IQRA NATIONAL UNIVERSITY

DEPARTMENT OF ALLIED HEALTH SCIENCES

Final-Term Examination (Summer)

DPT 1st semester

Course Title: Physiology **Instructor: Dr Sara Naeem**

Time: 4hrs **Max Marks:50**

Q1. What is the difference between skeletal muscle ,smooth and cardiac muscles? Also mention the similarities between skeletal and cardiac muscles.

Answer:

- **Smooth Muscles:**

1. Smooth muscles lines the walls of internal organs.

2. It performs involuntary muscular movements.

3. It moves walls of internal organs to help with its function.

4. Smooth muscles are self-stimulating.

5. They do not fatigue.

6. Rhythmic contraction.

7. Need low energy requirement.

8. They have low speed of contraction.

- **Skeletal Muscles:**

1. They are attached to the skin and bones.

2. They are involuntary in action.

3. They help in physical movement.

4. They are non-self-stimulating.

5. They are striated with orderly arranged myofibrils.

6. They have non rhythmic contraction.

7. They can easily be fatigue.

8. They have high energy requirement.

9. They have high speed of contraction.

- **Cardiac Muscles:**

1. They are found in the heart.

2. They are involuntary in action.

3. The cardiac muscles pumps blood.

4. They are self-stimulating.

5. They are striated and have many myofibrils which are orderly arranged.

6. Rhythmic contraction.

7. They do not fatigue.

8. Need average energy.

9. Average speed of contraction.

- **Similarities between skeletal and cardiac muscles:**
  Following are the similarities of skeletal and cardiac muscles;
- Skeletal and cardiac muscles are both striated in appearance.
- While smooth muscle is not.
- Both cardiac and smooth muscles are involuntary while skeletal muscle is voluntary.

Q2. What is arterial blood pressure? Explain the regulation of blood pressure by renin-angiotensin system.

<u>Answer:</u>

- **Arterial Blood Pressure:**

Blood pressure sometimes refers to as arterial blood pressure, the pressure exerted by circulating blood upon the walls of blood, and is one of the principal vital sign. All levels of arterial pressure put mechanical stress on the arterial walls.

- **Systolic Bp and diastolic Bp:**

When the left ventricle ejects blood into the aorta, the aortic pressure rises. The maximal aortic pressure following ejection is termed the systolic pressure. As the left ventricle is relaxing and refilling, the pressure in the aorta falls. The lowest pressure in the aorta which occurs just before the ventricle ejects blood into the aorta is termed the diastolic pressure.

- **The Reninangiotensin system and blood pressure control:**
- The RAS regulates blood pressure and fluid balance in the body. When blood volume or sodium level in the body are low or blood potassium is high cells in the kidney release enzyme renin.
- Renin converts angiotensinogen which is produced in the liver to the hormone angiotension I.

- An enzyme known as angiotension converting enzyme found in the lungs metabolizes angiotension I inti angiotension II.
- Angiotension II causes blood vessels to constrict and blood pressure to increase. Angiotensin II stimulates the release of the hormone aldosterone in the adrenal gland. Which causes the renal tubules to retain sodium and water and excrete potassium.
- Together angiotensin II aldosterone work to raise blood volume, blood pressure and sodium level in the blood to restore the balance of sodium, potassium and fluids. If Reninangiotensin system become overactive, consistently high blood pressure results.

Q3. Explain the following

a. **Unitary smooth muscles**
b. **Cardiac output**
c. **Stroke volume**

Answer:

1. **Unitary Smooth Muscles:**
   The term unitary smooth muscle or visceral muscle, this type of smooth muscle is the most common observed in the human body, forming the walls of hollow organs. Single unit smooth muscle produce slow, steady contractions that allow substances such as food in the digestive tract to move through the body.

2. **Cardiac Output:**

Cardiac output also known as heart output denoted by the symbols or is a term used in cardiac physiology that describe the volume of blood being pumped by the heart, by the left and right ventricle, per unit time.

