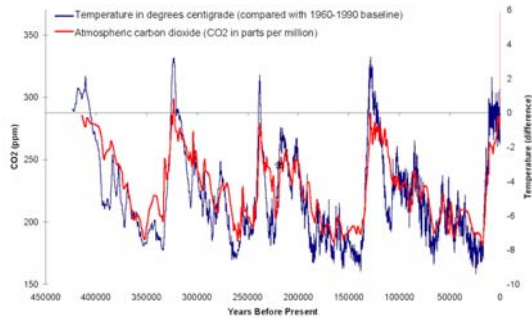


NOTE: I've eliminated several questions that come from material we'll cover after next week, but this should give you a good feel for the types of questions I'll ask.

Correct answers in bold or italics.

I. Multiple choice. Select the best answer from the choices given and circle the appropriate letter of that answer.



1) Climate scientists have extracted a record of global average temperature and atmospheric CO₂ concentrations using gases trapped in ice cores, and these two correspond closely over the last several glacial/interglacial cycles, as shown in the figure above. These data

- A. conclusively show that elevated CO₂ causes higher global temperatures
- B. conclusively show that higher global temperatures cause elevated atmospheric CO₂
- C. show that atmospheric CO₂ concentrations and global temperatures are strongly correlated, but by themselves don't allow us to determine which causes which.**
- D. None of the above

2) Many crustaceans (e.g., lobsters, shrimp, and crayfish) use their tails to swim, but crabs have reduced tails that curl under their shells and are not used in swimming. This is an example of:

- A. artificial selection
- B. an extinction
- C. the law of succession
- D. a vestigial trait**
- E. convergent evolution

3) Some beetles and flies (insects) have antler-like structures on their heads, much like male deer (chordates) do. The existence of antlers in beetle, fly, and deer species with strong male-male competition is an example of:

- A. structural homology
- B. developmental homology
- C. genetic homology
- D. analogy/convergent evolution**

4) A farmer uses triazine herbicide to control pigweed in his field. For the first few years, the triazine works well and almost all the pigweed dies; but after several years, the farmer sees more and more pigweed. Which of these explanations best describes this observation?

- A. The herbicide company lost its triazine formula and started selling poor-quality triazine.
- B. Natural selection caused the pigweed to mutate, creating a new triazine-resistant species.
- C. Triazine-resistant pigweed has less efficient photosynthesis metabolism.
- D. Only triazine-resistant weeds survived and reproduced, so each year more pigweed was triazine-resistant.**

5) If you can't measure it repeatably and verifiably,

- A. it's too small.
- B. it's not worth thinking about.
- C. it's not science.**
- D. it can still be scientifically confirmed by logic alone.

6)

7)

8)

- 9) Vestigial traits and neutral changes in DNA sequences are good examples of:
- A. adaptation
 - B. acclimation
 - C. convergent traits
 - D. nonadaptive traits**
 - E. developmental homology
- 10) How can Darwinian fitness be estimated?
- A. Document how long different individuals in a population survive.
 - B. Count the number of offspring produced by different individuals in a population.**
 - C. Determine which individuals are strongest.
 - D. Determine which phenotype is the most common one in a given population.
- 11) Why does the presence of extinct and transitional forms in the fossil record support the pattern component of the theory of evolution by natural selection?
- A. It supports the hypothesis that individuals change over time.
 - B. It supports the hypothesis that weaker species are eliminated by natural selection.
 - C. It supports the hypothesis that species evolve to become more complex and better adapted over time.
 - D. It supports the hypothesis that species have changed through time.**
- 12) Why are homologous traits similar?
- A. They are derived from a common ancestor.**
 - B. They are derived from different ancestors.
 - C. They result from convergent evolution.
 - D. They result from gene flow from adjacent populations.
- 13) What are the four requirements for evolution by natural selection in a given population?
- A. (1) The population varies; (2) all variation is heritable; (3) some individuals produce more offspring than others; (4) populations differ in their production of offspring.
 - B. (1) Individuals in a population vary; (2) the variation is neutral; (3) offspring are produced that can survive; (4) individuals produce offspring.
 - C. (1) Individuals in a population vary; (2) the variation is heritable; (3) more offspring are produced than can survive; (4) all individuals have different alleles.
 - D. (1) Individuals in a population vary; (2) the variation is heritable; (3) some individuals produce more offspring than others; (4) certain traits lead to greater reproductive success than other traits.**
- 14) Has evolution by natural selection recently occurred in populations of *Mycobacterium tuberculosis*?
- A. Yes; some people are now resistant to tuberculosis, but before they weren't. The resistance alleles have changed frequency in some human populations.
 - B. Yes; the frequency of the adaptive allele for drug resistance has increased over time.**
 - C. No; evolution has not occurred, because the resistance trait occurs with a frequency of approximately 10 percent.
 - D. No; *Mycobacterium tuberculosis* is still the same species.
- 15) How does Mendel's law of independent assortment relate to meiosis?
- A. Meiosis leads to mixing of maternal and paternal chromosomes in gametes
 - B. Meiosis explains why one gets a 9:3:3:1 ratio of phenotypes when crossing double heterozygotes (e.g., RrYy x RrYy)
 - C. Meiosis leads to gametes with new alleles not seen in either parent
 - D. A & B**
 - E. A, B & C
- 16) Sexual reproduction is advantageous evolutionarily
- A. Because it leads to offspring with traits intermediate between the two parents.
 - B. Because it potentially leads to many more offspring than asexual reproduction.
 - C. when the biotic environment changes greatly, but not when the abiotic environment changes.
 - D. When either the abiotic or biotic environment changes.**
 - E. None of the above.

