

- 1) The digestion and absorption of carbohydrates happens in many locations and involves many different enzymes. Which of the following statements is true regarding the digestion and absorption of carbohydrates?
- A) Most long chain carbohydrates are broken down in the stomach
 - B) The mucosal cells of the intestines express the salivary amylases necessary to break down starches
 - C) Absorption of fructose requires a Na^+/K^+ ATPase
 - D) Galactose and glucose use the same route of uptake into the enterocytes
 - E) People who cannot digest milk sugar lack the enzyme sucrase.
- 2) The 11 steps of anaerobic glycolysis include the lactate dehydrogenase reaction. Which of the following correctly describes this reaction or its significance to the overall process of glucose breakdown?
- A) It is necessary to generate NAD^+ from NADH to keep glyceraldehyde 3-P dehydrogenase (GAPDH) active
 - B) It converts phosphoenolpyruvate to lactate
 - C) During strenuous exercise, the product is exported from the liver in the Cori cycle
 - D) It catalyzes an essentially irreversible reaction
 - E) The reaction takes place in the matrix of the mitochondria
- 3) A patient is suffering from a metabolic disorder in which his glucokinase has a greatly diminished V_{max} such that its value is similar to that of his normal hexokinase. What would be one evident symptom for this patient?
- A) Will be hypoglycemic during times of starvation
 - B) Will be hyperglycemic after eating a baked potato with M&Ms on top
 - C) Will be hypoglycemic after eating a baked potato with M&Ms on top
 - D) Will be hyperglycemic during times of starvation
 - E) The disorder will not affect his ability to maintain normal blood sugar following a meal.
- 4) Following a carbohydrate rich meal, which of the following would correctly describe the metabolic state of your cells?
- A) The pyruvate dehydrogenase (PDH) complex would be phosphorylated and inactive
 - B) Glycogen phosphorylase would be phosphorylated and inactive
 - C) Fructose 2,6-bisphosphate will be increased and fructose 1,6-bisphosphatase (FBP1) will be inactive
 - D) Pyruvate carboxylase will be active
 - E) The TCA (tricarboxylic acid cycle) enzyme malate dehydrogenase will favor the production of malate
- 5) A patient with a severe deficiency in the erythrocyte isozyme of glucose 6-phosphate dehydrogenase has all of the following clinical/biochemical manifestations **except**?
- A) Prone to hemolytic anemia following treatment with oxidative drugs such as antimalarials
 - B) Increased levels of reduced glutathione will be found in the red blood cells
 - C) Partially protected against the malaria parasite due to weakened red blood cells
 - D) Decreased levels of 6-phosphogluconolactone in the red blood cells
 - E) Elevated levels of serum bilirubin on oxidant challenge

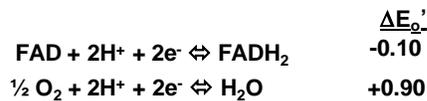
6) One enzyme of the glycolytic pathway is regulated by feed forward activation. Which of the following pairs listed below gives the correct enzyme and the regulatory intermediate?

<u>Enzyme</u>	<u>Intermediate</u>
A) phosphofructokinase	glucose 6-phosphate
B) hexokinase	2-phosphoglycerate
C) pyruvate kinase	fructose 1,6-bisphosphate
D) phosphoglycerate kinase	fructose 2,6-bisphosphate
E) glyceraldehyde 3-phosphate dehydrogenase	fructose 6-phosphate

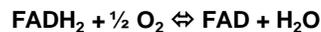
7) A patient was poisoned with antimycin, what would you expect to find if you could isolate their mitochondria and assay them for their response to 2,4-dinitrophenol (2,4-DNP) and their pools of cofactors?

<u>Response to 2,4-DNP</u>	<u>Cofactors</u>
A) Oxygen consumption restored	Increased QH ₂
B) Oxygen consumption restored	Increased reduced cytochrome C
C) Oxygen consumption unchanged	Increased NADH
D) Oxygen consumption unchanged	Increased QH ₂
E) Oxygen consumption unchanged	Increased reduced cytochrome C

8) Given the following half reactions:



What would be the standard state free energy of the following reaction if $\Delta G^{\circ} = -nF\Delta E_o'$ ($F = 23 \text{ kcal/volt mole e}^-$):



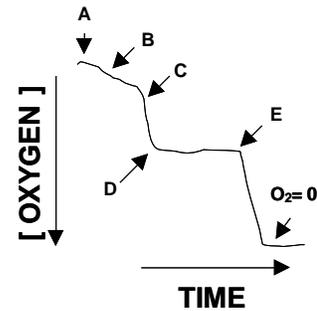
- A) -46 kcal/mole
- B) +36.8 kcal/mole
- C) -23 kcal/mole
- D) -36.8 kcal/mole
- E) + 46 kcal/mol

9) A patient with a mitochondrial defect is brought into the clinic. You quickly deduced that her mitochondria are not producing as much NADH as a normal person suggesting a defect in the TCA (tricarboxylic acid cycle) cycle. Upon further evaluation, you determine her mitochondria have an excess succinyl CoA and a deficiency in GTP. Which of her TCA enzymes is most likely to be defective?

