

The grey matter of the spinal cord :

### Anterior horns

Each nucleus of anterior horn contains:

Large multipolar nerve cells which give  $\alpha$ -efferents that innervate extrafusal skeletal muscle.

Small multipolar nerve cells which give  $\beta$ -efferents which innervate contractile elements of muscle spindles (intrafusal muscle fibers ) the 2nd order neurons of the somatic motor pathway

3 groups of nuclei are present in the anterior horns:

(1) Medial group: It includes: antero& postero- medial group It is present in all segments of spinal cord It innervates axial muscles (intercostal & abdominal).

(2) Central group: Present in all the segments except thoracic segments, It innervates some muscle of the neck (spinal XI), diaphragm & external anal and urethral sphincters

Phrenic nucleus: part of central nucleus of anterior horn of C2- C5 for innervations of diaphragm.

Spinal accessory nucleus: Is a part of central nucleus of anterior horn of C1- C5 for innervations of trapezoid and sternomastoid muscles

(3) Lateral group: It includes antero& postero-lateral, Present in all the segments except thoracic segments, It innervates the skeletal muscles of upper and lower limbs

### Posterior horn

Posteromarginal nucleus: It covers the tip of posterior horn In all levels of spinal segments. It mediates pain and temperature sensation

SGR: Its nerve cells are present at the apex of the posterior horns beneath the posteromarginal nucleus. Present in all levels of spinal segments, Its cells form the 2nd order neurons in the pathway of pain and temperature sensations (lateral spino- thalamic tract), It is the homologue of spinal trigeminal nucleus

(3) Main sensory nucleus (Nucleus proprius): Its cells are present in the centre of the posterior horns. Present in all levels of spinal segments. Its cells form the 2nd order neurons in the pathway of crude (light) touch (anterior spino- thalamic tract)

(4) Clark's nucleus (nucleus dorsalis): Its cells present at the base of posterior horn. Present in (C8 - L3). Its cells form the 2nd order neurons of anterior&posterior spino- cerebellar tracts (unconscious proprioception)

### Lateral horns

Sympathetic nuclei: (T1\_L2 )contain intermediolateral sympathetic nuclei. They give preganglionic fibers which pass in anterior root of spinal nerve

Parasympathetic nuclei: Present in S (2\_4 )

## The tracts in white matter of spinal cord

### Short associative tracts

(ascending or descending tracts that begin and terminate in the spinal cord. Their functions are association and coordination of the different movements of the body with each other) 4 short tracts in spinal cord:

**Fasciculi proprii, Lissauer's, Comma shaped and Septo-marginal)**

### Long tracts:

#### Long ascending tracts (sensory)

carry sensation from all the body **except the head**. The sensations from the head are carried by **trigeminal nerve**

These sensory tracts are divided into three categories according to their termination

**I- Sensory tracts that reach cerebral cortex (C.C.): -**

All these tracts are known to carry **conscious sensations** which reach the cerebral cortex of **opposite side (crossed)** and any lesion in one of them leads to loss of sensation on the opposite side

They are 4 tracts:

**1- Lateral spinothalamic 2- Ventral (anterior) spinothalamic. 3- Gracile tract. 4- Cuneate tract**

**II - Sensory tracts that reach cerebellum (spinocerebellar pathway): -**

These tracts do not reach C.C. but carry sensation to cerebellar cortex of the **same side for coordination (uncrossed) except anterior spinocerebellar**, Lesion in one of them does not lead to loss of sensation but leads to loss of coordination.

