

# Basic Dysrhythmias

## CARDIAC ANATOMY & PHYSIOLOGY

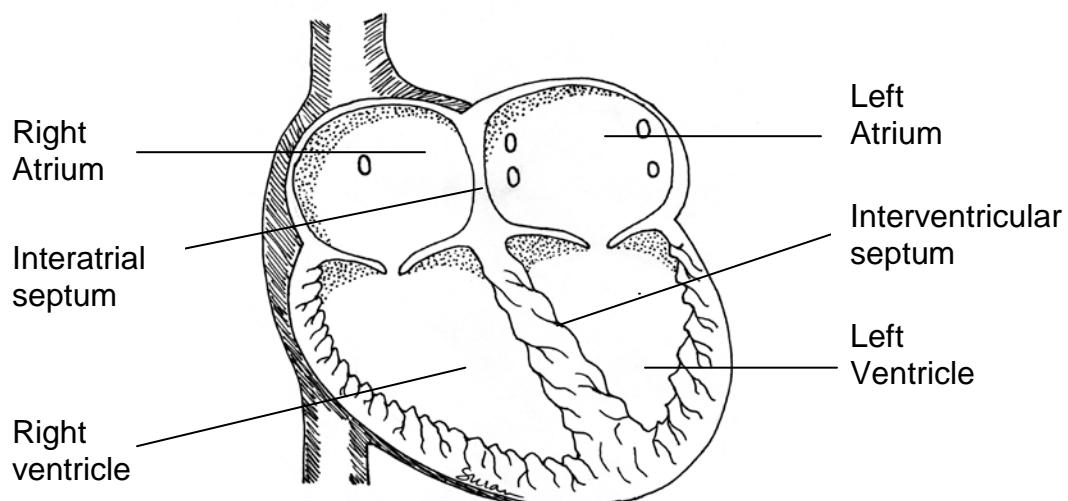
The heart is a hollow, cone shaped, muscular organ about the size of your fist. It is located in the center of the chest behind the sternum and situated between the lungs. Approximately 2/3's of the heart lies to the left (L) of the sternum, 1/3 lies to the right (R) of the sternum. The top of the heart is referred to as the "base", and the bottom of the heart is called the "apex". The primary purpose of the heart is to pump enough blood into the pulmonary (lung) and circulatory system (blood vessels) to meet the needs of the body. In a circular motion, blood is pumped out of the heart to arteries, capillaries and veins, then back to the heart.

## HEART CHAMBERS

The heart is divided into four chambers. The two **upper chambers** are referred to as the right and left **atria**. The **lower chambers** are the right and left **ventricles**. Although there are four chambers total, the heart functions as two separate systems. The right atrium and right ventricle are responsible for getting venous blood to the lungs where it will pick up oxygen. The left atrium and left ventricle are responsible for pumping oxygenated blood out to all parts of the body.

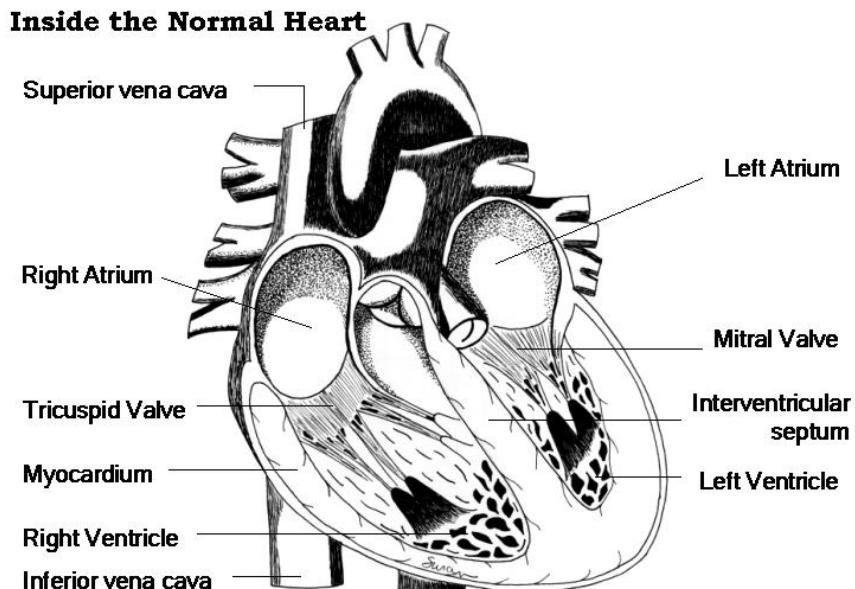
## INTERATRIAL & INTERVENTRICULAR SEPTUM

The interatrial septum is a wall of muscle tissue that separates the right and left atria (upper chambers). The interventricular septum is a wall of muscle tissue that separates the right and left ventricles (lower chambers). The muscle walls of the ventricles are thicker than the walls of the atria, and the muscle wall of the left ventricle is thicker than the right ventricle giving it the name "the workhorse of the heart (see picture below). Collectively, the septums provide structure and function for the heart and separate the two interconnected systems.



