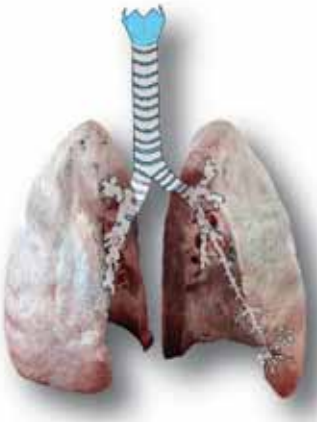


Textbook of General Anatomy

With Case Scenarios & Clinical Applications

Clinically Integrated with

- Systemic Anatomy
- Radiological Anatomy
- Dissection of Cadaver

As per the Competency Based Medical Education Curriculum (NMC)

2nd Edition

V Subhadra Devi

JAYPEE

CONTENTS

COMPETENCY TABLE

Number	*The student should be able to*	*Core (Y/N)*	*Chapter No.*	*Page No.*
AN1.1	Demonstrate normal anatomical position, various planes, relation, comparison, laterality and movement in our body	Y	1	5
AN1.2	Describe composition of bone and bone marrow	Y	4	59, 61
AN2.1	Describe parts, blood and nerve supply of a long bone	Y	4	55, 60
AN2.2	Enumerate laws of ossification	N	4	69
AN2.3	Enumerate special features of a sesamoid bone	N	4	65
AN2.4	Describe various types of cartilage with its structure and distribution in body	Y	4	53
AN2.5	Describe various joints with subtypes and examples	Y	6	100
AN2.6	Explain the concept of nerve supply of joints and Hilton's law	Y	6	120
AN3.1	Classify muscle tissue according to structure and action	Y	5	77
AN3.2	Enumerate parts of skeletal muscle and differentiate between tendons and aponeuroses with examples	Y	5	78
AN3.3	Explain shunt and spurt muscles	N	5	93
AN4.1	Describe different types of skin and dermatomes in body	N	3	34, 38
			9	170
AN4.2	Describe structure and function of skin with its appendages	Y	3	34
AN4.3	Describe superficial fascia along with fat distribution in body	Y	3	43
AN4.4	Describe modifications of deep fascia with its functions	Y	3	43
AN4.5	Explain principles of skin incisions	N	3	34
			12	219
AN5.1	Differentiate between blood vascular and lymphatic system	Y	7	125
AN5.2	Differentiate between pulmonary and systemic circulation	Y	7	130
AN5.3	List general differences between arteries and veins	Y	7	128
AN5.4	Explain functional difference between elastic, muscular arteries and arterioles	Y	7	131
AN5.5	Describe portal system giving examples	Y	7	134
AN5.6	Describe the concept of anastomoses and collateral circulation with significance of end-arteries	Y	7	135, 137
AN5.7	Explain function of meta-arterioles, precapillary sphincters, arterio-venous anastomoses	N	7	136
AN5.8	Define thrombosis, infarction and aneurysm	N	7	139
AN6.1	List the components and functions of the lymphatic system	N	8	146
AN6.2	Describe structure of lymph capillaries and mechanism of lymph circulation	N	8	146
AN6.3	Explain the concept of lymphoedema and spread of tumors via lymphatics and venous system	N	8	153
AN7.1	Describe general plan of nervous system with components of central, peripheral and autonomic nervous systems	Y	9	157
AN7.2	List components of nervous tissue and their functions	Y	9	158
AN7.3	Describe parts of a neuron and classify them based on number of neurites, size and function	Y	9	158

Number	*The student should be able to*	*Core (Y/N)*	*Chapter No.*	*Page No.*
AN7.4	Describe structure of a typical spinal nerve	Y	9	169
AN7.5	Describe principles of sensory and motor innervation of muscles	N	5	87
			9	180
AN7.6	Describe concept of loss of innervation of a muscle with its applied anatomy	Y	5	87
			9	180
AN7.7	Describe various type of synapse	N	9	164
AN7.8	Describe differences between sympathetic and spinal ganglia	N	9	165
AN13.5	Identify the bones and joints of upper limb seen in anteroposterior and lateral view radiographs of shoulder region, arm, elbow, forearm and hand	Y	11	206
AN13.6	Identify and demonstrate important bony landmarks of upper limb: Jugular notch, sternal angle, acromial angle, spine of the scapula, vertebral level of the medial end, Inferior angle of the scapula	Y	12	219
AN13.7	Identify and demonstrate surface projection of: Cephalic and basilic vein, Palpation of Brachial artery, Radial artery, Testing of muscles: Trapezius, pectoralis major, serratus anterior, latissimus dorsi, deltoid, biceps brachii, Brachioradialis	Y	12	219
AN20.6	Identify the bones and joints of lower limb seen in anteroposterior and lateral view radiographs of various regions of lower limb	Y	11	206
AN20.7	Identify and demonstrate important bony landmarks of lower limb: Vertebral levels of highest point of iliac crest, posterior superior iliac spines, iliac tubercle, pubic tubercle, ischial tuberosity, adductor tubercle, Tibial tuberosity, head of fibula, Medial and lateral malleoli, Condyles of femur and tibia, sustentaculum tali, tuberosity of fifth metatarsal, tuberosity of the navicular	Y	12	219
AN20.8	Identify and demonstrate palpation of femoral, popliteal, post tibial, anti-tibial and dorsalis pedis blood vessels in a simulated environment	Y	12	219
AN20.9	Identify and demonstrate: Palpation of vessels (femoral, popliteal, dorsalis pedis, post-tibial), Mid-inguinal point, Surface projection of: femoral nerve, Saphenous opening, Sciatic, tibial, common peroneal and deep peroneal nerve, Great and small saphenous veins	Y	12	219
AN43.7	Identify the anatomical structures in 1) Plain X-ray of skull, 2) AP view and lateral view, 3) Plain X-ray cervical spine-AP and lateral view, 4) Plain X-ray of paranasal sinuses	Y	11	206
AN54.1	Describe and identify features of plain X-ray abdomen	Y	11	206
AN54.2	Describe and identify the special radiographs of abdominopelvic region (contrast X-ray, Barium swallow, Barium meal, Barium enema, Cholecystography, Intravenous pyelography and Hysterosalpingography)	Y	11	206
AN54.3	Describe role of ERCP, CT abdomen, MRI, Arteriography in radiodiagnosis of abdomen	N	11	206
AN55.1	Demonstrate the surface marking of; Regions and planes of abdomen, Superficial inguinal ring, Deep inguinal ring , McBurney's point, Renal angle and Murphy's point	Y	12	219

