FACULTY OF SCIENCE

DEPARTMENT OF BIOCHEMISTRY

MODULE : BIC02B2/BIC 2B01

CAMPUS : APK

MAIN EXAM

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SESSION: 8:00 - 11:00

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DURATION: 3 HOURS	MARKS: 160

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

1. An animal and plant are from the north pole. Which statement would be true about their component lipids for them to survive the cold temperatures?

a) the animal would need fewer saturated fatty acids than the plant
b) the animal would need more unsaturated fatty acids than the plant
c) the plant would need more unsaturated fatty acids than the animal
d) the plant would need fewer unsaturated fatty acids than the animal
e) the plant would need more saturated fatty acids than the animal

2. Which lipid may act like a soap?

a) sodium stearate
b) sodium cholate
c) phosphatidyl choline
d) all of the above
e) none of the above

3. Which of the following are derivatives of cholesterol?

a) sodium taurocholate.
b) sodium deoxycholic acid
c) oestrogen
d) vitamin D
e) all of the above

4. A lipid is largely hydrophilic if

a) its charge to hydrophobicity ratio is low.
b) its hydrophilicity to hydrophobicity ratio is low
c) its charge to hydrophobicity ratio is high
d) polarity to nonpolarity ratio is low
e) it is esterified

5. The major cytoskeletal protein responsible for movement of vesicles around the cell cytoskeleton.

a) tubulin
b) actin
c) microfilaments
d) none of the above
e) all of the above

6. Phosphatidyl inositol cleavage by a single phospholipase gives rise to 2 signalling 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

7. 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 8-11

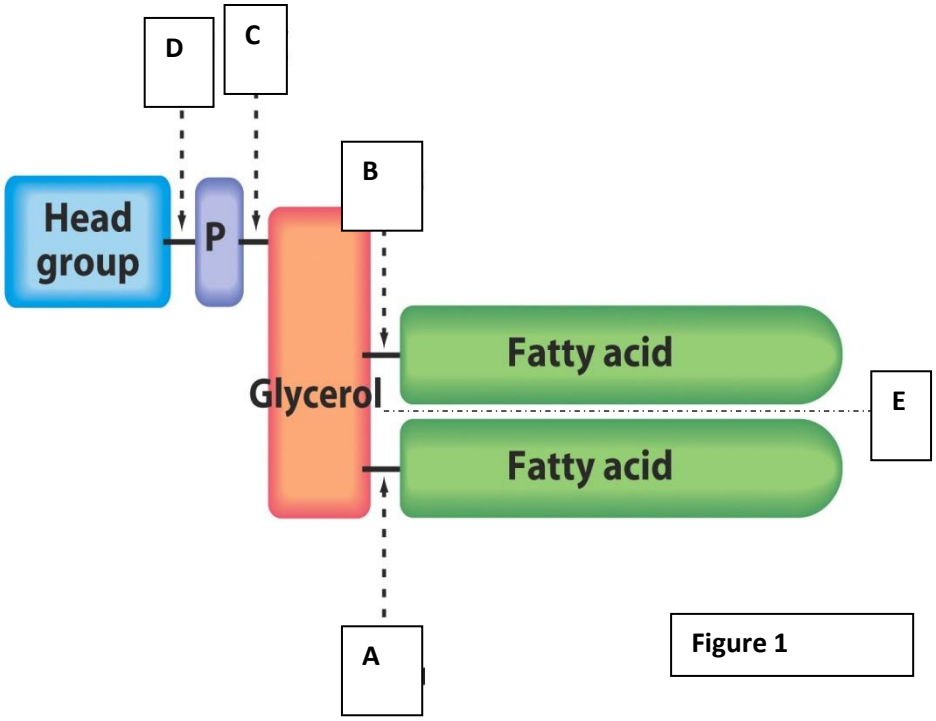

Figure 1

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

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

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

11. Phospholipase C is represented by
a) A
b) B

c) C
d) D
e) E

12. Arachidonic acid is a precursor from which _____are synthesised.
a) leukotrines
b) thromboxanes
c) prostaglandins
d) prostacyclins
e) all of the above

