

Name _____

BEP 210A - Epic of Evolution

Final Exam – May 5, 2000

Part I. (Short answers): Answer 12 of the following 15 questions in a few sentences in the spaces provided. Please cross out the 3 questions you don't answer. Each question is worth 4 points.

- 1) When the Cosmic Microwave Background was formed, at the period of decoupling, the average temperature of the photons was 5000 degrees Kelvin. Yet when the Cosmic Microwave Background is observed now, the average temperature of the photons is only 2.7 degrees Kelvin. Explain why the temperature has changed so dramatically.
- 2) Explain why each stage of nuclear burning in a star requires a higher temperature than the previous stage. What causes the temperature to increase after a stage of burning is completed?
- 3) Compare and contrast nucleosynthesis in the Big Bang with nucleosynthesis in a normal star (like the present sun). Focus on the "raw materials," the "end products," and the speed of the nuclear reactions involved.
- 4) Which is more compressed (denser), a neutron star or a white dwarf? Explain why in terms of the properties of the particles that provide the pressure to oppose gravity.
- 5) What do we mean by the critical energy density of the observed universe? What would it tell us about the observed universe if the actual energy density were found to be greater than, less than, or equal to the critical density?
- 6) Give three examples of how geological events have shaped human cultural myths.
- 7) Give an example of how climate has affected the course of human cultural evolution, and an example of how human activity has affected the climate.
- 8) Why do minerals undergo phase changes (change into different minerals) when they are pushed deep into the earth?

- 9) How is the melting of rock at mid-ocean ridges different from the melting of rock in subduction zones?
- 10) Most precious metals like gold, silver, and platinum exist in only tiny amounts within the earth. How do they get brought to and concentrated within subduction zones?
- 11) What is a gated channel (give an example)? Why is this kind of channel optimal for changing the properties of a cell in a short-term, reversible fashion?
- 12) Why is it the case that although parents each contribute half of their genetic endowment to a child, they basically end up with a stranger?
- 13) The human brain cortex is the size expected for a 1000-pound ape. Explain how this disparity is thought to have contributed to human evolution.
- 14) Explain the analogy between the genome of a eukaryote and a set of encyclopedia volumes. How does mitosis assure the distribution of complete sets?
- 15) What is the relationship between multicellularity and death?

Part II: (Longer answers): Answer 6 of the following 9 questions. You MUST answer at least ONE question from each section (A, B, and C); otherwise you can choose freely. Please cross out the 3 questions that you do not answer. Each question is worth 10 points.

Section A: Answer at least one question from the 3 below.

- A1) Choose two elements that are relatively abundant on Earth. Briefly tell why each of the elements are important either for the structure of the Earth or for life on Earth. (One sentence for each element will be sufficient.) Then discuss where and how the elements were produced, and how they ended up on Earth. Be sure your discussion includes an explanation of why your two chosen elements were produced abundantly.

- A2) Three key ingredients that motivated Einstein's theory of General Relativity were (a) the curving of paths in space-time due to gravity, (b) the Principle of Equivalence, and (c) the apparent curving of geodesics in a curved space. Describe how General Relativity incorporates or accounts for each of these three ingredients. In the famous test of General Relativity involving a solar eclipse, what did Einstein's theory predict and why? What was observed? Why can black holes exist in Einstein's theory of gravity but not in Newton's?
- A3) How do we know from the Cosmic Microwave Background that the observable universe is "flat?" (Give as detailed an argument as you can, including as much of the reasoning as possible.)

Section B: Answer at least one question from the 3 below.

- B1) Describe how geological events and processes have shaped the course of the evolution of life. Include the start of life, the increase in diversity of life, and major extinctions.
- B2) Describe the Rock Cycle. Start with an igneous rock. Follow the different possible paths that an atom within that rock can end up taking through the rock cycle.
- B3) Describe the Hydrologic Cycle. Where does water reside within the Hydrologic Cycle? What part of this cycle does the Hydrologic Cycle share with the Rock Cycle? How can human activity affect the Hydrologic Cycle?

Section C: Answer at least one question from the 3 below.

- C1) Describe the key differences between the way an asexual eukaryote moves through time and the way a sexual eukaryote moves through time. Include in your answer the concepts of niche dimension and speciation.
- C2) Starting from a fertilized animal egg, explain how cells become different from one another during embryology. Then describe 2 ways that the different cells types coordinate their activities to produce an integrated organism.
- C3) Molecular evolution describes how protein shapes, and hence their DNA instructions, move through time. Explain (a few sentences each) how molecular evolution is influenced by the following: 1) "Standard" mutation (change in a

single codon); 2) Gene duplication; 3) Gene rearrangement (bricolage) 4) Natural Selection; and 5) Sexual Selection.