeds are wiped out by a fungal infection. Birds with unusually large or small beaks would have higher fitness than those with medium sized beaks. Over time the population splits into two subgroups; one that eats small seeds and one that eats large seeds.
Section E: Fossils

1. Diagram A represents undisturbed rock strata in a given region. Which statement best describes a relationship between these representative organisms?
   a. Organism A was probably more structurally advanced than organism B and organism C
   b. Organism C probably gave rise to organism A and organism B.
   c. All the organisms evolved at the same time.
   d. Organism A was probably more primitive than organism B & C.

2. Fossils would most likely be found in __.
   a. amber that is over 8 billion years old
   b. sedimentary rock that are 500 million years old
   c. icebergs that are 500 billion years old
   d. volcanic rock that are 50 million years old

3. In the fossil bed at the Falls of the Ohio, located between Kentucky and Indiana, scientists found 212 species of coral. Consider the environmental conditions under which most coral live. Which scenario MOST LIKELY describes the ancient environment of the Falls?
   a. dry, hot and near the equator
   b. tropical and underwater
   c. temperate, northern latitudes, underwater
   d. tropical, at the boundary of two tectonic plates

4. **Dating the Fossil Record** -- You have received 9 rock samples from a paleontologist in California. Your job is to arrange the samples in order from oldest to youngest according to their fossil content. Results from absolute dating methods will not be available from a laboratory for several weeks, and the paleontologist needs the information immediately. You know from previous work that the rocks in sample 2 are the oldest.

<table>
<thead>
<tr>
<th>Order of Samples</th>
<th>Age of sample (in millions of years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.2 mya</td>
</tr>
<tr>
<td>2</td>
<td>15.5 mya</td>
</tr>
<tr>
<td>3</td>
<td>17.6 mya</td>
</tr>
<tr>
<td>4</td>
<td>18.3 mya</td>
</tr>
<tr>
<td>5</td>
<td>19.5 mya</td>
</tr>
<tr>
<td>6</td>
<td>23.1 mya</td>
</tr>
<tr>
<td>7</td>
<td>26.3 mya</td>
</tr>
<tr>
<td>8</td>
<td>28.5 mya</td>
</tr>
<tr>
<td>9</td>
<td>30.2 mya</td>
</tr>
</tbody>
</table>

5. **How old is the body?** -- The body of a man wearing the traditional clothes of the snow plains nomads was found at the bottom of a peat bog that remains from the last glacial retreat. He had a stone ax buried in his skull. The ax was made in the ancient nomad style, stone chipped to a sharp edge and bound by leather strips to a forked branch. Because of the victim’s dress and the unusual murder weapon, the police are assuming this homicide involves a clan dispute among the wandering deep snow people who still maintain their ancient territorial ways. The acid bod preserved the body. Forensic evidence shows the man was killed elsewhere, dragged to the bog and then thrown in, presumably to hide the crime. After months of investigation no new evidence or information was turned up. Eventually the police requested a Carbon-14 radioactive dating test done on the body and clothes. To their astonishment the test found that only 3,000 radioactive C\(^{14}\) atoms were present instead of the 10,000 atoms expected from a recently deceased person. How long ago did the murder take place? ________________

<table>
<thead>
<tr>
<th>Years since death</th>
<th>C(^{14}) atoms remaining per 100,000,000 C(^{12}) atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10,000</td>
</tr>
<tr>
<td>5,700</td>
<td>5,000</td>
</tr>
<tr>
<td>11,400</td>
<td>2,500</td>
</tr>
<tr>
<td>17,100</td>
<td>1,250</td>
</tr>
</tbody>
</table>
Section F: Adaptive Radiation, Embryology & Genetic Evidence

1. Adaptive radiation is the relatively fast evolution of many species from a single common ancestor. Adaptive radiation generally occurs when an organism enters a new area and different traits affect its survival. An example of adaptive radiation is the development of mammals after the extinction of dinosaurs. Watch video and summarize how the salamanders are undergoing adaptive radiation.

2. All vertebrate embryos follow a common developmental path due to their common ancestry. All have a set of very similar homeobox genes that define their basic body plan. As they grow, the differences that will distinguish the embryos as adults become more and more apparent. Why is embryology a good indicator of evolution?
   a. All embryos use the same genes at the exact same instant during development.
   b. The embryos of various groups of vertebrates all share the same features of early development, suggesting an evolutionary relationship.
   c. Embryological development occurs at the same pace in all organisms.
   d. The fact that any organisms undergo embryological development at all suggests evolution.

