

Excitable membrane nerve and muscle

BY

Al Shaimaa Mahmoud Kotb

Assistant Professor of Physiology

Faculty of Medicine- Muthah university

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The Nerve Cell

- The nerve cell (**neuron**) is the **structural unit** of the nervous system.
- The human nervous system contains more than **10 billion** neurons.

STRUCTURE OF THE NEURONE

• **Each neuron is formed of:**

- 1. The cell body (Soma).**
- 2. The cell processes.**

The Cell Body

- It contains a large central nucleus with a well marked nucleolus.
- The cytoplasm contains:
 1. **Neurofibrils:** delicate strands that pass the cell body and processes.
 2. **Nissel Bodies:** large triangular masses with high RNA content. They are absent from the axon hillock. Severe activity and anoxia cause disappearance of Nissel granules (i.e. Chromatolysis).
 3. Other organelles as in other cells (as Golgi apparatus, ER,...etc).
 4. The neuron doesn't contain a centrosome and can never divide.

• The Cell Processes

• A. Dendrites:

- short processes extending out from the cell body & branch extensively.

Function of Dendrites:

1. Increase the surface area of the cell body (i.e. receptive field of the neuron).
2. Conduct nerve impulse towards the cell body.

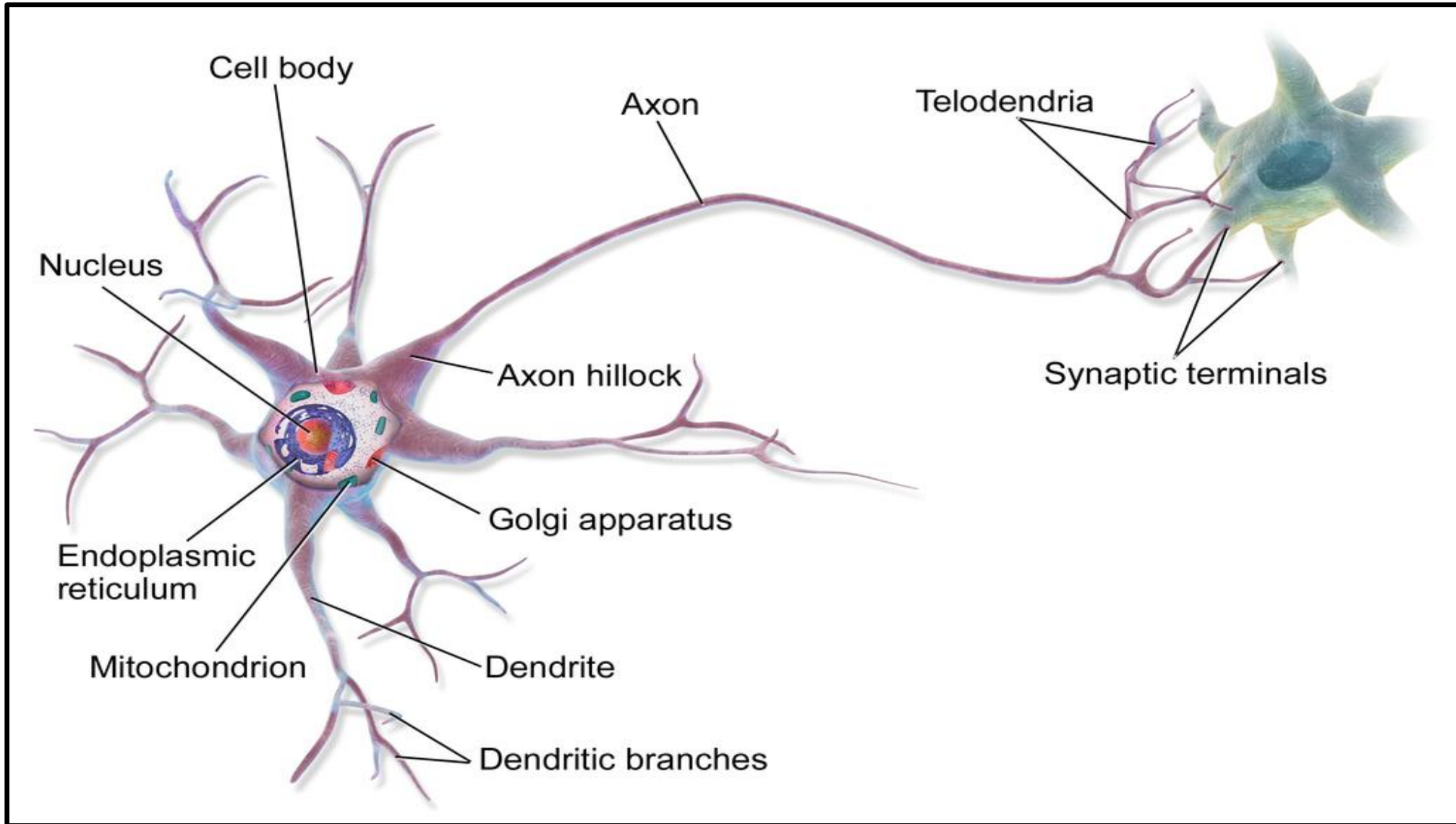
B. Axon (i.e. Nerve fiber):

