



# Understanding Life Science

## Midterm Exam

2019 Spring

Name

Student ID #

**\* Multiple Choice Questions (1 point each: no penalty for the wrong choice)**

1. Which of the followings is the least likely reason why a cell needs a constant supply of energy from outside?
  - a. Maintaining homeostasis
  - b. The first law of thermodynamics
  - c. To keep the cell of low entropy value
  - d. To carry out anabolic reactions
  - ☒ e. For ATP hydrolysis reaction (=  $\text{ATP} \rightarrow \text{ADP}$ )
  
2. Metabolism, Responding to External Stimuli, and Homeostasis are among the common characteristics of life...
  - a. that are found in all eukaryotes but only in some prokaryotes.
  - ☒ b. that are all dependent upon specific functions of proteins.
  - c. that require energy input.
  - d. that are not affected or influencing the process of evolution.
  - e. that consist of the processes all taking place on the surface of the cell.
  
3. If a prokaryotic cell somehow could have evolved to have a compartmentalization system within the cell,...
  - a. it could be more resistant to antibiotic drugs.
  - b. it would become the most dominant species among all bacteria.
  - c. it will be able to live under the environment having no oxygen.
  - d. its DNA will become linear in structure.
  - ☒ e. perhaps it could afford to become a much larger cell.
  
4. Brain is an organ made of numerous individual nerve cells called neurons. However, one cannot understand properties of brain, such as emotion, by analyzing individual neurons of the brain. This is because...
  - a. neurons are not brain, no matter how they are being sugar-coated.
  - b. they are the emergent properties.
  - c. they are traits that are not analyzable.
  - ☒ d. they are the results of complex interactions among various parts of the brain.
  - e. neurons cannot be studied by a systems biology approach.
  
5. The high ATP concentration maintained within a live amoeba cell is a good example of homeostasis because...
  - a. the hydrolysis of ATP into ADP is a spontaneous reaction.
  - ☒ b. it is achieved through an energy-requiring, active process.
  - c. ATP is in chemical equilibrium with ADP in a live cell.
  - d. it is observed only in a living amoeba cell.
  - e. ATP is an essential molecule universally used as the cell's energy currency.

6. The fundamental rationale behind the logic of using DNA sequence comparison for determining the evolutionary relationship among organisms is that...
- all DNA sequence changes are caused by mutation.
  - mutation occur randomly on each different individual.
  - mutations accumulate over time.
  - genetic recombination does not affect too much in the evolutionary relationship determination.
  - ☒ all organisms are derived from a single common ancestor.

7. Choose the one from below that is consistent with the data summarized by the table.

Major episode	bya
Transition from water to land (Plants and Fungi → Invertebrates → vertebrates)	0.4
First multicellular organisms	1.2
First eukaryotic organisms	1.8
Accumulation of O <sub>2</sub> in the atmosphere	2.4
Fist prokaryotic organisms	3.5
Origin of Earth	4.6

- Plants and fungi evolved later than animals did.
  - No eukaryotes can survive without the atmospheric oxygen.
  - ☒ The first accumulation of atmospheric oxygen in the early Earth was only due to the activity of photosynthetic prokaryotes.
  - The Creationists agree to the estimated time of the Earth's origin on the table.
  - All multicellular organisms are oxygen requiring heterotrophs.
8. Which of the following is most likely to enable RNA to function as ribozyme?
- Self-replicating molecules
  - Structural instability
  - ☒ Intra-strand complementary base paring
  - RNA-DNA duplex
  - "RNA world" hypothesis
9. The result of Neanderthals genome sequencing project revealed that the modern humans inherited several "bad genes" such as genes causing depression, allergy, diabetes, etc. from them. Which of the following explanations would be most reasonable interpretation to this finding?
- These genes underwent bad mutations after being transferred to us from them.
  - Neanderthals are the direct ancestors of the modern human.
  - Neanderthals migrated out of Africa to Europe earlier than the modern human did.
  - ☒ These troublesome genes might not have caused any problem to them under the environment they lived.
  - As two independent species, Neanderthals and modern humans could not interbreed properly, thus generating such bad genes during the interbreeding events.
10. Which of the followings is a correct account for the antibiotic resistance genes of "super bacteria"?
- The genes conferring resistance mechanism are usually present on the bacterial chromosome.
  - Normal bacteria cannot acquire the resistance gene spontaneously through genetic mutation.
  - The only way to keep the "super bacteria" from spreading is to use antibiotics more frequently.
  - The resistance genes cannot be transferred to another bacteria.
  - ☒ Normal bacteria usually outcompete the "super bacteria" in their natural habitats.
11. Because not all organisms ( ), growth and development cannot be observed in all life form as the common characters of life.
- have DNA as genetic material
  - are eukaryotes
  - evolve
  - autotrophs
  - ☒ are multicellular

