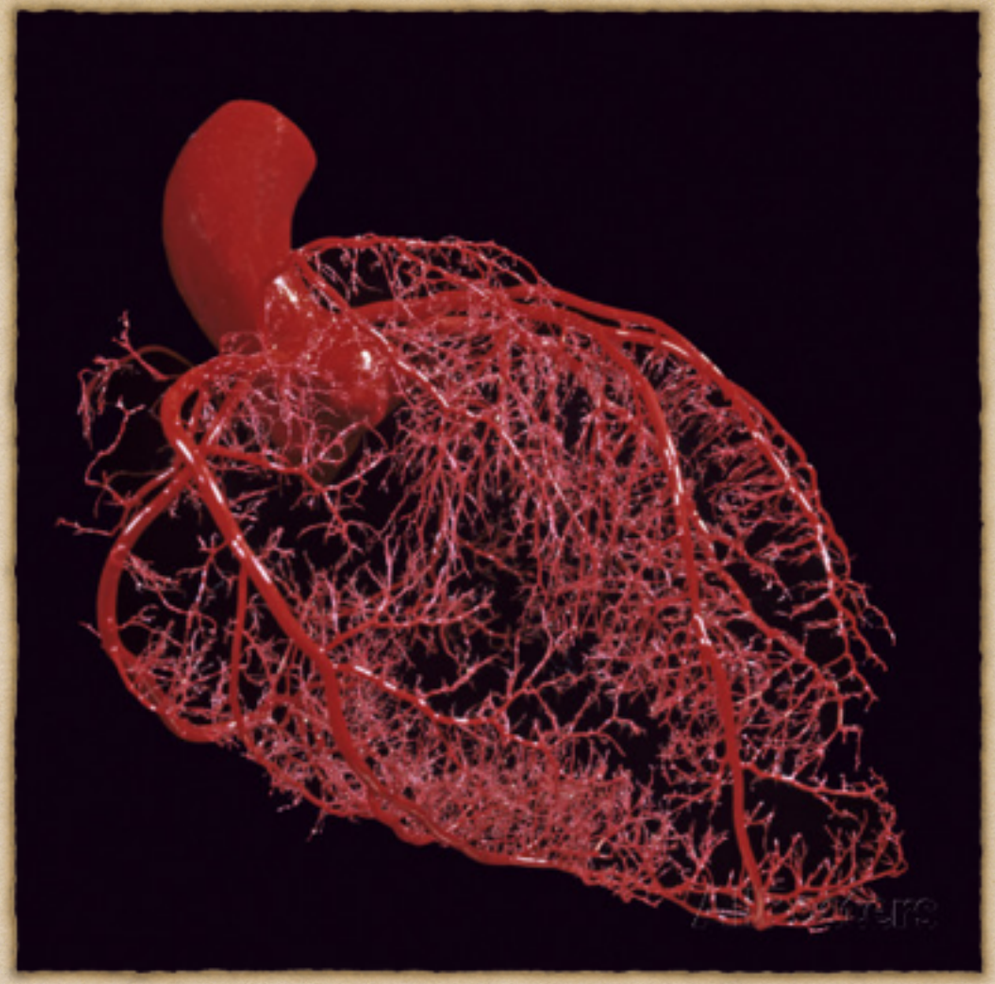

Coronary Circulation

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Coronary Circulation

- Consists of:

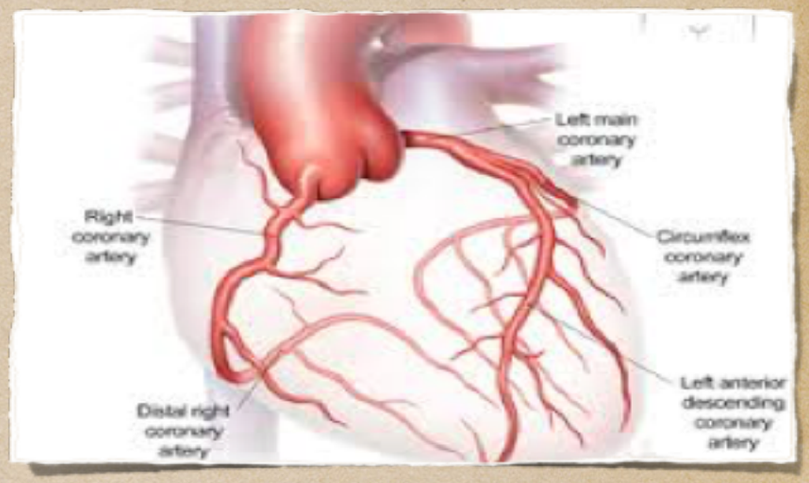
1. Arterial supply.
2. Venous drainage.
3. Lymphatic drainage.

Arterial Supply

- Cardiac muscle is supplied by two coronary arteries:

  A. Right coronary artery (RCA.)

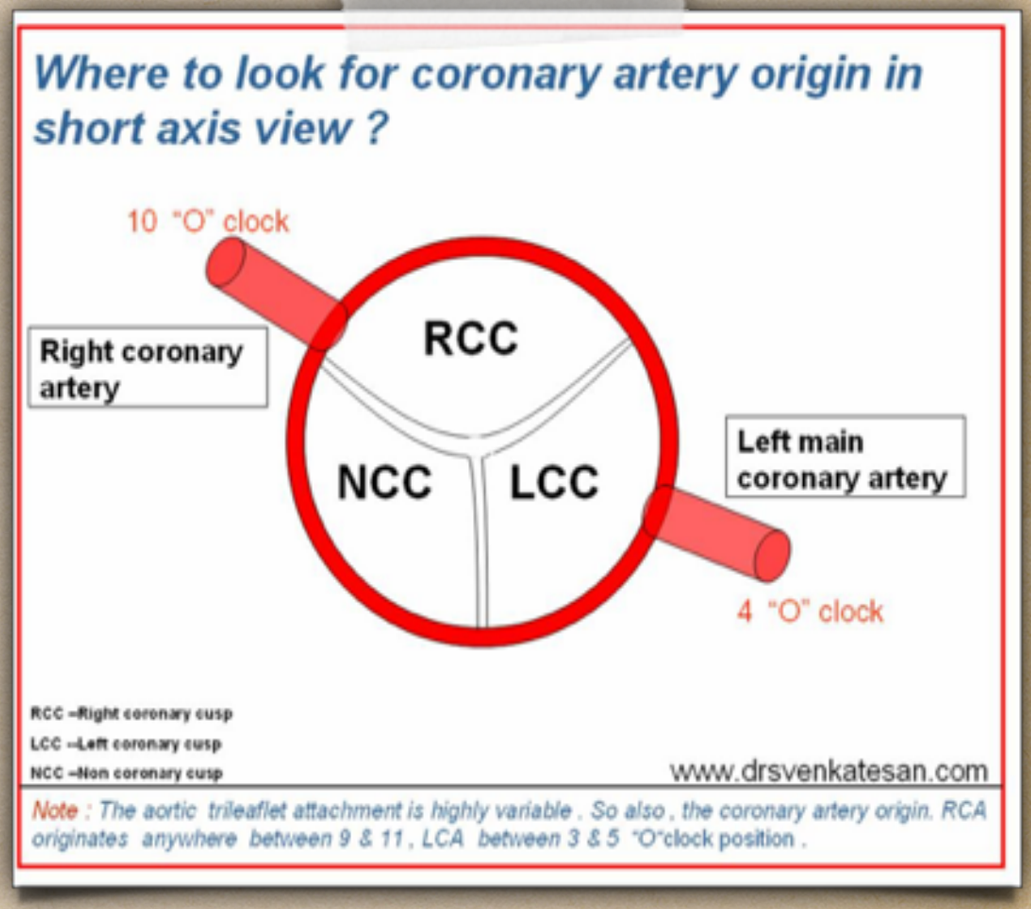
  B. Left coronary artery (LCA.)