## BLOOD FLOW THROUGH THE HEART

The right atrium receives unoxygenated blood into the heart from the **inferior** and **superior vena cava** and the **coronary sinus**. From the right atrium blood passes through the **tricuspid valve** into the right ventricle. The right ventricle pumps the blood through the **pulmonic valve** into the pulmonary artery and to the **lungs** (or the pulmonary circulation). Oxygenated blood returns from the lungs into the left atrium via one of four **pulmonary veins**. From the left atrium blood passes through the **mitral** (bicuspid) valve into the left ventricle. The left ventricle pumps blood through the **aortic** valve and into the aorta, out into the **systemic circulation** (the rest of the body). Blood is then carried by arteries, veins and capillaries to the rest of the organs in the body. Blood returns to the heart through veins.



## THE CARDIAC CYCLE

All of the events including pumping blood through the heart are referred to as the cardiac cycle. There are two phases in the cardiac cycle. **Systole** refers to the **contraction** and resulting ejection of blood out of the chambers. **Diastole** refers to the time period when the chambers **relax** and refill with blood. Factors affecting functionality of the cardiac cycle include disease of the conduction system, inefficient functioning of the heart valves and how well the muscles are able to contract. So if you have a heart attack that damages the conduction system or muscle layers, the heart will not pump as efficiently. A damaged valve will also lead to decreased function of the heart.

## CARDIAC CELLS

The heart is able to pump in a rhythmic action because it contains electrical (conductive) cells. Electrical cells have the ability to initiate an electrical impulse that is passed along the entire conduction system of the heart. The activity of electrical cells can be assessed through a graphical display on an electrocardiogram (ECG). Mechanical (contracting) cells are able to respond to the electrical impulse. Once stimulated by the impulse, mechanical cells cause the heart muscle to contract and eject blood out. We assess this mechanical activity by obtaining a blood pressure and a pulse.

## PHYSIOLOGICAL PROPERTIES OF MYOCARDIAL CELLS

The physiological property of myocardial cells that allows the cell to initiate an electrical impulse without an external stimulus is referred to as **automaticity**. This happens when cells alter their membranes and pull Sodium ( $\text{Na}^+$ ) into the cell.

The physiological property of myocardial cells that allows the cell to respond to an electrical impulse is referred to as **excitability**.

The physiological property of myocardial cells that allows the cell to transmit an impulse is called **conductivity**.

The physiological property of myocardial cells that allows the cell to pump in response to the stimulus is referred to as **contractility**.

So what does all this mean? It means a cardiac cell can generate its own electrical impulse through the alteration in the sodium & potassium pump (ions moving in and out the cells membrane). That is the automaticity. The cell can respond to the electrical impulse, meaning it can be excited. The cell conducts the electrical impulse from one cell to another, which then causes the muscle to contract or pump.

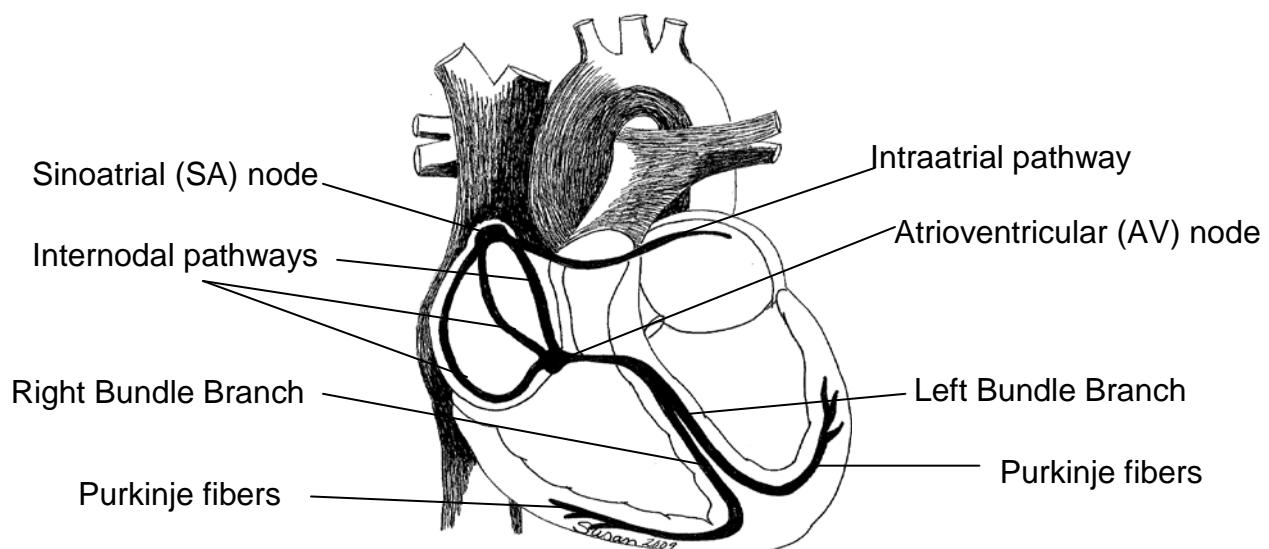
## THE SODIUM-POTASSIUM PUMP

We will take a brief look at the sodium-potassium pump. Please understand there are other important elements found in this pump such as calcium and magnesium but for this course we will talk about the sodium and potassium only. In a polarized (resting) state, sodium is normally found outside the cell, and potassium is found inside the cell. Although sodium and potassium are both positively charged, sodium has a stronger positive charge, which makes the outside of the cell more positive as compared to the inside. When the cell changes its membrane, sodium gets pulled inside the cell while potassium moves out. This movement of sodium inside the cell is referred to as **depolarization** or discharge state, which is equivalent to contraction. When sodium

moves back out of the cell, and potassium returns to the inside of the cell, the cell is said to **repolarize** (resting state), which is equivalent to relaxation.

