

Faculty of Science

FINAL EXAMINATION 2004

BIOL 201
CELL BIOLOGY AND METABOLISM

VERSION 1

Examiner: Professor R. Levine
Associate Examiner: Professor G. Brown

Date: April 26, 2004
Time: 2:00 p.m.

Student Name: _____ Student Number: _____

Instructions:

1. You must write the exam in the room assigned to you.
2. Your **name and student number must be placed on both** the answer sheet and the cover sheet of the questionnaire.
3. There will be four versions of the exam (1, 2, 3, & 4). **Enter the appropriate version number** (indicated above) in the upper corner of your answer sheet, and in the section headed "**version**" as circled.
4. You **MUST** turn in the whole questionnaire as well as the answer sheet.
5. Notes, text books, scrap papers, and calculators are **not permitted**.
6. Only French/English translation dictionaries are allowed.
7. If you find any questions ambiguous, specify the question number and explain your concerns on the bottom of this cover sheet.
8. The exam consists of 75 questions on 13 pages, excluding the cover page.

READ EACH QUESTION CAREFULLY AND SELECT THE BEST ANSWER.

DO NOT PANIC...

Warning: *Exam Security Monitor Program detects pairs of students with unusually similar answer patterns on multiple-choice exams. Data generated by this program can be used as admissible evidence, either to initiate or corroborate an investigation of a charge of cheating under Section of the Code of Student Conduct and Disciplinary Procedures.*

AMBIGUITIES

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7. How many molecules of NAD^+ are converted to NADH during the mitochondrial oxidation of a 4 carbon saturated fatty acyl CoA molecule to $4 \text{CO}_2 + \text{CoA}$?
1. Three
 2. Four
 3. Five
 4. Six
 5. Seven
8. As a consequence of the conformational change induced by phosphorylation, the Na^+/K^+ ATPase has:
1. Increased affinity for Na^+ and decreased affinity for K^+
 2. Increased affinity for K^+ and decreased affinity for Na^+
 3. Increased affinity for both Na^+ and K^+
 4. Decreased affinity for both Na^+ and K^+
 5. No change in its affinity for either Na^+ or K^+
9. ΔG for the movement of an ion across a cell membrane is composed of a concentration term ΔG_c and an electrical term ΔG_m . For the movement of Na^+ ions into cells
1. ΔG_c is negative and ΔG_m is positive
 2. ΔG_c is positive and ΔG_m is negative
 3. Both ΔG_c and ΔG_m are positive
 4. Both ΔG_c and ΔG_m are negative
 5. None of the above
10. Which of the following is not an example of transporter type?
1. antiporter
 2. channelporter
 3. symporter
 4. uniporter
 5. ATP powered pump
11. E_0' for the reaction $\text{A} + \text{e}^- \rightarrow \text{A}^-$ is -0.10 V and E_0' for the reaction $\text{B} + \text{e}^- \rightarrow \text{B}^-$ is -0.20 V . On the basis of this information, which of the following reactions can be expected to have a value of $\Delta G'_0$ that is greater than 0?
1. $\text{A}^- + \text{B} \rightarrow \text{A} + \text{B}^-$
 2. $\text{B}^- + \text{A} \rightarrow \text{B} + \text{A}^-$
 3. $\text{A} + \text{B} \rightarrow \text{A}^- + \text{B}^+$
 4. $\text{A} + \text{B} \rightarrow \text{A}^+ + \text{B}^-$
 5. $\text{A}^+ + \text{B} \rightarrow \text{A} + \text{B}^+$
12. Which of the following respiratory complexes contains a molecule of bound flavin mononucleotide (FMN)
1. Complex I
 2. Complex II
 3. Complex III
 4. Complex IV
 5. Complex V

