Department of Anesthesia Techniques
The lect. 1: Cardiovascular System

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LEARNING OBJECTIVES

- The functions of Cardiovascular system
- The structure of cardiac muscle and contractile cardiomyocytes
- Conducting system that distributes electrical impulses through the heart.

Cardiovascular physiology is the study of the functions of the heart, blood vessels.

- **The cardiovascular system consists of the heart, blood vessels, and blood.**

- **Its primary function** is to transport nutrients and oxygen-rich blood to all parts of the body and to carry deoxygenated blood back to the lungs.

Cardiovascular system consists of the following organs and tissues:

- • **The heart**: A muscular pump that forces blood around the body.
- • **A closed system of blood vessels** include:
  - ◦ Arteries: Vessels that carry blood away from the heart.
  - ◦ Veins: Vessels that bring blood back to the heart.
  - ◦ Capillaries: Tiny vessels that branch off from arteries to deliver blood to all body tissues

Structure of the heart

- The heart consists of four chambers **two on either side**:
- Two **receiving chambers** "atria" and two **pumping chambers** "ventricles." A wall or "septum" separates the atria and ventricles. Valves control the flow of blood in the heart.

1. **The right atrium** receives the blood retuning from the body tissues. This blood is low in oxygen, carried by veins

2. **The right ventricle** pumps the blood received from the right atrium and sends it to the lungs.

3. **The left atrium receives** blood which is high in oxygen as it returns from the lungs.

4. **The left ventricle**, which has the **thickest walls of all**, pumps oxygenated blood to all parts of the body through the arteries.

The Heart Valves: The human heart contain four valves:

A. Two atrioventricular valves (AV)

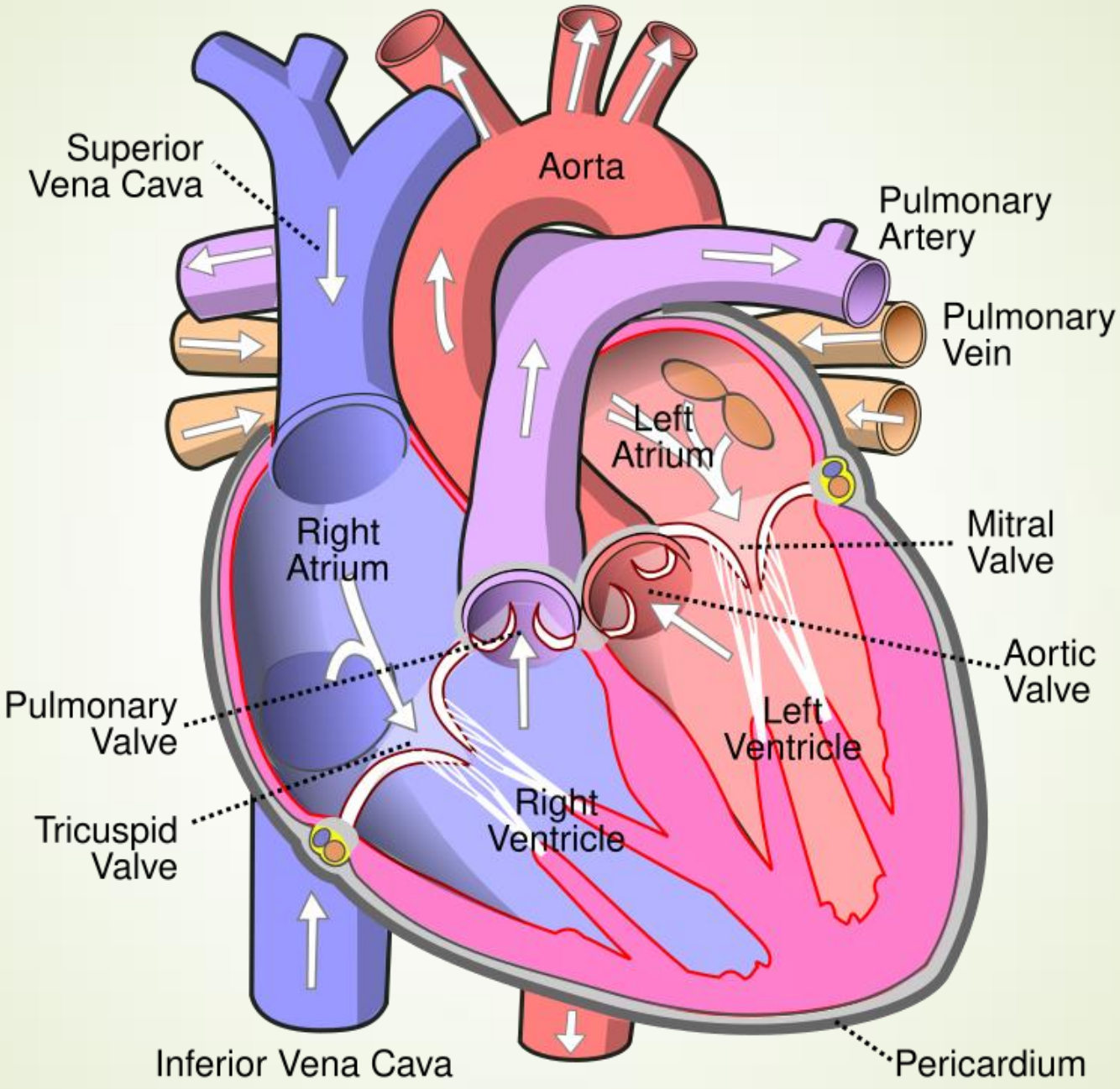
Between atria and ventricles:

