

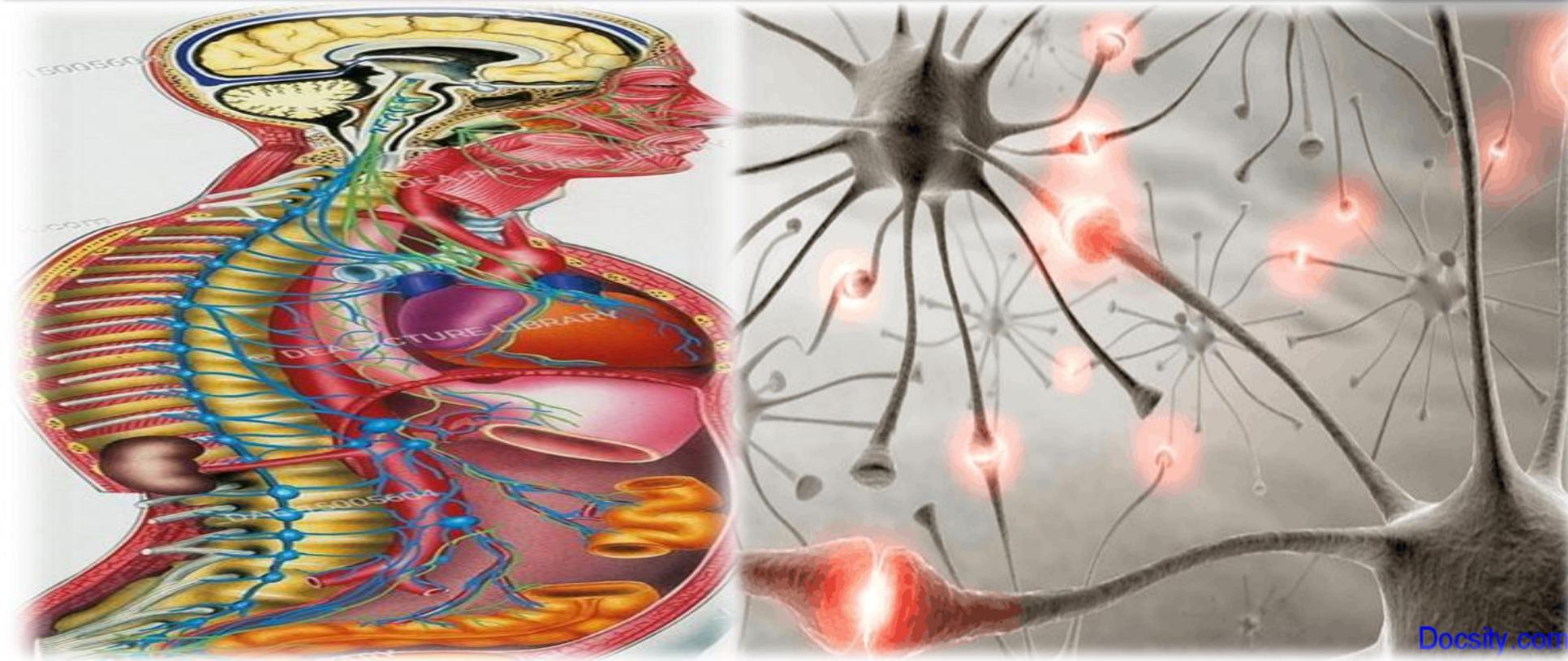
Physiology of the Nerve & Muscle System(3)

Second Stage/ University of Anbar-College of Dentistry

By : Dr. Rana Hazim

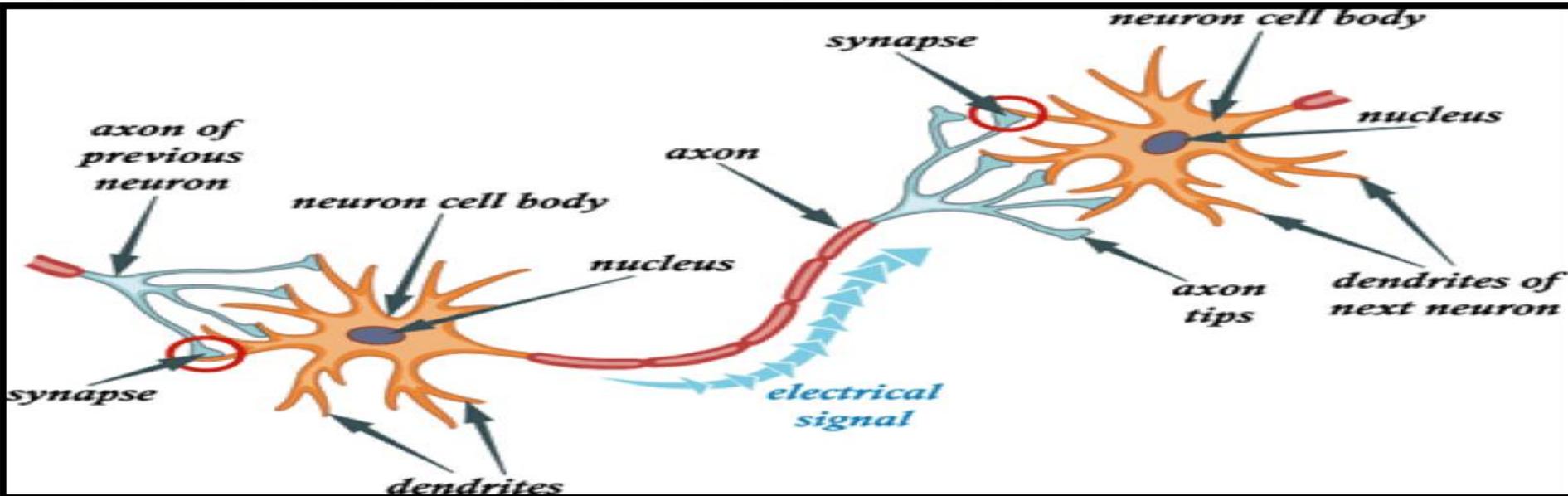
Ph.D. Human Physiology.

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Synapse

Synapse is the junction between the two neurons. It is not the anatomical continuation. But, it is only a physiological continuation between two nerve cells.

