University of Mosul
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Unit of Scientific Affairs
Website:

Lecture title: introduction on cardiovascular system

Lecturer Affiliation: University of Mosul / College of Veterinary Medicine / Department of Physiology, Biochemistry and Pharmacology

Summary: Overview of heart anatomy, blood flow, and conduction system emphasizing cardiovascular function, regulation, and structural components in veterinary physiology.

Cardiovascular system

The Cardiovascular System is composed from the heart & a closed system of blood vessels.

The Cardiovascular System functions are;

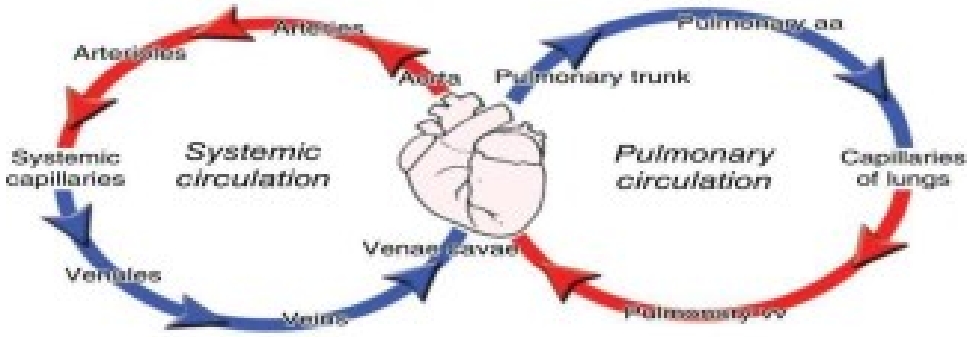
The primary function of the cardiovascular system is to deliver blood to the tissues, which provides essential nutrients to the cells for metabolism and removes waste products from the cells.

The cardiovascular system also is involved in sever a **homeostatic function**:

1. It participates in the regulation of arterial blood pressure.
2. It delivers regulatory hormones from the endocrine glands to their sites of action in target tissues.
3. It participates in the regulation of body temperature.
4. It is involved in the homeostatic adjustments to altered physiologic states such as hemorrhage, exercise, and changes in posture.

General Scheme of The Circulation:

- oxygenated blood is pumped by the left ventricle into the systemic arterial circulation.
- deoxygenated blood returns to the right atrium through the systemic veins.
- the right ventricle pumps this blood into the pulmonary circulation.
- reoxygenated blood subsequently returns to the left atrium through the pulmonary veins.



Heart:

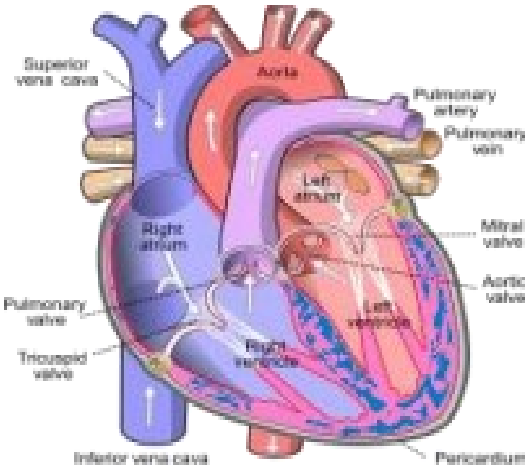
The mammalian heart consists of: 4 chambers:

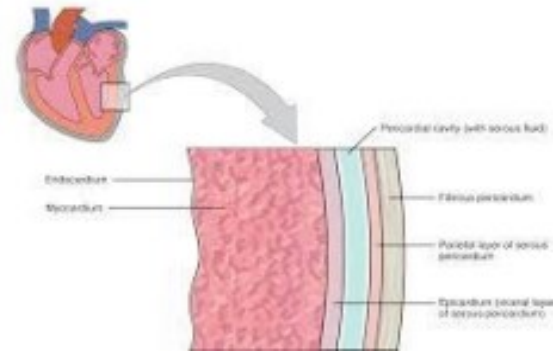
●**Atria**: Two thin-walled atria separated from each other by an ***interatrial septum***; (right & left), Right atrium (RA) receives blood from the systemic circulation via superior and inferior vena cavae, while left atrium (LA) receives blood from the lungs via pulmonary veins. (functions mainly as a blood reservoir).

