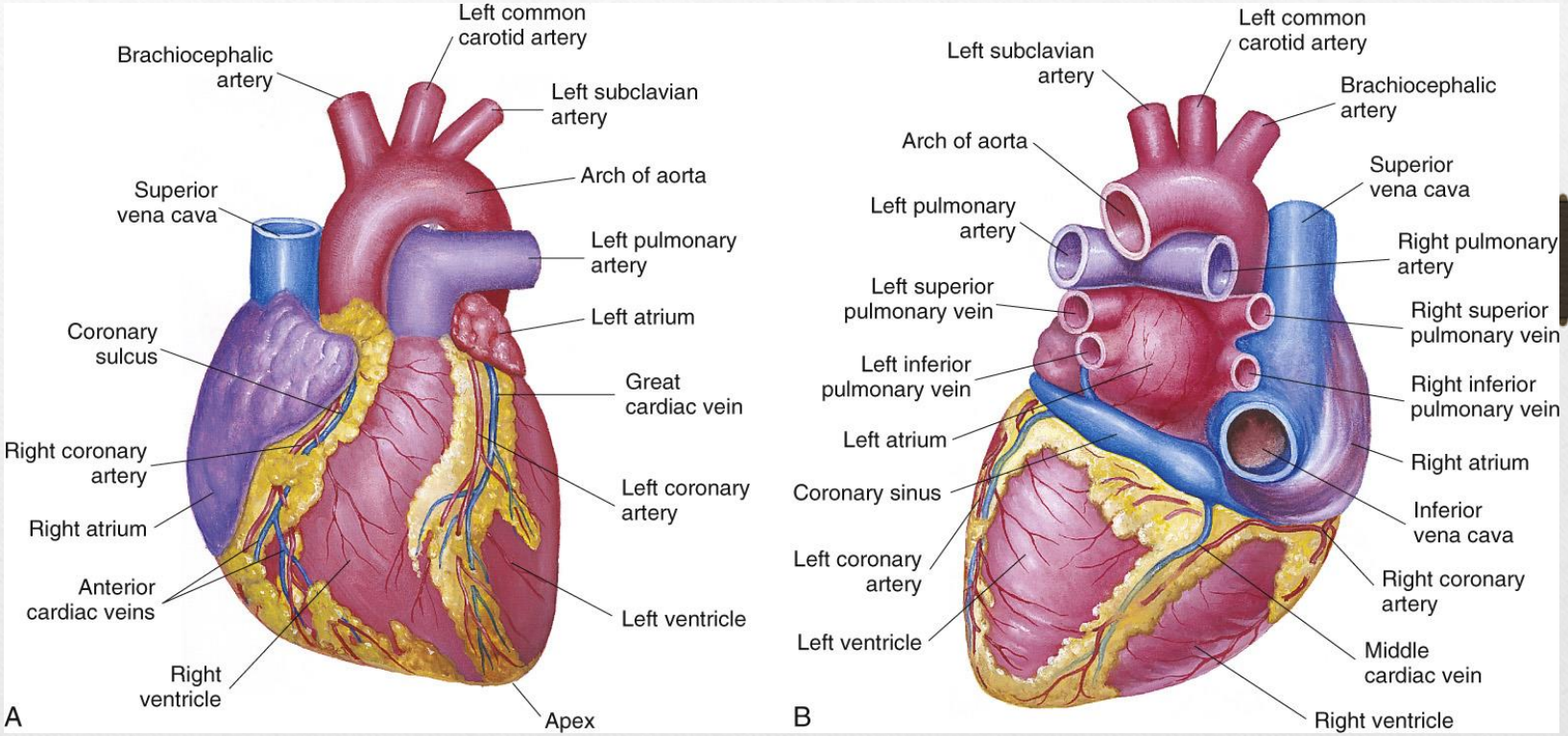
Cardiovascular System

The Heart

Major organ of the cardiovascular system



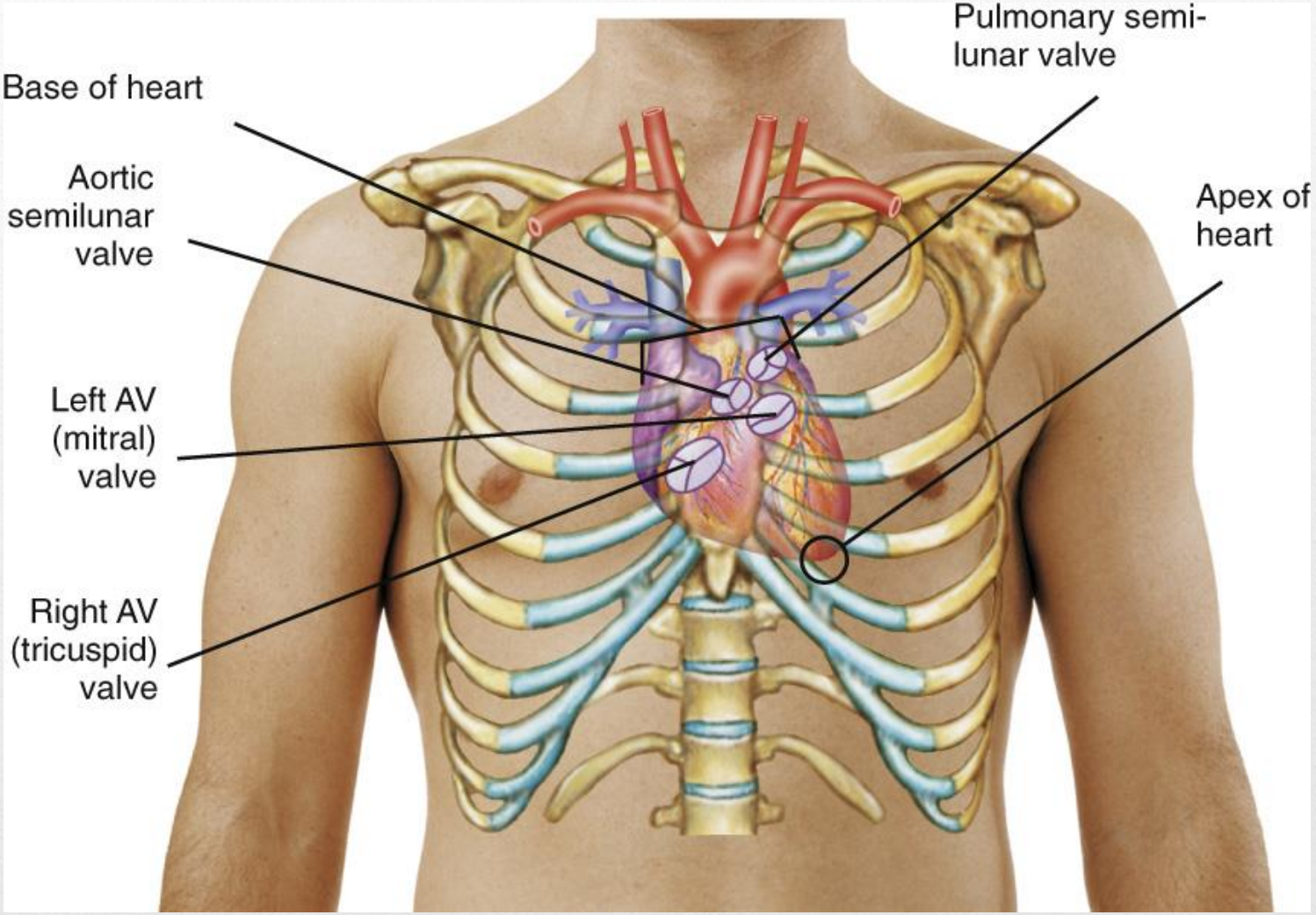
What is the mediastinum?

