

PHGY 209 MAMMALIAN PHYSIOLOGY 1

MIDTERM EXAMINATION

Wednesday, October 26, 2011

Version 3

NAME: _____ MCGILL STUDENT NO.: _____

COURSE SECTION: _____ (i.e. Sec 001: 9:35–10:25 a.m. lecture or Sec 002: 11:35–12:25 p.m. lecture)

INSTRUCTIONS:

1. **The 9 digit McGill STUDENT NUMBER (ID) and CHECK BITS** (the two first letters of your **last name** as indicated on your ID) will be used for identification purposes in this test. Please place your McGill ID number on this test paper and **also** in the spaces marked "Student No." **on your Answer Sheet.**

IMPORTANT: Below the words "Student No." and "Check Bits", **FILL IN THE APPROPRIATE CIRCLES.**

IMPORTANT: Place your name and course number (INCLUDING SECTION NUMBER, i.e. SEC 001 or SEC 002) in the space provided above and on your Answer Sheet.

2. **DO NOT FOLD** or **BEND** the Answer Sheet.
3. Use a No. 2 or HB black pencil to fill in the appropriate circle on the IBM answer sheet. **ALL ERASURES MUST BE COMPLETE.**
4. **ANSWER ALL 35 QUESTIONS.** Marks are **NOT** deducted for wrong answers.
5. The time allocated for the exam is 1 hour and 30 minutes.
6. **LEAVE THE ANSWER SHEET AND THE ENTIRE EXAMINATION PAPER** as directed at the end of the exam. You may **NOT** take any part of the examination paper with you.
7. The results of this examination may be submitted to statistical testing designed to **UNCOVER POSSIBLE CHEATING.**

NOTE: *The Department of Physiology will not tolerate any academic offences with regard to cheating. Students are **FORBIDDEN** to converse with any person, other than an **INVIGILATOR**, during the course of the exam. If you are seen speaking with another student, your examination and answer sheet **WILL BE IMMEDIATELY COLLECTED BY THE INVIGILATOR.***

TYPE A: Choose the **ONE** that is **BEST** in each case and darken the appropriate circle on the answer sheet.

1. Which one of the following statements regarding platelets is **FALSE**?
 - a) They have a lifespan in the circulation of about 7-10 days.
 - b) They participate in both the primary and the secondary hemostatic phases.
 - c) They provide phospholipids which act as cofactors in the coagulation scheme.
 - d) They play an essential role in clot retraction.
 - e) They are necessary for clot lysis.

2. A subject is undergoing a tooth extraction, and the dentist notices that, after more than half an hour, the patient is still bleeding profusely. This may be best explained by the fact that
 - a) the subject has a very low Ca^{++} concentration in his blood.
 - b) the subject suffers from iron-deficiency anemia.
 - c) the subject has a low hematocrit.
 - d) the subject suffers from a severe vitamin K deficiency.
 - e) Any one of the above statements provides a reasonable explanation.

3. Erythropoietin
 - a) is produced by cytokine-releasing cells in the bone marrow of adults.
 - b) stimulates pluripotential stem cells to divide and differentiate into committed red blood cell precursors.
 - c) is present in high concentrations in the plasma of patients suffering from aplastic anemia.
 - d) is present in very low concentrations in subjects who have moved a few days earlier from a sea-level location to a high altitude.
 - e) has been used successfully to extend the lifespan of circulating red blood cells.

4. Which one of the following statements regarding the COP (colloidal osmotic pressure) of plasma is **FALSE**?
 - a) It does not play a major role in the distribution of the respiratory gases across the capillary wall.
 - b) It plays a major role in the distribution of fluids across the capillary wall.
 - c) It is largely the result of the presence of albumin.
 - d) It is not significantly affected by a doubling in plasma fibrinogen concentration
 - e) It is always high in patients with edema.

TYPE A: Choose the **ONE** that is **BEST** in each case and darken the appropriate circle on the answer sheet.

