Introduction to Cardiology

Pharmacotherapy I
Spring 2020
Dr. Abdallah Abukhalil

Expectations

- Come to class on time
- Be attentive and engaged
- Time Management
- Read the chapters from DiPiro
- Do your homework and patient cases
- Apply PPCP

Objectives

- Interpret basic physical assessment findings related to vital signs
- Explain basic cardiology terms and definitions
- Calculate ejection fraction (EF) and mean arterial pressure (MAP)
- Compare & contrast inotrope, chronotrope, & dromotrope and identify medications with (+) and (-) properties
- Define Q_T prolongation, its causes, and consequences
- Identify medications contraindicated in various degrees of heart block

Lecture Outline

VITAL SIGNS

CIRCULATION

HEMODYNAMIC TERMS

CARDIAC CONDUCTION

VALVULAR HEART DISEASE

CARDIAC TESTING

Vital Signs

Vital Signs: Blood Pressure

Sphygmomanometer

- Manual
- Digital

Normal variation

Vital Signs: Blood Pressure

Patient Requirements

Seated in chair, arm unconstricted

Resting quietly ≥ 5 minutes

Legs uncrossed

Feet flat on floor

Comfortable ambient temperature

No tobacco or caffeine in prior 30 minutes

Avoid anxiety, bladder distension

Verification of Hypertension

Verification of High BP

Repeat in 2 min

- a) If differ < 5 mm Hg (average)
- b) If differ ≥ 5 mm Hg (repeat)

Check other arm; Use higher of two

Check BP after patient standing 2 minutes

Factors Affecting Blood Pressure

Age

- Isolated systolic hypertension

Race

Diurnal rhythm

Exercise

Obesity

Emotions

Medications

Factors Affecting Blood Pressure

Incorrect cuff size

- Too large – false low reading
- Too small – false high reading

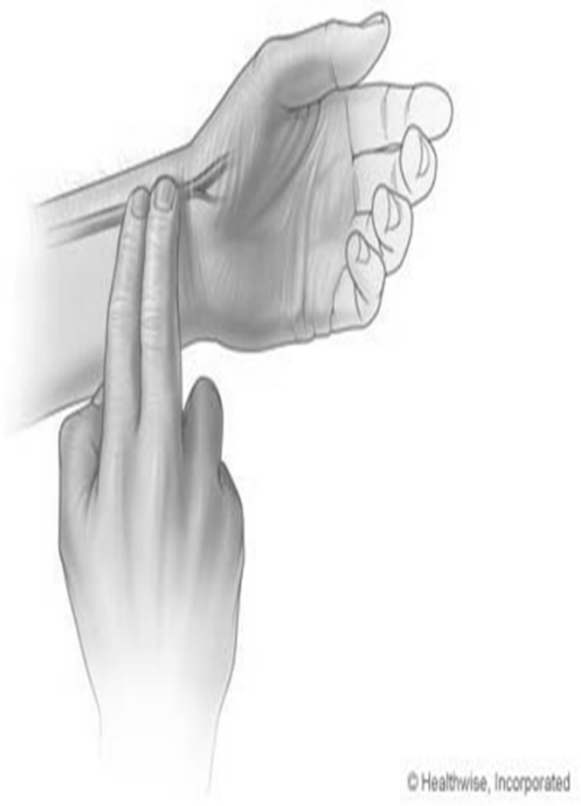
Improper position

- Above heart level – false low reading
- Below heart level – false high reading

Anxiety, pain, discomfort, full bladder

Deflating the cuff too quickly/too slowly

Vital Signs: Pulse



Pressure wave with each heartbeat

Used to assess heart rate and rhythm

Radial Pulse

- Site – radial artery medial to radius
- Palpation technique

Counting method

- 30 seconds and multiple by 2
- Shorter time increases errors
- If irregular, count for one minute

Heart rate (normal 60-100)

- Bradycardia < 60 beats per minute
- Tachycardia > 100 beats per minute

Rhythm

- Irregular = arrhythmia, e.g., atrial fibrillation

Vital Signs: Respirations

Techniques	Do not tell the patient	Keep “checking” radial pulse
Place hand on shoulder	Listen over sternum	Count breaths in 30 seconds, multiply by 2
Normal rate = 12-20	Bradypnea < 12 breaths per minute	Tachypnea > 20 breaths per minute

Vital Signs: Temperature

Temperature maintenance	Regulated by hypothalamus	Heat production through metabolism and exercise
Heat loss through evaporation of sweat	Peripheral vasoconstriction/-dilation	Diurnal variation
Normal: 37° C (98.6° F)	Fever: ≥ 38° C (100.4° F)	Hypothermia: < 35° C (95° F)

Vital Signs: Pain

Assessment of Pain

Assess “person with pain”

Part of routine assessment

Primary mode of assessment - clinical interview

Interdisciplinary process

Vital Statistics

Height

- Endocrine and developmental status
- Loss of height from osteopenia

Weight

- Nutrition
- Development
- Fluid status

Vital Statistics

Body mass index (BMI) = Wt(kg)/Ht (m)2 or

703.1 X Wt (lbs)/Ht (in)2

BMI interpretation

- Underweight: < 18.5 kg/m2
- Healthy weight: 18.5 to 24.9 kg/m2
- Overweight: 25 to 29.9 kg/m2
- Obesity: 30 and above kg/m2

Waist:Hip ratio (Normal ♂ ≤ 1.0; ♀ ≤ 0.8);

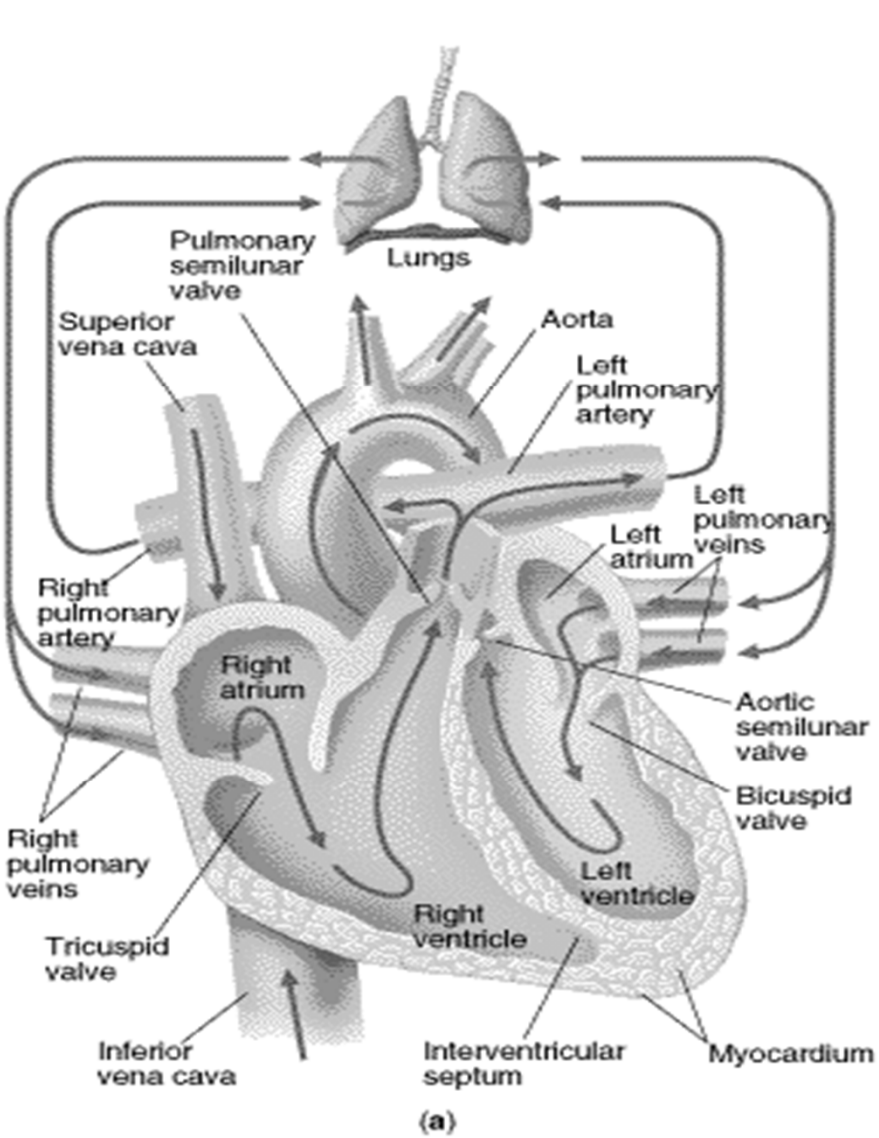
Replaced with waist circumference (>35" women, > 40" men at risk)

