I. Short Answer Questions DO ALL QUESTIONS

SAQ #1. Please state and BRIEFLY explain the major objectives of **this course in evolution**.
Recall there were 5 objectives in all, and the 5th one is given below. I need the other 4.

#1. – (4 pts.)
#2. – (4 pts.)
#3. – (4 pts.)
#4. – (4 pts.)
#5. – **Understand the Uses and Effects of the Theory of Evolution in Society.** Evolutionary knowledge is at the fore-front of the biological revolution that has characterized the past several decades, and will likely dominate biology, medicine, and policy in the next century as well….

SAQ #2. Please use the term "evolution" in a complete sentence in your own words (i.e. you can't just copy a sentence from one of the other exam questions) that reveals its meaning and uses an active verb (i.e. do not use any form of the verb "to be," including is, are, were, etc.)

(3 pts)

SAQ #3. Exactly what is at equilibrium according to the Hardy-Weinberg equilibrium?

(3 pts)

SAQ #4. Please offer a brief and concise definition of natural selection.

(3 pts)

SAQ #5. Please use the term "natural selection" in a complete sentence in your own words (i.e. you can't just copy a sentence from one of the other exam questions) that reveals its meaning and uses an active verb (i.e. do not use any form of the verb "to be," including is, are, were, etc.)

(3 pts)

SAQ #6. Please state the principal difference between evolution and natural selection.

(3 pts)

SAQ #7. Please offer a brief and concise definition of adaptation.

(3 pts)

SAQ #8. Please use the term "adaptation" in a complete sentence in your own words (i.e. you can't just copy a sentence from one of the other exam questions) that reveals its meaning and uses an active verb (i.e. do not use any form of the verb "to be," including is, are, were, etc.)

(3 pts)

SAQ #9. Some believe that evolution is the "process of progressively improving" a species, whereas others maintain that this is a misconception. What are some of the supporting arguments for these two views, and do you feel that the evidence weighs heavily one way or the other?

(3 pts)

SAQ #10. What are the principal assumptions of the Hardy-Weinberg equilibrium (your text lists 5)?
1 – 2 – 3 – 4 – 5 – (5 pts)

SAQ #11. What is the main prediction of the Hardy-Weinberg equilibrium?

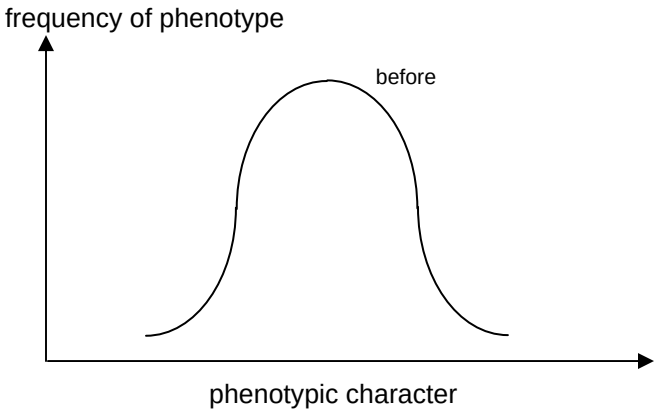
(3 pts)

SAQ #12. What are the three conditions that are necessary and sufficient for evolution to occur by natural selection?
1 – 2 – 3 – (6 pts)

The next three questions will assess your understanding of the mechanisms of natural selection.

SAQ #13. Please explain the concept of directional selection. Please use a brief sketch in the axes at right in your explanation

(4 pts)

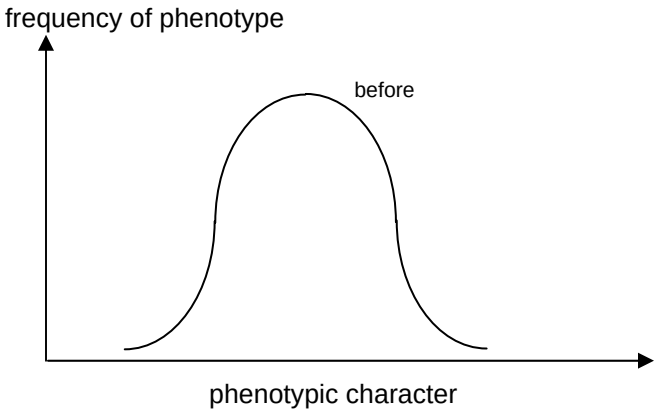


If you were to simulate the effects of directional selection on a computer what would be reasonable representative values for the genotype fitnesses w11, w12, and w22. Please offer numbers:
(3 pts)

w11 = _____, w12 = _____, and w22 = _____

SAQ #14. Please explain the concept of disruptive selection. Please use a brief sketch in the axes at right in your explanation