## THE CONDUCTION SYSTEM

The conduction system is made up of the following parts: the sinoatrial node (SA), intraatrial pathway, internodal pathway, atrioventricular node (AV), bundle of His, right and left bundle branches and the purkinje fibers.



The **SA node** is located in the upper part of the right atrium near the area where blood enters from the superior vena cava. The SA node is referred to as the “primary pacemaker” of the heart since it is known to have the highest rate of automaticity. The SA node generates its own electrical impulses (inherent rate range) at **60-100 beats per minute (BPM)**.

When electrical impulses (action potentials) leave the SA node, they are conducted to the left atrium via the intraatrial pathway. Electrical impulses then move through the right atrium via one of three internodal pathways. Electrical impulses spread from cell to cell over both atria causing atrial depolarization (contraction) resulting in ejection of blood from the atria into the ventricles.

The **AV node** is located between the right atrium and right ventricle in the lower portion of the interatrial septum. The AV node's job is to slow the electrical impulse down and send it to the ventricles. The electrical impulse is slowed to allow the atria to push an extra amount of blood (20-30% more blood) into the ventricle at the end of atrial

contraction. This process is referred to as “atrial kick.” The inherent rate range of the AV junction is **40-60 BPM**.

The electrical impulse leaves the AV node and spreads to the Bundle of His where the impulse is directed down the right and left bundle branches. Bundle branches travel down the right and left sides of the heart where they terminate as Purkinje fibers.

Purkinje fibers pass through all muscle layers of the ventricles. The fibers contain pacemaker cells enabling it to take over the role of the pacemaker when needed. Electrical impulses transfer from cell to cell over both ventricles causing ventricular depolarization (contraction) with resulting blood ejected out of the ventricles. Ventricular repolarization (relaxation) then occurs. The inherent rate range for the **ventricles** is **20-40 BPM**.

## ECG CONCEPTS

**Irritability** refers to the potential of a cardiac cell to become so irritated, or electrically charged, that it can produce an impulse faster than the rate of the SA node. The electrically charged cells can take over the role of the pacemaker of the heart, for a single beat or for an entire rhythm. Irritability is usually undesirable due to the fact that the heart is beating at a faster than normal rate. It can result in many abnormal rhythms which will be discussed in the class.

**Escape** refers to the protective mechanism built in the heart that protects it when the primary pacemaker of the heart, the SA node, fails. For example, when the SA node falls below the inherent rate range of 60-100 BPM, the AV junction can take over (escapes) with a pacemaker rate of 40-60 BPM. If the AV fails, the purkinje fibers will take over (escapes) at a rate of 20-40 BPM.

## AUTONOMIC NERVOUS SYSTEM (ANS)

The ANS is comprised of two systems: the sympathetic nervous system and the parasympathetic nervous system. The **sympathetic nervous system (SNS)** affects the atria and the ventricles. It does so by increasing the heart rate, conduction and irritability. A couple of examples of the ANS coming into play would be the patient that has pain or fever. There is an automatic increase in heart rate with fever and pain. The **parasympathetic nervous system (PNS)** on the other hand decreases heart rate, conduction and irritability. The PNS affects only the atria. However one should consider that most of the conduction system sits in the atria. An example of the PNS coming into play would be a patient who has nausea & vomiting stimulates the vagus nerve and drops his/her heart rate.

## **ELECTROCARDIOGRAM (ECG)**

An ECG provides a graphical picture of the electrical activity in the heart. The printed activity recorded on an ECG strip is called a rhythm. When we refer to the ECG rhythm as being abnormal, we call it an arrhythmia or dysrhythmia. A **cardiac dysrhythmia** represents a **disturbance in heart rhythm**. The disturbance can be minor, and some can be life-threatening.

The ECG does not tell us anything about the mechanical system of the heart (pumping ability), thus our emphasis in this class will be on the study of the electrical activity in the heart, or the ECG. We will not be studying the mechanical cells, as that would require us to assess a patient and we will not be doing that in class.

## **APPLICATION OF ELECTRODES**

Electrodes are adhesive pads that contain conductive gel and are placed on certain areas of the chest to pick up the electrical activity of the heart. The electrodes are connected to a wire that goes to a box or to a bedside monitor.

