FACULTY OF SCIENCE

DEPARTMENT OF BIOCHEMISTRY

MODULE : BIC02B2/BIC 2B01

CAMPUS : APK

MAIN EXAM

DATE: 20 November 2019

SESSION: 8:30 - 11:30

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MODERATOR: PROF LESETJA R MOTADI

DURATION: 3 HOURS MARKS: 100

NUMBER OF PAGES: 14 PAGES

Please read the following instructions carefully

1. Answer all the questions.
2. Answer all the questions in the exam answer sheet/book provided.
3. Hand in the question paper and answer sheets/book.

Section A **[35 marks: 1 mark each]**

1. The ultimate source of energy that sustains living systems is
   a) Glucose
   b) Oxygen
   c) Sunlight
   d) Carbon dioxide
   e) All of the above are correct

2. Insulin
   a) Stimulates gluconeogenesis and glycolysis
   b) Stimulates gluconeogenesis and inhibits glycolysis
   c) Inhibits gluconeogenesis and glycolysis
   d) Inhibits gluconeogenesis and stimulates glycolysis
   e) All of the above are correct

3. The hormones, glucagon and epinephrine, stimulate glycogen breakdown to G-6-phosphate
   a) Only in the liver
   b) Using ATP as the phosphoryl donor
   c) Directly, by binding to glycogen phosphorylase
   d) Indirectly, by first stimulating adenylate cyclase to make cAMP
   e) Only in the brain

4. What is the cause of the genetic disease known as Galactosemia?
   a) Deficiency in lactase
   b) Absence of galactose 1-phosphate uridyl transferase
   c) Absence of lactose synthetase
   d) Non-functioning of semnase
   e) UDP-glucose 4-epimase

5. Plants are examples of
   a) Photoautotrophs, because they use CO_2 as their carbon source and obtain energy from oxidation-reduction reactions
   b) Photoautotrophs, because they can fix CO_2 and obtain energy from light

c) Photoautotrophs, because they use light as their carbon source and obtain energy from oxidation-reduction reactions

d) Photoheterotrophs, because they use CO_2 as their carbon source and obtain energy from light

e) Photoheterotrophs, because they use organic compounds as their carbon source and obtain energy from light

6. Consider the following reaction:

Fructose 6-phosphate ↔ glucose 6-phosphate Keq = 1.97 (at 25°C)

If the free energy change (ΔG) is -4.4 kJ/mol and the concentration of glucose 6-phosphate is adjusted to 500 mM, what would be the concentration of fructose-6-phosphate at 25°C? [R= 8.315 J/mol.K]

a) 1.5 M

b) 1.5 mM

c) 0.165 mM

d) 0.165 M

e) 0.33 M

7. Phosphatidyl inositol cleavage by a single phospholipase gives rise to 2 signaling components _____and _____.

a) Phosphatidic acid and diacyl glycerol

b) Diacyl glycerol and phophatidyl inositol

c) Diacyl glycerol and inositol tri-phosphate

d) ip_3 and glycerol

e) B and C

8. The phospholipase responsible for cleavage of a phosphatidyl inositol (to give rise to 2 signaling components) would be

