UNIT 5

Cardiovascular System

The **cardiovascular system** (also known as the **circulatory system**) is responsible for transporting blood, nutrients, oxygen, hormones, and waste products throughout the body.

Components of the Cardiovascular System

1. **Heart** – the muscular pump
2. **Blood vessels** – arteries, veins, and capillaries
3. **Blood** – the circulating fluid

Anatomy of the Heart

The **heart** is a **muscular organ** that functions as a **double pump** for blood circulation — one pump sends blood to the lungs for oxygenation, and the other sends oxygenated blood to the body.

Location and Position

- Located in the **mediastinum** (central thoracic cavity), slightly tilted towards the left
- Lies behind the sternum and between the lungs
- Rests on the **diaphragm**

Shape and Size

- **Cone-shaped**
- About the size of a **clenched fist**
- Weight: ~250–300 grams

External Features of the Heart

1. Pericardium

A **double-walled sac** enclosing the heart, consisting of:

- **Fibrous pericardium** (outer tough layer)
- **Serous pericardium** (inner layer), which has:
    - **Parietal layer**
    - **Visceral layer (epicardium)** – adheres to heart wall

Between these is the **pericardial cavity** filled with **pericardial fluid** to reduce friction during contraction.

Layers of the Heart Wall

1. **Epicardium** – outer layer; protective and contains blood vessels
2. **Myocardium** – thick middle layer of **cardiac muscle**, responsible for contraction
3. **Endocardium** – inner smooth lining of chambers and valves

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Chambers of the Heart

The heart has **4 chambers**:

- **2 atria** (right and left) – receive blood
- **2 ventricles** (right and left) – pump blood

Right Side (deoxygenated blood):

- **Right atrium** receives blood from:
    - **Superior vena cava**
    - **Inferior vena cava**
    - **Coronary sinus**
- **Right ventricle** pumps blood to lungs via **pulmonary artery**

Left Side (oxygenated blood):

- **Left atrium** receives blood from **4 pulmonary veins**
- **Left ventricle** pumps blood to body via **aorta**

The **left ventricle** has thicker walls to generate high pressure needed for systemic circulation.

Valves of the Heart

Valves ensure **unidirectional blood flow**.

1. Atrioventricular (AV) valves

- **Tricuspid valve** – between right atrium and ventricle
- **Mitral (bicuspid) valve** – between left atrium and ventricle
- Supported by **chordae tendineae** and **papillary muscles**

2. Semilunar valves

- **Pulmonary valve** – between right ventricle and pulmonary artery

- **Aortic valve** – between left ventricle and aorta

Major Blood Vessels

- **Superior vena cava** – brings blood from upper body
- **Inferior vena cava** – brings blood from lower body
- **Pulmonary arteries** – carry deoxygenated blood to lungs
- **Pulmonary veins** – bring oxygenated blood from lungs
- **Aorta** – carries oxygenated blood to the body

Blood Flow Through the Heart

1. **Deoxygenated blood** enters right atrium → tricuspid valve → right ventricle → pulmonary valve → pulmonary artery → lungs
2. **Oxygenated blood** returns via pulmonary veins → left atrium → mitral valve → left ventricle → aortic valve → aorta → systemic circulation

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Coronary Circulation

The **heart muscle (myocardium)** receives blood from **coronary arteries**.

- **Right and left coronary arteries** (from base of aorta)
- Veins drain into the **coronary sinus**, which empties into the **right atrium**

Clinical relevance: Blockage leads to **myocardial infarction (heart attack)**

Innervation

- **Autonomic nervous system**:
    - **Sympathetic stimulation** increases heart rate and force
    - **Parasympathetic stimulation** (via **vagus nerve**) slows heart rate

