CARDIOVASCULAR SYSTEM

Khaleel Alyahya, PhD, MEd
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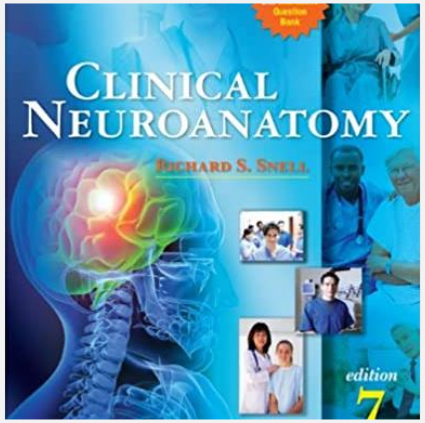
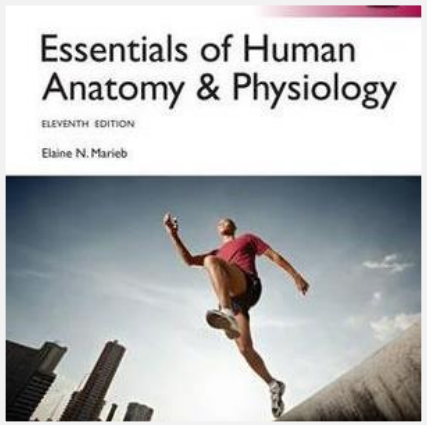
Resources



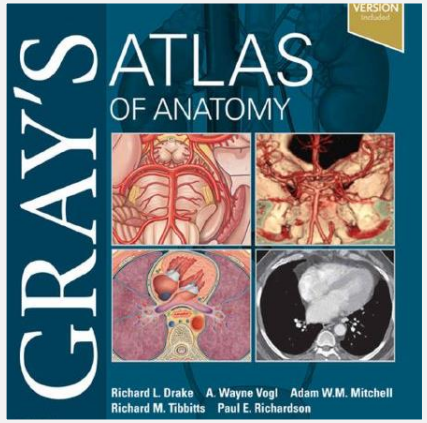
Clinical Neuroanatomy

Richard Snell



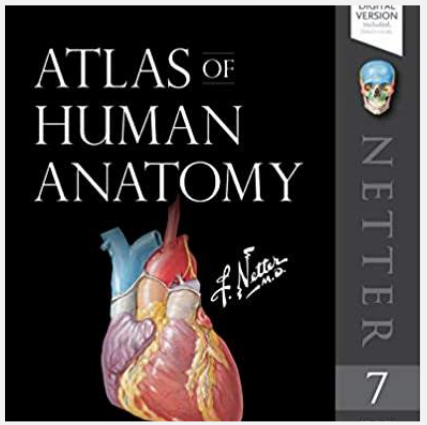
Essential of Human Anatomy & Physiology

Elaine Marieb



Gray's Anatomy

Richard Drake, Wayne Vogl & Adam Mitchell



Atlas of Human Anatomy

Frank Netter

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INTRODUCTION

- The cardiovascular system (also called the circulatory system) can be thought of as the transport system of the body.
- It is a closed system which consists of the heart and a network of vessels that carry blood to the body tissues.
- With each heartbeat, blood is sent through the body, carrying oxygen and nutrients to all the cells.
- The functions of the cardiovascular system are very closely linked with the functions of many other body systems such as the respiratory system.

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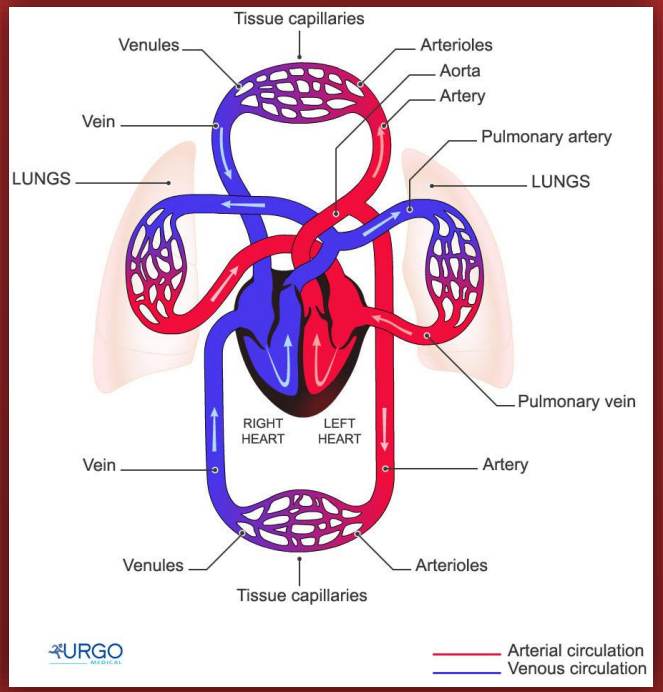
- It is a **transportation system** which uses the blood as the transport vehicle.
- It carries oxygen, nutrients, cell wastes, hormones and many other substances vital for body **homeostasis**.
- It provides **forces** to move the blood around the body by the beating Heart.

FUNCTIONS



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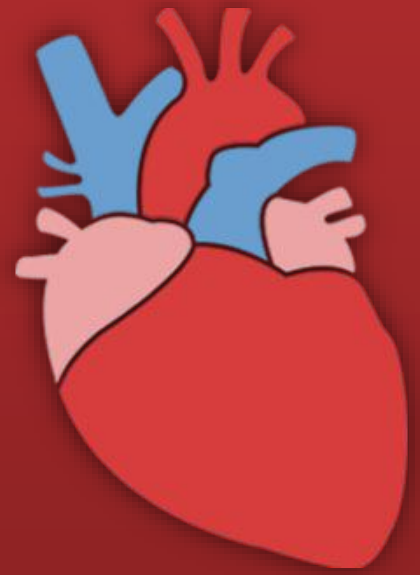
- The heart is made up of cardiac muscle.
- The size of a closed adult fist.
- It is located within the thoracic cavity between the lungs and behind the sternum.
- The main function of the heart is to act as the pump which circulates the blood in the body.

HEART



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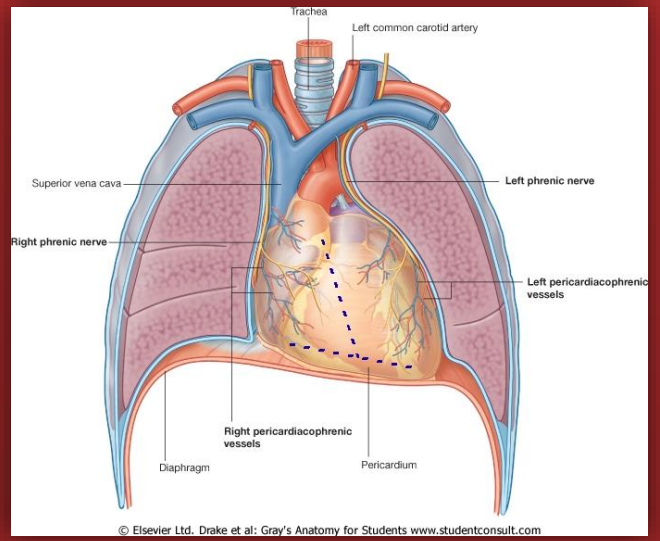
- The heart is enclosed by a double sac of serous membrane (Pericardium).
- 2/3 of the heart lies to the left of median plane.
- The outer wall of the heart is made up of three layers:
  - Epicardium.
  - Myocardium (muscle of the heart).
  - Endocardium.
- The heart is a hollow, cone shaped muscular pump that keeps circulation going on.
- It has:
  - Apex
  - Base
  - Surfaces
    - Diaphragmatic & Sternocostal
  - Borders
    - Right, Left, Inferior.

