



Central Nervous System

Lecture 2: Spinal Cord

Dr. Ashraf Ramzy

Professor of Anatomy & Embryology

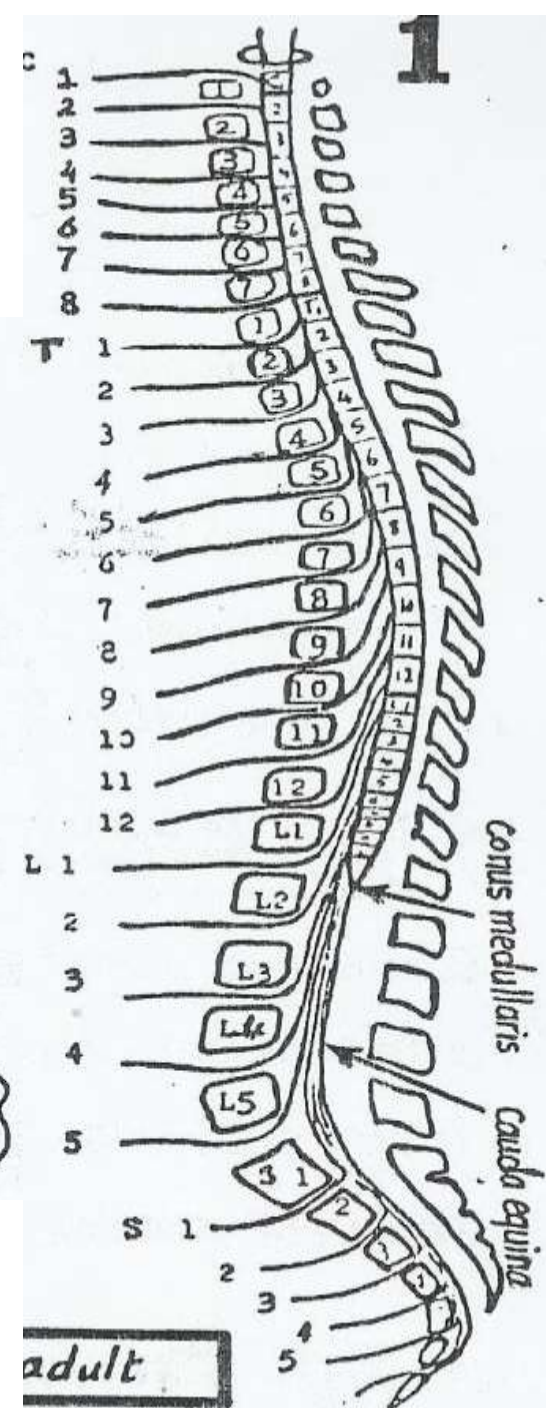
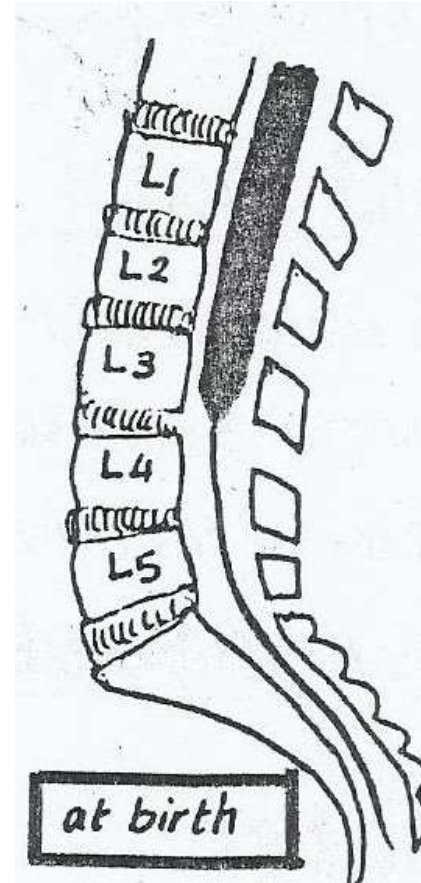
ash-ramzy@hotmail.com