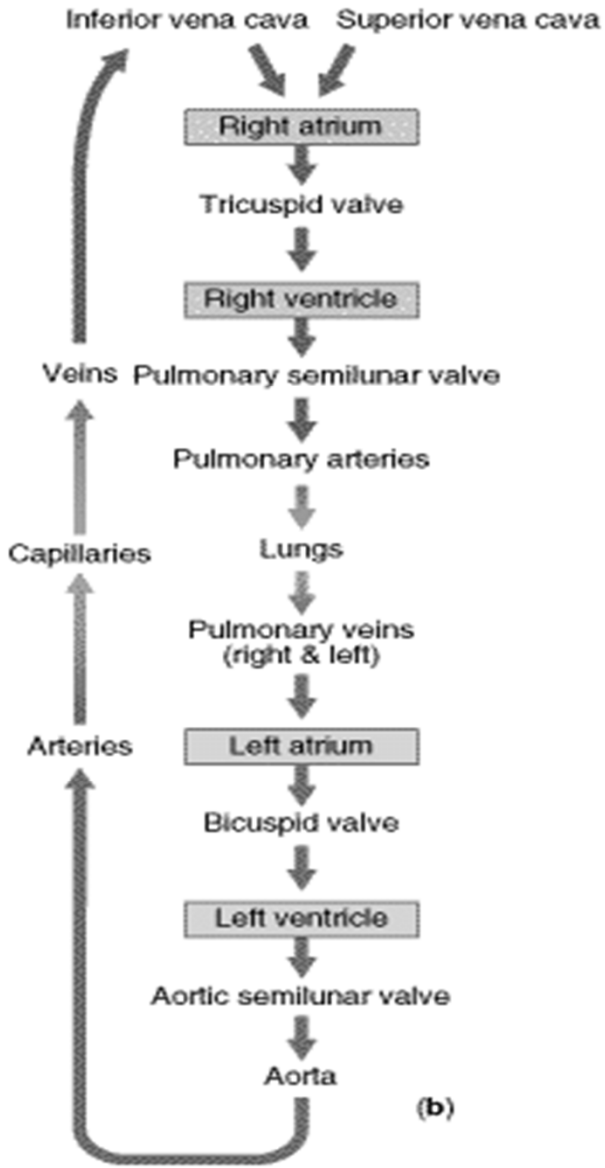
Vital Statistics

Ideal Body Weight

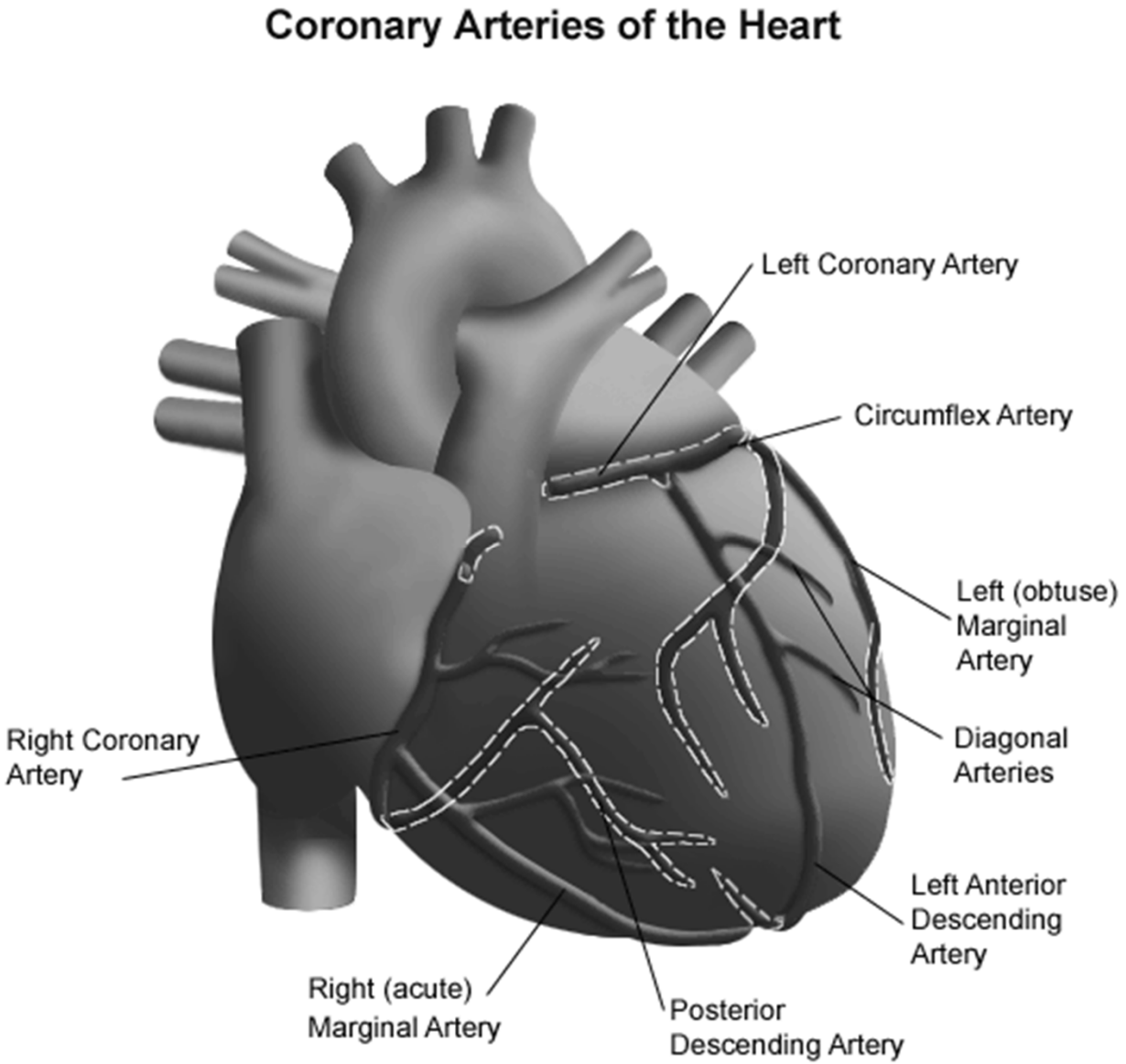
- Males = 50 kg + 2.3 kg per inch > 5 ft
- Females = 45.5 kg + 2.3 kg per inch > 5 feet
- ± 10% for large/small frame
- Example – IBW for male who is 5’10” = 73 kg

Blood Flow Through the Heart





Coronary Circulation



Coronary Arteries Circulation

5% of circulating blood is used to supply heart

Aorta → left coronary artery (left main)→ left anterior descending artery & left circumflex artery

Aorta → right coronary artery → marginal artery & posterior descending artery

Hemodynamic Terms

Terms & Definitions

Systole

- Contraction of the heart

Diastole

- Relaxation of the heart

Systolic blood pressure (SBP)

- Peak arterial blood pressure (BP) during ventricular systole

Diastolic pressure (DBP)

- Minimum arterial BP between heartbeats

Terms & Definitions

Stroke volume (SV)

- Amount of blood ejected during ventricular ejection
- Approximately 70 Ml; SV = EDV-ESV

Cardiac output (CO)

- Amount of blood ejected by each ventricle in one minute
- CO= SV x HR
- Usually about 4-6 liters/minute

Cardiac Index (CI)

- CI = CO/BSA – relates heart performance to size of individual
- Normal Range 2.6-4.2 L/min/m2

Terms & Definitions

End diastolic volume (EDV)

- Amount of blood in the ventricle at the end of filling (130 mL)

End systolic volume (ESV)

- Amount of blood left in ventricle after ejection (60 mL)
- ESV= EDV-SV

Ejection fraction (EF)

- Percentage of the end diastolic volume that is ejected (SV/EDV)

Terms & Definitions

Mean arterial pressure (MAP)

- Measures the stress on blood vessels throughout the cardiac cycle
- MAP=[(2 X DBP) + SBP] / 3

Peripheral resistance

- Resistance that blood encounters in the vessels as it moves away from heart
- Dependent on blood viscosity, vessel length, and vessel radius

Terms & Definitions

Preload

- The tension/wall stress in ventricular myocardium immediately before contraction
- ↑ Preload → ↑stroke volume

Afterload

- The force or load that left ventricle must pump against
- ↑ afterload → ↓stroke volume

Preload is the stretching of muscle fibers in the ventricles as the ventricles fill with blood. Think of preload as a balloon stretching as air is blown into it. The more air being blown, the greater the stretch.

Contractility refers to the inherent ability of the myocardium to contract normally. Contractility is influenced by preload. The greater the stretch, the more forceful the contraction — or, the more air in the balloon, the greater the stretch, and the farther the balloon will fly when the air is allowed to expel.

