

THE COLLEGE OF THE BAHAMAS

EXAMINATION

SEMESTER 01-2009

FACULTY OF PURE AND APPLIED SCIENCES

SCHOOL OF SCIENCES AND TECHNOLOGY

X NASSAU
FREEPORT
EXUMA
ELEUTHERA

DATE AND TIME OF EXAMINATION: Tuesday, April 21st, 2009 at 7pm

DURATION: 3 HOURS

COURSE NUMBER: CHEM336

COURSE TITLE: PRINCIPLES OF BIOCHEMISTRY

STUDENT NAME:

STUDENT NUMBER:

LECTURER'S NAME : MRS. B. HOGG

INSTRUCTIONS TO CANDIDATES: This paper has 9 pages and 35 questions. Follow the instructions at the beginning of each section.

10. The amino group from excess dietary amino acids are processed through the urea cycle. In what form does the amino group enter the cycle?
- A) carbonyl phosphate
 - B) arginosuccinate
 - C) ornithine
 - D) alpha-ketoglutarate
11. The saturated fatty acid, Palmitic acid has the molecular formula $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$. How many carbon atoms would be left in the acyl residue after palmitic acid had undergone three complete rounds of beta oxidation ?
- A) 13
 - B) 10
 - C) 4
 - D) not possible to calculate using the information provided
12. Essential amino acids include
- A) threonine, serine, proline
 - B) tyrosine, lysine, alanine
 - C) lysine, valine, leucine
 - D) phenylalanine, glutamine, glycine
12. If an enzyme acts in accordance with the Michaelis-Menton equation, addition of a competitive inhibitor will result in
- A) a decrease in both K_m and V_{max}
 - B) a decrease in K_m only
 - C) an increase in K_m only
 - D) an increase the K_m and decrease in V_{max}
13. Which of the following is true of the isoenzymes hexokinase and glucokinase ?
- A) They are inactive forms of enzymes.
 - B) They catalyse the same reaction.
 - C) They have different K_m values.
 - D) Both B and C are true.
14. During glycolysis, glucose is converted to pyruvate, what is the net production of energy in ATP when 8 molecules of glucose undergo glycolysis ?
- A) 12
 - B) 16
 - C) 20
 - D) 28
15. Increased blood levels of glucagon lead to
- A) decreased fatty acid synthesis
 - B) increased synthesis of glycogen in the muscles
 - C) increased liver malonyl CoA levels
 - D) decreased gluconeogenesis in the liver
16. During fasting, gluconeogenesis may use any of the following as substrates for net synthesis of sugars except :
- A) glycerol
 - B) leucine
 - C) acetyl-CoA
 - D) oxaloacetate
17. The final electron acceptor in the electron transport chain is
- A) oxygen
 - B) cytochrome oxidase
 - C) ATP synthase
 - D) Cu^{2+}

18. The major negative effects of Phenylketonuria may best be reduced by

- A) a high protein diet
- B) a low phenylalanine diet
- C) a high phenylalanine diet
- D) a low protein diet

19. When the beta cells of the pancreas decrease hormonal secretion

- A) blood glucose levels rise
- B) gluconeogenesis decreases
- C) beta oxidation increases
- D) glycolysis increases

20. The Calvin Cycle

- A) is activated by light.
- B) Takes place in the stroma of the chloroplasts
- C) Produces ribulose-5-P as an intermediate
- D) A,B and C are all true.

21. All of the following are true EXCEPT :

- A) The maximum velocity, V_{max} , of an enzyme reaction is proportional to the amount of enzyme present.
- B) The initial velocity of an enzyme reaction at high values of substrate concentration is proportional to the amount of enzyme present.
- C) The Michaelis constant, K_M , of a substrate for an enzyme is proportional to the amount of enzyme present.
- D) The slope of the line in a double reciprocal plot of enzyme kinetic data is equal to K_M/V_{max} .

22. An enzyme which is common to both gluconeogenesis and glycolysis is

- A) aldolase
- B) glucokinase
- C) phosphofructokinase
- D) pyruvate carboxylase

23. The major carbohydrate stored in plants is ____ and in animals is ____.

- A) glycogen , glycogen
- B) starch , triacylglyceride
- C) cellulose, starch
- D) starch , glycogen

24. The final product of the Calvin Cycle is

- A) ATP
- B) Ribulose biphosphate
- C) phosphoglycerate
- D) glyceraldehyde-3-phosphate

25. Select the statement that best describes the relationship between photosynthesis and

- A) Photosynthesis involves the capture of solar energy to form organic molecules; respiration involved the generation of energy from organic molecules.
- B) Photosynthesis involves glucose reduction; respiration involves glucose oxidation.
- C) Photosynthesis only occurs in plants; respiration occurs only in animals.
- D) Photosynthesis produces ATP; respiration consumes ATP.

SECTION II This section contains six (6) structured questions. Answer any five (5) of the questions. Each question is worth 15 marks. Write your answers in the spaces provided.