(4 pts)

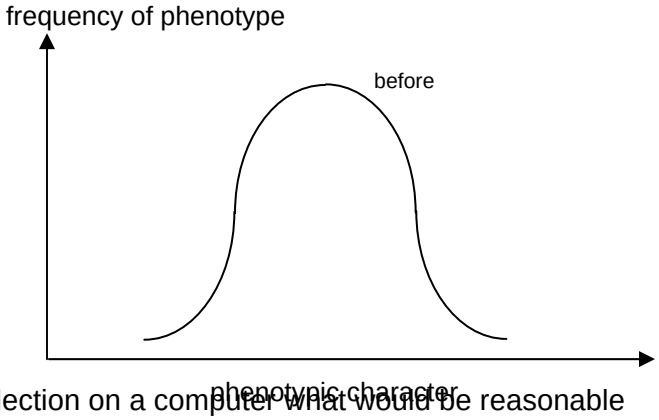


If you were to simulate the effects of disruptive selection on a computer what would be reasonable representative values for the genotype fitnesses w11, w12, and w22. Please offer numbers:
(3 pts)

w11 = _____, w12 = _____, and w22 = _____

SAQ #15. Please explain the concept of stabilizing selection. Please use a brief sketch in the axes at right in your explanation

(4 pts)



If you were to simulate the effects of stabilizing selection on a computer what would be reasonable representative values for the genotype fitnesses w11, w12, and w22. Please offer numbers:
(3 pts)

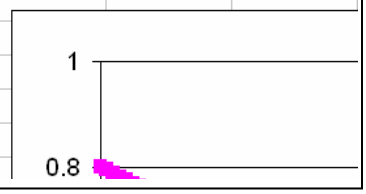
w11 = _____, w12 = _____, and w22 = _____

SAQ #16. Which of the three forms of natural selection just considered (directional, stabilizing, disruptive) destroys versus has the capacity to maintain genetic variation? Please explain your reasoning in paragraph form the space below (don't forget to include all three in your discussion).

(6 pts)

sAQ #17. In modeling the effect of natural selection on allele frequencies using EXCEL, what exact formula goes into cell D3? Recall that the equation is delta p = (p / wbar) { $pw_{11} + qw_{12}$ - wbar }

	A	B	C	D	E	F	G	H
1	time	p	q	delta p	wbar	w11	w12	w22
2	0	0.2	0.8	0.006896552	0.928	0.80	1.00	0.90
3	1	0.206897	0.793103	0.006703141	0.928537455			
4	2	0.2136	0.7864	0.006494577	0.92903249			
5	3	0.220094	0.779906	0.006273723	0.929486408			
6	4	0.226368	0.773632	0.006043341	0.929900858			
7	5	0.232411	0.767589	0.005806044	0.930277758			
8	6	0.238217	0.761783	0.005564256	0.93061922			



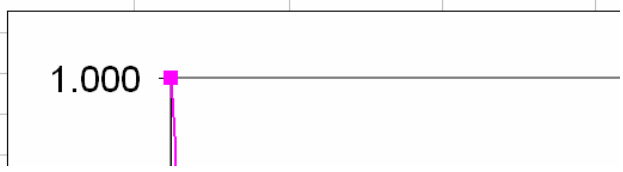
{ hint: don't forget the $'s where you need them }

(6 pts)

What type of natural selection is being modeled here? _____

SAQ #18. In modeling the dual processes of a forward (F) and backward (B) mutation rate on allele frequencies using EXCEL, what exact formula goes into cell B3?

