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SEARCH

SPORT EDUCATION FOR ACTIVE AND RESPONSIBLE CITIZENSHIP THROUGH HEALTH CARING

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MODULE 2

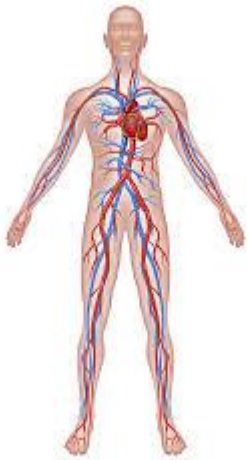
ENCOURAGING SPORTS PRACTICE FOR ONE'S OWN PSYCHO-PHYSICAL WELLBEING AND TO CONTROL NATIONAL SOCIAL AND HEALTH COSTS

SEGMENT 4

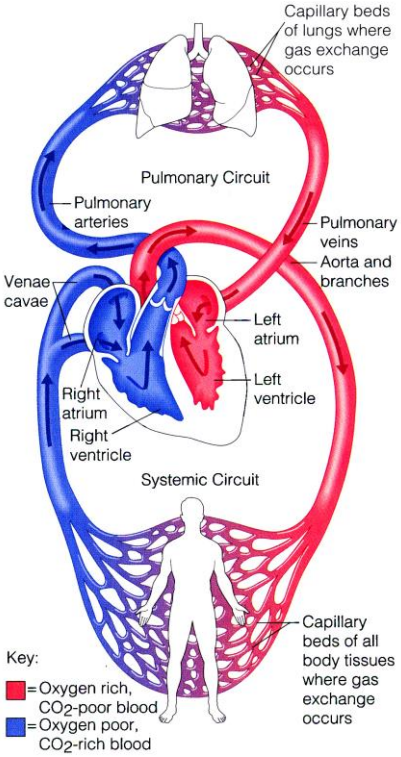
Cardio-Vascular System

Major components of the Cardio-vascular system

Heart, Blood and Blood vessels



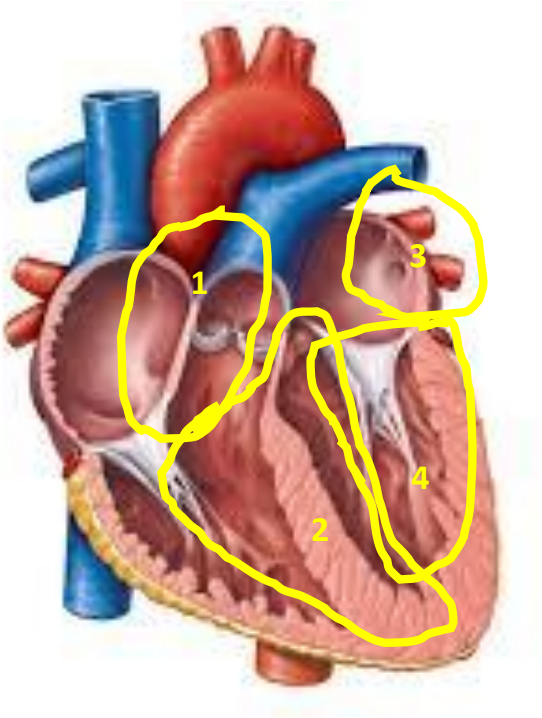
Major components of the Cardio-vascular system

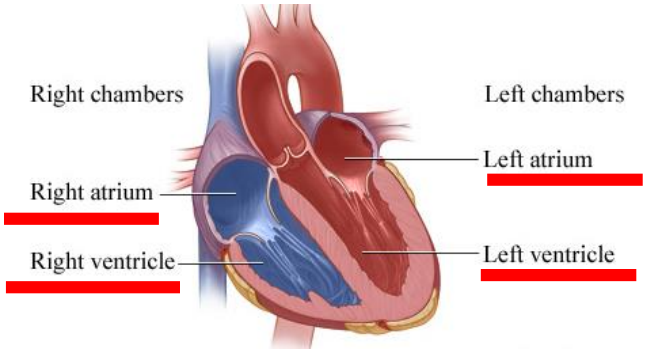


Cardiovascular system

- The heart
- Blood vessels
  - arteries
  - arterioles
  - capillaries
  - venules
  - veins
- 4-6 L of Blood

Functional organization of the CVS





The heart consists of **two separate pumps**:
a ***right heart*** that pumps blood through the lungs
a ***left heart*** that pumps blood through the peripheral organs.

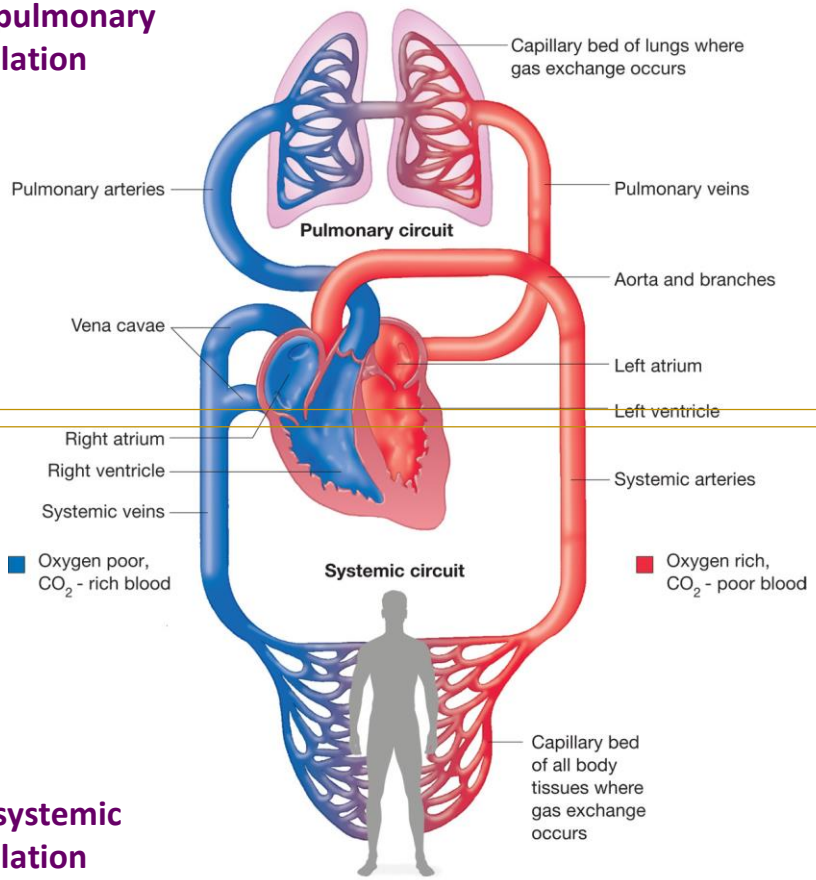
Each of these is a pulsatile two-chamber pump: composed of **an *atrium*** and **a *ventricle***.