- A) α -Ketoglutarate dehydrogenase
- B) Citrate synthase
- C) Fumarase
- D) Succinate dehydrogenase
- E) Succinate thiokinase

The next two questions refer to the graph on the right

10) The respiratory control ratio (RCR) can be used to assess “coupled” mitochondria. Given the representative RCR oxygen consumption graph and assuming all required substrates are added at time = 0, which position on the graph (labeled A – E) represents the point at which ADP = 0?



11) On the RCR oxygen consumption graph, if the positions labeled “D” and “E” represent the points at which mitochondrial poisons are added, which of the following best describes which ones they would be?
(2,4-DNP = 2,4-dinitrophenol)

- | | <u>“D”</u> | <u>“E”</u> |
|----|------------|------------|
| A) | 2,4-DNP | oligomycin |
| B) | antimycin | 2,4-DNP |
| C) | oligomycin | 2,4-DNP |
| D) | 2,4-DNP | Cyanide |
| E) | Azide | 2,4 DNP |

12) You have completely exhausted your glycogen stores. After eating a carbohydrate rich meal, all of the following are required to replenish your glycogen supply **except**:

- A) The protein primer glycogenin
- B) Glycogen phosphorylase
- C) Branching enzyme
- D) UDP-glucose pyrophosphorylase
- E) Nucleotide diphosphokinase

13) A red blood cell (RBC) requires a constant supply of NADPH and energy from the glucose entering the cell. Which of the following lists three enzymes necessary to meet the RBC’s needs?

- A) Hexokinase, transketolase, fructose 1,6-bisphosphatase
- B) Glucose 6-phosphate dehydrogenase, pyruvate carboxylase, phosphoglycerate kinase
- C) Phosphoglycerate mutase, transaldolase, phosphoenolpyruvate carboxykinase
- D) Phosphoglucomutase, glucose 6-phosphate dehydrogenase, glyceraldehyde 3-phosphate dehydrogenase
- E) Glucose 6-phosphate dehydrogenase, 6-phosphogluconate dehydrogenase, phosphoglycerate kinase

14) The term substrate level phosphorylation applies to which glycolytic reactions?

- A) Enolase and pyruvate kinase
- B) Glyceraldehyde 3-phosphate dehydrogenase and phosphoglycerate kinase
- C) Phosphoglycerate kinase and phosphoglycerate mutase
- D) Glucokinase and phosphoglucoisomerase
- E) Triose phosphate isomerase and glyceraldehyde 3-phosphate dehydrogenase

15) The four subunits that make up succinate dehydrogenase play an important role in the TCA cycle and electron transport chain. Which of the following correctly describes succinate dehydrogenase or the reaction it catalyzes?

- A) It oxidizes succinate to fumarate
- B) It directly transfers electrons to cytochrome c.
- C) It reduces succinate to malate
- D) It is positively regulated by a high $FADH_2/FAD$ ratio
- E) The NADH it produces is used to reduce Coenzyme Q_{10}

16) Which choice (A — E) for filling in the blanks makes a **true** statement?

In the regulation of glycogenolysis in liver cells, binding of the hormone **X** leads to the release of the second messenger **Y** that is responsible for initiating the reactions that lead to the conversion of glycogen to glucose 1-phosphate.

- | | <u>X</u> | <u>Y</u> |
|----|-----------------|-------------------|
| A) | epinephrine | insulin |
| B) | insulin | Ca^{2+} |
| C) | acetylcholine | glucagon |
| D) | glucagon | adenylate cyclase |
| E) | glucagon | cAMP |

17) How will high concentrations of AMP, citrate and fructose 2,6-bisphosphate, respectively, tend to affect the rate of gluconeogenesis?

- | | <u>AMP</u> | <u>citrate</u> | <u>fructose 2,6-bisphosphate</u> |
|----|-------------------|-----------------------|---|
| A) | increase | increase | decrease |
| B) | increase | decrease | decrease |
| C) | decrease | increase | increase |
| D) | decrease | decrease | increase |
| E) | decrease | increase | decrease |

18) Which of the following correctly describes the malate-aspartate shuttle?

- A) During gluconeogenesis malate is moving into the cytoplasm
- B) It transports NADH from the cytosol to the matrix
- C) It is essentially irreversible
- D) It swaps NADH for $FADH_2$
- E) During glycolysis the formation of oxaloacetate is favored in the cytoplasm

19) You have recently eaten a large meal complete with a large helping of mashed potatoes and caramel sauce. You have not been frightened in over 24 hours but have been doing one-arm push-ups for about 23 minutes. If you could examine the state of your glycogen metabolic machinery in the arm you have been using for your push-ups, what do you think you would find?