Number	*The student should be able to*	*Core (Y/N)*	*Chapter No.*	*Page No.*
AN55.2	Demonstrate the surface projections of: Stomach, Liver, Fundus of gallbladder, Spleen, Duodenum, Pancreas, Ileocaecal junction, Kidneys and Root of mesentery	Y	12	219
AN65.1	Identify epithelium under the microscope and describe the various types that correlate to its function	Y	2	20
AN66.1	Describe and identify various types of connective tissue with functional correlation	Y	2	26
AN72.1	Identify the skin and its appendages under the microscope and correlate the structure and function	Y	3	34
AN 82.1	Demonstrate respect and follow the correct procedure when handling cadavers and other biologic tissue	Y	13	228

CHAPTER

9 Introduction to Nervous System

LEARNING OBJECTIVES

- Subdivisions of nervous system
- Classification of nervous tissue
- Structure of neuron
- Classification of neurons with examples
- Synapse and types
- Classification of neuroglia
- Nerve ganglia
- Blood-brain barrier
- Spinal segment and course of a typical spinal nerve
- Formation of nerve plexuses
- Receptors and their classification
- Reflex arc components
- Process of myelination
- Structure of peripheral nerve and its functional components
- Injury to nerve, its degeneration and regeneration
- Autonomic nervous system
- Clinical case with anatomical explanation

INTRODUCTION

Nervous system is the most highly specialized system of the body. It is concerned with control and coordination of various body activities like movements of joints, contraction of muscles, various visceral sensations, such as hunger, thirst, pain, etc., It has got the properties of conductivity and elicitation of appropriate reflex in response to the stimulus either from environment or within the body.

SUBDIVISIONS OF NERVOUS SYSTEM (FLOWCHART 9.1 AND FIG. 9.1)

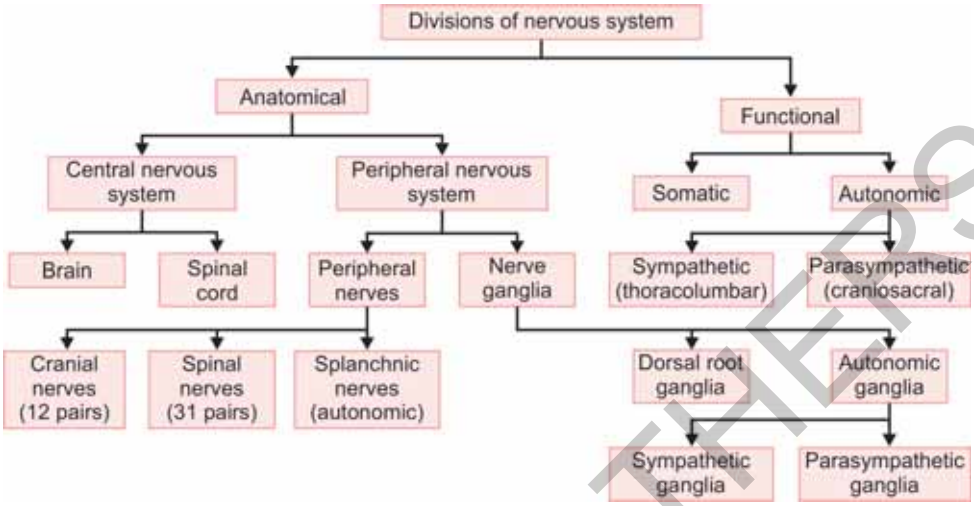
AN7.1: Describe general plan of nervous system with components of central, peripheral and autonomic nervous. systems.

