



Exam 7 October 2009, questions and answers

Cellular and Molecular Biology (McMaster University)

Duration: 80 Minutes

Part A = /30 (marks to be posted on ELM)

Name: _____

Part B = 13 /15

ID# _____

Lab Section: _____

This test has **11 pages** and **34 questions**. You are responsible for ensuring that your copy of the test is complete. Bring any discrepancies to the attention of your invigilator. **PLEASE WRITE YOUR NAME, STUDENT # AND LAB SECTION IN PEN ON PAGE 1 AND ON PAGES 8, 9, 10, & 11 OF THIS TEST PAPER.**

There are two parts to this test:

Part A: Multiple choice questions (Questions 1 to 30), worth a total of 30 marks.

Part B: Written answer-style questions (Questions 31 to 37), worth a total of 15 marks.

Please answer Questions 1-30 (Part A) on the optical scan sheets in dark HB pencil.

Note: 1. **THE FIRST QUESTION REQUIRES YOU TO INDICATE WHICH VERSION OF THE TEST YOU ARE WRITING.**

2. **CIRCLE YOUR MULTIPLE CHOICE ANSWERS ON THE OPTICAL SCAN SHEET AS WELL AS YOUR OWN TEST PAPER.**

Carefully read the following instructions for the optical scan sheets.

The scanner, which reads the sheets, senses the shaded areas by their non-reflection of light.

A heavy mark must be made, completely filling the circular bubble, with an HB pencil.

Marks made with a pen or felt-tip marker will **NOT** be sensed.

Erasers must be thorough or the scanner may still sense a mark.

Do **NOT** use correction fluid or correction tape on the sheets.

Do **NOT** put any unnecessary marks or writing on the sheet.

1. Print your **Name, Student Number, Course Name**, and the **Date** in the space provided at the top of **Side 1 (Red side)** of the form for Questions 1-30. The sheet **MUST** be signed in the space marked SIGNATURE.
2. Mark your **Student Number** in the space provided AND **fill in the corresponding bubbles underneath.**
3. Mark only **ONE** choice from the alternatives (A, B, C, D, E) provided for each question. The question number is to the left of the bubbles. **Make sure that the number of the question on the scan sheet is the same as the question number on the test paper. It is your responsibility to ensure that you have filled out your scanner sheet properly.**

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PART A: Multiple Choice (worth 30 marks)

Please answer Questions 1 to 30 on the **OMR Scan Sheet in HB pencil**, NOT pen.
Select the option which best answers the question. There is no penalty for guessing. Each question is worth 1 mark.

1. Which Version of the Test are you writing? (Refer to the top left corner of the Front Page.)
- A) 1
 - B) 2
 - C) 3
 - D) 4
 - E) 5

DR. KAJIURA'S MULTIPLE CHOICE QUESTIONS 2-30

2. Which of the following statements correctly describes how the beta and alpha structural forms of glucose differ from one another?
- A) the linear structures differ in the location of a hydroxyl group
 - B) the oxygen atom inside the ring is located in a different position
 - C) the beta form may be involved in 1,4 and 1,6 glycosidic linkages, which the alpha form can take part only in 1,4 glycosidic linkages
 - D) their ring structures differ in the location of the carboxyl and ribose groups
 - E) their ring structures differ in the location of the hydroxyl group
3. Your friends, Joe and Debbie, went to a Wine & Cheese Party last evening. When Debbie consumed some cheddar cheese, she suddenly experienced excess gas production, bloating, severe stomach aches, and other uncomfortable symptoms. Being 1A03 student, you informed Debbie that she probably suffers from a condition which involves the inability to _____.
- A) digest sucrose
 - B) digest lactose
 - C) digest milk fats
 - D) digest milk proteins
 - E) digest cellulose
4. During our Biology 1A03 lectures, we discussed the relatively rare condition called galactosemia in humans. Which of the following statements is CORRECT with regards to the galactosemia disorder?
- A) it results from the elevated consumption of lactase
 - B) it arises from increased amounts of D galactose and chloride
 - C) it results from a lack of the enzyme that converts galactose to glucose
 - D) it causes the increased production of hydrolytic enzymes found in damaged organelles
 - E) it is caused by reduced ATP production
5. Which of the following modifications would least likely alter the rate at which a DNA fragment moves through a gel during gel electrophoresis?
- A) neutralizing the negative charges within the DNA fragment
 - B) increasing the length of the DNA fragment
 - C) altering the sequences of the nucleotides of the DNA fragment
 - D) decreasing the length of the DNA fragment
 - E) adding methyl groups to the cytosine bases within the DNA fragment
- dep. on charge + size*