3. Adaptive radiation ___.
   a. is another term for natural background radiation that causes adaptive changes
   b. is the evolution of the biggest and fiercest animals
   c. is the formation of new adaptive structures or colors within a species
   d. is the evolution of many species that occupy various niches, from a single ancestral form

4. Similarities in embryonic development amount organisms often suggest that they ____.
   a. are all members of the same species
   b. all undergo external development
   c. may have evolved from a common ancestor
   d. have adaptations for the same environment as adults

5. Which is an example of adaptive radiation?
   a. Four flowers of the same species that happen to grow across the country from each other.
   b. Four flowers of different species that evolved from a common ancestry due to selective pressures in slightly different niches.
   c. One flower species, one dog species, one bacterium species and one virus species that all compete within the same niche.

6. Four of the five answers listed below are sources of variation in a population. Select the exception.
   a. mutation c. crossing over
   b. independent assortment d. asexual reproduction

7. The amino acids for beta hemoglobin found in five species were compared to the amino acids found in human (Homo sapiens) beta hemoglobin. The number of sequence differences was recorded. Based on the molecular data, which species is most closely related to humans?

<table>
<thead>
<tr>
<th>Species</th>
<th># of differences from Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gorilla</td>
<td>1</td>
</tr>
<tr>
<td>Gibbon</td>
<td>3</td>
</tr>
<tr>
<td>Lemur</td>
<td>30</td>
</tr>
<tr>
<td>Rhesus Monkey</td>
<td>8</td>
</tr>
<tr>
<td>Squirrel Monkey</td>
<td>11</td>
</tr>
</tbody>
</table>

8. If we compare the genetic codes of four organisms – dog, algae, flower and bacteria – which statement is MOST accurate?
   a. All 4 organisms have the exact same genetic code.
   b. All 4 organisms have the same genome, but the chromosome number varies.
   c. All 4 organisms have the same components of DNA, but it varies in number and sequence.
   d. There are no similarities between the genetic code of these 4 organisms.

9. The genetic information in human and chimpanzee DNA shows a degree of similarity, as humans share 96-99% of their DNA code with chimpanzees. What is an explanation for this similarity?
10. Which of the following organisms share the most recent ancestor? ______________________

11. Which of the following is a correct interpretation of this analysis?
   a. Species 4 is the ancestor of species 5.
   b. Species 5 is the ancestor of species 4.
   c. Species 3 is the ancestor of species 4 and 5.
   d. Species 4 and 5 share a common ancestor.

12. Cytochrome-C is an enzyme found in most organisms and is used during cellular respiration. The protein chain is composed of 60 amino acids and there is a slight variation in the amino acid sequence between organisms. Which organism is most closely related to a human? ______________________

<table>
<thead>
<tr>
<th>Organism</th>
<th>Amino Acid Sequence in Cytochrome-C</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>GDVEKGGKIFIMKCSQCHTVEKGGKHKTGPNLHGLFGRKTGQAPGYSYTAANKNKGIW</td>
<td></td>
</tr>
<tr>
<td>Horse</td>
<td>GDIEKGGKIFVQCSQCHTVEKGGKHKTGPNLHGLFGRKTGQAEGFSYTDANKNKGITW</td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>GDVEKGGKIFVQKCAQCHTVEKGGKHKTGPNLHGLFGRKTGQAPGRTYTDNKNNKGIW</td>
<td></td>
</tr>
</tbody>
</table>

Section G: Comparative Morphology

1. Which term is used to describe body structures that look alike and serve a similar function, but were not evolved from a common ancestor? ______________________

2. Structures of organisms that may look different but have strong similarities in construction and come from the same embryonic tissues are called ________________________ structures.