LOCATION



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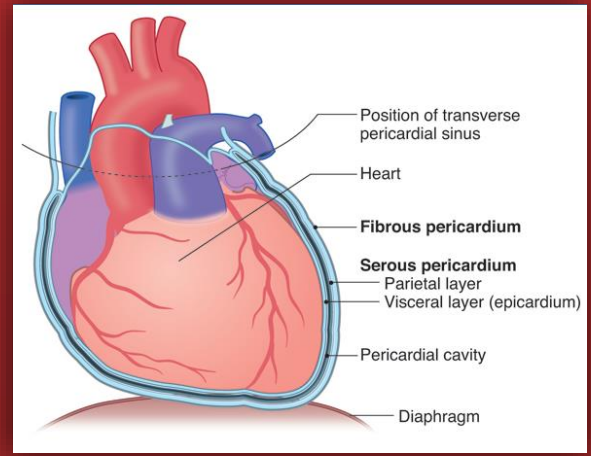
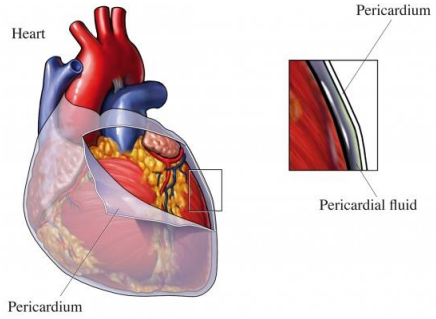
PERICARDIUM

- The pericardium is a tough double-walled sac containing the heart and the roots of the great vessels.
- There are two layers to the pericardial sac: the outermost fibrous pericardium and the inner serous pericardium.
- The space between the two layers of serous pericardium, the pericardial cavity, is filled with serous fluid which protects the heart from any kind of external shock.
- Pericardium functions to protects the heart from infections coming from other organs like the lungs.
- Also, it lubricates the heart and prevents excessive overfilling of the heart in cases of acute volume overload.





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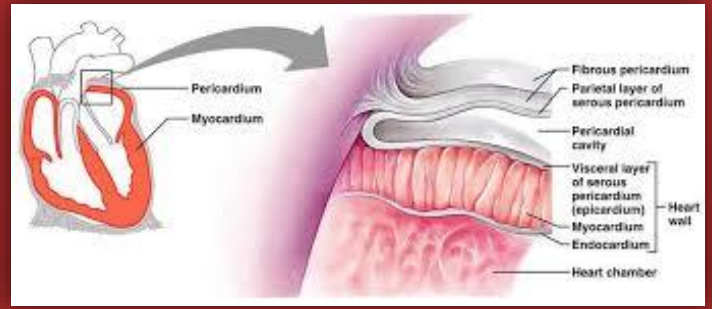
- The **epicardium** is a thin layer of connective tissue and fat, and serves as an additional layer of protection for the heart, under the pericardium.
- The **myocardium** is the muscle tissue of the heart, composed of cardiac muscle cells called cardiomyocytes, which contract like other muscle cells.
- The **endocardium** is composed of endothelial cells which provide a smooth, non-adherent surface for blood collection and pumping and help regulate contractility.

WALLS OF HEART



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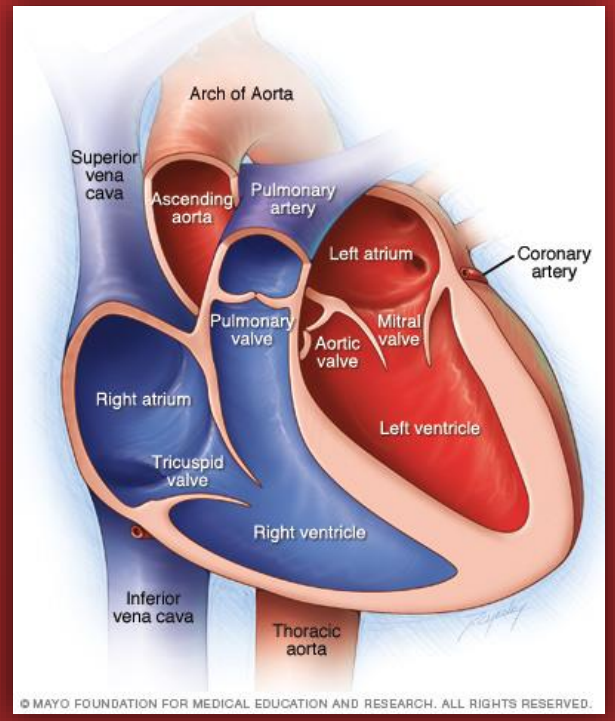
- **ATRIA**
  - They are two (Right & Left).
  - Superior in position.
  - They are the receiving chambers.
  - They have thin walls.
  - The upper part of each atrium is the Auricle.
  - The Right Atrium receives the venous blood coming to the heart.
  - Left Atrium receives arterial blood coming from the lungs.
- **VENTRICLES**
  - The inferior chambers.
  - They are two (right & left).
  - They have thick walls.
  - They are the discharging chambers (actual pumps).
  - Their contraction propels blood out of the heart into the circulation.

CHAMBERS



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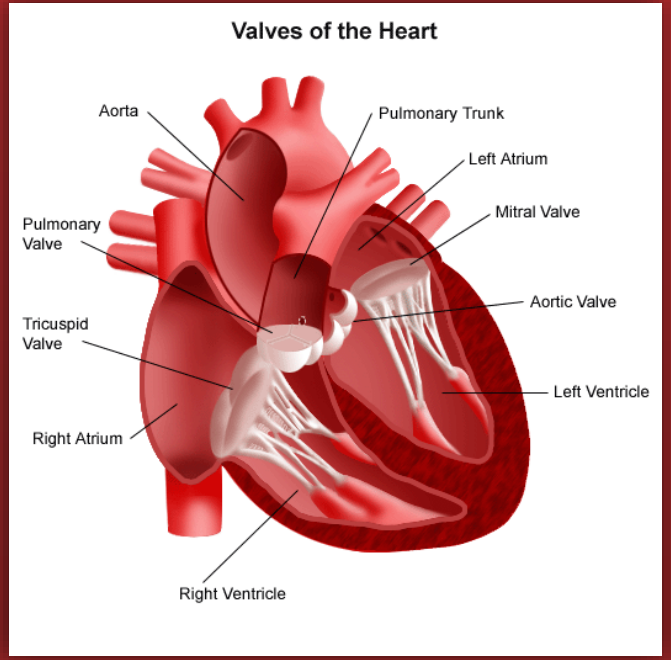
Atrioventricular Valves:

- Valves between atria & ventricles.
  - Right AVV (**Tricuspid**).
  - Left AVV (**Bicuspid**).
- They allow the blood to flow in one direction from the atria to the ventricles.