Atrium is a weak primer pump, helping to move blood into the ventricle.

The ventricles then supply the main pumping force that propels the blood either
(1) through the **pulmonary circulation** by the right ventricle
(2) through the **peripheral or systemic circulation** by the left ventricle.

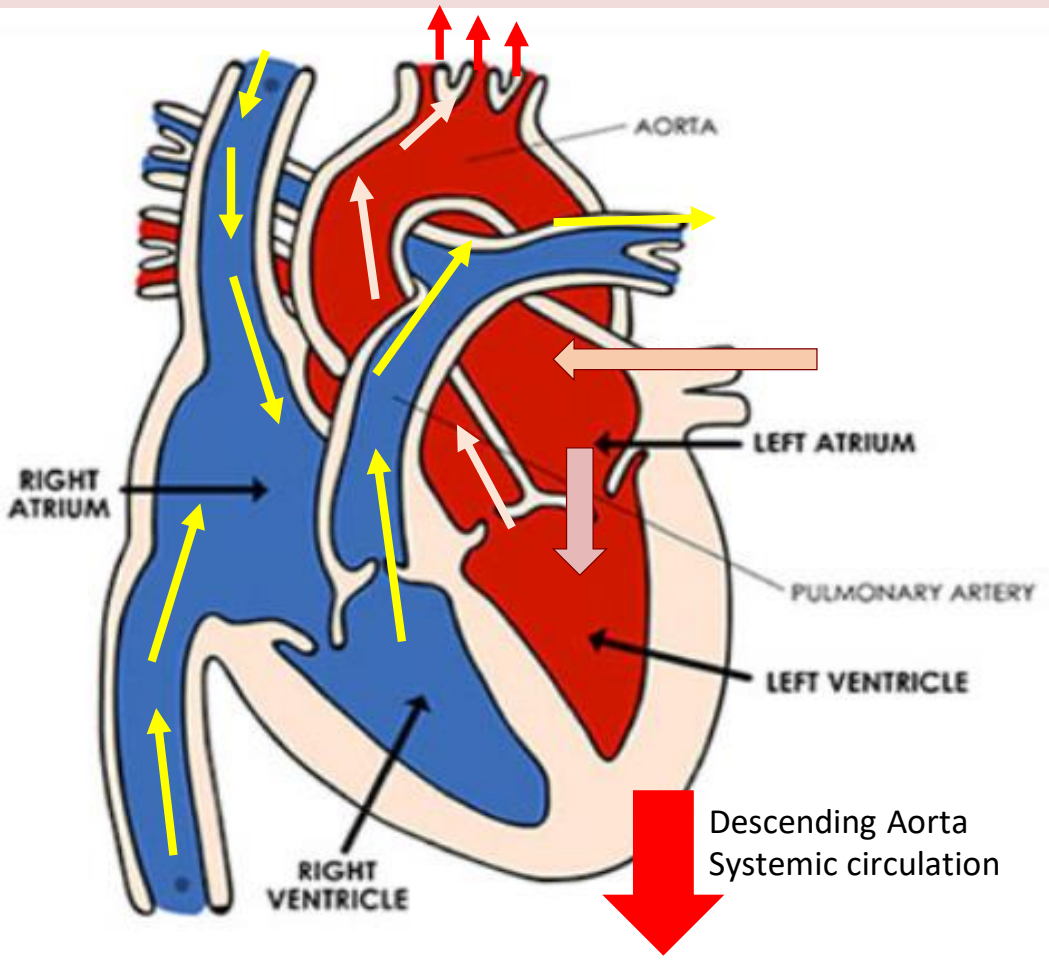
Functional organization of the CVS

The pulmonary circulation

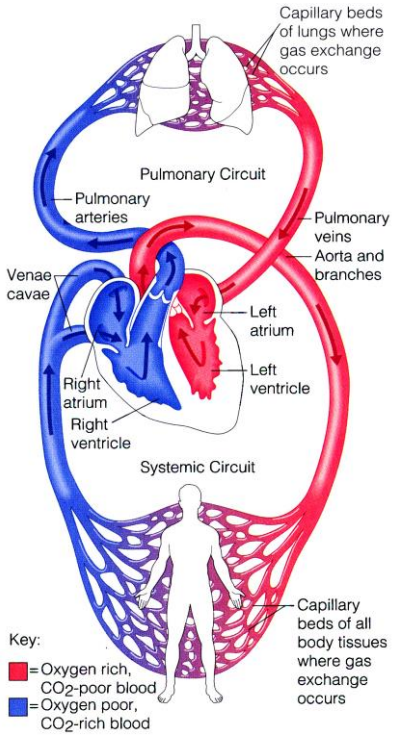


The systemic circulation

Blood flow through the heart



CARDIAC OUTPUT, PERIPHERAL RESISTANCE AND MEAN ARTERIAL PRESSURE



Three features of a circulation system

1. **Blood flow** (cardiac output [CO])

