higher than normal.

THRESHOLD STIMULUS :—

The minimum intensity of stimulus which, when applied for a given duration, gives rise to an AP is called threshold stimulus.

STRENGTH-DURATION CURVE (FIG. 6.5)

1. The intensity of threshold stimulus and the duration of its application are interrelated. Within limits, the strength and duration of threshold stimulus have an inverse relationship. This is expressed in the *strength-duration curve.*

   If the different strengths of threshold stimuli are plotted against the corresponding values of time

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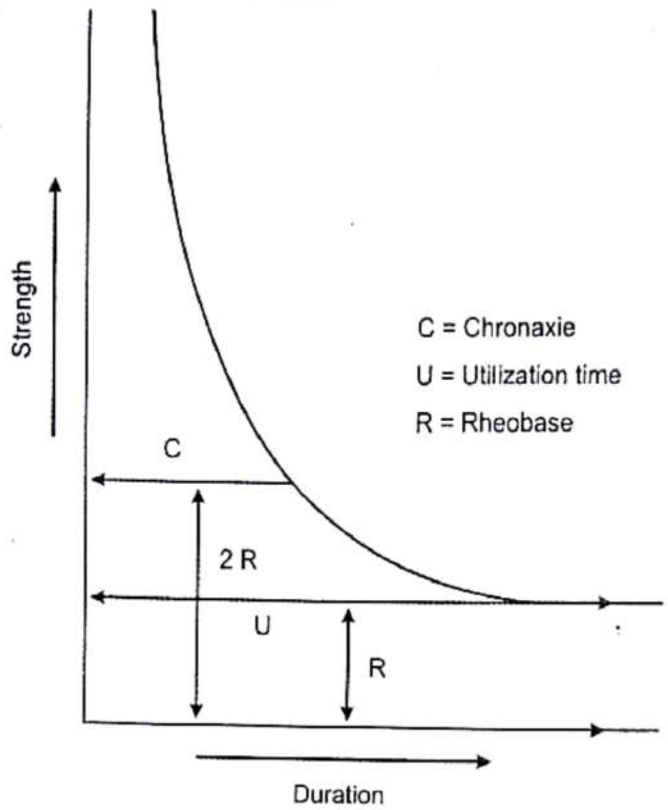

Fig. 6.5: The strength-duration curve showing rheobase, chronaxie, and utilization time.

required by the tissue to get excited, a strength-duration curve is obtained.

2. It is found that there is a minimum strength of current below which no excitation takes place.
3. Similarly, however strong the stimulus, there is a minimum duration which must elapse before an excitable tissue can be excited.
4. In between, values of strength and duration are inversely related and the product of strength and duration is constant. This means that low intensity stimuli take longer time to excite an excitable tissue whereas stronger stimuli need shorter duration for the same.

RHEOBASE :-

The minimum strength of current essential for stimulating an excitable tissue is known as rheobase.

UTILIZATION TIME :-

The time needed by a current of rheobasic strength to stimulate an excitable tissue is called utilization time.

CHRONAXIE :-

The time required by a current of twice the rheobasic strength to stimulate an excitable tissue is called chronaxie. Chronaxie is used as the index of excitability of an excitable tissue.

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ACCOMMODATION

1. When a stimulus is given to an excitable cell very slowly, the cell membrane adapts itself to the stimulus and AP is not formed. This is known as accommodation.
2. Normally, the explosive entry of Na^+ ions overwhelms the delayed opening of K^+ channels and this normally gives rise to the AP.
3. But, slow stimulation leads to slow influx of Na^+ ions, which is neutralized by the increasing efflux of K^+ ions. As a result, AP is not formed.
4. Moreover, some of the Na^+ channels opened get inactivated before threshold is reached. As a result, the required number of Na^+ channels to fire an AP is not reached.

ALL-OR-NONE LAW

1. Once the intensity of stimulus has reached threshold level, the amplitude of the AP will remain the same, irrespective of any increase in the intensity of stimulus.
2. Thus, stimulus of higher intensity will not cause any increase in the amplitude of AP.
3. At the same time, it should be noted that if the intensity of the stimulus falls below threshold value, no AP will result. That is why this is known as all- or-none law.

PROPAGATION OF ACTION POTENTIAL (FIGS. 6.6A AND B)

1. When an AP is produced at a particular point in an unmyelinated nerve or muscle, the inside of the cell becomes positive and outside negative during depolarization.
2. Its adjacent polarized portion is positive outside and negative inside.
3. So, transfer of charges takes place between the point of AP and its adjacent portions.
4. This forms a current sink which depolarizes adjacent portions towards threshold. Ultimately, as the threshold is reached, there is formation of AP in the adjacent portions.
5. This process is repeated at the new position of AP and the AP propagates in an undiminished intensity along the excitable tissue.
6. In an unmyelinated nerve, the propagation of AP is continuous as described above and as shown in Figures 6.6A and B. In contrast, in a myelinated nerve, the propagation of AP has a jumping nature known as saltatory conduction (see below).