- **Normal value of cardiac output:** A healthy heart with a normal cardiac output pumps about 5 to 6 liters of blood every minute when a person is resting.

- **Measurement of cardiac output:** Cardiac output is the volume of blood the heart pumps per minute. Cardiac output is calculated by multiplying the stroke volume by the heart rate.

3. **Stroke Volume:** Stroke volume is the volume of blood pumped from the left ventricle per beat. Stroke volume is calculated using measurements of ventricle volumes from an echocardiogram and subtracting the volume of the blood in the ventricle at the end of a beat from the volume of blood just prior to the beat. The term stroke volume can apply to each of the two ventricles of the heart although it

usually refers to the left ventricles .The stroke volumes for each ventricle are generally equal both being approximately 70 ml in a healthy 70 kg man.

Q4. Draw and explain excitation contraction in cardiac muscles. Why this mechanism is different from skeletal muscles.

Answer:

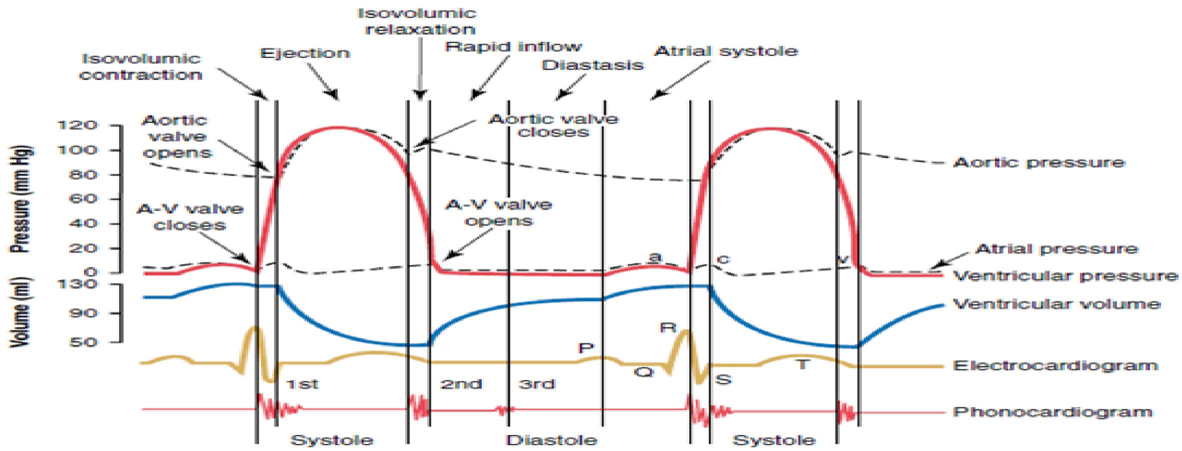
- **Excitation contraction in cardiac muscle:**

1. Binding of acetylcholine to muscarinic receptors.
2. Increased influx of $Ca2+$ into the cell.
3. Activation of calmodulin dependent myosin light chain kinase.
4. Phosphorylation of myosin
5. Increased myosin ATPase activity and binding of myosin to actin.
6. Contraction
7. Dephosphorylation of myosin by myosin light chain phosphatase.
8. Relaxation or sustained contraction due to the latch bridge and other mechanisms.

- **Mechanism of cardiac muscle contraction is different from skeletal muscle contraction:**
  - The comparison of cardiac and skeletal muscle structure reveals differences which can be related to differences in the functional characteristics of the two muscle types. Examples which are discussed include the sarcolemma, transverse tubules and sarcoplasmic reticulum which serve as major sources of contraction-dependent calcium.
  - Mechanisms by which calcium is made available to, and utilized by the myofibrils is discussed in relation to the mechanics of muscle contraction as a basis for the discussion of excitation-contraction coupling in cardiac and skeletal muscle.
  - Excitation-contraction coupling in skeletal muscle is considered to be mediated by a voltage-dependent charge movement within the region of the sarcolemma (T-tubule): junctional sarcoplasmic reticulum.
  - Depolarization of the sarcolemma initiates the charge movement which may result in a change in sarcoplasmic reticulum membrane potential and ion conductance which is associated with release of calcium to the myofibrils.
  - In cardiac muscle, excitation appears to be linked to contraction by a different although not mutually exclusive mechanism, ie, by a process of calcium induced-calcium release.