3. What do homologous structures indicate about the organisms? ________________________

4. What would cause organisms to develop analogous structures? ________________________

5. How do scientists explain the presence of vestigial structures in organisms? ________________________

6. Which one of the following sets of structures includes only analogous structures?
   a. Wings of a butterfly and a bat   c. Hind legs of horses and a zebra
   b. Hands of a monkey and a human   d. Fin of a salmon and a catfish

7. In the diagram to the right B, C, and D represent organisms that exist in the present time and show a striking similarity to each other in their bone structure. In the diagram, letter A most likely represents
   a. homologous structures   c. an acquired characteristic
   b. a common ancestor   d. geographic distribution

8. Which of the following are homologous structures?
   a. the fin of a dolphin and the fin of a shark
   b. the wing of a bat and the wing of a bird
   c. the beak of a bird and the beak of a turtle
   d. the leg of a horse and the leg of a dog

9. The streamline shape of sharks and whales, similar but not due to a common ancestor is an example of __.
   a. analogous structures   c. embryology
   b. homologous structure   d. vestigial organs

10. The wing of a bird and the leg of a horse are very different looking structures. Although they look different, bird wings and horse legs are very similar in the arrangement of the bones that make up the limb and developed from the same embryonic tissue. This is an example of __.
   a. analogous structures   c. embryology
   b. homologous structures   d. vestigial organs
Section H: The Making of the Fittest --- Evolving Bodies, Evolving Switches

http://www.hhmi.org/biointeractive/making-fittest-evolving-switches-evolving-bodies

1. Identify if the following statements are true or false. Explain your answer.
   a. “Having pelvic spines is always advantageous to a stickleback.”
   b. “All mutations are bad.”

2. In the film, Dr. Bell notes that in multiple freshwater populations and at multiple times in history, the frequency of stickleback fish with pelvic fins decreased and frequency of stickleback fish with reduced pelvises increased. This demonstrates that __.
   a. only fish with smaller pelvises migrate to freshwater
   b. similar environments select for similar genetic changes
   c. the pelvis of the marine fish is destroyed by freshwater

3. Circle whether each statement is true or false.
   a. True or False   Evolutionary change always takes millions of years.
   b. True or False   Dramatic changes in traits can occur through mutations affecting a single gene.

4. During a high-flood season, a lake overflows its banks and some resident freshwater stickleback fish are carried out to the ocean. For each of the following statements, circle the outcome most likely to occur.
   a. When they reach salt water, individual fish (will / will not) spontaneously generate pelvic spines during their lifetime.
   b. More fish (with / without) pelvic spines will be eaten by large-mouthed predators.

Section I: Mechanisms of Microevolution

   a. Explain how the environment plays a role in changing the frequency of a mutant allele in a population.
   b. Near the end of the film, Dr. Sean B. Carroll states that “while mutation is random, natural selection is not.” In your own words, explain how this is possible.

2. Genetic drift is the process where there are random fluctuations in the gene frequencies within a population. Which of these populations would most likely experience genetic drift?
   a. The world’s population of humans
   b. A small population of flowers in the amazon rain forest
   c. A population of bacteria experiencing exponential growth
   d. A large population of pine trees in the northern coniferous forest

3. There is a beetle population that has either green or brown coloration. Some beetles with brown genes immigrate into an existing population. This is an example of ____________________________.

4. A particular bird species found in North America obtains most of its food energy by catching and eating insects. A mutation arises in the bird population that increases beak length. This mutation has increased the ability of the bird to catch and eat certain insects. How will the mutation affect the frequency of beak length in the population? ____________________________________________________________________________

5. Which of these best describes the process of gene flow?
   a. The strongest organisms survive and reproduce.
   b. The movement of genes within a population.
   c. The transfer of genes from one population to another.
   d. Individuals within a species have genetic variability.
6. Polydactyly – extra fingers or toes – is one symptom of Ellis-van Creveld syndrome. This disease is more concentrated among the Amish because they marry within their own community, which prevents new genetic variation from entering the population. [http://www.pbs.org/wgbh/evolution/library/06/3/l_063_03.html](http://www.pbs.org/wgbh/evolution/library/06/3/l_063_03.html)
   a. Is this an example of genetic drift? Explain your answer. _____________________________________________________________
   b. Would the frequency of the disease be different in a larger population? Explain your answer. ____________________________________________________________

7. Northern elephant seals have reduced genetic variation because of a population bottleneck inflicted on them in the 1890's by humans. Hunting reduced their population size. Although their population has rebounded, their genes still have less genetic variation than a population of southern elephant seals. Big losses of genetic variation for small populations are caused by _________________________________.