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. The major lipids enriched in nerve endings are
a) cerebrosides
b) sphingomyelins
c) gangliosides
d) all of the above
e) none of the above

15. The following are soap derivatives of cholesterol
a) cholic acid
b) sodium taurocholate
c) sodium deoxycholic acid
d) all of the above
e) none of the above

16. _____ acts like a soap
a) phosphatidyl serine
b) phosphatidyl inositol
c) phosphatidyl choline
d) phosphatidyl-4,5-bisphosphate
e) diacylglycerol

17. What determines which tissue a virus will infect a cell?
a) the haemagglutin on the viral particle surface
b) the sugars on the surface of mammalian cells
c) sphingolipids
d) A and B
E) proteins in the surface of mammalian cells

18. 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

19. Movement through a secondary active ion channel requires

a) a pre-existing gradient
b) a gradient produced by another active transport channel
c) no gradient
d) a change in pH
e) a change in osmolarity

20. Movement of glucose in the gut into gut cells requires

a) a pre-existing gradient
b) a gradient produced by another active transport channel
c) sodium ion cotransport
d) all of the above
e) potassium

21. Hormone signalling from a neighbouring cell is known as

a) autocrine signalling
b) paracrine signalling
c) endocrine signalling
d) intracrine signalling
e) none of the above are correct

22. Hormone signalling from a distant cell is known as

a) autocrine signalling
b) paracrine signalling
c) endocrine signalling
d) intracrine signalling
e) none of the above are correct

23. Hydrophilic signalling molecules

a) pass straight through a membrane
b) bind a cytoplasmic receptor
c) require signal transduction
d) require an ion gradient
e) are dependent on pH

24. G proteins may directly activate

a) phospholipase C
b) adenylate cyclase
c) cAMP
d) ion channels
e) A and B are correct

25. G proteins are inactivated by binding

a) cAMP
b) GTP
c) GDP
d) ADP
e) ATP

26. Adenylate cyclase can convert

a) GTP to cGMP
b) GTP to GDP
c) GDP to GTP
d) ATP to ADP
e) ATP to cAMP

27. Cholera toxin

a) a domain removes nicotinic acid from ATP and adds it to the alpha subunit of GTP
b) b domain removes nicotinic acid from ATP and adds it to the alpha subunit of GTP
c) a domain removes ADP ribosyl group from ATP and adds it to the alpha subunit of GTP
d) a domain removes the ribosyl group from ATP and adds it to the alpha subunit of GTP
e) none of the above

28. Hydrophilic hormones are

a) testosterone, oestrogen, and insulin
b) insulin, glucagon and vitamin D
c) testosterone, oestrogen, progesterone and vitamin E
d) insulin, glucagon and human gonadotrophin hormone
e) adrenaline, vitamin A, aldosterone

29. Phospholipase C signals by

a) arachidonic acid
b) release of phosphatidyl choline
c) cleavage of phosphatidyl inositol
d) cleavage of phosphatidyl serine
e) none of the above are correct

30. Stearic acid released by phospholipase _____activates glycogen synthase.

a) phospholipase A2
b) phospholipase A1
c) phospholipase C
d) phospholipase D
e) phospholipase E

31. Aspirin/Disprin is an inhibitor of

a) inositol tri-phosphate
b) prostaglandin synthesis
c) eicosanoid synthesis
d) leukotrines
e) glycosides

32. Cholera toxin inhibits the

a) the production of cAMP
b) the activation of adenylate cyclase
c) inactivation of a G protein
d) cleavage of phosphatidyl serine
e) none of the above are correct

