# Understanding Life Science

## Midterm Exam

2019 Autumn

**Name** **Student ID #**

❄ Multiple Choice Questions (1 point each)

1. Which of the followings is the key consequence of Natural selection with which the evolution progresses?
   a. Traits that are heritable to the next generation
   b. Speciation through fewer genetic variation
   c. Decrease in population size
   d. Unequal chance of survival and mating
   e. Population having more competition among the members

2. Which of the followings is a character commonly shared by human, plants, flies, viruses, and bacteria?
   a. They are all cell-based.
   b. They all have DNA as their genetic material.
   c. They all grow and develop specialized tissues.
   d. They have the same mode of cell division.
   e. They all evolve.

3. The most critical event in the successful production of gametes is…
   a. exact copying of the genome before the cell division.
   b. the genetic recombination between homologous chromosomes.
   c. the sexual reproduction.
   d. paring of homologous chromosomes before the chromosome separation.
   e. reduction of DNA by half the amount.

4. Which of the followings does NOT correctly describe typical characteristics of homeostasis?
   a. It is a phenomenon of maintaining a constant internal environment.
   b. If the external environment changes, the internal environmental condition also changes accordingly.
   c. As a fundamental property of life, it is also subjected to the natural selection process.
   d. It usually shows a specific equilibrium condition, called “dynamic equilibrium”, which is different from the chemical equilibrium.
   e. It is a phenomenon that can be observed only in a living organism.

5. Receptors, transporters, and enzymes play important roles in carrying out the cell’s responses to the external stimuli. Which of the following properties would be responsible the most for them to perform such roles in the process?
   a. Being present on the cell surface

b. Being able to form variety of unique shapes
c. Requiring energy input
d. Not being affected or influencing the process of evolution
e. Being made up of organic macromolecules

6. By definition, an ecological niche includes the following except…
   a. a specific location
   b. a specific habitat
   c. specific genes
   d. a specific behavior
   e. a specific interaction among member of other species

7. The process by which ATP is converted into ADP and inorganic phosphate…
   a. requires energy input.
   b. decreases entropy after the reaction.
   c. is a spontaneous reaction.
   d. water molecule is added in order to form a new chemical bond during the reaction.
   e. cannot be observed in a dead cell.

8. The first law of thermodynamics explains why…
   a. the homeostasis is a dynamic, energy-requiring process.
   b. the second law of thermodynamics is necessary.
   c. cell is an entity of low entropy.
   d. organisms obtain energy by breaking down food molecules.
   e. ATP is a universal energy currency used by all living organisms.

9. Which of the following statements regarding metabolism is correct?
   a. Breakdown of a complex macromolecule into simple molecules will result in decreased entropy.
   b. Heterotrophs obtain foods in the form of inorganic molecules.
   c. Autotrophs can synthesize organic foods from inorganic molecules.
   d. Synthesis of ATP from ADP results in release of energy.
   e. A spontaneous chemical reaction usually results in decreased entropy.

10. Which of the followings is NOT correct description of prokaryotic cells?
    a. They do not have the organelles and it is probably because of their small cell size.
    b. They came to existence on Earth much earlier than eukaryotes.
    c. The first type of prokaryotes appeared on Earth were all heterotrophs.
    d. Eukaryotes could evolve only after some prokaryotes made enough oxygens available in the atmosphere.
    e. Some of them are diploid cells, but still reproduce asexually, without having any genetic recombination.

11. Complementary base pairing between specific nucleotides allows DNA…
    a. to encode specific order of amino acids.
    b. to be copied by “self-replicating” mechanism.

c. to be extremely hydrophilic molecule.
d. to be more stable than RNA structurally.
e. to carry genes.

12. According to the "Out of Africa Theory" of the modern human origin as well as the recent DNA sequence comparisons…
    a. Neanderthals and the modern humans (Homo sapiens) did not live together at the same time.
    b. Neanderthals are the direct ancestors of the modern humans.
    c. Both Neanderthals and modern humans migrated out of Africa to Europe at similar time period.
    d. Neanderthals and modern humans could not interbreed.
    e. Some of the genes present in present-day human populations are thought to be originated from Neanderthals.