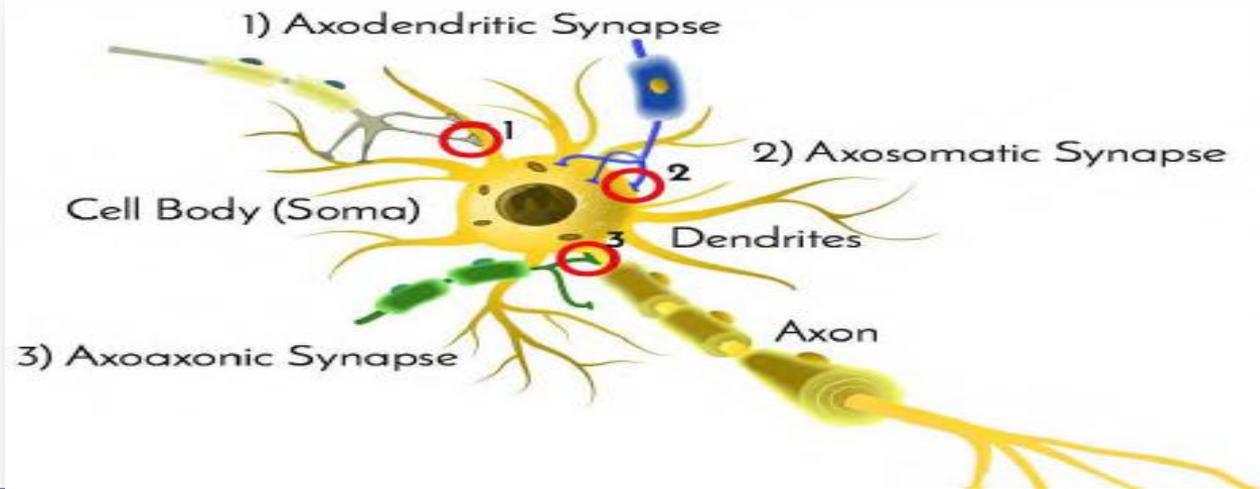


Classification of Synapse

Synapse is classified by two methods,

- 1- Anatomical classification**
- 2- Functional classification**

ANATOMICAL CLASSIFICATION



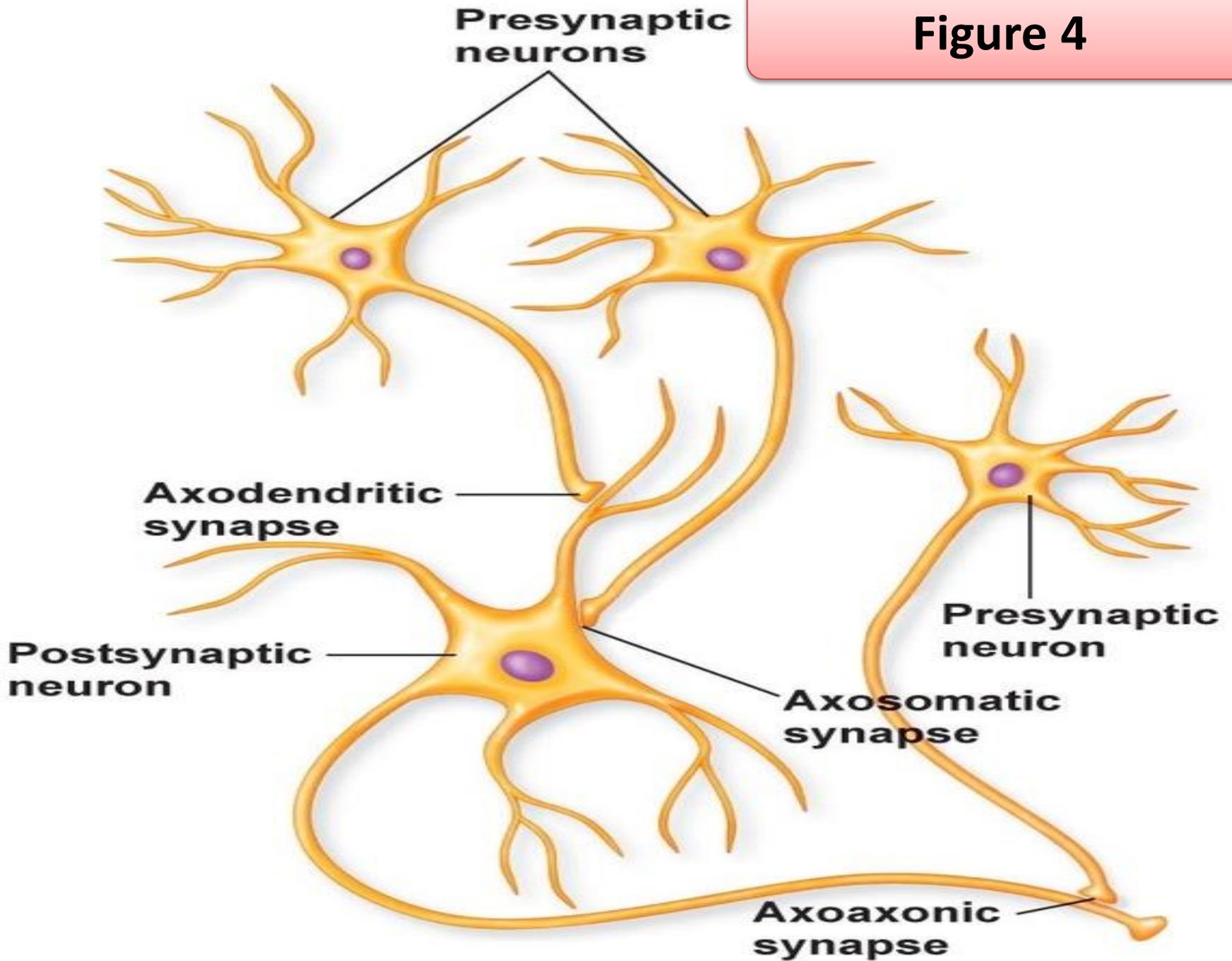
Depending upon the ending of axon, the synapse is classified into three types:- (Figure 4)

1. Axoaxonic synapse in which axon of one neuron terminates on axon of another neuron.

2. Axodendritic synapse in which axon of one neuron terminates on dendrite of another neuron.

3. Axosomatic synapse in which axon of one neuron ends on soma (cell body) of another neuron

Figure 4



FUNCTIONAL CLASSIFICATION

depends upon of mode of impulse transmission. On this basis, synapse is classified into two types:

1- Electrical synapse:-

Electrical synapse is the synapse in which the physiological continuation between the presynaptic and the postsynaptic neurons is provided by the gap junction between these two neurons (Fig. 5)

There is direct exchange of ions between the two neurons though the gap junction.