The mediastinum is the space between the lungs, where the heart is located.

The heart is divided into four chambers: the two small, thin-walled upper chambers are the left atrium and right atrium, and the two larger, lower chambers are the left and right ventricles.

The coordinated rhythm of the heart is initiated by the built-in electrical system in the sinoatrial node, which sets the pace of the heart rate.

Heart Valves



Atrioventricular valves allow blood to flow into the ventricles, and semiulnar valves allow blood to flow from the ventricles into the aorta and arteries.

Blood Vessels

- Great vessels
  - Aorta
  - Pulmonary trunk
  - Superior vena cava
- Other major blood vessels
  - Inferior vena cava
  - Pulmonary veins

Arteries carry oxygenated blood away from the heart, except for the pulmonary arteries. They carry deoxygenated blood away from the heart to the lungs.

Veins carry deoxygenated blood from the body to the heart, except for the pulmonary veins. They carry oxygenated blood to the heart from the lungs.

Blood Flow through the Heart

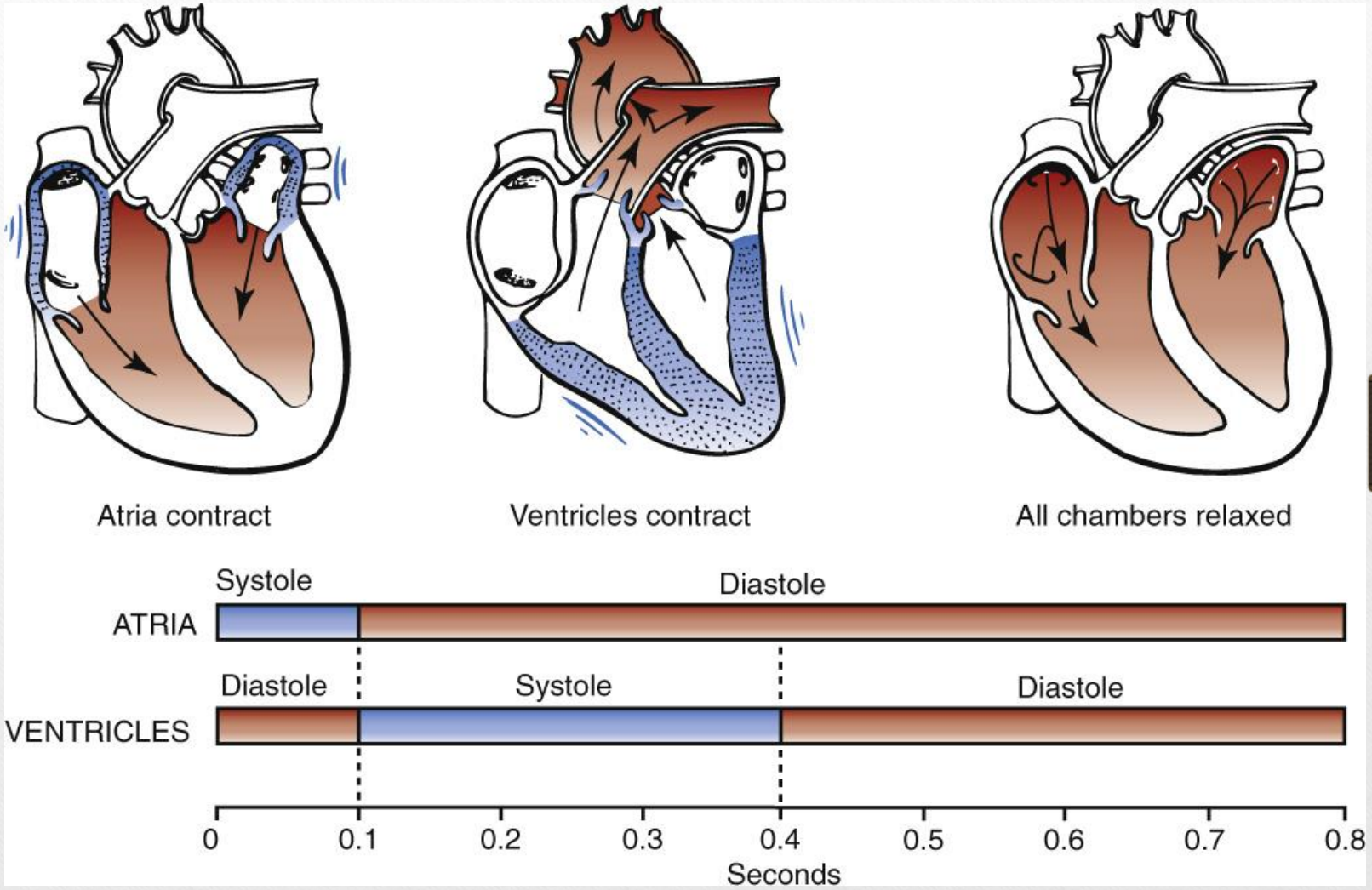
Stage 1: oxygen-poor blood enters.

Stage 2: right ventricle pushes blood into lungs.

Stage 3: oxygenated blood leaves lungs and goes back to left atrium and empties into left ventricle.

Stage 4: left ventricle pushes blood out into entire body.

Stage 1 and Stage 3 take place at the same time, and Stage 2 and Stage 4 take place at the same time


Atria contract
Ventricles contract
All chambers relaxed
Systole
Diastole
ATRIA
Diastole
Systole
Diastole
VENTRICLES
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Seconds

Heart Facts

Cardiac cycle

- Heart has own built-in rhythm.
- Average, healthy adult: 60–70 bpm

Conduction system

- Built-in electrical system

Heart sounds

- Can be checked with stethoscope

What is an electrocardiogram (EKG or ECG)?

A machine that monitors electric changes in the heart; it can detect dysfunction.

