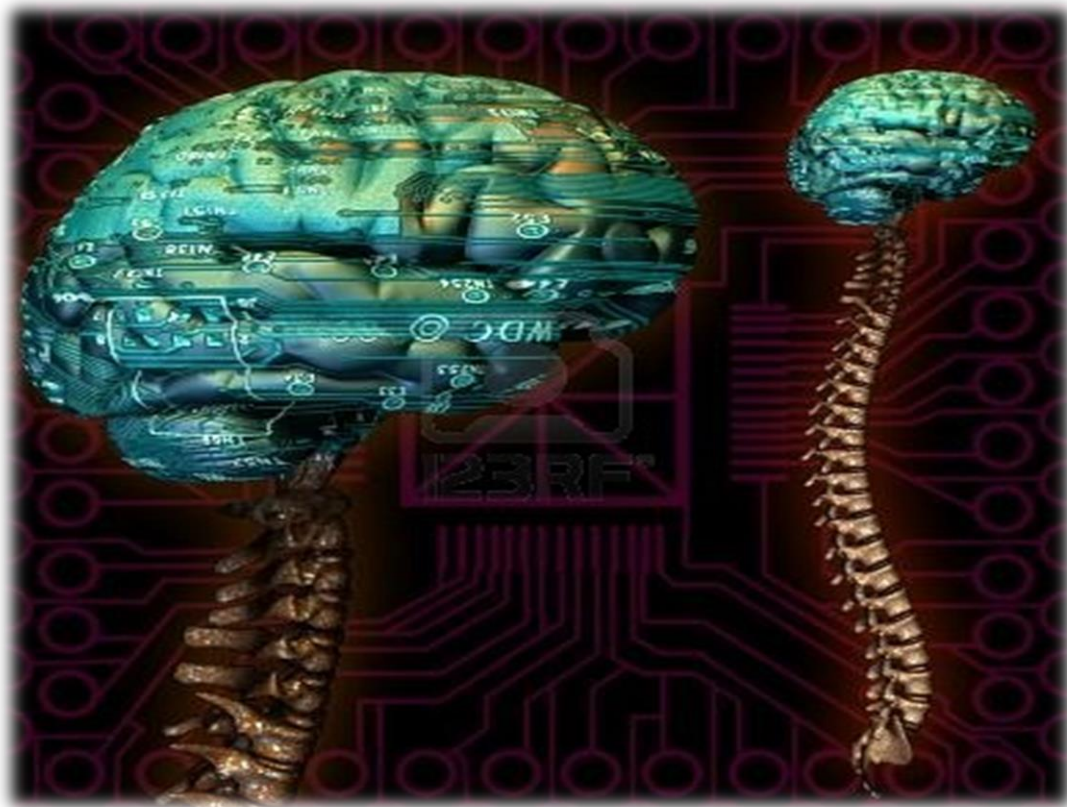




# CNS Block



## LECTURE (ANATOMY OF THE SPINAL CORD)

Done by: Abdulmohsen Almeshari & Yasser alhazzani

Reviewed by: Latifah Al-fahad

تنويه : هذا العمل لا يعتبر مصدر رئيسي للمذاكرة وإنما هو للمراجعة فقط

If there is any mistake please feel free to contact us:

[Anatomyteam32@gmail.com](mailto:Anatomyteam32@gmail.com)

Both - Black

Male Notes - BLUE

Female Notes - GREEN

Explanation and additional notes - ORANGE

Very Important note - Red





# Objectives:

- Describe the external anatomy of the spinal cord.
- Describe the internal anatomy of the spinal cord.
- Describe the spinal nerves: formation, branches and distribution via plexuses.
- Define Dermatome and describe its significance.
- Describe the meninges of the spinal cord.
- Define a reflex and reflex arc, and describe the components of the reflex arc



# Spinal Cord (General Features)

1. Elongated, cylindrical, suspended in the vertebral canal surrounded by the meninges and cerebrospinal fluid (CSF). Approximately 45 cm long in adult males, and is about the thickness of the little finger.

2. Extends from foramen magnum to second lumbar vertebra (L2) (the vertebral canal is longer than the spinal cord)

3. Continuous above with the medulla oblongata.

4. The tapered inferior end forms Conus Medullaris.

5. It is connected to the coccyx by a non-neuronal cord called Filum Terminale.

6. Gives rise to 31 pairs of spinal nerves

7. The bundle of spinal nerves extending inferiorly from lumbosacral enlargement and conus medullaris surround the filum terminale and form cauda equina

8. Segments:

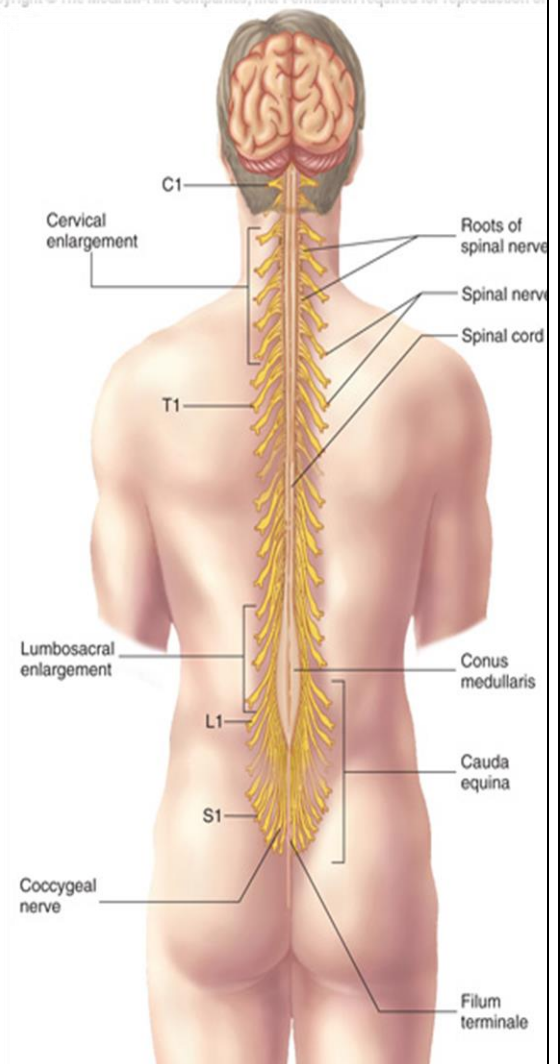
Cervical (8)

Thoracic (12)

Lumbar (5)

Sacral (5)

the spinal cord has a sacral segment although it doesn't reach to sacral bones, because the vertebral column develops faster than the spinal cord.