Afterload refers to the pressure that the ventricular muscles must generate to overcome the higher pressure in the aorta to get the blood out of the heart. Resistance is the knot on the end of the balloon, which the balloon has to work against to get the air out.

Terms & Definitions

Inotrope → influences contraction strength

- (+) inotrope, ↑ contractility
  - strengthens the force of cardiac contraction
  - Dopamine, Epinephrine, Isoproterenol, Amiodarone, etc)
- (-) inotrope, ↓ contractility
  - weakens force of contraction
  - labetol and propranolol

Chronotrope → influences heart rate & rhythm

- (+) chronotropes ↑ heart rate
  - accelerating the heart rate
  - Atropine, Milrinone and Theophylline)
- (-) chronotrope ↓ heart rate
  - slow down heart rate
  - digoxin, acetylcholine and metoprolol

Dromotrope → influences conduction

- (+) dromotrope ↑ AV node conduction
  - Speeds up conduction
  - Phenytoin
- (-) dromotrope ↓ AV node conduction
  - Slow down conduction
  - Verapamil

Receptors

Beta receptors

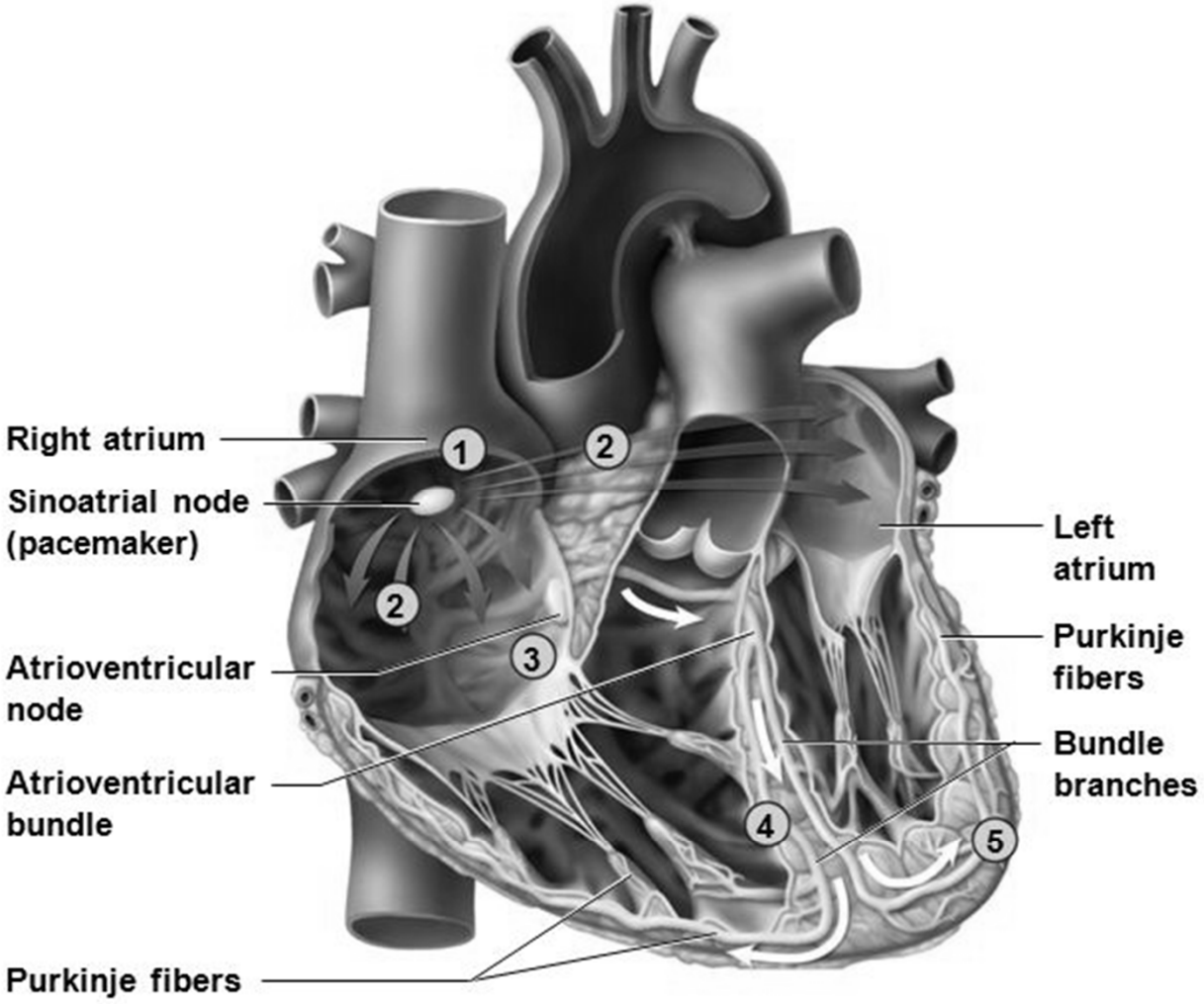
- Presynaptic stimulation facilitates norepinephrine release
- β_1 – predominantly in heart – stimulation causes ↑ in heart rate and contractility
- β_2 – stimulation causes vasodilation of vascular smooth muscle & bronchioles

Alpha receptors

- α_1 – stimulation causes vasoconstriction
- α_2 – stimulation inhibits release of norepinephrine

Cardiac Conduction

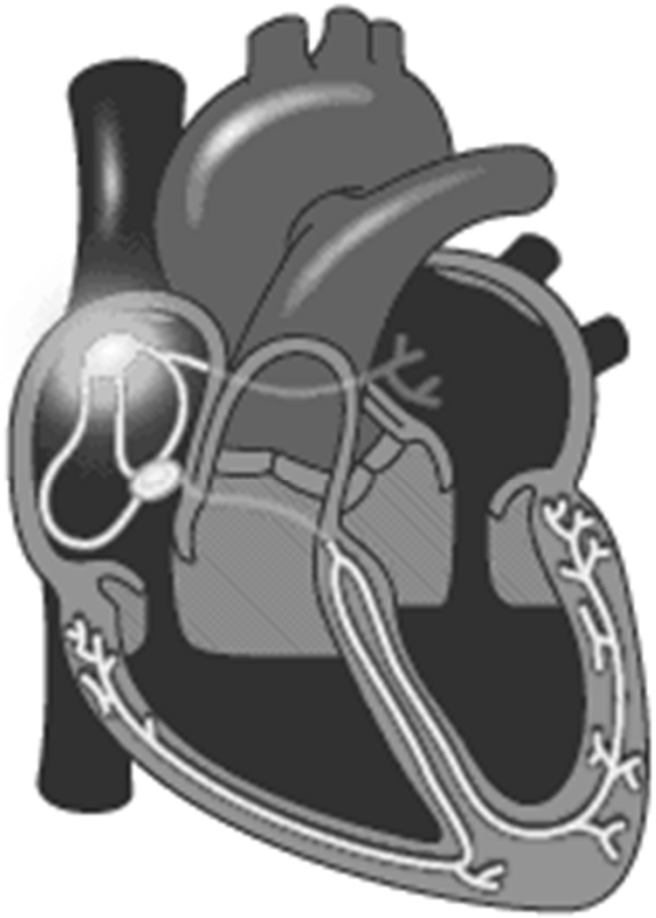
Cardiac Conduction System



1. SA node fires.
2. Excitation spreads through atrial myocardium.
3. AV node fires.
4. Excitation spreads down AV bundle.
5. Purkinje fibers distribute excitation through ventricular myocardium.