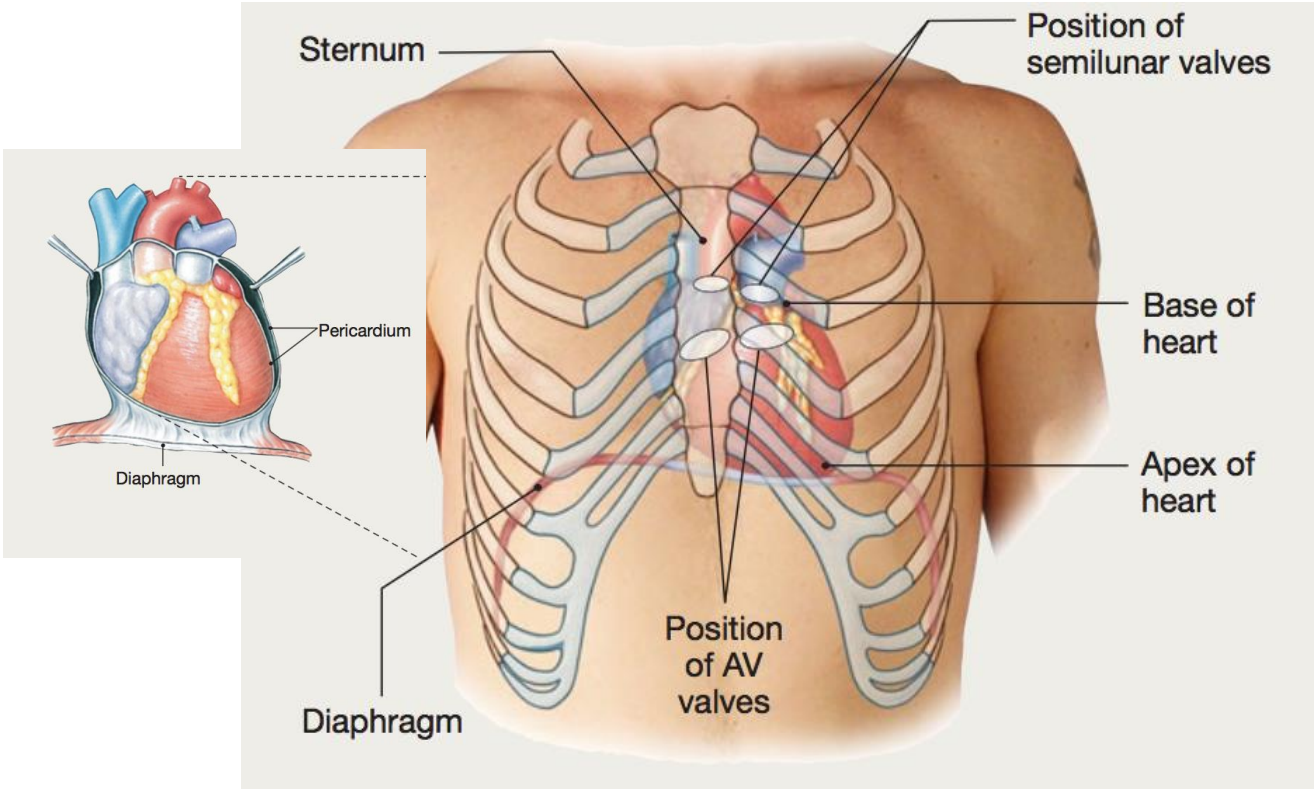
2. **Pressure** (mean arterial pressure [MAP])

3. **Resistance** (total peripheral resistance [TPR])

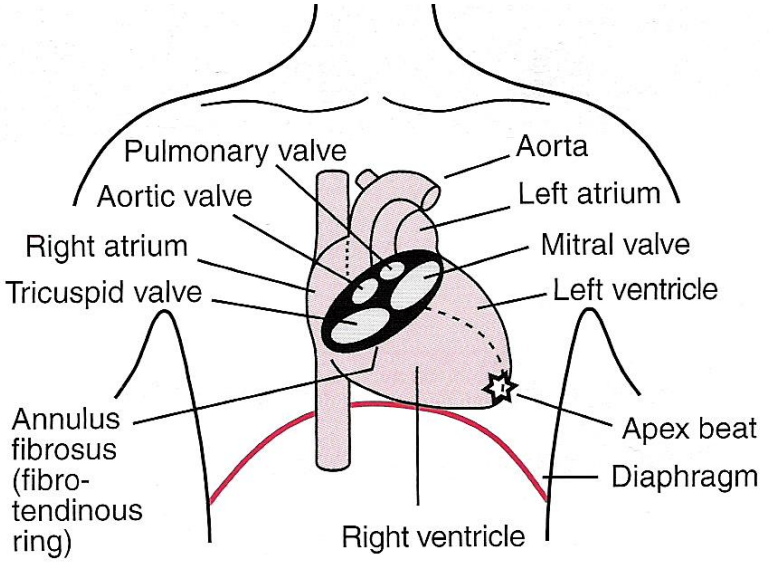
MAP = CO x TPR

($\Delta P = Q \times R$)

THE HEART


Sternum
Position of semilunar valves
Pericardium
Base of heart
Apex of heart
Diaphragm
Position of AV valves
Diaphragm

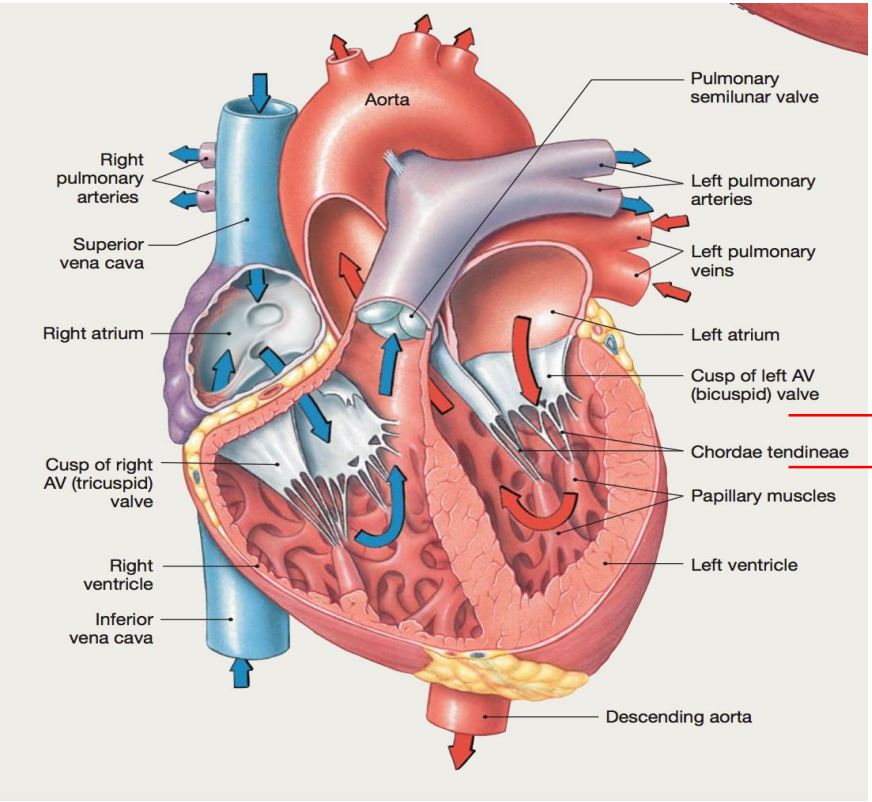
THE HEART



Heart:

- The heart: muscular organ in the pericardium
- Heart wall : cardiac muscle cells, the myocardium
- The heart: right and left side
- Each side: atrium and ventricle
- **A fibro-tendinous ring contains HEART valves**

THE HEART



AV valves (<u>Atrio-Ventricular valves</u>)

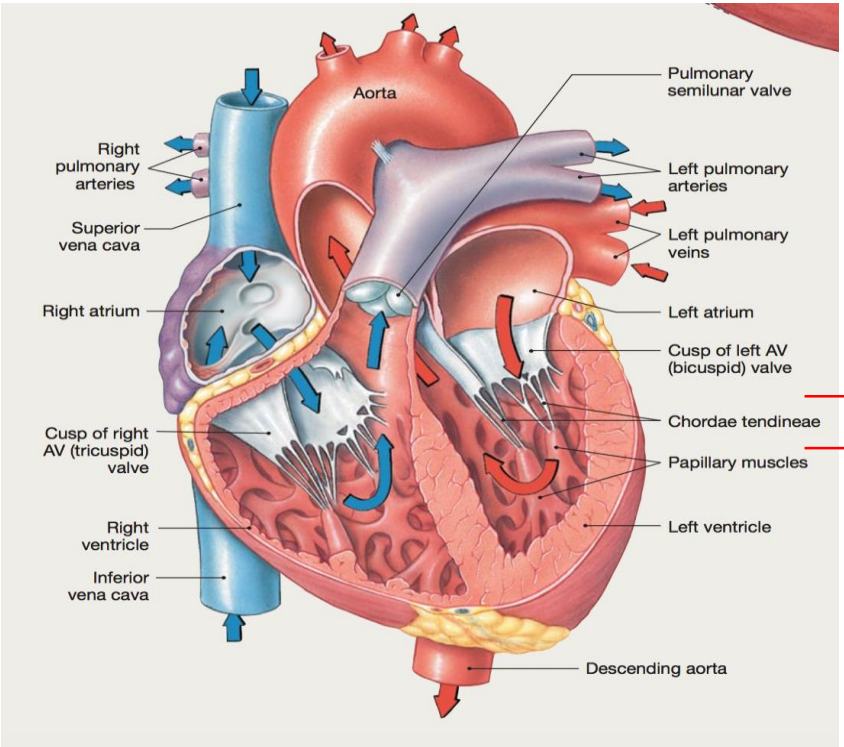
• Between the atria and the ventricles
- tricuspid valve : right heart
- mitral/bicuspid valve : left heart

• Attached to the free margins: **<u>chordae tendineae</u>** - attached to projections of ventricular muscle – **<u>papillary muscles</u>** (contraction of which help prevent eversion of the AV valves into the atria)

• The AV valves permit blood to flow uni-directionally from the atrium into the ventricle

• Opening and closing of the AV valves is a passive process dependent on the pressure difference across the valve

THE HEART



Semilunar valves

• Aortic valve : Between the left ventricle and aorta

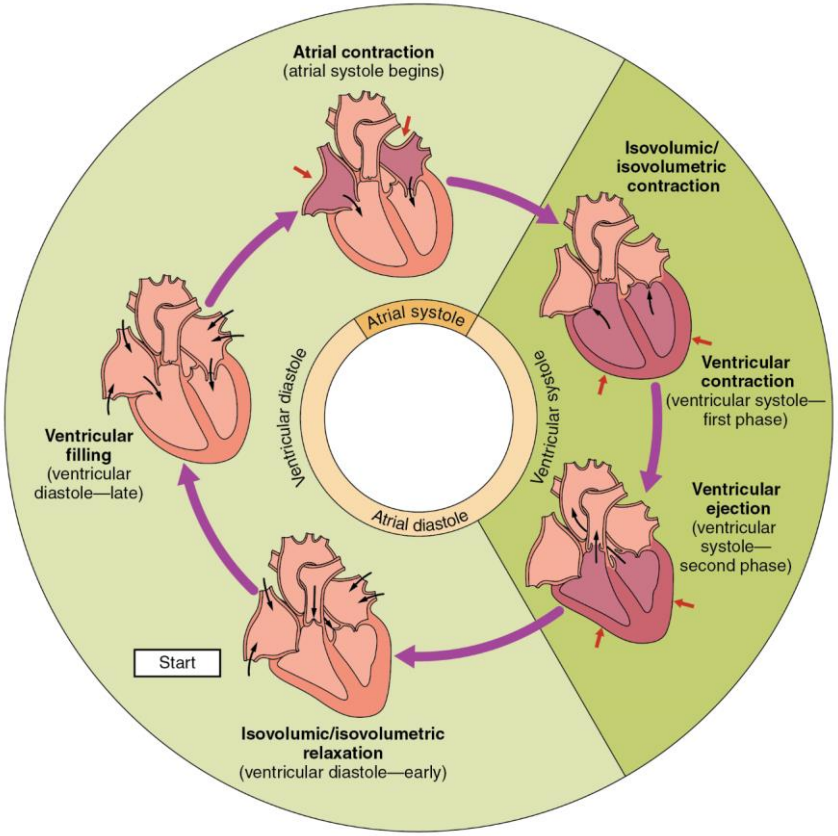
• Pulmonary valve : between the right ventricle and the pulmonary artery

• The semilunar valves:
- allow blood to flow into the arteries during systole
- prevent back-flow into the ventricles during diastole
- open and close passively by pressure difference, generated by ventricular contractions

THE CARDIAC CYCLE

The heart undergoes repeated sequence of **contraction and relaxation**. First the two atria fill with blood and then contract simultaneously. This is followed by simultaneous contraction of both ventricles, which send blood through the pulmonary and systemic circulations.

