

NERVOUS SYSTEM

STRUCTURAL CLASSIFICATION :

1. Central nervous system (CNS) : **Brain, spinal cord.**
2. Peripheral nervous system (PNS) :
 - **Cranial nerves** (carry impulses to & from the brain) + related ganglia.
 - **Spinal nerves** (carry impulses to & from spinal cord) + related ganglia.

FUNCTIONAL CLASSIFICATION OF PNS :

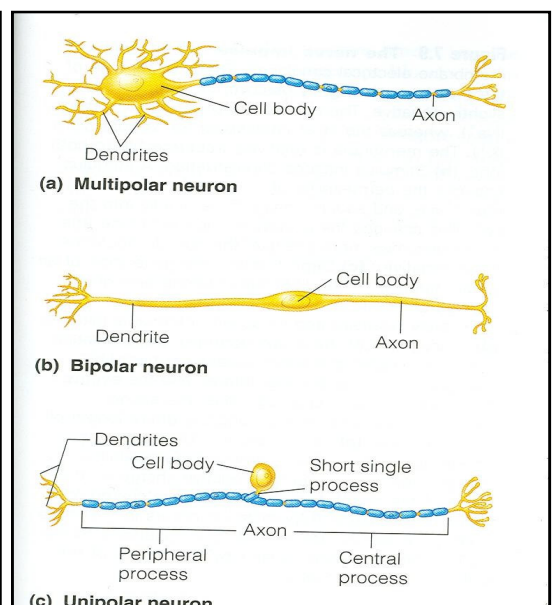
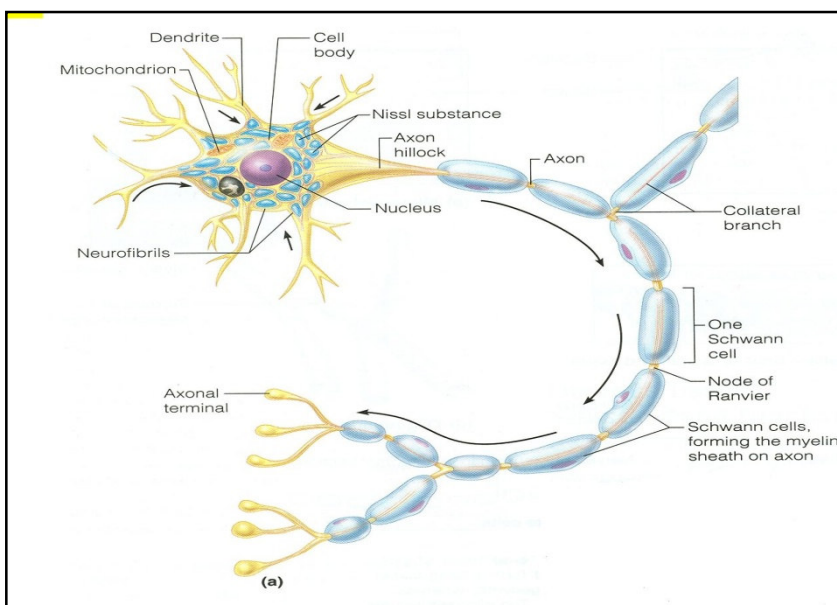
- Sensory (afferent) division : consists of nerves that conduct impulses to CNS.
- Motor (efferent) division : consists of nerves that conduct impulses from CNS. It is divided into :
 1. **Somatic** nervous system : concerned with voluntary control of skeletal muscles.
 2. **Autonomic** nervous system : concerned with involuntary control of glands, smooth & cardiac muscles.

