Chapter 12

Cardiovascular System Disorders

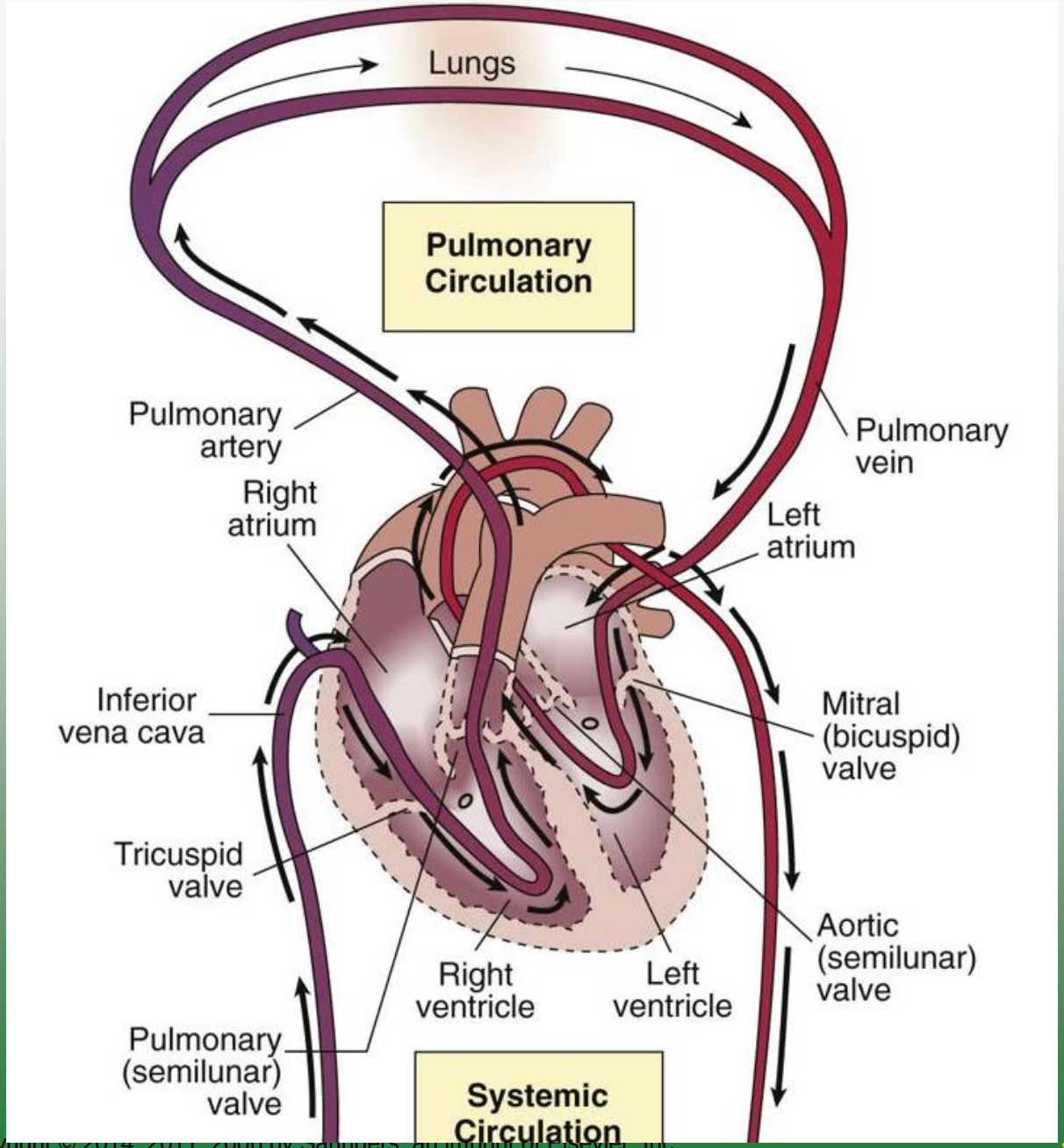
Review of the Normal Cardiovascular System

Circulatory System

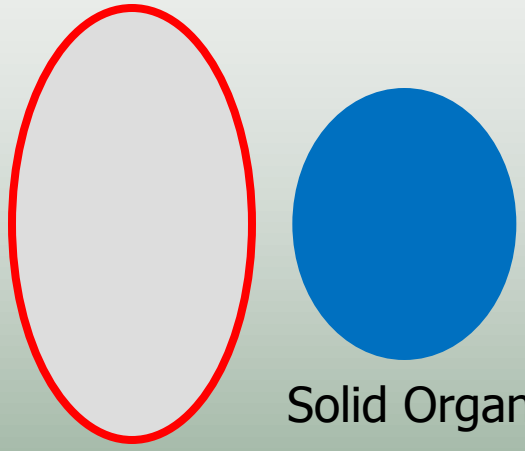
- The circulatory system is composed of:
  - Vessels (aterial, venous and capillary netwoks)
  - Fluid (blood – plasma and cells)
  - Pump (the heart)

- Blood flows from systemic to pulmonary to systemic circulation

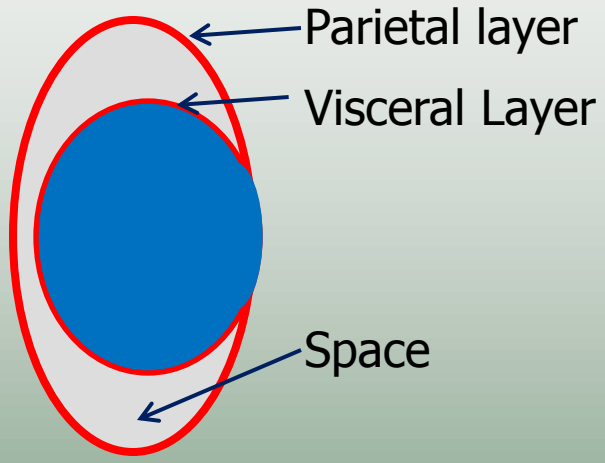
Path of Blood in the Circulation



How organs get a covering as they develop



Space lined by red sac membrane

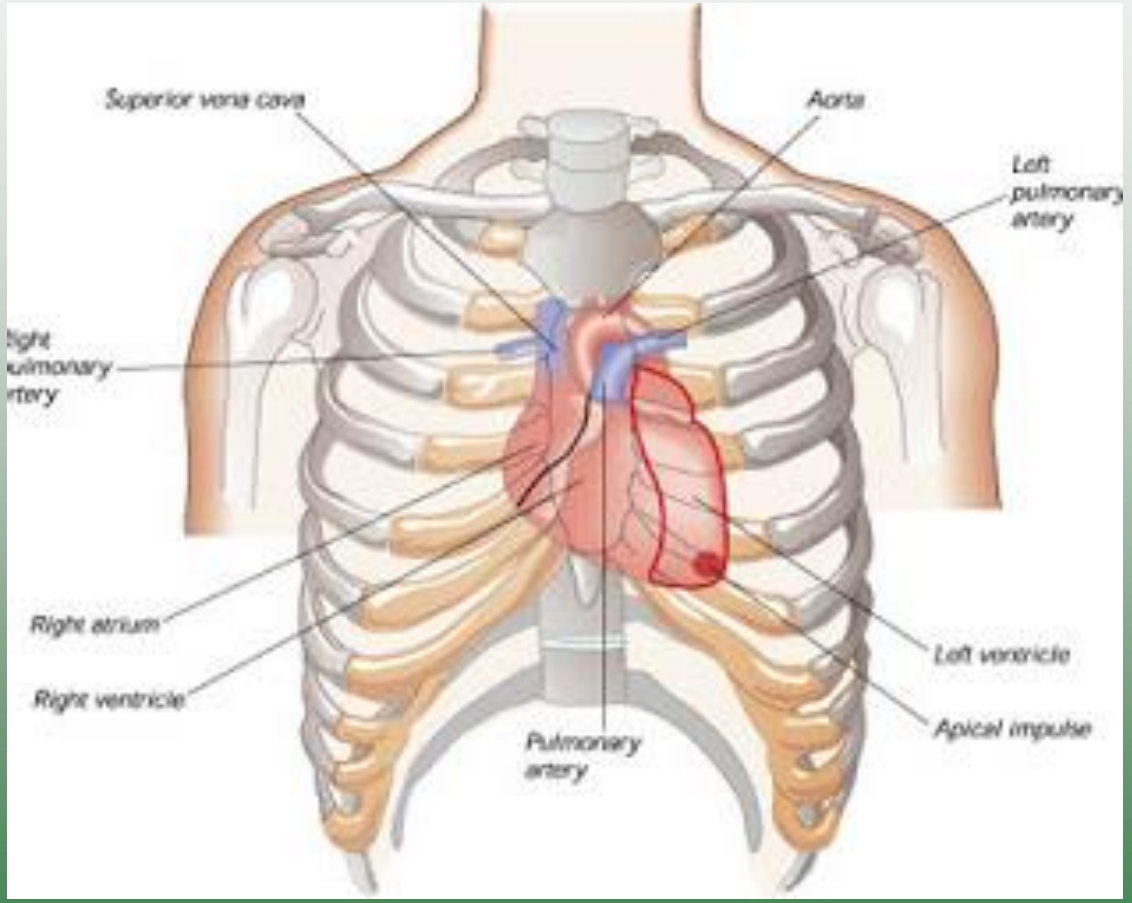


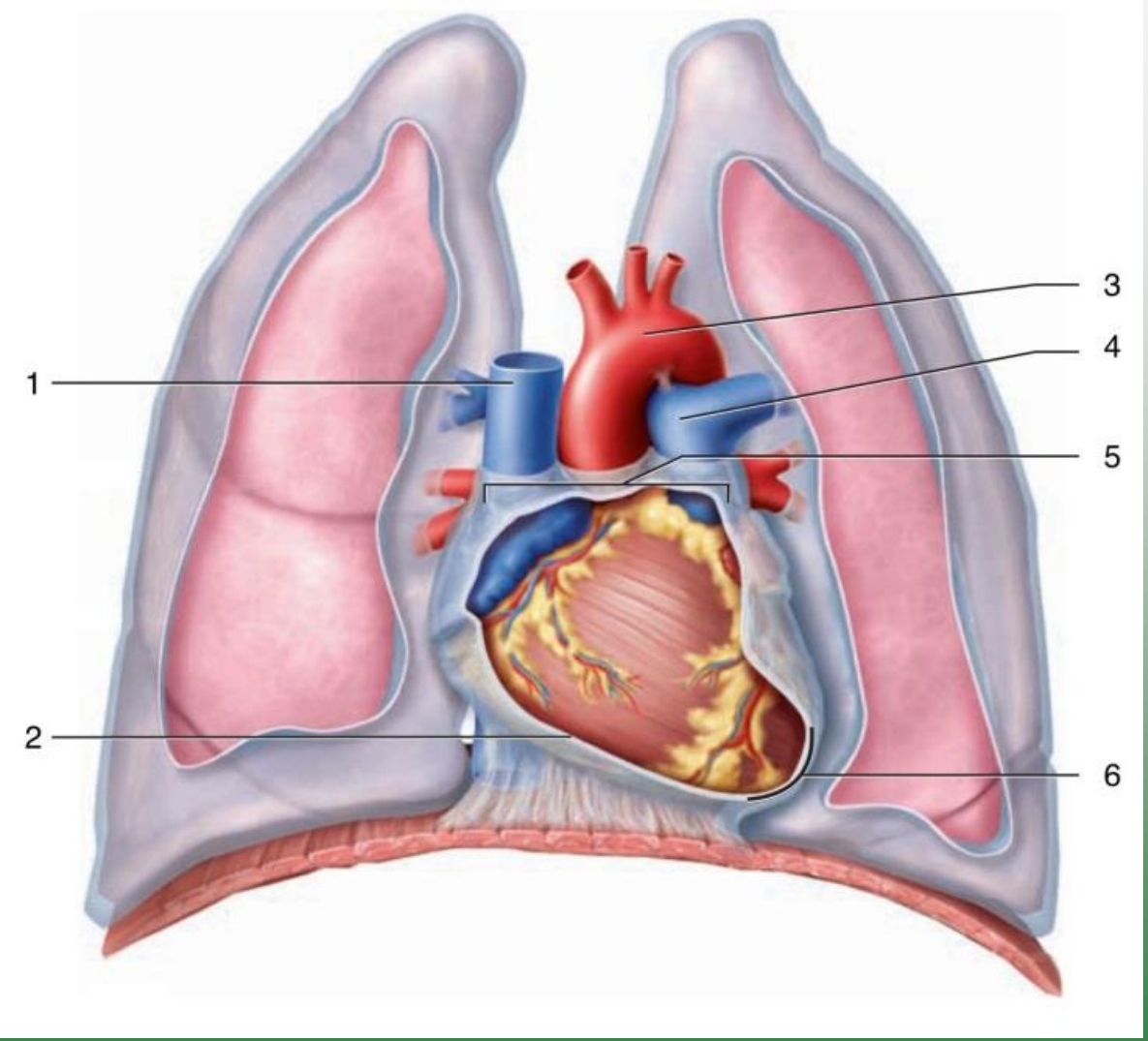
Solid Organ has pushed into the space, acquiring a layer of red space membrane.

- Normal – space minimal with visceral and parietal touching
- Disease – fluid or air expands space.

