Department of Anesthesia Techniques

Title of the lec5: Cardiovascular system

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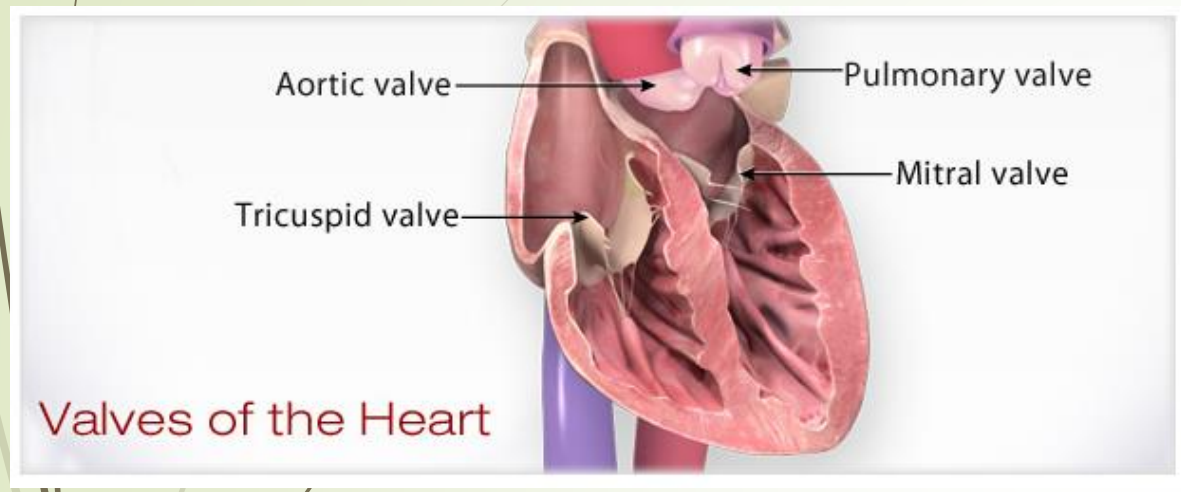
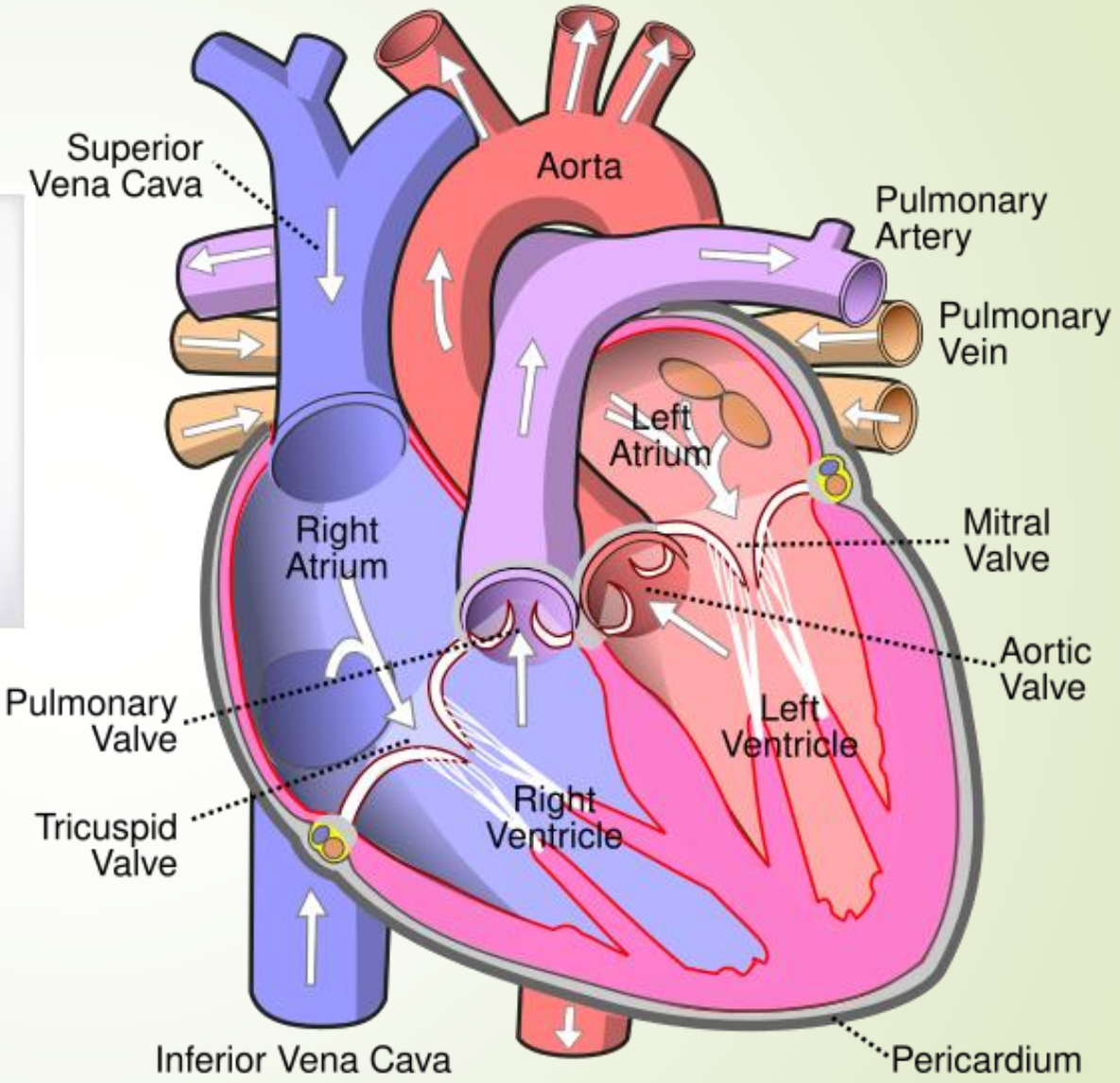
Heart sounds

Normal heart sounds

When listening to a normal heart with a stethoscope, one hears a sound usually described as “lub, dub, lub, dub.” The “lub” is associated with **closure** of the atrioventricular (A-V) (Mitral and Tricuspid valves) valves at the beginning of systole, and the “dub” is associated with **closure** of the semilunar (aortic and pulmonary) valves at the end of systole.

