

Young Scientist Program Anatomy Teaching Team



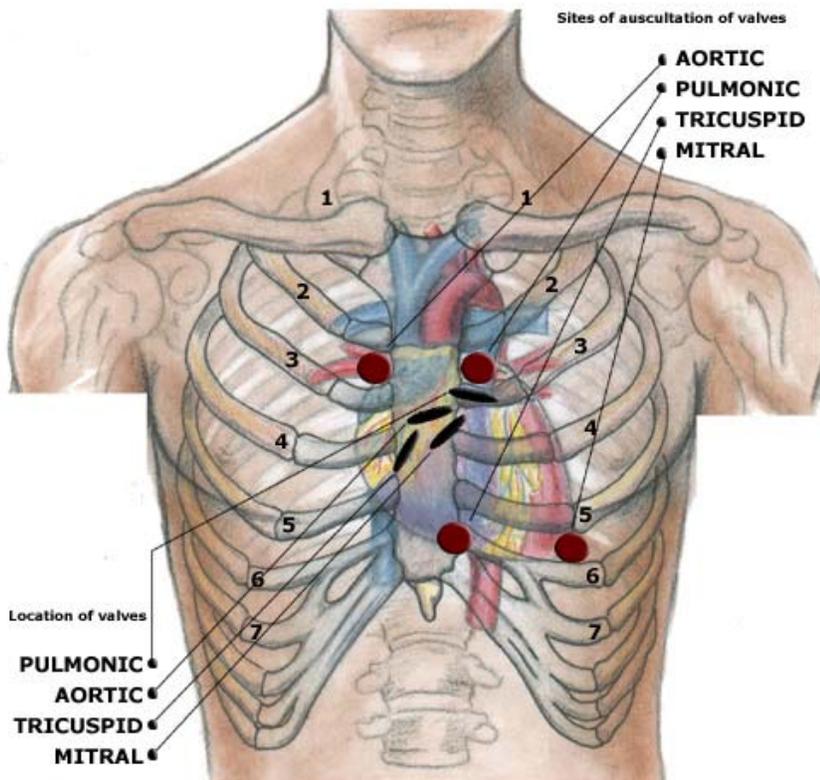
“Heart Auscultation and Cardiac Bioelectricity”

Lesson Goals:

1. Understand that a stethoscope can be used to listen to the heart and give information about health and disease.
2. Know what the pacemaker of the heart is called, and understand the path of cardiac electrical conduction.
3. Understand that electrical activity of the heart stimulates contraction.
4. Know what basic information an EKG can provide about heart function.

Listening to the heart (Auscultation)

Heart sounds can give a doctor clues about heart function and disease. We can listen to the heart's sounds using a device called a stethoscope. The noise that you can hear in your chest (your heartbeat) is actually made from the small leaflets of heart valves closing and hitting each other. The first sound of the heartbeat (the “lub” sound) is known to doctors as **S1**. This sound is produced by the closure of the **tricuspid valve** and the **mitral valve** (at the same time), and signifies the beginning of ventricular squeezing (after the atria are done contracting and pushing blood into the ventricles). The second sound of the heartbeat (the “dub” sound) is known to doctors as **S2**. This sound is produced by the closure of the **aortic valve** and **pulmonary valve**, and signifies that the ventricles are done contracting and done pushing blood out into the body. Show stethoscopes, and demonstrate how to use them—the earpiece should be pointing forward into the ear canal and when the diaphragm is tapped it should sound loud. Students should listen to the heart in four places which allow different



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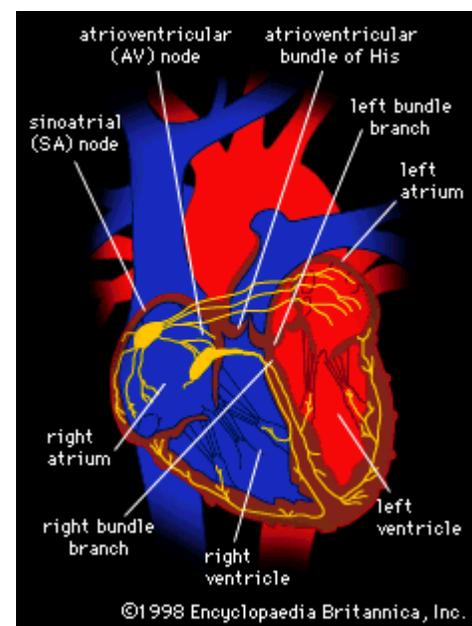
valves to be heard best. The **Aortic valve** can be heard on the mid-right upper chest, the **Pulmonary valve** can be heard on the mid-left upper chest, the **Tricuspid valve** can be auscultated on the mid-left lower chest, and, finally, the **Mitral valve** can be heard best on the lower left chest wall. This order can be remembered by the mnemonic **All Physicians Take Money** (see diagram).

If someone has a very bad heart condition these sounds will be very different from the normal “lub-dub”, and may even involve other sounds. In many older people the valves of the heart get very stiff and rigid. This can lead to conditions called **stenosis** (where the valve does not close all the way), or **valvular relapse** (where the valve actually collapses and flaps around like a swinging door). In some case a hole may form through the valve (mitral regurgitation during which blood flows backwards as well). In these cases abnormal sounds (murmurs) can often be heard with a stethoscope. Surgeons may need to replace these valves with artificial ones made out of plastic or artificial tissue. **Demonstrate abnormal heart sounds.** Play mitral regurgitation and mitral stenosis tracks on iPad or iPod. Note the relationship of the murmurs to the S1 and S2 sounds.

