

Name _____

**BEP 210 – Epic of Evolution
Final Exam - May 3, 2003**

This exam is closed-book and closed-note.

Part 1 (48 points): Answer 12 of the following 15 short questions. Please cross out the 3 that you do not do. Each of these questions is worth 4 points. Please *do not* feel obligated to use all of the space provided.

- 1) Although scientists can state quite definitely *that* the Big Bang occurred, there is no generally accepted understanding of *why* it occurred (i.e. what caused it). Explain the reason for this difference, and relate it to the reason for starting our narrative of the evolution of the universe at the time when the current observable universe was "beach-ball sized," and not at the instant of the Big Bang.
- 2) When, during a star's lifetime, can it become a supernova? Why? Does this happen to all stars? Why or why not? Why are supernovas important for life on Earth?
- 3) According to current theory, most of the energy and mass of the observable universe is not made up of ordinary matter, but of "dark matter" and "dark energy." Choose *either* dark matter *or* dark energy and give one reason we think it exists *and* one property that we believe it has. (Note: if the property you choose is that it's "dark," then you will need to explain why it's dark.)
- 4) From where does a star get its energy during the "T-Tauri" period of stellar evolution? Why are the processes that power a normal star (like the present Sun) not working during the T-Tauri period?
- 5) In Martin Rees's book, Just Six Numbers, he discusses the number "D", which is the number of dimensions of space. (In our universe, $D=3$). Give *one* reason why life would be unlikely to evolve if D were greater than 3, **AND** *one* reason why life would be unlikely to evolve if D were less than 3.
- 6) Igneous rocks can be either intrusive or extrusive. How are the appearances of intrusive and extrusive igneous rocks different? Why is this?
- 7) Suppose you start with mud, and compress it until it first becomes a sedimentary rock and then a metamorphic rock. Explain what happens to the mud, using rock names.
- 8) What are the two different kinds of weathering? Give an example of each.
- 9) What happened to Earth's early atmosphere? Where did Earth's current atmosphere come from?
- 10) What has been unusual (name 2 things) about Earth's climate over the past 10,000 years? Why is this significant from a human perspective?

11) Darwin's articulated what is called the premise of Common Descent. What is this premise, and what is the "evolutionary logic" behind it? (In other words, how does an understanding of the dynamics of evolution generate this premise?)

12) Explain what is meant by saying that embryology is based on encoding and displaying signifiers that represent aspects of oneself.

13) What is an adaptation? Explain what is meant by saying that respiration is an adaptation made possible by photosynthesis.

14) What is meant by niche construction? In what sense are hominids thought to have engaged in niche construction?

15) How is it argued that while mutations occur randomly, biological evolution is not a random process?

Part 2 (48 points): Answer 6 of the following 9 short questions. Please cross out the 3 that you do not do. Each of these questions is worth 10 points. Please *do not* feel obligated to use all of the space provided.:

1) Consider the case where two nuclei combine to make a nucleus larger than ^{56}Fe (iron 56). Sketch a picture of the "energy well" relevant to this case, and explain the origin its key features, using what you know about the strength, range, and direction (attractive or repulsive) of the relevant fundamental forces. Using your picture, explain why stars cannot be powered by making nuclei bigger than ^{56}Fe . When and how are such nuclei produced?

2) List the 3 key ingredients of Einstein's theory of General Relativity. Explain how general relativity incorporates or accounts for each of these ingredients. Give two examples of phenomena that are predicted or explained by General Relativity but either cannot be explained or are incorrectly predicted by Newton's theory of gravitation. Explain.

3) What is the Cosmic Microwave Background? When and why was it formed? Is the frequency of the Cosmic Microwave Background the same today as when it was formed? Why or why not? What does the Cosmic Microwave Background tell us about the shape of our observable universe? Explain briefly.

4) (a) Explain what is meant by the "Rock Cycle". (b) What is the difference between the "deep" rock cycle and the near-surface rock cycle? (c) What are the next possible steps through the rock cycle that could occur for magma? (d) ... for sediment? (e) ... for a limestone?

5) (a) What is the Greenhouse Effect? (b) Why is it called this? (i.e., what does it have to do with a "greenhouse"?) (c) How do humans affect the greenhouse effect? (d) Why doesn't Earth have a runaway greenhouse effect like Venus or Mars? (e) What is a possible result of an increased greenhouse effect on Earth?

6) The Earth, our solar system, and our place in the galaxy all have to have particular characteristics in order for life to continuously exist on Earth's surface for nearly four billion years. Choose and explain five of these characteristics.

7) What is meant by evolvability? How is it illustrated in vertebrate brain evolution? In the evolution of social species?

8) Explain the evolutionary dynamics of sexual selection. How does it work? What is the role of fitness indicators in the process?

9) Explain this statement: Motility and snowflakes are both manifestations of second-order emergence; motility, but not snowflakes, is the product of third-order emergence.