CORONARY ARTERY DISEASE (CAD) Electrocardiogram (ECG)

Lect.13

CORONARY ARTERY DISEASE (CAD)

heart disease that caused by inadequate blood supply to cardiac muscle due to occlusion of coronary artery, also called coronary heart disease.

Coronary Occlusion

means the partial or complete obstruction of coronary artery. The occlusion occurs because of atherosclerosis, a condition associated with

deposition of cholesterol on the walls of artery= this part of arterial wall becomes fibrotic & it is called atherosclerotic plague.

The plague is made up of cholesterol, calcium & other substances from blood- the lumen of the coronary artery becomes narrow. In severe conditions, the artery is completely occluded.

Smaller blood vessels occluded by the thrombus or part ofatherosclerotic plague detached from coronary artery. This thrombus or part of the plague is called embolus.

Myocardial Ischemia

is the reaction of a part of myocardium in response to hypoxia- develops when blood flow to a part of myocardium decreases severely due to occlusion of a coronary artery.

When the ischemia is mild due to obstruction of smaller blood vessel, the blood flow can be restored by rapid development of coronary collateral arteries.

When coronary occlusion is severe involving larger blood vessels, the severe ischemia leads to necrosis of myocardium.Necrosis is irreversible.

Myocardial Infarction – Heart Attack

is the necrosis of myocardium caused by insufficient blood flow due to embolus, thrombus or vascular spasm. It is also called heart attack.

Cardiac Pain – Angina Pectoris

chest pain that caused by myocardial ischemia. It is the common manifestation of coronary artery disease. The pain starts beneath the sternum and radiates to the surface of left arm and left shoulder. The cardiac pain is called referred pain since it is felt over the body away from the heart- because, heart and left arm develop from the same dermatomal segment in embryo.

CEREBRAL CIRCULATION

Brain tissues need adequate blood supply continuously. Stoppage of blood flow for 5 seconds leads to unconsciousness, and for 5 minutes leads to irreparable damage to the brain cells.

STROKE

is the sudden death of neurons in localized area of brain due to inadequate blood supply.-characterized by reversible or irreversible paralysis with other symptoms. Stroke is also called cardiovascular accident (CVA) or brain attack.

HEMORRHAGE is the excess loss of blood due to the rupture of blood vessels.

TYPES AND CAUSES OF HEMORRHAGE

Based on the cause, is classified into five categories:

1. Accidental hemorrhage
2. Capillary hemorrhage
3. Internal hemorrhage
4. Postpartum hemorrhage
5. Hemorrhage due to premature detachment of placenta.

EFFECTS OF HEMORRHAGE

The effects are different in acute hemorrhage and chronic hemorrhage.

Acute Hemorrhage

is the sudden loss of large quantity of blood- occurs in conditions like accidents. Decreased blood volume in acute hemorrhage causes hypovolemic shock.

Chronic Hemorrhage

is the loss of blood either by internal bleeding (occurs in conditions like ulcer) or by external bleeding over a long period of time(occurs in conditions like hemophilia and excess vaginal bleeding (menorrhagia)). produces different types of effects such as anemia.

Circulatory shock

refers to the shock developed by inadequate blood flow throughout the body. It is a life threatening condition and if the affected person is not treated immediately it may result in death.

The characteristic feature of all types of circulatory shock is the insufficient blood flow to the tissues particularly the brain. The blood flow decreases due to the reduction in cardiac output.

MANIFESTATIONS OF SHOCK

When cardiac output reduces, the arterial blood pressure drops down produces reflex tachycardia and reflex vasoconstriction, the pulse also becomes feeble. The velocity of the blood flow decreases resulting in stagnant hypoxia, Skin becomes pale and cold.

Cyanosis in many parts of the body, particularly ear lobes and fingertips.

Acceleration of metabolic activities of myocardium resulting in accumulation of excess lactic acid and acidosis leading to further reduction in cardiac output, So, the blood flow to vital organs is severely affected, produces ischemia resulting in fainting and irreparable damage to the brain.

HEART FAILURE

Heart failure or cardiac failure is the condition in which the heart looses the ability to pump sufficient amount of blood to all parts of the body- may involve left ventricle or right ventricle or both. **Acute Heart Failure**

refers to sudden & rapid onset of signs and symptoms of abnormal heart functions. Its symptoms are severe initially, the symptoms last for a very short-time and the condition improves rapidly.

Chronic Heart Failure

is characterized by the symptoms that appear slowly over a period of time and become worst gradually.

Congestive Heart Failure

It is a general term used to describe heart failure resulting in accumulation of fluid in lungs and other tissues. When heart is not able to pump blood through aorta, the blood remains in heart. It results in dilatation of the chambers and accumulation of blood in veins (vascular congestion). This condition is also manifested by fluid retention and pulmonary edema.