6. In lectures we discussed that patients with Sickle Cell Anemia possess red blood cells with characteristic "sickle" shapes. This condition results from a mutation or alteration in one of the amino acids present in hemoglobin. What is the level of protein structure that is most affected by this single amino acid mutation?
- A) Quaternary
 B) Primary
 C) Tertiary
 D) Both A and B
 E) Both A and C
7. If a sample contains 15% thymine in its DNA, then how much cytosine will there be?
- A) 25%
 B) 35%
 C) 20%
 D) 60%
 E) 30%
8. All of the following statements are correct regarding a condensation reaction EXCEPT:
- A) this reaction is essential for the breakdown of complex molecules into simple ones
 B) this reaction is essential for the production of glycogen from glucose monomers
 C) this reaction is essential for the synthesis of fat from fatty acids and glycerol
 D) this reaction is essential for the formation of polypeptides
 E) this reaction results in the removal of a water molecule
9. Suppose that an enzyme is able to break down alpha glycosidic linkages between monomers found in carbohydrates. Which of the following polysaccharides would the enzyme be able to break down?
- A) chitin
 B) amylopectin
 C) glycogen
 D) A and B only
 E) B and C only
10. In lectures, we reviewed the primary functions of carbohydrates in living systems. Which of the following pairs is MISMATCHED?
- A) cell-cell recognition - chitin
 B) energy storage - glycogen
 C) cell-cell signaling - glycoproteins
 D) both A and B
 E) both A and C
11. Which of the following is CORRECT regarding the structure of amphipathic molecules when placed in an aqueous solution?
- A) the interior portion consists of hydrophilic hydrocarbon chains
 B) the interior portion of the amphipathic molecules are comprised of polar hydrocarbon chains and the exterior portion consists of nonpolar head groups
 C) the interior portion of the amphipathic molecules are composed of nonpolar hydrocarbon chains and the exterior portion consists of polar head groups
 D) the exterior portion consists of hydrophobic side groups
 E) both A and D

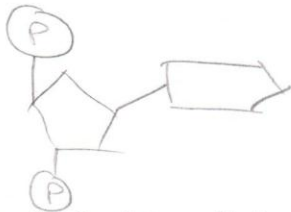
together

starch

starch
- glucose
chitin
glycogen
pentose

12. Dr. Breanna examines a patient with a genetic disease, which causes the excessive production of mucus in the respiratory tract. The accumulation of thick mucus causes other secondary infections. Upon examination of tissue samples, Dr. Breanna notices that the membrane proteins do not function properly. What is the name of this genetic disease and what type of membrane protein is affected?
- A) galactosemia – receptor mediated membrane protein
 - B) cystic fibrosis – chloride channel protein
 - C) rheumatoid arthritis – receptor G protein
 - D) sickle cell anemia – glycoprotein channels
 - E) hypertension – cholesterol pump
13. During the morning, Chef Sara drove to the local supermarket to buy some lard for baking a blueberry pie. When she returned home, she placed the container of lard on her kitchen counter. She noticed later in the afternoon that the lard remained solid at room temperature. Upon making that observation, what can Chef Sara conclude about the fats in the lard?
- A) the lard is composed of mostly unsaturated fats
 - B) the lard is composed of three glycerols and one fatty acid
 - C) the fats are mostly phospholipids
 - D) the lard is composed of saturated fats
 - E) both B and D
14. How does one account for the nonpolar nature of fats?
- A) fats lack both double and triple bonds
 - B) glycerol is not soluble in water and linked with at least one long-chained alcohol
 - C) $-COOH$ are not present in fats and their ions share electrons unequally
 - D) carbon and hydrogen atoms share electrons equally
 - E) both B and C
15. What is the primary difference between a phospholipid and a fat?
- A) a fat has 3 fatty acids attached to glycerol, whereas a phospholipid has 4
 - B) a phospholipid has 3 fatty acids attached to glycerol, whereas a fat has 2
 - C) a phospholipid has 2 fatty acids attached to glycerol whereas a fat has 3
 - D) a fat has 4 fatty acids attached to glycerol, whereas a phospholipid has 3
 - E) a fat has 3 phosphodiester linkages, whereas a phospholipid has 2 ester linkages
16. In deoxyribonucleic acid, phosphate groups bond to which of the following?
- A) adenine
 - B) pyrimidine bases
 - C) purine bases
 - D) ribose
 - E) deoxyribose
17. In lectures, we discussed the process of osmosis. How is osmosis different from that of facilitated diffusion?
- A) osmosis does not require energy
 - B) osmosis involves the diffusion of free water molecules
 - C) osmosis is always assisted by transport membrane proteins
 - D) osmosis involves the transport of solute from an area of high concentration to an area of low concentration
 - E) osmosis requires energy in the form of ATP