5. A subject was injected intravenously with a small volume of a solution containing 60 mg of indicator A (which does not cross the capillary wall), and 600 mg of indicator B (which cannot cross the cell membrane). Half an hour later, his blood was sampled and found to contain 0.02 mg of A per ml of plasma, and 0.04 mg of B per ml of plasma (assume that neither indicator is metabolized, nor lost in the urine). With this information alone, you can conclude that
- a) his plasma volume is 3 L, but his ISF volume cannot be determined.
 - b) his plasma volume is 3 L, and his ISF volume is 15 L
 - c) his plasma volume is equal to 1/5 of his ECF volume, and his ISF volume is 12 L .
 - d) his plasma volume is 3 L, but neither his ISF volume, nor his ECF volume can be determined without additional measurements.
 - e) None of the above statements is correct.
6. Transcellular fluid
- a) constitutes the true “Milieu Interieur”, as defined by Claude Bernard.
 - b) is the term applied to the fluid exchange that takes place across the capillary walls.
 - c) is considered to be an extracellular fluid.
 - d) has the same composition as lymph.
 - e) has the same colloidal osmotic (oncotic) pressure as plasma.
7. Insensible perspiration
- a) represents a facultative loss.
 - b) involves the loss of an isotonic fluid.
 - c) is absent in dehydrated individuals.
 - d) is absent in individuals lacking sweat glands.
 - e) does not require the expenditure of metabolic energy.

TYPE A: Choose the **ONE** that is **BEST** in each case and darken the appropriate circle on the answer sheet.

8. An individual stranded on a boat at sea without any drinking water decides to drink sea water. Which of the following would you expect in this individual?
- a) An increase in extracellular fluid (ECF) osmolarity, and a decrease in intracellular fluid (ICF) osmolarity.
 - b) An increase in ECF volume, and an increase in ICF volume.
 - c) An increase in ECF osmolarity, and a decrease in ICF volume.
 - d) An increase in ECF osmolarity, and a decrease in ECF volume.
 - e) An increase in ECF volume, and no change in ICF volume.
9. Facilitated diffusion is associated with which one of the following properties?
- a) It requires energy supplied directly by ATP.
 - b) It involves the diffusion of solute through ion channels.
 - c) It transports solute against the solute concentration gradient.
 - d) It is carrier-mediated.
 - e) The flux of the solute transported does not saturate at high extracellular solute concentrations.
10. Which one of the following is **NOT** a function of cell membrane proteins?
- a) They transport molecules into and out of the cell.
 - b) They act as enzymes.
 - c) They serve as receptors of chemical signals.
 - d) They provide stability for the cell membrane.
 - e) They contribute to cell adhesion.
11. The cell that links the innate and adaptive immune responses is
- a) a CD4+ lymphocyte.
 - b) a neutrophil.
 - c) a tissue macrophage.
 - d) a dendritic cell.
 - e) a B cell.

TYPE A: Choose the **ONE** that is **BEST** in each case and darken the appropriate circle on the answer sheet.

12. The specific interaction of the T_{H2} helper cell receptor (TCR) during the humoral immune response is with
- a) an MHC Class I molecule.
 - b) an immunoglobulin molecule.
 - c) an MHC Class II-peptide complex.
 - d) an MHC Class II molecule.
 - e) an MHC Class I-peptide complex.
13. The Natural Killer Cell (NK cell)
- a) must be inhibited by a normal HLA molecule to stop NK cell killing.
 - b) is largely involved with adaptive immunity.
 - c) is specific for a triggering immune reactivity.
 - d) will attack only cells infected with the hepatitis virus.
 - e) is normally only inhibited by a specific immunoglobulin antibody molecule.
14. One of the key elements characterizing the innate immune system is
- a) the minor role that it plays in immune protection.
 - b) its manifestation of memory of the immune event.
 - c) its lack of memory of any inciting event.
 - d) its utilization of only humoral factor mechanisms of defense.
 - e) its utilization of only cellular defense mechanisms.
15. In the process of T lymphocyte maturation and specialization *in utero* (before birth), the route of movement of these cells is
- a) yolk sac to fetal liver to bone marrow to lymph node.
 - b) fetal liver to yolk sac to bone marrow to lymph node.
 - c) yolk sac to lymph nodes to fetal liver to bone marrow.
 - d) yolk sac to bone marrow to liver to lymph node.
 - e) lymph node to fetal liver to yolk sac to bone marrow.