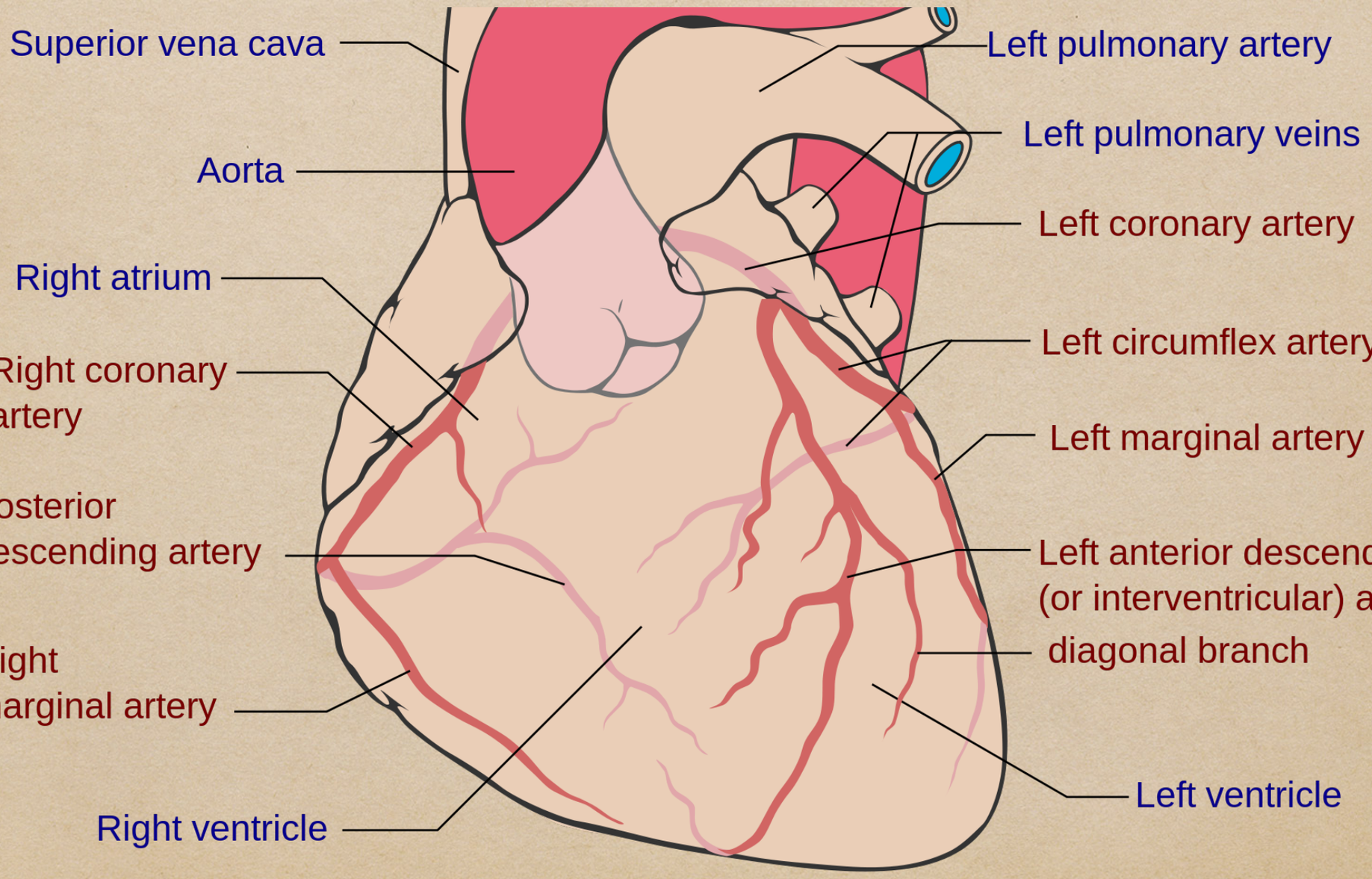
- both arise from the coronary sinuses just superior to the aortic valve cusps at the aortic root.

Arterial Supply

- The aortic valve has three cusps: left coronary (LC), right coronary (RC), & posterior non-coronary (NC) cusps.
- There may be variations in the number, shape & location of coronary ostia or origins of the coronary arteries, most of which are of no clinical significance.
- Coronary arteries deliver oxygenated blood to the cardiac muscle.