Posterior view

The spinal cord is protected by bones of the skull, meninges and CSF

9. Not uniform in diameter. It has two enlargements:

Cervical Enlargement: supplies upper limbs.

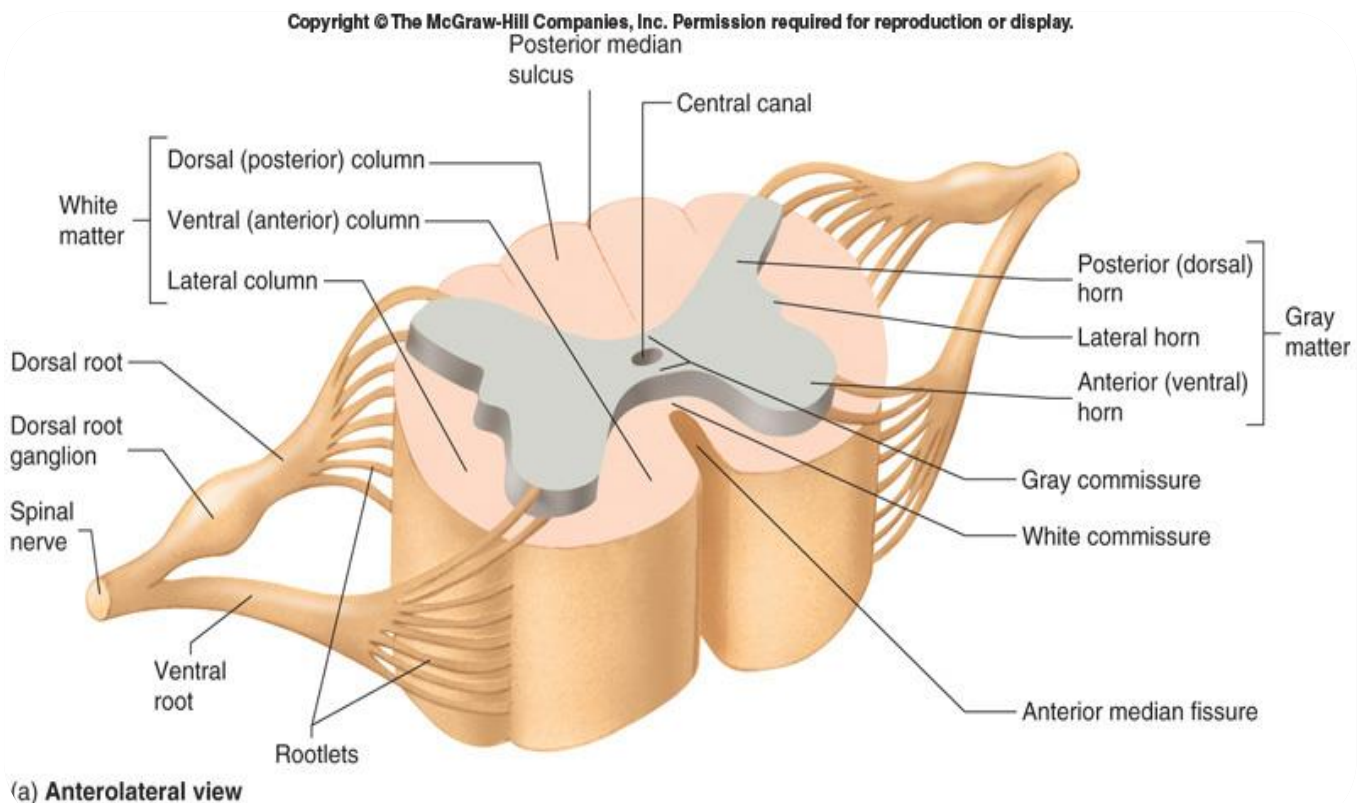
Lumbosacral Enlargement: supplies lower limbs





10. The spinal cord is incompletely divided into two equal parts, anteriorly by a short, shallow median fissure and posteriorly by a deep narrow septum, the posterior median sulcus (septum).

11. the spinal cord is composed of grey matter in the center surrounded by white matter supported by neuroglia.



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12. Commissures: connections between left and right halves

A. Gray Commissure with central canal in the center

B. White Commissure

13. Roots: spinal nerves arise as rootlets then combine to form roots



✓ Dorsal (posterior) root has a ganglion



- ✓ Ventral (anterior)
- ✓ Two roots merge laterally and form the spinal nerve

## Grey Matter

- ❖ The arrangement of grey matter in the spinal cord resembles the shape of the **letter H**, **having two posterior, two anterior and two lateral horns/columns**.
- ❖ Components: NERVE CELL BODIES and their processes, neuroglia and blood vessels. The nerve cells are multipolar, and are of 3 main categories:

### Categories

#### Sensory neurons (Tract cells)

They receive impulses from the periphery of the body and whose axons constitute the ascending fasciculi of the white matter. They are **located in the dorsal horns**

#### Lower motor neurons

1. Transmit impulses to the skeletal muscles.
2. Located in the ventral horns (similar neurons in the lateral horn are the preganglionic neurons of the autonomic system)

