Pericardium
Pericardium

• **Definition**
  Fibro-serous sac that encloses the heart and the roots of great vessels

• **Function**
  - Restrict excessive movements of the heart as a whole
  - Serve as lubricated container

• **Position**
  Lies within the middle mediastinum
  Posterior to the body of sternum and the 2\(^{nd}\) to 6\(^{th}\) costal cartilages
  Anterior to the 5\(^{th}\) to 8\(^{th}\) thoracic vertebrae
The pericardium and heart occupy the middle mediastinum.
Pericardium

- Fibrous Pericardium
- Serous Pericardium
  - Parietal layer
  - Visceral layer
Diagrammatic Coronal Section

- Fibrous pericardium
- Parietal layer
- Visceral layer

Serous pericardium
Pericardium

• The **fibrous pericardium** is a strong fibrous sac that is attached firmly to the central part of the diaphragm.

• It **fuses with the outer coats of the great blood vessels passing through it, namely; the aorta, the pulmonary trunk, the superior and inferior venae cavae and the pulmonary veins.**

• The fibrous pericardium is **attached in front to the sternum by the Sterno-Pericardial ligaments.**

• The **serous pericardium** lines the fibrous pericardium and coats the heart.

• It is divided into **parietal and visceral layers.**
Pericardium
• The slit-like space between the parietal and visceral layers is referred as the **pericardial cavity**

• It contains a small amount of tissue fluid (50ml) of pericardial fluid - lubricant
Pericardial sinuses

- On the posterior surface of the heart, the reflection of the serous pericardium around the large veins (pulmonary veins and superior and inferior vena cava) forms a recess called the **oblique sinus**.

- A short passage lies between the reflection of serous pericardium around the aorta & pulmonary trunk and the reflection around the large veins, called **transverse sinus**.

- They have no clinical significance.
Pericardial sinuses

• The lines of reflection between visceral and parietal pericardium form two pericardial sinuses, the transverse pericardial sinus and the oblique pericardial sinus.

• The transverse pericardial sinus lies anterior to the superior vena cava and posterior to the ascending aorta and pulmonary trunk. Place your finger in the transverse pericardial sinus and examine the relationships of the structures.

• The oblique pericardial sinus lies posterior to the heart in the pericardial sac. Lift the apex of the heart and place your fingers posterior to the heart to identify the oblique pericardial sinus and examine its borders.

• On the right side, the oblique sinus is bounded by the lines of reflection of the serous pericardium onto the inferior vena cava and the right pulmonary veins.

• On the left, the sinus is bounded only by the lines of reflection of serous pericardium onto the left pulmonary veins. Observe that the two sinuses are not continuous with one another.
FIGURE 1.45. Development of heart and pericardium. The longitudinal embryonic heart tube invaginates the double-layered pericardial sac (somewhat like placing a wiener in a hot dog bun). The primordial heart tube then “loops” ventrally, bringing the primordial arterial and venous ends of the heart together and creating the primordial transverse pericardial sinus (T) between them. With growth of the embryo, the veins expand and spread apart, inferiorly and laterally. The pericardium reflected around them forms the boundaries of the oblique pericardial sinus. IVC, inferior vena cava; SVC, superior vena cava.
Pericardial sinuses

- Observe that the two sinuses are not continuous with one another.
Figure 3.55 Posterior portion of pericardial sac showing reflections of serous pericardium.
- The fibrous pericardium & parietal layer of serous pericardium are supplied by the **phrenic nerves**.
- The visceral layer of serous pericardium is innervated by branches of the **sympathetic trunks and the vagus nerves**.
**Pericardium Summary**

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>DEFINITION</th>
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<tr>
<td><strong>Fibrous pericardium</strong></td>
<td>Tough, outer layer that reflects onto great vessels</td>
</tr>
<tr>
<td><strong>Serous pericardium</strong></td>
<td>Layer that lines inner aspect of fibrous pericardium (parietal layer); reflects onto heart as epicardium (visceral layer).</td>
</tr>
<tr>
<td><strong>Innervation</strong></td>
<td>Phrenic nerve (C3-5) for conveying pain; vasomotor innervation via sympathetic fibers.</td>
</tr>
<tr>
<td><strong>Transverse sinus</strong></td>
<td>Space posterior to aorta and pulmonary trunk; can clamp vessels with fingers in this sinus and above.</td>
</tr>
<tr>
<td><strong>Oblique sinus</strong></td>
<td>Pericardial space posterior to heart.</td>
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Clinical notes
Pericarditis