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13. Which of the following is thought to play a role in the phenomenon where a marathoner “hits the wall”?
1. Low blood oxygen content
 2. High blood oxygen content
 3. Depletion of stored fat
 4. Depletion of stored carbohydrate
 5. Poor eyesight
14. Yeast ATP synthase has 10 c subunits. How many ATP molecules will be synthesized for each 10 protons that are translocated by this enzyme from the mitochondrial intermembrane space to the matrix?
1. One
 2. Two
 3. Three
 4. Four
 5. Five
15. How many cytochrome c molecules are reduced for each CoQH_2 that is oxidized by complex III (CoQH_2 – cytochrome c oxidoreductase) of the mitochondrial electron transfer chain?
1. one
 2. two
 3. three
 4. four
 5. five
16. Excitation of photosystem II results in:
1. The transfer of electrons to oxygen
 2. The reduction of NAD^+ to NADH
 3. The creation of a positively charged chlorophyll a molecule
 4. The oxidation of NADPH to NADP^+
 5. Transfer of protons from the chloroplast to the cytosol
17. Ferredoxin:
1. is reduced through the action of photosystem I.
 2. can transfer its electron to NADP^+ .
 3. can transfer its electron to the cytochrome bf complex.
 4. is located in the stroma.
 5. Answers 1 through 4 are all correct.
18. In their experiments on protein translocation across the ER, Blobel and Dobberstein found that a protein product of the same size as the secreted protein could be obtained:
1. only if microsomes were included while the mRNA for the protein was being translated.
 2. only if microsomes were added after the translation of the protein was completed.
 3. regardless of whether microsomes were included before or after translation of the protein took place.
 4. only if microsomes were included while the mRNA being translated and the mixture was treated with a protease.
 5. only if microsomes were added after the translation of the protein was completed and the mixture was treated with a protease.

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19. The presence of a single internal stop transfer sequence in a plasma membrane protein indicates that:
1. the N-terminus of the protein will remain in the cytoplasm during synthesis
 2. the protein will be directed to the lysosome
 3. the protein will remain in the endoplasmic reticulum
 4. the N-terminus of the protein will remain in exoplasmic space
 5. the protein will contain internal disulfide bonds
20. Which of the following binds directly to proteins that carry a nuclear localization signal?
1. Ran-GTP
 2. Importin
 3. Ran-GDP
 4. Ran GTPase Activating Protein (GAP)
 5. Ran Guanine nucleotide Exchange Factor (GEF)
21. When the terminal glucose residue (Glc₁) is removed from an oligosaccharide on an N-linked glycoprotein
1. the oligosaccharide can bind calnexin, but only if the polypeptide chain is properly folded
 2. the oligosaccharide can bind calnexin, but only if the polypeptide chain is unfolded
 3. the oligosaccharide loses its ability to bind calnexin
 4. no further modification of the oligosaccharide can occur
 5. the modification of the oligosaccharide is normally completed
22. Which of the following is not a characteristic of the process by which proteins are imported into peroxisomes
1. the signal sequence is normally found at the C terminus of the protein
 2. the protein is normally imported in a folded form
 3. the signal sequence is removed after import
 4. the protein associates with a cytosolic receptor prior to import
 5. the protein is imported through a protein complex embedded in the peroxisomal membrane
23. Cargo proteins can be selected for a particular vesicle type on the basis of:
1. their hydrophobicity
 2. their affinity for a coat protein
 3. signal sequences that are removed after import into the vesicle
 4. the type of signal recognition particle they associate with
 5. the number of transmembrane domains they contain
24. Modification of the N-linked oligosaccharides of lysosomal proteins
1. occurs in the ER
 2. involves modification of specific glucose residues
 3. involves the transfer of a phosphate group from ATP
 4. involves the addition of an N-acetyl-glucosamine phosphate residue
 5. is unrelated to the localization of these proteins to the lysosome

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25. Which of the following does not play a role in the proper localization of a protein to the plasma membrane?
1. SRP
 2. translocon
 3. signal sequence
 4. M6P receptor
 5. SRP receptor
26. What is the function of the myosin II tail domain?
1. It binds myosin II molecules together in thick filaments.
 2. It binds to transport vesicles.
 3. It binds to the plasma membrane
 4. It hydrolyzes ATP.
 5. It binds to actin thin filaments.
27. What action allows myosin II to let go of actin?
1. release of inorganic phosphate (Pi)
 2. binding ATP.
 3. hydrolysis of ATP.
 4. binding of ADP.
 5. structural changes in the tail domain.
28. In this list, there is one component that is NOT necessary for the movement of *Listeria* in a cell- which one is it?
1. Act A
 2. Arp 2/3
 3. fimbrin
 4. cofilin
 5. capping protein
29. In a moving cell, the mechanism for extending the lamellipodium is different from the mechanism for pulling the back part of the cell forward. What molecule is involved in this second process?
1. Arp2/3
 2. cofilin
 3. profilin
 4. myosin II
 5. myosin XI
30. At what point in cell division is myosin II important?
1. anaphase A
 2. centrosome migration
 3. anaphase B
 4. telophase
 5. cytokinesis