33. The A domain of cholera toxin is a

a) lectin

b) adenylate cyclase
c) ADP ribosylase
d) GTPase
e) adenosyl transferase

34. Protein kinase A (PKA) is activated by high levels of

a) cAMP
b) adenylate cyclase
c) GTP
d) ATP
e) adenosyl transferase

35. Why would snake venoms that contain phospholipase A2 result in the lysis of red blood cells?

a) because of action on ion pumps
b) because of bilayer would become unstable
c) because of an osmotic effect
d) because diacylglycerol is produced
e) because the membrane would become weak

36. The A, B, O blood group antigen is assembled on

a) a phospholipid
b) a sphingolipid
c) a glycerol backbone
d) a phosphatidic acid backbone
e) none of the above are correct

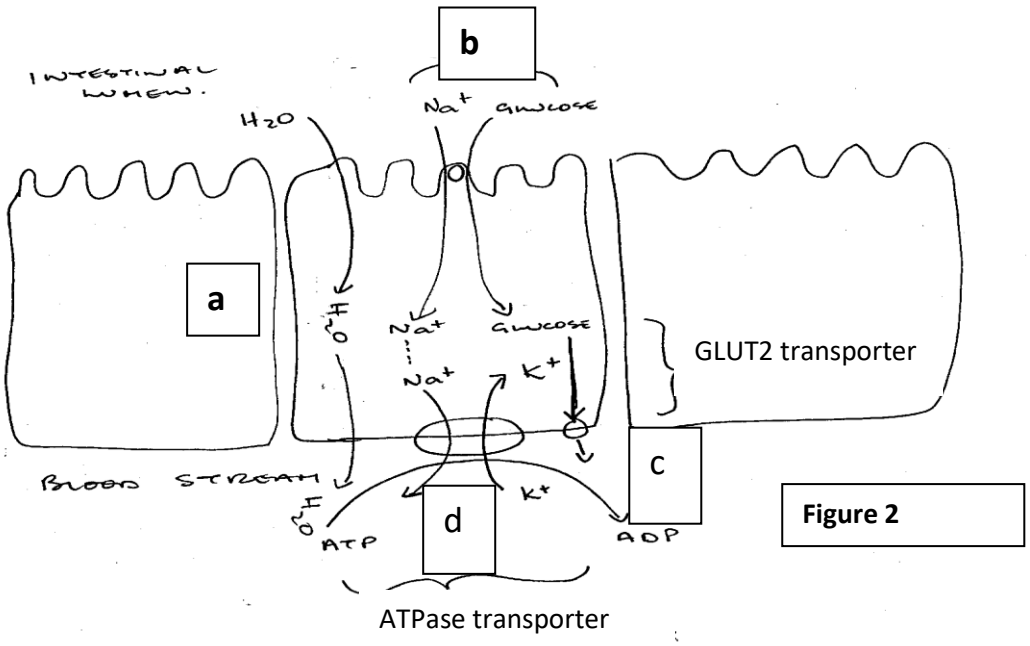

Figure 2

37. 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

38. How would you describe the transporter "b"

a) secondary active transporter
b) co-transporter
c) antiporter
d) passive transporter
e) a and b

39. 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

40. 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

41. Another name for facilitated diffusion is

a) active transport
b) non-selective diffusion
c) lateral diffusion
d) passive transport
e) non-selective transport

42. Facilitated diffusion through a biological membrane is

a) generally irreversible
b) driven by the ATP to ADP conversion
c) driven by a concentration gradient
d) endergonic
e) amphipathic

43. In neutrotransmission (signaling via nerve endings) the impulse generated is

a) produced by charge depolarisation
b) driven by the ATP to ADP conversion
c) driven by a concentration gradient
d) endergonic
e) Both (a) and (c) are corect

44. 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

45. 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

46. Which of the following directly drives secondary active transport of an ion across a membrane through a secondary active transporter?

a) Light
b) the generated ion concentration gradient
c) electron transport
d) the conversion of ATP → ADP
e) an antiport ion

47. Which statement is not true about G proteins?

a) They are integral membrane proteins
b) They are multi-subunit proteins consisting of α, β and γ subunits
c) They are activated by exchanging GDP for GTP
d) They act as transducers for hydrophilic signalling hormones
e) They are farnesylated proteins