Blood volume and flow

Volume: 5 to 6 L per minute

Entrainment

Heart rhythm guides other body rhythms

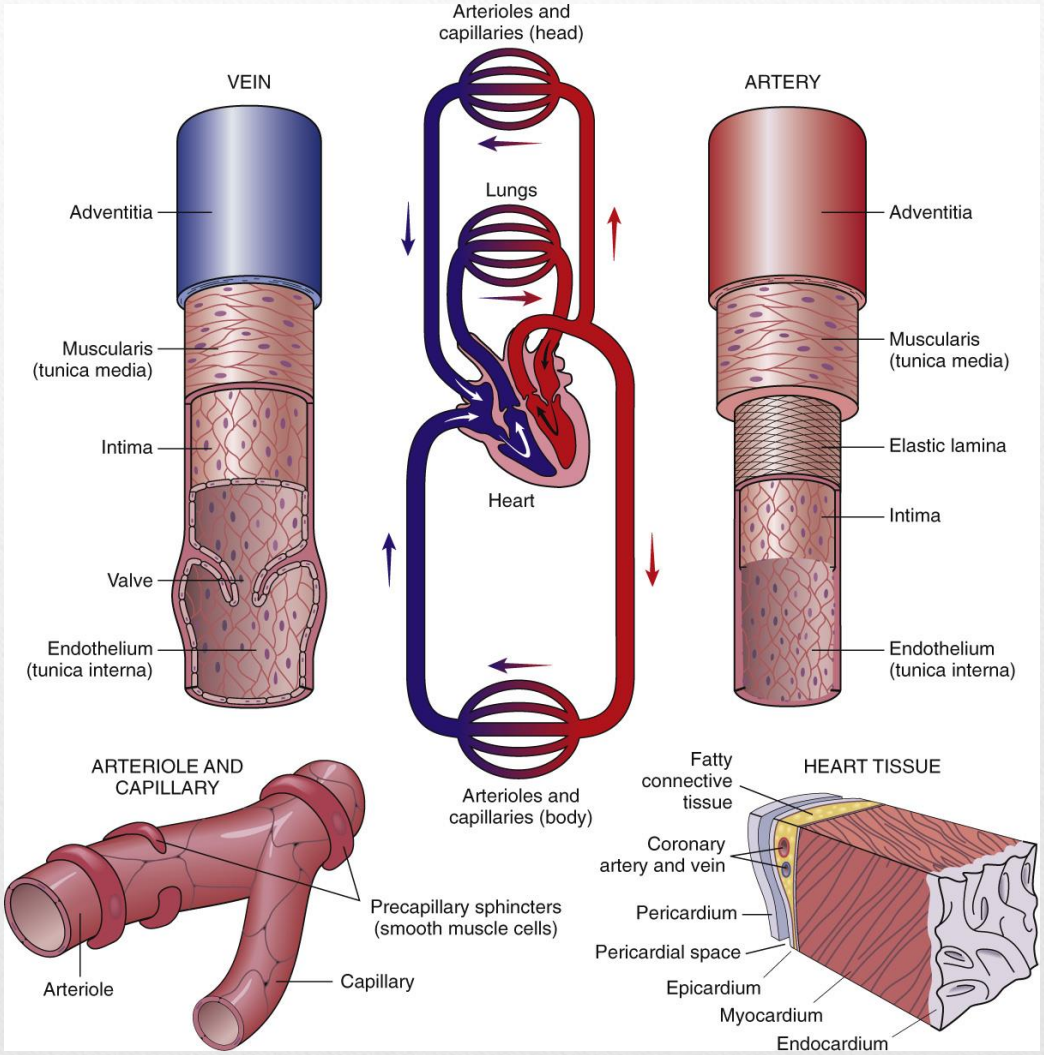
To pump more oxygen and nutrients to the cells during exercise and in times of stress, output may rise to 20 liters or more. Why does this happen?

The output increases because the heart beats faster and stronger.

Vascular System

The walls of arteries are much thicker than those of veins.

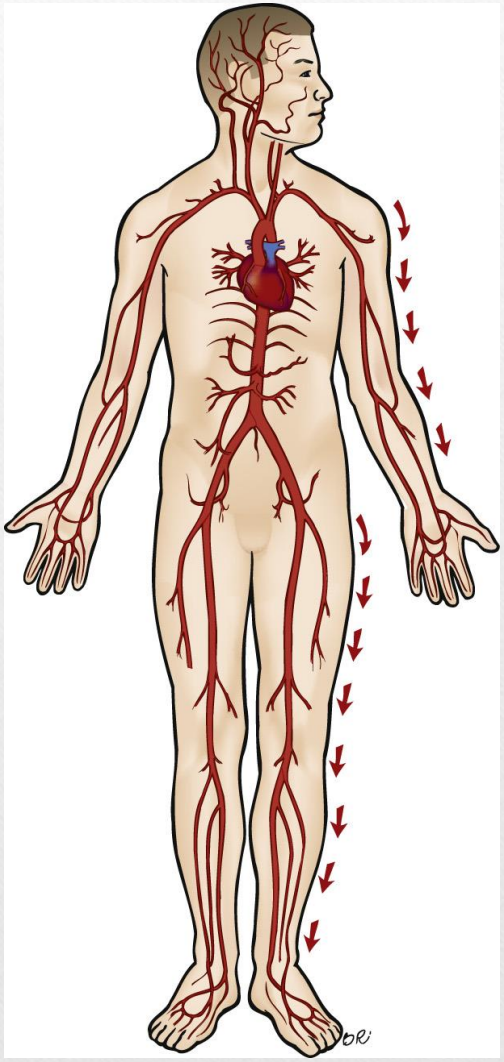
Capillaries are the smallest of the veins.



Practical Application

Increase arterial blood flow by:

- Stimulating sympathetic autonomic functions to increase heart rate
- Mechanically through pump-and-tube mechanism



This image shows the direction of compression to be applied over arteries to increase arterial flow.

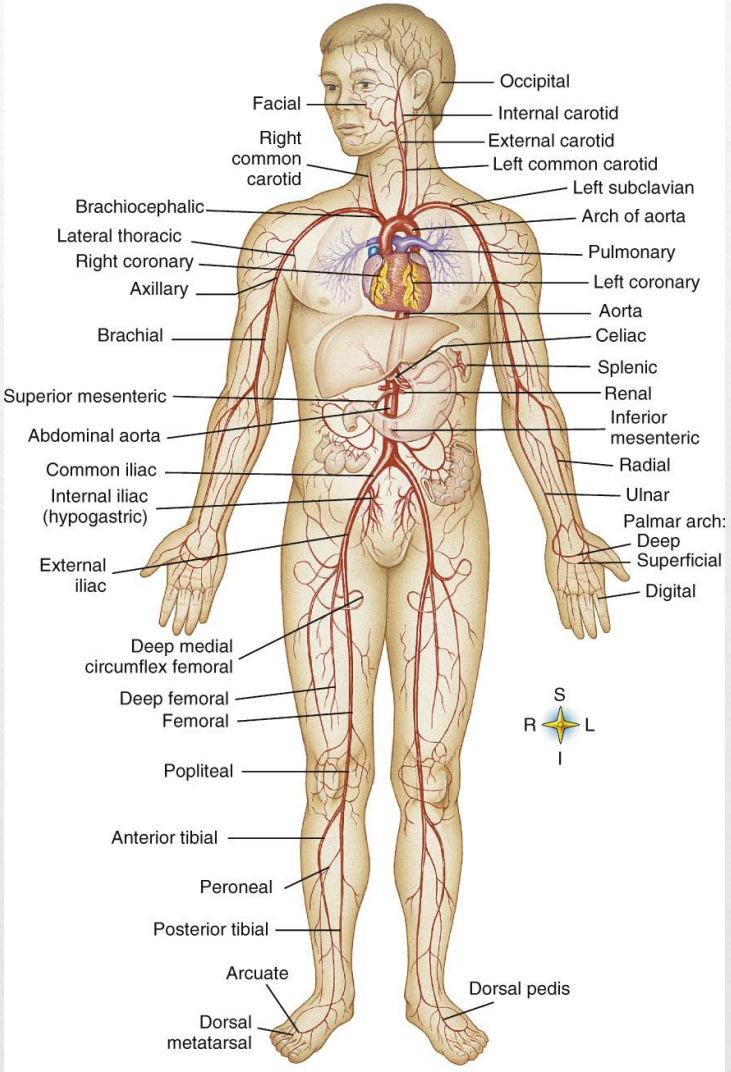
Arteries

Three types:

- Elastic arteries
- Muscular arteries
- Arterioles

Take blood away from heart

Arterioles are the smallest branches of the arterial tree. They are smaller than 0.5 mm in diameter.



