

Part I: Multiple Choice. Circle the letter that best answers the question. Each question has only 1 answer!

1. Polymerization reactions in which proteins are synthesized from amino acids
  - A) require the formation of phosphodiester bonds between the amino acids.
  - B) occur in the nucleus of the cell.
  - C) are hydrolysis reactions.
  - D) depend upon van der Waals forces to hold the amino acids together.
  - E) result in the formation of water.
  
2. Semiconservative replication of DNA involves
  - A) each of the original strands acting as a template for a new strand.
  - B) only one of the original strands acting as a template for a new strand.
  - C) the complete separation of the original strands, the synthesis of new strands, and the reassembly of double-stranded molecules.
  - D) the use of the original double-stranded molecule as a template.
  - E) None of the above
  
3. During the formation of a peptide linkage, which of the following occurs?
  - A) A molecule of water is formed.
  - B) A disulfide bridge is formed.
  - C) A hydrophobic bond is formed.
  - D) A hydrophilic bond is formed.
  - E) An ionic bond is formed.
  
4. Polysaccharides that serve as energy storage molecules tend to have \_\_\_\_\_ linkages.
  - A)   $\alpha$ -1,4
  - B)   $\alpha$ -2,3
  - C)   $\beta$ -1,4
  - D)   $\beta$ -2,3
  - E) Both a and c

*glycosidic*
  
5. If  $\Delta G$  of a chemical reaction is negative and the change in entropy is positive, what can you conclude about the reaction?
  - A) It requires energy.
  - B) ~~It is~~ endergonic.
  - C) ~~It is~~ exergonic.
  - D) It will not reach equilibrium.
  - E) It decreases the disorder in the system.
  
6. When a molecule loses hydrogen atoms (not hydrogen ions), it becomes
  - A) reduced.
  - B) oxidized.
  - C) redoxed.
  - D) hydrogenated.
  - E) hydrolyzed.

7. Which of the following is (are) found in prokaryotic cells?
- A) Mitochondria
  - B) Chloroplasts
  - C) Nuclear membrane
  - D) Ribosomes
  - E) Endoplasmic reticulum
8. The products of mitosis are
- A) one nucleus containing twice as much DNA as the parent nucleus.
  - B) two genetically identical cells.
  - C) four nuclei containing half as much DNA as the parent nucleus.
  - D) four genetically identical nuclei.
  - E) two genetically identical nuclei.
9. Genes code for
- A) enzymes.
  - B) polypeptides.
  - C) RNA.
  - D) All of the above
  - E) None of the above
10. A nucleotide contains a pentose, a phosphate, and a(n)
- A) lipid.
  - B) acid.
  - C) nitrogen-containing base.
  - D) amino acid.
  - E) glycerol.
11. Biological membranes are composed of
- A) nucleotides and nucleosides.
  - B) enzymes, electron acceptors, and electron donors.
  - C) fatty acids.
  - D) monosaccharides.
  - E) lipids, proteins, and carbohydrates.
12. The drug 2,4-dinitrophenol (DNP) destroys the proton gradient across the inner mitochondrial membrane.  
What would you expect to be the effect of incubating isolated mitochondria in a solution of DNP?
- A) Oxygen would no longer be reduced to water.
  - B) No ATP would be made during transport of electrons down the respiratory chain.
  - C) Mitochondria would show a burst of increased ATP synthesis.
  - D) Glycolysis would stop.
  - E) Mitochondria would switch from glycolysis to fermentation.
13. The DNA of prokaryotic cells is found in the
- A) plasma membrane.
  - B) nucleus.
  - C) ribosome.
  - D) nucleoid region.
  - E) mitochondria.

14. Lactose, or milk sugar, is composed of one glucose unit and one galactose unit. It can be classified as a
- A) disaccharide.
  - B) hexose.
  - C) pentose.
  - D) polysaccharide.
  - E) monosaccharide.
15. What accounts for the uniform diameter of the DNA molecule?
- A) The two sides of the DNA molecule are held together by hydrogen bonds.
  - B) A purine always bonds with a pyrimidine.
  - C) One side of the DNA molecule has an unconnected 5' phosphate group and the opposite end has an unconnected 3' hydroxyl group.
  - D) The 3' carbon of one deoxyribose and the 5' carbon of another deoxyribose bond together.
  - E) The alternating sugar and phosphate backbone coils around the outside of the helix.
16. Proteins that will function outside of the cytosol are made by
- A) the Golgi apparatus.
  - B) ribosomes within the mitochondrion.
  - C) the smooth endoplasmic reticulum.
  - D) ribosomes on the rough endoplasmic reticulum.
  - E) ribosomes within the nucleus.
17. In all sexually reproducing organisms, the diploid phase of the life cycle begins at
- A) spore formation.
  - B) gamete formation.
  - C) meiosis.
  - D) mitosis.
  - E) fertilization.
18. Osmosis moves water from a region of
- A) high concentration of dissolved material to a region of low concentration.
  - B) low concentration of dissolved material to a region of high concentration.
  - C) hypertonic solution to a region of hypotonic solution.
  - D) negative osmotic potential to a region of positive osmotic potential.
  - E) low concentration of water to a region of high concentration of water.
19. The hydrolysis of maltose to glucose is an exergonic reaction. Which of the following statements is true?
- A) The reaction requires the input of free energy.
  - B) The free energy of glucose is larger than the free energy of maltose.
  - C) The reaction is not spontaneous.
  - D) The reaction releases free energy.
  - E) At equilibrium, the concentration of maltose is higher than the concentration of glucose.
20. Amino acids can be classified by the
- A) number of monosaccharides they contain.
  - B) number of carbon-carbon double bonds in their fatty acids.
  - C) number of peptide bonds they can form.
  - D) number of disulfide bridges they can form.
  - E) characteristics of their side chains.