Heart: Anatomy

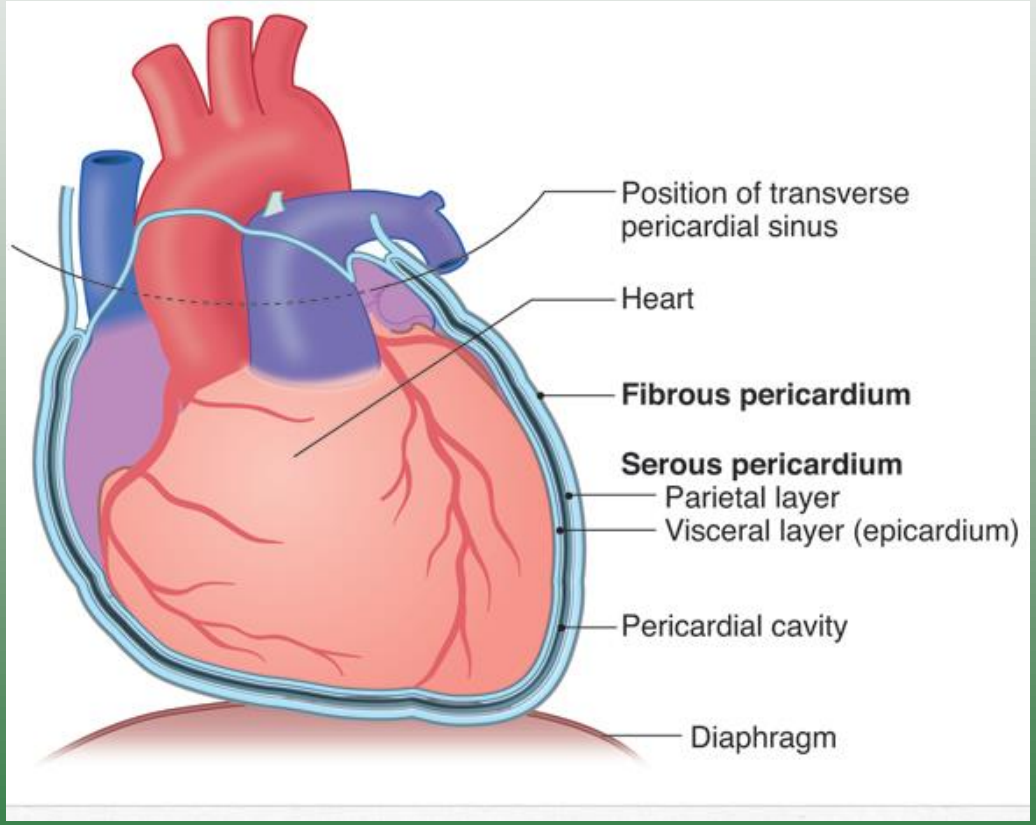
- Located in the mediastinum



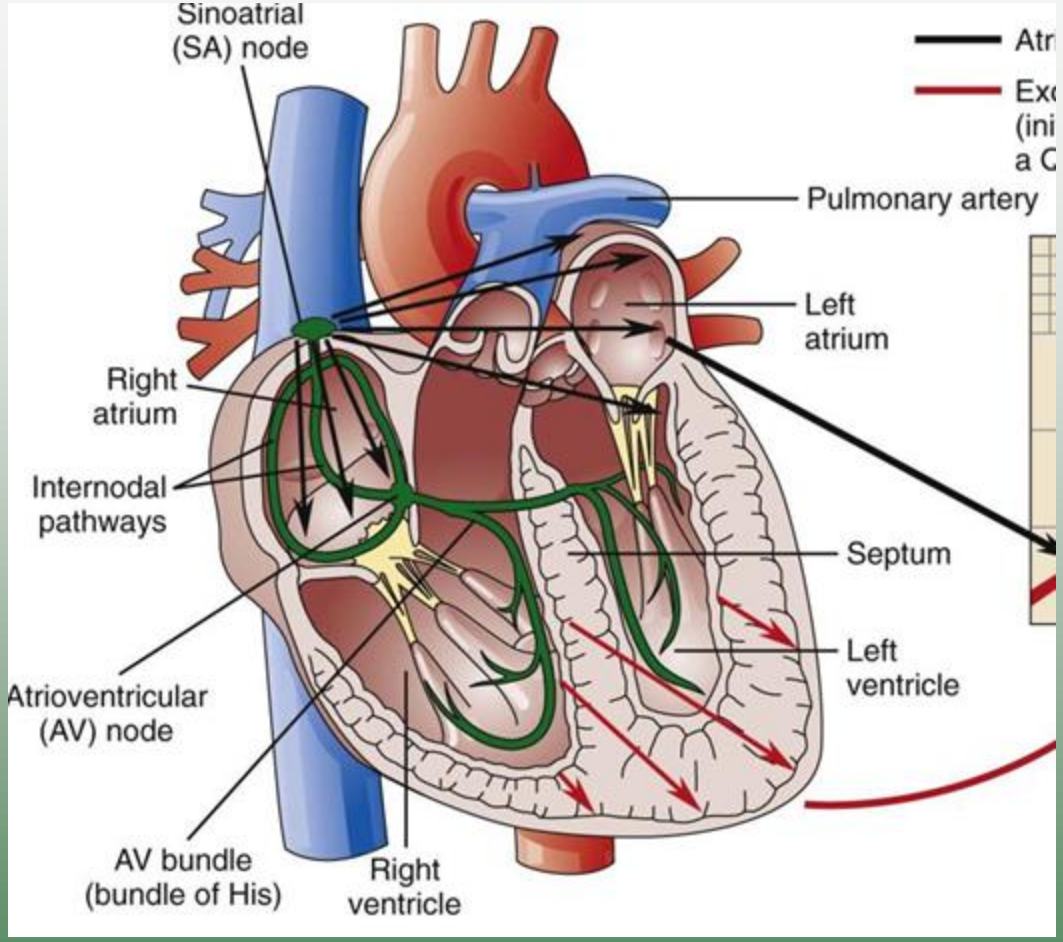


Heart: Anatomy

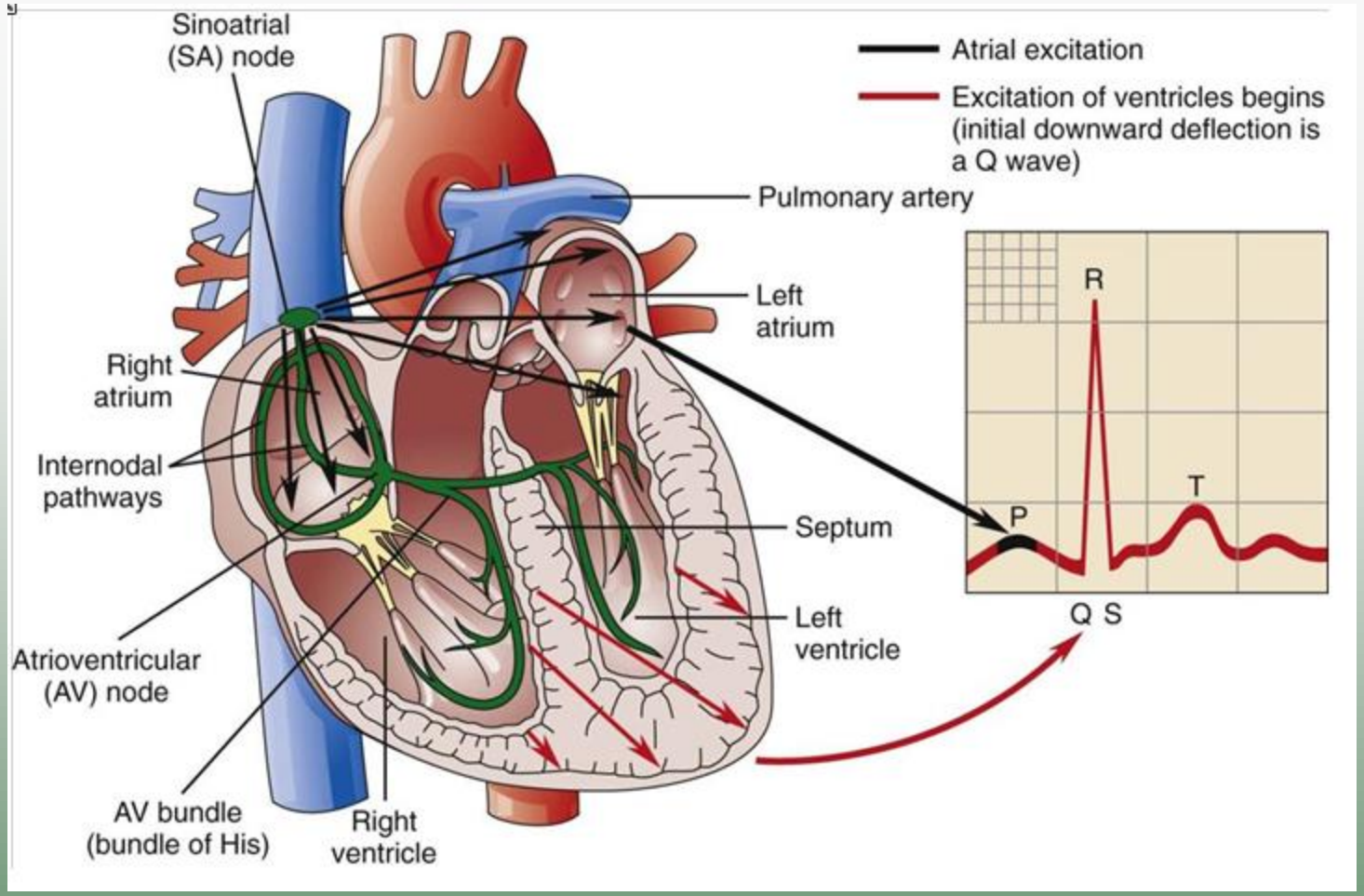
- Located in the pericardial sac
  - Parietal pericardium
  - Visceral pericardium
    - (Epicardium)
  - Pericardial cavity
  - Myocardium
  - Endocardium



Heart: Conduction System



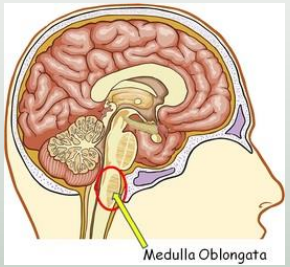
SA node > AV node > Bundle of His > Right and Left Bundle Branches > Purkinje Fibers

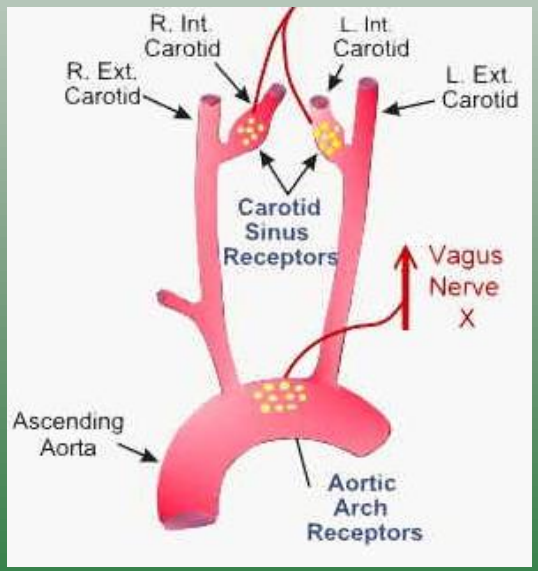


- P wave
  - Depolarization of atria
- QRS wave
  - Depolarization of ventricles
- T wave
  - Repolarization of ventricles

Control of the Heart

- Cardiac control center in medulla oblongata
  - Controls rate and force of contraction
  - Located in the medulla
- Baroreceptors
  - Detect changes in blood pressure
  - Located in the aorta and internal carotid arteries
- Sympathetic stimulation (cardiac accelerator nerve)
  - Increases heart rate (tachycardia)
- Parasympathetic stimulation (cranial nerve [CN] X; vagus nerve)
  - Decreases heart rate (bradycardia)





Factors that Increase Heart Rate

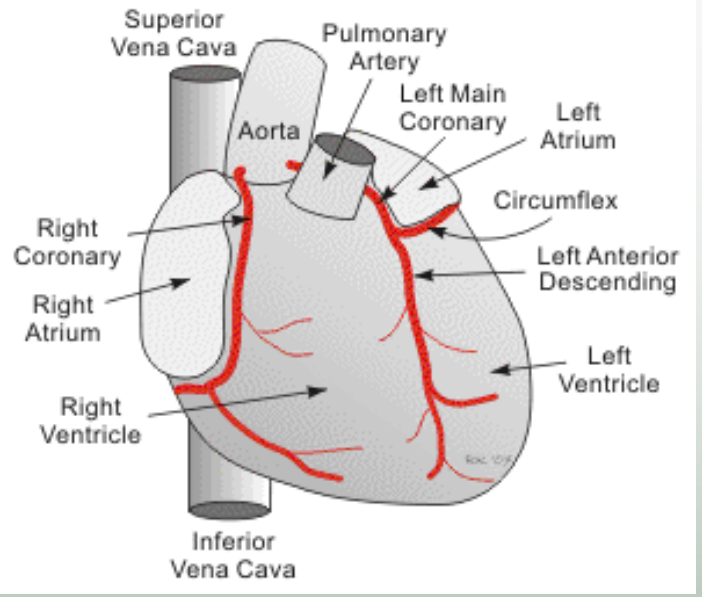
- Increased thyroid hormones or epinephrine
- Elevated body temperature, infection
  - Example: Fever
- Increased environmental temperature
  - Especially in high humidity
- Exertion or exercise
- Smoking
- Stress response
- Pregnancy
- Pain

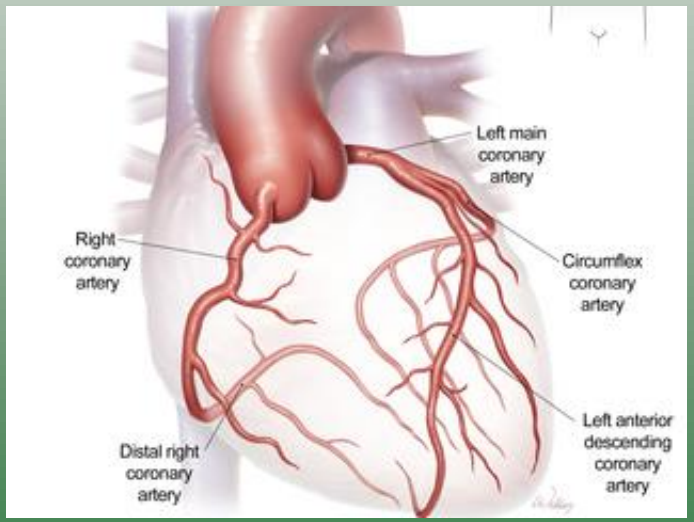
Coronary Circulation

- Right and left coronary arteries
  - Branch of aorta immediately distal to the aortic valve
  - Part of the systemic circulation

- Left coronary artery divides into:
  - Left anterior descending or interventricular artery
  - Left circumflex artery

- Right coronary artery branches
  - Right marginal artery
  - Posterior interventricular artery





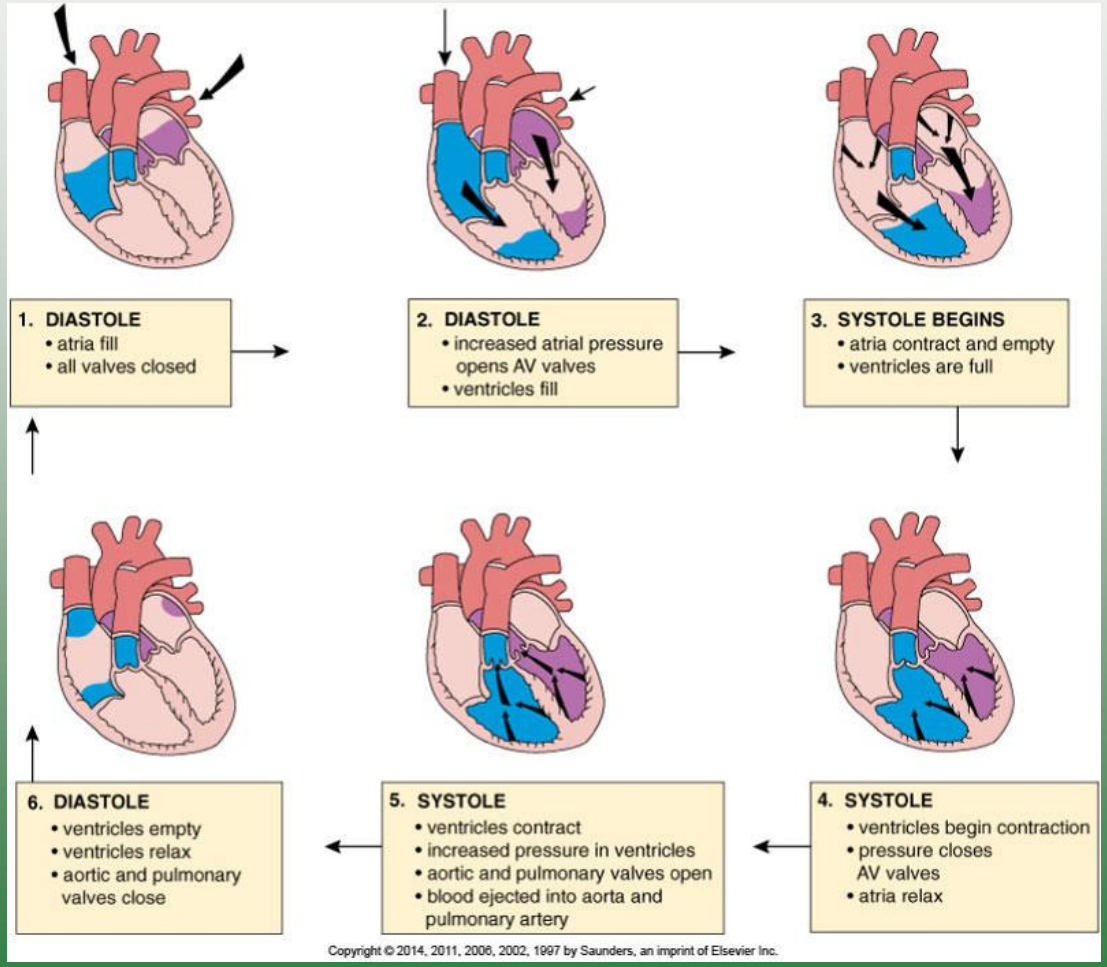
Coronary Circulation (Cont.)

- Many small branches extend from these arteries to supply the myocardium and endocardium.
- Collateral circulation is extremely limited.