#### Interneurons (connector neurons)

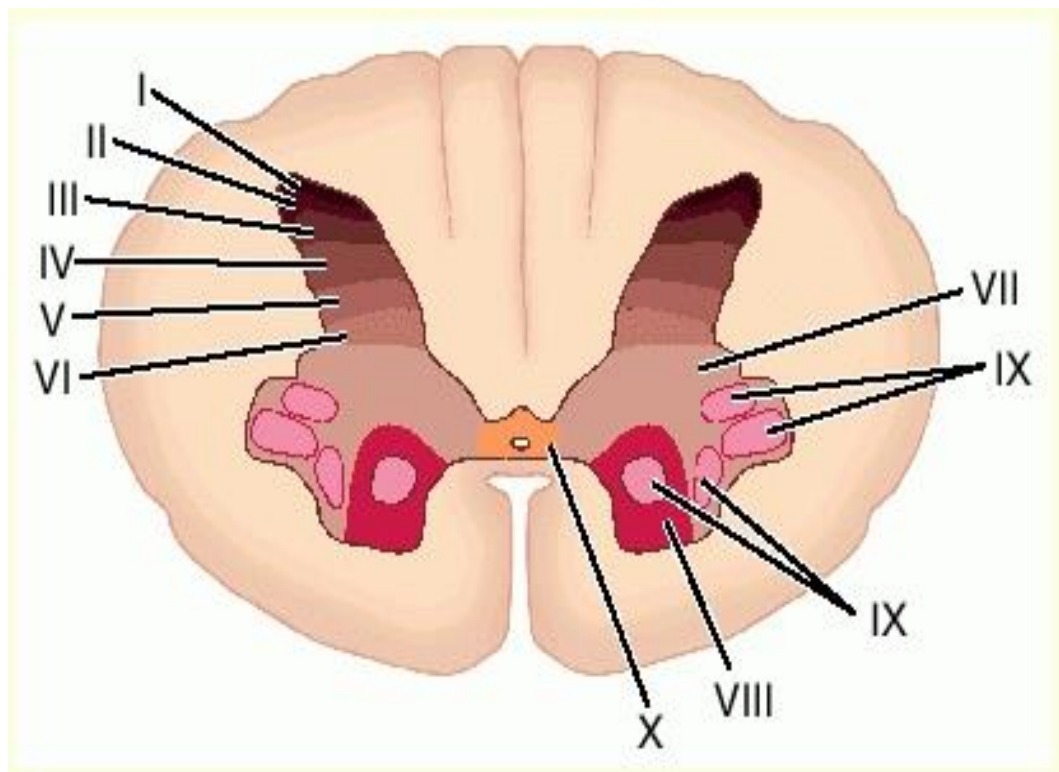
- They link sensory and motor neurons, at the same or different levels, which form spinal reflex arcs. (Without going to the brain)





## Neuronal Architecture of Spinal Grey Matter

- Cells of the same type are clustered into groups, which occur in long columns. (Same type: they share the same function, origin, or destination).
- In transverse section, these columns appear as layers, especially within the dorsal horn.
- These layers are called the laminae of Rexed. (a Swedish neuroscientist), that are numbered consecutively by Roman numerals, starting from the tip of the dorsal horn and moving ventrally into the ventral horn. (10 groups)





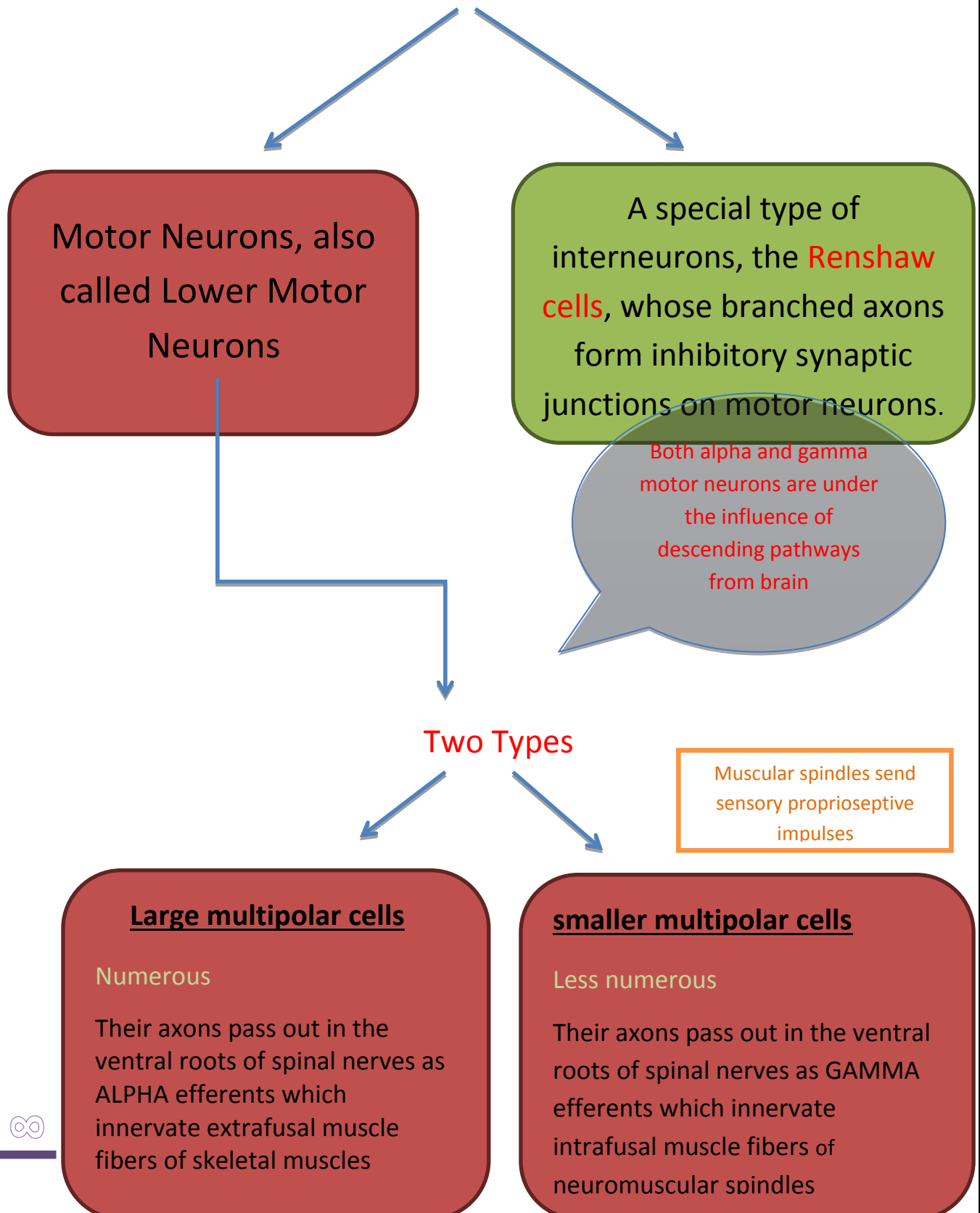
The doctor focused on the following schedule. He said he might ask about the afferents of one of them.