- A single long process that originates from a thickened area of the cell body called the axon hillock.

Function of the Axon:

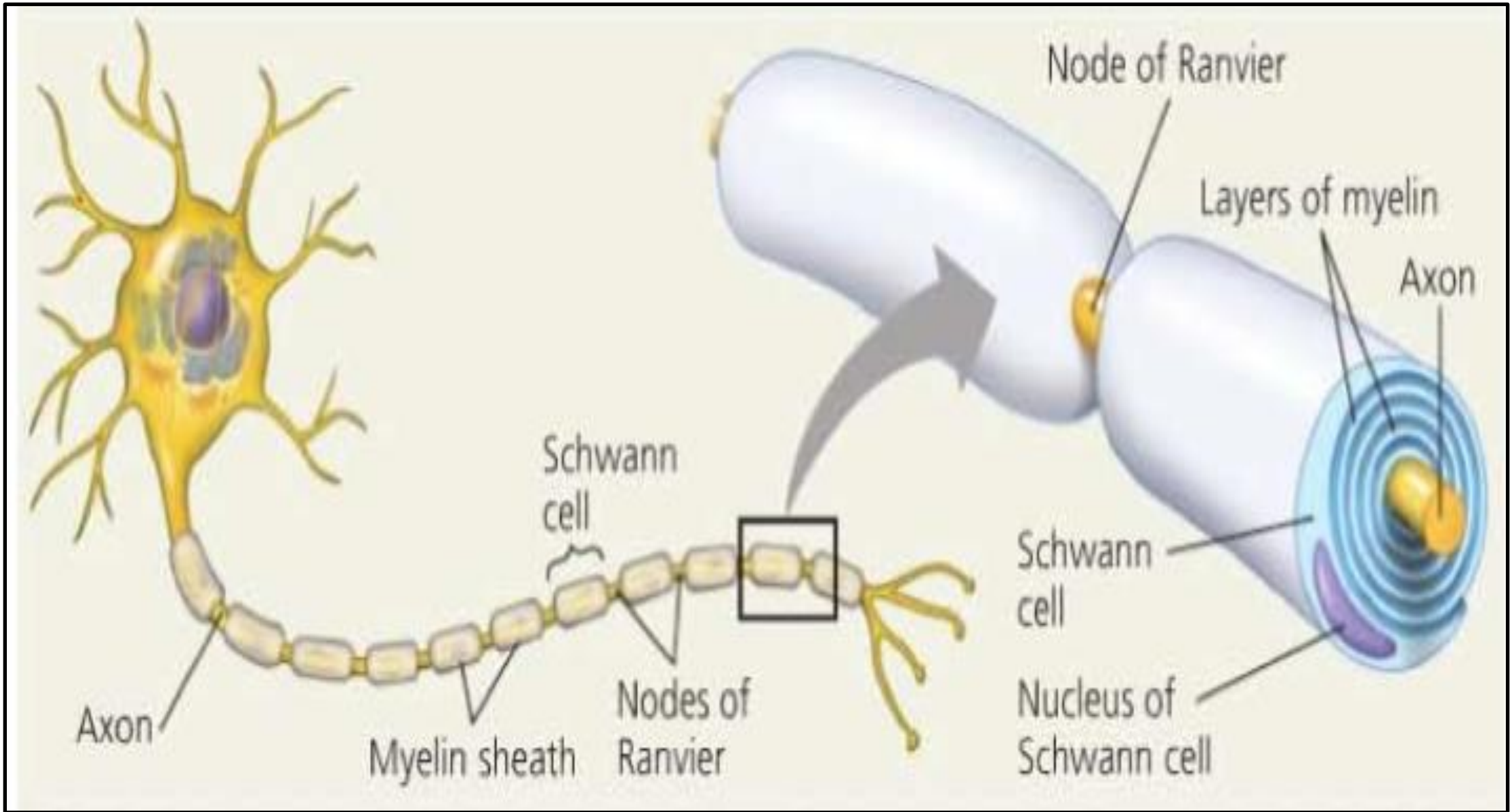
- Conduct the nerve impulse away from cell body & dendritic zone.