a) Phospholipase A1

b) Phospholipase A2

c) Phospholipase C

d) Phospholipase D

e) Phospholipase B

Study Figure 1 below and answer questions 9-12

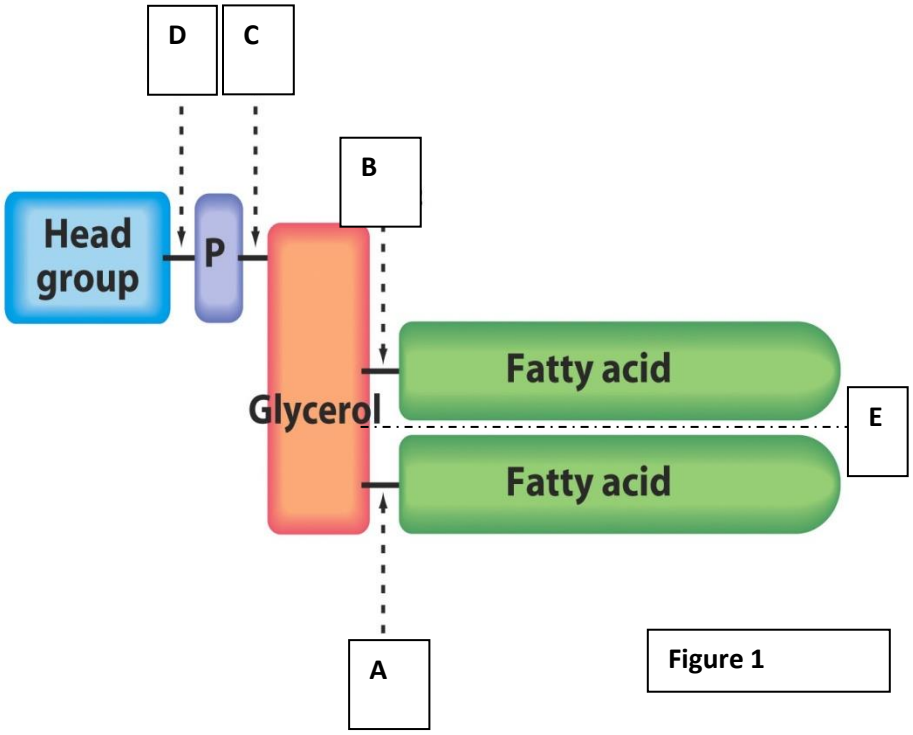


Figure 1

9. Phospholipase A1 is represented by
   a) A
   b) B
   c) C
   d) D
   e) E

10. Phospholipase A2 is represented by
   a) A
   b) B
   c) C
   d) D
   e) E

11. Phospholipase D is represented by
    a) A
    b) B
    c) C
    d) D
    e) E

12. Phospholipase C is represented by
    a) A
    b) B
    c) C
    d) D
    e) E

13. Arachidonic acid is released from a phospholipid by phospholipase
    a) Phospholipase A1
    b) Phospholipase A2
    c) Phospholipase C
    d) Phospholipase D
    e) Phospholipase B

14. What causes uptake of a ligand upon binding of a receptor?
    a) Clathrin assembly
    b) The pH change
    c) The transmembrane shape change in the receptor
    d) The shape change in the ligand
    e) Decrease in ion concentration

15. Hormone signaling from a distant cell is known as
    a) Autocrine signaling
    b) Paracrine signaling
    c) Endocrine signaling
    d) Intracrine signaling
    e) None of the above are correct

16. Adenylate cyclase can convert
    a) GTP to cGMP
    b) GTP to GDP
    c) GDP to GTP
    d) ATP to ADP
    e) ATP to cAMP

17. Protein kinase A (PKA) is activated by high levels of
    a) cAMP
    b) Adenylate cyclase
    c) GTP
    d) ATP
    e) Adenosyl transferase