The “lub” sound is called the first heart sound, and the “dub” is called the second heart sound

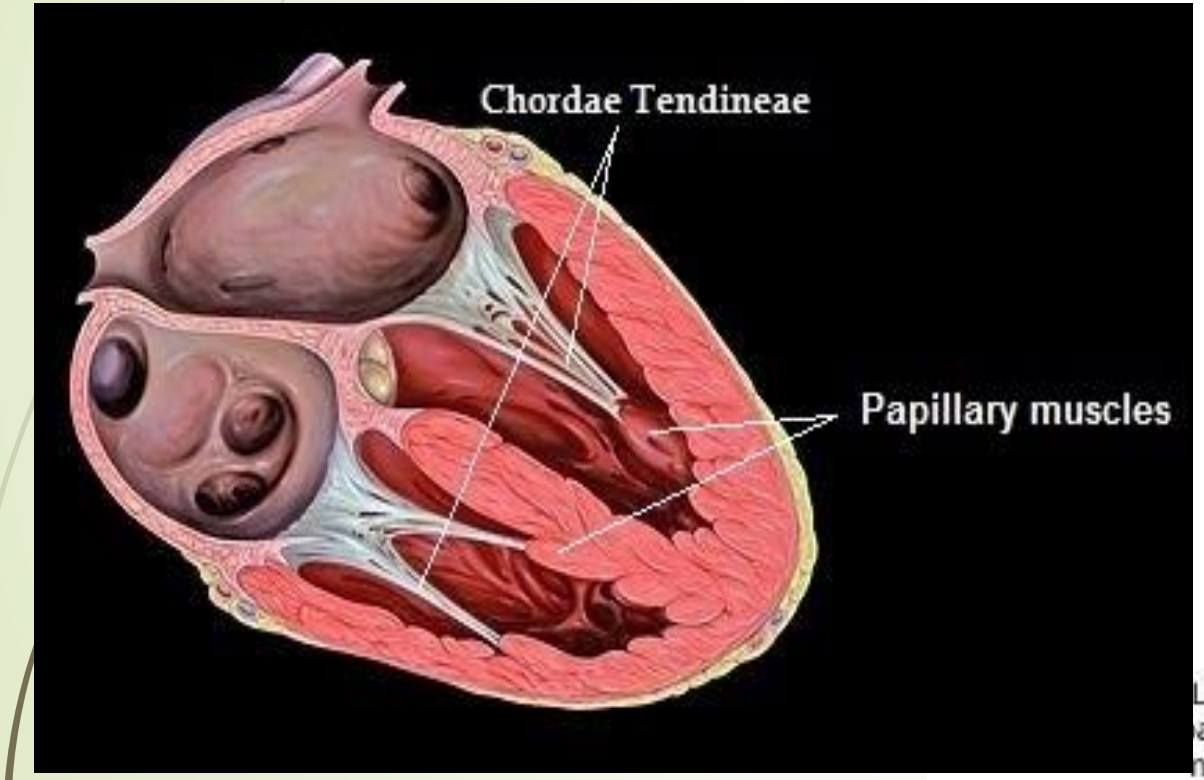

Aortic valve
Pulmonary valve
Mitral valve
Tricuspid valve
Valves of the Heart

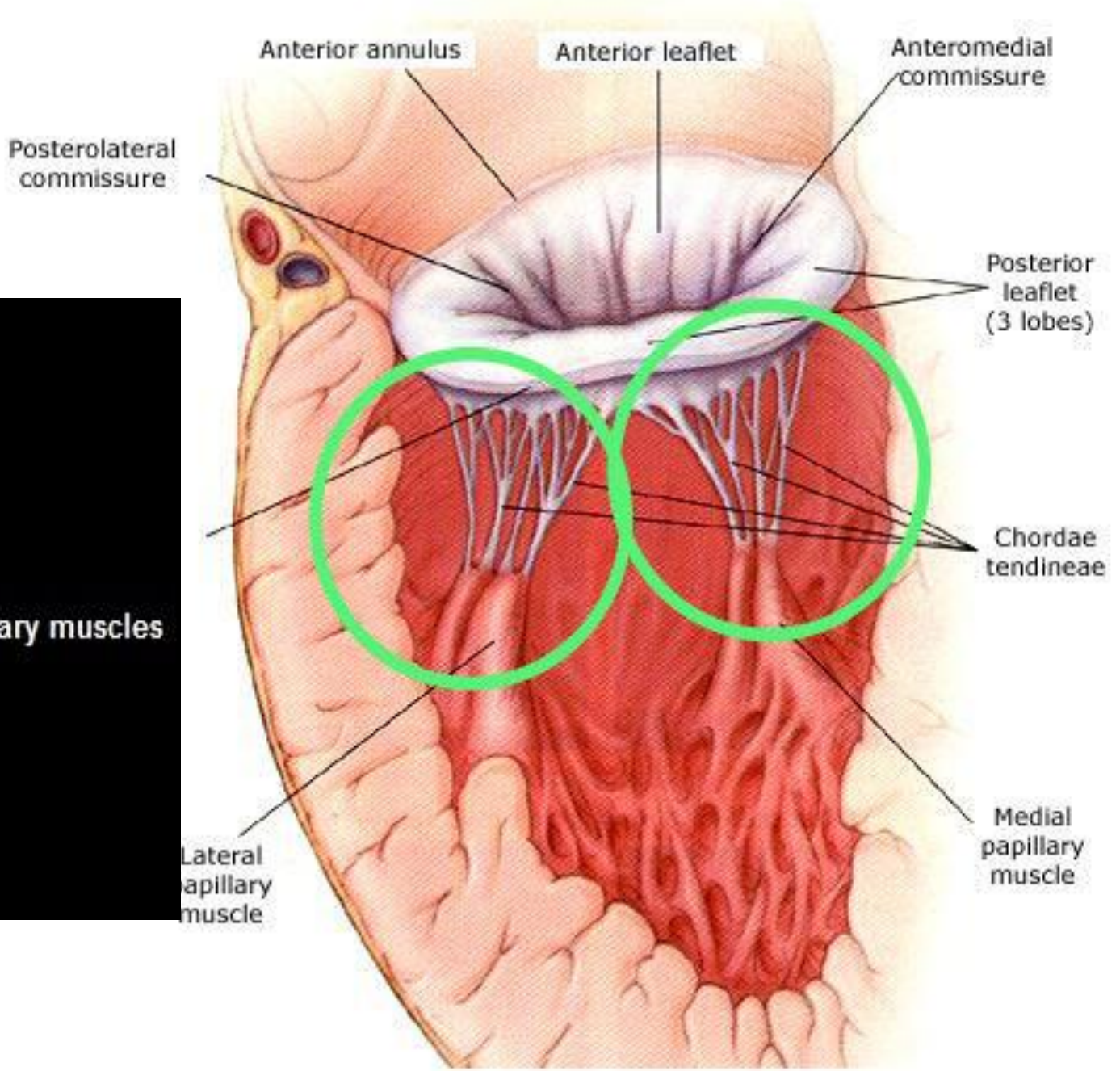

Superior Vena Cava
Aorta
Pulmonary Artery
Pulmonary Vein
Left Atrium
Right Atrium
Mitral Valve
Aortic Valve
Pulmonary Valve
Left Ventricle
Tricuspid Valve
Right Ventricle
Inferior Vena Cava
Pericardium

The First Heart Sound Is Associated with Closure of the A-V Valves.

The cause of the heart sounds is vibration of the taut valves immediately after closure, along with vibration of the adjacent walls of the heart and major vessels around the heart. That is, in generating the first heart sound, contraction of the ventricles first causes sudden backflow of blood against the A-V valves (the tricuspid and mitral valves), causing them to close and bulge toward the atria until the chordae tendineae abruptly stop the back bulging. The elastic tautness of the chordae tendineae and of the valves then causes the back-surging blood forward again into each respective ventricle. This mechanism causes the blood and the ventricular walls, as well as the taut valves, to vibrate and causes vibrating turbulence in the blood. The vibrations travel through the adjacent tissues to the chest wall, where they can be heard as sound by using the stethoscope.