18. Which of the following is rich in unsaturated fats?
- A) Bacon grease at room temperature
 - B) Beef fat at room temperature
 - C) Butter at room temperature
 - D) Canola oil at room temperature
 - E) Both A and C
19. If placed in a hypotonic solution, an animal cell will _____, whereas a plant cell will _____.
- A) be normal, lyse
 - B) become turgid, become flaccid
 - C) lyse or burst, become turgid
 - D) crenate, become plasmolyzed
 - E) shrivel, crenate
20. If placed in an isotonic solution, a plant cell will _____, whereas an animal cell will _____.
- A) become turgid, become flaccid
 - B) become flaccid, be normal
 - C) burst (lyse), shrivel
 - D) crenate, become plasmolyzed
 - E) be normal, crenate
21. While working in a Biology lab, you discover a protein known as Protein BPB which transports oxygen in muscle cells. Protein BPB has only the first three levels of protein structure. Protein BPB does not display the quaternary level of protein structure. From these observations, what can you conclude about Protein BPB?
- A) its shape is not beta pleated or alpha helical
 - B) it does not have hydrogen bonds
 - C) it is made of several nucleic acids
 - D) it is made of a single polypeptide chain
 - E) both A and D
22. In lectures, we examined the pharmacological significance of optical isomers. L-DOPA and D-DOPA are optical isomers. This means that they have:
- A) the same molecular formula, but D-DOPA is effective against Parkinson's disease and L-DOPA is biologically inactive
 - B) the same number of carbon atoms, but different numbers of hydrogen and oxygen atoms
 - C) the same molecular formula, but different chemical properties
 - D) the same molecular formula, but L-DOPA is the liquid form of the compound, and D-DOPA is the solid form
 - E) different molecular formula and the same chemical properties
23. The general structure of a nucleotide is composed of which of the following components?
- A) a four carbon sugar, a phosphate group, and a nitrogenous base
 - B) a five carbon sugar, a nitrogenous base, and a phosphate group
 - C) a five carbon sugar, an amino group, and an R group
 - D) a six carbon sugar, a phosphate group, and a nitrogenous base
 - E) a five carbon sugar, a carbonyl group, and a nitrogenous base

24. Nitrogen (element) is present in all of the following EXCEPT:
- A) nucleic acids
 - B) proteins
 - C) DNA
 - D) disaccharides
 - E) amino acids
25. Which of the following best describes DNA's secondary structure?
- A) a beta pleated sheet
 - B) a turn-loop-turn strand
 - C) an alpha pleated sheet
 - D) double antiparallel helical strands
 - E) both A and B
26. Enzymes that break down DNA catalyze the hydrolysis of the covalent bonds that join nucleotides together. What would happen to DNA molecules if they were treated with these enzymes?
- A) the two strands of the double helix would separate
 - B) the phosphodiester bonds between deoxyribose would be broken
 - C) the pyrimidines would be separated from the deoxyribose sugars
 - D) the purines would be separated from the deoxyribose sugars
 - E) both A and B
- 
27. New government regulations require that foods containing trans fats be labeled appropriately. A trans fat is formed when food manufacturers turn liquid oils into solid fat by adding hydrogen to vegetable oils. How would this hydrogenation process produce a solid fat?
- A) the extra hydrogen forms a wax molecule
 - B) adding the hydrogen allows fats to form a tertiary and quaternary structures
 - C) adding the hydrogen causes a phospholipid to form
 - D) adding hydrogen allow the fatty acid chains to pack together to form solids
 - E) both A and B
28. Suppose that Stanley Miller repeated his chemical evolution experiment, but without a source of electrical sparks. What would be the purpose of such an experiment?
- A) to ensure that the glassware had not been contaminated, and that any new molecules collected were actually produced by chemical evolution
 - B) to test that energy (kinetic) is required for chemical evolution
 - C) to test the hypothesis that reduced molecules are required for chemical evolution
 - D) both A and B
 - E) both B and C
29. A series of hydrophobic side chains will congregate together as a protein folds in an aqueous solution and be stabilized by:
- A) quaternary structural bonds
 - B) hydrogen bonds
 - C) disulfide bonds
 - D) van der Waals interactions
 - E) both B and C