Capillaries

Smallest vessels of circulatory system

Form a complex interlinking network

Cardiac tissue, kidneys, liver have large number of capillaries

Drain into a series of vessels that form venules and veins

Why are the capillaries the most important vessels functionally?

They transport essential materials to and from the cells.

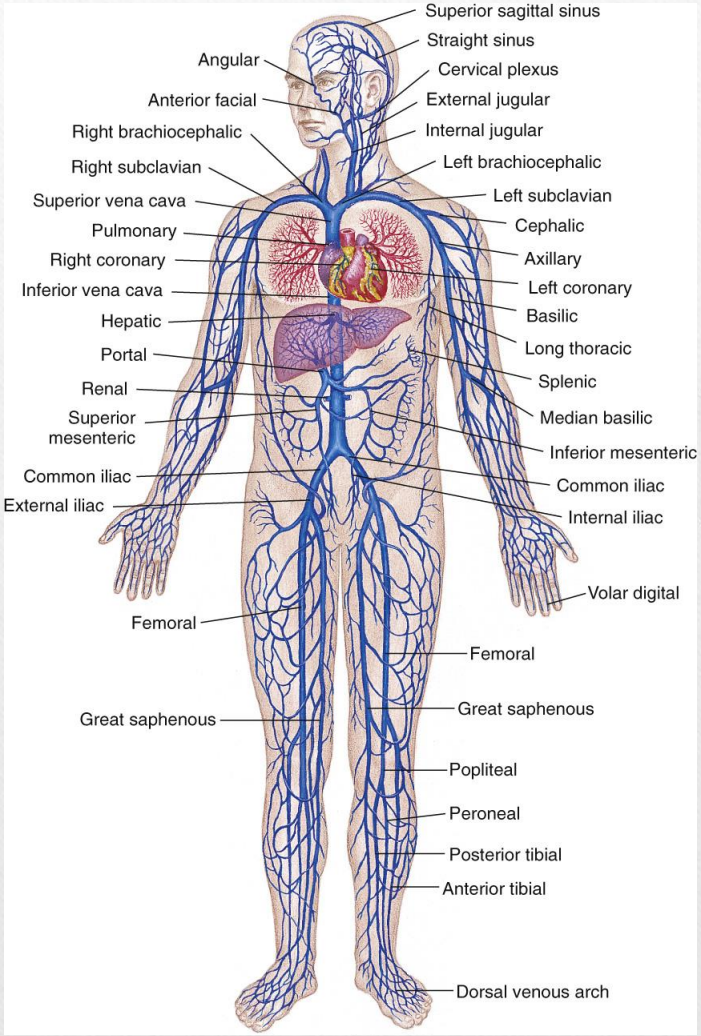
Veins and Venous Return

Collecting system

- Large diameter
- Low resistance to blood flow
- Some have valves

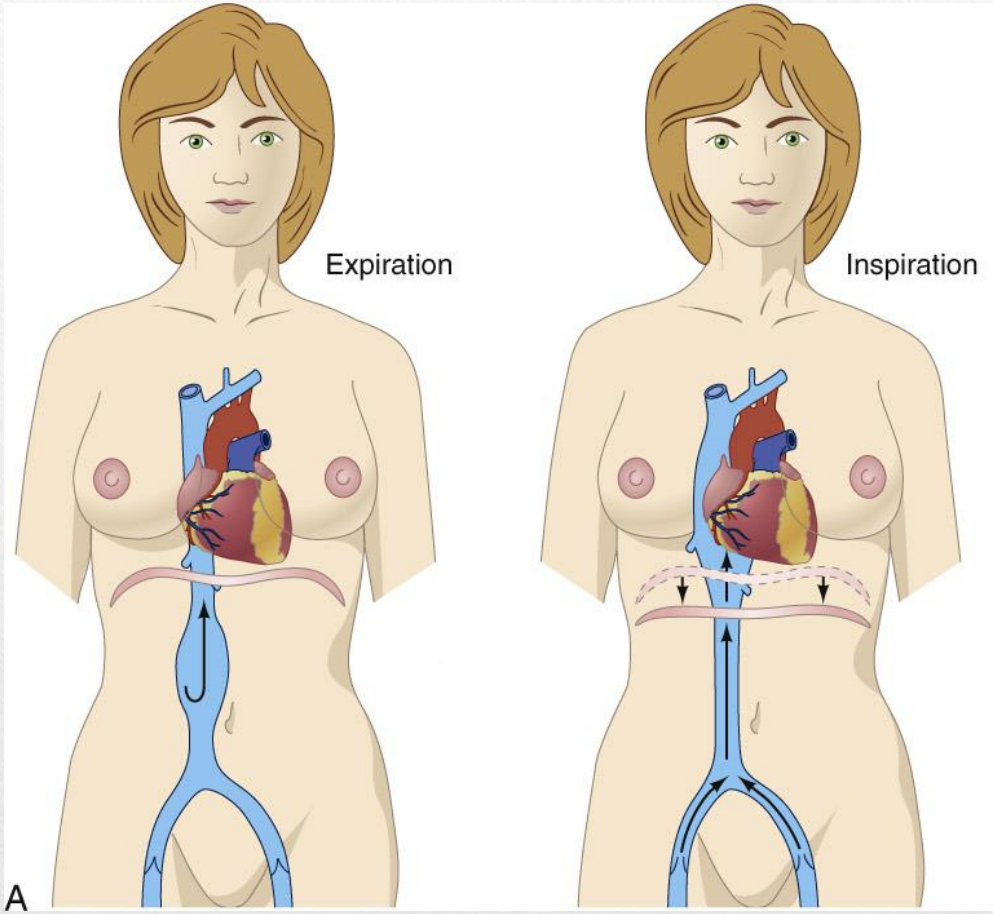
Take blood back to heart

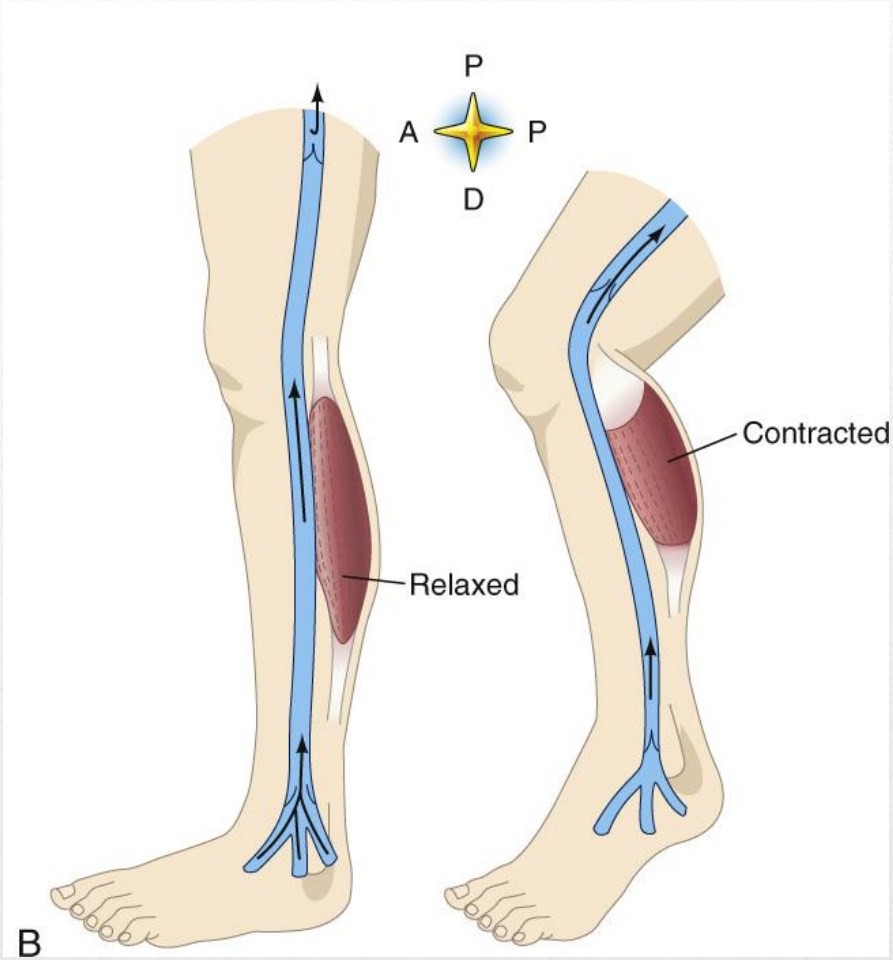
The skeletal muscle pump and the respiratory pump aid in pushing blood back toward the heart along the system of veins.



Venous Pumping Mechanisms

A. *The respiratory pump operates by alternately decreasing thoracic pressure during inspiration (thus pulling venous blood into the central veins) and increasing pressure in the thorax during expiration (thus pushing central venous blood into the heart).*





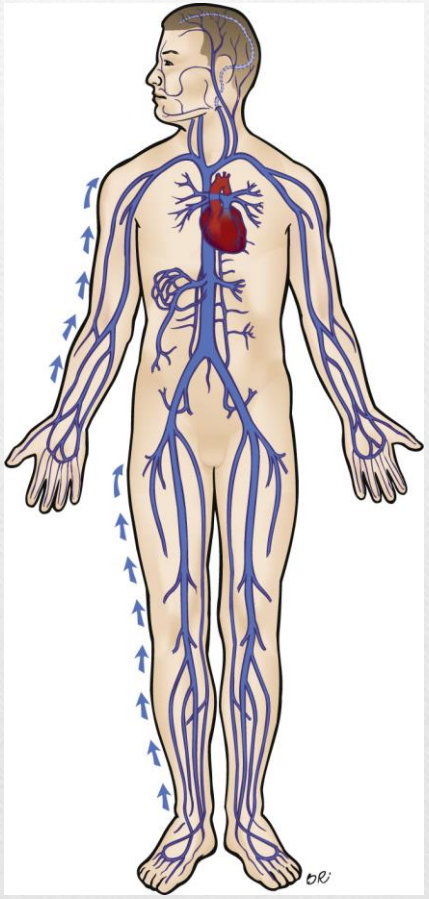
B. *The skeletal muscle pump operates by the alternate increase and decrease in peripheral venous pressure that normally occurs when the skeletal muscles are used for the activities of daily living. Both pumping mechanisms rely on the presence of semilunar valves in the veins to prevent backflow during the low-pressure points in the pumping cycle.*

Practical Application

Stroking over the veins toward the heart passively moves the blood in the veins

The practitioner can incorporate the principles affecting venous return into massage by using approaches that encourage venous return flow.

This image shows the direction of gliding strokes to be applied to facilitate venous flow.



