

DO NOT BEGIN THIS EXAM UNTIL INSTRUCTED TO DO SO

IMPORTANT!!! DO THIS FIRST!!

Properly Fill in Test Version (A) and Student ID # on your Scantron form.

- There are **27** multiple choice questions on this exam.
- All questions have ONE and only ONE correct answer (we hope).
- All questions are worth the same number of points.
- No points are subtracted for incorrect answers (you should guess).
- No points are awarded for a question if more than one answer is given.
- **No use of any electronics or notes is permitted during the exam.**

The exam ends at 11:15. No exams will be accepted before 11:15.

Students turning in a late exam will be penalized.

You may leave ONLY after ALL exams have been collected.

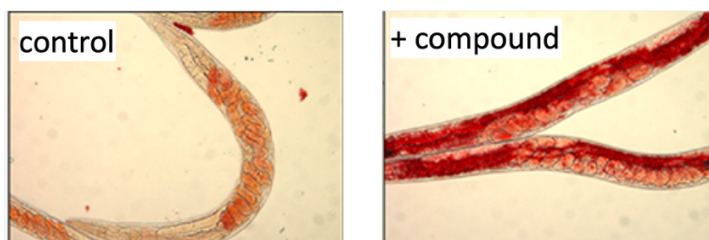
1. How are fatty acids mobilized from adipose tissue transported to the liver?
 - A. In VLDL particles.
 - B. In LDL particles.
 - C. In HDL particles.
 - D. Bound to a FA binding protein (FABP).
 - E. Bound to albumin.

2. You add a drug that **inactivates** S-adenosylmethionine (SAM) synthase (the enzyme that generates SAM from methionine) to cell culture. Which of these phospholipids will be depleted from the cells in this culture?
 - A. Phosphatidyl choline
 - B. Phosphatidyl ethanolamine
 - C. Phosphatidyl glycerol
 - D. Phosphatidyl inositol
 - E. Phosphatidyl serine

3. You add rapamycin to a culture of hepatocytes to inhibit TOR kinase. What happens?
 - A. Citrate transport out of the mitochondria increases.
 - B. HMG-CoA reductase becomes phosphorylated.
 - C. Acetyl-CoA carboxylase forms filaments.
 - D. Increased mitochondrial biogenesis.
 - E. CPT I (carnitine palmitoyl transferase I) is inhibited.

4. Which of these statements about cholesterol synthesis is **FALSE**?
 - A. HMG-CoA used for cholesterol synthesis is produced in the mitochondria during ketogenesis.
 - B. Two PPi (4 ATP equivalents) are released in the final condensation of activated isoprenes to form squalene.
 - C. One carbon is removed from mevalonate in the production of activated isoprenes.
 - D. Three acetyl-CoA are combined to generate mevalonate.
 - E. HMG-CoA reductase is inhibited by phosphorylation.

5. Which of these would **increase** insulin secretion from pancreatic β cells?
- A. Activation of PI-3 kinase in the β cells.
 - B. Decreasing mitochondrial respiration in the β cells.
 - C. Phosphorylation of AMPK in the β cells.
 - D. Increased GLUT4 on the plasma membrane of the β cells.
 - E. Increasing cytoplasmic Ca^{2+} in the β cells.
6. In 1982, a 42-year-old patient was hospitalized in San Jose, frozen like a statue. Then two drug-addict brothers in their 20s were reported to have advanced symptoms of Parkinson's. All these patients had consumed the same illegal street drug, which turned out to have an impurity. The patients were given L-DOPA, which alleviated their motor symptoms. Based on these data, which of these neurotransmission pathways can you infer were **NOT** disrupted by the impurity?
- A. Norepinephrine
 - B. Serotonin
 - C. Dopamine
 - D. Epinephrine
 - E. All of these have been altered.
7. Oil-Red-O (ORO) is a dye that stains neutral lipids, such as TAGs. If there are more lipids, the stain becomes more intense. You decide to feed ORO to *C. elegans*. On the left is ORO staining of control, untreated animals. The image on the right shows animals treated with a new compound you purified from a weird mushroom you found outside. What does the mushroom compound do?



- A. Inhibits phosphatidic acid phosphatase.
- B. Activates HMG-CoA reductase.
- C. Inhibits carnitine palmitoyl transferase I (CPT I).
- D. Inhibits the malic enzyme.
- E. Activates the AMP-activated kinase (AMPK).

8. Free ammonia is captured by synthesis of (1), an amino acid, and then transferred to the amino acid (2). This amino acid (2) provides amino groups for amino acid synthesis.

A. 1=glutamate; 2=glutamine.
B. 1=glutamate; 2=glutamate.
C. 1=glutamine; 2=glutamine.
D. 1=glutamine; 2=glutamate.
E. Ammonia cannot be incorporated into amino acids.

