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BCH 3120 Intermediary Metabolism

Midterm 1

Version 'A'

Wednesday February 2, 2011

Exam duration: 1 hour

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Your Name: _____

Student Number: _____

Hand in this booklet, and the pink Scantron computer sheet. Remember to record your name and student number on both of them.

[Type text] Name: _____ Student number: _____

Multiple Choice Questions Each question is worth one mark. There are 30 questions in this section. Make sure that you write your answers on the Scantron (pink) sheet for marking.

1) The version of the midterm is: (a bonus mark to start!) [Mark your answer on the Scantron sheet!]

- a) version A
- b) version B

2) How much ATP is stored in the adult human body? (i.e., in kcal units)

- a) less than 100 kcal
- b) approximately 1000 kcal
- c) 5,000-7,000 kcal
- d) approximately 30,000 kcal
- e) approximately 10,000 kcal

a

3. Most of the dietary energy that most North American adults consume each day is from

- a) fat
- b) carbohydrate
- c) protein
- d) ethanol
- e) lactose

b

4) Most of the energy content of the adult human body is in the form of:

- a) triglyceride
- b) glycogen (liver content and muscle content combined)
- c) protein
- d) glucose circulating in the blood
- e) free fatty acids circulating in the blood

a

5) Which of the following statements regarding allosteric control of enzymes is UNTRUE?

- a) An allosteric inhibitor functions by competing with the enzyme's substrate at the substrate binding pocket.
- b) In the "R" (relaxed) state the enzyme has high affinity for the substrate
- c) The inhibition of glyceraldehyde kinase by glucose is an example of allosteric inhibition.
- d) Allosteric inhibitors and activators induce conversion from the relaxed state to the tense state, and the tense state to the relaxed state, respectively.
- e) Allosteric control of enzymes is commonly observed in metabolic pathways.

a

6) Which of the following is a common method through which enzyme degradation is initiated?

- a) protein acetylation
- b) protein ubiquitination

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- c) protein methylation
- d) protein phosphorylation

b)

7) Glucose has several metabolic fates in muscle cells. Which of the following is not a product of glucose metabolism in muscle cells?

- a) pyruvate
- b) ribose5-phosphate
- c) glycogen
- d) sucrose
- e) acetyl-CoA

(d)

8) Which of the following is not an intermediate in glycolysis

- a. 1,3-bisphosphoglycerate
- b. fructose 2,6-bisphosphate**
- c. dihydroxyacetone phosphate
- d. phosphoenolpyruvate
- e. All of the above

9) Which of the following inhibits phosphofructokinase-1 activity

- a. ATP
- b. citrate
- c. low pH
- d. glucagon
- e. All of the above**

10) What is the purpose of the pentose phosphate pathway

- a. generates NADH for biosynthetic pathways
- b. generates ribose-5-phosphate for the synthesis of DNA and RNA**
- c. regenerates NAD⁺ for the continuation of glycolysis
- d. a and b
- e. None of the above

11) Which two products are formed from the activity of transketolase in the PPP pathway?

- a. erythrose 4-phosphate + fructose 6-phosphate
- b. sedoheptulose 7-phosphate + glyceraldehyde 3-phosphate
- c. glyceraldehyde 3-phosphate + fructose 6-phosphate
- d. xylulose-5 phosphate + ribose 5-phosphate
- e. b and c**

12) In analyses of the glycolytic pathway, if carbon #3 of glucose were radiolabeled (e.g., using ¹⁴C), which carbon in the 1,3 bisphosphoglycerate molecule would subsequently be labeled during glycolysis?

- a) 1
- b) 2**
- c) 3

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d) 4

e) None of carbons in 1,3, bisphosphoglycerate molecule would be radiolabeled.

a)

13) The 'lysis' step of the glycolysis pathway is catalyzed by which of the following enzymes?

a) hexokinase

b) aldolase

c) phosphofruktokinase-1

d) fruktokinase

e) enolase

b)

14) Lactose is a disaccharide composed of:

a) one glucose molecule and one galactose molecule

b) two molecules of glucose

c) one glucose molecule and one mannose molecule

d) one glucose molecule and one fructose molecule

e) two molecules of galactose

a)

15) Which of the following enzymes and substrates is not involved in ethanol fermentation reactions?

a) pyruvate

b) acetaldehyde

c) pyruvate decarboxylase

d) alcohol dehydrogenase

e) pyruvate transketolase

e

16) Which of the following statements about the activity of the pyruvate dehydrogenase complex is UNTRUE?

a) Thiamine pyrophosphate is a carrier of active methyl groups in the reactions

b) It carries out five enzymatic reactions

c) It is an excellent example of substrate channeling.