- Inflammation of the serous pericardium, that may lead to accumulation of pericardial fluid which can compress the thin-walled atria and interfere with the heart filling during diastole.
- The heart compression is called cardiac tamponade. It can be secondary to stab or gunshot wounds to the heart. The blood escapes into the pericardial cavity and can restrict heart filling.
- Roughening of the visceral & parietal layers of serous pericardium by inflammatory exudate in pericarditis produces pericardial friction rub, felt on palpation and heard through a stethoscope.
Enlarged neck veins

Blood in pericardial sac
Cardiac Tamponade

- Patient in variable degrees of shock or in extremis
- Neck veins distended
- Heart sounds distant
- Venous pressure elevated (pathognomonic)
- Decreased arterial and pulse pressures often exist but not pathognomonic
- Pericardial tap at Larrey’s point (diagnostic and decompressive)
Mild fibrinous pericarditis

Pericardial effusion. Pleuropericardial window being created and biopsy specimen taken via incision in 5th left intercostal space

Purulent pericarditis

Adhesive pericarditis
Pericarditis

- Diseases of the pericardium involve inflammatory conditions (pericarditis) and effusions (fluid accumulation in the pericardial cavity).

- The usual cause of primary disease is a virus, although bacteria and fungi are also causative agents.

- Uremia (in renal failure) is the most common systemic disorder associated with pericarditis.

- Findings of pericarditis include:
  - Atypical chest pain.
  - High-pitched friction rub.
  - Effusion caused by inflammation (mimics cardiac tamponade).
  - Exudate associated with acute disease: fibrous (with uremia or a viral etiology) or fibrino-purulent (when bacterial etiology).
**Paracentesis:** the needle can be introduced to the left of the xiphoid process in an upward and backward direction at an angle of 45° to the skin.

When paracentesis is performed at this site, the pleura and lung are not damaged because of the presence of the cardiac notch in this area.
• **Definition**

- Is a Hollow muscular organ that is somewhat **pyramid shaped** and lies **within the pericardium** in the middle **mediastinum**.
- It is **connected at its base to the great blood vessels** but otherwise lies **free within the pericardium**.
Heart

Surfaces of the heart
It has 3 surfaces & an apex

- Sternocostal (Anterior)
- Diaphragmatic (Inferior)
- Base (Posterior)
- Apex
Figure 3.56 Schematic illustration of the heart showing orientation, surfaces, and margins.
• **Sternocostal surface:**
  - Is formed mainly by the **right atrium** and the **right ventricle**.
  - **Right border** is formed by the right atrium.
  - **Left border** is formed by left ventricle, and part of left auricle.
• **Diaphragmatic surface:**
  - Is formed mainly by the right and left ventricles.
  - Inferior surface of the right atrium.
• **Base of the heart:**

- Is formed mainly by the **left atrium** with a small portion of the **right atrium**. It lies **opposite** to the apex.
• Apex of the heart:
  - Is formed by the **left ventricle**.
  - Directed **downward, forward, and to the left**.
  - Lies at the level of the **5th left intercostal space** 9cm from midline (mid-clavicular line)
Borders of the Heart

- **The right border**: is formed by the Rt. atrium.

- **The left border**: by the Lt. auricle; and by the Lt. ventricle.

- **The inferior border**: is formed mainly by the Rt. ventricle; and to a lesser extent by Lt. ventricle.