CAUSES OF HEART FAILURE

1. Coronary artery disease
2. Defective heart valves
3. Arrhythmia (abnormal heartbeat)
4. Cardiac muscle disease such as cardiomyopathy
5. Hypertension
6. Congenital heart disease
7. Diabetes
8. Hyperthyroidism
9. Anemia

10. Lung disorders
11. Inflammation of cardiac muscle (myocarditis) due to viral infection, drugs, alcohol, etc.

Signs and Symptoms of Chronic Heart Failure

1. Fatigue and weakness
2. Rapid and irregular heartbeat
3. Shortness of breathing
4. Fluid retention and weight gain
5. Loss of appetite, nausea and vomiting
6. Cough
8. Chest pain, if developed by myocardial infarction.

Signs and Symptoms of Acute Heart Failure

The signs and symptoms of acute heart failure may be same as chronic heart failure. But the signs and symptoms appear suddenly and severely. When heart starts to fail suddenly, the fluid accumulates in lungs causing pulmonary edema. It results in sudden and severe shortness of breath,

cough with pink, foamy mucus and heart palpitations. It may lead to sudden death, if not attended immediately.

Electrocardiogram

(ECG) is the record or graphical registration of electrical activities of the heart, which occur prior to the onset of mechanical activities--is the summed electrical activity of all the cardiac muscle fibers recorded from the surface of the body. USES OF ECG- is useful in determining and diagnosing the following:

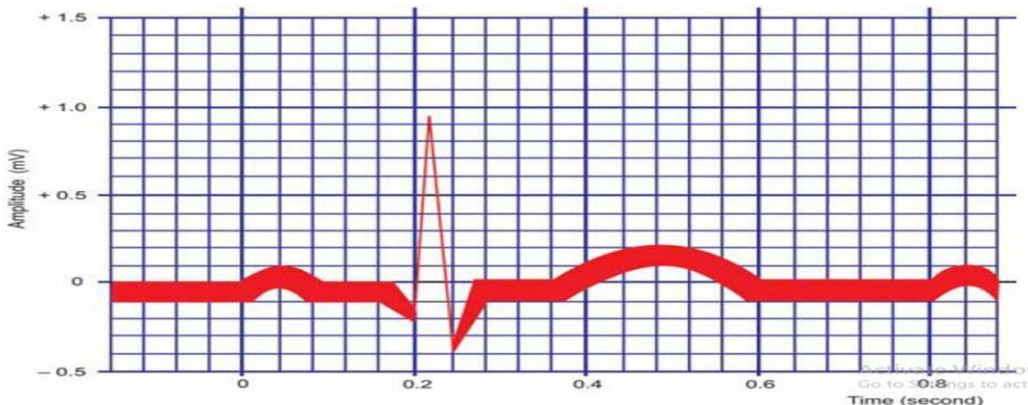
1. Heart rate 2. Heart rhythm 3. Abnormal electrical conduction
4. Poor blood flow to heart muscle (ischemia) 5. Heart attack
6. Coronary artery disease 7. Hypertrophy of heart chambers.

ELECTROCARDIOGRAPHIC GRID

The paper that is used for recording ECG is called ECG paper. The electrocardiograph or ECG machine amplifies the electrical signals produced from the heart & records these signals on a moving ECG paper. ECG grid refers to the markings (lines)on ECG paper, has horizontal & vertical lines at regular intervals of 1 mm.

The duration of different ECG waves is denoted by the vertical lines.

Interval between 2 thick lines (5 mm) = 0.2 sec. Interval between 2 thin



lines (1 mm) = 0.04 second. The amplitude of ECG waves is denoted by horizontal lines. Interval between 2 thick lines (5 mm)= 0.5 mV. Interval between two thin lines (1 mm)= 0.1 mV.