d) It requires five coenzymes

e) Acetyl-CoA is a product

a

17) In individuals exposed to ionizing radiation and who have inherited a mutation in the gene for glucose-6-phosphate dehydrogenase, there would be abnormally low levels of all of the following in their red blood cells, except:

a) GSH

b) NADPH + H⁺

c) H₂O₂

d) 6-phosphoglucono- δ -lactone

e) None of the above

c)

18) Gluconeogenesis occurs in the following tissue(s):

i) muscle

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- ii) adipose tissue
- iii) red blood cells
- iv) liver
- v) kidney

- a) i and ii
- b) ii and iv
- c) i and v
- d) iii and iv
- e) iv and v

e

19) Glycogenolysis occurs mainly in the following tissue(s):

- i) muscle
- ii) adipose tissue
- iii) red blood cells
- iv) liver
- v) kidney

- a) i and ii
- b) i and iv
- c) i and v
- d) iii and iv
- e) iv and v

b

20) With regard to gluconeogenesis which of the following glycolytic enzymes must be bypassed?

- i) hexokinase
- ii) glucose 6 phosphatase
- iii) phosphofructokinase
- iv) enolase
- v) pyruvate kinase

- a) i ; ii ; iv
- b) ii ; iii ; iv
- c) ii ; iii ; v
- d) i ; iii ; iv
- e) i ; iii ; v

e

21) Which of the following tissues/cell types has an obligatory need for glucose? (In other words, this tissue or cell type requires glucose all the time)

- a) adipose tissue
- b) muscle
- c) lung
- d) red blood cells
- e) Actually, ALL of the above cells/tissues are obligatory glucose users

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d)

22) All of the twenty common amino acids can be used as precursors in gluconeogenesis, EXCEPT:

- a) arginine and glutamate
- b) phenylalanine and tyrosine
- c) alanine and arginine
- d) leucine and lysine
- e) glutamate and glutamine

d)

23) When glycogen is catabolized by glycogen phosphorylase, the product immediately released from the glycogen molecule is:

- a) glucose
- b) UDP-glucose
- c) glucose-1-phosphate
- d) glucose-6-phosphate
- e) glucose 2,6-bisphosphate

c)

24) The maximum number of ATP molecules produced through the complete oxidation of one molecule of glucose (*i.e.*, including glycolysis, the Krebs cycle, the electron transport chain and ATP synthase activities) is:

- a) 10-12
- b) 24-26
- c) 30-32
- d) 36-38
- e) 48-50

c)

25) The name of the scientist who devised the chemiosmotic theory of oxidative phosphorylation:

- a) Peter Mitchell
- b) Carl Cori
- c) Dorothy Hodgkin
- d) John Walker
- e) Hans Krebs

a)

26) The protonmotive force across the mitochondrial inner membrane is usually in the range of:

- a) 50-80 volts
- b) 170 – 200 volts
- c) 50-80 millivolts
- d) 170 – 200 millivolts
- e) none of the above

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d)

27) The complexes of the electron transport chain that pump protons out of the matrix into the intermembrane space are:

- a) Complexes I and III
- b) Complexes I, II and III
- c) Complexes I, III, and IV
- d) Complexes I, III and V
- e) Complexes I and V

c)

28) The aerobic metabolism of one glucose molecule provides approximately _____ times as much ATP as its anaerobic metabolism.

- a) 1-2
- b) 5
- c) 10
- d) 15
- e) 30

(d)

29) Cyanide, and rotenone inhibit, respectively, the following complexes of the electron transport chain:

- a) Complex I, Complex III
- b) Complex II, Complex III
- c) Complex III, Complex IV
- d) Complex IV, Complex I
- e) Complex IV, Complex II

d

30) Uncoupling protein-1 is expressed in:

- a) skeletal muscle
- b) pancreas
- c) white adipose tissue
- d) brown adipose tissue
- e) all of the above

d

True/False (Each of these 20 questions is worth 1/2 mark; thus this section is worth 10 marks) * Mark "A" for True and "B" for False on the Scantron sheet.**

31) Compartmentalization of metabolites is a more important means of metabolic control in eukaryotes than in prokaryotes. (T) True (A) or False (B)?

32) Proteomics is an investigative approach that is used by researchers to assess protein levels and characteristics of post-translational modifications of proteins. (T) True (A) or False (B)?