	A	B	C	D	E	F	G
1	time	p	q	forward mutation rate		F =	0.3
2	0	0.000	1.000	backward mutation rate		B =	0.2
3	1	0.200	0.800				
4	2	0.300	0.700				
5	3	0.350	0.650				
6	4	0.375	0.625				



{ hint: don't forget the $'s where you need them }

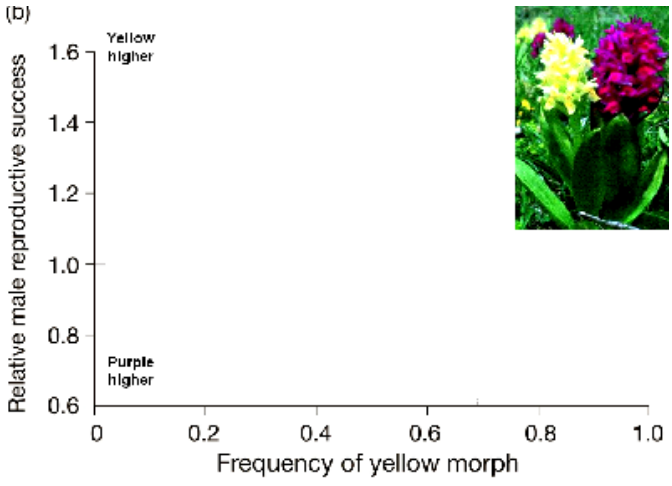
(6 pts)

SAQ #19. Please explain the concept of frequency-dependent selection. What exactly is dependent on what? Specifically address the genotype fitnesses w11, w12, and w22, in your response.

(4 pts)

SAQ #20. It has been suggested that flower color polymorphism in Elderflower Orchids is stabilized by frequency dependent selection. If so, what do you predict is the relationship between the frequency of the yellow morph and yellow morph individual reproductive success for this population? Sketch your answer on the graph and explain your reasoning below.

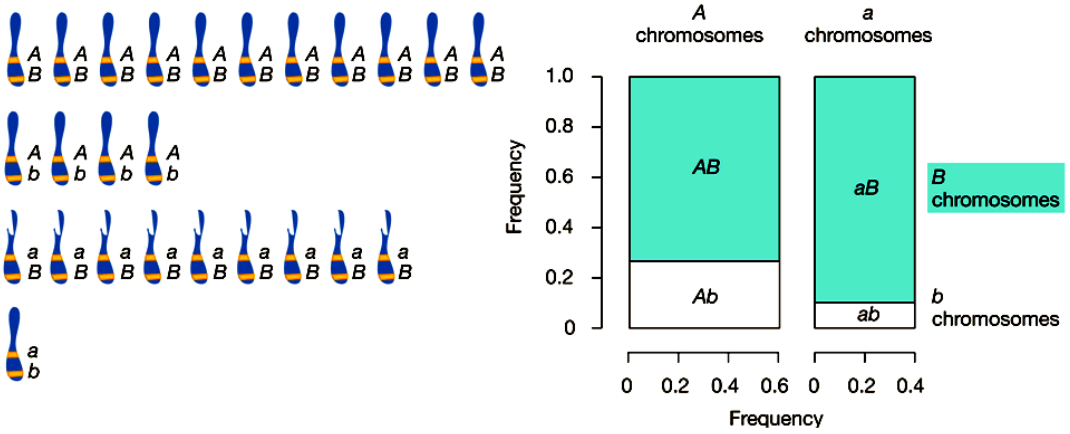
(6 pts)



SAQ #21. Please explain the concept of genetic linkage disequilibrium. What exactly does linkage mean, and what exactly is not at equilibrium?

(4 pts)

SAQ #22. In the example below taken from the textbook, is the population in linkage equilibrium or disequilibrium? Explain your reasoning based upon evidence in the figure.

