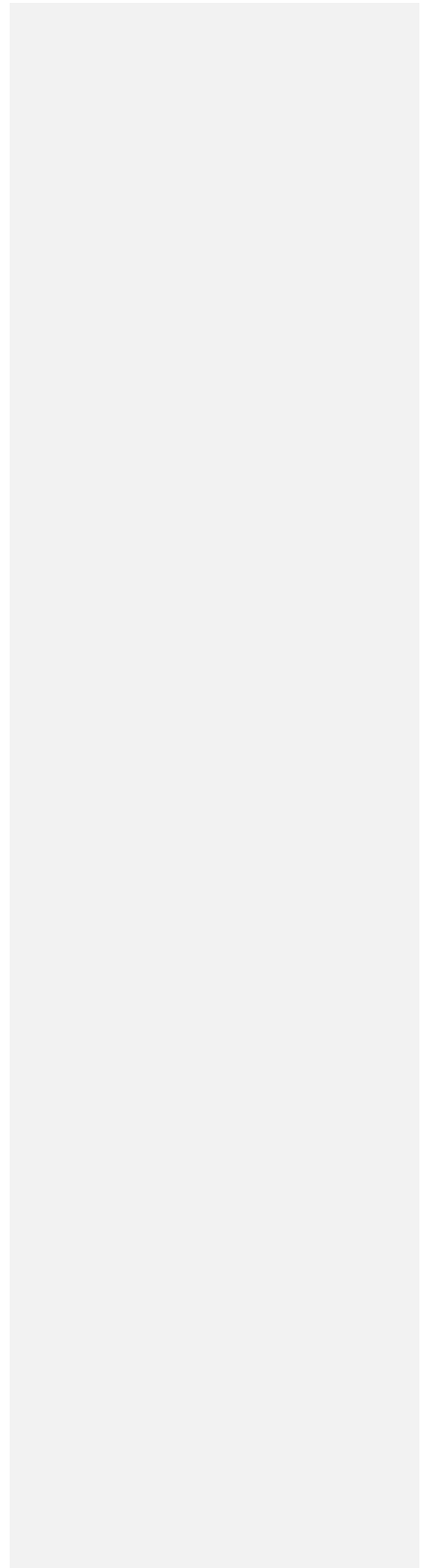
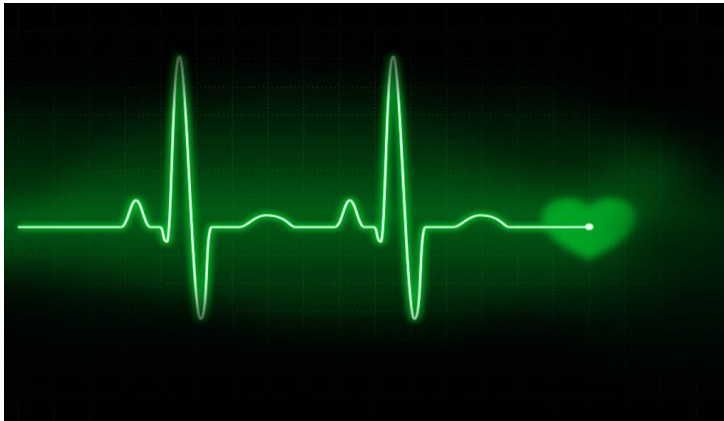
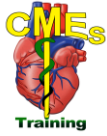














# Basic ECG Interpretation

FBON: 421694





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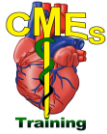
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## **Welcome: Instructions**

Welcome to CMEs Training course for Basic ECG Interpretation. Below, you will find the portion of the program that is intended to be completed prior to the “in-house” session. Please follow the program in the order it is presented to provide the highest possibility of understanding the content.

Keep in mind, there may be material in this packet that may need further explanation that you will receive when you visit the campus. Please take notes, document your questions and complete, to the best of your ability, the quizzes throughout the packet.



## CARDIOLOGY DEFINITIONS

**Cardiac Cycle:** The period from one cardiac contraction to the next. Each cardiac cycle consist of ventricular contraction (systole) and relaxation (diastole)

**Ejection:** Normally when the heart contracts each ventricle ejects about two-thirds of the blood it contains. (The ejection fraction)

**Stroke Volume:** The amount of blood ejected (average 70 ml) stroke volume depends on three factors, preload, cardiac contractility, and after load.

**Preload:** The pressure within the ventricles at the time of diastole end diastolic volume (it influences the force of the next contraction because of the stretch it exerts. (Starling's law of the heart)

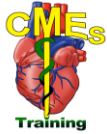
**Starling's Law:** States that the more myocardial muscle is stretched, the greater its force of contraction will be

**AfterLoad:** The pressure in the aorta against which the left ventricle must pump blood. The resistance the heart must pump against. An increase in peripheral vascular resistance will decrease the stroke volume. A decrease in resistance will increase stroke volume.

**Cardiac Output:** The amount of blood pumped out of the heart in one minute (stroke volume X HIR -70ml X 70bpm = 4900 ml/min)

**Regulation:** Heart function is regulated by the sympathetic and parasympathetic nervous components of the ANS. Working in opposition to one another to maintain balance. During stress the sympathetic system dominates to increase the HIR and increase the contractile force. During sleep the parasympathetic system dominates to decrease the heart rate and decrease the contractile force.

**Chronotropic Effect:** Pertaining to the heart rate (H/R)



**Inotropic Effect:** Pertaining to the cardiac contractile force.

**Dromotropic Effect:** Pertaining to rate of nervous impulse conduction  
autonomic control of the heart rate.

**Cardiac Function:** Cardiac function depends heavily on electrolyte balances.  
Electrolytes that affect the cardiac function include  
Sodium ( $\text{Na}^{++}$ ), Calcium ( $\text{Ca}^{++}$ ), Potassium ( $\text{K}^{+}$ ), Chloride ( $\text{Cl}^{-}$ ), Magnesium  
( $\text{Mg}^{++}$ ).

**Sodium:** Plays a major role in depolarizing the myocardium.

**Calcium:** Takes part in myocardial depolarization and myocardial contraction

**Potassium:** Influences repolarization.

**Electrophysiology:** Within the cardiac muscle fibers are special structures  
called intercalated discs these discs connect cardiac muscle fibers and conduct  
electrical impulses quickly from one muscle fiber to the next. When the  
myocardial muscle is electrically stimulated it contracts. While in a resting  
state myocytes are polarized, the interior of every cell is negatively charged.  
When these cells are depolarized their interiors become positive and the cells  
contract.

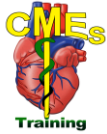
**Depolarization:** Moves as a wave through the myocardium as this wave of  
depolarization stimulates the heart's myocytes they become positive and  
contract. Then the myocyte interiors regain their resting negative charge  
during the repolarization phase that follows.

**Absolute Refractory:** The time which no cardiac stimulation can occur.

**Relative Refractory:** The time when cardiac stimulation can be achieved by a  
strong enough stimulus.

**Tachycardia:** Heart rate > than a 100 beats per minute.

**Bradycardia:** Heart rate < than 60 beats per minute.



**Ectopic Beat:** Cardiac depolarization resulting from the depolarization of a cell within the heart that is not part of the heart's normal conductive system.

**SA Node:** The pacemaker of the heart located high in the RA has an intrinsic rate of 60-100 beats per minute.

**A V Junction:** (gate keeper) Location where the electrical impulse is slowed to allow for ventricular filling. A V Node Location where the electrical impulse is delivered to depolarize the ventricles.

**Bundle of His:** Located just below the A V node they assist in conduction of the impulse to the bundle branches.

**Bundle Branches:** Conductive fibers that deliver electrical impulses to the Right and Left ventricles.

**Purkinje System:** Conductive network that delivers the electrical impulse across the ventricular myocardium.

**Non Compensatory Pause:** The pause following an ectopic beat where the SA node is depolarized and the normal cadence of the heart is interrupted.

**R on T Phenomenon:** Occurring when PVC falls on the back half of the T wave during the relative refractory which could precipitate V-Fib.

**Interpolated Beat:** A PVC that falls between two sinus beats without interrupting the normal sinus rhythm.

**Bigeminy:** Ectopic that falls on every other beat.

**Trigeminy:** Ectopic that falls on every third beat.

**Antegrade Conduction:** Conduction that follows the normal directional path down the heart.

**Retrograde Conduction:** That follows a reverse path through the heart.



**Unifocal:** Originating from the same ectopic focus or of the same morphology.

**Multifocal:** Originating from multiple ectopic foci or having different morphology.

**Malignant PVC's** That fall within a pattern of having more than 6 per minute Ron T phenomenon couplets or runs of V-Tach, multifocal in nature or associated with chest pain.

**Benign PVC's:** That are a normal variant or do not fit the definitions of Malignant PVC's.

**Syncytium:** When one cell becomes excited the action potential spreads rapidly across the entire group of cells, resulting in a coordinated contraction. The heart has 2 Syncytium the atria and the ventricular.

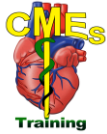
**Self Excitation:** Each conductive component has an intrinsic rate of self-excitation **SA 60-100 / AV 40-60 / PS 15-40**

**P Wave:** Each depolarization wave emitted by the SA Node spreads through both atria producing a P wave. It represents atrial depolarization and contraction of both atria. Depolarization slows producing a brief pause thus allowing time for the blood in the atria to enter the ventricles before depolarization is conducted to the ventricles. But upon reaching the ventricular conduction system depolarization rapidly shoots through the HIS Bundle and the L and R Bundle Branches.

**AV Valves:** A V valves (atrial-ventricular mitral on the L and tricuspid on the R) prevent ventricle- to atrium blood backflow. The AV node is the only conducting path between the atria and the ventricles'

**HIS Bundle:** The location where the ventricular conduction system originates. Which penetrates the A V valves then immediately bifurcates into the intraventricular septum and into the R and L bundle branches?

**Purkinje Fibers:** HIS bundles and both bundle branches are bundles of rapidly conducting purkinje fibers. The terminal filaments of the Purkinje fibers



rapidly distribute depolarization to the ventricular myocytes depolarization of the entire ventricular myocardium produces a QRS complex

**Q Wave:** Is always the first downward wave of the QRS complex, however it is often absent on the EKG

**QRS Complex:** The entire QRS complex represents ventricular depolarization. A complete QRS complex can be said to represent ventricular depolarization and the initiation of ventricular contraction

**ST Segment:** Follows the QRS complex, a horizontal baseline known as the ST segment. The ST represents the plateau (initial) phase of ventricular repolarization.

