Nervous System

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Nervous system

Nervous system is the chief controlling and coordinating system of the body. It controls and regulates all activities of the body, whether voluntary or involuntary, and adjusts the individual (organism) to the given surroundings

The sensory impulses are transmitted by the sensory (afferent) nerves from the periphery (skin, mucous membranes, muscles, tendons, joints, and special sense organs) to the central nervous system (CNS).

The motor impulses are transmitted by the motor (efferent) nerves from the central nervous system to the periphery (muscles and glands).

Thus the CNS is kept continuously informed about the surroundings (environment) through various sensory impulses, both general and special.

The CNS in turn brings about necessary adjustment of the body by issuing appropriate orders which are passed on as motor impulses to the muscles, vessels, viscera and glands.

The adjustment of the organism to the given surroundings is the most important function of the nervous system, without which it will not be possible for the organism to survive

Parts of Nervous System

The nervous system is broadly divided into central and peripheral parts which are continuous with each other. Further subdivisions of each part are given below.

A. **Central nervous system (CNS) includes:**
1. *Brain* or *encephalon,* which occupies cranial cavity, and contains the higher governing centres.

2. *Spinal cord* or *spinal medulla,* which occupies upper twothirds of the vertebral canal, and contains many reflex centres.

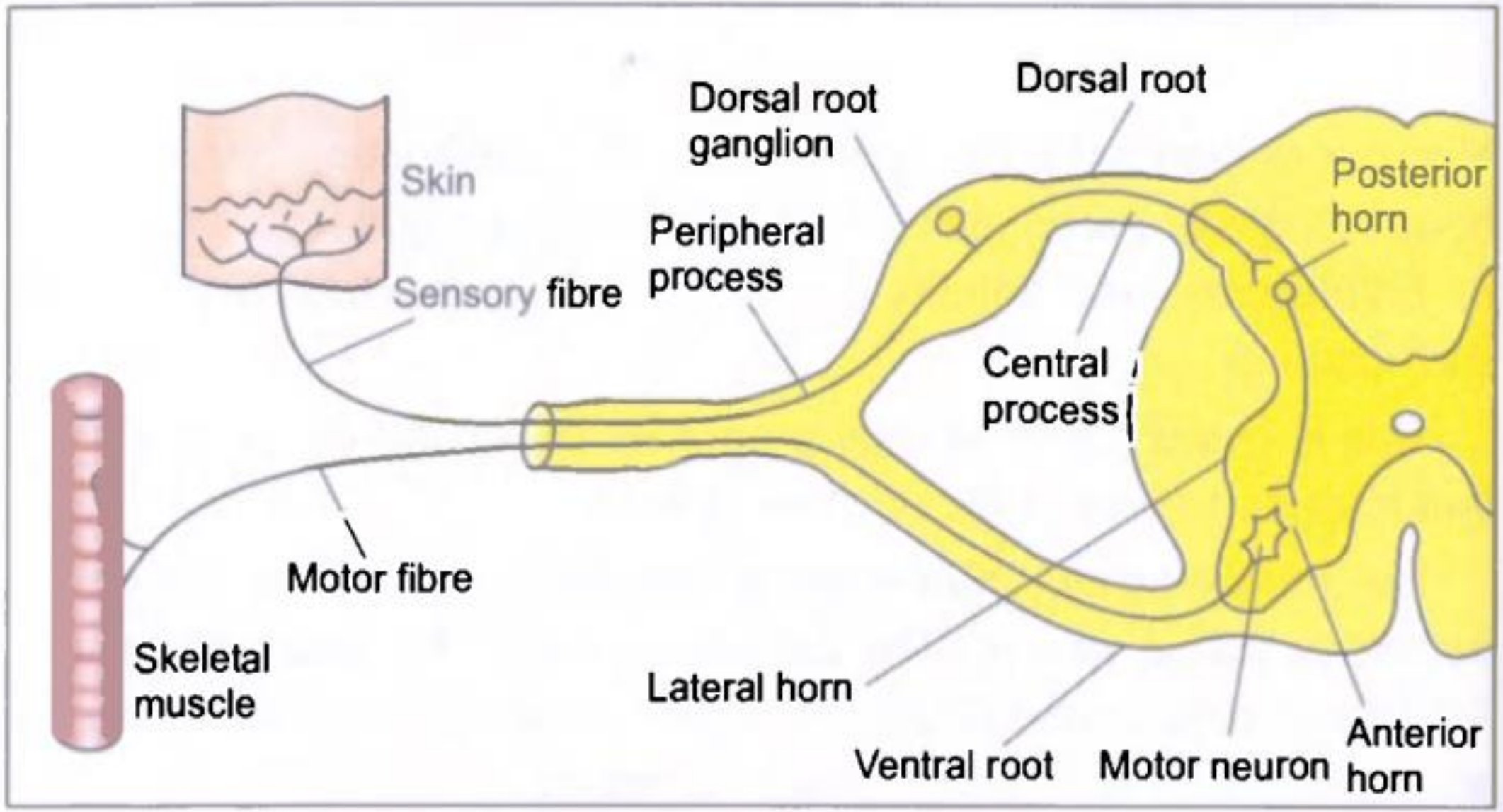

Fig. 7.1: Afferent and efferent pathways through the spinal cord

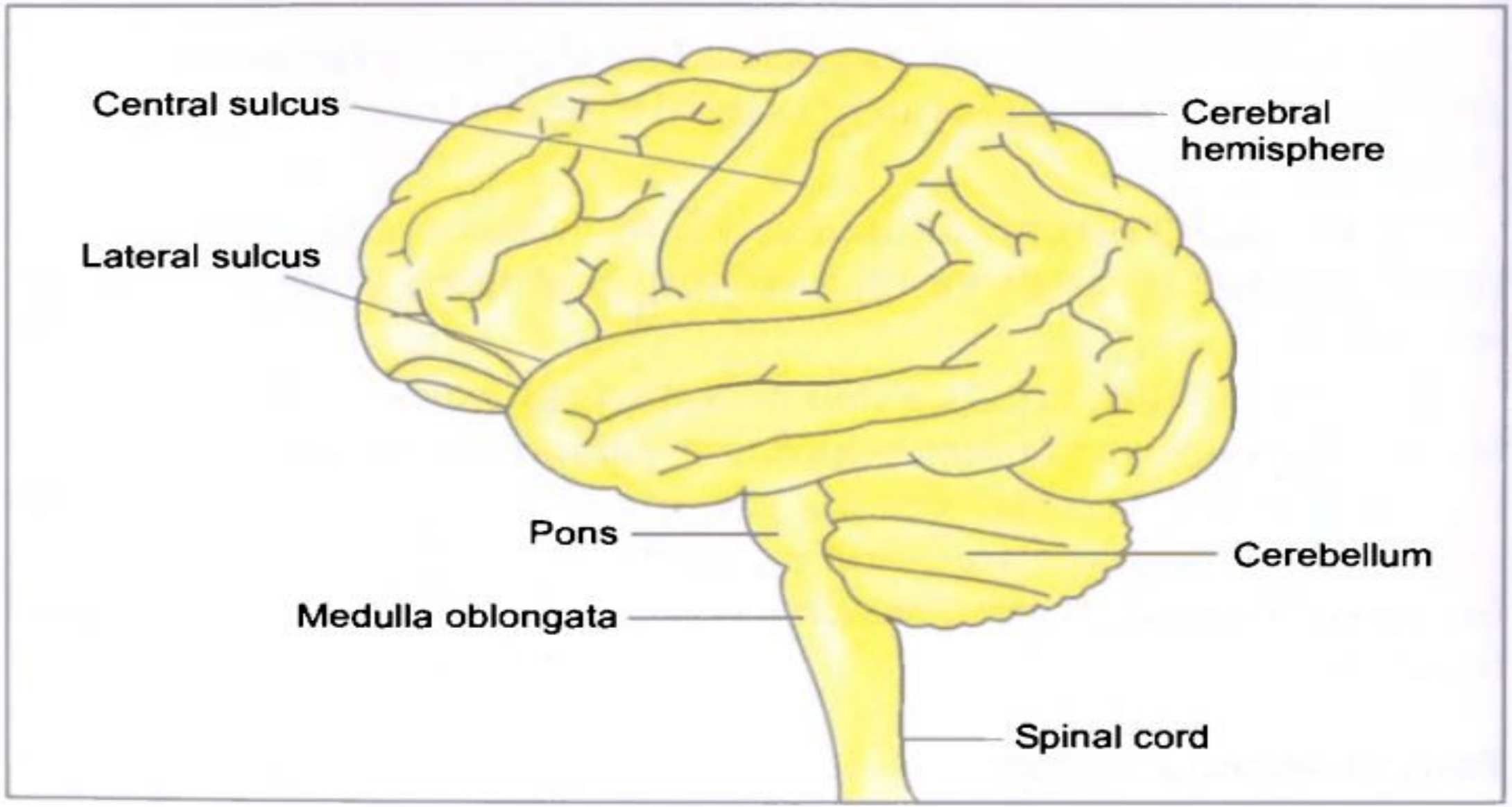

Fig. 7.2: Brain and spinal cord

Peripheral nervous system (PNS)

Is subdivided into the following two components.
1 . *Cerebrospinal nervous system* is the somatic component of the peripheral nervous system, which includes 12 pairs of cranial nerves and 31 pairs of spinal nerves. It innervates the somatic structures of the head and neck, limbs and body wall, and mediates somatic sensory and motor functions.

2. *Peripheral autonomic nervous system* is the visceral component of the peripheral nervous system, which includes the visceral or splanchnic nerves that are connected to the CNS through the somatic nerves. It innervates the viscera, glands, blood vessels and nonstriated muscles, and mediates the visceral functions.