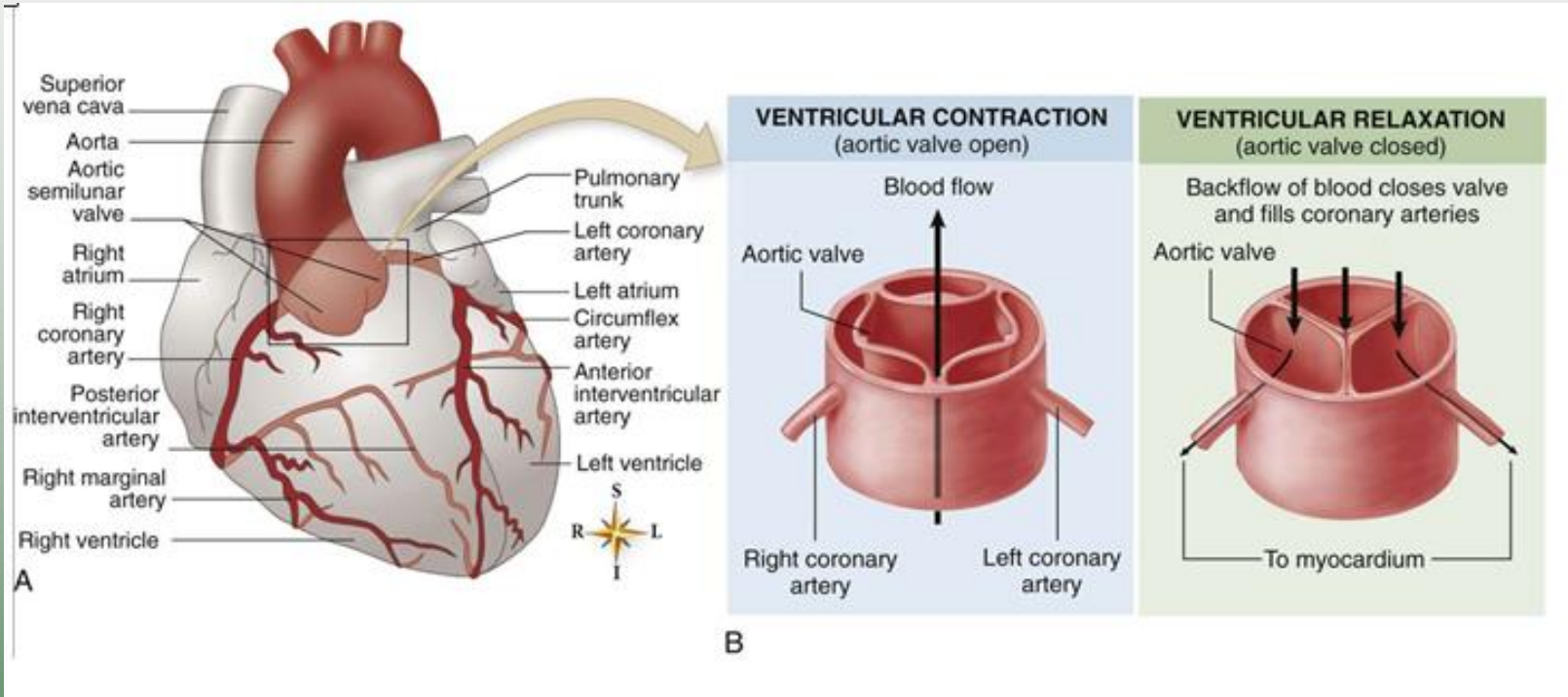
Cardiac Cycle

- Diastole
  - Relaxation of myocardium required for filling chambers
- Systole
  - Contraction of myocardium provides increase in pressure to eject blood
- Cycle begins with
  - Atria relaxed, filling with blood → AV valves open → blood flows into ventricles → atria contract, remaining blood forced into ventricles → atria relax → ventricles contract → AV valves close → semilunar valves open → blood into aorta and pulmonary artery → ventricles relax

ECG Strip Chart Recordings



Cardiac Cycle (Cont.)



Heart Sounds

- “Lubb-dub”
  - “Lubb”—closure of AV valves (tricuspid and mitral)
  - “Dub”—closure of semilunar valves (aortic and pulmonic)
- Murmurs
  - Caused by incompetent valves
- Pulse
  - Indicates heart rate
- Pulse deficit
  - Difference in rate between apical (at heart) and radial pulses

Cardiac Function

- Cardiac output (CO)
  - Blood ejected by a ventricle in 1 minute
  - CO = SV × HR (heart rate)
- Stroke volume (SV)
  - Volume of blood pumped out of ventricle—contraction
- Preload
  - Amount of blood delivered to heart by venous return
- Afterload
  - Force required to eject blood from ventricles
    - Determined by peripheral resistance in arteries

Blood Pressure

120/80 systolic/diastolic

- Systolic pressure
  - Exerted when blood is ejected from ventricles (high)
- Diastolic pressure
  - Sustained pressure when ventricles relax (lower)
  - Blood pressure (BP) is altered by cardiac output, blood volume, and peripheral resistance to blood flow.

Blood Pressure (Cont.)

- Changes in blood pressure
  - Sympathetic branch of ANS
    - Increased output → vasoconstriction and increased BP
    - Decreased output → vasodilation and decreased BP
  - BP is directly proportional to blood volume.
  - Hormones
    - Antidiuretic hormone (↑ BP); aldosterone (↑ blood volume, ↑ BP); renin-angiotensin-aldosterone (vasoconstriction; ↑ BP)

<hormones that retain water and salt or vasoconstric the periphery, elevate blood pressure>

Heart Disorders

Diagnostic Tests for Cardiovascular Function

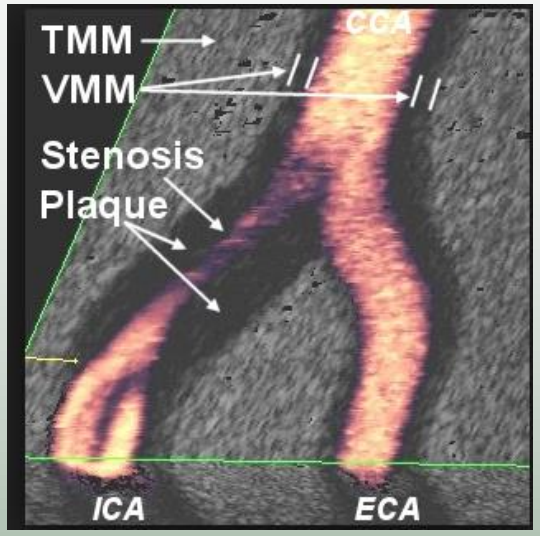
- Electrocardiography
  - Useful in the initial diagnosis and monitoring of dysrhythmias, myocardial infarction, infection, pericarditis
- Auscultation
  - Determination of valvular abnormalities or abnormal shunts of blood that cause murmurs
  - Detected by listening through a stethoscope
- Echocardiography (ultrasound)
  - Used to record heart valve movements, blood flow, and cardiac output
- Exercise stress tests
  - Used to assess general cardiovascular function

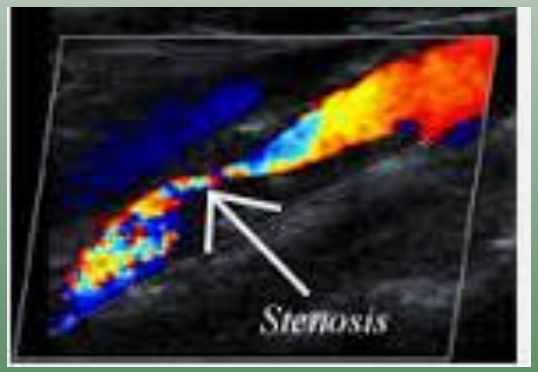
Diagnostic Tests for Cardiovascular Function (Cont.)

- Chest x-ray films
  - Used to show shape and size of the heart
    - Nuclear imaging
    - Tomographic studies
- Cardiac catheterization
  - Measures pressure and assesses valve and heart function
    - Determines central venous pressure and pulmonary capillary wedge pressure
- Angiography
  - Visualization of blood flow in the coronary arteries

Diagnostic Tests for Cardiovascular Function

- Doppler studies
  - Assess blood flow in peripheral vessels
  - Record sounds of blood flow or obstruction
  -
- Blood tests
  - Assess levels of serum triglycerides, cholesterol, sodium, potassium, calcium, other electrolytes
- Arterial blood gas determination
  - Checks the current oxygen level and acid-base balance





General Treatment Measures for Cardiac Disorders

- Dietary modifications
  - To decrease total fat intake
  - General weight reduction
  - Reduce salt intake
- Regular exercise program
  - Increases high-density lipoprotein levels
  - Lowers serum lipid levels
  - Reduces stress levels
- Cessation of smoking
  - Decreases risk of coronary disease

General Treatment Measures for Cardiac Disorders: Drug Therapy

- Vasodilators
  - Reduction of peripheral resistance
- Beta blockers (block beta adrenergic – sympathetic)
  - Treatment of hypertension and dysrhythmias
  - Reduction of angina attacks
- Calcium channel blockers
  - Decrease cardiac contractility
  - Antihypertensives and vasodilators
  - Prophylactic against angina

General Treatment Measures for Cardiac Disorders: Drug Therapy (Cont.)

- Digoxin
  - Treatment for heart failure
  - Antidysrhythmic drug for atrial dysrhythmias
- Antihypertensive drugs
  - Used to lower blood pressure
- Adrenergic blocking drugs
  - Act on SNS centrally or on the periphery
- Angiotensin-converting enzyme (ACE) inhibitors
  - Block conversion of angiotensin I to angiotensin II

General Treatment Measures for Cardiac Disorders: Drug Therapy (Cont.)

- Diuretics
  - Remove excess sodium and/or water.
  - Treat high BP and congestive heart failure.
- Anticoagulants
  - Reduce risk of blood clot formation
- Cholesterol-lowering drugs
  - Reduce low-density lipoprotein and cholesterol levels

Selected Cardiovascular Drugs

TABLE 12-1 Selected Cardiovascular Drugs

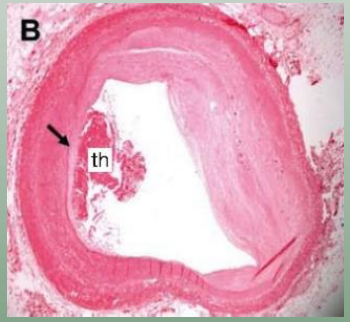
Name	Use	Action	Adverse Effects
Nitroglycerin	Angina attacks and prophylaxis	Reduces cardiac workload, peripheral and coronary vasodilator	Dizziness, headache
Metoprolol (Lopressor)	Hypertension, angina, antiarrhythmic	Blocks beta-adrenergic receptors, slows heart rate	Dizziness, fatigue
Nifedipine (Adalat)	Angina, hypertension, peripheral vasodilator, antiarrhythmic	Calcium blockers, vasodilator	Dizziness, fainting, headache
Digoxin (Lanoxin)	Congestive heart failure and atrial arrhythmias	Slows conduction through AV node and increases force of contraction (cardiotonic) to increase efficiency	Nausea, fatigue, headache, weakness
Enalapril (Vasotec)	Hypertension	ACE inhibitor—blocks formation of angiotensin II and aldosterone	Headache, dizziness, hypotension
Furosemide (Lasix) hypertension	Edema with CHF, hypertension	Diuretic—increases excretion of water and sodium	Nausea, diarrhea, dizziness
Simvastatin (Zocor)	Hypercholesteremia (CHD)	Decreases cholesterol and LDL	Digestive discomfort
Warfarin (Coumadin)	Prophylaxis and treatment of thromboemboli	Anticoagulant—interferes with vitamin K in synthesis of clotting	Excessive bleeding (antidote: vitamin K)
ASA (aspirin)	Prophylaxis of thromboemboli	Prevents platelet adhesion, anti-inflammatory	Gastric irritation, allergy

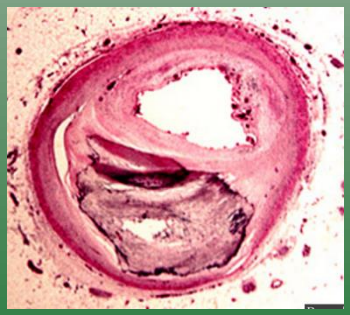
CHD, Coronary heart disease; CHF, congestive heart failure; LDL, low-density lipoprotein.

Coronary Artery Disease (CAD) or Ischemic Heart Disease (IHD) or Acute Coronary Syndrome

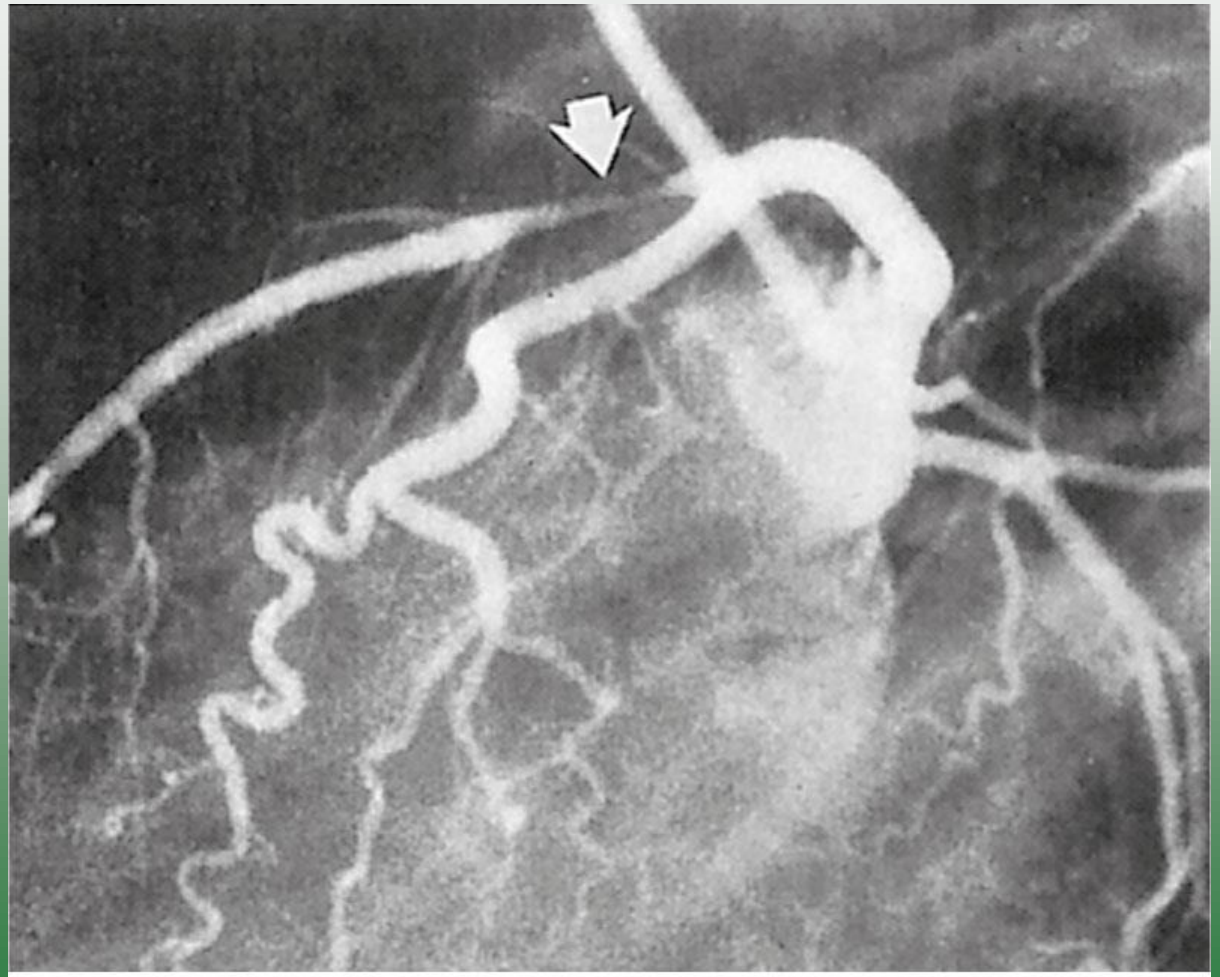
Arteriosclerosis and Atherosclerosis

- Arteriosclerosis
  - General term for all types of arterial changes
    - Degenerative changes in small arteries and arterioles
    - Loss of elasticity
    - Lumen gradually narrows and may become obstructed
    - Cause of increased BP
- Atherosclerosis
  - Presence of atheromas in large arteries
    - Plaques consisting of lipids, calcium, and possible clots
    - Related to diet, exercise, and stress





Normal (*top*) Versus Atherosclerotic Aorta (*bottom*)

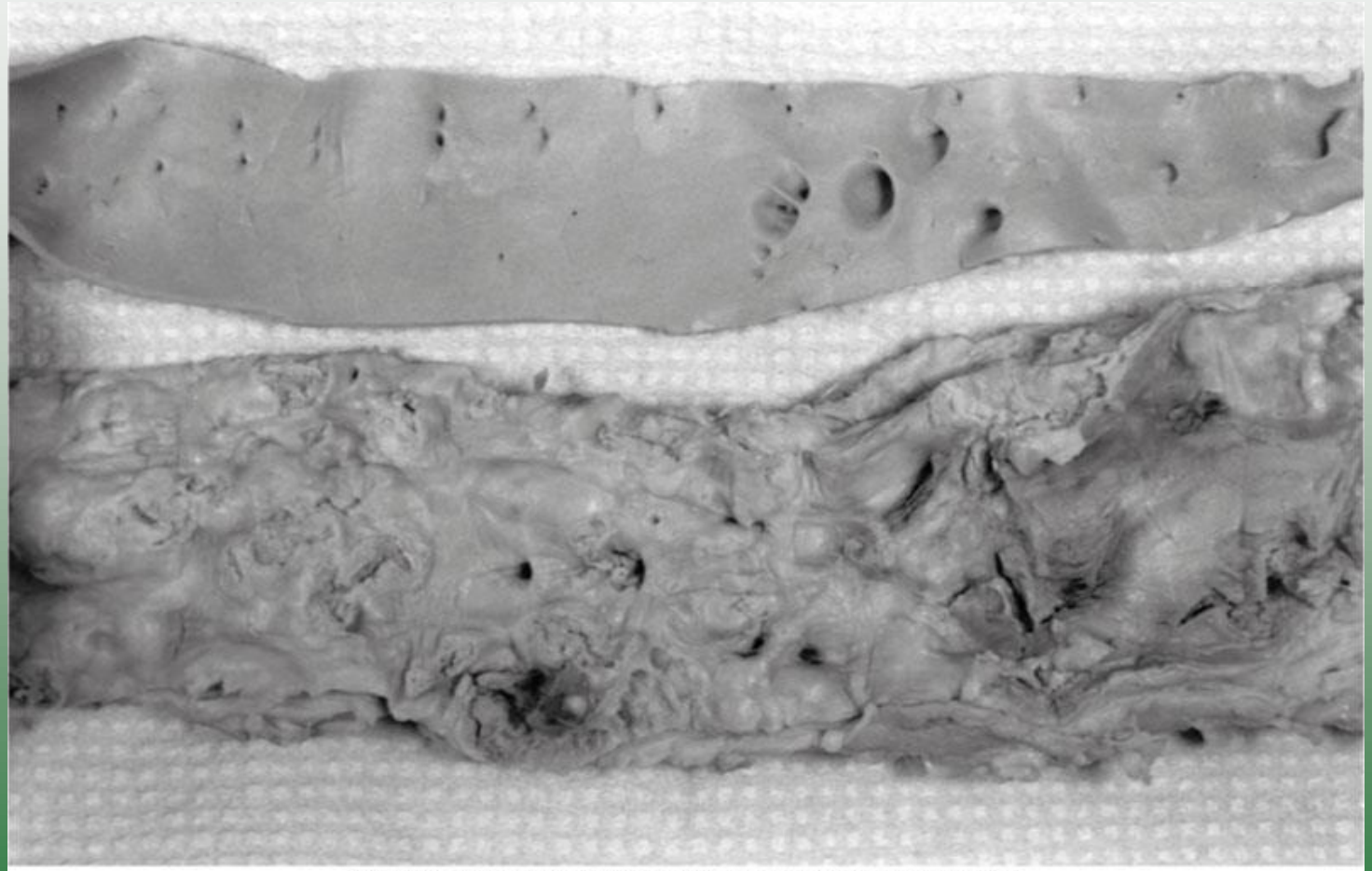


From Braunwald E: Heart Disease: A Textbook of Cardiovascular Medicine, *ed 4, Philadelphia, 1992, Saunders.*

Lipid Transport

- Lipids are transported in combination with proteins.
- Low-density lipoprotein (LDL)
  - Transports cholesterol from liver to cells
  - Major factor contributing to atheroma formation
- High-density lipoprotein (HDL)
  - Transports cholesterol away from the peripheral cells to liver—“good” lipoprotein
  - Catabolism in liver and excretion

Possible Consequences of Atherosclerosis



Courtesy of Paul Emmerson and Seneca College of Applied Arts and Technology, Toronto, Canada.