Pulse and Blood Pressure

Blood pressure

- Amount of pressure exerted by the blood on walls of blood vessels
- Systolic: when ventricles contract
- Diastolic: when ventricles relax

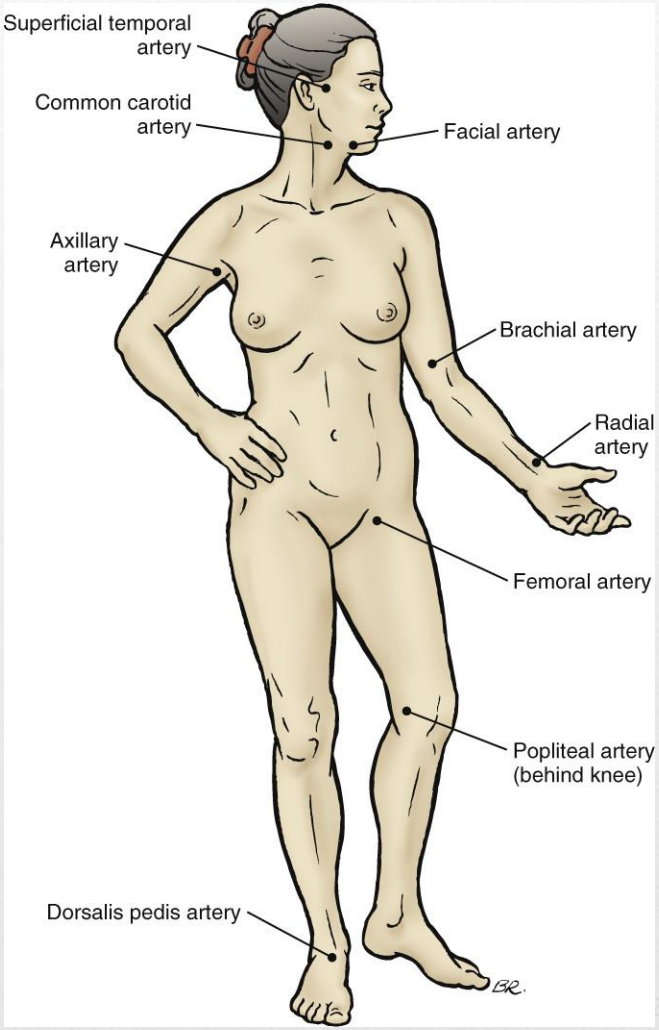
Sympathetic nerves to the arterioles regulate blood pressure.

What instrument might one use to measure blood pressure?

A sphygmomanometer.

Pulse Points

Pulse points are named after the arteries with which they are associated.



A blood pressure reading is the number of millimeters of mercury displaced by the changes in pressure.

The first number is the systolic pressure, and the second number is the diastolic pressure.

Box 11-1 Blood Pressure

Blood pressure depends on the person's size.

The average newborn has a blood pressure of 90/60.

At 15 years of age, the average blood pressure is approximately 120/60.

An average, healthy young adult has a blood pressure less than 120/80.

A blood pressure with a systolic reading of less than 90 is considered hypotension.

A pressure of 120/80 or higher is considered prehypertension.

A pressure of 140/90 or higher is considered stage I, or mild, hypertension.

A pressure of 160/100 or higher is considered stage II, or moderate to severe, hypertension.

The blood pressure changes under various conditions, and a single reading should never be used as a final determinant.

A systolic increase occurs under temporary conditions such as anxiety and exercise.

Hypertension involves an increase in the systolic and diastolic pressures.

Hypotension is a decrease in the systolic and diastolic pressures and is an important manifestation of shock, which results from an inadequate blood supply to vital organs.

