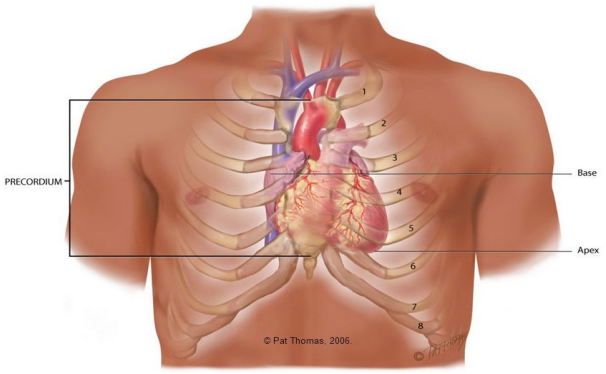
Condensed Chapter Material
Chapter 14: Heart

Location of Heart:

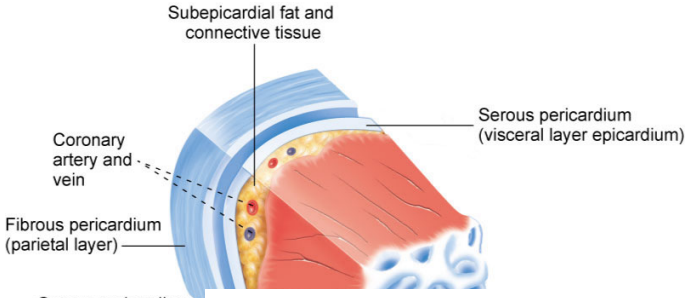
1) Behind sternum, between 3rd to 6th costal cartilage.
2) The broad upper portion of heart is the base, while the narrower lower tip is the apex.
3) Area of chest overlying the heart is the precordium

Precordium, Apex and Base



Layers of heart (outside to in):

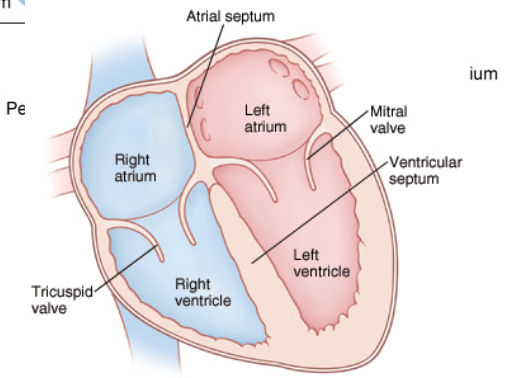
1) Pericardium-tough, double-walled, fibrous sac covering the heart with few mL of fluid between the two layers allowing for low-friction movement
2) Epicardium- Thin, outermost muscle layer
3) Myocardium-Thick muscular middle layer, responsible for most of the pumping action
4) Endocardium-Innermost layer, lining the chambers of the heart and covers the heart valves.



Structure of the heart:

-Made of four chambers, two upper chambers (right and left atria) and two bottom chambers (right and left ventricles).

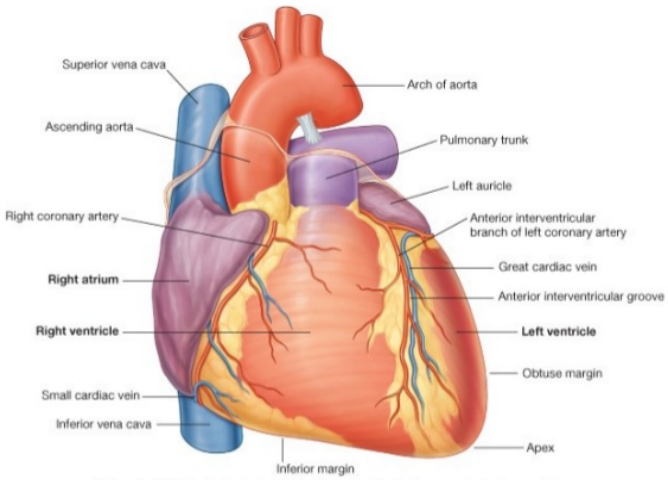
1) Atria are thin-walled chambers acting as a reservoir for blood returning to the heart.
2) The ventricles are large, thick-walled chambers, pumping blood to the lungs and throughout the body. In adults, the left ventricle muscle mass>right ventricle because it displaces blood throughout the body against the higher pressure in the systemic circulation, as compared to the right ventricle which has to pump blood to the lungs against low pressures.



-The left and right side of heart are divided by interventricular septum.