48. 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

49. Match the description "paracrine signal transduction" to the signalling transduction descriptions below:

a) signal to neighboring cells
b) signal to self
c) signal to distant organ cells
d) signalling to the pituitary from the adrenal gland
e) signal to the thyroid from the adrenal gland

50. Tetanus toxin has an enzyme component that is an/a

a) ATP-dependent phosphorylating enzyme

b) APD-ribosylating enzyme
c) pore-forming toxin
d) fusion-protein cleavaging enzyme
e) guanylate cyclase

51. 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)

52. 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

53. Ketone bodies

a) replace glucose as a major energy source during starvation
b) replace amino acids as a major energy source during starvation
c) examples are acetoacetate, acetone and 3-hydroxybutyrate
d) All of the above
e) Only a) and b)

Study Figure 3 below and answer questions 54-56

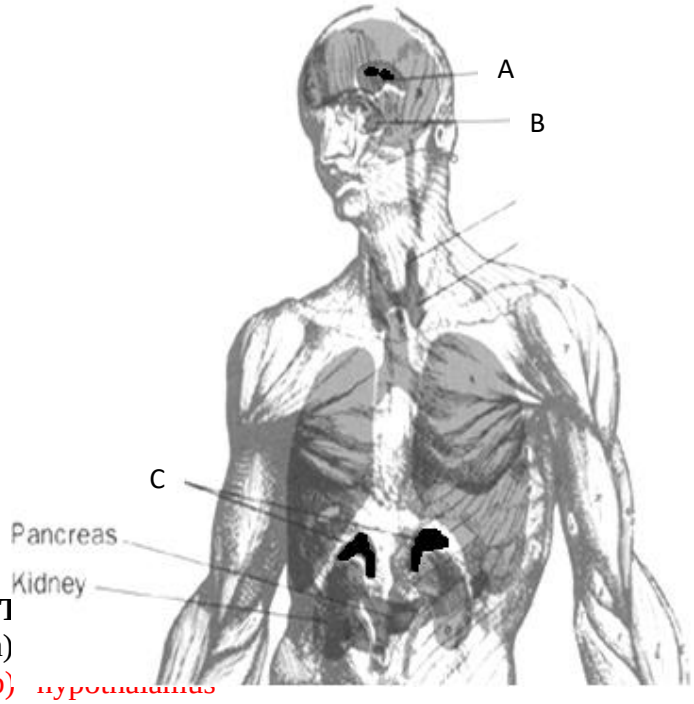

Figure 3

54. T

a)
b) hypothalamus
c) adrenal gland
d) parathyroid
e) thyroid

55. The hormone-secreting gland labelled B is

a) pituary
b) hypothalamus
c) adrenal gland
d) parathyroid
e) thyroid

56. The hormone-secreting gland labelled C is

a) pituary
b) hypothalamus
c) adrenal gland
d) parathyroid
e) thyroid

Use Figure 4 below, showing the mechanism for freeing fatty acids from fat tissue stores to answer questions 99-102