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- 33) The hexokinase reaction is highly endergonic. **F** True (A) or False (B)?
- 34) The committing step in metabolic pathways is usually one that has a large positive free energy change. **F** True (A) or False (B)?
- 35) Substrate-level phosphorylation occurs when a highly exergonic reaction allows the transfer of a phosphate group to from a substrate to ADP, forming ATP. **T** True (A) or False (B)?
- 36) Fructose 1-phosphate, derived from dietary fructose, enters the glycolytic pathway by the action of the enzyme aldolase to produce dihydroxyacetone phosphate and glyceraldehyde 3-phosphate. **F** True (A) or False (B)?
- 37) In earlier times, hat makers often displayed strange behaviours, and were called "Mad Hatters"; eventually it was discovered that this was due in part to mercury-induced inhibition of glycogen phosphorylase. **F** True (A) or False (B)?
- 38) The multi-enzyme structural characteristics and overall function of pyruvate dehydrogenase are similar to those of alpha-ketoglutarate dehydrogenase. **T** True (A) or False (B)?
- ~~39) In rapidly proliferating cells, phosphoenolpyruvate transfers its phosphate group to phosphoglycerate mutase instead of ADP to produce pyruvate. **T** True (A) or False (B)?~~
- 40) Glycogenolysis in muscle results in the release of glucose into the blood. **F** True (A) or False (B)?
- 41) Liver glycogen phosphorylase is inhibited by insulin. **T** True (A) or False (B)?
- 42) The intramitochondrial concentrations of oxaloacetate are low (in relation to other TCA cycle metabolites). **T** True (A) or False (B)?
- 43) The only TCA cycle enzyme to be bound in the mitochondrial inner membrane is succinate dehydrogenase. **T** True (A) or False (B)?
- 44) Isocitrate dehydrogenase causes a decarboxylation of its substrate, isocitrate. **T** True (A) or False (B)?
- 45) Pyruvate carboxylase is an important cataplerotic reaction for the TCA cycle in liver. **F** True (A) or False (B)?
- 46) Glyoxysomes are not found in mammalian cells. **T** True (A) or False (B)?
- 47) *The synthesis of one molecule of ATP by ATP synthase occurs when one pair of protons move through the core of the protein from the mitochondrial intermembrane space into the matrix.* **F** True (A) or False (B)?
- 48) *The mitochondrial inner membrane has a negative charge on the matrix side of the membrane and a positive charge on the side of the intermembrane space.* **T** True (A) or False (B)?
- 49) *Cytochrome c is a small hydrophobic protein that moves through the mitochondrial inner membrane carrying electrons from complex I and complex II to complex III.* **F** True (A) or False (B)?

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50) Mitochondrial proton leak is responsible for up to 50% of resting energy expenditure of skeletal muscle. **T** True (A) or False (B)?

Fill in the blanks: Each of the blanks is worth one mark (20 marks total for this section). *Mark your answers on these pages.**

1) Because glucose 6-phosphate can proceed through either glycolysis or the PPP, the first true committing reaction of glycolysis catalyzes the production of fructose 1,6-bisphosphate by the enzyme _____ . **phosphofruktokinase-1**

2. In the preparatory phase of glycolysis, 2 molecule(s) of ATP is/are consumed, while in the pay-off phase, _____ (write in a number) molecule(s) of ATP is/are produced from each molecule of glyceraldehyde 3-phosphate. **2**

3. The anaerobic fermentation of pyruvate produces _____ **ethanol** in yeast and _____ **lactate** in vertebrates. In both cases, _____ **NAD⁺** is regenerated to allow glycolysis to continue

4. Lactate produced in hypoxic muscles is converted to glucose in the liver through a process known as _____ cycle. **Cori**

5. The consumption of fava beans causes haemolytic anemia in people suffering from a deficiency in the enzyme, _____ **glucose 6-phosphate dehydrogenase**. The reaction catalyzed by this enzyme produces _____ **NADPH** needed to reduce GSSG to 2GSH and prevent oxidative damage to red blood cells.

6. Draw the chemical structures of:

a) acetyl CoA:

b) citrate:

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c) lactate:

7. Citrate synthase catalyzes is one of the irreversible steps of the TCA cycle, another of the irreversible steps is catalyzed by the enzyme, _____. (either isocitrate dehydrogenase or alpha ketoglutarate dehydrogenase)

8. Name the enzyme in the TCA cycle that catalyzes the step producing GTP:
_____ (succinyl CoA synthetase)

7. When a chemical that causes uncoupling of oxidative phosphorylation is added to mitochondria, oxygen consumption is _____ (increased or decreased?); protonmotive force is _____ (increased or decreased?); and the components of the electron transport chain are in a _____ (reduced or oxidized ? either was accepted as correct) state.

8. Name the complex of the electron transport chain that pumps 2 (rather than 4) protons out of the mitochondrial matrix: _____ (cytochrome c oxidase)

9. Name the two shuttles that transport reducing equivalents from the cytosol to the mitochondrial electron transport chain: 1. The _____ shuttle, and 2. The _____ shuttle. (malate aspartate; glycerol 3-phosphate)

10. In bacteria ATP synthesis by chemiosmosis takes place in the _____
(name the location in the bacterial cell). (Cell membrane/Plasma membrane)

***** HAND IN THIS BOOKLET AND YOUR SCANTRON COMPUTER SHEET.**

DID YOU REMEMBER TO MARK ALL OF YOUR ANSWERS TO THE MULTIPLE CHOICE AND TRUE/FALSE QUESTIONS ON THE COMPUTER SHEET?