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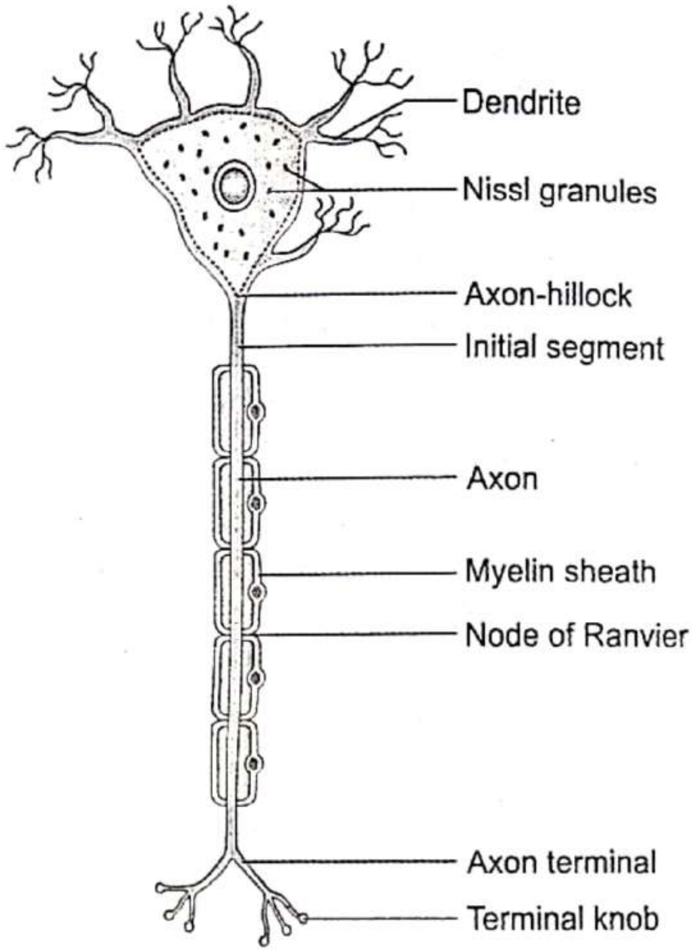

Fig. 76.1: Parts of a neuron

electrotonic potential changes. The initial segment generates an action potential (AP). The axon transmits the AP whereas the axon terminal forms synapses with another neuron.

PROPERTIES OF NERVE FIBER

The properties of nerve fiber are briefly discussed below:

1. *Excitability*: It is the property of a nerve fiber to respond to a stimulus which may be electrical, thermal, mechanical or chemical.

   If the stimulus crosses a 'threshold' value, the nerve fiber responds with production of an action potential. Excitability of a nerve fiber is measured by chronaxie (see p. 39).

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2. *Resting membrane potential (RMP)*: The resting membrane potential in a nerve fiber is about –70 mV. For further details, see p. 33.
3. *Latent period*: A time interval elapses between the application of stimulus and the beginning of action potential by which the nerve fiber responds. This is called the latent period.
4. *Local response*: When a subthreshold stimulus is applied to a nerve fiber, depolarization takes place.

   This depolarization varies in amount proportionate to the intensity of the stimulus and spreads locally but a propagating action potential fails to occur.

   This locally limited response is termed local response.
5. *Action potential*:–
   a. When a threshold stimulus excites a nerve fiber, a rapid change in membrane potential takes place, which is propagating in nature. The sequence of rapid depolarization and repolarization that takes place, is called action potential which is transmitted along the nerve fiber without any decrement in its amplitude.
   b. Another important property of the action potential is that it is an *all or none response*. This means that it occurs only when the stimulus reaches a threshold intensity.

      But, even if the stimulus exceeds the threshold, there is no further increase in the magnitude of the response.

      For more details about action potential, see p. 36.
6. *Refractory period*: (See also p. 38)
   a. When a stimulus causes an action potential in the nerve fiber, it is unresponsive to a second stimulus for some time. The duration of this diminished responsiveness is known as refractory period.
   b. During the initial portion of the refractory period, no stimulus however strong it might be, can excite the nerve fiber.

      This period is called the absolute refractory period.
   c. However, in the later part of refractory period, a stronger than normal stimulus can evoke a response. This period is known as relative refractory period.
7. *Accommodation*: (See also p. 40)

   If the change in potential during depolarization is very slow, action potential fails to occur. This is because the nerve fiber gets adapted to the stimulus. This is known as accommodation.
8. *Conductivity*:–
   a. The property of the nerve fiber to conduct action potential is called conductivity. The mechanism of conduction of an action potential in an unmyelinated nerve has been described in p. 40.