- **The superior border**: is formed by the Rt. & Lt. atria.
Chambers of the Heart
The right atrium lies anterior to the left atrium.
The right ventricle lies anterior to the left ventricle.
Heart

Wall of the heart

Epicardium
Myocardium
Endocardium
Wall of the Heart

Heart wall

Epicardium (visceral pericardium)

Myocardium

Endocardium

Visceral pericardium

Pericardial cavity

Parietal pericardium

Fibrous pericardium

Serous pericardium
• **Right atrium:**

- Main cavity + auricle (small outpouch).
- At the junction between right atrium and right auricle there is a vertical groove: *sulcus terminalis* (outside) form ridge inside (*crista terminalis*).
- **Musculi pectinati:**
  - Run from the crista terminalis to the auricle.
- **Posterior wall:**
  - is smooth walled: *sinus venous.*
• Openings into the Right Atrium

- Superior vena cava - SVC (with no Valve).
- Inferior vena cava - IVC (larger than SVC & with rudimentary, nonfunctional valve).
- Coronary sinus - drains most blood from the heart wall, opens into Rt. atrium. (between the IVC and atrio-ventricular orifice with rudimentary Valve)
- Right Artrio-Ventricular orifice.
• **Fetal Remnants of Right Atrium**

- The rudimentary Valve of the Inferior vena cava.
- **Fossa ovalis**: shallow depression, site of the foramen ovalis in the fetal life.
- **Annulus ovalis**:
  - upper margin of the fossa.
  - located at the atrial septum.
• Right ventricle:
  - Communicates with the Rt. atrium through atrio-ventricular orifice; and with the pulmonary trunk through pulmonary orifice.
  - As the cavity approaches the pulmonary orifice, it becomes tunnel shaped called **infundibulum**.
- **Trabeculae carneae**: (The projecting ridges which give the ventricular wall a sponge-like appearance) has 3 types:

  - **1st type**: Papillary muscles (attached by their bases to the ventricular wall; their apices are connected by fibrous chords (the chordae tendineae) to the cusps of the tricuspid valve.

  - **2nd type**: Attached at their ends to ventricular wall, free in middle: One of these, is the **moderator band** crosses the ventricular cavity from the septal to the anterior wall. It conveys the right branch of the atrioventricular bundle, which is part of the conducting system of the heart.

  - **3rd type**: is simply composed of Prominent ridges
The bases of the cusps are attached to the fibrous ring.
Free edges are attached to the chordae tendineae.
Chordae tendineae connect the cusps to the papillary muscles.
Heart in diastole:
viewed from base with atria removed

- Pulmonary valve
  - Anterior semilunar cusp
  - Right semilunar cusp
  - Left semilunar cusp
- Aortic valve
  - Right coronary semilunar cusp
  - Left coronary semilunar cusp
  - Posterior (noncoronary) semilunar cusp
- Circumflex branch
  - Anterior cusp
  - Commissural cusps
  - Posterior cusp
  - Left fibrous ring (of mitral valve)
- Mitral valve
  - Anterior cusp
  - Posterior cusp
- Left fibrous ring (of tricuspid valve)
- Right fibrous ring (of tricuspid valve)
- Right fibrous trigone
- Atrioventricular (AV) nodal branch
- Posterior interventricular branch
- Interventricular part (broken line)
- Atrioventricular part
- Membranous septum
- Anterior cusp
- Septal cusp
- Posterior cusp
- Tricuspid valve
**FIGURE 1.54. Interior of right ventricle of heart.** The sternocostal wall of the right ventricle has been excised. A. The tricuspid valve at the entrance to the ventricle (right atrioventricular [AV] orifice) is open and the pulmonic valve at the exit to the pulmonary trunk is closed, as they would be during ventricular filling (diastole). The smooth funnel-shaped conus arteriosus is the outflow tract of the chamber. B. The inflow of blood enters the chamber from its posterior and inferior aspect, flowing anteriorly and to the left (toward the apex); the outflow of blood to the pulmonary trunk leaves superiorly and posteriorly. IVC, inferior vena cava; SVC, superior vena cava.
- **Right ventricle:**

  - **Pulmonary valve:** consists of three semilunar cusps.
**Left atrium:**
- Main cavity + auricle.
- Forms the posterior surface of the heart.
- Behind it lies the oblique sinus of serous pericardium.
- The fibrous pericardium separates it from the esophagus.
- Interior of the left atrium is smooth, but the left auricle possesses muscular ridges as in the right auricle.
• **Openings into the left atrium:**
  - Four pulmonary veins
  - Left artioventricular orifice
• Left ventricle:

- Communicates with the left atrium through artroventricular orifice; and with the aorta through aortic orifice.
- The walls of the left ventricle are three times thicker than right.
- Well-developed trabeculae carneae.
- Two large papillary muscles but no moderator band.
- Aortic vestibule:
  Below the aortic orifice.
• **Left ventricle**
Heart - Left ventricle

Mitral valve
guards the atrioventricular orifice

Anterior

Posterior
Left ventricle- Aortic valve

- The aortic valve guards the aortic orifice and is precisely similar in structure to the pulmonary valve.
- One cusp is situated on the anterior wall (right cusp) and two are located on the posterior wall (left and posterior cusps).
- Behind each cusp the aortic wall bulges to form an aortic sinus.
- The anterior aortic sinus gives origin to the right coronary artery, and the left posterior sinus gives origin to the left coronary artery.
Heart in diastole: viewed from base with atria removed

- Pulmonary valve
- Anterior semilunar cusp
- Right semilunar cusp
- Left semilunar cusp
- Right (coronary) semilunar cusp
- Left (coronary) semilunar cusp
- Posterior (noncoronary) semilunar cusp
- Circumflex branch
- Anterior cusp
- Commissural cusps
- Posterior cusp
- Left fibrous ring (of mitral valve)
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- Membranous septum
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- Interventricular part (broken line)
- Atroventricular part
- Anterior cusp
- Septal cusp
- Posterior cusp
- Right fibrous ring (of tricuspid valve)
- Right fibrous trigone
- Tricuspid valve
• **Left ventricle:**
  - **Aortic valve:** consists of three semilunar cusps
  - **Aortic sinus:** coronary arteries
Opening of coronary arteries in the aortic valve (anterior view).

(A) When the left ventricle contracts, the aortic valve opens. The valve cusps prevent filling of the coronary arteries.

(B) When the left ventricle relaxes, backflow of blood closes the aortic valve and causes filling of the coronary arteries.
• **Structure of the heart**

- **Atrial (inter-atrial) septum**
  - Lower part is thick and formed of muscle
  - Upper part is thin and membranous

- **Ventricular (interventricular) septum**
  - Lower part is thick and formed of muscle
  - Upper part is thin and membranous
Skeleton of the heart: Fibrous rings that surround the atrioventricular, pulmonary & aortic orifices.
• **Conducting system of the heart:**

- Normal heart contract rhythmically at about 70-90 beats/min.
- Atria contracts first and together followed by ventricles together.
- Slight delay in the passage of impulse from atria to ventricles.
  - Sinuatrial node.
  - Atrioventricular node.
  - Atrioventricular bundle.
  - Right & left terminal branches.
  - Purkinje fibers.
• **Sinuatrial node**

- Located in the wall of the right atrium in the upper part of the sulcus terminalis to the right of the SVC opening.
- Spontaneously gives origin to rhythmical electrical impulses.
• **Atrioventricular node**

- Located in the lower part of the atrial septum above the attachment of septal cusp of tricuspid valve.
- It is stimulated by the excitation wave as it passes through the atrial myocardium.
- The speed of conduction of the cardiac impulse through the atrioventricular node (about 0.11 seconds) allows sufficient time for the atria to empty their blood into the ventricles before the ventricles start to contract.
• **Atrioventricular bundle (bundle of His)**

- The **only route** along which cardiac impulse can travel from the atria to the ventricles.
- Descends behind the septal cusp of the tricuspid valve.
- The bundle descends through the fibrous skeleton of the heart.
- At the upper border of the muscular part of the septum it is divided into two branches (left – right).
• Atrioventricular bundle (bundle of His)

- RBB passes down on the right side of the ventricular septum to reach the moderator band then to anterior wall of RV (Here it becomes continuous with the fibers of the Purkinje plexus).
- LBB pierces the septum and passes down on its left side beneath the endocardium; divided into (anterior, posterior) which eventually become continuous with the fibers of the Purkinje plexus of the left ventricle.
**FIGURE 1.62. Conducting system of heart.** A. Impulses (arrows) initiated at the SA node, located at the superior end of the sulcus (internally, crista) terminalis, are propagated through the atrial musculature to the AV node. B. Impulses (arrows) received by the AV node, in the inferior part of the interatrial septum, are conducted through the AV bundle and its branches to the myocardium. The AV bundle begins at the AV node and divides into right and left bundles at the junction of the membranous and muscular parts of the IVS.
• Conducting system of the heart