## Nerve Cell Groups in Dorsal Horn

Nerve cell groups	1. Substantia Gelatinosa	2. Nucleus Proprius	3. Nucleus Dorsalis	4. Visceral Afferent
Rexed Lamina #	II	IV	VII	VII
Location	Apex of the horn	Anterior to Substantia Gelatinosa	Base of dorsal horn	Lateral to nucleus dorsalis
Composition	Large Neurons	Large Neurons	Large Neurons	<u>MEDIUM</u> sized neurons
Extension	Throughout the length of spinal cord	Throughout the length of spinal cord	From C8 to L3-4	T1-L3
<u>Afferents</u>	Dorsal root fibers. Pain, Temperature, and touch	Dorsal root fibers. Sense of position & movement (Proprioception) and two point discrimination & vibration	Associated with proprioceptive endings. Dorsal root fibers concerned with information from muscle spindles and tendon organs	Visceral afferents



## Nerve Cell Groups in Ventral Horn

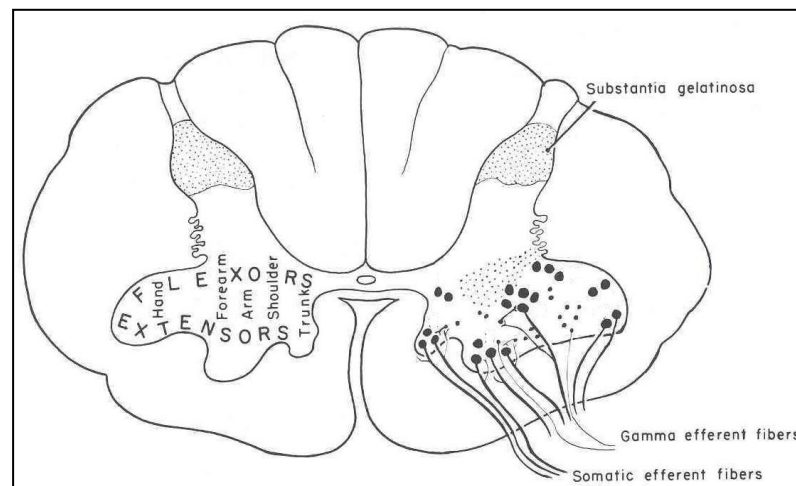






## Organization of Motor Neurons in ventral horn

Groups of motor neurons	1. Medial	2. Central	3. Lateral
Present in	Most segments	Some Cervical (Phrenic C3-5, Spinal Accessory C1-C6) and lumbosacral (L2-S1) segments	Cervical and Lumbosacral segments
Innervation	Muscles of neck and trunk (including intercostal and abdominal muscles)	Note: they are the smallest	Muscles of limbs





Neurons supplying flexor muscles are located dorsal to neurons for extensor muscles

## Nerve Cell Groups in Lateral Horn (Associated with Sympathetic and Parasympathetic fibers)

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Small Column composed of small neurons

1. Extends from T1 to L2-3 segments:

- Gives rise to preganglionic sympathetic fibers

2. Extends from S2-4 segments:

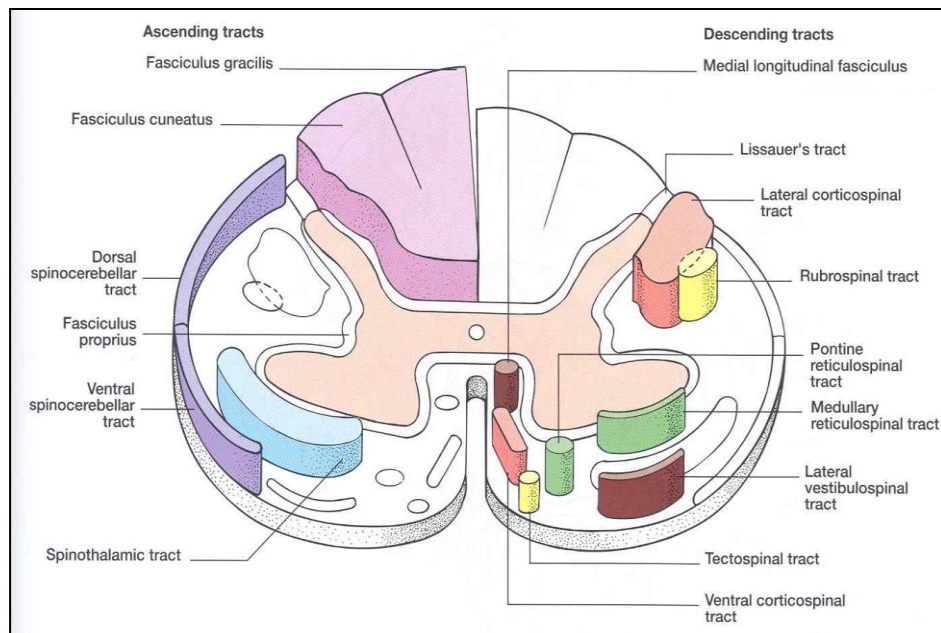
- Gives rise to preganglionic parasympathetic fibers