Hydrostatic Pressure and Viscosity

Hydrostatic pressure

- Force exerted by liquid against walls of its container
- Pressure difference between two ends of vessel
- Resistance: measure of ease of flow
- Smaller radius → greater resistance

Viscosity

- Normally, the viscosity of blood remains constant.

What is arteriosclerosis?

Arteriosclerosis is a hardening of the arteries that may result from hypertension.

Viscosity is a measure of the tendency of a liquid to resist flow.

What could cause the viscosity of blood to change?

In polycythemia, the red cell content is high, and the viscosity of the blood can be considerably greater, reducing the blood flow. Severe dehydration, in which loss of plasma occurs, and cooling of the blood also can lead to increased viscosity.

Medulla and Baroreceptors

Medulla regulates:

- Heart rate
- Blood pressure
- Respiration

Baroreceptors

- Nerve centers in the cardiovascular system
- Transmit signals about sudden, brief changes in blood pressure

Stimulation of baroreceptors during therapeutic massage could affect blood pressure.

The blood pressure could drop, and the client may be light-headed and show other signs of low blood pressure.

Names of Specific Arteries and Veins

The names of most arteries and veins are derived from the anatomic structure they serve.

E.g., femoral artery serves the femur.

The subclavian artery and the axillary artery are the same artery.

Why do they have different names?

Arteries change names in accordance with the region of the body through which they are passing.

Arteries by Region

Head and neck

Brachiocephalic, common carotid, left subclavian, superficial temporal

Upper extremity

Subclavian → axillary → bracial → ulnar and radial

Trunk

Intercostal arteries

Stroking over the veins toward the heart passively moves blood in the veins. This method is particularly effective in the limbs.

Abdomen

Abdominal aorta → celiac trunk, superior mesenteric, renal, testicular or ovarian, inferior mesenteric

Lower extremities

External iliac → femoral → popliteal → anterior and posterior tibial → dorsalis pedis

The femoral artery is an important pulse-taking artery.

Veins by Region

Head and neck

- Superficial: external jugular
- Deep: internal jugular

Upper extremities

- Superficial: cephalic, basilic, medial cubital
- Deep: axillary → subclavian

Trunk

- Subclavian → brachiocephalic (2) → superior vena cava
- Inferior vena cava and branches; portal vein

Lower extremities

- Great saphenous drains into femoral
- Small saphenous drains into popliteal →femoral

The great saphenous veins may become chronically dilated in some persons and develop into varicose veins. They then may become inflamed and form blood clots, a condition known as thrombophlebitis.

The deep veins of the leg may become inflamed, a condition referred to as deep vein thrombosis, which is a more serious condition than superficial thrombophlebitis. The clot may break off and travel to the heart and then lodge in the lung as a pulmonary embolism.

Hepatic Portal System

Begins in the capillaries of organs of the digestive tract and ends in the portal vein

Hepatic triad

- Hepatic artery, bile duct, and portal vein

Portal blood contains substances absorbed by the stomach and intestines

- Liver cells absorb, excrete, or convert nutrients and toxins.
- Passes into central vein → hepatic veins

A portal system is one in which blood drains from one venous system into another without arteries in between.

The hepatic vascular system has a considerable ability to store and release blood, and it functions as a reservoir within the general circulation.

Blood

Red blood cells (erythrocytes)

- 90%+ of formed elements
- Transport oxygen to cells and CO_2 away from cells

White blood cells (leukocytes)

- Protect the body from pathogens and remove dead cells and substances
- Neutrophils, lymphocytes, monocytes, eosinophils, basophils

Blood is a form of connective tissue. It transports nutrients to cells and removes waste products.

Why are leukocytes white in color?

Their white color results from their lack of hemoglobin.

Platelets (thrombocytes)

- Involved in blood clotting

Plasma

- Straw-colored liquid found in blood and lymph
- About 90% water
- Constitutes about 55% of blood
- Plays major role in movement of water between tissues and blood

The clotting process starts the instant the blood vessel is damaged and takes only a few minutes to complete.

Pathologic Conditions

Cardiac disorders

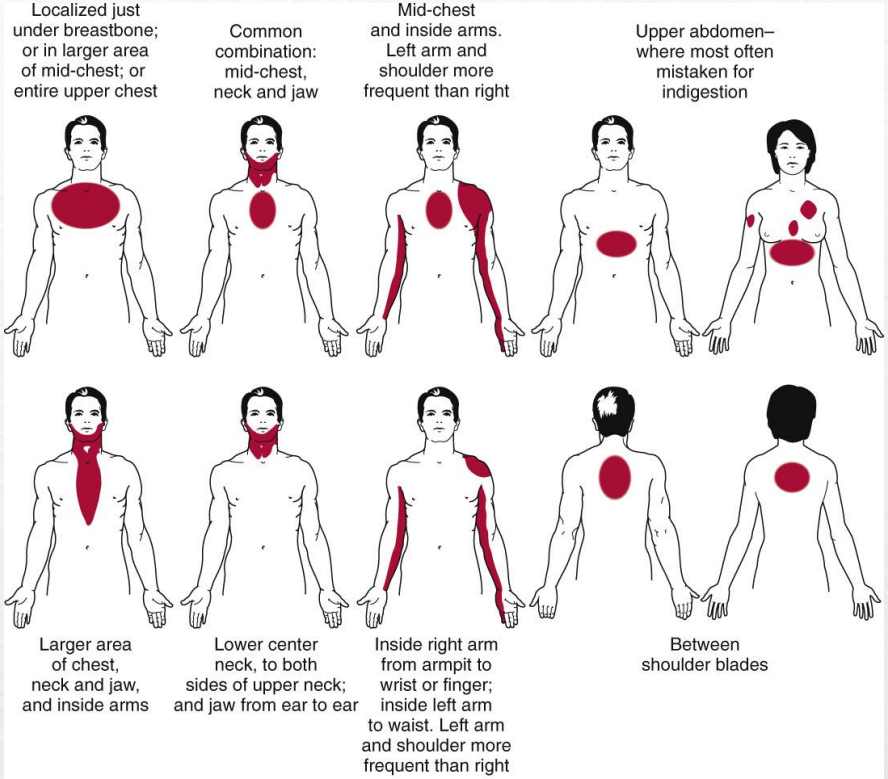
- Bradycardia
- Tachycardia
- Arrhythmia
- Mitral valve dysfunction
- Angina pectoris
- Myocardial infarction (heart attack)
- Congestive heart failure
- Rheumatic heart disease
- Heart and pericardial infarction

An infarct is an area of dead tissue that results when the blood supply to that area is cut off.

Most heart attacks occur because of blockage of a coronary artery by a blood clot, especially in arteries narrowed by coronary artery disease.

The blocking of blood flow damages or destroys the heart muscle.

