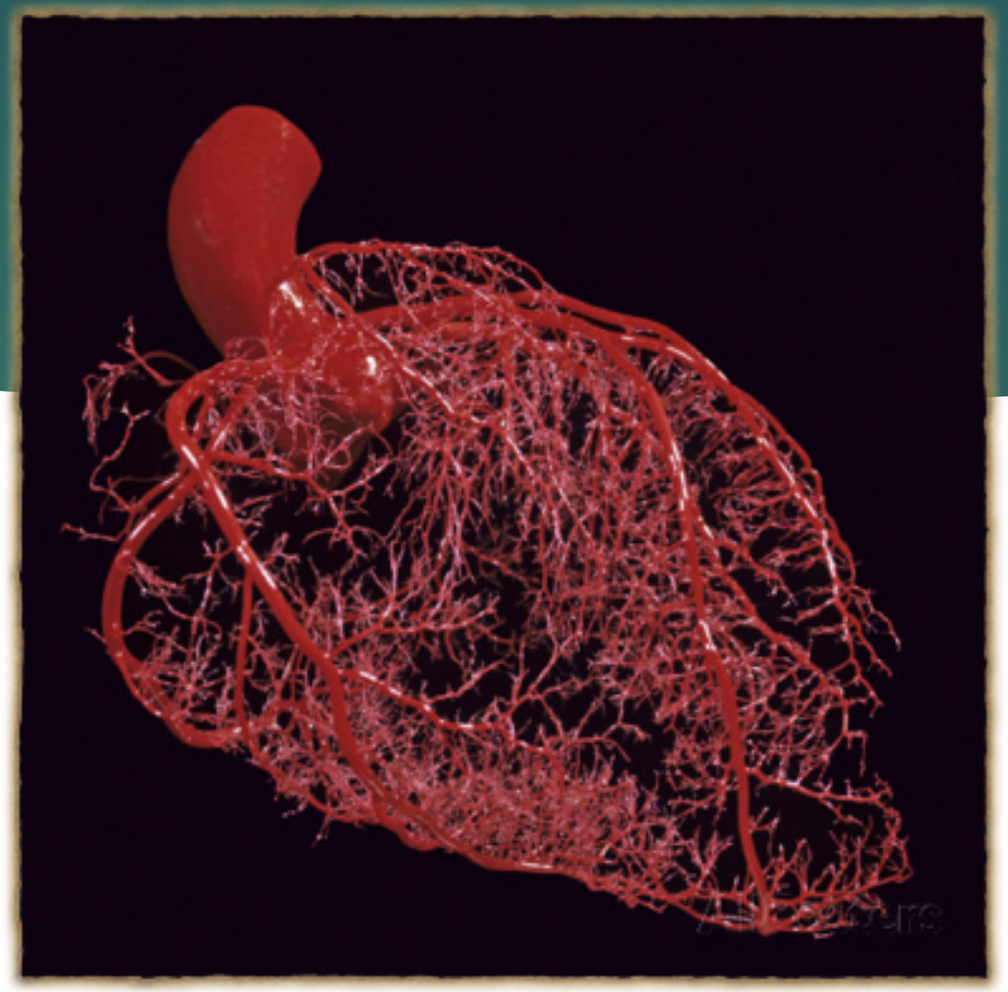

Coronary Circulation

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At end of this lecture you should be able to know:

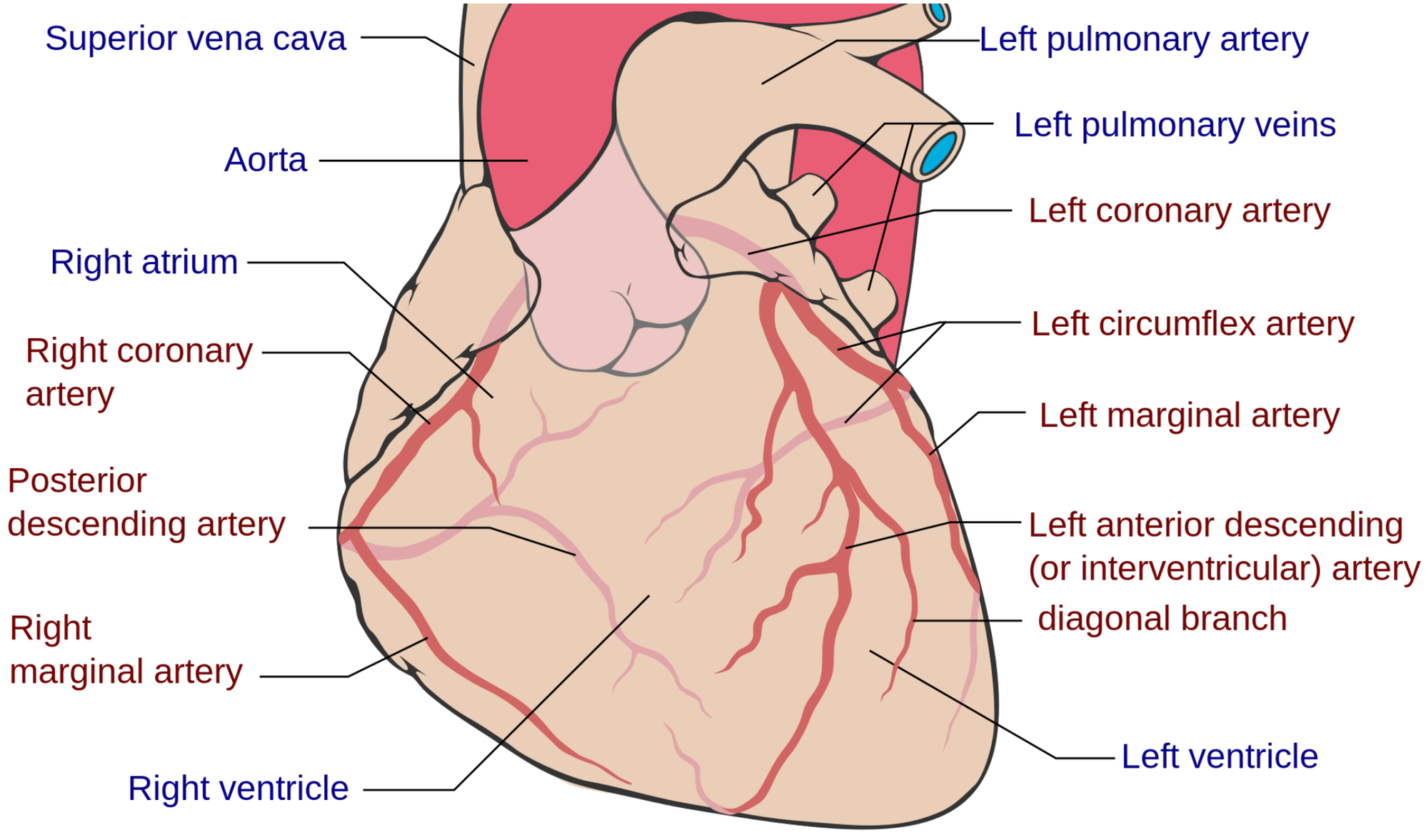
Coronary Circulation:
Arterial Supply, venous & lymphatic drainage