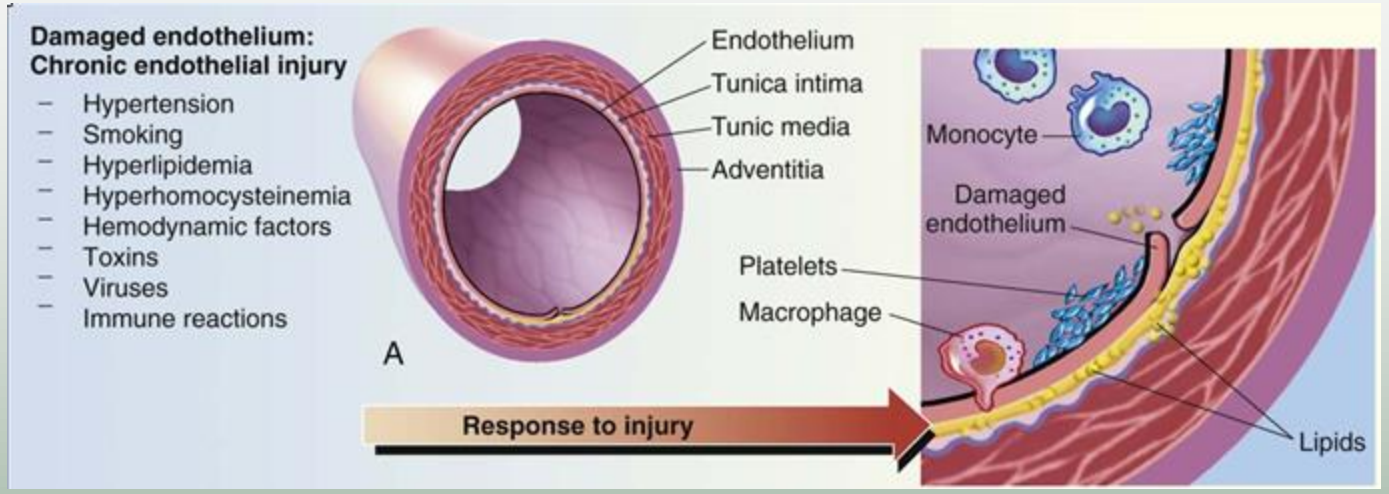
Risk Factors for Atherosclerosis

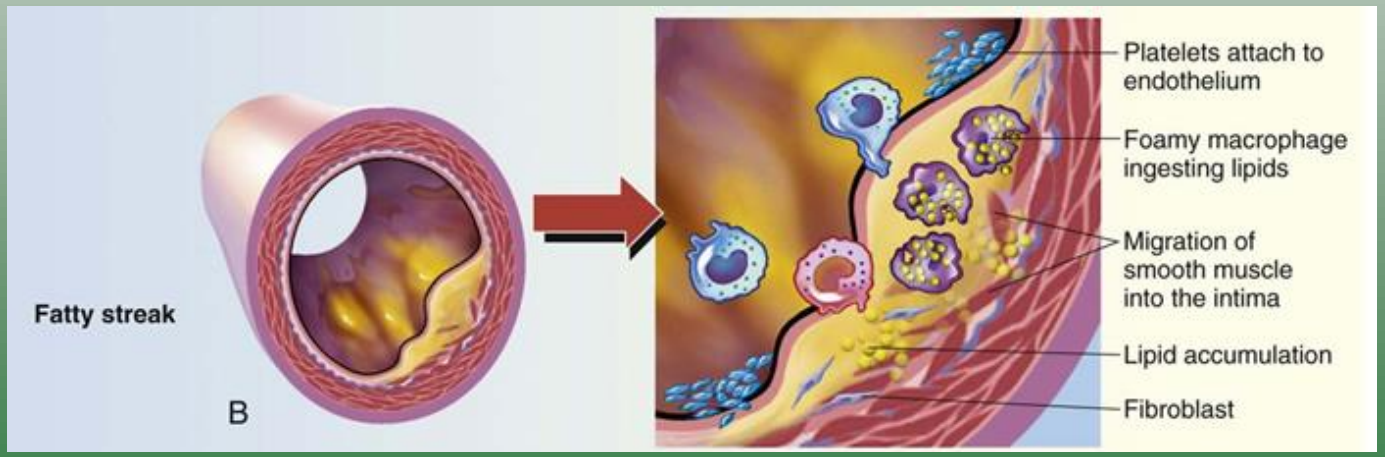
- Nonmodifiable
  - Age
  - Gender
  - Genetic or familial factors
- Modifiable
  - Obesity
  - Sedentary lifestyle
  - Cigarette smoking
  - Diabetes mellitus
  - Poorly controlled hypertension
  - Combination of oral contraceptives and smoking

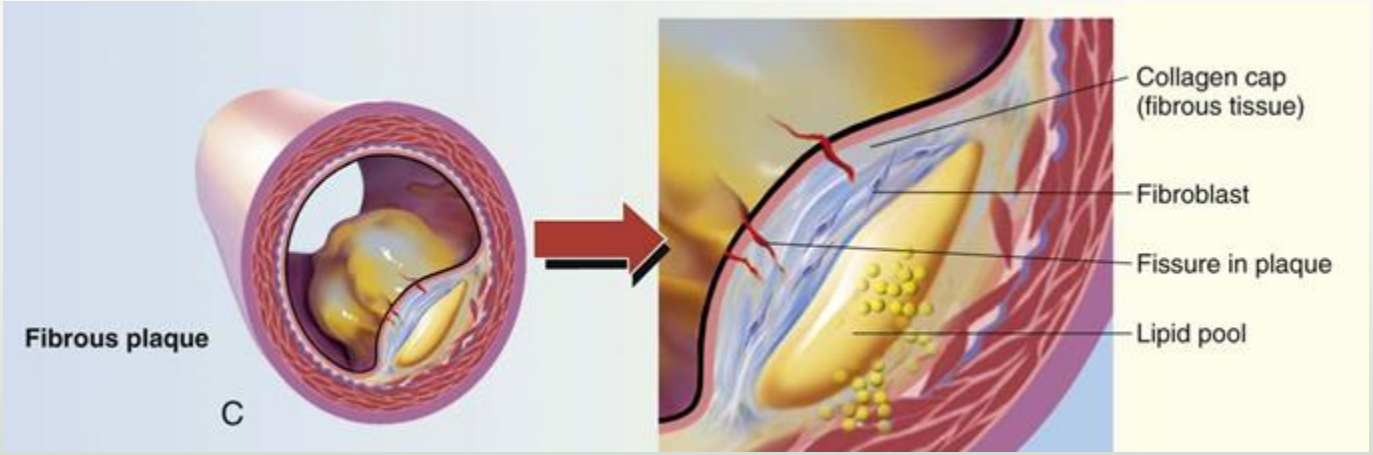
Atherosclerosis

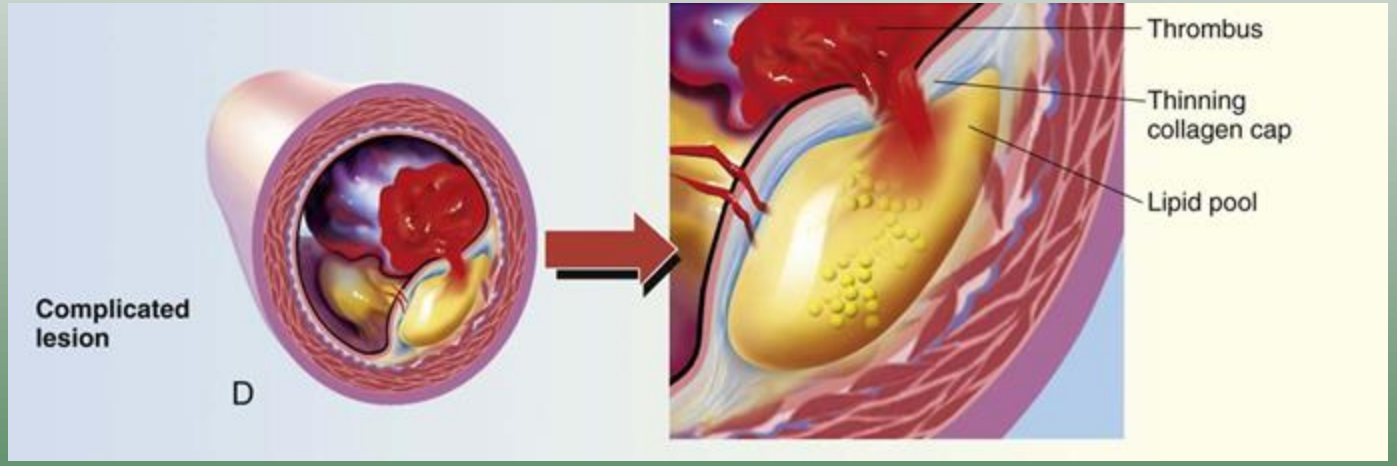
- Diagnostic tests
  - Serum lipid levels
- Treatment
  - Weight loss
  - Increase exercise.
  - Lower total serum cholesterol and LDL levels by dietary modification.
  - Reduce sodium intake.
  - Control hypertension.
  - Cessation of smoking
  - Antilipidemic drugs
  - Surgical intervention, such as coronary artery bypass grafting

Pogression of Atherosclerosis









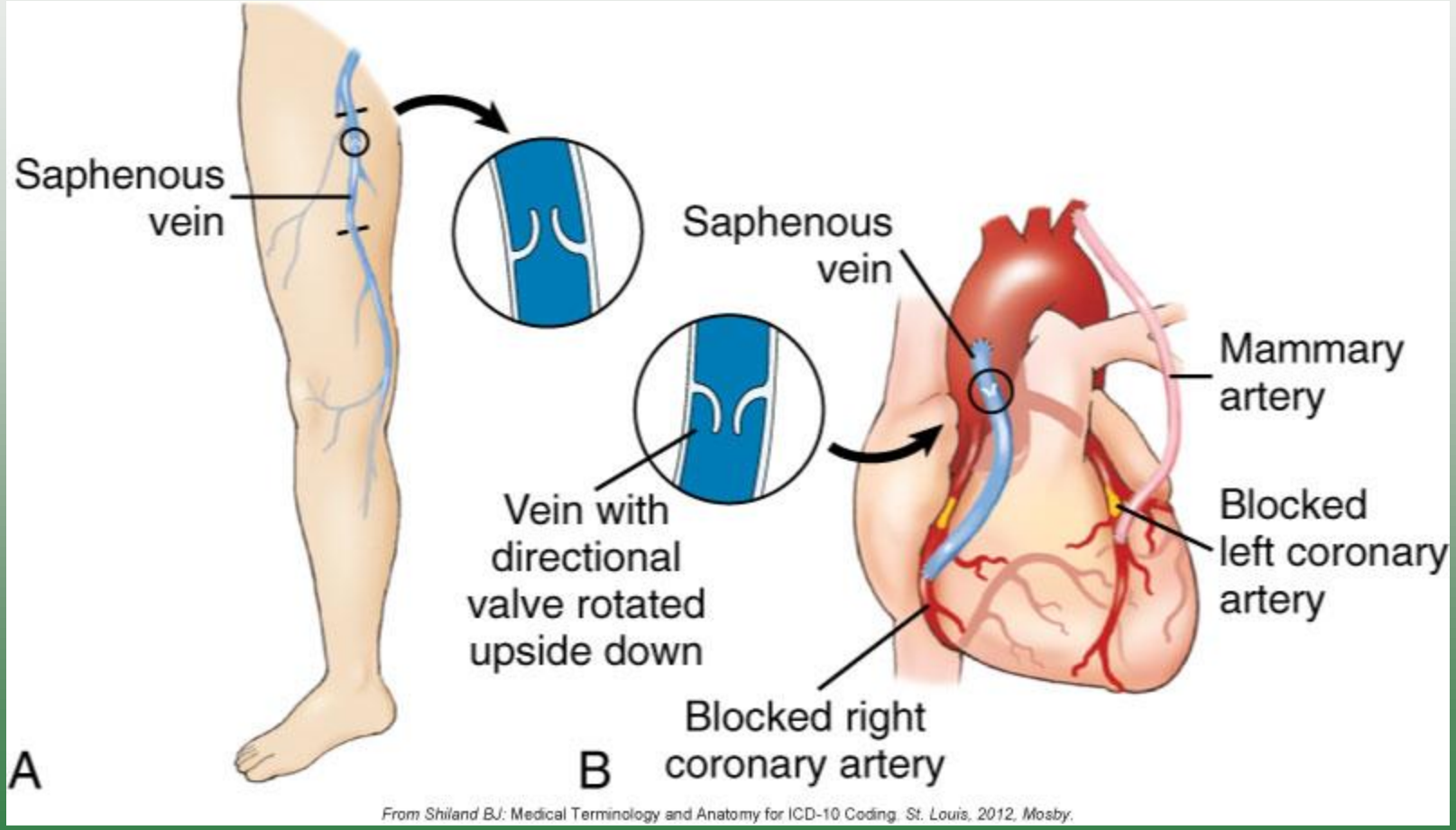
Angina Pectoris

- Occurs when there is a deficit of oxygen to meet myocardial needs
- Chest pain may occur in different patterns.
  - Classic or exertional angina
  - Variant angina
    - Vasospasm occurs at rest.
  - Unstable angina
    - Prolonged pain at rest—may precede myocardial infarction

Emergency Treatment for Angina

- Rest, stop activity
- Patient seated in upright position
- Administration of nitroglycerin—sublingual
- Check pulse and respiration.
- Administer oxygen, if necessary.
- Patient known to have angina
  - Second dose of nitroglycerin
- Patient without history of angina
  - Emergency medical aid

Coronary Artery Bypass



From Shiland BJ: Medical Terminology and Anatomy for ICD-10 Coding. St. Louis, 2012, Mosby.

Myocardial Infarction

- Occurs when coronary artery is totally obstructed
- Atherosclerosis is most common cause
- Thrombus from atheroma may obstruct artery
- Vasospasm is cause in a small percentage.
- Size and location of the infarct determine the damage.

Warning Signs of Heart Attack

- Feeling of pressure, heaviness, or burning in chest—especially with increased activity
- Sudden shortness of breath, weakness, fatigue
- Nausea, indigestion
- Anxiety and fear
- Pain may occur and, *if present,* is usually
  - Substernal
  - Crushing
  - Radiating (to left arm).

Myocardial Infarction (Cont.)