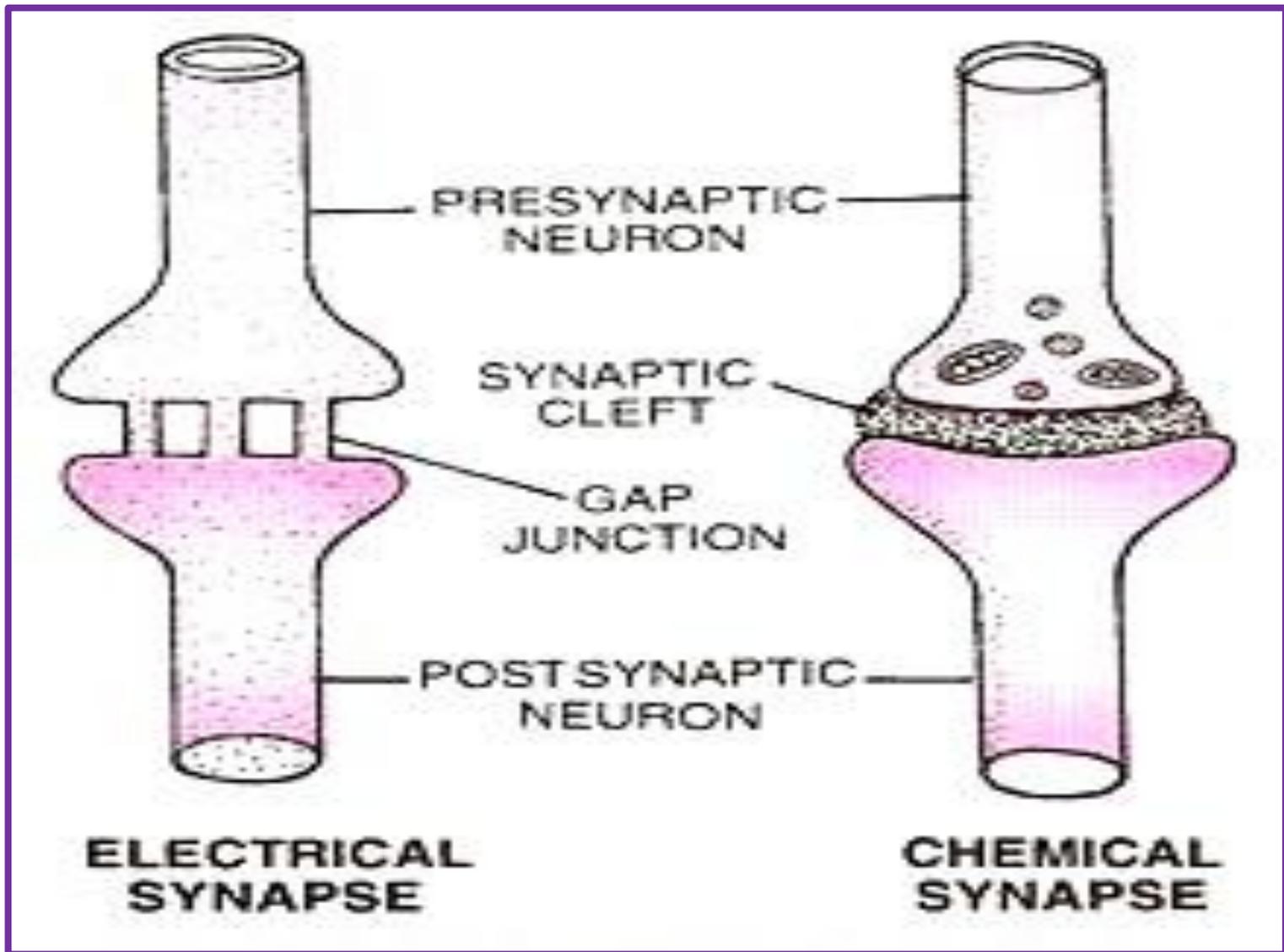


FIGURE 5: Structure of chemical synapse

FUNCTIONAL CLASSIFICATION

2. Chemical Synapse

- **Chemical synapse is the junction between a nerve fiber and a muscle fiber or between two nerve fibers, through which the signals are transmitted by the release of chemical transmitter.**
- **In the chemical synapse, there is no continuation between the presynaptic and postsynaptic neurons**

FUNCTIONS OF SYNAPSE

The function of the synapse is to transmit the impulses from one neuron to another. However, some synapses inhibit the impulses.

Accordingly, synapse is divided into two types:

1. Excitatory synapses:-

which transmit the impulses - excitatory function

2. Inhibitory synapses:-

which inhibit the transmission of impulses — inhibitory function.

Neurotransmitters

Neurotransmitter is a chemical substance that acts as the mediator for the transmission of nerve impulse from one neuron to another neuron through a synapse.

CLASSIFICATION OF NEUROTRANSMITTERS

A- Depending Upon Chemical Nature :-

Depending upon chemical nature, neurotransmitters are classified into three groups :-