http://slideplayer.com/slide/6330533/21/images/32/Cardiac+Conduction+System.jpg

Figure 19.12



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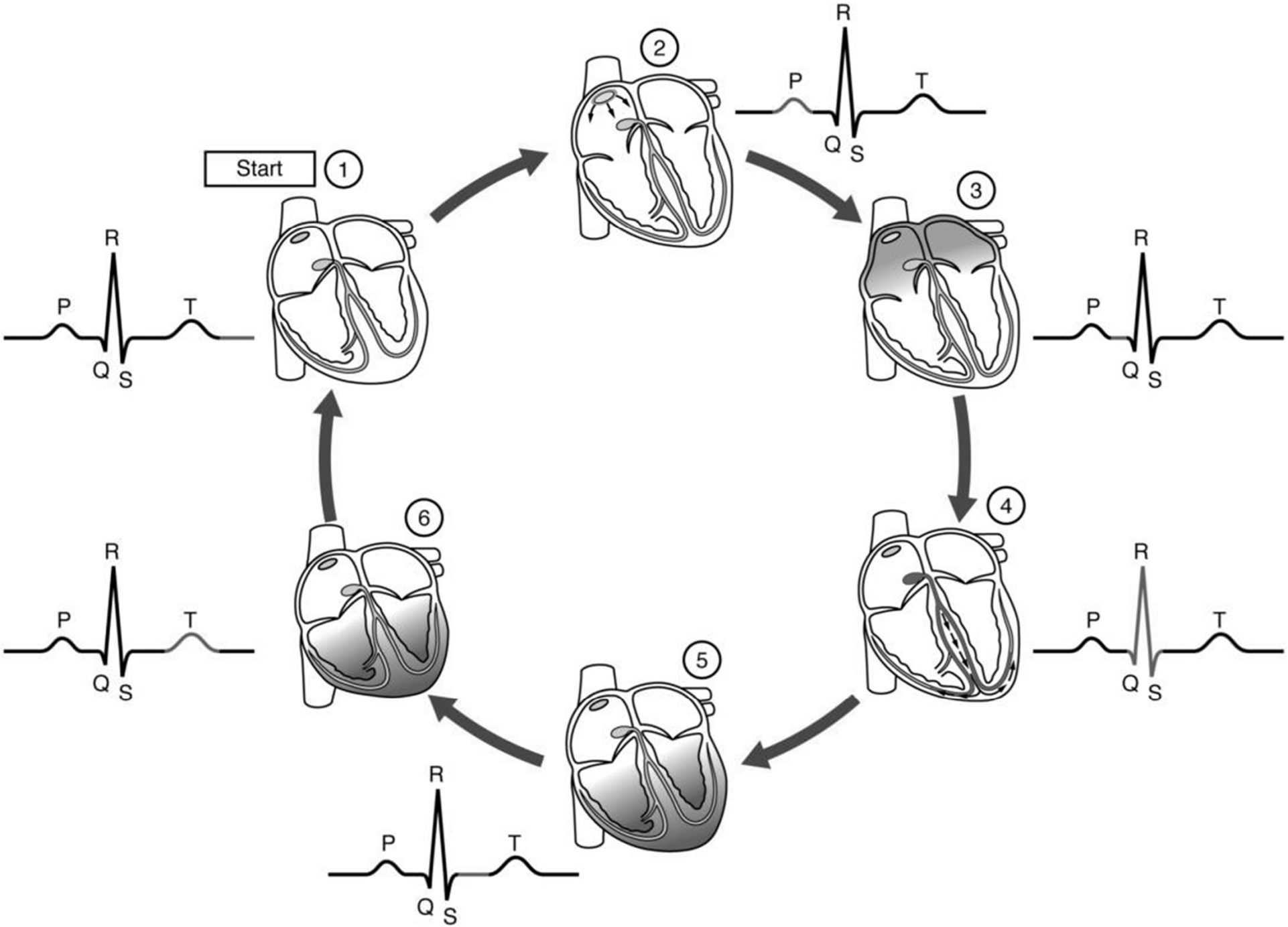


Cardiac Conduction

Sinoatrial node (SA node)

- In upper part of right atrium
- Pacemaker of heart
  - Initiates heartbeat
  - Determines heart rate

Atrioventricular node (AV node)

- Near right AV valve
- Sends electrical signal to ventricles

Cardiac Conduction

Bundle of His

- Carries electrical signal from AV node to ventricles

Right and left bundle branches

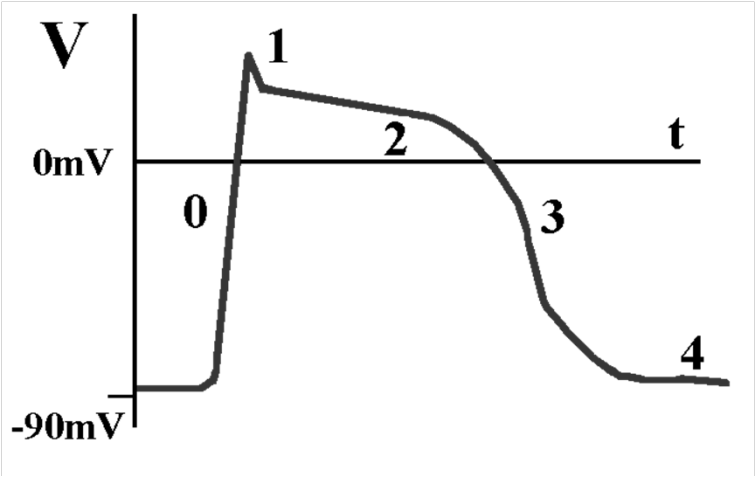
- Part of bundle of His
- Carry electrical signal towards apex