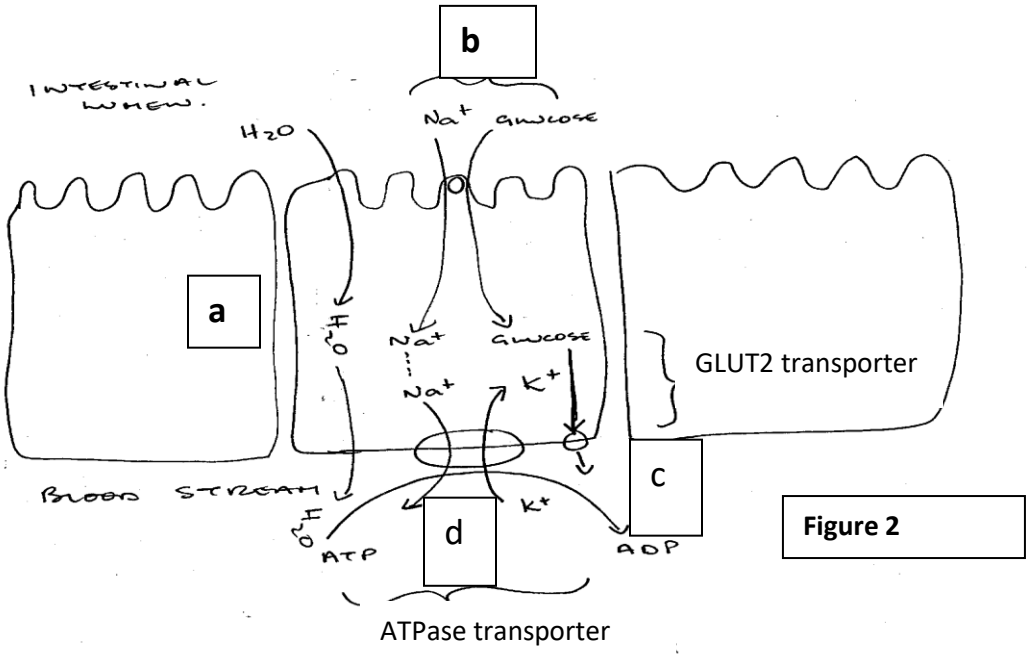


Figure 2

18. In the reaction scheme “a” above, why does water come into the cell?
    a) It is moving up a concentration gradient
    b) Due to osmosis
    c) Due to the blood stream movement below the cell
    d) Due to the lack of water inside the cell
    e) A and B are correct

19. How would you describe the transporter “b”
    a) Secondary active transporter
    b) Co-transporter
    c) Antiporter
    d) Passive transporter
    e) A and B

20. In the reaction scheme above, the Glut 2 transporter is a
    a) Passive transporter
    b) Secondary active co transporter
    c) Antiporter
    d) Secondary active transporter
    e) Synergistic activator

21. In signal transduction what is an effector enzyme?
    a) An integral membrane protein that changes conformation upon binding of a ligand to a cell surface receptor
    b) A small molecule that diffuses within a cell and carries a signal to its ultimate destination
    c) A protein, associated with the interior of a cell membrane via a lipid anchor, that generates a second messenger
    d) An enzyme, bound on the exterior surface of a cell that is a receptor site for a ligand
    e) An enzyme that generates energy

22. If the concentration of a solute is the same both inside and outside the cell, what might you expect with regard to its transport by an active membrane transport protein?
    a) Since there is no concentration gradient, no transport either in or out of the cell is possible
    b) Movement of the solute across the membrane could occur and cause accumulation on one side of the membrane
    c) The transport protein would have been saturated and no movement would occur
    d) The solute must be phosphorylated before further transport can occur
    e) Movement could not occur

23. The membrane transport protein Na^+-K^+ ATPase carries both Na^+ and K^+ ions across the plasma membrane. Typically this maintains the concentration of K^+ at inside the cell at about 30 times that in extracellular fluids. The concentration of Na^+ is maintained at a level about 20 times lower inside the cell than that outside the cell in extracellular fluids. Based on this information, which statement below is false?

a) The proper functioning of Na^+/K^+ ATPase could serve as an energy source for secondary active transport proteins
b) The pump is a symport
c) Transport of Na^+ and K^+ must be coupled to an exergonic reaction
d) Na^+/K^+ ATPase likely undergoes conformational changes during transport
e) The pump is an antiport pump

24. The toxins from cholera and whooping cough both interfere with the proper functioning of

a) G proteins
b) DNA polymerase
c) ATP synthesis
d) Protein kinase A
e) Protein synthesis

25. The transporter required for import of long chain fatty acids into the mitochondrion is called

a) Co-enzyme A
b) Carnitine
c) Aconitase
d) The pyruvate dehydrogenase complex
e) Acyl carrier protein (ACP)

26. Ketone bodies are produced due to

a) Starvation or prolonged fasting
b) Excessive breakdown of fatty acids
c) Diversion of acetyl-CoA by the liver
d) All of the above
e) None of the above

Use Figure 3 below, showing the mechanism for freeing fatty acids from fat tissue stores to answer questions 27-30

