TTWRDC (G) - MAHABUBABAD

DEPARTMENT OF ZOOLOGY

ANIMAL PHYSIOLIGY

MUSCLE

The study of muscular tissues is called Myology. Muscular tissue is "mesodermal" in origin except Muscles of the iris and ciliary body which are ectodermal in origin Muscles show three essential properties such as excitability, Conductivity and contractility. Muscles play an active role in the Movements of the body to adjust to changes in the surrounding environment and to maintain the posture of the body.

Types of Muscles :-

Muscles are madeup of many elongated cells. Called Musde fibres. Each Musde cell inturn consists of numerous thick (myosin) and thin (actin) filaments Called myofibrils. Based on the type of arrangement of myofibral and certain structural and functional characteristics Muscle is classified into three types they are.

① Skeletal Muscle ② Smooth Muscle ③ Cardiac Musc

1) Skeletal Muscle :-

The skeletal muscle is also called striat Striped or Voluntary Muscle. it is called skeletal becau it is attached to the skeleton and moves it. Straite or Striped because its cells show horizontal

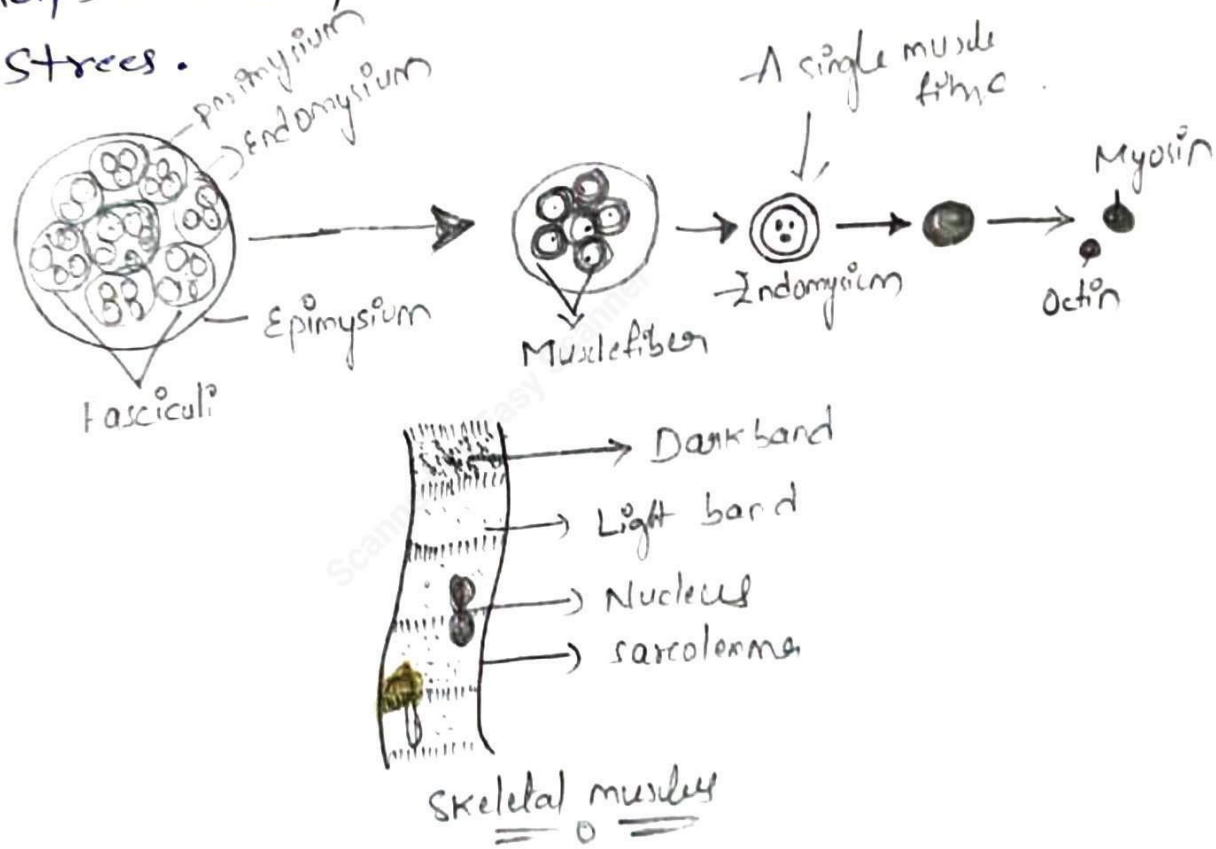
Hence the name "visceral muscle" It is also found in the iris and ciliary body of eye and in the dermis of skin as "arrector pili" muscles attached to hair follicles

It is innervated by the autonomic nervous system and thus its contraction is not under the control of the will. Hence smooth muscle is an involuntary muscle.