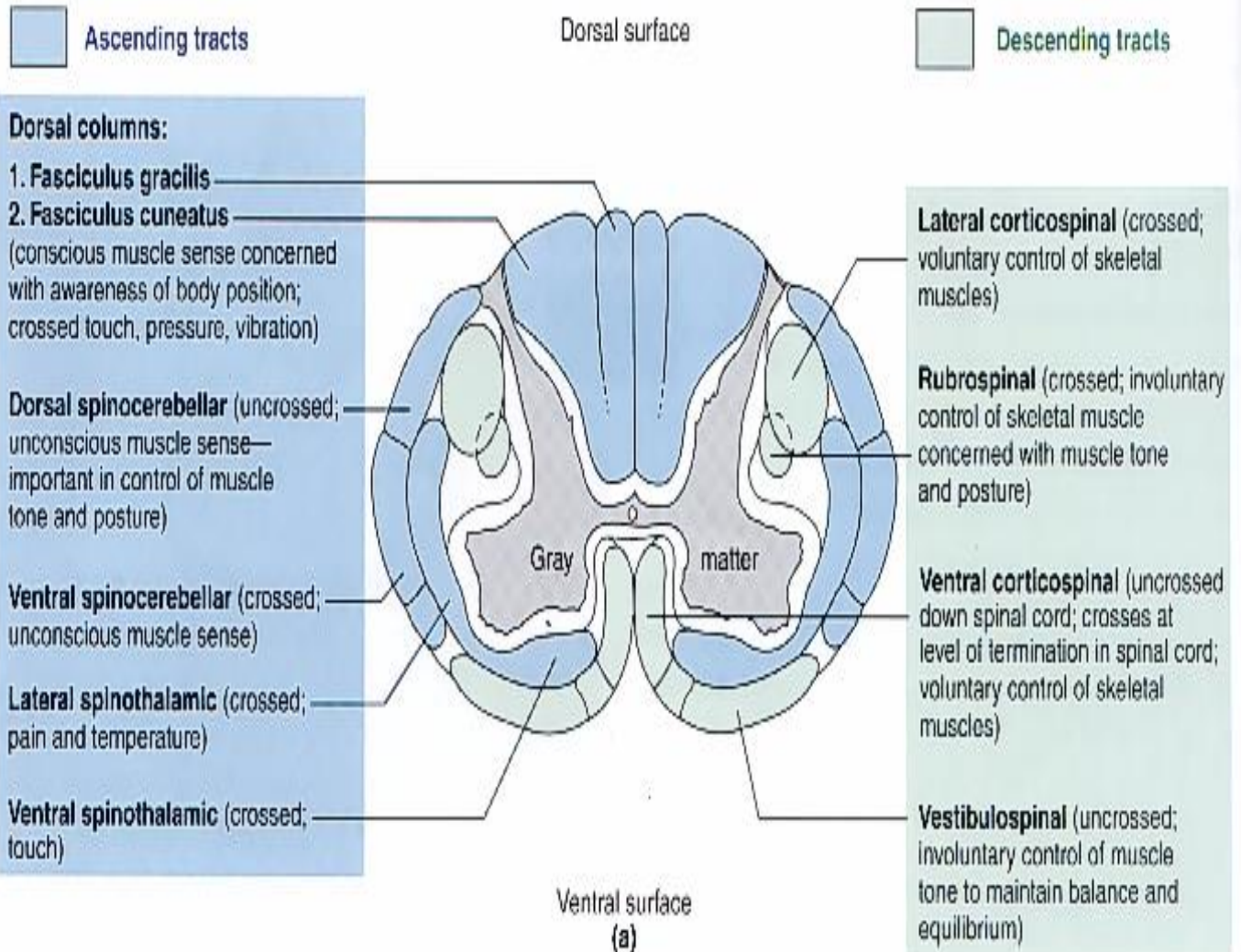


# White Matter (General Information)

1. Consists of mixture of NERVE FIBERS, (Not cell bodies) neuroglia and blood vessels.
2. White color is due to high proportion of MYELINATED nerve fibers
3. The white matter of the spinal cord is arranged in columns/funiculi; anterior, posterior and lateral.
4. The nerve fibers are arranged as bundles, running vertically through the cord.
5. A group of nerve fibers (axons) that share a common origin, termination and function form a tract or fasciculus
6. These tracts are formed by sensory nerve fibers ascending to the brain, motor nerve fibers descending from the brain and fibers of connector neurons.
7. Tracts are often named according to their points of origin and destination, e.g. *spinothalamic*, *corticospinal*.