Semilunar Valves (Aortic & Pulmonary):

- Between the right and left ventricles and the great arteries leaving the heart.
  - Aortic Semilunar Valve
  - Pulmonary Semilunar Valve
- They allow the flow of blood from the ventricles to these arteries.

VALVES



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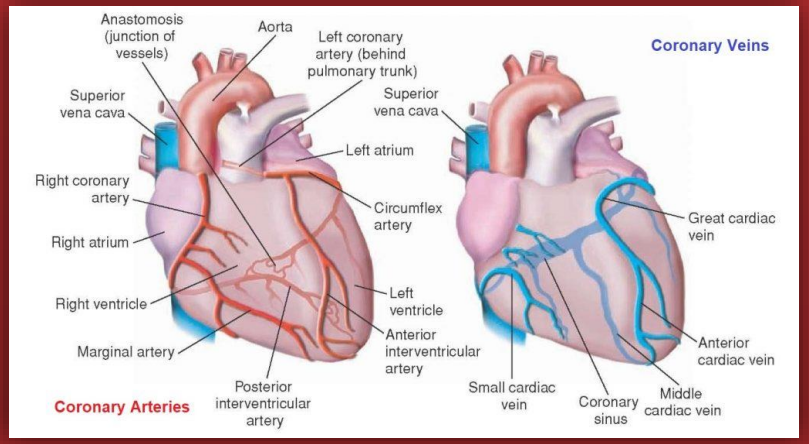
- The heart has its **own** blood vessels that provide the myocardium with the oxygen and nutrients necessary to be able to pump blood to the body.
- The left and right **coronary arteries** branch off from the aorta and provide blood to the left and right sides of the heart.
- The **coronary sinus** is a vein on the posterior side of the heart that returns deoxygenated blood from the myocardium to the vena cava.
- Great, middle and small **coronary veins** drain into **coronary sinus**.
- Coronary sinus drains into **right atrium.**

CORONARY CIRCULATION



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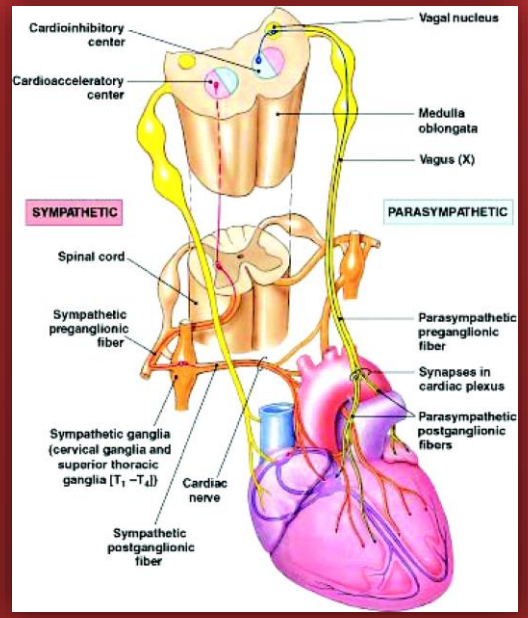
- Visceral motor innervation.
- The heart receives visceral motor innervations, by:
  - Sympathetic (speeds up)
  - Parasympathetic (slows down)

INNERVATION



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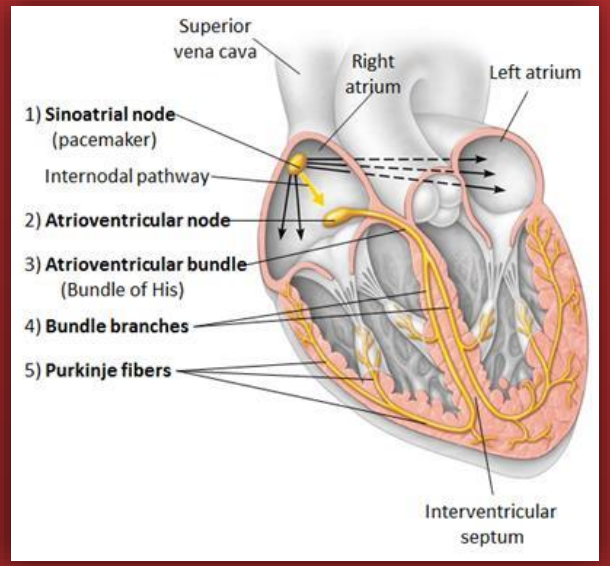
- Two system controlling the heart activities:
- The **autonomic nervous system** that increases or decreases the heart beets.
- The **nodal system** where the intrinsic conduction system initiates the heart contraction (heartbeat).
- The nodal system is composed of the **sinoatrial node** (SA node), **atrioventricular node** (AV node), **atrioventricular bundle** (AV bundle- bundle of His), right and left bundle branch, and lastly **Purkinji fibers**
- Heart contraction is referred to as **systole,** while relaxation is **diastole**

CONDUCTING SYSTEM



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BLOOD PRESSURE

- As the blood is pumped around the body, it exerts pressure on the walls of the arterial vessels.
- This is known as **blood pressure** and is measured as a comparison of **systolic** (maximum) pressure as the heart pumps blood over **diastolic** (minimum) pressure as the heart relaxes before its next beat.
- Normal blood pressure is around 120/80 mmHg although this varies from individual to individual and from time to time in the one person according to the body's requirements.
- The rhythmic beating of the heart is controlled by the **sinoatrial node** located in the right atrium.
- This node controls the contraction of heart muscle by generating impulses which cause other heart cells to contract in an orderly sequence that forces blood to be pumped around the heart.
- Normal heart rhythm is known as **sinus rhythm**.

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- What makes the heartbeat?

- Unlike skeletal muscle cells, which must be stimulated by nerve impulses before they will contract, **cardiac muscle** cells can and do contract spontaneously and independently, even if all nervous connections are severed.

- Moreover, these spontaneous contractions occur in a regular and continuous way.

- Although cardiac muscle can beat independently, the muscle cells in different areas of the heart have different rhythms.

HEARTBEAT

By Khaleel Alyahya, PhD, MEd

- When using a stethoscope, you can hear two distinct sounds during each cardiac cycle.
- These heart sounds are often described by the two syllables "lub" and "dup," and the sequence is lub-dup, pause, lub-dup, pause, and so on.
- The first heart sound (**lub**) is caused by the closing of the **AV valves.**
- The second heart sound (**dup**) occurs when the **semilunar valves close** at the end of ventricular systole.
- The first heart sound is longer and louder than the second heart sound, which tends to be short and sharp.

HEART SOUND

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BLOOD VESSELS

- There are three types of vessels in the human body, known as **arteries**, **veins** and **capillaries**.

- **Arteries**
  - Thick walls.
  - Do not have valves.
  - The smallest arteries are arterioles.

- **Veins**
  - Thin walls.
  - Many of them possess valves.
  - The smallest veins are venules.

- **Capillaries**
  - Connect arterioles and venules.
  - Help to enable the exchange of water, oxygen and other nutrients between blood and the tissues.