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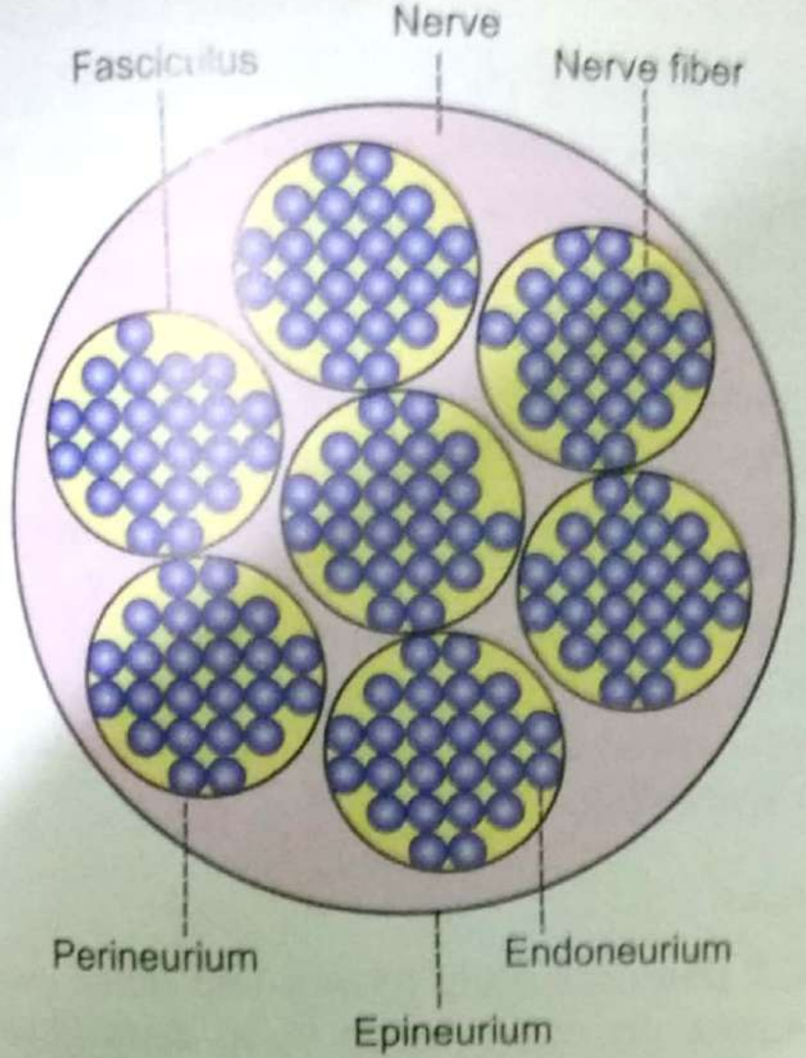

FIGURE 131.3: Cross-section of a nerve

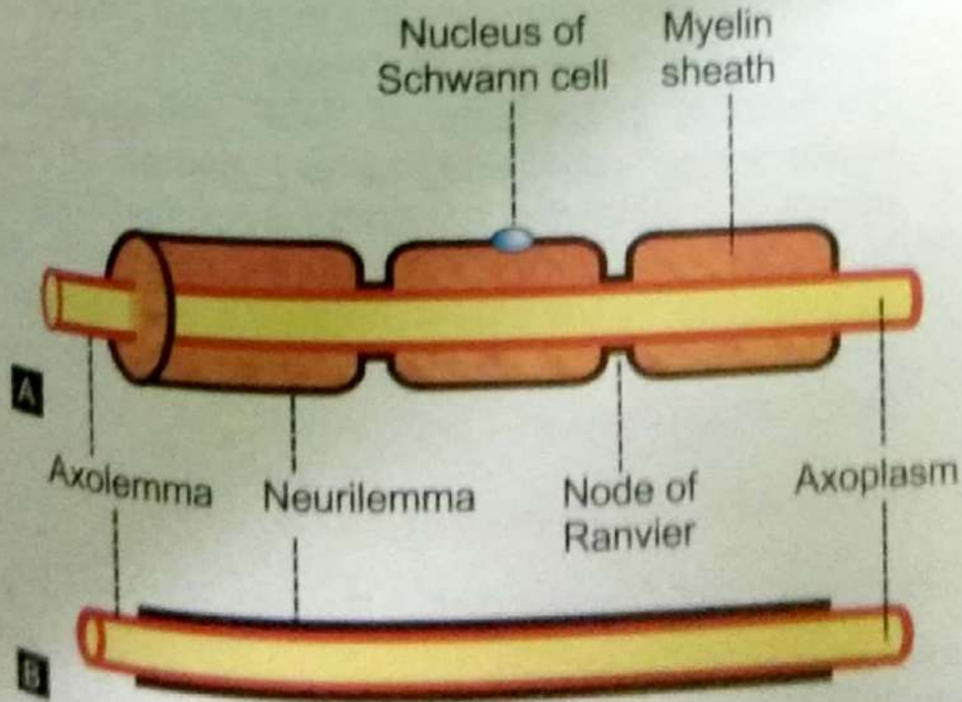

FIGURE 131.4: A. Myelinated nerve fiber; **B.** Non-myelinated nerve fiber.

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