Exam I

Biology 110: Biological Exploration
Fall 2022

This exam is worth 100 points.

This is a CLOSED BOOK exam; calculators ARE permitted.

Answers must be written legibly and be confined to the space provided; answers that exceed this space will not be read or graded.

GOOD LUCK!

Name:_____
Lecture Section: 10am_____11am_____

You have 90 minutes to complete the exam

Date Taken:_____
Exam Start Time:_____
Exam End Time:_____

Multiple Choice: Circle the letter that corresponds with the SINGLE BEST answer to each question. (2 points each).

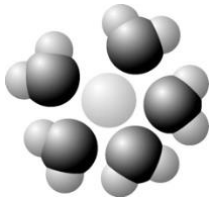
1. Victoria grows the same bacteria in 20 petri dishes. She places 10 of the dishes in a container with a normal atmosphere. The remaining dishes she places in a container in which the oxygen level is double the normal level. At the end of the experiment she measures the growth of the bacteria. She labels the first group "A" and the second group "B." Which statements is correct?
   a) The hypothesis for this experiment is, “the size of the petri dish affects bacterial growth”.
   b) The amount of oxygen in the petri dish is the dependent variable.
   c) Group A is the control group and Group B is the experimental group
   d) This appears to be a well-controlled experiment because all conditions besides oxygen concentration are being kept the same.

2. In what kind of chemical bond are electrons evenly shared?
   a) Ionic
   b) Polar Covalent
   c) Non-polar Covalent
   d) Hydrogen

3. Which of the following statements correctly describes the property of hydrophobic substances such as vegetable oil?
   a) nonpolar substances that repel water molecules
   b) nonpolar substances that have an attraction for water molecules
   c) polar substances that repel water molecules
   d) polar substances that have an affinity for water molecules

4. Which of the following represents cohesion?
   a) Polar covalent bonds found within the same water molecule
   b) Water forming hydrogen bonds with a non-polar covalent molecule
   c) Unequal distribution of charges in a non-polar covalent molecule
   d) Water forming hydrogen bonds with other water molecules
   e) Water forming hydrogen bonds with polar covalent molecules other than water

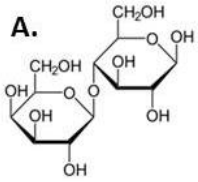
5. The solute molecule shown below is surrounded by a hydration shell of water. Based on your knowledge of the polarity of water molecules, the solute molecule is most likely:
   a) positively charged
   b) negatively charged
   c) amphipathic
   d) hydrophobic
   e) nonpolar



6. To act as an effective coolant in a car's radiator, a substance has to have the capacity to absorb a great deal of heat. Which physical property is the best indicator for a good coolant?
   a. pH
   b. density at room temperature
   c. heat of vaporization
   d. specific heat

Use the structures below to answer questions 7 - 9. You may use the structures once, multiple times, or not at all.

A.



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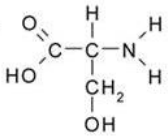

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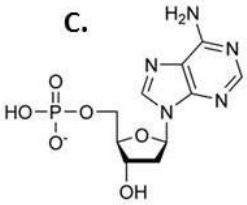

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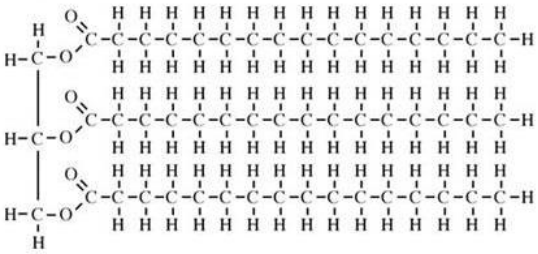

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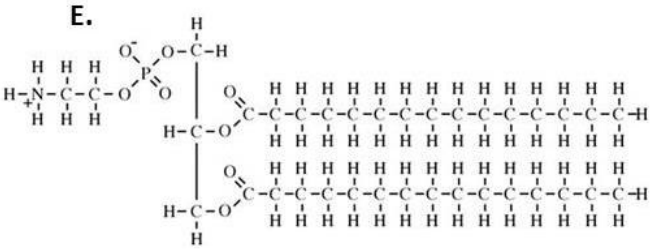


7. Which structure is a carbohydrate?
   a) A
   b) B
   c) C
   d) D
   e) E

8. Which structure would be found <u>inside</u> a fat cell?
   a) A
   b) B
   c) C
   d) D
   e) E

9. Which monomer would be used to make a protein?
   f) A
   g) B
   h) C
   i) D
   j) E

10. How is a polymer formed from multiple monomers?
    a) from the growth of the chain of carbon atoms
    b) by the removal of an –OH group from one molecule and a hydrogen atom from another molecule
    c) by the addition of an –OH group to one molecule and a hydrogen atom to another molecule
    d) through hydrogen bonding