21. You look at the label on a container of shortening and see "hydrogenated vegetable oil." This means that during processing the number of carbon-carbon double bonds in the oil was decreased. What is the result of decreasing the number of double bonds?
- A) The oil now has a lower melting point.
  - B) The oil is now a solid at room temperature.
  - C) There are more "kinks" in the fatty acid chains.
  - D) The oil is now a derivative carbohydrate.
  - E) The fatty acid is now a triglyceride.
22. The Hershey-Chase experiment persuaded most scientists that
- A) bacteria can be transformed.
  - B) DNA is indeed the carrier of hereditary information.
  - C) DNA replication is semiconservative.
  - D) the transforming principle requires host factors.
  - E) All of the above
23. You would *not* expect to find RNA in which of the following structures?
- A) Nucleus
  - B) Mitochondrion
  - C) Vacuole
  - D) Ribosome
  - E) Prokaryotic cell
24. Diploid cells of the fruit fly *Drosophila* have 10 chromosomes. How many chromosomes does a *Drosophila* gamete have?
- A) 1
  - B) 2
  - C) 5
  - D) 10
  - E) 20
25. The hydrophilic regions of a membrane protein are most likely to be found
- A) only in muscle cell membranes.
  - B) associated with the fatty acid region of the lipids.
  - C) in the interior of the membrane.
  - D) exposed on the surface of the membrane.
  - E) either on the surface or inserted into the interior of the membrane.

**Part II: Short Answer**

1. Huntington's disease is a dominant genetic trait that results in nervous system degeneration that starts when people are in their 30's or 40's. Huntington's sufferers are always heterozygous because the homozygous condition is lethal. If only one parent develops this disease, what is the probability that a child will develop the disease? Show your work!

Hh x HH

	H	h
H	HH	Hh
H	HH	Hh

Child has 1 in 2 (50%) chance.

2. In *Drosophila*, *B* is the allele for normal body color and at the same gene *b* is the allele for black body color. A second gene controls wing shape. The shape can be either normal (*N*) or vestigial (*n*). A cross is made between a homozygous wild type fly and fly with black body and vestigial wings. The  $F_1$  offspring were then mated to black body, vestigial winged flies. The following ratio was observed in the  $F_2$ :

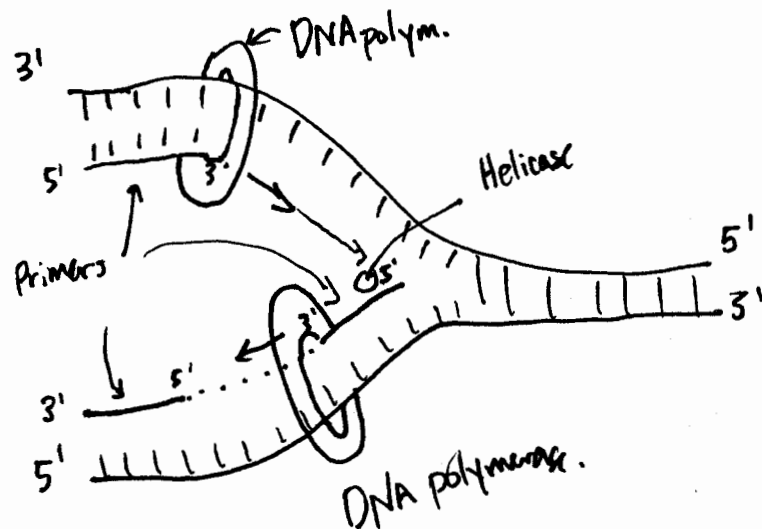
$F_2$ Phenotype	# Observed
• Wild Type	405
• Normal, vestigial	85
• Black, normal	100
• Black, vestigial	410

- a. What are the genotypes of the parents,  $F_1$  and testcross offspring flies?  
 b. Are these two genes linked (on the same chromosome)? How can you tell?

$BBNN \times bbnn$   $F_1 \times bbnn : BbNn \times bbnn$   
 Gametes:  $BN$   $bn$  Gametes :  $BN, Bn$   $bn, bn$   
 $F_1$   $BbNn$   $F_2$  Genotype :  $BbNn, Bbnn, bbNn, bbnn$   
 $F_2$  Phenotype : Normal, Norm, Norm, vest, black normal, black vestigial

They are linked  $\rightarrow$  it's the only way to get all 4 phenotypes is with crossing over.