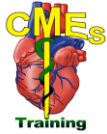
**T Wave:** After the QRS there is a segment of horizontal baseline. Followed by a broad hump called the T wave. It represents the rapid phase of ventricular repolarization.

**QT Interval:** Represents the duration of ventricular systole and is measured from the beginning of the QRS until the end of the T wave. The QT interval is a good indicator of repolarization since repolarization comprises most of the QT interval. PIT with hereditary Long QT interval (LQT) syndromes are vulnerable to dangerous or even deadly rapid ventricular rhythms.

**QTC Values:** QT interval varies with HR precise QT interval measurements are corrected for rate so they are called QTC values. As a rule of thumb the QT interval is considered normal when it is less than half of the R-to-R interval at normal rates HR the QT interval. HR usually prolong it.

**Repolarization:** Occurs so that the ventricular myocytes can recover their interior resting **negative** charge so they can be depolarized again. Repolarization of the ventricular myocytes begins immediately after the QRS and persists until the end of the T wave.

**Cardiac Cycle:** Represented by the P wave, the QRS complex, the T wave, and the baseline that follows until another P wave appears. A cardiac cycle represents atrial systole (atrial contraction) and the resting stage that follows



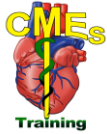
until another cycle begins. Atrial depolarization (and contraction) P wave  
ventricular depolarization (contraction) QRS Ventricular repolarization  
(plateau and the rapid) T wave regulates vital functions of all organs by both  
reflex and CNS control, but not by conscious control.

**ANS:** ANS controls all organs and organ systems; our main concern is  
autonomic control of the heart and also of the systemic arteries as they relate  
to blood pressure. The ANS has two divisions; these two divisions have well  
defined roles in the heart and the systemic arteries, sympathetic system. One  
division stimulates and one division inhibits, the ANS consists of a  
sympathetic system and an opposing parasympathetic system. Each of these  
two systems secretes its own neurotransmitter from its terminal; in order to  
activate specific cell receptors in the cell membrane. The terminal ends  
(boutons) of sympathetic nerves secrete Nor-epinephrine (N-epi) an  
adrenaline like neurotransmitter that activates specific cell receptors called  
adrenergic receptors. The terminal parasympathetic nerve ends (boutons)  
secrete the neurotransmitter acetylcholine (Ach), which exclusively activates  
cell receptors called cholinergic receptors.

**Sympathetic System:** Activates cardiac B 1 adrenergic receptors, cardiac  
excitatory effects rate of SA Node pacing increase rate of conduction increase  
force of contraction increase irritability of foci. The heart is stimulated by the  
sympathetic system through terminal boutons. The boutons deliver N-epi to  
the B 1 (**adrenergic**) receptors, this activates the B 1 receptors producing an  
excitatory response at the cellular level.

$$H/R \times SV = CO - CO \times SVR = BIP$$

**Parasympathetic System:** Activates cholinergic receptors cardiac inhibitory  
effects decrease rate of SA Node pacing decrease rate of conduction decrease  
force of contraction decrease irritability of atrial and junction foci.  
Parasympathetic activation of cholinergic receptors by ACH inhibits the SA  
Node decrease the heart rate decrease the speed of myocardial conduction  
and depresses the AV node which diminishes the force of myocardial  
contraction and depresses irritability of automaticity foci mainly those in the  
atria and A V junction.



**Norepinephrine: (N-epi)** the neurotransmitter of the sympathetic system activates the heart's  $\beta_1$  (adrenergic) receptors, stimulating the SA node to pace faster. It also improves AV node conduction and accelerates conduction through the atrial and ventricular myocardium increase the force of myocardial contraction and increase the irritability of atrial and junction automaticity foci and minimally affects ventricular foci.

**Epinephrine :( adrenaline)** is secreted into the blood by the adrenal glands. Epinephrine is an even more potent stimulator of the heart's  $\beta_1$  receptors.

**Vagus Nerve:** There are two Vagus nerves, **L** and **R** each supplies the heart and GI tract. One inhibits and one stimulates. The Vagus nerves are the body's main parasympathetic pathway, so vagal stimulation means parasympathetic stimulation with the understanding that vagal stimulation of the heart is inhibitory.

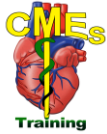
**Autonomic Control of:    Sympathetic        Parasympathetic**

**Blood Flow & B/P     $\alpha_1$  adrenergic receptors    cholinergic receptors**

Sympathetic stimulation of arterial  $\alpha_1$  (adrenergic) receptors constricts arteries throughout the body, increase B/P and blood flow. The  $\alpha_1$  receptors are more responsive to the neurotransmitter N-epi than circulating epinephrine. Parasympathetic activation of arterial (cholinergic) receptors dilates arteries BIP and blood flow.

**Blood Flow:** Depended on the HR. Sympathetic stimulation **increases** the SA node pacing rate, while the parasympathetic decreases it, and slows the SA node pacing (**Bradycardia**). The same reflex parasympathetic response dilates systemic arteries causing hypotension, as the B/ P falls.

**Lead II:** Gives the best view of the ECG waves and best depicts the conduction system's activity.



**Normal Interval:** PR 0.12-0.20 sec QRS 0.08-0.12 sec QT 0.33-0.42 sec  
Prolonged greater than .44 sec durations.

**5 Ps of Acute Arterial Occlusion:** 1.Pallor 2.Pain 3.Pulselessness -  
4.Paralysis 5.Paresthesia

**ABERRANT CONDUCTION:** Conduction of the electrical impulse through the heart's conductive system in an abnormal fashion.

**ABSOLUTE REFRACTORY PERIOD:** The period of the cardiac cycle when stimulation will not produce any depolarization what so ever.

**ACUTE ARTERIAL OCCLUSION:** The sudden occlusion of arterial blood flow.

**ACUTE PULMONARY EMBOLISM:** Blockage that occurs when a blood clot or other particle lodges in a pulmonary artery.

**ANEURYSM:** The ballooning of an arterial wall resulting from a defect or weakness in the arterial wall.

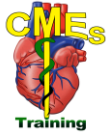
**ANGINA PECTORIS:** The sudden pain from myocardial ischemia, caused by diminished circulation to the cardiac muscle. The pain is usually substantial and often radiates to the arm, jaw or abdomen.

**ANTEROGRADE AMNESTIC EFFECTS:** Inabilities to recall long-ago events but with normal recall of recent happenings.

**ANTEROGRADE MEMORY:** Ability to recall events long past but not recent happenings (AKA) senile memory.

**ARRHYTHMIA:** The absence of cardiac electrical activity, often used interchangeably with dysrhythmia.

**ARTERIOSCLEROSIS:** a thickening, loss of elasticity, & hardening of the walls of the arteries from calcium deposits.



**ARTIFACT:** Deflection on the ECG produced by factors other than the heart's electrical activity.

**ATHEROSCLEROSIS:** Is a disease almost solely limited to developed countries that have drifted away from a balanced.

**Agrarian Diet:** A progressive degenerative disease of the medium-sized & large arteries.

**AUGMENTED LIMB:** Another term for unipolar limb leads, reflecting the fact that the ground lead is disconnected, which increases the amplitude of deflection on the ECG tracing.

**BI-POLAR LIMB LEADS,** EKG leads applied to the arms & legs that contain 2 electrodes of opposite (positive & negative) polarity, leads I -II -III.

**BISULFITES:** Sulfur dioxide and some sulfites, bisulfate's and metabisulfites.

**BRUIT Sound:** of turbulent blood flow around a partial obstruction, usually associated with atherosclerotic disease.

**BUNDLE BRANCH BLOCK:** A kind of intraventricular heart block in which conduction through either the Right or left bundle branches is blocked or delayed.

**BUNDLE OF KENT:** an accessory A V conduction pathway that is thought to be responsible for the ECG findings of pre-excitation syndrome.

**CARDIAC ARREST:** The absence of ventricular contraction.

**CARDIAC TAMPONADE:** Accumulation of excess fluid inside the pericardium.

**CARDIOGENIC SHOCK:** The inability of the heart to meet the metabolic needs of the body resulting in inadequate tissue perfusion. It is the most form of pump failure. It has a high mortality rate.

**CLAUDICATION:** Severe pain in the calf muscle due to inadequate blood supply, it typically occurs with exertion & subsides with rest.



**COMPENSATORY PAUSE:** The pause following an ectopic beat where the SA node is unaffected & the cadence of the heart is uninterrupted.

**CONGESTIVE HEART FAILURE (CHF):** Condition in which the heart's reduced stroke volume causes an overload of fluid in the body's other tissue.

**CYSTIC MEDIAL NECROSIS:** A death or degeneration of a part of the wall of an artery.

**DEFIBRILLATION:** The process of passing an electrical current through a fibrillating heart to depolarize a critical mass of myocardial cells. This allows them to depolarize uniformly resulting in an organized rhythm.

**DEEP VENOUS THROMBOSIS (DVT):** A blood clot in a vein usually in the lower extremity.

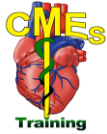
**DELIRIUM TREMENS (DTs):** A disorder found in habitual and excessive users of alcoholic beverages after cessation of drinking for 48-72 hours. Patients experience visual, tactile, and auditory disturbances. Death may result in severe cases.

**DISSECTING AORTIC ANEURYSM:** Aneurysm occurs when blood gets between and separates the layers of the aortic wall. A weakening of the lining of an arterial wall.

**DOWN TIME:** Duration from the beginning of the cardiac arrest until effective CPR is established.

**DYSRHYTHMIA:** Any deviation from the normal electrical rhythm of the heart.

**DYSTONIC DRUG REACTION:** Posturing or difficulty speaking, and are usually quite upset and worried that they are having a stroke. Often there is no history offered at all--the patient may not be able to speak, may not be aware he took any phenothiazines or butyrophenones (e.g., Haldol has been used to cut heroin), may not admit he takes psychotropic medication, or may not



make the connection between symptoms and drug (e.g., one dose of compazine given for vomiting). **Acute Dystonias:** Usually present with one or more of the following symptoms: buccolingual: protruding or pulling sensation of tongue torticollic: twisted neck, or facial muscle spasm oculogyric: roving or deviated gaze tortipelvic: abdominal rigidity and pain opisthotonic: spasm of the entire body. These acute dystonias can resemble partial seizures, the posturing of psychosis, or the spasms of tetanus, strychnine poisoning, or electrolyte imbalances. More chronic neurologic side effects of phenothiazines, including the restlessness of akathisia, tardive dyskinesias, and Parkinsonism, do not usually respond as dramatically to drug treatment as the acute dystonias.

