

## MCDB/CHEM 103/203 Final Examination, March 19, 2012

Print Your Name as Registered in this Course on the Line Below:

*(Exams Lacking Names or with Illegible and Incomplete Names will not be Graded)*

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*Absent, illegible or otherwise unclear responses will be considered wrong responses. Carefully circle answers to multiple-choice questions and legibly write answers to questions requiring written responses. Return all pages for credit.*

1) Which of the below organelles, components, or structures are absent from prokaryotes? (4 pts)

- a) nucleus
- b) endoplasmic reticulum
- c) plasma membrane
- d) a and b
- e) none of the above

*Answer: d*

2) What does a chloroplast do? (4 pts)

*Answer: photosynthesis or produce energy*

3) How many different eggs and sperm are needed to generate fraternal (dizygotic) twins? (4 pts)

*Answer: two eggs and two sperm*

- 4) Which below are features of the scientific method? (4 pts)
- a) evidence-based reasoning and logic
  - b) opinion-based belief and faith
  - c) conclusions can be appealed and overturned by authority
  - d) skepticism is unacceptable and suppressed
  - e) all of the above

*Answer: a*

- 5) Which macromolecules of all cells are not encoded by the genome? (4 pts)

*Answer: glycans and lipids (no credit for sugars as they are not macromolecules)*

- 6) (True or False) All enzymes are proteins. (3 pts)

*Answer: false*

- 7) Which is incorrect? (4 pts)
- a) ribosomes bind both mRNAs and tRNAs during translation
  - b) most cellular RNAs do not encode proteins
  - c) lipids must be obtained in humans from both diet and cellular biosynthesis
  - d) glycans are made from nine essential monosaccharides present in the diet
  - e) DNA is transcribed into RNA before intron splicing occurs

*Answer: d*

8) The unusual amino acids selenocysteine and pyrrolysine are not found in the standard genetic code that determines the 20 amino acids of proteins. How are they encoded? (4 pts)

*Answer: They are encoded by “stop” or “amber” or “amber stop” codons, in some cells and organisms*

9) In water, which are the three possible packing forms of lipids having either one or two fatty acid tails? (4 pts)

- a) planar monolayer, spherical monolayer, and spherical bilayer
- b) spherical monolayer, cubical monolayer, planar bilayer
- c) spherical monolayer, planar bilayer, spherical bilayer
- d) cubical monolayer, cubical bilayer, planar bilayer
- e) spherical monolayer, planar monolayer, cubical bilayer

*Answer: c*

10) The leaflets of biological membranes are often asymmetric. What about them is asymmetric? (4 pts)

*Answer: Each membrane leaflet (inner and outer) is enriched in different lipids defined by their heads or headgroups. Partial credit for listing specific lipids.*

11) In membrane transport, under what condition would the rate of molecular transport by simple diffusion be higher than by protein/transporter-mediated (saturable) diffusion? (4 pts)

- a) whenever the concentration of the transported molecule is above the  $K_m$  of the transporter
- b) whenever the rate of transporter-mediated transport is above  $\frac{1}{2}$  of its  $V_{max}$
- c) when the transporter is saturated and the rate of simple diffusion is greater than  $V_{max}$
- d) it never happens
- e) simple diffusion always has a higher rate of molecular transport

*Answer: c*

12) What must the potassium channel exclude from its pore in order to selectively transport the larger potassium ion instead of the smaller sodium ion? (4 pts)

*Answer: water or water- $Na^+$  complex*

13) Which type of cellular glycan consists only of a simple disaccharide repeat? (4 pts)

- a) glycosaminoglycans of proteoglycans
- b) hyaluronan
- c) N-glycans
- d) glycans of glycolipids
- e) glycans of GPI-anchors

*Answer: b*

14) What is a major distinguishing feature of vertebrate N-glycans compared to the N-glycans of lower organisms including yeast? (4 pts)

*Answer (any one of the below is acceptable):*

*Vertebrate N-glycans have fewer mannose linkages*

*Vertebrate N-glycans have fewer exposed/terminal mannose linkages*

*Vertebrate N-glycans are made up of different monosaccharides (more complex glycans, less oligomannose)*