- Diagnostic tests
  - Changes in ECG
  - Serum enzyme and isoenzyme levels
  - Serum levels of myosin and cardiac troponin are elevated.
  - Leukocytosis, elevated CRP and ESR common
  - Arterial blood gas measurements may be altered in severe cases.
  - Pulmonary artery pressure measurements helpful

Myocardial Infarction: Complications

- Sudden death
- Cardiogenic shock
- Congestive heart failure
- Rupture of necrotic heart tissue/cardiac tamponade
- Thromboembolism causing cerebrovascular accident (CVA; with left ventricular MI)

Myocardial Infarction: Treatment

- Reduce cardiac demand.
- Oxygen therapy
- Analgesics
- Anticoagulants
- Thrombolytic agents may be used.
- Tissue plasminogen activator
- Medication to treat:
  - Dysrhythmias, hypertension, congestive heart failure
  - Cardiac rehabilitation begins immediately.

Cardiac Dysrhythmias (Arrhythmias)

- Deviations from normal cardiac rate or rhythm
  - Caused by electrolyte abnormalities, fever, hypoxia, stress, infection, drug toxicity
  - Electrocardiography—for monitoring the conduction system
    - Detects abnormalities
- Reduction of the efficiency of the heart's pumping cycle
  - Many types of abnormal conduction patterns exist.

Sinus Node Abnormalities

- SA node
  - Pacemaker of the heart; rate can be altered.
- Bradycardia
  - Regular but slow heart rate
- Tachycardia
  - Regular rapid heart rate
- Sick sinus syndrome
  - Marked by altering bradycardia and tachycardia
    - Often requires mechanical pacemaker

Atrial Conduction Abnormalities

- Premature atrial contractions or beats (PACs, PABs)
  - Extra contraction or ectopic beats
    - Irritable atrial muscle cells outside conduction pathway
- Atrial flutter
  - Atrial heart rate of 160 to 350 beats/min
    - AV node delays conduction—ventricular rate slower
- Atrial fibrillation
  - Rate over 350 beats/min
    - Causes pooling of blood in the atria
    - Thrombus formation is a risk.

Ventricular Conduction Abnormalities

- Bundle branch block
  - Interference with conduction in one of the bundle branches
- Ventricular tachycardia
  - Likely to reduce cardiac output as reduced diastole occurs
- Ventricular fibrillation
  - Muscle fibers contract independently and rapidly
  - Cardiac standstill occurs if not treated immediately!
- Premature ventricular contractions (PVCs)
  - Additional beats from ventricular muscle cell or ectopic pacemaker; may lead to ventricular fibrillation

Treatment of Cardiac Dysrhythmias

- Cause needs to be determined and treated.
- Antidysrhythmic drugs are effective in many cases.
- SA nodal problems or total heart block require pacemaker
- Defibrillator may be implanted for conversion of ventricular fibrillation.

Cardiac Arrest

- Cessation of all heart activity
  - No conduction of impulses
  - Flat ECG
- Many reasons
  - Excessive vagal nerve stimulation
  - Potassium imbalance
  - Cardiogenic shock
  - Drug toxicity
  - Insufficient oxygen
  - Respiratory arrest
  - Blow to heart

Congestive Heart Failure

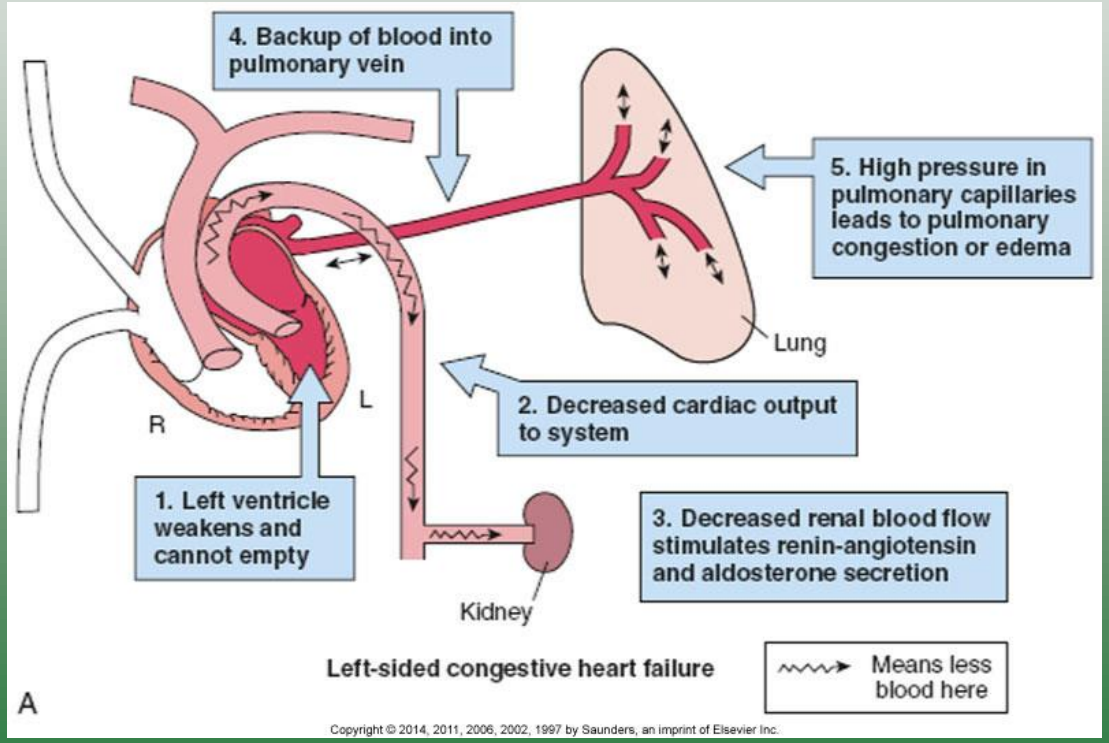
- Heart is unable to pump out sufficient blood to meet metabolic demands of the body.
- Usually a complication of another cardiopulmonary condition
- May involve a combination of factors
- Various compensation mechanisms maintain cardiac output.
  - Some of these often aggravate the condition.

Congestive Heart Failure (Cont.)

- When heart cannot maintain pumping capability
  - Cardiac output or stroke volume decreases.
    - Less blood reaches the various organs.
    - Decreased cell function
    - Fatigue and lethargy
    - Mild acidosis develops.
  - Backup and congestion develop as coronary demands for oxygen and glucose are not met.
    - Output from ventricle is less than the inflow of blood.
    - Congestion in venous circulation draining into the affected side of the heart

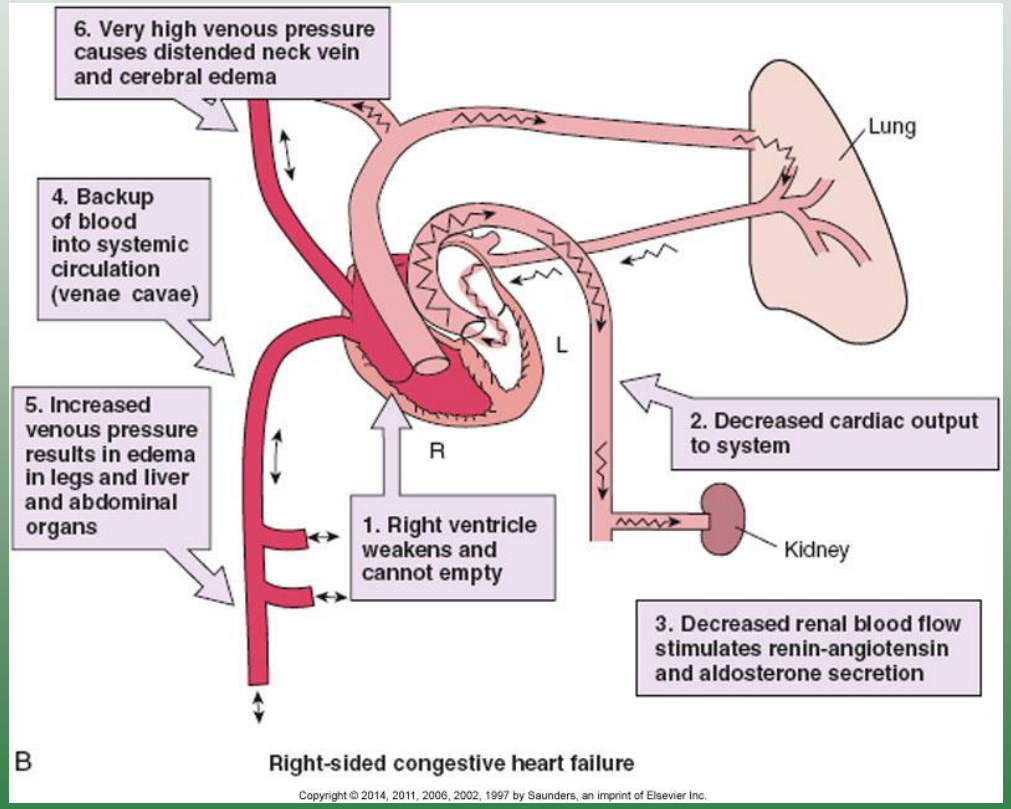
Effects of Congestive Heart Failure

- Left-sided congestive heart failure



Effects of Congestive Heart Failure

- Right-sided congestive heart failure



Signs and Symptoms of Congestive Heart Failure

- Forward effects (similar with failure on either side)
  - Decreased blood supply to tissues, general hypoxia
  - Fatigue and weakness
  - Dyspnea and shortness of breath
- Compensation mechanisms
  - Tachycardia
  - Cutaneous and visceral vasoconstriction
  - Daytime oliguria

Signs and Symptoms of Congestive Heart Failure

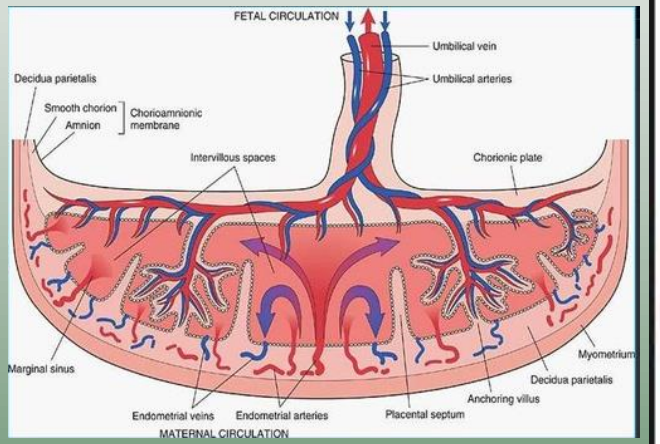
- Backup effects of left-sided failure
  - Related to pulmonary congestion
  - Dyspnea and orthopnea
    - Develop as fluid accumulates in the lungs
  - Cough
    - Associated with fluid irritating the respiratory passages
  - Paroxysmal nocturnal dyspnea
    - Indicates the presence of acute pulmonary edema
    - Usually develops during sleep
    - Excess fluid in lungs frequently leads to infections such as pneumonia.

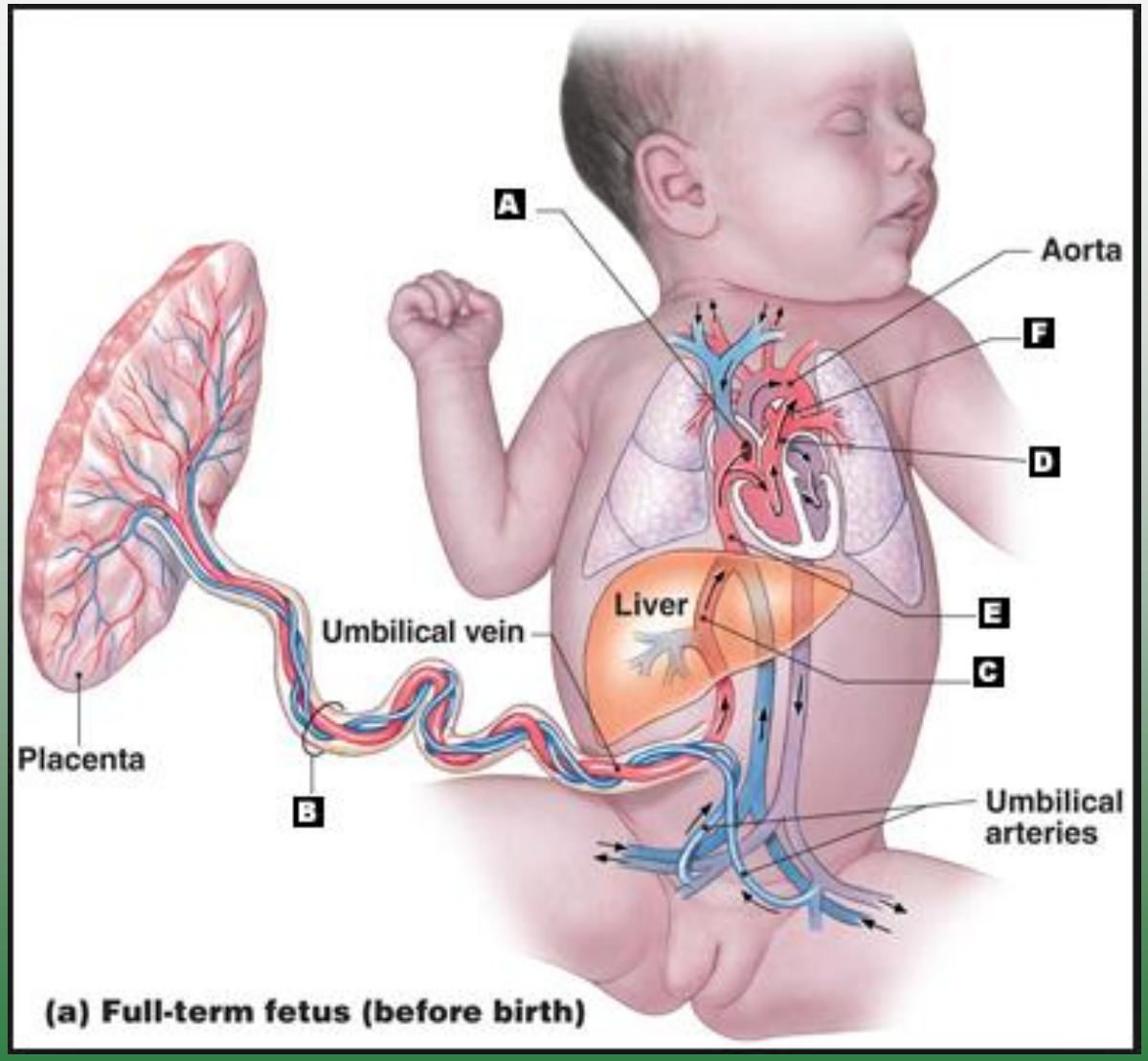
Signs and Symptoms of Congestive Heart Failure

- Signs of right-sided failure and systemic backup
  - Dependent edema in feet, legs, or buttocks
  - Increased pressure in jugular veins leads to distention.
  - Hepatomegaly and splenomegaly
    - Digestive disturbances
  - Ascites
    - Complication when fluid accumulates in peritoneal cavity
    - Marked abdominal distention
  - Acute right-sided failure
    - Flushed face, distended neck veins, headache, visual disturbances