Individual cells are spindle shaped and tapered at their ends. They vary in length depending upon the organ which they are found. they are approximately 20 µm long in blood vessels. 200 µm long in the intestine and as much as 500 µm long in the pregnant uterus. Singl nucleus is present in each cell at its wider part at the centre.

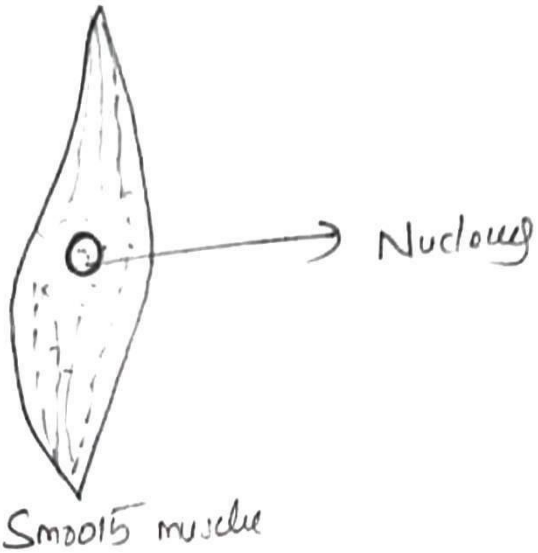
The smooth muscle plays many roles. It functions largely as a regulator of the internal environment. It regulates the flow of blood in the arteries, moves food in the gastrointestinal tract. expels urine from urinary bladder. sends babies out into the world from the uterus and regulates the flow of air through the lungs.

The skeletal muscle is highly specialized to provide rapid and powerful contraction for body movements, locomotion, breathing and for the maintainance of posture. It contracts quickly and fatigues (tires) quickly. It also helps in heat production (thermiogenesis) during cold stress.



(2) Smooth muscle :-

Smooth muscle is also called "unstraiated" or "viscera" or "involuntary" muscle. It is located in the walls of visceral organs such as blood vessels, trachea, bronchi, stomach, intestine, urinary bladder etc.



(3) Cardiac muscles :-

The heart muscle is called cardiac muscle, It is found only in the walls of heart. It resembles both skeletal and smooth muscles. Like the skeletal muscle. its cells are cylindrical and striated. Like the smooth muscle. it is involuntary and controlled by the autonomic nervous system, and its contraction is independent of one's conscious control

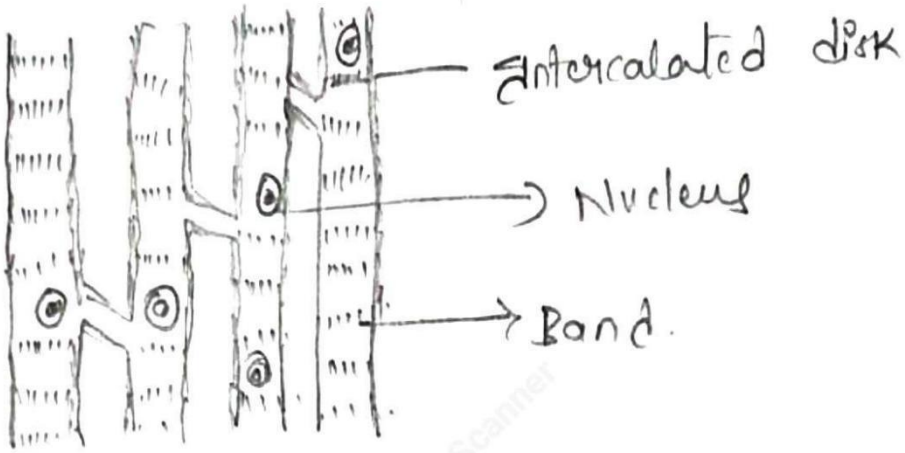
The cardiac muscle cells are short. cylindrical mononucleate or binucleate cells. The cardiac muscle has its own features. Its cells are interconnected with one another at specialized regions called "intercalated discs" resistant to fatigue. because it has numerous Sarcosomes, many molecules of myoglobin.

