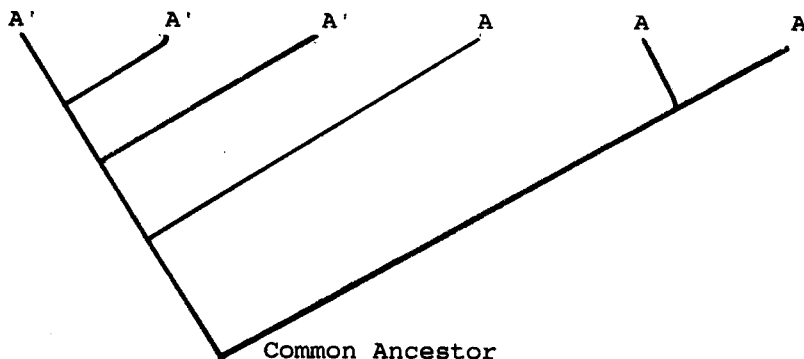


Work through the test as fast as possible, answering the easiest questions before returning to more difficult ones. Read each question carefully and completely, review all of the options presented before selecting. Do not hesitate to ask for clarification if you are unsure about the meaning of a question. Reread both the questions and your answers before turning in your answer sheet. If you do not know an answer, cross out all answers you know are incorrect and make a guess from among the remaining possibilities. Your test should have seven (7) pages. The amount of credit for non-multiple choice questions is indicated, and the remainder of the 200 points will be assigned to the multiple choice questions.

1. (3 pt) In the cladogram below, indicate where the character state A' evolve?



2. Which of the following concepts was a major contribution of Greek philosophy to later developments in biology?
- Typological thinking in biology.
 - Recognition that populations grow exponentially.
 - The law of superposition.
 - Recognition of the importance of natural selection in evolution.
 - Development of binomial nomenclature.
3. Why do we believe that carbon dioxide (CO₂) was at the surface of the earth before life originated?
- It would have had to be there for the earliest monomers to form.
 - It occurs in gasses discharged from volcanic sources today.
 - Carbonate minerals are present in the earliest sedimentary rocks.
 - All of the above.
 - None of the above.
4. Suppose a sample of lava has a ratio of 1 part parent radioisotope to 31 parts stable daughter isotope, and the half life of the parent isotope is 3 million years. How old is the sample?
- 15 million years.
 - 3 million years.
 - 16 million years.
 - 5 million years.
 - 32 million years.

Data Summary

Half life = 3 million years.

Parent:Daughter = 1:31

5. Why do virtually all natural populations of plants and animals have roughly constant population sizes (i.e., the carrying capacity, K) one generation after another for many generations?
- The maximum number of offspring produced is typically two per female.
 - The average number of offspring produced is typically two per female.
 - Individuals usually decide not to reproduce if the environment is too crowded.
 - many more offspring are produced than can survive and reproduce, but only two per female survive to reproduce, on average.
 - None of the above.
6. Who is the author of the biological species concept?
- Ernst Mayr.
 - Charles R. Darwin.
 - Malthus.
 - Lamarck.
 - Linnaeus.
7. The meaning of materialism in science is that:
- we simply collect data and do not engage in development of models or hypotheses.
 - the only acceptable source of information to test hypotheses is that observed in the real world.
 - observations of phenomena in the real world have causes.
 - the simplest explanations for observations of phenomena in the real world are preferred.
 - None of the above.
8. Which of the following are homologous character states?
- forelimbs of birds and forelimbs of bats.
 - kidney of humans and eyes of chimpanzees.
 - eyes of humans and limbs of birds.
 - wings of bats and wings of birds.
 - flippers of turtles and flippers of whales.
9. What is the best independent evidence that the "Cambrian Explosion" was a real biological phenomenon?
- Molecular data indicate that all phyla originated a long time ago over a very short period of time.
 - It is reasonable to believe that hard-bodied animals could not be preserved in the fossil record prior to the beginning of the Cambrian.
 - Geological evidence shows that the concentration of oxygen (O₂) in the atmosphere was too low to support metazoans until the beginning of the Cambrian.
 - Soft-bodied fossils that occur before the Cambrian explosion are all unicellular or metazoans that belonged to phyla that did not occur in the Cambrian explosion.
 - There is no evidence of photosynthesis prior to the time of the Cambrian Explosion.
10. Which of the following criticisms is not applicable to the biological species concept?
- It is arbitrary and there are no objective criteria for different species.
 - It is hard to apply in practice to geographically separated populations.
 - Its criteria cannot be applied to asexual species.
 - It cannot be applied to fossils.
 - None of the above.

11. The Greek philosopher, Plato, envisioned a dual world of:
- cause and effect.
 - forms and sense objects.
 - phenomena and objectives.
 - known and unknown.
 - None of the above.

12. (10 pt.) The eucaryote cell evolved by symbiosis of several independent organisms. Match up the procaryote organisms with their eucaryote cellular derivatives by drawing a line between them. (More than one line may go from a Unicellular Organism to a Cellular Derivative.)