النوتات باللون الأخضر

**** Site:**

Spinal Cord

- * Occupies the upper 2/3 of the vertebral canal.
- * القناة الي داخل العمود الفقري
- * Begins opposite the upper border of Atlas vertebra, as a continuation of the medulla oblongata. (At the foramen magnum)
- * Ends opposite the disc between L1 & 2 in adults. At birth, it ends opposite L3. Later, the vertebral column grows faster than the spinal cord. أكيد ما قصرش وإنما الثنين بطولوا بس مش بنفس السرعة....
- * العمود الفقري أسرع



Length: 45 cm.

ال vertebral canal طولها حوالي 70 سم وبالتالي رح يكون موجود بالثلثين العلويات فقط

****Shape: cylindrical** but shows:

* **2 enlargements:**

1. Cervical enlargement: gives origin to brachial plexus (C4-T1). لي رح يغذي الجلد والعضلات في الأطراف العلوية

2. Lumbar enlargement: الي رح يغذوا الأطراف السفلية gives origin to lumbar & sacral plexuses (L1-S4).

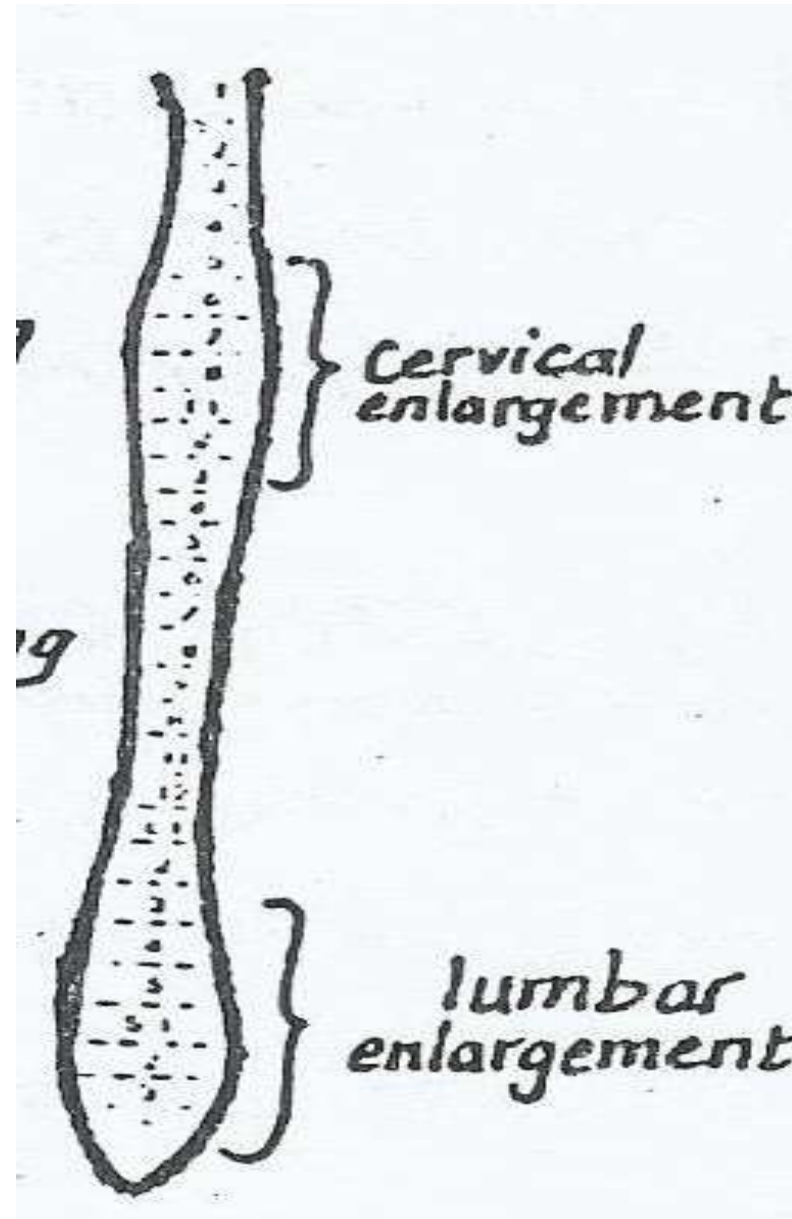
* **A tapering lower end called conus medullaris.**