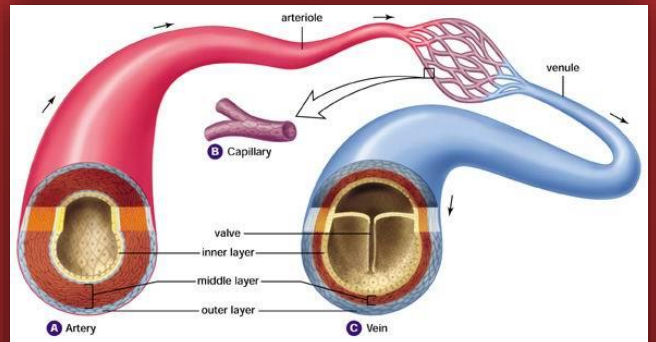

Figure 9.12. Sections through an artery, capillary, and vein. At any given moment, about 30% of the blood in your systemic circulation will be found in the arteries, 5% in the capillaries, and 65% in the veins.

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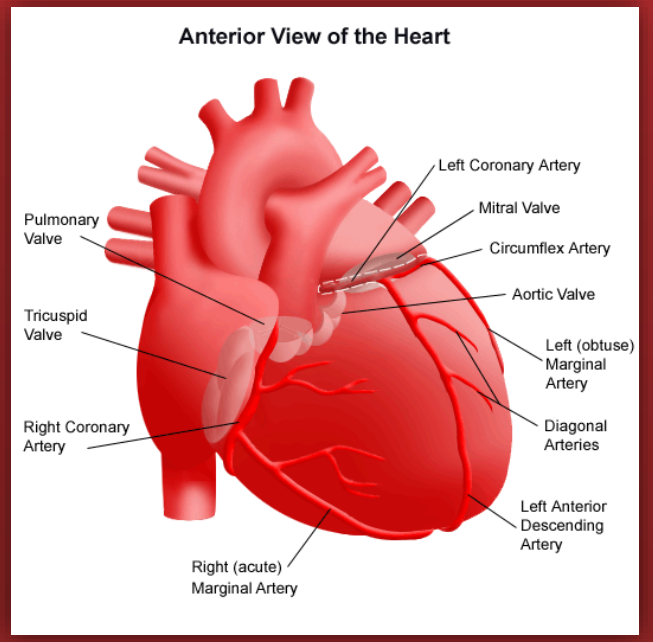
ARTERIES

- **Arteries** are elastic vessels responsible for carrying oxygenated blood away from the heart to the rest of the body.
- There are two main types of arteries:
- **Pulmonary Arteries**
  - Responsible for taking blood from the heart to the lungs to collect oxygen.
  - These are the only arteries in the body to carry deoxygenated blood.
- **Systemic Arteries**
  - Transport the blood to the remainder of the body.
  - The aorta is the largest and originates in the heart but branches out into smaller vessels to supply the head, the heart itself and the lower body.
  - As the arteries branch out, they get smaller and smaller.



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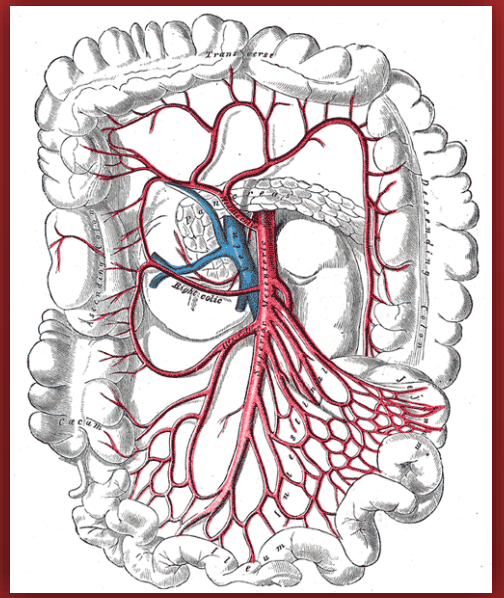
- It is the connection of two structures.
- It is the joining of terminal branches of the arteries.

ANASTOMOSIS



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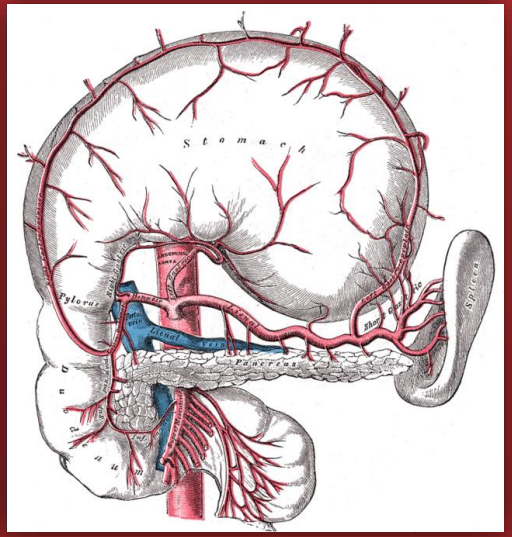
END ARTERIES

- It is the artery that is the only supply of oxygenated blood to a portion of tissue.
- Arteries which do not anastomose with their neighbors are called end arteries.
- Examples:
  - Splenic artery.
  - Renal artery.



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- There are three main types of veins:
  - Pulmonary veins
  - Systemic veins
  - Portal veins

- Pulmonary Veins
  - Transport the oxygenated blood from the lungs to the left atrium of the heart.

- Systemic Veins
  - Responsible for returning the deoxygenated blood from the tissues back to the heart.

- Portal Veins
  - Drain the gastrointestinal tract carrying nutriments to the liver.

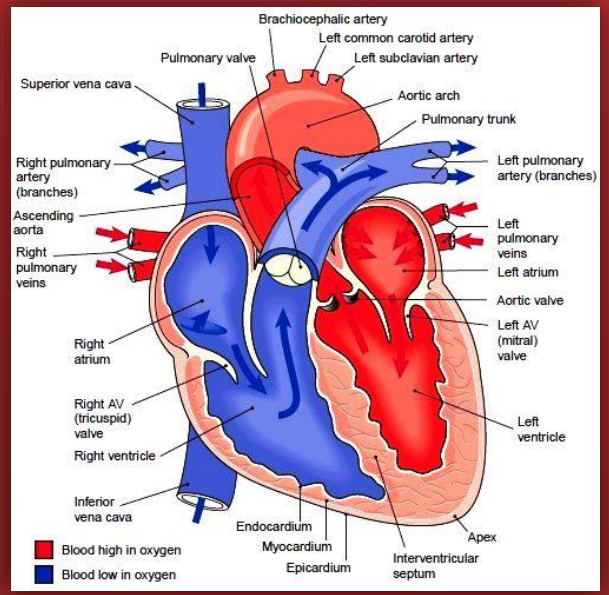
- The largest systemic veins are the inferior and superior **venae cava.**

- Some veins are located close to the surface of the body and are called superficial veins.

- Deep veins are those that are found in deep muscle tissue and are usually co-located with a corresponding artery.

- Within the veins are valves that prevent blood from moving in the wrong direction.