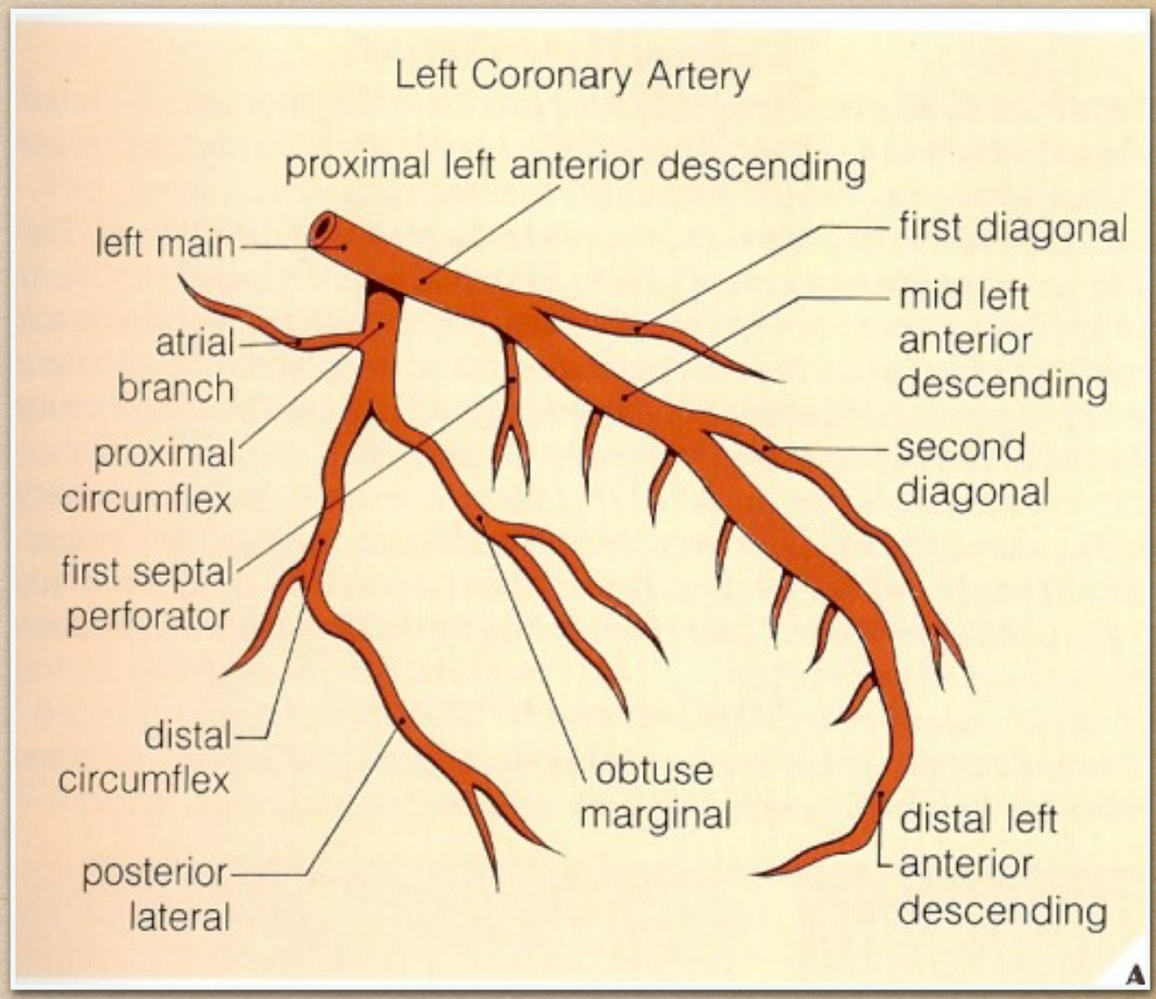


Coronary Circulation



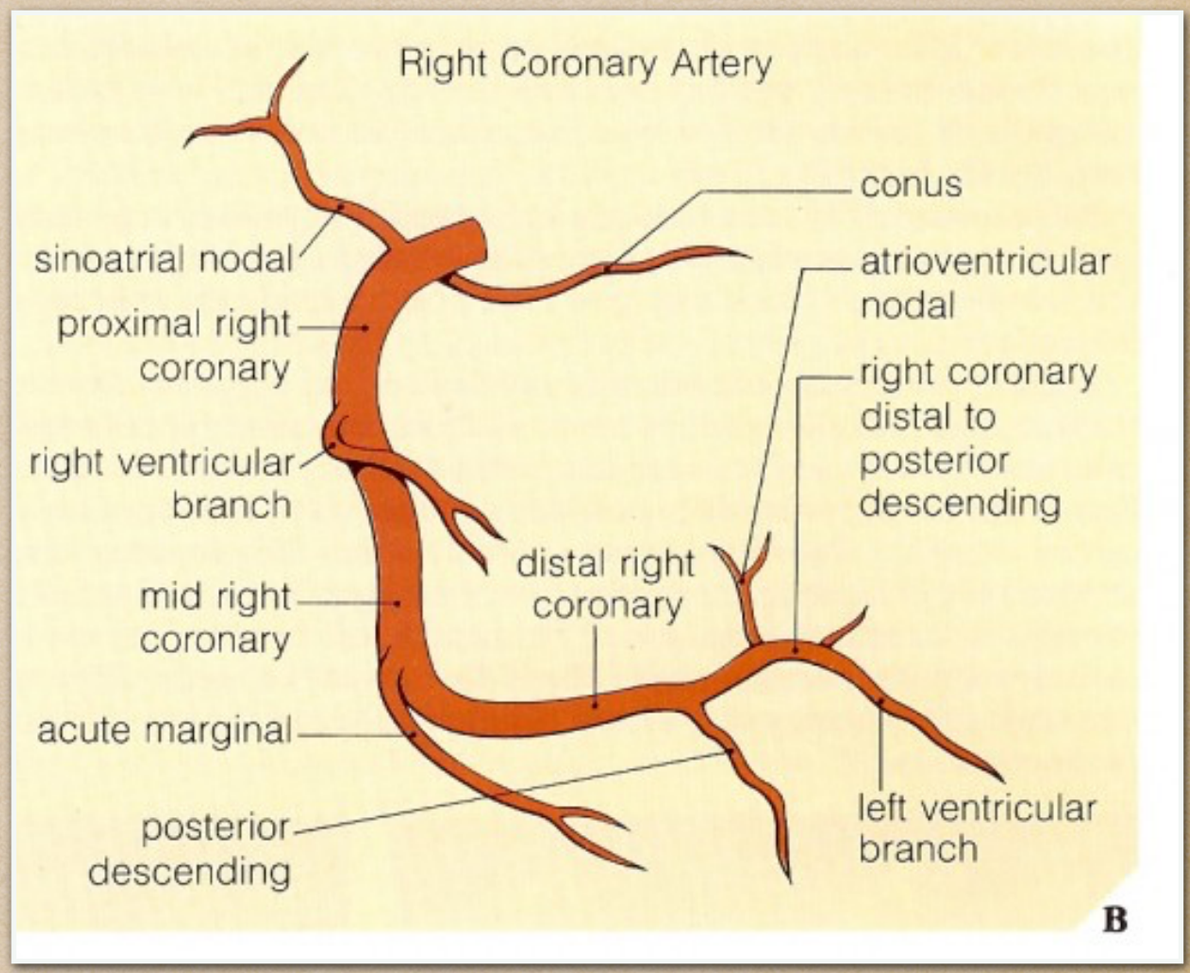
The Left Coronary Artery

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



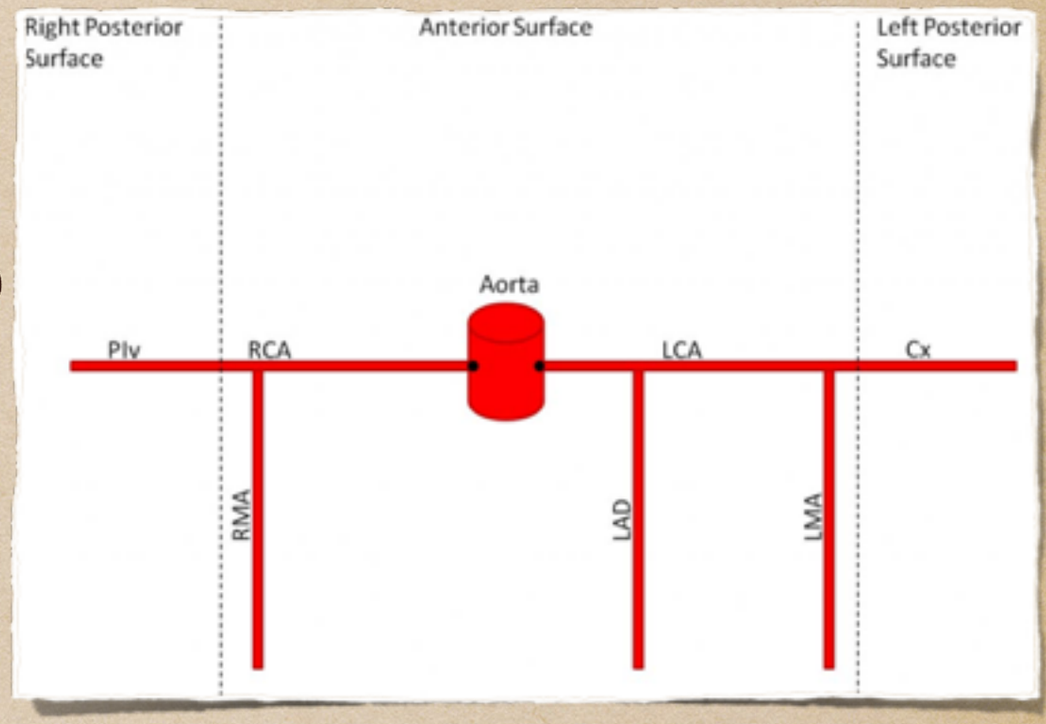