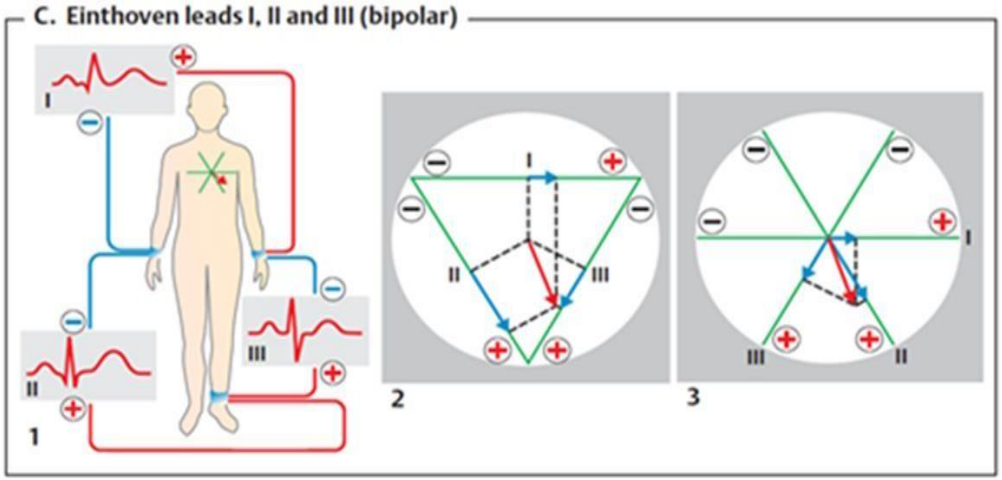
SPEED OF THE PAPER

The movement of paper can be adjusted in 2 speeds, 25 mm/second & 50 mm/second. Usually, the speed of the paper during recording is fixed at 25 mm/second. If the heart rate is very high, the speed of the paper is changed to 50 mm/second.

ECG LEADS

ECG is recorded by placing series of electrodes on the surface of body. These electrodes are= ECG leads & are connected to the ECG machine.

The electrodes are fixed on the limbs. The heart is said to be in the center of an imaginary equilateral triangle drawn by connecting the roots of these three limbs. This triangle is = Einthoven's triangle. The electrical potential generated from the heart appears simultaneously on the roots of these three limbs.



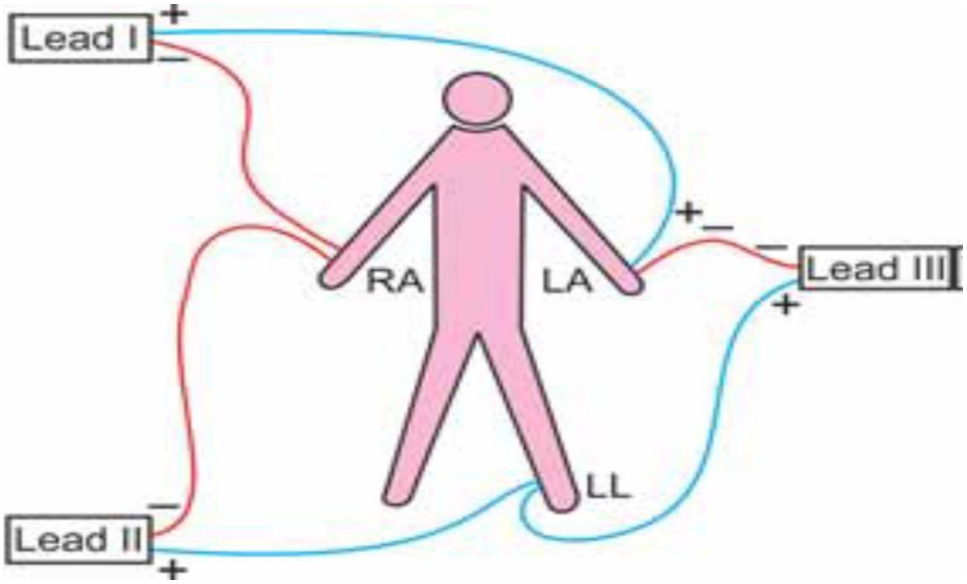
ECG is recorded in 12 leads which are generally classified into two categories.

A. Bipolar leads

B. Unipolar leads

BIPOLAR LIMB LEADS

Bipolar limb leads = standard limb leads. Two limbs are connected to obtain these leads and both the electrodes are active recording electrodes, i.e. one electrode is positive and the other one is negative.



There are three standard limb leads:

Limb lead I

Limb lead II

Limb lead III

UNIPOLAR LEADS

Here, one electrode is active electrode is positive and the other one is an indifferent electrode-is serving as a composite negative electrode. The unipolar leads are 2 types:

1. Unipolar limb leads

also called augmented limb leads. The active electrode is connected to one of the limbs. The indifferent electrode obtained by connecting the other two limbs through resistance. are of 3 types: aVR lead , ii. aVL lead, iii. aVF lead .

2. Unipolar chest leads.

WAVES OF NORMAL ELECTROCARDIOGRAM

normal ECG consists of waves namely P, Q, R, S & T. The major complexes in ECG are:

1. 'P' wave, the atrial complex produced due to the depolarization of atrial musculature.

Atrial repolarization is not recorded as a separate wave in ECG because it merges with QRS complex.