- The activities of the conducting system can be influenced by the autonomic nervous system.
- The parasympathetic nerves slow the rhythm and diminish the rate of conduction of the impulse; the sympathetic nerves have the opposite effect.
• Internodal conduction paths

- Impulses from SA node have been shown to travel to AV node more rapidly than they can travel by passing along ordinary myocardium.
- This phenomenon has been explained by the description of special pathways in the atrial wall which have a structure consisting of a mixture of Purkinje fibers and ordinary cardiac muscle cells.

- Anterior internodal pathway - leaves the anterior end of the SA and passes anterior to the SVC opening. It descends on the atrial septum and ends in the AV node.

- Middle internodal pathway - leaves the posterior end of the SA node and passes posterior to the SVC opening. It descends on the atrial septum to the AV node.

- Posterior internodal pathway - leaves the posterior part of the SA node and descends through the crista terminalis and the valve of the inferior vena cava (IVC) to the AV node.
Failure of the Conduction System of the Heart

• The sinuatrial node is the spontaneous source of the cardiac impulse.
• The atrioventricular node is responsible for picking up the cardiac impulse from the atria.
• The atrioventricular bundle is the only route by which the cardiac impulse can spread from the atria to the ventricles.
• Failure of the bundle to conduct the normal impulses results in alteration in the rhythmic contraction of the ventricles (arrhythmias) or, if complete bundle block occurs, complete dissociation between the atria and ventricular rates of contraction.
• The common cause of defective conduction through the bundle or its branches is atherosclerosis of the coronary arteries, which results in a diminished blood supply to the conducting system.
Arterial Supply of the Heart

Coronary Arteries of the Heart

- Left Coronary Artery
- Circumflex Artery
- Oblique Marginal Artery
- Diagonal Arteries
- Left Anterior Descending Artery
- Acute Marginal Artery
- Posterior Descending Artery

Right Coronary Artery
Arterial supply of the heart

Coronary arteries

- Left
- Right

- Arise from the ascending aorta immediately above the aortic valve.
Arterial supply of the heart

• Right coronary artery

- Arises from the anterior aortic sinus.
- Runs forward between the pulmonary trunk and the right auricle.
- Descends in the right AV groove.
- At inferior border of the heart it continues posteriorly to anastomose with the left coronary artery.
Branches of Right Coronary Artery

- Supplies the RA, RV, & parts of LA & LV and the atrioventricular septum.

1. Right conus artery: supplies RV Infundibulum & upper part of the anterior wall of the RV.

2. Anterior ventricular branches: 2 or 3 in number and supply the ant. surface of the RV.
   - Marginal branch is the largest & runs along the lower margin of the costal surface to reach the apex.

3. Posterior ventricular branches: 2 in number and supply the diaphragmatic surface of the right ventricle.

4. Posterior interventricular (descending) artery: runs toward the apex in the posterior interventricular groove.
   - It gives off branches to RV and LV.
   - A large septal branch supplies the atrioventricular node.
   - In 10% of individuals the posterior interventricular artery is replaced by a branch from the left coronary artery.
Branches of the Right Coronary Artery

5. **Atrial branches**: supply the anterior and lateral surfaces of the right atrium. One branch supplies the posterior surface of both right and left atria.

6. **The artery of the sinuatrial node**: supplies the SA node and the right and left atria.
   - In 35% of individuals, it arises from the left coronary artery.

**Right coronary artery supplies**: 
- Right atrium.
- Right ventricle.
- Parts of left atrium.
- Parts of left ventricle.
- Atrioventricular septum.
- Ventricular septum (post. 1/3).
- SA node (60%).
- AV node and bundle (80%).
(A) Anterior view

- Arch of aorta
- Pulmonary trunk
- Left coronary artery (LCA)
- Circumflex branch of LCA
- Anterior interventricular branch of LCA
- Left marginal artery
- Lateral (diagonal) branch of anterior IV branch
- Apex of heart
- Posterior interventricular branch within posterior interventricular groove

Sinu-atrial (SA) nodal branch
Site of SA node
Right coronary artery (RCA) within coronary sulcus
Atrioventricular (AV) nodal branch of RCA
Right marginal branch of RCA
Plane of section for (D)
• **Left coronary artery** - usually larger than right coronary artery.