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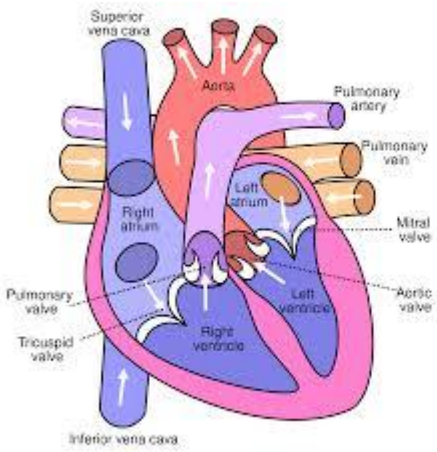
Applied Anatomy

- **Pericarditis** – inflammation of the pericardium
- **Endocarditis** – infection of endocardial layer
- **Valvular disorders** – stenosis or regurgitation (e.g., mitral valve prolapse)
- **Congenital defects** – e.g., septal defects



Blood Circulation

The circulatory system functions to **transport blood throughout the body**. This blood delivers oxygen, nutrients, and hormones, and removes waste products like carbon dioxide and urea.

Types of Circulation

There are **four major types** of blood circulation:

1. Pulmonary Circulation

- Carries **deoxygenated blood** from the heart to the lungs and returns **oxygenated blood** back to the heart.

Pathway:

- Right ventricle → Pulmonary trunk → Pulmonary arteries → Lungs (gas exchange) → Pulmonary veins → Left atrium

Function:

- Oxygenation of blood and removal of carbon dioxide

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2. Systemic Circulation

- Circulates **oxygenated blood** from the heart to all body tissues and returns **deoxygenated blood** back to the heart.

Pathway:

- Left ventricle → Aorta → Arteries → Arterioles → Capillaries (exchange) → Venules → Veins → Vena cava → Right atrium

Function:

- Delivers oxygen, nutrients, and hormones to tissues
- Removes waste products like CO_2 and urea

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3. Coronary Circulation

- Supplies **oxygenated blood to the heart muscle (myocardium)** itself.

Pathway:

- Right and Left Coronary Arteries (from aorta) → Branches over myocardium → Cardiac veins → Coronary sinus → Right atrium

Clinical Note:

- Blockage leads to **myocardial infarction (heart attack)**

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4. Hepatic Portal Circulation (Portal System)

- Specialized circulation where **blood from digestive organs** is carried to the **liver first**, before entering systemic circulation.

Pathway:

- Stomach/intestine/spleen/pancreas → Hepatic portal vein → Liver (nutrient processing, detoxification) → Hepatic veins → Inferior vena cava → Heart

Function:

- Metabolism and detoxification of nutrients absorbed from GIT

Blood Vessels

Blood vessels are **tubular structures** that carry blood throughout the body. They form a **closed circulatory system** and include:

- **Arteries**
- **Arterioles**
- **Capillaries**
- **Venules**
- **Veins**

General Structure of Blood Vessels

Most vessels (except capillaries) have **three layers (tunics)**:

1. **Tunica Intima (interna)**
    - Innermost layer
    - Composed of **endothelium** (simple squamous epithelium)
    - Provides a **smooth surface** for blood flow

2. **Tunica Media**
    - Middle layer
    - Made of **smooth muscle** and **elastic fibers**
    - Controls **vasoconstriction** and **vasodilation**
3. **Tunica Externa (adventitia)**
    - Outermost layer
    - Composed of **connective tissue**
    - Provides **strength and support**

Types of Blood Vessels

1. Arteries

- Carry **oxygenated blood** away from the heart (except pulmonary artery)
- Have **thick tunica media** for high pressure
- Types:
    - **Elastic arteries** (e.g., aorta)
    - **Muscular arteries** (e.g., brachial artery)

2. Arterioles

- Small branches of arteries
- Control **blood flow to capillaries**
- Important in **blood pressure regulation**

3. Capillaries

- **Microscopic vessels** with thin walls (single endothelial layer)
- Site of **exchange of gases, nutrients, and wastes**
- Types:
    - **Continuous capillaries** – most common (e.g., muscles, lungs)
    - **Fenestrated capillaries** – pores for more exchange (e.g., kidneys)
    - **Sinusoids** – wide, leaky (e.g., liver, bone marrow)