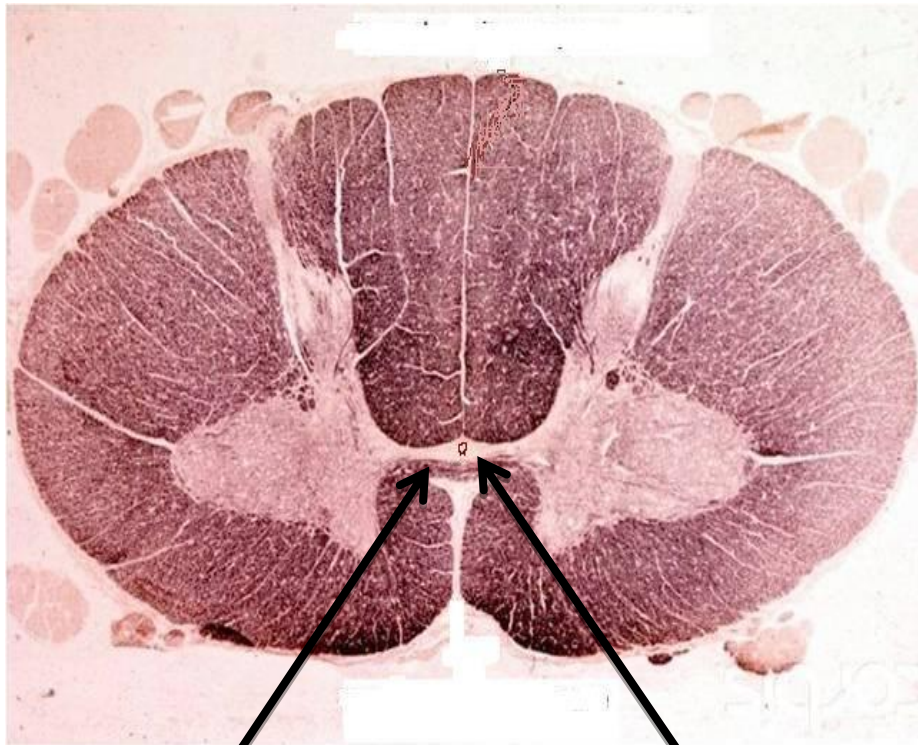
Difference with Grey Matter







## Commissures of the Spinal Cord



### White Commissure:

1. Lies ventral to the gray commissure
2. Mainly contains decussating nerve fibers

### Grey commissure:

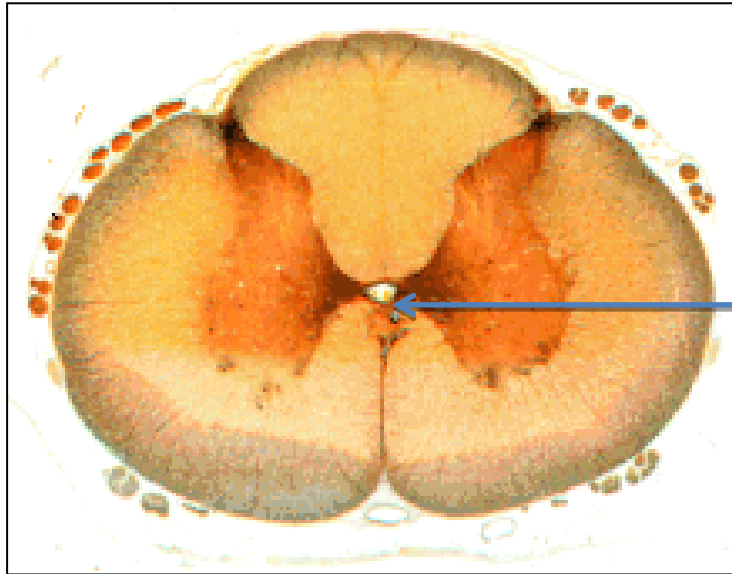
1. Transverse bridge of grey matter connecting the anterior and posterior gray horns on each side.
2. The **CENTRAL CANAL** that divides it into anterior and posterior parts pierces it in the middle.



## Central Canal

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1. The cerebrospinal-filled space that runs longitudinally through the entire length of the spinal cord.
2. Lined by **ependyma (ciliated columnar epithelium)**



3. Continuous with the ventricular system of the brain
4. Superiorly opens into the 4<sup>th</sup> ventricle
5. Inferiorly in the conus medullaris, it expands into the fusiform terminal ventricle and terminates below at the root of filum terminale.





## Regional Differences

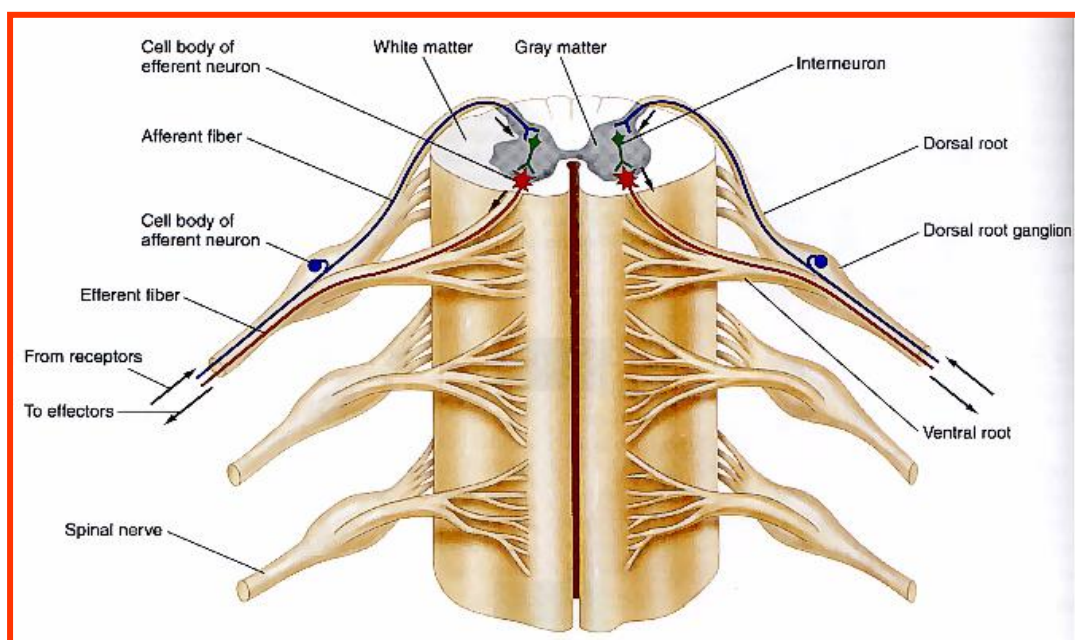
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- Although the general pattern of gray matter is the same throughout spinal cord, regional differences are apparent in transverse sections
- The amount of white matter increases in a caudal-to-cranial direction because fibers are added to ascending tracts and fibers leave descending tracts.
- The gray matter is in increased volume in cervical & lumbosacral enlargements for innervation of upper & lower limbs
- The lateral horn is a characteristic of thoracic and upper lumbar segments