STRUCTURE & FUNCTION OF NERVOUS TISSUE :

- The nervous tissue is formed of two types of cells :
 1. **Neurones.**
 2. **Neuroglia.**

NEURONES :

- **Function** : conduct nerve impulses.
- **Structure** : formed of :
 1. **Body** : contains nucleus.
 2. **Processes** : **axon** (a single process that conducts impulses away from the cell body) and **dendrites** (one or more processes that conduct impulses to the cell body).
- **Coverings** :
 1. **Myelin sheath** : fatty sheath, present in both CNS & PNS.
 - **Formed by** : neurilemma (in PNS) & neuroglia (in CNS).
 - **Function** : insulates neurones.
 2. **Neurilemma (Schwann cells)** : cellular sheath, present in PNS only.
 - **Function** : regenerates axons & forms myelin.



CLASSIFICATIONS OF NEURONES :

- According to number of processes :
 1. **Unipolar neurones.**
 2. **Bipolar neurones.**
 3. **Multipolar neurones.**
- According to function :
 1. **Sensory (afferent) neurones** : carry impulses from receptors to CNS.
 2. **Motor (efferent) neurones** : carry impulses from CNS to muscles & glands.
 3. **Interneurones** : connect sensory & motor neurones.

NEUROGLIA :

- **Function** : support, protect & insulate neurones.
- Difference between neuroglia & neurones :
 1. **Neuroglia do not transmit nerve impulses.**
 2. **Neuroglia never lose the ability to divide.**

DEFINITIONS :

- **Nucleus** : Collections of **cell bodies** of neurones having the same function found in CNS.
- **Ganglia** : Collections of **cell bodies** of neurones having the same function outside CNS.
- **Tract** : collection of **axons** of neurones having the same origin, termination & function found in CNS.
- **Nerves** : collection of **axons** of neurones having the same origin, termination & function outside CNS.
- **Grey matter** of a part of CNS : collections of all nuclei in that part of CNS.
- **White matter** of a part of CNS : collections of all tracts in that part of CNS.

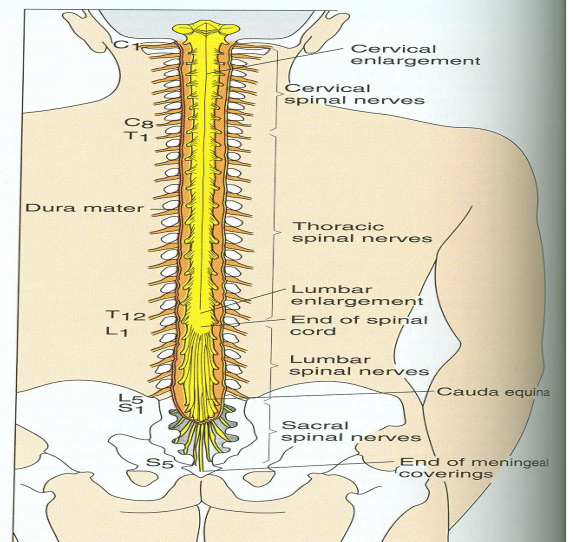
PROTECTION OF CNS :

- **Bones** : Skull, vertebral column.
- **Meninges** : 3 fibrous membranes that covers the CNS :
 1. **Dura matter** : outer, tough.
 2. **Arachnoid matter** : middle, web-like.
 3. **Pia matter** : inner delicate, vascular.
- **Cerebrospinal fluid** :
 1. Fluid similar to plasma in composition.
 2. Formed from blood in the capillaries present inside cavities of CNS (**Choroid plexus**).
 3. Circulates in cavities of CNS then around CNS (**between arachnoid & pia matter**).
 4. Forms a water jacket around CNS.