11. Which two functional groups are always found in amino acids?
    a) Carboxyl and carbonyl
    b) Amino and sulfhydryl
    c) Carbonyl and amino
    d) Carboxyl and amino
    e) Methyl and carbonyl

12. What organelle synthesizes lipids?
    a) Rough ER
    b) Smooth ER
    c) Lysosomes
    d) Vacuoles

13. Functional ribosomes are found in:
    a) the nucleus
    b) the cytoplasm
    c) attached to the ER
    d) the nucleus and cytoplasm
    e) the cytoplasm and attached to the ER

14. Which of the following macromolecules leaves the nucleus of a eukaryotic cell through pores in the nuclear membrane?
    a) phospholipids
    b) glycogen
    c) DNA
    d) amino acids
    e) mRNA

15. A Pair of chromosomes, one from each parent, are called:
    a) Homologous chromosomes
    b) Sister chromatids
    c) Chromatin
    d) None of the above

16. Which of the following is true?

i. According to the endosymbiotic theory, chloroplasts must have evolved before mitochondria.
ii. Both chloroplasts and mitochondria have their own ribosomes.
iii. Chloroplasts can still live on their own.

a) Only i is true
b) Only ii is true
c) Only iii is true
d) i and ii are true

17. During which phase does DNA replication occur?

a) G1 phase
b) S phase
c) G2 phase
d) Mitosis

18. Which gives the most complete and correct description of a signal transduction pathway?

a) binding of a signal molecule to a cell protein
a) catalysis mediated by an enzyme
b) sequence of changes in a series of molecules resulting in a response
c) the cell's detection of a chemical or mechanical stimulus

19. Signaling that acts over long distances is known as:

a) Endocrine
b) Paracrine
c) Autocrine
d) Distant

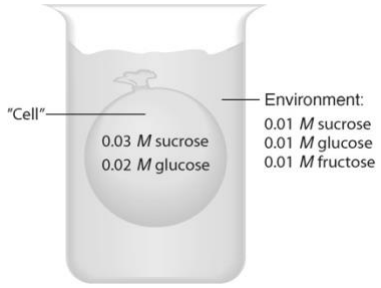
20. Phospholipids form a bilayer in aqueous solution because:

a) The nonpolar hydrophobic tails form hydrogen bonds with water.
b) The nonpolar hydrophobic tails avoid contact with water.
c) The polar hydrophilic tails avoid contact with water.
d) Proteins insert into them.

21. Glucose, a large polar molecule, diffuses slowly through artificial phospholipid bilayers. The cells lining the small intestine, however, rapidly move large quantities of glucose from glucose-rich food into their glucose-poor cytoplasm. Based on this information, which transport mechanism is most probably functioning in the intestinal cells?

a) Simple diffusion
b) Osmosis
c) Active transport pumps
d) Facilitated diffusion

An artificial cell consisting of an aqueous solution enclosed in a selectively permeable membrane is immersed in a beaker containing a different solution. The membrane is permeable to water and to the monosaccharide sugars glucose and fructose, but impermeable to the disaccharide sucrose. Use this information to answer questions 22 – 25 below.



22. **Initially** the cell is placed in a _____ solution.
    a) Isotonic
    b) Hypotonic
    c) Hypertonic
    d) Unable to tell

23. Indicate the net movement of glucose below:
    a) Into the cell
    b) Out of the cell
    c) No movement

24. Indicate the net movement of sucrose below:
    a) Into the cell
    b) Out of the cell
    c) No movement

25. Indicate the net movement of water below:
    a) Into the cell
    b) Out of the cell
    c) No movement

26. During an experiment, you discover that an enzyme-catalyzed reaction has a ΔG of -10 kcal/mol. If you triple the amount of enzyme in the reaction, what will be the ΔG for the new reaction?
    a) -30 kcal/mol
    b) -10 kcal/mol
    c) +10 kcal/mol
    d) +30 kcal/mol

27. What is the primary role of oxygen in oxidative phosphorylation?
    a) To serve as the final acceptor of electrons in the electron transport chain
    b) To fuel the breakdown of food molecules
    c) To produce carbon dioxide for plants
    d) To combine with carbon to make CO2

28. What is the purpose of fermentation reactions?
    a) to regenerate NAD^+ so glycolysis can continue to make ATP
    b) to make alcohol or lactic acid that cells can metabolize for energy under anaerobic conditions
    c) to make additional ATP when respiration can't make ATP fast enough
    d) to slow down cellular oxygen consumption when oxygen is scarce
    e) to make organic molecules that cells can store until oxygen becomes available

29. Which statement about the citric acid cycle is true?
    a) It occurs during the movement from the cytosol through the mitochondrial membranes.
    b) It makes ATP through substrate-level phosphorylation.
    c) It makes the most ATP compared to the other steps in the breakdown of glucose.
    d) It occurs in the eukaryotic cytoplasm.
    e) It splits glucose.