*Vertebrate N-glycans have sialic acids*

15) (True or False) Some proteins are synthesized in the nucleus before they are transported to the cytosol. (4 pts)

*Answer: false*

16) Which two organelles have double membranes? (4 pts)

- b) nucleus and Golgi
- a) endoplasmic reticulum and lysosomes
- c) Golgi and peroxisomes
- d) lysosomes and endosomes
- e) mitochondria and nucleus

*Answer: e*

17) Which of the following is incorrect? (4 pts)

- a) ATP is made in both the mitochondria and the cytosol.
- b) The electron transport chain is coupled to ATP synthesis by the proton gradient and ATP synthase.
- c) The majority of mitochondrial proteins are synthesized in mitochondria.
- d) a and c
- e) None of the above

*Answer: c*

18) What are the four main functions of the Golgi apparatus? (4 pts)

*Answer: biosynthesis of glycolipids, covalent modification of proteins (i.e. glycosylation, sulfation, rare phosphorylation), sorting of proteins, and targeted secretion*

19) Name two of the three pathways/processes that can lead to lysosomal degradation? (4 pts)

*Answer: endocytosis, phagocytosis and/or autophagy*

20) Which statement below is incorrect about kinases and phosphatases? (4 pts)

- a) Kinases can activate proteins
- b) Phosphatases can activate proteins
- c) Phosphatases phosphorylate proteins
- d) Proteins can be phosphorylated at serines, tyrosines, and threonines
- e) None of the above

*Answer: c*

21) Which of the choices below is correct about phosphatidylinositol (PI) and phosphoinositides (PIPs)? (4 pts)

- a) They are major components of cellular lipids
- b) They are primarily found among the outer leaflet of the plasma membrane
- c) They are glycolipids that can act as membrane and organelle localization signals
- d) a and c
- e) None of the above

*Answer: c*

22) Which of the following is correct? (4 pts)

- a) Both PI and PIPs are phospholipids
- b) PIPs are phosphorylated PI at positions 3, 4, and/or 5
- c) Different PI/PIP kinases and phosphatases have different subcellular compartmental localizations
- d) All of the above
- e) None of the above

*Answer: d*

23) (True or False) PIPs, like  $\text{PIP}_2$ , can be cleaved by phospholipases to generate signaling molecules. (4 pts)

*Answer: true*

24) What are the three mechanisms of intracellular transport? (6 pts)

*Answer: gated transport, transmembrane transport, vesicular transport*

25) (True or False) All gated and transmembrane transport is non-vesicular. (4 pts)

*Answer: true*

26) Proteins that are transported into organelles originate from which cellular locations? (4 pts)

- a) nucleus and endoplasmic reticulum
- b) endoplasmic reticulum and cytosol
- c) cytosol and Golgi
- d) a and b
- e) All of the above

*Answer: b*

27) What is different about protein structures transported by co-translational and post-translational mechanisms? (4 pts)

*Answer:*

*Post-translational transport can include both folded and unfolded proteins*

*Co-translational transport includes only unfolded proteins*

28) (True or False) Both signal sequences and signal patches can be involved in co-translational transport. (4 pts)

*Answer: False*



29) (Yes or No) Consider a large protein (>60kDa) with a single nuclear transport signal. Can that signal be sufficient but not necessary for nuclear transport? (4 pts)

*Answer: No*

30) If you fuse an endoplasmic reticulum signal sequence to the N-terminus of a nuclear protein, where would this fusion protein be targeted? (4 pts)

- a) endoplasmic reticulum
- b) nucleus
- c) both endoplasmic reticulum and nucleus
- d) remain in the cytosol
- e) None of the above

*Answer: a*

31) How can phosphorylation and de-phosphorylation control trafficking between the nucleus and cytosol? Use the NF-AT protein as an example. (4 pts)

*Answer: Phosphorylation and de-phosphorylation can change NF-AT conformation reversibly exposing either nuclear export or nuclear import signals.*

32) Which is incorrect about GTPases? (4 pts)

- a) GTPases bind and hydrolyze GTP
- b) GTP hydrolysis is a single step
- c) GDP to GTP exchange is a two step process
- d) GDP dissociation is typically faster than GTP association
- e) None of the above

