Scenario: Tradeoffs in Selection

**Natural selection** is the mechanism of evolution by which populations become adapted to their environments. As a result, all organisms exhibit certain phenotypic traits (physical, chemical, and behavioral) that enhance their ability to survive and reproduce. **Sexual selection** is a special case of natural selection that acts solely on traits that influence an individual’s chances of reproducing. In order to operate, each type of selection requires heritable genetic variation for a trait coupled with a difference in relative fitness between genotypes that encode the trait. Biologists think of **fitness** as the expected contribution of a gene or genotype to succeeding generations compared to other genes or genotypes in a population. Natural selection and sexual selection are not mutually exclusive, and may operate simultaneously on the same trait(s). This may lead to some interesting and unexpected outcomes.

Imagine yourself as an evolutionary biologist working in the Amazon rain forest. You discover and name a new species of bird, *Mytal llsigorguese*, in which males typically have extremely long and colorful tails. You suspect that sexual selection might be responsible for the evolution of this trait and, after securing funding through a grant from the NSF (National Science Foundation), you fly off to the wilds of the Amazon to test your hypothesis.

After months of careful observation, you find that there is significant genetic variation among males for showiness and tail length – some males are extremely colorful with very long tails, while others have stubby tails and are of a drab brown color. Over the next couple of years you collect data on the frequency of male mating success and, to your delight, discover that the brightest colored males have a 5:1 advantage over their duller colored counterparts. Females dig the brightly colored males! You write up your results and the paper is published in the journal *Science*. You are flying high! Not only does this secure you tenure and promotion to associate professor, but it greatly increases the chances that your next NSF grant will be funded. Your next few years are filled with speaking invitations from universities around the world, where you enthrall audiences with tall tales of bright tails from the heart of the Amazon. But eventually you tire of the lecture circuit and, having secured another grant from the NSF, return to the jungle to continue your research.

As you trudge through the sweltering jungle to reach your field site, you are haunted by a question asked at one of your lectures. “Professor… have you observed any differences in predation rates between the brightly and dull colored birds? It would seem that the brighter birds, being more conspicuous, would be more vulnerable to attack from the forest hawk, *Illripyo urfeathersout*, that is known to be common in the region. If this is true, why doesn't natural selection favor the dull colored males?”

After another year of observing the birds, your data show that the bright birds are indeed at higher risk of attack from the hawks. In fact, a bright colored male is **three** times as likely to be picked off compared to a dull colored male. As you struggle to explain how a trait which leads to the premature death of its bearer can be favored by selection, you recall Theodosius Dobzhansky's famous observation. “Nothing in biology,” he once said, “makes sense except in the light of evolution.”
Carefully read ‘Tradeoff in Selection’ and answer the following questions.

1. Relative fitness is best defined as:
   a. vigor.
   b. the expected contribution of a gene or genotype to succeeding generations.
   c. average life expectancy.
   d. the extent to which a trait is under genetic control.

2. All of the following statements applies to sexual selection except
   a. It can result from females choosing males having preferred traits.
   b. It often leads to the evolution of traits found in one sex and not the other.
   c. It may result from males fighting amongst themselves for access to females.
   d. It results in more offspring of one sex than the other sex.

3. In order to operate, both sexual selection and natural selection require:
   a. heritable genetic variation for some trait.
   b. equivalence of fitness among genotypes.
   c. that the target trait affects an organism’s ability to attract a mate.
   d. that more fit individuals have longer lifespans compared to less fit individuals.

4. Assuming that all the traits contributing to the results below are genetically controlled, which member of a population of *Mytai lisgorgeous* is most evolutionarily fit? One that
   a. lives 12 years, produces 36 eggs, 19 hatch and reproduce.
   b. lives 14 years, produces 26 eggs, 14 hatch and reproduce.
   c. lives 7 years, produces, 24 eggs, 21 hatch and reproduce.
   d. lives 5 years, produces 23 eggs, 18, hatch and reproduce.
   e. lives 17 years, produces 20 eggs, 20 hatch and reproduce.
Activity: Tradeoff in Selection

Consider the consequences of natural and sexual selection operating simultaneously on plumage color among male birds. Following the scenario outlined in your reading, assume that, in the absence of predators, bright colored and dull colored males are identical in all ways except for their attractiveness to females.

1. Explain why selection can operate only on traits for which there is heritable genetic variation.

2. Does sexual selection result in organisms becoming optimally adapted to their environments? Explain your reasoning.

3. Calculate the relative fitnesses of bright and dull colored males under the scenario described in your reading. (Hint: In nature, fitness is very hard to measure accurately. Make use of the data reported for mating success and mortality from hawk attacks)

4. Consider Dobzhansky's statement that “Nothing in biology makes sense except in the light of evolution”. What do you think he meant?
Post-Activity Assignment: Tradeoff in Selection  Name ________________________________

1. Heritable genetic variation implies _____
   a. a trait is strictly under the control of genes.
   b. there are differences in fitness among genotypes.
   c. the presence of genetic variation upon which selection can operate.
   d. that offspring look nothing like their parents.

2. Which of the following would be most useful in predicting the outcome of evolution in *Mytai lispogorous*?
   a. the intensity of hawk predation
   b. the strength of female preference for bright males
   c. the relative fitnesses of the genes which encode the bright and dull coloration
   d. the frequency of the two genes in the population

3. Which of the following could account for an increase in the frequency of dull males in the population?
   a. a decrease in female preference for bright males
   b. an increase in the number of hawks in the area
   c. an increase in female preference for dull males
   d. all of the above

4. Which of the following statements is *not* correct?
   a. Natural selection results in perfect adaptation.
   b. Fitness is determined by the relationship between the phenotype and the environment.
   c. Both natural and sexual selection are non-random processes.
   d. An increase in the number of hawks in the area would result in a decrease in the number of brightly colored male birds in the population over time.