Name _____

Student No. _____

MBB231 Midterm exam 4 (Fall 2016) – November 25, 2016 (IK)

Exam guidelines

1. All materials must be securely put away under your desk. Notes or other non-beverage materials that are left out during the exam will be considered cheating. No restroom breaks will be allowed during testing unless you provide medical documentation of this need prior to the exam.

2. All cellphones, iPods, laptop computers, and other technologies must be turned OFF and put away. Failure to respect this policy, including your cellphone ringing, will result in a zero on the exam.

3. Collect a Scantron form, take a seat, and put your name and ID on the Scantron form using a #2 pencil. Bubble in your name and ID clearly.

4. Write your name and student number in the upper right corner on this page.

5. Wait for all other students to receive exams. When prompted by your instructor, open your exam and complete it.

6. When you have completed the exam, you should exit your seat and come to the front of the room to turn in your exam and Scantron form. Do so as quietly as possible and then exit the classroom.

7. When time is called, you must stop working immediately. Any work after time is called, even writing your name, will be treated as cheating. You will have 50 minutes to complete this exam (11:30 AM-12:20 PM).

8. This exam has 10 single-sided pages with 40 multiple choice questions.

ALL 40 QUESTIONS ARE MULTIPLE CHOICE. Choose the one answer that best completes the statement or answers the question. Bubble in the appropriate answer on the Scantron form. It is your responsibility to bubble in the answers correctly as your exam will not be re-graded under any circumstances.

1. King Henry VIII of England suffered from gout and ingested which of the following drugs to alleviate his pain?
   A. nocadazole
   B. taxol
   C. phalloidin
   D. colchicine
   E. acrylamide

2. The only TAG breakdown product that can enter gluconeogenesis is _____ through the formation of _____
   A. glycerol, pyruvate
   B. glycerol, glyceraldehyde 3-phosphate
   C. β-oxidized fatty acid, acetyl CoA
   D. β-oxidized fatty acid, oxaloacetate
   E. none of the above

3. Which of the following statements regarding the regulation of glycolysis and gluconeogenesis in the liver is *false*?
   A. When the blood glucose level decreases, the hormone glucagon signals the liver to produce and release more glucose and to stop consuming it for its own needs
   B. In the fasting liver, one source of glucose is glycogen stored there
   C. In the fasting liver, another source of glucose is gluconeogenesis, using pyruvate, lactate, glycerol, and glycogenic amino acids as starting material
   D. When blood glucose is high, insulin signals the liver to use glucose as fuel and as a precursor for the synthesis and storage of glycogen and triacylglycerols
   E. None of the above

4. ATP is both a substrate and an allosteric _____ of phosphofructokinase-1 (PFK-1). This means that ATP greatly _____ PFK-1's K_m for its second substrate, fructose 6-phosphate.
   A. activator, increases
   B. inhibitor, decreases
   C. inhibitor, increases
   D. activator, decreases
   E. none of the above

5. _____ occurs primarily in populations that rely on a diet consisting mainly of white (polished) rice that lacks the hulls, in which most of the thiamine of rice is found. Thiamine-deficient animals are unable to oxidize _____ properly because thiamine pyrophosphate is critical for the function of _____.
   A. Diabetes mellitus, oxaloacetate, malate dehydrogenase
   B. Beriberi, pyruvate, pyruvate dehydrogenase
   C. Acidosis, acetyl CoA, acyl-CoA dehydrogenase
   D. Ketosis, acetoacetate, acetyltransferase
   E. None of the above

6. Which of the following statements regarding mitochondria is *false*?
   A. Mitochondria are often present where the ATP needs are greatest
   B. The outer mitochondrial membrane is not a significant permeability barrier for ions and small molecules because it contains transmembrane channel proteins called porins that permit passage of small molecules and ions
   C. The inner mitochondrial membrane is highly folded into cristae that project into the mitochondrial matrix
   D. Respiratory electron carriers (the electron transport system) are embedded in the outer mitochondrial membrane
   E. Pyruvate oxidation, citric acid cycle, and β oxidation of fats take place in the mitochondrial matrix

7. In addition to substrate availability and inhibition by accumulating products, the citric acid cycle may be regulated via
   A. allosteric inhibition of NADH-generating enzymes
   B. feedback control by citrate on PFK1
   C. phosphorylation of pyruvate dehydrogenase
   D. A and B
   E. A and C