9. You keep a pet rat, Poppy, in your room. You come home after a long day, and Poppy is hungry – he hasn't eaten in almost 12 hours. When you open the door to the cabinet where you store the rat food, your cat jumps out lunges toward Poppy. Poppy is scared and has clearly activated the "fight or flight" response, and his blood glucose levels rise rapidly. Which combination of molecular responses has been activated in Poppy's tissues?

A. ↑ AMPK activity, ↓ mTOR activity, ↓ fructose-2,6-bisphosphate, ↑ glycogen synthase activity
B. ↑ cAMP, ↑ PKA activity, ↓ fructose-2,6-bisphosphate, ↑ gluconeogenesis
C. ↑ insulin signaling, ↑ PI3K activation, ↑ GLUT4 translocation, ↑ gluconeogenesis
D. ↓ AMPK activity, ↑ mTOR activity, ↑ glycolysis, ↑ glycogen synthesis
E. ↑ cAMP, ↑ mTOR activation, ↑ fatty acid synthesis, ↓ glycogen synthase activity

10. Hartnup disease is a genetic syndrome in which there is an inactivating mutation in a gene required for the absorption of tryptophan. Based on this information, which of these drugs might help treat the neurological symptoms of patients with Hartnup disease?

A. A selective serotonin reuptake inhibitor (SSRI).
B. A dopamine reuptake inhibitor.
C. An antihistamine.
D. Reserpine, which depletes monoamines from synaptic vesicles.
E. A GPCR inhibitor.

11. Biotin is attached to carboxylase enzymes through the action of a biotin-ligating protein. Which of these would occur if you **inhibited** the activity of the biotin-ligating protein in rodents?
 - A. Fatty acid oxidation would be inhibited.
 - B. Acetyl-CoA would accumulate in the cytoplasm.
 - C. Palmitate would accumulate.
 - D. Malonyl CoA would accumulate.
 - E. TAG synthesis would increase.

12. Folate (vitamin B9) deficiency can lead to megaloblastic anemia, where red blood cells become abnormally large. You see a patient with severe megaloblastic anemia even though they have eaten spinach (a good source of folate) daily for several weeks. Which of these could explain this observation?
 - A. A defect in dihydrofolate reductase (DHFR).
 - B. Accumulation of S-adenosylmethionine.
 - C. Decreased expression of intrinsic factor.
 - D. Increased production of glutathione.
 - E. Decreased activity of pancreatic lipase.

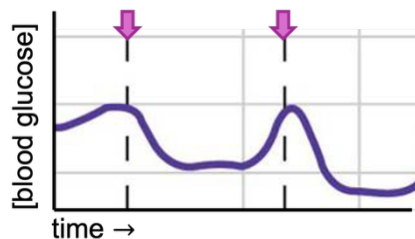
13. Which of these fatty acids is synthesized using **BOTH** a desaturase AND an elongase in plants?
 - A. C18:1(Δ 9)
 - B. C18:2(Δ 6, 9)
 - C. C20:0
 - D. C20:1(Δ 9)
 - E. C20:2(Δ 6, 9)

14. Which of these is **NOT** a source for amino acid carbon skeletons in mammals?
 - A. Glycolysis
 - B. Pyruvate
 - C. PPP (pentose phosphate pathway)
 - D. TCA cycle
 - E. All of these can be used to generate carbon skeletons.

15. Which of these statements about biological nitrogen fixing is **TRUE**?

- A. The reduction of N_2 to NH_3 occurs at the FeMo cofactor.
- B. The P-cluster dissociates after each electron is transferred to the FeMo cofactor.
- C. ATP hydrolysis stimulates the reduction of N_2 to NH_3 .
- D. The reduction of N_2 to NH_3 occurs when 6 electrons have collected at the FeMo cofactor.
- E. Reduction of the dinitrogen reductase (Fe-protein) requires ATP hydrolysis.

16. You volunteer to participate in a medical trial, and as an initial screen the doctor measures your blood glucose over the course of a day, which is shown in this graph. You get an injection every few hours (indicated with magenta arrows). What are you being injected with?

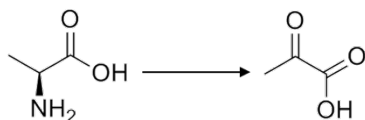


- A. glucagon
 - B. insulin
 - C. ghrelin
 - D. cortisol
 - E. epinephrine
17. What would you expect to happen to cellular lipid levels if you add a drug that **increases** the activity of phosphatidic acid phosphatase (lipin)?
- A. Increased accumulation of triacylglycerol.
 - B. Increased production of membrane phospholipids.
 - C. Increased amount of phosphatidic acid.
 - D. Increased production of sphingolipids.
 - E. Increased synthesis of cholesterol.