4. Venules

- Collect blood from capillaries
- Merge to form veins
- Start regaining layers lost in capillaries

5. Veins

- Carry **deoxygenated blood** back to the heart (except pulmonary vein)
- **Thinner walls** than arteries
- **Larger lumen**
- Contain **valves** to prevent backflow (especially in limbs)
- Act as **blood reservoirs** (hold ~65–70% of total blood)

Comparison: Arteries vs. Veins

Feature	Arteries	Veins
Direction	Away from heart	Toward heart
Oxygen content	Oxygenated (except pulmonary)	Deoxygenated (except pulmonary)
Wall thickness	Thick (high pressure)	Thin (low pressure)
Lumen	Narrow	Wide
Valves	Absent	Present
Elasticity	High	Low

Special Vascular Systems

1. Pulmonary Circulation

- Pulmonary artery → lungs → pulmonary veins → heart
- Oxygenation of blood

2. Coronary Circulation

- Supplies the myocardium via coronary arteries

3. Portal Circulation

- GIT organs → hepatic portal vein → liver → systemic circulation
- Important for nutrient metabolism and detoxification

Clinical Conditions

- **Atherosclerosis** – plaque formation inside arteries
- **Varicose veins** – due to weak valves in veins
- **Aneurysm** – bulging of artery wall
- **Deep vein thrombosis (DVT)** – clot in deep veins

Structure and Functions of Arteries, Veins, and Capillaries

1. Arteries

Structure:

- **Wall Composition:**
  - **Tunica Intima:** Innermost layer; consists of endothelial cells lining the lumen.
  - **Tunica Media:** Middle layer; thick, composed mainly of smooth muscle fibers and elastic tissue, allowing for elasticity and contractility.
  - **Tunica Externa (Adventitia):** Outer layer; made of connective tissue containing collagen fibers, providing strength and support.
- **Lumen:** Narrower compared to veins but maintains a round shape.
- **Elasticity:** High elastic fiber content, especially in elastic arteries (e.g., aorta), allowing them to stretch and recoil.

Functions:

- **Transport of Oxygenated Blood:** Carry oxygen-rich blood from the heart to various tissues (except pulmonary arteries).
- **Regulation of Blood Pressure:** Elastic arteries help dampen the pulsatile output of the heart, maintaining steady blood flow.
- **Distribution:** Distribute blood to different body regions through smaller muscular arteries.

2. Veins

Structure:

- **Wall Composition:**
  - Similar layers as arteries but with thinner tunica media and less elastic tissue.
  - **Tunica Intima:** Endothelial lining.
  - **Tunica Media:** Thinner smooth muscle layer.
  - **Tunica Externa:** Relatively thick connective tissue layer, often containing valves.
- **Lumen:** Larger and more irregular in shape, often collapsed.
- **Valves:** Presence of one-way valves to prevent backflow, especially in limbs.

Functions:

- **Return of Deoxygenated Blood:** Carry deoxygenated blood from tissues back to the heart (except pulmonary veins which carry oxygenated blood).
- **Blood Reservoir:** Capable of storing large volumes of blood due to their high compliance.

- **Assist Venous Return:** Valves and muscular contractions (muscle pump) facilitate blood flow back to the heart.

3. Capillaries

Structure:

- **Wall Composition:**
    - Composed solely of a single layer of endothelial cells (tunica intima) supported by a basement membrane.
- **Types:**
    - **Continuous Capillaries:** Endothelial cells form a continuous lining; found in muscle, skin, lungs.
    - **Fenestrated Capillaries:** Have pores (fenestrations) for increased permeability; found in kidneys, intestines.
    - **Sinusoidal Capillaries:** Larger openings; found in liver, bone marrow, spleen, allowing passage of large molecules and cells.
    - **Functions:**
    - **Exchange of Gases and Nutrients:** Facilitate diffusion of oxygen, carbon dioxide, nutrients, and waste products.
    - **Filtration and Absorption:** Participate in filtration (e.g., in kidneys) and absorption processes.
    - **Metabolic Exchange:** Serve as sites for metabolic exchange between blood and tissues.