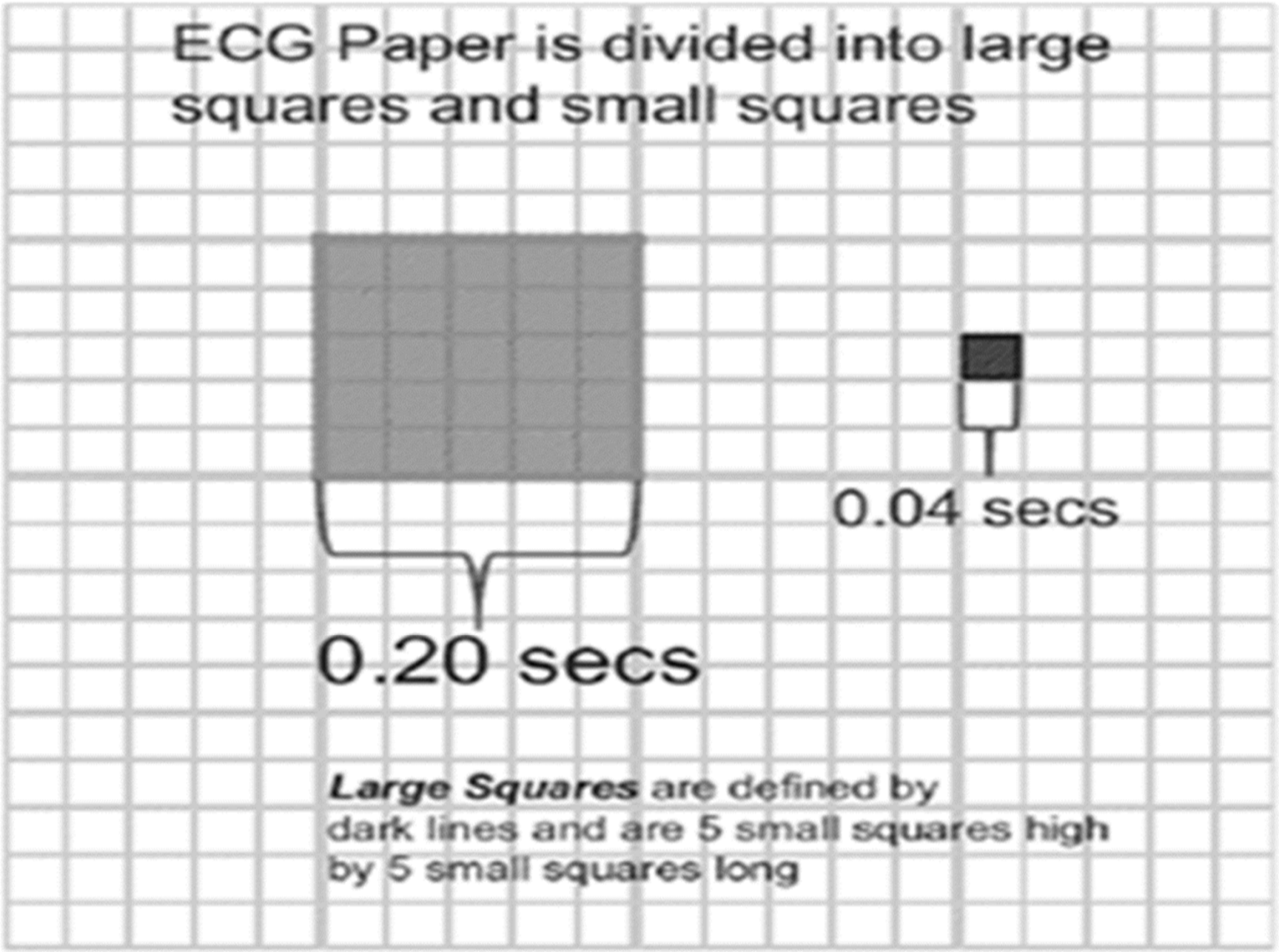
Purkinje fibers

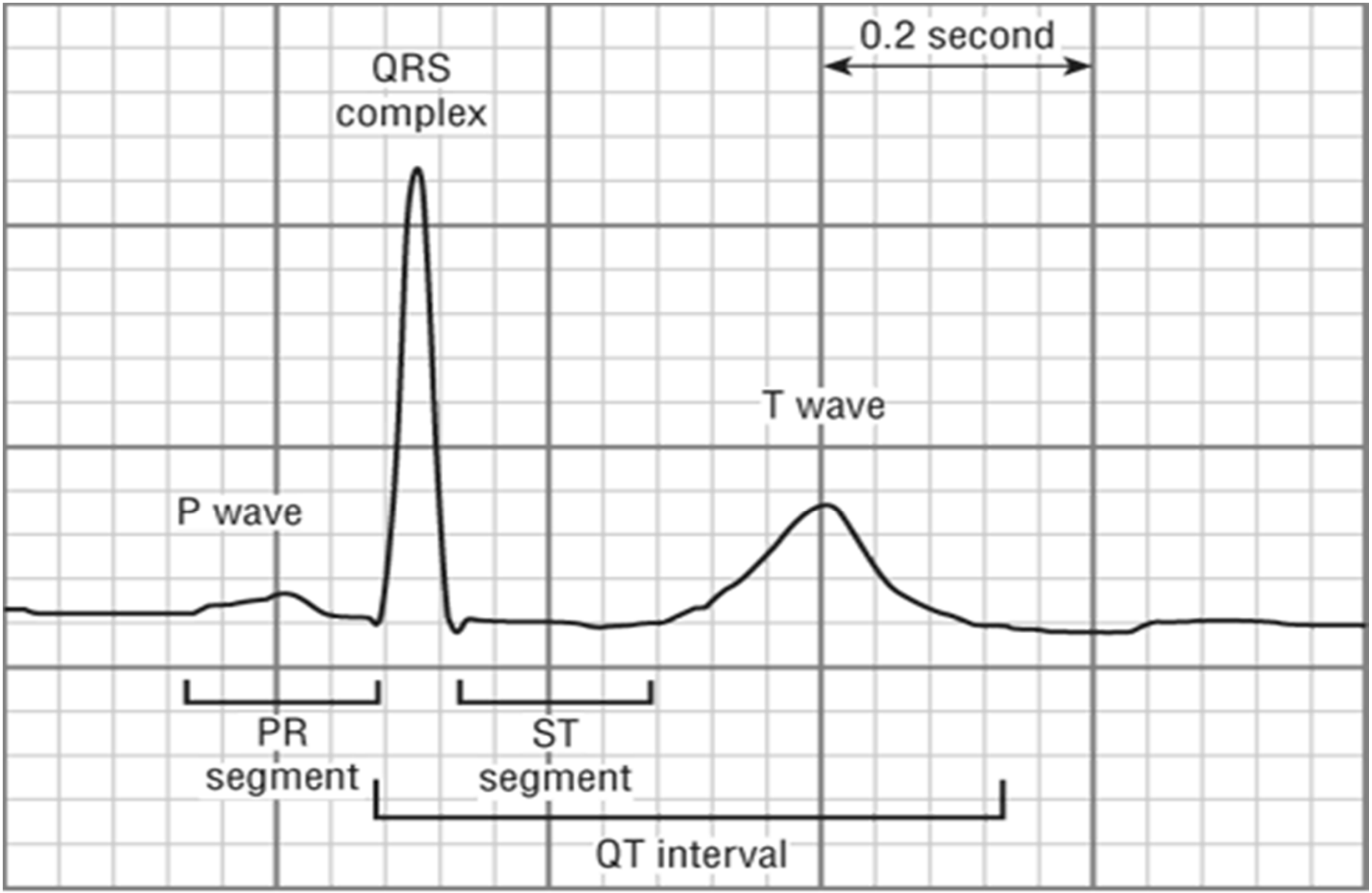
- Arise from bundle branches in apex
- Spread throughout ventricular myocardium
- Carry electrical signal to myocytes of ventricle

Action Potential Phases

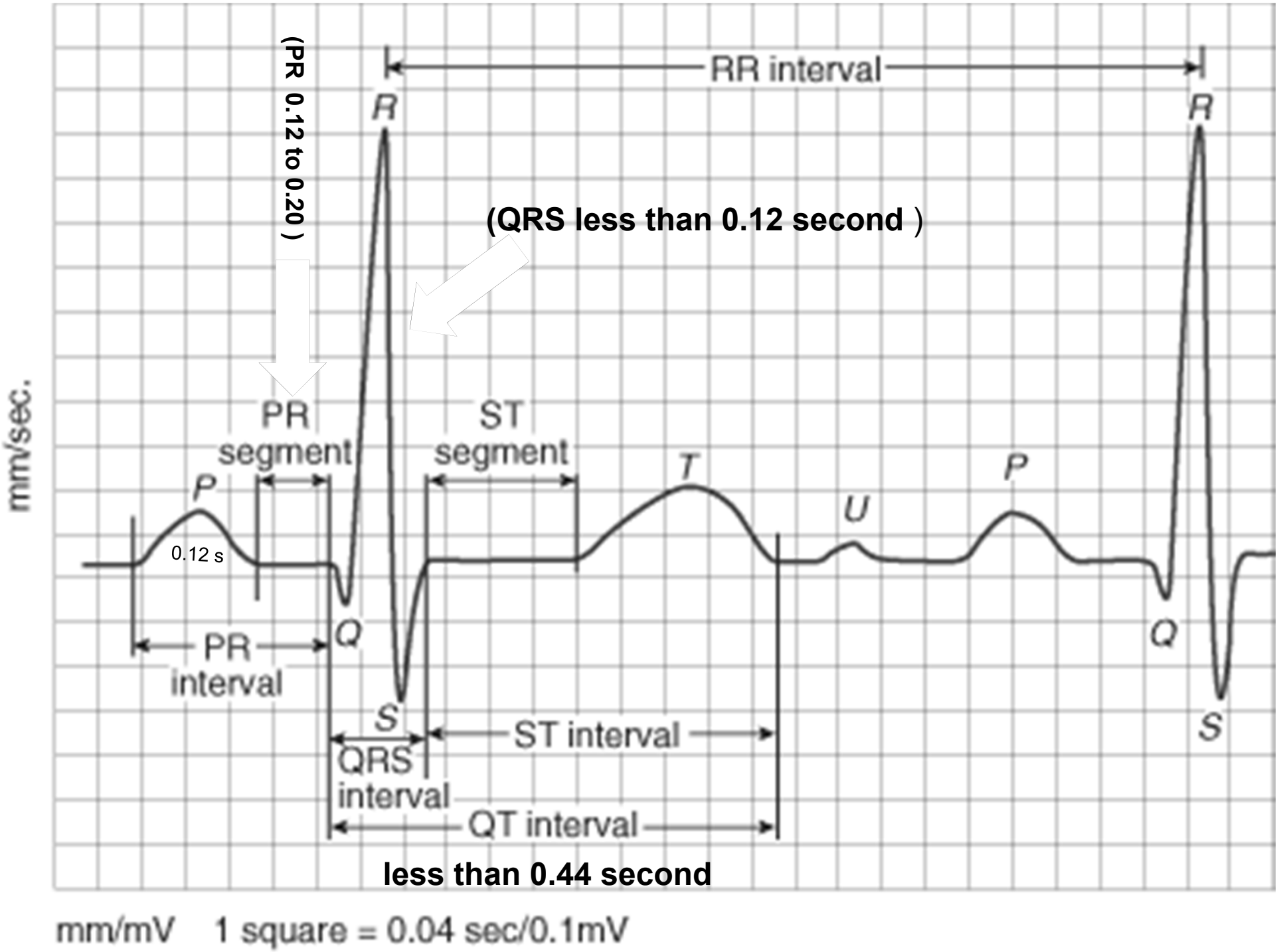
- Phase 0: depolarization
- Phase 1: early-rapid repolarization
- Phase 2: plateau
- Phase 3: repolarization
- Phase 4: refractory period







Source: J.T. DiPiro, R.L. Talbert, G.C. Yee, G.R. Matzke, B.G. Wells, L.M. Posey: Pharmacotherapy: A Pathophysiologic Approach, 10th Edition, www.accesspharmacy.com



Electrocardiogram (EKG)

P wave

- Atrial systole
- Signal from SA node spreads through atria and depolarization begins
- Correlates with phase 0 of myocardial action potential

QRS complex

- Firing of AV node and ventricular depolarization
- Atrial repolarization and diastole
- Correlates with phase 1 of myocardial action potential

Electrocardiogram (EKG)

S-T segment

- Ventricular systole
- Contraction and ejection of blood
- Correlates with phase 2 of myocardial action potential

T wave

- Ventricular repolarization
- Immediately before ventricular diastole
- Correlates with phase 3 of myocardial action potential

Terms & Definitions

Sinus rhythm

- Normal heartbeat produced by sinoatrial node (SA node)
- Typically 70-80 beats per minute (bpm), Normal = 60-90

Nodal rhythm

- Heartbeat generated by AV node
- Occurs when SA node is damaged
- Typically 40-50 bpm

Ectopic foci

- Any area of spontaneous firing other than SA node
- 20-40 bpm

Terms & Definitions

Arrhythmia

- Abnormal cardiac rhythm

Tachycardia

- Heart rate >100 bpm

Bradycardia

- Heart rate (<60 bpm)