Coronary Blood Flow:
Phasic changes, affecting factors & its control

Collateral Circulation

Coronary Dominance

Coronary Circulation



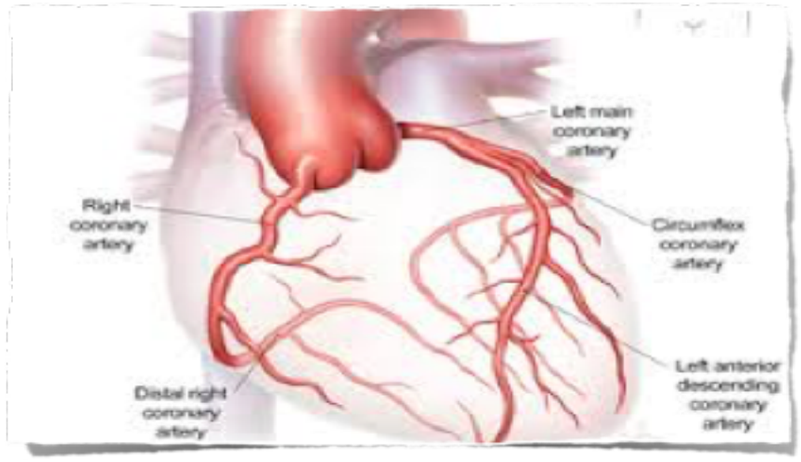
Coronary Circulation

- **Consists of:**

1. Arterial supply.
2. Venous drainage.
3. Lymphatic drainage.

Arterial Supply

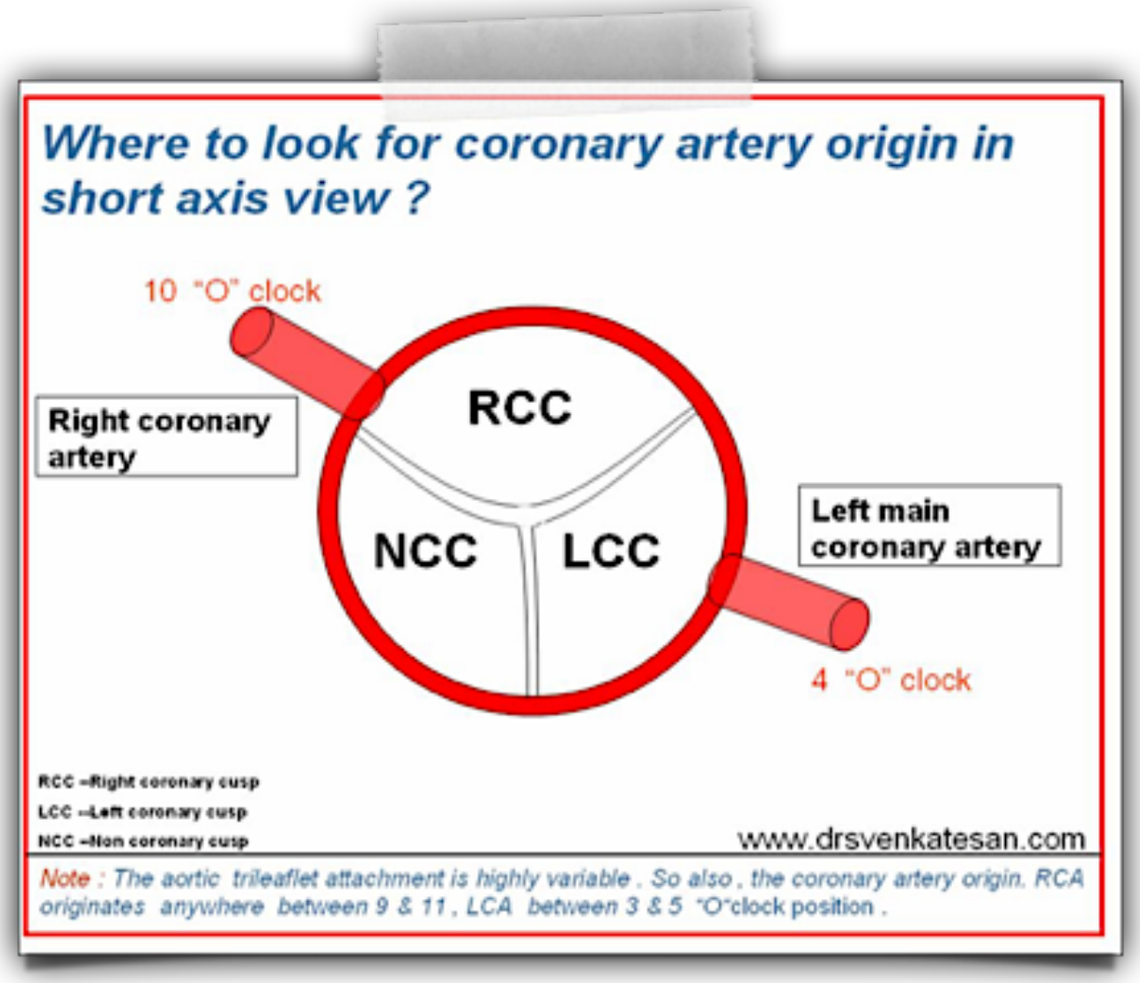
- **Cardiac muscle is supplied by two coronary arteries:**
  - A. Right coronary artery (RCA.)
  - B. Left coronary artery (LCA.)