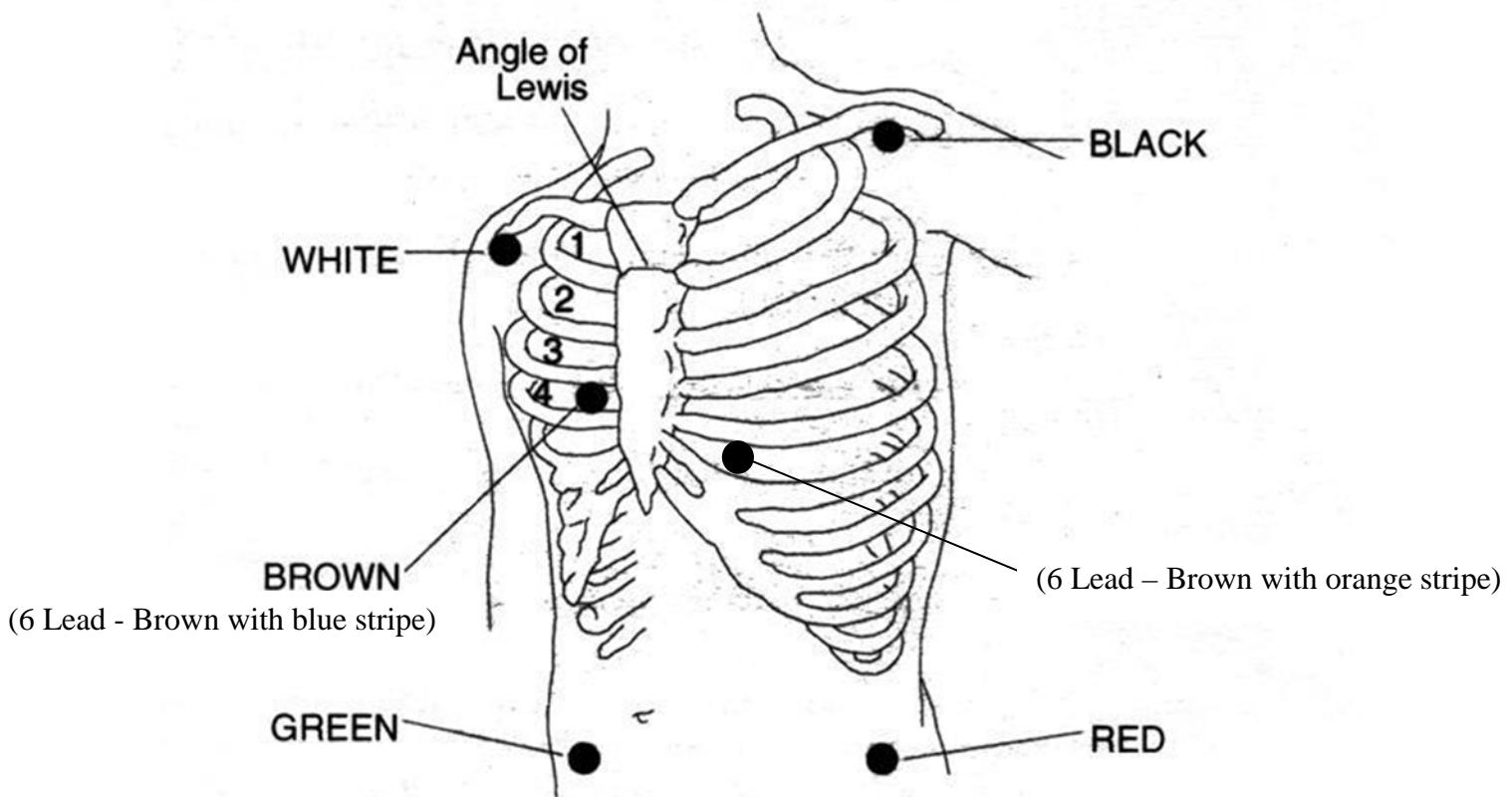
Cleaning the skin of the patient and correct placement of the EKG electrodes will provide monitoring to detect changes in the electrical activity of the heart. The size of the P, QRS and T waves depends on correctly placing the electrodes. EKG electrodes improperly placed will result in less than optimal EKG monitoring of the patient. The hospital uses Lead II most frequently for monitoring. EKG electrodes are changed daily and as requested by the patient. Observe skin daily for redness or rash.

## **Steps for Placement of Bedside Monitor or Telemetry Box**

1. Explain the procedure and purpose of the EKG monitoring to the patient.
2. Identify areas of the chest that electrodes will be placed.
3. Cleanse the skin with soap and water or alcohol, and if necessary, clip the chest area for hair that is present, at the site the electrodes are to be placed.
4. Once the skin is dry, abrade the skin with a gauze or washcloth to remove dead skin cells that interfere with transmission of the EKG current.
5. Make sure the lead wires are not frayed or broken. To lessen the discomfort to the patient, attach lead wires to the electrodes before placing them on the patient's skin.

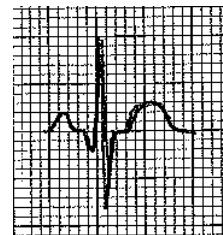
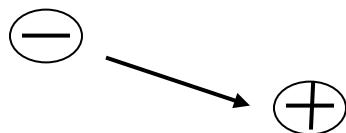
6. Attach the electrodes to the patient using placement guidelines below. Push down on the electrode all the way around and in the center to get the adhesive on the electrode to touch the skin.
7. Assess electrodes for proper placement on the patient every 12 hours and as needed.
8. Change electrode sites on a 24-hour basis and observe skin condition. Document skin condition daily in the nurse's notes.