**ECTOPIC BEAT:** Cardiac depolarization resulting from depolarization of ectopic focus.

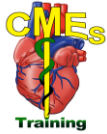
**ECTOPIC FOCUS:** No pacemaker heart cell that automatically depolarizes of ectopic foci.

**Einthoven's Triangle:** The triangle around the heart formed by the bipolar limb leads.

**FABRY DISEASE:** Fabry disease is caused by the lack of or faulty enzyme needed to metabolize lipids, fat-like substances that include oils, waxes, and fatty acids. The enzyme is known as ceramide trihexosidase, also called alpha-galactosidase- A patients with Fabry disease often survive into adulthood but are at increased risk of strokes, heart attack and heart disease, and renal failure.

**HEART FAILURE:** clinical syndrome in which the heart's mechanical performance is compromised so that cardiac output cannot meet the body's needs.

**HYPERTENSIVE EMERGENCY:** An acute elevation of B/P that requires the B/P to be lowered within one hour, characterized by end-organ changes such as hypertensive encephalopathy, renal failure, or blindness.



**HYPERTENSIVE ENCEPHALOPATHY:** A cerebral disorder of hypertension indicated by severe Headache, nauseous & vomiting, A/M/S status. Neurological symptoms may include blindness, muscle twitches, inability to speak, Weakness, Paralysis.

**LITHIUM THERAPY:** Drug Lithane® and Eskalith to TX manic episodes of bipolar (manic-depressive) disorder. Adverse effects include kidney damage, salt & water retention, & sometimes disturbances in mental and muscular functioning.

**MYASTHENIA:** Disease characterized by chronic fatigability & weakness of muscles esp. in the face & neck region, but also affecting the muscles of the trunk and limbs. O/S gradual, with drooping eyelids and facial muscle weakness caused by deficiency of acetylcholine at the neuromuscular junctions. TX restricted phys activity & anticholinesterase drugs.

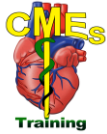
**MYOCARDIAL INFARCTION:** (MI) is irreversible & we hope to intervene before this occurs. Death & subsequent necrosis of the heart muscle caused by inadequate blood supply (AMI).

**NEPHRITIC SYNDROME:** Abnormal condition marked by edema, that presents of large amounts of protein in the urine, and lower than normal levels of albumin in the blood, often accompanied by nausea, weakness, associated with disease of the glomerulus.

**NONCOMPENSATORY PAUSE:** Pause following an ectopic beat where the SA node is depolarized & the underlying cadence of the heart is interrupted.

**NORMAL SINUS RHYTHM:** The normal heart rhythm. Rate 60-100, rhythm regular. P waves normal, upright, only before each QRS complex. PR interval 0.12-0.20 sec. QRS complex morphology: normal duration: < 0.12 sec

**PAROXYSMAL NOCTURNAL DYSPNEA (PND),** sudden onset of S.O.B. at night after lying down, most commonly caused by left heart failure short attacks of dyspnea that occurs at night and interrupts sleep.



**PERIPHERAL ARTERIAL ATHEROSCLEROTIC DISEASE:** A progressive degenerative disease of the medium-sized and large arteries.

**PORPHYRIA:** Any of several inherited disorders characterized by disturbance of the metabolism of porphyrins, affecting primarily the liver or bone marrow. The affected person excretes large amounts of porphyrins in the urine and has photosensitivity, neuritis, and mental disturbances.

**PRECARDIAL:** (*chest*) LEADS, EKG leads applied to the chest in a pattern that permits a view of the horizontal plane of the heart, leads VI, V2, V3, V4, V5, and V6.

**PRINZMETAL'S ANGINA:** Variant of angina pectoris caused by vasospasm of the coronary arteries, not blockage per se also called vasospastic angina or atypical angina.

**PULMONARY EMBOLISM:** (PE) Blood clots that travels to the pulmonary circulation & hinders oxygenation of the blood. Blood clot in one of the pulmonary arteries.

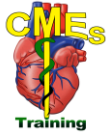
**REFRACTORY PERIOD:** The period of time when myocardial cells have not yet completely repolarized & cannot be stimulated again.

**RELATIVE REFRACTORY PERIOD:** The period of the cardiac cycle when a sufficiently strong stimulus may produce depolarization.

**RESUSCITATION:** Provision of efforts to return a spontaneous pulse & breathing.

**RETURN OF SPONTANEOUS CIRCULATION:** Resuscitation results in the patient having a return of a spontaneous pulse (ROSC).

**SUBENDOCARDIAL INFARCTION:** Myocardial infarction that affects only the deeper levels of the myocardium, also called non Q wave infarction because it typically does not result in a significant Q wave in the affected lead.



**SUDDEN DEATH:** Death within 1 hour after the onset of symptoms.

**SURVIVAL:** A patient that is resuscitated & survives to be discharged from the hospital.

**SYNCHRONIZED CARDIOVERSION:** The passage of an electric current through the heart during a specific part of the cardiac cycle, to terminate certain kinds of dysrhythmia.

**Cardiac Cycle:** to terminate certain kinds of dysrhythmia. Total downtime, duration from beginning of the arrest until the patient delivered to the emergency department.

**TRANSMURAL INFARCTION:** Myocardial infarction that affects the full thickness of the myocardium & almost always results in a pathological Q wave in the affected leads.

**UNIPOLAR LIMB LEADS:** EKG leads applied to arms & legs, consisting of 1 polarize (positive) electrode & 1 nonpolarized reference point that is created by the EKG machine combining 2 additional electrodes, also called augmented limb leads, leads a VR, a VL, and a VF.

**VARICOSE VEINS:** Dilated superficial veins, usually in the lower extremity.

**VASCULITIS:** Inflammation of blood vessels.

The human body has 11 body systems Integumentary, Skeletal, Muscular, Nervous, Endocrine, Cardiovascular, Lymphatic, Respiratory, Digestive, Urinary, and Reproductive.

### **Heart**

The heart structure makes it an efficient, never-ceasing pump. From the moment of development through the moment of death, the heart pumps. The heart, therefore, has to be strong. The average heart muscle, called cardiac muscle, contracts and relaxes about 70 to 80 times per minute without you ever having to think about it. As the cardiac muscle contracts it pushes blood through the chambers and into the vessels. Nerves connected to the heart regulate the speed with which the muscle contracts. When you exercise your heart pumps more quickly, when you sleep, your heart pumps more slowly.



Considering how much work it has to do, the heart is surprisingly small. The average adult heart is about the size of a clenched fist and weighs about 11 ounces (310 grams). Located in the middle of the chest behind the breastbone, between the lungs, the heart rests in a moistened chamber called the pericardial cavity which is surrounded by the ribcage. The diaphragm, a tough layer of muscle, lies below. As a result, the heart is well protected. It lies near the anterior chest wall, directly behind the sternum, it is enclosed by the mediastinum, surrounded by the pericardial cavity, and the lining of the pericardial can be subdivided into two membranes,

- (1) **Visceral Covers** the outer surface of the heart, (2) Parietal lines the inner surface of the pericardial sac, which surrounds the heart. Then the pericardial sac is reinforced by a dense network of fibers that stabilizes the position of the pericardium, Heart, and the Vessels, in the mediastinum. The space between the parietal and the visceral surface is the pericardial cavity.
- (2) **Surface Anatomy** in simple term the human body is made of (1) Pump heart (2) Pipes veins and the arteries (3) liquid the blood

**Differential:** The cells of the cardiac conductive system have four important properties.

**Excitability:** It has the ability to respond to an electrical stimulus

**Conductivity:** It has the ability to propagate the electrical impulse from one cell to another.

**Automaticity:** Its pacemaker cells capability of self-depolarization

**Contractility:** It has the ability of muscle cells to contract, or to shorten.

**Cardiac Cycle:**

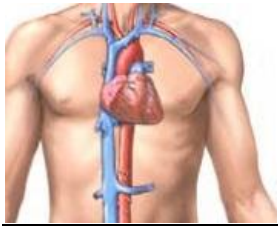
**Pulmonary circuit:** which carries blood to and from exchange surface of the lungs?

**Systemic Circuit:**, which transports blood to and from the rest of the body, each begins and ends at the heart. Blood returns to the heart from the systemic circuit must complete the pulmonary circuit before reentering the systemic circuit.



### **Anatomy and Physiology**

The Heart is a muscular, cone-shaped organ whose function is to pump blood throughout the body. It is about the size of a closed fist (roughly 5" long, 3" wide, and 2 1/2" thick). It weighs 10 to 12 oz in male adults and 8 to 10 oz in female adults.



**Myocardium** – Refers to the heart muscle. The term comes from “myo,” meaning muscle and “cardium,” meaning heart. The location of the heart is behind the sternum. Roughly two thirds of the heart lies in the left part of the mediastinum.

**Pericardium** (pericardial sac) is a thick fibrous membrane that surrounds the heart. The pericardium anchors the heart within the mediastinum and prevents overdistention.

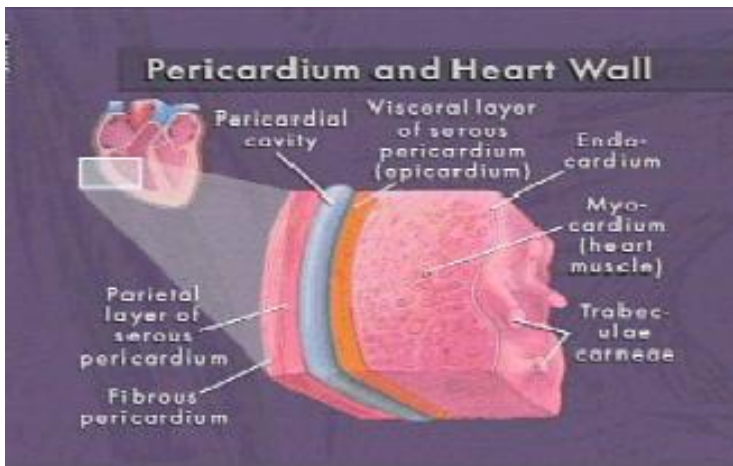
Serous pericardium – Inner membrane of the pericardium contains two layers: visceral and parietal.