⇒ Straitions in the form of light and dark bands under microscope and valuntary because it is possible to move the muscle at will

The muscle cells are cylindrical, unbranched and arranged in the form of bundles. They are quite long and their length range from 1 to 30 cm. (Shortest muscle cells are present in the "Stapedius" Muscle of inner ear; 0.1 cm and longest muscle cells are found in "Sartorius" muscle of the thigh :30cm)

Each muscle is made up of large numbers of muscle cells these muscle cells are called Muscle fibres. Each muscle fibre is covered by a thin connective tissue layer called "endomysium" Groups of muscle fibres form bundles called "fascicles" (In Latin fascia means band or bandage). The fascicles are surrounded by a connective tisse layer called "perimysium". The fascicles (10 to 100) in turn are bound together to form the muscle. The whole muscle is surrounded by a connective tissue sheath called "epimysium" Each muscle bears at the ends a fibrous cord of inelastic fibrous connective tissue called "tendons" The muscle is attached to the bones by the tendons.

and rich: supply of blood which facilitate continuous aerobic respiration.



Cardiac muscle

The Mechanism of muscle contraction

→ Muscle contraction occurs when the thin actin and thick myosin filaments slide past each other.

→ It is generally assumed that this process is driven by cross-bridges which extend from the myosin filaments and cyclically interact with the actin filaments as ATP is hydrolysed.

→ ATP binds to a myosin head and forms ADP + Pi. When ATP binds to a myosin head, it is converted to ADP and Pi, which remain attached to the myosin head.

→ Ca^{+2} exposes the binding sites on the actin filaments. Ca^{+2} binds to the troponin molecule, causing tropomyosin to expose positions on the actin filament for the attachment of myosin heads.

→ ADP and Pi are released and a sliding motion of actin results. The attachment of cross bridges b/w myosin and actin causes the release of ADP and Pi. This in turn causes a change in the shape of the myosin head, which generates a sliding movement of the actin toward the center of the sarcomere. This pulls the two Z-discs

together, effectively contracting the muscle fiber to produce a power stroke.

→ ATP causes the cross bridges to unbind. When a new ATP molecule attaches to the myosin head, the cross bridge b/w the actin and myosin breaks, returning the myosin heads to it's unattached position.

→ With out the addition of a new ATP molecule, the cross bridges remain attached to the actin filaments. This is why corpses become stiff with rigor mortis.

Stimulation of muscle contraction

→ Neurons or nerve cells are stimulated when the polarity across their plasma membrane changes. The polarity change called an action potential, travels along the neuron until it reaches the end of the neuron.

→ A gap called a synapse or synaptic cleft separates the neuron from a muscle cell or another neuron.

→ If a neuron stimulates a muscle then the neuron is a motor neuron, and it's specialized synapse is called a neuromuscular junction.

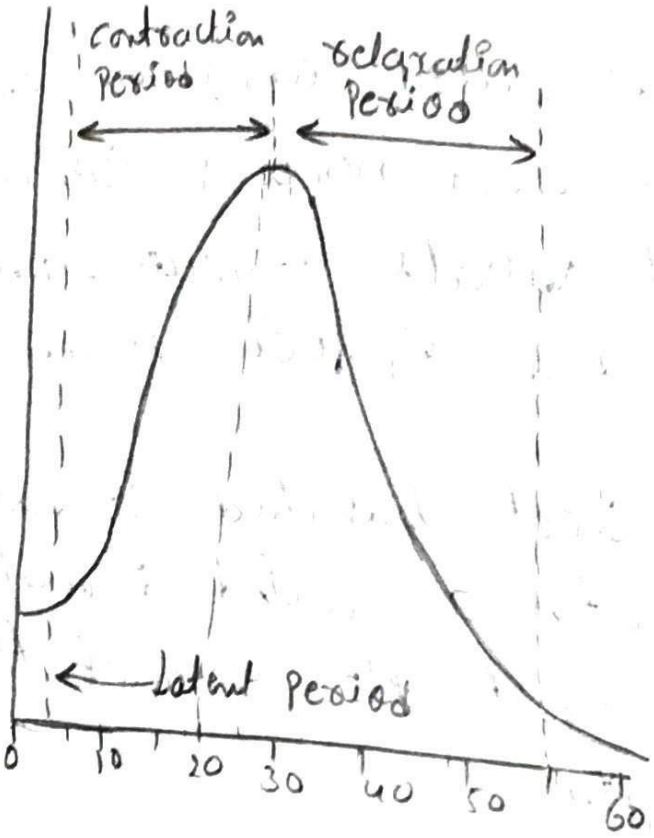
following steps.