1. Elements of the Conduction System of the Heart

The heart has a **specialized conduction system** made up of autorhythmic (self-excitable) cells. These cells initiate and propagate electrical impulses that control heart contractions.

The major elements are:

Structure	Function
Sinoatrial Node (SA node)	Pacemaker of the heart; initiates impulses (70–100/min)
Atrioventricular Node (AV node)	Delays impulse to allow atria to contract before ventricles
Bundle of His (AV Bundle)	Conducts impulses from AV node to interventricular septum
Right and Left Bundle Branches	Carry impulses to respective ventricles
Purkinje Fibers	Spread throughout ventricles; cause rapid ventricular contraction

🌀 **Sequence of Impulse Flow:**

SA Node → Atrial muscles → AV Node → Bundle of His → Bundle branches → Purkinje fibers → Ventricular muscles

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🫀 2. Heartbeat and Its Regulation

A **heartbeat** is one complete cycle of contraction (systole) and relaxation (diastole) of the heart.

- **Normal Heart Rate**: ~70–75 beats/min
- **Intrinsic rate** is set by the **SA node**, but modified by the **Autonomic Nervous System (ANS)** and hormones.

🌐 3. Regulation by Autonomic Nervous System (ANS)

The **ANS regulates heart rate and force of contraction** through two main components:

🔹 **Sympathetic Nervous System (SNS)**

- Neurotransmitter: **Norepinephrine**
- Receptor: **β1-adrenergic receptors**
- **Increases**:
    - Heart rate (**positive chronotropic effect**)
    - Force of contraction (**positive inotropic effect**)
    - Conduction velocity (**positive dromotropic effect**)

🔹 **Parasympathetic Nervous System (PNS)**

- Nerve: **Vagus nerve (cranial nerve X)**
- Neurotransmitter: **Acetylcholine**
- Receptor: **Muscarinic M2**
- **Decreases**:
    - Heart rate (**negative chronotropic effect**)
    - Slightly reduces force (mainly in atria)

Cardiac Output

Definition:

Cardiac output is the **amount of blood pumped by each ventricle of the heart in one minute**. It represents how efficiently the heart is supplying blood to the body.

Key Terms:

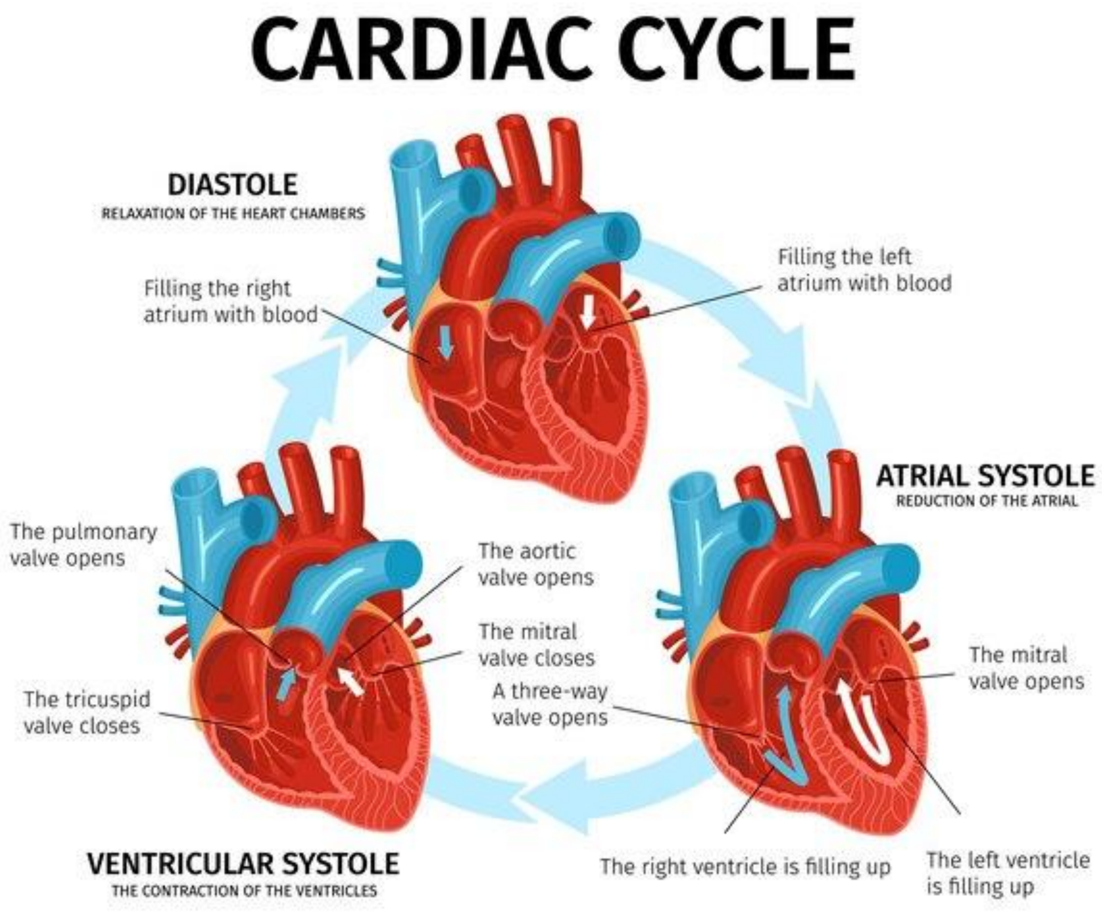
- **Heart Rate** is the number of times the heart beats in one minute. In a healthy adult, it is usually around seventy-two beats per minute.
- **Stroke Volume** is the amount of blood ejected by one ventricle during a single heartbeat. In a resting adult, it is approximately seventy milliliters per beat.
- When heart rate and stroke volume are multiplied, it gives cardiac output. For example, if the heart beats seventy-two times per minute and ejects seventy milliliters per beat, the cardiac output will be around five liters per minute.

Factors Affecting Cardiac Output:

1. **Heart Rate:**
   - If heart rate increases, cardiac output generally increases.
   - However, extremely fast heart rates can reduce the time for filling, which may reduce output.
2. **Stroke Volume:**
   - More blood pumped per beat increases the overall output.
3. **Venous Return:**
   - More blood returning to the heart increases filling and leads to stronger contractions.
4. **Contractility:**
   - Stronger heart muscle contractions increase stroke volume.
5. **Peripheral Resistance or Afterload:**
   - Higher resistance in blood vessels can make it harder for the heart to pump blood, reducing output.
6. **Autonomic Nervous System:**
   - The **sympathetic nervous system** increases heart rate and contractility, which increases cardiac output.
   - The **parasympathetic nervous system** slows down the heart, reducing cardiac output.
7. **Hormonal Influence:**
   - Hormones like adrenaline increase heart rate and force of contraction, raising cardiac output.
   - Thyroid hormone also increases heart rate over time.

Physiological Importance:

- During **exercise**, cardiac output can increase up to five times the normal rate in healthy individuals.
- In **heart failure**, cardiac output may decrease significantly, which can reduce oxygen delivery to tissues.
- **Shock** is a condition where cardiac output is too low to meet the body's needs.



Cardiac Cycle

🫀 **Definition:**

The **cardiac cycle** refers to the complete sequence of **events that occur in the heart during one heartbeat**. It includes the contraction and relaxation of both the atria and the ventricles.

One full cardiac cycle takes about **0.8 seconds** in a healthy adult at rest.

🔄 **Phases of the Cardiac Cycle:**

The cardiac cycle is divided into three main phases:

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1. Atrial Systole (Duration: approximately 0.1 seconds)

- The **atria contract**.
- Blood is pushed from the atria into the ventricles.
- The **atrioventricular valves** (tricuspid and mitral) are **open**.
- The **semilunar valves** (pulmonary and aortic) are **closed**.