The axon ends in a number of synaptic terminal buttons or axon telodendria. They contain vesicles filled with the chemical transmitter (i.e. Acetylcholine).



The structure of nerve axon

- Central core of cytoplasm called axis cylinder.
- 2. Myelin sheath: it is a protein-lipid complex and act as an insulator.
- The myelin sheath is absent at:
 - Axon hillock.
 - Axon terminal.
 - Nodes of Ranvier.
- 3. An outer nucleated layer called neurilemmal (or Schwann) sheath.
- Function of Schwann sheath:
 - It regenerates nerve fiber when it is cut and forms myelin sheath. It is absent in neurons of the CNS. The myelin sheath in CNS is formed by another type of cells called **oligodendrocytes**



• Important Definitions

- *Excitability:*

It is the ability of any living tissue to respond to a stimulus. It is a property of life. The nerve is one of the **most excitable tissues**.

- *Stimulus:*

It is any change in the environment surrounding a living tissue that causes it to react.

- **Types of stimuli:**

1. Electrical.
2. Chemical.
3. Mechanical.
4. Thermal.

- Electrical stimuli are preferred in practical experiments
- Because:
 1. They are similar to the natural signals inside the human body.
 2. Their intensity and duration of application can be easily controlled.
 3. They produce response without causing damage (so, they can be reproducible or repeated).