Visceral layer (epicardium) lies closely against the heart



↳ Parietal layer, second layer of the pericardium, separated from the visceral layer by a small amount of pericardial fluid that reduces friction within the pericardial sac.

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### Major structures

Normal heart consists of four chambers: two Atrium and two ventricles.

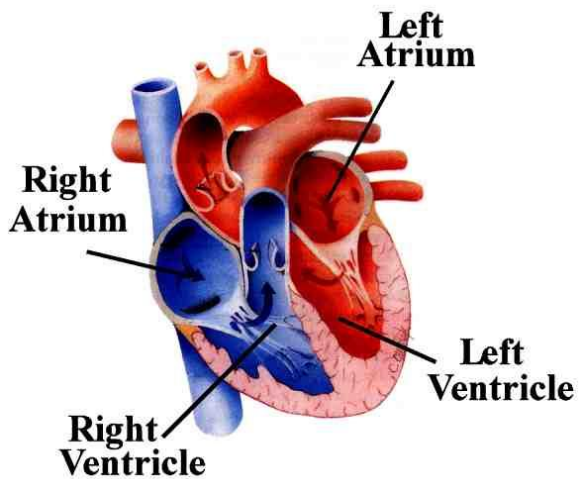
#### Atria

- Upper two chambers of the heart are the Atrium
- Interatrial septum – Membrane that separates the two atria.
- Each atrium receives blood that is returned to the heart from other parts of the body.



## Ventricles

- Lower two chambers of the heart are the ventricles.
- Interventricular septum - Thicker wall that separates the right and left ventricles.
- Each ventricle pumps blood out of the heart.



## Valves of the Heart

The valves consist of flaps called cusps.

Blood passing from the atria to the ventricles flows through one of the two atrioventricular valves.



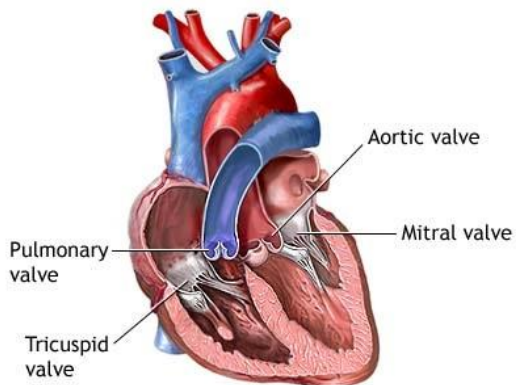
**Atrioventricular valves:** – Valves that separate the upper and lower portions of the heart to prevent backward flow of blood; they are the mitral and tricuspid valves.

- Tricuspid Valve: Separates the right atrium from the right ventricle.
- Mitral Valve: Separates the left atrium from the left ventricle.

Two Semilunar Valves, the aortic valve and the Pulmonic Valve, divide the heart from the aorta and the pulmonary artery.

- Pulmonic Valve: Regulates blood flow from the right ventricle to the pulmonary artery.
- Aortic Valve: Regulates blood flow from the left ventricle to the aorta.

The semilunar valves are not attached to papillary muscles. When these valves close, they prevent backflow from the aorta and pulmonary artery into the left and right ventricles, respectively.





### **Anatomy and Physiology Quiz**

1. The size of the human heart is about:
  - a. One pound
  - b. The size of a closed fist
  - c. Approximately 10 oz in adult males
  - d. B and C are correct
2. There are \_\_\_\_\_ atriums in the heart
  - a. One
  - b. Two
  - c. Three
  - d. Four
3. There are \_\_\_\_\_ ventricles in the heart
  - a. One
  - b. Two
  - c. Three
  - d. Four
4. Which valves separate the atria
  - a. Mitral and tricuspid
  - b. Aortic and Pulmonic
  - c. Mitral and Pulmonic
  - d. Aortic and Tricuspid
5. Which valves separate the ventricles and vessels
  - a. Mitral and tricuspid
  - b. Mitral and Pulmonic
  - c. Aortic and Tricuspid
  - d. Aortic and Pulmonic



### **Blood flow through the heart**

Understanding the blood flow through the heart is imperative as we interpret ECG's. As we move along in the program, the electrical conduction you see on the monitor has a direct correlation with the blood flow in the heart. Take your time and review this material thoroughly

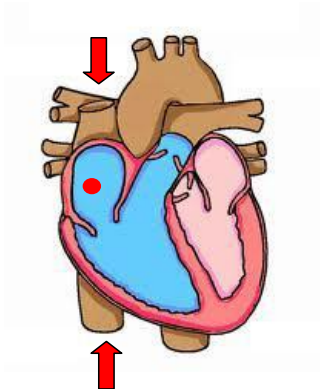
Two large veins, the superior vena cava and the inferior vena cava, return deoxygenated blood from the body to the *right atrium*.

#### **Superior vena cava**

- Blood from the upper part of the body returns to the heart through the superior vena cava.

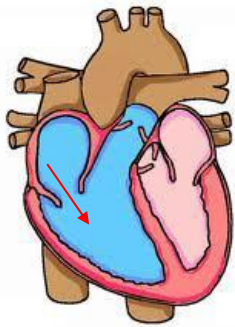
#### **Inferior vena cava**

- The larger of the two veins.
- Blood from the lower part of the body returns through the inferior vena cava



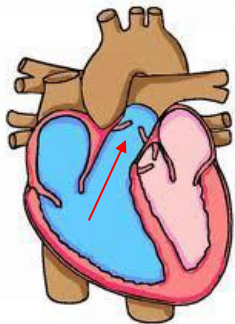


From the right atrium, blood passes through the tricuspid valve into the right ventricle



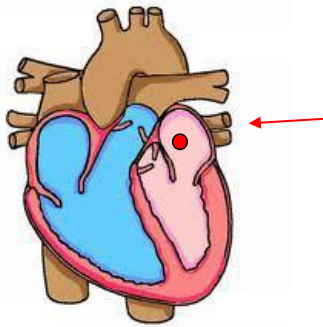
Blood is then pumped by the right ventricle through the pulmonic valve into the pulmonary artery and to the lungs

- In the lungs, various processes take place that return oxygen to the blood, and, at the same time, remove carbon dioxide and other waste products.

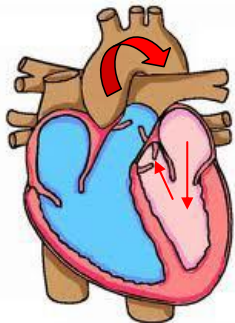




Freshly oxygenated blood is returned to the left atrium through the pulmonary veins



Blood then flows through the mitral valve into the left ventricle, which pumps the oxygenated blood through the aortic valve, into the aorta and then to the entire body



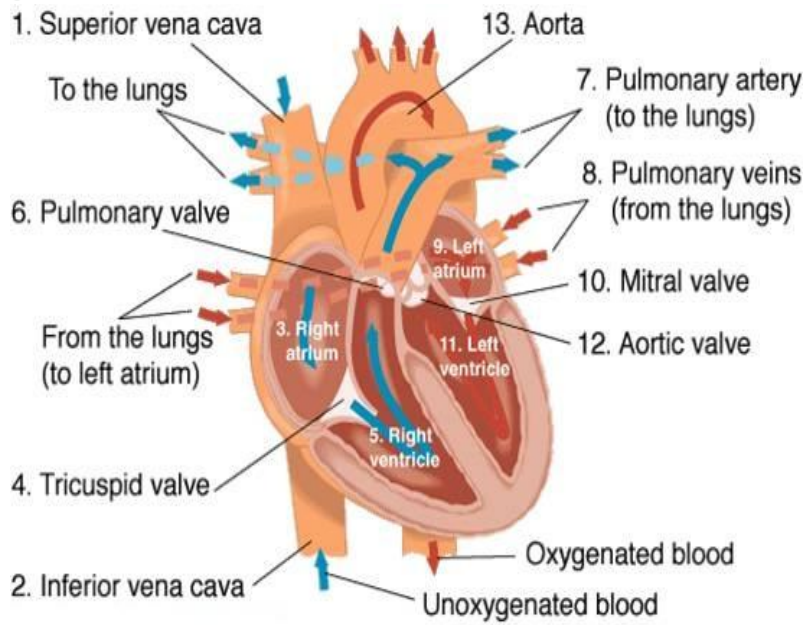
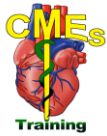


Aorta – The body’s largest artery.

The Left ventricle is the strongest and largest of the four cardiac chambers because it is responsible for pumping blood through blood vessels throughout the body

In review:

1. De-oxygenated blood enters the heart via the Superior and Inferior vena cava.
2. Blood travels from the right atrium through the tricuspid valve
3. After the tricuspid valve blood enters the right ventricle
4. From the right ventricle blood travels through the pulmonic artery (the only artery in the body to carry deoxygenated blood) into the lungs
5. In the lungs carbon dioxide is off loaded and oxygen is bound to hemoglobin
6. Blood then returns to the heart via the pulmonary vein (the only vein in the body to carry oxygenated blood) into the left atrium
7. From the left atrium blood travels through the mitral or bicuspid valve into the left ventricle
8. From the left ventricle blood travels through the aortic valve into the aorta and out to the body.