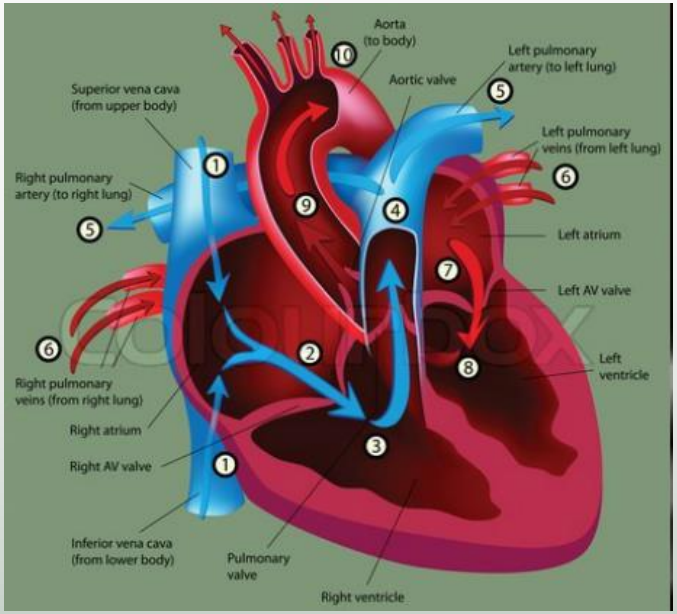
END OF PART ONE

Congenital Heart Defects – Review Fetal Circulation

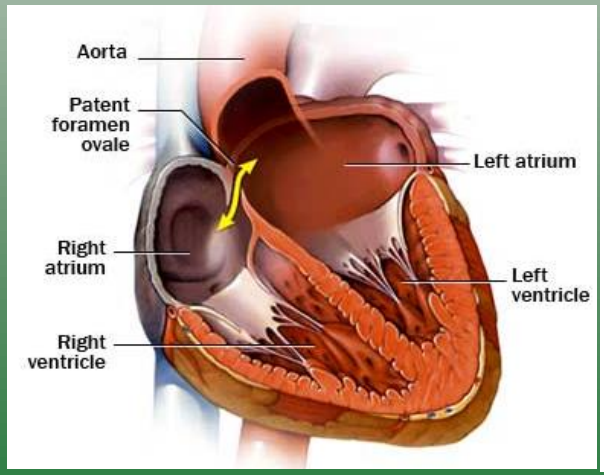




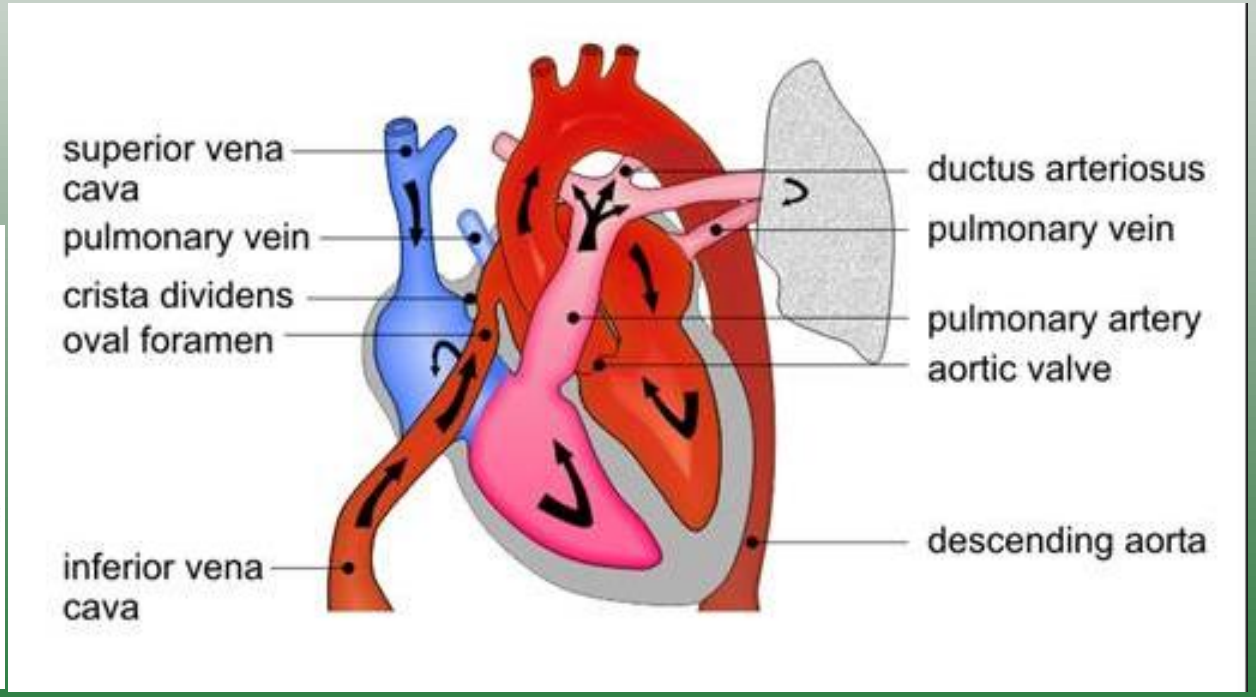
Fetal vs Post-Natal Circulation



After Being Born



Before Being Born



Congenital Heart Defects

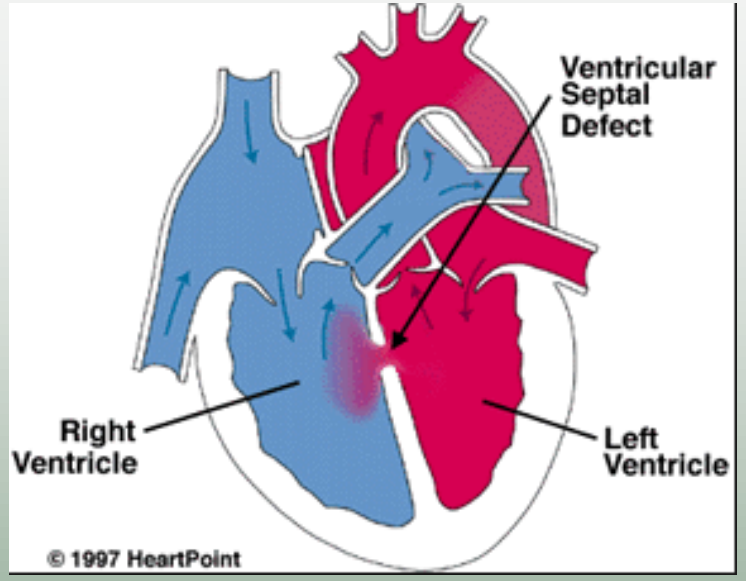
- Signs and symptoms of large defects
  - Pallor
  - Tachycardia
    - Occurs with very rapid sleeping pulse and frequent pulse deficit
  - Dyspnea on exertion
  - Squatting position—toddlers and older children
    - Appears to modify blood flow, more comfortable
  - Clubbed fingers
  - Intolerance for exercise and exposure to cold weather
  - Delayed growth and development

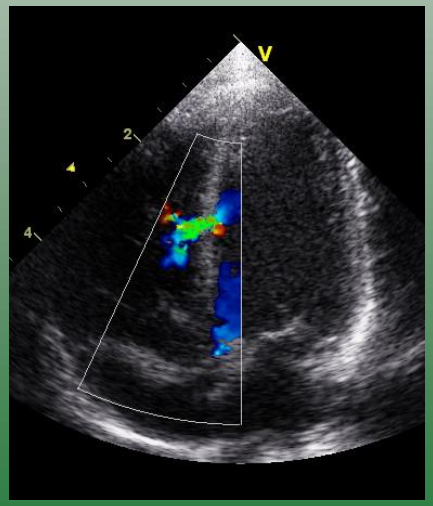
Congenital Heart Defects (Cont.)

- Severe defects are often diagnosed at birth.
- Others may not be detected for some time.
- Examination techniques
  - Radiography
  - Diagnostic imaging
  - Cardiac catheterization
  - Echocardiography
  - Electrocardiography
- Surgical repair

Ventricular Septal Defect

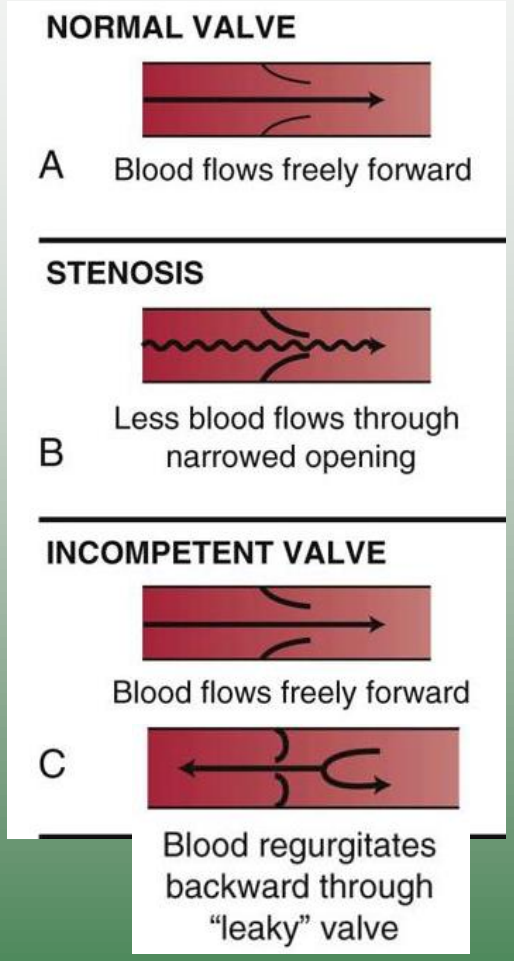
- VSD is the most common congenital heart defect.
- Opening in the interventricular septum
  - May vary in size and location
- Untreated VSD
  - Pressure usually higher in left ventricle.
  - Shunt from left → right (leading to pulmonary hypertension).
  - Acyanotic condition unless respiratory condition increases pressure in right ventricle



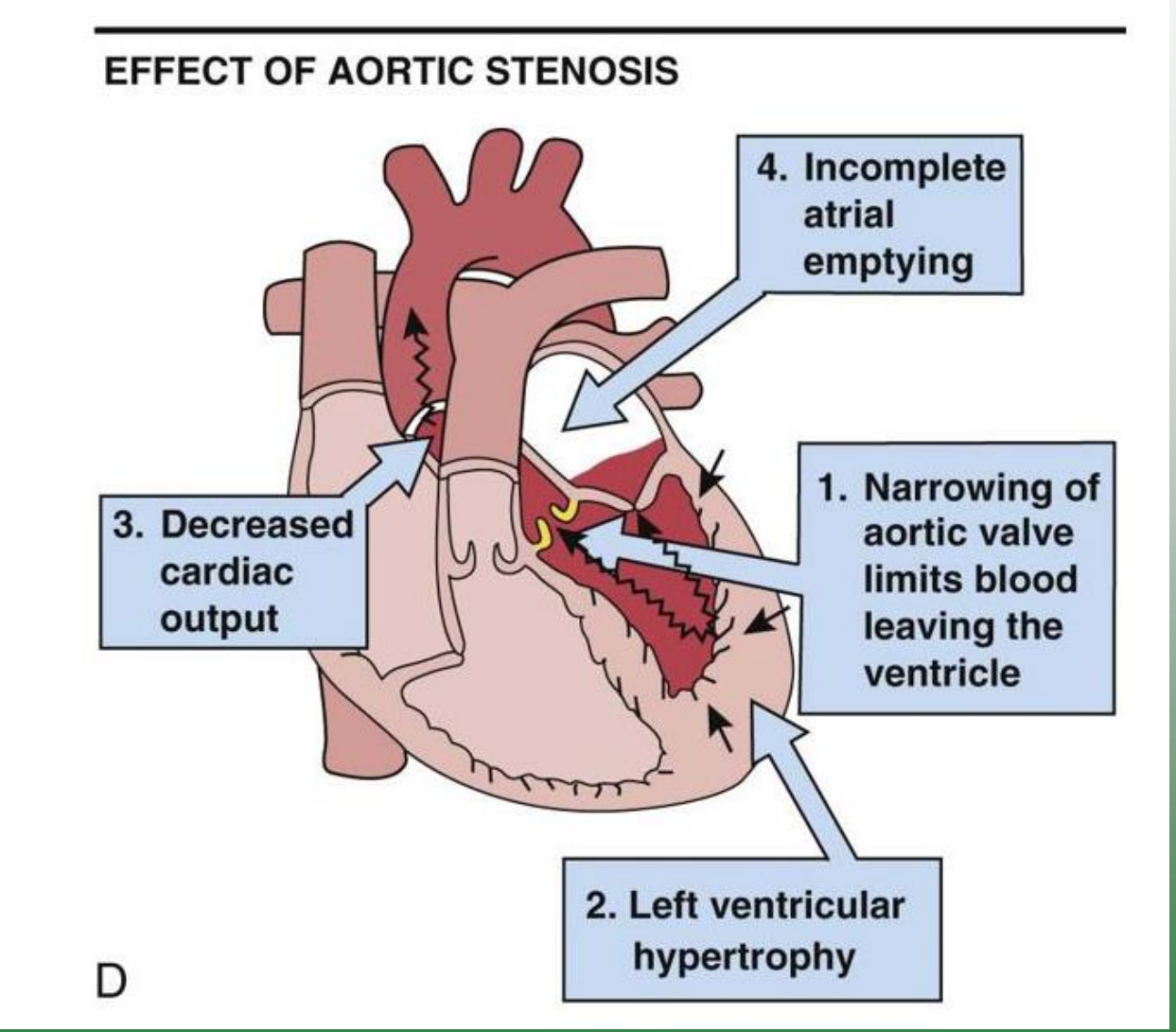


Valvular Defects

- Usually affect aortic and pulmonary valves
- May be classified as stenosis or valvular incompetence
  - Failure of valve to close completely
  - Blood regurgitates or leaks backward
- Mitral valve prolapse
  - Abnormally enlarged and floppy valve leaflets
- Surgical replacement
  - Mechanical or animal (porcine) tissue

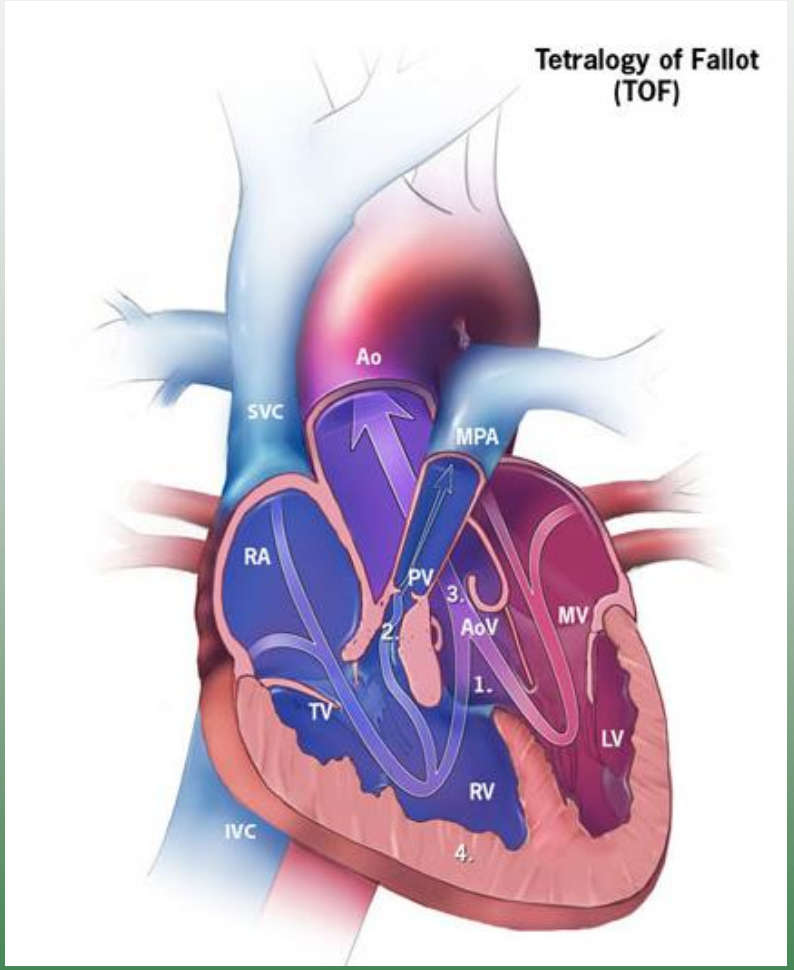


Effects of Heart Valve Defects

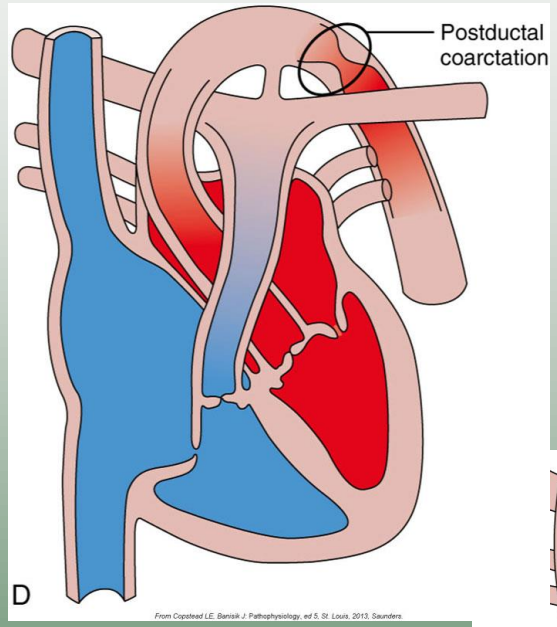


Tetralogy of Fallot

- Most common cyanotic (R → L shunt) congenital heart condition
- Cyanosis occurs because shunt bypasses the pulmonary circulation.
- Alters pressures in heart and alters blood flow
- Includes four abnormalities
  - Pulmonic stenosis (pulmonic valve narrowed)
  - VSD
  - Dextroposition of the aorta
  - Right ventricular hypertrophy