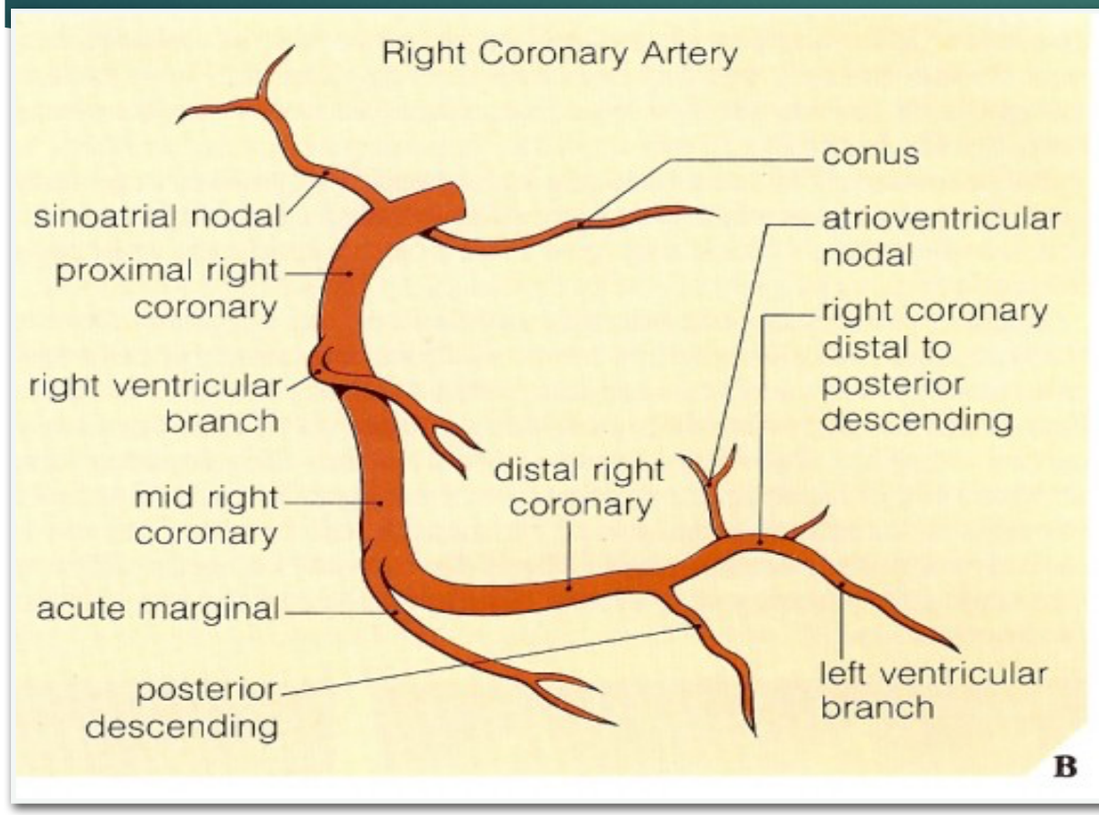
- **Both coronaries arise from the coronary sinuses just superior to the aortic valve cusps at the aortic root.**

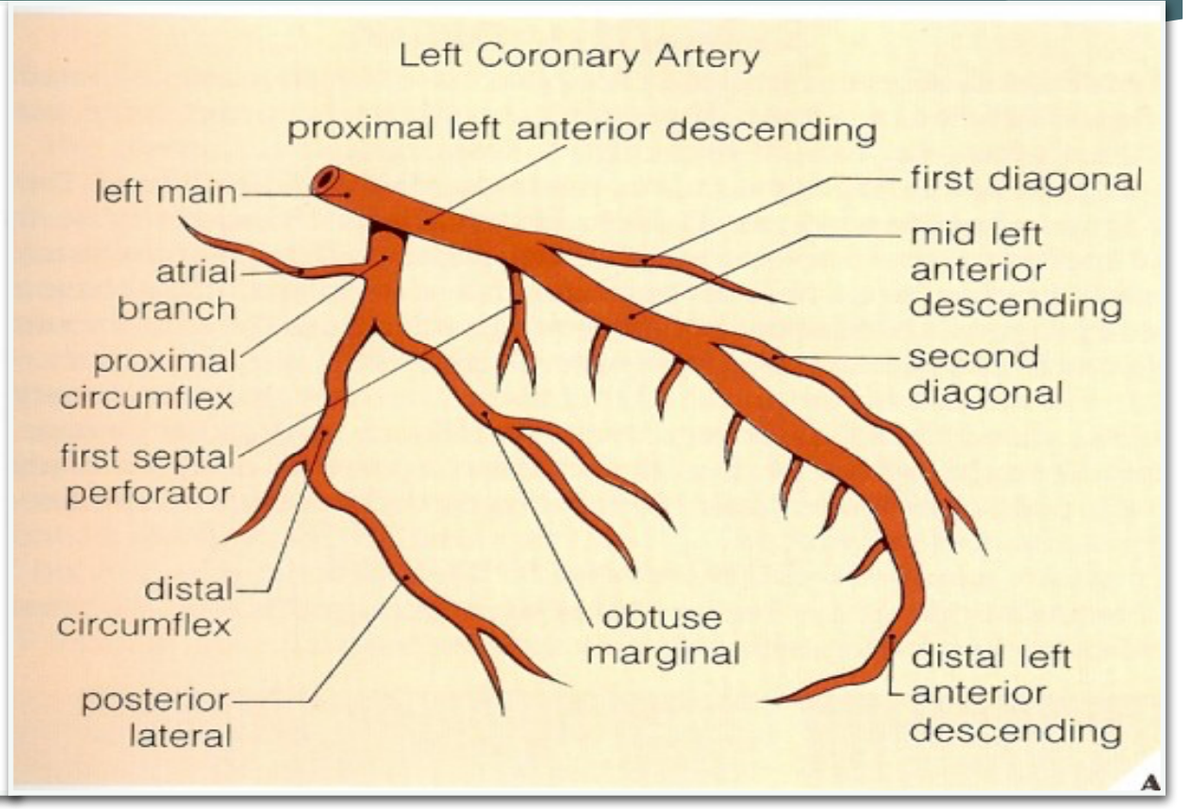
I: Arterial Supply

- **The aortic valve has three cusps:** left coronary (LC), right coronary (RC) & posterior non-coronary (NC) cusps.
- **Coronary arteries arise just superior to the aortic valve cusps.**
- **Coronary Ostia** (origins of the coronary arteries) may vary in shape & location, most of which are of no clinical significance.
- **Coronary arteries deliver oxygenated blood to the cardiac muscle.**



Right vs Left Coronary Arteries





- Smaller than the left coronary artery.
- Arises from the right coronary sinus.
- Terminates by anastomosing with the left coronary artery.

- Larger than the right coronary artery.
- Arises from the left coronary sinus.
- Terminates by anastomosing with the right coronary artery.