* Action potential .. generates release of acetylcholine When an action potential of a neuron reaches the neuromuscular junction, the neuron secretes the neuro transmitter acetylcholine, which diffuses across the Synaptic cleft.
* Action potential is generated on the motor end plate and throughout the T-Tubules. Receptors on the motor end plate, a highly folded region of the Sarcolemma, initiate an action potential
→ The action potential travels along the Sarcolemma throughout the transverse system of tubules
* Sarcoplasmic reticulum releases Ca^{+2} As a result of the action potential throughout the transverse System of tubules, the Sarcoplasmic reticulum releases Ca^{+2}.
* Myosin cross bridges form The Ca^{+2} released by the Sarcoplasmic reticulum binds to troponin molecules on the actin helix, bumping the tropomyosin molecules to expose binding sites for myosin cross-bridge formation If ATP is available, muscle contraction begins.

Phases of a muscle contraction.

⇒ A muscle contraction in response to a single nerve action potential is called a twitch contraction. A myogram, a graph of muscle strength with time, shows several phases.

1. The latent period is the time required for the release of Ca^{+2}.
2. The contraction period represents the time during actual muscle contraction.
3. The relaxation period is the time during which Ca^{+2} are returned to the sarcoplasmic reticulum by active transport.
4. The refractory period is the time immediately following a stimulus. This is the time period when a muscle is contracting and therefore will not respond to a second stimulus. Since this is occurring at the same time as the contraction, it does not appear on the myogram as a separate event.



NERVE IMPULSE

Structure of Neuron:-

⇒Neuron is the structural and functional unit of the nervous system. It is a nerve cell. The neuron is the largest cell in the body. It is oval in shape or flask-shaped or star-shaped, Neurons are electrically excitable cells which receive, initiate and conduct impulses. Neuron consists of 3 Parts.

1. cell body :- It is also called Perikaryon, Cyton or Soma. It varies considerably in size and form. It may be rounded, oval, pyramidal or star-like.

neurolemma". membrane called

→ The cytoplasm of cyton is called neuroplasm. The neuroplasm contains a prominent nucleus, small basophilic granules called Nissal's granules, mitochondria, Golgi complex etc and lipofucin granules.

2. Dendrites :- Several short, branched Process which arise from the cyton are called dendrites or dendrons. Dendrons are short, they conduct the impulses in to the cyton.

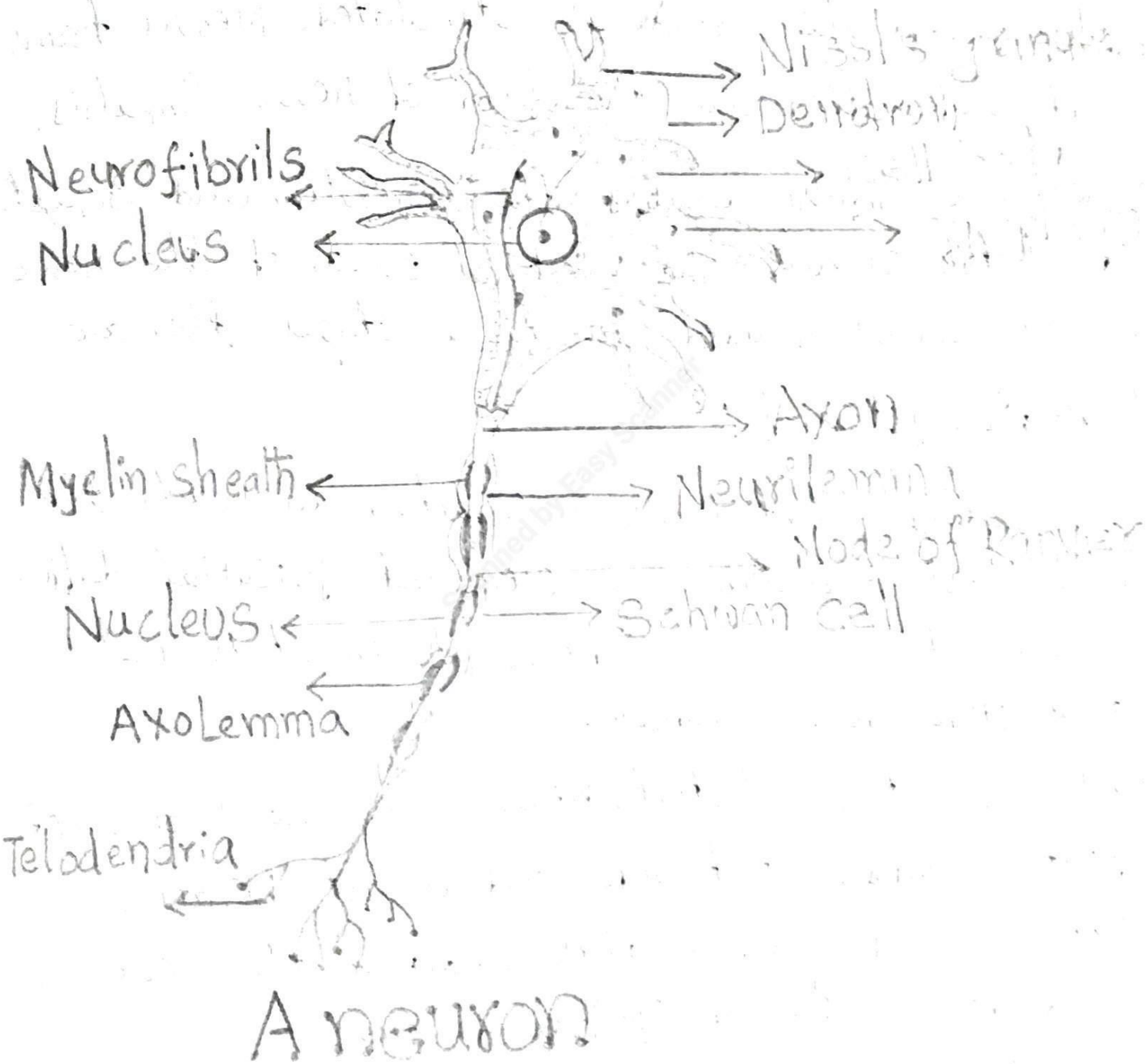
3. Axon :- An axon is a single, long cylindrical Process that originates from a region of the cyton called axon hillock. The plasmalemma of an axon is called axolemma and the cytoplasm is called axoplasm.