- **Tricuspid valve:** allows blood flowing one way from right atrium to right ventricle.
- **Mitral valve**: from left atria to left ventricle.

The function of AV valves is to prevent backflow of blood into the atria during ventricular contraction.

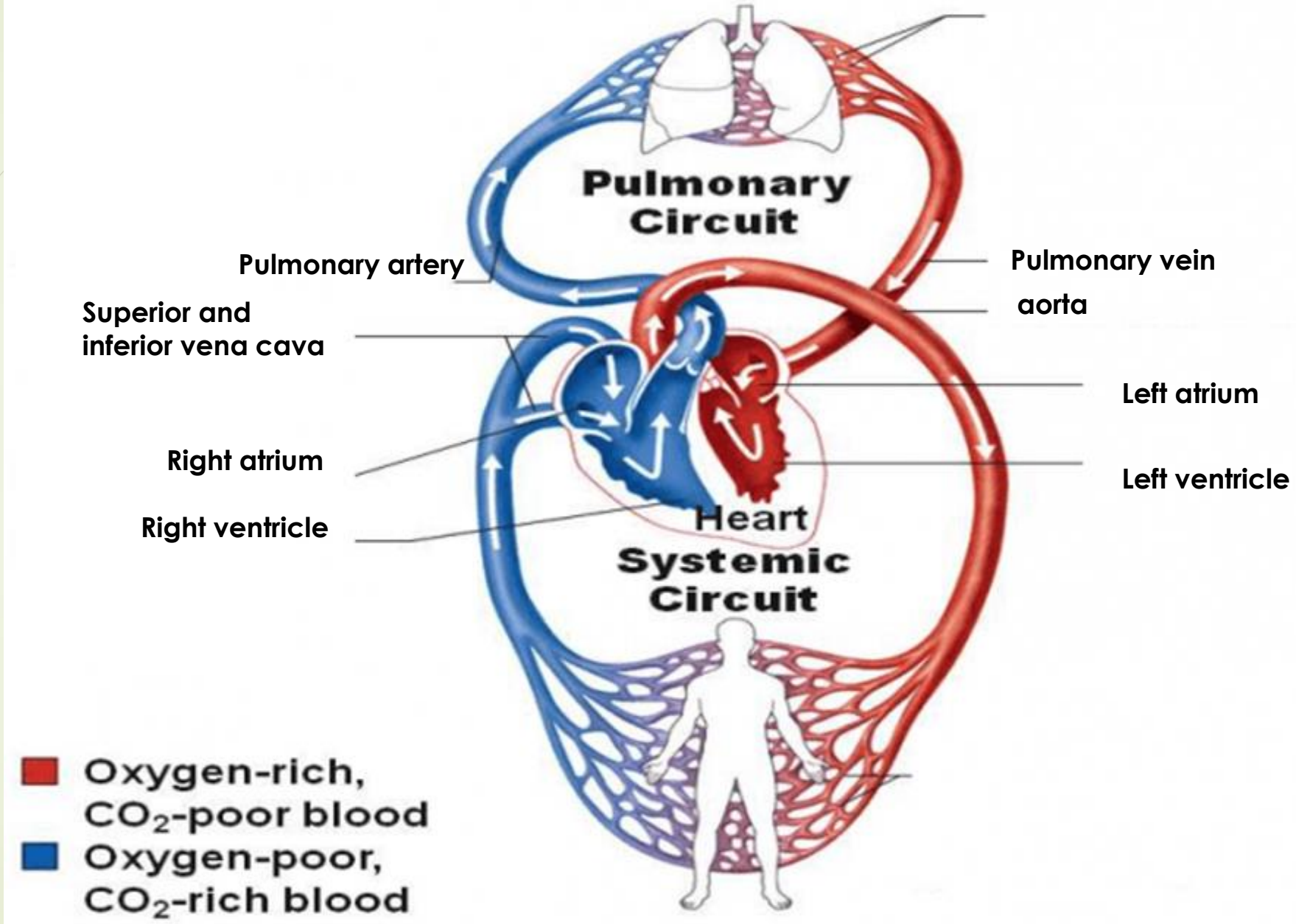
B. Two semilunar valves

- **Aortic valve:** allows blood flowing one way from left ventricle to aorta (transport oxygenated blood to the body).
- **Pulmonary valve:** from right ventricle to pulmonary artery (Transport deoxygenated blood to lung)


Superior Vena Cava
Aorta
Pulmonary Artery
Pulmonary Vein
Left Atrium
Right Atrium
Mitral Valve
Aortic Valve
Pulmonary Valve
Left Ventricle
Tricuspid Valve
Right Ventricle
Inferior Vena Cava
Pericardium