Heart block

- Failure of cardiac conduction system to transmit electrical signals

Q_T prolongation

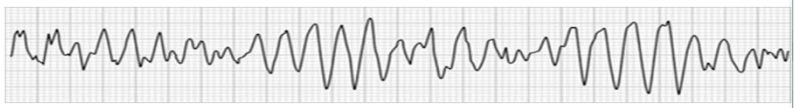
Genetic or acquired

Caused by drugs and electrolyte abnormalities

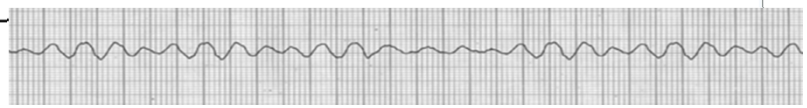
- Antiarrhythmics, antipsychotics, antibiotics, methadone
- *Hypo*kalemia, *hypo*magnesemia

Increased risk of life-threatening arrhythmias

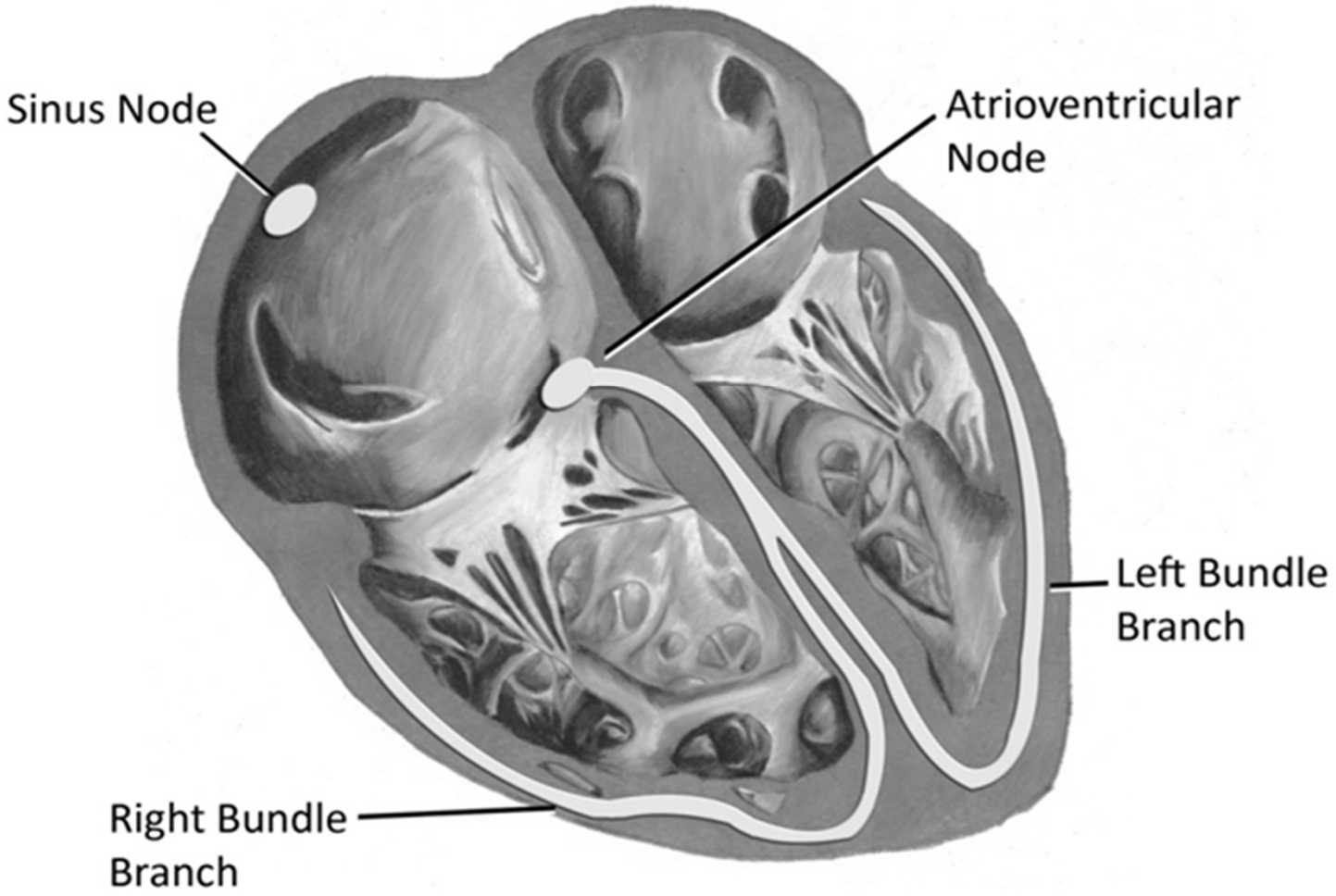
- Torsades de pointes
- (twisting of the points)



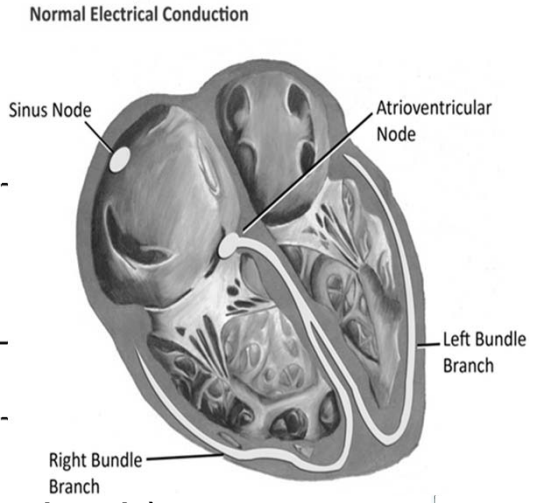
Could lead to ventricular fibrillation and sudden cardiac death



Normal Electrical Conduction



Heart Block (AV block)



First Degree

- Delayed impulse from the SA node to the ventricles

Second Degree

- Type 1 – conduction delay within the AV node (Wenckebach)
- Type 2 – conduction delay BELOW the AV node
  - Bundle of His or bundle branches

Third Degree

- Impulses from SA node are blocked before reaching the ventricles (complete AV block)
  - Atria and ventricles beat independently

Heart Block and Contraindications

Second or third Heart block

- Beta blockers contraindicated
  - Meds that end in –olol
  - Atenolol, metoprolol, etc
- Non-dihydropyridine calcium channel blockers contraindicated
  - Diltiazem
  - Verapamil

Heart Valve Disease

Atrioventricular valves

Mitral valve (bicuspid)

- Located between left atrium and ventricle
- Prevents backflow of blood from left ventricle into left atrium

Tricuspid valve

- Located between right atrium and ventricle
- Prevents backflow of blood from right ventricle into right atrium

Semilunar valves

3 valve leaflets

Pulmonary valve

- Located between the right ventricle and pulmonary trunk
- Prevents backflow of blood from pulmonary artery into right ventricle

Aortic valve

- Located between left ventricle and aorta
- Prevents backflow of blood from aorta into left ventricle

Mitral Valve Problems

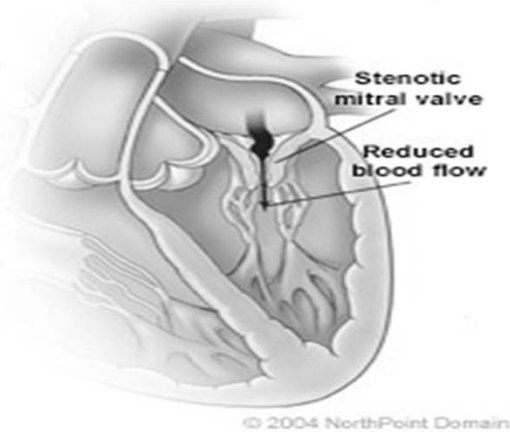
Mitral stenosis

- Causes left atrial enlargement
- Increased pulmonary venous *pressure*
- Right ventricular compromise
- 30-40% pts will develop atrial fibrillation