The Right Coronary Artery

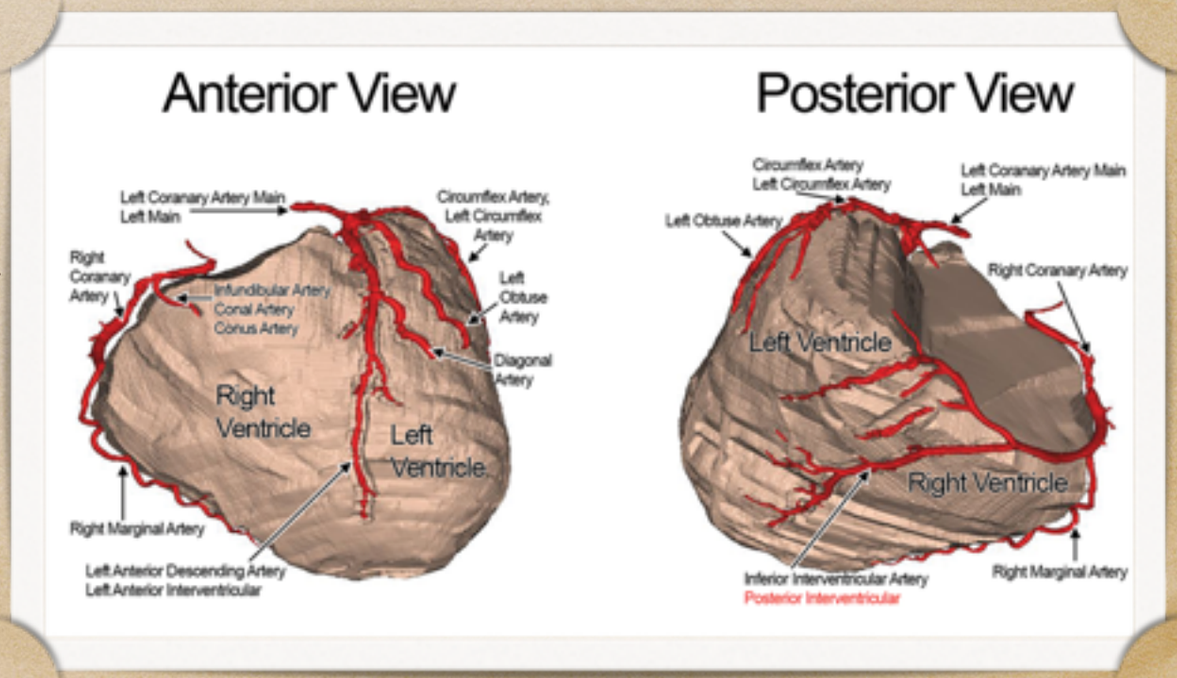
- Smaller than the left coronary artery.
- Arises from the right coronary sinus.
- Terminates by anastomosing with the left coronary artery.