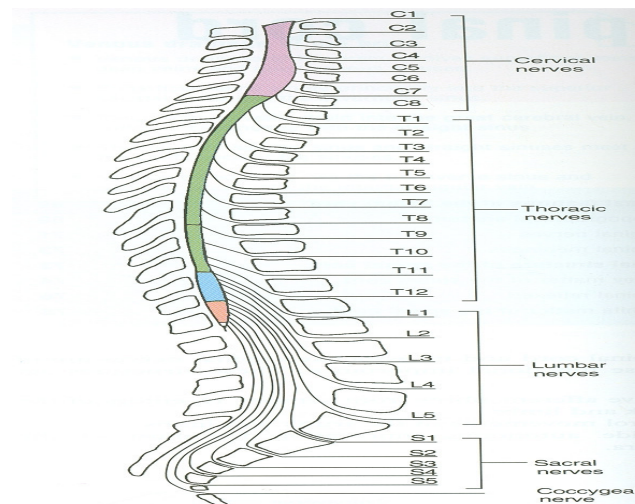
EXTERNAL FEATURES OF SPINAL CORD

THE SPINAL CORD :

- **Shape** : cylindrical.
- **Position** : occupies the upper 2/3 of vertebral canal.
- **Origin** : continuation of medulla oblongata through the margin of **foramen magnum**.
- **Termination** :
 1. **In adult life** : it narrows to form the **conus medullaris** which ends at the level of the disc between L1 & L2.
 2. **Until 3rd month of fetal life** : it occupies the entire length of vertebral canal.
 3. **At birth** : it ends at the level of L3.
- **Segments** : divided into **31 segments** (8 cervical, 12 thoracic, 5 lumbar, 5 sacral & 1 coccygeal).
- **Attachments** : each segment is attached to a **pair of spinal nerves**.
- **Enlargements** :
 1. **Cervical (C3 to T1)** : gives the brachial plexus supplying the upper limb.
 2. **Lumbar (L1 to S3)** : gives lumbar & sacral plexus supplying the lower limb.
- **Cauda equina (horse's tail)** : collection of lumbar, sacral & coccygeal nerves below the termination of the spinal cord.
- **Filum terminale** : a thin fibrous band extending from the tip of conus medullaris (in the middle of cauda equina) to the dorsal surface of first coccygeal vertebra

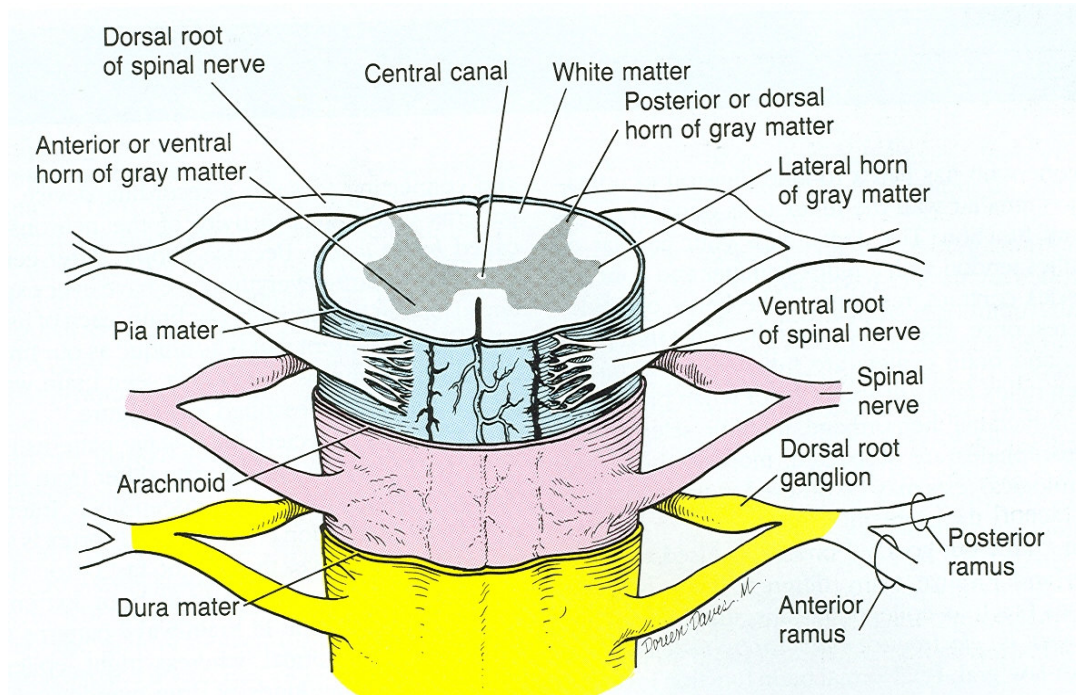


SPINAL NERVES :