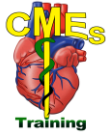
## Blood flow through the Heart Quiz

1. Deoxygenated blood from the body returns to the heart via which vessel?
  - a. Coronary Sinus
  - b. Aorta
  - c. Inferior/Superior Vena Cava
  - d. Pulmonary vein
2. Blood leaving the right atrium travels through which valve?
  - a. Tricuspid
  - b. Bicuspid
  - c. Aortic
  - d. Pulmonic
3. Blood leaving the right ventricle travels through which valve?
  - a. Tricuspid
  - b. Bicuspid
  - c. Aortic
  - d. Pulmonic
4. Blood leaving the left atrium travels through which valve?
  - a. Tricuspid
  - b. Bicuspid
  - c. Aortic
  - d. Pulmonic
5. Blood leaving the left ventricle travels through which valve?
  - a. Tricuspid
  - b. Bicuspid
  - c. Aortic
  - d. Pulmonic



6. Which is the only artery in the body the carries deoxygenated blood?
  - a. Pulmonary
  - b. Ventricular
  - c. Aorta
  - d. Coronary
7. Blood leaving the atria's contract
  - a. Superior to inferior
  - b. Inferior to superior
  - c. Laterally
  - d. Circular
8. Blood leaving the ventricles contract:
  - a. Superior to inferior
  - b. Inferior to superior
  - c. Laterally
  - d. Circular
9. The valves separating the atria/ventricles are considered \_\_\_\_ valves
  - a. Semilunar
  - b. Cusp
  - c. High pressure
  - d. Closed
10. The valves separating the ventricles and valves are considered valves:
  - a. Semilunar
  - b. Cusp
  - B.c. High pressure
  - d. Closed

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## **Electrophysiology of the heart**

The mechanical pumping action of the heart can only occur in response to an electrical stimulus.

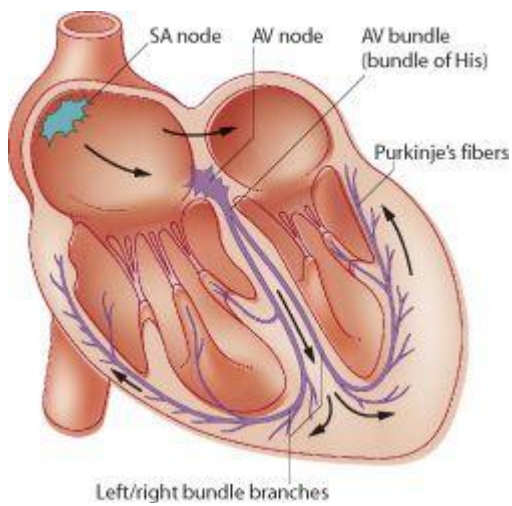
- This impulse causes the heart to beat via a set of complex chemical changes within the myocardial cells.
- The brain partially controls the heart's rate and strength of contraction via the autonomic nervous system

Cardiac conduction system

- Contractions of the myocardial tissue, however, are initiated within the heart itself, in a group of complex electrical tissue that is part of a conduction system.
- The cardiac conduction system consists of six parts:
  - the sinoatrial valve, the atrioventricular (AV) node, the bundle of His, the right and left bundle branches, and the Purkinje fibers.
    - i. Sinoatrial (SA) node – The heart's natural pacemaker; it is the normal site of origin of the electrical impulse and is located high in the right atrium.
    - ii. Atrioventricular (AV) node – Site located in the right atrium adjacent to the septum that is responsible for transiently slowing electrical conduction; the impulse that starts in the SA node comes here next.
    - iii. Bundle of His – The next region to receive the electrical impulse; it is a continuation of the AV node.



- iv. Right and left bundle branches – Receive the impulse from the Bundle of His, stimulating the intraventricular septum.
- v. Purkinje fibers – Allow the impulse coming from the left and right bundle branches to spread out to the left and then the right ventricular myocardium, resulting in ventricular contraction or systole.





### Special electrical properties of cardiac cells

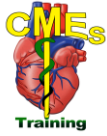
1. ● Excitability – The ability of cells to respond to electrical impulses.
2. ● Conductivity – The ability of the cells to conduct electrical impulses.
3. ● Automaticity – The ability of cardiac cells to generate an impulse to contract, even when there is no external nerve stimulus.

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### Regulation of heart function

The heart's chronotropic, dromotropic, and inotropic states are provided by the brain via the autonomic nervous system.

- Chronotropic state – Related to the control of the heart's rate of contraction.
- Dromotropic state – Related to the control of the heart's rate of electrical conduction.
- Inotropic state – Related to the control of the heart's strength of contraction.



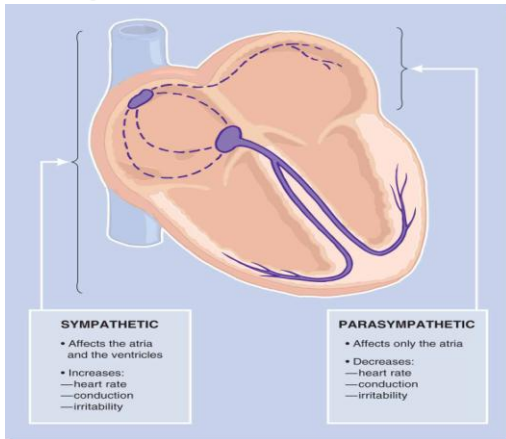
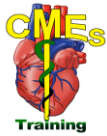
**Receptors** in the blood vessels, kidneys, brain, and heart constantly monitor body functions to maintain homeostasis.

- Baroreceptors respond to changes in pressure, usually within the heart or the main arteries.
- Chemoreceptors sense changes in the chemical composition of the blood.
  - Stimulation of receptors causes activation of either the parasympathetic or sympathetic branches of the autonomic nervous system, affecting both the heart rate and contractility.
- Contractility = The strength of heart muscle contraction.
- Parasympathetic stimulation = Slows the heart rate, primarily by affecting the AV node.

**Sympathetic stimulation** = Two potential effects, alpha effects or beta effects, depending on which nerve receptor is stimulated.

- Alpha effects = Occur when alpha receptors are stimulated, resulting in vasoconstriction.
- Beta effects = Occur when beta receptors are stimulated, resulting in increased inotropic, dromotropic, and chronotropic states.

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The hormones epinephrine and norepinephrine can also regulate heart rate, and therefore, can be used as cardiac drugs.

### **Electrolytes (ions) and the heart**

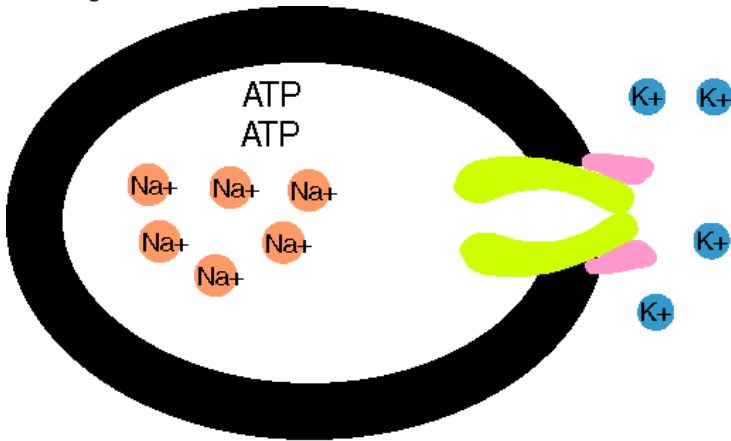
Myocardial cells are bathed in solutions of chemicals, or electrolytes.

Three positively charged ions found in these electrolyte solutions, sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), and calcium ( $\text{Ca}^{2+}$ ), are responsible for initiating and conducting electrical signals in the heart.

In the resting cell, the concentration of potassium is greater inside the cell, and the concentration of sodium is greater outside the cell.

To maintain this difference, sodium is pumped out of the cell by a special ion-transporting mechanism called the sodium-potassium pump, a process requiring the expenditure of energy.

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### Electrical potential

An electrical charge difference caused by the difference in sodium and potassium concentration across a cell membrane at any given instant.

- An electrical potential is measured in millivolts.
- In a resting cell, the area outside the cell is more positively charged than the inside of the cell, hence, a negative electrical potential exists across the cell membrane.
- The resting cell normally has a net negative charge with respect to the outside of the cell.
- This is referred to as the polarized state.



## 6. Depolarization and cardiac contraction

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### Depolarization

- Process of electrical discharge and flow of electrical activity.
- Occurs when a myocardial cell receives a stimulus from the conduction system, causing the permeability of the cell wall to change and allowing sodium to rush into the cells.
- Causes the inside of the cell to become more positive and calcium to enter the cell.
- The resulting exchange of ions generates an electrical current.
- The rapid influx of sodium and the slow influx of calcium continue, causing the inside of the cell to continue to become more positively charged, eventually achieving a slightly positive electrical potential.
- The flow of electrical current is passed from cell to cell along the conduction pathway in a wave-like motion throughout the heart.
- As the myocardial cells are depolarized, calcium is released and comes into close proximity with the actin and myosin filaments.
- This process causes the filaments to slide together, resulting in muscle contraction.
- Contraction of heart muscle squeezes blood out of the chambers.
- The combination of electrical stimulation and the resultant muscle contraction sometimes is referred to as excitation-contraction coupling.



## H. Repolarization

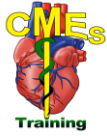
### Repolarization

- Period after cardiac cells depolarize, when cells begin to return to their resting (polarized) state.
- At this time, the inside of the cell returns to its negative charge.
- Begins when the entry of sodium into the cells slows down and positively charged potassium ions begin to flow out of the cells.
- Following the efflux of potassium, sodium is actively pumped out of the cells, and potassium is pumped back in.
- Calcium is returned to storage sites in the cells.
- As a result, the transmembrane potential returns to its baseline negative resting membrane potential and the cells regain both their polarized state and resting length.

Absolute refractory period – In the early phase of repolarization, the cell contains such a large concentration of ions that it cannot be stimulated to depolarize.

Relative refractory period – In the latter phase of repolarization, the cells are able to respond to a stronger-than-normal stimulus.

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## **The Electrical Conduction System of the Heart**

Automaticity - Generates its own electrical impulses without stimulation from nerves. This is a unique feature of the heart. Specialized conduction tissue that can rapidly propagate electrical impulses to the muscular tissues of the heart

Pacemaker: area of conduction tissue in which the electrical activity arises at any given time; sets the pace for cardiac contraction

Electrical conduction system:

- The dominant pacemaker: the sinoatrial (SA) node
  - Theoretically, any cell can act as a pacemaker.
- The sinoatrial node is located in the right atrium, near the inlet of the superior vena cava.
- Receives blood from the right coronary artery (RCA) if the RCA is occluded, the SA node will become ischemic. Fastest pacemaker in the heart. Internodal pathways: spread electrical impulses across the two atria in about 0.08 s, causing the atrial tissue to depolarize as they pass
- Atrioventricular node: serves as a “gatekeeper” to the ventricles; blood supply comes from a branch of the RCA.
- AV junction: when the atrial rate becomes very rapid, not all atrial impulses make it.
- Bundle of His: normal recipient of impulses from the AV junction
- Purkinje fibers: thousands of fibrils distributed through the ventricular



### **ECG Leads and Placement**

Electrodes are generally adhesive and have a gel center to aid in skin contact. “Diaphoretic” electrodes stick to a sweating patient more effectively

Basic principles of placement

- May be necessary to shave body hair from the electrode site
- To remove oils and dead tissues from the surface of the skin, rub the electrode site briskly with an alcohol swab before application. (Wait for the alcohol to dry.)
- Gently scrape the electrode site with the disposable plastic backing of the electrode.
- Attach the electrodes to the ECG cables before placement.
- Once all electrodes are in place, switch on the monitor, and print a sample rhythm strip.