Chordae tendineae





The Second Heart Sound Is Associated with Closure of the Aortic and Pulmonary Valves.

The second heart sound results from sudden **closure** of the semilunar valves (the aortic and pulmonary valves) **at the end of systole**. When the semilunar valves close, they bulge backward toward the ventricles and their elastic stretch recoils the blood back into the arteries, which causes a short period of vibration of blood back and forth between the walls of the arteries and the semilunar valves, as well as between these valves and the ventricular walls. The vibrations occurring in the arterial walls are then transmitted mainly along the arteries. When the vibrations of the vessels or ventricles come into contact with a “sounding board,” such as the chest wall, they create sound that can be heard.

Duration of the First and Second Heart Sounds.

The duration of each of the heart sounds is slightly more than 0.10 second, with the first sound about 0.14 second and the second about 0.11 second. The reason for the shorter second sound is that the semilunar valves are more taut than the A-V valves, so they vibrate for a shorter time than do the A-V valves.

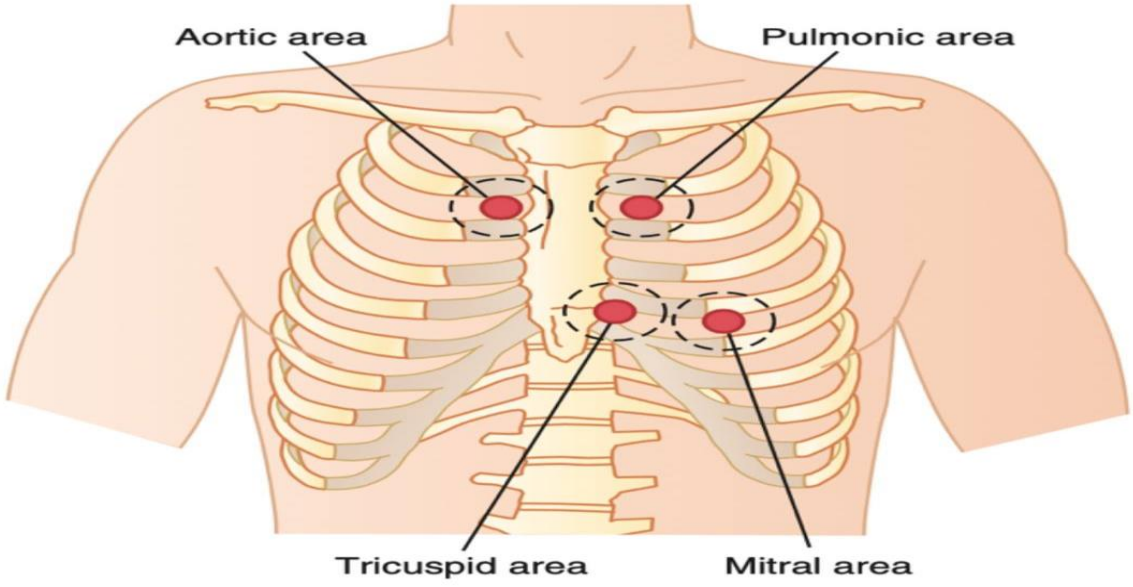


Figure 1: Chest areas from which sound from each valve is best heard

The Third Heart Sound Occurs at the Beginning of the Middle Third of Diastole.