- Depolarization of the cardiac sarcolemma is associated with an influx of calcium into the cell which initiates the release of more calcium from the sarcoplasmic reticulum to activate the myofibrils.
- One major mechanism that is predominantly active in cardiac muscle to regulate excitation-contraction coupling is the adenylate cyclase-cAMP-protein kinase system.
- Cyclic AMP-dependent protein kinase mediated phosphorylation of at least three sites within the myocardium have been identified (myofibrils, sarcoplasmic reticulum and sarcolemma) which appear to modulate myocardial function.
- These sites, which are the primary regulatory sites of calcium and muscle contraction, may be sites of major dysfunction during cardiac disease.

Q5. What is cardiac cycle. Explain the events occurring in the graph below .



<u>Answer:</u>

- **Cardiac Cycle:**

"Cardiac cycle refers to the sequence of events that take place when the heart beats."

- **Cardiac Cycle Physiology:**

The human heart consists of four chambers, comprising left and right halves. Two upper chambers include left and right atria; lower two chambers include right and left ventricles. The key function of the right ventricle is to pump deoxygenated blood through the pulmonary arteries and pulmonary trunk to the lungs. While the left ventricle is responsible for pumping newly oxygenated blood to the body through the aorta.

- **Cardiac Cycle Phases**
  Following are the different phases that occur in a cardiac cycle:

  1. Atrial Diastole: In this stage, chambers of the heart are calmed. That is when the aortic valve and pulmonary artery closes and atrioventricular valves open, thus causing chambers of the heart to relax.

  2. Atrial Systole: At this phase, blood cells flow from atrium to ventricle and at this period, atrium contracts.

  3. Isovolumic Contraction: At this stage, ventricles begin to contract. The atrioventricular valves, valve, and pulmonary artery valves close, but there won't be any transformation in volume.

  4. Ventricular Ejection: Here ventricles contract and emptying. Pulmonary artery and aortic valve close.

  5. Isovolumic Relaxation: In this phase, no blood enters the ventricles and consequently, pressure decreases, ventricles stop contracting and begin to relax. Now due to the pressure in the aorta – pulmonary artery and aortic valve close.

  6. Ventricular Filling Stage: In this stage, blood flows from atria into the ventricles. It is altogether known as one stage (first and second stage). After that, they are three phases that involve the flow of blood to the pulmonary artery from ventricles.

  7. Electrocardiography (ECG): Potential differences between electrodes record a spreading depolarization. Complete depolarization or complete polarization is a flat line (midline, zero millivolts). Five waves corresponding to upward or downward deflections from zero millivolts on an ECG chart are designated alphabetically as P,Q,R,S, and T waves. Sometimes a U wave (of similar shape to a T wave, but of lower amplitude) follows the T wave. A U wave is usually seen in people with low heart rates, and is rarely seen when heart rate is high. The Q,R, and S waves are grouped together as the QRS complex.

- **Depolarization and repolarizations corresponding to these waves can be summarized by:**

  P–wave — atrial depolarization (upward deflection, beginning of atrial contraction)
  QRS complex — ventricular depolarization (ventricular contraction)
  T–wave — ventricular repolarization (upward deflection, beginning of ventricular relaxation)
  Normal T waves are slightly skewed to the right, rather than being completely symmetrical. U waves are believed to be a delayed component of repolarization associated with the T wave.

- **Atrial repolarization is obscured by the more powerful QRS complex. The waves of the QRS complex can be described in more detail:**

  Q–wave — depolarization of the ventricular septum (small downward deflection)
  R–wave — activation of most of the ventricle (large upward deflection)
  S–wave — last stage of ventricular depolarization (downward deflection)