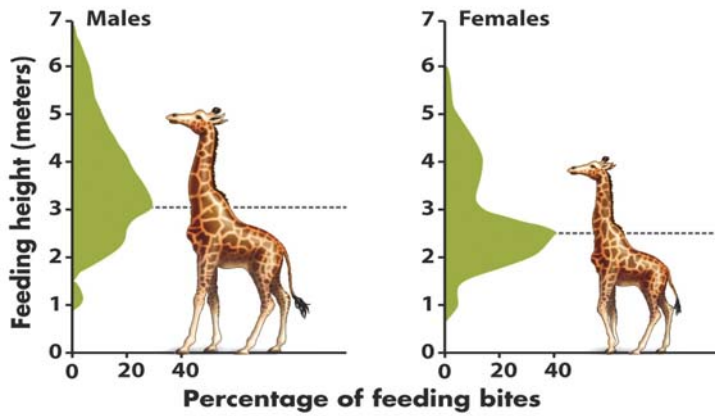


Figure 1-9a Biological Science, 2/e © 2005 Pearson Prentice Hall, Inc.

- 17) Given the data above, which of the following observations lead to the conclusion that the food competition hypothesis for giraffe neck length might not be correct?
- A. In the populations studied to date, giraffes never feed high in trees.
 - B. In certain populations at certain times of year, only male giraffes feed high in trees.
 - C. Male and female giraffes spend most of their time feeding low in trees.**
 - D. Giraffes rarely die of starvation, so food availability is unimportant.
 - E. Neck length in giraffes correlates strongly with maximum feeding height.
- 18) Given the data above, could both the food competition hypothesis and the sexual selection hypothesis explain why giraffes have long necks? Why or why not?
- A. No. In science, only one hypothesis can be correct.
 - B. No. The data above show that food competition never limits giraffe survival or reproduction.
 - C. Yes. Long necks could be advantageous for more than one reason.**
 - D. Yes. The data above show that giraffes preferentially feed at the highest possible height and fight for mates.
- 19) Which of the following is a condition needed for natural selection to occur?
- A. Random mating must occur.
 - B. The population must be large for natural selection to occur.
 - C. Humans select which individuals mate.
 - D. Individuals within a population vary in their characteristics.**
- 26) The genes for the traits that Mendel worked with often are located on different chromosomes, or they are so far apart on the same chromosome that crossing over almost always occurs between them. How did this circumstance help Mendel recognize the principle of independent assortment?
- A. Otherwise, his dihybrid crosses would not have produced a 9:3:3:1 ratio of F₂ phenotypes.**
 - B. The occurrence of individuals with unexpected phenotypes led him to the discovery of recombination.
 - C. It led him to the realization that the behavior of chromosomes during meiosis explained his results.
 - D. It meant that the alleles involved were either dominant or recessive, which gave 3:1 ratios in the F₁ generation.
- 28) What does it mean when an allele reaches fixation?
- A. It is eliminated from the population.
 - B. It has a frequency of 1.0.**
 - C. It is dominant to all other alleles.
 - D. It is adaptively advantageous.
- 32) Darwin conclusively showed that natural selection is the only mechanism by which evolution occurs.
- A. True
 - B. False**

II. Short answer (35 points total). For questions involving calculations, you need to **show all work and equations used**, or you will not get full credit (even if you get the numerical answer correct).

