

Name \_\_\_\_\_

## **BEP 210 – Epic of Evolution Final Exam - May 11, 2005**

This exam is closed-book and closed-note.

**Part 1 (60 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 5 points. Please *do not* feel obligated to use all of the space provided.**

- 1) Put the following three milestones of the Big Bang in chronological order: decay of neutrons, matter domination, baryogenesis. Then briefly explain why each milestone was important in determining the structure or properties of our universe.
- 2) Two types of electromagnetic waves are microwaves and blue (visible) light. Compare them by answering each of the following questions with "microwaves", "blue light," or "neither." No explanation is required.
  - a. Which has the higher frequency?
  - b. Which has the longer wavelength?
  - c. Which moves at a greater speed through a vacuum?
  - d. Which is composed of photons with greater energy?
- 3) Assuming both are at rest, which has a longer wavelength, a neutron or an electron? Why? Which is denser (more compressed), a white dwarf or a neutron star? Explain why, using what you said about neutrons and electrons.
- 4) According to Einstein's Theory of General Relativity, the Earth curves the space-time around it. Since objects under the influence of the Earth's gravity move along geodesic paths, the theory says those paths will be curved. When you drop a rock, however, it falls straight down. Explain why the rock's path is nevertheless considered to be curved in General Relativity.
- 5) "Dark Matter" was discussed in Rees' book and, to a lesser extent, in lecture. What do we mean by dark matter? Give one reason why we believe it to exist and one possible particle or object that may comprise it.
- 6) Describe three ways that glaciers can shape the surface of the land.
- 7) Earth's climate has been unusually stable for the past 10,000 years. What effect might this have had on human culture?
- 8) Why do many scientists think that life might have first begun at mid-ocean ridges?

- 9) Describe an effect that the Coriolis force has on the large-scale pattern of air flow in Earth's atmosphere.
- 10) Some climate models suggest that global warming, causing a lot of melting of Greenland ice, could actually trigger a period of extreme cold weather in North America and Europe. How?
- 11) A major factor leading to Darwin's theory of evolution was his observation of different beak shapes in Galapagos finches. How do recent studies on bone morphogenetic protein 4 (Bmp4) shed "molecular light" on these different beak shapes?
- 12) Explain how excitatory and inhibitory neurotransmitters collaborate to influence whether or not a cortical neuron will fire.
- 13) Explain what is involved in neuronal cell death and why the grafting of extra legs onto a frog embryo "spares" neurons from cell death.
- 14) Explain why, in animals, it's in the male's best interest to compete and strut his stuff while it's in the female's best interest to be choosy.
- 15) It has been argued that hominid brains enlarged so as to enable hominids to make useful tools ("Man the Toolmaker"). What feature of the archeological record is not in accord with this hypothesis?

**Part 2 (60 points): Answer 6 of the following 9 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) A proton is moving towards a deuteron (deuterium nucleus). The proton "sees" an "energy well" of a certain distinctive shape. Sketch a picture of the energy well and explain the origin of 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 protons and deuterons inside a star will only combine if the temperature is high enough.
- 2) Discuss the cause, mechanism, and result of a supernova explosion. For full credit, your answer should
  - a. Identify the final end product of nuclear burning before the explosion.
  - b. Explain why the final end product can't be recycled as a fuel for further burning.
  - c. Explain how the LACK of fuel triggers the explosion.
  - d. Explain each of the 2 parts of the explosion.
  - e. State why past supernova explosions are important for the Earth and life on it.

- 3) What are the three possible shapes of the universe according to Einstein's theory of General Relativity? Explain how it is possible to find out the shape of a space without "looking at it from outside." What recent observations tell us the shape of our observable universe, and what is that shape? Finally, explain the current theory of why the observable universe has the shape that it does, and why the theory actually doesn't tell us anything about the shape of the entire universe.
- 4) Describe the three main ways that volcanoes form. What causes the rock to melt? Where would you expect to find them? Are some more explosive than others?
- 5) The two main ways that rocks weather are by mechanical weathering and chemical weathering. Describe the main ways that these occur. Are they related in any ways?
- 6) We live on just the right kind of planet in just the right solar system in just the right place in just the right galaxy for humans to have had the opportunity to evolve. List and describe five of these "just right" factors.
- 7) Explain what is meant by saying that social traits are highly evolvable, using examples from the chimp/bonobo divergence as illustrations.
- 8) Explain the evolutionary dynamic known as "masking," giving one specific example of masking in the course of your explanation.
- 9) How does the beaver help us think about the human?