- Supplies major part of the heart, including the greater part of the LA, LV, and ventricular septum.

- It arises from the left posterior aortic sinus of the ascending aorta and passes forward between the pulmonary trunk and the left auricle. It then enters the atrioventricular groove and divides into an **anterior interventricular branch** and a **circumflex branch**.
Branches of the Left Coronary Artery

1. Anterior interventricular (descending) artery: runs downward in the ant. interventricular groove to the apex.
   - *In most individuals* it then passes around the apex of the heart to enter the post. interventricular groove and anastomoses with the terminal branches of Rt. coronary artery.
   - *In one third of individuals* it ends at the apex of the heart.
   - It supplies the RV, LV with numerous branches that also supply the ant. part of the ventricular septum.
   - One of these branches (left diagonal artery) may arise directly from the trunk of the left coronary artery.
   - A small left conus artery supplies the pulmonary conus.
Branches of the Left Coronary Artery

2. **Circumflex artery**: same size as ant. interventricular artery.
   - It winds around left heart margin in the atroventricular groove.
   - A left marginal art. is a large branch that supplies Lt margin of the LV down to the apex.
   - Ant. ventricular and post. Vent. branches supply the LV.
   - Atrial branches supply the LA.

- **Left coronary artery supplies:**
  - Most of the left ventricle.
  - Small area of the right ventricle.
  - Ventricular septum (ant. 2/3).
  - Most of the left atrium.
  - RBB,LBB.
<table>
<thead>
<tr>
<th>Artery/Branch</th>
<th>Origin</th>
<th>Course</th>
<th>Distribution</th>
<th>Anastomoses</th>
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<tr>
<td>Right coronary (RCA)</td>
<td>Right aortic sinus</td>
<td>Follows coronary (AV) sulcus between atria and ventricles</td>
<td>Right atrium, SA and AV nodes, and posterior part of IVS</td>
<td>Circumflex and anterior IV branches of LCA</td>
</tr>
<tr>
<td>SA nodal</td>
<td>RCA near its origin (in 60%)</td>
<td>Ascends to SA node</td>
<td>Pulmonary trunk and SA node</td>
<td></td>
</tr>
<tr>
<td>Right marginal</td>
<td>RCA</td>
<td>Passes to inferior margin of heart and apex</td>
<td>Right ventricle and apex of heart</td>
<td>IV branches</td>
</tr>
<tr>
<td>Posterior interventricular</td>
<td>RCA (in 67%)</td>
<td>Runs in posterior IV groove to apex of heart</td>
<td>Right and left ventricles and posterior third of IVS</td>
<td>Anterior IV branch of LCA (at apex)</td>
</tr>
<tr>
<td>AV nodal</td>
<td>RCA near origin of posterior IV artery</td>
<td>Passes to AV node</td>
<td>AV node</td>
<td></td>
</tr>
<tr>
<td>Left coronary (LCA)</td>
<td>Left aortic sinus</td>
<td>Runs in AV groove and gives off anterior IV and circumflex branches</td>
<td>Most of left atrium and ventricle, IVS, and AV bundles; may supply AV node</td>
<td>RCA</td>
</tr>
<tr>
<td>SA nodal</td>
<td>Circumflex branch of LCA (in 40%)</td>
<td>Ascends on posterior surface of left atrium to SA node</td>
<td>Left atrium and SA node</td>
<td></td>
</tr>
<tr>
<td>Anterior interventricular</td>
<td>LCA</td>
<td>Passes along anterior IV groove to apex of heart</td>
<td>Right and left ventricles and anterior two thirds of IVS</td>
<td>Posterior IV branch of RCA (at apex)</td>
</tr>
<tr>
<td>Circumflex</td>
<td>LCA</td>
<td>Passes to left in AV sulcus and runs to posterior surface of heart</td>
<td>Left atrium and left ventricle</td>
<td>RCA</td>
</tr>
<tr>
<td>Left marginal</td>
<td>Circumflex branch of LCA</td>
<td>Follows left border of heart</td>
<td>Left ventricle</td>
<td>IV branches</td>
</tr>
<tr>
<td>Posterior interventricular</td>
<td>LCA (in 33%)</td>
<td>Runs in posterior IV groove to apex of heart</td>
<td>Right and left ventricles and posterior third of IVS</td>
<td>Anterior IV branch of LCA (at apex)</td>
</tr>
</tbody>
</table>