*Answer: d*

33) In order for the Ran GTPase to participate in bi-directional transport between the nucleus and cytosol, what additional molecules besides GTP, GDP, and the nuclear pore complex are needed? (6 pts)

*Answer: Ran-GAP (or GAP), Ran-GEF (or GEF), nuclear import receptors (or importins), nuclear export receptors (or exportins), nuclear transport factor 2 (or NTF2)*

34) (True or False) Protein translocation into mitochondria can occur either by diffusion or protein-mediated translocation. (4 pts)

*Answer: false*

35) Which is correct? (4 pts)

- a) peroxisome protein translocation is post-translational
- b) peroxisomal proteins are translocated in the folded state
- c) chaperones can aid in both protein folding and unfolding
- d) all of the above
- e) none of the above

*Answer: d*

36) Vesicular transport can be divided into four steps. What are they? (4 pts)

*Answer: budding or fission, movement or trafficking, tethering or docking, fusion*

37) Which statement is incorrect about vesicular transport between the endoplasmic reticulum and Golgi? (4 pts)

- a) COPI vesicles transport cargo primarily to the endoplasmic reticulum
- b) COPII vesicles transport cargo primarily from the endoplasmic reticulum to the Golgi
- c) The VTC is formed by homotypic membrane fusion between ER-derived transport carriers.
- d) coat proteins are used to identify and bind target membranes.
- e) none of the above

*Answer: d*

38) What controls the disassembly of a COPII coat? (4 pts)

*Answer (any one of the following): GTP hydrolysis, GTPase activity, GTP to GDP binding/exchange, or conversion of Sar1-GTP to Sar1-GDP. Partial credit for only saying Sar1 GTPase.*

39) Which statement is incorrect regarding vesicle transport processes? (4 pts)

- a) SNAREs assist in vesicle formation
- b) Rab GTPases participate in the specificity of membrane targeting
- c) SNAREs participate in the specificity of membrane targeting
- d) ATP is needed for the recycling of SNAREs
- e) none of the above

*Answer: a*

40) (True or False) The vesicular tubular structure is an intermediate compartment for protein transport between the nucleus and the endoplasmic reticulum. (4 pts)

*Answer: false*

41) In order to keep resident proteins localized to a particular compartment or organelle, two types of mechanisms are used by the cell. What are these two mechanisms and what do they do? (4 pts)

*Answer: retention mechanism for preventing cargo from leaving a particular compartment, and retrieval mechanism for capturing and sending cargo back to a particular compartment*

42) The KDEL receptor controls protein retention in the endoplasmic reticulum. Which of the following statements in a-d is incorrect? (4 pts)

- a) the KDEL receptor must have a Golgi retention signal
- b) the KDEL receptor must have an endoplasmic reticulum export signal
- c) the KDEL receptor must have a Golgi to endoplasmic reticulum transport signal
- d) the KDEL receptor must bind cargo preferentially in the endoplasmic reticulum
- e) all of the statements in a-d are correct

*Answer: d*

43) What are the two models of transport within the Golgi? (4 pts)

*Answer: The vesicular transport model and the cisternal maturation model*

44) Which is not one of the major sorting pathways/destinations from the trans Golgi network (TGN)? (4 pts)

- a) lysosome
- b) plasma membrane
- c) endoplasmic reticulum
- d) secretory vesicle
- e) b and d

*Answer: c*

45) What does the mannose-6-phosphate modification do? (4 pts)

*Answer: targets proteins (or enzymes, or hydrolases) to the lysosome or to the lysosome via the endosome.*

*Partial credit for only mentioning that it binds to mannose 6-phosphate receptor without specifically mentioning of the lysosome.*

46) If protein phosphorylation by kinase activity does not occur in the Golgi apparatus, then how does the mannose residue in N-glycans obtain a phosphate group at the 6<sup>th</sup> carbon position to become the mannose-6-phosphate signal? (4 pts)

*Answer (either is correct): the phosphate comes from the UDP-sugar, or the phosphate comes from UDP-GlcNAc, or the phosphate comes from GlcNAc-phosphate (GlcNAc-P) (if GlcNAc is spelled out, it must be correctly identified as N-acetyl-glucosamine) which is added on by enzymes, or is added on by GlcNAc phosphotransferase*