## Spinal Nerves (General Information)

- Thirty-one pairs of spinal nerves
- First pair exit vertebral column between skull and atlas, last four pairs exit via the sacral foramina and others exit through intervertebral foramina



- Eight pair cervical, twelve pair thoracic, five pair lumbar, five pair sacral, one pair coccygeal
- Each spinal nerve arises as rootlets which then combine to form dorsal (posterior) & ventral (anterior) roots.
- Two roots merge laterally and form the spinal nerve.
- Dorsal (posterior) root has a ganglion (dorsal root/sensory ganglion) that contains the cell bodies of the sensory neurons.
- Each spinal nerve then divides into a smaller dorsal and a larger ventral ramus



## Branches of Spinal Nerves

1. Dorsal Ramus: innervate deep muscles of the trunk responsible for movements of the vertebral column and skin near the midline of the back.
2. Communicating Rami: communicate with sympathetic chain of ganglia
3. Ventral Ramus: what they innervate depends upon which part of the spinal cord is considered:

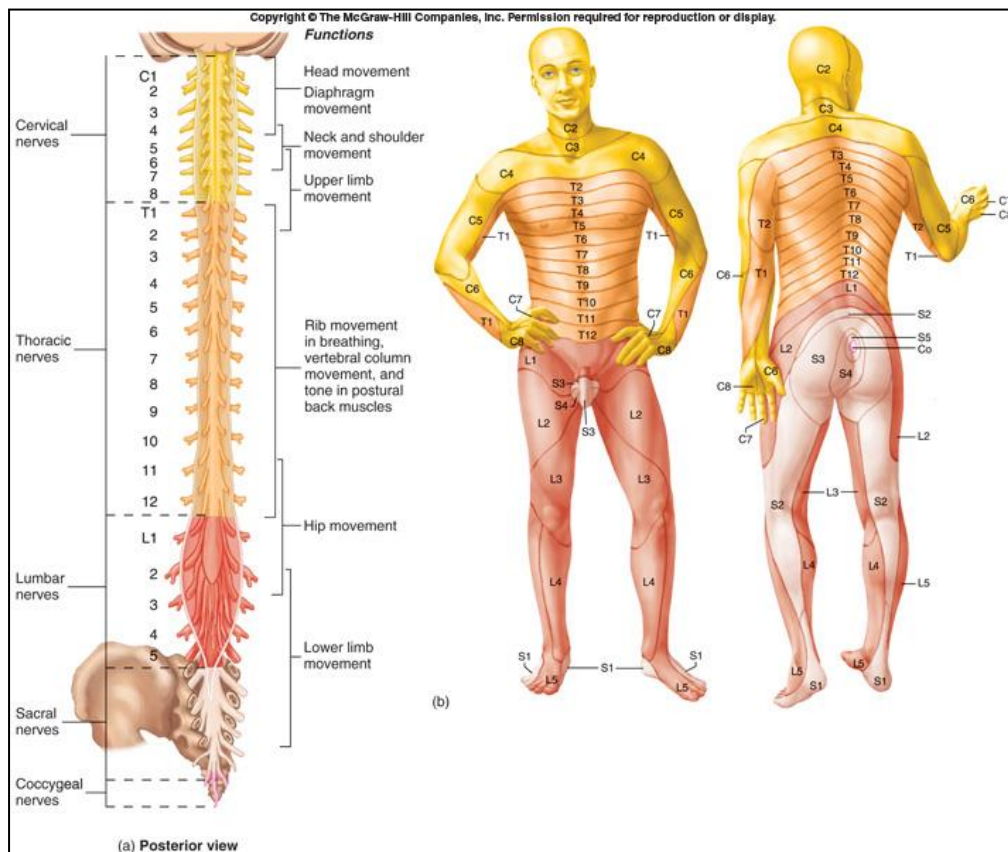
**Thoracic region:** form **intercostal nerves** that innervate the intercostal muscles and the skin over the thorax

Remaining spinal nerve ventral rami (**roots** of the plexus): **form five plexuses** (intermingling of nerves).

- Ventral rami of C1-C4= **cervical plexus**
- Ventral rami of C5-T1= **brachial plexus**
- Ventral rami of L1-L5= **lumbar plexus**
- Ventral rami of L4-S4= **sacral plexus**
- Ventral rami of S4 & S5= **coccygeal plexus**

# Dermatomes

- A dermatome is an area of skin in which sensory nerves derive from a single spinal nerve root (or in other words, is a segment of skin supplied by one spinal nerve)
- Cutaneous areas supplied by adjacent spinal nerves overlap. There is therefore little or no sensory loss after interruption of a single spinal nerve or dorsal root



**Help to diagnose the level of spinal cord injury**



## Spinal Meninges

- Connective tissue membranes that surround the spinal cord and brain:

	Dura Mater	Arachnoid Mater	Pia Mater
Characteristics	<b>tough outer layer.</b> Continuous with epineurium of spinal nerves	Thin and wispy layer <b>deeper to dura mater</b>	<b>delicate membrane</b> bound tightly to surface of brain and spinal cord. It forms the filum terminale, which anchors spinal cord to coccyx and the denticulate ligaments that attach the spinal cord to the dura mater.