2. ‘QRS’ complex, the initial ventricular complex

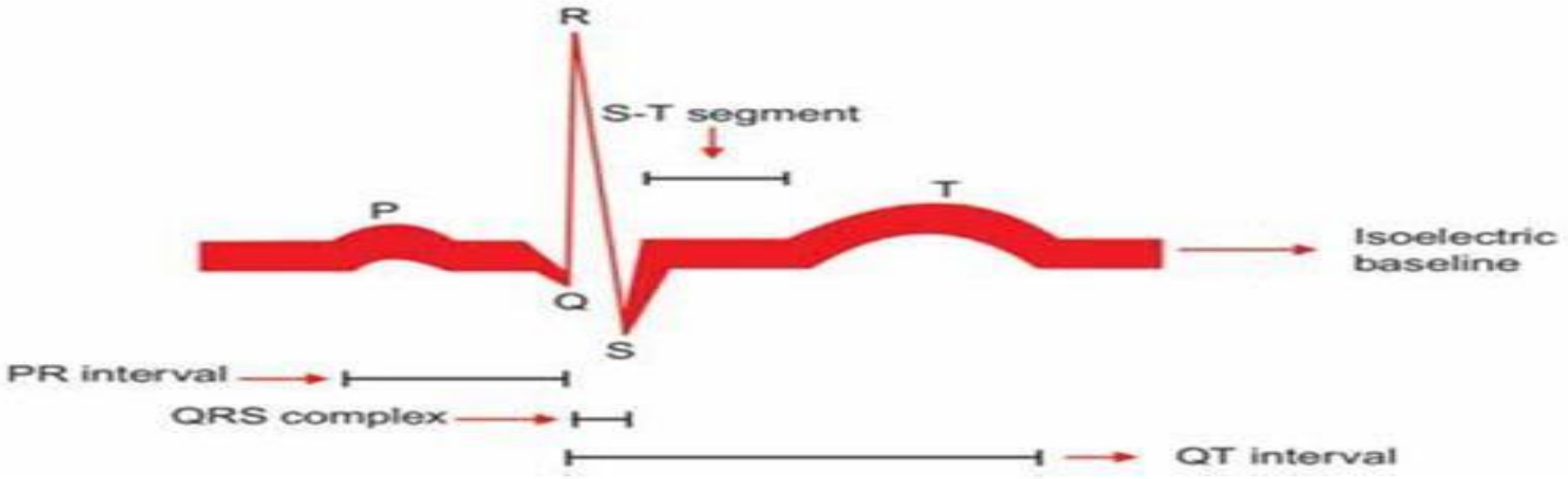
3. ‘T’ wave, the final ventricular complex.

4. ‘QRST’, the ventricular complex.

‘QRS’ complex is due to depolarization of ventricular musculature.

‘Q’ wave

is due to the depolarization of basal portion of interventricular septum.-continued as the tall ‘R’ wave,



‘R’ wave- positive wave,is due to the depolarization of apical portion of interventricular septum and apical portion of ventricular. is followed by .

‘S’ wave--small negative wave, is due to the depolarization of basal portion of ventricular muscle near the atrioventricular ring.

‘T’ WAVE

It is the final ventricular complex & a positive wave,due to the repolarization of ventricular musculature

‘U’ WAVE

is not always seen. It is also an insignificant wave in ECG. It is supposed to be due to repolarization of papillary muscle.

INTERVALS AND SEGMENTS OF ECG

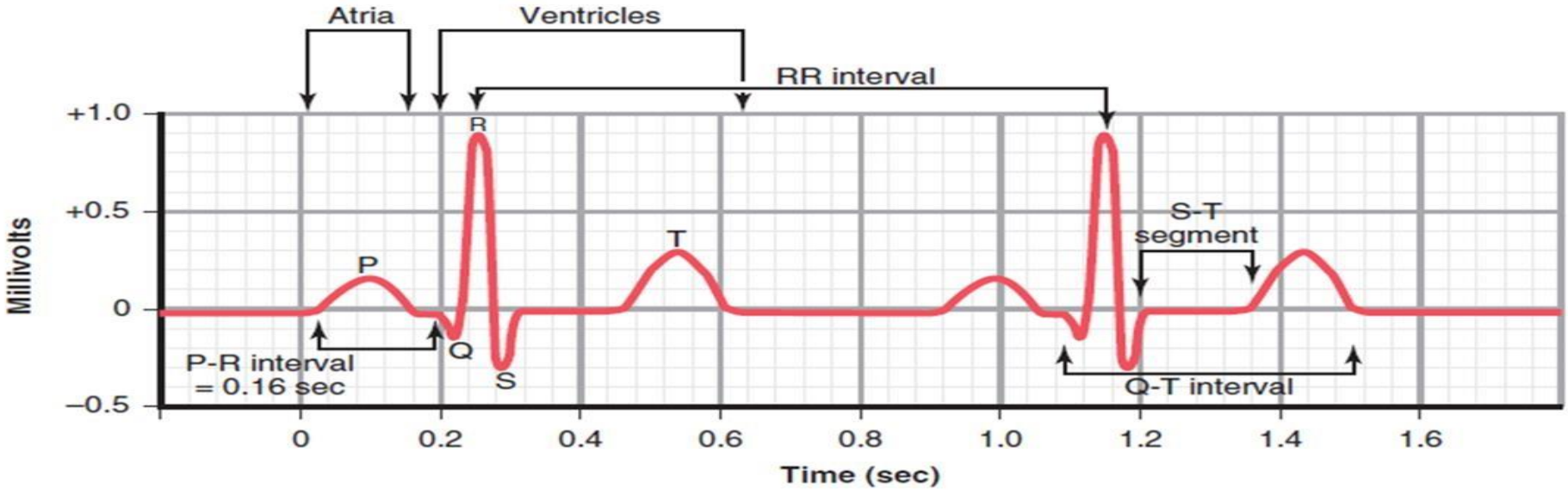
‘P-R’ INTERVAL the interval between the onset of ‘P’ wave &
onset of ‘Q’ wave.