→ The axon ends in branches called telodendria. The telodendria terminate in minute knobs called "Synaptic knobs".

→ The axon is surrounded by cells called Schwann cells. In most of the neurons; the axon is covered by a sheath called myelin sheath.

→ The myelin sheath is constricted in to segments

at regular intervals. The point of constriction is called "node of Ranvier".



Generation And conduction of Nerve impulse

Nerve impulse may be defined as an electrochemical change occuring in the membrane of a nerve fibre when the nerve is stimulated. Nerves transmit information in the form of nerve impulses.

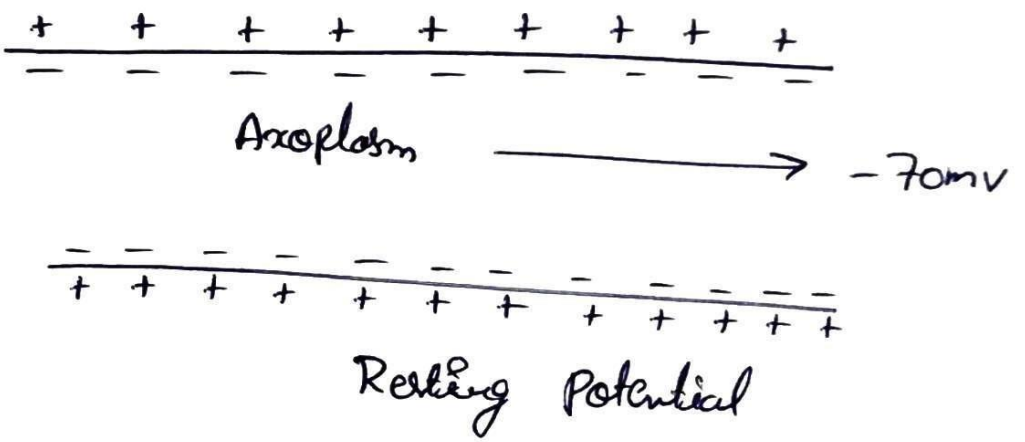
→ The nerve impulse involves the generation and propagation of electric signals. The electrical events of the nerve impulse can be divided in to '2' stages they are

1. Resting Potential :-

→ The Resting potential is a condition in which the nerve cell maintain an electrical potential difference across it's plasma membrane, when it is not transmitting nerve signals.

→ At the resting potential, nerve membrane shows net positive charge out side and a net negative charge inside. Under this condition the nerve is said to be in a "polarised stage".

→ This charge difference is called "membrane potential" or transmembrane potential. Since it is maintained when the nerve is not sending nerve signals this is also called "resting potential".



2. Action Potential :-

→ The momentary change in electrical potential on the membrane of neuron that occurs when it is stimulated, resulting in the transmission of an electrical impulse, is termed "Action Potential".

→ The nerve impulse is recorded in the form of an action potential or spike potential on the oscilloscope screen.

→ Action Potential is a self propagating event that begins at a dendrite and travels down the axon to the end of the neuron.

→ When the neuron is stimulated, a little bit of Na+ spills in to the neuron through leak channels. The entry of Na+ depolarizes the neuron and is referred to as a graded Potential.