AV, atrioventricular; IV, interventricular; IVS, interventricular septum; SA, sino-atrial.
Variations in the coronary arteries

- The most common variations affect the blood supply to the diaphragmatic surface of both ventricles, here the **Origin, size, distribution of the posterior interventricular artery** are variable:
  - **Right dominant** – most individuals (90)% - the posterior interventricular artery is a large branch of the Rt coronary artery.
  - **Left dominant** (10)% - the posterior interventricular artery is a branch of the circumflex branch of the Lt coronary artery.
Variations in Coronary Artery Distributions

FIGURE 1.60. Variations in distribution of coronary arteries. A. In the most common pattern (67%), the RCA is dominant, giving rise to the posterior interventricular branch. B, C. The LCA gives rise to the posterior interventricular branch in approximately 15% of individuals. D. Many other variations occur.
Most blood from the heart wall drains into RA through coronary sinus a continuation of:
- great cardiac vein

Tributaries of coronary sinus:
- Small and middle cardiac veins

The reminder of the blood is returned to RA by:
- Anterior cardiac vein
The cardiac plexuses lies below the arch of the aorta.

Parasympathetic fibers from vagus nerve.

Sympathetic from cervical & upper thoracic portion of S. trunk.

If blood supply is impaired significantly, pain impulses will reach consciousness via autonomic nerve fibers.
<table>
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<th>Nerve supply to the heart</th>
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<tbody>
<tr>
<td><strong>Sympathetic activation</strong></td>
</tr>
<tr>
<td>❖ Cardiac acceleration</td>
</tr>
<tr>
<td>❖ ↑ force of contraction</td>
</tr>
<tr>
<td>❖ Dilatation of coronary arteries</td>
</tr>
</tbody>
</table>
Coronary Artery Disease (CAD)

• The myocardium receives its blood supply through the right and left coronary arteries.
• Although the coronary arteries have numerous anastomoses at the arteriolar level, they are essentially functional end arteries.
• A sudden block of one of the large branches of either coronary artery will usually lead to necrosis of the cardiac muscle (myocardial infarction) in that vascular area, and often the patient dies.
• Most cases of coronary artery blockage are caused by an acute thrombosis on top of a chronic atherosclerotic narrowing of the lumen.
Coronary Artery Disease (CAD)

- Arteriosclerotic disease of the coronary arteries may present in three ways, depending on the rate of narrowing of the lumina of the arteries:
  
  1. **General degeneration and fibrosis of the myocardium** occur over many years and are caused by a gradual narrowing of the coronary arteries.
  
  2. **Angina pectoris** is cardiac pain that occurs on exertion and is relieved by rest. In this condition, the coronary arteries are so narrowed that myocardial ischemia occurs on exertion but not at rest.
  
  3. **Myocardial infarction** occurs when coronary flow is suddenly reduced or stopped and the cardiac muscle undergoes necrosis. Myocardial infarction is the major cause of death in industrialized nations.
Coronary Artery Disease

Anterior infarct

Occlusion of proximal left anterior descending a. (LAD)

Infarct

Anterolateral infarct

Occlusion of left circumflex coronary a., marginal branch of left circumflex a., or diagonal branch of left anterior descending a.

