

# **THE COLLEGE OF THE BAHAMAS**

## **EXAMINATION**

**SEMESTER 04-2003**

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**FACULTY OF PURE AND APPLIED SCIENCES**  
SCHOOL OF NATURAL SCIENCES AND ENVIRONMENTAL STUDIES

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FREEPORT  
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**DATE AND TIME OF EXAMINATION:** Monday, December 1, 2003 at 2 p.m.  
**DURATION: 3 HOURS**

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COURSE NUMBER: CHEM 336

COURSE TITLE: BIOCHEMISTRY

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME:

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**INSTRUCTIONS TO CANDIDATES:** This paper has 10 pages and 35 questions. Please follow instructions given.

THE COLLEGE OF THE BAHAMAS  
SCHOOL OF NATURAL SCIENCES AND ENVIRONMENTAL STUDIES  
FINAL EXAMINATION, FALL SEMESTER 04-2003  
CHEMISTRY 336: BIOCHEMISTRY



TIME: 3 HOURS  
CODE: R

**INSTRUCTIONS TO CANDIDATES**

***DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.***

This paper has 10 pages (including the cover sheet). It contains three sections as follows:

**Section I** – Twenty-five multiple-choice questions. You are instructed to answer all questions on the multiple choice answer sheet provided.

**Section II** – Five structured questions. You are expected to answer all the questions in this section.

**Section III** – Four extended answer questions. Select ONE question and answer it completely.

**COMPLETE THE FOLLOWING CAREFULLY**

YOUR LECTURER'S NAME

YOUR SECTION NO.

YOUR STUDENT NUMBER

YOUR FULL NAME (PRINT CAREFULLY)

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(FOR OFFICIAL USE ONLY)

**SECTION I –**

**Multiple Choice Questions:** Each question is followed by four possible answers. Select the answer that best fits. Indicate your choice by marking the answer sheet as indicated.

1. What is the pH of a sample of pure water at 25°C.

- a. 3
- b. 5
- c. 7
- d. 9

2. How do you account for the unusually high boiling point of water?

- a. It is an ionic compound.
- b. The molecules can hydrogen bond to each other.
- c. Intermolecular covalent bonds form.
- d. Intramolecular hydrogen bonds form.

3. Which of the following is true of an acid solution?

- a.  $[H^+] > [OH^-]$
- b.  $[H^+] < [OH^-]$
- c.  $[H^+] = [OH^-]$
- d. None of the above

4. Select the statement that is **true** of water.

- a. Water molecules are dipoles.
- b. Water has a low dielectric constant.
- c. The density of ice is greater than that of water.
- d. The boiling point of water is 100°F.

5. The solubility of lipids in polar substances is low because

- a. They contain long hydrocarbon chains that are hydrophobic
- b. Lipids are negatively charged.
- c. Lipid molecules are too small to dissolve.
- d. They contain charged metal ions which are hydrophilic.

6. Enzymes can

- a. Increase the reaction rate by increasing substrate concentration
- b. Increase reactant concentration by elimination of product molecules.
- c. Bind with substrates irreversibly during reactions.
- d. Increase the reaction rate by providing an alternate reaction pathway or mechanism.

7. The activity of an enzyme may be stimulated by

- a. Addition of more product.
- b. Thermal denaturation.
- c. Removing the polypeptide chain of a zymogen.
- d. Addition of a substrate mimic.

8. Where are the enzymes of the Citric Acid Cycle located?

- a. On the inner membrane of the mitochondria
- b. On the outer membrane of the mitochondria
- c. In the cytosol
- d. In the mitochondrial matrix

9. Select the reaction that releases the least amount of energy.

- a.  $AMP + H_2O \rightarrow Adenosine + Pi$
- b.  $ADP + H_2O \rightarrow AMP + Pi$
- c.  $ATP + H_2O \rightarrow AMP + PPi$
- d.  $ATP + H_2O \rightarrow ADP + Pi$

10. Name the two carbon unit that links the glycolytic pathway to the citric acid cycle.

- a. oxaloacetate

- b. pyruvate
- c. acetyl co-A
- d.  $\alpha$ -ketoglutarate

11. In oxidative phosphorylation, how are electrons transported ?

- a. Across the mitochondrial membrane by ATP synthetase
- b. Within the membrane by enzyme + metal complexes
- c. Into the matrix by H<sup>+</sup> ions
- d. Across the cell by acyl carrier proteins

12. The enzymes associated with Glycolysis are located in

- a. The cell membrane
- b. On the outer membrane of the mitochondria
- c. In the cytosol
- d. In the mitochondrial matrix

