Study questions. First Exam. Evolution (L567) 2006

What were Darwin's major contributions to the theory of evolution? Why was his idea of gradual evolutionary change through the action of "natural selection" rejected by most of his contemporaries?

Is natural selection necessary and (always) sufficient for evolutionary change? What is the difference between natural selection and evolution? Define both.

What is essentialism? What is typological thinking? How are these different from populational thinking?

What is meant by blending inheritance? Why was it thought to be a problem for natural selection?

Give a formal definition of an ESS. Contrast an evolutionarily stable strategy with an evolutionarily stable state. What is a mixed ESS? What is a pure strategy? What is a conditional strategy?

What did the study by Nick Davies indicate regarding the defense of sunspots by butterflies?

What is the difference between dynamic equilibria (limit cycles) and static equilibria? Give examples.

What is the difference between discrete strategies and continuous strategies? How does the difference affect the modeling strategy?

What is Fisher's argument for the evolution of investment in the sexes? What are the assumptions, and how were these assumptions later relaxed by Hamilton?

How could restricted access to mates (Local Mate Competition) affect the evolution of gender allocation in hermaphrodites?

How could restricted access to mates (LMC) affect sex ratio evolution in species with separate sexes (females and males)? How could you find the optimum investment in sons? How could you tell if the candidate ESS was actually stable to invasion (i.e., at a local maximum)?

How will natural selection operate on offspring size? What is a size-number compromise? How can a size-number compromise lead to parent-offspring conflict? Give a graphical model for the evolution of optimal allocation to each offspring.

What was the main result of the Salmon study with respect to life-history evolution?

When might selection operate to reduce the variance in offspring survival over time? How would such a reduction affect the geometric mean? How might it affect the amount of resources allocated to individual offspring? What, if anything, would the solution have to do with Bet Hedging?
Contrast the assumptions and predictions of Muller’s Ratchet and Kondrashov’s hatchet. How does Muller’s Ratchet work? How does Kondrashov’s hatchet work?

If mutations act independently, how could you find fitness at mutation-selection balance? (You don’t need to do the math, just indicate what must be true at mutation selection balance.)

Write a brilliant question, and briefly answer it (5 points for the brilliance of the question and 5 points for the answer; total score is the product of the two).

Write a brilliant question, and briefly answer it (13 points for the brilliance of the question and 12 points for the answer; total score is the sum of the two).

Which of the above two questions is most scary? Why?

What three concepts would you insist on including in an undergraduate course in evolution?

What is meant by diminishing returns? Give an example. Exactly how do diminishing returns figure into Local Mate Competition?

What is Bateman's principal? Can you think of ways is which it can be violated? How would changing the assumptions affect the model for sex ratio evolution?

How would you determine the position of a local maximum for fitness?

Compare the macroevolutionary models for the prevalence of sexual reproduction in higher plants and animals.

Population Genetics:

What was Darwin's provisional theory of pangenesis?

What is blending inheritance? Why did it present a problem to the theory of evolution by natural selection?

Why did Huxley think that Darwin's commitment to gradual change was an unnecessary burden?

What did Galton mean by his "principle of regression"? Was he right? Why or why not?

For one locus with two alleles, write the equation for $W$. What does it mean?

The equation for $p'$ is: $p' = p(pW_{11} + qW_{12})/\overline{W}$. Give an intuitive feeling for why this should be so. What is true at the equilibrium value for $p$?

What is Hardy Weinberg equilibrium? Show how is can be derived from the above equation.
Is $W$ always maximized by selection? Why or why not?

What is meant by mutation-selection balance?

What difference does it make if an allele is dominant or recessive on the spread of that allele when it confers a slight fitness advantage when expressed.

Remember that $\Delta p = pq^2$'s for a favored dominant and $\Delta p = p^2qs$ for a favored recessive. Give an intuitive feeling for why the equations are correct (or incorrect, if they seem wrong to you).

Quantitative Genetics:

Give an intuitive feeling for the equation: $R = h^2S$. How is $h^2$ related to Galton's worry about regression on the mean?

What is the selection differential? How is it similar/different to the selection gradient? How is it different from the selection coefficient in Population Genetics?

What is meant by additive genetic variance. Why is it so important? How is it affected by dominance? How is it affected by allele frequencies? How is it related to the rate of evolution?

Give an intuitive feeling for the equation: $h^2 = \frac{V_A}{V_P}$

$h^2 = \beta_{o, \bar{p}}$, where $\beta_{o, \bar{p}}$ is the regression coefficient for the regression of the mean of a brood for a quantitative trait against the mean of the parents for the same trait. Why? How is this relationship used to estimate narrow sense heritability? Why is $\beta_{o, \bar{p}} = \frac{\text{cov}(\bar{p}, o)}{\text{var}(\bar{p})}$? What does it mean, in words?

What is meant by $H^2$? This is the broad-sense heritability. How is it different from $h^2$? (I don’t think I explicitly covered this. $H^2 = \frac{V_G}{V_P}$.) In words, $H^2$ is the genetic variance divided by the total phenotypic variance. So the numerator for $H^2$ and $h^2$ are different ($V_G$ and $V_A$, respectively). Why would that matter?

"Unpack" $V_G$. Give graphical examples of Dominance, Additivity, and an interaction between two loci. Make a clear distinction between dominance and $V_D$.

Does complete dominance mean that there is no additive genetic variance? Does an interaction between loci imply that there is no additive genetic variance? Why or why not?
Give an intuitive feeling for why the additive genetic variance depends on allele frequencies. Connect your reasoning with the population genetic models.

Design a simple experiment to estimate the environmental variance, $V_E$.

Give an intuitive explanation (or graph) for why dominance might reduce the slope of the regression of offspring value on mid-parent value compared to the slope of the regression of the same slope under co-dominance.

Explain why heritability, $h^2$, is different from the probability of inheriting a trait. Design an undergraduate lab to get the difference across to the students.

What do you think the effect of strong directional selection would be on $h^2$, $V_A$, and $V_P$.

What was the gist of Boag and Grant's result regarding the effect of the 1977 drought on Darwin's ground finch.

What are breeding values? How are they involved in the calculation of Additive Genetic Variance? How are breeding values calculated.

Across the modeling strategies.

In your opinion, what are the strengths and weaknesses of using the following kinds of models to study evolution by natural selection: population genetic models (1-locus, 2 allele); quantitative genetic models; discrete games models (e.g. the Hawk-Dove game), and continuous strategy models (e.g. sex ratio models). Which would you use to study the evolution of anisogamy (unequal sized gametes), and the evolution of correlated traits.