- **Number** : **31 pairs** (8 cervical , 12 thoracic, 5 lumbar, 5 sacral & 1 coccygeal).
- **Types of fibers** : mixed (sensory + motor)
- **Site of exit from vertebral canal** :
 - **C1 to C7** : leave above corresponding vertebrae.
 - **C8** : leaves below C7 vertebra.
 - **T1 to L5** : leave below corresponding vertebrae.
 - **S1 to S4** : Leave through sacral foramina.
 - **S5 & coccygeal nerve** : leave through sacral hiatus.

FORMATION OF A SPINAL NERVE :



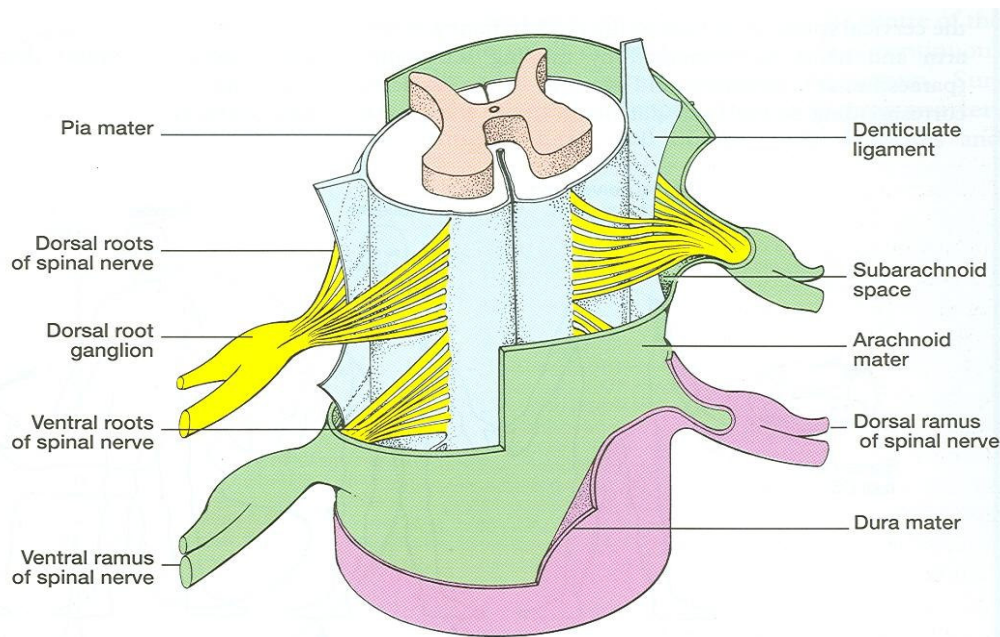
CONSTITUENTS OF A TYPICAL SPINAL NERVE :

- It is attached to spinal cord by **2 roots** :
 - Dorsal (posterior) sensory root** : formed of *afferent neurones*; their cell bodies are located in the dorsal root ganglia which appear as enlargements in the root near the intervertebral foramen.
 - Ventral (anterior) motor root** : formed of *efferent neurones*; their cell bodies are located in the grey matter of spinal cord.
- Both roots unite to form the spinal nerve, just before its exit from intervertebral foramen.
- After its exit : the spinal nerve divides into :
 - Dorsal (posterior) ramus** : a small mixed branch that supplies skin & muscles of the back.
 - Ventral (anterior) ramus** : a larger mixed branch that supplies skin & muscles of limbs and antero-lateral body walls.