1. Amino acids(Glycine, Aspartate)
2. Amines(Histamine, Serotonin)
3. Others(Nitric oxide, Acetylcholine)

Neurotransmitters

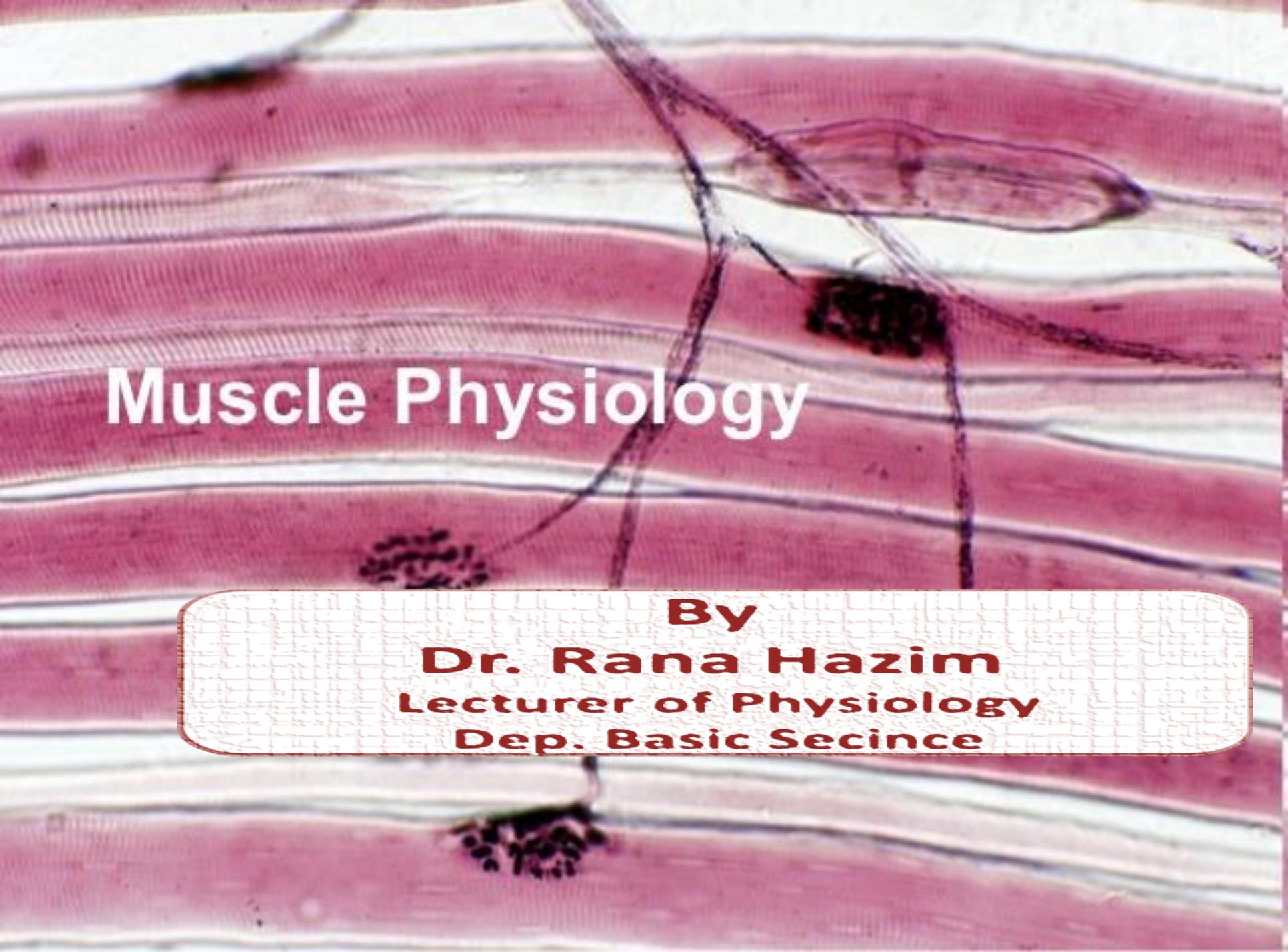
B- Depending Upon Function

Depending upon function, neurotransmitters are classified into two types: (Table 3)

1. Excitatory neurotransmitters which are responsible for the conduction of impulse.
2. Inhibitory neurotransmitters which inhibit the conduction of impulse

TABLE 3 : Excitatory and inhibitory neurotransmitters

Excitatory neurotransmitters	Inhibitory neurotransmitters	Neurotransmitters with excitatory and inhibitory act
Acetylcholine	GABA	Noradrenaline
Nitric oxide	Glycine	Adrenaline
Histamine	Dopamine	—



Muscle Physiology

By

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INTRODUCTION

- ✓ **Muscle is a contractile tissue. It contains contractile filaments that move past each other and change the size of the cell.**
- ✓ **There are more than 600 muscles in our body**

Functional characteristics of muscles

Excitability

- the ability to receive and respond to stimuli.

Conductivity

- The ability to receive a stimulus and transmit a wave of excitation (electrochemical activity)

Contractility

- the ability to shorten forcibly when stimulated.

Extensibility

- the ability to be stretched or extended.

Elasticity

- The ability to bounce back to original length

Types of Muscle fiber

The muscles are classified into three types :-

1-Skeletal muscle

- ✓ is situated in association with bones forming the skeletal system.
- ✓ The skeletal muscles form 40 to 50% of body mass and are voluntary and striated.
- ✓ These muscles are supplied by somatic nerves.
- ✓ In most of the skeletal muscles, the muscle fibers are attached to tendons on either end.
- ✓ The skeletal muscles are anchored to the bones by the tendons.

Types of Muscle fiber

2- Cardiac Muscle

- **Cardiac muscle forms the musculature of the heart.**
- **These muscles are striated and involuntary.**
- **Cardiac muscles are supplied by autonomic nerve fibers**

Types of Muscle fiber

3- Smooth Muscle

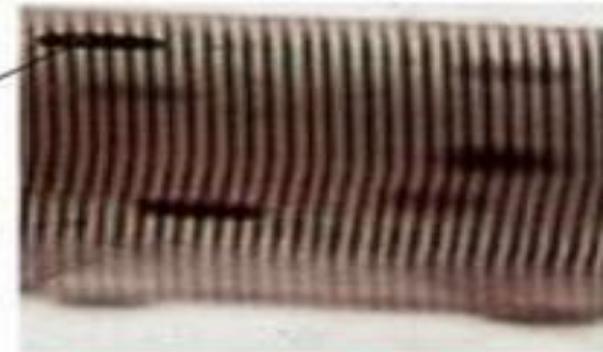
- Smooth muscle or visceral muscle is situated in association with viscera.
- Smooth muscle is non-striated and involuntary. Because of the absence of cross striations it is called smooth or plain muscle.
- It is supplied by autonomic nerve fibers.

Types of muscles

Skeletal muscle



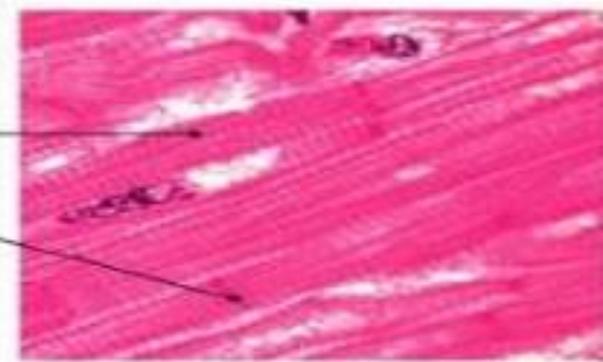
Nucleus
Muscle fiber (cell)
Striations



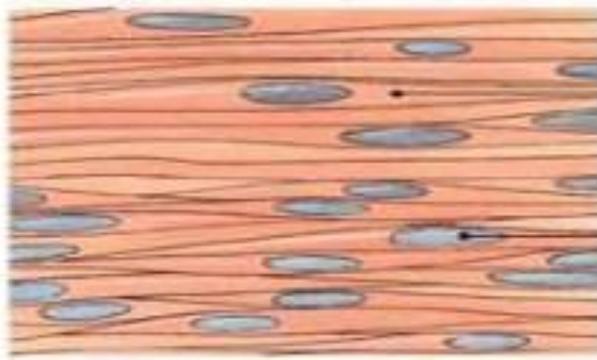
Cardiac muscle



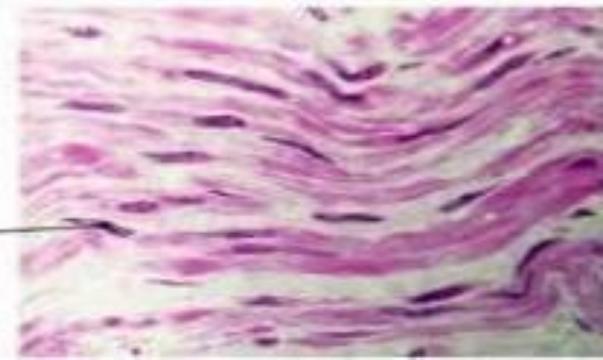
Striations
Muscle fiber
Intercalated disk
Nucleus



Smooth muscle



Muscle fiber
Nucleus



Contractility

Contractility:- is the response of the skeletal muscle to a stimulus by change in either the length or tension of the muscle fibers.