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2. Ventricular Systole (Duration: approximately 0.3 seconds)

- The **ventricles contract**.
- The **atrioventricular valves close** to prevent backflow into the atria (this produces the **first heart sound**, "lub").
- The **semilunar valves open**, allowing blood to be ejected into the aorta and pulmonary artery.

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3. Complete Cardiac Diastole (Duration: approximately 0.4 seconds)

- Both atria and ventricles are relaxed.
- Blood flows passively into the atria and then into the ventricles.
- The **semilunar valves close**, producing the **second heart sound**, "dub".
- The **atrioventricular valves are open** again.

🕒 **Time Distribution in One Cardiac Cycle (at rest):**

Phase	**Duration**
Atrial systole	0.1 second
Ventricular systole	0.3 second
Complete diastole	0.4 second
Total cycle	**0.8 second**

🎧 **Heart Sounds:**

1. **First heart sound ("lub")** – closure of the atrioventricular valves.
2. **Second heart sound ("dub")** – closure of the semilunar valves.

🧠 **Key Points to Remember:**

- The cardiac cycle ensures **unidirectional blood flow**.

- The **systole** phase refers to contraction.
- The **diastole** phase refers to relaxation.
- Valves prevent the **backflow of blood**.
- Heart sounds are due to **valve closures**, not muscle contraction.

Regulation of Blood Pressure and Pulse

Blood Pressure: Definition

Blood pressure is the force exerted by circulating blood on the walls of blood vessels. It is mainly measured in the arteries and is expressed in terms of systolic and diastolic pressures.

- **Systolic pressure**: The pressure during ventricular contraction.
- **Diastolic pressure**: The pressure during ventricular relaxation.

A normal adult blood pressure is approximately 120 over 80 millimeters of mercury.

Factors Affecting Blood Pressure

1. **Cardiac output**: Higher output raises pressure.
2. **Peripheral resistance**: Narrower blood vessels increase resistance and raise pressure.
3. **Blood volume**: More volume increases pressure.
4. **Viscosity of blood**: Thicker blood increases resistance and pressure.
5. **Elasticity of blood vessels**: Loss of elasticity increases pressure.

Regulation of Blood Pressure

Blood pressure is regulated by **short-term** and **long-term** mechanisms.

Short-Term Regulation

Controlled by the **autonomic nervous system** and **baroreceptors** (pressure sensors) located in the aortic arch and carotid sinus.

1. **Baroreceptor Reflex**:
   - When blood pressure rises, baroreceptors send signals to the medulla oblongata.
   - This inhibits sympathetic activity and activates parasympathetic activity, reducing heart rate and causing vasodilation.
   - When blood pressure falls, the opposite occurs: sympathetic activity increases, causing increased heart rate, vasoconstriction, and increased pressure.
2. **Chemoreceptor Reflex**:
   - Chemoreceptors in carotid and aortic bodies respond to changes in oxygen, carbon dioxide, and pH.

    - Low oxygen or high carbon dioxide triggers increased heart rate and vasoconstriction to maintain pressure and oxygen supply.

Long-Term Regulation

Controlled by hormones and kidneys:

1. **Renin-Angiotensin-Aldosterone System**:
    - When pressure drops, kidneys release renin.
    - Renin leads to the formation of angiotensin two, which causes vasoconstriction and stimulates aldosterone secretion.
    - Aldosterone increases sodium and water retention, raising blood volume and pressure.
2. **Antidiuretic Hormone (ADH)**:
    - Increases water reabsorption in the kidneys, increasing blood volume and pressure.
3. **Atrial Natriuretic Peptide (ANP)**:
    - Released when blood volume increases.
    - Causes vasodilation and promotes loss of sodium and water in urine, reducing pressure.

Pulse: Definition

Pulse is the rhythmic expansion and recoil of an artery due to the heartbeat. It reflects the heart rate and the strength of the heartbeat.

- Normal pulse rate in adults is about seventy to seventy-two beats per minute.