8. β-oxidation of fatty acids after activation to fatty acyl-CoA takes place in a series of four cyclical steps: _____, each of which releases two-carbon fragments in the form of acetyl CoA
   A. oxidation, hydration, oxidation, thiolysis
   B. oxidation, dehydration, reduction, thiolysis
   C. reduction, hydration, oxidation, thiolysis
   D. thiolysis, oxidation, dehydration, hydrolysis
   E. reduction, dehydration, oxidation, decarboxylation

9. Because the citric acid cycle is a central link between anabolic and catabolic pathways, it is often called a(n)_____ pathway.
   A. anaplerotic
   B. metabolic
   C. amphibolic
   D. anaphylactic
   E. none of the above

10. Complex V (ATP synthase) isolated *in vitro* has only ATP-hydrolyzing activity, and no ATP-synthesizing activity, because
    A. it is extracted out of its place in the outer mitochondrial membrane and there is no electrochemical potential across it to synthesize ATP
    B. oxidative phosphorylation is allosterically inhibited by ADP
    C. reducing equivalents (NADH and $FADH_2$) are unavailable
    D. terminal oxygen is unavailable
    E. none of the above

11. The inner mitochondrial membranes of brown adipose tissue contain an endogenous protein called _____ that creates a passive proton channel through which protons flow back to the matrix without passing through the F_oF_1 complex. As a result of this short-circuiting of protons, the energy of oxidation is not conserved by ATP formation but is dissipated as heat, which contributes to maintaining the body temperature.
    A. monooxygenase
    B. thermolysin
    C. cytochrome oxidase
    D. thermogenin
    E. none of the above

12. The F_o mobile component of *E. coli* ATPase discussed in class consists of a ring of ____ *c* subunits that rotate as protons get translocated across the plasma membrane. The F_1 mobile component of the same enzyme consists of the __ and __ subunits, and the latter rotates to transmit energy from F_o to F_1.
    A. 10, ε, γ
    B. 12, ε, γ
    C. 8, ε, γ
    D. 10, β, ε
    E. 6, α, β

13. During starvation, _____ depletes CAC intermediates, diverting acetyl CoA to _____ _____ production
    A. glycolysis, acetone and acetoacetate
    B. gluconeogenesis, ketone bodies
    C. gluconeogenesis, oxaloacetate and D-β-hydroxybutyrate
    D. β oxidation pathway, ketone bodies
    E. none of the above

14. The continuous release of mucus by the epithelial cells lining the respiratory tract is an example of
    A. regulated secretion
    B. clathrin-coated pit formation
    C. the mucus response
    D. constitutive secretion
    E. phagocytosis

15. According to the binding change model for ATP synthesis by the β subunits of the F_oF_1 complex, each of the β subunits of the F_1 complex is in a different confirmation at any instant. As the ____ subunit of the F_1 complex rotates inside the hexameric catalytic ring, each β subunit undergoes a series of conformational changes. When the β subunit is in the ___ conformation, ADP and P_i bind to it. Next, the β subunit changes to the ___ conformation, where ADP and P_i are held loosely in place. Then, it changes to the ___ conformation, where ADP and P_i are converted to ATP, after which it changes back to the ___ conformation. Thus, each rotation causes the synthesis of ___ molecules of ATP.
    A. γ, O, L, T, O, 6
    B. γ, O, L, T, L, 3
    C. ε, O, L, T, O, 3
    D. ε, O, L, T, O, 6
    E. none of the above

16. According to the chemiosmotic coupling model, the _____ _____ _____ that is generated by the electron transport system represents the potential energy that provides the driving force for ATP synthesis.
    A. high-energy chemical intermediate
    B. chemical proton gradient
    C. electrical proton gradient
    D. electrochemical proton gradient
    E. none of the above

17. Which of the following microtubule-binding proteins associates with GTP-tubulin at the MT plus ends and exhibits a characteristic "firework" pattern when tagged with green fluorescent protein?
    A. EB1
    B. Tau
    C. MAP
    D. MCAK
    E. Catastrophin

18. Which of the following statements regarding rough and/or smooth ER is *false*?
    A. Newly synthesized proteins enter the ER lumen, which is functionally equivalent to the interior of vesicles, the Golgi, lysosomes, endosomes, and the cell exterior
    B. Smooth ER lacks ribosomes and has several roles not involving protein synthesis that depend on the particular cell type
    C. Smooth ER is involved with drug detoxification and regulation of glycogen degradation in the liver, in storage of calcium in muscle cells, and in steroid hormone biosynthesis in hormone-producing cells
    D. Rough ER gets its name from the presence of numerous ribosomes on its lumenal surface, reflecting its importance in synthesis of membrane proteins and secreted proteins
    E. None of the above