Congenital Heart Defects



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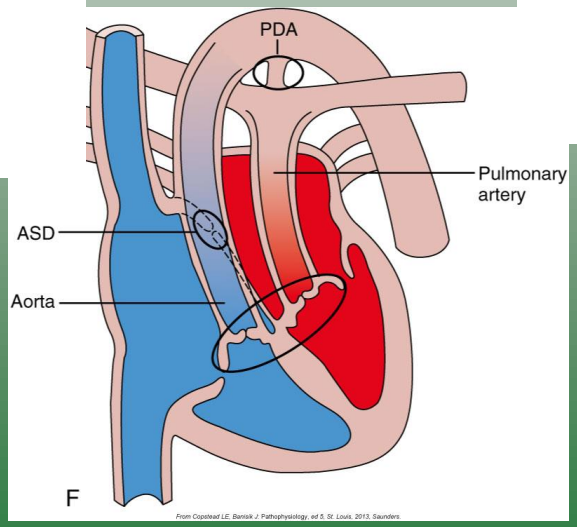
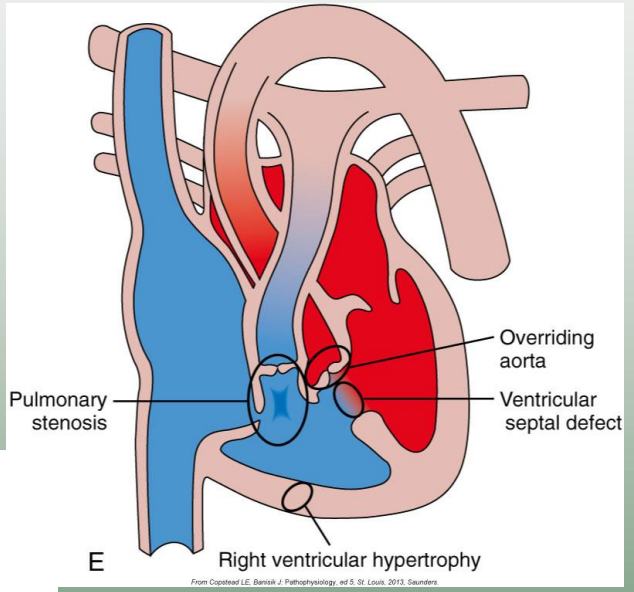


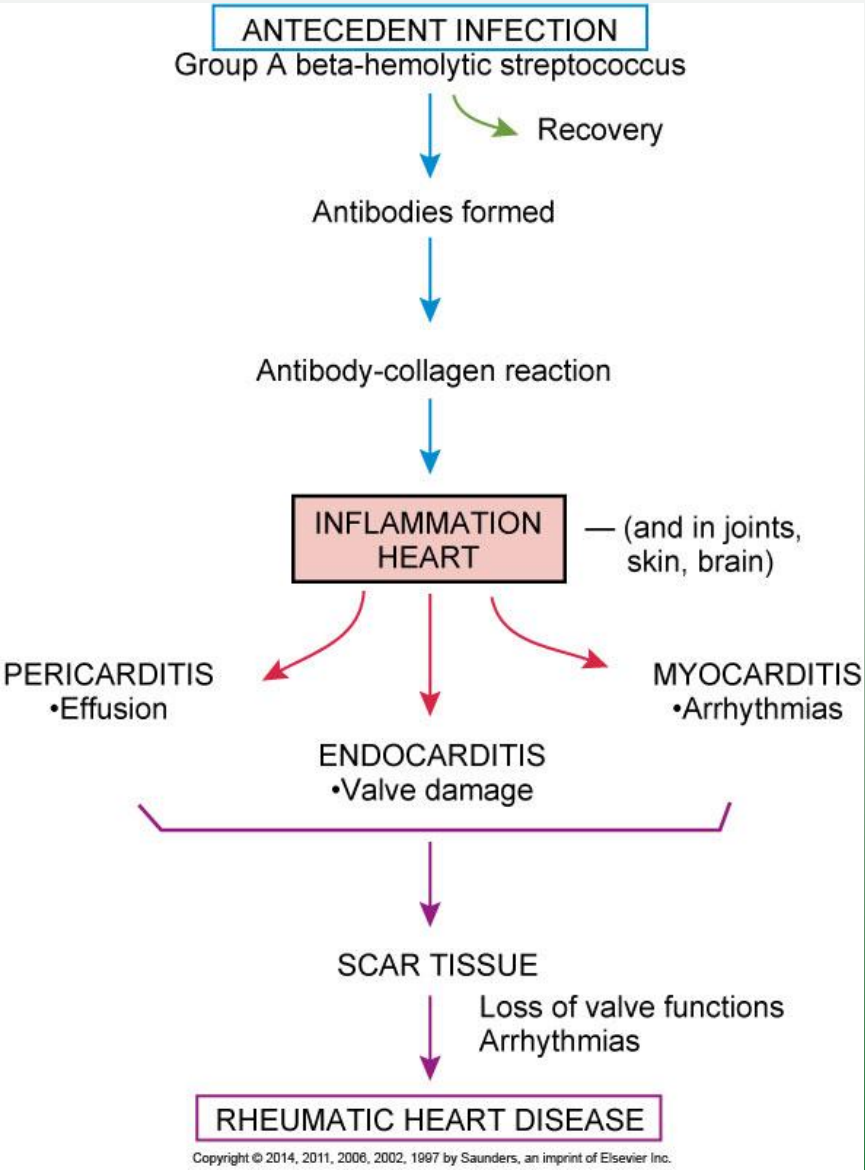


Tetralogy of Fallot

Transposition of
the great arteries

Inflammation and Infection in the Heart

Development of Rheumatic Fever and Rheumatic Heart Disease



Rheumatic Fever and Rheumatic Heart Disease

- Signs and symptoms
  - Low-grade fever, leukocytosis, malaise, anorexia, fatigue, tachycardia
- Diagnostic tests
  - Heart function test
  - Electrocardiography
  - ASO titer
- Treatment
  - Prophylactic antibacterial agents
  - Anti-inflammatory agents

Infective Endocarditis

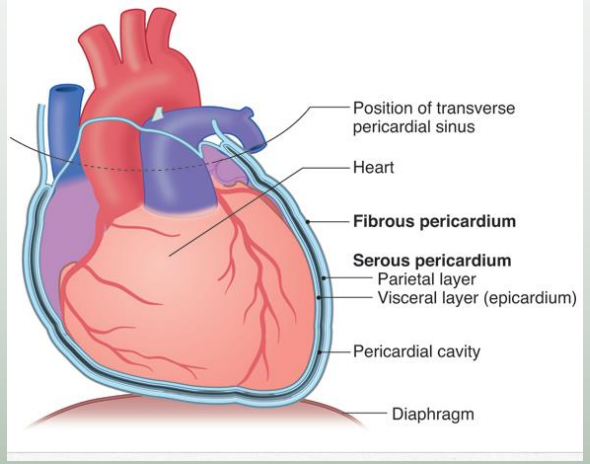
- Subacute
  - *Streptococcus viridans*
- Acute
  - *Staphylococcus aureus*
- Basic effects
  - Same regardless of organism
- Factors that predispose to infection
  - Presence of abnormal
  - valves in heart
  - Bacteremia
  - Reduced host defenses

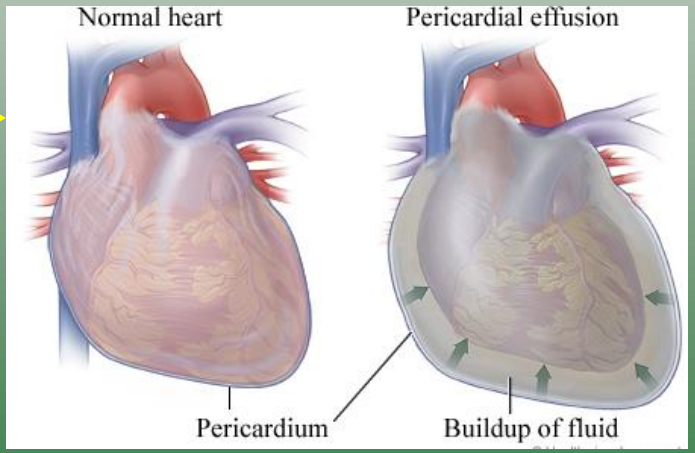
Infective Endocarditis (Cont.)

- Low-grade fever or fatigue
- Anorexia, splenomegaly, congestive heart failure in severe cases
- Acute endocarditis
  - Sudden, marked onset—spiking fever, chills, drowsiness
- Subacute endocarditis
  - Insidious onset—increasing fatigue, anorexia, cough, and dyspnea
- Blood culture to identify causative agent
  - Antimicrobial drugs for several weeks, often IV

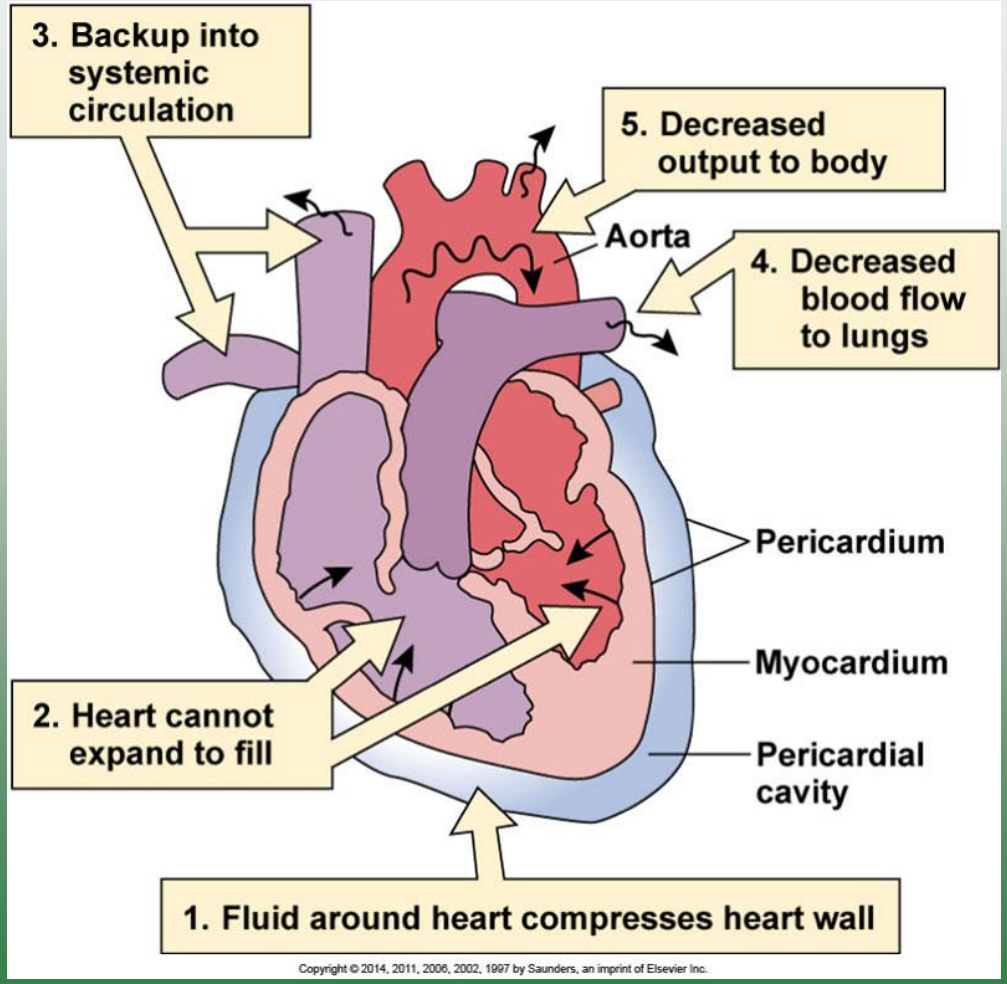
Pericarditis

- Usually secondary to another condition
- Classified by cause or type of exudate
- Acute pericarditis
  - May involve simple inflammation of the pericardium
  - May be secondary to:
    - Open heart surgery, myocardial infarction, rheumatic fever, systemic lupus erythematosus, cancer, renal failure, trauma, viral infection
  - Effusion may develop.
    - Large volume of fluid accumulates in pericardial sac
    - Leads to distended neck veins, faint heart sounds, pulsus paradoxus





Effects of Pericardial Effusion



Pericarditis (Cont.)

- Chronic pericarditis
  - Results in formation of adhesions between the pericardial membranes
  - Fibrous tissue often results from tuberculosis or radiation to the mediastinum.
  - Limiting movement of the heart during diastole and systole → reduced cardiac output
  - Inflammation or infection may develop from adjacent structures.
  - Causes fatigue, weakness, abdominal discomfort
    - Caused by systemic venous congestion

Vascular Disorders

Arterial Diseases—Hypertension

- High blood pressure
  - Common
  - May occur in any age group
  - More common in individuals of African ancestry
- Sometimes classified as systolic or diastolic

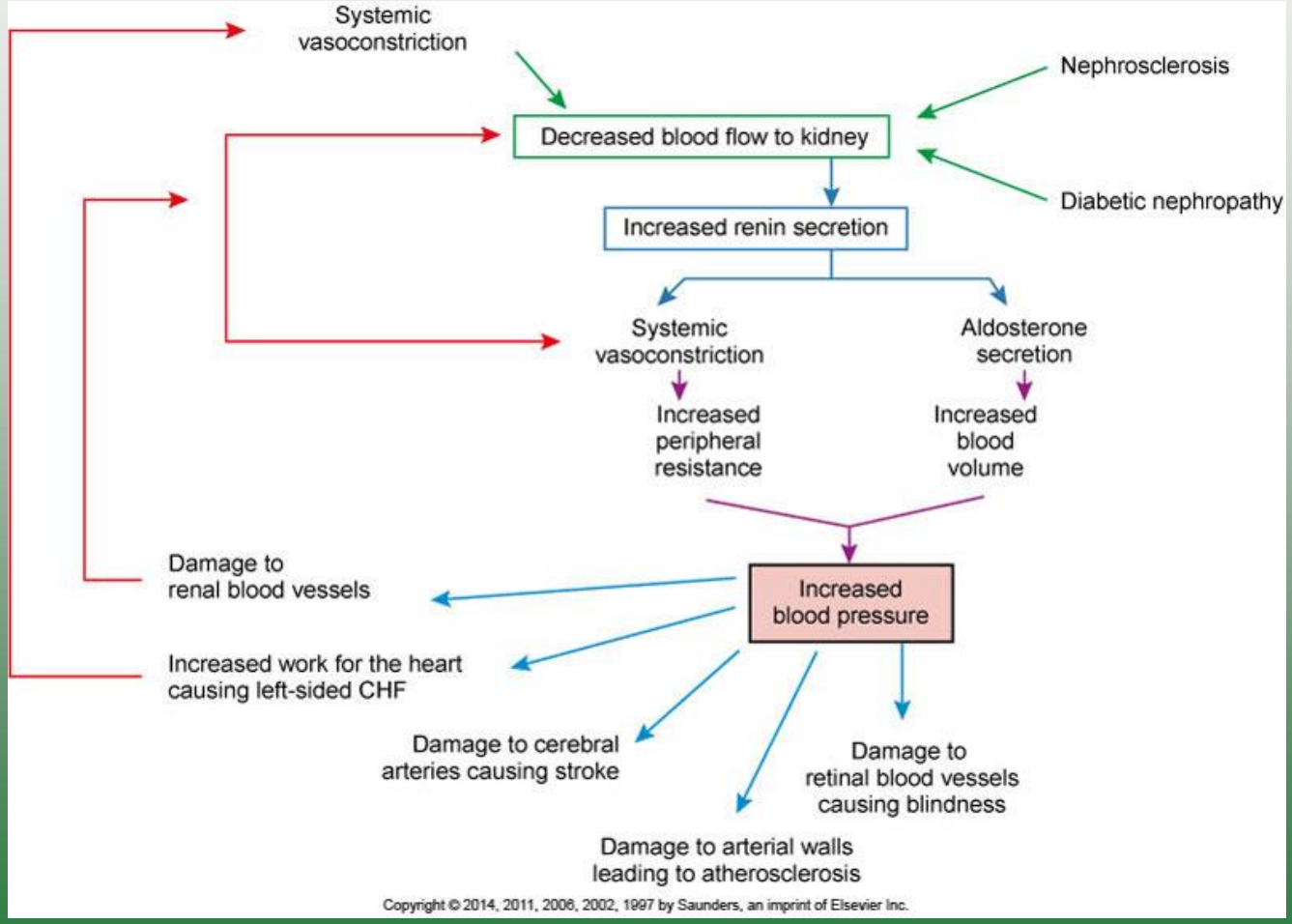
Arterial Diseases—Hypertension (Cont.)

- Primary
  - Essential hypertension
  - Blood pressure consistently above 140/90 mm Hg
    - May be adjusted for age
  - Increase in arteriolar vasoconstriction
  - Over long period of time—damage to arterial walls
    - Blood supply to involved area is reduced.
    - Ischemia and necrosis of tissues, with loss of function

Arterial Diseases—Hypertension (Cont.)

- Secondary hypertension
  - Results from renal or endocrine disease, pheochromocytoma (benign tumor of the adrenal medulla)
  - Underlying problem must be treated to reduce blood pressure.
- Malignant or resistant hypertension
  - Uncontrollable, severe, and rapidly progressive form with many complications
  - Diastolic pressure is extremely high.

