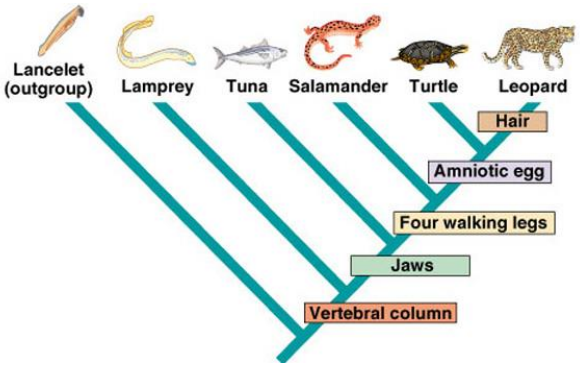
Flagstaff High School Pre-AP Biology Evolution Packet & Study Guide #2

Part I. Sexual Selection

Male guppies (*Poecilia reticulata*) exhibit genetically determined spots while juvenile males and females lack spots.

1. Describe an investigation set-up that could answer the following questions:
   a. Do females prefer to mate with males with more spots such that these males have a reproductive advantage?
   b. Are predatory fish better able to find males with more spots such that these males have a survival disadvantage in the presence of predatory fish?

Part II. Phylogeny



Use information from the cladogram (phylogenetic tree) to justify your answers to the following questions:

2. Do all tetrapods have amniotic eggs?
3. Is the salamander or the turtle more closely related to the leopard?
4. Do turtles share a more recent common ancestor with tuna or lamprey?
5. Which species lacks all of the characters shown?

Another commonly studied protein is cytochrome *c*. This protein, consisting of 104 amino acids, is located in the mitochondria of cells. There it functions as a respiratory enzyme. Examine Figure 2. Using human cytochrome *c* as a standard, the amino acid differences between humans and a number of other organisms are shown.

Species Pairings	Number of Differences
Human-chimpanzee	0
Human-fruit fly	29
Human-horse	12
Human-pigeon	12
Human-rattlesnake	14
Human-red bread mold	48
Human-rhesus monkey	1
Human-screwworm fly	27
Human-snapping turtle	15
Human-tuna	21
Human-wheat	43

Figure 2

Use information from the data table to justify your answers to the following questions:

6. Are horses or pigeons more closely related to humans?
7. Do humans and chimpanzees have identical amino acid sequences for cytochrome c?
8. Do humans and rhesus monkeys have identical amino acid sequences for cytochrome c?
9. Draw a phylogenetic tree that show: Humans, rhesus monkeys, horse & tuna:

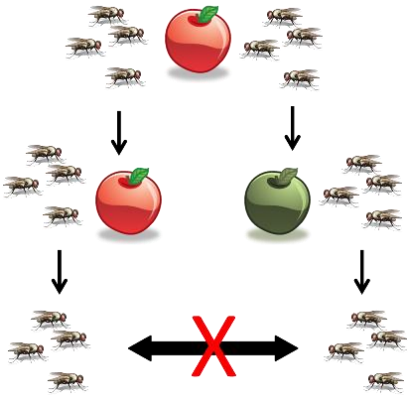
Table of Nucleotide Differences

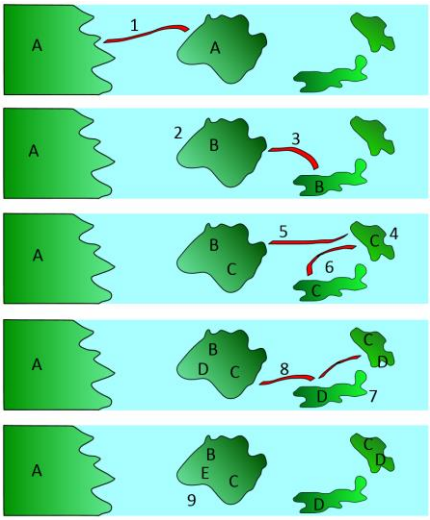
Species	1	2	3	4	5
1	-	4	13	15	30
2		-	13	15	28
3			-	2	29
4				-	29
5					-

10. Construct a phylogenetic tree that best represents the evolutionary relationships between the five species shown:

Population	Tasters	Nontasters	Size of Population
1	888	544	1432
2	73	54	127
3	4307	2422	6729
4	7286	4857	12143

11. The table shows the frequency data for four isolated populations that are in Hardy-Weinberg equilibrium. The allele for nontasters is recessive. In which population is the frequency for the recessive allele highest? Justify:





12. What is the biological definition of a species?

13. Use the allopatric model of speciation to explain how the Abert and Kaibab squirrels are on their way to becoming separate species:

14. Use the sympatric model of speciation to explain how one species of fruit fly could become two species after the introduction of a new host tree (the fruit fly feeds upon the tree's fruit):

15. With adaptive radiation, one species may become many new species. This process is particularly observable on volcanic island chains (see left). Discuss the mechanisms that can result in rapid speciation in such environments:

16. Elephant seals were hunted to near extinction in the northern hemisphere by the end of the 1800s. The seals were hunted for their blubber, which was used to make lamp oil at the time.

a. Predict how the allelic frequencies of the reduced population would compare to the initial population:

b. Predict how the reduced population would be expected to fare against a brand new disease, when compared to the initial population:

17. Europeans accidently introduced a bird form of malaria (called avian malaria) to the Hawaiian Islands in 1820. Use what you know about genetics and evolution to explain why this new disease has been devastating to native Hawaiian birds:

18. 400 million years ago, lobed-finned fish were present in the oceans of the world and by 265 million years ago, the first tetrapods emerged. Explain how researchers could test the hypothesis that tetrapods evolved from lobe-finned fish:

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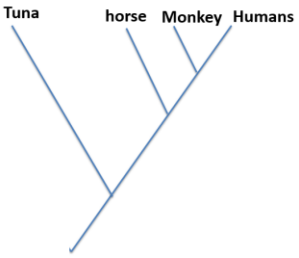
1. Collect guppies from many pools/ponds so as to capture a wide-range of genetic diversity and place these guppies together in a common pond/pool. Collect data on the number of male spots at time zero. Continue to collect data on the number of spots on male guppies over time. After a number of generations (perhaps six months) separate the pond/pool into two with one having predatory fish of guppies and the second lacking predators. Continue to collect data on the number of spots over time (perhaps another six months) in both environments.
2. No, all tetrapods (animals with four limbs) do not have an amniotic egg because salamanders are tetrapods but do not have the amniotic egg.
3. The turtle shared a common ancestor more recently with the leopard than the salamander because the turtle and leopard diverge higher up on the phylogenetic tree.
4. The turtle shares a more recent common ancestor with the tuna than the lamprey because the tuna and turtle diverge higher up the phylogenetic tree than the tuna and turtle.
5. The lamprey is the outgroup, it lacks all of the characteristics shown in this phylogenetic tree.
6. There are 12 amino acid differences between humans and horses and humans and pigeons for cytochrome c. So just by this data alone, it appears as if humans are equally closely related to both horses and pigeons.
7. Humans and chimpanzees have identical amino acid sequences for cytochrome c.
8. There is one amino acid difference between the human and rhesus monkey version of the cytochrome c protein.
9. Tree:



10. Tree:

11. Population 1: Take the square root of 522/1432 = 0.62; Population 2: Take the square root of 54/127 = 0.65; Population 3: Take the square root of 2422/6729 = 0.6; Take the square root of 4857/12143 = 0.63, the population with the largest frequency of the recessive allele is population 2 because 0.65 is larger than 0.6, 0.62, and =0.63.
12. The biological definition of a species: a group of populations, whose members interbreed with one another to produce viable (live) offspring that are fertile.
13. When the Grand Canyon (and Colorado River) divided the squirrels into two populations that were reproductively isolated due to geography (a canyon and river separating them). Each population continued to accumulate new mutations, but these could not be shared because they could not mate with each other. Additionally, the conditions on both sides of the canyon were slightly different (N. rim is higher in elevation and cooler) and thus selective pressures and natural selection differed and the squirrels and chipmunks continued to diverge due to selection. Eventually the populations are expected to become different enough that they will become separate biological species.

14. The change that can cause speciation in fruit flies is the introduction of a new host-plant. If some flies stay on the original, native host-plant but some flies switch to and prefer the newly introduced host-plant, the flies could become reproductively isolated even without a geographic barrier. This could happen if female flies that hatch out of the nonnative fruit prefer to mate with males that also hatch out of this type of fruit and then they lay their eggs in the nonnative fruit.
15. Adaptive radiation on volcanic island chains can result in the rapid evolution of new species because of the reproductive isolation as a result of geography (separation due to the ocean), adaptation to different habitats and way of life (niches) due to the process of natural selection, and potentially also due to random changes in allele frequencies as a result of small population sizes (genetic drift).
16. Elephant seals were hunted to near extinction in the northern hemisphere by the end of the 1800s. The seals were hunted for their blubber, which was used to make lamp oil at the time.
    a. Predict how the allelic frequencies of the reduced population would compare to the initial population: Population bottlenecks (decline in population size) is associated with a genetic bottleneck (loss of genetic diversity and random changes in allele frequency due to genetic drift). Therefore, a change in allele frequency (and microevolution) is expected to have occurred.
    b. Predict how the reduced population would be expected to fare against a brand new disease, when compared to the initial population: The initial population is expected to have a better chance at survival when a brand new disease enters the population because the initial population has a higher genetic diversity and thus would be more likely to have individuals that happen to have genetic resistance to the new disease.
17. Europeans accidently introduced a bird form of malaria (called avian malaria) to the Hawaiian Islands in 1820. Use what you know about genetics and evolution to explain why this new disease has been devastating to native Hawaiian birds: Since the native birds evolved in the absence of this new disease, the first time they were exposed to the disease, very few individuals had a genetic resistance to the disease and thus most birds were killed. However, those few that happened to have a genetic resistance, had a survival advantage and thus when they reproduced, they were able to pass on this resistance to their offspring.
18. 400 million years ago, lobed-finned fish were present in the oceans of the world and by 365 million years ago, the first tetrapods emerged. Explain how researchers could test the hypothesis that tetrapods evolved from lobe-finned fish: Researchers could explore this hypothesis by searching for fossils between 400 and 365 million years old that show a transitional state between fish with fins and tetrapods with limb. Researchers would then compare the arrangement of the fin and limb bones in such transitional fossils.