LAST NAME, first name_____

Biology 354 – spring 2006 – Exam I

Please read instructions CAREFULLY before answering questions. **Put your name at the top of each page** (**last name, first name**) – one bonus point if you do this! Answers need not be in complete sentences. Accuracy, completeness, clarity, *and* brevity are the traits under selection!

1. Describe the biological significance of FOUR of FIVE of the following terms (@ 6 points):

Selection differential (Define it. Indicate its magnitude in most studies.)

*A measure of the strength of selection. The difference between the **mean** phenotype of the selected individuals and the **mean** of the entire population (before selection). Very small in most studies*

Panglossian Fallacy (Define it. Why is it relevant to the study of adaptation?)

The incorrect assumption that all traits are perfect adaptations (named after Dr Pangloss, a character in Candide). It represents a challenge to biologists to test (not just assume) whether and how traits are adaptive.

Evolutionary anachronism (what is it? Give an example)

*Traits that were adaptations (or perhaps exaptations) in the past but are **not so at present**, presumably because the environment has changed. Such traits are probably no longer adaptive and will eventually lost (see p. 4). Example: large fruits of some tropical trees, which might have evolved to promote dispersal by large herbivores (e.g., gomphotheres) that have gone extinct.*

Exaptation (what is it and **how is it different from an adaptation**? Give an example of an exaptation)

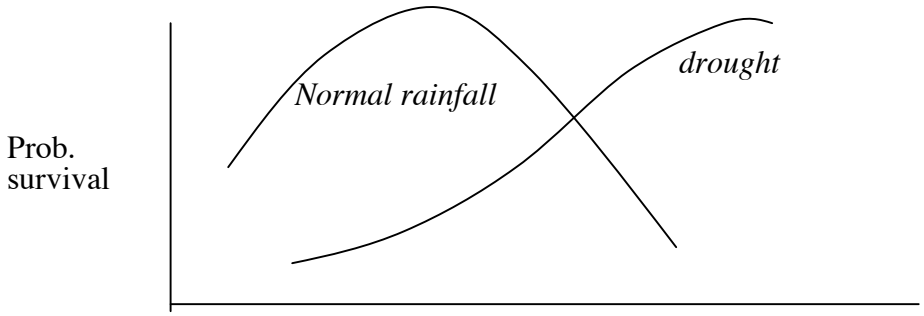
*A trait that **originally evolved for one function but was later co-opted for another**. An adaptation is a trait that evolved by natural selection **for its current use**. Example of examptation: bird wings, possibly pit organ of pit vipers.*

Selection mutation balance (what is it? Would you see it if selection favored a mutation?)

Most mutations are deleterious and so will be selected against, but such mutations can still persist if they are recreated (by new mutation) at a high enough rate. The equilibrium frequency of the mutation in a population will thus depend on the balance between the mutation rate versus the selection coefficient. No. If selection favored a mutation, it would eventually be fixed.

1

2. The Medium Ground Finch on the Galapagos is a classical example of selection in nature. Draw a fitness graph showing the probability of survival vs. beak size for these birds **during** a drought (solid line) and during a year of normal rainfall (dashed line). (@ 3 points).



The type of section during the drought is called _ *directional*___ selection, and that after the drought is called _*stabilizing*_ selection (@ 1 point).

The population crash during the drought might have influenced the genetic properties of the population. Here are two processes that might have been affected. Indicate whether you think each would have been affected ("**yes**" or "**no**") and briefly justify your argument (@ 5 points)

Genetic drift *yes – the crash would have resulted in a population bottleneck, with a resultant loss of genetic variation by chance (drift).*

Inbreeding depression – *yes. Recall that selection favored large billed birds and that bill size had a genetic basis. Thus the survivors were likely to be close relatives and this would lead to some inbreeding and possibly to inbreeding depression.*

3. In many species the males are more brightly colored than are females. In Trinidad, male guppies are brightly colored and display conspicuously to females. The males also fight each other for access to the best territories. Consider two ponds – one that has predators of the guppies, and one that does not. 1) Predict the relative magnitude of sexual size and color dimorphism in the two ponds. 2) Justify your answer in terms of the strength of sexual versus "survival" selection. (8 points)

1) sexual size and color dimorphism is **GREATER** or **THE SAME** or **WEAKER** (**circle** one) in the population with predatory fish

WEAKER

2) *because predatory fish would likely select against the large colorful males (conspicuous), even if they were favored by the females (sexual selection). Thus survival selection would likely be stronger than sexual selection WHEN predators are present*

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5. Imagine a genetic disease that is caused by a mutation in a single recessive gene ("b"), which is relatively rare in humans (B = 0.9, b = 0.1). Anyone carrying two mutant alleles (bb) develops the disease. The disease has no effects early in life but causes progressive deterioration of the central nervous system beginning about 55 years of age.

What is the expected frequency of genotypes in the population if Hardy-Weinberg holds? *(show your math)* (3 points) NOTE: there were two versions of this question, one using different frequencies. But the principle is the same

BB = .9*.9 **=.81** Bb = 2*.9*.1= **0.18** bb = .1*.1= **.01**
OR = .8*.8 = .64 **2 * .8 * .2 = 0.32** **0.2*0.2 = 0.4**

Do you expect that Hardy-Weinberg will hold (**yes**, **no**, **maybe**)? Justify your answer. (4 points)

Yes. The disease does not affect Darwinian fitness, either by reducing survival or reproduction, AND it occurs late in life, when the force of selection is weak. (Note: credit given for answering "no" if the justification was adequate).