Table 7.1. Comparison of cerebrospinal and peripheral autonomic nervous systems

Cerebrospinal nervous system	**Peripheral autonomic nervous system**
The somatic efferent pathway is made up of one neuron which passes directly to the effector organ (skeletal muscles) Neuron ↓ axon Skeletal muscle	The autonomic efferent pathway is made up of two neurons (preganglionic and postganglionic) with an intervening ganglion for the relay of the preganglionic fibre. The effector organ (viscera) are supplied by the postganglionic fibre

CELL TYPES OF NERVOUS SYSTEM

The nervous tissue is composed of two distinct types of cells:
(a) The excitable cells are the nerve cells or neurons; and
(b) The non-excitable cells constitute neuroglia and ependyma in the CNS, and Schwann cells in the PNS.

1. *Neuron*

Nerve cell or neuron has:

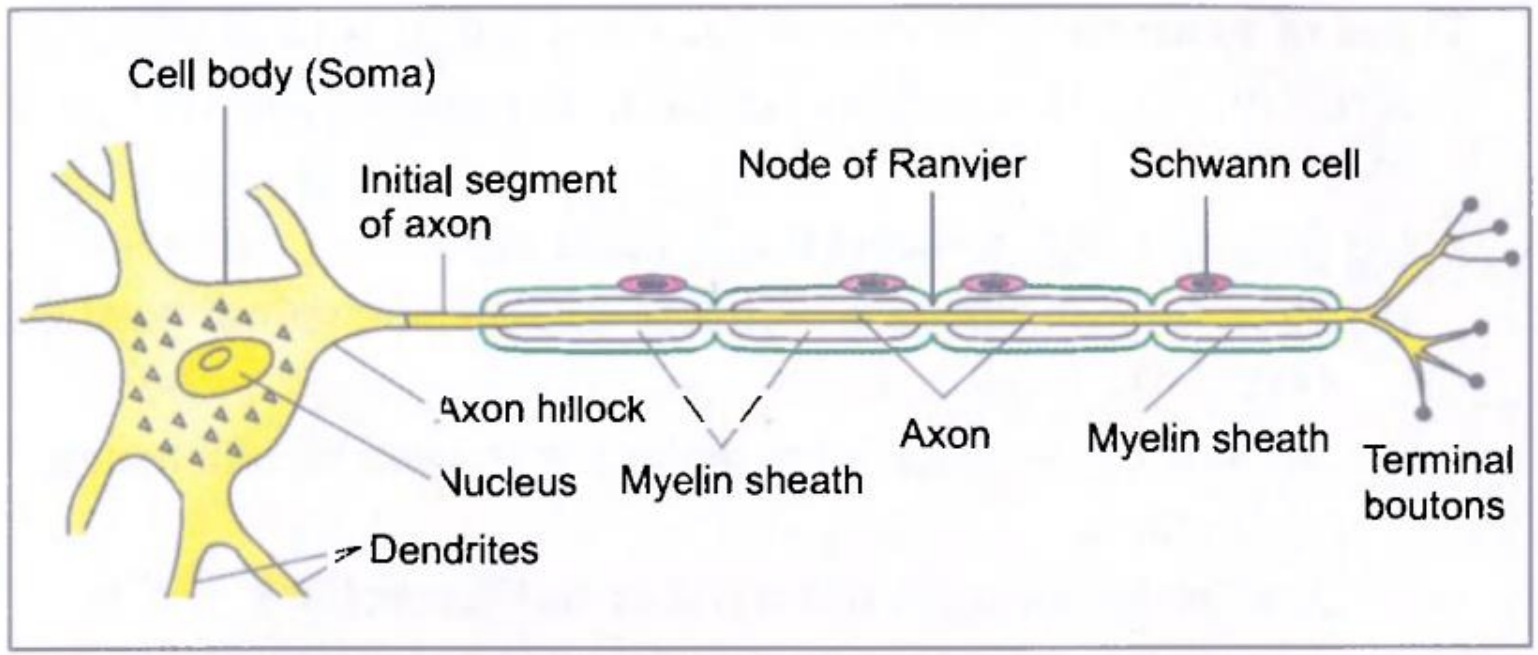

Fig. 7.4: Components of a neuron with a peripheral nerve

Components

(a) A cell body or *perikaryon,* having a central nucleus and Nissl granules in its cytoplasm

(b) Cell processes called neurites, which are of two types. Many short afferent processes, which are freely branching and varicose, are called *dendrites.*

A single long efferent process called axon, which may give off occasional branches (collaterals) and is of uniform diameter.

The terminal branches of the axon are called axon terminals or telodendria.

The cell bodies (somata) of the neurons form grey matter and nuclei in the CNS, and ganglia in the PNS. The cell processes (axons) form tracts in the CNS, and nerves in the PNS

Table 7.2. Comparison of axon and dendrite

Axon	Dendrite
1. Only one axon is present in a neuron.	Usually multiple in a neuron.
2. Thin long process of uniform thickness and smooth surface.	These are short multiple processes. Their thickness diminishes as these divide repeatedly. The branches are studded with spiny projections.
3. The branches of axon are fewer and at right angles to the axon.	The dendrites branch profusely and are given off at acute angles.
4. Axon contains neurofibrils and no Nissl granules.	Dendrites contain both neurofibrils and Nissl granules.
5. Forms the efferent component of the impulse.	Forms the afferent component of the impulse.