Mitral regurgitation

- LA and LV enlargement

Mitral valve prolapse



Aortic Valve Problems

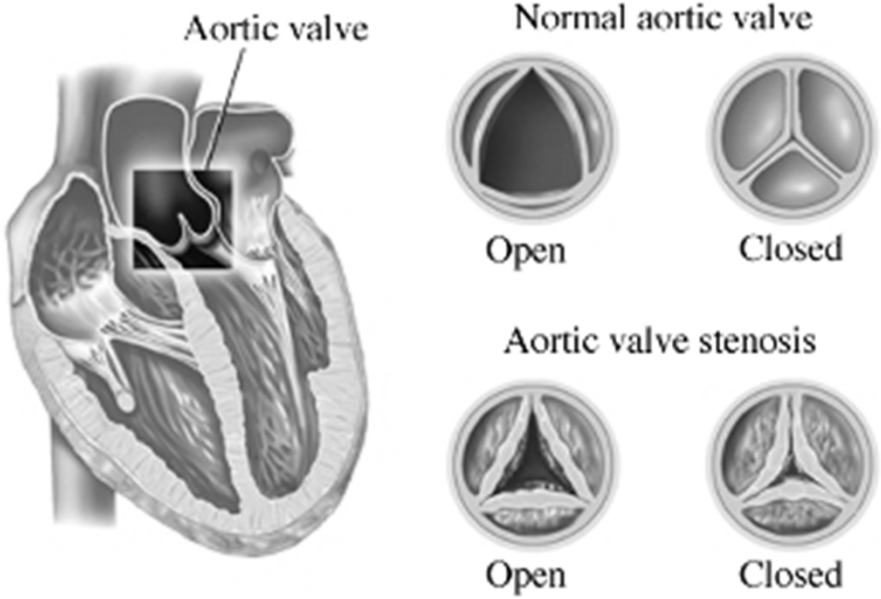
AORTIC STENOSIS

INCREASED AFTERLOAD

INCREASED LEFT VENTRICULAR SYSTOLIC PRESSURE

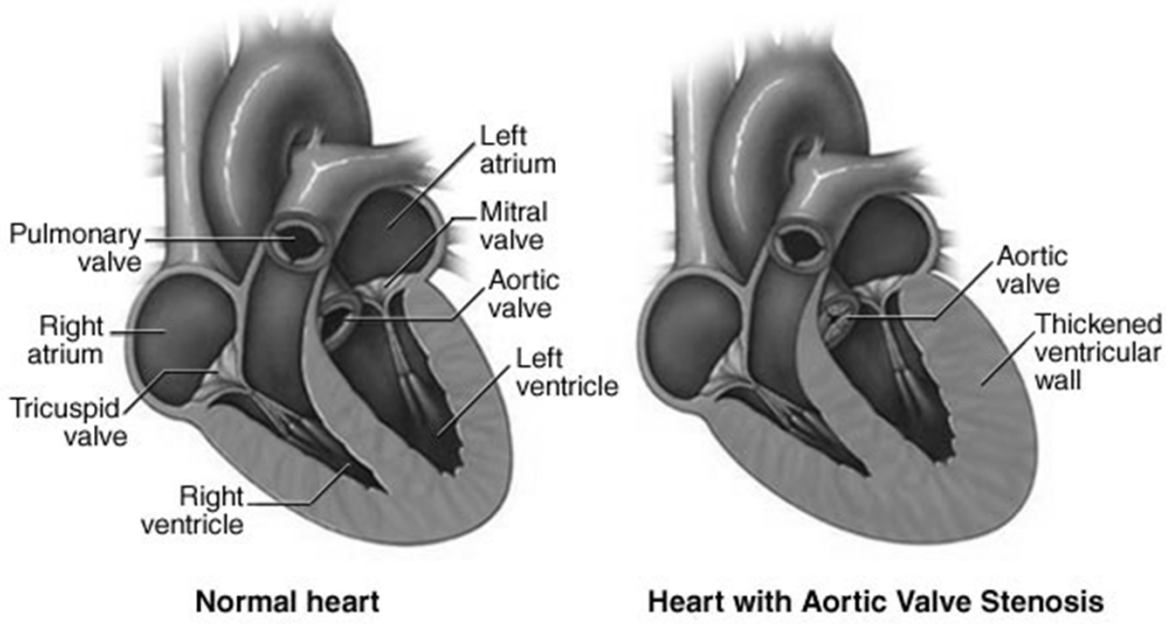
LEADS TO LV HYPERTROPHY

DECREASED CARDIAC OUTPUT



Aortic Stenosis

http://daquandisease.com/aortic-valve-regurgitation/



http://www.mayoclinic.org/aortic-stenosis/enlargeimage5584.html

Aortic Valve Problems/Aortic regurgitation

Caused by abnormal valve leaflets or dilated aortic root

Increases afterload

LV (and eventual LA) enlargement

LV hypertrophy

LV systolic dysfunction

Aortic Regurgitation

Normal valve operation

Leakage of valve

http://www.cvtsa.com/AorticValveDiseaseandSurgery/C-539.html

Cardiac Testing

Chest X-Ray

Global information on position and size of the heart and chambers & surrounding anatomy

Things to look for:

Cardiomegaly	Pleural effusions	Alveolar edema	Left ventricular enlargement

Exercise Stress Test

Value in diagnosis of CAD is based on risk

- Not useful for low risk patients without comorbidities

Should not be used as a screening tool

Diagnostic info for patients with known or suspected ischemic heart disease

Provides prognostic info on patients after MI or revascularization

Exercise Stress Test

- Commonly conducted on treadmill
- Increase oxygen demand beyond supply and therefore inducing ischemia by using exercise
- Patient symptoms, EKG (ECG), and hemodynamics are monitored
- Peak heart rate and heart rate recovery evaluated
- Can detect location and severity of disease

Pharmacologic Stress Test

Alternative to exercise stress test for patients unable or unwilling to undergo exercise stress

Agents used:
Adenosine, regadenoson, dipyridamole, and dobutamine

Evaluates wall motion abnormalities and perfusion defects under stress

Echocardiogram

Ultrasound used to visualize anatomic structures (i.e., valves) and describe wall motion

Diagnosis/evaluation of mitral or aortic stenosis/regurgitation, endocarditis, wall motion abnormalities, congenital defects

Estimate chamber wall thickness, ejection fraction, ventricular function

Detect abnormalities of pericardium (effusions, thickening)