- A) Glycogen phosphorylase phosphorylated and inactive
- B) Glycogen phosphorylase unphosphorylated and active
- C) Glycogen synthase phosphorylated and active
- D) Glycogen synthase unphosphorylated and active
- E) Glycogen phosphorylase phosphorylated and active

20) Which of the following correctly describes galactose metabolism?

- A) Galactose is a substrate for hexokinase.
- B) Primarily ingested in the form of sucrose
- C) Galactokinase and galactose 1-phosphate uridyl transferase deficiencies cause mental retardation
- D) Galactose 1-phosphate uridyl transferase releases free glucose
- E) UDP-galactose requires a phosphoglucomutase to convert it to UDP-Glucose

21) Malonyl CoA, which was ^{14}C labeled (a radioactive isotope of carbon) at carbon #2, and unlabeled acetyl CoA were mixed together with the fatty acid synthase complex in a test tube. Which of the carbons of the final product, palmitate, will be ^{14}C labeled?

- A) All of the carbons will be labeled
- B) None of the carbons will be labeled
- C) Only the methyl carbon (carbon #16) will be labeled
- D) All of the even numbered carbons will be labeled, except for carbon #16
- E) All of the odd numbered carbons will be labeled, except for carbon #15

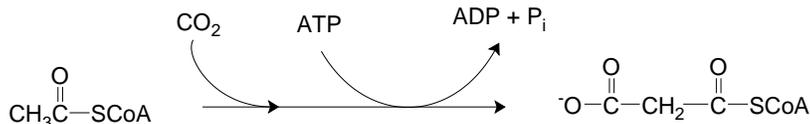
22) You suspect your patient has a defective carnitine acyl transferase I (CAT I) enzyme. After a 24 hour fast, which of the following molecules would you expect to have a lower blood plasma concentration than a person with a normal CAT I enzyme?

- A) triacylglycerols
- B) fatty acids
- C) ketone bodies
- D) glucose
- E) Both C and D

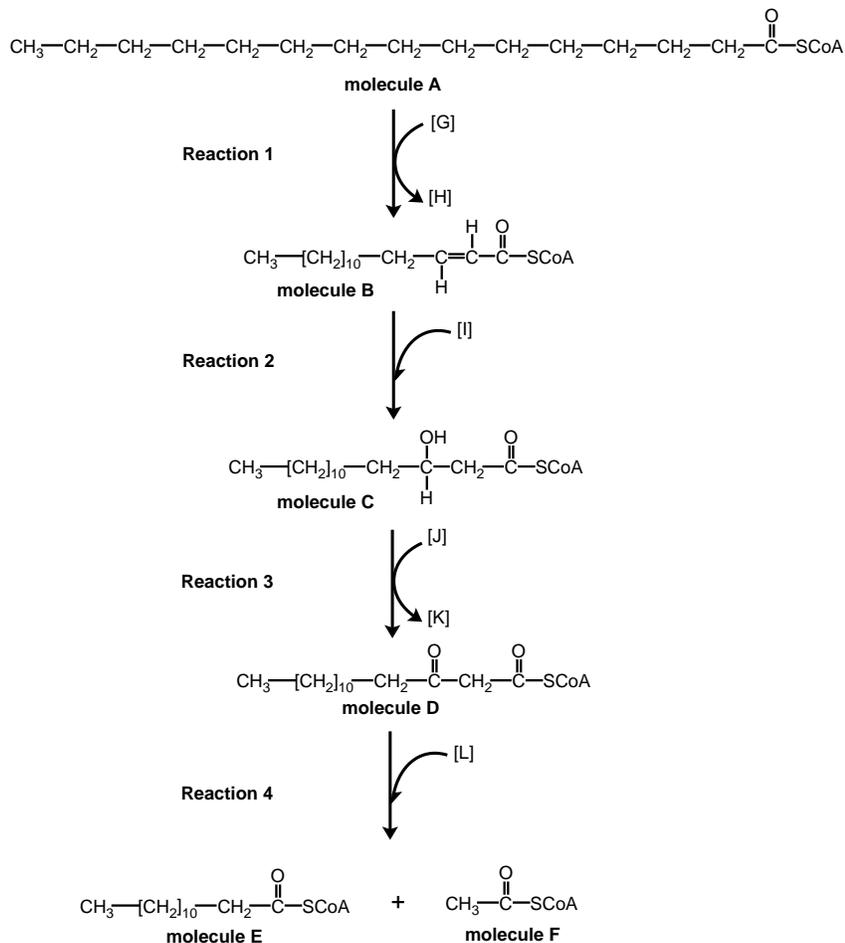
23) You want to develop a new diet pill by inhibiting a person's ability to make triacylglycerols (TAGs). Based on your knowledge of the synthesis of TAGs and phospholipids, which of the following enzymes would be the best target for your new drug? (The reactions catalyzed by the enzymes are in parentheses.)