They are 4 tracts:

**1- Dorsal (posterior) spinocerebellar 2- Cuneocerebellar. 3- Ventral (anterior) spinocerebellar 4- Rostral spinocerebellar**

**III-Sensory tracts that reach brain stem:**

**1- Spino-tectal 2- Spino-olivary**

#### Long descending tracts (motor)

• All voluntary movements are done by nerve impulse starting from cerebral cortex, to **Anterior Horn Cells of spinal cord or motor nuclei of cranial nerves (bulbar) then go to skeletal muscle**

This pathway is divided into upper and lower motor neuron (or 1st, 2nd and 3rd order neurons)

The axons of upper motor neuron reach lower motor neuron through long descending tracts., The lower motor neuron includes anterior horn cells of the spinal cord and motor cranial nuclei of the brain stem

The long descending tracts are classified into:

#### **Pyramidal tracts:**

**1 Cortico-spinal tract → to spinal cord**

**2 Cortico-bulbar (cortico nuclear) → to cranial nerve nuclei**

Each pyramid in lower medulla contains about 1 million axons, Most of pyramidal cells are 10-50 μm (small).

Axons of the largest pyramidal cells supplying the digits arise from Betz cells (3.5%). These cells are the largest in size 120 μm in height.

#### **Extra-pyramidal tracts:**

**4 single tracts and 2 paired tracts:**

- ✓ **Rubrospinal tract**
- ✓ **Olivospinal tract**
- ✓ **Sulco-marginal tract (medial longitudinal bundle or fasciculus MLB=MLF)**
- ✓ **Tecto-spiral tract**
- ✓ **Lateral & ventral (anterior) reticulo-spinal tracts**
- ✓ **Lateral & ventral (medial) vestibulo-spinal tract**

Levels of the spinal cord	
cervical region	The grey matter contains all motor, sensory and commissural nuclei <b>except Clark`s nucleus</b> (only present in C8). • The white matter is abundant and full of almost all short and long tracts <b>(except the septomarginal tract)</b>
upper thoracic region	The posterior horns contain <b>Clark`s nucleus</b> in addition to the same nuclei in the cervical region the anterior horns contain <b>the medial nuclei only.</b> <b>It has lateral horns which contain sympathetic nuclei.</b> The white matter contains the same tracts as in cervical region <b>except olivospinal, ventral vestibulospinal &amp; tectospinal tract</b> <b>3 disappeared tracts</b>
lower thoracic region	The posterior horns contain <b>Clark`s nucleus</b> in addition to the same nuclei in the cervical region while the anterior horns contain <b>the medial nuclei only.</b> <b>It has lateral horns which contain sympathetic nuclei.</b> • The white matter contains the same tracts as in cervical region <b>except comma shaped tract, cuneate tract and direct pyramidal tract</b> in addition to the three previous absent tracts. Vs  <b>The septomarginal short tract appears.</b> <b>6 disappeared tracts</b>
lumber region	• The grey matter contains all motor, sensory and commissural nuclei (lateral horn present only in L1 &L2) • The white matter contains the same tracts as in lower thoracic but; <b>posterior spinocerebellar tract is absent</b> <b>7 disappeared tracts</b>

### **spinal lemniscus=**

#### THE LATERAL SPINOTHALAMIC TRACT

Neolateralspinothalamustract carry mechanosensitive , thermosensitive pain sensation and cold sensation=A-delta = VPLN=sensory areas

Plaeolateralspinothalamustract carry chemosensitive pain sensationand warm sensation = C afferent nerve fibers = reticularformation =all areas of cerebral cortex.

#### THE VENTRAL SPINOTHALAMIC TRACT

A-delta and C afferent nerve fibers to main sensory nucleus \_ventral posterolateral nucleus(VPLN) in thalamus \_the cortical sensory areas

- This tract transmits 1- crude touch 2- crude pressure 3- the tickle and itch sensations.