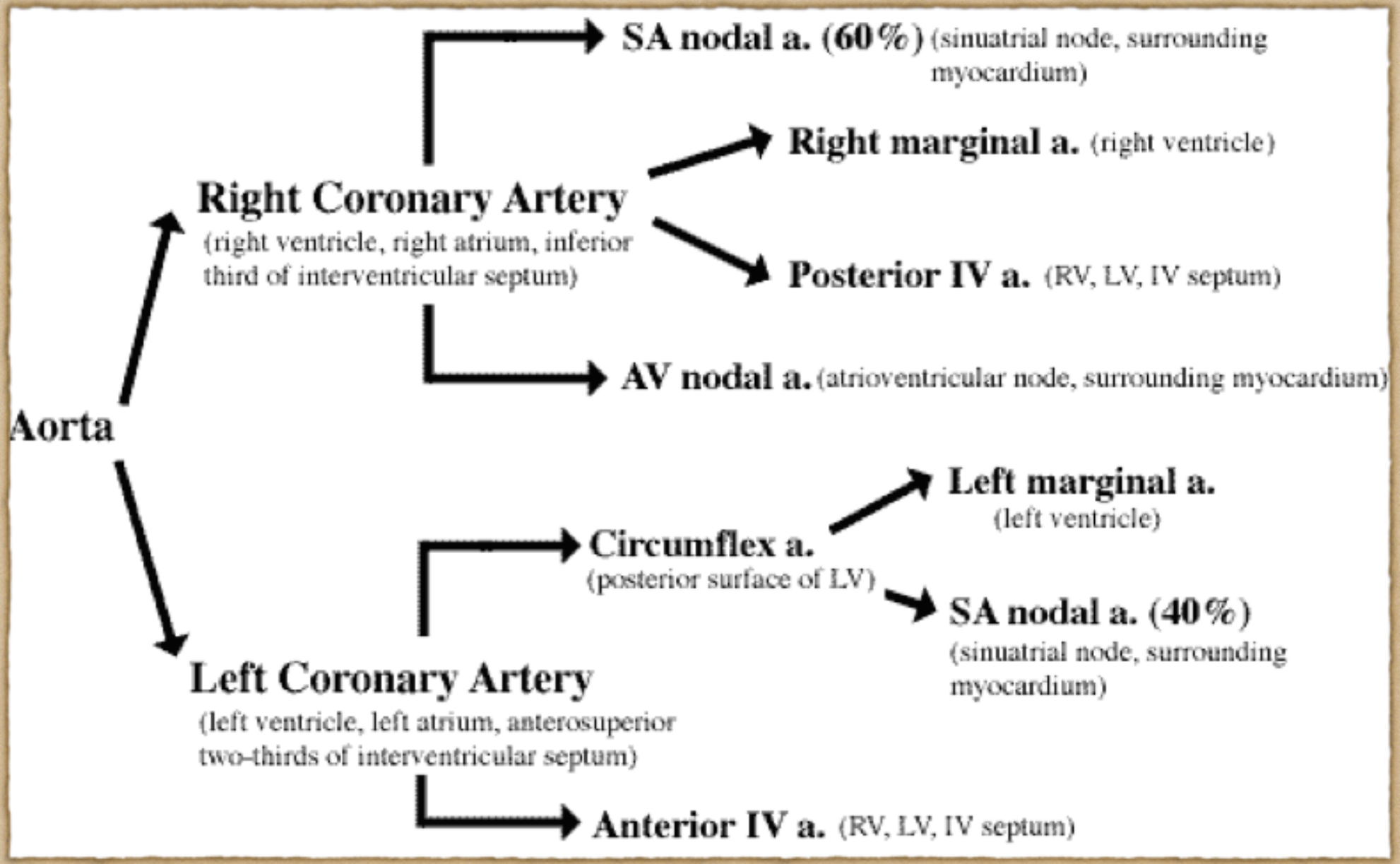
Branches of The Coronary Arteries

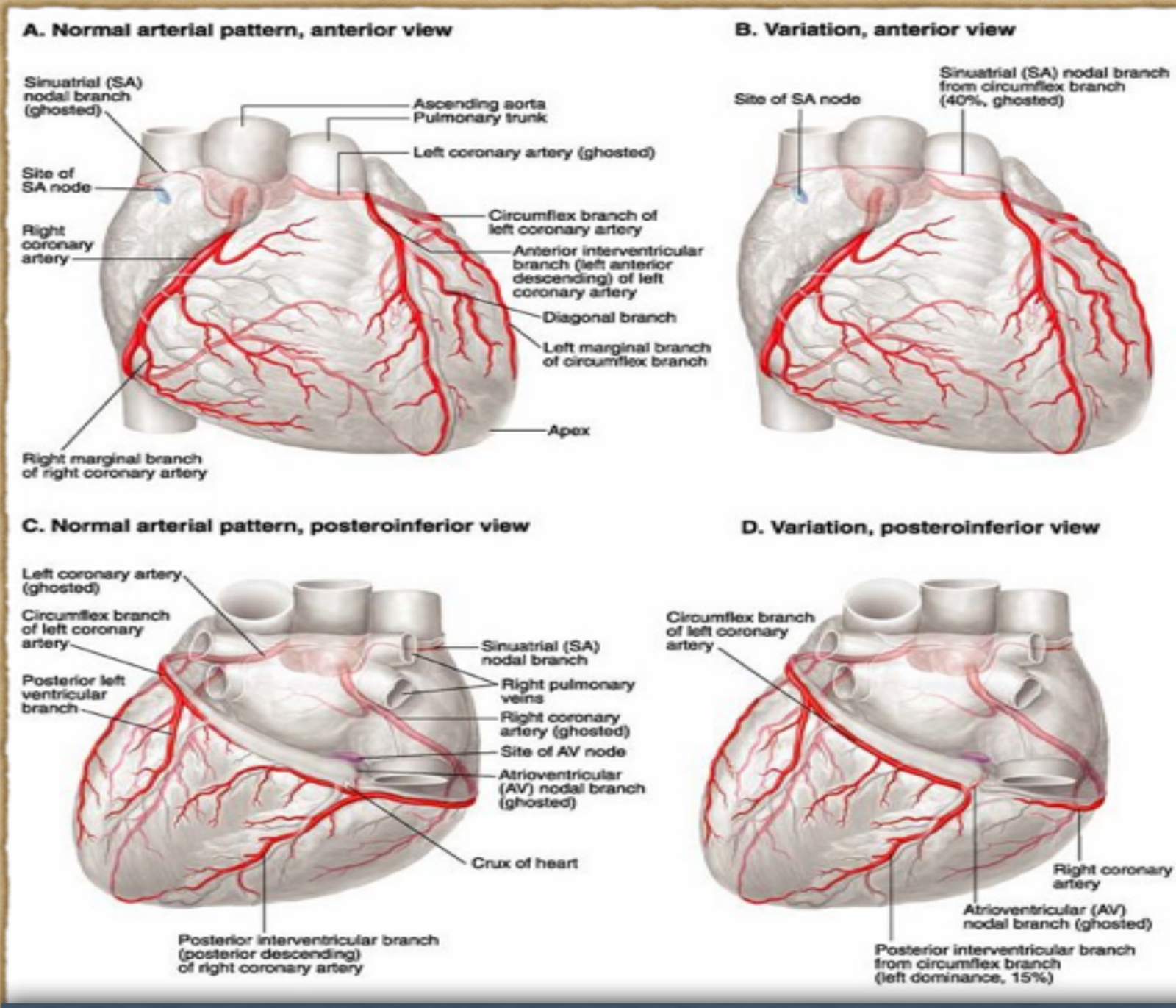
- LCA:
  - Left Anterior Descending (LAD.)
  - Marginal Artery.
  - Circumflex Artery (CX.)
- RCA:
  - Marginal Artery.
  - Posterior Descending Branch.