- A) Phosphatidate cytidyltransferase (phosphatidate + CTP \rightarrow CDP-diacylglycerol)
- B) Acyl transferase (glycerol-P + 2 acyl-CoA \rightarrow phosphatidate + 2 CoA-SH)
- C) Phosphatidate phosphatase (phosphatidate \rightarrow 1,2-diacylglycerol + P_i)
- D) Glycerol-P dehydrogenase (dihydroxyacetone phosphate + NADH + H^+ \rightarrow glycerol-P + NAD^+)

24) What is the correct enzyme name for the reaction drawn below?



- A) malonyl-CoA synthase
- B) acetyl CoA kinase
- C) fatty acyl CoA synthetase
- D) acetyl CoA carboxylase
- E) acetyl CoA synthetase



The following two questions refer to the pathway drawn above.

25) Which of the following statements describing the above pathway is correct?

- A) Acetyl CoA carboxylase attaches CoA to the free fatty acid to make molecule A.
- B) The enzymes that catalyze reactions 1 and 3 require FAD and NAD⁺, respectively.
- C) Glucagon inhibits this pathway.
- D) The 4 reactions, respectively, are dehydrogenation, dehydration, dehydrogenation, and cleavage.
- E) Steps 1 through 4 require high concentrations of ATP.

26) Repeating reactions 1 through 4 will ultimately yield:

- A) 7 acetyl CoA, 6 FADH₂, 6 NADH + H⁺
- B) 1 propionyl CoA, 5 acetyl CoA, 5 FADH₂, 5 NADH + H⁺
- C) 1 propionyl CoA, 6 acetyl CoA, 6 FADH₂, 6 NADH + H⁺
- D) 8 acetyl CoA, 7 FADH₂, 7 NADH + H⁺
- E) Palmitate

27) Ketone bodies

- A) are the main fuel source for the brain.
- B) are hydrophobic and require a carrier for transport in the blood.
- C) include acetoacetate, which can spontaneously decarboxylate.
- D) include acetone, which is a fuel source for many tissues.
- E) are formed from three molecules of malonyl CoA.

28) Which of the following situations would result in an increase in ketone body synthesis?

- A) High insulin/glucagon ratio
- B) High citrate levels in the cytosol
- C) High levels of fructose 2,6-bisphosphate
- D) Low oxaloacetate levels in the mitochondria
- E) Low acetyl CoA levels in the mitochondria

29) Which of the following statements is correct?

- A) Lipid soluble vitamins are readily excreted from the body.
- B) All of the carbons in cholesterol synthesis come from molecules of acetyl CoA.
- C) Sphingosine is derived from palmitoyl CoA and glycerol phosphate.
- D) CTP (cytidine triphosphate) is used to activate ceramide in glycolipid synthesis.
- E) Bile salts are derived from vitamin D.

30) The regulation of cholesterol synthesis involves which of the following:

- A) cholesterol inhibits the degradation of HMG-CoA reductase
- B) cholesterol increases the synthesis of HMG-CoA reductase
- C) cholesterol stimulates the activity of HMG-CoA reductase
- D) cholesterol increases the synthesis of the LDL (low density lipoprotein) receptor
- E) insulin activates HMG-CoA reductase

31) The digestion and absorption of dietary lipids involves

- A) absorption of intact molecules of phospholipids across the intestinal mucosa.
- B) pancreatic lipase to cleave the dietary triacylglycerols.
- C) Emulsification of large lipid droplets by cholesterol.
- D) lipase breakdown of triacylglycerols in the mouth.
- E) dietary lipid products are ultimately packaged into VLDLs (very low density lipoproteins) for transport.

32) Which of the following statements regarding both sphingomyelin and phosphatidylcholine is correct?

- A) Both are synthesized from ceramide.
- B) Both contain 2 fatty acids linked via ester bonds.
- C) Both contain choline as part of their polar headgroups.
- D) Phosphatidylcholine is a membrane lipid, but sphingomyelin is used for fuel storage.
- E) Phosphatidylcholine contains a phosphate group, but sphingomyelin does not.

END OF EXAMINATION

Tear off this sheet and save to check your answers.

Please remember to:

- Write the letter corresponding to your **FORM** in the appropriate place on the **answer sheet**.
- SIGN AND RETURN YOUR EXAMINATION** to an instructor **before leaving the exam room.**

FORM: A

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| 2. _____ | 12. _____ | 22. _____ | 32. _____ |
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