Anatomical Subdivision

The nervous system is divided into two parts:

1. *Central nervous system (CNS)*—consisting of brain and the spinal cord located in the cranial cavity and vertebral canal respectively.
   - *Brain or encephalon*: It is located in the cranial cavity. The brain contains higher *controlling centers* (decision making, thinking, analysis, judgment, etc., based on the information received).
   - *Spinal cord*: It is located in the vertebral canal. It contains *reflex centers* [initiating appropriate movements of joints, contraction of muscles (skeletal, cardiac, and smooth), secretion of glands, etc.] for requisite response.
2. *Peripheral nervous system (PNS)*: It consists of nervous tissue lying outside the brain and spinal cord. It is composed of nerve *fibers* and small aggregates of nerve cells called "nerve ganglia".
   - *Nerve fibers*:
     - Twelve pairs of cranial nerves
     - Thirty-one pairs of spinal nerves
     - Splanchnic nerves

Flowchart 9.1: Divisions of nervous system.



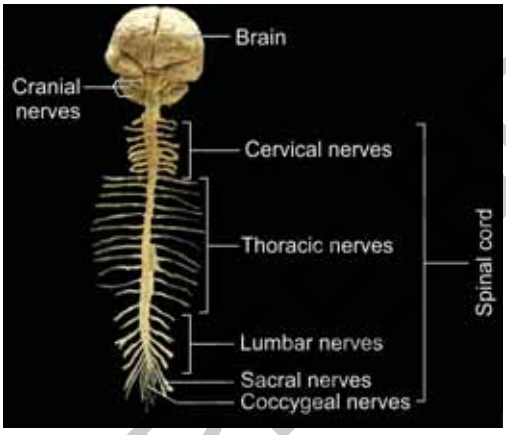


Fig. 9.1: Divisions of nervous system.

- *Ganglia*:
  - Sensory/dorsal root ganglia
  - Autonomic ganglia
    - Sympathetic
    - Parasympathetic.

Functional Subdivision

It is divided into *somatic* and *visceral* components with each in turn having afferent and efferent components.

1. *Somatic nervous system*: It is composed of:
   - *Afferent or sensory nerves*—concerned with transmission of sensory formation from various parts of body to the CNS.
   - *Efferent or motor nerves*—concerned with innervation of skeletal muscles of the body.
     It is further divided into spinal nerves and cranial nerves. This system is responsible for voluntary activities.
2. *Visceral/autonomic nervous system (ANS)*: This is concerned with innervation of various visceral muscles (cardiac and smooth) and glands. The activities of ANS are involuntary.

NERVOUS TISSUE (FLOWCHART 9.2)

AN7.2: List components of nervous tissue and their functions.

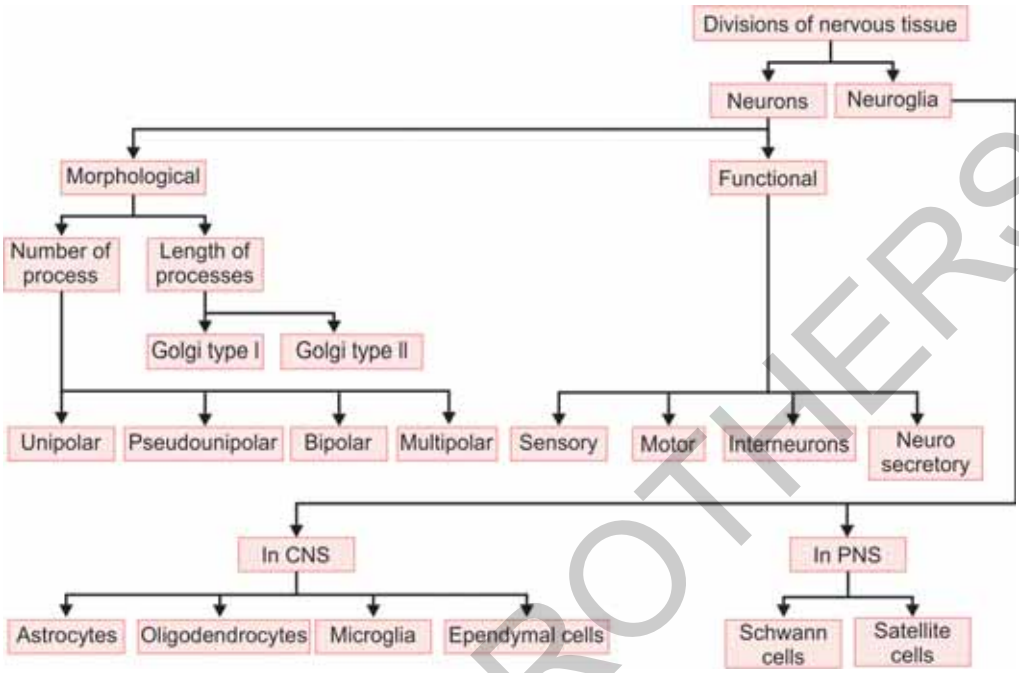
Nervous tissue is one of the four basic tissues of the body. Nervous tissue consists of two cell types. They are *neurons and neuroglia*.

