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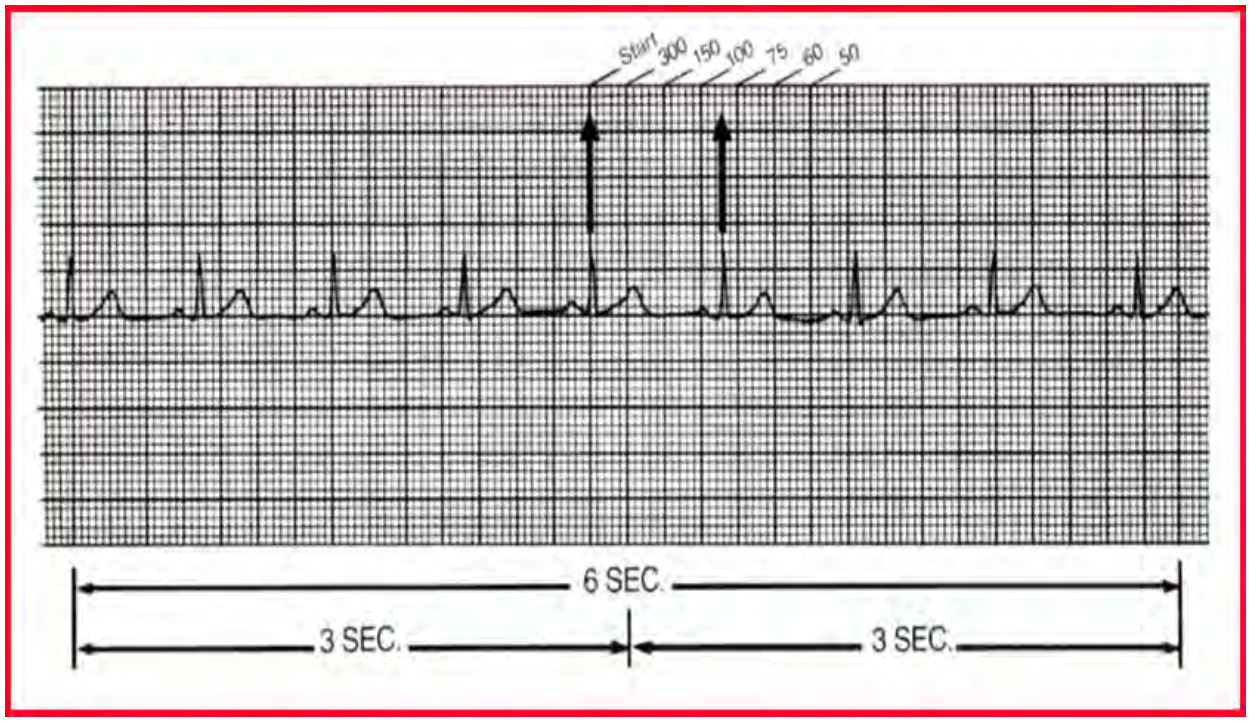
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Cardiac Electrophysiology

Basic Definitions Related to Electrophysiology of the Cardiac System

Automaticity: The ability of cardiac cells to spontaneously initiate an electrical impulse without external stimulation.

Conductivity: The ability of cardiac cells to propagate an electrical impulse from cell to cell.

Conducting Cells: Specialized cells of the conduction system of the heart that are capable of initiating an impulse and rapidly spreading the impulse in an organized manner throughout the heart. These cells do not contract, but are capable of rapidly conducting electrical impulses.

Contractility: The ability of cardiac muscle cells to contract (shorten and lengthen) in response to electrical stimulation.

Contracting Cells: These cells make up the walls of the atria and walls of the ventricles, and are responsible for contraction of those chambers. Contracting cells must receive an electrical stimulus before they will contract. When one cell is stimulated, the impulse is spread to all cells in the chamber, resulting in all the cells contracting as a single unit.

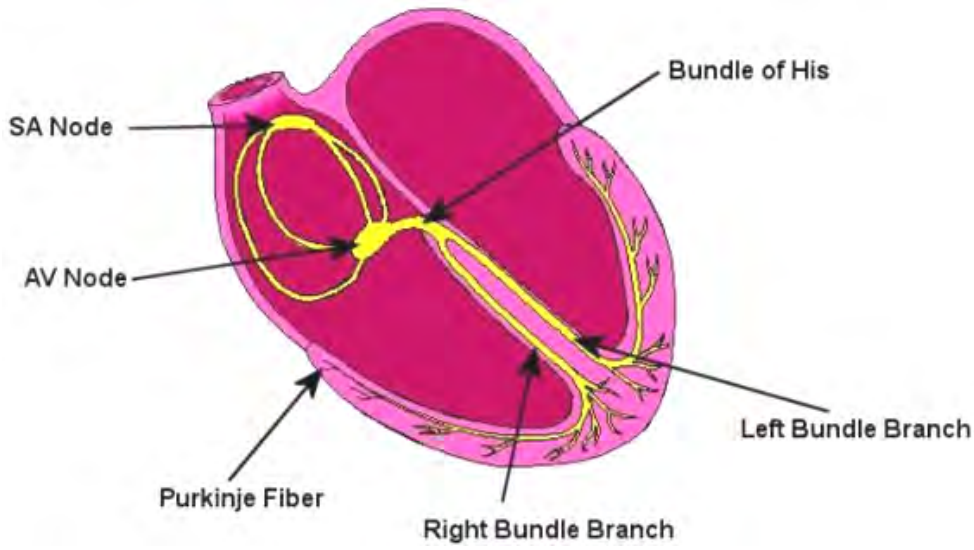
Depolarization: Electrical excitation of the cell membrane resulting from the flow of ions across the cell's membrane. The electrical impulse spreads through out the conduction system and muscle fibers of the heart, providing the stimulus to contract.