Early Warning Signs



Most common warning signs of heart attack

- Uncomfortable pressure, fullness, squeezing or pain in the center of the chest (prolonged)
- Pain that spreads to the throat, neck, back, jaw, shoulders, or arms
- Chest discomfort with lightheadedness, dizziness, sweating, pallor, nausea, or shortness of breath
- Prolonged symptoms unrelieved by antacids, nitroglycerin, or rest

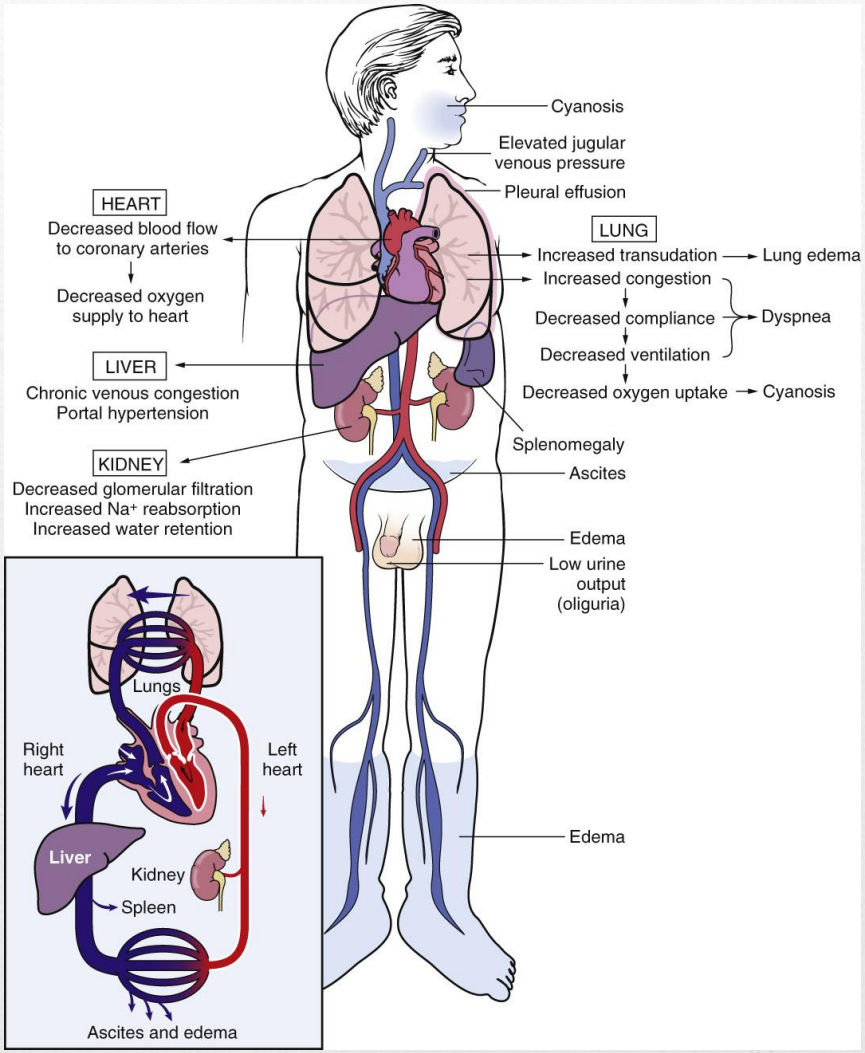
Atypical, less common warning signs (especially women)

- Unusual chest pain (quality, location, such as, burning, heaviness; left chest), stomach or abdominal pain
- Continuous midthoracic or interscapular pain
- Continuous neck or shoulder pain
- Isolated right biceps pain
- Pain unrelieved by antacids; pain unrelieved by rest or nitroglycerin
- Nausea and vomiting; flu-like manifestation without chest pain/discomfort
- Unexplained intense anxiety, weakness, or fatigue
- Breathlessness, dizziness

Congestive Heart Failure

Left heart failure leads to pulmonary edema.

Right ventricular failure causes peripheral edema that is most prominent in the lower extremities.



Vascular Disorders

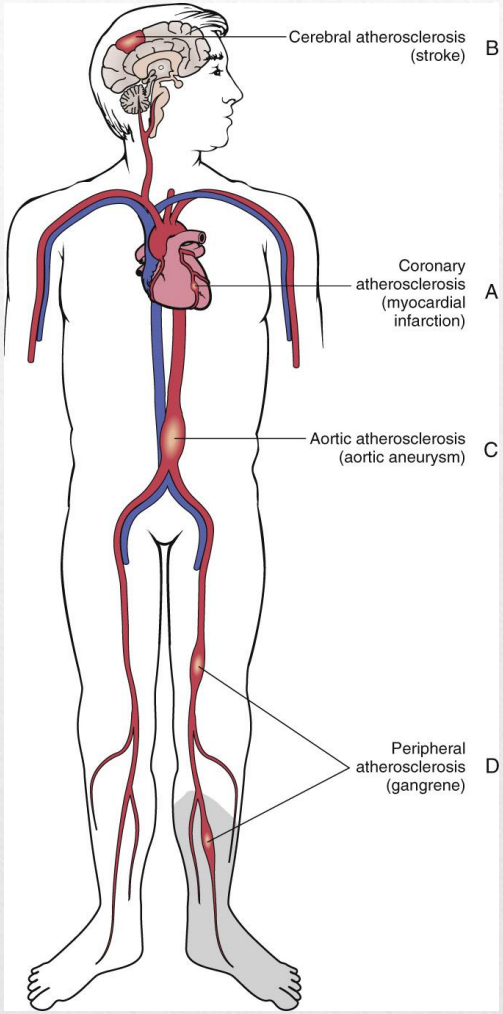
Ischemia

Arteriosclerosis and atherorsclerosis

Coronary artery disease

Hypertension

There are four major forms of atherosclerosis, as shown here.



What is the difference between arteriosclerosis and atherosclerosis?

Arteriosclerosis is a general term that means "hardening of the arteries" and refers to arteries that have lost their elasticity. In atherosclerosis, the most common type of arteriosclerosis, small fat deposits from cholesterol in the blood build up at stress points in the arteries.

Vascular Disorders

Varicose veins

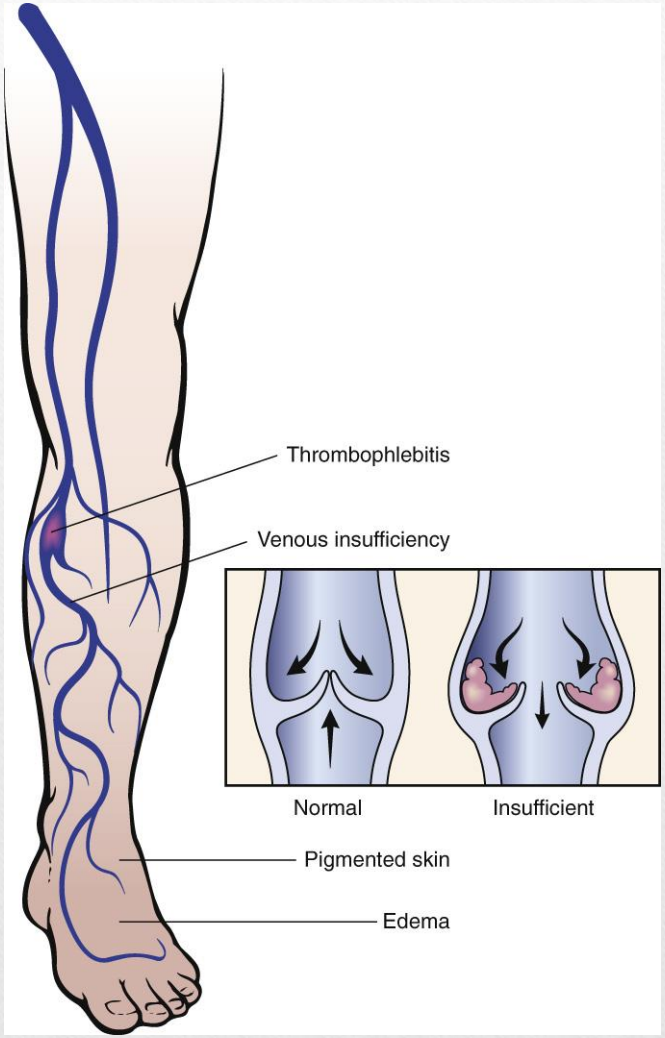
Aneurysm

Shock

Arterial inflammation

Raynaud's disease

Temporal arteritis



What are some causes of varicose veins?