Neurons

AN7.3: Describe parts of a neuron and classify them based on number of neurites, size and function.

- These are intercommunicating network of specialized cells containing cell bodies (perikaryon) and their processes.

Flowchart 9.2: Classification of nervous tissue.



(PNS: peripheral nervous system; CNS: central nervous system)

- These are anatomical and functional units of the nervous system.
- The human nervous system consists of at least 10 billion neurons.
- The neurons are highly differentiated and do not undergo mitosis after birth. Hence, *no regeneration of neurons in postnatal life.*

Note: If the neurons increase in number in postnatal life one will have fleeting memories.

- The neurons are excitable cells and are specialized to respond and transmit the signals to activate other neurons.
- The neurons receive information from external and internal environment and transmit it to the CNS for processing and for making a decision on appropriate action.
- They convey the decision to the effector tissue for implementation.
- The neurons exhibit the property of irritability and conductivity.

Structure of Neuron

The neuron has two main parts **(Fig. 9.2)**:

1. *Cell body* (*soma/perikaryon*)
2. *Processes* (*neurites*): There are two types of processes.
   i. *Dendrites*: Numerous in number and are short.
   ii. *Axon*: Single long process.

Perikaryon (soma/cell body):

- It is the expanded portion of the neuron.
- Cell bodies of most of the neurons are situated in the gray matter of the brain and spinal cord with the exception of cell bodies of spinal ganglia that are located outside the CNS.
- They are 5–100 μ in diameter.
- They are of different shapes—pyramidal, fusiform, stellate, flask-shaped, etc.,
- The cell body presents the following features:
  - *Cell membrane*: Trilaminar with inner and outer phospholipid bilayer and an intermediate lipid layer.

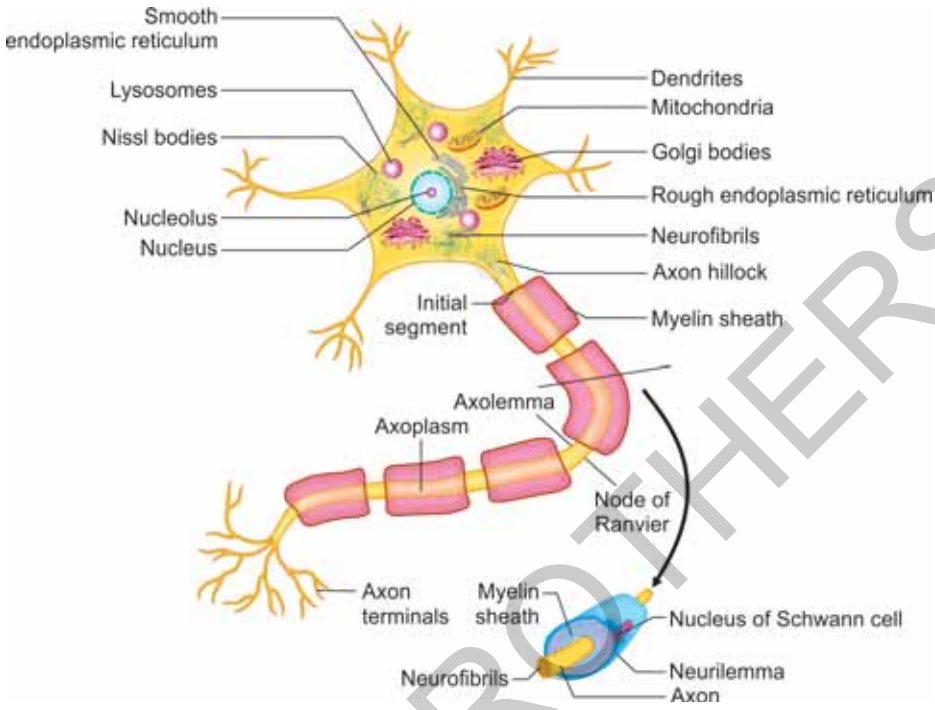


Fig. 9.2: Structure of neuron.

- *Nucleus*: It is large, vesicular and centrally placed with prominent nucleolus. The nucleus is eccentric in position in cases of injury or fatigue of the neuron. It is eccentric in healthy sympathetic ganglia. In females a planoconvex heterochromatin mass known as sex-chromatin or Barr body is present close to the nuclear membrane.
- *Cytoplasm*: It contains the following organelles:
  - Nissl bodies: These are deeply stained (basophilic) bodies of rough endoplasmic reticulum studded with abundant ribosomes. These are distributed throughout the cytoplasm and also extend into the dendrites. They are *absent in axon hillock and axon*. They are active in protein synthesis. They are more in number in motor neurons than in sensory.

Clinical Importance

In case of injury (mechanical or chemical) or fatigue of the nerve cell the Nissl bodies disappear and the nucleus moves to the periphery (eccentric) and this process is known as *chromatolysis*. When the nerve cell is recovering from stress in a reasonable time the Nissl bodies reappear.

  - Golgi bodies: These are located close to the nucleus and extend into the dendrites.
  - Mitochondria: These are present in cytoplasm and extend into all the processes.
  - Smooth endoplasmic reticulum: It is an extensively folded membrane without ribosomes. It is the site of lipid synthesis.
  - Lysosomes: These are thick-walled membranous vesicles and contain hydrolytic enzymes and acid phosphatase.