Excitability: The ability of cardiac cells to reach a threshold and respond to a stimulus.

Refractory Period: The period of time after a cell has depolarized during which it cannot depolarize again until it has partially or fully repolarized.

Repolarization: The return of the cell membrane to its resting potential, due to the flow of ions across the cell membrane. A cell must repolarize before it can respond to a stimulus.

Cardiac Conduction System



Sinus Node (SA Node): The SA Node is a small group of specialized cells that is located high in the right upper atria. The SA Node has the highest automaticity rate of any site in the heart and serves as the primary pacemaker, generating a heart rate of 60-100 beats per minute.

Atrioventricular Node (AV Node): The AV Node is a small group of specialized cells located in the lower portion of the right atrium, near the tricuspid valve. The AV Node has three major functions:

- It slows the conduction of the impulse from the atria to the ventricles to allow the atria to fully depolarize and contract, allowing for atrial kick and adequate ventricular filling time.
- The AV Node has the second highest automaticity rate of 40-60 beats per minute, and functions as the backup pacemaker, should the SA Node fail.
- The AV Node screens rapid atrial impulses to protect the ventricles from extremely fast rates.

Bundle of His: This is a short bundle of fibers at the bottom of the AV Node leading down towards the bundle branches.

Bundle Branches: The bundle branches have the 3rd highest rate of automaticity and serve as the tertiary backup pacemaker should the SA and AV node fail. The bundle branches are capable of generating a pacing rate of 20-40 BPM. The bundle branches are bundles of fibers located along the septum of the heart that convey electrical impulses to the right and left ventricles. The right bundle branch consists of one branch that supplies electrical impulses to the muscle cells of the right ventricle. The left bundle branch consists of two branches (anterior fascicle and posterior fascicle).

The left ventricle has a much larger muscle mass than the right ventricle. To keep the ventricles in synch with each other, the left bundle branch consists of two fascicles that are utilized to quickly depolarize the larger muscle mass of the left ventricle, so that both the left and right ventricles contract at the same time. Without two fascicles the much larger left ventricle muscle mass would depolarize at a slower rate than the smaller muscle mass of the right ventricle. The end result would be asynchronous ventricular contraction.

Electrical Conduction Through The Heart

The SA-Node fires and produces an electrical impulse, which is conducted through the atria, causing them to depolarize, creating the P-Wave. The impulse is held in the AV-Node for 0.10 seconds, allowing the left and right atria to fully depolarize. The impulse is then conducted through the AV-Node to the Bundle of His and then to the left and right bundle branches. As the impulse leaves the AV-Node it picks up speed rapidly and conducts very quickly through the Bundle of His and left and right bundle branches, finally reaching the Purkinje fibers and ventricular myocardium.

Rates of Cardiac Pacing Sites:

- SA-Node: 60-100 BPN
- AV-Node: 40-60 BMP
- Purkinje Fibers: 20-40 BMP

Rhythm Analysis

When looking at a cardiac rhythm ask your self the following questions.

What is the rate? Is it fast or slow?

Rhythm	*Rate*
NSR	60-100
Sinus Brady	< 60
Sinus Tachycardia	100-150
SVT	>150
Junctional	40-60
Accelerated Junctional	60-100
Junctional Tachycardia	>100
Idoiventricular Rhythm	20-40
Accelerated Idoiventricular	40-100
Ventricular Tachycardia	>100

Calculating Heart Rates:

For regular rhythms count the number of large boxes between R waves and divide into 300 or look up on chart. Use the same method to calculate the atrail rate by counting large boxes between P waves.

For irregular heart rates count the number of R waves in a 6 second strip and multiply by 10. Do the same for P waves to calculate atrial rate. Some rhythms may have atrial rates that differ from the ventricular rate.

# Of Large Boxes	Rate
1	300
2	150
3	100
4	75
5	60
6	50
7	43
8	37
9	33
10	30

Measure the following: PRI, QRS, QT.

Is there a P wave for each and every QRS Complex?

Are the P waves upright and regular?

Do the P waves march out regularly?

Is the QRS narrow or wide? Grossly abnormal in appearance?

- If the QRS is narrow .12 or less, the impulse will have originated above the ventricles.
- If the QRS is very wide, .16 or greater with a T waves the opposite direction of the QRS complex. It would be suspected that the impulse is ventricular in origin.

Is the rhythm regular or irregular?

What rhythms are regular? Which rhythms are irregular?

Can you name the rhythm yet?