Types of neurons:

Neurons can be classified in several ways.
I. According to the number of their processes (neurites) they may be:

(a) *Unipolar,* e.g. mesencephalic nucleus;

(b) *Pseudo-unipolar,* e.g. sensory ganglia or spinal ganglia

(c) *Bipolar,* e.g. spiral and vestibular ganglia and bipolar neurons of retina.

(d) *Multipolar,* neurons in cerebrum and cerebellum.

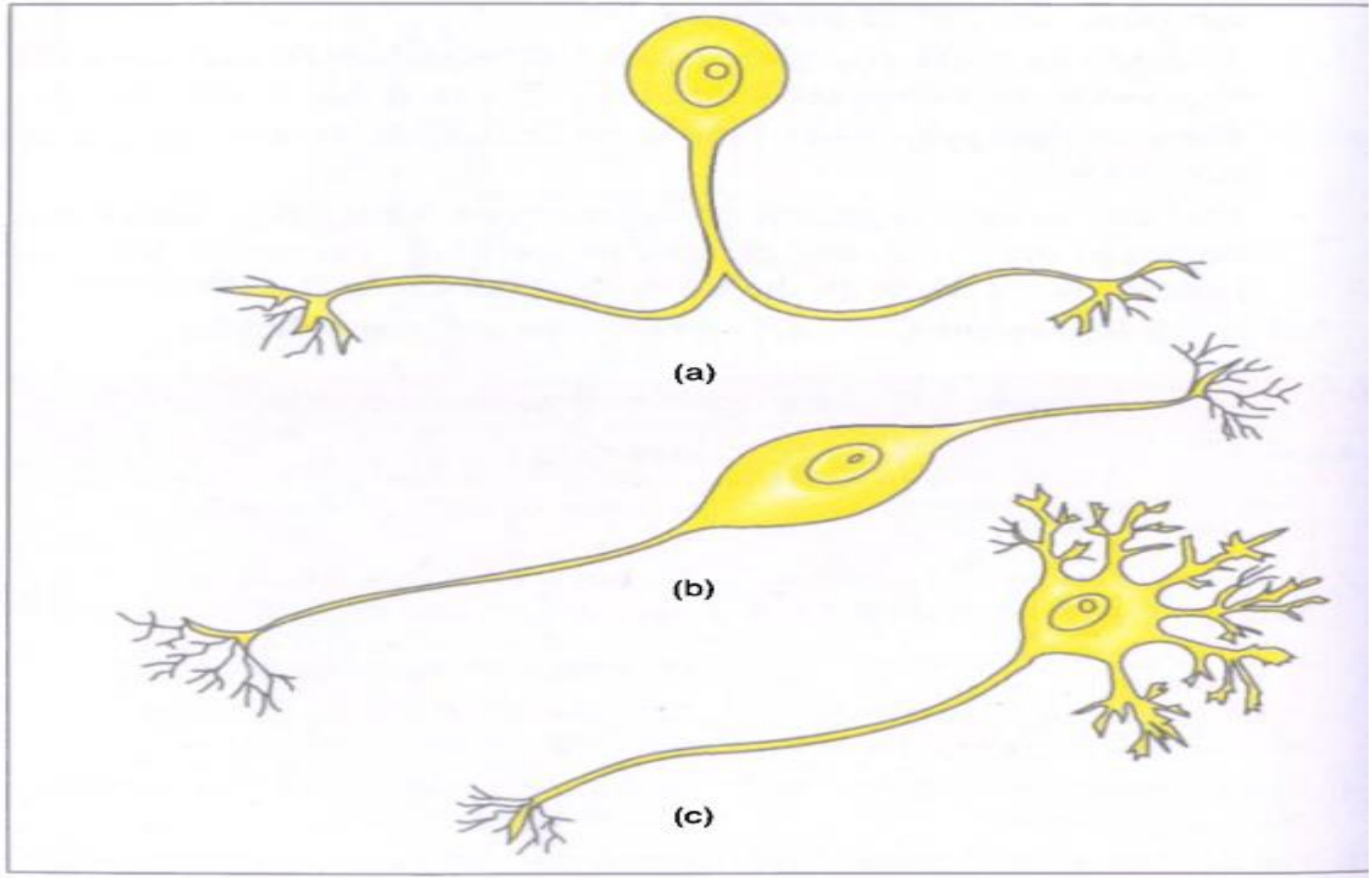

Fig. 7.5: Types of neurons: **(a)** Pseudounipolar, **(b)** bipolar, **(c)** multipolar

II . According to the length of axon, the neurons are classified as

(a) *Golgi type I* neurons, with a long axon; and

(b) *Golgi type II* neurons (microneurons), with a short or no axon

Dynamic polarity:

The neurons show dynamic polarity in their processes. The impulse flows towards the soma in the dendrites, and away from the soma in the axon (Fig. 7.6a). However, in certain microneurons, where the axon is absent, the impulse can flow in either direction through their dendrites.