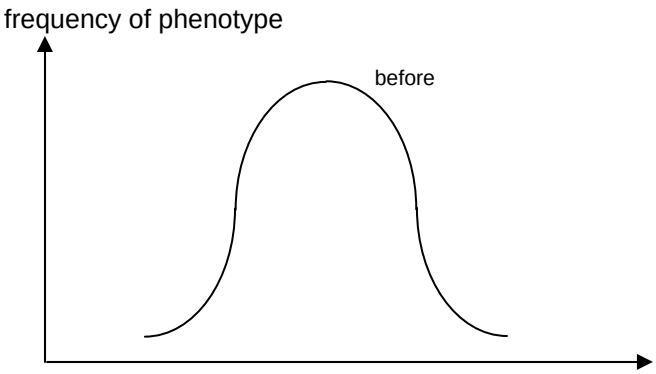


(4 pts)

SAQ #23. Please use the figure at right to explain the concept of heritability (broad sense). Hint:

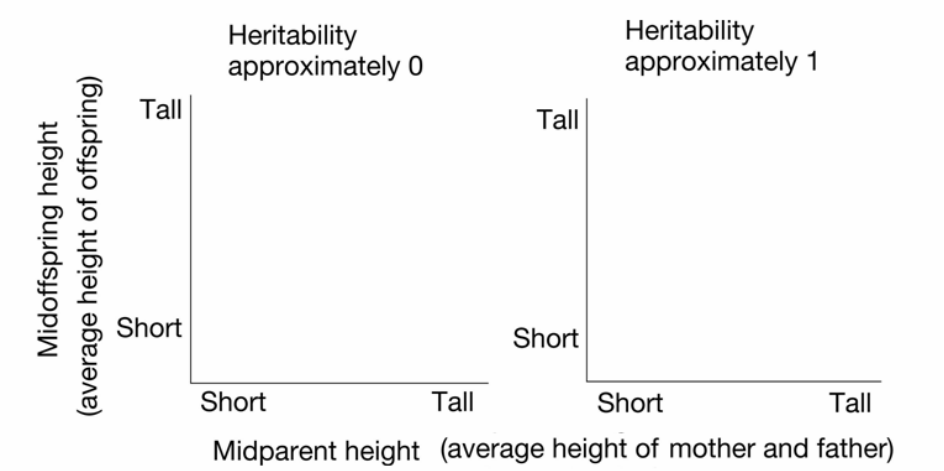
"broad-sense" heritability = $V_G / V_P = V_G / (V_G + V_E)$

(4 pts)



SAQ #24. Please sketch directly on the figures at right the relation between parent and offspring for the cases of zero trait heritability (narrow sense heritability $h^2 \rightarrow 0$) and high heritability (narrow sense heritability $h^2 \rightarrow 1$).

(4 pts)



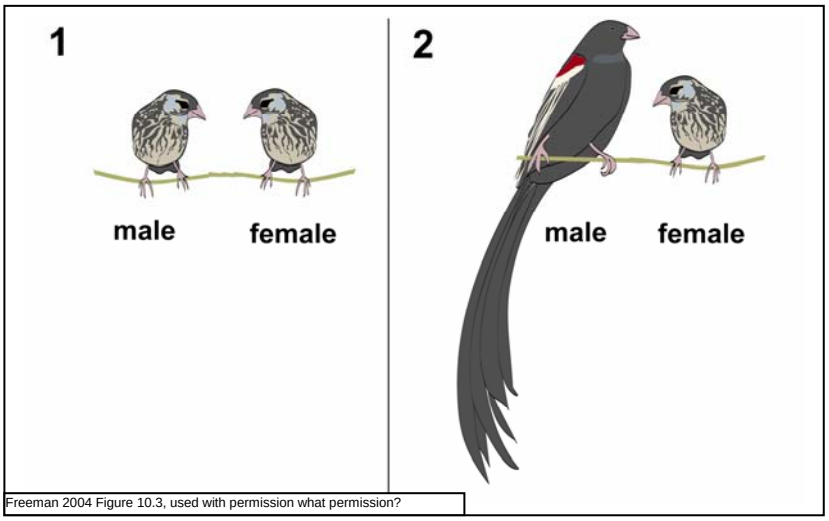
SAQ #25. Please offer a brief definition of "additive genetic variation" and explain why this is so important to the definition of heritability. Hint:

narrow-sense Heritability = $h^2 = V_A / V_P = V_A / (V_A + V_D + V_E)$

(4 pts)

SAQ #26. At right is a cartoon entitled "Evolution by Sexual Selection Made Simple" that shows sexual dimorphism from (1) to (2) in Long-Tailed Widow Birds (*Euplectes progne*):

Create a biological scenario that explains the phenotypic changes in the male for this species from (1) to (2). Use your understanding of **evolution by sexual selection** and include the relevant concepts and terms to describe this process. (12 pts)



Freeman 2004 Figure 10.3, used with permission what permission?