Clinical importance: They phagocytose the foreign particles and hydrolyze the Nissl granules during chromatolysis.

- Neurofibrils—filaments of protein that form a network.
- Lipofuscin: A golden brown pigment seen in cell bodies of aged neurons. It is a wear and tear pigment.

Note: *Centrosomes and centrioles are absent in neuron and is responsible for the inability of the neuron to divide. In case of damage to the neuron the neuroglial cell replaces it.*

Nuclei: Collections of nerve cell bodies within the CNS.

Ganglia: Collections of nerve cell bodies outside the CNS. Examples: Dorsal root ganglia of spinal nerves, ganglia in relation with certain cranial nerves (facial), ganglia in the autonomic nervous system (ANS).

Dendrites:

- Short multiple processes arising from the cell body and each of it presents extensive branching forming dendritic tree.
- They contain all the cytoplasmic contents of the cell body.
- They provide structural support for the neurons in CNS.
- The terminal arborizations of dendrites are thorn-like and are called dendritic spines or gemmules. The dendrites convey the nerve impulse from periphery to cell body.

Axon **(Fig. 9.2)**:

- Each neuron has a single axon which is a long process.
- The length of axons is variable. The diameter of the axon is constant.
- Axons originate at a short pyramid-like structure, the axon hillock, which lacks Nissl substances.
- The plasma membrane of the axon is termed the *axolemma*, and the cytoplasm of the axon is termed the *axoplasm*. The axoplasm contains neurofilaments and microtubules but lacks Golgi apparatus and Nissl substance.
- The thicker axons have concentric wrappings of the enveloping Schwann cell in PNS and oligodendrocyte in CNS that forms the myelinated sheath. The nerve fibers wrapped with myelinated sheaths are called *myelinated fibers*.
- The myelin sheaths increase the velocity of conduction of an impulse. Myelin also forms an insulating sheath around the axons in the CNS and PNS.
- In myelinated axons the initial portion, between the axon hillock and the starting of the myelin sheath, is called the *initial segment*. Axons sometimes have right-angled branches the *axon collaterals*.
- Outside the myelin sheath in the PNS a thin layer of cytoplasm of Schwann cell and its cell membrane persists forming an additional sheath known as Schwann cell sheath or *neurilemmal sheath*.
- The neurilemmal sheath plays an important role in regeneration of a peripheral nerve after injury. Neurilemmal sheath is not found in CNS.

Clinical Importance

Hence, regeneration of an axon after injury is not possible in CNS due to the absence of neurilemmal sheath.

- Each unit of axon is myelinated by Schwann cell or oligodendrocyte. A gap occurs where axon is not covered by myelin. This gap is known as *node of Ranvier*.
- The segment of axon between two nodes of Ranvier is called *internode,* which is covered by a single Schwann cell whose nucleus is seen at the periphery.
- At the nodes of Ranvier a number of collaterals arise from the axon.
- Near the termination the axon divides into smaller branches called telodendria.
- The terminal parts of axon forms synapses with other neurons, muscle fibers and secretory units of exocrine glands.
- At the synapse the collaterals and terminals of axons form small bulbous expansions called boutons terminaux.

Motor endplate is the specialized terminal of axon in a skeletal muscle.

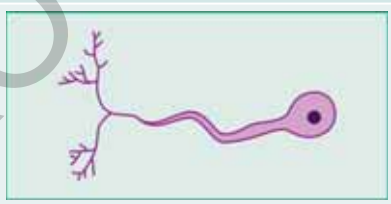
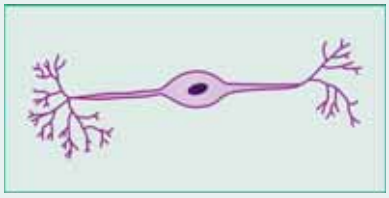
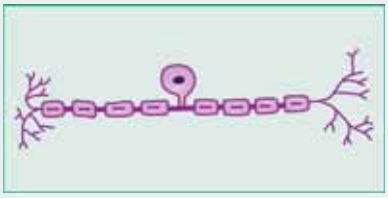
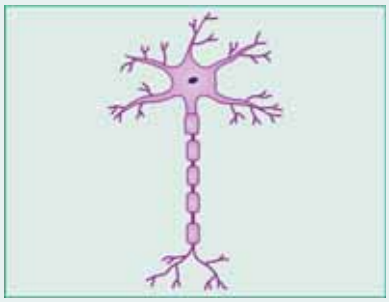
- Bundles of axons form the peripheral nerve. In the CNS the axon forms the nerve fiber.
- An *endoneurial connective tissue sheath* surrounds each fiber.