Synapse:

The neurons form long chains along which the impulses nare conducted in different directions. Each junction between the neurons is called a synapse . It is important to know that the contact between the neurons is by contiguity and not by continuity. This is neuron theory of Waldeyer (1891). The impulse is transmitted across a synapse nby specific neurotransmitters, like acetylcholine, catecholamines (noradrenalin and dopamine), serotonin, histamine, glycine, GABA and certain polypeptides.

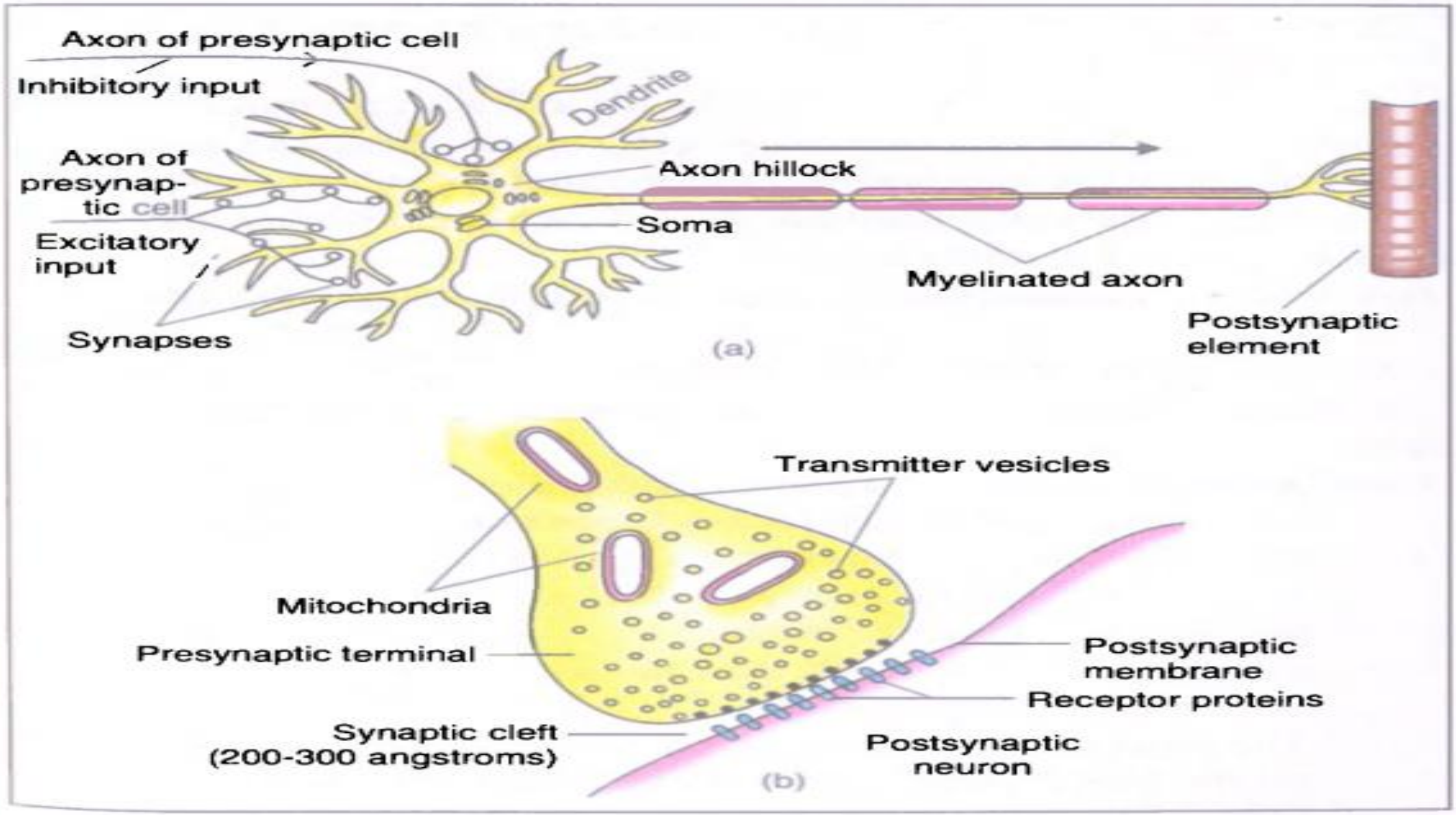

Fig. 7.6: (a) Neuron and its components. (b) Physiological anatomy of

2. Neuroglia

The non-excitable supporting cells of the nervous system form a major component of the nervous tissue. These cells include the following.

1. *Neuroglial cells,* found in the parenchyma of brain and spinal cord.

2. *Ependymal cells* lining the internal cavities or ventricles.

3. *Capsular* or *satellite cells,* surrounding neurons of the sensory and autonomic ganglia.

4. *Schwann cells,* forming sheaths for axons of peripheral nerves.