Occasionally a weak, rumbling third heart sound is heard at the beginning of **the middle third of diastole.** A logical but unproved explanation of this sound is oscillation of blood back and forth between the walls of the ventricles initiated by inrushing blood from the atria.

The frequency of this sound is usually so low that the ear cannot hear it, yet it can often be recorded in the phonocardiogram.

The third heart sound may be normally present in children, adolescents, and young adults but generally indicates systolic heart failure in older adults.

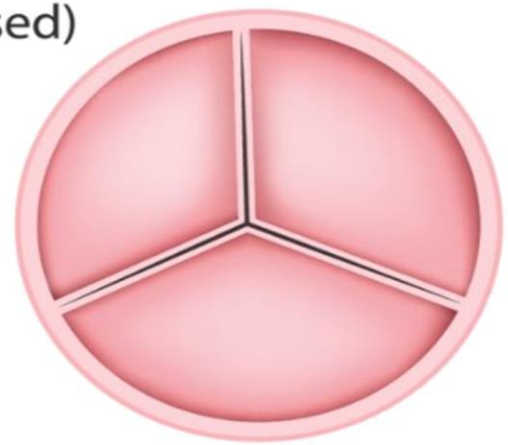
Atrial Contraction Sound (Fourth Heart Sound)

An atrial heart sound can sometimes be recorded in the phonocardiogram, but it can almost **never be heard with a stethoscope** because of its weakness and very low frequency (usually 20 cycles/sec or less). This sound occurs when the atria contract, and presumably, it is caused by the inrush of blood into the ventricles, which initiates vibrations similar to those of the third heart sound.

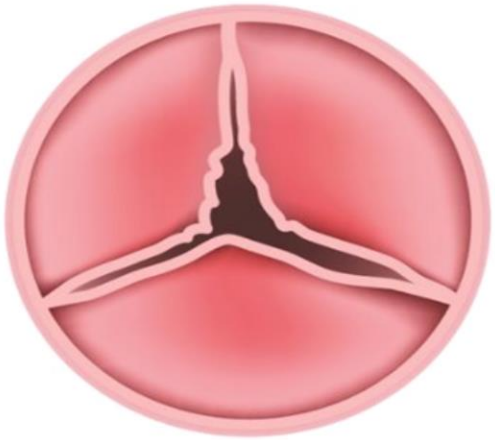
The fourth heart sound is often heard in older patients with left ventricular hypertrophy.

HEART VALVE DISEASE

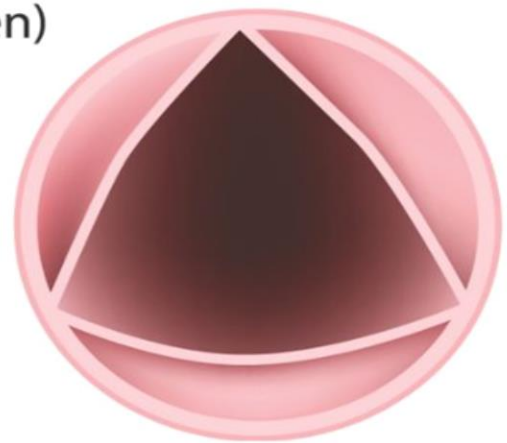
Normal valve
(closed)



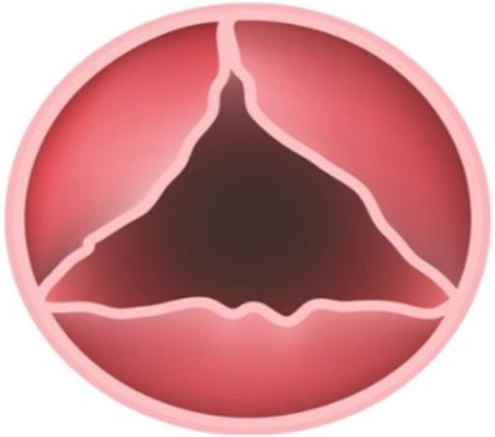
Valve stenosis
(closed)



Normal valve
(open)



Valve stenosis
(open)