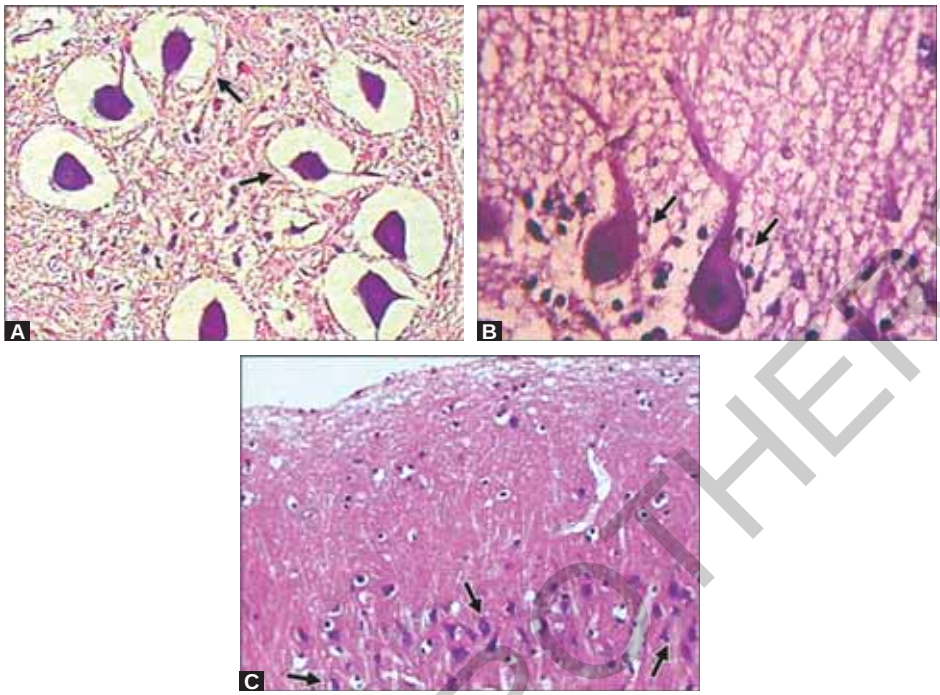
Classification of Neurons

Anatomical:

- *According to polarity* (**Table 9.1** and **Figs. 9.3A to D**)*:*
  - Unipolar
  - Bipolar
  - Pseudounipolar
  - Multipolar
- *According to length of processes*:
  - Golgi type I: A neuron with long process, e.g., pyramidal cells of cerebral cortex and Purkinje cells of cerebellar cortex
  - Golgi type II: A neuron with short process, e.g., cerebellar cortex neurons.
- *According to shape of cell bodies* **(Figs. 9.4 A to C):**
  - Stellate or star shaped, e.g., in spinal cord.
  - Triangular or pyramidal, e.g., in cerebral cortex.
  - Flask-shaped, e.g., Purkinje cells in cerebellar cortex.

Table 9.1: Description of different types of neurons **(Figs. 9.3A to D)**.

Neurons—description	*Structure* **(Figs. 9.3A to D)**
Unipolar neuron: ❑ Have single process extending from cell body that is usually a dendrite ❑ *Example*: Mesencephalic nucleus of trigeminal nerve	 A
Bipolar neurons: ❑ These have two processes, i.e., one dendrite and one axon extending from each end of the cell body ❑ *Examples*: Retina, olfactory epithelium, sensory ganglia of vestibular and cochlear nerves	 B
Pseudounipolar neurons: ❑ Have a single, short process that extends from the cell body and bifurcates forming a T-shape. One of it is peripherally directed and receives information from the peripheral receptors. Other process enters the central nervous system and conveys the information ❑ *Example*: Sensory ganglia on dorsal roots of spinal nerves	 C
Multipolar neurons: ❑ They possess single axon and several dendrites extending from the cell body ❑ *Example*: Most common type of neurons present in the spinal cord, cerebrum and cerebellum. They are also present in autonomic ganglia	 D



Figs. 9.4A to C: Classification of neurons—according to shape of cell body: (A) Stellate or star-shaped cell bodies in spinal cord; (B) Flask-shaped cell bodies (Purkinje cells) in cerebellar cortex; (C) Triangular-shaped cell bodies in cerebral cortex.

Functional:

- *Sensory neurons*: Receive sensory stimuli from the environment (from receptors) and from within the body. Example: Pseudounipolar neurons and bipolar neurons. The cell bodies of all sensory neurons lie outside the CNS except mesencephalic nucleus of trigeminal nerve.
  - *Motor neurons*: These control the effector organs (muscles, exocrine glands, and endocrine glands). They are located in CNS *except* postganglionic autonomic neurons. There are two types of motor neurons:
    1. *Upper motor neurons*: These are confined to cerebral cortex.
    2. *Lower motor neurons*: These are confined to anterior gray horn of spinal cord and brainstem.
  - *Autonomic neurons*: These are arranged in two sets **(Fig. 9.5)**:

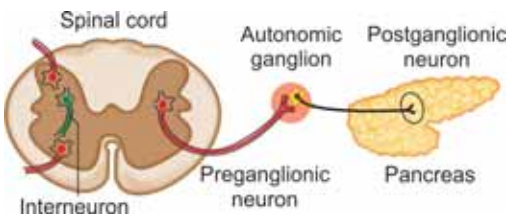


Fig. 9.5: Autonomic neurons.