8. Which mechanisms are responsible for introducing new alleles into a population’s gene pool?

9. Tasmanian devils, a marsupial carnivore, have experienced a severe decline in their numbers due to the spread of a cancer known as Devil facial tumor disease. The facial tumors can interfere with their ability to eat or see. Females generally produce their litter toward the end of their second year. Scientists have recently observed a dramatic increase in the sexual maturity of females at an earlier age. How might genetic drift account for this change?
   a. More fertile female Tasmanian devils have larger litters.
   b. Females that reproduce at an early age are immune to DFTD.
   c. Females reaching sexual maturity at an early age are more likely to reproduce before being infected with DFTD.
   d. Females reaching sexual maturity sooner are more likely to mate with healthy males and have offspring that survive infection by DFTD.

10. A population is a group of individuals of the same species. Can the frequency of certain traits in a population change as a result of an environmental change?
   a. Yes, individuals in a population can change their inherited traits to better fit the environment, and this changes the proportion of individuals with certain traits.
   b. Yes, individuals with certain inherited traits survive and reproduce. Other individuals with different inherited traits die, and this changes the proportion of individuals with certain traits.
   c. No, the proportion of individuals with certain inherited traits in a population changes randomly from one generation to the next, never as a result of changes to the environment.
   d. No, the proportion of individuals with certain inherited traits in a population cannot change because a population is all one species and so will always have the same inherited traits.

**Section J: Patterns & Rates of Evolution**
1. Sharks and dolphins look very much alike – both have streamlined bodies, fins and sharp teeth. The body structures have evolved independently. Which evolutionary pattern describes the process by which two species may evolve in similar ways and come to resemble one another? __________________________

2. Darwin surmised that a few finches migrated to the Galapagos from the mainland. These finches gave rise to the many species of finches on the island today due to adaptive radiation. Which evolutionary pattern is illustrated in the finches? __________________________

3. What evolutionary evidence supports divergent evolution? __________________________

4. The African yellow-throated long-claw has a yellow breast with a black chevron "V". This bird looks and acts so much like an American meadowlark that a competent bird watcher might mistake them for the same species, yet they belong to different avian families. Why would these organisms that are not related start to look similar? __________________________

5. Video: Explain how the relationship between the toxic newt and the garter snake is an example of coevolution. __________________________
6. Which rate of evolution is illustrated in the diagram – punctuated equilibrium or gradualism? __________________________
7. Which model (rate) of evolution suggests that species stay the same for long periods of time, then changes abruptly due to mutations in key genes? __________________________
8. Which model (rate) of evolution would a scientist find an abundance of transitional fossils? ________________________________

Section K: Macroevolution
1. What initial factor has to be present for speciation to occur? ________________________________
2. Identify the type of isolation mechanism illustrated in these examples.
   a. In North America, five frog species of the genus *Rana* differ in the time of their peak breeding activity. __________________
   b. The lion and tiger habitat overlapped in India until 150 years ago, but the lion lived in open grassland and the tiger in forest. The two species did not hybridize in nature. __________________
   c. If a male firefly tries to impress a female and the female firefly does not recognize the patterns of light created by a male firefly. __________________
   d. Hawthorn flies lay eggs in Hawthorn trees where the eggs hatch into larvae and feed on fruits. Some flies started laying eggs in nearby apple trees. When the eggs hatched, the larvae fed on apples. Overtime, they become reproductively isolated; the breeding season matches the season when the apple or hawthorn fruits mature. __________________
   e. When the Grand Canyon formed many small mammal populations were divided and were unable to mate. Over time the separation and inability to mate with one another led to the emergence of new species. __________________
3. If two populations of the same species of insects have been geographically isolated from each other for an extended period of time, the will MOST LIKELY exhibit __.
   a. increased rates of genetic mutations
   b. very few differences in terms of appearance
   c. evolution into two different species that can mate and interbreed
   d. different traits that allow each to better survive in its particular environment
4. The leopard frog and the pickerel frog are two closely related species. In areas where their ranges overlap, the frogs will remain separate species if they __.
   a. maintain different color markings on their skin
d. reproduce at different times of the year
   b. eat different types of insects and crustaceans
e. occupy burrows in different parts of a creek
5. Natural selection can lead to the formation of a new species which is called ____________________.
6. Which statement would probably NOT result in the formation of a new species?
   a. The introduction of a predatory fish that only eats the largest native bass in a Georgia lake.
b. A period of stable weather that lasts for hundreds of years, allowing a species of grass to do well.
c. A mutation that causes a purple color form to appear in peacock males, which the peahen females seem to either strongly like or dislike.
d. Isolation of a population of lizards on an island, which later become too distant form the mainland for other lizards to swim to the island.