19. Fill in the blanks in the overall reaction for the maximum theoretical ATP yield obtainable by the complete aerobic respiration of glucose:

$C_6H_{12}O_6 + 6O_2 +$ ___ ADP + ____ $P_i \rightarrow$ ____$CO_2 + 6H_2O +$ ____ ATP

A. 32, 32, 6, 32
B. 38, 38, 12, 38
C. 34, 34, 6, 34
D. 32, 32, 12, 32
E. 38, 38, 6, 38

20. Oxidative phosphorylation is regulated by cellular _____ needs, such that electron flow from organic fuel molecules to oxygen is adjusted to the energy needs of the cell. This regulatory mechanism is called _____ _____ and it becomes apparent during exercise, when the accumulation of ADP in muscle tissue causes an increase in electron transport rates, followed by a dramatic rise in the need for oxygen.
A. ATP, respiratory control
B. ADP, respiratory control
C. ATP, respiratory dependency
D. ATP, respiratory dependency
E. oxygen, respiratory control

21. *Amanita phalloides* (commonly known as the death cap) is a deadly poisonous mushroom that contains phalloidin, which binds to tightly and selectively to
A. β tubulin.
B. keratin.
C. F-actin.
D. glial fibriary acidic protein.
E. G-actin.

22. Hemagglutinin is a trimeric protein that forms the spikes that protrude from the surface of an influenza virus particle. The HA trimer is formed within the _____ of an infected host cell from three copies of a precursor protein HA_0, which has a single membrane-spanning α helix. Transient binding of _____ and calnexin, to certain oligosaccharide chains on HA_0 promotes proper _____ of adjacent segments.
A. ER, calreticulin, folding
B. Golgi, BiP, folding
C. ER, BiP, secretion
D. Golgi, calreticulin, folding
E. None of the above

23. Order the events of receptor-mediated endocytosis in the correct sequence:
    1. an internalized coated vesicles lose its clathrin coat
    2. transport vesicles carry material to a late endosome for digestion
    3. molecules to be internalized bind to specific receptors on the surface of the plasma membrane
    4. invagination of the plasma membrane is facilitated by adaptor proteins, clathrin, and dynamin
    5. a vesicle fuses with an early endosome
    6. receptor-ligand complexes accumulate in coated pits

    A. 3, 4, 6, 5, 1, 2
    B. 3, 6, 4, 5, 1, 2
    C. 3, 4, 1, 5, 2, 6
    D. 3, 6, 4, 1, 5, 2
    E. 5, 1, 2, 4, 6, 3

24. What feature(s) of membrane lipids contribute to their proper trafficking and targeting in cells?
    A. Membrane lipids are often tagged by the addition of one or more phosphate groups to a membrane phosphatidylinositol to assist with proper targeting
    B. The length and degree of saturation of some membrane lipids are important in trafficking
    C. The placement of dolichol phosphate in the Golgi membrane
    D. **A and B**
    E. A and C

25. Individuals with familial hypercholesterolemia (FH) discussed in class continue to make cholesterol and sustain high circulating LDL and cholesterol levels because
    A. they have mutations in apoB-100 protein
    B. they have high LDL and low HDL
    C. they cannot produce cholesterol esters
    D. they develop atherosclerotic plaques
    E. they have mutations in the LDL receptor gene

26. Many soluble ER-resident proteins contain a KDEL sorting signal. A protein with a functional KDEL motif will be retrieved from the Golgi apparatus by retrograde transport to the ER lumen. The name of the signal - "KDEL" - refers to
    A. the attachment side for kamamycin deletion mutant
    B. the keratin, dynein, estradiol, and lysine receptor
    C. the four amino acids written in one-letter-code
    D. the Golgi-derived clathrin delight
    E. King Daenerys Lannister of Eyrie

27. Which of the following intracellular transport processes would you expect to be affected when cells are treated with a GTPase inhibitor?
    A. "Pinching off" of clathrin-coated vesicles
    B. Production of COPI-coated vesicles
    C. Production of COPII-coated vesicles
    D. Association of v-SNAREs and t-SNARE proteins prior to vesicle fusion
    E. **All of the above**

28. Each of the following is the product of the citric acid cycle except
    A. CO_2
    B. ATP
    C. acetyl-CoA
    D. $FADH_2$
    E. NADH