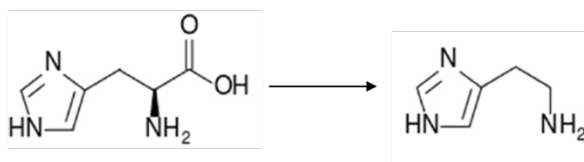
18. The nematode *C. elegans* **cannot** synthesize cholesterol because it expresses none of the enzymes following HMG-CoA reductase in the biosynthetic pathway. As a result, they rely on dietary cholesterol to survive. What would happen if you forgot to add cholesterol to the media?
- A. Fewer lipidated proteins will be associated with the plasma membrane.
 - B. Increased activity of HMG-CoA reductase.
 - C. Increased production of ketone bodies.
 - D. Depletion of Coenzyme Q from the mitochondria.
 - E. Reduced production of steroid hormones that regulate development.
19. Which of these would occur if you **depleted** bile salts from the small intestine?
- A. More chylomicrons would be secreted.
 - B. More cholesterol would be absorbed by the intestinal epithelial cells.
 - C. Dietary fats would not be hydrolyzed by pancreatic lipase.
 - D. Lipoprotein lipase activity would increase.
 - E. Pancreatic lipase activity would increase.
20. You found an interesting lichen while hiking in the Olympic National Park. You bring the lichen to lab, make an extract, and feed it to some agouti mice in your breeding colony. When the pups are born, they are all yellow (suggesting low methylation at the agouti promoter). Which of these conclusions are most consistent with this observation?
- A. The lichen extract increases production of S-adenosyl methionine.
 - B. The lichen extract increases the amount of N⁵-methyl THF.
 - C. The lichen extract increases flux through the transsulfuration pathway.
 - D. The lichen extract has high levels of vitamin B12.
 - E. The lichen extract increases activity of serine hydroxy methyltransferase (SHMT).
21. Which of these statements about fatty acid catabolism is **FALSE**?
- A. ATP is required to conjugate free fatty acids to CoA-SH.
 - B. Carnitine is required for fatty acids to enter the mitochondria.
 - C. After the first reduction, the β carbon is bonded to two carbonyl carbons.
 - D. Electrons from β oxidation enter the mitochondrial respiratory chain.
 - E. In the final step of β oxidation, reaction with CoA-SH releases acetyl-CoA.

22. Which of these reactions does **NOT** require PLP (pyridoxal phosphate)?

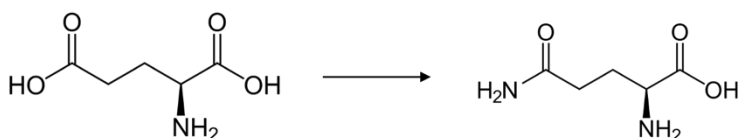
A.



B.



C.



D.



E. These all require PLP

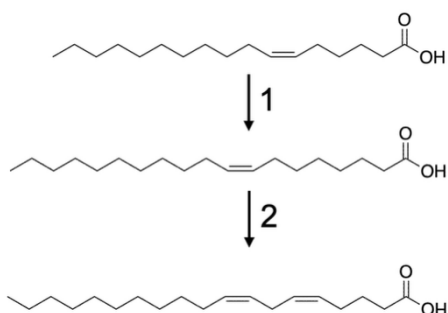
23. Which of these lipoprotein particles are released by the liver?

- A. chylomicrons
- B. VLDL
- C. LDL
- D. HDL
- E. remnants

24. You see a patient that complains of fatigue and confusion. Lab tests indicate this patient is anemic, has high levels of circulating homocysteine and low circulating cysteine, but normal levels of glutamate, serine, glycine, and glutamine. Which of these enzymes is dysfunctional?

- A. dihydrofolate reductase (DHFR)
- B. methionine synthase
- C. serine hydroxymethyltransferase (SHMT)
- D. S-adenosylmethionine synthase
- E. cystathionine β -synthase (transsulfuration)

25. In this series of reactions, what kind of enzyme catalyzes each step?



- A. 1: elongase, 2: desaturase
- B. 1: desaturase, 2: elongase
- C. 1: elongase, 2: cytb5 reductase
- D. 1: enoyl isomerase, 2: dienoyl reductase
- E. 1: dienoyl reductase, 2: enoyl isomerase

26. You add ^{13}C bicarbonate to a liver extract that is actively synthesizing fatty acids. After 10 min, you stop the reaction and isolate metabolites. Which of these metabolites will have the most ^{13}C ?

- A. Palmitate
- B. Acetyl-CoA
- C. Malonyl-CoA
- D. Citrate
- E. None of these

27. Metformin, used to treat type 2 diabetes, is one of the most widely prescribed drugs in the world. One effect of metformin is to inhibit mitochondrial respiration and **increase** the activity of the AMP-activated kinase (AMPK). Which of these might be expected after administration of metformin?
- A. Increased activity of acetyl-CoA carboxylase (ACC).
 - B. Increased activity of adipose triglyceride lipase (ATGL).
 - C. Increased activity of Phospholipase C (PLC).
 - D. Increased activity of PI-3 kinase (PI3K).
 - E. Increased activity of HMG-CoA reductase.