3. Sketch a replication fork of DNA in which one strand is being replicated discontinuously and the other is being replicated continuously. Identify the following features on your sketch: DNA template indicating the 5' and 3' strands, RNA primers (also labelled 5' and 3'), DNA polymerase, and helicase.



4. The following is part of the amino acid sequence of a transmembrane protein. A) **Circle** the region that would most likely be embedded in the middle of a phospholipid bilayer (Use the amino acid table to help you). B) Indicate how many water molecules were lost during the polymerization of this polypeptide?

A) Lys-Arg-His-Asp-Cys-Val-Phe-Met-Val-Iso-Leu-Iso-Met-Phe-Gly-Tyr-Arg-Glu-Gly-Asp-His

B) Number of water molecules lost = 20

5. The effect of temperature and lipid composition on membrane fluidity are often studied using artificial membranes containing only one or a few kinds of lipids and no proteins. Pretend that you and your lab partner have made the following artificial membranes:

- Membrane 1: made entirely from phosphatidylcholine with all saturated 16-carbon fatty acids. *most solid*
- Membrane 2: The same as (a) except that each of the 16-carbon fatty acids contains a single double bond.
- Membrane 3: The same as (a) except that the fatty acids are polyunsaturated. *most fluid*

After determining the transition temperatures (the temperature at which it changes phase from a solid to a liquid) for each of the three membrane samples, you discover that your lab partner did not record the data in her notebook! The three temperature values you determined were  $-36^{\circ}\text{C}$ ,  $23^{\circ}\text{C}$ , and  $41^{\circ}\text{C}$ . Using your knowledge of lipids, can you assign each of these transition temperatures to the correct artificial membrane?

Membrane #1:  $41^{\circ}\text{C}$

Membrane #2:  $23^{\circ}\text{C}$

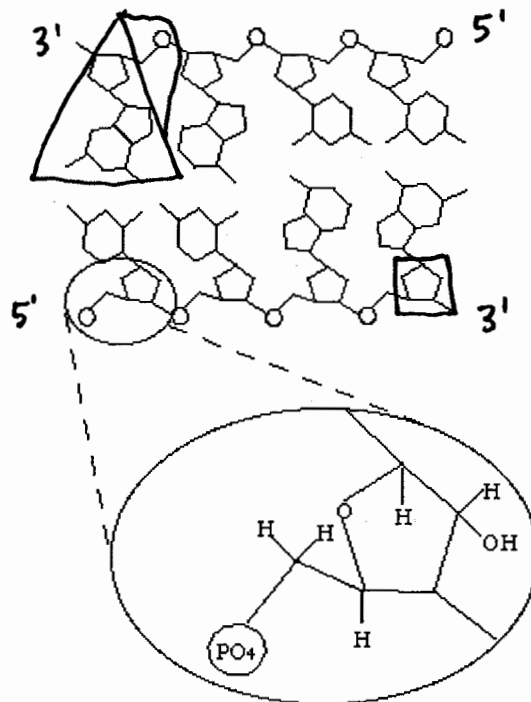
Membrane #3:  $-36^{\circ}\text{C}$

6. In the first step of glycolysis, the enzyme hexokinase uses ATP to transfer a phosphate to glucose to form glucose-6-phosphate. The product continues to be oxidized forming pyruvate in glycolysis and is a precursor to acetyl-CoA for the citric acid cycle. Suppose that a cell has only glucose available for energy and that the activity of hexokinase is suddenly stopped in this cell. Which of the following conditions will occur and **why**?
- The use of oxygen by the cell will increase.
  - The cell will continue to produce energy from mitochondrial electron transport.
  - The cell will continue to produce ATP using the citric acid cycle.
  - The cell will be forced to switch to fermentation to produce ATP.
  - The cell will ultimately be unable to produce ATP.

WHY? \_\_\_\_\_

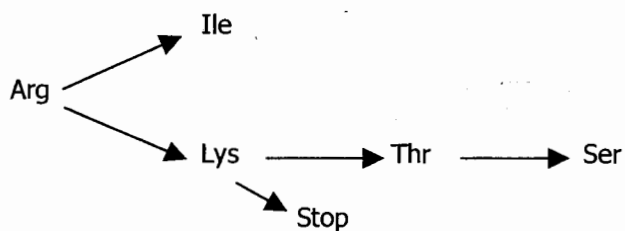
7. Using the diagram below:

- A: Draw a **box** around a pentose sugar.
- B: Label the 5' and 3' ends of both strands.
- C: Draw a **triangle** around the nucleotide on the top strand that was added last when the strand was synthesized.
- D: Is this DNA or RNA? (See magnified picture below). How can you tell?



**Bonus Questions!**

5. Tracking a series of mutations: The diagram below shows the amino acids that result from mutations in the codon (3 base sequence of nucleotides that code for a particular amino acid) of a particular amino acid in a bacterial peptide.



A. Assume that each arrow denotes a **single base substitution** in the bacterial DNA. Referring to the table of the genetic code on the following page, determine the likely codons for each of the amino acids and the STOP signal.