

THE COLLEGE OF THE BAHAMAS

EXAMINATION

SEMESTER 04-2007

FACULTY OF PURE AND APPLIED SCIENCES

SCHOOL OF SCIENCES AND TECHNOLOGY

X NASSAU
FREEPORT
EXUMA
ELEUTHERA

DATE AND TIME OF EXAMINATION: Tuesday, December 11, 2007 at 2 pm
DURATION: 3 HOURS

COURSE NUMBER: CHEM 336

COURSE TITLE: PRINCIPLES OF BIOCHEMISTRY

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME

INSTRUCTIONS TO CANDIDATES: This paper has 8 pages and 36 questions. Please follow instructions given.

CHEMISTRY 336 SEMESTER 04-2007 FINAL EXAMINATION

CHEM336 PRINCIPLES OF BIOCHEMISTRY

FINAL EXAMINATION,

SEMESTER 04-2007

TIME: 3 HOURS

CODE: R

INSTRUCTIONS TO CANDIDATES

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

This paper has **8** pages (including this sheet). It contains three sections as follows:

Section I -Thirty 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 – Five extended answer questions. Select ONE question and answer it completely.

(FOR OFFICIAL USE ONLY)

SECTION A: ____/30

SECTION B: ____/50

SECTION C: ____/20

TOTAL EXAM ____ @ 40%

TERM WORK ____ @60%

TOTAL : ____/100

GRADE : ____

CHEMISTRY 336 SEMESTER 04-2007 FINAL EXAMINATION

SECTION A: This section consists of thirty multiple choice questions. Each is worth 1 mark. Select your answer from the five options provided in each case. Mark your answer as illustrated on the answer sheet.

- The pH of a solution is 7.4. If 50% of the hydrogen ions were removed, what would the new pH be?
 - 14.8
 - 7.7
 - 7.4
 - 7.2
 - 3.7
- Where does the primary buffering activity of the bicarbonate buffer system take place?
 - in the blood
 - in the kidneys
 - in the electron transport chain
 - in the chloroplast
 - in the cytoplasm of adipocytes
- The high heat of vaporization of water allows a large body of water to
 - exist in three states
 - release energy as the water changes to a gas
 - rapidly convert from liquid to gaseous state when gently heated
 - absorb a relatively large amount of energy without changing state
 - absorb energy as the liquid cools
- Which of the following best accounts for the ability of water to climb up a drinking straw?
 - surface tension
 - Hydrophobic interactions
 - Adhesive forces
 - Capillary action
 - Coercive forces
- Which of the following is true of a basic solution?
 - $[H^+] > [OH^-]$
 - $[H^+] < [OH^-]$
 - $[H^+] = [OH^-]$
 - $[H^+] \leq [OH^-]$
 - None of the above
- The activity of an enzyme may be reduced by
 - Addition of more product
 - Decreased temperature
 - Addition of acid
 - Addition of a substrate mimic.
 - All of the above
- If an enzyme acts in accordance with the Michaelis-Menten equation, addition of a competitive inhibitor will result in
 - a decrease in both K_m and V_{max}
 - a decrease in K_m only
 - an increase in K_m only
 - an increase in the K_m and decrease in V_{max}
 - no change in either K_m or V_{max}
- Which of the following is true of isoenzymes?
 - They are inactive forms of enzymes.
 - They catalyse the same reaction.
 - They have different K_m values.
 - They have identical amino acid composition.
 - Both B and C are true.
- Which of the following enzymes catalyses the reaction that commits glucose to glycolysis
 - hexokinase.
 - phosphoglucose isomerase.
 - phosphofructokinase-1 (PFK-1).
 - glucokinase.
 - fructose-1,6-bisphosphate aldolase
- Select the reaction that has the largest negative standard free energy of hydrolysis?
 - $AMP + H_2O \rightarrow Adenosine + Pi$
 - $ADP + Pi \rightarrow ATP + H_2O$
 - $AMP + PPi \rightarrow H_2O + ATP$
 - $ATP + H_2O \rightarrow ADP + Pi$
 - $GDP + Pi \rightarrow GTP + H_2O$
- The two-carbon unit that links the Glycolytic Pathway to the Citric Acid Cycle is called
 - Citrate
 - Acetyl-CoA
 - α -Ketoglutarate
 - Pyruvate
 - Oxaloacetate