### **Artifact**

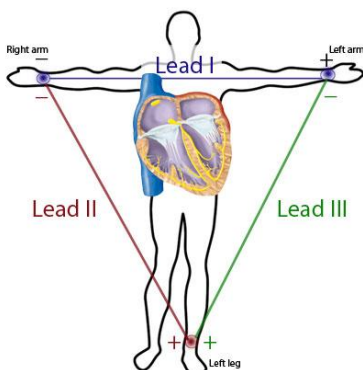
Can be tricky. A straight-line ECG in an alert, communicative patient indicates a loose or disconnected lead, not asystole (flat line). A wavy baseline may be caused by patient movement or muscle tremor





## Leads

- Offer an electrical snapshot of certain parts of the heart
- The standard is to use one of the “bipolar” leads for monitoring purposes (lead I, II, or III).
- Generally lead II will give the best overall view of the PQRST complexes.
- Bipolar leads: consist of two electrodes, one positive and one negative, that are placed on two different limbs
- Any impulse in the body moving to a positive electrode will cause a positive deflection on the ECG.
- If an impulse is moving toward a negative electrode, it will result in a negative deflection on the ECG tracing.
- If the impulse moves perpendicular to the lead, the result will be a “biphasic” waveform.
- Form a triangle around the heart (Einthoven triangle).

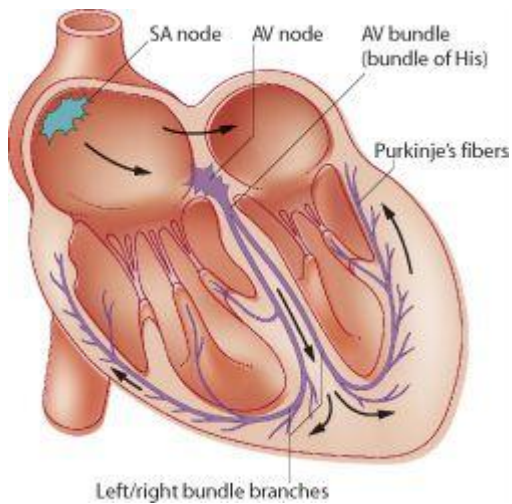




### **Intrinsic Firing Rates**

By now you should understand the basic anatomy and physiology, blood flow through the heart and some basic electrophysiology.

Paying close attention to the electrical conduction of the heart, you must realize the general properties “norms” for each pacemaker site.



As you begin to understand how the electrical conduction takes place, and what the normal rates are for each pacemaker site the ECG waveform will begin to make sense



The SA (sinoatrial) node is the primary pacemaker site. The SA node intrinsic or “normal” firing rate is 60-100bpm (beats per minute). If the electrical stimulation is coming from the SA node and the rate is 60-100 then it is considered normal.

If the electrical stimulus is coming from the SA node and the rate is below 60 then it is considered bradycardic or bradycardia

If the electrical stimulus is coming from the SA node and the rate is above 100 then it is considered tachycardic or tachycardia

The “gatekeeper” or AV node is considered our secondary pacemaker. It is located at the atrioventricular junction and sometimes referred to as the “junction”. The AV node intrinsic or “normal” firing rate is 40-60bpm. Since the rate is already in the definition of bradycardia, the rate is considered normal if the electrical stimulus comes from the AV node. To the contrary, since the definition for tachycardia is 100bpm, an AV rate of 60 – 100 is considered accelerated.

The final pacemaker site is the ventricles or purkinje system. The normal intrinsic firing rate of the purkinje system is 15-40bpm. Any rate generated from purkinje stimulus between 40-100bpm is considered accelerated



Examples:

SA node fires at a rate of 60 – 100bpm = Normal

SA node fires at a rate of less than 60bpm = bradycardia

SA node fires at a rate of greater than 100bpm = tachycardia

AV node or junction fires at a rate of 40-60bpm = normal

AV node or junction fires at a rate greater than 60 = accelerated

AV node or junction fires at a rate greater than 100 = tachycardia

Purkinje system or ventricular fires at a rate of 15-40bpm = normal

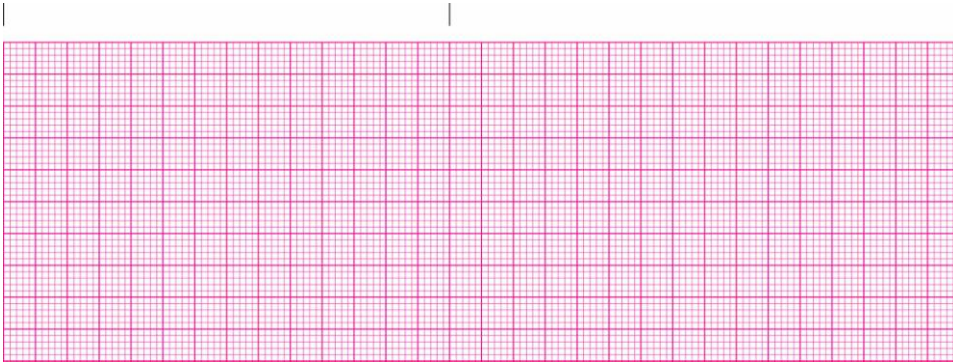
Purkinje system or ventricles fire at a rate greater than 40bpm = accelerated

Purkinje system or ventricles fire at a rate greater than 100bpm = tachycardia

If you can understand these general properties, then ECG waveforms will begin to make sense. DON'T PANIC YOUR DOING FINE!



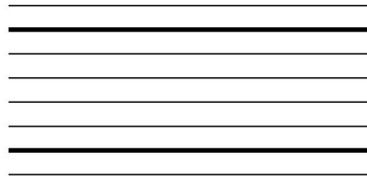
## ECG paper



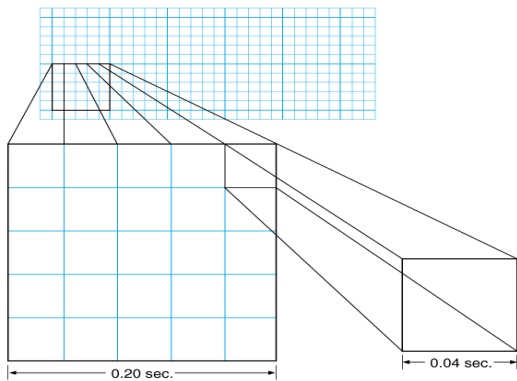
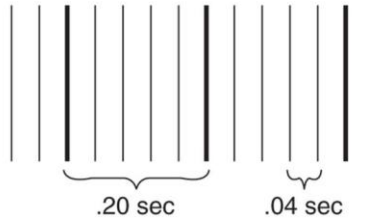
- Leaves the machine at constant speed of 25 millimeters per second (mm/sec)
  - The rate at which the paper goes through the printer is adjustable and is designated on the ECG. Standard paper speed is 25 mm/sec. A faster paper speed makes the rhythm appear slower and the QRS wider. Thus in cases of tachycardia a faster paper speed makes it easier to see the waveforms and analyze the tachycardia. A slower paper speed makes the rhythm appear faster and the QRS narrower.
- Time—measured on horizontal line
- Amplitude or voltage—measured on vertical line on graph paper



**VOLTAGE** is measured by comparing the height of the spike to the *horizontal* lines on the graph paper.



**TIME** is measured by comparing the markings to the *vertical* lines on the graph paper.

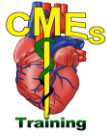


In layman's terms, anything vertical on an ECG is considered the amplitude, horizontal is indicative of time or rate.

Why is this important?



As we interpret an ECG, we will be looking for general or “normal” properties for each deflection on the ECG tracing. Anything out of the “norm” as it pertains to amplitude (vertical height) or time (horizontal) parameters will be a significant finding.



## Analytical Approach

Answer the following questions

### REGULARITY

(also called *Rhythm*)

- Is it regular?
- Is it irregular?
- Are there any patterns to the irregularity?
- Are there any ectopic beats? If so, are they early or late?

### RATE

- What is the exact rate?
- Is the atrial rate the same as the ventricular rate?

### P WAVES

- Are the P waves regular?
- Is there one P wave for every QRS?
- Is the P wave in front of the QRS or behind it?
- Is the P wave normal and upright in Lead II?
- Are there more P waves than QRS complexes?
- Do all the P waves look alike?
- Are the irregular P waves associated with ectopic beats?

### PR INTERVAL

- Are all the PRIs constant?
- Is the PRI measurement within normal range?
- If the PRI varies, is there a pattern to the changing measurements?

### QRS COMPLEX

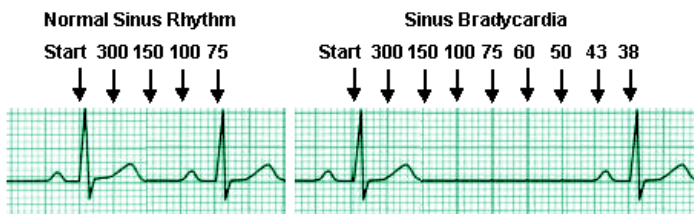
- Are all the QRS complexes of equal duration?
- What is the measurement of the QRS complex?
- Is the QRS measurement within normal limits?
- Do all the QRS complexes look alike?
- Are the unusual QRS complexes associated with ectopic beats?



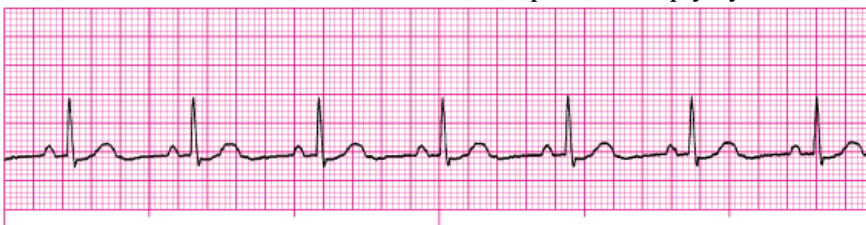
Calculating heart rate is used interchangeably with ventricular rate. Heart rate is not synonymous with pulse rate, although they should be the same.

You may calculate heart rate several ways.

1. Count number of large squares between two R waves and divide into 300



2. Count number of small squares between two R waves and divide into 1500
3. Count number of R waves in a 6-second strip and multiply by 10

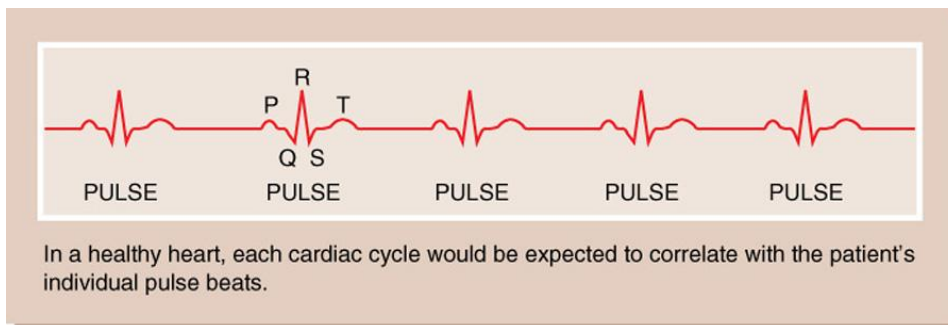


Heart rate approximately 70



## The General Properties of PQRST

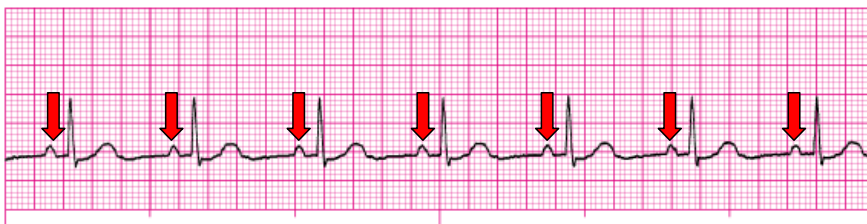
Each cardiac cycle should produce a pulse.



### P wave:

P wave represents *atrial depolarization*. In lead II it is the first positive deflection seen on an ECG. Its characteristics are:

- First deviation from the isoelectric line
- Upright and rounded in lead II
- Each P wave followed by a QRS
- Should have a rate of between 60-100 per minute
- P wave is SA node pacing or firing at regular intervals
- This pattern referred to as a sinus rhythm



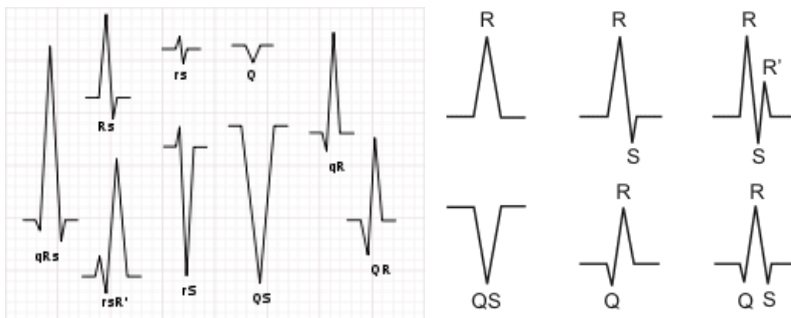


- No P wave or inverted P wave could be generated from the Junction
- No P wave and a wide QRS complex could be generated from the Purkinje fibers (ventricular)

### QRS Width

QRS complex represents ventricular depolarization. This takes place simultaneously with atrial repolarization (you cannot see atrial repolarization on the ECG tracing due to the amount of electrical conduction during ventricular depolarization)

- The QRS complex can take on many shapes.
- The Q wave is the first negative deflection following the P wave. Not every QRS complex has a Q wave
- The R wave is the first positive deflection following the P wave
- The S wave is the first negative deflection following the R wave.
- Again these complexes can differ
- Normal QRS width is 0.04 – 0.12 seconds (1 to 3 small boxes)

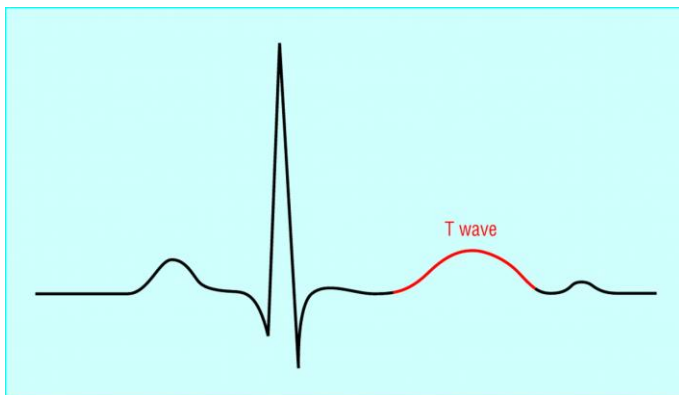




### T wave

The T wave represents ventricular repolarization.

- The T wave should also be upright and rounded. Slightly larger than the P wave.
- Remember this is a ventricular complex so the electrical movement is larger than atrial so the complex will be larger than atrial.
- T waves can be mistaken for P waves of the upcoming complex especially in tachycardia rhythms.



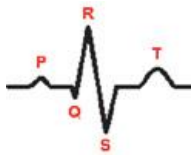


In review:

P wave: Atrial depolarization

QRS complex: Ventricular depolarization

T wave: Ventricular repolarization



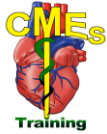
General Properties:

SA node stimulus should generate a P wave on the ECG (normal). If it does and the rate falls between the normal intrinsic firing rate of the SA node (60-100) and all other properties normal the rhythm is *Normal Sinus Rhythm (NSR)*

If the SA node stimulus generates a P wave on the ECG and the rate falls below the normal 60-100 and all other properties are normal the rhythm is *Sinus (SA) bradycardia*

If the SA node stimulus generates a P wave on the ECG and the rate falls above the normal 60-100 and all other properties are normal the rhythm is *Sinus (SA) tachycardia*

If the SA node does not fire and the stimulus comes from the AV node or junction (the P wave is absent or inverted) and the rate falls within the normal intrinsic firing rate of the junction (40-60) and all other properties are normal the rhythm is *Junctional*



If the SA node does not fire and the stimulus comes from the AV node or junction (the P wave is absent or inverted) and the rate falls below the normal intrinsic firing rate of the junction (40-60) and all other properties are normal the rhythm is *Junctional*.

If the SA node does not fire and the stimulus comes from the AV node or junction (the P wave is absent or inverted) and the rate falls between (60-100) and all other properties are normal the rhythm is *Accelerated Junctional*.

*\*\*Remember the term tachycardia does not take place until the rate is above 100.*

If the SA node does not fire and the stimulus comes from the AV node or junction (the P wave is absent or inverted) and the rate falls above 100 and all other properties are normal the rhythm is *Junctional Tachycardia*.

*\*\*Remember the term tachycardia does not take place until the rate is above 100.*

If the SA node and the junction do not create the electrical stimulus the purkinje fibers must generate their own (automaticity)

This will display NO P wave. Also the QRS will widen greater than the normal 0.04 -0.12 seconds. The reason for this is the time it takes for the electrical stimulus to generate from the ventricles.

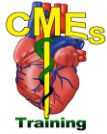
So an ECG, No P wave and a wide QRS is considered ventricular in nature. Remember the intrinsic firing rate of the purkinje system (ventricles) is 15-40

A wide QRS with no P wave and a rate of 15-40 is considered *Idioventricular*.

*\*\*The term "idio" since it is undetermined the exact stimulus generation*

A wide complex with no P waves and a rate of 40-100 is called \_\_\_\_\_...  
yes you guessed it *Accelerated Idioventricular*.

A wide complex with no P waves and a rate of above 100 is called *Ventricular Tachycardia*.

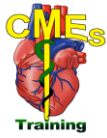


If you can remember these general rules, and not the way an ECG should “look” reading ECG’s is relatively easy!

**Take the Quiz below and document the properties of each rhythm before you attempt to diagnose the ECG strip. We will discuss these and many others in the in house portion of the class.**

### **Rhythm strip analysis**

1. Regularity (Rhythm)
  - a. Is it regular?
  - b. Is it irregular?
  - c. Are there any patterns to the irregularity?
  - d. Are there any ectopic beats; if so, are they early or late?
2. P Waves
  - a. Are P waves regular?
  - b. Is there one P wave for every QRS?
  - c. Is P wave in front of QRS or behind it?
  - d. Is P wave normal and upright in Lead II?
  - e. Are there more P waves than QRS complexes?
  - f. Do all P waves look alike?
  - g. Are irregular P waves associated with ectopic beats?
3. PR Interval
  - a. Are all PRIs constant?
  - b. Is PRI measurement within normal range?
  - c. If PRI varies, is there a pattern to changing measurements?
4. QRS Complex
  - a. Are all QRS complexes of equal duration?
  - b. What is the measurement of QRS complex?
  - c. Is QRS measurement within normal limits?
  - d. Do all QRS complexes look alike?
  - e. Are unusual QRS complexes associated with ectopic beats?



## ECG Quiz

1.

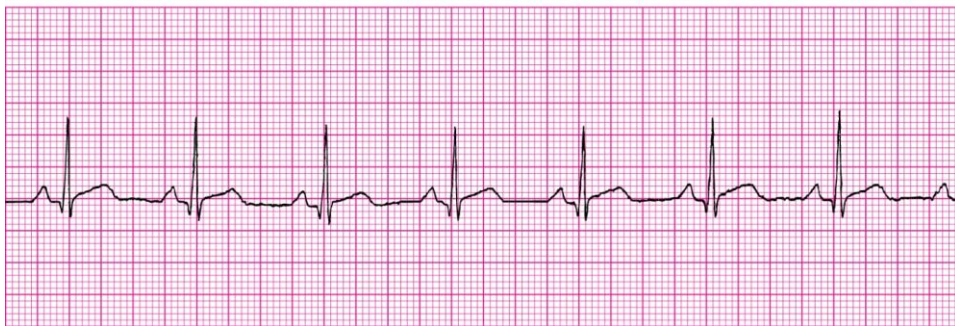


P wave: \_\_\_\_\_ PR Interval: \_\_\_\_\_ QRS Width: \_\_\_\_\_

Rate: \_\_\_\_\_ Pacemaker site: SA AV Purkinje

Rhythm Diagnosis: \_\_\_\_\_

2.