SAQ #27. Please explain how Geographic Isolation (= Allopatric Speciation) can be a cause of the origin of new species (speciation). Please use a sketch and a biologically realistic example in your response.

(6 pts)

SAQ #28. Please explain how Isolation for some other reason in the same place (= Sympatric Speciation) can be a cause of the origin of new species (speciation). Please use a sketch and a biologically realistic example in your response.

(6 pts)

Part II. Longer Answer Questions (12 points each)

LAQ#1. This question will assess your understanding of the Theory of Natural Selection

which simplify to:

$$\text{delta } p = (p / \text{wbar}) \{ pw_{11} + qw_{12} - \text{wbar} \}$$
$$\text{delta } q = (q / \text{wbar}) \{ qw_{22} + pw_{12} - \text{wbar} \}$$

and recall that mean fitness is $\text{wbar} = p^2 w_{11} + 2pqw_{12} + q^2 w_{22}$

Derive a general equation for the change in q in the next generation under the assumptions of a lethal dominant allele A_1 of initial frequency q_0. (Hint start with the general equations above and simplify as much as possible.)

(12 pts)

LAQ#2. This question will assess your understanding of the Theory of Evolution by Mutation

Derive a general equation for the change in q in the next generation under the assumptions of forward mutation rate "F" and backward mutation rate "B" between the 2 alleles A_1 and A_2.

$$A_1 \underset{B}{\overset{F}{\rightleftharpoons}} A_2.$$

(6 pts)

Begin with your answer above and derive a general equation for the equilibrium frequencies of p and q many generations later under the assumptions of forward mutation rate "F" and backward mutation rate "B" between the 2 alleles A_1 and A_2.

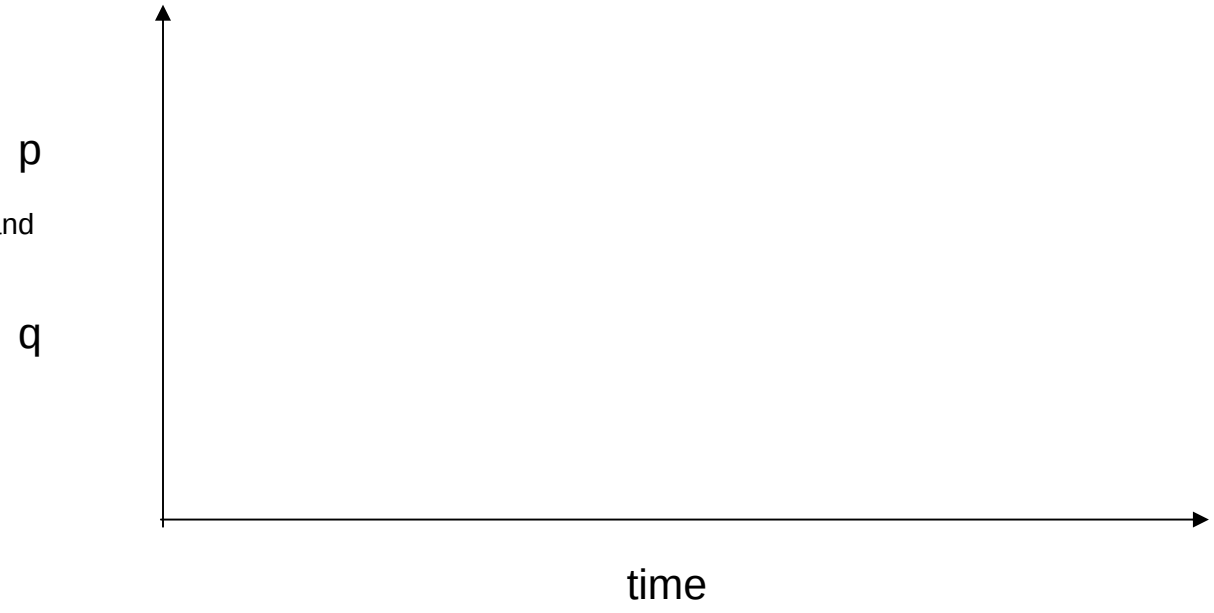
(6 pts)