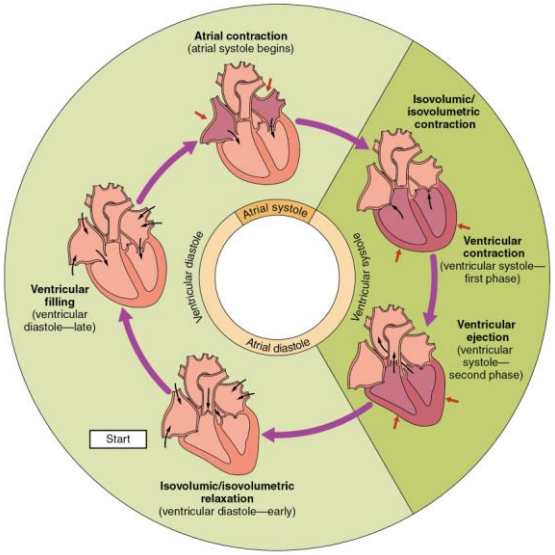
The **cardiac cycle** refers to the repeating pattern of contraction and relaxation of the heart. The phase of contraction is called **systole,** and the phase of relaxation is called **diastole.**



THE CARDIAC CYCLE

One Heart beat = One complete set of contraction **(systole)** and relaxation **(diastole)** of the heart is called the **cardiac cycle**

- **electrical events** (ECG) (lecture 4)
- **mechanical events** (volume and hydrostatic pressure changes)
- **valvular events** (opening and closing of valves results in heart sounds)



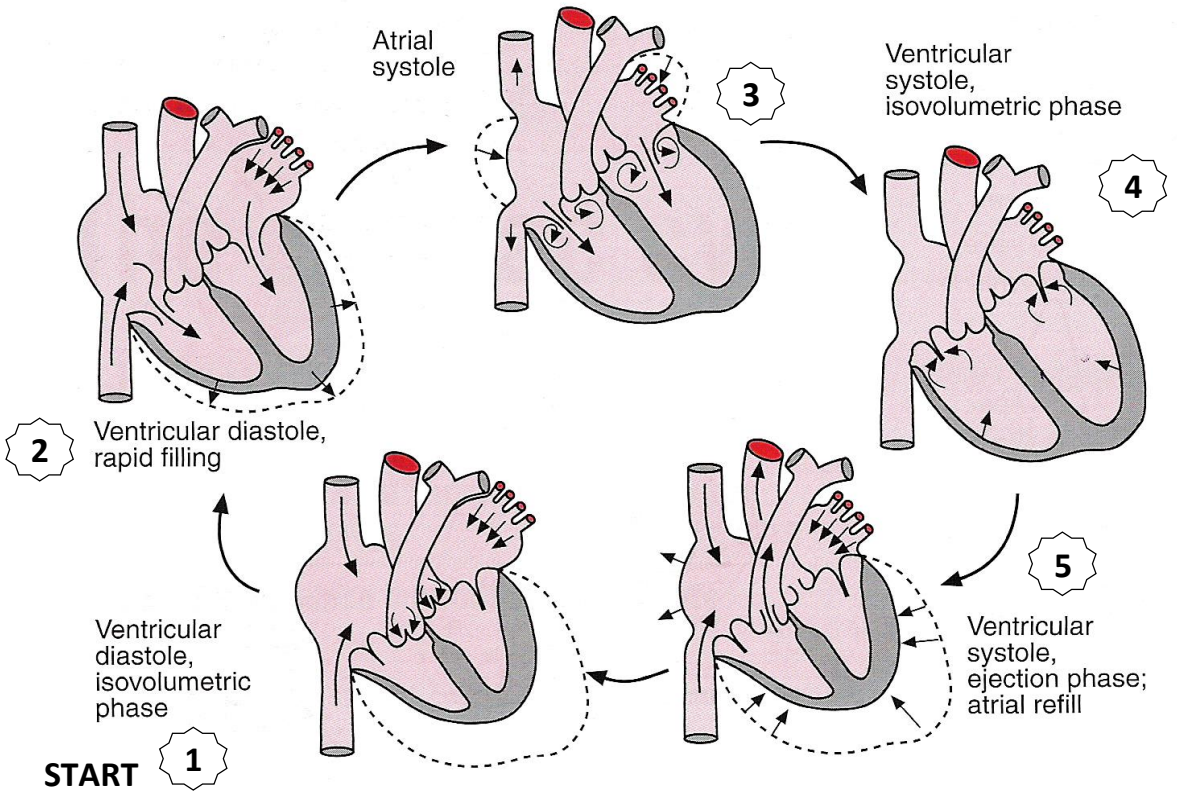
TOTAL DURATION of the CARDIAC CYCLE (For a heart rate of 72 beats/min) = 1/72 min = 0.8 second of which 0.3s IS SYSTOLE AND 0.5s IS DIASTOLE

The cardiac cycle is divided into 2 phases :

