Understanding Life Science

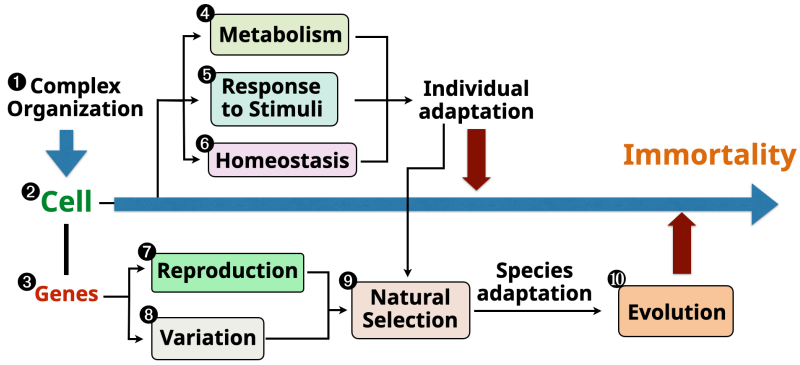
Midterm Exam

2021 Spring

Name **Student ID #**

❊ Multiple Choice Questions (1.5 point each, except for questions 1~4)

In reference to the figure shown here, answer the **question 1~4** (1 point each)



1. Indicate, in number, which is responsible for all life forms have the characteristics of ❼ & ❽.

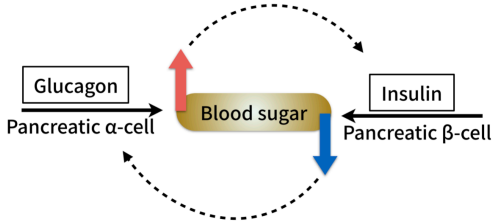
2. Indicate, in number, one character that is most necessary for a successful operation of ❾.

3. True (T) or False (F): the emergent properties found in life is due to the character ❽.

4. An acquired trait is a [ ] that is not derived from [ ].

5. If a trait is determined by an epigenetic effect...
   a. it will be found to be identical among different races of human.
   b. it is not a heritable trait.
   c. it is not a true trait.
   d. It does not cause changes in the sequence of the gene responsible for the trait.
   e. it cannot be subjected to the process of natural selection.

6. Which of the following descriptions about the figure shown here is NOT correct?

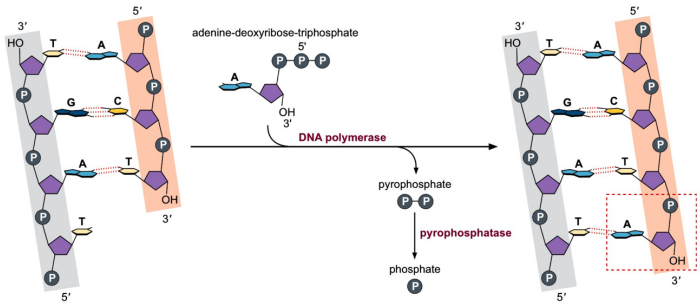


   a. It is an example of a dynamic equilibrium.
   b. It is also an example of differentiation in multicellular organism.
   c. Energy input is required to maintain this process.
   d. After detecting the blood sugar level, receptor proteins present in the pancreatic a-cells and b-cells will trigger the same mode of action.
   e. It is an effective way of adjusting the amount of blood sugar according to the different amount of sugar in foods taken into the body.

7. A common take way from the fact that sucralose is a sugar substitute that generates zero calory and that trans-fat causes a number of health hazard is…
   a. the enzyme-substrate specificity.
   b. that overnutrition is doing harm than benefits to us.
   c. that artificial foods have very little nutrition value.
   d. that these molecules were not synthesized by condensation reaction.
   e. YOLO, so enjoy what you can.

8. Covid-19 vaccines made by Pfizer and Moderna are mRNA vaccines, and they are delivered into the cells packaged in liposome mainly because…
   a. RNAs are chemically unstable.
   b. RNAs that contain virus genome sequence could trigger inflammation responses in the body.
   c. it can form complementary base pairing with other RNAs in the body otherwise.
   d. mRNAs are polar molecule.
   e. RNA vaccines could cause a lot of unknown side effects since RNA can act as enzymes, if they are not protected with liposome.

9. Which of the following is a correct account for the figure shown here?
   a. The nucleotide bases of the two DNA strands are held together through a specific covalent bond called complementary base pairing.
   b. The first nucleotide added to both strands
   c. The reaction shown here does not need any additional energy input.
   d. The direction of the polymer assembly is top to bottom for both strands shown here.
   e. The structure shown here is not possible for RNA both in nature as well as in test tubes.



10. The relationship between Van der Waal Force and Hydrophobic Interaction can best describe as that…
    a. both are weak, non-covalent chemical bonds in which carbon is not involved.
    b. the Van der Waal Force occurs only in the hydrophobic molecules.
    c. the complementary surface affecting the Van der Waals Force occurs only on the surface of hydrophobic molecules.
    d. both chemical bonds are important in the antibody-antigen interaction.
    e. the Van der Waals Force is the chemical bond maintains the hydrophobic interaction.

11. The carbon dating method cannot be applied to any alive organisms because…
    a. the ratio of carbon isotopes in the living body would be identical to that of the external environment.
    b. the ratio of each carbon isotope in the body is not consistent.
    c. injecting radioactive isotope into the body would hamper the health of the organism.
    d. the lifespan of organisms is too short to be distinguished by the decay half-life.
    e. living organisms do not absorb any radioactive isotopes.