1. *Preganglionic neurons—located in CNS and are arranged as*:
   - *Craniosacral (parasympathetic) outflow—the preganglionic neurons are located in the brainstem (for cranial part) and sacral segments of spinal cord (for sacral part).*
   - *Thoracolumbar (sympathetic) outflow—the preganglionic neurons are located in the thoracic and lumbar segments of spinal cord.*

2. *Postganglionic neurons—situated outside CNS.*

– *Interneurons (intermediate neurons)*: These are typically found in the CNS and connect other neurons (often between sensory and motor neurons). They are multipolar neurons, e.g., majority of ascending and descending tracts are axons of interneurons.
– *Neurosecretory neurons*: These are specialized neurons that synthesize and secrete hormones. These are present in the hypothalamus and produce the hormones antidiuretic hormone (ADH) and oxytocin.

AN7.7: Describe various type of synapse.

Synapse: Synapse is the site of contact between two neurons for easy transmission of information. It is a specialized junction. It contains three parts **(Fig. 9.6)**:

1. Presynaptic membrane of terminal bouton of one presynaptic neuron. It contains synaptic vesicles filled with neurotransmitter.
2. *Synaptic cleft*: It is an extracellular space between pre- and postsynaptic neurons. The neurotransmitter is released into this space.
3. Postsynaptic membrane of one postsynaptic neuron. Once the neurotransmitter comes in contact with this membrane action potential is generated.

Classification of synapses—based on the nerve cell components that are coming into contact they are classified as **(Fig. 9.7)**:

- *Axodendritic*: These are the *most common* type of synapses. In this type axon of presynaptic neuron makes contact with dendrites of postsynaptic neuron.
- *Axosomatic*: These are *less common*. In this type the axon terminal of presynaptic neuron comes into contact with the cell body or soma of postsynaptic neuron.
- *Axoaxonal*: The axon of presynaptic neuron makes contact with axon of postsynaptic neuron. These are *least common* type of synapses.

Neuroglia

- In Greek the term "Glia" means *glue*. These are the connective tissue cells in the nervous system.
- These are nonexcitable cells.

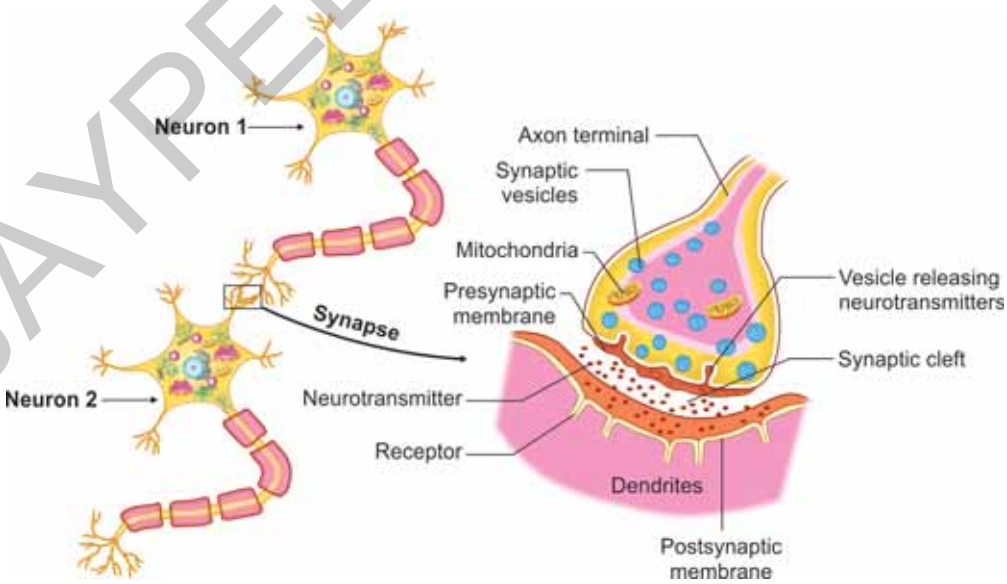


Fig. 9.6: Structure of synapse.

Anatomical Basis for Clinical Condition

Case Scenario

Problem: A 30-year-old person complaints of frequent episodes of the following symptoms with normal health in between for the past 5 years:

- Tingling and numbness of face and fingers
- Fatigue and weakness
- Muscle stiffness
- Frequent urination and inability to control the bladder movements
- Blurring of vision
- Slurred speech.

Questions:

1. What could be the probable diagnosis?
2. What investigations will be ordered by the attending physician to confirm the diagnosis?
3. What could be the probable anatomical explanation for this condition?

Anatomical explanation:

1. The probable diagnosis is relapsing and remitting multiple sclerosis.
2. The investigations that are to be advised are:
   - Blood tests to rule out other causes for the condition.
   - Spinal tap to find out abnormal antibodies in cerebrospinal fluid.
   - Magnetic resonance imaging (MRI) of brain and spinal cord to find out areas with lesions.
   - Evoked potential tests to record the electrical signals produced by brain in response to stimuli.
3. It is an autoimmune disease with a cause unknown. The disease is caused by inflammation of nerves resulting in damage to the myelin sheath which plays an important role in the conduction of nerve impulse for appropriate response to a stimulus. Damage to the myelin sheath causes slowing of impulse conduction or even stoppage of nerve impulse leading to neurological problems. The severity of neurological problems depends on the severity of the disease, part of nervous system affected. It varies from mild to severe physical disability, impaired speech, vision, etc.