The condition may be congenital and may result from remaining in one position, especially standing, too long or may be caused by obesity, pregnancy, or menopause. Women suffer from varicose veins more than men.

What are the four main types of shock?

The four main types of shock are hypovolemic shock, which results from a loss of blood or other bodily fluids; cardiogenic shock, which occurs when the heart does not pump sufficient blood; septic shock, which is caused by a bacterial infection; and anaphylactic shock, which results from an allergy or overreaction by the immune system.

Blood Disorders

Anemia

Nutritional anemias

Bone marrow suppression anemia

Thrombosis

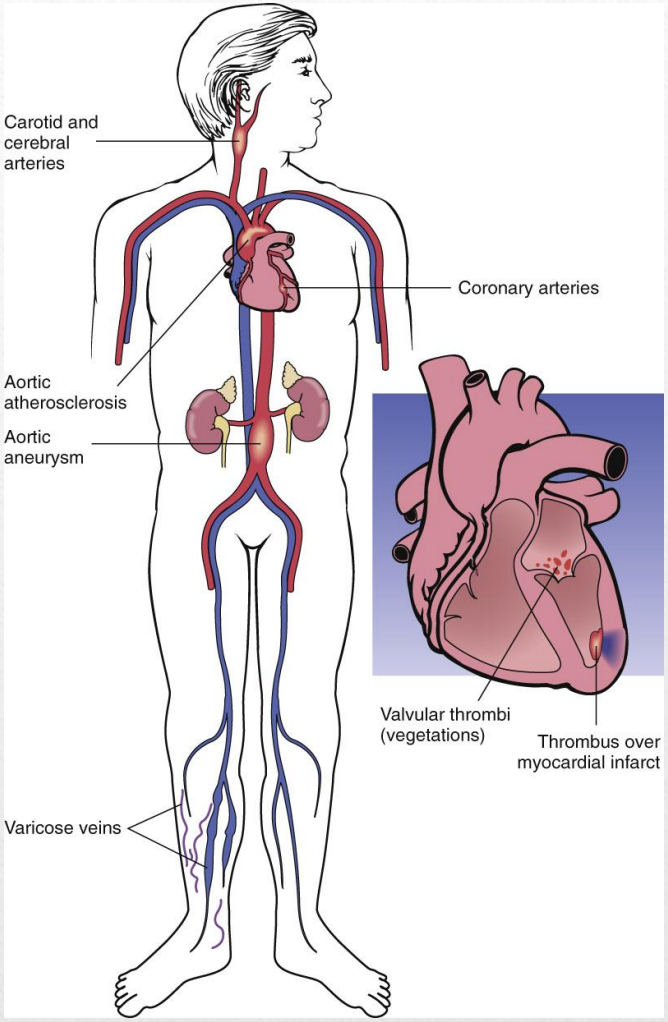
Phlebitis, thrombophlebitis, and deep vein thrombosis

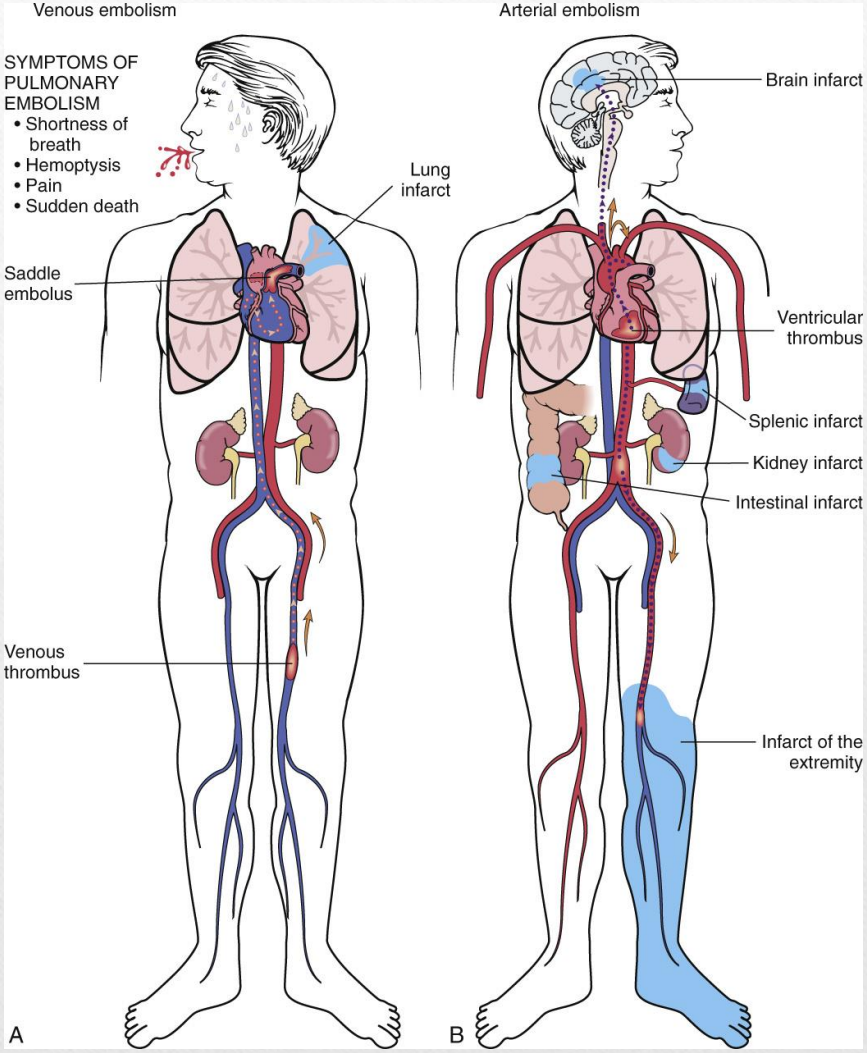
Embolus

What is a thrombus?

It is an intravascular blood clot and a type of embolus.

Thrombus Sites and Embolism





Hemorrhage

Sickle cell disease

Hemophilia

Polycythemia

Thombocytopenia

Hemorrhage refers to passage of blood outside of the cardiovascular system. Depending on the source, hemorrhage may be classified as cardiac, aortic, arterial, capillary, or venous.

Sickle-shaped cells evolved in Africa in response to the threat of malaria. Many people in the Mediterranean and Africa (and their descendants in other parts of the world) still exhibit the trait.

Indications/Contraindications for Therapeutic Massage

Requires close supervision

Refrain from massage over sites of thrombophlebitis or DVT

Refer clients with unexplained leg pain

Massage therapy is usually contraindicated for cardiovascular disease. If the condition itself doesn't preclude massage, then medications might. Clients can benefit from massage therapy applied under close medical supervision.

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