CELLULAR DERIVATIVE

Chromosome
Mitochondria
Chloroplast
Cilia
Flagella
Nucleus
Centrosomes

PROCARYOTE

Stromatolite
No independent precursor
Trilobite
Spirochaete
Aerobic bacteria
Blue-green algae (cyanobacteria)
Coacervate

In the space below, describe the evidence for the derivation of any one of the above cellular derivatives from its procaryote ancestors.

13. Which of the following statements is associated with the concept of uniformitarianism?

- The present is the key to the past.
- Inheritance of acquired characteristics.
- Slow processes that occur for a long time can produce large effects.
- Rocks that occur deeper in the crust of the earth were deposited earlier.
- None of the above.

14. What led to Darwin's conclusion that living species had descended from common ancestors that lived in the past.

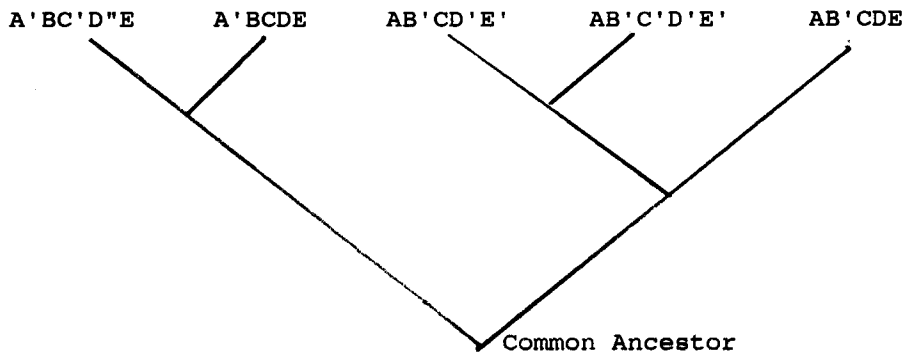
- Insights he gained from Malthus' book.
- Insights he gained from Mendel's genetic experiments.
- Observation of related species, like the Galapagos finches, that appear to have been derived from a common ancestor.
- His understanding of principles of animal breeding.
- The presence of gradual transitions between species in the fossil record.

15. What is a stromatolite?

- A basic evolutionary unit used in population genetics.
- Mat-like communities of anaerobic, unicellular procaryotes that included photosynthesizers.
- One of the phyla present in the Ediacaran Fauna.
- A major group that appeared early in the Cambrian Explosion.
- None of the above.

16. Industrial melanism
- occurs only in the peppered moth, Biston betularia.
 - is restricted to insect populations in the United Kingdom.
 - results from selection only on caterpillars in Biston betularia.
 - involves selection on a polygenic trait producing a gradual trend for increasing darkness of coloration over thousands of years.
 - None of the above.
17. Which of the following terms does not reflect the general principle in biology that larger, more complex units are built up by combining sets of smaller, essentially similar, repeating units.
- Metamerism.
 - Metazoa.
 - Polyphyletic.
 - Origin of the eucaryote cell by symbiosis.
 - Polymer.
18. How would you characterize the immediate impact of the publication of Darwin's *Origin of Species*?
- An instant sell out that rapidly effected the thinking of the educated public..
 - A technical work that immediately influenced scientists but was ignored by the public.
 - A popular book that failed to gain a wide audience.
 - A technical work that was not appreciated until the development of the New Synthesis in the middle of the 20th century.
 - An important book that stimulated evolutionary thinking, but only a small step to establish the central place of evolution in modern biology.
19. The geographic or allopatric speciation model envisions that:
- populations still exchanging genes by interbreeding with geographically intermediate populations can still become separate species.
 - a geographical barrier that cuts off gene flow must be imposed to isolate a population before speciation can take place.
 - individuals must become stranded on an island or some similar isolated habitat to form new species.
 - species formation can occur within a single population in one place.
 - All of the above.
20. In which of the following classes of molecules have examples of autocatalysis been observed, suggesting that that class of molecule constituted the original genetic material and biological catalyst when life first evolved?
- RNA.
 - DNA.
 - Protein.
 - Enzyme.
 - Polysaccharide.
21. Which of the following two phyla are more closely related to each other than are members of any of the other pairs?
- Mollusca and Echinodermata.
 - Arthropoda and Chordata (e.g., vertebrates, fish, amphibians, birds).
 - Annelida (e.g., earth worms and other segmented worms) and Echinodermata (sea urchins, sand dollars, starfish).
 - Annelida and Chordata.
 - Arthropoda (e.g., spiders, crabs, insects) and Mollusca (e.g., clams, squid, snails).

Answer the questions below using the following tree:



22. Assuming that there are no evolutionary reversals (i.e., evolution of the primitive state from derived) on the tree above, identify the character that has a homoplasy. (Circle one.)

A B C D E

23. Which character provides support for the grouping of species 4 and 5 as closest relatives? (Circle one.)

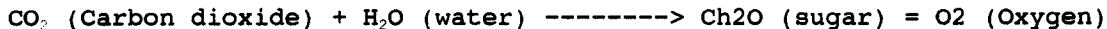
A B C D E

24. Which character state provides support for the grouping of species 3, 4 and five into a monophyletic group that excludes species 1 and 2? (Circle one.)

A B C D E

25. The use of index fossils allowed
- a. proof that there had been extinctions.
 - b. demonstration that the earth was billions of years old.
 - c. long geological sequences to be assembled in correct order.
 - d. demonstration of evolution by identification of transitions between living species.
 - e. demonstration of uniformitarianism.

26. The following reaction equation describes what important phenomenon?



- a. Photosynthesis.
- b. Oxidation.
- c. Peptide bond formation in proteins.
- d. Nucleic acid polymerization to form DNA.
- e. Nucleic acid polymerization to form RNA.

27. What is the great advantage of sexual reproduction?

- a. Larger cell size is possible.
- b. A larger number of multigene genotypes can be produced.
- c. Multicellularity is possible.
- d. Photosynthesis is possible.
- e. Aerobic metabolism is possible.

28. What did Malthus contribute to the development of evolutionary thought?
- Concept of gradualism.
 - Recognition of that biological populations have the potential for exponential growth.
 - Discovery of genetics.
 - Development of a universally accepted biological classification and system of nomenclature.
 - Concept of uniformitarianism.

29. About how long ago did the earliest metazoans (multicellular animals) appear in the fossil record?

- 3.2 billion years.
- 10.0 billion years.
- 2.1 billion years.
- 0.67 billion years.
- 1.4 billion years.

30. Using the classification below, tell me which two species are more closely related to each other pair. (Circle a pair of species.)

| CATEGORIES | Species A | Species B | Species C | Species D |
|------------|---------------------|-------------------|--------------------|---------------------|
| Kingdom | Animalia | Animalia | Animalia | Animalia |
| Phylum | Chordata | Chordata | Chordata | Mollusca |
| Class | Pisces | Mammalia | Mammalia | Cephalopoda |
| Order | Gasterosteiformes | Primates | Perissodactyla | Octopoda |
| Family | Gasterosteidae | Hominidae | Equidae | Nautilidae |
| Genus | <i>Gasterosteus</i> | <i>Homo</i> | <i>Equus</i> | <i>Nautilus</i> |
| Species | <i>G. aculeatus</i> | <i>H. sapiens</i> | <i>E. caballus</i> | <i>N. pompilius</i> |

31. In general, how did the animals of the Ediacaran Fauna differ from the main adaptive radiation of the Metazoa.

- They were unicellular.
- They were anaerobic.
- They consisted of procaryote cells.
- They had very flat and thin bodies.
- None of them could be assigned to a modern phylum.

32. An advanced character state is the expression of a character that is similar to the expression in the common ancestor of the set of species in question.

- equivalent to the primitive state.
- more different from the expression of that character in the ancestor than any in other species.
- equivalent to the ancestral state.
- a nonhomologous state of a character, a homoplasy.

33. Which of the following is a postmating isolating mechanism?

- Ecological or habitat isolation.
- Mechanical isolation.
- Ethological or sexual isolation.
- Seasonal or temporal isolation.
- Hybrid sterility.

34. (4 pt) Using the space below and "x" marks for each species, draw the cladogram for species 1-5 based on the character matrix presented below. Label the "x" at the top of each branch on the tree with the number of the species that belongs there. Assume parsimony and that there is no evolutionary reversal or homoplasy in the cladogram you draw. Species numbers do not have to be in numerical order across the top of the cladogram.

| SPECIES | CHARACTERS | | | | | |
|---------|------------|----|----|----|----|----|
| | A | B | C | D | E | F |
| 1 | A' | B | C | D' | E' | F |
| 2 | A | B' | C' | D' | E | F' |
| 3 | A | B' | C' | D | E | F' |
| 4 | A' | B | C | D | E' | F |
| 5 | A | B' | C' | D | E | F |

x

x

x

x

x

. Common Ancestor

35. (3 pt) Mark the tree to show where character state A' must have evolved (assuming parsimony).

32. How do we recognize modern typological species?

- They are genetically distinct from other known typological species.
- They do not interbreed with members of other typological species.
- They are morphologically distinct from other known typological species.
- Typological species are arbitrary, and one must have the type specimens to tell them apart.
- They do not occur in the same place (i.e., they are allopatric) as other related typological species.

36. What is founder effect and why is it potentially so important?

- It is a change in genetic composition of a small, isolated population due to sample error and resulting changes in its response to natural selection.
- It is the change in evolutionary direction due to colonization of a new habitat.
- It is a population explosion that follows colonization of a new environment.
- It is very intense natural selection that reduces a population to just a few individuals.
- None of the above.