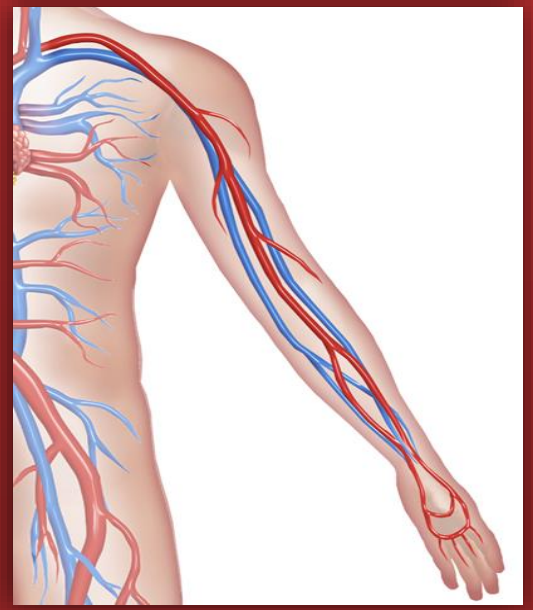
VIENS



By Khaleel Alyahya, PhD, MEd

- Two veins that accompany medium sized deep arteries
- Vena Comitans is **Latin** for accompanying vein.
- They are found in close to arteries so that the pulsations of the artery aid venous return.
- Venae Comitantes are usually found with smaller arteries, especially those in the limbs.
- Larger arteries do not have venae comitantes. They usually have a single, similarly sized vein.

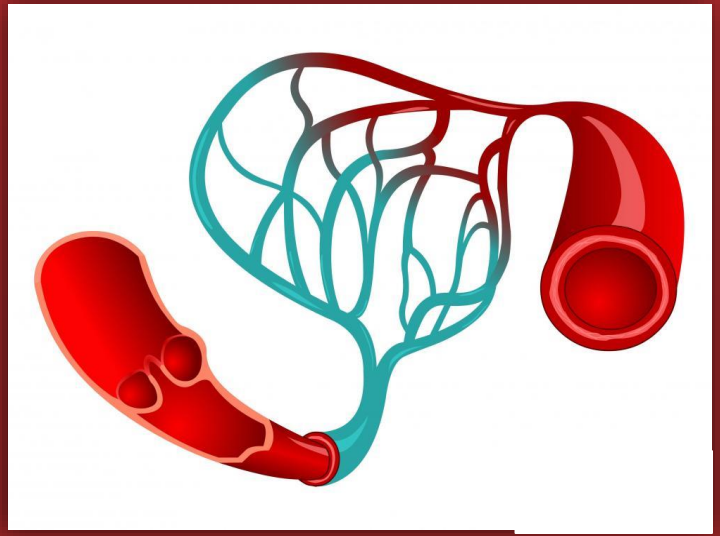
DEEP VEINS (VENAE COMITANTES)



By Khaleel Alyahya, PhD, MEd

- **Capillaries** are tiny blood vessels that are so small that red blood cells can only pass through them in single file.
- The **capillaries** exist in a network like a web that connects the arteries and veins.
- Oxygen, carbon dioxide, nutrients and wastes pass through the thin walls of capillaries.
- **Capillaries** also have a role in regulating temperature within the body.
- When body temperature rises, the temperature of blood also rises.
- The heated blood travels in the capillaries to the body tissues where the heat is released.

CAPPILARIES



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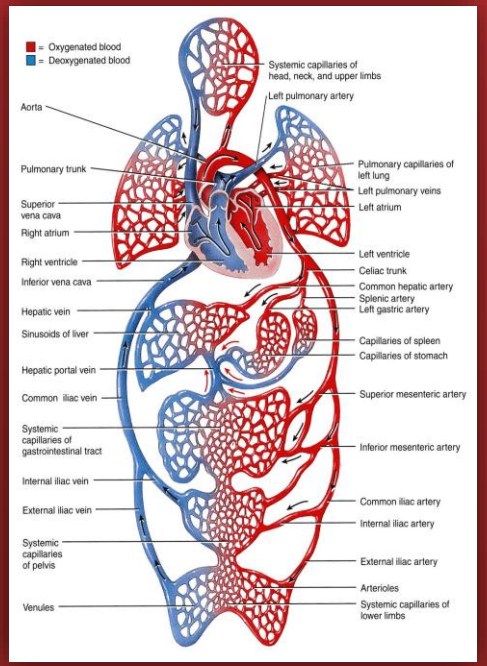
- **Portal Venous System** occurs when a capillary bed pools into another capillary bed through veins, without first going through the heart.
- Veins leaving the gastrointestinal tract do not go direct to the heart.
- They pass to the Portal Vein.
- This vein enters the liver and breaks up again into veins of diminishing size which ultimately join capillary like vessels (Sinusoids).

PORTA CIRCULATION



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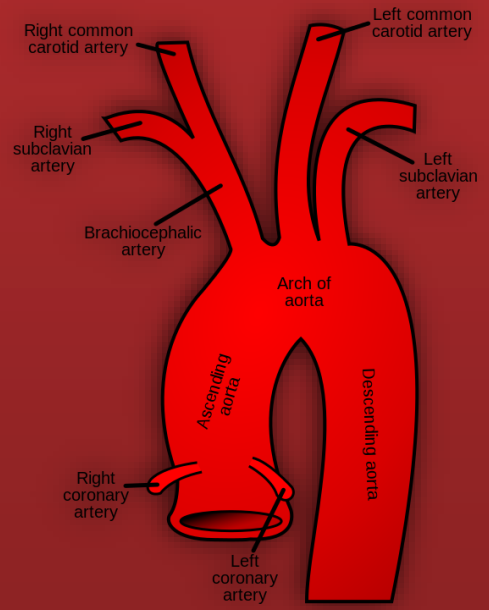
- The aorta is the largest artery of the body.
- It leaves the left ventricle of the heart, and it decreases only slightly in diameter as it runs to its terminus.
- Different parts of the aorta are named for either their location or their shape.
- Branches of the aorta;
  - **Ascending aorta**
  - **Arch of aorta**
  - **Descending aorta**

MAJOR ARTERIES



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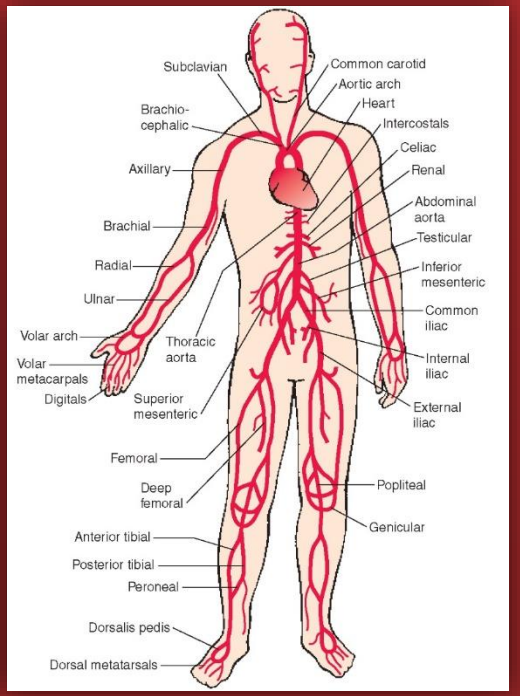
- **Ascending aorta**
  - Left coronary artery
  - Right coronary artery
- **Arch of aorta**
  - Left Subclavian.
    - Vertebral arteries
    - Axillary arteries
    - Brachial arteries
    - Ulnar arteries
    - Radial arteries
    - Palmar arches
  - Left Common Carotid.
    - Internal carotid arteries
    - External carotid arteries
  - Brachiocephalic Trunk.
    - Right Subclavian.
    - Right Common Carotid.
- **Descending aorta**
  - Thoracic aorta
    - Intercostal arteries
  - Abdominal aorta
    - Celiac trunk
    - Superior mesenteric arteries
    - Inferior mesenteric arteries
    - Renal arteries
    - Gonadal arteries
    - Right and left common iliac trunk
      - Internal iliac arteries
      - External iliac arteries
        - ✓ Femoral arteries
        - ✓ Popliteal arteries
        - ✓ Tibial arteries
        - ✓ Fibular arteries
        - ✓ Feet arteries