- 47) Which of the following is correct? (4 pts)
- a) lysosomal sorting is dependent upon pH
  - b) proteins are targeted to lysosomes by signal sequences
  - c) unlike most transport machinery, the M6P receptor is not recycled
  - d) a and b
  - e) none of the above

*Answer: a*

- 48) What would happen to acid hydrolases in patients with Inclusion-cell (I-cell) disease? (4 pts)

*Answer: The hydrolases would not reach the lysosome and would be secreted from the cell*

- 49) (True or False) Transport from the trans Golgi network (TGN) to the plasma membrane is always constitutive and part of the default pathway. (4 pts)

*Answer: false*

- 50) What is the fate of endocytic cargo (such as the EGF/EGFR) that becomes sequestered in internal vesicles of the multi-vesicular body (MVB)? (4 pts)

*Answer: It gets degraded (2 points) by the lysosome (2 points).*

- 51) Which of the below are not endocytosis pathways in mammals? (4 pts)
- a) phagocytosis
  - b) clathrin-mediated endocytosis
  - c) macropinocytosis
  - d) microtubular endocytosis
  - e) caveolin-mediated endocytosis

*Answer: d*

- 52) (True or False) If you use a G-actin mutant unable to hydrolyze ATP for the *in vitro* F-actin assembly experiment, there would be no polarity present on the two ends of F-actin filaments. (4 pts)

*Answer: False*

- 53) Which type of proteins do proteasomes degrade? (4 pts)
- a) misfolded membrane proteins
  - b) misfolded cytosolic proteins
  - c) ubiquitinated proteins
  - d) folded cytosolic proteins
  - e) all of the above

*Answer: e*

54) After the polymerization of F-actin filaments has reached the steady state in a solution containing actin monomer, what would happen if the solution is diluted by 10-fold? Assume that the critical concentration ( $C_c$ ) of the + (plus) ends of the F-actin filaments is one third of that of the – (minus) ends. (4 pts)

- a) The preassembled F-actin filaments will start to depolymerize from both ends
- b) Actin monomers will be polymerized at both ends
- c) No effects on the preassembled F-actin
- d) The – end of F-actin will disassemble and the + end will remain the same
- e) The – end of F-actin will disassemble and the + end will grow

*Answer: a*

55) In most cells, the concentration of total actin monomer is about 100  $\mu\text{M}$  and the critical concentration is about 1  $\mu\text{M}$ . Based on these observations, one may mistakenly assume that the condition always favors polymerization *in vivo*. How do you explain this apparent paradox? (4 pts)

*Answer: actin monomers can be complexed by thymosin to keep them from forming F-actin*

56) (True or False) Although microtubules are linked to the microtubule organizing center (MTOC), they typically nucleate at the + end located near the plasma membrane. (4 pts)

*Answer: false*

57) List the five basic mechanisms / types of cell signaling. (5 pts)

*Answer: contact-dependent, paracrine, endocrine, autocrine, synaptic*



58) Which of the following is incorrect? (4 pts)

- a) cells can respond differently to the same molecule at the same concentration
- b) cells can respond differently to different concentrations of the same molecule
- c) enzymes may be positively or negatively regulated by their products
- d) Negative feedback in protein phosphorylation and dephosphorylation can generate signal oscillation
- e) the *src* oncogene in the Rous sarcoma virus is an exact duplicate of the cellular *src* gene found in the host organism

*Answer: e*

59) List the five phases in the cell cycle, and each of the four phases of cell division. In which phase of the cell cycle does cell division occur? (10 pts)

*Answer:*

*Cell cycle phases (in any order): G1, G0, S, G2 and M (or mitosis);*

*Cell division phases (in any order): prophase, metaphase, anaphase, telophase and cytokinesis (half point for only listing telophase or cytokinesis)*

*Cell division occurs in the M phase (or mitosis) of the cell cycle*

60) What is different about the products of meiosis and mitosis? (4 pts)

*Answer: the products of meiosis are haploid gametes while the products of mitosis are diploid cells*