Biology 115D Schulze 2023

**Evolution, Behavior, & Ecology Exam #1**

**Name (printed) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**I completed this exam in accordance with the Austin College academic integrity**

**policy. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (your signature)**

° Read each question carefully.

° If a question appears ambiguous, ask for clarification.

° Keep an eye on the clock. Do not get bogged down on difficult questions when relatively easy questions remain to be answered.

° Write legibly and try to confine your answers to the space provided. If you must have more space, continue elsewhere on the exam – but indicate that you have done so.

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1. Evolution is a result of three circumstances and one consequence of those circumstances. Define evolution, list the 3 circumstances, and explain how the consequence of those circumstances results in evolution. Use natural processes, not intentional human processes, as the basis of your explanation. (15 points)

The three circumstances are more offspring are born than the environment can support, individual offspring vary from one another, and some of that variation is heritable. The first consequence of this is that those offspring that happen to be best suited to surviving and reproducing in their environment will tend to leave the most offspring (this is natural selection). The consequence of natural selection is that more copies of some alleles than others will make it into the next generation. In other words, allele frequencies (and thus the composition of the gene pool) will change – which is the definition of Evolution.

(Evolution can also occur as a result of some other processes that we have studied, but this process is most important.)

2. Explain three reasons why genetic diversity persists within populations despite the processes that cause evolution. (15 points)

We discussed five.

Diploidy (zygotes that have two alleles for each gene) causes rare recessive alleles to persist in populations carried by herterozygotic individuals. Because these alleles are not expressed, they are not selected against.

Selection pressures can change with time, causing different alleles to be favored at different times. This can cause an allele that has become rare under one set of environmental conditions to become more abundant under a new set of conditions.

Some variation among alleles has not fitness consequences, so the various alleles are not selected for or against.

Mutations add new genetic variation to populations.

Sometimes heterozygotes have the highest fitness (higher than either homozygote). This causes heterozygotes to pass on both alleles, so both persist in the population.

Correct answers were indicated on the multiple choice questions. See my answers below to the questions that required brief written answers.

Multiple choice and similar questions. Choose the single best answer. Do not select 2 or more answers. (2 points unless noted otherwise)

3. Is a mutation ever helpful?

\_\_\_ No, because mutations are random.

\_\_\_ No, because mutations are rapidly eliminated in the next generation.

\_\_\_ Yes, because some mutations increase fitness and genetic diversity of populations.

\_\_\_ Yes, because mutations are only harmful when they are dominant.

4. Adaptive radiation is most likely if…

\_\_\_ many reproductively-isolated populations exist

\_\_\_ different populations experience different selective conditions

\_\_\_ small numbers of individuals found the various populations

\_\_\_ all the above

\_\_\_ none of the above

5. The definition of an allele is …

\_\_\_ an ancestral form of a gene.

**\_\_\_** a variant of a gene.

**\_\_\_** anything that causes a gene to give its bearer higher fitness.

\_\_\_ all the above.

\_\_\_ none of the above.

6. Which of the following is an example of an anatomical homology?

\_\_\_ The vertical orientation of whale tail flukes (fins).

**\_\_\_** The pattern of gradual change in horse fossils.

**\_\_\_** The similarities in the body shapes of a shark and a whale.

**\_\_\_** The bones of your arm and a bird wing.

**\_\_\_** All the above

\_\_\_ None of the above

7. Which is most likely to reduce the genetic diversity of a population?

\_\_\_ mutations

\_\_\_ gene flow

\_\_\_ genetic drift

\_\_\_ a bottleneck event

\_\_\_ all the above

\_\_\_ none of the above

8. Which is true of the guppies modeled in the guppy spot simulation

\_\_\_ The males have bright spots after several generations when few predators are present because females select for bright males.

\_\_\_ Camouflaged guppies always have the highest fitness.

\_\_\_ The females are most brightly colored after several generations with predators present because the predators avoid the toxic females.

\_\_\_ The males have bright colors when dangerous predators are present because the coloration serves as a warning that the males are toxic to predators.

\_\_\_ All of the above.

\_\_\_ None of the above.

9. Which of the following two organisms would you expect to have the most similar amino acid sequences in their hemoglobin molecules? (You do not need to know anything about hemoglobin, including what it is, to answer this question.)

\_\_\_ a cat and a frog

\_\_\_ a tiger and a leopard

\_\_\_ a human and a trout

\_\_\_ a salamander and an elephant

\_\_\_ none of the above – none of them would be expected to have any similarities in the amino acid sequences of their hemoglobin molecules.

10. What is the purpose of a mutation?

\_\_\_ To create new genetic variants.

\_\_\_ To enable populations to develop genetic diversity.

\_\_\_ To ensure that natural selection occurs.

\_\_\_ Mutations do not have a purpose. They have consequences (effects), but do not occur on purpose.