13. according to the idea which predicts an evolution of a new human species in a near future, the core technological advancement enabling such innovation is…
    a. medicines that increase human longevity.
    b. acquisition of the ability to change our environment.
    c. rapid progress in robotics research.
    d. progress in DNA sequencing technique and a new genome editing capability
    e. the artificial intelligence.

14. The Y chromosome is an ideal material with which the origin and interrelationship of all human population around the world, males in particular, can be examines because…
    a. it contains very few genes.
    b. it is transmitted through males only.
    c. it has a very low mutation rate as compared with other chromosomes.
    d. has higher rate of genetic recombination by crossing-over.
    e. all of the above.

15. Which of the following is NOT a result of the organisms' efforts of adaptation to a specific environment?
    a. Genetic variation
    b. Adaptive radiation
    c. Homologous structure
    d. Analogous structure
    e. Establishing ecological niches

16. Which of the followings is the least contributing factor in the recent dramatic decrease in the Monarch butterfly population in North America?
    a. Elevated atmospheric carbon dioxide level
    b. Increased landscape development
    c. Evolution of tolerance against the milkweed toxin by predatory birds
    d. Global warming
    e. Herbicide resistant GMO crops

17. DNA sequencing results revealed that there are basically no distinct differences in gene sequences among different human races. Thus, it is likely that the different traits of different human races are the result of…
    a. the random mutations occurred in different human races.
    b. different level of expressions in some genes among different human races.
    c. reduced interbreeding practices between different races.
    d. acquired traits that are not heritable.
    e. the failure in maintaining proper homeostasis in each different race.

18. Which of the following serves as the strongest evidence for the "RNA world hypothesis" which claims that the first genetic material was RNA, rather than DNA?
    a. Ribozyme
    b. DNA
    c. RNA
    d. Both DNA and RNA
    e. Self-replicating molecules

19. The general function of organelles in eukaryotic cells is…
    a. providing specific micro-environments for the enzymes of specialized function.
    b. protein synthesis.
    c. mediating the signal transduction within the cell.
    d. maintaining homeostasis of the internal environment.
    e. enabling endergonic reactions in the cell.
20. Which of the followings is correct about the general property of cell?
    a. It consists of phospholipids bilayer which is permeable to most types of molecules.
    b. there are only two different types of cells: prokaryotic cells & eukaryotic cells.
    c. ATP is used as the major source of energy because it can easily pass through phospholipids bilayer.
    d. the mode of cell regeneration is identical between prokaryotic cells and eukaryotic cells.
    e. It is a structure of high entropy

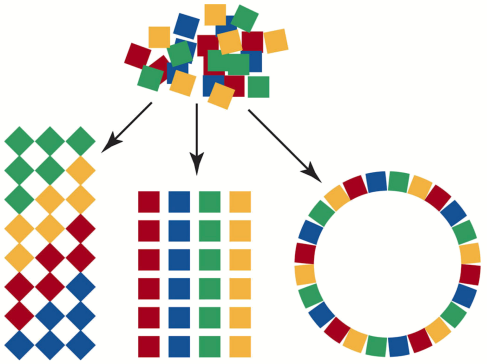
Essay Questions (5 points each)

1. Explain how climate changes might have affected the evolution of Hyracotherium into modern horse.

2. Explain why DNA sequence comparisons between members of two different species can be a legitimate method of determining the evolutionary relationship of the two.

3. Provide your own perspective or insight into the finding that modern humans inherited many genes originated from the Neanderthals, many of which are troublesome, such as the genes for depression, allergy, diabetes, etc.

4. Explain how this illustration can explain the emergent property, and briefly discuss the relationship between the emergent property and “systems biology”.



Answers to multiple choice questions:

1. d 2. e 3. d 4. b 5. b 6. c 7. c 8. d 9. c 10. e 11. b 12. e 13. d 14. b 15. a 16. c 17. b 18. a 19. a 20. b