P wave: \_\_\_\_\_ PR Interval: \_\_\_\_\_ QRS Width: \_\_\_\_\_

Rate: \_\_\_\_\_ Pacemaker site: SA AV Purkinje

Rhythm Diagnosis: \_\_\_\_\_



3.

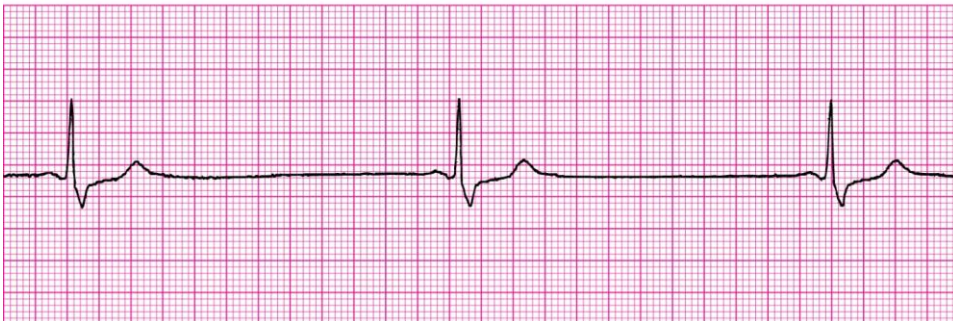


P wave: \_\_\_\_\_ PR Interval: \_\_\_\_\_ QRS Width: \_\_\_\_\_

Rate: \_\_\_\_\_ Pacemaker site: SA AV Purkinje

Rhythm Diagnosis: \_\_\_\_\_

4.



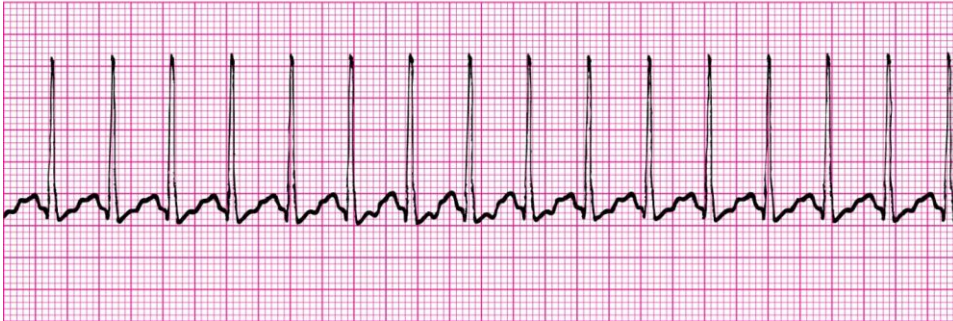
P wave: \_\_\_\_\_ PR Interval: \_\_\_\_\_ QRS Width: \_\_\_\_\_

Rate: \_\_\_\_\_ Pacemaker site: SA AV Purkinje

Rhythm Diagnosis: \_\_\_\_\_

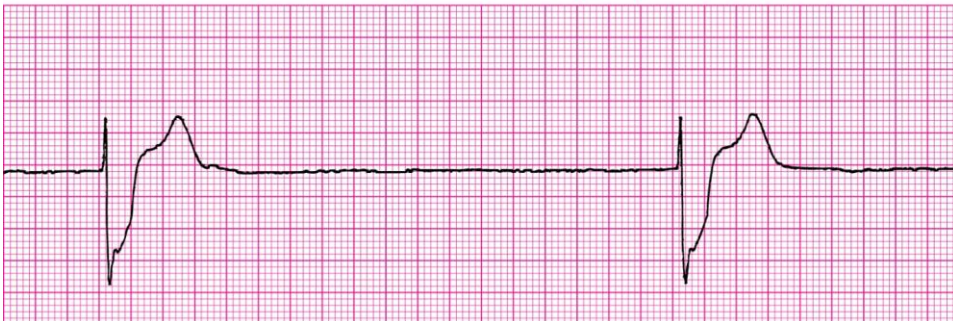


5.



P wave: _____	PR Interval: _____	QRS Width: _____
Rate: _____	Pacemaker site: SA AV Purkinje	
Rhythm Diagnosis: _____		

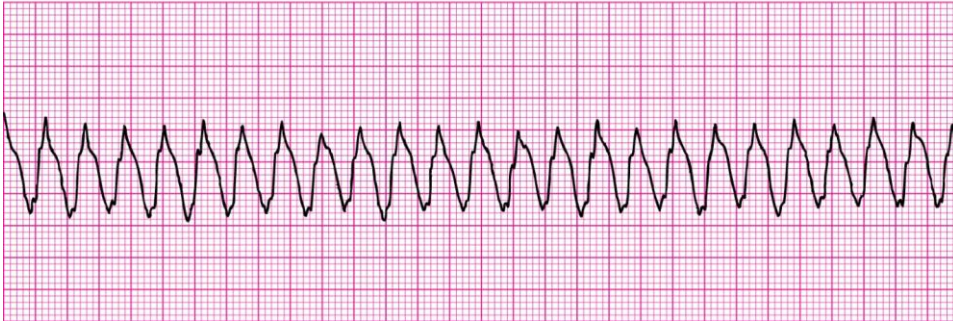
6.



P wave: _____	PR Interval: _____	QRS Width: _____
Rate: _____	Pacemaker site: SA AV Purkinje	
Rhythm Diagnosis: _____		

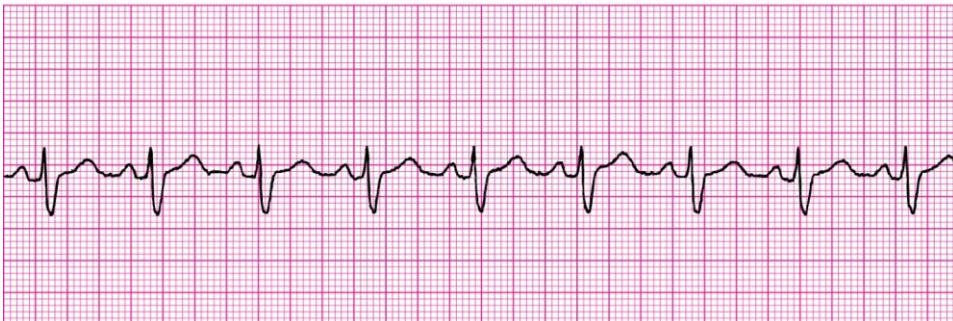


7.



P wave: _____	PR Interval: _____	QRS Width: _____
Rate: _____	Pacemaker site: SA AV Purkinje	
Rhythm Diagnosis: _____		

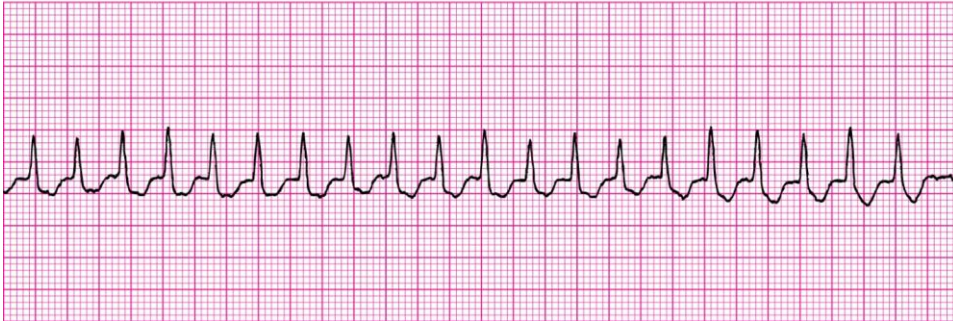
8.



P wave: _____	PR Interval: _____	QRS Width: _____
Rate: _____	Pacemaker site: SA AV Purkinje	
Rhythm Diagnosis: _____		

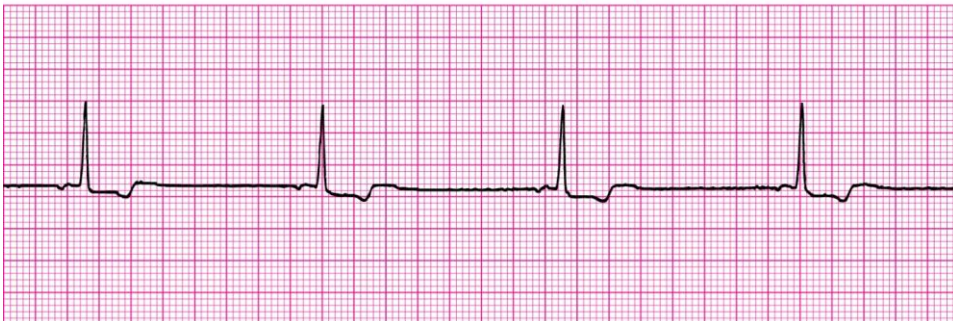


9.



P wave: _____	PR Interval: _____	QRS Width: _____
Rate: _____	Pacemaker site: SA AV Purkinje	
Rhythm Diagnosis: _____		

10.



P wave: _____	PR Interval: _____	QRS Width: _____
Rate: _____	Pacemaker site: SA AV Purkinje	
Rhythm Diagnosis: _____		



## Quiz Answers Key

### Anatomy and Physiology

1. D
2. B
3. B
4. A
5. D

### Blood Flow through the Heart

1. C
2. A
3. D
4. B
5. C
6. A
7. A
8. B
9. B
10. A

### ECG Quiz

1. Junctional Rhythm
2. Normal Sinus Rhythm
3. Sinus Bradycardia
4. Sinus Bradycardia
5. Sinus Tachycardia
6. Idioventricular
7. Ventricular Tachycardia
8. Normal Sinus Rhythm
9. Junctional Tachycardia
10. Junctional Rhythm