Understanding Life Science

Midterm Exam

2020 Spring

Name **Student ID #**

❊ Multiple Choice Questions (1 point each)

1. An acquired trait is not usually transmitted to next generation because…
   a. it is obtained as a result of adaptation to the environment.
   b. it does not cause changes in gene sequences.
   c. it is not a true trait.
   d. it is an epigenetic effect.
   e. it cannot be subjected to the process of natural selection.

2. Gametes are haploid cells because…
   a. they lack the homologous chromosome pairs.
   b. they were produced with genetic recombination.
   c. they have half the amount of DNA compared with diploid cell.
   d. they can function normally only after fertilization.
   e. they do not replicate DNA before cell division.

3. It has been reported that the Covid-19 virus is highly infectious and, in particular, human lung tissues are extremely vulnerable to it. Judging from the report…
   a. it may be possible to reduce the infection if a person carries the symbiotic bacteria producing the antibiotics lugdunin in his or her nose.
   b. it appears that the function of lysosome in the lung cells is not very active.
   c. the virus may bind tightly with a receptor specifically present on the lung cell membrane.
   d. it appears that the virus is able to freely pass through the lung cell membrane.
   e. it appears the white blood cells carrying out phagocytosis in our body are not well dispatched on the lung tissue.

4. The first law of thermodynamics…
   a. explains why ATP is a universal energy molecule in all living system.
   b. is a law of energy conservation.
   c. explains why entropy of the universe keeps increasing.
   d. is a law of energy utilization.
   e. does not apply to the autotrophs.

5. Recent global warming was one of the factors responsible for dramatic decrease in the population size of monarch butterfly near extinction. Which of the following adaptations, if monarch butterflies can acquire, could save them from extinction?
   a. A much further extended life span in the 4^{th} generations.
   b. A modified aerobic respiration metabolism that can emit less CO_2.
   c. A mutation that enables better adaptation to climate changes.
   d. Physically much stronger 4^{th} generations that can migrate longer distance.
   e. Ability to feed on other variety of plant leaves in addition to milkweed.

6. If there were no competition among members of a population…
   a. Traits in the population become not heritable to the next generation.
   b. evolution by natural selection can speed up.
   c. the population size will decrease.
   d. there will be less genetic variations in the population.
   e. natural selection would fail to generate unequal chance of survival and mating within the population.

7. Which of the following is most closely related with the idea of endosymbiotic origin of mitochondria and chloroplasts?
   a. Cell membrane of archaebacteria is highly resistant to heat.
   b. Mitochondria is not involved in the process of exocytosis.
   c. Phagocytosis is mediated through formation of vesicles budding off from cell membrane.
   d. If overdose of some antibiotics is harmful to eukaryotic cells, these antibiotics are likely to targeting bacterial ribosome
   e. Mitochondria and chloroplasts provide new kind of metabolic processes present only in the eukaryotic cells.

8. The chemical reactions shown below are all to be carried out in test tubes filled with water. Which one can be completed without adding any enzymes?
   a. Synthesis of cell membrane from individual phospholipids
   b. Synthesis of proteins from amino acids
   c. Synthesis of glucose from CO_2 using the energy provided by breakdown of ATP into ADP
   d. Synthesis of RNA from nucleotides
   e. Replication of DNA double strands.

9. Which is NOT an event that would be affected by a defect in the synthesis of microtubules?
   a. Transmission of nerve signals
   b. Transport of proteins to the cell membrane
   c. Internalization of bacteria by phagocytosis
   d. Separation of chromosomes during cell division
   e. Acidification of lysosome

10. Those organisms that carry out fermentation under anaerobic condition…
    a. are all unicellular eukaryotes.
    b. are all heterotrophs.
    c. are unable to oxidize glucose through glycolysis.
    d. cannot survive under the environment rich in O_2.
    e. can live with only small amount of ATP produced.

11. The fact that human insulin can be produced in bacteria after putting the gene into plasmid indicates that…
    a. plasmid DNA is circular in shape.
    b. human genes can be correctly recognized and expressed in bacteria.
    c. humans and bacteria share a common ancestor at some point in the phylogeny.
    d. plasmids can be replicated in human cells.
    e. GMO insulin is not as healthy as natural insulin.

12. Even though dolphins are a mammal derived from an ancestral land mammal, their morphological feature, including aerodynamic body shape with fins, strikingly resembles that of fishes. Which one below is NOT a reasonable account for this finding?
    a. This resemblance is an analogous structure.
    b. It is a result of environmental adaptation.
    c. The feature has no implication in assessing the evolutionary relationship among different organisms.
    d. This type of similarity can be confused with the homologous structure, but generally the homologous structures look much more similar in appearance.
    e. The similarity in wings of insect, birds, and bats is another example of this type of resemblance.

13. If the DNA double strands were maintained by covalent bonds instead of hydrogen bonds between the nitrogenous bases…
    a. the complementary base paring between the two strands would have been a catabolic reaction.
    b. DNA would have been a hydrophobic molecule.
    c. DNA double helix structure would not have been maintained stably.
    d. DNA would have been able to function as enzyme, similar to RNA.
    e. DNA replication would have taken much longer time.