30. Nucleic acids have a definite polarity or directionality. That is, one end of the molecule is different in comparison to the other end of the molecule. How are these ends described?
- A) one end has one phosphate group; the other end has three phosphate groups
 - B) one end has an unlinked 3' carbon; the other end has an unlinked 5' carbon
 - C) one end contains a nitrogenous base; the other end lacks a nitrogenous base
 - D) one end has a hydroxyl group on the 2 carbon, the other end has a hydrogen atom on the 2 carbons
 - E) both A and C

PART B: WRITTEN ANSWER-STYLE QUESTIONS 31 - 34 (worth 15 marks)

**PLEASE COMPLETE THE FOLLOWING QUESTIONS IN BLUE OR BLACK PEN.
ANSWERS WRITTEN IN PENCIL WILL NOT BE RE-GRADED.**

31. Linda has curly hair. Carolyn has straight hair. State the name of the hair protein. Describe how the specific linkages in the hair protein are affected to give Linda curly hair. Also describe how the linkages are different in comparison to Carolyn's straight hair. (4 marks)

The hair protein is called "Keratin". Proteins are made of different primary, secondary, tertiary and quaternary structures. It is ~~the~~ ~~see~~ mainly the secondary and tertiary structures that affect the linkages causing hair to either be straight or curly. In secondary structure, parts of the protein are identified by the presence of α -helices and β -pleated sheets, which involve hydrogen bonding. Tertiary structure illustrates the overall 3-D shape of a single polypeptide, involving more complex reactions between side chains and R-groups. These interactions include disulphide bridges as well as Van der Waals interactions. In essence, the "straightness" of hair ~~is~~ is determined by a sequence of amino acids, and how their β -pleated sheets / α -helices as well as tertiary structure interact with one another to form a specific shape.

32. Explain how the components of the double helix structure facilitate the copying of the DNA. (3 marks)

The structure of the DNA double helix is comprised of two strands, each containing nucleotides. ~~The~~ specific nitrogenous base from one strand binds to a specific nitrogenous base on the adjacent strand. Guanine and cytosine always bind together. Adenine and Thymine always bind together. A purine binds with a pyrimidine. DNA is able to replicate because the hydrogen bonds separating the two strands can be broken by enzymes and thus cause the helix to unwind. Once the helix unwinds, ~~each~~ one strand will attract corresponding free nitrogenous bases and bond accordingly (complementary base pairing). The same occurs for the other strand. This, therefore, results in two new ^{double} helices which both contain one old (template strand) and one new (complementary) strand. This is known as the "semi-conservative method".

33. An enzyme, called Enzyme KRB, can break down alpha (α) glycosidic linkages between monomers found in carbohydrates. In the following table, write the specific glycosidic linkages (state all details) found in each of the polysaccharides listed below and clearly indicate which of the following Enzyme KRB could break down. (6 marks)

	Write the <u>SPECIFIC</u> glycosidic linkages (<u>STATE TYPE & NUMBERS</u>) present in between the monomers of these polysaccharides	Would Enzyme KRB be able to break down these molecules? (Write either "YES" <u>or</u> "NO")
PEPTIDOGLYCAN	β -1,4-glycosidic linkages Also present: NAc and peptide bonds from the presence of amino acids.	NO
AMYLOSE	α -1,4-glycosidic linkages A component of starch, and is unbranched.	YES
CHITIN	β-1,4 β -1,4-glycosidic linkages A component of insect exoskeletons.	NO

34. Explain why the Davson-Danielli Sandwich Model is considered incorrect and the Singer-Nicholson's Fluid Mosaic Model is currently accepted as the correct model of membrane structure. Describe the evidence which identified the correct model. (2 marks)

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The D-D model proposed that the cell membrane is composed of a lipid bilayer sandwiched by proteins on the outer and inner surface. ^{but not present in between the bilayer.} The S-N model proposed that the cell membrane is composed of proteins that are found inside, outside and in between the lipid bilayer. This method was proven to be accepted after the freeze-fracture technique experiment. This involved freezing a cell, then chipping away part of its membrane. In between the lipid bilayers, scientists found "pits" and "mounds" suggesting the presence of these proteins, and thus providing evidence for the S-N model.

THE END

When you have completed your test, please raise your hand, remain seated, do not talk or look at other students until your test paper has been collected by an invigilator.

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