13. During glycolysis, two three carbon molecules are formed, which establish an equilibrium. These are

- a. Glycerol and phosphoenolpyruvate
- b. Glyceraldehyde and glyceraldehyde-3-phosphate
- c. Dihydroxyacetone phosphate and glyceraldehyde
- d. Pyruvate and acetyl coA

14. When pyruvic acid reacts with glutamic acid to form  $\alpha$ -ketoglutaric acid and alanine, the type of reaction that occurs is

- a. oxidative deamination
- b. dehydration
- c. isomerization
- d. transamination

15. You have been provided with 1 gram portions each of butter, chicken breast-meat ,water and table sugar. Which item will provide the greatest amount of energy when it is metabolised ?

- a. water
- b. table sugar
- c. chicken breast-meat
- d. butter

16. Which diseases are associated with vitamin C deficiency ?

- a. Rickets
- b. Scurvy
- c. Pellagra
- d. Night Blindness

17. In yeast, anaerobic glycolysis results in the formation of

- a. Pyruvate
- b. Lactic acid
- c. Ketone bodies
- d. Ethanol

18. In what form does nitrogen enter the urea cycle ?

- a. carbomyl phosphate
- b. lactate
- c.  $\alpha$ -ketoglutarate
- d. glutamine

19. Complete the sentence using the appropriate selection from below.

The receptors on the surfaces of cells are composed of \_\_\_\_\_. These are the site of action of \_\_\_\_\_.

- a. lipids,enzymes
- b. lipids, hormones
- c. proteins, hormones

d. proteins, enzymes

20. The saturated fatty acid, Palmitic acid has the molecular formula  $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$ . How many runs through the  $\beta$ - oxidation cycle would be needed for the complete oxidation of one molecule of this compound ?
- a. 16
  - b. 4
  - c. 7
  - d. none of the above.

21. ATP, in the human body,

- a. Has a low turnover rate
- b. Is very stable and is stored in muscle tissue for days
- c. Is converted to GTP during glycolysis
- d. Lasts in the body for less than two minutes

22. Another way of describing "positive modulation of an allosteric enzyme" is

- a. Stimulation of enzyme activity
- b. Inhibition by feedback mechanisms
- c. Competitive inhibition
- d. Occupation of the enzyme active site.

23. Cellular respiration and photosynthesis both occur in plants. How is  $\text{CO}_2$  fixation promoted in preference to glycolysis and the citric acid cycle ?

- a.  $\text{CO}_2$  fixation enzymes only work in high concentrations of  $\text{CO}_2$ .
- b. The enzymes for  $\text{CO}_2$  fixation are photosensitive.
- c. Plant mitochondria only function in the absence of light
- d. Ribulose-5-phosphate kinase is inhibited by high oxygen concentrations

24. What methods are employed in human cells, to modify or control cellular metabolism ?

- a. Regulatory enzymes
- b. Hormonal activity
- c. Feedback inhibition
- d. all of the above

25. An essential amino acid may be defined as one that

- a. is needed for structural proteins
- b. the body must be able to synthesise .
- c. must be provided from dietary sources
- d. plays an integral role in producing other amino acids

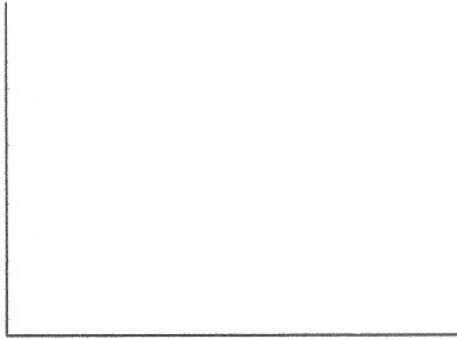
*END OF SECTION I*

**SECTION II**

This section contains five questions. You should answer ALL questions. Write your answers in the spaces provided on the examination script. Credit will be given for clear relevant illustrations.

**ENZYMOLOGY**

1. a. Sketch a reaction profile diagram comparing a reaction with and without the presence of a suitable enzyme. Label your diagram. (4)



- b. The decomposition of glycogen to produce glucose is catalyzed by the enzyme phosphorylase. Studies found that at very low concentrations of glycogen, doubling the glycogen concentration of the enzyme-catalyzed reaction could increase the rate. After the concentration of glycogen reached a certain point, however, addition increases in glycogen concentration had no effect on the reaction rate. Give a detailed explanation for these observations. (5)

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- c. The cyanide ion  $\text{CN}^-$  inhibits the last enzyme in oxidative phosphorylation, cytochrome-c oxidase. Small amounts of cyanide can lead to rapid death.