11. Natural selection acts upon\_\_\_\_\_\_\_\_\_\_\_.

\_\_\_ phenotypes

\_\_\_ genotypes

\_\_\_ recessive alleles

\_\_\_ heterozygotes

\_\_\_ homozygotes

\_\_\_ None of the above

12. Which of the following is correct?

\_\_\_ When sticklebacks move from lakes to the ocean, they lose their armor because in the ocean they need to maneuver quickly to catch prey.

\_\_\_ When sticklebacks move from the ocean to lakes, they evolve more armor because armor protects them from freshwater predators.

\_\_\_ When sticklebacks move from the ocean to lakes their teeth evolve from adapted to crushing to adapted to tearing.

\_\_\_ All of the above.

\_\_\_ None of the above.

13. The text discusses side-blotched lizards as an example of

\_\_\_ molecular homology

\_\_\_ frequency dependent selection

\_\_\_ non-random mating

\_\_\_ punctuated equilibrium

\_\_\_ all the above

\_\_\_ none of the above

14. Medical officials recommend flu and coronavirus vaccines, but if you get the shots you may still get ill. What is the basic reason (described in the assigned reading) that a flu shot may be ineffective?

The virus may have mutated since the vaccine was prepared. Your immune response to the vaccine may not be as effective against the new strain as against the strain that served as the basis for the vaccinie.

(Not this this has some similarities to but is not the same process as that responsible for antibiotic resistance.)

15. Choose the best scientific definition of theory.

\_\_\_ Someone’s idea regarding the workings of something.

\_\_\_ An idea that may be right or wrong.

\_\_\_ A hypothesis that has been proven correct.

\_\_\_ An idea for which there is not yet any strong evidence.

\_\_\_ A synonym for a hypothesis. In other words, all hypotheses are theories, and vice-versa.

\_\_\_ A hypothesis that explains a great deal and is supported by extensive evidence.

\_\_\_ None of the above.

16. If an individual has two different alleles for a gene that individual is

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for that gene.

17. Compared to large populations, small populations are at a higher risk for\_\_\_\_\_\_\_\_\_\_.

\_\_\_ Mutation

\_\_\_ Inbreeding depression

\_\_\_ Natural selection

\_\_\_ Heterozygosity

\_\_\_ Gene flow

\_\_\_ All of the above

\_\_\_ None of the above

18. Is it possible to prove that every bluebird has blue feathers? Why or why not? (4 points)

No because you can never be certain that you have seen every bluebird.

19. If the 10-meter width of our classroom represents the time since life first arose on Earth until the present, the most recent two hundred of years, since the beginning of the industrial revolution and thus the first substantial use of fossil fuels, the invention of plastics, electronics and the great majority of toxic chemicals, the invention of air travel and space flight, etc. all occurred in the last

\_\_\_\_ 1 meter

\_\_\_\_ 1 centimeter (a bit less than ½ inch)

\_\_\_\_ 1 millimeter (about the width of a pen tip)

\_\_\_\_ 100 micrometers (about the width of a piece of paper)

\_\_\_\_ 1 micrometer (about 1/20th of the diameter of a human hair)

20. Which of the following is true of mutations

\_\_\_\_ As far as anyone can tell they occur randomly

\_\_\_\_ When expressed in the phenotype they are more likely to reduce than increase individual fitness

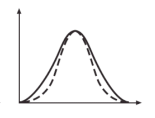
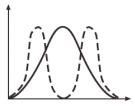
\_\_\_\_ They are the ultimate source of new genetic variation

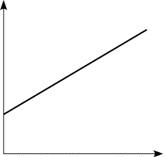
\_\_\_\_ They increase the genetic diversity of populations and thus the potential of populations to evolve in response to new circumstances

\_\_\_\_ All the above

\_\_\_\_ None of the above

21. Which graph (some may be on the next page) represents directional selection? [The solid line is the earlier situation. The dotted line is the later situation. The x-axis is a quantitative (numerical) measure of the phenotype. The y-axis is the frequency of individuals with any given x-axis value.]

A\_\_\_B\_\_\_C \_\_\_

D\_\_\_  E\_\_\_ None of the above.

22. Which of the following examples was described as a case of stabilizing selection?

\_\_\_ horn lengths of longhorn cattle.

\_\_\_ selection for sickle cell heterozygotes in areas with malaria.

\_\_\_ beak depths of Galapagos finches on the island Daphne Major.

\_\_\_ birth weight of human babies.

\_\_\_ all the above.

\_\_\_ none of the above.

23. Inbreeding is harmful because it

\_\_\_ maximizes the chance that deleterious dominant alleles will occur in homozygotes \_\_\_ maximizes the chance that deleterious dominant alleles will occur in

heterozygotes

\_\_\_ maximizes the chance that deleterious recessive alleles will occur in heterozygotes

\_\_\_ causes mutations

\_\_\_ all the above

\_\_\_ none of the above

24. What is *the* key characteristic of science done well?

\_\_\_ Science focuses upon natural phenomena.