MAJOR ARTERIES



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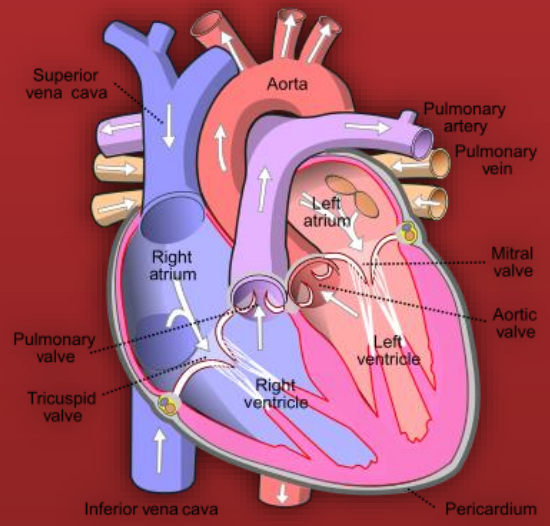
- Although arteries are generally located in deep, well-protected body areas, many veins are more superficial, and some are easily seen and palpated on the body surface.
- Most deep veins follow the course of the major arteries, and with a few exceptions, the naming of these veins is identical to that of their companion arteries.
- Major systemic arteries branch off the aorta, whereas the veins converge on the venae cavae, which enter the right atrium of the heart.
- Veins draining the head and arms empty into the superior vena cava, and those draining the lower body empty into the inferior vena cava.

MAJOR VEINS



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- **Superior Vena Cava**
  - Internal jugular veins
    - ✓ Dural venous sinuses
  - External jugular veins
    - ✓ Anterior jugular veins
  - Subclavian veins
    - Veins of hands
    - Radial vines
    - Ulnar veins
    - Brachial veins
    - Axillary veins
    - Cephalic veins (superficial)
    - Basilic veins (superficial)
- **Inferior Vena Cava**
  - Common iliac veins
    - Internal iliac veins
    - External iliac veins
      - Tibial veins
      - Fibular veins
      - Popliteal veins
      - Femoral veins
      - Great saphenous (superficial)
      - Short saphenous (superficial)
    - Gonadal veins
    - Renal veins
    - Inferior mesenteric veins
    - Superior mesenteric veins

MAJOR VEINS

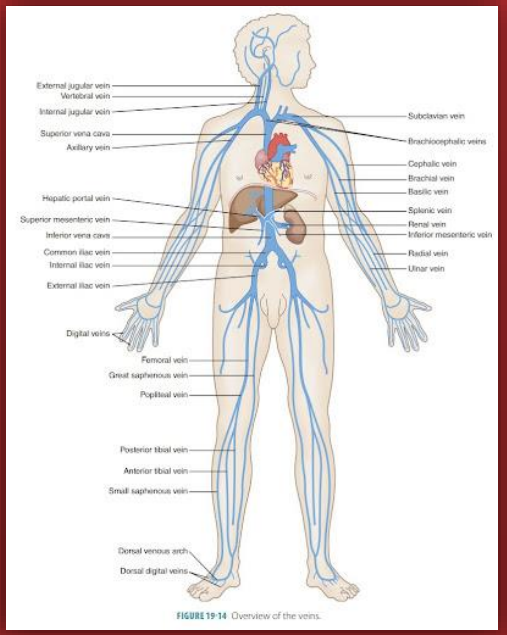

FIGURE 19-14 Overview of the veins.

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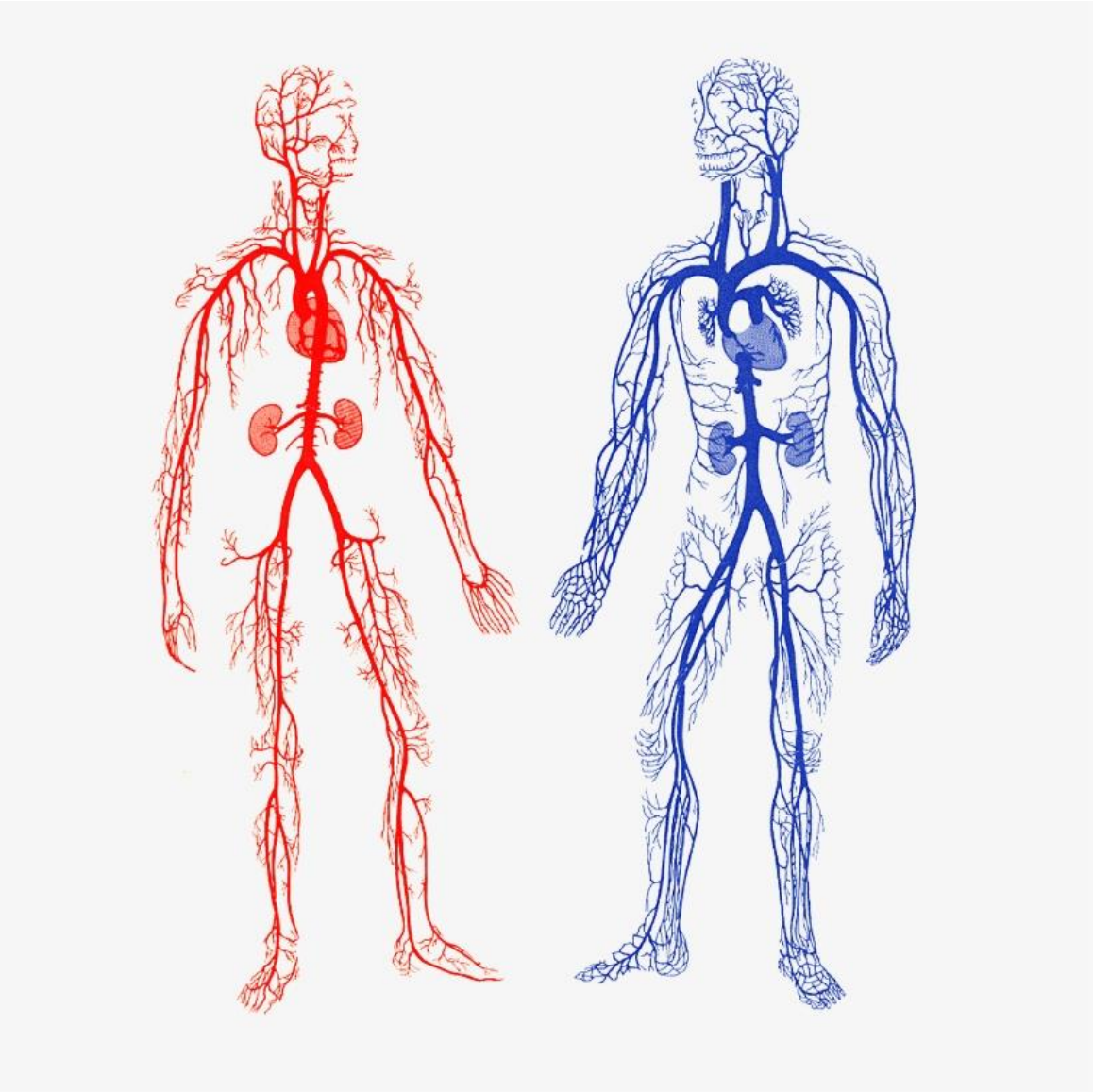