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31. Which of the following actin binding proteins functions most similarly to MAP2?
1. α -actinin
 2. filamin
 3. gelsolin
 4. fimbrin
 5. cofilin
32. You polymerize microtubules on centrosomes in vitro. You then add tiny ($<1\mu\text{m}$) glass beads that are coated with cytoplasmic dynein. What is the most likely outcome of this experiment?
1. The beads bind to the microtubules but do not move.
 2. The beads bind to the microtubules and move away from the centrosome.
 3. The beads bind to the microtubules and cause them to depolymerize.
 4. The beads bind to the microtubules and move toward the centrosome.
 5. The beads bind to the microtubules and move in both directions on them.
33. Which of these ATPases does NOT act as a transport motor?
1. kinesin
 2. axonemal dynein
 3. XKCM1
 4. cytoplasmic dynein
 5. myosin V
34. The ciliary basal body is most similar to the..
1. centrosome
 2. metaphase chromosome
 3. centromere
 4. centriole
 5. kinetochore
35. Which motors push chromosomes away from the spindle poles?
1. cytoplasmic dynein
 2. MCAK
 3. axonemal dynein
 4. CENP-E
 5. chromokinesins
36. Where are the least stable microtubules?
1. mitotic spindle
 2. ciliary axoneme
 3. interphase microtubules
 4. axon
 5. flagellar axoneme

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37. What determines the selectivity of the potassium channel?

1. The presence of negative charges at the cytosolic opening of the channel.
2. peptide backbone carbonyl oxygens in the selectivity filter
3. the presence of water in the selectivity filter
4. amino acid side chains in the selectivity filter.
5. The diameter of the selectivity filter which is large enough to let potassium pass but too small for sodium.

38. You have expressed the resting (leak) potassium channel in a *Xenopus* oocyte. You use a patch-clamp electrode to monitor current through a single channel. How does the channel change behaviour when you depolarize the membrane?

1. it opens more frequently
2. it only opens partially.
3. it does not change its behaviour.
4. it stays open longer.
5. it completely stops opening.

39. What is it about the S4 α helix in voltage sensitive channels that makes it suitable as a voltage sensor?

1. It is situated at the exterior surface of the plasma membrane where it can sense voltage changes.
2. Its overall charge is negative.
3. It is long enough to extend completely through the membrane.
4. It contains many positively charged amino acids.
5. It contains many hydrophobic residues that make it exquisitely sensitive to changes in membrane voltage.

40. Which ion has the largest driving force or negative free energy moving into a cell?

1. Sodium
2. Chloride
3. Potassium
4. Impermeant anions
5. Calcium

41. Which receptors does smoking a cigarette directly affect?

1. acetylcholine receptors on muscle
2. glycine receptors
3. GABA receptors
4. acetylcholine receptors on heart
5. glutamate receptors

42. How is transmitter taken up into synaptic vesicles in a nerve terminal?

1. by a transmitter ATPase, i.e., by an active uptake system.
2. by a proton/transmitter antiport
3. by a sodium/ transmitter symport
4. by a proton/ transmitter symport
5. by osmotic transfer

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43. Which of the following transmitters is enzymatically degraded in the synaptic cleft?

1. GABA
2. norepinephrine
3. acetylcholine
4. dopamine
5. glutamate

44. What is an effective way to inhibit a neuron from firing?

- 1..Close K^+ channels
- 2..Open Cl^- channels
- 3..Open K^+ channels
- 4..Open Na^+ channels
- 5..Open Ca^{++} channels

1. 1
2. 4 or 5..
3. 2 only
4. 2 or 3
5. 2, 3 or 4

45. What is the major inhibitory transmitter in the brain?

1. dopaminic
2. glycine
3. norepinephrine
4. endorphin
5. GABA

46. What is the function of Ca^{++} that is released from the sarcoplasmic reticulum in muscle?

1. It causes tropomyosin to shift thereby allowing muscle contraction to occur.
2. It activates myosin so that it can interact with the thin filaments.
3. It causes synaptic release of transmitter.
4. It binds to myosin and prevents it from interacting with actin.
5. It activates myosin V thereby allowing muscle contraction to occur.