1. Ventricular Diastole : ventricles are relaxed

2. Ventricular Systole : ventricles are contracting

THE CARDIAC CYCLE



Blood Vessels

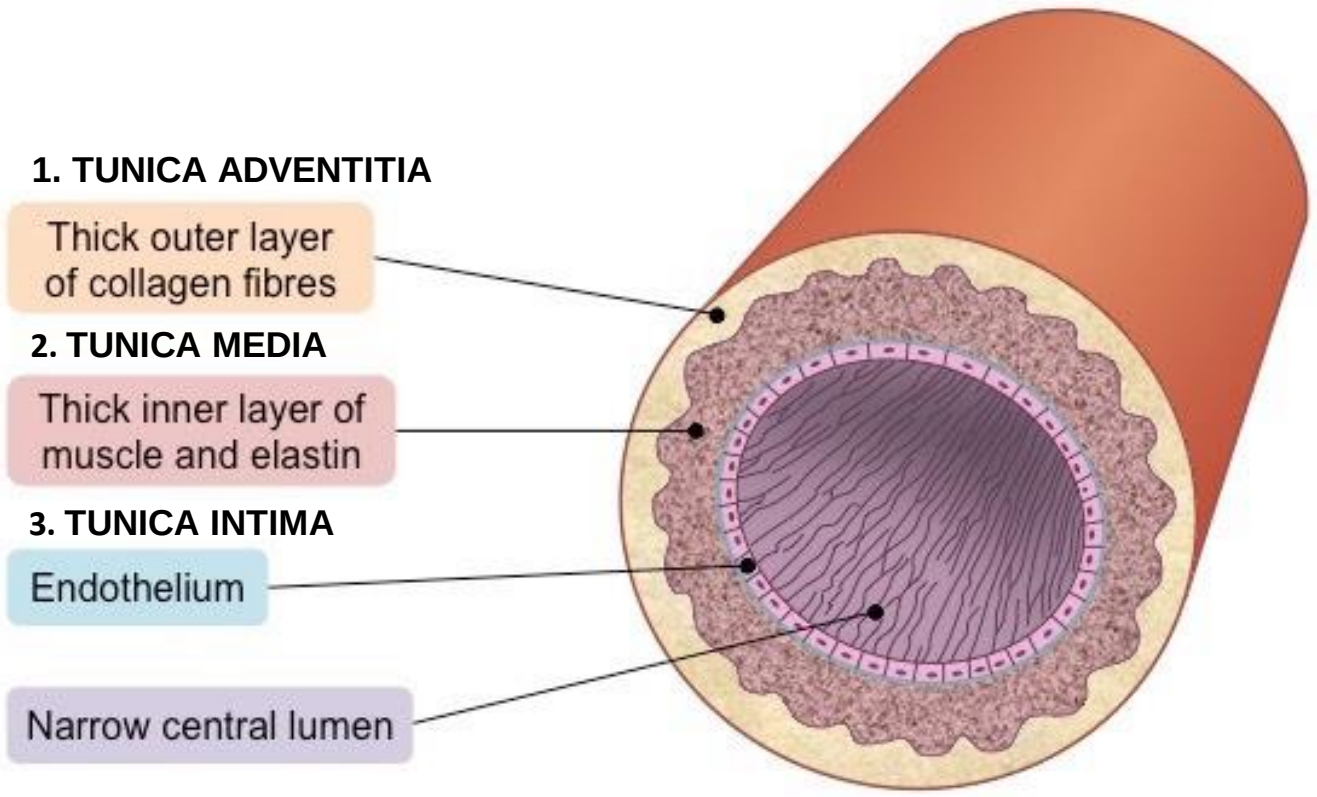
- Blood vessels can be divided into arteries (muscular and elastic/conduit), arterioles, capillaries, venules and veins.

- All ARTERIES carry blood away from the heart (Divergent).
- All VEINS carry blood to the heart (Convergent).

- In general, arteries carry oxygenated blood and veins carry deoxygenated blood.

The exception to this is the pulmonary arteries carry deoxygenated blood to the lungs to get oxygenated and the pulmonary veins carry oxygenated blood to the heart to get sent to the rest of the body.

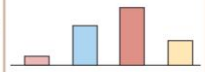
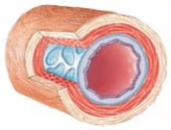
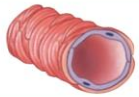
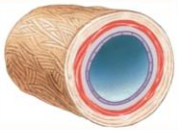
Structure of the blood vessels



Structure of the blood vessels

BLOOD VESSEL STRUCTURE

The walls of blood vessels vary in diameter and composition. The bars show the relative proportions of the different tissues. The endothelium and its underlying elastic tissue together form the tunica intima. (Adapted from A.C. Burton, *Physiol Rev* 34: 619–642, 1954).

	Mean diameter	Mean wall thickness	Endothelium / Elastic tissue / Smooth muscle / Fibrous tissue	
Artery	4.0 mm	1.0 mm		
Arteriole	30.0 µm	6.0 µm		
Capillary	8.0 µm	0.5 µm		
Venule	20.0 µm	1.0 µm		
Vein	5.0 mm	0.5 mm		

Elastic Arteries : More Recoil
Pressure Reservoirs

Muscular Arteries (Arterioles):
More Resistance

Single layer of cells allow exchange

Volume reservoirs

Elastic (Conduit) Arteries

- An Elastic Artery (conducting or conduit artery) is an artery with a large number of collagen and elastin filaments in the tunica media, which gives it the ability to stretch in response to ventricular contraction
- The Aorta is an example of a **CONDUIT** vessel
- These are large lumen vessels (low resistance)
- This allows them to be "PRESSURE RESERVOIRS" — they expand and contract (elastic recoil) as blood is ejected by the heart.
- This allows blood flow to be continuous.

Arteries

Blood enters the arteries during systole causing their elastic walls to stretch to accommodate the increased volume

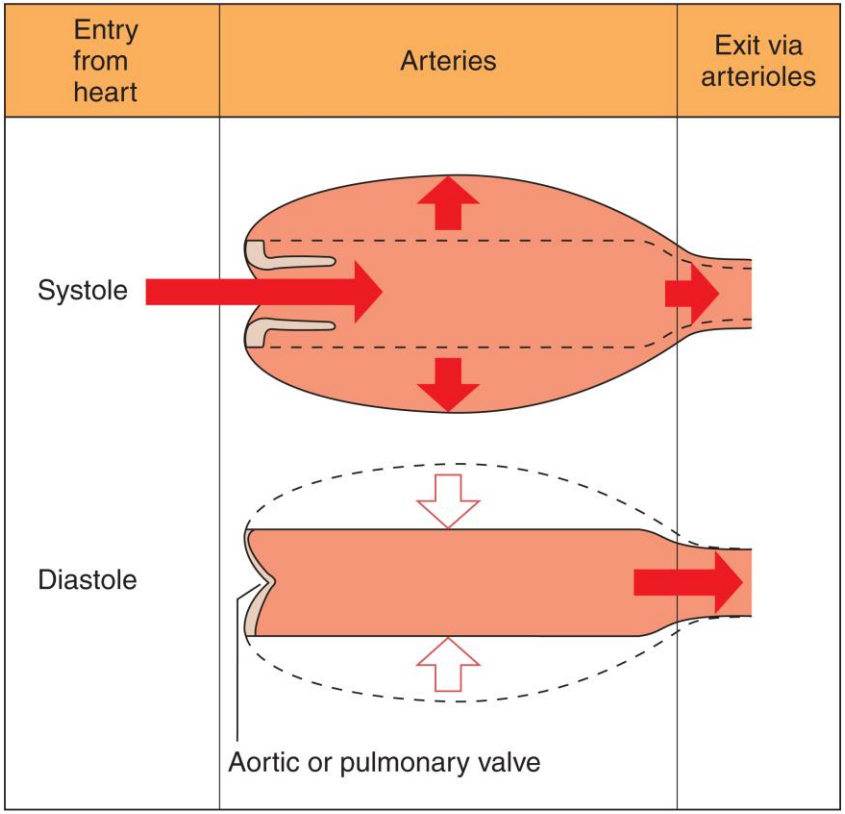
Stretchablity of an elastic container is defined as compliance

Compliance = Δvolume/Δ pressure

The higher is the compliance of a structure, the more easily it can be stretched.