5. Several types of *supporting cells,* ensheathing the motor and sensory nerve terminals, and supporting the sensory epithelia

REFLEX ARC

A reflex arc is the basic functional unit of the nervous system which can perform an integrated neural activity. In its simplest form, i.e. mono-synaptic reflex arc, is made up of:

(a) A receptor, e.g. skin;
(b) A sensory or afferent neuron;
(c) A motor or efferent neuron; and
(d) An effector, e.g. muscle.

The complex forms of reflex arc are polysynaptic due to addition of one or more internuncial neurons (interneurons) in between the afferent and efferent neurons.

An involuntary motor response of the body is called a reflex action. The stretch reflexes (tendon jerks) are the examples of monosynaptic reflexes. whereas the withdrawal reflex (response to a painful stimulus) is a polysynaptic reflex.

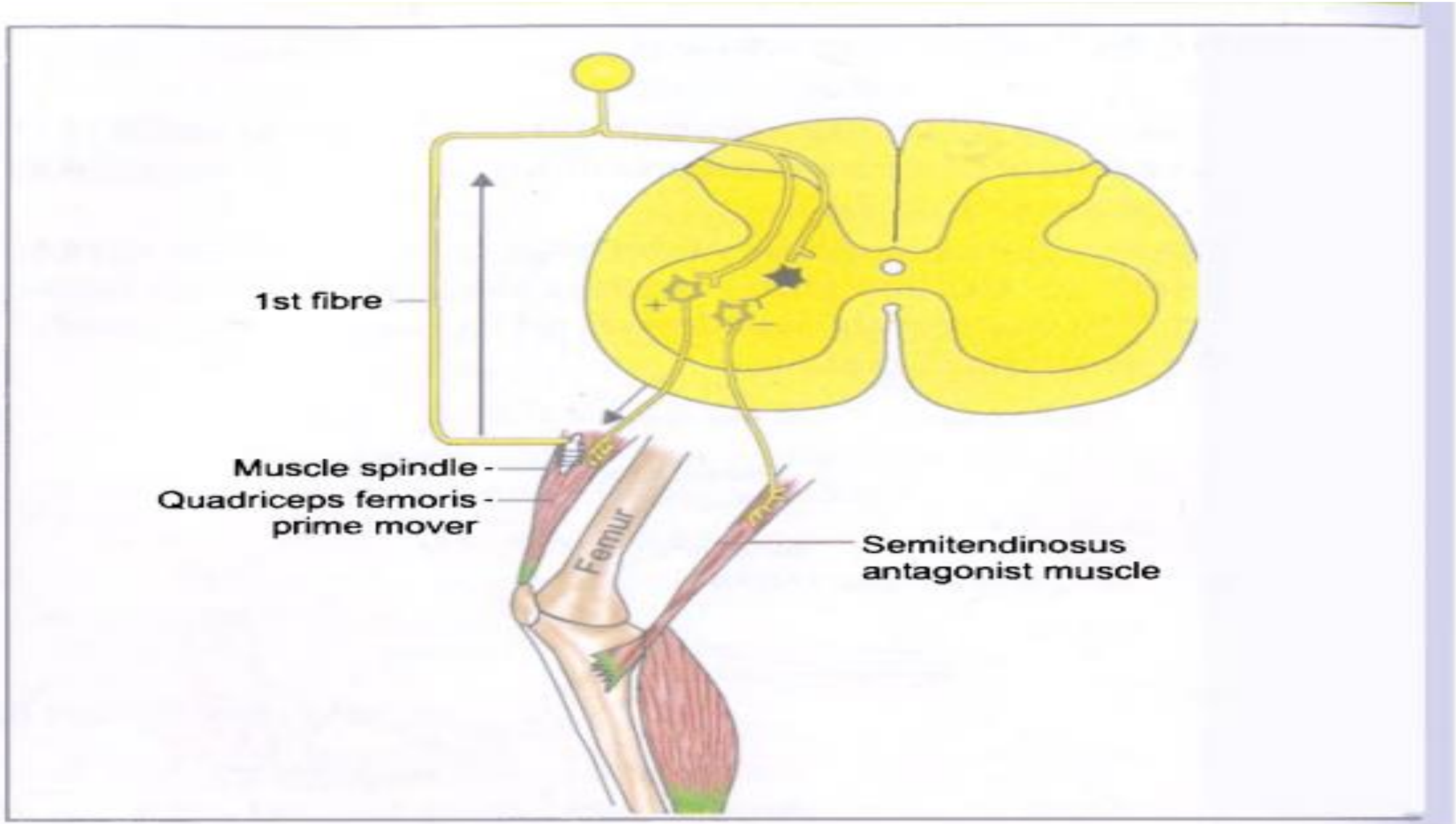

Fig. 7.9: Reflex arc of the stretch reflex

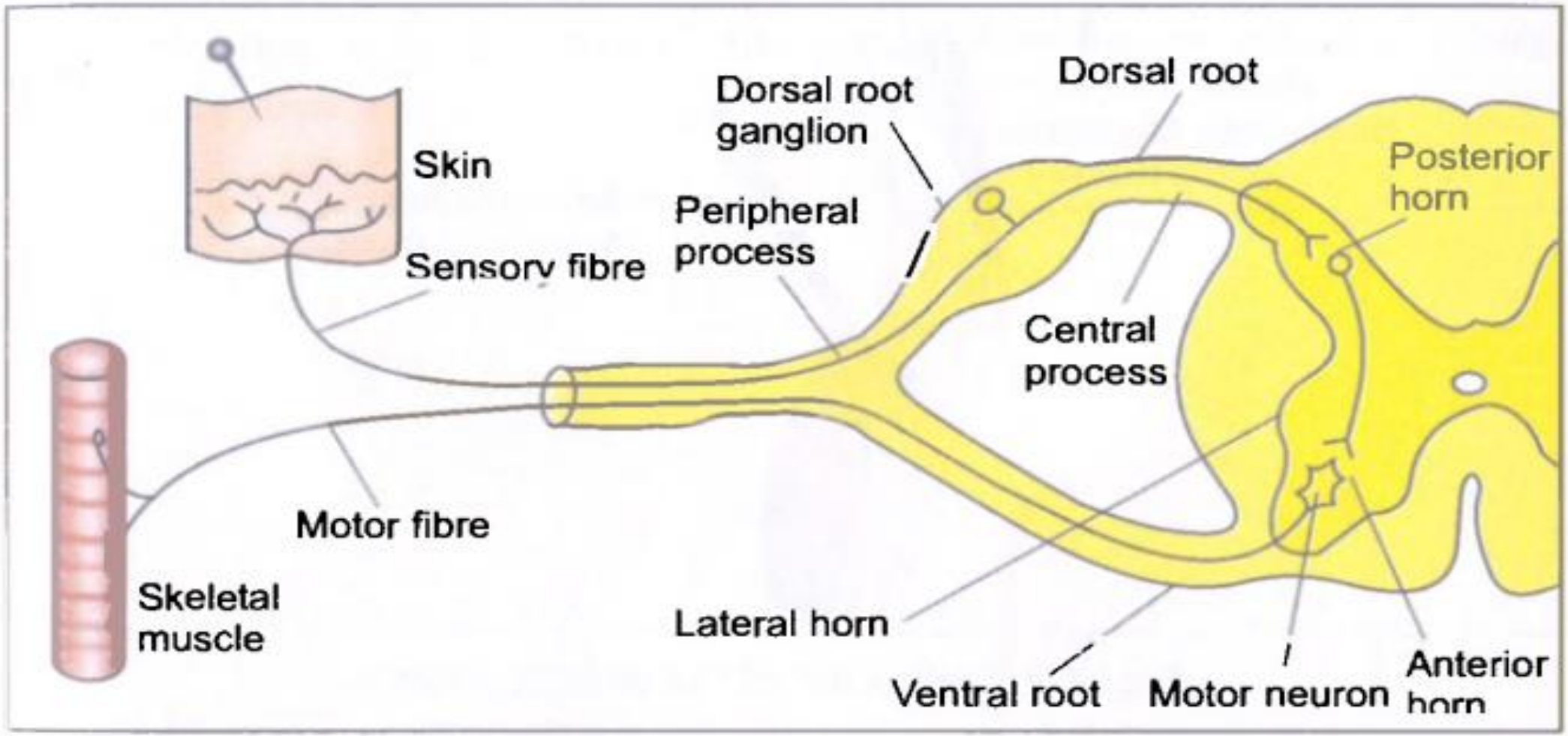

Fig. 7.8: Polysynaptic reflex

PERIPHERAL NERVES

The nerves are solid white cords composed of bundles (fasciculi) of nerve fibres. Each nerve fibre is an axon with its coverings.

The nerve fibres are supported and bound together by connective tissue sheaths at different levels of organization of the nerve.

The whole nerve trunk is ensheathed by *epineurium,* each fasciculus by *perineurium,* and each nerve fiber by a delicate *endoneurium.*

The toughness of a nerve is due to its fibrous sheaths, otherwise the nerve tissue itself is very delicate and friable.