### ***Standard Electrode Placement***



## NORMAL FLOW OF ELECTRICITY IN THE HEART

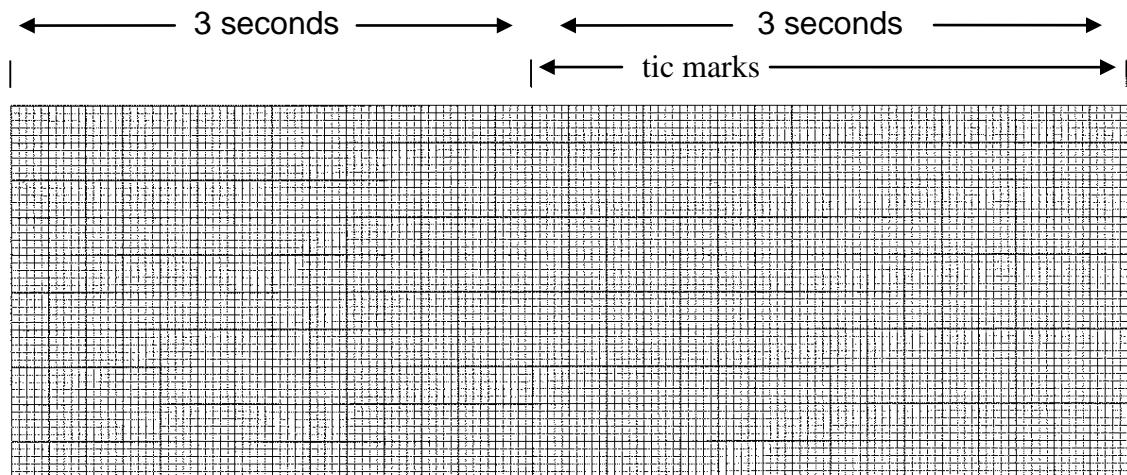
Electricity normally flows from a negative to a positive direction in the heart producing upright P, R and T waves. See picture.



Because Lead II allows us to “see” this normal upright P wave, it is referred to as the universal monitoring lead.

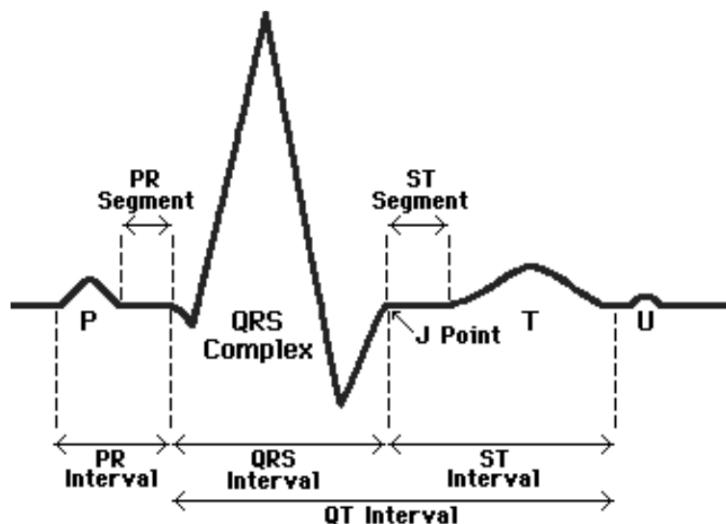
## EKG GRAPH PAPER

ECG graph paper is composed of groups of horizontal and vertical lines that provide a graphical representation of the electrical activity of the heart. The paper is standardized to run at a speed of 25 millimeters per second. Below you will find an example of ECG graph paper. Inside the bold lines you will find 5 small boxes. Each box measures **0.04 seconds**. There are 5 boxes in one large box (indicated by the bold lines). Therefore, one large box measures **0.20 seconds** ( $5 \times 0.04 = 0.20$  secs). The squares represent the time it takes the electrical impulse to reach a specific part of the heart. You will need to understand measurements in order to interpret rhythm strips. Also, note at the top of the rhythm strip, the three black lines. These black lines are referred to as “tic” marks. The time from one tic mark to the next tic mark on the strip below is 3 seconds. Some monitors print tic marks at 6 second intervals. In order to determine the heart rate on a strip using the “rule of 10” method you will need a six second section of a strip. When you look at the strip, ensure there are the appropriate number of tic marks at the top of the strip based on how your monitor is printing them.



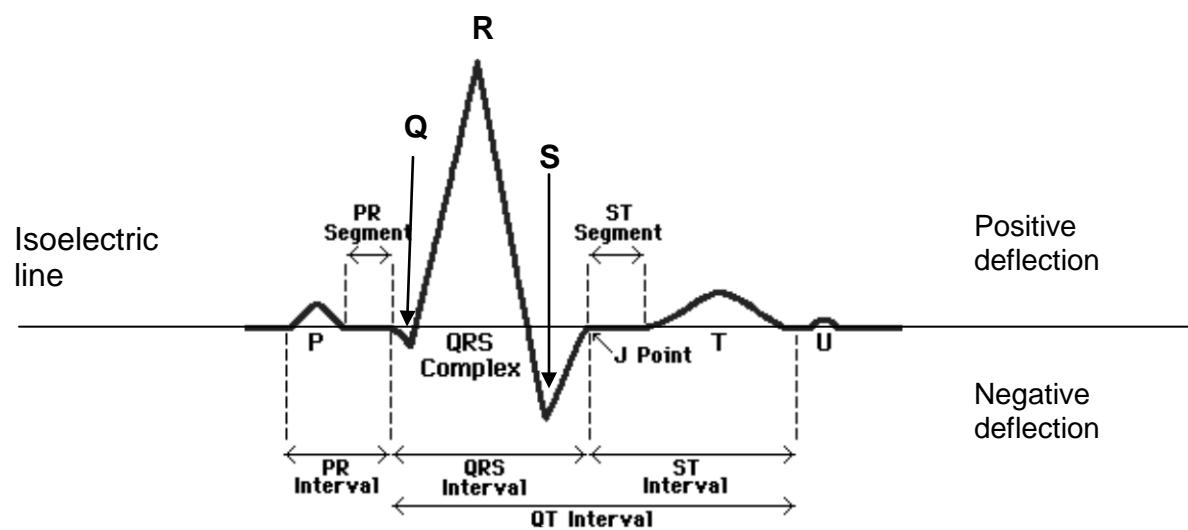
## ECG WAVEFORMS

A waveform is what is recorded each time an electrical impulse travels through the heart. After initiation of the electrical impulse, waveforms are graphically represented on the ECG paper. One cardiac cycle is represented on graph paper by the following waves: P wave, Q, R, and S waves, and the T wave. Some patients might also have a U wave. First view a picture of the waveforms and then we will discuss each one:



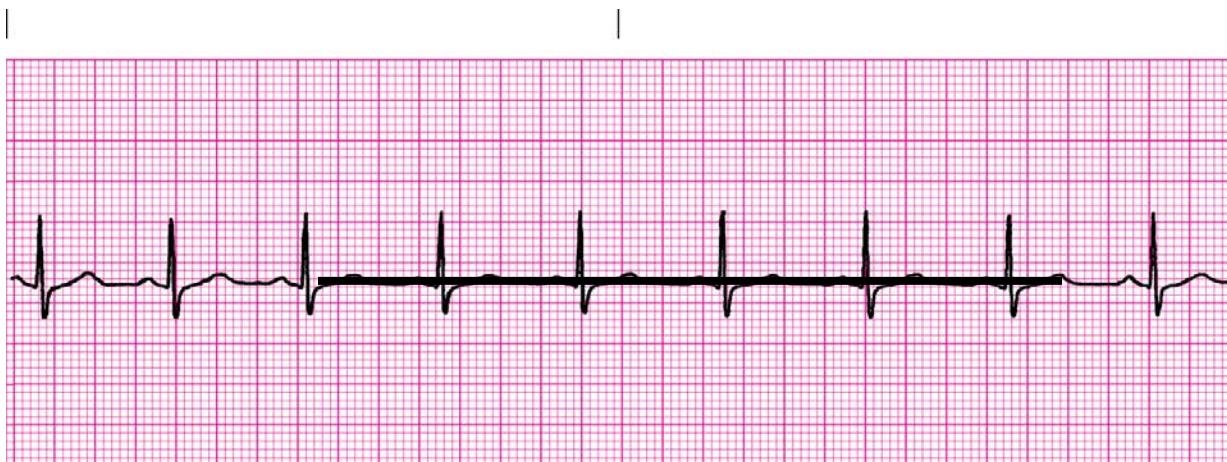
## ISOELECTRIC LINE

The baseline voltage of the ECG is referred to as the **isoelectric line**. Isoelectric refers to **no electrical activity**. The isoelectric line is usually measured from the end of the P wave to the beginning of the QRS complex. You can refer to the PR segment or the TP segment for locating the isoelectric line. Observe the isoelectric line in the following picture.

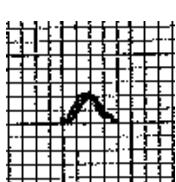


So if you look at the picture you will see that in the normal heart, the P, R, T and U waves have a positive deflection, and the Q and S waves are negatively deflected.

## Determining the Isoelectric Line



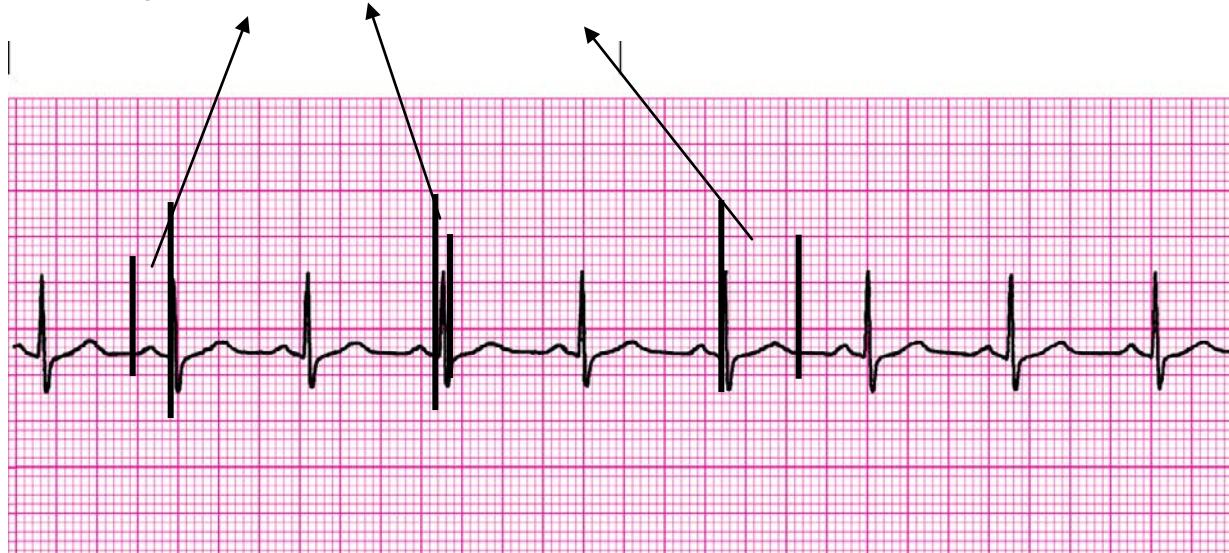
### P WAVE



As we discussed earlier, the heart has the ability to generate its own electrical impulses. In the normal heart electrical impulses start in the SA node. As the SA node “fires”, the electricity spreads into the right atrium and along the intraatrial pathway to the left atrium. The atria contract, producing a P wave. A P wave is normally upright, rounded and uniform (meaning they look alike) but can be negative or biphasic (half above the isoelectric line and half below the isoelectric line). The **P wave** represents **atrial depolarization**.

