NAME: _____ STUDENT #: _____

BIO 1140 Introduction to cell biology

MIDTERM #1

February 9th, 2013

Dr. K.M. Gilmour

MULTIPLE CHOICE QUESTIONNAIRE KK

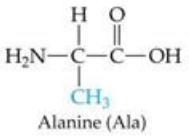
Instructions:

1. Make sure that you have a complete test package. You should have a set of multiple choice questions with a written-answer questionnaire, and a Scantron. Both components must be returned at the end of the midterm.
2. Fill in the Scantron with your name, student number and course code **BIO 1140 KK**.

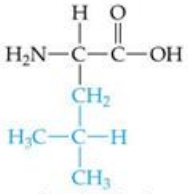
Answer the following 20 multiple choice questions **on the Scantron sheet** provided. Choose only one answer from among the choices. (20 marks)

1. Which one of the following is not a model organism?
   a. *Danio rerio*
   b. *Saccharomyces cerevisiae*
   c. *Caenorhabditis elegans*
   d. *Escherichia coli*
   e. *Elysia chlorotica*

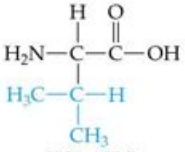
2. Which one of the amino acids below could be phosphorylated?



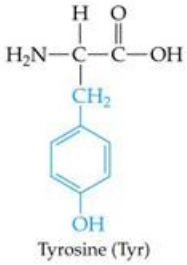
Alanine (Ala)



Leucine (Leu)



Valine (Val)

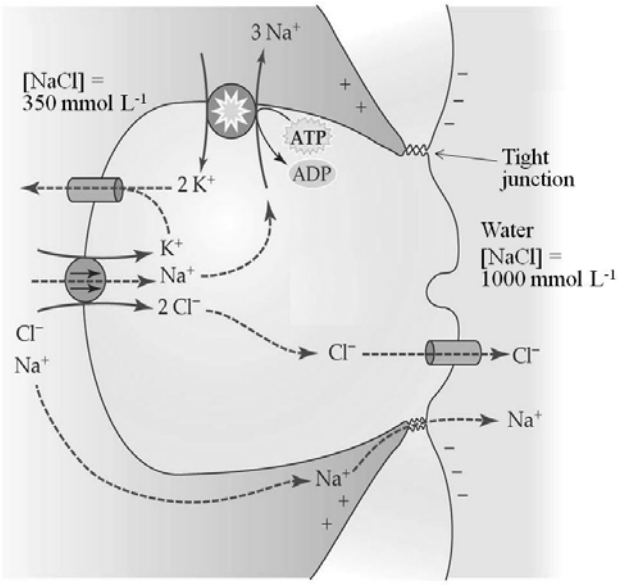


Tyrosine (Tyr)

   a. Alanine
   b. Leucine
   c. Valine
   d. Tyrosine

3. You are attempting to characterize a novel receptor. You note that the receptor includes seven transmembrane domains. The novel receptor probably belongs to the family of…
   a. G protein-coupled receptors
   b. Steroid hormone receptors
   c. Receptor tyrosine kinases
   d. None of the above

4. In the schematic at right, Cl^- enters the cell by…
   a. Simple diffusion
   b. Facilitated diffusion
   c. Primary active transport
   d. Secondary active transport



5. You have grown a culture of *Arabidopsis thaliana* root cells and discovery that they are heavily contaminated with a mould, a type of fungus. Which one of the following procedures is most likely to eliminate the mould without killing the plant cells?
   a. Treating the culture with a drug that impairs chlorophyll synthesis.
   b. Treating the culture with a drug that dissolves cell walls.
   c. Treating the culture with a drug that damages DNA.
   d. Treating the culture with a drug that inhibits ergosterol synthesis.
   e. None of a, b, c or d will eliminate the mould without killing the plant cells.

6. In an aerobic bacterium, the proteins of the electron transport chain are located…
   a. On the inner mitochondrial membrane.
   b. In the cytosol.
   c. On the plasma membrane.
   d. In the mitochondrial matrix.
   e. On the outer mitochondrial membrane.

7. To investigate the nature of a membrane protein, you tag the protein with a fluorescent marker and then measure membrane fluorescence after a variety of treatments designed to detach the protein from the membrane. Treatment with phospholipase C is ineffective, as is changing the solution pH or ionic strength. Membrane fluorescence is eliminated only after the membrane is disrupted by treating it with a detergent. Which of the following conclusions is most consistent with your observations?
   a. The protein of interest is linked to the membrane by a glycosylphosphatidylinositol (GPI) anchor.
   b. The protein of interest is an integral protein.
   c. The protein of interest behaves like a peripheral protein.
   d. The protein of interest is anchored to the inner (cytosolic) leaflet of the lipid bilayer via a covalent interaction with a membrane fatty acid.
   e. Both b and d are consistent with your observations.

8. Which one of the following statements about G proteins is correct?
   a. G proteins are heterotrimeric fatty acid-anchored membrane proteins.
   b. G proteins function as molecular switches – they are active when GTP is bound to the α subunit and inactive when this GTP is hydrolyzed to GDP.
   c. When activated by a cell surface receptor, a G protein dissociates into an α subunit and a $\beta\gamma$ complex.
   d. All of a, b and c are true of G proteins.
   e. None of a, b or c is true of G proteins.

9. To whom are the first two tenets of the Cell Theory, i.e. that all organisms are composed of one or more cells and that the cell is the structural unit of life, attributed?
   a. Virchow
   b. Schwann and Schleiden
   c. Gorter and Grendel
   d. Singer and Nicolson
   e. Ediden

10. A ligand-gated ion channel...
   a. Opens or closes in response to changes in the membrane potential of the cell.
   b. Is an integral membrane protein receptor.
   c. Regulates gene transcription when activated by the binding of a lipid-soluble messenger molecule.
   d. Is opened or closed by the binding of a water-soluble messenger molecule.
   e. Both b and d are true of ligand-gated ion channels.