26. GLYCOLYSIS AND THE KREB'S CYCLE

- A. The first step in glycolysis is the phosphorylation of the glucose molecule. Why is ATP "sacrificed" in this way? (2)
- B. Describe and explain the effects on intermediate concentrations and glycolysis rate that would result from the addition of an irreversible phosphofructokinase inhibitor to a tissue in which glycolysis was occurring. (5)
- C. List two items that are typical of the Bahamian diet that are ready sources of hexose sugars. (2)
- D. Indicate an enzyme that catalyzes each of the following reaction types in glycolysis or the Krebs cycle. (3)
- cleavage _____
- dehydrogenation _____
- decarboxylation _____
- E. Pyruvate dehydrogenase catalyzes the conversion of pyruvate to acetyl-CoA, with the simultaneous conversion of NAD^+ to NADH . Briefly suggest how the activity of this enzyme may be regulated in the cell. (3)

27. THE PENTOSE PHOSPHATE PATHWAY

- A. Write an equation to illustrate the first step of the pathway. (2)
- B. What three substances from the PPP are also common to the glycolytic pathway ? (3)
- C. What factors determine whether intracellular glucose-6-phosphate is used for glycolysis or the pentose phosphate pathway ? (3)
- D. What effect, if any, would inhibition of the Pentose Phosphate Pathway have on erythrocytes? (2)
- E. Studies have shown that muscle cells have low quantities of PPP enzymes. However adipose cells and the liver have high quantities. What benefit do you think there is to having this type of difference in enzyme distribution ? (5)

28. OXIDATIVE PHOSPHORYLATION AND MITOCHONDRIAL SHUTTLES

- A. Name the complex and enzyme in the electron transport chain (ETC) where electrons first enter (2)
- B. When electrons enter the ETC, is the electron donor oxidized or is it reduced ? (1)
- C. How is the proton gradient generated across the mitochondrial membrane ? (3)
- D. What role does the proton gradient play in ATP production ? (2)
- E. What effect, if any, would the presence of a dehydrogenase inhibitor have on energy production ? (2)

F. Using a named example, explain the function of a biochemical "shuttle".

(5)

29. AMINO ACID METABOLISM

A. What is a glucogenic amino acid? Which pathways do their catabolic products enter? (2)

B. Illustrate the process of transamination, using a named amino acid and a named enzyme. (2)

C. Explain how the production of urea during a fast is related to the need to maintain blood glucose levels. (5)

D. **Either** -Outline the four reactions of the Urea Cycle. State the enzymes, substrates and products in each case. (6) **OR** - Describe the activation and regulation of the Urea Cycle (6)

30. FATTY ACID OXIDATION

A. 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 acyl-CoA units can not cross the mitochondrial membrane. Yet β -oxidation takes place within the mitochondria. Describe the mechanism(s) used to transport the acyl-CoA unit to the oxidation site. (4)

B. The β -oxidation process is composed of a four reaction cycle.

i. Identify two products of this cycle that are linked to the electron transport chain. (2)

ii. What modifications or additional steps are needed when processing a fatty acid with an odd number of carbon atoms. (1)

iii. Account for the observation that high concentrations of malonyl-CoA reduce the rate of fatty acid oxidation (2)

C. James Thompson, a noncompliant diabetic, was stopped by the police on a Saturday evening, while driving to a party. He was given a Breathalyzer test. He was given a ticket for driving under the influence. James was very upset and confused. He knew that he had not been drinking at all, yet the test did give a positive result. In fact John had not had been so busy on Thursday Friday and Saturday that he had had nothing to eat or drink except a few glasses of water. Assuming that the analyzer was working properly, how do you account for James' positive test result. (Include reference to lipid metabolism in your answer) (5)

31. PHOTOSYNTHESIS

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

B. Plants have chlorophyll a and chlorophyll b, two light catching pigments. They capture light at different wavelengths. What advantage is there in being able to work with different wavelengths? (2)

C. How many carbon dioxide molecules would it take to produce a 6 carbon sugar molecule through

D. Give the term that best fits the description given: (6)

- _____ Organelle responsible for respiration
- _____ Complex of proteins and pigments that captures light energy
- _____ Electron accepting molecule produced during the light reactions
- _____ Term given to ATP production during photosynthesis
- _____ Term that describes the stacks of thylakoids in chloroplasts
- _____ By-product of the light reactions in photosynthesis

E. Briefly describe what you would expect to happen to animals on earth if all photosynthesis were to stop for a one year period. Justify your answer, with reference to the role of photosynthesis. (4)

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.

32. Metabolic pathways and cycles are usually regulated at several levels. Discuss the roles of genetics, hormones and enzyme effectors in regulation of metabolism. Give a specific example, including the name of the enzyme and the relevant reaction, for each regulation method discussed.

33. Acetyl-CoA may be described as a central metabolic intermediate. With reference to metabolism of carbohydrates, lipids and proteins, discuss this statement.

34. 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.

35. You may answer EITHER part i/ OR part ii/

i/ 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.

ii/ Insulin and glucagon are known to affect metabolism in different ways. Prepare a table to compare the effects of these hormones on each of the following:

- a. storage of glucose in glycogen. (2)
- b. breakdown of liver glycogen. (2)

- c. synthesis of fatty acids from glucose in the liver.(2)
- d. synthesis of triacylglycerols in liver and adipose tissue .(3)
- e. mobilization of free fatty acids from adipose tissue. (2)
- f. protein synthesis (2)
- g. use of amino acids for gluconeogenesis.(2)
- h. Describe the circumstances under which ketone body production and use increases significantly. (4)
- I. State one possible negative effect of long term use of ketone bodies as a fuel source. (1)

END OF THE EXAMINATION