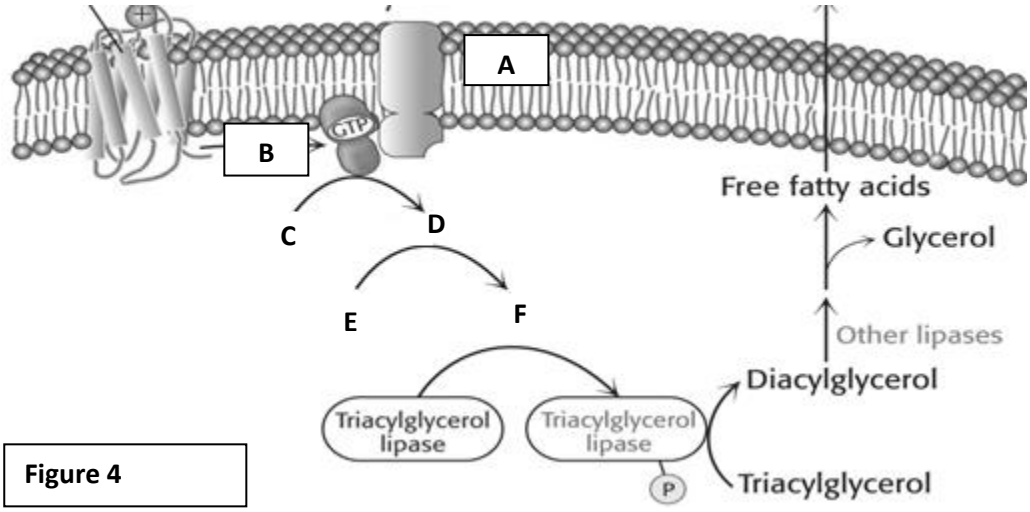

Figure 4

57. 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

58. 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

59. 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

60. 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

61. Breakdown of fatty acids (beta-oxidation) in the cell occurs

a) in the cytoplasm and requires the action of PKA
b) in the mitochondrial inner membrane and requires an aconitase enzyme
c) in the mitochondrial matrix and requires an aconitase enzyme
d) in the mitochondrial matrix and requires an acyl carnitine transport
e) in the smooth ER

Use following diagram of the low density lipoprotein (LDL) particle (Figure 5) to answer questions 62-65.

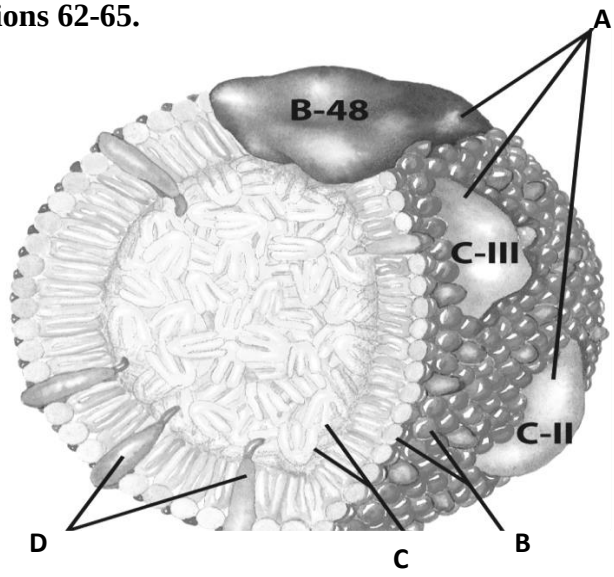

Figure 5

62. Component A represents:

a) cholesteryl esters and triacylglycerols
b) alipoproteins
c) phospholipids
d) cholesterol
e) diacylglycerol

63. Component B represents

a) cholesteryl esters and triacylglycerols
b) alipoproteins
c) phospholipids
d) cholesterol

e) diacylglycerol

64. Component C represents

a) cholesteryl esters and triacylglycerols
b) alipoproteins
c) phospholipids
d) cholesterol
e) diacylglycerol

65. Component D represents

a) cholesteryl esters and triacylglycerols
b) alipoproteins
c) phospholipids
d) cholesterol
e) diacylglycerol

66. 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

Use the diagram below shows the conversion of glycerol to DHAP and GAP (Figure 6) to answer questions 67 and 68.