LAQ #3. Please explain how frequency dependent selection could lead to the maintenance of a stable polymorphism? (hint: all that we mean here by "stability" is that neither p nor q go to fixation)

(6 pts)

On the axes below please sketch out what one might see in a plot of "p" and "q" versus time for a population undergoing stabilizing frequency dependent selection. (label which is "p" and which is "q", please)

(6 pts)



LAQ #4. This questions will further explore your understanding of genetic linkage disequilibrium. A useful equation to describe this process is the Coefficient of Linkage Disequilibrium = D

$$D = freq(AB)*freq(ab) – freq(Ab)*freq(aB)$$

Given two populations A and B below with the frequencies of the chromosomes AB, Ab. aB, and ab as given , calculate the values for D.

:

	AB	Ab	aB	ab
Population A	0.48	0.12	0.32	0.08
Population B	0.44	0.16	0.36	0.04

D for Population A =

(2 pts)

D for Population B =

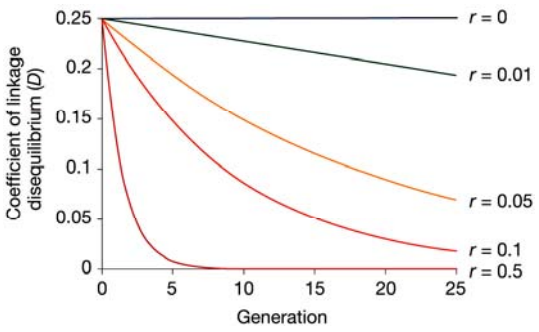
(2 pts)

Q – which of these populations is at linkage equilibrium?

(2 pts)

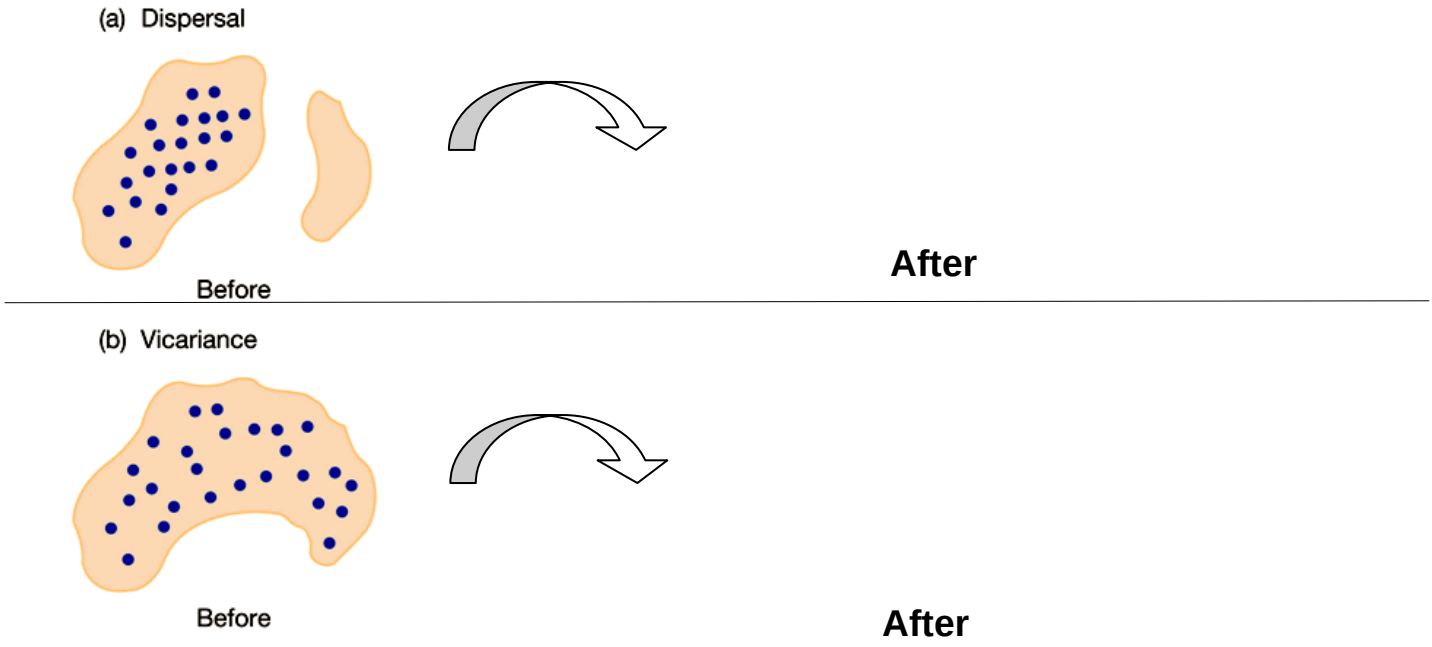
Q – Please explain why the Coefficient of Linkage Disequilibrium tends to approach a value of zero over time with sexual reproduction (meiosis and random mating)? Please also explain why higher rates of meiotic recombination speed this process up.