Borders of the heart: The heart is turned ventrally on its axis with the right side more forward.

1) Anterior border-right ventricle
2) Left border-left ventricle (when left ventricle contracts the apical impulse is at the 5th left intercostal space at the midclavicular line)
3) Posterior border-left atrium
4) Right border-Right atrium



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Valves of the heart:

-Two atrioventricular valves (between atria and ventricles)-these valves are open when atria contract (diastole) and closed when ventricles contract (systole) to prevent backflow

1) Tricuspid valve-three cusps, separates right atrium from right ventricle
2) Mitral valve aka bicupsid valve, separates left atrium from left ventricle

-Two semilunar valves each with three cusps-these valves are open during ventricular contraction (systole) and close during ventricular relaxation (diastole) to prevent backflow

1) Pulmonic valve-separates right ventricle from the pulmonary artery
2) Aortic valve-separates left ventricle from aorta

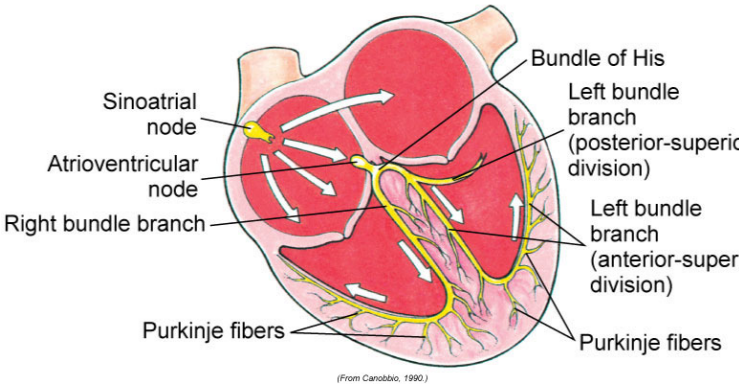
Cardiac Cycle:

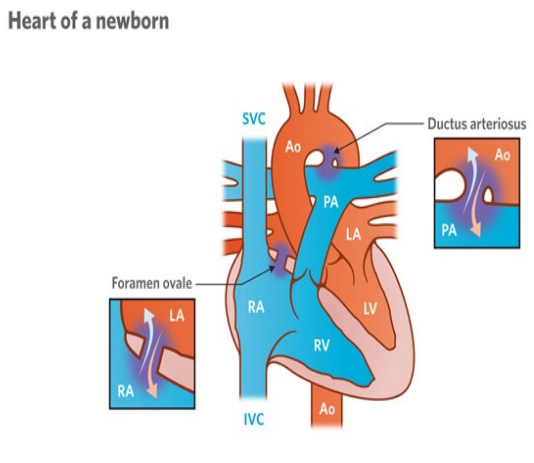
Consists of two phases:

1) Systole: ventricles contract, blood moves from ventricles into pulmonary artery/aorta.
2) Diastole: ventricles dilate, drawing blood into the ventricles as atria contract (usually a longer interval than systole)

Electrical Activity: (Intrinsic electrical conduction causing myocardial contraction)

1) Impulse starts and is paced by sinoatrial node (in wall of right atrium)
2) Impulse moves through atria to atrioventricular node, where it is slowed down (located in atrial septum)
3) Impulses moves down Bundle of His
4) Impulse moves to the Purkinje fibers (muscle cells specialized for ventricular contraction, which occurs from apex and proceeds to base of heart.





Differences in infants:

-Umbilical vein brings oxygenated blood due to nonfunctional fetal lungs

-Most blood flows from the right atrium to left atrium through foramen ovale (bypassing the lungs). The blood that goes into the right ventricle gets pumped through the patent ductus arteriosus rather than into lungs.

-Both ventricles have equal muscle mass

-At birth: ductus arteriosus closes within 1-2 days, and as left atrium increases in pressure there is a functional closure of foramen ovale.

-By one year of age the left ventricle is twice the size of the right ventricle.

Pregnant Women:

-Increase in blood volume due to increase in plasma volume (by 50-70 percent)

-Increase in heart rate and stroke volume (amount of blood ejected from left ventricle per contraction) and cardiac output.

-Left ventricle increases in thickness

-Enlarged uterus->diaphragm is moved upward->heart is shifted to more horizontal position

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Older Patients:

-Increase in size of left ventricular wall, and calcification of valves.

-Decrease in stroke volume, cardiac output and elasticity of myocardium (becomes more rigid).