it signifies the atrial depolarization & conduction of impulses through AV node, shows the duration of conduction of the impulses from the SA node to ventricles through atrial muscle and AV node.

It is represented by the short isoelectric (zero voltage) period after the end of 'P' wave & onset of 'Q' wave. It denotes the time taken for the passage of depolarization within AV node.

The normal duration is 0.18 second & varies between 0.12 - 0.2 sec. If it is more than 0.2 second, signifies the delay in the conduction of impulse from SA node to the ventricles. Usually, the delay occurs in the AV node. So it is called= the AV nodal delay.

'Q-T' INTERVAL



the interval between the onset of ‘Q’ wave and the end of ‘T’ wave. indicates the ventricular depolarization & ventricular repolarization, i.e. it signifies the electrical activity in ventricles. Duration--Between 0.4 and 0.42 second.

‘S-T’ SEGMENT

The time interval between the end of ‘S’ wave and the onset of ‘T’ wave is called ‘S-T’ segment. It is an isoelectric period.

Duration of ‘S-T’ Segment 0.08 second.

J Point

The point where ‘S-T’ segment starts is called ‘J’ point. It is the junction between the QRS complex and ‘S-T’ segment.

‘R-R’ INTERVAL

‘R-R’ interval is the time interval between two consecutive ‘R’ waves. signifies the duration of one cardiac cycle.

The normal duration of ‘R-R’ interval is 0.8 second.

Nervous system

- Central nervous system (CNS) ncludes brain and spinal cord.

formed by neurons and supporting cells called neuroglia.

2. Peripheral nervous system.

Peripheral nervous system (PNS)

formed by the neurons and their processes present in all regions of the body- consists of cranial nerves arising from brain and spinal nerves arising from the spinal cord. It is again divided into two subdivisions:

1. Somatic nervous system: is concerned with somatic functions. includes the nerves supplying skeletal muscles.- controls the movements of the body by acting on the skeletal muscles.

2. Autonomic nervous system : is concerned with regulation of visceral or vegetative functions. So, otherwise called vegetative or involuntary nervous system.- consists of two divisions, sympathetic division & parasympathetic division.

NEURON

the structural and functional unit of the nervous system,- otherwise called nerve cell- like any other cell in the body having nucleus and all the organelles in the cytoplasm. However, it is different from other cells by two ways:

1. Neuron has branches or processes called axon and dendrites 2.

Neuron does not have centrosome; so it cannot undergo division.

 CLASSIFICATION OF NEURON

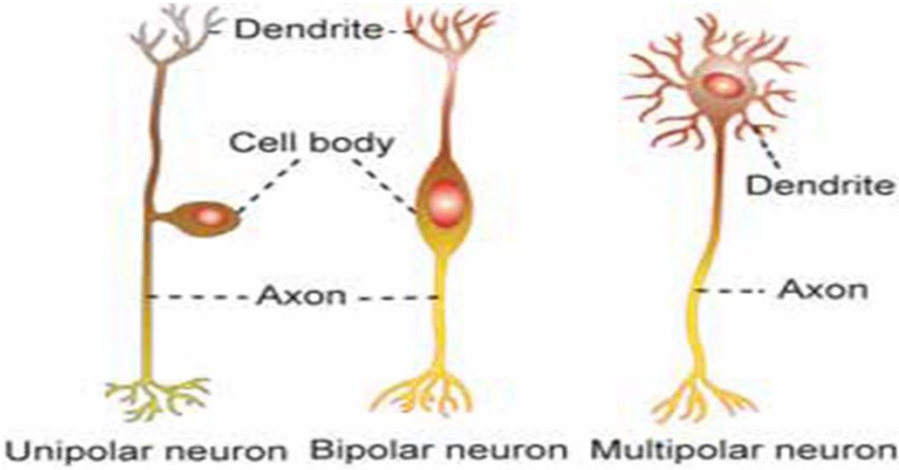
are classified by three different methods.