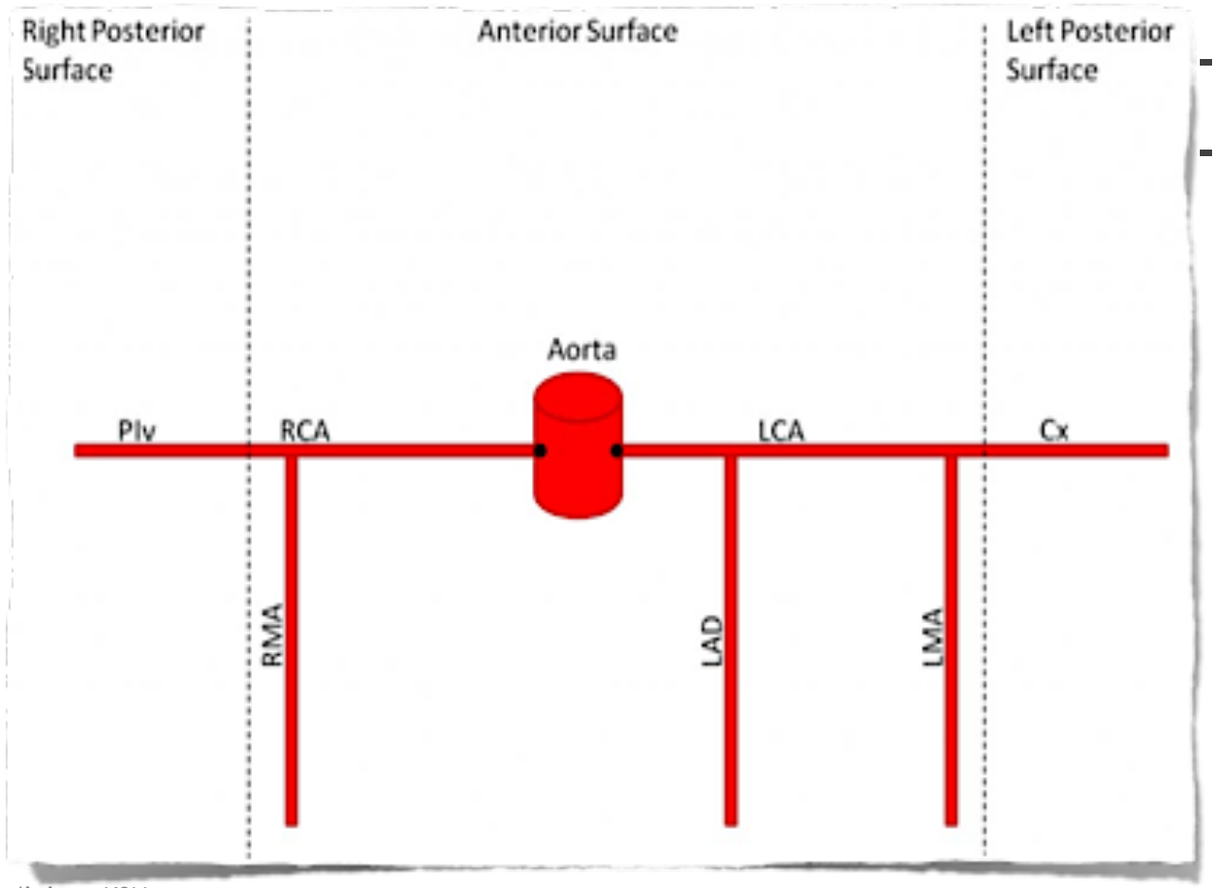
Branches of Coronary Arteries

Right Coronary Artery (RCA):

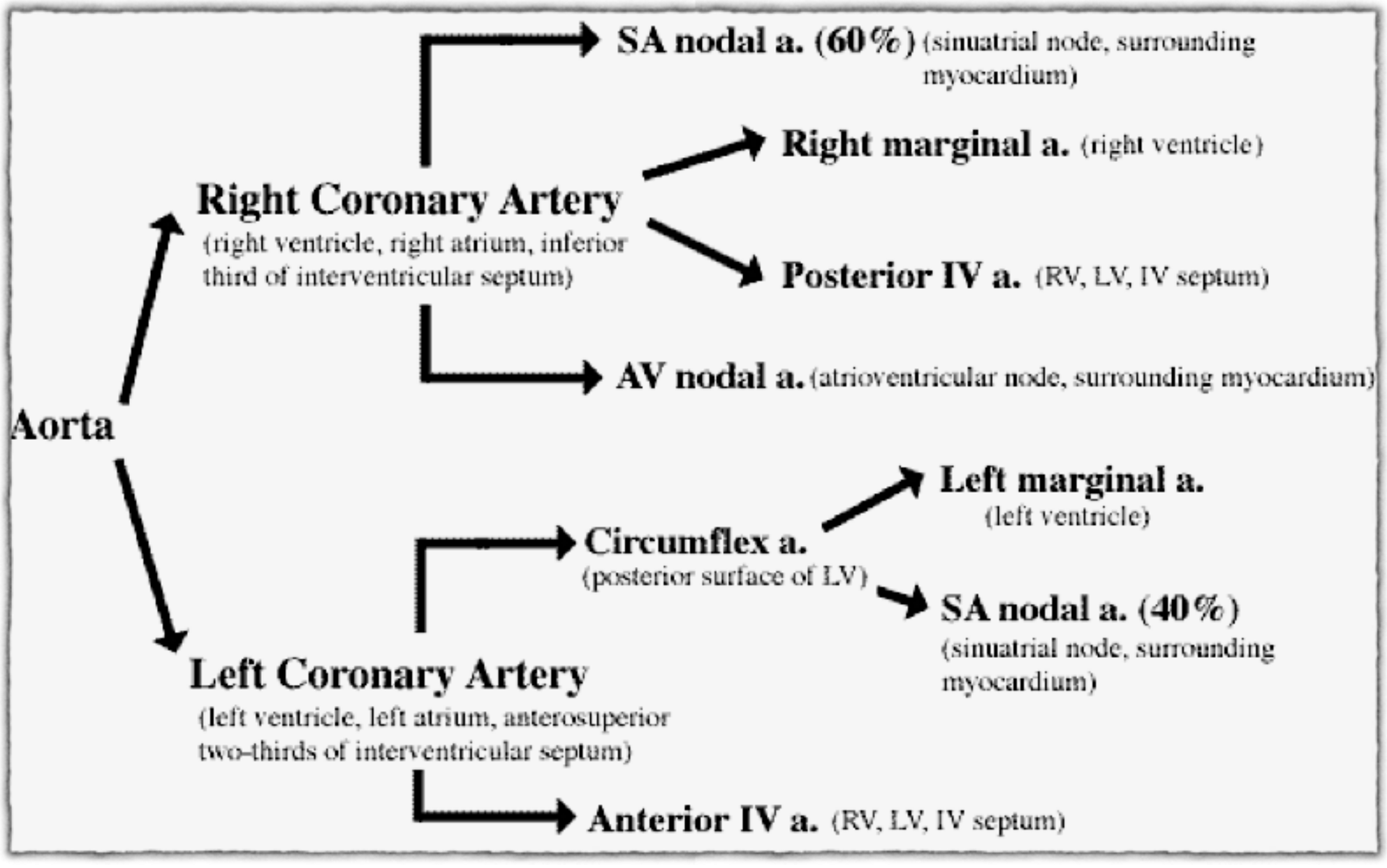
- Right Marginal Artery (RMA)
- Posterior Descending Branch
- SA nodal Artery
- AV nodal Artery

Left Coronary Artery (LCA):

- Left Anterior Descending (LAD)
- Circumflex Artery (CX)
- Left Marginal Artery (LMA)
- SA nodal Artery



Branches and Areas of Distribution of Coronary Arteries



Areas of Distribution of Left Coronary Artery (LCA)

