EEB 2245, Spring 2017.

Study guide Lectures 19 (April 4th), 20 (April 11th), and 21 (April 13th).

Lecture 19

1. Define silent substitution? Synonymous substitution? Non-synonymous substitution? Replacement substitution?

2. How does the secondary and tertiary structure of molecules affect DNA substitutions?

3. Describe the primary, secondary, and tertiary structure of proteins. Note that at all three levels, sites that preserve function or structure are least likely to accept substitutions.

4. At the level of primary sequence, substitutions are least common in: a) first positions b) second position, or c) third positions.

5. Do all third positions accept substitutions (evolve) at the same rate? Why or why not? Note: This is similar to asking " Are all third positions of codons selectively neutral?"

6. Are all/any second positions of codons selectively neutral? Explain.

7. What is a pseudogene?

8. How does the rate of evolution of pseudogenes compare to the rate of evolution of other gene regions?

9. Note on Figure 10.14 in Futuyma and in your lecture notes, that various untranslated regions do not evolve as quickly as four-fold degenerate sites or pseudogenes, this indicates that they have some structural or functional elements that are important.

10. What are ribosomes made of?

11. What are the most conserved parts of ribosomes?

12. True or False: If organisms were perfectly adapted to their environment then variation would make individuals less adapted and less able to compete.

13. Note: We saw in earlier lectures how genetic drift, inbreeding and gene flow can reduce genetic variation in natural populations. Drift in very special circumstances can preserve variation but those circumstances are rare so we now look toward selection as the main mechanisms for preserving variability. There are multiple kinds of natural selection. These two lectures discuss how each can preserve genetic variability (or not).

14. Will directional selection alone help to maintain variation in natural populations? If not, explain.

15. In Lenski's amazing 11-year experiment, 12 identical populations of *E. coli* were started from a single flask. Why did Lenski make sure to keep the population sizes high for all those years?

16. What initial hypothesis was supported by Lenski result that identical *E. coli* clones had evolved to be different (have different adaptive mutations) even though all were able to metabolize glucose equally well?

17. What is meant by a "directed mutation"?

18. Do directed mutations exist?

19. Can mutation rates be elevated by environmental stressors such as radiation or toxins?

20. If all mutations are random with respect the environmental challenges, how do adaptive traits increase in a population?

21. Give two examples of factors that cause extremely strong selection on natural populations.

22. What three conditions are necessary for natural selection to take place?

23. Explain how El Nino was an important opportunity for Galapagos finch researchers Peter and Rosemary Grant and why it was important that this was a long-term study.

24. Explain how the Galapagos finches were used to illustrate a natural case of competitive character displacement.

25. Explain how studies of Hawaiian finches reinforced the Grant's results in the Galapagos.

Lecture 20.

1. What experiment did Dolph Schluter perform to demonstrate competitive character displacement? What was his control group? Explain the results of the experiment.

2.Why do females respond differently to sexual selection than males? Which sex is more choosey and why? Use the word "fitness" in your answer.

3. What is runaway sexual selection?

4. Give one reason why the runaway evolution of a sexually selected ornament might come to a halt.

5. Not all exaggerated traits in males are reflected in the phenotype. We discussed and saw in a video, one case where the males with certain behaviors had enhanced fitness. What was this bizarre behavior?

6. Explain how sexual selection works in opposition to another form of natural selection in John Endler's Trinidad guppies? What experiment did he perform to confirm the hypothesis he proposed after observing the guppies in their natural habitats? How long did it take for an effect to be seen experimentally?

7. Are differences in mating success among males guaranteed to have evolved by sexual selection? What case did we discuss where sexual selection was demonstrated not to operate?

8. Why are rare deleterious recessive alleles difficult to eliminate by natural selection? (We learned this early in the semester and it relates to the next question.)

9. Finish this sentence: Deleterious dominant alleles will be eliminated quickly from a population unless _____.

10. We talked about many variants of directional selection. For each of the following examples we discussed, know the presumed trait under selection, the selective agent, and the result of selection: peppered moth, Darwin's finches, sticklebacks, Trinidad guppies, and citrus swallowtail butterflies.

11. What kind of selection is illustrated by the example of the African scale-eating cichlids?

12. How is frequency dependent selection related to the concept of "search image" in vertebrate predators.

13. True or False: "Fitness" is affected by both bioitic (other species) and abiotic (physical factors) aspects of the environment that might affect reproduction.