- i. Classify the inhibition as reversible, or non-reversible (1)

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- ii. State your reasoning for this choice. (2)

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2. GLYCOLYSIS AND THE CITRIC ACID CYCLE

a. State two sources of glucose in the human diet. (1)

b. The first step in glycolysis involved the phosphorylation of glucose.

i. Why is it necessary to "sacrifice" an ATP molecule at this point? (2)

ii. State the name of a suitable enzyme. (1)

iii. Write a reaction equation for this process. (2)

c. In the sixth step,  $\text{NAD}^+$  is converted to NADH.

i. Classify this process as either oxidation or reduction. (1)

ii. Briefly describe how the NADH from glycolysis may be used to generate ATP (Reaction equations are not necessary). (2)

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d. Pyruvate dehydrogenase catalyzes the conversion of pyruvate to acetyl-CoA, with the simultaneous conversion of  $\text{NAD}^+$  to NADH. Briefly suggest how the activity of this enzyme may be regulated in the cell. (3)

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3. OXIDATIVE PHOSPHORYLATION

a. Write a balanced redox equation showing the oxidation of NADH. (1)

b. Describe the mechanisms used to move electrons through the electron transport chain. (4)

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c. What is the role of oxygen in oxidative phosphorylation? (1)

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d. Under which conditions (after a meal, during fasting) would you expect the rate of oxidative phosphorylation to increase? Give reasons to justify your answer. (3)

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e. Explain, with reference to oxidative phosphorylation and ATP, the term **chemiosmotic coupling**. (2)

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4. FATTY ACID OXIDATION

a. State the two chemical components of triacylglycerides. (1)

b. The initial step of fatty acid oxidation involves the condensation of the fatty acid with CoA.

i. Name the enzyme that catalyzes this reaction. (1)

ii. Long chain fatty acid-CoA units can not cross the mitochondrial membrane. Yet  $\beta$ -oxidation takes place within the mitochondria. Describe the mechanism(s) used to transport the fatty acid-CoA unit to the oxidation site. (3)

c. The  $\beta$ -oxidation process is composed of a four reaction cycle.

i. What are the three energy producing products of this cycle ? (3)

ii. How many carbon atoms are removed as the Acyl-CoA passes through the cycle once ? (1)

ii. What modifications or addition steps are needed when processing a fatty acid with an odd number of carbon atoms. (2)

iii. What effect, if any would you expect high concentrations of acetyl CoA to have on the rate of fatty acid oxidation (1)

5. AMINO ACID METABOLISM

a. What is the main use of amino acids in the human body ? (1)

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b. Give the general formula of an amino acid. (1)

c. Amino acid breakdown often proceeds by a common first step called transamination.

i. What group of enzymes catalyze this process ? (1)

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ii. The reaction process is readily reversible. What factor(s) determine the equilibrium position for transamination reactions ? (2)

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iii. Describe how the factor(s) described in ii act to modify the reaction. (3)

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d. What role(s) if any does transamination play in amino acid synthesis ? Illustrate your answer with a suitable example. (3)

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e. Why is excess nitrogen excreted as urea rather than ammonia (1)

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**SECTION III**

This section is worth 20 marks. Select any ONE question. Answer the question on the lined sheets provided. Credit will be given for relevant reaction equations and illustrations.

1. The Citric acid cycle may be described as a central metabolic pathway. Justify this statement, using relevant examples of reactions and metabolic pathways. Your discussion should include examples of biosynthesis and breakdown.
2. Using relevant examples, describe what occurs in the body when blood glucose is low, as in a fasting state and when blood glucose is high, as in a post meal state. Your discussion should include descriptions of hormonal responses as well as the effects on amino acid, fatty acid and glucose metabolism.
3. The failure of an enzyme or group of enzymes within the human body can have serious physical, physiological and even psychological effects. Illustrate this statement with reference to any two diseases. Your discussion should include the name of the disease, the enzyme(s) affected, the reaction(s) affected. You should also include at least three of the symptoms of the disease and at least one method of treatment or prevention.
4. Environmental factors can have significant impacts in human metabolism. Illustrate this statement with relevant examples. Your discussion should include information on the specific environmental factors, their metabolic effects, and possible solutions/remedies.
5. Compare and contrast the processes of photosynthesis and gluconeogenesis. Your discussion should include a summary of each process, points of difference and points of similarity. You should also state the main reactants and products of each process.

END OF SECTION III  
END OF THE EXAMINATION