(Types of Contraction)

Muscular contraction is classified into two types based on change in the length of muscle fibers or tension of the muscle:

- 1. Isotonic contraction**
- 2. Isometric contraction**

Types of Contraction

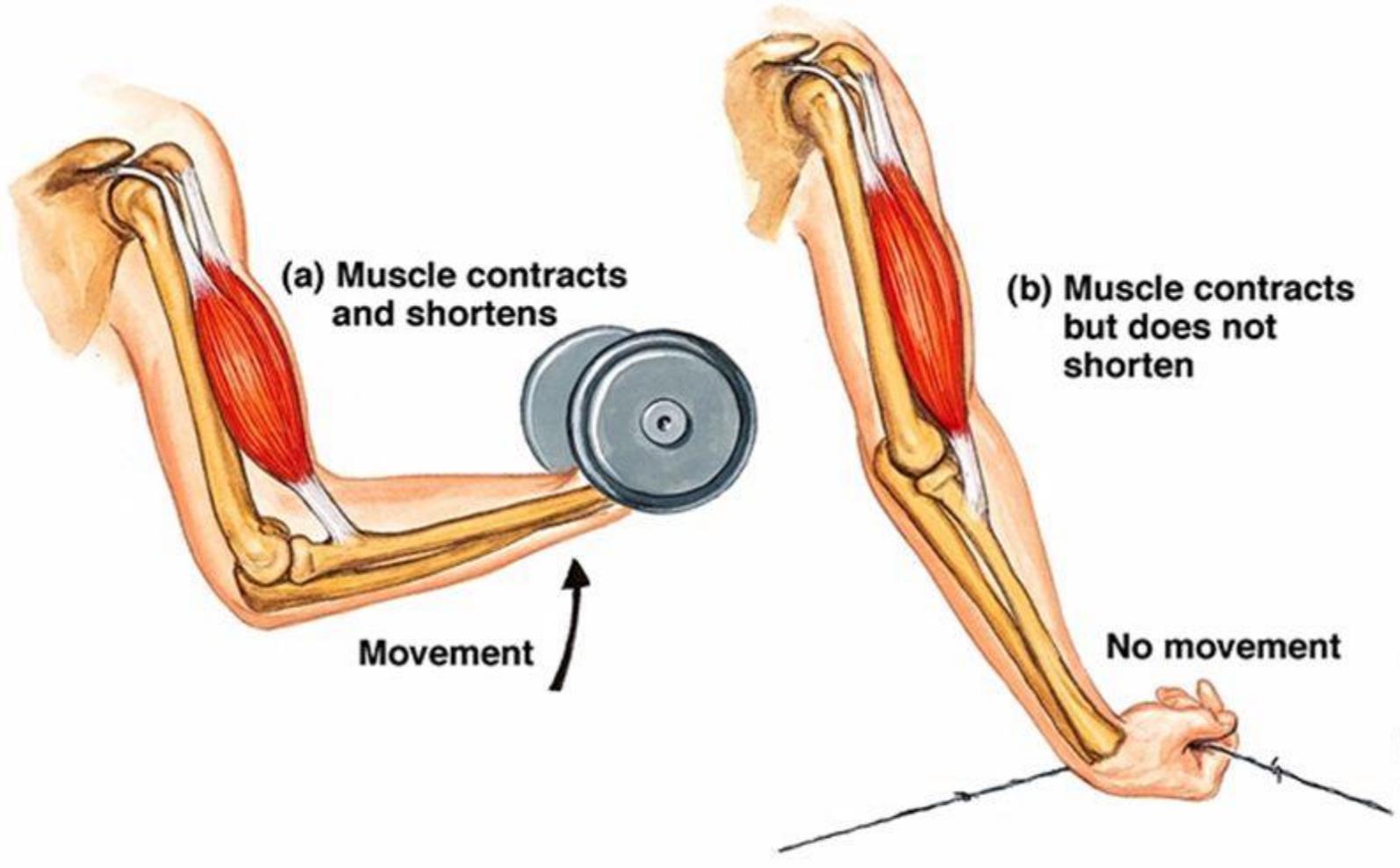
Isotonic contraction

- **Is the type of muscular contraction in which the tension remains the same and the length of the muscle fiber is altered (Iso = same, equal : Tonic = tension).**

Isometric Contraction

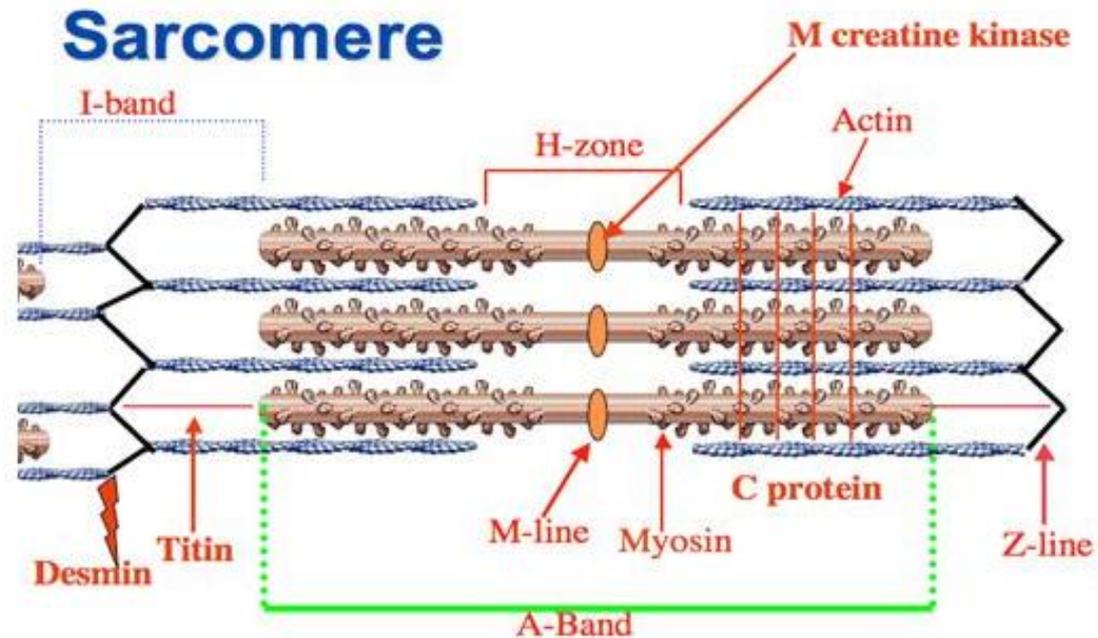
- **Isometric contraction is the type of muscular contraction in which the length of muscle fibers remains the same and the tension is increased**