- **Factors affecting the degree of response to a particular stimulus:**

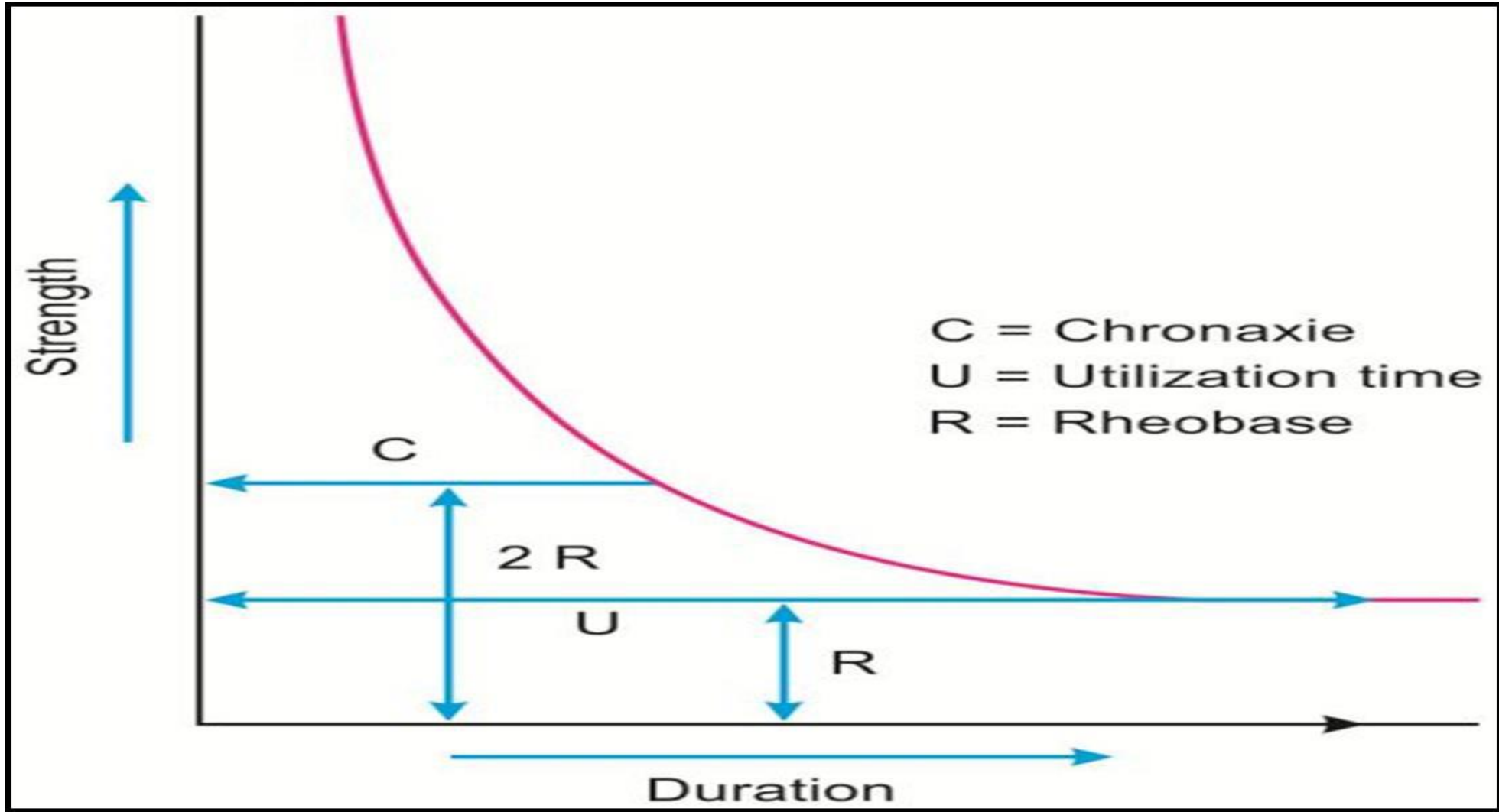
- 1. The **rate** of application.
- 2. The **strength** of the stimulus
- 3. The **duration** of application.

- 1. **Effect of the rate of application:**

- A suddenly applied stimulus of certain intensity is **more effective** than when a weaker stimulus is applied and then gradually increased to the same intensity as the previous one.

- 2. **Effect of the strength of the stimulus and its duration of application:**

- This is best illustrated by the **Strength-Duration (SD) Curve**.



- **From the curve above, it is concluded that:**
- The stronger is the stimulus, the shorter is the time needed to excite and vice versa.
- There is a **minimal or threshold intensity called (Rheobase, R)** which can stimulate. It is the minimal intensity of a current of a very long duration which can stimulate or, it is the minimal galvanic current which can stimulate.
- **The Utilization Time (UT)**: it is the time needed by the Rheobase (R, Threshold) to stimulate.
- **The Chronaxie (C)**: It is the **time** needed by a current of double the rheobase (2 R or 2 threshold) intensity to stimulate.
- **The Minimal Duration (t)**: it is minimal time needed for a stimulus to produce a response. If the duration of application is less than (t), no response whatever the strength of the stimulus is.

- **Significance of SD Curve:**

1. Minimal time (t):

In diathermy, the use of high voltage alternating currents for a very short period of time less than (t) during each phase causes rapid oscillation of ions leading to heating of tissues **without** stimulation. This is used in **electrocautery** to stop bleeding.

2. Chronaxie:

- It is the time needed by a current of **double** rheobase (2 R or 2 threshold) intensity to stimulate.
- **Significance:** It is used to **compare** excitability of different tissues. The **shorter** the chronaxie, the **greater** is the excitability.
- **(Excitability of the Nerve > Skeletal m. > Cardiac m. > Smooth m.)**



THANK

YOU