47. What motor protein is necessary for vesicle movement in the cell cortex?

1. kinesin
2. myosin
3. chromokinesin
4. dynein
5. XKCM1

48. What happens to the polar microtubules during anaphase B?

1. They grow by polymerization at the – end.
2. They are fragmented by microtubule severing proteins.
3. They grow by polymerization at the + end.
4. They shrink by depolymerization at the + end.
5. They undergo treadmilling.

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49. If the critical concentration (C_c) for the + end of a microfilament is $0.1\mu\text{m}$ and the C_c for the – end is $0.8\mu\text{m}$ at what concentration of actin monomers would treadmilling be most likely to occur?

1. $1.2\mu\text{m}$
2. $0.1\mu\text{m}$
3. $0.8\mu\text{m}$
4. $0.45\mu\text{m}$
5. $0.01\mu\text{m}$

50. Gamma tubulin is to microtubules as _____ is to microfilaments.

1. profilin
2. kinesin
3. fimbrin
4. Act A
5. Arp 2/3

51. What is the effect of cocaine on nerve cells?

1. It blocks reuptake of dopamine.
2. It blocks the breakdown of acetylcholine in the synaptic cleft.
3. It is an antagonist of glycine synapses.
4. It blocks reuptake of acetylcholine.
5. It blocks the breakdown of dopamine in the synaptic cleft.

52. ATP supplies energy for what aspect of action potential conduction?

1. inactivation of Na^+ channels.
2. maintenance of the Na^+ and K^+ gradients.
3. pumping of Ca^{++} out of the cell.
4. keeping the impermeant anions in the cell.
5. maintenance of the Na^+ and Cl^- gradients.

53. What is one mechanism by which catastrophes are thought to occur in microtubules?

1. loss of the ATP cap
2. loss of the GDP cap
3. loss of the GTP cap
4. loss of the ADP cap
5. increased binding of ATP tubulin to the + end of the microtubule

54. Myosin II and the kinesins responsible for transport away from the centrosome are quite similar in many ways. WHICH ONE of the following statements about their similarities is TRUE?

1. They both form thick filaments.
2. They both have short (<10%) duty cycles.
3. They both move toward the – end of their respective polymer tracks.
4. They both form dimers held together by a coiled coil tail.
5. They can both move along actin microfilaments.

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55. The structure that cilia grow from (are nucleated from) is most similar to which intracellular structure?
1. the centromere
 2. the centrosome
 3. gamma tubulin ring complex
 4. the kinetochore
 5. the centriole
56. Some members of the steroid receptor superfamily bind to direct repeats in their DNA response element. Where are these receptors located in the cell?
1. in the nucleus
 2. on the surface of the endoplasmic reticulum
 3. at the plasma membrane
 4. both in the cytoplasm and at the plasma membrane
 5. in the cytoplasm
57. What happens when a glucocorticoid receptor binds hormone?
1. It increases intracellular levels of cAMP.
 2. It translocates to the nucleus.
 3. It becomes bound in an inhibitory complex.
 4. It translocates to the cytoplasm.
 5. It blocks transcription.
58. Assume you have a cell with receptors that activate a $G_{s\alpha}$ protein when they bind hormone. What will happen if you greatly enhance the activity of the associated GAP?
1. More cAMP will be produced than usual.
 2. The $G_{s\alpha}$ will interact with adenylyl cyclase and inhibit it.
 3. Less cAMP will be produced than usual.
 4. Phospholipase C will be activated for an extended period of time.
 5. The $G_{s\alpha}$ will remain activated for a longer time than usual.
59. Which protein is NOT a GTPase?
1. beta tubulin
 2. $G_{s\alpha}$
 3. ras
 4. actin
 5. $G_{i\alpha}$
60. What is the effect of light on retinal rods?
1. It opens Na^+ channels in the rod plasma membrane causing an action potential.
 2. It activates a G protein ($G_{t\alpha}$) that causes an increase in cAMP in the rod.
 3. It causes a slight depolarization of the rods which is translated into visual signals to the brain.
 4. It activates a guanylyl cyclase in the rod plasma membrane.
 5. It closes nonselective cation channels in the rod plasma membrane.