TYPE A: Choose the **ONE** that is **BEST** in each case and darken the appropriate circle on the answer sheet.

16. In the hypothetical situation where subject A is immunized with a bacterium ('antigen X'), and the dendritic cells, after antigen processing, are transfused into subject B, then subject B can be expected to
- generate a greater than normal antibody response to X.
 - develop immunological tolerance to X.
 - make no significant antibody response to X.
 - develop Th2 cell death of those Th2 cells programmed to respond to the peptide fragment(s) of X.
 - develop B cell death of those B cells programmed to respond to the bacterium X.
17. Ingestion of cocaine causes increased alertness and elevation of mood. These effects are due to which one of the following?
- Inhibition of voltage-gated sodium channels.
 - Modulation of metabotropic synaptic transmission.
 - Activation of voltage-gated potassium channels.
 - Inhibition of voltage-gated calcium channels.
 - Activation of fast axonal transport.
18. You are testing a new drug with possible therapeutic value, and discover, to your dismay, that it causes side-effects which include hallucinations and other manifestations of psychosis, as well as, abnormalities of learning and memory. Which one of the following is the most likely mechanism of action for this drug?
- It potentiates GABA_A receptors.
 - It potentiates potassium channels.
 - It blocks the pore of the NMDA receptor.
 - It blocks voltage-gated sodium channels.
 - It blocks voltage-gated calcium channels.
19. Puffer fish make a deadly neurotoxin called tetrodotoxin. Which of the following is the most likely explanation for why the toxin does not kill the puffer fish?
- Puffer fish have evolved a voltage-gated calcium channel which is insensitive to tetrodotoxin.
 - They have evolved a form of myelin which is insensitive to tetrodotoxin.
 - Their neuromuscular junctions do not use acetylcholine as a neurotransmitter.
 - They have evolved a form of voltage-gated sodium channel which is insensitive to tetrodotoxin.
 - They have developed highly efficient enzymes for degrading glutamate in the synaptic cleft.

TYPE A: Choose the **ONE** that is **BEST** in each case and darken the appropriate circle on the answer sheet.

20. In a classic study from the 1960's, the experimenters injected Ca^{2+} directly into the presynaptic terminal of a presynaptic neuron and then recorded EPSPs in the postsynaptic neuron. This experiment tested which one of the following hypotheses?
- a) Depolarization of the presynaptic terminal is required for neurotransmitter release.
 - b) Ca^{2+} is a neurotoxin.
 - c) Ca^{2+} activates calmodulin.
 - d) Increased intracellular Ca^{2+} in the presynaptic terminal triggers neurotransmitter release.
 - e) Ca^{2+} is required for synaptic plasticity.
21. An experimenter depolarizes the presynaptic terminal of an axon and observes that an action potential is initiated in the presynaptic terminal and travels back to the cell soma. How is this possible?
- a) The experimenter was recording from a rare "backpropagating" axon.
 - b) There must have been a flaw in the experimenter's equipment, because axons are designed to propagate action potentials only from the initial segment to the presynaptic terminal.
 - c) The direction that an action potential travels along an axon depends entirely on where it starts.
 - d) The experimenter must have been recording from an unmyelinated axon.
 - e) The experimenter was on a spaceship, moving away from earth at greater than the speed of light
22. The axons that send information about touch from the skin surface to the spinal cord have large diameters and thick layers of myelin. These features indicate that these axons have which one of the following characteristics?
- a) Rapid propagation of action potentials.
 - b) Slow propagation of action potentials.
 - c) Propagation of large amplitude action potentials.
 - d) Propagation of electrical signals without the use of action potentials.
 - e) Backpropagation of action potentials into the soma and dendrites.

TYPE B: For each of the four incomplete statements below, **ONE** or **MORE** of the completions given may be correct. Decide which completion or completion(s) is/are correct and darken the appropriate circle as follows:

1. if only a, b and c are correct
 2. if only a and c are correct
 3. if only b and d are correct
 4. if only d is correct
 5. if all or none are correct
-

23. Plasmin

- a) is produced by plasma cells.
- b) is an anticoagulant.
- c) converts plasma to serum.
- d) is an enzyme which breaks down the fibrin network.