\_\_\_ Science is based on running controlled experiments.

\_\_\_ Science is restricted to questions of great importance to society.

\_\_\_ Science focuses on natural processes

\_\_\_ All of the above

\_\_\_ None of the above are the key characteristic of science done well.

25. Convergent evolution requires

\_\_\_ that humans determine which individuals survive and reproduce.

\_\_\_ recent common ancestors.

\_\_\_ similar selective forces acting upon different species.

\_\_\_ complex organisms such as vertebrates.

\_\_\_ All of the above.

\_\_\_ None of the above.

26. Genetic drift is most important to populations.

\_\_\_ small

\_\_\_ large

\_\_\_ adaptive

\_\_\_ migratory

\_\_\_ nonmigratory

27. Succinctly but precisely explain the difference between the definitions of a species and a population.

A species is a group of organisms with the potential to produce fertile offspring under natural conditions if they have an opportunity to do so.

A population is a group of organisms with both the potential and opportunity to produce fertile offspring under natural conditions.

28. Which of the following does *not* make sense given the logic of evolution by natural (question should have said “or artificial”) selection and what you have learned about the species in question?

\_\_\_ Commercial fishing with nets will lead to an increase in the size a maturity of harvested fish species.

\_\_\_ If an El Niño causes a drought in the Galapagos Islands, then the bills of the finches on Daphne Island will evolve to a larger size.

\_\_\_ If a new antibiotic is invented and widely used, it will eventually become useless.

\_\_\_ If a new herbicide is invented to replace Roundup and widely used, weeds will eventually become resistant to it.

\_\_\_ None of the above make sense.

\_\_\_ All of the above make sense.

29. What is the difference between micro- and macroevolution?

\_\_\_ Microevolution describes the evolution of small organisms, such as insects, while macroevolution describes the evolution of large organisms, like people and elephants.

\_\_\_ Microevolution describes the evolution of microscopic entities, such as molecules and proteins, while macroevolution describes the evolution of whole organisms.

\_\_\_ Microevolution describes the evolution of populations, while macroevolution describes the evolution of new species.

\_\_\_ Microevolution describes the evolution of individual organisms over their lifetimes, while macroevolution describes the evolution of organisms over multiple generations.

\_\_\_ None of the above. All the above are wrong.

30. Which of the following was used in class, the text, or simulations as example of directional selection?

\_\_\_ horns of cattle

\_\_\_ finch bills

\_\_\_ ~~sizes of African Seedcracker finches~~

\_\_\_ peppered moths

\_\_\_ all the above

\_\_\_ none of the above

31. Which of the following does not cause evolution?

\_\_\_ genetic drift

\_\_\_ use of herbicides

\_\_\_ gene flow

\_\_\_ mutations

\_\_\_ commercial fishing

\_\_\_ All of the above cause evolution.

\_\_\_ None of the above cause evolution.

32. An individual’s complete set of genes is its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

33. The expression of an individual’s genes is that individual’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

34. Which of the following *does not prevent* evolution from resulting in perfect organisms?

\_\_\_ The environment frequently changes and natural selection has no means of anticipating changes.

\_\_\_ Natural selection can only act upon existing genetic variation (can only select for or against individuals with existing traits).

\_\_\_ Adaptations involve trade-offs.

\_\_\_ All of the above prevent evolution from resulting in perfect organisms.

\_\_\_ None of the above prevent evolution from resulting in perfect organisms.

35. Fitness (as the term is used by evolutionary biologists) *is*

\_\_\_ the relative number of offspring an individual contributes to the next generation.

\_\_\_ an organism’s strength.

\_\_\_ the age at which an organism dies.

\_\_\_ the average life span of an individual’s offspring.

\_\_\_ all the above.

\_\_\_ none of the above.

36. *Deleterious recessive* alleles accumulate in populations because of all the following except

\_\_\_ Since they are recessive they cannot affect an organism’s fitness and therefore are never selected against.

\_\_\_ Unless inbreeding occurs, they are rarely expressed and therefore are rarely selected against.

\_\_\_ Mutations are often harmful.

\_\_\_ Most large populations are not inbred, they are outbred, because evolution selects against inbred mating.

\_\_\_ All of the above are false.

\_\_\_ None of the above are false. All the above statements are correct.

37. Neotropical birds called Jacanas are unusual in that the males raise the young. Based on just that information and your understanding of evolution, it is safe to predict that

\_\_\_\_ the population is undergoing disruptive selection.

\_\_\_\_ the population will go extinct because the male’s behavior will be selected against and all the males display the same behavior.

\_\_\_\_ the males are choosier than the females when selecting mates.

\_\_\_\_ the population is undergoing directional selection.

\_\_\_\_ all the above

\_\_\_\_ none of the above