Factors Affecting Pulse Rate

1. Age: Higher in infants, lower in adults.
2. Gender: Slightly higher in females.
3. Physical activity: Increases during exercise.
4. Emotions and stress: Increase pulse.
5. Body temperature: Higher temperature increases pulse.
6. Medications: Certain drugs can raise or lower the pulse rate.

Clinical Importance

- Both blood pressure and pulse are vital signs used to monitor cardiovascular health.
- Abnormal blood pressure may indicate hypertension, shock, or heart failure.
- Abnormal pulse rate may suggest arrhythmias, fever, or cardiovascular disease.

Electrocardiogram (ECG)

Definition:

An **electrocardiogram (ECG)** is a graphical recording of the **electrical activity of the heart** over time. It is recorded using electrodes placed on the skin. The ECG helps in assessing the rhythm, rate, and condition of the heart.

Principle:

The heart produces electrical impulses during each heartbeat. These impulses spread through the atria and ventricles and can be detected at the surface of the body. An ECG machine records these impulses as waves on graph paper or a monitor.

Standard ECG Waves and Intervals:

A normal ECG consists of several waves, each representing specific electrical events in the cardiac cycle.

1. **P Wave**:
    - Represents atrial depolarization (contraction of atria).
    - Small, rounded wave before the QRS complex.
2. **QRS Complex**:
    - Represents ventricular depolarization (contraction of ventricles).
    - Q: small downward deflection
    - R: sharp upward spike
    - S: downward deflection following R
3. **T Wave**:
    - Represents ventricular repolarization (recovery of ventricles).
4. **U Wave** (occasionally seen):
    - May represent repolarization of Purkinje fibers.

Intervals and Segments:

1. **PR Interval**:
    - Time between the beginning of atrial depolarization and the beginning of ventricular depolarization.
    - Represents the time taken for the impulse to travel from the SA node to the AV node.

2. **ST Segment**:
    - Time between the end of ventricular depolarization and beginning of repolarization.
    - Elevation or depression may indicate myocardial infarction or ischemia.
3. **QT Interval**:
    - Time from the beginning of ventricular depolarization to the end of repolarization.

Clinical Significance:

1. **Heart rate** can be determined from the distance between R waves.
2. Abnormalities in the shape or timing of waves can indicate:
    - Arrhythmias
    - Heart block
    - Myocardial infarction
    - Electrolyte imbalance
    - Conduction defects

Disorders of the Heart

The heart may be affected by various **structural**, **electrical**, or **functional** problems that impair its ability to pump blood efficiently. These are classified into several categories:

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1. Coronary Artery Disease (CAD)

- Caused by **narrowing or blockage** of the coronary arteries due to **atherosclerosis** (plaque buildup).
- Leads to **reduced oxygen supply** to the heart muscle.

Types:

- **Angina pectoris**: Chest pain due to temporary reduced blood flow.
- **Myocardial infarction (heart attack)**: Death of heart muscle due to prolonged lack of oxygen.

Symptoms: Chest pain, shortness of breath, fatigue, pain in arm or jaw.

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2. Congestive Heart Failure (CHF)

- A condition where the heart is **unable to pump blood effectively** to meet the body's needs.
- Can affect either the **left**, **right**, or **both sides** of the heart.

Causes: High blood pressure, coronary artery disease, previous heart attack, valve disorders.

Symptoms: Swelling (edema), breathlessness, fatigue, fluid retention.

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3. Arrhythmias (Abnormal Heart Rhythms)

- Disturbance in the **electrical activity** of the heart.
- The heartbeat may be **too fast, too slow, or irregular**.

Examples:

- **Bradycardia**: Slow heart rate.
- **Tachycardia**: Fast heart rate.
- **Atrial fibrillation**: Rapid, irregular contraction of atria.
- **Ventricular fibrillation**: Life-threatening, uncoordinated contraction of ventricles.

Causes: Damage to conducting system, electrolyte imbalance, drugs, stress.

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4. Valvular Heart Disease

- Malfunction of one or more of the **four heart valves** (mitral, tricuspid, aortic, pulmonary).
- Valves may become **stenotic** (narrowed) or **incompetent** (leaky).