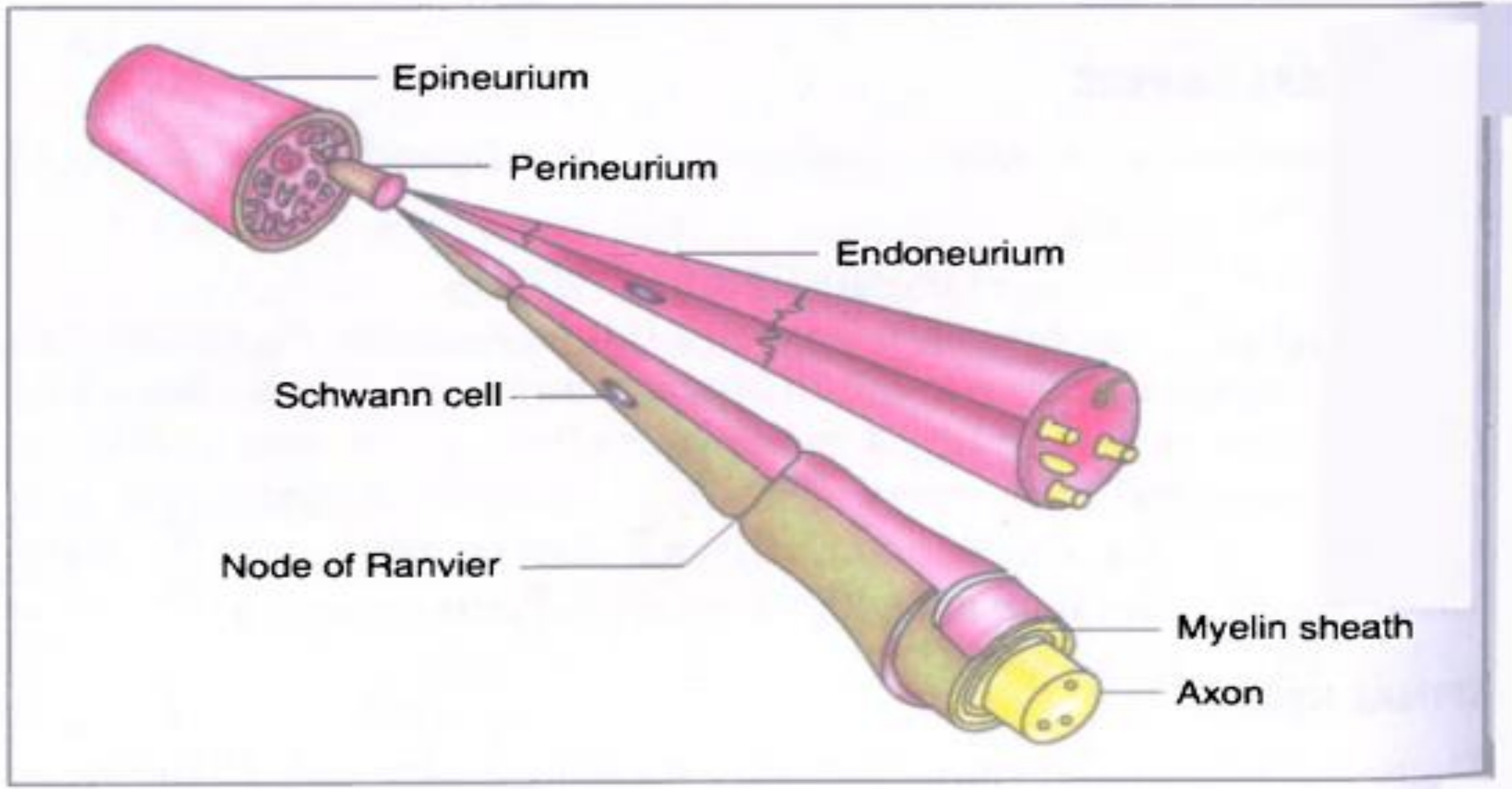

Fig. 7.10: Fibrous support of the nerve fibres

SPINAL NERVES

There are 31 pairs of spinal nerves, including 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal.

Area of skin supplied by a single segment of spinal cord is called a dermatome. Each spinal nerve is connected with the spinal cord by two roots, a *ventral root* which is motor, and a *dorsal root* which is sensory

Blood an d Nerve Supply of Peripheral Nerves

The peripheral nerves are supplied by vessels, called *vasa nervorum,* which form longitudinal anastomoses on the surface of the nerves. The nerves distributed to the sheaths of the nerve trunks are called *nervi nervorum.*

NERVE FIBRES

Each nerve fibre is an axon with its coverings.

Larger axons are covered by a myelin sheath and are termed *myelinated* or *medullated fibres.*

The fatty nature of myelin is responsible for the glistening whiteness of the peripheral nerve trunks and white matter of the CNS.

Thinner axons, of less than one micron diameter, do not have the myelin sheath and are therefore termed *non-myelinated or nonmedullated*

CLINICAL ANATOMY

- *Irritation* of a motor nerve causes muscular spasm. Mild irritation of a sensory nerve causes tingling and numbness, but when severe it causes pain along the distribution of the nerve. Irritation of a mixed nerve causes combined effects.

- *Damage* to a motor nerve causes muscular paralysis, and damage to a sensory nerve causes localized anaesthesia and analgesia.

Damage to a mixed nerve gives rise to both the sensory and motor losses.

CLINICAL ANATOMY

Regeneration of a damaged nerve depends on the degree of injury, particularly on the continuity of the nerve. Different degrees of nerve injury are expressed by the following three terms.

(a) *Neurapraxia* is a minimal lesion causing transient functional block without any degeneration. Recovery is spontaneous and complete, e.g. sleeping foot.

(b) *Axonotmesis* is a lesion where, although continuity is preserved, true Wallerian degeneration occurs. Regeneration takes place in due course.

(c) *Neurotmesis* is the complete division of a nerve. For regeneration to occur the cut ends must be sutured

THANK YOU