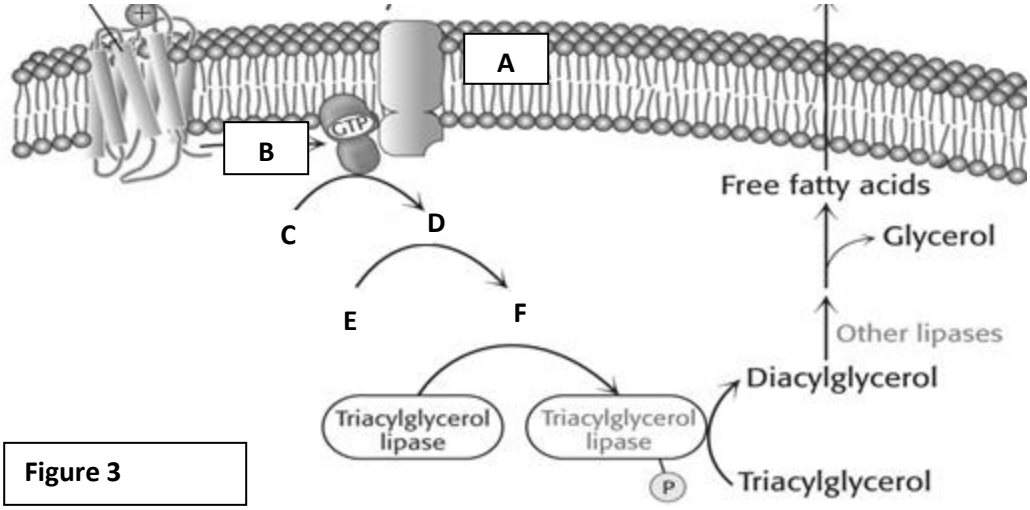


Figure 3

27. The protein labelled “A” is
    a) An ATP-dependent phosphorylating enzyme
    b) APD-ribosylating enzyme
    c) A G protein
    d) An adenylate cyclase enzyme
    e) An NADH-dependent enzyme

28. The protein labelled “B” is
    a) An ATP-dependent phosphorylating enzyme
    b) APD-ribosylating enzyme
    c) A G protein
    d) An adenylate cyclase enzyme
    e) An NADH dependant enzyme

29. C and D represent
    a) ATP and cAMP, respectively
    b) cAMP and ATP, respectively
    c) cAMP and PKA
    d) cGMP and GTP
    e) ADP and ATP

30. E and F represent

a) ATP and cAMP, respectively

b) cAMP and ATP, respectively

c) Inactive and active PKA, respectively

d) cGMP and GTP

e) ADP and ATP

Use the diagram below shows the conversion of glycerol to DHAP and GAP (Figure 6) to answer questions 31-34.

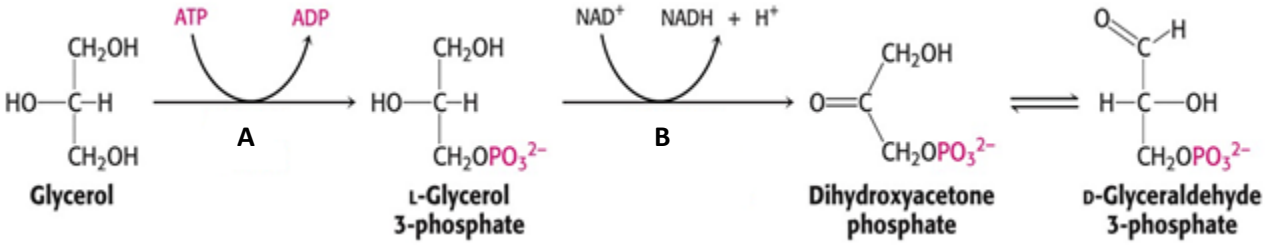


Figure 6

31. The enzyme labeled A is

a) Isomerase

b) Glycerol phosphate dehydrogenase

c) Glycerol kinase

d) Glycerol dehydrogenase

e) Glycerol phosphate isomerase

32. The enzyme labeled B is

a) Isomerase

b) Glycerol phosphate dehydrogenase

c) Glycerol kinase

d) Glycerol dehydrogenase

e) Glycerol phosphate isomerase

33. Acetyl units are shuttled
    a) Out of the mitochondrion into the cytoplasm via the malate shuttle
    b) Out of the mitochondrion into the cytoplasm via the citrate shuttle
    c) Into the cytoplasm from the mitochondrion as citrate
    d) Into the mitochondrion from the cytoplasm as pyruvate
    e) All of the above

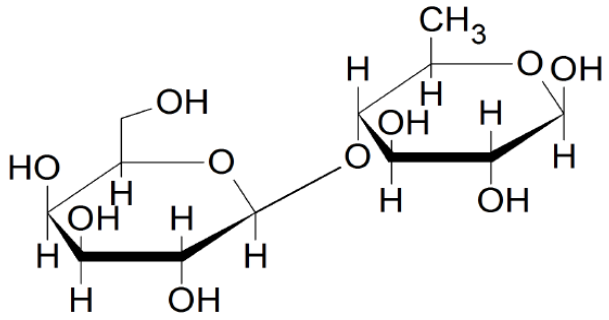
34. In the fatty acid synthase complex reaction the acyl carrier protein contains the vitamin
    a) Biotin
    b) Vitamin B12
    c) Pantothenic acid
    d) Niacin
    e) Adenosine