11. Which one of the following macromolecules is **least** likely to be found in the cytosolic leaflet of the cell membrane?
   a. Sterols
   b. Phosphoglycerides
   c. Glycolipids
   d. Proteins
   e. All of the above macromolecules are equally likely to be found in the cytosolic leaflet of the cell membrane.

12. You are investigating the mechanism through which a solute (we'll call it X), exits a plant cell across the plasma membrane. You observe that the transport of X exhibits saturation kinetics, depends on the presence of both H^+ ions and ATP, and occurs even when a high concentration of X is present in the extracellular solution. The transport of X most likely occurs by:
   a. Simple diffusion
   b. Facilitated diffusion
   c. Primary active transport
   d. Secondary active transport

13. The transmembrane domain of an integral membrane protein often consists of an alpha-helix sequence of nucleotides.
   a. True
   b. False

14. A typical prokaryotic cell is...
    a. 0.03 mm long
    b. 3×10^{-6} m long
    c. 30 nm long
    d. 3×10^{6} µm long
    e. None of the above

15. Lactate fermentation…
    a. Occurs in the skeletal muscle of anoxic goldfish.
    b. Regenerates NAD^+ by transferring electrons from NADH to pyruvate.
    c. Results in CO_2 production as the 3-C pyruvate is decarboxylated to a 2-C molecule of acetyl-CoA.
    d. All of a, b and c are true of lactate fermentation.
    e. None of a, b or c is true of lactate fermentation.

16. Amphipathic refers to...
    a. The adjustment of membrane composition to maintain membrane fluidity at different environmental temperatures.
    b. A molecule that includes both hydrophobic and hydrophilic regions.
    c. The unique, three-dimensional, stable structure adopted by a polypeptide chain that allows it to acquire biological activity.
    d. A membrane that allows selected molecules to pass while preventing or impeding the passage of other molecules.

17. The endosymbiont theory…
    a. Is supported by the fossil record, which indicates that protists evolved before eukaryotes.
    b. Suggests that mitochondria may have originated as anaerobic bacteria and chloroplasts as photosynthetic bacteria that established stable, symbiotic relationships with a prokaryotic host cell.
    c. Is supported by similarities between mitochondria/chloroplasts and bacteria, including the use of binary fission for reproduction.
    d. Is supported by the absence of phosphoglycerides from the inner membrane of mitochondria and chloroplasts, a trait shared with the plasma membrane of bacteria.

18. Which one of the following adjustments would **not** be used by a soybean plant to maintain the same level of membrane fluidity when the temperature in the greenhouse in which the plant is growing is adjusted from 10°C to 28°C?
    a. Increase the length of the hydrocarbon tails in its membrane phosphoglycerides.
    b. Increase the proportion of saturated hydrocarbon tails in its membrane phosphoglycerides.
    c. Increase the amount of cholesterol in the membrane.
    d. Increase the proportion of phosphatidylcholine relative to phosphatidylethanolamine.
    e. All of a, b, c and d would be employed by a soybean plant following a temperature change from 10°C to 28°C.

19. Adenylyl cyclase…
    a. Is a membrane-associated enzyme that produces the second messenger cAMP.
    b. Is an enzyme that catalyzes the transfer of a phosphate group from ATP to a protein.
    c. Is a cytosolic enzyme that catalyzes the breakdown of the second messenger cAMP.
    d. Is the kinase activated by cAMP.
    e. None of a, b, c or d is true of adenylyl cyclase.

20. Which one of the following statements about cell membranes is **not** correct?
    a. The two layers of the bilayer differ in protein and lipid composition, a phenomenon termed membrane asymmetry.
    b. The phopholipid bilayer constitutes a permeability barrier that can be overcome by transport proteins such as channels and pumps.
    c. Membrane glycolipids play a key role in regulating membrane fluidity.
    d. Membrane proteins serve numerous functions including cell-to-cell attachment and the detection of extracellular signals.

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WRITTEN-ANSWER QUESTIONNAIRE KK

Answer the following questions **on the questionnaire in the space** provided. (20 marks)

1. Complete the following statements. (1 mark per answer)
   a. The signalling molecule binds to the _____ of a receptor.
   b. A transport protein that carries two different solutes across the membrane in opposite directions is termed _____.
   c. The Na^+,K^+-ATPase is considered to be a _____ pump because it is reversibly phosphorylated as part of its pumping mechanism.
   d. In the process of _____, a 6-C glucose molecule is split into two 3-C pyruvate molecules with the production of ATP and NADH.
   e. To maintain membrane fluidity as temperature changes, organisms alter the chemical composition of cell membranes, a phenomenon termed _____.
   f. NADH is <u>oxidized OR reduced</u> (**choose one**) to NAD^+ by the loss of two electrons and a proton, with the release of energy.

2. Sketch and label a sterol. Use your sketch to explain the orientation of the molecule within the cell membrane. (3 marks)

3. Distinguish between a membrane channel and a porin. (2 marks)

4. You hypothesize that the increase in heart rate that occurs during a “fight-or-flight” response is mediated by a G protein-coupled receptor that uses cAMP as its second messenger. Design an experiment to test this hypothesis. Briefly describe the experimental approach that would be taken, the rationale for this experimental approach, and the expected results. (4 marks)

5. Discuss the structure of the plasma membrane with respect to its function as a permeability barrier that selectively regulates the entry and exit of solutes. (5 marks)