MAJOR ARTERIES & VEINS

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- The cardiovascular system is a transporting system.
- It is composed of the heart and blood vessels.
- The heart is cone shaped, covered by pericardium and composed of four chambers.
- The blood vessels are the arteries, veins and capillaries.
- Arteries transport the blood from the heart.
- The terminal branches of the arteries can anastomose with each other freely or be anatomic or functional end arteries.
- Veins transport blood back to the heart.
- Capillaries connect the arteries to the veins.
- The portal system is composed of two sets of capillaries.
- The veins from the GIT go first to the liver through the portal vein.

SUMMARY

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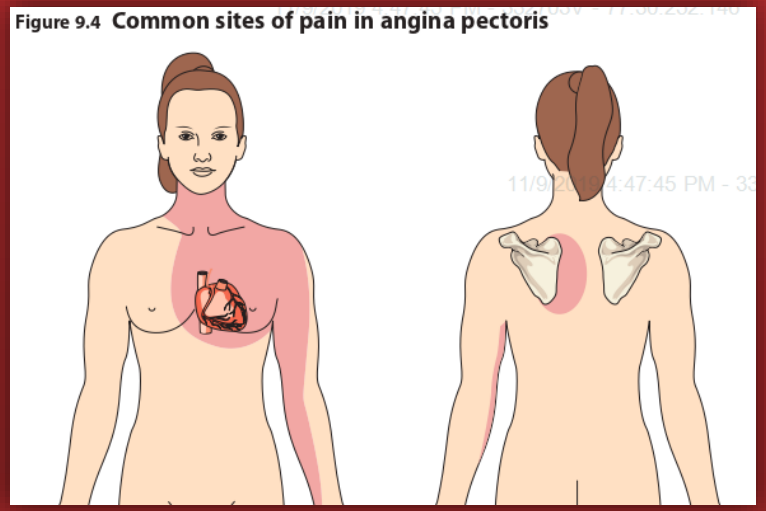
CLINICAL NOTES

- **Angina pectoris** is the medical term used to describe the temporary chest pain that occurs when the heart is not getting enough blood.
- It presents as a severe steady pain and constriction around the heart, typically radiating from the chest to the left shoulder and down the left arm, creating a feeling of pressure in the chest.
- An attack of angina pectoris will last a few seconds to a few minutes.

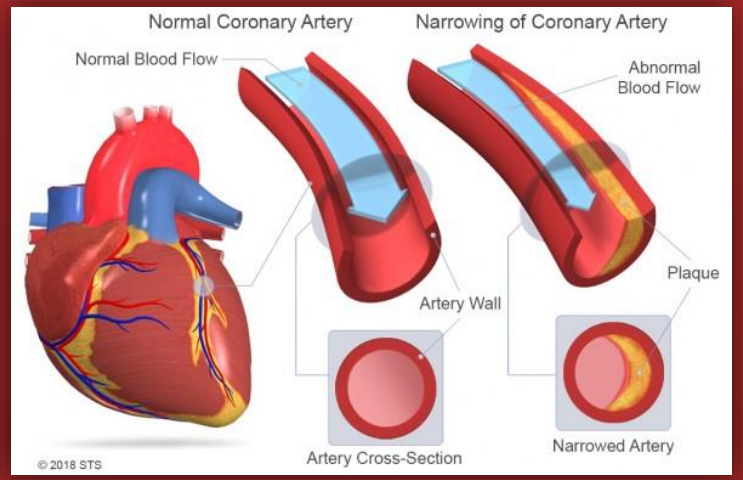
ANGINA PECTORIS



By Khaleel Alyahya, PhD, MEd

- **Coronary Artery Disease** (CAD) occurs when the arteries that supply blood to heart muscle (the coronary arteries) become hardened and narrowed.
- This is due to **atherosclerosis** which is the buildup of cholesterol-rich plaque, on the inner walls of the vessels.
- Over time, this plaque hardens and may rupture.
- Hardened plaque narrows the coronary arteries and reduces the flow of oxygen-rich blood to the heart.
- This reduced blood supply to the heart muscle is called ischemia.
- Coronary artery disease is also called **coronary heart disease**.

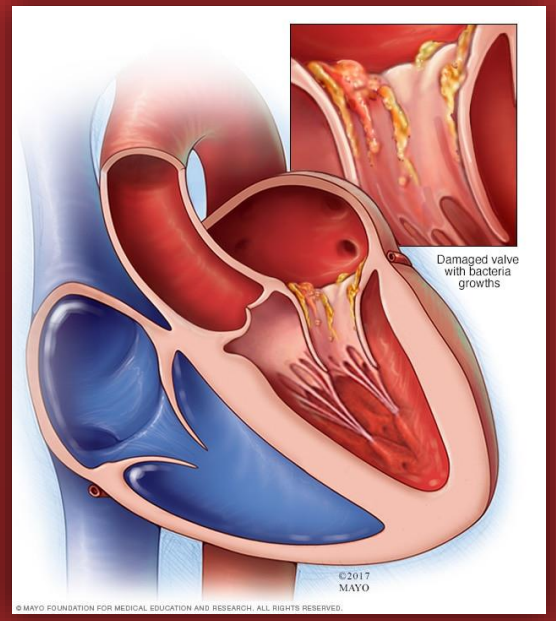
CORONARY ARTERY DISEASE



By Khaleel Alyahya, PhD, MEd

- **Endocarditis** is a bacterial infection of the endocardium resulting in valvular deformity.
- It most commonly occurs in susceptible patients whose circulatory system has been breached in some way such as through insertion of a central venous line, recent dental work, drug injections, or previous cardiac surgery.