24. Which of the following statements regarding Megakaryocytes is/are correct?

- a) They are derived from lymphoid stem cells.
- b) They undergo rapid nuclear divisions, and become progressively smaller as they mature.
- c) They give rise to many thousands of reticulocytes.
- d) They are highly phagocytic cells.

25. A macrocytic, normochromic anemia may be seen in the following situation(s)

- a) a subject whose stomach was surgically removed a number of years ago.
- b) a subject whose ileum (the distal portion of the small intestine) had been surgically removed a number of years ago.
- c) a subject suffering from a severe folic acid deficiency.
- d) a subject suffering from a vitamin B12 deficiency.

26. Being a good citizen, you have donated 400 ml of blood to the Red Cross. If you were to return to the clinic 6 days later and have a small volume of blood drawn and analyzed, you would find – by comparison with the situation prior to the donation – a significant **increase** in

- a) the ratio of your plasma volume/your packed red cell volume.
- b) the ratio of your reticulocyte count/total red blood cell count.
- c) the ratio of your plasma erythropoietin concentration/plasma NaCl concentration.
- d) the oxygen carrying capacity of a unit volume of your plasma.

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27. Hemoglobin

- a) synthesis is known to take place in the liver of the fetus.
- b) concentration in the blood of men is higher than in the blood of women.
- c) molecules are incapable of binding more than 4 molecules of oxygen.
- d) molecules are broken down in macrophages, and all their constituents are recycled in the body.

28. CORRECT statements regarding the Starling Forces include the following one(s):

- a) They include the force generated by the concentration gradient of ions across the capillary wall.
- b) They include both filtration and absorption.
- c) They operate in such a way that the volume of fluid absorbed directly into the venule end of the capillary is exactly equal to the volume filtered out at the arteriolar end.
- d) They determine the ratio of ISF volume/plasma volume.

29. If a cell (300 mOsm) were placed into an extracellular solution that contains 300 mOsm NaCl (non-penetrating solute) and 50 mOsm of urea (penetrating solute) which of the following statements is/are **TRUE**?

- a) The initial solution is hyperosmotic.
- b) The cell shrinks, so the solution is hypertonic.
- c) The cell does not change the volume, so the solution is isotonic.
- d) The initial solution is isoosmotic.

30. Cells capable of antigen presentation (APCs) include the following one(s):

- a) the dendritic cell.
- b) the B cell.
- c) the macrophage.
- d) the T_{H1} helper cell.

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31. Primary immune organs include
- a) the bone marrow.
 - b) the spleen.
 - c) the thymus.
 - d) the tonsils.
32. In the hypothetical case where the Toll-Like Receptors (TLRs) are abnormal, one may expect
- a) a poor antibody response to bacterial antigens.
 - b) the immediate cell death of invading bacteria.
 - c) a poor initial inflammatory response.
 - d) an intense initial inflammatory response.
33. Excitotoxicity plays a role in neuronal death in which one(s) of the following conditions?
- a) Neurodegenerative diseases.
 - b) Epileptic seizures.
 - c) Strokes.
 - d) Overdose of barbiturates.
34. The intensity of pressure on the skin surface is encoded in the nervous system as:
- a) The size of the action potentials evoked in pressure sensitive axons that innervate the skin surface.
 - b) The duration of the action potentials evoked in pressure sensitive axons that innervate the skin surface.
 - c) The shape of the action potentials evoked in pressure sensitive axons that innervate the skin surface.
 - d) The frequency of the action potentials evoked in pressure sensitive axons that innervate the skin surface.

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-

35. Which one(s) of the following factors determine(s) the neuronal membrane potential?
- a) The concentration gradients across the cell membrane for physiological ions.
 - b) The amount of cholesterol in the cell membrane.
 - c) The relative permeability of the cell membrane to different physiological ions.
 - d) The concentration of synaptic vesicles in the cytoplasm.