(6 pts)



LAQ #5. Please diagram and explain the key differences between the two major modes of allopatric speciation – dispersal and vicariance.

Diagram here:

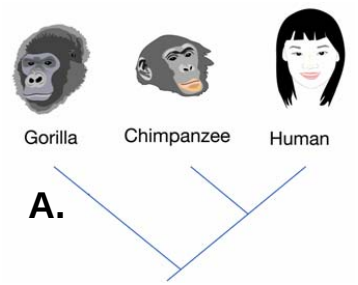


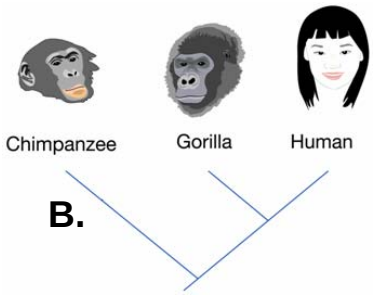
(6 pts)

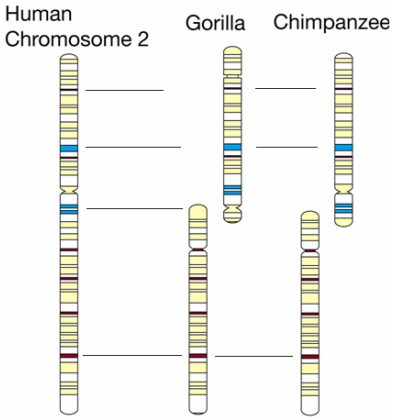
Explain here:

(6 pts)

LAQ #6. Based on the chromosomal analyses of human chromosome #2 and the homologous chromosomes of chimps and gorillas by Enard et al. (2002), which of the two phylogenies below is correct. Please explain your reasoning.







(10 pts)

According to your text…

Approximately how long ago did the species *Homo sapiens* first evolve? _____

(1 pt)

Approximately how long ago did *Homo neandrathalensis* first evolve? _____

(1 pt)

Approximately how long ago did the genus *Homo* first evolve? _____

(1 pt)

Approximately how long ago did the genus *Australopethecus* first evolve? _____

(1 pt)

Approximately how long ago did the lineage that gave rise to humans diverge from the lineage that gave rise to chimpanzees? _____

(1 pt)

Final Exam, Bio 313, spring 2005: Phylogenetic inference Unit

You should be able to answer all the questions in the end of the chapter on phylogenetic inference in the text book (we did these in class!)

Additionally you should be able to consider the following questions in greater depth

(1) What is the molecular clock? How is it used to infer phylogenies? What are the strengths and weaknesses of using the molecular clock? Specifically address the interpretation of differences in rates of evolution among different molecules or genes.

(2) This question will assess you understanding of the methods of phylogenetic inference

a) What are the differences and similarities between cladograms, rooted and, unrooted phylograms. What information each tree conveys (e.g. the branch length),

b) Describe the 3 methods for constructing phylogenies: Maximum Likelihood, Neighbor Joining, and Maximum Parsimony,

c) What additional information do consensus trees and bootstrapping provide,

d) What are the effects of the outgroup used to the topology of trees.

(3) Explain what was accomplished in each of the steps and utilities that you used to construct your phylogeny (e.g. searching the NCBI data base, using CUSTAWL, protdis, consensus tree, etc)