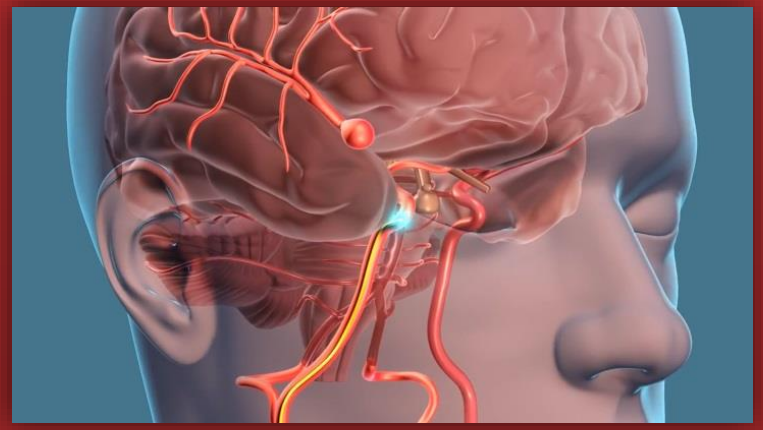
ENDOCARDITIS



By Khaleel Alyahya, PhD, MEd

- An **aneurysm** is a localized dilation or ballooning of an arterial wall due to weakness in the wall of the blood vessel.
- If the aneurysm ruptures it becomes a life-threatening emergency.

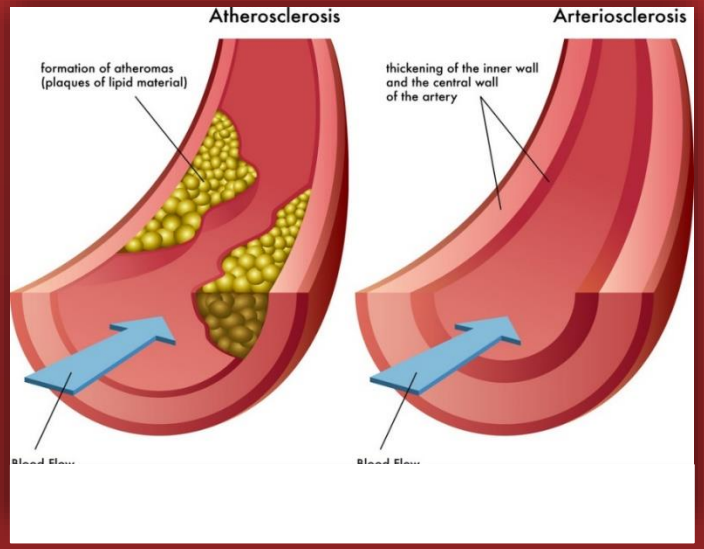
ANEURYSM



By Khaleel Alyahya, PhD, MEd

- **Arteriosclerosis** is a general term for a hardening and thickening of arterial walls with a subsequent loss of elasticity and diminished blood flow to the heart, extremities and cerebrum.
- It is commonly referred to as hardening of the arteries.
- **Arteriosclerosis** may be present in any artery of the body, but the disease is most concerning when it attacks the coronary arteries and threatens to cause a myocardial infarction.

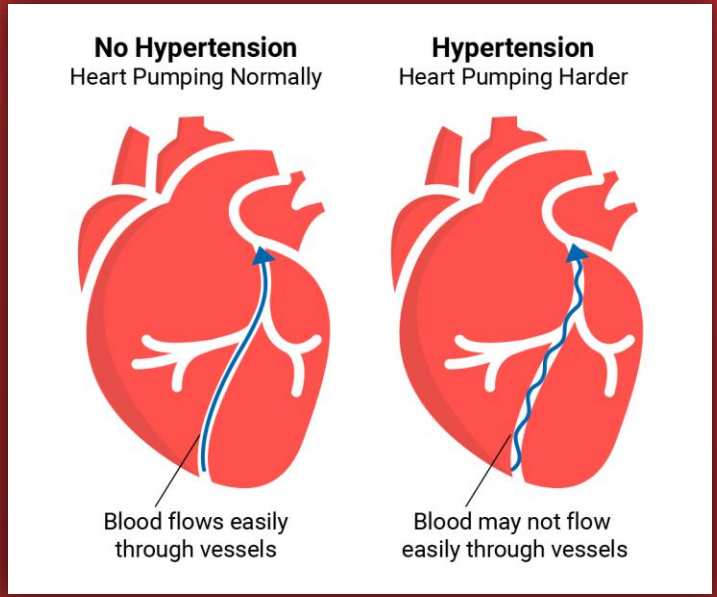
ARTERIOSCLEROSIS



By Khaleel Alyahya, PhD, MEd

- **Hypertension** is more commonly known as high blood pressure.
- There are two main types of hypertension.
- **Essential** (also called primary) **hypertension** accounts for about 90% of all cases.
- The other type is **secondary hypertension** which occurs when the patient has another disease such as a complication of pregnancy or kidney disease which causes the hypertension.

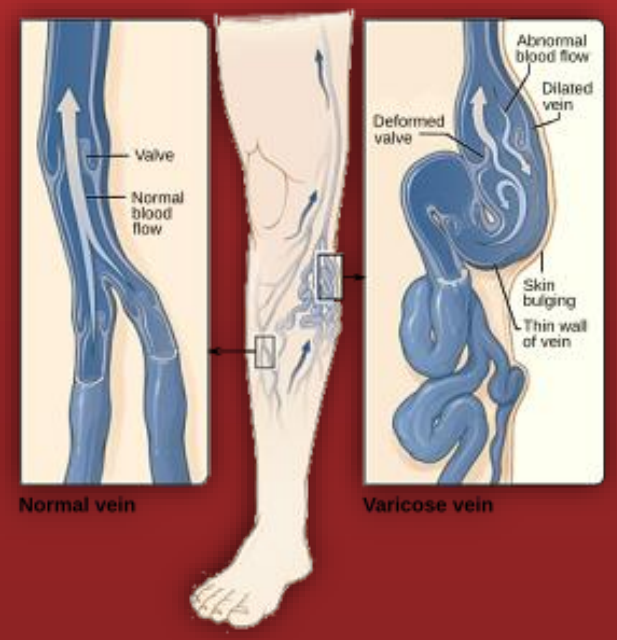
HYPERTENSION



By Khaleel Alyahya, PhD, MEd

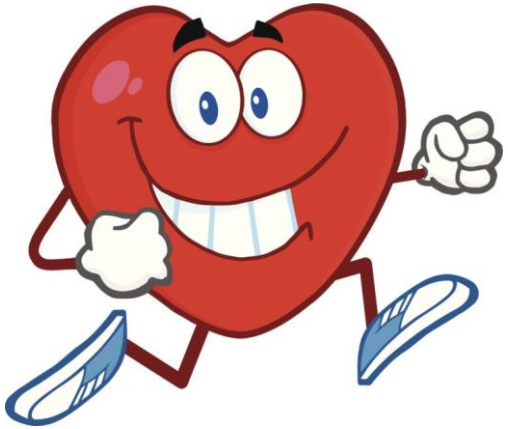
- **Varicose veins** are enlarged, twisted veins that are often dark in color.
- They have a ropey appearance and are usually thick and enlarged.
- While any vein can be affected, the veins in the lower legs and thighs have a greater tendency to varicose.
- This is due to leaking valves in the leg veins which allow blood to flow backwards, resulting in poor venous return to the heart.

VARICOSE VEINS



By Khaleel Alyahya, PhD, MEd

- Change lifestyle
- Eat well and healthy
- Go to gym



FOR HAPPY HEART

By Khaleel Alyahya, PhD, MEd

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QUESTIONS?