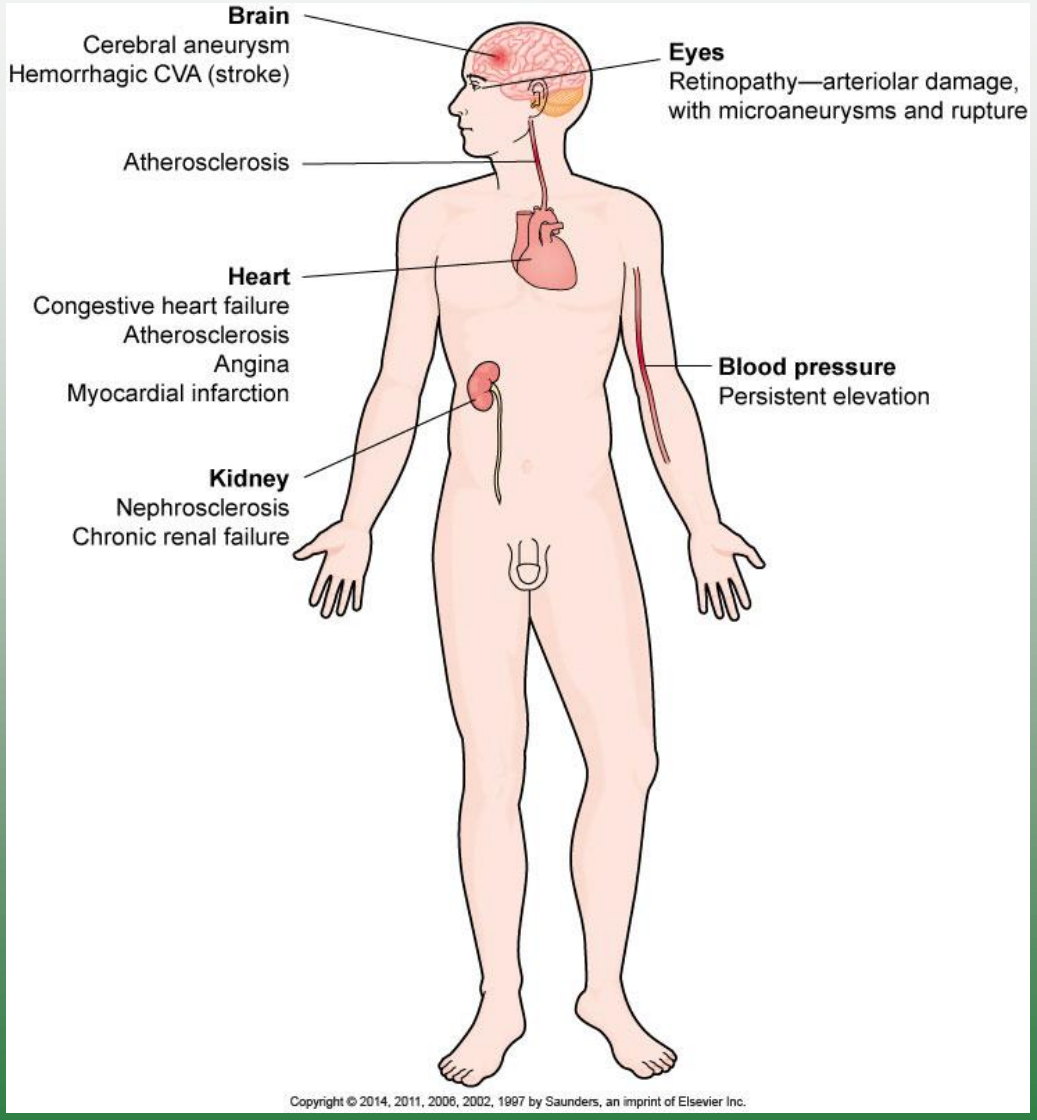
Development of Hypertension



Arterial Diseases—Hypertension (Cont.)

- Areas most frequently damaged by hypertension
  - Kidneys
  - Heart
  - Brain
  - Retina
- Predisposing factors
  - Incidence increases with age.
  - Men affected more frequently and more severely
  - Incidence in women increases after middle age.
  - Genetic factors
  - Sodium intake, excessive alcohol intake, obesity, smoking, prolonged or recurrent stress

Effects of Uncontrolled Hypertension



Arterial Diseases—Hypertension

- Frequently asymptomatic in early stages
  - Initial signs vague and nonspecific
    - Fatigue, malaise, sometimes morning occipital headache
- Essential hypertension treated in steps
  - Lifestyle changes
  - Reduction of sodium intake
  - Weight reduction
  - Reduction of stress
  - Drugs
    - Diuretics, ACE inhibitors, drug combinations

Peripheral Vascular Disease: Atherosclerosis

- Disease in arteries outside the heart
- Increased incidence with diabetes
- Most common sites
  - Abdominal aorta
  - Carotid arteries
  - Femoral and iliac arteries
- Diagnostic tests
  - Blood flow assessed by Doppler studies and arteriography
  - Plethysmography measures the size of limbs and blood volume in organs or tissues.

Peripheral Vascular Disease: Atherosclerosis

- Signs and symptoms
  - Increasing fatigue and weakness in the legs
  - Intermittent claudication (leg pain)
    - Associated with exercise caused by muscle ischemia
  - Sensory impairment
    - Tingling, burning, numbness
  - Peripheral pulses distal to occlusion become weak.
  - Appearance of the skin of the feet and legs changes.
    - Marked pallor or cyanosis
    - Skin dry and hairless
    - Toenails thick and hard

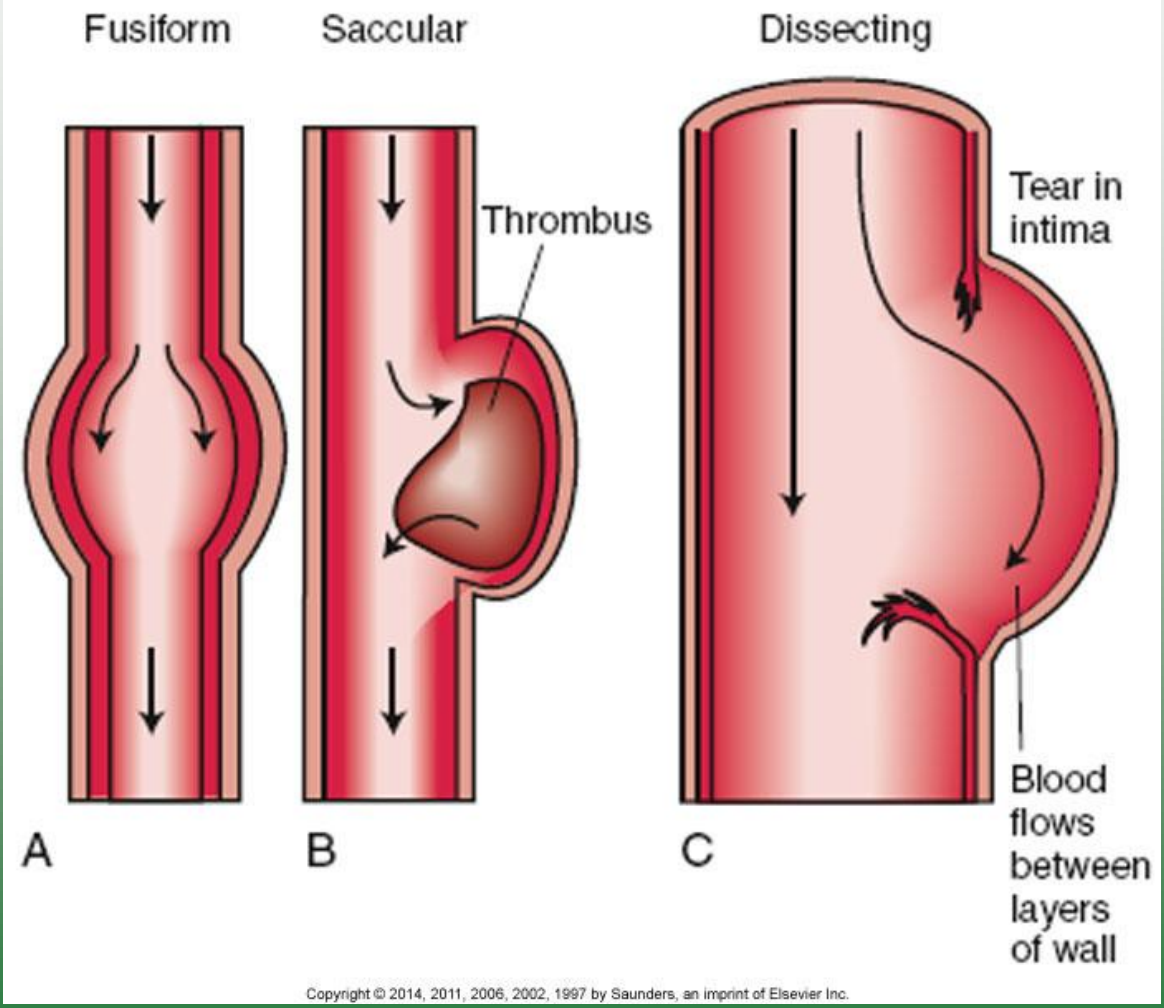
Peripheral Vascular Disease: Atherosclerosis

- Treatment
  - Maintain control of blood glucose level.
  - Reduce body mass index.
  - Reduce serum cholesterol level.
  - Platelet inhibitors or anticoagulant medication
  - Cessation of smoking
  - Increase activity and exercise
  - Maintain dependent position for legs—improves arterial perfusion
  - Peripheral vasodilators
  - Observe skin for breakdown and treat promptly.
  - If gangrene develops, amputation is required.

Aortic Aneurysm

- Localized dilation and weakening of arterial wall
- Develops from a defect in the medial layer
- Different shapes
  - Saccular
    - Bulging wall on the side
  - Fusiform
    - Circumferential dilation along a section of artery
  - Dissecting aneurysm
    - Develops when there is a tear in the intima of the wall and blood continues to dissect or separate tissues

Types of Aortic Aneurysms



Aortic Aneurysm (Cont.)

- Causes
  - Atherosclerosis
  - Trauma
  - Syphilis and other infections
  - Congenital defects
- Signs and symptoms
  - Bruit may be heard on auscultation.
  - Pulse may be felt on palpation of abdomen.
  - Frequently asymptomatic until they become large or rupture
    - Rupture may lead to moderate bleeding but usually causes severe hemorrhage and death.

Aortic Aneurysm (Cont.)

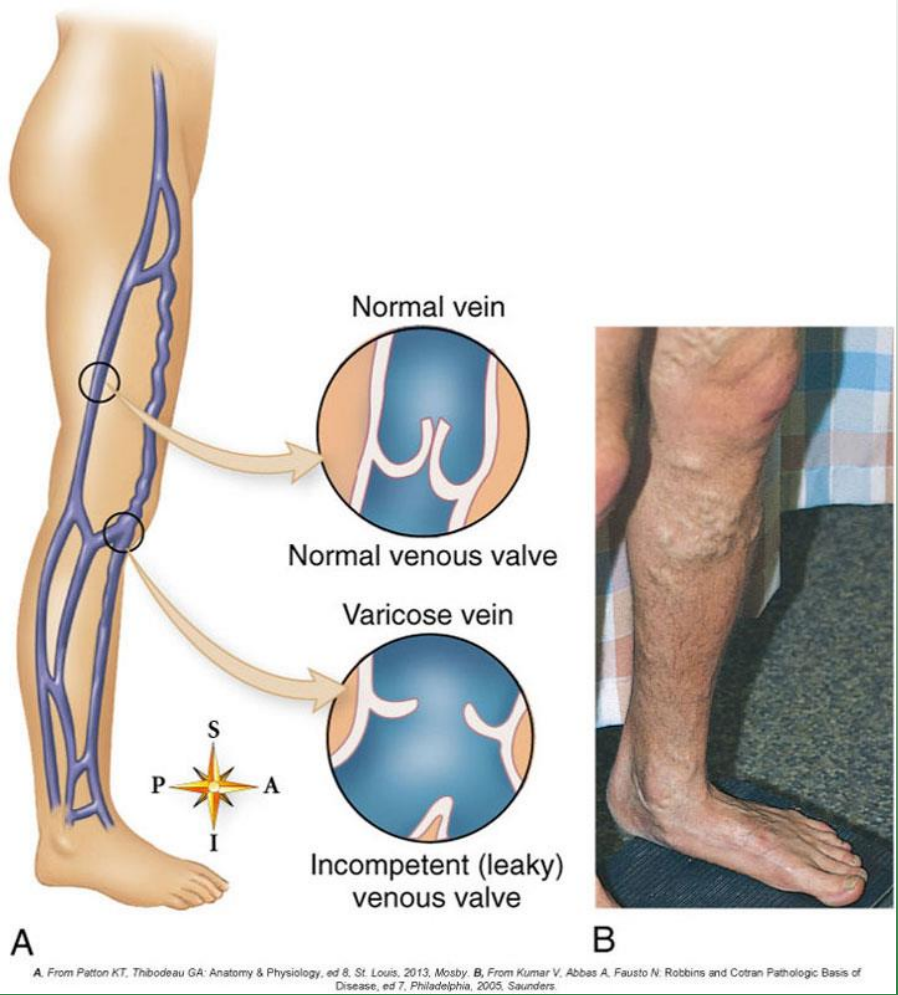
- Diagnostic tests
  - Radiography
  - Ultrasound
  - CT scanning
  - MRI
- Treatment
  - Maintain blood pressure at normal level.
  - Prevent sudden elevations caused by exertion.
  - Prevent stress, coughing, constipation
  - Surgical repair

Venous Disorders

Varicose Veins

- Irregular, dilated, tortuous areas of superficial veins
- Familial tendency
- Increased body mass index, parity, and weight lifting are risks.
- In the legs
  - May develop from defect or weakness in vein walls or valves
  - Appear as irregular, purplish, bulging structures
- Treatment
  - Keep legs elevated, support stockings
  - Restricted clothing, crossing legs to be avoided

Varicose Veins (Cont.)



A. From Patton KT, Thibodeau GA: Anatomy & Physiology, ed 8, St. Louis, 2013, Mosby. B, From Kumar V, Abbas A, Fausto N: Robbins and Cotran Pathologic Basis of Disease, ed 7, Philadelphia, 2005, Saunders.

Thrombophlebitis and Phlebothrombosis

- Thrombophlebitis
  - Thrombus development in inflamed vein (e.g., IV site)
- Phlebothrombosis
  - Thrombus forms spontaneously without prior inflammation; attached loosely
- Factors for thrombus development
  - Stasis of blood or sluggish blood flow
  - Endothelial injury
  - Increased blood coagulability

Thrombophlebitis and Phlebothrombosis

- Signs and symptoms
  - Often unnoticed
  - Aching, burning, tenderness in affected legs
  - Systemic signs—fever, malaise, leukocytosis
- Complication—pulmonary embolism
- Treatment
  - Preventive measures
    - Exercise, elevating legs
  - Anticoagulant therapy
  - Surgical intervention

Shock

- Hypovolemic shock
  - Loss of circulating blood volume
- Cardiogenic shock
  - Inability of heart to maintain cardiac output to circulation
- Distributive, vasogenic, neurogenic, septic, anaphylactic shock
  - Changes in peripheral resistance leading to pooling of blood in the periphery

Types of Shock

TABLE 12-4 Types of Shock

Type	Mechanism	Specific Causes
Hypovolemic	Loss of blood or plasma	Hemorrhage, burns, dehydration, peritonitis, pancreatitis
Cardiogenic	Decreased pumping capability of the heart	Myocardial infarction of left ventricle, cardiac arrhythmia, pulmonary embolus, cardiac tamponade
Vasogenic (neurogenic or distributive)	Vasodilation owing to loss of sympathetic and vasomotor tone	Pain and fear, spinal cord injury, hypoglycemia (insulin shock)
Anaphylactic	Systemic vasodilation and increased permeability owing to severe allergic reaction	Insect stings, drugs, nuts, shellfish
Septic (endotoxic)	Vasodilation owing to severe infection, often with gram-negative bacteria	Virulent microorganisms (gram-negative bacteria) or multiple infections

Shock: Early Manifestations

- Anxiety
- Tachycardia
- Pallor
- Light-headedness
- Syncope
- Sweating
- Oliguria

Shock (Cont.)

- Compensation mechanisms
  - SNS and adrenal medulla stimulated—increase heart rate, force of contraction, systemic vasoconstriction
  - Renin secretion increases.
  - Increased ADH secretion
  - Secretion of glucocorticoids
  - Acidosis stimulates increased respiration.
    - With prolonged shock, cell metabolism is diminished, waste not removed—leads to lower pH

Shock (Cont.)

- Complications of shock
  - Acute renal failure
  - Shock lung, or adult respiratory distress syndrome
  - Hepatic failure
  - Paralytic ileus, stress or hemorrhagic ulcers
  - Infection or septicemia
  - Disseminated intravascular coagulation
  - Depression of cardiac function

END OF PART TWO