CHEMISTRY 336 SEMESTER 04-2007 FINAL EXAMINATION

12. The primary product of anaerobic respiration in muscle tissue is
- Lactate
 - Pyruvate
 - Ketone bodies
 - Ethanol
 - succinate
12. In what form does nitrogen enter the Urea Cycle ?
- carbamyl phosphate
 - fumarate
 - citrulline
 - α -ketoglutarate
 - glutamine
13. Cellular respiration and photosynthesis both occur in plants. What promotes CO_2 fixation rather than cellular respiration ?
- CO_2 fixation enzymes are activated by high concentrations of CO_2 .
 - The enzymes for glycolysis are photosensitive.
 - Plant mitochondria only function in the absence of light.
 - Glucose inhibits oxygen uptake.
 - Ribulose-5-phosphate kinase is inhibited by high oxygen concentrations
14. During aerobic glycolysis, glucose is converted to pyruvate, what is the net production of energy in ATP equivalents when 4 molecules of glucose undergo glycolysis ?
- 6 ATPs
 - 8 ATPs
 - 10 ATPs
 - 14 ATPs
 - 20 ATPs
15. The products of one round of β -oxidation of a fatty acid include :
- NADH
 - FADH_2
 - Acetyl- CoA
 - Acyl- CoA
 - All of the above
16. The addition of cyanide to the electron transport chain would result in
- an increased yield of ATP
 - coupling of the electron transport chain with ATP synthesis
 - decreased cytochrome oxidase activity
 - increase ATP synthase activity
 - No net effect on ATP production
17. Increased blood levels of glucagon lead to
- Decreased fatty acid synthesis in adipose tissue
 - Increased synthesis of glycogen in the muscles
 - Increased liver malonyl CoA levels
 - Increased gluconeogenesis in the liver
 - Both D and A
18. Identify the substance that is NOT a substrate or a product of reactions catalysed by acyl CoA synthase.
- Crotonyl-ACP
 - Acetoacetyl-ACP
 - NADPH
 - H_2O
 - Acetyl CoA
19. The amino group from excess dietary amino acids is incorporated into which of the following compounds/group of compounds ?
- Acetyl CoA
 - Urea
 - Glutamate
 - One of the intermediates of the Citric Acid Cycle
 - Pyruvate
20. In the pentose phosphate pathway, the products of the oxidative phase include
- ribose-5-P and NADPH
 - ribose -3-P and $\text{NADH} + \text{H}^+$
 - ribulose -5-P and NADPH
 - fructose-6-P and glyceraldehyde-3-P
 - glyceraldehyde-3-P
21. During fasting, gluconeogenesis may use any of the following as substrates **except** :
- alanine
 - glycerol
 - lactate
 - oxaloacetate
 - acetyl CoA

CHEMISTRY 336 SEMESTER 04-2007 FINAL EXAMINATION

22. Which of the following is the final electron acceptor in the respiratory chain?
- A. oxygen
 - B. cytochrome reductase
 - C. FADH_2
 - D. cytochrome c
 - E. ATP synthase
23. Select the statement that is true.
- A. The Citric Acid Cycle is the primary source of NADH.
 - B. NADH freely crosses the mitochondrial membranes.
 - C. Malate is unable to enter the mitochondria without a carrier.
 - D. NADH generates 3 ATPs through the electron transport chain and oxidative phosphorylation.
 - E. Aspartate may cross the mitochondrial membranes, when combined with malate.
24. Phenylketonuria is a disease that is characterised by
- A. Elevated urinary ketones
 - B. Phenylketone deficiency
 - C. Inability to metabolise phenylalanine
 - D. Increased liver protein synthesis
 - E. Both A and C.
25. Hyperglycemia refers to
- A. Elevated blood glucose levels
 - B. Increased gluconeogenesis
 - C. Cellular resistance to insulin
 - D. Reduced beta oxidation
 - E. Depressed blood glucose levels
26. The Calvin Cycle
- A. is activated by light.
 - B. Produces 3 ATP for each complete turn of the cycle
 - C. Takes place in the stroma of the chloroplasts
 - D. Produces ribose-5-P as an intermediate
 - E. Produces one molecule of hexose per turn of the cycle
27. What effect does ketoacidosis have on erythrocytes ?
- A. Increased glycolysis
 - B. Increased uptake of lipids
 - C. Reduced oxygen carrying capacity
 - D. Oxygen uptake is increased
 - E. The cells are not affected.
28. The enzymes of the Citric Acid Cycle are primarily located _____ whilst the enzymes of the electron transport chain are located
- A. In the mitochondrial matrix/in the cytoplasm
 - B. In the cytoplasm/on the inner membrane of the mitochondria
 - C. On the inner membrane of the mitochondria/in the mitochondrial matrix
 - D. In the mitochondrial matrix/on the inner membrane of the mitochondria
 - E. On the outer mitochondrial membrane/in the inner membrane of the mitochondria
29. Which of the following would you expect to see as products of the dark reaction of photosynthesis ?
- A. carbon dioxide, NADPH and ATP
 - B. NADPH, P_i and ATP
 - C. carbon dioxide, ATP and glucose
 - D. glucose, NADP^+ and ADP
 - E. water, carbon dioxide and light
30. A dietary deficiency in folic acid is likely to impair production of
- A. lysine
 - B. glutamate
 - C. valine
 - D. serine
 - E. All of the above

CHEMISTRY 336 SEMESTER 04-2007 FINAL EXAMINATION

SECTION II This section contains 5 questions. You are expected to answer each question completely. Write your answers in the spaces provided on the question paper.