Cardiac Bioelectricity

One amazing thing about the heart is that it can beat on its own, even when it is disconnected from the brain! Even though this seems pretty crazy, it is actually the reason that our heart beats in such a rhythmic manner all day and all night every day of our lives.

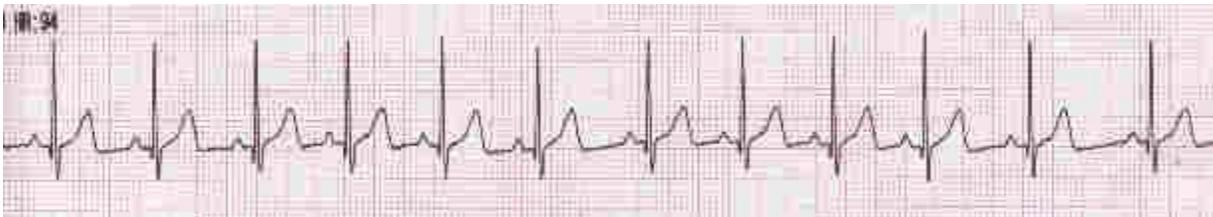
The path of conduction through the heart: The basis behind this mechanism lies in a small patch of cells in an area called the **sinoatrial (SA) node** (which actually is on the inner wall of the right atrium). **(show anatomical location)**. In this region there are very special myocardial (heart) cells that excite themselves and release a small burst of electricity every 0.5-1.0 seconds in a very rhythmic fashion. These cells serve as the pacemaker of the heart and set the rate at which the heart contracts. The normal range of heart rate is typically 60-100 beats per minute **(measure heart rates, take pulse)** Can you think of some activities/situations that can normally raise or lower your heart rate? (e.g exercise, excitement, sleep). Other heart cells can also fire but in a normal heart the SA node takes over. The electrical signal generated in the SA node spreads to the atria through specialized tracts (think of power lines) and reaches the walls of the atria. Because all heart cells are connected by tiny “bridges,” known as **gap junctions**, this electric signal spreads through the atria wall and “activates” the muscle cells to contract. **Remember: heart cells contract (and the heart squeezes) when the electrical signal stimulates them to do so.** The signal travels from the SA node to the atria first and thus the atria contract first. Thinking of the four chamber heart anatomy, why is it important for the atria to contract first? What happens when the atria contract (hint what is sitting in the atria?) Where does the blood go during this contraction? It should go to the ventricles! Who makes sure the flow is from the atria to the ventricles? (correlate briefly with valves) What should happen next? Let’s find out...



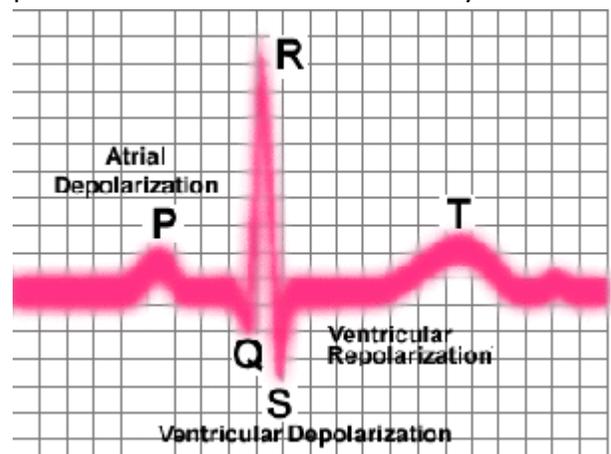
The ventricles are (normally) electrically insulated from the atria with only one path for the electrical signal to reach them from the SA node. This path includes the **atrioventricular (AV) node** (in the right atrium close to the ventricles) where conduction (travel) of the electrical signal slows down just a bit. Once past the AV node the electrical signal (the same one that was generated by the SA node and contracted the atria) continues through the **His bundle and Purkinje system** which transmit the signal with tremendous speed again towards the ventricular walls. The **Purkinje fibers** conduct the electrical signal so that it reaches most parts of the ventricles at the same time. Why do you think it is important that the electrical conduction happens simultaneously in the ventricles? The ventricles need to contract simultaneously in order to effectively pump blood.

1.) Review the order that the electric pulse moves through the heart. Find which chambers of the heart contract/activate first and then second.

In order to test whether the electrical activity of a patient's heart is normal or abnormal, a doctor can order a special test called an **electrocardiogram**, or **EKG**. This is usually the beeping noise that you hear on any type of doctor TV show. Electrical activity is recorded by placing small sensors (the electrodes) onto someone's skin. As the electrical signal (positive charge to be specific) moves towards these sensors an upwards spike (bleep) is formed. This heart activity recording looks like this:



Each of these peaks and bumps represents an important part of the heart's electrical activity. The first bump (before the large spike) is known as the **P-wave**, and represents the activation of the atria and their pumping blood into the ventricles. The following big spike, and the little downward spikes around it, is known as the **QRS complex**, and represents the activation of the ventricles and the beginning of their pumping blood out into the body. Which comes first the P or the QRS waves? Which contracts first the atria or the ventricles? Finally, the last bump after the big spike is known as the **T-wave**, and represents the "resetting" of the ventricles for the next time they contract. **If the EKG machine (PowerLab26T) is available, see instructions for use.**



2.) How does the EKG reflect what is going on in the heart? What could you tell about the heart, and how it is working, by looking at an EKG recording?