

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2023-24
BIO F313 ANIMAL PHYSIOLOGY
Comprehensive EXAM (OPEN BOOK)

Max. Marks: 80

Time: 180 mins

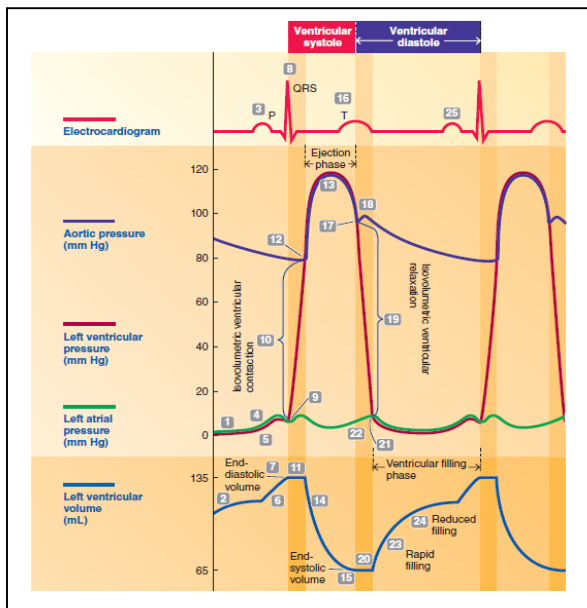
Date: 07/12/2023

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

PART-A

Q1. (A) In the animal physiology course, you learned about stenosis of the cardiac valve. Let’s think you are a Cardiologist and a patient turns up to you who is suffering from cardiac problems. How do you in the *EASIEST* way confirm if the patient has stenotic valves? Justify. **3M**

(B) “Speed of conduction” and “rate/frequency of conduction”, how do you justify these terms in context to the auto-rhythmic cells present in your heart? Explain with examples, how such diversity is essential for the appropriate functioning of the heart. **1.5+1.5=3M**



(C) You may be aware of the following figure depicting the cardiac cycle and its relation to different parameters of the heart. The following figure indicates different parameters of heart functions recorded in a normal individual. If these parameters are recorded in an individual with significant myocardial infarction (death of cardiac cells) in the left ventricle, can you draw a similar figure **ONLY** for the following parameters (i) left ventricular pressure, (ii) aortic pressure and (iii) left ventricular volume. You need to draw the same for only one cardiac cycle (that includes one round of ventricular diastole and systole). **4.5M**

(D) Mr. Usain Bolt is a well-known sprinter (an athlete who races over short distances) and is greatly admired as an athlete. Imagine you have been given the task of understanding the cardiac function of Mr. Bolt when he is undergoing intense exercise. You took a pencil and a page to draw a figure depicting the “Left-ventricular pressure-volume loop for a single cardiac cycle” of Mr. Bolt’s heart during such an intense exercise. You felt joyful that you studied this in your Physiology course and started drawing the “Left-ventricular pressure-volume loop for a single cardiac cycle” of Mr. Bolt’s heart. How do you think such a curve will look like (draw this in your answer sheet)? In specific, **MENTION** the difference between Mr. Bolt’s “Left-ventricular pressure-volume loop for a single cardiac cycle” to that of a non-athlete healthy individual at sedentary (non-active) condition. **5M**

(E) Your friend was taking a slow walk through the roads going from FD III to Gandhi Statue on the misty morning of December. She was truly enjoying the slow walk and the weather, however, as said “Good things do not last long”, a dog started chasing her, she got frightened and all of a sudden she started running fast. Based on your understanding of the neuronal integration of heart function, can you exactly define how her “Brain” controlled her heart (specifically at the level of the SA node, AV node, and Purkinje fibers)

during these two situations; (i) during the slow walk and (ii) frightened and running fast? Justify your answer. **4.5M**

(F) If a person has a blood pressure of 160/110, when do you think the first and last sound will be heard in the stethoscope while measuring the person's blood pressure? Justify why? **2M**

Q2. (A) After completing your degree from BITS Pilani, you decided to pursue your career as a researcher in the field of biomedical engineering. You joined a lab where you started working with skeletal muscle cells to build bioengineered muscles. Before you start working in this area, you decided to experiment with these cells and therefore you treated these cells with thapsigargin, a known inhibitor of SERCA followed by inducing the cells with acetylcholine. You then imaged the level of calcium in cellular compartments using calcium labeling fluorescence dye. In this situation, which cellular compartment(s) are you likely to find the fluorescence-labeled calcium? What will be the structure (length) of the sarcomeres in these cells in comparison to a non-treated skeletal muscle cell? Justify. **2+2=4M**

(B) "The complex integration of motor neurons precisely regulates the function of your skeletal muscle". You decided to test this and took a group of fast oxidative fibers and connected them with motor units that normally work on the slow oxidative fibers. If these motor units are stimulated, based on your knowledge from this course, how do you think the fast oxidative fibers will contract in comparison to their normal physiological situation? Justify. **4M**