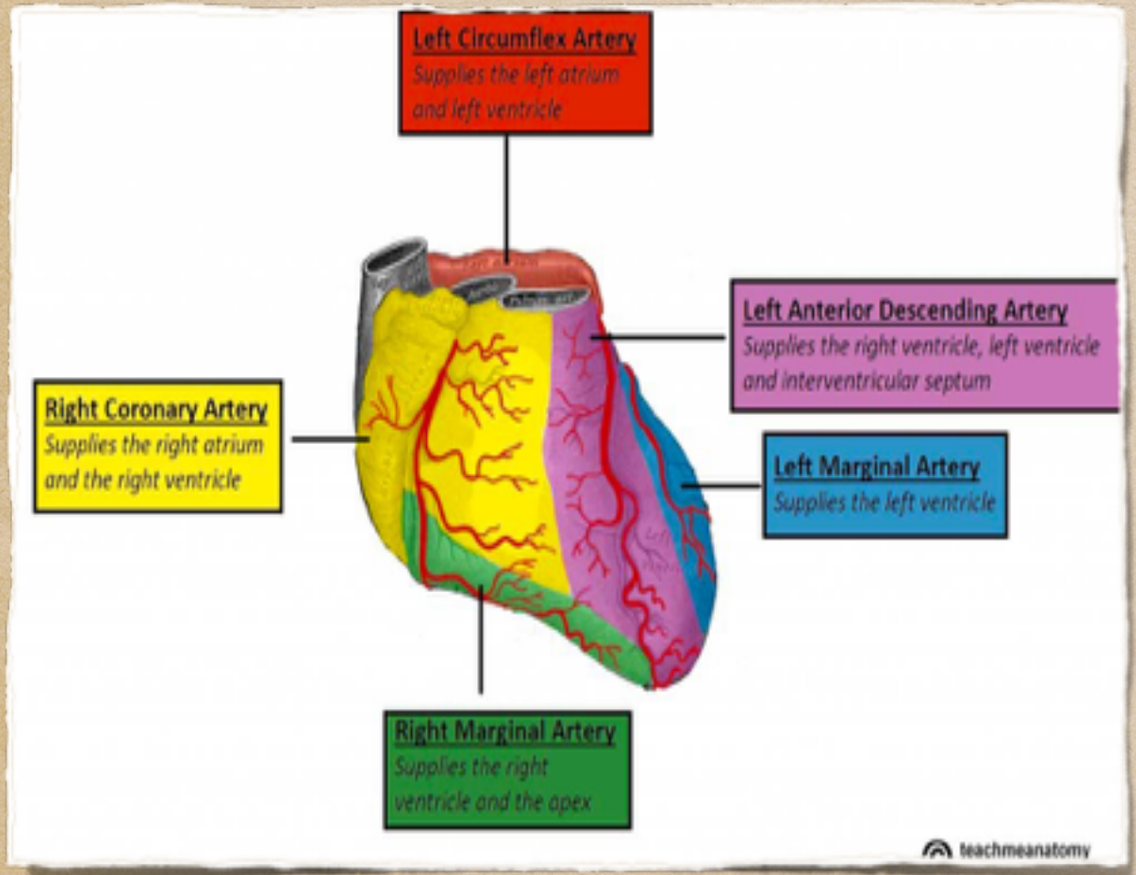
Branches of The Coronary Arteries

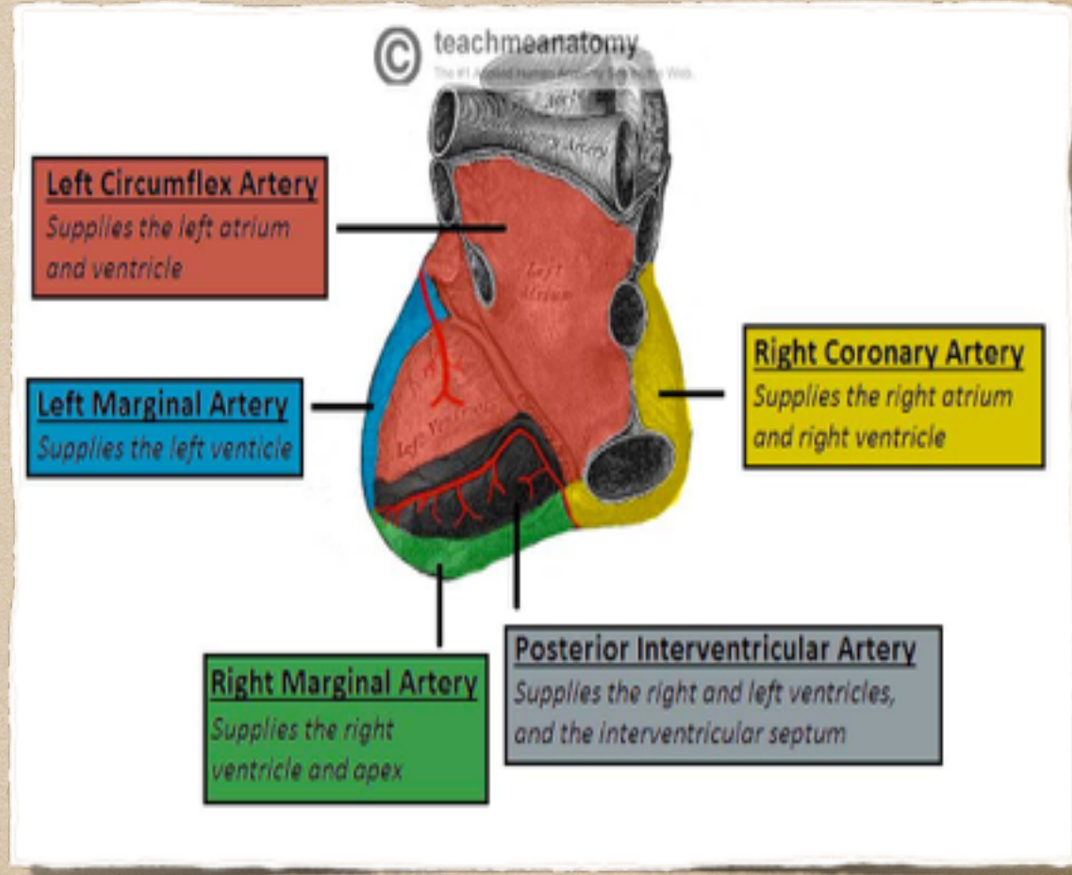



A. Normal arterial pattern, anterior view
Sinuatrial (SA) nodal branch (ghosted)
Ascending aorta
Pulmonary trunk
Left coronary artery (ghosted)
Site of SA node
Circumflex branch of left coronary artery
Right coronary artery
Anterior interventricular branch (left anterior descending) of left coronary artery
Diagonal branch
Left marginal branch of circumflex branch
Apex
Right marginal branch of right coronary artery
B. Variation, anterior view
Site of SA node
Sinuatrial (SA) nodal branch from circumflex branch (40%, ghosted)
C. Normal arterial pattern, posteroinferior view
Left coronary artery (ghosted)
Circumflex branch of left coronary artery
Posterior left ventricular branch
Sinuatrial (SA) nodal branch
Right pulmonary veins
Right coronary artery (ghosted)
Site of AV node
Atrioventricular (AV) nodal branch (ghosted)
Crux of heart
Posterior interventricular branch (posterior descending) of right coronary artery
D. Variation, posteroinferior view
Circumflex branch of left coronary artery
Right coronary artery
Atrioventricular (AV) nodal branch (ghosted)