14. Proteins transported to the nucleus, such as histones, are not glycosylated. From this, it can be concluded that…
    a. they are mostly positively charged (+).
    b. they are not synthesized on the surface of the rough endoplasmic reticulum (RER).
    c. they are not properly folded.
    d. they are not as big as other proteins.
    e. they are synthesized in the nucleus by the nucleus-specific ribosomes.

15. If an RNA can catalyze a reaction that converts chemical A into B…
    a. the reaction by which A is converted into B is an anabolic reaction.
    b. A is oxidized into B.
    c. A would specifically bind with this RNA.
    d. this RNA will be able to incorporate some amino acids, as if it were a protein.
    e. this RNA can only be found in ancient prokaryotic cells.

16. Certain drugs make inner mitochondrial membrane leaky, making impossible to accumulate hydrogen ions in the space between the outer- and the inner mitochondrial membrane during aerobic respiration. Under such condition, the electrons still flow through and oxygen is reduced into water. What would be a likely outcome of such condition?
    a. ATP cannot be synthesized at all in the cell.
    b. Much less amount of ATP will be synthesized.
    c. Cells will die soon due to a lack of O_2 supply.
    d. The electron transport chain will completely stop.
    e. Cells cannot metabolize glucose.

17. Which one is the best reason why multicellular organisms being able to appear on Earth only after enough O_2 was accumulated in the atmosphere?
    a. Because the function of mitochondria was essential to them.
    b. Because only then they could get protection from hazardous UV lights and etc.
    c. Because the organisms which they depend on for food could be available abundantly only then.
    d. Because they arose through adaptive radiation after the extinction of gigantic flying insects.
    e. Because it is more difficult for them to evolve under reducing environment.

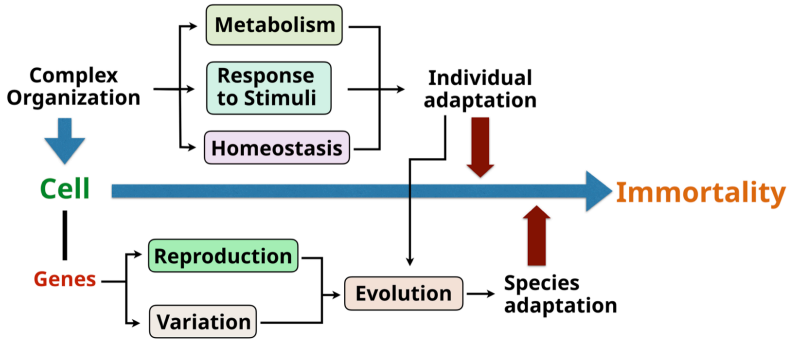
18. Which of the followings correctly describes about the light reaction of photosynthesis?
    a. It takes place in the internal space of the chloroplasts called stroma.
    b. The electrons flow from $NADPH_2$ to oxygen, similar to the case of the electron transport chain of aerobic respiration.
    c. Oxygen is produced as a result of water being oxidized.
    d. The process has to be followed immediately by the dark reaction.
    e. The energy required for driving the reaction comes from light, such as sunlight, but the ATP produced from aerobic respiration can replace this energy requirement if necessary.

19. Which of the followings does NOT require ATP hydrolysis as energy source?
    a. Accumulation of hydrogen ions inside of lysosome by proton pump.
    b. Accumulation of hydrogen in the space between the outer- and inner- membranes of mitochondria by proton pump.
    c. Acidification of stomach by proton pump.
    d. Movement of transport vesicles on the microtubule tracts by motor proteins.
    e. Contraction of muscle fibers

20. Certain drugs such as quinolones serve as an effective antibiotic by inhibiting bacterial DNA replication. This is possible because…
    a. the enzyme catalyzing DNA replication in bacteria is different structurally from that of eukaryotes.
    b. the drugs attack only the bacterial genes.
    c. the drugs cannot penetrate the eukaryote cells.
    d. prokaryotic ribosomes are structurally different from those of eukaryotes.
    e. the drugs inhibit the bacterial cell wall synthesis.

Essay Questions (5 points each)

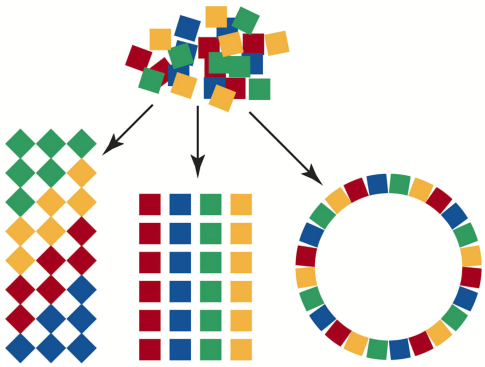
1. In reference to this figure, briefly explain why certain characters are found in all living organisms as common characters.



2. What do you think (in your opinion) the most decisive evidence for the origin of mitochondria and chloroplasts explained by the endosymbiosis theory? Do you think there is any flaws in the theory that need to be explained more clearly?

3. Blood glucose level is maintained within a constant range by the action of two hormones, insulin and glucagon. Taking this example as an inspiration, briefly propose a mechanism by which the amount of ATP is maintained at a constant level in the cell.

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



5. **Bonus question (5 point).**
   If you are to redesign the mitochondria, what features would you like to add or modify, or delete? (Explain the reason, but do not worry about any technical details and accuracy.)