During diastole the artery wall recoils and pushes the blood into the peripheral circulation (elastic recoil)

Arteries act as pressure reservoirs



ARTERIES ACT AS PRESSURE RESERVOIRS

The force that creates blood flow through the cardiovascular system is the ventricular contraction. As blood under pressure is ejected from the left ventricle, the aorta and arteries expand (bulge) to accommodate it

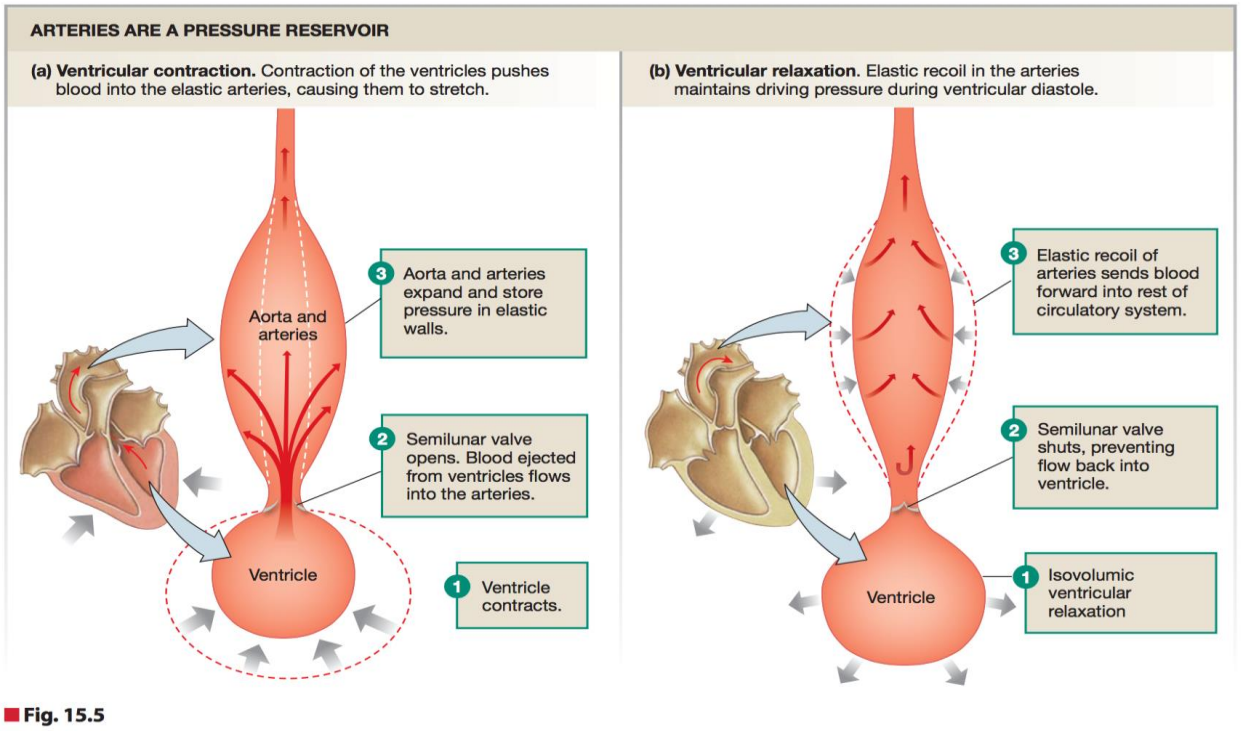
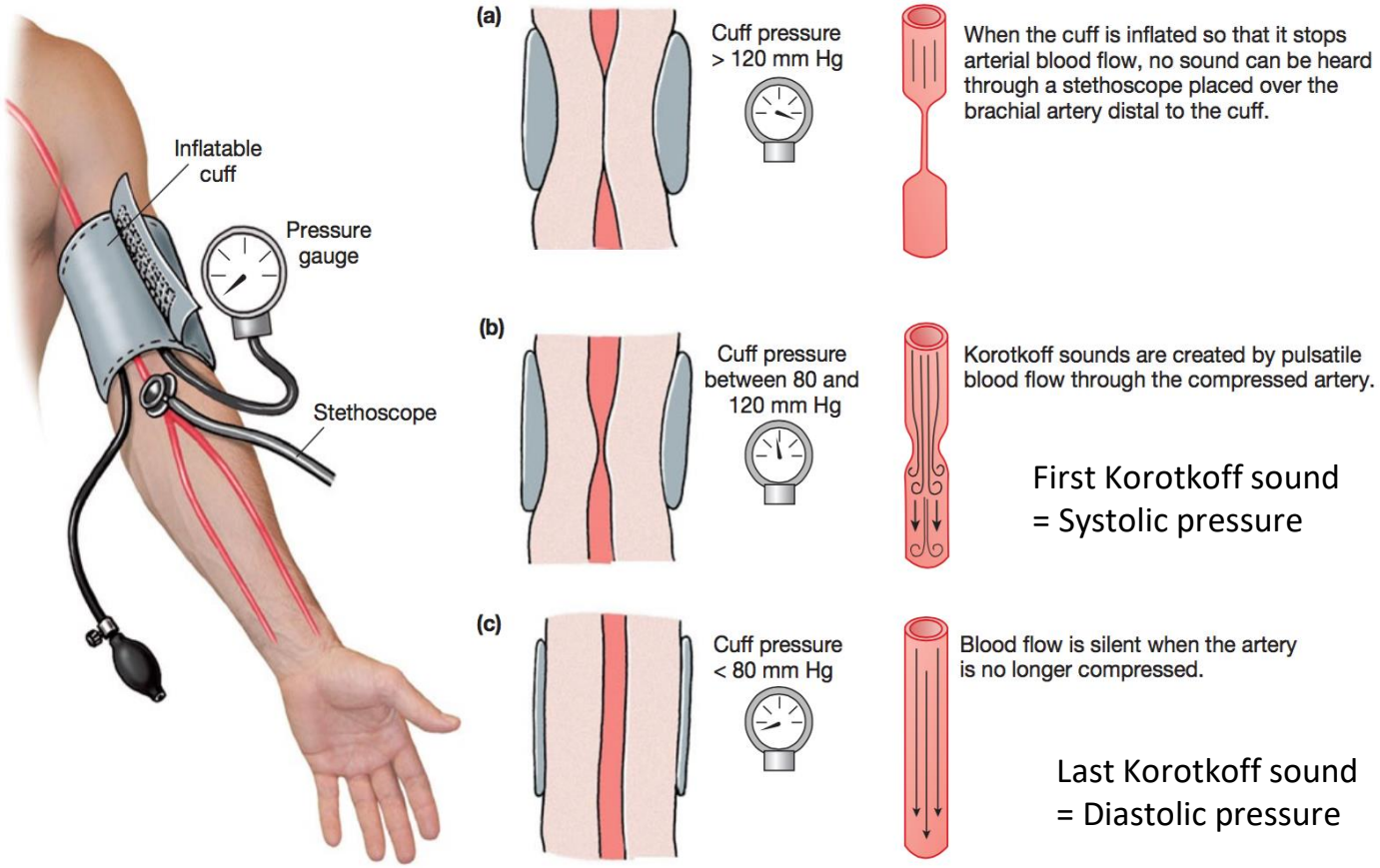