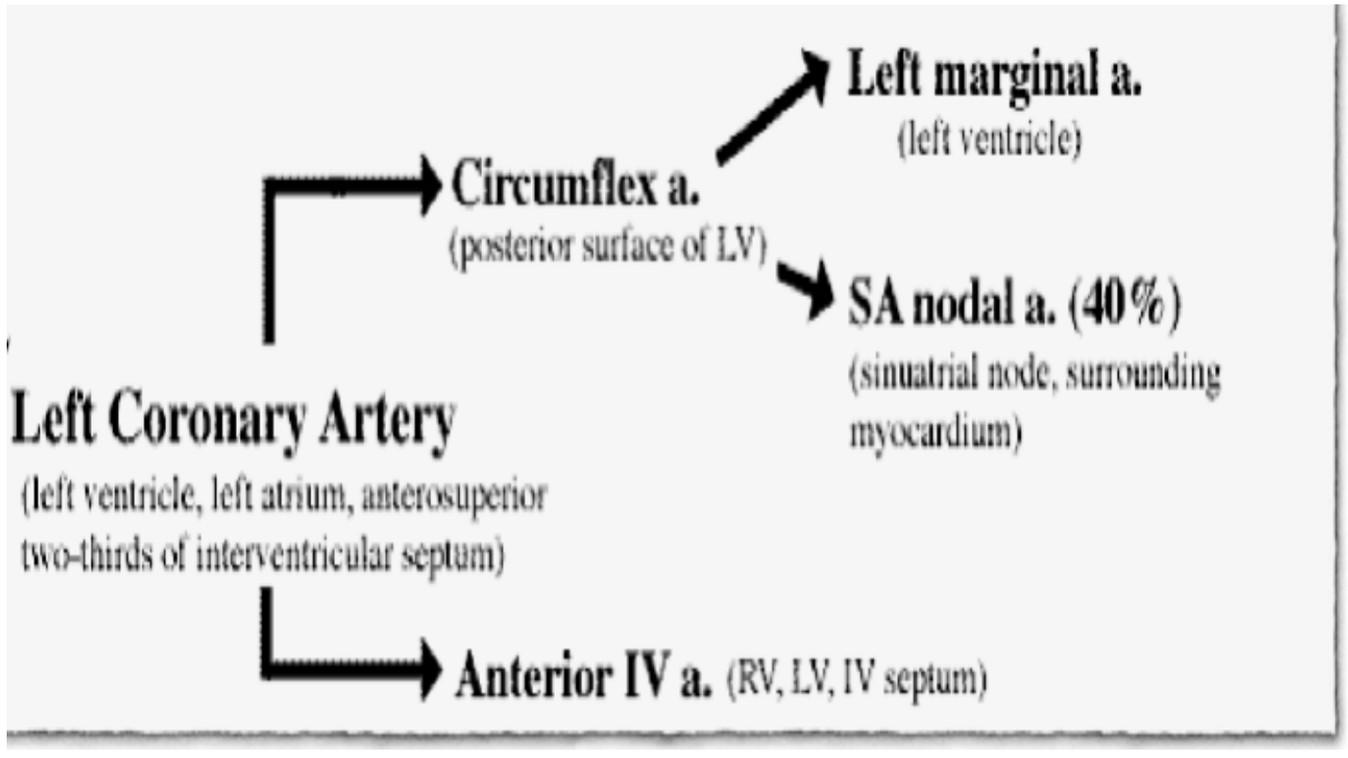
- **LAD supplies:**

  - Anterior & apical parts of the heart: LV & the TV area adjoining the anterior inter ventricular (IV) groove.

  - Anterior 2/3rd of the inter ventricular (IV) septum.

- **CX & LMA supplies:**

  - Lateral & posterior surfaces of the heart: LV & SA- node.



Areas of Distribution of Right Coronary Artery (RCA)

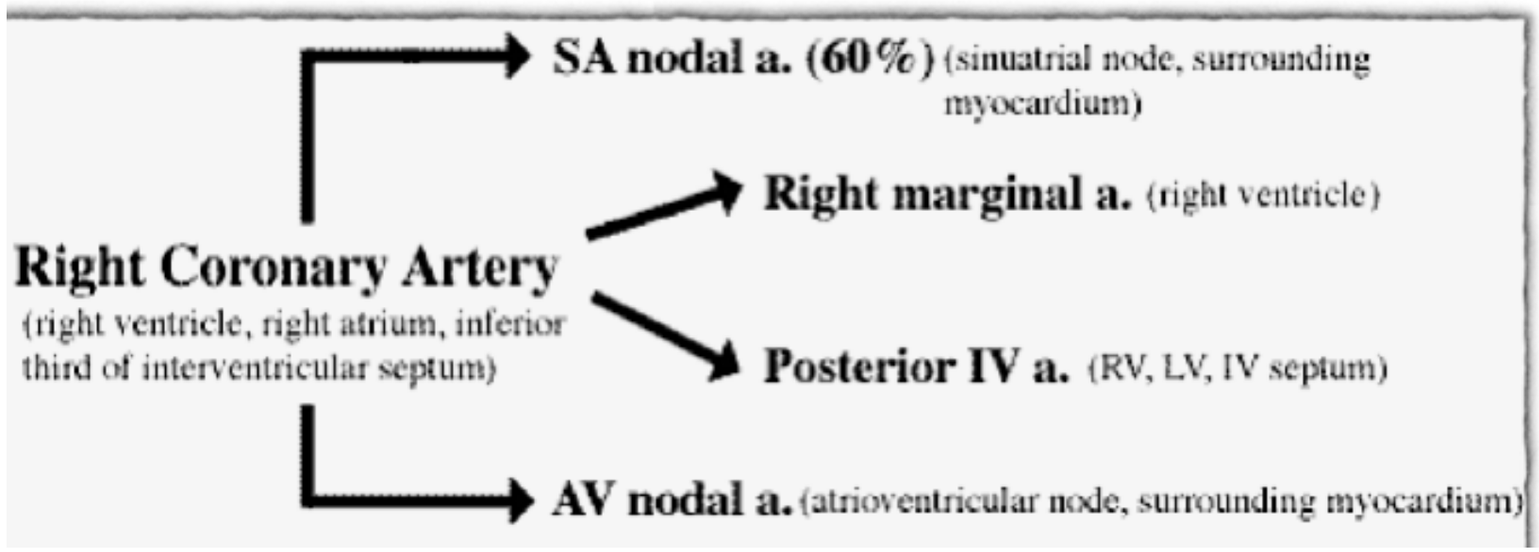
- **RMA supplies:**

  - RV, except the area adjoining the anterior inter ventricular (IV) groove.

- **PDA supplies:**

  - Posterior 1/3rd of the inter ventricular (IV) septum.