Examples:

- **Mitral valve prolapse**
- **Aortic stenosis**
- **Tricuspid regurgitation**

Symptoms: Heart murmur, fatigue, breathlessness, palpitations.

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5. Hypertensive Heart Disease

- Caused by **chronic high blood pressure**.
- Leads to **left ventricular hypertrophy** (thickening of heart muscle) and reduced efficiency.

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6. Pericarditis

- Inflammation of the **pericardium**, the membrane surrounding the heart.
- Can be due to infection, injury, or autoimmune diseases.

Symptoms: Sharp chest pain, especially when lying down, and fever.

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7. Endocarditis

- Infection of the **inner lining of the heart** (endocardium), often involving heart valves.

- Caused by **bacteria**, usually entering through bloodstream.

Symptoms: Fever, weakness, heart murmur, embolic complications.

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8. Congenital Heart Defects

- **Structural abnormalities present at birth**.
- Examples include **septal defects** (hole in heart wall), **patent ductus arteriosus**, or **tetralogy of Fallot**.

Symptoms: Cyanosis (blue skin), poor growth, difficulty feeding (in infants), fatigue.

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9. Cardiomyopathy

- Disease of the heart muscle, affecting its ability to contract.
- Types include:
    - **Dilated cardiomyopathy**: Enlarged and weakened chambers.
    - **Hypertrophic cardiomyopathy**: Thickened heart muscle.
    - **Restrictive cardiomyopathy**: Stiff heart walls.

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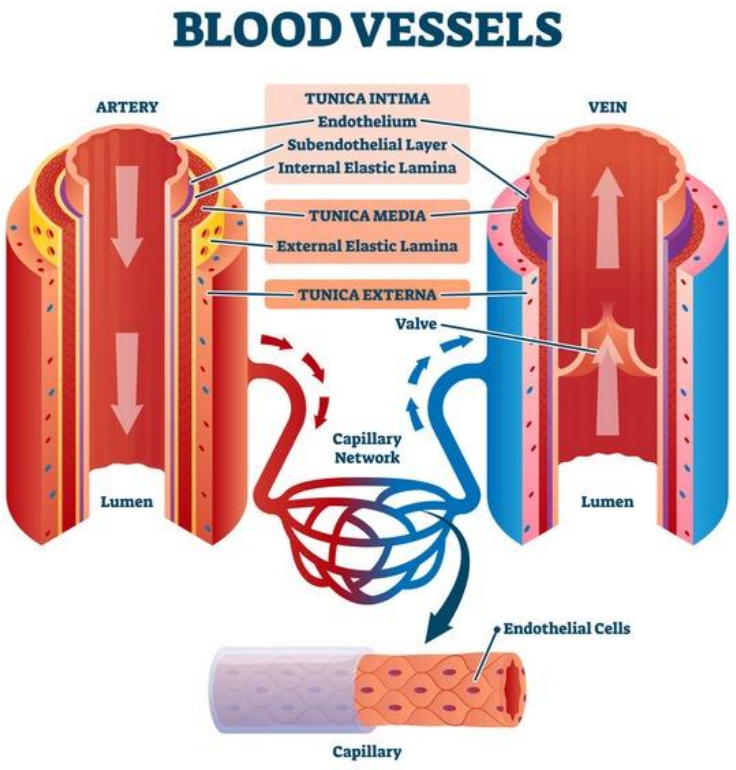
10. Heart Block

- Delay or complete interruption in the conduction of electrical impulses from atria to ventricles.
- May require **pacemaker** implantation.

Diagnosis and Treatment

- **Diagnosis**: ECG, echocardiogram, chest X-ray, blood tests, stress test, cardiac catheterization.
- **Treatment**: Lifestyle changes, medications (like beta-blockers, diuretics), surgeries (like bypass, valve replacement), pacemakers.


BLOOD VESSELS
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VEIN
TUNICA INTIMA
Endothelium
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Internal Elastic Lamina
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