Abnormal heart sounds

Heart Murmurs

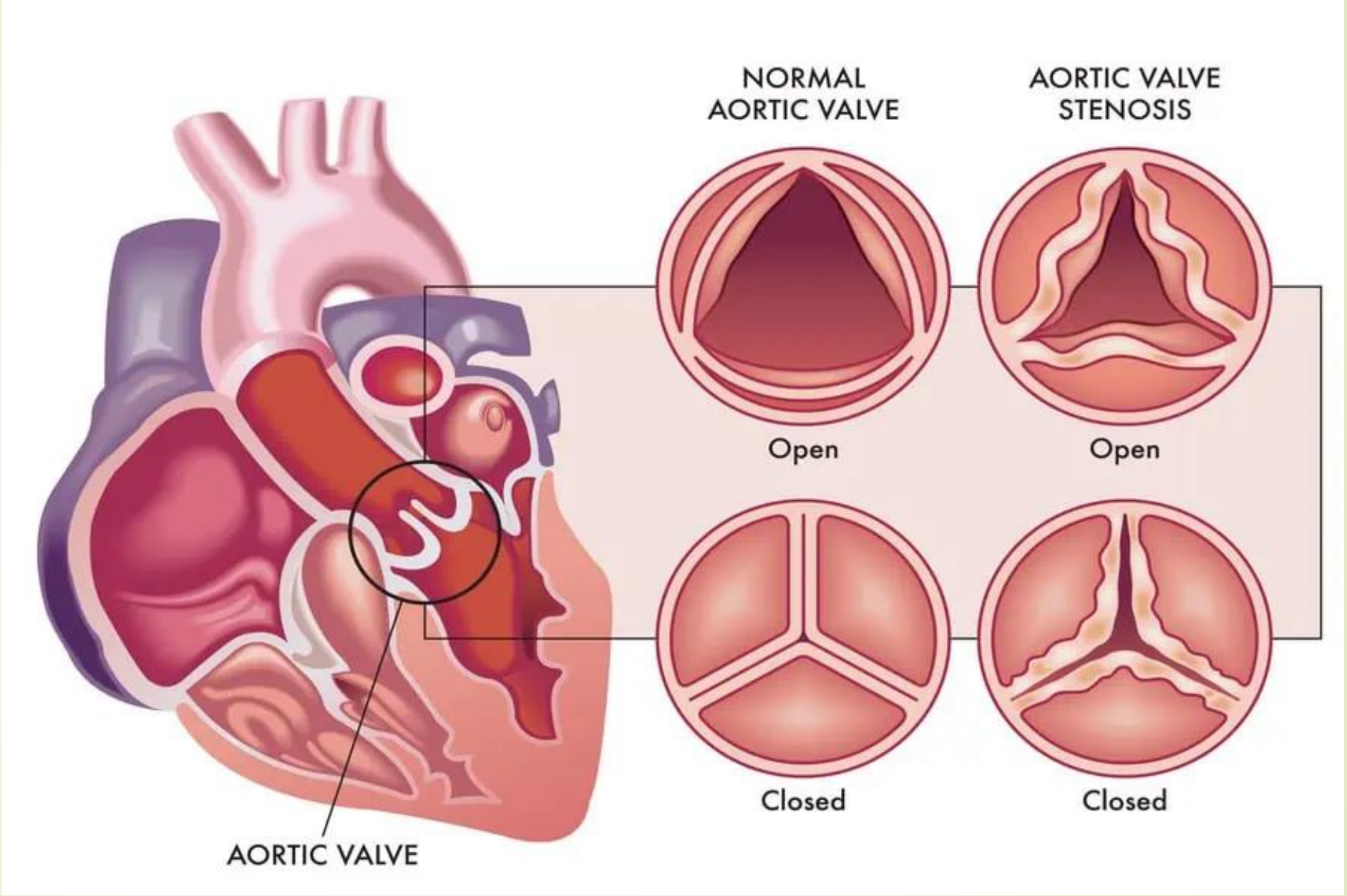
Many abnormal heart sounds, known as “heart murmurs,” occur when abnormalities of the valves are present, as follows.

1. Systolic Murmur of Aortic Stenosis:

In persons with aortic stenosis, blood is ejected from the left ventricle through only a small fibrous opening of the aortic valve. Because of the resistance to ejection, *sometimes the blood pressure in the left ventricle rises as high as 300 mm Hg, while the pressure in the aorta is still normal.*

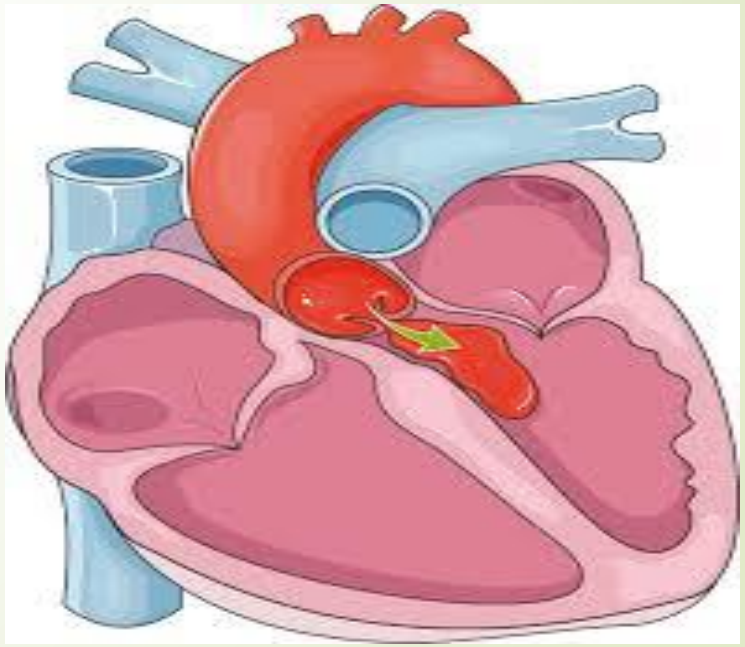
This phenomenon causes **severe turbulence** of the blood in the root of the aorta.

The turbulent blood against the aortic walls causes intense vibration, and **a loud murmur** occurs during systole and is transmitted throughout the superior thoracic aorta and even into the large arteries of the neck. This sound is harsh, and in persons with severe stenosis it may be so loud that it can be heard several feet away from the patient. Also, the sound vibrations can often be felt with the hand on the upper chest and lower neck, a phenomenon known as **a thrill**.


NORMAL
AORTIC VALVE
AORTIC VALVE
STENOSIS
Open
Open
Closed
Closed
AORTIC VALVE

2. Diastolic Murmur of Aortic Regurgitation:

In aortic regurgitation, during diastole, blood flows backward from the high pressure aorta into the left ventricle, causing a **“blowing” murmur** of relatively high pitch sound heard maximally over the left ventricle. This murmur results from turbulence of blood jetting backward into the left ventricle during diastole.