(C) Trained athletes usually have larger heart sizes. How and why do you think they have a large heart size? If you identify the same in a sedentary individual, what will be your inference and why? **3M**

Q3. (A) Both alpha and beta cells respond to varying levels of blood glucose to release their respective hormones thereby maintaining glucose homeostasis. Although the intracellular mechanism of glucose action to release these hormones from these independent cells of the pancreas remains exactly the same, however, their response to blood glucose levels remains completely opposite. Explain the EXACT biological mechanism that allows these cells to respond differently to blood glucose levels. Justify briefly. **4M**

(B) In the human body, many hormones act to increase blood glucose levels including glucagon, cortisol, epinephrine, etc. However, there is ONLY one hormonal mechanism to reduce blood glucose levels; insulin. Justify why so in the context of the body system. Answer in two sentences. **3M**

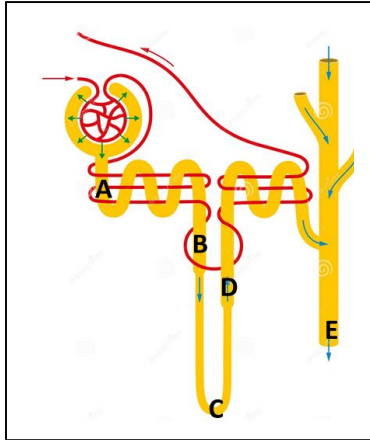
PART-B

Q4. (A) In adult humans, a typical sleep pattern is observed where an individual spends differential time in Slow-wave sleep or Paradoxical/REM Sleep. Based on the understanding of the same, can you comment on the pattern of sleep that a newborn infant will likely have during their sleep? Justify with reasoning. **3M**

(B) You are very social and like to attend different social gatherings. In one such gathering, you met one person named Krish with good humor. Both of you were hanging together enjoying all the fun talks. To have more fun, you both eventually started making fun of your friend about something your friend did in college. But you did not realize when that went over the limit, your friend suddenly punched on the face of Krish. Your friend was obviously angry which led to such action, however, eventually, he realized the mistake and very politely apologized to Krish. Krish was a gentleman and accepted his apology. Based on your understanding of the human brain and its regulation mechanisms, how can you explain the action of your friend, on one side "he suddenly punched on the face of Krish" while on the other side "he realized

the mistake and very politely apologized to Krish”. Be specific in your answer and briefly justify with appropriate reasoning. **5M**

(C) Briefly explain the pathways/mechanism, how short-term memory is stored as long-term memory at the level of the brain as an organ, at the level of the neurons and associated cells, and within the neurons intracellularly. Be specific in your answer and briefly justify. **6M**



Q5. (A) The figure given shows the structure of an entire human nephron. Based on the knowledge gained in this course, can you mention the osmolality (in mOsm/L units ranging from 100-1200) of the solution within the Nephron at locations A, B, C, D, and E in two individuals (i) Individual 1: highly hydrated and (ii) Individual 2: highly dehydrated? Also, in one line explain why you chose that particular number for each of these locations for Individuals 1 and 2. **5M**

(B) Diabetes mellitus results from a disorder of glucose uptake by systemic cells and can result in a number of symptoms including high levels of blood glucose and the presence of glucose in the urine. What will be your reasonable explanation for the presence of glucose in the urine? **3M**

(C) Proper functioning of the human kidney requires considerable active transport of sodium in the kidney tubules. If these active transport mechanisms were to stop completely, how would urine production be affected? **3M**

(D) “Spatial matrix composition of a pig kidney is almost similar to that of a human kidney and any pig origin matrix proteins of the organ cause least cross-species immune reactions”, if this statement holds true, how can you apply this advantage in creating a bio-engineered human kidney? Briefly explain what will you do to create a personalized bio-engineered kidney using this concept. Justify your answer with proper reasoning. **4M**

Q6. (A) The inner mitochondrial membrane contains numerous inward folds called cristae, which greatly increase the surface area of this membrane. Because ATP is produced on the inner mitochondrial membrane, cristae enhance the ability of the mitochondria to generate ATP. What structure can be thought of as similar to these cristae and mention what is its function? **3M**

(B) The nervous system can directly affect the activities of the digestive system locally through the collection of neurons within the walls along the gastrointestinal tract. How might the brain exert its regulation of digestion from a distance? Take one example and justify it. **3M**

(C) Oral rehydration solutions that contain both salt and glucose are highly effective in treating severe dehydration caused by diarrhea and vomiting. However, glucose or salt alone is not effective. Why? Explain briefly. **3M**

(D) Contrary to popular belief, stress is not usually the primary cause of peptic ulcers, and many patients with ulcers do not overproduce acid. What could be the possible cause of peptic ulcers then? **2M**

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