Causes of Chest Pain (examples, not comprehensive):

	Cardiac	Respiratory	Gastrointestinal	Musculoskeletal
Causes	Angina, Acute myocardial infarction, Mitral valve prolapse, Pericarditis	Pneumothorax Emphysema, Pulmonary hypertension, Pulmonary embolus	Reflux esophagitis, Peptic ulcer disease, Esophageal spasm	Shoulder disorder (arthritis, bursitis, rotator cuff injury), Costochondral disorder
Characteristic	Substernal, provoked by effort, emotion, relieved by rest or nitroglycerin (vasodilator), often accompanied by diaphoresis	Precipitated by breathing or coughing, often sharp, present during respiration, absent when breath is held	Burning, substernal, occasional radiation to shoulder, nocturnal occurrence, worse when lying flat, relief with food and antacids	Intensified by movement, long lasting, often with focal tenderness
Additional common features	Presence of cardiac risk factors, acute onset, may radiate to shoulder and down arm, palpitations, syncope, dizziness		History of indigestion, vague onset, may go on for several hours	History of trauma, vague onset, delays falling asleep, relief with heat and NSAIDs,

Risk factors for cardiac disease include: gender (men>women before menopause), hyperlipidemia, smoking, obesity, sedentary lifestyle, and family history of CVD, diabetes, hyperlipidemia and hypertension

Physical Examination: Palpation and Auscultation of the heart.
Remember that findings from examination of other systems can help in your assessment of the cardiovascular system such as pitting edema, crackles and palpation of liver (all three can be associated with heart failure) and xanthelasma, which are yellowish deposits of fat underneath the skin (indicating increased likelihood of impaired blood through coronary arteries)

1) Palpation of PMI (point of maximal impulse)-the point where the apical impulse is most readily felt:

1) Have patient sit upright and approach patient from the right.

2) Use the proximal halves of your four fingers to palpate with light pressure.

3) If patient is a female, have patient lift left breast up and to the left.

PMI is typically at the left 5th intercostal space at the midclavicular line in adults and 4th intercostal space medial to the nipple in children.

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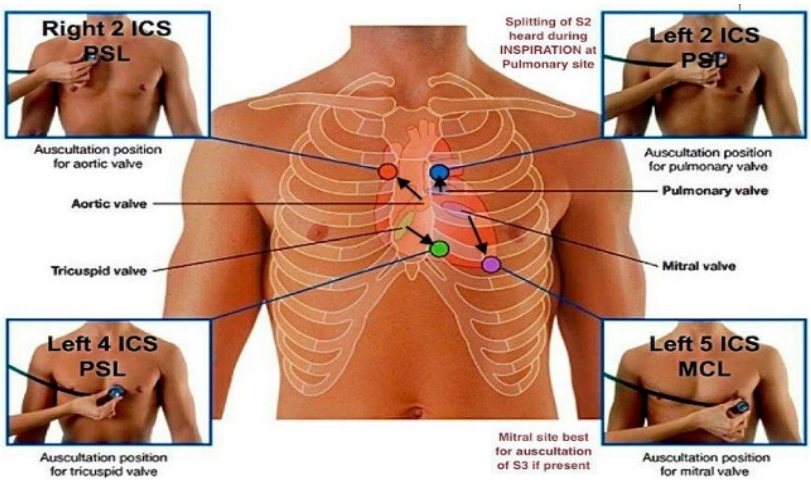
Usually palpable within small diameter (no more than 1 cm)

Normal: impulse is gentle and brief, not lasting as long as systole.
PMI may be difficult to feel in some adults due to thickness of chest wall.
If impulse is more vigorous than normal=heave or lift.
If impulse if more forceful and widely distributed, fills systole, or is displaced laterally and downward, it may indicate left ventricular hypertrophy or increased cardiac output.
A lift along left sternal border may be due to right ventricular hypertrophy.

Auscultation:

-Patient should be comfortable and not moving.
-Always listen on bare skin!
-Sounds are best heard in areas where the blood flows after it passes through a valve.
Four common auscultated areas: (these are not where the valves are located but rather where the sound is heard the best)

1) Aortic valve area: Second right intercostal space at the right sternal border
2) Pulmonic valve area: Second left intercostal space at the left sternal border
3) Tricuspid area: fourth left intercostal space along the left sternal border
4) Mitral (apical) area: at the apex of the heart in the fifth left intercostal space at the midclavicular line