Infarct
Coronary Artery Disease

- True posterior infarct
  - Occlusion of distal circumflex a.
  - Infarct

- Diaphragmatic or inferior infarct
  - Occlusion of posterior descending or distal right coronary aa.
  - Occlusion of right coronary a.
  - Infarct
<table>
<thead>
<tr>
<th>Coronary Artery</th>
<th>Infarct Location</th>
<th>ECG Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximal LAD</td>
<td>Large anterior wall</td>
<td>ST elevation: I, L, V1–V6</td>
</tr>
<tr>
<td>More distal LAD</td>
<td>Anteroapical</td>
<td>ST elevation: V2–V4</td>
</tr>
<tr>
<td></td>
<td>Inferior wall if wraparound LAD</td>
<td>ST elevation: II, III, F</td>
</tr>
<tr>
<td>Distal LAD</td>
<td>Anteroseptal</td>
<td>ST elevation: V1–V3</td>
</tr>
<tr>
<td>Early obtuse, marginal</td>
<td>High lateral wall</td>
<td>ST elevation: I, L, V4–V6</td>
</tr>
<tr>
<td>More distal marginal branch, circumflex</td>
<td>Small lateral wall</td>
<td>ST elevation: I, L, or V4–V6, or no abnormality</td>
</tr>
<tr>
<td>Circumflex</td>
<td>Posterolateral</td>
<td>ST elevation: V4–V6; ST depression: V1–V2</td>
</tr>
<tr>
<td>Distal RCA</td>
<td>Small inferior wall</td>
<td>ST elevation: II, III, F; ST depression: I, L</td>
</tr>
<tr>
<td>Proximal RCA</td>
<td>Large inferior wall and posterior wall</td>
<td>ST elevation: II, III, F; ST depression: I, L, V1–V3</td>
</tr>
<tr>
<td></td>
<td>Some lateral wall</td>
<td>ST elevation: V5–V6</td>
</tr>
<tr>
<td>RCA</td>
<td>Right ventricular</td>
<td>ST elevation: V2R–V4R; some ST elevation: V1; or ST depression V2, V3</td>
</tr>
<tr>
<td></td>
<td>Usually inferior</td>
<td>ST elevation: II, III, F</td>
</tr>
</tbody>
</table>

ECG, electrocardiographic; LAD, left anterior descending (interventricular); RCA, right coronary artery.
## Coronary Artery Disease

<table>
<thead>
<tr>
<th>Artery and Area Affected by MI</th>
<th>Frequency and affected area</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAD</td>
<td>40–50%; affects anterior and apical left ventricle and anterior two thirds of interventricular septum (IVS)</td>
</tr>
<tr>
<td>Right coronary</td>
<td>30–40%; affects posterior wall of left ventricle, posterior one third of IVS (if right-dominant coronary circulation)</td>
</tr>
<tr>
<td>Left circumflex</td>
<td>15–20%; affects lateral wall of left ventricle (can also affect posterior wall if left dominant coronary circulation)</td>
</tr>
</tbody>
</table>
Coronary Artery Disease (CAD)

- **Treatment of CAD:**
  - Coronary angioplasty
  - Coronary bypass surgery
  - Coronary artery stenting
Coronary Bypass

A **coronary artery bypass graft** (CABG), also called “the cabbage procedure,” offers a surgical approach for revascularization. Veins or arteries from elsewhere in the patient’s body are grafted to the coronary arteries to improve blood supply. In a **saphenous vein graft** a portion of the great saphenous vein is harvested from the patient’s lower limb. Alternatives include internal thoracic artery and radial artery grafts.

If indicated the physician may prefer to use coronary angioplasty to widen the partially occluded artery, which may include using a stent to keep the artery open.
Coronary Angioplasty

Balloon catheter headed toward coronary artery

Deflated balloon catheter approaches blockage

Inflated balloon crushes blockage

Circulation re-established

**FIGURE B1.28.** Percutaneous transluminal angioplasty.
Auscultation of the Heart Valves

• On listening to the heart with a stethoscope, one can hear two sounds: lub-dup.

• The first sound is produced by: the contraction of the ventricles and the closure of the tricuspid and mitral valves.

• The second sound is produced by: the sharp closure of the aortic and pulmonary valves.
Auscultation of the Heart Valves
(cont'd)

• The **tricuspid valve** is best heard over the left 4th intercostal space, parasternal line.

• The **mitral valve** is best heard over the apex beat, that is, at the level of the left fifth intercostal space, 3.5 in. (9 cm) from the midline.

• The **pulmonary valve** is heard with least interference over the medial end of the second left intercostal space.

• The **aortic valve** is best heard over the medial end of the second right intercostal space.
Auscultation of the Heart Valves
(cont'd)
Thank You