14. Define multiple niche polymorphism, frequency dependent selection, and balancing selection. Give an example of each.

15. Describe how the multiple niches and the polymorphism of the citrus swallowtail butterfly could hypothetically lead to speciation (hint: how would the behavior of the adult butterfly need to change?)

16. Which kind of selection acts in favor of the mean phenotype in the population, and against both extreme phenotypes?

17. How does balancing selection work in the case of Cystic Fibrosis? How does CF interact with typhoid fever? (mention mutations in sodium channel proteins in your answer).

18. How many mutations been implicated in cystic fibrosis? a) one or a few, b) many (more than 500).

19. Define genetic "hitchhiking" and "genetic load". How is genetic load related to balancing selection and recessive deleterious alleles?

20. Define: population, sympatric, parapatric, allopatric, and allochronic.

21. What do we mean when we say that broods (= year classes) of periodical cicadas are "allochronic"?

22. Be able to distinguish between a step cline and a gradual cline. Know that a cline in one trait will not necessarily occur in the same direction as a cline for another trait (e.g., north-south cline versus an east-west cline).

23. Burbrink et al. (2000) found that the named subspecies of rat snakes in North America did not correspond to groups defined on the basis of color pattern. Explain how they used morphometric measurements and mtDNA genotypes to understand the genetic structure of the species. In the end, they described three subspecies of rat snake rather than five. What environmental cause did they hypothesize to explain the three subspecies?

24. Explain the evidence that suggested that race is an artificial concept in humans.

25. Where geographically is the majority of human genetic variation found? Where is the least genetic variation found? (We discussed this in a previous lecture; under the topic of geographic variation/heterozygosity.)

26. If the vast majority of variation is within human populations, how do companies like "Ancestry.com" and "23andMe" trace human ancestry?

27. Natural selection evidence is stronger when parallel clines in multiple traits are found. What examples did we discuss? Why do parallel clines strengthen the evidence for natural selection?

28. Explain why the parallel cline in two *Heliconius* butterfly species in Central and South America is stepped.

Lecture 21.

1. Explain how secondary contact between two formerly isolated species can mimic a cline that results from a gradual change in an abiotic environmental variable.

2. Define ring species and explain what they illustrate about geographic variation, gene flow, and genetic variation? What happened in the case of the salamander genus *Ensatina when* populations at the southern end of the range met?

3. What four factors determine the success of mating?

4. Give two example of pre-mating factors that reduce gene flow in each of the following categories: spatial isolation, temporal isolation, and behavioral isolation.

5. There are a wide variety of behaviors that limit gene flow among species by serving as specific mate recognition systems: some are visual, some aural (sound), and some chemical. List three types of visual communication. Give examples of three major animal taxa we discussed that use aural communication.

6. True or False. All insect sound communication is carried by airwaves. Explain your answer.

7. True or False. All insect communication sounds are detectable by the human ear. Explain your answer.

8. One way that plants and animals have evolved to avoid mating with close relatives is temporal isolation. Give two examples of ways in which temporal isolation has evolved.

9. In other cases of pre-mating, pre-zygotic isolation adults meet but they do not mate. Why not? We discussed several categories of reasons.

10. Define: aggressive mimicry. What two examples did we discuss?

11. Define "cryptic female choice" as defined by Eberhard. Is there much evidence for this?

12. What is the lock and key hypothesis?

13. What are the four stages at which egg and sperm union (zygote formation) can fail?

14. True or False? The more distantly related two species, the less likely they are to produce viable hybrid offspring. Why? What exception to this rule did we discuss?

15. Lee and Vacquier (1992) sequenced the sperm binding protein in seven species of abalone. After comparing the DNA sequences among all species, they found more differences among species at second positions in the active sites of proteins than at third positions? What does this result imply?

16. What is the MacDonald Kreitman test and how is it used? Know the formula and what it means.

17. Is it usual to find more second than third position changes when comparing proteins of closely related species? Why or why not?

18. At what stages of development can post zygotic isolation operate?

19. Discuss possible postzygotic cellular level processes that might cause mating between species to fail to produce viable fertile offspring.

20. What is Haldane's Rule? And what is the major cause?

21. Coyne and Orr (1997) reviewed 60 years of Drosophila studies and compiled data on reproductive isolation. One of the things that Coyne and Orr (1997) found was that prezygotic isolation was stronger between sympatric/parapatric populations than between allopatric populations but that postzygotic isolation is virtually identical in the two groups. Using the information you learned in the class so far, devise an explanation for this finding.