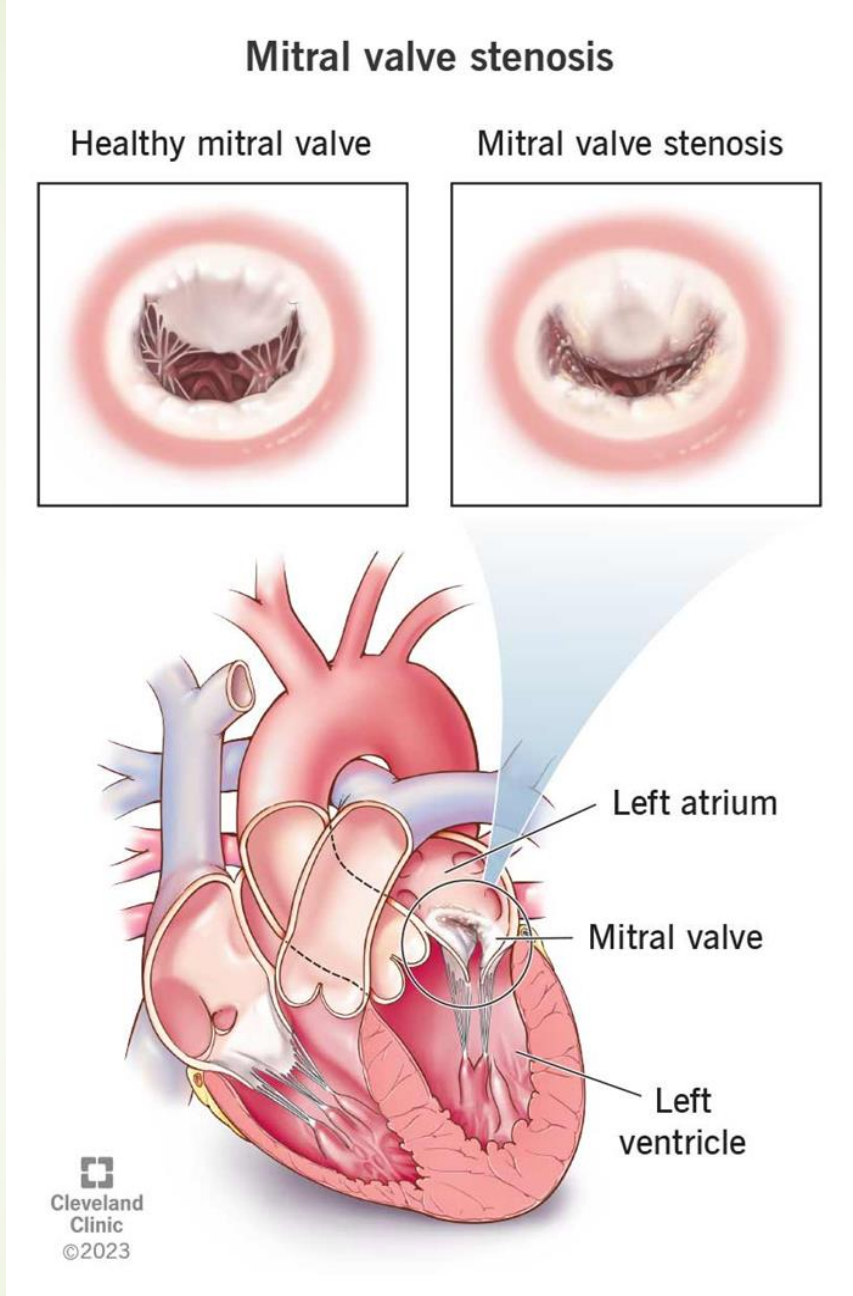


3. Systolic Murmur of Mitral Regurgitation:

In persons with mitral regurgitation, blood flows backward through the mitral valve into the left atrium during systole. This backward flow also causes a high-frequency “blowing” swishing sound similar to that of aortic regurgitation but occurring during systole rather than diastole. It is transmitted most strongly into the left atrium.

4. Diastolic Murmur of Mitral Stenosis:

In persons with mitral stenosis, blood passes with difficulty through the stenosed mitral valve from the left atrium into the left ventricle, and because the pressure in the left atrium seldom rises above 30 mm Hg, a large pressure differential forcing blood from the left atrium into the left ventricle does not develop. Consequently, the abnormal sounds heard in mitral stenosis (see the Figure) are usually weak and of very low frequency, so most of the sound spectrum is below the low-frequency end of human hearing.



Phonocardiograms of Valvular Murmurs:

Phonocardiograms B, C, D, and E of Figure 2, show respectively, idealized records obtained from patients with aortic stenosis, mitral regurgitation, aortic regurgitation, and mitral stenosis. It is obvious from these phonocardiograms that the aortic stenotic lesion causes the loudest murmur, and the mitral stenotic lesion causes the weakest murmur. The phonocardiograms show how the intensity of the murmurs varies during different portions of systole and diastole. Note especially that the murmurs of aortic stenosis and mitral regurgitation occur only during systole, whereas the murmurs of aortic regurgitation and mitral stenosis occur only during diastole.