12. Which of the following best describes the biggest advantage of using fluorescence microscope in exploring the cells?
    a. Specific proteins of interest can be traced for their locations and activities in living cells.
    b. Can observe cells with higher resolution than does in the electron microscope.
    c. Unlike other standard light microscopes, does not need to apply oil for viewing at high magnification.
    d. Can achieve magnification high enough to be able to view individual ribosomes.
    e. Can observe proteins by having them fuses with GFP.

13. Which of the following is NOT correct about the general characteristics of archaebacteria?
    a. Their habitats are usually those of very hostile environment.
    b. Their cell walls and cell membranes are chemically different than those of bacteria.
    c. Often serve as the source of novel enzymes of unusual ability.
    d. DNA sequence for their rRNA genes would be more different than that of bacteria when it was compared with ours.
    e. Without them, developing an effective test kits for Covid-19 detection would have been extremely difficult, if not impossible.

14. In which of the following imaginary scenario could mitochondrial genome become diploid?
    a. If they can duplicate their genome so that they have twice the amount of DNA.
    b. If they can undergo genetic recombination.
    c. If their DNA become linear, just like the chromosomes in the nucleus.
    d. If they are inherited fathers also, and the ones derived from sperm cell fuse with the ones in the eggs during fertilization.
    e. If they divide just like the host cell divides.

15. The key reason for the ability of Cryo-EM deciphering structure of molecules in their native state, while other conventional electron microscopes can't, is because…
    a. it allows live imaging of biologically important molecules.
    b. its way of the sample preparation through quick freezing at extremely low temperature.
    c. it does not bring in any artifacts during the sample preparation.
    d. it employs the slicing of images through many layers and combines them by computer.
    e. it allows viewing molecules at much higher magnification and even in color.

16. The fact that the outer membrane of mitochondria is chemically similar to that of archaea, while the inner membrane is more similar to bacterial cell membrane…
    a. predicts that DNA of mitochondria would be more chemically more similar to that of bacteria.
    b. predicts the presence of bacterial ribosome in the mitochondria.
    c. explains why the gram-negative bacteria also have the inner and outer membrane, which are chemically different each other.
    d. the origin of mitochondria as a bacterial cell happened to be engulfed by an archaebacteria that was in the process of evolving into the eukaryote.
    e. is the sole, and decisive evidence for the endosymbiosis theory that explains the origin of mitochondria and chloroplasts.

17. Which of the following explains the First Law of Thermodynamics the best?
    a. Cell is an entity of low entropy with complex organization, thus constant supply of energy needs to be provided.
    b. ATP is synthesized from ADP with the energy obtained through breakdown of glucose.
    c. The hydrolysis of ATP into ADP is a spontaneous reaction.
    d. The total amount of energy in the Universe keeps increasing.
    e. Enzyme catalysis is still required for a catabolic reaction because enzymes lower the activation energy of the reaction.

18. If limited resources (= food) in a population caused an allopatric speciation in the population, it probably means that it must have…
    a. created an unstable environment to speed up the process of evolution.
    b. allowed only selected individuals could leave their genes into the next generations.
    c. caused migration of some members to other geographically isolated area.
    d. reduced the genetic diversity of the population.
    e. Reduced viability of the offspring in the population.

19. The main reason why covalent bonds are used almost exclusively in building macromolecules is because…
    a. non-covalent bonds are not capable of generating many different forms of molecules.
    b. it is the most stable bond that cannot be easily breakable.
    c. complex structure of enzymes cannot be made by non-covalent bonds.
    d. forming covalent bonds is energetically more favorable.
    e. the covalent bod formation will always result in the increase of entropy.

20. 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 a reasonable account for this finding?
    a. This resemblance is a homologous structure.
    b. It is a result of their effort of adaptation to the similar type of environmental pressure.
    c. The feature is a useful clue in assessing the evolutionary relationship among different organisms.
    d. Their actual evolutionary relationship cannot be determined by using DNA sequence comparison in this case.
    e. The similarity in wings of birds and bats is another example of this type of resemblance.

21. 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?
    a. Many copies exist per cell
    b. Being transmitted through males only
    c. Its sequence variations are caused from mutations as well as genetic recombination
    d. Has higher rate of genetic recombination by crossing-over.
    e. Does not reflect any complexity of the nuclear genome.

22. 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.

23. Which of the following parameters was the most fundamental driving force for the evolution of modern horses from Hyracotherium?
    a. Change in feeding habit from browsing to grazing
    b. Climate change
    c. Transition of habitat into grassland from forest
    d. Evolution of the hoofed legs with fused toes
    e. Increase in body and tooth size

24. The key reason why DNA can act as a genetic material, among many other organic macromolecules is because…
    a. it allows to encode specific order of amino acids.
    b. it consists of four different types of nucleotides whose chemical structures are very similar one another.
    c. it exists double stranded maintained through the complementary base paring.
    d. it has a very stable chemical structure.
    e. it allows for genetic recombination between the two strands.

Essay Questions (4 points each)

1. Explain why triploid watermelons and bananas are sterile.

2. Explain the rationale behind the logic of using DNA sequence comparison for determining the evolutionary relationship among organisms.

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. Propose your idea that can explain the mechanism for the monarch butterfly having increased longevity in every 4^{th} generation.