12. Process of speciation by natural selection cannot take place properly if there were no overpopulation outgrowing the limited resources/opportunities in the population. This is probably because...
- the underpopulation will result in a non-random competition among members of the population, which is counterproductive to evolution.
  - it will cause the population to have fewer genetic variations that are not enough for facilitating speciation.
  - smaller population size will be more prone to an accidental extinction by extreme environmental changes.
  - ☒ then every member of the population will have equal chance of survival and mating.
  - In a smaller population competition among members of the population become much fiercer affecting negatively the outcome of evolution of the population.
13. Which of the following parameters was the most fundamental driving force for the evolution of modern horses from Hyracotherium?
- Change in feeding habit from browsing to grazing
  - ☒ Climate change
  - Transition of habitat into grassland from forest
  - Evolution of the hoofed legs with fused toes
  - Increase in body and tooth size
14. The recent discovery of lugdunin suggest that we can develop a new type of antibiotics to fight against the multidrug-resistant bacteria by searching for many previously unknown microorganisms living in our body. In this regard, what aspect of metagenomics would play a pivotal role in facilitating such pursuits?
- Being able to handle large amount of data at a time
  - Ability to identify probiotic microorganisms in human guts
  - Ability to identify genes responsible for controlling the metabolism specific to prokaryotes
  - ☒ Enabling genome sequencing of the microbes directly isolated from their natural habitats
  - Enabling genome sequencing of the microbes after bring to the laboratory and cultivating them
15. Which of the following activities/properties of life can be found in both prokaryotes and eukaryotes?
- |   |  |
|---|--|
| a. Production of gametes                                | d. Growth and development                    |
| b. Compartmentalization                                 | e. Genetic recombination through conjugation |
| <input checked="" type="radio"/> c. Signal transduction |  |
16. Perhaps one of the most immediate benefits that can be obtained by studying the archaebacteria living in bizarre, extreme habitats is...
- using them as a source of new antibiotics.
  - ☒ obtaining a novel enzyme from them that can solve many difficult metabolic obstacles.
  - a better understanding of our ancestral origin during the course of evolution.
  - utilizing them as a source of new bioenergy.
  - to better understanding of a complexity of biodiversity.
17. Which of the following properties of human mitochondrial DNA would have made it ideal to use in examining sequence of DNA obtained from fossil samples in particular?
- ☒ Many copies exist per cell
  - Being transmitted through males only
  - Its sequence variations are caused from mutations as well as genetic recombination
  - Has higher rate of genetic recombination by crossing-over
  - Does not reflect any complexity of the nuclear genome

18. If the human racial differences were intrinsically determined at the gene level...
- the traits would not have been affected by environmental factors.
  - all the different human races will become one eventually.
  - members of different races would not have been able to interbreed.
  - ☒ results of human genome sequencing would have revealed the differences among different races.
  - effect of epigenetic factors on racial differences would have been much greater.
19. Of many other organic macromolecules, the key reason why DNA can act as a genetic material that can "self-replicate" is because...
- it allows to encode specific order of amino acids.
  - it consists of four different types of nucleotides whose chemical structures are very similar one another.
  - ☒ it exists as double stranded maintained through the complementary base pairing.
  - it has a very stable chemical structure.
  - it allows for genetic recombination between the two strands.
20. The reason why the genetic make-up of a gamete cell (sperm or egg, for example) can be different from its parental cell is because...
- it contains only half the amount of the parental genome.
  - ☒ during its production genetic recombination occurs between homologous chromosomes.
  - it is produced through the sexual reproduction.
  - it can contain either X or Y chromosome, but not both.
  - it does not contain any mitochondrial genome.
21. Which of the following ~~descriptions about "genetic trait" is NOT correct?~~ <sup>is not a possible way of developing resistance to the antibiotics quinolone?</sup>
- Having a mutant enzyme that destroys quinolones inside the bacteria.
  - ☒ Mutation in bacterial DNA that makes the DNA polymerase unable to perform its catalytic activity on the DNA.
  - Having a mutant DNA polymerase that is not recognized by quinolones.
  - Having a mutation that make the bacterial cell membrane less permeable to the quinolones.
  - All of the above.
22. Theoretically, manipulation of crop genome by genome editing technology can achieve the followings except...
- Making the crop grow faster
  - Making the crop more resistant to disease
  - Increasing genetic diversity of the crop population
  - ☒ Predicting to which particular diseases would the crop be more susceptible
  - Increasing the crop yield
23. The process of adaptive radiation involves establishment of distinct ecological niches for the community members of a given habitat. This would provide the community members with the benefit of...
- Increasing potential food resources.
  - diversifying the interrelationship among different species.
  - increasing population size.
  - speeding up the process of speciation.
  - ☒ reducing competition.

1. What evidences support the endosymbiotic theory that explains the origin of mitochondria in eukaryotic cell?

2. Explain why it is generally difficult for an acquired trait to become heritable, and how it can be inherited in some cases?

3. All present-day humans are believed to be originated from the ones lived in Africa, whose skin was presumably dark in color. Explain evolution of a different human race afterwards, such as the Scandinavian, according to the theory of Evolution by Natural Selection.
4. **Bonus Question:** Among the features of the Monarch Butterfly introduced during the first lecture of the class, what did you find most interesting and why?