SPINAL NERVE INJURY :

- Spinal nerves are exposed to compression by :
 - Spondylosis** : degenerative changes in the joints of vertebral column.
 - Prolapse of intervertebral discs**.
 - Prolapse is common in lumbar region leading to back pain radiating into the legs (**sciatica**).

SPINAL MENINGES :



1) Dura matter :

- Outer covering, thick & dense membrane.
- Separated from the periosteum of the vertebral column by a space called the **epidural space** containing loose fat & a plexus of veins (epidural or internal vertebral venous plexus).
- Ends at the level of **S2**.

2) Arachnoid matter:

- Translucent membrane, between the dura & pia matters.
- Separated from dura by a space called **subdural space** containing serous fluid acting as a bursa between the tough dura & the delicate arachnoid.
- Separated from pia by a space called **subarachnoid space** containing cerebrospinal fluid & blood vessels.
- Ends at level of **S2**.
- Both dura & arachnoid extend to form **sleeves for ventral & dorsal roots** extending as far as fusion of both roots to form the spinal nerves.
- They become continuous with the epineurium of the spinal nerve.

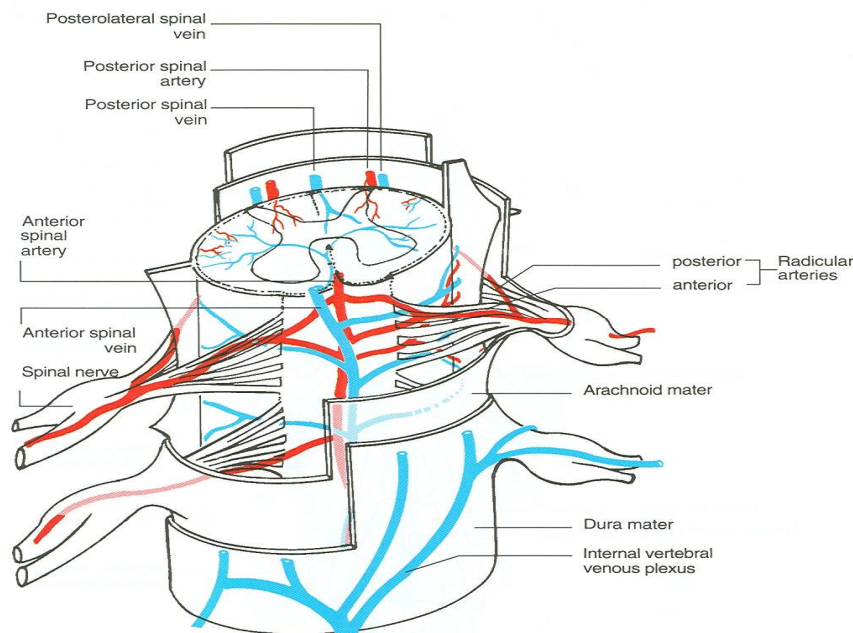
3) Pia matter:

- Inner delicate, vascular, closely applied to spinal cord.
- Along a line midway between the dorsal & ventral roots, the pia projects laterally to form **denticulate ligaments** that pass through arachnoid to be attached to dura.

LUMBAR PUNCTURE :

- The subarachnoid space is large below the level of termination of spinal cord (from L2 to S2). This site is a favorable site for lumbar puncture (**best between L3 & L4 or L2 & L3**).

BLOOD SUPPLY OF SPINAL CORD :



A) Arterial supply :

1. Longitudinal arteries : one anterior spinal & two posterior spinal arteries.

- Branches of 4th part of vertebral artery.
- Run along the length of spinal cord (the anterior artery runs along the anterior median fissure, the posterior arteries run behind the dorsal roots).
- Main supply for cervical part of spinal cord.