- **There are two blood circulatory systems in the body:**

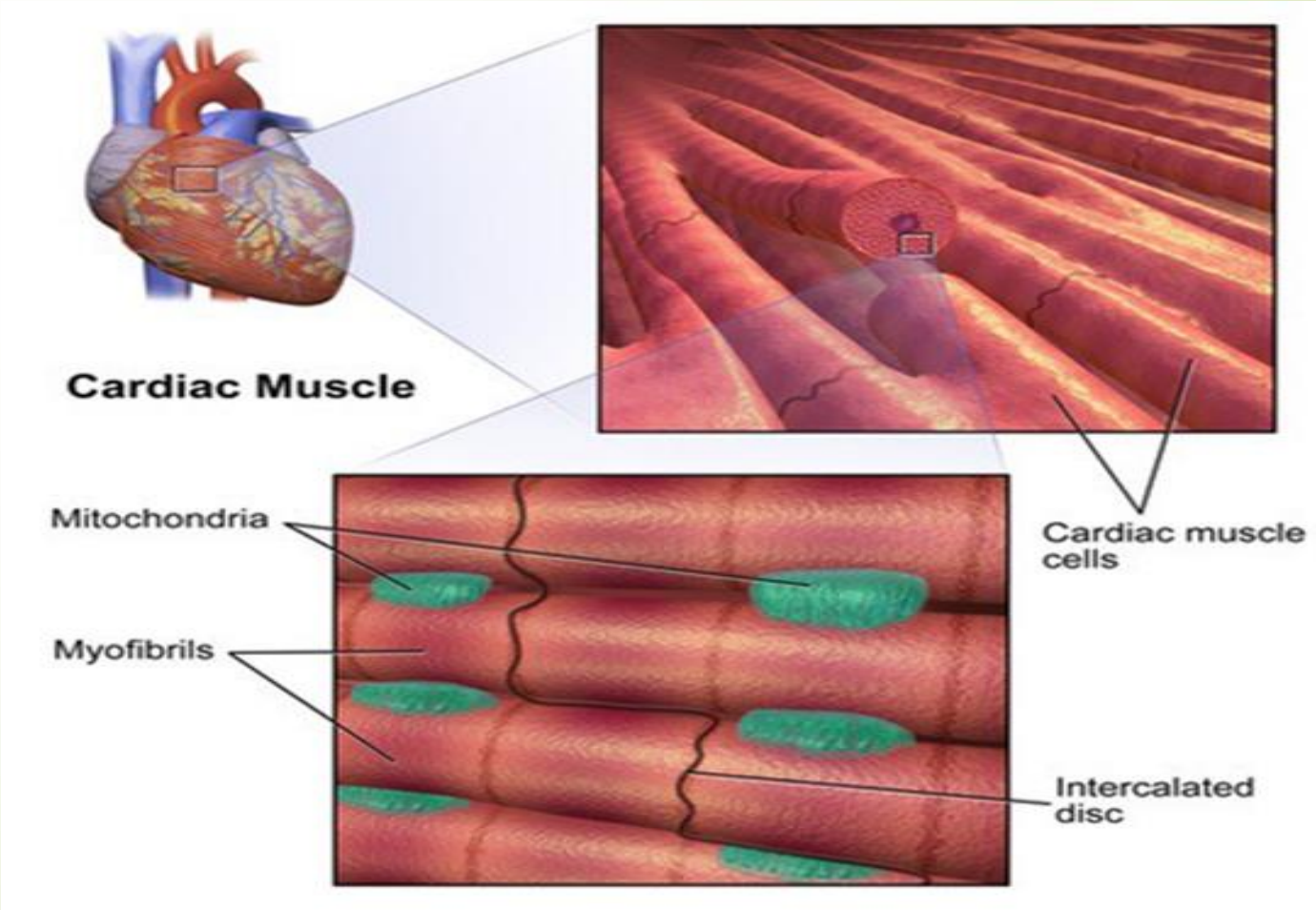
1. **The systemic circulatory system.** This is the main blood circulatory system that transports blood to the organs, tissues, and cells throughout the body.
2. **The pulmonary circulatory system.** This circulatory system moves blood between the heart and lungs


Pulmonary Circuit
Pulmonary artery
Pulmonary vein
aorta
Superior and inferior vena cava
Left atrium
Right atrium
Left ventricle
Right ventricle
Heart
Systemic Circuit
Oxygen-rich, CO_2-poor blood
Oxygen-poor, CO_2-rich blood

Cardiac cells

There are **two** major types of cardiac cells:

1. **Contractile cells** (99%) called cardiomyocytes
2. **Conducting cells**.