I. Depending upon number of poles
II. Depending upon function
III. Depending upon length of the axon.

Depending upon Number of Poles

Based on the number of poles from which the nerve fibers arise:

1. Unipolar neurons that have only one pole from which, both the axon and dendrite arise
2. Bipolar neurons which have two poles. Axon arises from one pole and dendrites arise from the other pole.
3. Multipolar neurons which have many poles. One of the poles gives rise to the axon and, all the other poles give rise to dendrites.



Depending upon Function

two types

- Motor neurons or efferent neurons

which carry the motor impulses from central nervous system to the peripheral effector organs like muscles, glands, blood vessels, etc. ▪ 2. Sensory neurons or afferent neurons which carry the sensory impulses from periphery to the central nervous system. **The Neurons**

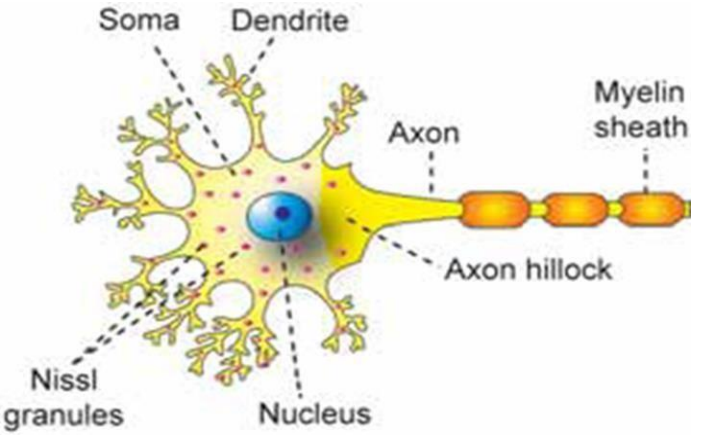
Function- send impulses to & from CNS and

PNS and the effectors(muscles, gland, receptor, nerve endings).

Receive, integrate , and transmit information

Operate through electrical impulses

Communicate with other neurons through chemical signals



The transmission of information along the length of the neuron is electrochemical in nature.

Neurons do not actually touch each other, instead, there is a space between the end of one & the beginning of the next (continuity without contact). A specified chemical, called neurotransmitter- is required to cross the gap between one neuron and the next.

STRUCTURE OF NEURON Each neuron is made up of three parts:

1. Nerve cell body known as soma or perikaryon. is constituted by a mass of cytoplasm called neuroplasm. The nucleus does not contain centrosome. So, the nerve cell cannot multiply like other cells.

Neurofibrils are thread like structures present in form of network in soma & nerve processes. Presences- is another characteristic feature of the neurons.

2. Dendrite

is the branched process of neuron- branched repeatedly. The dendrite may be present or absent. If present, it may be one or many in number.

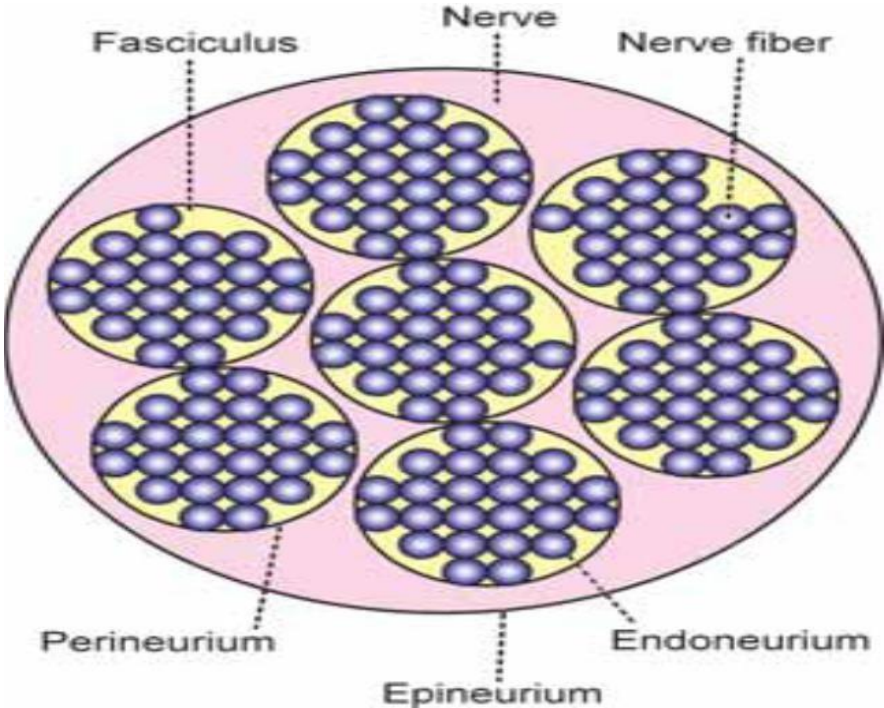
- is conductive in nature-- transmits impulses towards nerve cell body.