Posterior interventricular branch from circumflex branch (left dominance, 15%)

Variations

Areas of Distribution of Coronary Arteries





Areas of Distribution of Left Coronary Artery

- **LCA supplies:**
  - Anterior & apical parts of the heart.
  - Anterior 2/3rd of the inter ventricular (IV) septum.
- **CX branch supplies:**
  - Lateral & posterior surfaces of the heart.

Areas of Distribution of Right Coronary Artery

- Right atrium.
- Ventricles:

  - Greater part of Rt ventricle, except the area adjoining the anterior inter ventricular groove.
  - Inferior part of Lt ventricle adjoining the posterior inter ventricular groove.

- Posterior 1/3rd of the inter ventricular septum.
- The conducting system of the heart, except:

  - A part of the Lt branch of AV- Bundle.
  - The SA- node is supplied by the LCA in 40% of cases.

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 emergencies when the coronary arteries are blocked.

Venous Drainage of The Heart

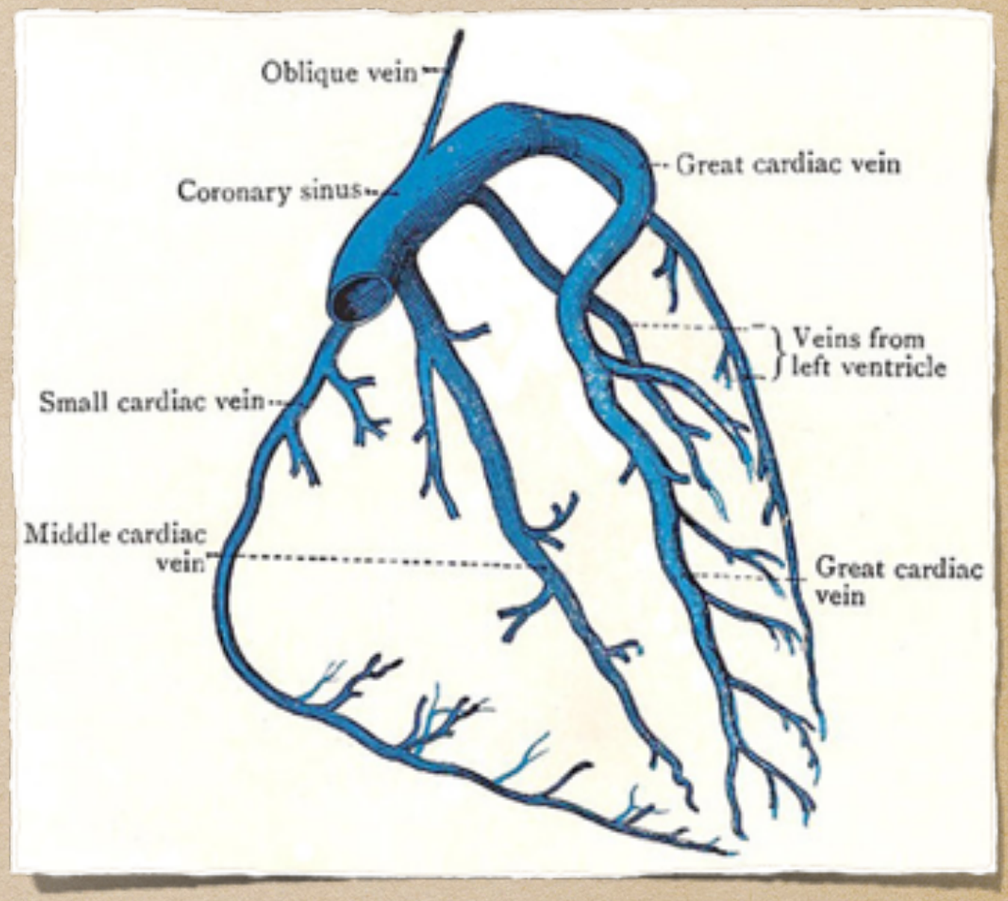
- Venous drainage brings deoxygenated cardiac blood back to the heart.

- 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.