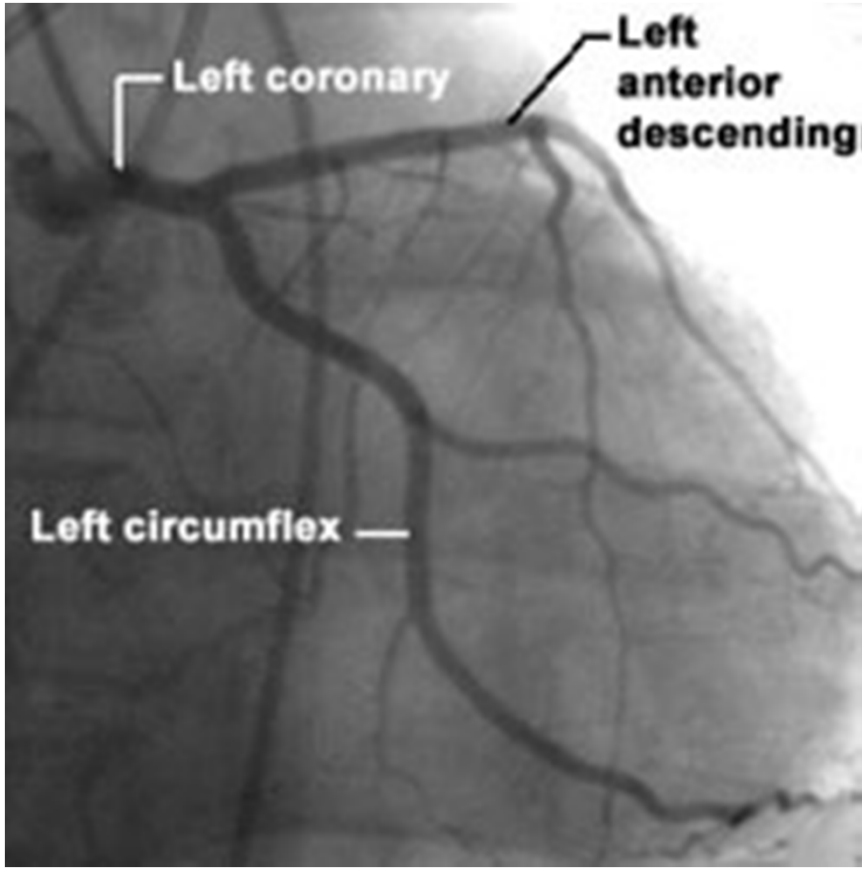
Catheterization/ Angiography

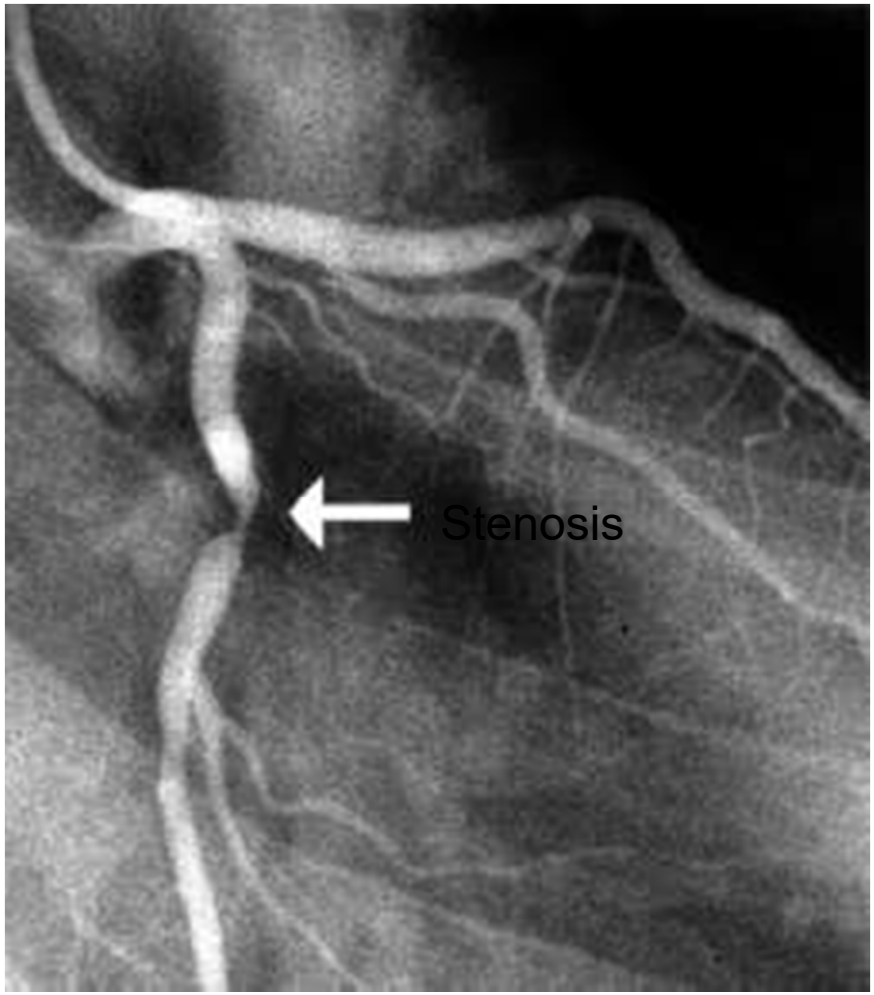
Physiologic and anatomic approach to assess patency of coronary vessels and hemodynamic parameters of cardiac function

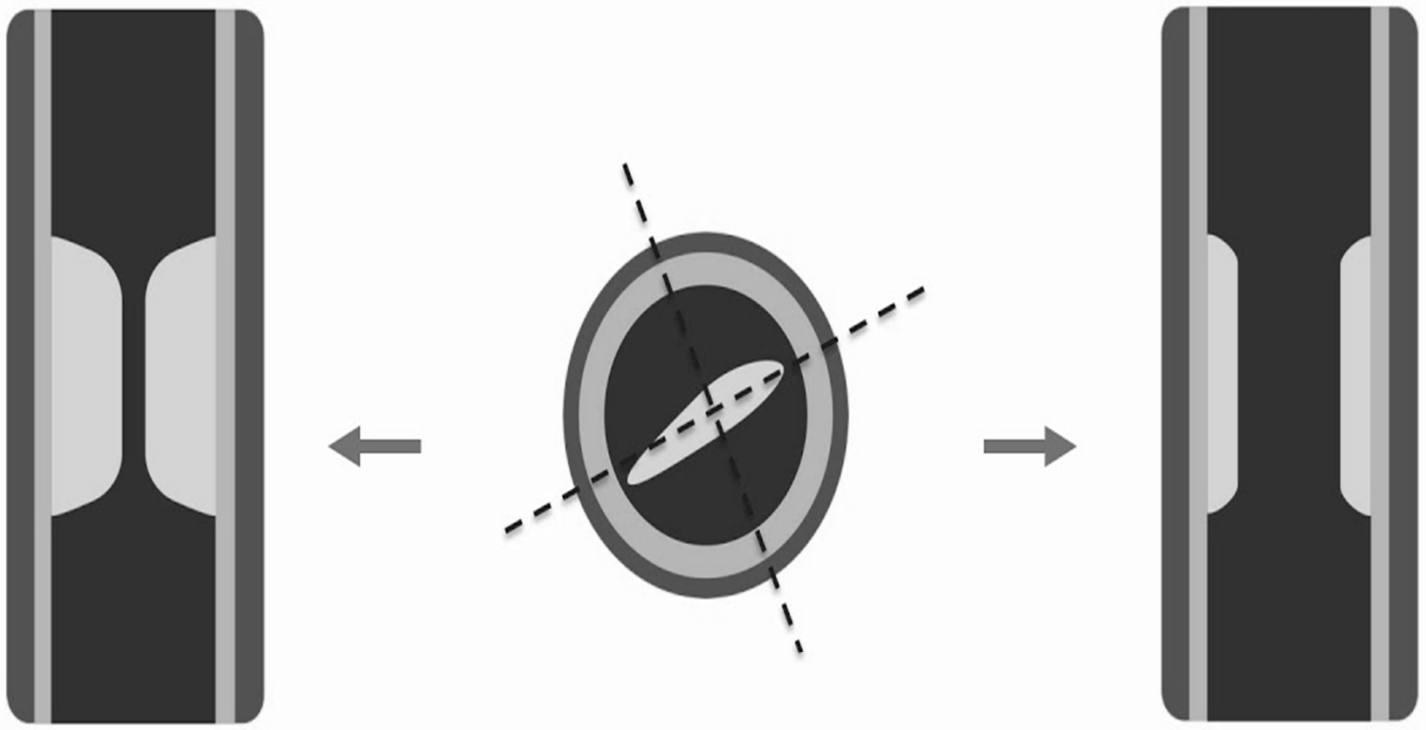
Assesses valvular function, computes cardiac output, stroke volume, systemic vascular resistence, cardiac chamber pressures, and blood flow

Requires IV contrast

Angiography



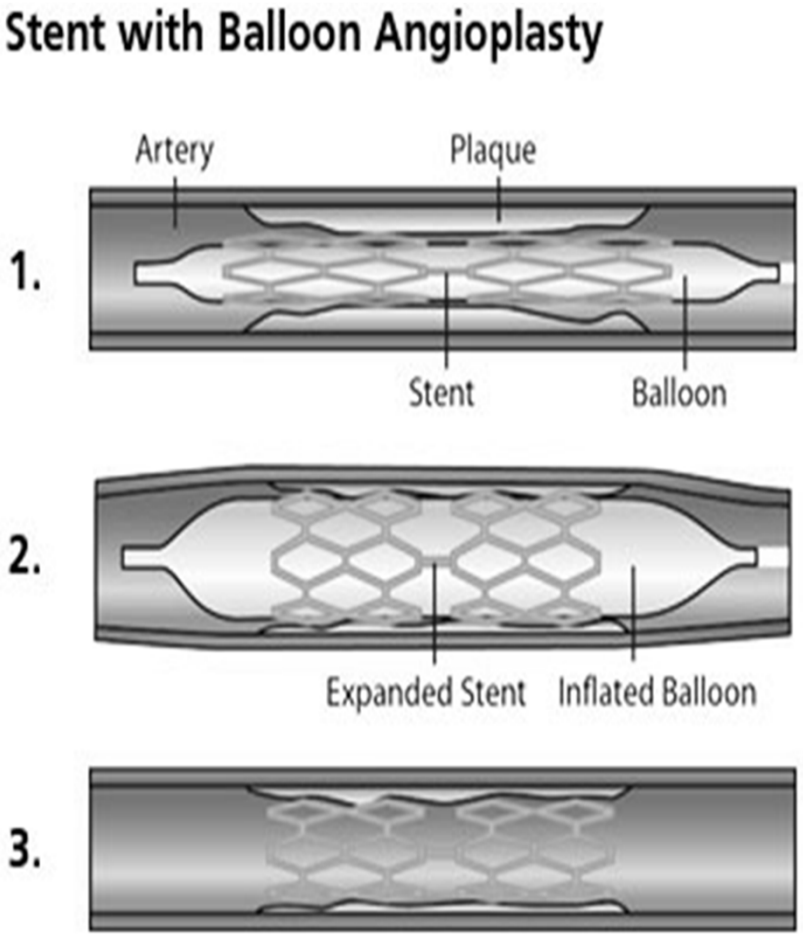




Stenosis assessed as 90%

Stenosis assessed as 20%

Angioplasty



Procedure to open blocked or narrowed coronary arteries

Done during the left cardiac catheterization

Balloon angioplasty alone or with stent placement

CABG

Coronary artery bypass grafting

Open heart surgery

Grafts harvested from

- legs, chest, or arms

Grafts are used as a

- “detour” around the blocked portion of the coronary artery