●**Ventricles**: Two thick-walled ventricles separated from each other by an ***interventricular septum*** (right & left) (serve as pump). They consist of 2 separate pumps:

a) **Right ventricle (RV)** supplies the lung circuit via pulmonary artery. Because of intrathoracic location of pulmonary blood vessels, pulmonary circuit offers less resistance to blood flow.

b) **Left ventricle (LV)** supplies the systemic circuit via aorta and pumps the blood to the peripheral tissue (cells throughout the body).

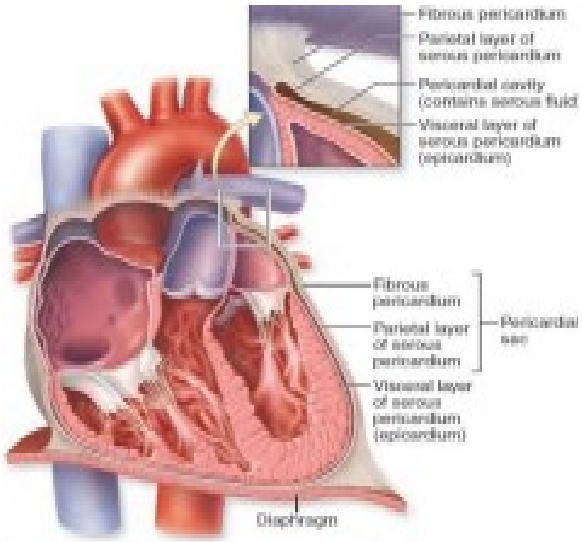


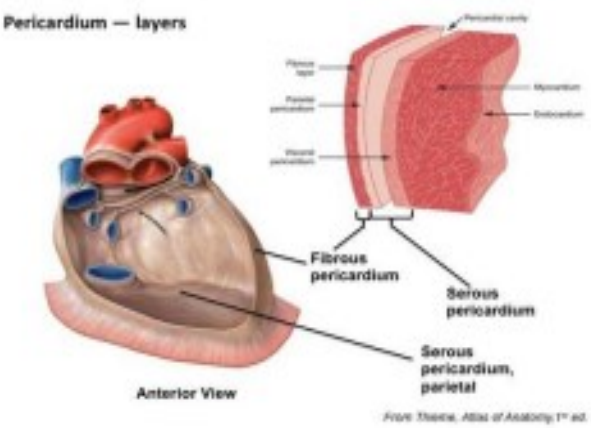


- 'LV' has to do a larger amount of work, and blood ejected from the left ventricle during its contraction is under higher pressure than the blood ejected from the right ventricle, Therefore, the 'LV' wall becomes thicker than the 'RV' wall (Thickness: LV wall: RV wall: 3:1).

    - The cavities of the cardiac chamber are lined by endothelial lining, called ***endocardium***, whereas the muscles of the heart including pacemaking and conducting system structures are called ***myocardium.***

    - The entire heart is enclosed by a double layered structure, called ***pericardium***. *The inner layer of the pericardium is closely affixed to the heart and is called the* ***epicardium***. In between its two layers is a cavity called pericardial cavity. It normally contains (5-30 mL) of clear fluid, called ***pericardial fluid*** which lubricates the heart; permits it to contract with minimal friction and protects the heart from external injury.





❖ **The valves of the heart**:

Note: allow the passage of blood one direction only& not the reverse.

1. **The Atrio-Ventricular valves (A-V) valves:** which separate the atria from the ventricles.

I. They prevent backflow of blood from the ventricles to the atria during systole (contraction).

II. Close and open passively with the pressure gradient forces.

It be divided into;

a-**The bicuspid or mitral valve** which separates the left atrium from the left ventricle. It is composed of 2 flaps or cusps.

b -**The tricuspid valve** which separates the right atrium from the right ventricle. It is composed of 3 flaps or cusps.

The 'tricuspid' and 'mitral' valves consist of flaps (or cusps) which are attached at the of the periphery valve ring . **Chordae Tendinea,** the cord like structures originate from ***papillary muscles*** arising from the inner border of the ventricle, are attached to the free edges of the valve flaps. The chordae tendinea and papillary muscles ***function to*** *prevent eversion of the mitral and*