☞ Key Concept

Take Home Message—Nervous System

- The nervous system is broadly divided into central nervous system (CNS) and peripheral nervous system (PNS).
- The CNS is broadly divided into brain and spinal cord. The PNS consists of 12 pairs of cranial nerves, 31 pairs of spinal nerves that are connected to brain and spinal cord.
- The nervous tissue is classified into excitable neuron and nonexcitable neuroglia.

Contd…

Contd…

- The parts of a neuron are cell body, a single long process the axon and the short, multiple processes the dendrites.
- Collections of nerve cell bodies with in CNS are called nuclei whereas the same outside the CNS are called ganglia.
- The neurons are classified based on their function into motor and sensory. Based on number of processes they are classified into unipolar, bipolar, and multipolar. Majority of the neurons are multipolar.
- The axons of neurons unite to form tracts in CNS and peripheral nerves in PNS.
- Peripheral nerves contain various functional components that will differ in cranial and spinal nerves.
- Basic sensations from external and internal environment are received by specialized cells called receptors. Majority of receptors are located in the dermis.
- Reflex arc is the basic functional unit of nervous system and consists of a receptor, sensory neuron, interneuron, motor neuron, and an effector.
- Myelination of axon in CNS is by oligodendrocytes and in the PNS by Schwann cells.
- Myelination of the nerve fibers facilitates conduction of nerve impulse.

QUESTIONS

1. Structure of neuron.
2. Classification of neurons.
3. Neuroglia.
4. Myelin sheath.
5. Process of myelination.
6. Peripheral nerve.
7. Formation of a nerve plexus.
8. Reflex arc.

MULTIPLE CHOICE QUESTIONS

1. Myelination of nerves in central nervous system is by:
A. Schwann cells
B. Microglia
C. Oligodendrocytes
D. Protoplasmic astrocytes

2. Bipolar neurons are seen in:
A. Sympathetic ganglia
B. Dorsal root ganglion
C. Retina
D. Spinal cord

3. Nissl granules are absent in:
A. Cell body
B. Axon
C. Dendrites
D. Axon hillock

4. Central nervous system contains all the following types of neuroglia, *except:*
A. Astrocytes
B. Oligodendrocytes
C. Satellite cells
D. Microglia

ANSWERS

1. C 2. C 3. D 4. C

Textbook of General Anatomy

Salient Features

- Provides broad outline of introductory remarks for each topic students learn in subsequent regions of anatomy.
- Incorporation of the competencies prescribed by National Medical Council (NMC).
- Simple language and easy-to-understand tables, flowcharts.
- Realistic and self-explanatory images.
- Each chapter has:
  - Learning outcomes with clinical relevance.
  - Clinical application in boxes and case scenarios to facilitate the reader to prepare for competitive examinations.
  - Take home message with key concepts at the end of each chapter.
  - Multiple choice questions (MCQs) at the end.
- Covers additional information needed for understanding importance of dissection and radiological anatomy and surface anatomy.
- This book is highly useful for medical, dental, and allied health courses, and for students of alternate systems of medicine (Ayurveda, Homeopathy, etc.).

V Subhadra Devi MS (Anatomy) is Professor of Anatomy, Apollo Institute of Medical Sciences and Research (AIMSR), Chittoor, Andhra Pradesh, India. She did her graduation and postgraduation from SV Medical College, Tirupati, Andhra Pradesh, India. She worked as teaching faculty in various capacities at SV Medical College, Tirupati; Osmania Medical College, Hyderabad, Telangana, India, and Sri Padmavathi Medical College for Women (SPMCW), Tirupati.

She has more than 40 years of teaching and research experience. She has to her credit 76 publications in both national and international journals. She has authored the *Basic Histology: A Color Atlas and Text,* 3 volumes of *Inderbir Singh's Textbook of Anatomy* and *Inderbir Singh's Human Embryology.*

She is a recipient of Combined Andhra Pradesh State Meritorious Teachers Award. National resource person in Medical Education Technology, Reviewer of Swayam Project of MHRD of Government of India.

She is a Life Member of Anatomical Society of India (ASI), Society of Clinical Anatomists (SOCA), Basic Sciences Association, Indian Geriatric Society, and Indian Society of Human Genetics. She is also Honorary Editor-in-Chief for International Journal of Anatomy and Research and Editorial Board Member for various national and international journals.

Printed in India

Available at all medical bookstores
or buy online at www.jaypeebrothers.com

JAYPEE BROTHERS
Medical Publishers (P) Ltd.
EMCA House, 23/23-B, Ansari Road,
Daryaganj, New Delhi - 110 002, INDIA
www.jaypeebrothers.com

Join us on facebook.com/JaypeeMedicalPublishers

Shelving Recommendation
ANATOMY