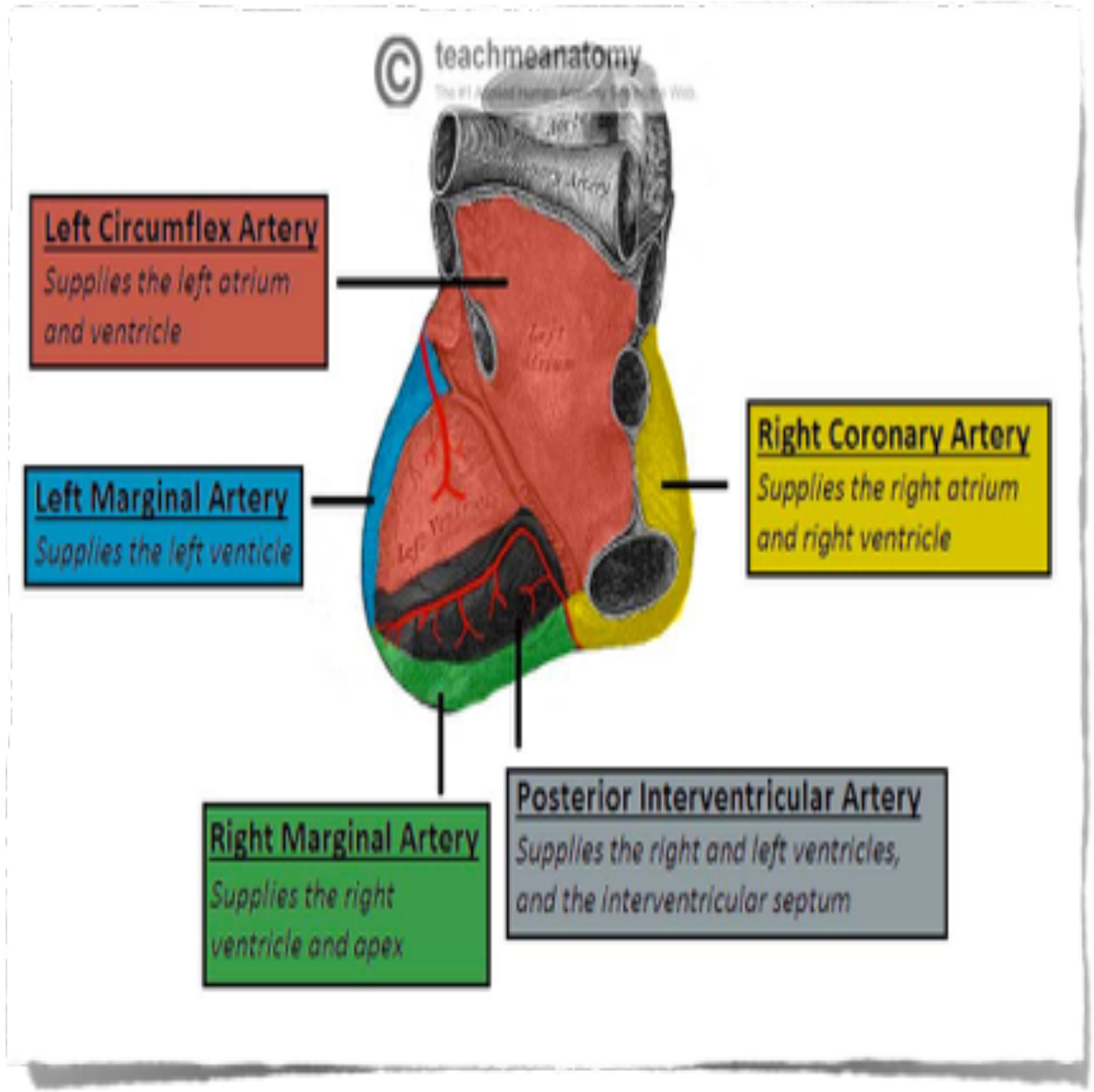
  - Inferior part of Lt ventricle adjoining the posterior inter ventricular groove.



- **SA nodal Artery supplies:**
  - The SA- node
    (Note: in 40% of cases, it is supplied by LCA)
  - Surrounding Right atrium.

- **AV nodal Artery supplies:**
  - The AV- node
    (Note: A part of the Lt branch of AV- Bundle)
  - Surrounding Right atrium.

Areas of Distribution of Coronary Arteries



Collateral Circulation

- **Cardiac anastomosis:**

  The two coronary arteries anastomose in the myocardium.

- **Extra cardiac anastomosis:**

  The two coronary arteries anastomose with:

  - Vasa vasorum of the aorta.
  - Vasa vasorum of pulmonary arteries.
  - Internal thoracic arteries.
  - The bronchial arteries.
  - Phrenic arteries.

- **Extra cardiac channels open up in case of emergencies, when the coronary arteries are blocked.**

II: Venous Drainage of The Heart

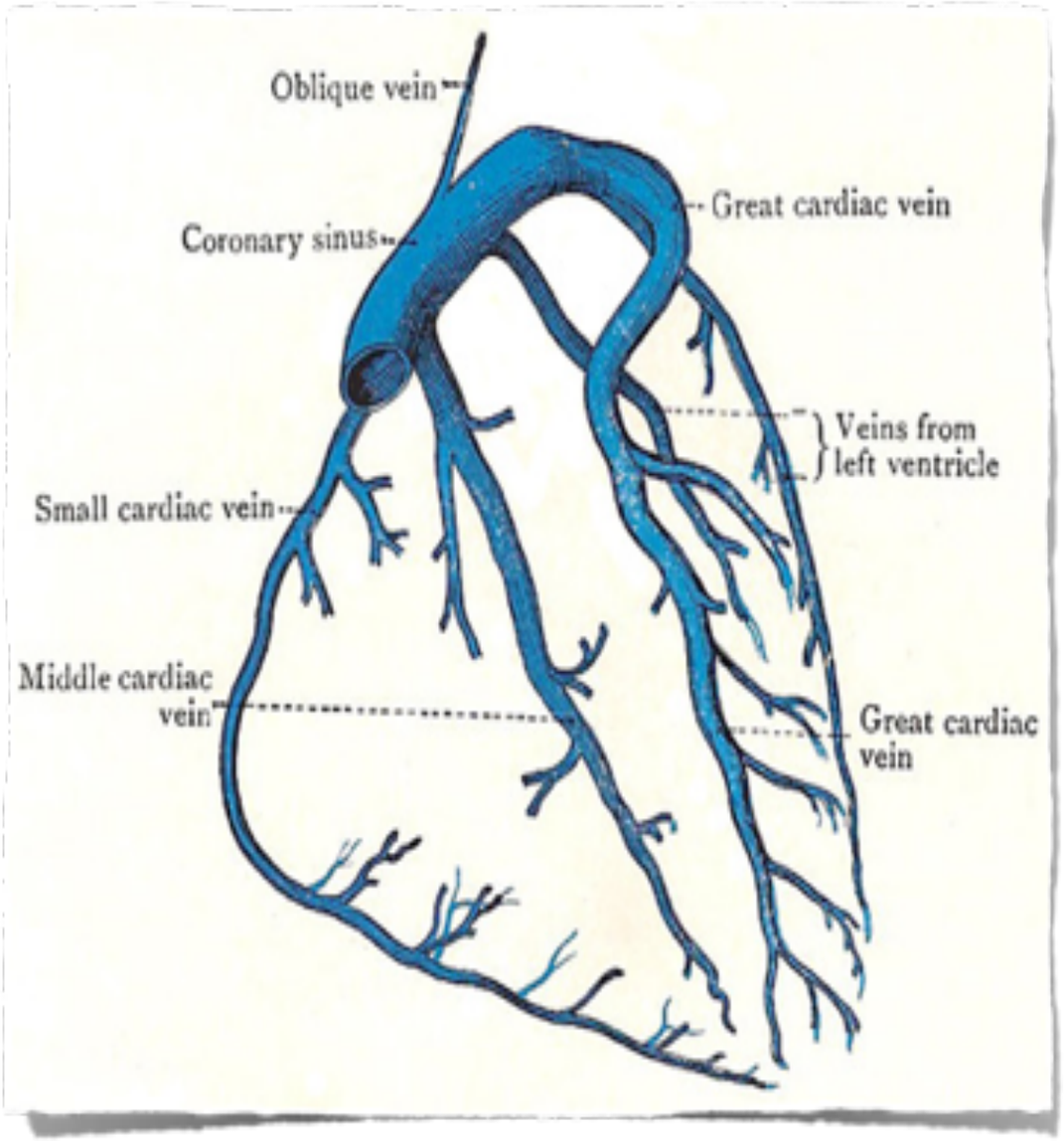
- **Venous drainage brings deoxygenated blood back to the heart.**

- **Cardiac venous drainage occur through:**

  - **Coronary sinus,** which lies in the posterior part of the atrioventricular groove & is a continuation of the great cardiac vein.