Isotonic and Isometric Contractions

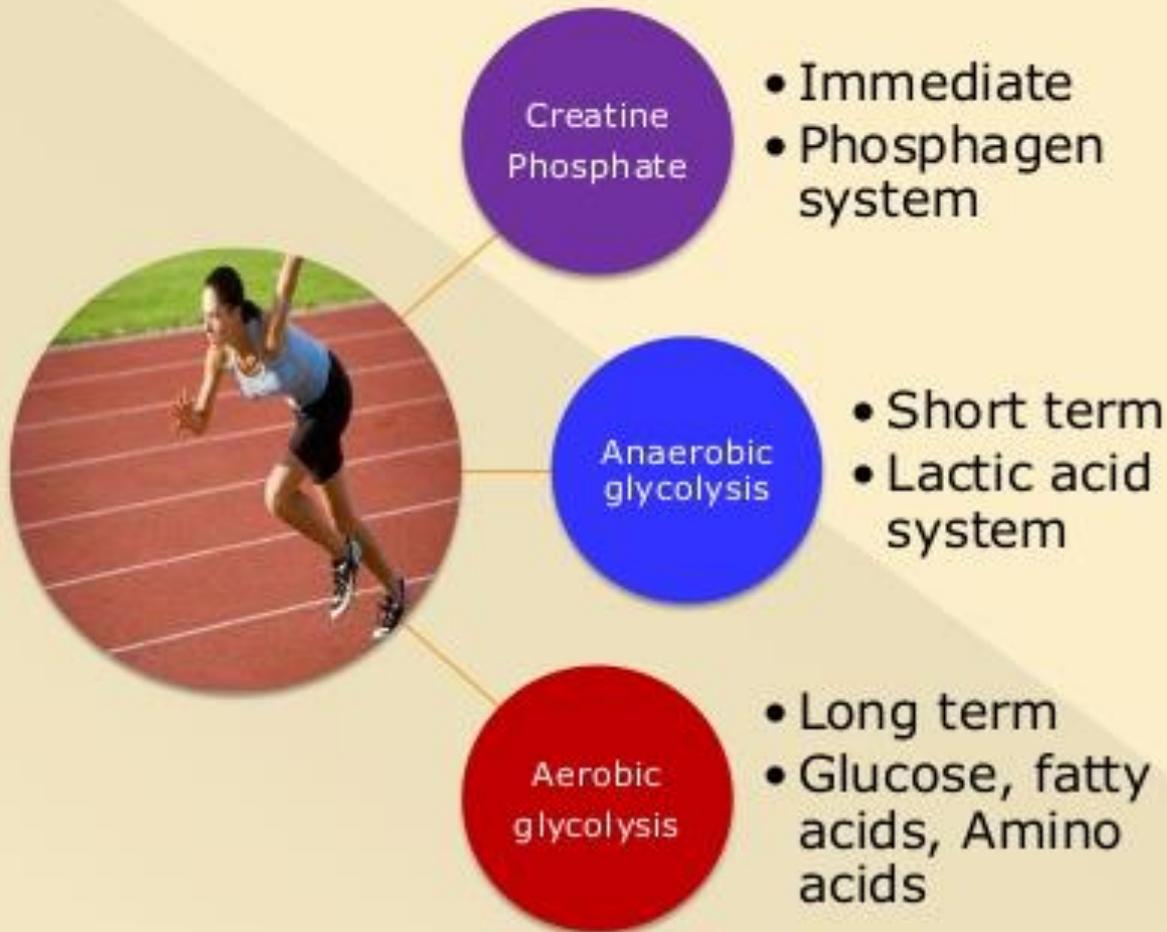


Muscle Proteins

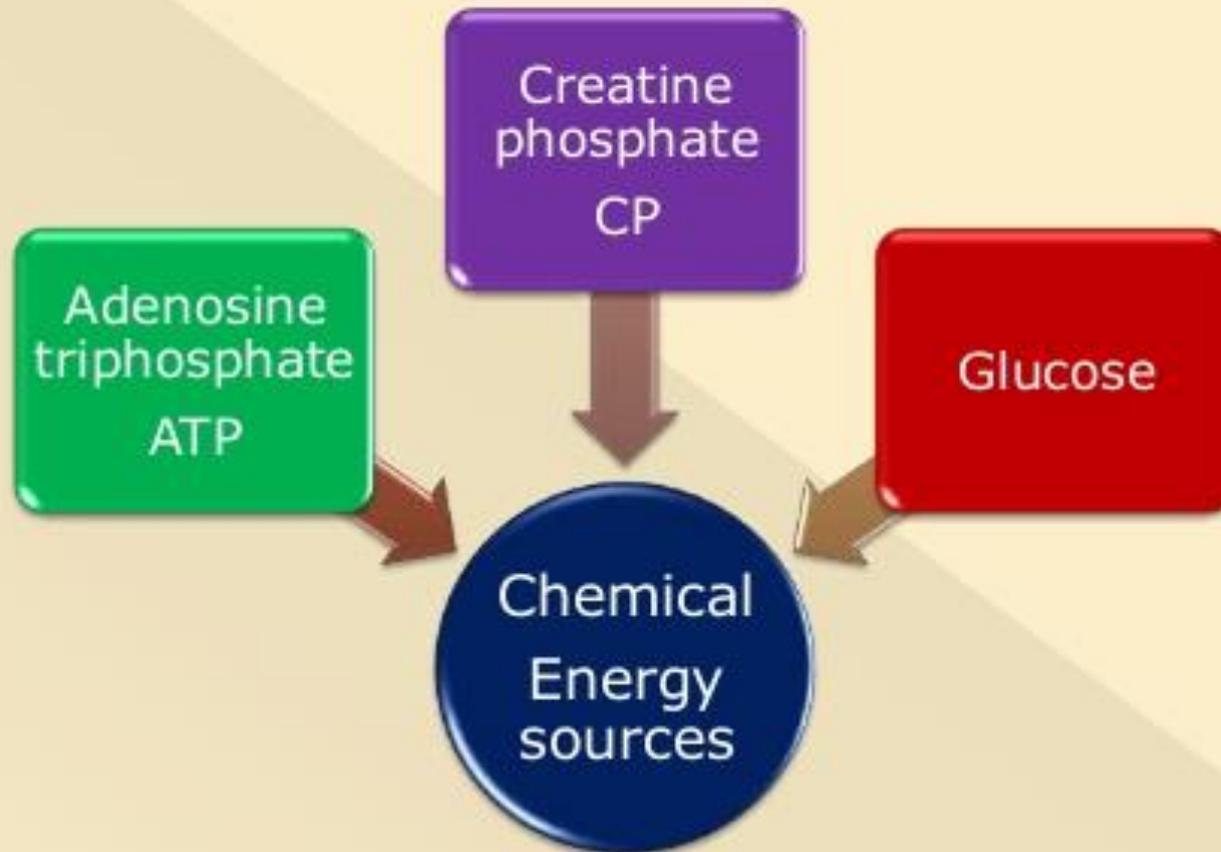
- Myofibrils are built from three kinds of proteins
 - 1) Contractile proteins
 - Generate force during contraction
 - 2) Regulatory proteins
 - Switch the contraction process on and off
 - 3) Structural proteins
 - Align the thick and thin filaments properly
 - Provide elasticity and extensibility
 - Link the myofibrils to the sarcolemma



Energy for muscle contraction



Sources of chemical energy



Adenosine triphosphate, ATP

- ATP is the immediate source of energy for muscle contraction.
- The break down of phosphate bond of ATP releases maximum energy.