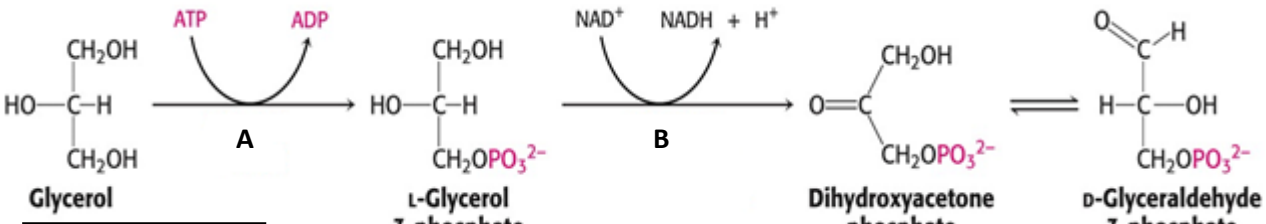

Figure 6

67. The enzyme labeled A is

a) isomerase
b) glycerol phosphate dehydrogenase
c) glycerol kinase
d) glycerol dehydrogenase
e) glycerol phosphate isomerase

68. The enzyme labeled B is

a) isomerase
b) glycerol phosphate dehydrogenase
c) glycerol kinase
d) glycerol dehydrogenase
e) glycerol phosphate isomerase

69. Conversion of odd numbered propionyl fatty acids to succinyl CoA require the presence of two vitamins

a) biotin and vitamin B12
b) vitamin B1 and B12
c) B3 and B6
d) B6 and B12
e) E and K

70. 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

SECTION B:
Please note: Complete this section in your answer book.
CANDIDATES ARE REQUESTED, IN THEIR OWN INTERESTS, TO WRITE LEGIBLY

1. **Five sucrose molecules undergo hydrolysis by sucrose phosphorylase, and the products of the reaction undergo aerobic respiration in a brain cell.**

   a) **Show the net reaction of the sucrose hydrolysis. (3)**

   5 Sucrose + 5P_i *(1)* → 5 Glucose-1-phosphate *(1)* + 5 Fructose *(1)*

   b) **Use the table below to show the net ATP production of all the hydrolysis products of the five sucrose molecules (from question 1a above) from substrate-level phosphorylation during the different stages of aerobic respiration (8)**

	Show the hydrolysis products below [from your answer to Question 1a) above]	
	Hydrolysis product(s) 1: **5 Glucose-1-phosphate *(0.5)***	Hydrolysis product(s) 2: **5 Fructose *(0.5)***
Glycolysis	3 x 5 = 15 ***(1)***	2 x 5 = 10 ***(1)***
Pyruvate dehydrogenation step	-	-
Citric acid cycle	2 x 5 = 10 ***(1)***	2 x 5 = 10 ***(1)***
Total ATP molecules	**25 *(0.5)***	**21 *(0.5)***

2. **Acetyl-CoA carboxylase catalyzes the first committed step in the biosynthesis of fatty acids.**

   A. Name two allosteric regulators of acetyl-CoA carboxylase. Indicate for each whether it is a stimulator or inhibitor of the enzyme. (4)
   Stimulator: Citrate
   Inhibitor: AMP OR Palmitoyl-CoA
   (Any two of these 3 answers)

   B. Name two hormone regulators of acetyl-CoA carboxylase. Indicate for each whether action of the hormone results in stimulation or inhibition of the enzyme. (4)
   Stimulator: Insulin
   Inhibitor: Glucagon OR Epinephrine (adrenaline)
   (Any two of these 3 answers)

3. The citric acid cycle is frequently described as the major pathway of aerobic catabolism, which means that it is an oxygen-dependent degradative process. However,

none of the reactions of the cycle directly involves oxygen as a reactant. Why is the pathway oxygen-dependent? (4)

The citric acid cycle produces NADH. If this NADH is not reoxidized via the electron transport chain, the citric acid cycle will come to a stop, by feedback inhibition (or because NAD+ is a required substrate for several reactions). Oxygen is consumed by the re-oxidation of NADH.

4. Compound X is an inhibitor of mitochondrial ATP synthesis. It was observed that when compound X was added to cells, the NAD+/NADH ratio decreased. Would you expect X to be an uncoupling agent or an inhibitor of respiratory electron transfer? Explain in 30 words or less. (4)

It is an inhibitor of electron transfer; its addition lowers the NAD^+/NADH ratio because NADH produced by oxidative reactions in mitochondria can no longer be reoxidized by electron flow to O_2.