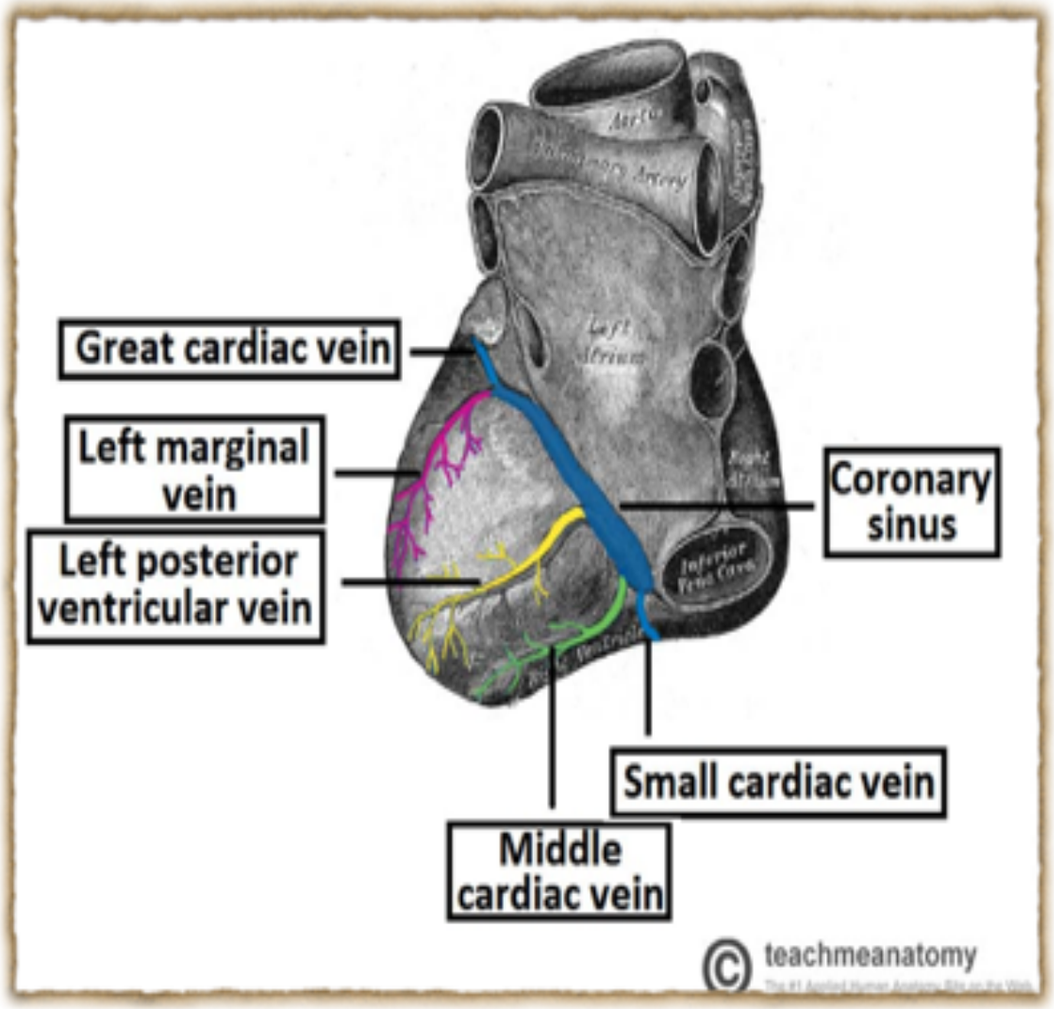
  - **Anterior, middle & small cardiac veins.**

  - **Venae Cordis Minimae** (smallest cardiac veins.)



Venous Drainage of The Heart.. Cont.

- Most of the venous blood return to the heart into the Right atrium through the coronary sinus via the cardiac veins.
- **5- 10% drains directly into heart chambers, Right atrium & Right ventricle:** by the anterior cardiac vein & the small veins that open directly into the heart chambers.



III: Lymphatic Drainage of The Heart

- **Lymphatics of the heart accompany the two coronary arteries.**

- **Lymphatics of the heart form two trunks:**

  - The right trunk: ends in the brachiocephalic node.

  - The left trunk: ends into the tracheo-bronchial lymph nodes, at the bifurcation of the trachea.

Coronary Dominance

- Coronary dominance depends on which artery (or arteries) gives rise to the posterior descending artery (PDA), that runs along the posterior side of the heart & supplies the AV- node.

- **A person can be:**

  - Right dominant,

  - Left dominant, or

  - Co-dominant.

Coronary Dominance… Cont.

- Coronary dominance is recognized by the presence of septal perforating branches.
- **The right coronary artery is dominant in 80–85% cases.**
- The circumflex branch of the left coronary artery is dominant in 8-10% cases0
- Balanced or co-dominance is found in 7-10% of population where the posterior inter ventricular artery is formed by both Right coronary & LCX arteries.
- **Clinical importance:**

  - In left dominance, a block in LCA affect the entire left ventricle & IV septum.
  - In right or balanced dominance, a block in RCA at least spares part (2/3) of the septum & Lt ventricle.

Coronary Blood Flow (CBF)

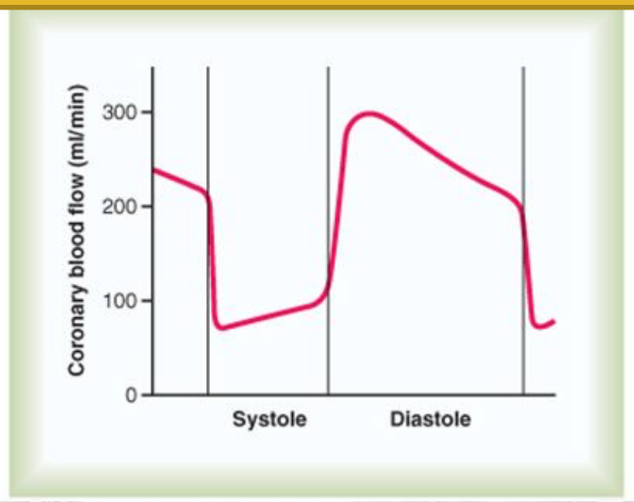
- **Coronary blood flow (CBF) at rest in humans is about 5% of the cardiac output, which is about 225-250 ml/min.**

- CBF increases in proportion to exercise or work output.