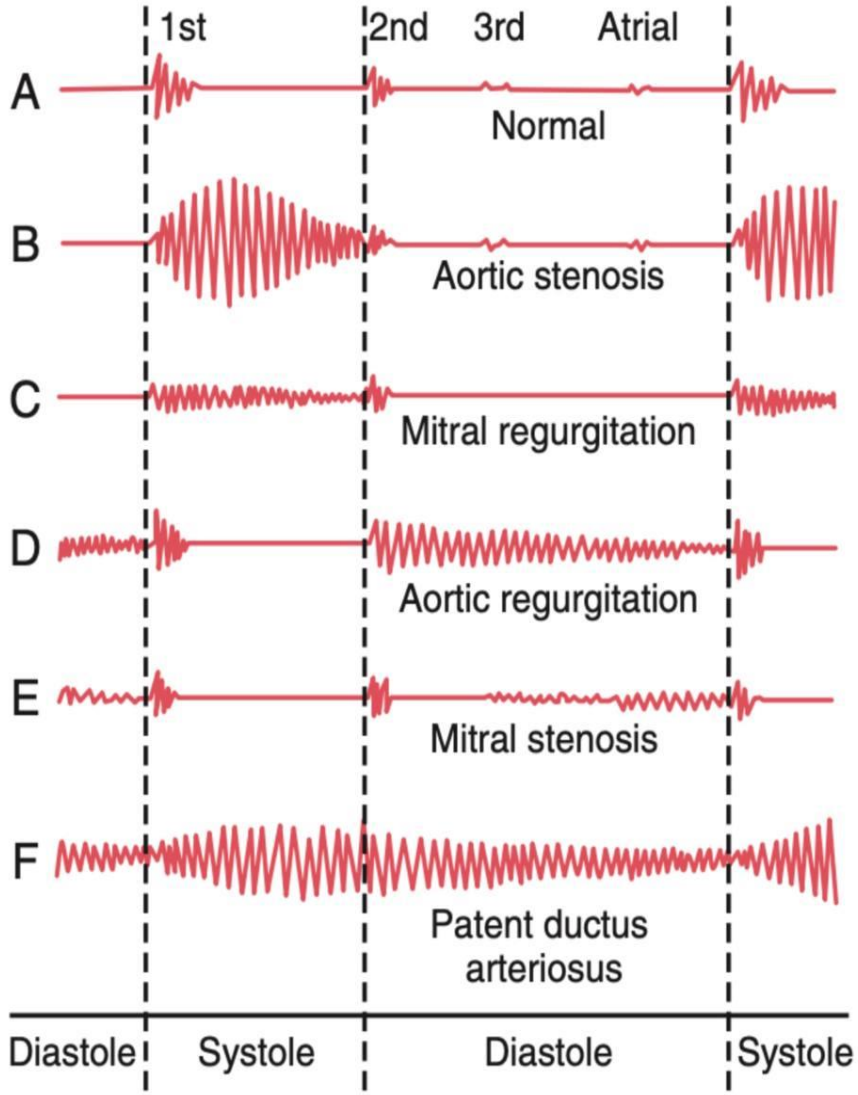


Figure 2: Phonocardiograms from normal and abnormal hearts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Cardiac output:

Cardiac output varies widely with the level of activity of the body.

Factors affect cardiac output

(1) the basic level of body metabolism,

(2) Exercise

(3) Age: with increasing age, body activity and mass of some tissues (e.g., skeletal muscle) diminish. The size of the body.

For young, healthy men, resting cardiac output averages about 5.6 L/min. For women, this value is about 4.9 L/min.

The average cardiac output for the resting adult, in round numbers, is often stated to be about 5 L/min.

- In most tissues, blood flow increases mainly in proportion to each tissue's metabolism. For instance, local blood flow almost always increases when tissue oxygen consumption increases. Note that at each increasing level of work output during exercise, oxygen consumption and cardiac output increase in parallel to each other. Figure 3 shows the parentage of cardiac output in tissues and organs.

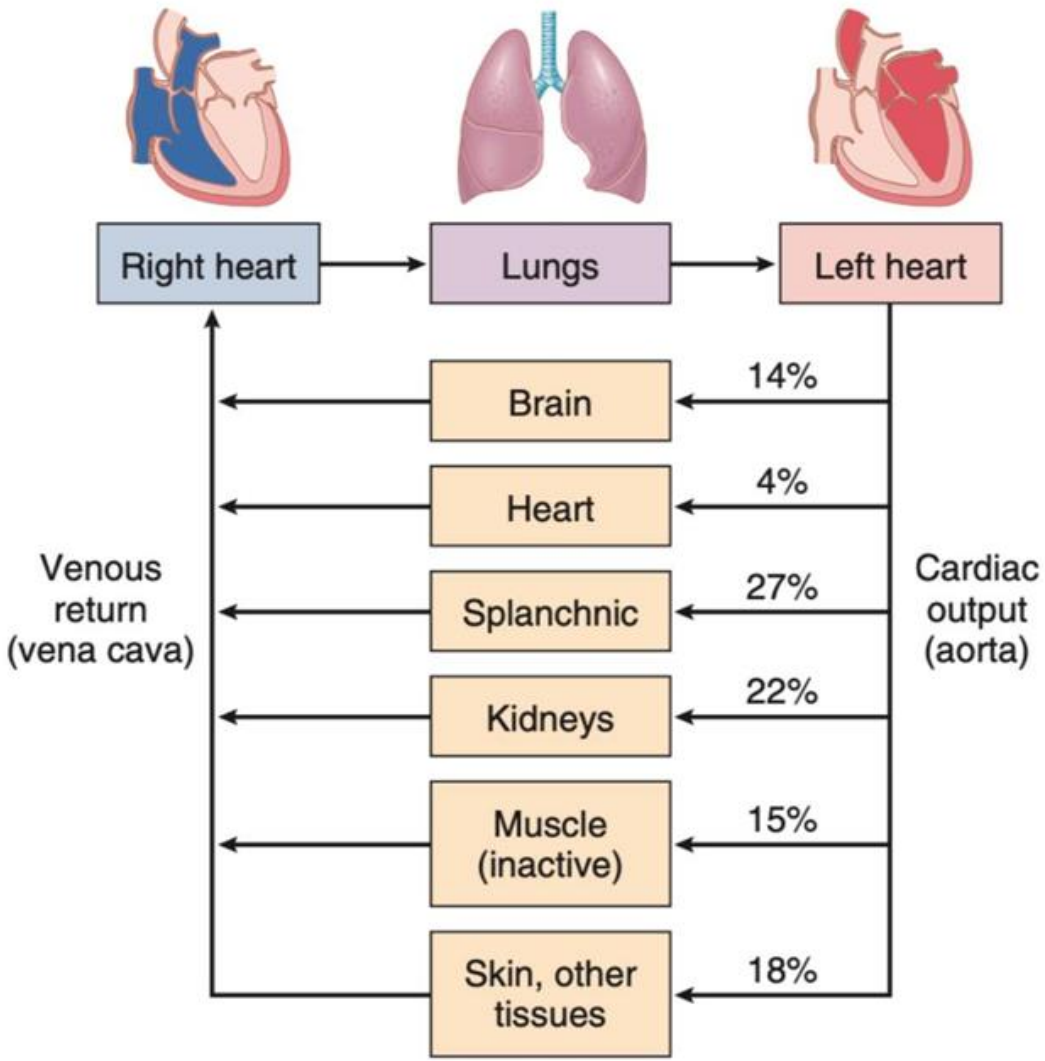

Figure 3: Cardiac output is the sum of tissue and organ blood flows and it is equal to venous return.