31. GLYCOLYSIS AND THE CITRIC ACID CYCLE

- a. The first step in glycolysis involves the phosphorylation of glucose.
- Why is it necessary to "sacrifice" an ATP molecule at this point ? (1)
 - Write an equation showing this first step, including the name of the enzyme.(2)
- b. Pyruvate dehydrogenase catalyzes the conversion of pyruvate to acetyl-CoA, with the simultaneous conversion of NAD^+ to NADH. What regulatory measures affect the activity of pyruvate dehydrogenase ? (Positive and negative) (4)
- c. Illustrate the process of **substrate level phosphorylation** using :
- an example either from from the Glycolytic Pathway OR the Tricarboxylic Acid (Citric Acid) Cycle (giving the relevant reaction and enzyme) (3)

32. FATTY ACID METABOLISM

- a. Complete the table below. 6 marks

ITEM	FATTY ACID SYNTHESIS	FATTY ACID OXIDATION
Where the process takes occurs (cellular location)		Mitochondria
Carrier of intermediates	Acyl carrier protein	
Coenzymes		NADH / NAD +
2 carbon transfer unit		
Hormone which stimulates the process		

- b. The initial step of fatty acid oxidation involves the condensation of the fatty acid with CoA.
- Name the enzyme that catalyzes this reaction. (1)

CHEMISTRY 336 SEMESTER 04-2007 FINAL EXAMINATION

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- ii. Long chain fatty acid-CoA units can not cross the mitochondrial membrane. Yet β -oxidation takes place within the mitochondria. Explain how the Acyl CoA moves into the mitochondria for oxidation. (3)
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-
-
-
-

33. AMINO ACID METABOLISM

- a. Explain/define the term **essential amino acid**. Give an example of one. (2)
-
-

- b. Differentiate between glucogenic and ketogenic amino acids. (2)
-
-
-

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

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

- iii. What roles do transamination and deamination play in removal of toxic nitrogen compounds ? (3)
-
-
-
-

- iii. Illustrate the role of transamination in amino acid synthesis with a suitable example. (2)
-
-
-
-

CHEMISTRY 336 SEMESTER 04-2007 FINAL EXAMINATION

34. THE ELECTRON TRANSPORT CHAIN AND OXIDATIVE PHOSPHORYLATION

- a. Briefly explain how the Glycolytic Pathway , the Tricarboxylic Acid Cycle (TCA) and Oxidative Phosphorylation are linked .(3)

- b. When CoQ converts to CoQH₂, is this oxidation or reduction ?(1)

- c. Describe the mechanism by which proton-motive force in the mitochondria is used to drive the synthesis of ATP. (3)

- d. A suspension of cells was treated with antimycin. The antimycin is known to block the flow of electrons from complex III of the electron transport chain. What impact would you expect this to have on

- i. ATP production (1)

- iii. Justify your answer to part i above.(2)

35. PHOTOSYNTHESIS

- a. Write a chemical equation summarizing the process of photosynthesis. (2)

- b. What is the overall source of energy for photosynthesis (1)

- c. What three key chemical reactions are associated with the light phase ? (3)

- d. What is the source of energy that drives the formation of ATP in the thylakoid membranes ? (1)

- e. Account for the observation that plants such as sugarcane and maize (classified as C₄) are able to photosynthesise more effectively in hot, dry conditions than most other plants (classified as C₃) . (3)

CHEMISTRY 336 SEMESTER 04-2007 FINAL EXAMINATION

END OF SECTION II

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 examples and illustrations.

36. The flow of metabolites through various pathways and cycles may be regulated in three main ways. Give an example for each of the three main mechanisms of regulation, showing how the rate of metabolic flux is regulated.

37. Diseases/sickness can result from a number of causes. Two significant causes are

- a. inadequate dietary intake
- b. enzyme deficiency

These may result in serious have serious physical, physiological and even psychological effects

Using either a OR b, discuss a specific disease/sickness. Your discussion should include the name of the disease, the enzyme(s) /nutrients affected, the biochemical pathway(s) and 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.

38. Compare the changes that take place in metabolism during the post meal state to those that occur in the starvation state. Your discussion should include information on hormones, enzymes and overall effects on amino acid, fatty acid and glucose metabolism

39. 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.

40. Discuss the role of the Pentose Phosphate Pathway in terms of biosynthesis.

Your discussion should include: key reactions, products and pathway regulation,

THE END