A. **Myocardial contractile cells** (99%) called **Cardiomyocytes**:

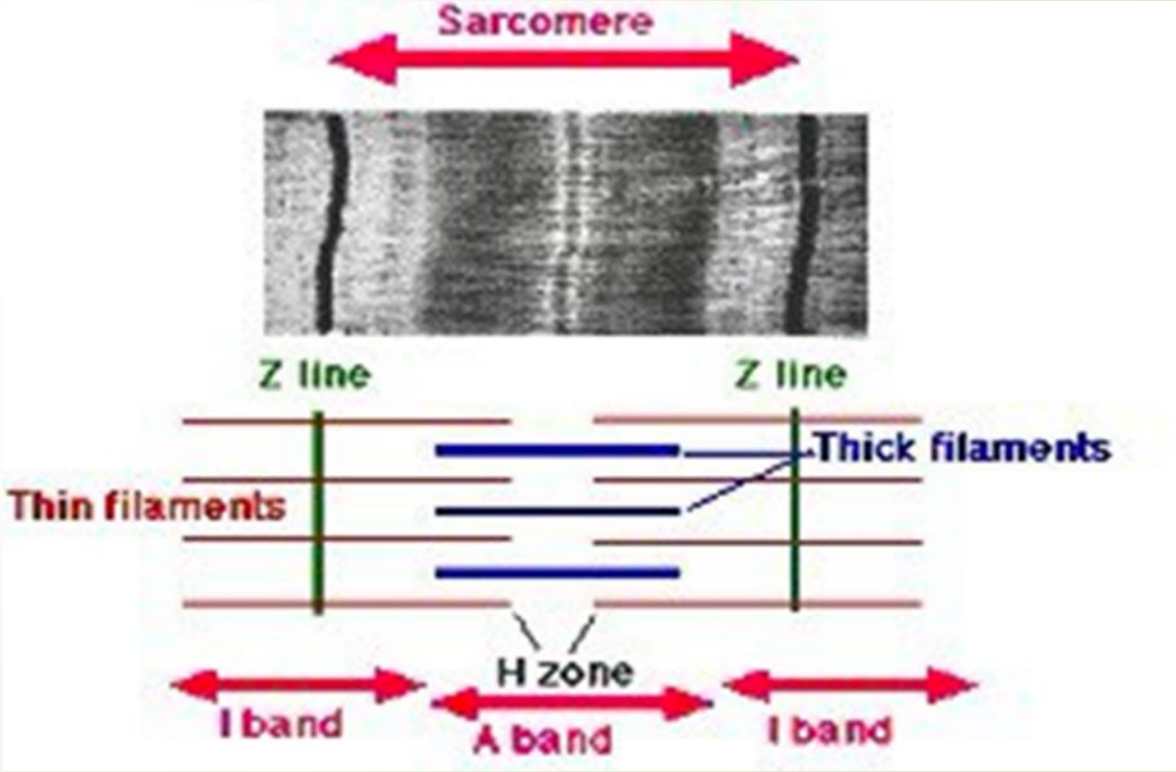
➨ Cardiac muscle cells or cardiomyocytes are the muscle cells that make up the heart muscle. Cardiomyocytes go through a contraction-relaxation cycle that enables cardiac muscles to pump blood throughout the body.

➨ Its characteristics :

- ❖ short and have small diameter
- ❖ involuntary contraction
- ❖ striated

➨ These striations are caused by

- lighter I bands (actin)
- darker A bands (myosin).