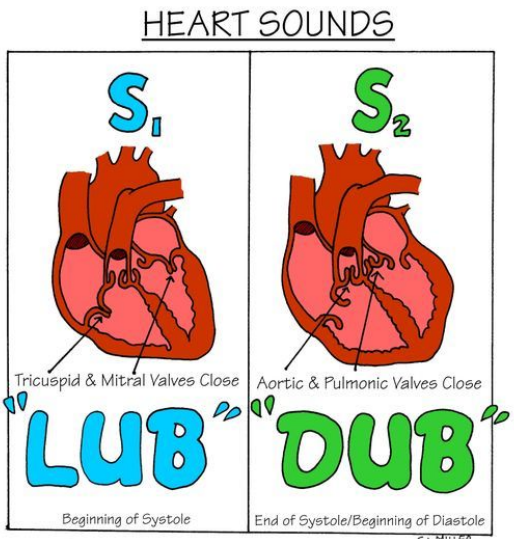


-Pay attention to the rate and rhythm while listening
-You can have the patient hold his/her breath in expiration to determine the effects of respiration on the heart sounds.
-You can instruct the patient to inhale deeply, listening closely for S2 to become two components (split S2) during inspiration which is best heard in the pulmonic auscultatory area.

Heart sounds: characterized by pitch, intensity, duration and timing in the cardiac cycle. Heart sounds usually are low in pitch except in certain pathologic states.
There are four basic heart sounds (S1, S2, S3 and S4), with S1 and S2 being most distinct. S3 and S4 may or may not be present and their absence is not unusual. More on these sounds will come later.

-First sound: Indicates beginning of systole; ventricular contraction increases pressure which causes closure of the mitral and tricuspid valve->creating the first sound (S1) or "lub".

a) Though there is a slight difference in closure of the mitral and tricuspid valve, S1 is heard as a one sound. If splitting is heard, it is best heard at the tricuspid area, particularly on deep inspiration.



-Once the pressure in the ventricle exceeds pressure in pulmonary artery/aorta, the aortic and pulmonic valve

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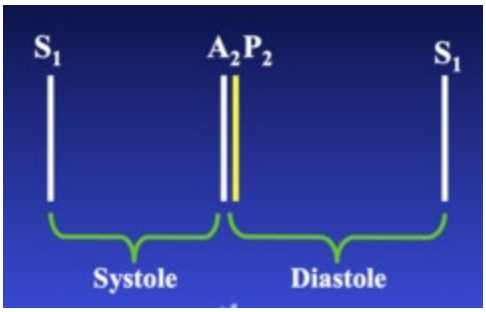
are forced open. (Valves opening generally does not make a sound)
-Second Sound: Marks the end of systole and initiation of diastole. When ventricles are almost empty, pressure falls below aorta/pulmonary artery causing closure of semilunar valves, creating second heart sound (S2), "dub".

a) S2 is composed of A2 (sound of closure of the aortic valve) and P2 (sound of closure of the pulmonic valve). The aortic valve closes slightly before the pulmonic, therefore, A2 is heard before P2. A2 generally masks the sound of P2 but during inspiration P2 occurs slightly later, giving S2 two distinct components. An S2 split is easier to detect in the young than older adults.



Causes of a Split S2: it is an expected event due to higher pressures and earlier depolarization of the left heart. During inspiration->lungs fill and chest expands->intrathoracic pressure becomes more negative->increased venous return to the right heart->more blood entering right side of heart and less blood returning to left side (blood wants to stay in lungs)->pulmonary valve stays open longer during systole than aortic valve due to differences in blood volume. Ejection times usually equalize during expiration.

Intensity of Heart Sounds in Relation to Auscultatory Area				
	Aortic	Pulmonic	Mitral	Tricuspid
Pitch	S1<S2	S1<S2	S1>S2	S1=S2
Loudness	S1<S2	S1<S2	S1>S2	S1>S2
Duration	S1>S2	S1>S2	S1>S2	S1>S2
S2 Split	Increased during inhalation in all areas. Decreased during exhalation in all areas.			
A2	Loudest	Loud		
P2	Decreased	Louder		

Heart murmurs are prolonged extra sounds heard during systole or diastole

1) Caused by disruption in flow of blood
2) Characteristic: depends on adequacy of valve function, size of opening and rate of blood flow
3) Common causes: diseased valves caused by thickening or weakening of leaflets. When thickened, the passage is narrowed causing restriction of forward blood flow (stenosis). When valve loses competency, blood flows backward (regurgitation).

$$\text{Murmur} = \frac{\text{Flow}}{\text{Area}}$$

The greater the flow, the louder the murmur

The smaller the area, the louder the murmur

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