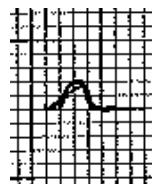
This P measures three blocks or 0.12 seconds

### Measuring the PRI, QRS and QT Interval



## PR INTERVAL (PRI)

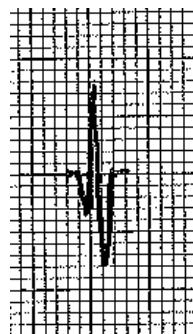
The PRI measures the time it takes for the electrical impulse to travel from the SA node through the internodal pathways to the AV node. The PRI starts at the first sign of the P (atrial depolarization) and ends at the beginning of the QRS (the beginning of ventricular depolarization). The normal **PRI** measurement is **0.12- 0.20 seconds** or 3 to 5 small blocks on the ECG graph paper.



This PRI measures 5 blocks or 0.20 seconds

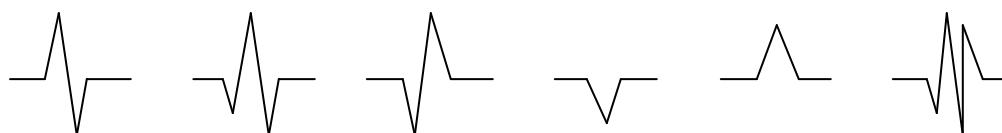
## QRS COMPLEX

The **QRS** measures the time interval it takes the impulse to go from the Bundle of His to the purkinje fibers and throughout the ventricular muscles. The QRS represents **ventricular depolarization**. The Q wave is the first negative deflection following the P wave or before the R wave. The R wave is the first positive deflection after the P wave. The S wave is the negative deflection after the R wave. A QS wave would be a totally negative wave. The normal **QRS** measurement is **0.12 seconds or less** or 3 small squares or less on the ECG graph paper. Look at the following example.



This QRS measures 3 blocks or 0.12 seconds

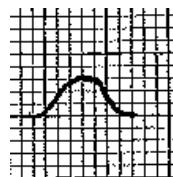
Practice labeling the following QRS complexes. The answers are at the end of the packet.



If the 6<sup>th</sup> QRS does not look familiar, you are right. There are times when the patient has something we call a Bundle Branch Block (we will cover later). The impulse travels down the conduction system and encounters a blockage in either the right or left bundle. The impulse has to “get around” the blockage, and so it travels another route to cause the ventricles to contract. So, in QRS number six above the first negative deflection is a Q, the first upright deflection is an R. The R crosses over the isoelectric line becoming and S wave. But you have another positive deflection referred to as R<sup>1</sup> or R prime.

## T WAVE

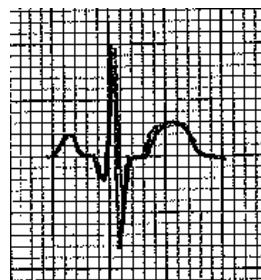
The T wave is a slightly asymmetrical positive deflection following the QRS. In certain disease states the T wave can be negatively deflected or peaked. The **T wave** represents **ventricular repolarization**.



This is what a normal T wave would look like.

## QT INTERVAL (QT)

The **QT interval** is measured from the beginning of the QRS complex to the end of the T wave. The **QT** interval represents the time from ventricular depolarization to ventricular repolarization. The normal **QT** interval measures: **up to 0.45 seconds in the male and 0.46 seconds in the female**. Why is the QT interval measurement important? Delays in ventricular repolarization, some medications; specifically antiarrhythmics, antibiotics and low electrolyte levels predispose the patient to a rhythm that can cause sudden death. A decision to say that a patient has a prolonged QT interval should come after at least three consecutive measurements of a prolonged QT.



This QT interval measures 9 blocks or 0.36 seconds

## U WAVE

Some patients might also have a U wave, which is a small waveform following the T wave. Causes of U waves include electrolyte imbalances and certain medications.

## **REFRACTORY PERIODS**

Cardiac cells need time to recover (relax) after discharging impulses before the cell can depolarize (discharge) another stimulus. Refractory periods are shorter for the atria than the ventricles. During cardiac repolarization (resting) phase, the heart goes through two refractory periods. During the absolute refractory period the cardiac cell is not able to respond to another stimulus, or depolarize (discharge another impulse). No matter how strong the electrical impulse is the cell will not discharge a new impulse. However in the relative refractory period, if the stimulus is strong enough, the cardiac cell can generate a new impulse. If you look at the ECG strip, the absolute refractory period starts at the beginning of the Q and ends at the middle of the T wave. The relative refractory period begins at the middle of the T wave until the end of the T wave. This corresponds to the period when ventricular repolarization is almost complete therefore the cardiac cell is vulnerable to a strong stimulus.

## **ARTIFACT, INTERFERENCE**

Even in the best of situations, a hospitalized patient will move about in bed and equipment will wear out or need replacement. These in addition to other events will make it difficult to interpret rhythm strips. Practice in identifying the P and QRS waves on the rhythm strip will enable you to become successful in rhythm interpretation even when artifact or interference are present. Some common examples of patients that are hard to monitor include those patients with tremors, shivering and agitation. Also diaphoresis, loose electrodes, breaks in the ECG lead wires, or other electrical equipment in the room can affect the look of the rhythm strip.