Fig. 15.5

SPHYGMOMANOMETRY

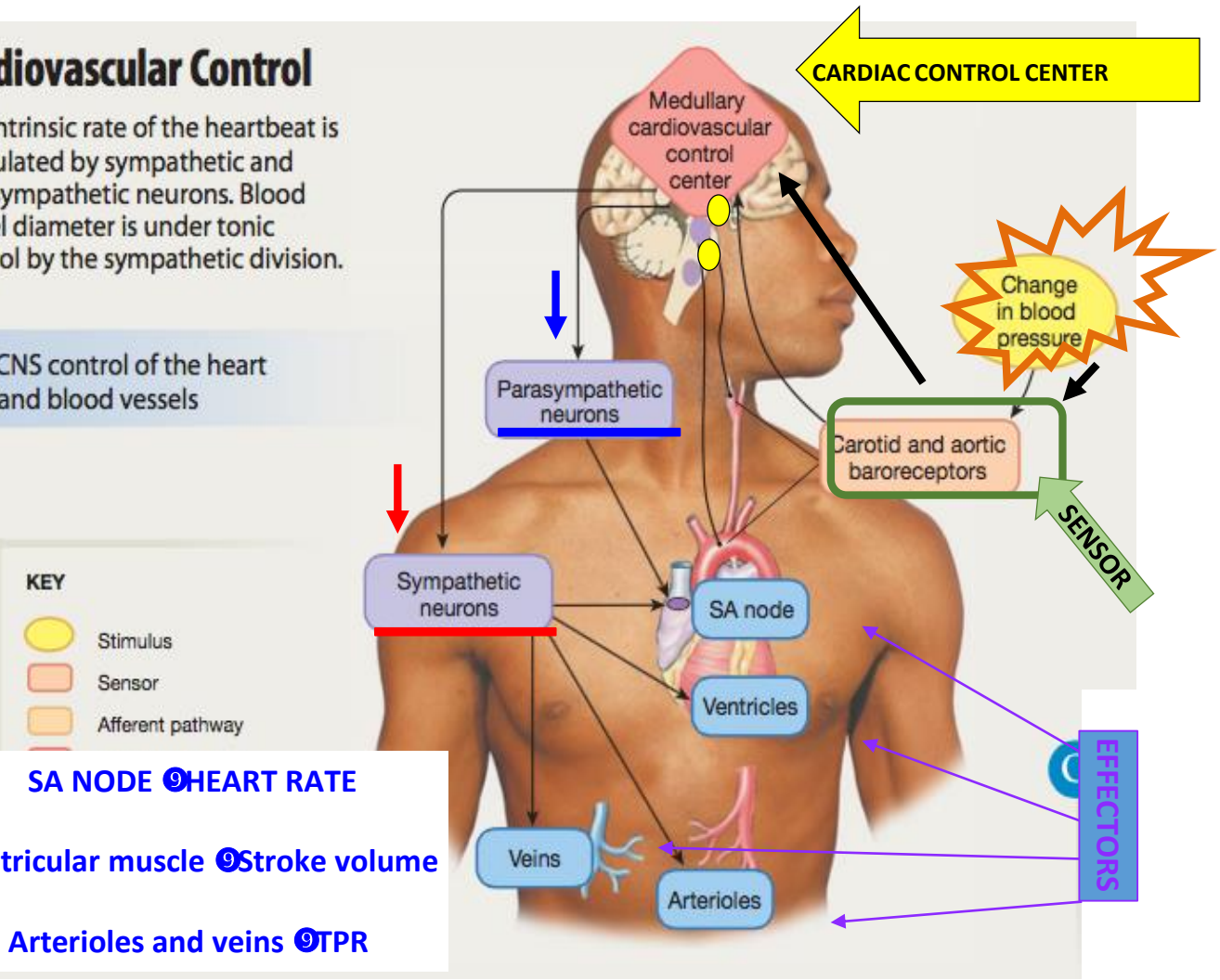
Arterial blood pressure is measured with a sphygmomanometer (an inflatable cuff plus a pressure gauge) and a stethoscope. The inflation pressure shown is for a person whose blood pressure is 120/80.



Cardiovascular Control

The intrinsic rate of the heartbeat is modulated by sympathetic and parasympathetic neurons. Blood vessel diameter is under tonic control by the sympathetic division.

(a) CNS control of the heart and blood vessels



SA NODE ❾HEART RATE

Ventricular muscle ❾Stroke volume

Arterioles and veins ❾TPR

Keywords

Cardiovascular System

Heart

Blood

Metabolites

Aorta

Mitral valve

Tricuspid Valve

Heart Rate

Adrenaline

Immune Defense