Anaerobic glycolysis:

Glucose \rightarrow 2 moles of lactic acid + 8ATPs.

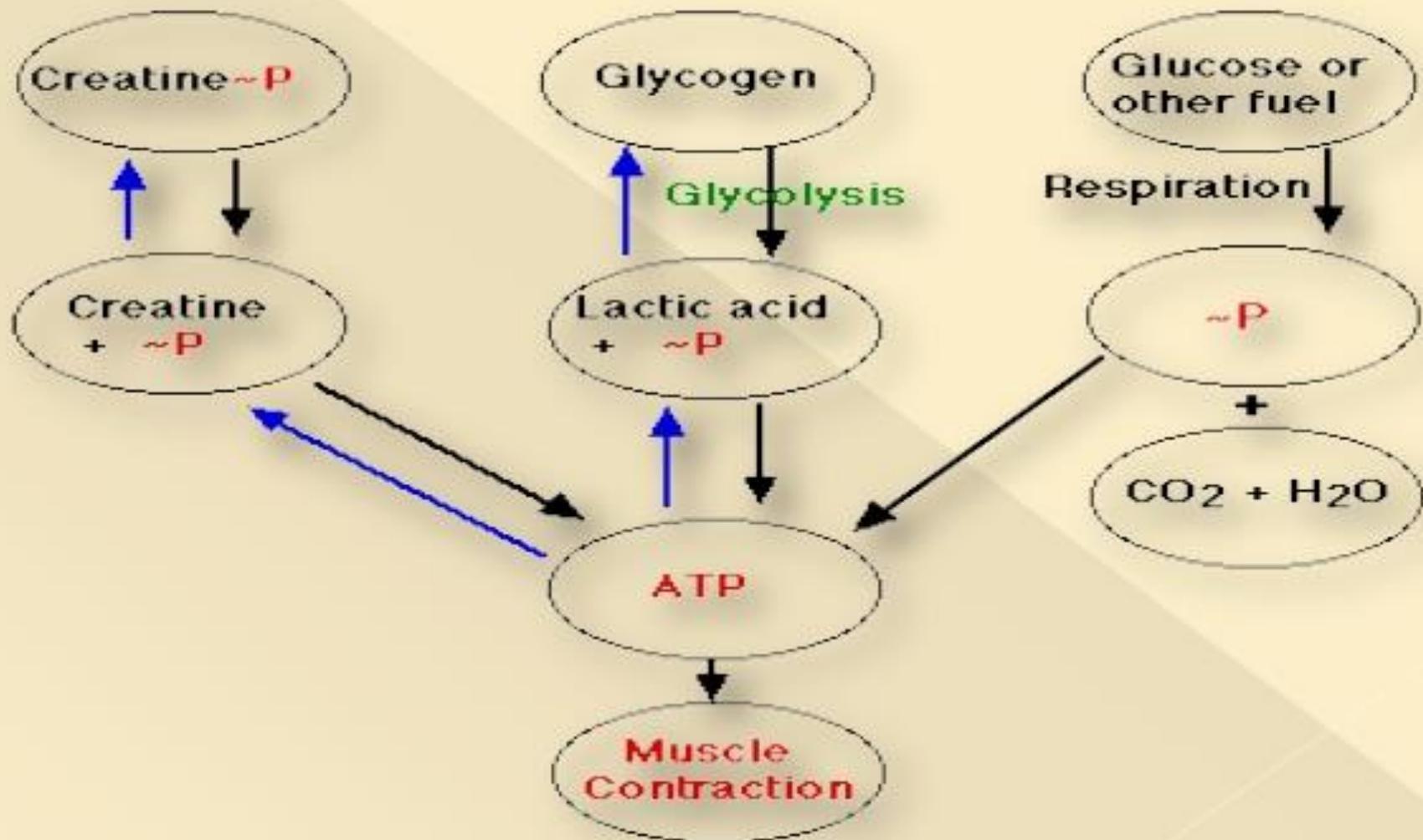
Aerobic glycolysis coupled with Krebs's cycle:

Glucose \rightarrow 6 CO₂ + 6H₂O + 38 ATPs.

Creatine phosphate(CP) or phosphagen

- Forms a reservoir of high energy phosphate in the muscle
- Cannot be used as a direct source of energy.
- Used for regeneration of ATP from ADP.
- *Creatine phosphate* $\xrightarrow{\text{Creatine phosphatase}}$ *creatine + phosphoric acid*
- *Phosphoric acid + ADP* $\xrightarrow{\hspace{2cm}}$ *ATP*

Energy sources of muscle



Neuromuscular junction

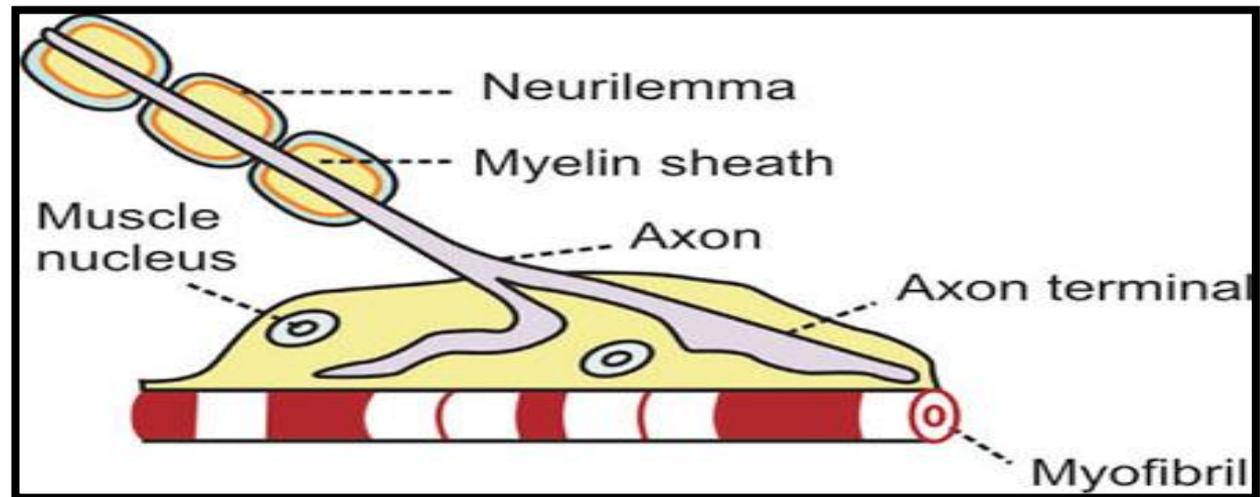
✓ Is the junction between the terminal branch of the nerve fiber and muscle fiber.