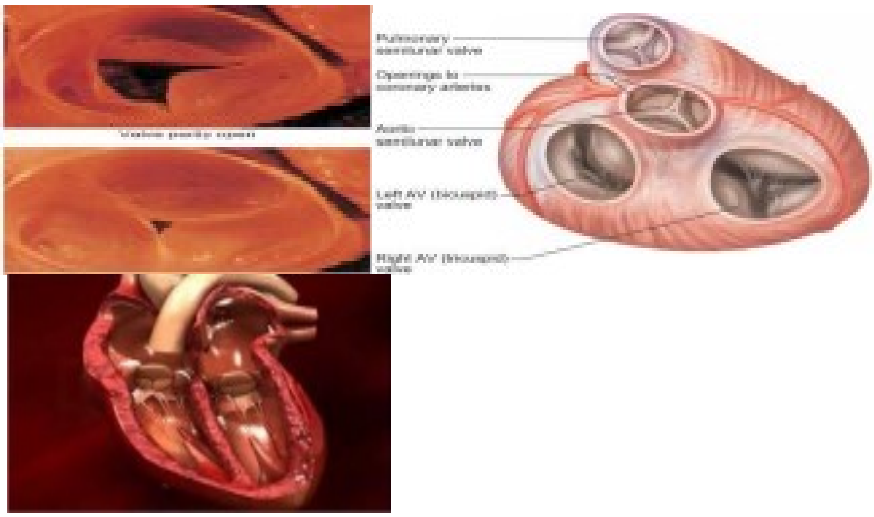
tricuspid valves into the atria during ventricular ejection, thereby preventing "regurgitation" of blood back into the atria.

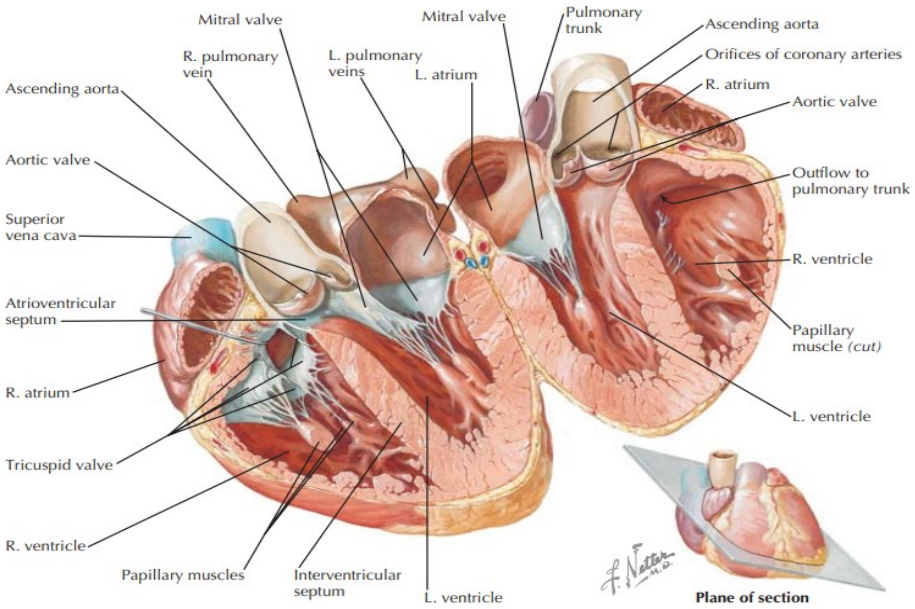
The papillary muscles:

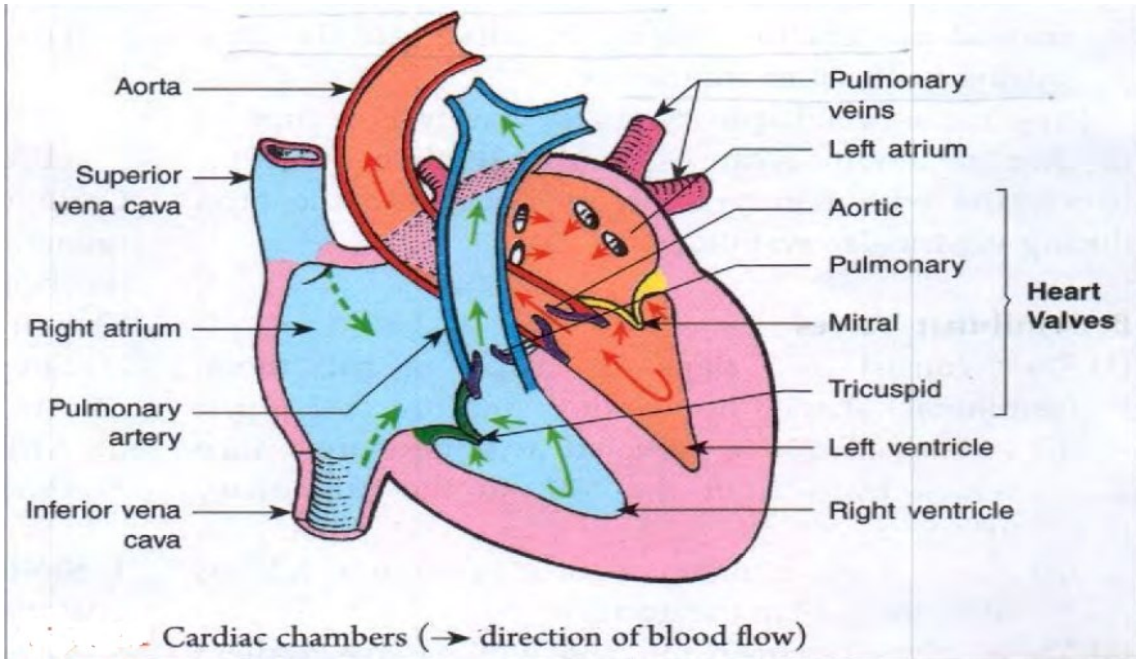
These are ventricular muscles flaps attached to the cusps of the A-V valves by the cordea tendinea. They contract with ventricular walls and pull the cusps of the valves toward the ventricles.

2. The semilunar valves (the aortic and pulmonary artery valves):

- ✓ seen at the origin of the aorta which leads from (LV) to aorta and pulmonary artery which leads from (RV) to pulmonary artery.
- ✓ They have three cusps.
- ✓ prevent *backflow of blood from the aorta and pulmonary arteries into the ventricle during diastole.*
- ✓ These valves also open and close with **passive gradient forces**, therefore; the valves open at the onset of ventricular ejection and close when the relevant arterial pressure exceeds that of the corresponding ventricle when it begins to relax.







Origin and Spread of Excitation within the Heart

The heart consists of two kinds of muscle cells:

- **Contractile cells (**Contractile cells constitute the majority of atrial and ventricular tissues and are the working cells of the heart).
- **Conducting cells** (Conducting cells constitute the tissues of the sinoatrial (SA) node, the atrial internodal tracts, the atrioventricular (AV) node, the bundle of His, and the Purkinje system).

Conducting cells (not nervous tissue) are specialized muscle cells, they **function to**:

1. their capacity to generate action potentials spontaneously.
2. rapidly spread action potentials over the entire myocardium.

✓ Conduction System of The Heart:

Effective ejection of blood from the heart requires coordinated contraction and relaxation of the chambers. At rest, this cycle occurs approximately 70 times per minute, and this system is composed from:

1. **Sinu-Atrial Node (SAN) (*SA node)***. Normally, the action potential of the heart is initiated in the specialized tissue of the SA node, which serves as the ***pacemaker*** *(is a specialized tissue consist of modified excitatory cardiocyte that have spontaneous generation of action potential located within SA node)*. After the action potential is initiated in the SA node, there is a specific sequence and timing for the conduction of action potentials to the rest of the heart.
   - ***Atrial internodal tracts and atria***, The action potential spreads from the SA node to the right and left atria via the atrial internodal tracts. Simultaneously, the action potential is conducted to the AV node.
2. **Atrio Ventricular Node (AVN)** ***AV node.*** Conduction velocity through the AV node is considerably slower than in the other cardiac tissues.

Note: The slow conduction in SAN and AVN is caused by decreased numbers of gap junction between the successive cells in the conducting pathways.

3. Bundle of His: From the AV node, the action potential enters the specialized conducting system of the ventricles. The action potential is first conducted to the bundle of His through the common bundle. It then invades the left and right bundle branches, both branches divide repeatedly to form a network of fibers lying subendocardially in the ventricles.
4. Purkinje system: Takes origin from terminal divisions of right and left branch of the Bundle of His to penetrate the ventricular wall. These fibers are somewhat larger and thicker than the SAN fibers; Because of large diameter and very high level of permeability of the gap junction at intercalated discs, they transmit the impulse at a fast velocity of 4mts/sec as compared to other conducting tissue. This allows almost immediate transmission of the cardiac impulse throughout the entire ventricular system. Conduction through the His-Purkinje system is extremely fast, and it rapidly distributes the action potential to the ventricles.