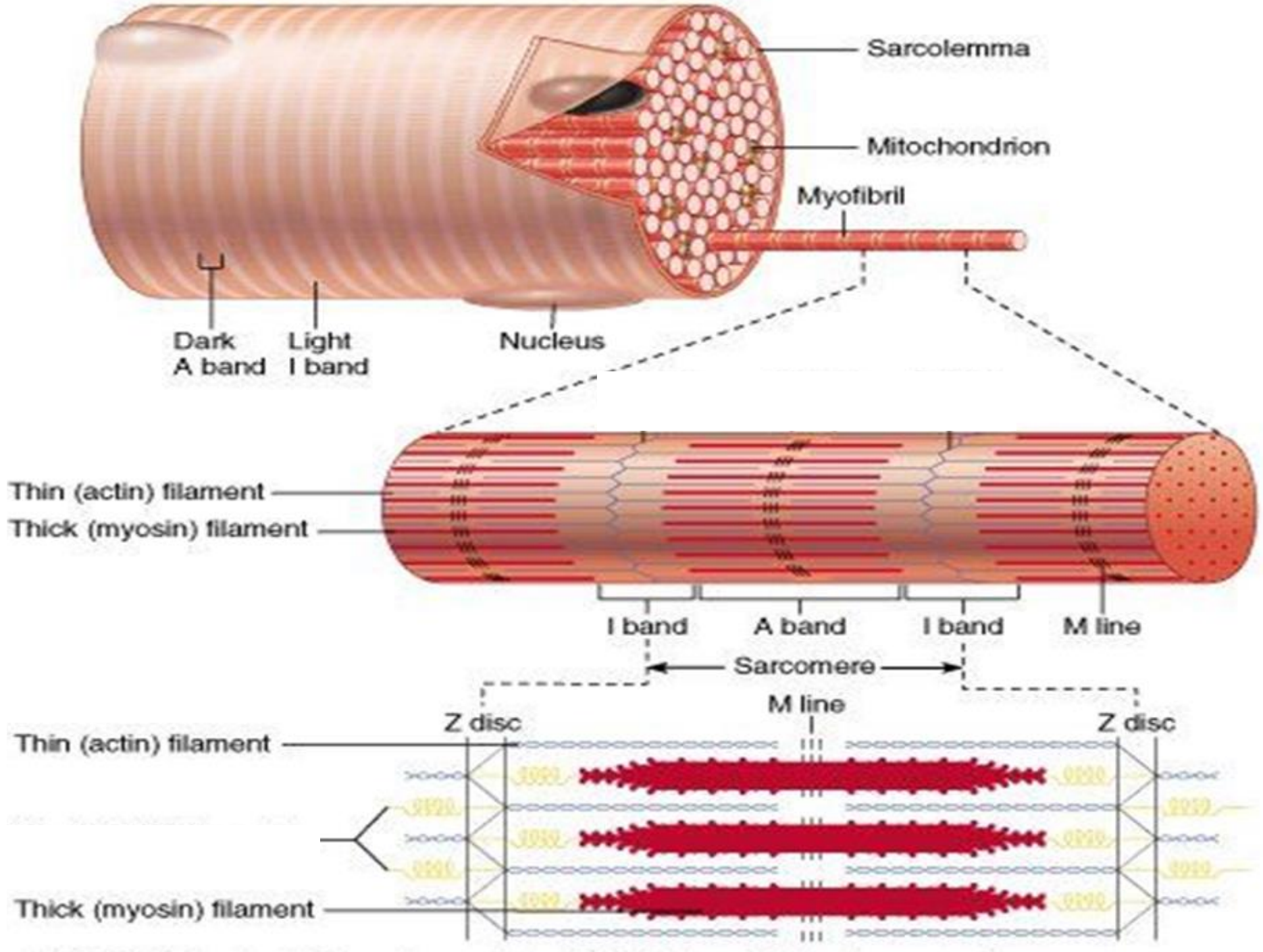


- Each myocyte contains a single nucleus
- surrounded by a cell membrane known as the sarcolemma.
- The sarcolemma of cardiac muscle cells contains voltage-gated calcium channels
- The functional unit of cardiomyocyte contraction is the **sarcomere**
- Each cardiomyocytes contains chain of sarcomeres which are composed of long proteins that organize into myofilaments:

1. Thin myofilaments contain the protein **actin**.

2. Thick myofilaments contain the protein **myosin**.

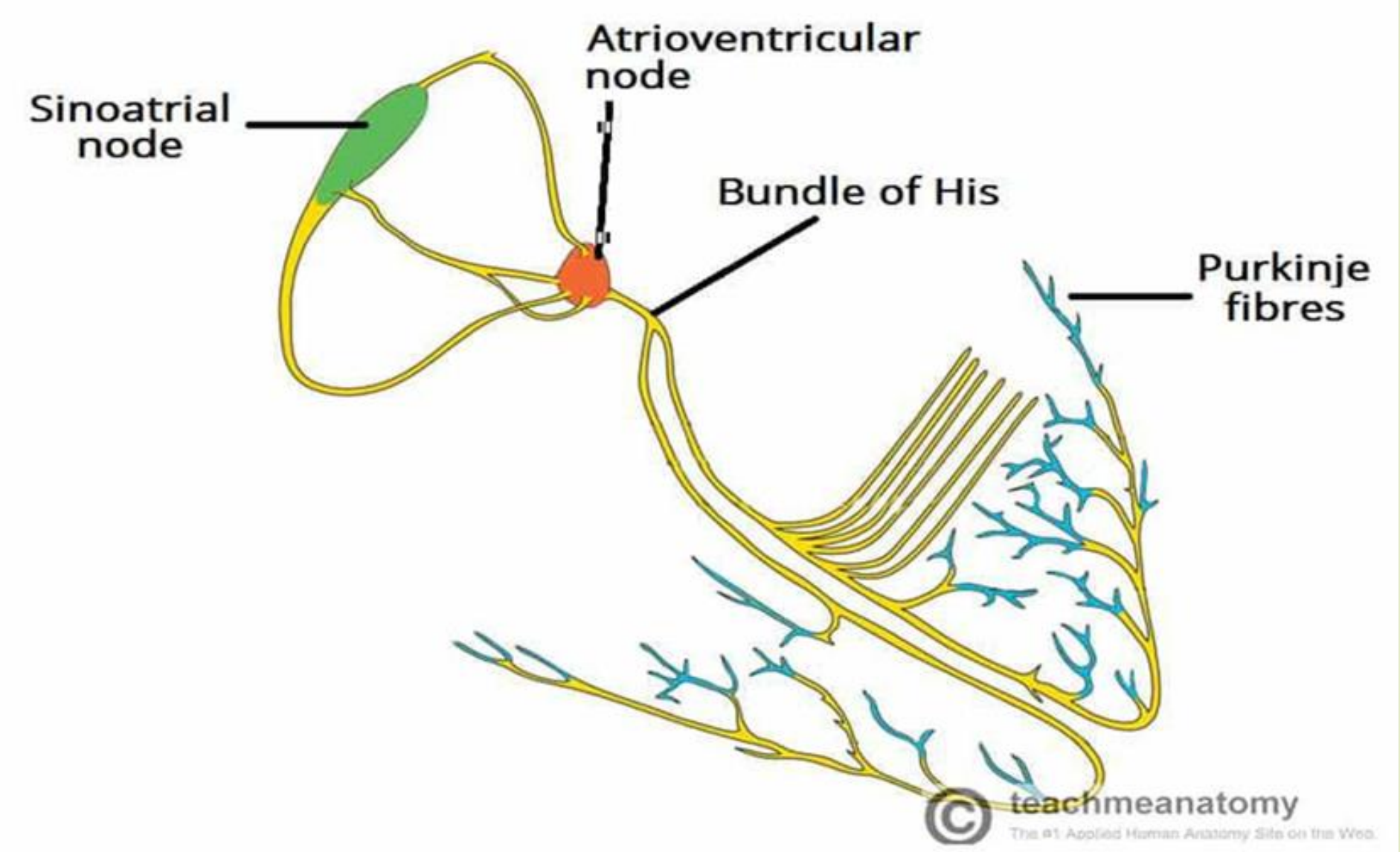
The myofilaments slide past each other as the muscle contracts and relaxes.


Sarcolemma
Mitochondrion
Myofibril
Dark
A band
Light
I band
Nucleus
Thin (actin) filament
Thick (myosin) filament
I band
A band
I band
M line
Sarcomere
M line
Z disc
Z disc
Thin (actin) filament
Thick (myosin) filament

- **Diseases of the heart muscle known as cardiomyopathy**, they are very important and include ischemic conditions caused by restricted blood supply to the muscle from coronary arteries such as **angina** and **myocardial infarction**

B. Myocardial conducting cells, Pacemaker cells:

- Specialized modified cardiomyocytes known as pacemaker cells has the ability to initiate an electrical potential at a fixed rate that spreads rapidly from cell to cell to trigger the contractile mechanism. This property is known as **autorhythmicity**
- Pacemaker cells carry the impulses that are responsible for the beating of the heart.
- The highest concentration of pacemaker cells is in the **sinoatrial (SA) node**, the natural and primary pacemaker, and the resultant rhythm is a **sinus rhythm**.