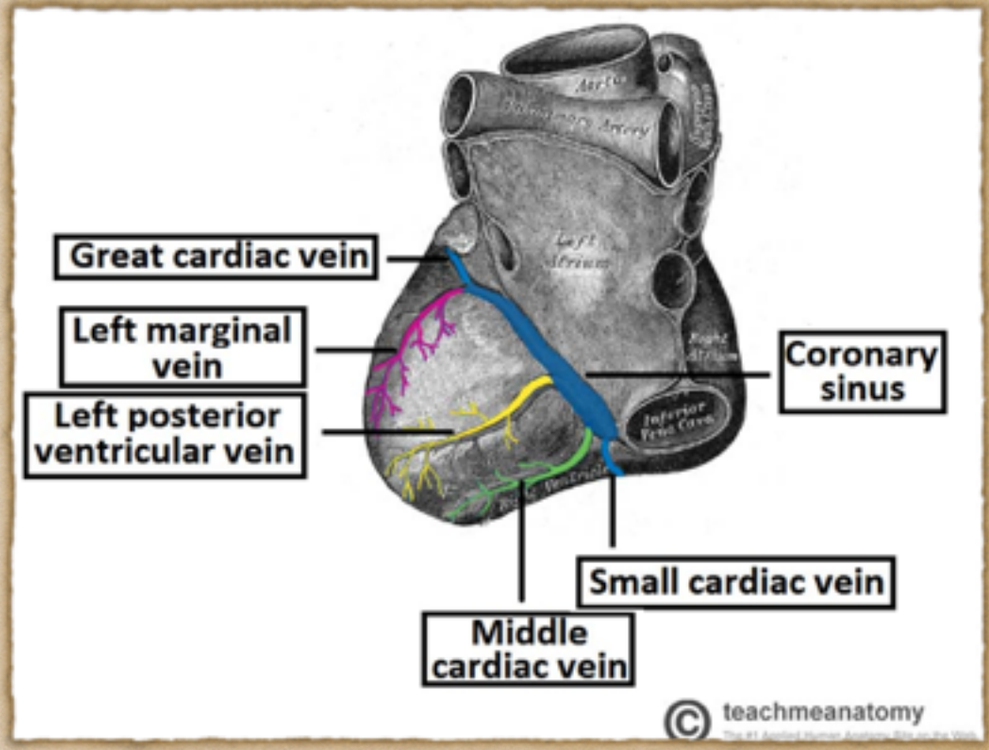
  - Venae Cordis Minimae (smallest cardiac veins.)



Venous Drainage of The Heart

- Most of the venous blood return to the heart into the Rt atrium through the coronary sinus via the cardiac veins.

- 5-10% drains directly into heart chambers, Rt atrium & Rt ventricle, by the anterior cardiac vein & by the small veins that open directly into the heart chambers.



Lymphatic Drainage of The Heart

- Lymphatics of the heart accompany the two coronary arteries & 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

- A person can be:
  - Right dominant,
  - Left dominant, or
  - Co-dominant.
- Coronary dominance depends on which artery (or arteries) gives rise to the posterior descending artery (PDA), which runs along the posterior side of the heart & supplies the AV- node.

Coronary Dominance

- Coronary dominance is recognized by the presence of septal perforating branches arise from:

  - The right coronary artery is dominant, in 80–85% cases.

  - The circumflex branch of the left coronary artery, in 8-10% cases.

- balanced or co-dominance is found in 7-10% of population where the posterior inter ventricular artery is formed by both Rt coronary & LCX arteries.

- Clinical importance:

  - In Lt dominance, a block in LCA affect the entire Lt ventricle & IV septum.

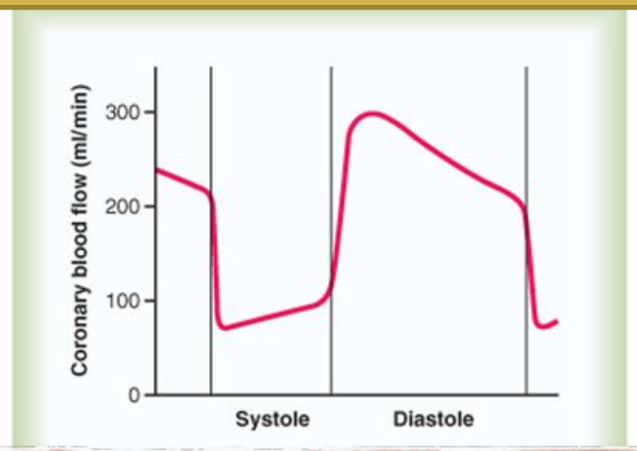
  - In Rt or balances dominance, a block in RCA at least spares part (2/3) of the septum & Lt ventricle.

Coronary Blood Flow

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

- Pressure in the aorta.
- Chemical factors.
- Neural factors.

Effect of Pressure Gradient of Aorta & Different Chambers of the Heart

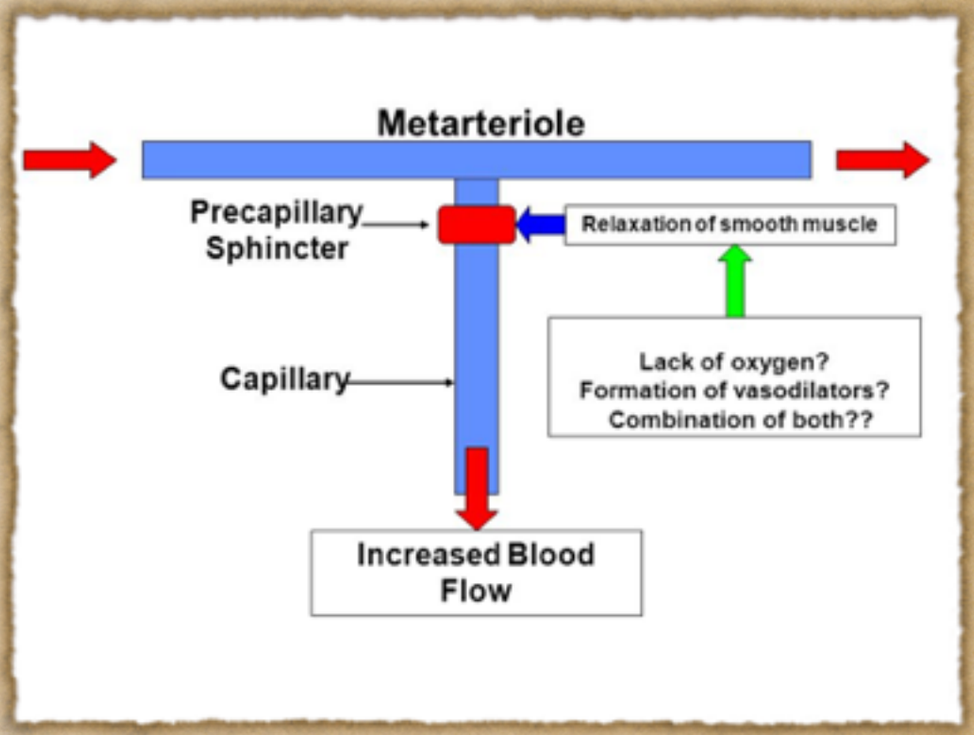
		Pressure (mmHg) in		Pressure difference (mmHg) between aorta &	
	Aorta	Lt Ventricle	Rt Ventricle	Lt Ventricle	Rt Ventricle
Systole	120	120	25	0	95
Diastole	80	0-2	0-2	80	80

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

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

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 & nor adrenaline, increasing HR & force of contraction. Vasodilator metabolites will be released 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 shows considerable auto regulation.
- 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