2. Transverse (Radicular) arteries :

- Branches of **segmental artery** (vertebral, ascending cervical, posterior intercostal, lumbar arteries).
- Enters through intervertebral foramen and divides into anterior & posterior branches running along the ventral & dorsal roots of the spinal nerve.
- **The great radicular artery (artery of Adamkiewicz)** : a particular large artery that may arise from intercostal or lumbar arteries (from T8 to L3).
- Main supply of the spinal cord, below cervical levels.

B) Venous drainage :

- **Six longitudinal veins** : one anterior, one posterior, two *anterolateral* & two *posterolateral* veins.
- The veins drain into anterior & posterior radicular veins which end into the internal vertebral venous plexus.

DISORDERS OF BLOOD SUPPLY :

- The anterior portion of spinal cord together with its arterial supply (anterior spinal artery) are more liable to be damaged in the thoracic region.
- Occlusion of anterior spinal artery leads to an **acute thoracic cord syndrome** with paraplegia & incontinence.



THE END

LoveTomy Team 426
Team leader : Dr. hams

REVIEW

- The difference between central nerve system and peripheral nerve system :

	CNS	PNS
Consist of	brain & spinal cord	cranial nerves & spinal nerves
Myelin sheath	produce by oligodendroglia	produce by Schwann cell also cause regeneration of axon

- Note : regeneration of nerves only found in peripheral nervous system because it has *Schwann cell*.
- In central nervous system, there is no regeneration, because there is no Schwann cell.
There is Only *oligodendroglia* that cannot make regeneration.

- The difference between dendrites and axon :

	Dendrite	Axon
Direction	to cell body	away from the cell body
Number	numerous	only one
Length	short	long
Myelin sheath	no myelin sheath	has myelin sheath

- The difference between dorsal root and ventral root :

	Dorsal root	Ventral root
Type	Sensory	Motor
Direction	Afferent	Efferent
Cell body	located in the dorsal root ganglia	located in the grey matter of spinal cord
Both roots unite to form the spinal nerve, <i>just before its exit from intervertebral foramen</i>		

- The difference between dorsal ramus and ventral ramus :

	Dorsal ramus	Ventral ramus
Size	small	large
Supply	skin & muscles of the back	skin & muscles of limbs and antero-lateral body walls
Both dorsal and ventral ramus are mixed motor and sensory nerve fibre		

- The difference between Spinal Dura matter and Cranial Dura matter :

- Spinal Dura matter is separated from the periosteum of the vertebral column by a space (**epidural space**).
- In Cranial Dura matter, it is attached to the inside surface of the skull bones without space.

- Note** : the (one) anterior Longitudinal spinal artery actually, it is formed from (two) anterior Longitudinal arteries which **fuse** together.

SELF QUIZ

1- Regarding the spinal cord, choose the incorrect statement :

- a. It bears 2 enlargements the cervical and lumbar.
- b. The rate of elongation of the spinal cord exceeds that of the vertebra Column.
- c. It bears 31 pairs of spinal nerves.
- d. In adults the spinal cord ends at the level of L1-L2.
- e. Cervical plexuses provide innervations to the brachial plexus.

2- All of the following spinal nerves exit below the corresponding vertebra, EXCEPT :

- a. L1.
- b. T8.
- c. T7.
- d. C8.
- e. C4.

3- Choose the correct pair :

- a. Dorsal ramos : efferent fibres.
- b. Spinal nerves : pure motor.
- c. Ventral root : muscles of the front of the body.
- d. Posterior root : afferent fibres.
- e. Ventral ramos : muscles of the back.

4- Regarding the spinal meanings, choose the incorrect statement :

- a. All 3 layers cover the spinal cord.
- b. The Pia mater covers the spinal cord and both the ventral and dorsal roots.
- c. Denticulate ligament is a continuation of the dura mater.
- d. Anaesthetics can be introduced into the epi-dural space.
- e. Dura mater covers the dorsal and ventral roots.

1. b	2. e	3. d	4. c
------	------	------	------