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61. Which enzymatic step is crucial in causing blood glucose levels rise after epinephrine binds to its receptors on the liver?
1. the phosphorylation of glycogen phosphorylase by glycogen phosphorylase kinase
 2. the activation of glycogen synthase by phosphatase.
 3. the conversion of cAMP to AMP by phosphodiesterase.
 4. the entry of glucose-6-phosphate into glycolysis
 5. the dephosphorylation of glycogen phosphorylase kinase by phosphatase
62. Which molecule(s) directly activate protein kinase C?
1. cGMP
 2. Ca^{++} and diacylglycerol
 3. IP3 and cAMP
 4. cAMP
 5. Ca^{++} and cAMP
63. What role does Ca^{++} play in the relaxation of vascular smooth muscle?
1. it directly activates guanylate cyclase
 2. it blocks interaction of myosin heads with actin thin filaments
 3. it directly activates nitric oxide synthase
 4. it activates IP3
 5. it directly activates protein kinase G
64. What is an important difference between $G\alpha$ proteins and ras?
1. $G\alpha$ is activated by binding GTP while ras is activated by binding GDP.
 2. $G\alpha$ is attached to the membrane by a lipid tail while ras is an integral membrane protein
 3. The primary effect of activated $G\alpha$ is to raise or lower levels of cAMP in the cell while activated ras invariably raises cAMP levels.
 4. $G\alpha$ has intrinsic GTPase activity while ras requires GAP activity from an accessory protein in order to hydrolyze GTP.
 5. $G\alpha$ is never part of a complex in the plasma membrane while ras is part of a trimeric complex.
65. What is the function of GRB2 in signal transduction by a receptor tyrosine kinase?
1. It acts as the guanine nucleotide exchange factor (GEF) for ras.
 2. It causes dimerization of the receptor.
 3. It functions as the GTPase accelerating protein (GAP) for ras.
 4. It creates docking sites for adaptor proteins by phosphorylating tyrosines on the receptors.
 5. It is an adaptor protein.
66. What is an example of a cell junction that contains integrins?
1. a hemidesmosome
 2. a gap junction
 3. an adherens junction
 4. a tight junction
 5. a desmosome

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67. Which molecule is NOT a component of the basal lamina?

1. laminin
2. collagen I
3. entactin
4. collagen IV
5. perlecan

68. What is the order of the junctions in a junctional complex, starting from the apical surface of the cell?

1. tight junction, desmosome, adherens junction
2. adherens junction, tight junction, desmosome
3. tight junction, adherens junction, desmosome
4. tight junction, adherens junction, hemidesmosome
5. tight junction, gap junction, desmosome

69. What is/are the function(s) of tight junctions in the intestinal epithelium?

- 1-To restrict glucose/Na⁺ symporters to the apical plasma membrane and glucose uniporters to the basolateral plasma membrane.
- 2-To allow the epithelial cells to communicate with each other using small molecule second messengers.
- 3-To prevent molecules from the lumen of the intestine from passing between the epithelial cells
- 4-To fix the epithelium to the underlying basal lamina.
- 5-To anchor the cells of the epithelium in a sheet by connecting the cytoskeletal elements (intermediate filaments) of its cells together.

1. 4 and 5
2. 1 only
3. 5 only
4. 1 and 3
5. 2 only

70. What role does phosphorylation of tyrosine (Y) 15 in cdc2 of *S. pombe* play in the function of the cdc2::mitotic cyclin complex.

1. It activates the kinase activity of the cdc2
2. It targets the cyclin for destruction.
3. It serves as a docking site for adapter proteins.
4. It serves as a binding site for beta arrestin.
5. It inhibits the kinase activity of the cdc2.

71. Phosphorylation of which protein is directly responsible for nuclear envelope breakdown?

1. histone H1'
2. beta tubulin
3. lamin
4. cdc2
5. cyclin D

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72. Mitotic cyclin levels in early *Xenopus* embryos are regulated by.
1. phosphorylation of cyclin
 2. synthesis and degradation of cyclin mRNA
 3. degradation of cyclin directed by APC
 4. variations in the translation rate of cyclin mRNA
 5. degradation of cyclin directed by MPF
73. In what aspect of mitosis does protein degradation play a role?
1. breakdown of the nuclear envelope
 2. chromosome condensation
 3. cytokinesis
 4. separation of sister chromatids at anaphase
 5. disruption of the golgi apparatus
74. Which protein is stabilized by DNA damage?
1. p53
 2. Cdc 25A
 3. ubiquitin
 4. Rb
 5. cyclin B
75. What prevents the cell from replicating its DNA more than once during S phase?
1. polyubiquitination of cyclin B
 2. phosphorylation of pre-replication complex proteins.
 3. limiting amounts of nucleotides
 4. phosphorylation of origin-recognition complex proteins
 5. activation of APC