1. (5 pts.) What is the best current definition of evolution?

A change in allele frequencies in a population over time.

2. (6 pts.) Name at least 3 mechanisms that could cause microevolution, and state whether they necessarily increase fitness, decrease fitness or leave fitness unchanged.

Ignore this for now – we'll get to microevolution next. But, in case you're dying of curiosity, here it is:

Natural selection – by definition increases fitness of population over time as less fit individuals are selected against. Note: this includes directional selection, disruptive selection, stabilizing selection, AND sexual selection. Yes, the last of these does increase fitness: while there may be a tradeoff with survival, overall the sexually selected individuals must still have higher reproductive fitness, otherwise their traits wouldn't become more common in the population.

Genetic drift – could increase fitness, decrease fitness, or leave fitness unchanged, depending on the random fluctuations of alleles frequencies. Bottleneck effects and founder effects are both subsets of genetic drift.

Gene flow - could increase fitness, decrease fitness, or leave fitness unchanged, depending on which traits come with individuals into the population. Often, gene flow can slow selection to novel environments, but it can also provide adaptive alleles to populations lacking them.

Mutation – formation of new alleles by changes in DNA. These changes could increase fitness, decrease fitness, or leave fitness unchanged. Note: while it's true that most mutations are deleterious or neutral, there's a very, very important exception: the occasional beneficial mutation. These are the ones that are the stuff of natural selection!

Nonrandom mating - We've already covered sexual selection above, which increases fitness; inbreeding, the other main form of nonrandom mating we discussed, generally decreases fitness through the accumulation of deleterious recessive homozygotes. But if you just said non-random mating without specifying sexual selection or inbreeding, you'd have to say either increase or decrease fitness.

3) In humans, albinism is caused by loss-of-function mutations in genes involved in the synthesis of melanin, the dark pigment in skin. Albinism is an autosomal (not sex-linked) recessive trait. A man and woman are both of normal pigmentation, but both have one parent who is albino (without melanin pigmentation). What is the probability that their first child will be an albino? Show all work and equations used in the calculations below to get full credit.

Since both the man and woman have a homozygote recessive parent, they must have a recessive allele. Since neither is albino, they must be heterozygous. So, if A = normal melanin and a = lack thereof, then Aa x Aa gives a 1:2:1 genotype ratio of AA:Aa:aa, with aa as albino. The chance of the first child being albino is therefore 1/4. A Punnett square can be useful here.

4. Gray seed color in peas is dominant to white. Assume that Mendel conducted a series of experiments where plants with gray seeds were crossed among themselves, and the following progeny were produced: 302 gray and 98 white.
- a) (3 pts.) What is the most probable genotype of each parent? (Assume the following symbols: G = gray and g = white.)

A 3:1 ratio of dominant phenotype to recessive phenotype results from a cross between heterozygous parents: $Gg \times Gg$. A Punnett square can illustrate.

- b) (5 pts) Based on your answer in (a) above, what genotypic and phenotypic ratios are expected in the progeny? (State explicitly for each genotype and phenotype).

Genotype ratio - 1 GG : 2 Gg : 1 gg .

Phenotype ratio – 3 gray : 1 white.

- 5) (6 pts.) Mitosis and meiosis are both forms of cell division. Briefly state three ways in which mitosis and meiosis differ.

- a. *Mitosis takes place in somatic cells; meiosis only takes place in cells that form gametes.*
- b. *Mitosis involves 1 cell division (2 daughter cells), meiosis involves 2 cell divisions (4 daughter cells).*
- c. *Mitosis leads to genetically identical daughter cells which are identical to the parent cell also; meiosis leads to genetically distinct daughter cells that also differ from the parent cell.*
- d. *Mitosis leads to daughter cells with same ploidy as parent cell; meiosis halves the ploidy of the parent cell.*