Name of the two evolutionary theories of aging, and **circle** the one (or both) that is seemingly consistent with this disease, and justify your answer (6 points)

1) *mutation-accumulation*
2) *antagonistic pleiotropy*

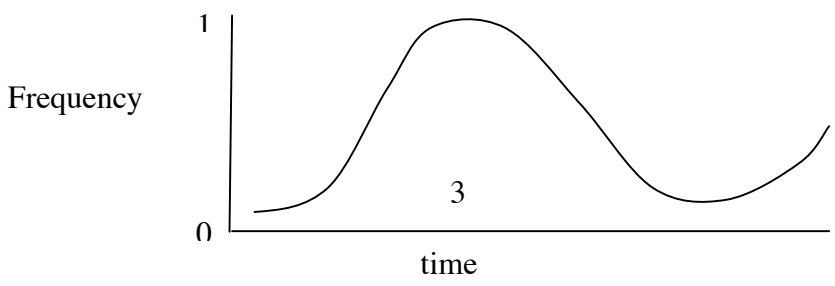
justification: *Mutation accumulation because the disease is expressed only late in life. Had antagonistic pleiotropy been involved, one would see a beneficial effect of the alleles early in life ("The disease has no effects early in life").*

6. Darwin realized that organisms are not perfectly adapted. List 4 reasons why this is the case (@ 2 points)

1) traits evolve from something else so are contrivances (or vestiges or exaptations)
2) the benefit of the trait may be context (environment) specific (environments change)
3) traits may have multiple functions, forcing compromises
4) there may be trade-offs (e.g., snake resistance to TTX causes slow speed)

other full-credit responses: time lag, gene flow, genetic drift, maladaptation, selection favors slight improvements. Partial credit for some other answers, or if answers overlapped.

7. Imagine an allele that is subject to frequency dependent selection. Draw how its frequency will change over time, assuming it starts at a low frequency (thus near 0). (4 points)



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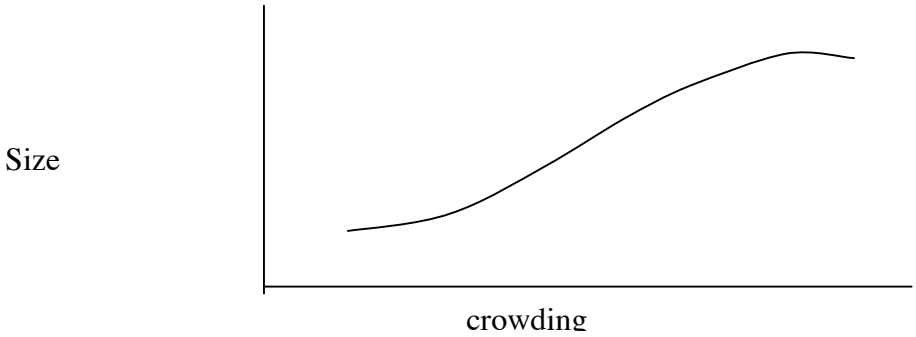
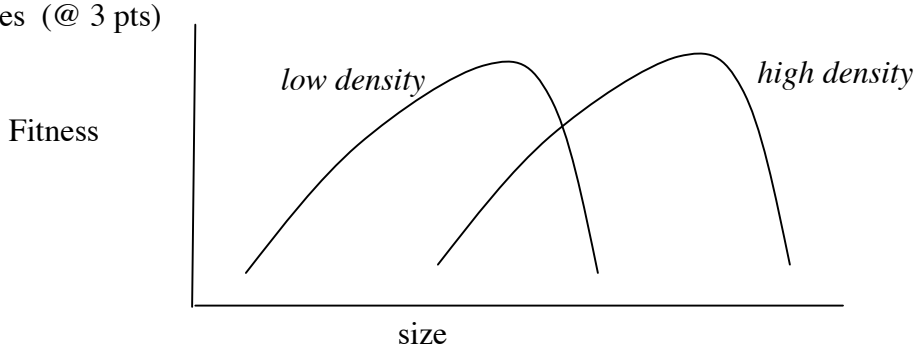
7. A graphical depiction of how a phenotype changes (or doesn't change) with some environmental variable is called a ____*norm of reaction*____. When phenotypic variation is discrete, the variations are called ___*polyphenism* (NOT polymorphism)____. (@ 2 pts)

Annie Schmitt and colleagues studied plastic responses of plant height in *Impatiens* to crowding. Draw a graph showing the pattern of the response. (3 pts)



Name the environmental "cue" that plants use to detect crowding in their environment? (2pts)
Red:far red ratio

If this plastic response is adaptive, draw a graph showing how fitness of plants of different size should change under conditions of high density (solid line) AND low density (dashed line). Thus draw **two** lines (@ 3 pts)



Imagine that 1000 years ago some *Impatiens* invaded an island with limited nutrients, so that plants could never become dense enough to be crowded. Initially, the invaders had typical genotypes enabling a plastic response to crowding. You now want to measure their current responses to crowding. Do you think that the response would differ from that of their ancestors? Justify your prediction, and suggest a genetic basis for the change (or lack thereof). (10 pts)

*Yes, they would probably lose the plastic response either because any plasticity genes will not be expressed in the new environment and thus could be lost by genetic drift or by the accumulation of deleterious (but **unexpressed**) mutations that eventually wipe out the plastic response. Also, if the ability to be plastic has some cost, then selection would favor plants with reduced plastic responses, as resources could be devoted to other activities. Some students wrote that plasticity would be lost because "it isn't needed." That is a Lamarckian view.*