29. A protein that is normally localized in the cytoplasm has been engineered so that it will be secreted from the cell instead. Which of the following represents the most likely pathway for the protein after it has been completely synthesized?
    A. eER → Golgi → sER → cytoplasm → environment
    B. rER → Golgi → cytoplasm → environment
    C. rER → Golgi → secretory vesicle → environment
    D. cytoplasm → rER → Golgi → environment
    E. sER → Golgi → secretory vesicle → environment

30. The "molecular address" of soluble lysosomal proteins is
    A. core oligosaccharide
    B. 2 GlcNAc, 9M, 3G
    C. KDEL
    D. M6P
    E. N-glycosylation

31. What problems would a cell/organism have if it could not produce lysosomes?
    A. Cells that depend on phagocytosis for nutrient ingestion would be unable to feed and would likely die without supplied nutrition
    B. Autophagy would not be possible, and old, defective organelles could not be recycled
    C. Because so many hydrolytic enzymes would be absent, the cell would accumulate a large macromolecular "garbage" such as misfolded proteins and undigested lipids and polysaccharides
    D. Certain inflammatory diseases, such as rheumatoid arthritis, may result from release of lysosomal enzymes by white blood cells in the joints, damaging joint tissue
    E. **All of the above**

32. Microtubule (MT) assembly occurs at the (+) end and disassembly at the (-) end if
    A. the free GTP-tubulin concentration is higher than the critical concentration at the (+) end
    B. the free GTP-tubulin concentration is lower than the critical concentration at the (-) end
    C. the free tubulin concentration is balanced at both ends but GDP-tubulin concentration is higher at the (+) end
    D. A and B
    E. None of the above

33. The frequency of catastrophes in MT dynamics is inversely related to
    A. critical concentration
    B. the number of centrioles
    C. the free GTP-tubulin concentration
    D. the concentration of γ-tubulin
    E. none of the above

34. Dense tangles of neurites, known as neurofibrillary tangles, are a hallmark of several diseases that result in dementia, such as Alzheimer disease, Pick disease, and several types of palsy. In the case of Alzheimer disease, these tangles contain large amounts of hyperphosphorylated _____ protein, which forms paired helical filaments.
    A. Tau
    B. MAP2
    C. MCAK
    D. Katanin
    E. +-TIP

35. This microtubule-severing protein is named after a Japanese sword
    A. severin
    B. gelsolin
    C. samurain
    D. katanin
    E. filamin

36. Wiskott-Aldrich syndrome discussed in lectures is a rare genetic disease characterized by eczema, immune deficiency, and bloody diarrhea that affects mostly males. This disease was linked in 1994 to a gene on a short arm of the X chromosome, which codes for the protein WASp. The main function of WASp is to activate _____ polymerization by binding the _____.
    A. actin, Rho
    B. tubulin, profilin
    C. tubulin, gelsolin
    D. intermediate filament, Cdc42
    E. actin, Arp2/3 complex

37. _____ typing is especially useful in the diagnosis of cancer because tumour cells are known to retain the _____ proteins characteristic of the tissue of origin, regardless of where the tumour occurs in the body. Because the appropriate treatment often depends on the tissue of origin, this diagnostic tool is especially valuable in cases where diagnosis using conventional microscopy is difficult.
    A. IF, keratin
    B. IF, IF
    C. Antibody, desmin
    D. MT, tubulin
    E. MF, actin

38. On which of the following intracellular locations does clathrin organize a coat and form vesicles?
    A. inner membrane of mitochondria
    B. endoplasmic network
    C. trans-Golgi complex
    D. lysosomes
    E. regulatory secretory vesicles

39. Which statement regarding the fasting state in a healthy human is *false*?
    A. After some hours without a meal, the liver becomes the principal course of glucose for the brain
    B. Liver glycogen is broken down, and the glucose 1-phosphate produced is converted to glucose 6-phosphate, then to free glucose, which is released into the bloodstream
    C. Amino acids from the degradation of proteins in liver and muscle, and glycerol from the breakdown of TAGs in adipose tissue, are used in the citric acid cycle
    D. The liver uses fatty acids as its principal fuel, and excess acetyl-CoA is converted to ketone bodies for export to other tissues; the brain is especially dependent on this fuel when glucose is in short supply
    E. None of the above

40. You have isolated two fractions containing similar-sized vesicles by centrifugation. You suspect that one fraction contains lysosomes and the other contains peroxisomes. To confirm that a fraction contains peroxisomes, you would assay for which of the following enzymes?
    A. glucuronidase
    B. catalase
    C. acid phosphatase
    D. ribonuclease
    E. plectin