30. Which of the following is not an immediate net product of the typical mitochondrial electron transport chain?
    a) ATP
    b) water
    c) NAD^+
    d) FAD
    e) a proton electrochemical gradient

True or False: If false correct the statement or explain way (2 points each)

1. Energy coupling allows endergonic reactions to proceed harvesting the energy from an exergonic reaction.

True

2. In a redox reaction the molecule that loses an electron is reduced.

False- oxidized

3. Hydrophilic molecules have an affinity for water.

True

Short Answer Questions: Answer each question thoroughly but concisely. Remember to define terms utilized in your answer. Please write your answers in the space provided. The point value is indicated for each question.

1. You have just eaten a delicious meal from an Indian restaurant. Unfortunately, the Indian food has given you heartburn and acid reflux (increased acidity). Your roommate suggests you take some bicarbonate to ease your discomfort. What is the logic behind your roommate's suggestion? Hint: you are considering the carbonic acid buffer system here. How will this buffer system reduce stomach acidity? (3 points)

$$H_2CO_3 \Leftrightarrow H^+ + HCO_3^-$$

If pH drops (i.e. more acidic), then concentration of H^+ has increased. The bicarbonate buffer system would remove the excess H^+ by combining bicarbonate ion with the H^+ to shift the reaction to the LEFT to form carbonic acid.

2. A protein's structure is very important for its function.

   A. Describe the difference between the **primary**, **secondary**, and **tertiary** structure of a protein. What kind of interactions are associated with secondary and tertiary levels? (4 points)

Primary: Amino acid sequence
Secondary: alpha helix or beta pleated sheets– due to hydrogen bonding in backbone
Tertiary: 3D shape – mediated by interactions of R groups

   B. Increasing the temperature of a protein often results in an inability of the protein to carry out its function. Briefly explain how increasing the temperature of a protein decreases is function. (2 points)

Heating up a protein breaks hydrogen bonds and causes protein to denature

3. The cell cycle must be carefully regulated to ensure that cells divide at an appropriate rate. Explain how cells regulate their movement through the cell cycle. In your answer include appropriate terms and a brief description of key factors that contribute to this regulation. (8 points)

Cell cycle control system coordinates a cells movement through the cell cycle – controlled at specific points during the cell cycle - Check point.
Regulated by activity of Cyclins and CDKs – Cyclins produced during checkpoints and bind/activate CDKs (always around).
Activated CDKs phosphyorylate additional proteins important for progressing through the cell cycle.

4. Describe the difference between competitive and non-competitive inhibition. (4 points)

Competitive: Inhibitor binds to active site blocking ability of substrate to bind
Non-competitive inhibitor binds to allosteric site, changes shape of enzyme- no longer bind substrate

5. Explain what is meant by exergonic vs endergonic. How do the terms relate to hydrolysis vs synthesis. (6 points)

Exergonic: Reactions where energy is released/negative delta G. Molecules will go from more complex and less stable to less complex and more stable – hydrolyzed.

Endergonic: Reactions where energy is required to proceed/ positive delta G. Molecules will go from more stable and less complex to less stable and more complex – Synthesized

6. Describe one exergonic process we have discussed this semester and explain why you think this process falls into this category. (3 points)

Lots of options here, most common answers
ATP hydrolysis to ADP
Glycolysis - Breakdown glucose to pyruvate and release energy in form of electrons.

7. What metabolic process would you expect to be affected in an individual with a mutation that inhibits the activity of pyruvate dehydrogenase. In your answer explain the function/s of this enzyme. (4 points)

Glycolysis/TCA junction also known as pyruvate oxidation

Enzyme is Responsible for three things

1. oxidation of pyruvate and release of CO2
2. Reduction of NAD+ to NADH
3. Formation of Acetyl CoA for TCA)

Extra Credit: Briefly (1-2 Sentences) Explain one-way Aerobic Respiration and Fermentation are the same? One way they are different?