Blood pressure

- In general, an individual's "blood pressure," or systemic arterial pressure, refers to the pressure measured within large arteries in the systemic circulation. This number splits into systolic blood pressure and diastolic blood pressure.
- Blood pressure is traditionally measured using auscultation with a mercury-tube sphygmomanometer. It is measured in millimeters of mercury and expressed in terms of systolic pressure over diastolic pressure.
- **Systolic pressure** refers to the maximum pressure within the large arteries when the heart muscle contracts to propel blood through the body.
- **Diastolic pressure** describes the lowest pressure within the large arteries during heart muscle relaxation between beating.

- Arterial pressure directly corresponds to cardiac output, arterial elasticity, and peripheral vascular resistance.
- Blood pressure is remarkably easy to alter and can be affected by many activities.
- Maintaining blood pressure within normal limits is essential.
- Normal Bp between 90/60 to 120/80
- Above 140/89 mmHg called **hypertension.**
- Greater than 180/120 mmHg is a hypertensive emergency, refers to a very high blood pressure that results in potentially life-threatening symptoms and end-organ damage.
- **Hypotension**, on the other hand, is a blood pressure less than 90/60 mmHg.

sphygmomanometer

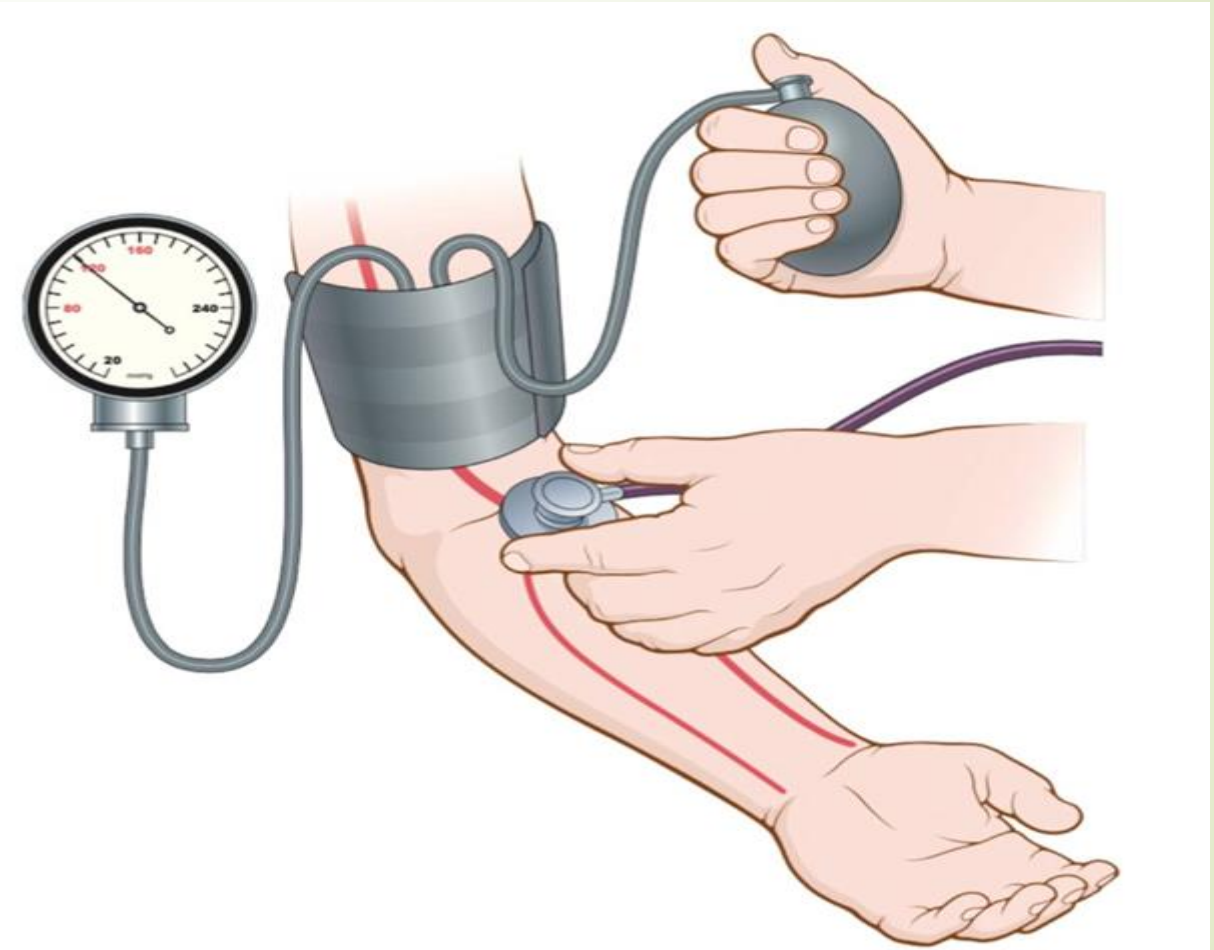

Figure 4: The auscultatory method for measuring systolic and diastolic arterial pressures.

Mechanisms regulates arterial pressure.

1. **Baroreceptor Reflex**

In response to acute changes in blood pressure, the body responds through the baroreceptors located within blood vessels. Baroreceptors are a form of **mechanoreceptor** that become activated by the stretching of the vessel.

2. **Antidiuretic Hormone**

Antidiuretic hormone (ADH), also known as vasopressin, is a hormone synthesized in the hypothalamus. ADH is synthesized and released in response to hypotention.

3. Renin-Angiotensin-Aldosterone System.

- The renin-angiotensin-aldosterone system.
- The system relies on several hormones that act to increase blood pressure.
- It begins with the production and release of renin from the kidney.
- They respond to decreased blood pressure.

GOOD LUCK