

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2016-17
BIO F313 ANIMAL PHYSIOLOGY
COMPREHENSIVE EXAM (Total Marks 45)

Max. Marks: 25

Time: 90 mins

Date: 03/12/16

Note: "NO" marks would be allotted if you don't justify your answer. We would appreciate 1-2 line answers for conceptual questions. Marks will be deducted for unnecessary long answers.

(OPEN BOOK)

1a. The voltage gated (VG) Na⁺ channels are comprised of two polypeptide chains and its activation results in the action potential. What is the highest order of protein structure in a voltage gated Na⁺ channel?

b. AcotininE is a neurotoxin that specifically binds to the open / active conformation of VG Na⁺ channel and causes its persistent activation via allosteric modulation. Eventually the channels close and later reset so they are ready to depolarize. Would AcotininE mediate its effect by binding in the pore of the VG Na⁺ channel through which Na⁺ ions can pass (Yes/ No)? Explain.

c. You stimulate a neuron with an excitatory neurotransmitter and measure the frequency of the resulting action potential. You next stimulate a similar neuron with the same neurotransmitter together with AcotininE. What do you expect to observe with the frequency of the action potential? Explain.

d. Serotonin (5-HT) can serve both as an excitatory or inhibitory neurotransmitter based on the type of receptors to which it binds. The 5-HT₃ receptors act as ligand gated Na⁺ channels. In comparison, the 5-HT₂ receptors are ligand-gated Cl⁻ channels that are coupled to G proteins. You are studying a neuron that expresses functional 5-HT₂ and 5-HT₃ receptors and secretes glycine in the synaptic cleft when stimulated. You stimulate this neuron with serotonin in the presence of latrotoxin, which induces a large Ca⁺⁺ influx specifically through VG Ca⁺⁺ channels located at the axon terminus of the neuron. Would this treatment have an effect on the amplitude of action potentials elicited by this neuron (Yes/ No)? Explain.

e. A victim of a severe head injury can live for years in nonresponsive state in which the cerebral cortex is not functioning but the person is still alive and performing metabolic functions. Based on your knowledge of brain structure and function, how can this be possible? **(0.5+0.5+1+2+1=5)**

2a. Progesterone is given as an oral contraceptive pill. Can you suggest the mechanism of its action as a contraceptive?

b. Sometimes the most practical way to do an experiment is not to perform it in an animal, but to look at cell responses in culture. Cells from mice, humans, and other mammals have been used to establish cell culture lines that have been very important for research. You are studying a novel water-soluble mouse hormone. You know cell culture can be a practical model to reveal protein function, so you apply the hormone to yeast cells, but nothing happens. What is a likely explanation for why nothing happened in your experiment?

c. A physician is trying to determine the cause of a male patient's infertility. This person is able to produce sperm in appropriate number required for successful fertilization along with semen. What can be the cause to infertility.

d. Do you think Na⁺ is required for absorption of food through your intestinal cells? If so, explain how.

e. Explain the positive feedback component of an action potential. **(2+1+1+1+2=7)**

3a. Your friend Suresh is a heavy cigarette smoker, and has emphysema. How this will affect his airway resistance. How his respiratory muscle activity and intra alveolar pressure changes compared to normal person to accomplish a normal tidal volume? Would it be appropriate to administer oxygen to your friend to relieve his condition?

b. What change would you expect to occur in the hematocrit of a person who is dehydrated? Explain.

c. Leeches, the blood-sucking organisms are used to treat conditions involving poor blood supply to various tissues. Why do you think this might be a useful treatment when reattaching a cut finger?

d. You normally eat your lunch at 2' o clock. However, due to work pressure, you had to skip your lunch and this resulted in lot of acidity. Which type of homeostatic mechanism are we talking about? Explain.

(2+1+2+1=6)

4a. What is the advantage of having 2 separate paths (extrinsic and intrinsic) that both result in the formation of prothrombin activator?

b. In comparison to skeletal muscles, smooth muscles are slow yet very economical. Comment on the statement

c. Your friend who has been standing for a long time in a same position suddenly faints. What may be the physiological reason for the same. Explain the steps you should immediately implement to bring him back to consciousness.

d. Even when the diffusion coefficient of CO₂ is 20 times more than O₂, equal quantity of O₂ and CO₂ are exchanged. How?

(2+2+2+1=7)

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(CLOSED BOOK)

- 1a.** Why would a lesion in axon hillock be more detrimental to nerve impulse propagation than a lesion with similar dimension in dendrites or nodes of Ranvier.
- b.** Chronic high cortisol levels can lead to **both** hypertension and diabetes. True or false. Justify your answer.
- c.** Schematically describe the steps leading to generation of thirst, starting with kidney.
- d.** Presence of what molecule/s would you estimate in urine if you are to determine a kidney function.
- e.** You took milk before going for classes. The milk proteins are then digested in the stomach and small intestine. Digested proteins enter the intestinal epithelial cells in the form of amino acids only. True/False. Justify your answer. **(1+1+1+1+1=5)**

- 2a.** Why is both FSH and LH required for production of estrogen from a developing Graafian follicle.
- b.** What is the role of estrogen in preparation of the uterine bed, before luteal phase begins in a human female reproductive cycle.
- c.** How are the pituitary and adrenal glands each really two glands in one?
- d.** A child is born without the ability to make parietal cells. What consequences he may suffer from with respect to digestion of food?
- e.** What is the advantage of folding in vasa recta of a typical nephron. **(1+1+1+1+1=5)**

- 3a.** During which phase the heart receives most of its blood supply in coronary circulation: systole or diastole? Why is it not possible in the other phase?
- b.** Which hormone is responsible for stimulating the production of RBC by the bone marrow? Explain the mechanism.
- c.** Briefly explain the formation of platelet plug for clotting of blood. What ensures that the platelet plug does not expand over the surface of adjacent normal vessel lining?
- d.** During the ventricular diastole, no blood gets pumped into the aorta. In such circumstances, which two factors ensures the continuous flow of blood in the aorta.
- e.** The resting membrane potential of the neuron is not equal to the equilibrium potential of K⁺ ions. Why?
- f.** Many athletes take oral creatine supplements to boost their performance in short term, high intensity activities lasting couple of minutes. Explain how this boosts their performance. **(2+2+2+2+1+1=10)**