- **At rest, the heart extracts 60-70% of oxygen from each unit of blood delivered to the heart**, due to the presence of more mitochondria which generate energy for contraction by aerobic metabolism (other tissue extract only 25% of O_2.)

Phasic Changes in Coronary Blood Flow During Systole & Diastole

- During systole, coronary arteries are compressed & the blood flow to the left ventricle is reduced.



- Blood flow to the subendocardial portion of the Lt ventricle occurs only during diastole, & is not there during systole.
- Therefore, this subendocardial region of Lt ventricle is prone to ischemic damage & is most common site of Myocardial infarction.

Factors Affecting Coronary Blood Flow (CBF)

- Pressure gradient across the aorta.
- Chemical factors.
- Neural factors.

Pressure Gradient between Aorta & Ventricles Affects CBF

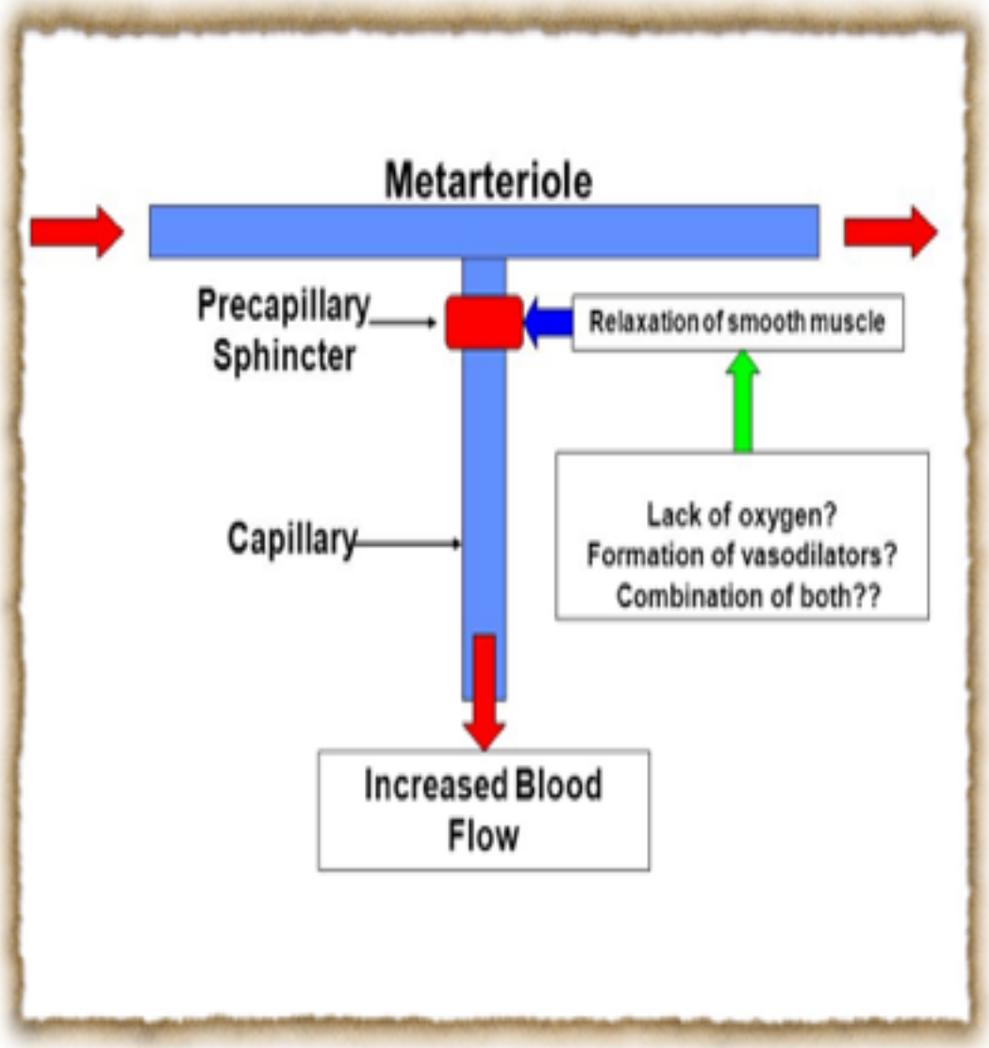
- **CBF to the Right side is not much affected during systole.**

  Pressure difference between the aorta & Right ventricle is greater during systole than during diastole, therefore more blood flow to Right ventricle occurs during systole.

		Pressure (mmHg) in		Pressure difference (mmHg) between aorta &	
	Aorta	Left Ventricle	Right Ventricle	Left Ventricle	Right Ventricle
Systole	120	120	25	0	95
Diastole	80	0-2	0-2	80	80

Chemical Factors Affecting Coronary Blood Flow

- **Chemical factors causing Coronary vasodilatation (Increased coronary blood flow):**
  - Lack of oxygen.
  - Increased local concentration of Co_2.
  - Increased local concentration of H^+ ion.
  - Increased local concentration of k^+ ion.
  - Increased local concentration of Lactate, Prostaglandin, Adenosine, Adenine nucleotides.



Neural Factors Affecting Coronary Blood Flow

- Sympathetic stimulation.
- Parasympathetic stimulation.

Effect of Sympathetic Stimulation on Coronary Blood Flow

- **Coronary arteries have:**
  - Alpha Adrenergic receptors, which mediate vasoconstriction (more epicardial.)
  - Beta Adrenergic receptors, which mediate vasodilatation (more in the intramuscular arteries.)
- **Indirect effect of sympathetic stimulation:**
  Sympathetic stimulation in intact body will lead to release of adrenaline & noradrenaline, increasing HR & force of contraction. Vasodilator metabolites will be increased leading to coronary vasodilatation.
- **Direct effect of sympathetic stimulation:**
  Experimentally, injection of noradrenalin after blocking of the beta adrenergic receptors in un-anesthetized animals elicits coronary vasoconstriction.

Benefits of indirect effect of nor-adrenergic discharge

- When systemic blood pressure decreases very low.
- Reflex increase of nor adrenergic discharge.
- Increase CBF secondary to metabolic changes in the myocardium.
- In this way, circulation of the heart is preserved while the flow to other organs compromised.

Effect of Parasympathetic Stimulation on Coronary Blood Flow

- Vagal stimulation (Parasympathetic) causes coronary vasodilatation.
- However, parasympathetic distribution is not great.
- There is more sympathetic innervation of coronary vessels.

Effect of Tachycardia on Coronary Blood Flow

- CBF is reduced with tachycardia, as the diastolic period will be shortened.

Control of Coronary Blood Flow (CBF)

- CBF shows considerable autoregulation.
- **Local muscle metabolism is the primary controller:**
  - Oxygen demand is a major factor in local coronary blood flow regulation.
- **Nervous control of CBF:**
  - Direct effects of nervous stimuli on the coronary vasculature.
  - Sympathetic greater effects than parasympathetic.

Thank You