Structure :-

Skeletal muscle fibers are innervated by the motor nerve fibers. Each nerve fiber (axon) divides into many terminal branches.

Each terminal branch innervates one muscle fiber through the neuromuscular junction

Longitudinal section
of neuromuscular
junction

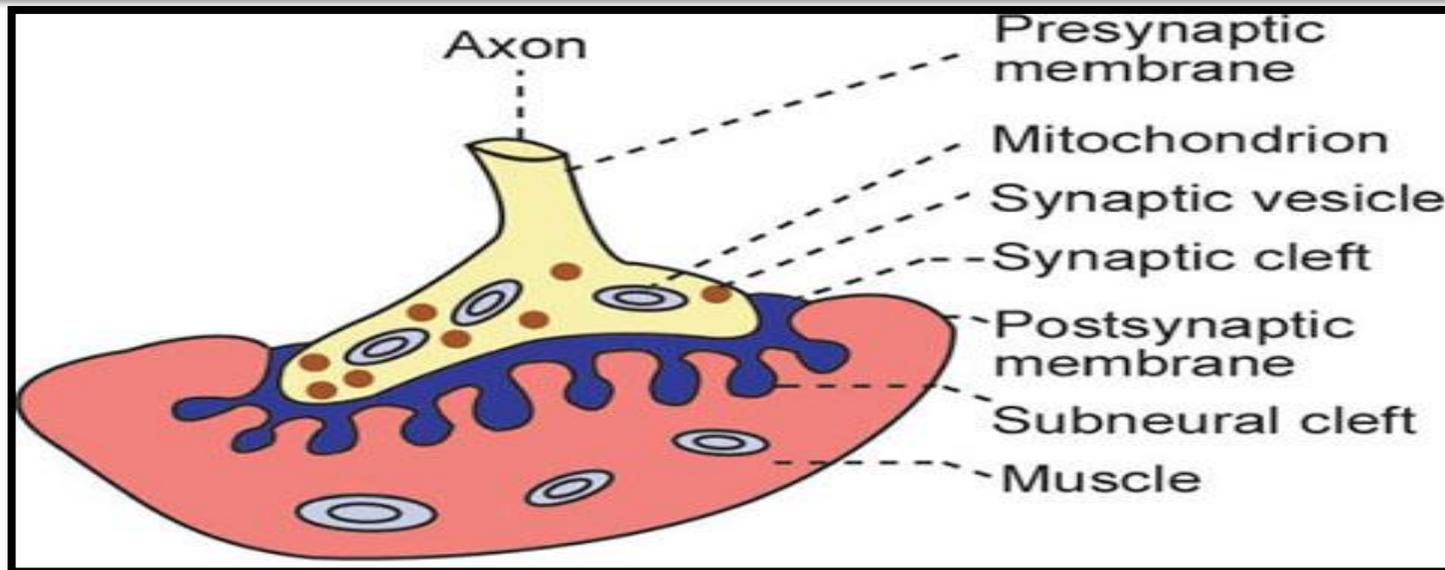


Neuromuscular junction

- **Axon terminal**- terminal branch of nerve fiber
- **Motor end plate**- bulb like expansion of axon terminal
- **Synaptic trough/ gutter**- depression on the muscle fiber due to invagination of motor end plate
- **Subneural cleft**- numerous folds of post synaptic membrane

Neuromuscular junction

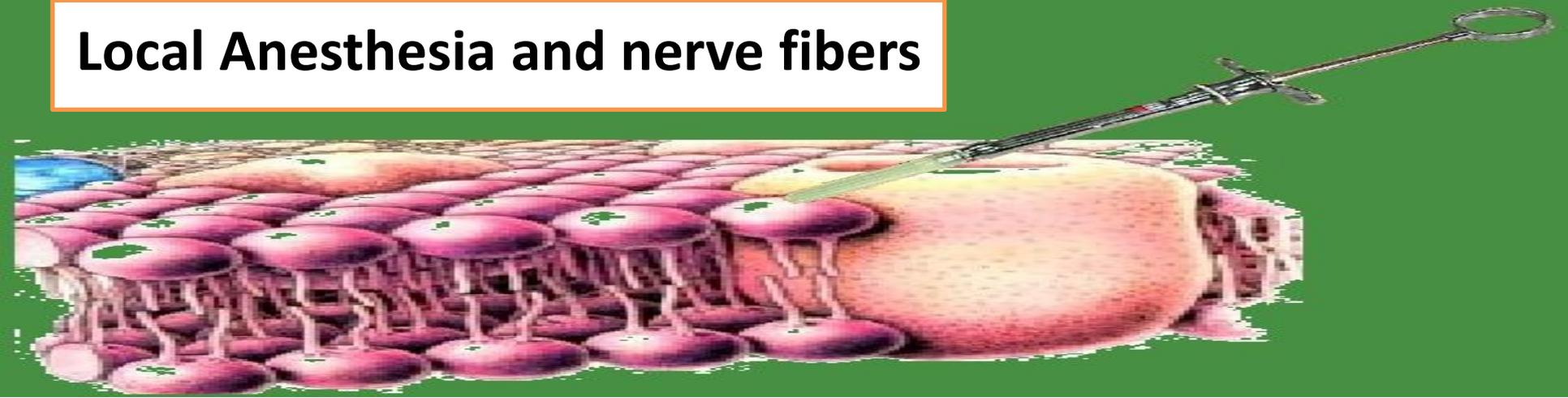
- **Presynaptic membrane**- membrane of nerve ending
- **Postsynaptic membrane**- membrane of muscle fiber
- **Synaptic cleft**- space between post and presynaptic membrane
- **Basal lamina**- thin spongy layer of reticular matrix in synaptic cleft



Electromyography (EMG)

- Is a technique for evaluating and recording the electrical activity produced by skeletal muscles.
- Is performed using an instrument called an electromyograph, to produce a record called an electromyogram .
- a resting muscle does not show recordable electrical potential but with increase force of contraction, amplitude of potential increases

Local Anesthesia and nerve fibers



- ✓ local anesthetics act by blocking both sensory and motor nerve conduction to produce a temporary loss of sensation without a loss of consciousness.
- ✓ unlike general anesthetics, they normally do not cause central nervous system (CNS) depression.
- ✓ General anesthetics act on the CNS or autonomic nervous system to produce analgesia, amnesia, or hypnosis



1-Essentials of Physiology for Dental Students. K Sembulingam and Prema Sembulingam ,2016, four Edition , Jaypee Brothers Medical Publishers.

2- Human Physiology. Stuart Ira Fox., TWELFTH EDITION,2017. Published by McGraw-Hill

Thank

You!