3. Axon.

Organization of nerve

Many axons together form a bundle called fasciculus. Many fasciculi together form a nerve. whole nerve is covered by tubular sheath, called epineurium. Each fasciculus is covered by perineurium & each nerve fiber(axon) is covered by endoneurium

The axon has long central core of cytoplasm called axoplasm- covered by axolemma is the continuation of cell membrane of the nerve cell body. The axoplasm along with the axolemma is called the axis cylinder of the nerve fiber. Which is covered by a membrane called neurilemma.



The nerve fibers which are insulated by myelin sheath are called myelinated nerve fibers. is responsible for the white color of the nerve fibers. **Myelinated nerve fiber** formation of myelin sheath around the axon is called myelinogenesis. It is formed by Schwann cells in neurilemma.

Functions of myelin sheath

1. is responsible for faster conduction of impulse through the nerve fibers. In the myelinated nerve fibers, the impulses jump from one node to another by saltatory conduction.
2. has a high insulating capacity. Because of this quality, the myelin sheath restricts the nerve impulse within the single nerve fiber, and prevents the stimulation of neighboring nerve fibers.

CLASSIFICATION OF NERVE FIBERS

Depending upon structure(i. Myelinated nerve fibers ii. Nonmyelinated nerve fibers)

2. Depending upon distribution (Somatic nerve fibers ii. Visceral or autonomic nerve fibers)
3. Depending upon origin(i. Cranial nerves ii. Spinal nerves arising)
4. Depending upon function(i. Sensory or afferent nerve fibers ii. Motor or efferent nerve fibers)

5. Depending upon secretion of neurotransmitter(i. Adrenergic nerve fibers ii. Cholinergic nerve fibers)
6. Depending upon diameter & conduction of impulse (Erlanger-Gasser classification). Type A nerve fibers 2. Type B nerve fibers 3. Type C nerve fibers.

Type A nerve fibers divided into four subtypes. Except 'C' type of fibers, all the nerve fibers are myelinated.

The velocity of impulse through a nerve fiber is directly proportional to the thickness of the fibers.

PROPERTIES OF NERVE FIBERS

Excitability is as the physiochemical change that occurs in a tissue when a stimulus is applied.

The stimulus is an external agent, which produces excitability in the tissues. When the nerve fiber is stimulated action potential develops. **Conductivity**

is the ability of nerve fibers to transmit the impulse from the area of stimulation to the other areas. The action potential is transmitted through the nerve fiber as nerve impulse. Normally in the body,- is transmitted through the nerve fiber in only one direction. Mechanism of conduction of action potential

The depolarization occurs first at the site of stimulation in the nerve fiber. It causes depolarization of the neighboring areas. Like this, travels throughout the nerve fiber- is followed by repolarization.

Summation

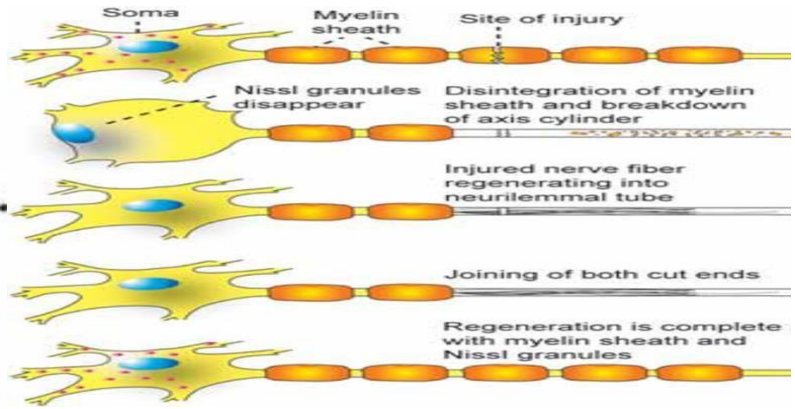
Adaptation

While stimulating a nerve fiber continuously, the excitability of nerve fiber is greater in beginning. Later the response decreases slowly & finally the nerve fiber does not show any response at all.