## Medulla oblongata

closed m.o motor decussation	closed m.o sensory decussation	open m.o
<p>It contains central canal which is posterior</p> <p><b>Gracile and cuneate nuclei start to appear</b> and they are small while their tracts are large.</p> <p><b>Spinal trigeminal nucleus and tract</b> replace the substantia gelatinosa of Rolandi and Lissauer`s tract</p> <p><b>80-90 % of pyramidal fibers cross to opposite side forming motor decussation</b></p> <p>10-20 % descend as direct pyramidal tract.</p> <p><b>Physiology :</b></p> <p><b>THE GRACILE AND CUNEATE TRACTS</b></p> <p>These tractstransport:</p> <ol style="list-style-type: none"> <li>1. Fine touch sensations</li> <li>2. Fine pressure and muscle tension sensations.</li> <li>3. The vibration sense</li> <li>4. The conscious proprioceptive sensations.</li> </ol> <p>First order neurons: DRG ; <b>A-alpha and beta</b> afferent nerve fibers enter the spinal cord, then immediately divide into <b>medial and lateral branches</b>. <b>The medial branch</b> turns upwards in the ipsilateral dorsal column relay in the gracile and cuneate nuclei in the medulla oblongata .</p> <ul style="list-style-type: none"> <li>▪ The gracile tract carries sensations from the lower part of the body and lies medially in the dorsal column</li> <li>▪ The cuneate tract carries sensations from the upper part of the body and lies laterally in the dorsal column</li> </ul>	<p>It contains central canal which becomes more posterior</p> <p><b>Gracile and cuneate nuclei are large</b> while their tracts become small</p> <p>Axons from gracile and cuneate nuclei form the <b>internal arcuate fibers</b> which cross to opposite side forming sensory decussation</p> <p>The crossed sensory fibers ascend in the opposite side as <b>medial lemniscus</b></p> <p><b>The ventral (anterior) vestibulo spinal tract and sulcomarginal tract</b> join each other and form <b>medial longitudinal bundle (fasciculus)</b></p> <p>Cortico-spinal fibers (pyramidal tract) are present on both sides of anterior median fissure and form two masses on the anterior surface of the medulla (pyramids)</p> <p>Lower parts of some cranial nerve nuclei start to appear in the grey matter around the central canal which are:</p> <ol style="list-style-type: none"> <li>a) Hypoglossal nucleus</li> <li>b) Dorsal vagal nucleus (motor)</li> <li>c) lower part solitary nucleus of vagus</li> </ol>	<p>No central canal (the central canal opens posteriorly into 4th ventricle)</p> <p>The pyramids are present in the anterior part</p> <p>In the midline there are: -</p> <p>Medial longitudinal bundle (posterior) Tecto spinal tract (at the middle) Medial lemniscus (anterior)</p> <p>The grey matter has increased due to the presence of Olivary complex which include: -</p> <p><b>Inferior olivary nucleus (the largest one)</b> <b>Dorsal and medial accessory olivary nuclei</b> which are smaller</p> <p><b>The arcuate nuclei:they lie anterior to the pyramids. They are descending pontine nuclei that give the motor external arcuate fibers in the corticocerebellar pathway</b></p> <p><b>Reticular formation</b></p> <p>Presence of cranial nerve nuclei of the lower 4 cranial nerves (9, 10, 11 &amp;12):</p> <p><b>The sensory nuclei of cranial nerves (IX &amp; X) form solitary nucleus</b></p> <p><b>the motor nuclei of cranial nerves (IX, X and XI) form nucleus ambigus and dorsal nucleus of vagus.</b></p> <p><b>5th (trigeminal) spinal nucleus and tract. 8th (vestibular; medial, lateral &amp; inferior) and cochlear nuclei start to appear</b></p> <p>Inferior cerebellar peduncles (I.C.P) are laterally located.</p>

What is the second order neuron for the dorsal column medial lemniscus (Archive )?

**a. Gracile and cuneate nuclei\*\***

**b. the ventral posterolateral (VPL) nucleus of the thalamus**

**c. dorsal root ganglia at all levels.**

All of the following tracts are ASCENDING except (Archive )?

a.Dorsal column-medial lemniscus

**a.Dorsal column-medial lemniscus**

**b.Ventral spinothalamic tract**

**c.Lateral spinothalamic tract**

**d.dorsal spinothalamic tract\*\*\***

**e.Cuneocerebellar tract**