5. Name the three ketone bodies, and why are they important in metabolism? (5)

The three ketone bodies are acetone, acetoacetate and β-hydroxybutyrate.
They are water soluble reduced carbon compounds that can be transported in the circulation (blood) and cross the blood/brain barrier. Their concentration increases under conditions of (extreme) glucose starvation.

6.What is the final sugar of pentose phosphate pathway and why is it such an essential intermediate? (4)

The final sugar is ribulose 5-phosphate which is converted to ribose 5-phosphate, required in nucleic acid biosynthesis.

7.Briefly discuss the fate of pyruvate under different metabolic conditions (5)

Pyruvate has a few main fates. Pyruvate can be converted to alanine. Alternatively, pyruvate can be converted to oxaloacetate, either as part of gluconeogenesis or for other biosynthetic purposes, or it can be converted to acetyl -CoA. In animals, the conversion of pyruvate to acetyl-CoA is irreversible, and produces a compound that has fewer physiological uses. Pyruvate can also be converted to lactate under anaerobic conditions in vigorously exercising muscles.

8.Briefly explain the "Cori" cycle and why your body would undergo this particular cycle (6)

The Cori Cycle is the cycling of Lactate produced by red blood cells during anaerobic respiration in the muscles back into glucose **(1).** The Cori Cycle is undergone when a muscle reverts to anaerobic glycolysis to quickly produce an abundance of ATP because the muscle requires a burst of energy for short, strenuous movements **(1)**.

The lactate produced by the anaerobic glycolysis is cycled into the liver through the blood **(1)**. In the liver it is converted to pyruvate by lactate dehydrogenase **(1)**. The pyruvate is

then cycled back into glucose by glycogenesis and recycled back into the blood for use by red blood cells and muscles **(1)**.

The Cori Cycle is significant two fold; it is necessary to prevent lactic acidosis and in the conservation of oxygen's being carried by erythrocytes (red blood cells). Because erythrocytes do not contain mitochondria, any aerobic respiration they would undertake would require the use of the oxygen they are transporting, which would negate the transport **(1).**

9. Explain the relationship between the light and dark reactions. (5)

Photosynthesis is a process in which electrons from excited chlorophyll molecules are passed through a series of acceptors that convert electronic energy to chemical energy

***Photosynthesis occurs in 2 phases*:**

Light reaction (thylakoid membrane) = light energy used to generate NADPH & ATP.

$$H_2O + CO_2 \rightarrow (CH_2O) + O_2$$

Dark reaction (stroma) = light-independent, uses NADPH & ATP to drive the synthesis of carbohydrates from CO_2 & H_2O.

10. How many isomerization reactions occur in glycolysis. Name the enzymes that catalyze these reactions (3)

Three isomerization reactions, phosphoglucose isomerase, triose phosphate isomerase and phosphoglycerate mutase.

11. What is the impact/effect on the glycolytic pathway if glucose-6-phospate is used as the starting intermediate for pentose phosphate pathway? Explain in detail (2)

Glucose -6-phosphate is funnelled out of glycolysis and enters PPP. This results in a decrease in levels of G-6-P (i.e. not an accumulation), so does never accumulate to such levels that it will inhibit HK (hexokinase). So although HK functions far form equilibrium (and 1st committed step of glycolysis), it is not the NB enzyme regulated (this is PFK).

12. List the three enzymes required for the breakdown of glycogen and the three enzyme required for glycogen synthesis (6)

Glycogen phosphorylase (Formation of glucose-1-phosphate (G1P) □

GLYCOGEN(n) + Pi □ GLYCOGEN(n-1) + G1P

Glycogen Debranching Enzyme

Removes branches (allows further functioning of phosphorylase)

Enzyme: = □(1□4) transglycosilase (glycosyl transferase)

= transfer of □(1□4) linked trisaccharides to a non-reducing end of branch point.