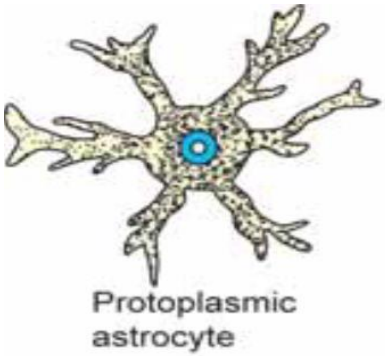
DEGENERATION OF NERVE FIBERS

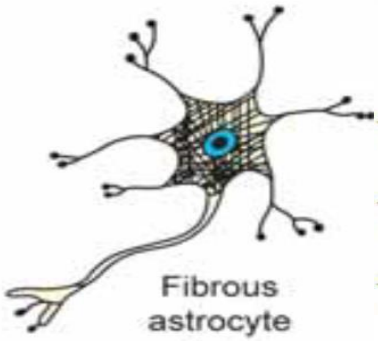
When a nerve fiber is injured, various changes occur in the nerve fiber & nerve cell body- called degenerative changes. The injury occurs due to obstruction of blood flow, local injection of toxic substances, crushing of nerve fiber or the transection of the fiber. **Degenerative Changes in the Neuron**

refers to deterioration or impairment or pathological changes of an injured tissue. When a peripheral nerve fiber is injured, the degenerative changes occur in the nerve cell body and the nerve fiber same neuron and the adjoining neuron- are classified to 3 types: 1. Wallarian degeneration



2. Retrograde degeneration

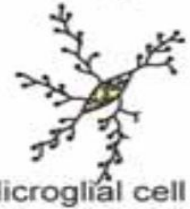




3. Transneural degeneration

Neuroglia or the glia





is the supporting cell of the nervous system== non-excitable and do not transmit nerve impulse (action potential). So, these cells are also called non-neural cells or glial cells.

CLASSIFICATION OF NEUROGLIAL CELLS

The neuroglial cells are distributed in CNS as well as PNS.

Central Neuroglial Cells

1. Astrocytes
2. Microglia
3. Oligodendrocytes.

Peripheral Neuroglial Cells neuroglial cells in PNS are two types:

1. Schwann cells
2. Satellite cells

Receptors

are the sensory (afferent) nerve endings that terminate in the periphery as bare unmyelinated nerve endings or in the form of specialized capsulated structures. When stimulated, receptors produce a series of impulses which are transmitted through the afferent nerves.

Actually receptors function like a transducer.

So, the receptors are often defined as the biological transducers which convert various forms of energy (stimuli) in the environment into action potentials in nerve fiber. Generally, receptors are classified into two types:

EXTEROCEPTORS

the receptors which give response to stimuli arising from outside the body-- a three groups.

1. Cutaneous Receptors

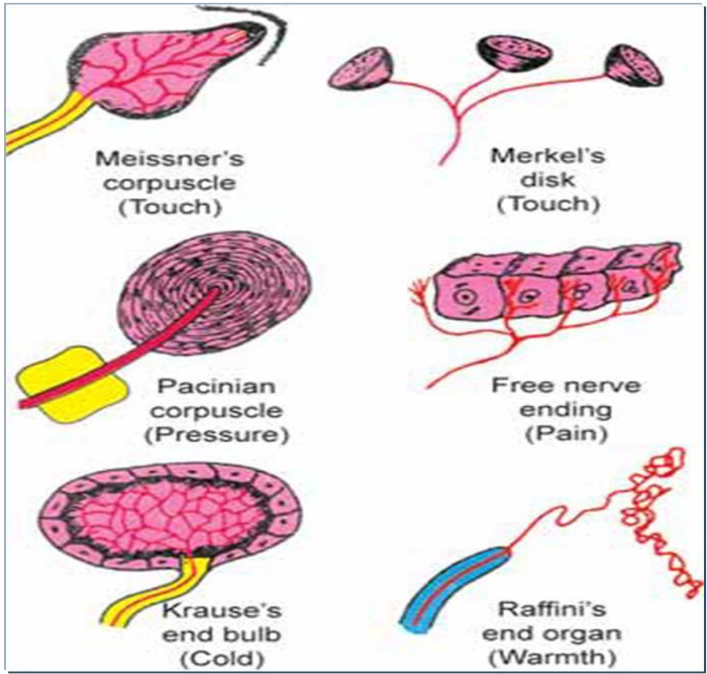
The receptors situated in the skin, also called mechanoreceptors because of their response to mechanical stimuli such as touch, pressure and pain. Touch and pressure receptors give response to vibration also.

2. Chemoreceptors

The receptors, which give response to chemical stimuli

3. Telereceptors

are the receptors that give response to stimuli arising away from the body. also called distance receptors



INTEROCEPTORS receptors which give response to stimuli arising from within the body. two types:

