

PART I. Multiple choice questions – (5 points each, 50 points total).

1. Natural Selection is the driving force behind evolution. Which of the following is **NOT** a correct concept relating to natural selection?
 - A. change in the trait distribution of populations
 - B. acts at the level of the individual
 - C. forward looking process
 - D. operates on existing traits or phenotypes
 - E. descent with modification

2. The advent of land animals is associated with the fin bones of the lobe-finned fishes. When did these fish first crawl “out of the ooze”?
 - A. Precambrian
 - B. Devonian
 - C. Silurian
 - D. Archean
 - E. Holocene

3. Which of the following dates is erroneous (just plain wrong!) as described by the fossil record?
 - A. The end of the ammonites @ 65 Mya
 - B. The end of the trilobites @ 250 Mya
 - C. The first hominins @ 100 Mya
 - D. The Cambrian explosion of animal forms @ 550 Mya
 - E. The first Eucarya algae @ 2.1 Bya

4. When considering the types of gene expression used during the development of animal body plans, which of the following would be considered most important for this process?
 - A. lac operon
 - B. hom/hox genes
 - C. rrn operon
 - D. heat shock genes
 - E. mtDNA

5. Mass extinction events are thought to be associated with a number of possible catastrophes. In addition to the ever-popular asteroid impact scenario, which of the following are also possible extinction causing catastrophes?
- A. Electromagnetic pulse from Magnatars
 - B. Extreme acid rain poisoning groundwater
 - C. Extreme volcanic activity
 - D. Drop in sea level (regression) followed by a rise in sea level (transgression)
 - E. All of the above
6. Consider the evolutionary comparison between the vertebrate eye (e.g., human) and the cephalopod eye (e.g., octopus). Remember that vertebrates have a blind spot, whereas cephalopods do not. This scenario can best be described as:
- A. Homology
 - B. Homoplasy
 - C. Synapomorphy
 - D. Analogy
 - E. Parsimony
7. In order to make the leap from abiotic chemicals to cellular life, four major **theoretical hurdles** must be overcome. Which of the following is NOT one of these hurdles?
- A. Abiotic synthesis of monomers such as amino and nucleic acids.
 - B. Polymerization of monomers into polymers such as proteins and DNA.
 - C. Transference of heredity information from one generation to the next.
 - D. Development of ribozymes catalyzing metabolic functions.
 - E. Formation of protobionts through the aggregation of a membrane.
8. Which of the following evolutionary forces occurs strictly by **chance**?
- A. genetic drift
 - B. speciation
 - C. mutation
 - D. natural selection
 - E. migration

9. When considering the various methods of phylogeny, which of the following seeks to specifically group organisms based solely on their related similarities?
- A. Distance matrix methods
 - B. Maximum Likelihood
 - C. Cladistics
 - D. Parsimony
 - E. Phenetics
10. Of the following, which is NOT a lesson from the BIG TREE of life?
- A. Indicates photosynthesis occurred near the earliest ancestor
 - B. Demonstrated three domains of life regarding genetic diversity
 - C. Points towards a single ancestor for the origin of life
 - D. Indicates prokaryotes had a thermophilic origin
 - E. Shows that each domain is nearly as distantly related as any other

PART II. SHORT answer questions – (Number of points in parentheses, 100 points total).

11. (10 points) What are the factors that lead up to **extinction vortex** and how might one offer a solution to an escape from this scenario?
12. (10 points) Describe the concept of **impact frustration** and at what point did this process make a dramatic shift happen allowing life on Earth to proceed without the constant threat of total annihilation?

- 13.** (10 points) One of the most heated aspects of human racial politics is the contention that human races are genetically distinct. How does the African replacement (Out of Africa) model vs. multiregional model of human evolution address this issue? That is, which model predicts that human races are more genetically similar and/or different AND why?
- 14.** (10 points) A recent study of the bone strength of *Tyrannosaurus rex* revealed that if a fast running *T. rex* ever tripped, it would probably not survive due to broken bones. Given these high costs, why did large body size ever evolve? Can you think of some costs associated with small body size?

- 15.** (10 points) The **Cambrian explosion** as exemplified by the Burgess shale and Chengjiang phosphorite fossils demonstrates a major achievement regarding the **adaptive radiation** of animals. What do these fossils represent collectively in terms of animal diversification? What is meant by the contrasting idea of a “slow fuse”?
- 16.** (10 points) Describe the **primary observation** witnessed regarding the size of the habitat range of multicellular organisms regardless of the type of extinction affecting them (mass or background). What percent of **all** extinctions did the “big five” mass extinctions accumulatively account for?

17. (20 points) Based on reciprocal transplant experiments, the relative fitness for **big sagebrush** is greater for hybrids only in the intermediate elevations or transitional habitats. **(A)** This is an example of what specific type of speciation model? **(B)** What would you predict as the eventual outcome based on what you know about secondary contact and the narrow range of the hybridization zone and why?
18. (20 points) Examine the graph provided which shows F_{st} , a measure of genetic variability between populations as a function of geographic distance. These data are from human populations in Europe. F_{st} has been calculated from autosomes (from both parents), mtDNA (only from the mother), and Y chromosome (only from the father) loci. Consider these data and develop a hypothesis using an evolutionary force/mechanism to explain why these alleles are more homogenized across populations of autosomal and mtDNA loci rather than for Y-chromosome loci.

PART III. Short Essay – (Number of points in parentheses, 50 points total).

- 19.** (25 points) In some species of deep-sea anglerfish, the male lives as a symbiont permanently attached to the female. The male is tiny compared to the female and many of his organs including the eyes are reduced. The jaws and teeth are specifically modified for attachment to the female. The circulatory systems become fused and the male gets all his nutrition from the female this way. **(A)** What mechanism do you think drives this relationship? **(B)** What is/are the limiting factor(s) and forcing function involved? **(C)** Do you think the male's symbiotic habit evolved due to natural selection or sexual selection?

20. (25 points) Describe the role that **oxygen** has played regarding the evolution of multicellular organisms. **(A)** What is thought to have caused multicellularity to get “put off” for such a long time? **(B)** What were the sources and the sinks for oxygen over the history of the Earth? **(C)** Now that an excess of oxygen has occurred, what are the feedback mechanisms that control its level in terms of upper AND lower limits in the atmosphere?

21. Extra Credit, Short answer (10 points): What specific method of **sperm competition** is used by male damselflies?