Phosphglucomutase (PGM) converts G-1-P to G-6-P

13. Summarize the role of insulin, glucagon and epinephrine (adrenaline) in maintaining glucose homeostasis (Hint: glycolysis, gluconeogenesis and glycogen metabolism). (3x5=15)

Adrenaline (epinephrine) & nor-adrenaline

- Produced by adrenal glands
- Defined as catecholamines
- Deals with emergencies, i.e. cold, exercise, exposure, flight/fright, hypoglycemia
- Insulin leads to release of adrenaline BUT adrenaline can suppress insulin secretion & stimulate glucagon secretion.
- Adrenaline binds to plasma-membrane receptor (□ or □), increases adenylate cyclase (membrane-bound enzyme), increases [cAMP]
- Catecholamines = catabolic functions (oppose anabolic role of insulin & reinforces function of glucagon)
- Catecholamines = make glucose supplies & free fatty acids.
- Adrenaline promotes glucose glycogenolysis (glycogen □ glucose) in muscle & liver, = increases blood glucose levels & increases lactic acid formation in muscle (accompanied by increased O2 consumption) & increased lipolysis.
- Adrenaline will augment blood flow to heart, brain & muscle.

Insulin

- Secreted by □-cells of pancreas (islets of Langerhans)
- Classified as polypeptide hormone
- Targets muscle, liver, adipose cells
- Utilizes CH (carbohydrates): increases energy reserves via glycogen & lipid formation (lipogenesis) (=anabolic actions), stimulates protein synthesis & storage.
- Opposes action of glucagon (antagonistic effects)
- Insulin increases: glycolytic enzymes: glucokinase, PFK, pyr. kinase, glycogen synthase (glycogenic enzyme)
- Insulin decreases: gluconeogenic enzymes; glycogen phosphorylase; decreases adenylate cyclase.

Glucagon

- Secreted by □-cells of pancreas (islets of Langerhans)
- Classified as polypeptide hormone

- Targets liver & adipose tissue
- Promotes glycogenolysis (glycogen breakdown); release of lipids & breakdown of tri-acyl glycerols; proteolysis; fatty acid oxidation, ketogenesis
- Catabolic actions

14.What are the functions of the following compounds during lipid digestion, absorption, transport and oxidation:

a) Albumin (1)

Transports through the bloodstream free fatty acids released from adipose tissue stores.

b) Chylomicrons (1)

Transports lipid digestion products through lymphatic system and then the bloodstream to the tissues

c) Carnitine (1)

Since beta-oxidation occurs in mitochondrial matrix, the acyl groups are transferred to carnitine by carnitine palmitoyl transferase I because the acyl-CoA derivative cannot cross inner mitochondrial membrane.

d) Acyl-CoA dehydrogenase (1)

This enzyme catalyzes the formation of a trans-2,3 (α,β) double bond. The enzyme's bound FAD is thus reduced to $FADH_2$.

e) Enoyl-CoA isomerase (2)

When a cis-3,4 double bond is encountered during oxidation of POLY-UNSATURATED FA, this enzyme coverts it to a trans-2,3 double bond.

f) Acyl-CoA synthetase (1)

Before being degraded by oxidation, fatty acids are first activated by the formation of an acyl-CoA in an ATP-dependent reaction catalyzed by thiokinase AKA acyl-CoA synthetase (process AKA "priming")

15. Match each of the following: (5)

Column A	Column B
1. Asparagine is degraded to this compound. [Oxaloacetate]	Acetyl-CoA **(1)**
2. Serine is degraded to this compound.[Pyruvate]	Succinyl-CoA **(1)**
3. Glucogenic degradation of phenylalanine leads to this compound.[Fumarate]	Fumarate **(1)**
4. Valine is degraded to this compound.[Succinyl-CoA]	Oxaloacetate **(1)**

5. Ketogenic degradation of phenylalanine leads to this compound.[Acetoacetate]	Acetoacetate **(1)**