## **INTERPRETING AN ECG STRIP**

First and most important; it is valuable to mention that no matter what is happening on your ECG strip – look at what is happening with your patient! If the patient is laughing and talking with their family, there is no need to be alarmed if you see a straight line going across the monitor. In his/her laughter, the patient probably just pulled a lead wire off his/her chest.

## **CALCULATING THE HEART RATE**

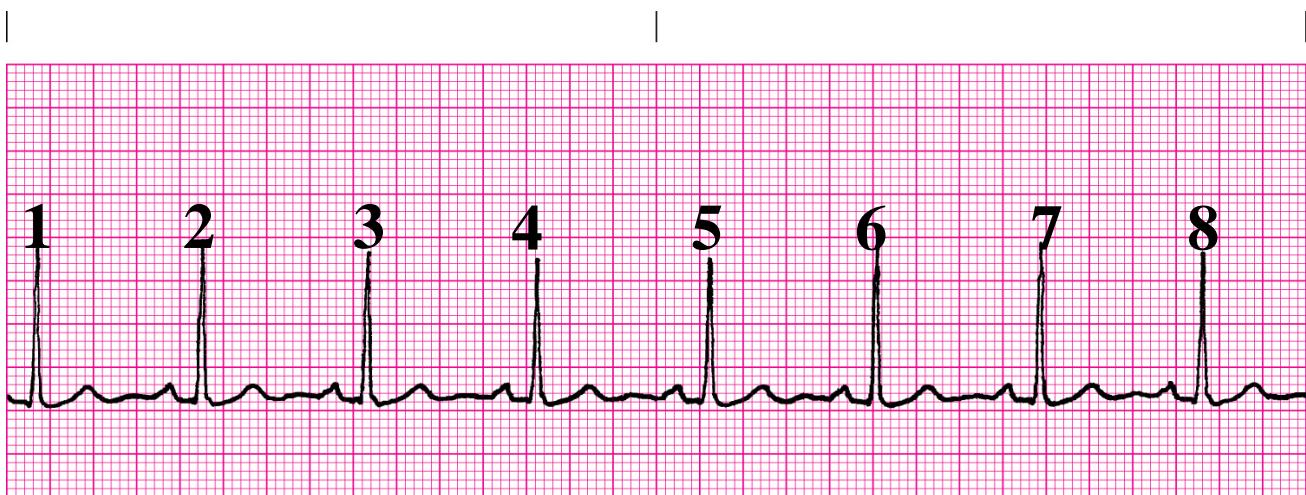
There are two methods that you can use to interpret the heart rate of a rhythm strip.

- 1. Rule of 10** – Use the “tic” marks to locate a six second rhythm strip. Count the number of R waves on complete QRS complexes within the six-second strip (stay inside the tic marks). Multiply the number of R waves counted times ten (10). Using the example located below, there are eight (8) R waves (remember the R waves are

the first positive deflection after the P wave). So multiply that times 10, and you get a heart rate of 80 BPM.

**2. R to R Method** – One large square of ECG graph paper is equivalent to 0.20 seconds. There are five (5) large squares per second and 300 per minute. When the rhythm is regular and the speed is running a 25 mm/sec., the heart rate can be calculated using this method. Look for a QRS that falls on a bold line on the graph paper. Next, count the number of large boxes between the first R wave and the next R wave. Divide 300 by that number. An example: There are 5 large boxes between two consecutive R waves. Divide 5 into 300. The heart rate will be 60 BPM. It is helpful if you are going to use this method to memorize that 1 large square = 300 BPM, 2 large squares = 150 BPM, 3 large squares = 100 BPM, 4 large squares = 75 BPM, 5 large squares = 60 BPM, 6 large squares = 50 BPM. You can also count the number of small squares between two (2) consecutive R waves and divide by 1500. This is the most accurate method for calculating the heart rate. An example: There are 17 small squares between two consecutive R waves. Divide 1500 by 17. The heart rate will be 88.

Most nurses will find the Rule of 10 method adequate for rhythm interpretation, and it is the method we will use in class instruction.



When examining an ECG strip, we use a systematic approach to look for clues and then we assess information found in the rules to determine the named arrhythmia. It is very important in the beginning of learning ECG interpretation not to skip steps. The following steps are vital to interpreting strips: regularity, rate, P waves, PR interval, QRS interval and QT interval.

**Regularity** – Are the R to R intervals regular or irregular? Are there any patterns to the irregularity? Are there any premature (early) beats?

**Rate** – Determine the heart rate using the “Rule of 10” on a 6 second strip.

**P waves** - Are P waves present? Do all the P waves look alike? Is there one P wave for every QRS? Is a P wave in front of every QRS? Are there P waves behind the QRS? Are there more P waves than QRS complexes?

**PR Interval** - Are all PRI measurements of normal duration (0.12 to 0.20 seconds)? Does the PRI measurement vary? Do you see any patterns to the variation?

**QRS Interval** - Are all QRS complex measurements of normal duration (0.06 to 0.12 seconds)? Do all the QRS complexes look alike?

**QT Interval** - What is the QT interval? Is it normal for the heart rate of the patient?

Good luck on your pre-test!