Atrioventricular node
Sinoatrial node
Bundle of His
Purkinje fibres
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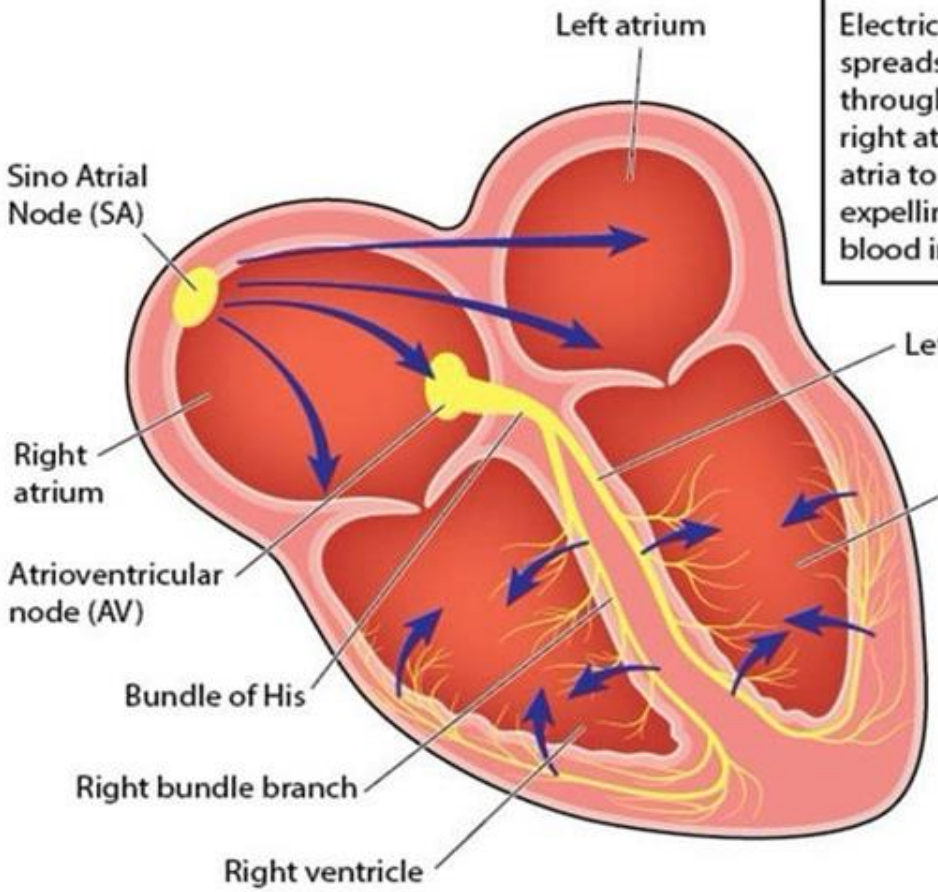
Conducting System of the Heart

- The heartbeat originates in a specialized cardiac muscle cells (cardiac conducting system) and spreads via this system to all parts of the myocardium.
- **Parts of conducting system:**

1. Sinoatrial (SA) node is located in the right atrium
2. Atrioventricular (AV) node
3. Bundle of His: located in the interventricular septum and divided into right and left branches.
4. Purkinje fibers

****A heart block refers to an interruption in the normal conduction pathway like left or right bundle branch block**

Heart Conduction System



Electrical impulse spreads from sinus node throughout left and right atria causing the atria to contract and expelling its volume of blood into the ventricles

Electrical impulse spreads from bundle branches throughout left and right ventricles which causes the ventricles to contract, forcing them to expel their volume of blood out into the general circulation


THANK YOU!