- Spaces:

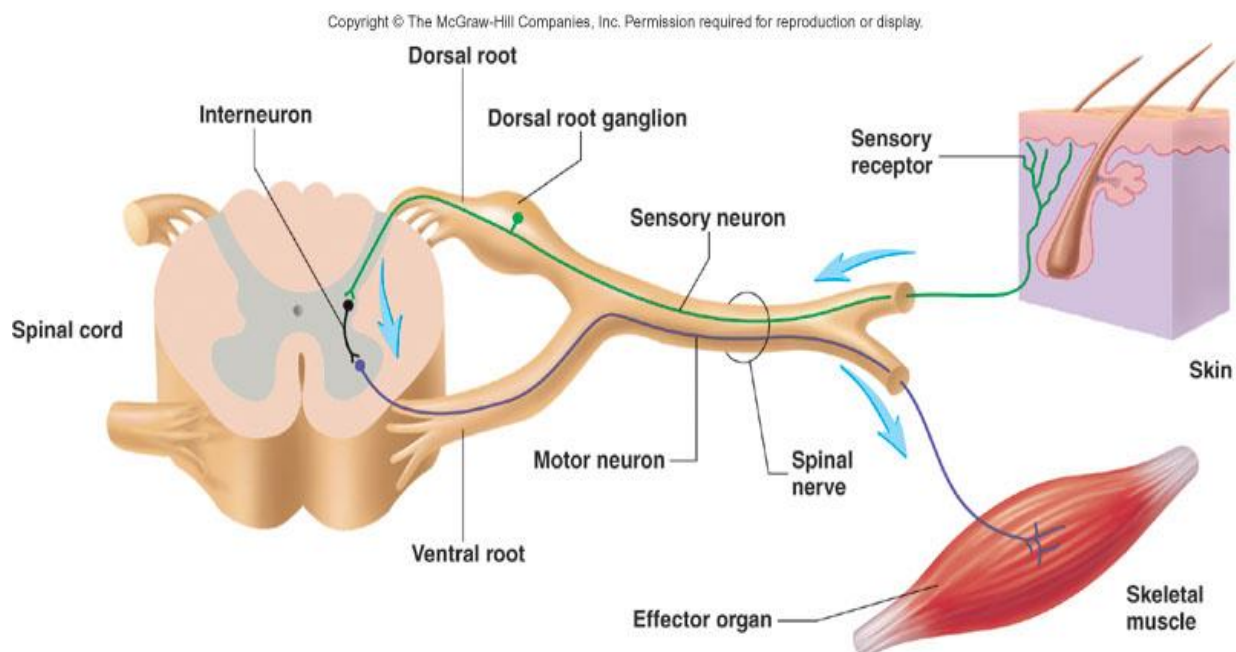
	Epidural	Subdural	Subarachnoid
Characteristics	Contains blood vessels, connective tissue and fat	<b>a potential cavity between the dura and arachnoid mater.</b> Contains serous fluid	Contains CSF and blood vessels <b>within web-like strands of arachnoid tissue</b>



## Reflex & Reflex Arc

A reflex is a rapid, involuntary, stereotyped pattern of response brought by a sensory stimulus

A neural pathway mediating the reflex actions is called reflex arc



### Components of a reflex arc:

1. Sensory Receptor
2. Sensory Neuron
3. Interneuron
4. Motor Neuron
5. Effector Organ (which responds with a reflex)





## Variety of reflex

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Some integrated within spinal cord; some within brain

Some involve excitatory neurons yielding a response; some involve inhibitory neurons that prevent an action

Higher brain centers can influence, suppress, or exaggerate reflex responses



# Quiz

**1. Spinal cord Extends from foramen magnum to**

- a) 4th sacral vertebra
- b) second lumbar vertebra
- c) 1<sup>st</sup> coccygeal vertebra
- d) second sacral vertebra

**2. Spinal Cord Gives rise to :**

- a) 2 pair coccygeal Segment of spinal nerves
- b) 7 pair cervical Segment of spinal nerves
- c) 4 pair coccygeal Segment of spinal nerves
- d) 8 pair cervical Segment of spinal nerves

**3. Substantia Gelatinosa:**

- a) Rexed Laminae I
- b) Rexed Laminae II
- c) Rexed Lamina IV
- d) Rexed Lamina VII

**4. Which one of the following is associated with proprioceptive endings:**

- a) Nucleus Proprius
- b) Visceral Afferent Nucleus
- c) Clark's column
- d) Substantia Gelatinosa

**5. Visceral Afferent Nucleus :**

- a) Extends from C8 to L3-4 segments
- b) Rexed Lamina IV
- c) composed mostly of medium size neurons
- d) Located at the base of dorsal horn

**6. Central Canal**

- a) Superiorly opens into the 3<sup>rd</sup> ventricle



- b) Lined by ependyma
- c) Superiorly opens into the 2<sup>nd</sup> ventricle
- d) Lined by columnar epithelium

**7. The amount of white matter of spinal cord**

- a) increases in a cranial-to-caudal direction
- b) increases in a caudal-to-cranial direction
- c) it is the
- d) same along with spinal cord

**8. Motor Neurons in Ventral Horn consist :**

- a) alpha efferents which innervate extrafusal muscle fibers
- b) gamma efferents which innervate extrafusal muscle fibers
- c) beta efferents which innervate intrafusal muscle fibers

**9. abdominal muscles innervated by :**

- a) **Central** Motor neurons
- b) **Lateral** Motor neurons
- c) **Medial** Motor neurons

**10. brachial plexus :**

- a) Ventral rami of C1-C4
- b) Dorsal rami of C5-T1
- c) Dorsal rami of C8-T1
- d) Ventral rami of C5-T1

**11. Which one of these spaces is Contains CSF**

- a) Subarachnoid
- b) Epidural space
- c) Subdural space

**12. Which one of the following Located at the base of dorsal horn**

- a) Substantia Gelatinosa
- b) Visceral Afferent Nucleus
- c) Nucleus thoracis
- d) Nucleus Proprius**

**13. Which statement is NOT true?**

- a) Alpha efferents innervate extrafusal muscle fibers.
- b) Nucleus Dorsalis extends from T1 to L3 segments
- c) Substantia Gelatinosa concerned with pain, temperature and touch



d) Visceral Afferent Nucleus composed mostly of medium size neurons

1	B
2	D
3	B
4	C
5	C
6	B
7	B
8	A
9	C
10	D
11	A
12	C
13	B

**GOOD LUCK**

**Anatomy Team Leaders:**

**Fahad AlShayhan & Eman AL-Bedica.**