35. During lipid synthesis
    a) $FADH_2$, NADH and acetyl-SCoA are produced
    b) $FADH_2$, NADH are produced
    c) ATP and NAD are produced
    d) 2 NADP, CoA, CO_2, and water are produced
    e) 2 NADPH, $FADH_2$ and ATP are produced

NB: PLEASE HAND THIS PART OF THE QUESTION PAPER IN WITH YOUR MCQ ANSWER SHEET AND ANSWER BOOKS

SECTION B **[20 marks]**

1. Some people cannot digest the sugar lactose (lactose intolerant). Use the lactose molecule shown below to answer the following questions. **(5)**



a) What is the name of the enzyme that would catalyze lactose digestion? What type of reaction is catalyzed - hydration, redox, synthetic dehydration, hydrolysis, or isomerzation?

b) Classify lactose as a mono-, di-, oligo-, or polysaccharide/

c) Circle the anomeric carbon.

d) Point an arrow to the glycosidic bond and classify it using the alpha or beta-(#,#) format.

e) If the glycosidic bond was broken, what are the names of the products? Remember to include the alpha or beta designator for the anomeric carbons.

2. Eaten a meal full of polysaccharide in preparation of your exam. Show through different stages of catabolism how polysaccharides would be converted to ATP. Note: show major reactions, intermediate compounds and biochemical pathways. **(8)**

3. Pyruvate can undergo different processes depending upon the conditions it can be found in.

   a) What happens to pyruvate when there is no oxygen to draw upon? **(1)**

   b) What happens when there is oxygen available or which of these two does not generate something that can proceed to the next stage of metabolism? **(1)**

4. The catabolism of maltose can be divided into 3 stages.

   a) What is the end product of the first stage? **(2)**

   b) What is the end product of the second stage? **(1)**

   c) What is the name of the biochemical cycle that begins the third stage? **(2)**

SECTION C **[19 marks]**

1. During catabolism of triglyceride into ATP. What are the major reactions/stages intermediate compounds formed, and biochemical pathways that occur? **(5)**

2. Explain the process for the body obtaining fatty acids from our diets. What molecules are responsible for delivering fatty acids into the body? Are fatty acids ever consumed directly or only as part of large biomolecules? **(2)**

3. Explain why lipoproteins are needed to transport triglycerides in aqueous body fluids. Name the five major lipoproteins, their similarities and differences. **(5)**

4. How many steps are involved in beta-oxidation? What type of reaction does each step entail? Are any of them more frequent than others? **(2)**

5. Match each of the following: **(5)**

Column A	**Column B**
1. Asparagine is degraded to this compound.	Acetyl-CoA
2. Serine is degraded to this compound.	Succinyl-CoA
3. Glucogenic degradation of phenylalanine leads to this compound.	Fumarate
4. Valine is degraded to this compound.	Oxaloacetate
5. Ketogenic degradation of phenylalanine leads to this compound.	Acetoacetate

SECTION D **[26 marks]**

1. The body requires reactions that both build up smaller molecules into larger ones and break down larger ones into smaller ones. Which of the two processes is called anabolic, and which is called catabolic? **(2)**

2. From start to finish, how many molecules of NADH and $FADH_2$ are produced in the Citric acid circle? **(2)**

3. What particular two steps are responsible for releasing CO_2? What is the name of the reaction that releases these molecules from their parent molecules? **(2)**

4. Compare and contrast the characteristics and functions of coenzyme Q (ubiquinone) and cytochrome c. Feel free to use diagrams, although explanations in text should accompany them. **(10)**

5. Since both glycolysis and gluconeogenesis are irreversible, there is no thermodynamic barrier to their simultaneous operation.
   a) We know that gluconeogenesis is not simply a reversal of glycolysis. Why is this so? In your explanation be sure to mention at least two of the important steps and the enzymes involved **(6)**
   b) What would the result be if both pathways were operating simultaneously and at the same rate? **(4)**