# Study Guide for Exam 3
## (Exam 3 will be held Tuesday, April 16, 2019)

This study guide will grow with a new section added after each lecture, so please revisit it often! Pace your studying so that you master each set of concepts before the next lecture.

## Tuesday, March 12: Introduction to natural selection

• What are the three ingredients required for natural selection?

• What is the result of natural selection?

• When does natural selection not lead to evolution?

• What is the difference between viability and fecundity?

• Define fitness (Darwinian fitness, not physical fitness)

• Does "survival of the fittest" accurately describe natural selection? Why or why not?

• What tends to happen to populations of daisies that become established on small islands?

• Why did soapberry bugs in Florida evolve smaller beaks whereas those in south-central US evolved larger beaks?

## Thursday, March 14: Natural selection at a single locus

• What gene controls bony armor in threespine sticklebacks? Is it dominant? If so, which allele is dominant?

• Threespine stickleback populations evolve when they become permanently trapped in inland freshwater lakes. Describe the typical evolutionary change that happens in these freshwater stickleback populations.

• What is a selective sweep? What is meant when the term "hitchhiking" is used in the context of a selective sweep?

• How does the G allele from the PtFT2 locus benefit European aspen living in the northern half of Sweden?

• Is it possible for a trait to become fixed in a population when it is not the underlying cause of fitness differences? (Hint: consider Fig. 3.14 in the textbook.)

## Tuesday, March 26: Modeling natural selection

• Be sure you can obtain allele frequencies if you are given genotype frequencies.

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• Be sure you understand how to calculate the mean fitness.

- Be sure you can compute genotype frequencies after selection given the fitness of each genotype and genotype frequencies before selection.

## Thursday, March 28: Rise and fall of the melanic peppered moth

- Why did the dark melanic allele evolve to near fixation in British peppered moths in the late 1800s?

- Define selection coefficient. What does it mean if the selection coefficient is 0? What does it mean if the selection coefficient is 1?

- Use the "Peppered moth in the 1800s" applet to estimate the selection coefficient needed to explain the rise of the melanic phenotype from a frequency of 0.01 to 0.99 over 50 years.

- Why did the light colored allele evolve to near fixation in recent decades?

- Use the "Peppered moth in the 1900s" applet to explore values of the selection coefficient in a model that attempts to explain the recent demise of the melanic phenotype. Does it appear that selection pressure has been constant over the 40 years from 1960 to 2000? If not, has selection against the melanic phenotype increased or decreased?

## Tuesday, April 2: Balancing selection, quantitative traits, heritability

- How does the model for $\beta$-hemoglobin (sickle-cell vs. normal alleles) differ from the model for peppered moth (melanic vs. normal alleles)?

- Plotting mean fitness (vertical axis) against allele frequency (horizontal axis), what is the main difference between the mean fitness curve for balancing selection compared to the mean fitness curve for directional selection?

- How does a quantitative trait differ from a Mendelian trait?

- What is a purely additive locus? What is additive genetic variance?

- What effect does environmental variation have on trait variance compared to the additive genetic variance?

- How is heritability ($h^2$) defined in terms of variance? How is it possible for a trait that is genetically determined to have low heritability?

- Heritability is the slope of a line in what kind of plot? That is, what quantities are plotted on the horizontal and vertical axes of this plot?

- What is the selection differential (S)?

- What is the response to selection (R)?

- How does the breeder's equation relate heritability, selection differential, and the response to selection?

## Thursday, April 4: Quantitative trait evolution by natural selection

- Does dominance in a locus increase or decrease the phenotypic (trait) variance compared to the additive genetic variance?

- How would you calculate the heritability of a trait if the additive, environmental, and dominance variance components are known?

- The selection gradient is the slope of a line in what kind of plot? That is, what quantities are plotted on the horizontal and vertical axes of this plot?

- Why did the mean beak depth of Geospiza fortis (Medium Ground Finch) birds increase from 1976 to 1978? Was the selection gradient positive, negative, or zero during the 1977 drought? Is this an example of directional, stabilizing, or disruptive selection?

- Which of the following types of selection primarily affects the variance of a trait? Which primarily affects the mean of the trait? Choices: directional, stabilizing, disruptive.

- Is a trait that undergoes a shift in mean across generations necessarily under selection? That is, what is the difference between selection "of" a trait and selection "for" a trait?