

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2022-23
BIO F313 ANIMAL PHYSIOLOGY
Comprehensive EXAM (OPEN BOOK)

Max. Marks: 50

Time: 120 mins

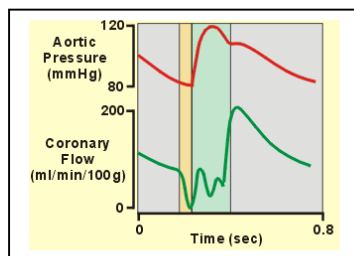
Date: 30/12/2022

Note: "NO" marks will be awarded if you don't justify your answer. Answers should be to the point.

Section A

Q1. (i) Being an enthusiastic student of Animal Physiology, you decided to take a paper and a pen and draw the left-ventricular pressure–volume loop for a single cardiac cycle in two different individuals, one with cardiac anomalies having restricted defective ventricular contraction (referred to as Person A) and the other of an athlete with stronger ventricular contraction (referred to as Person B). If the end-systolic volume remains to be constant in both Person A and B, based on the knowledge gained in the course, draw the left-ventricular pressure–volume loop for a single cardiac cycle for these individuals. Specify the differences you will observe between Person A and Person B with respect to a normal person's left-ventricular pressure–volume loop that has been referred in the class. **4M**

(ii) Alex decided to specifically inhibit the firing of the pacemaker cells of the heart to study such inhibitor effects on heart function in mice. He thought he will be using some inhibitors that can interplay with a transmembrane protein that plays a critical role in the rhythmic firing of the pacemaker cells. Based on your knowledge, which such protein should Alex target and why? Justify with appropriate reasoning. **3M**



(iii) In the given image in side, the aortic pressure level and the level of blood flow in the coronary artery have been depicted with respect to time. Why does the maximum flow in the coronary artery not take place when there is the maximum pressure in the aorta? Justify with the most appropriate reasoning. **3M**

Q2. (i) Your friend is a good sprinter (an athlete who races fast over short distances) and performs regular exercise. During one such intense exercise session, just after a fast-running session, you decided to measure the calcium level in his muscle cells that are involved in expiration. Based on your knowledge, in such circumstances, what will be the calcium level in the sarcoplasm of muscle cells that are present in; (a) Internal intercostal muscle, (b) Diaphragm muscle, (c) external intercostal muscle and (d) abdominal muscle. Justify your answer with appropriate reasoning. **4M**

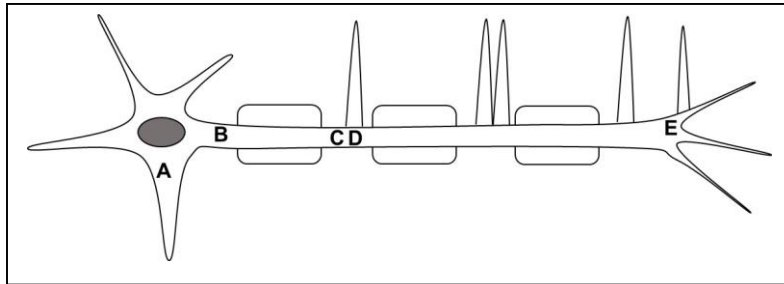
(ii) Draw diagrams of the architecture of thick and thin filament of a sarcomere (from a skeletal muscle cell that undergone an action potential just 90 msec before) where (a) SERCA is least active and (b) SERCA is hyperactive (active more than normal). Remember to specify the H-zone, I-band, and A-band in such sarcomeres. Also, justify the reason behind drawing such a sarcomere architecture diagram for these circumstances. **4M**

(iii) You are in search of new species on one of the islands in the Pacific Ocean. You came across a specific animal species that do have a human-like skeletal muscle system. Upon physical, biochemical, and microscopic analysis, you found that skeletal muscle fibers in these species have high mitochondrial content with the least glycogen content. Based on the knowledge gained in this course, what do you think this specific animal could be in context to their ability to run faster and longer? Justify your answer. **3M**

Q3. (i) Rohit lives in New Delhi in a prime location where the traffic is heavy throughout the entire day and even the vehicles keep honking through the night. Interestingly, Rohit has no issues sleeping through the night despite the noise from passing by vehicles. Interestingly, Rohit needs must wake up early every day to go to the office. For this, he uses an alarm clock on his phone and this alarm clock wakes him up as it rings. Although the intensity/strength of the noise from the alarm is much lower than that of the vehicle

honking, how do you think such a differential effect is imparted? Be very specific in your answer and justify. **3M**

(ii) Please see the figure given below depicting the traveling of action potentials through the axon. Based



on the following figure, answer the following questions; (a) Do you think there is anything wrong with this figure? Justify your answer. (b) What is the relative level of Na^+ , K^+ and Ca^{2+} ions (mention on a scale of 0 to 10, where 0 is lowest and 10 is highest) at locations A, B, C, D (D location signifies the end of depolarization), and E? Use 0 to 10

scale of the level of these ions in relative to each other. Justify why you have chosen such levels for each location and ions. **1+5=6M**

Q4. (i) “Drinking way too much water can be dangerous to your body system”, do you think this statement is correct? Justify your answer with appropriate reasoning. **2M**

(ii) If you have an excess quantity of K^+ and H^+ in your system, which part of the nephron do you think will be most active to take care of it and why? **1M**

Section B

Q5. (i) A person with wild type Chymotrypsin and trypsin gene is still compromised in digestion of proteins. Further genetic analysis reveals an inactivating mutation in a key gene in the associated pathway that also encodes a putative enzyme. Can you identify the reason for his compromised protein digesting ability? **2M**

(ii) A person with disrupted/severed sympathetic pre-ganglionic fiber emanating from the spinal cord had poor hormonal output from specific endocrine glands which are located outside the human brain, resulting in poor mobilization of metabolic resources. Justify this statement. **1.5M**

(iii) A person with identified and reported hormonal dysregulation shows defects in spermatogenesis. Given that the hypothalamo-hypophysial portal system is functional, this person was given LH therapy to stimulate testosterone release and hence spermatogenesis. Testosterone activity seemed normal. However, though improvements were seemingly observed, it didn't show complete reversal of spermatogenic dysfunction. Justify why. **2M**

(iv) Zap2 protein helps to maintain cell to cell connection during gametogenesis as reduction division occurs in the gonads. Disruption of the Zap2 function with small molecules that can cross the blood-testes barrier was found to disrupt the potential of gametes for successful fertilization. Provide reasons for the same. **2M**

Q6. (i) Justify the histological orientation of the developing spermatogonial cell in the seminiferous tubules during spermatogenesis. Do you think natural selection has any association with the reproductive age of an organism? **3M**

(ii) Older individuals who have a reduced tissue iodine uptake capability from blood, show low pulse, reduced metabolism, and might have a higher rate of mortality. Provide relevant justifications for the same. **1.5M**

(iii) ATP derived from glucose uptake by specific endocrine cells of human body is associated with subsequent glucose uptake by different tissues across the human body. Explain how. **2M**

(iv) Justify the specific spatial location of the intestinal stem cells in the small intestine of the digestive tract. **1M**

(v) A person who is genotypically male and producing testosterone is compromised in masculine features. Provide the putative underlying reason/s? **2M**

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