conus جاي من قمع أو مخروط لأنه هيك شكله...

medullaris جاي من اسم ال spinal cord باللاتيني والي هو medullaris spinalis

From its apex, a thin filament of pia mater called filum terminale extends down to be attached to the back of coccyx.

ال pia mater هي الطبقة الملزقة بال spinal cord مباشرة رح تكمل على شكل خيط نازل من راس هذا المخروط



**** 31 segments** → 8 cervical,
12 thoracic, 5 lumbar, 5
sacral & 1 coccygeal.

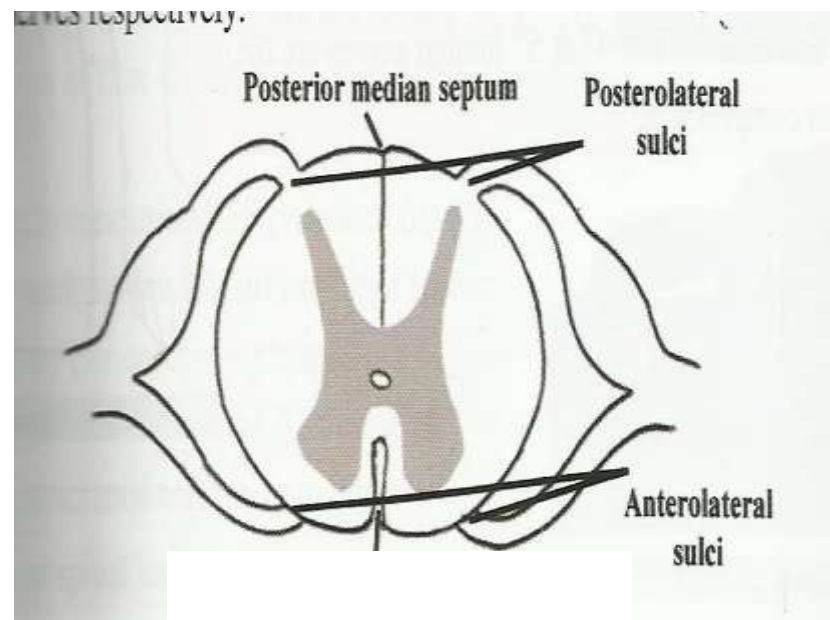
**** Segments** are not
demarcated externally but
each segment gives origin to
a pair of spinal nerves.

فشي واضح بفصل القطع عن بعضها .. احنا بنعرف اننا
خلصنا قطعة وبيدينا في الي بعدها من الأعصاب الطالعة
.... كل عصب طالع من قطعة

**** Longitudinal grooves:**

شغلات ماشية على طول ال spinal cord

1. an anterior median fissure & a posterior median septum divide the cord almost completely into right and left halves.
2. 2 posterolateral & 2 anterolateral sulci give attachment to posterior & anterior roots of spinal nerves respectively.



Anterior median sulcus

**** Levels:** spinal cord segments do not lie opposite the corresponding vertebrae

ال spinal cord segments كلهن محشورات
 قبال 20 فقرة من فقرات العمود الفقري يعني
 بقدرش أقول إن كل قطعة بتيجي قبال الفقرة
 الي الها نفس الرقم وإنما في قواعد عشان
 اعرف كل قطعة قبال أي فقرة

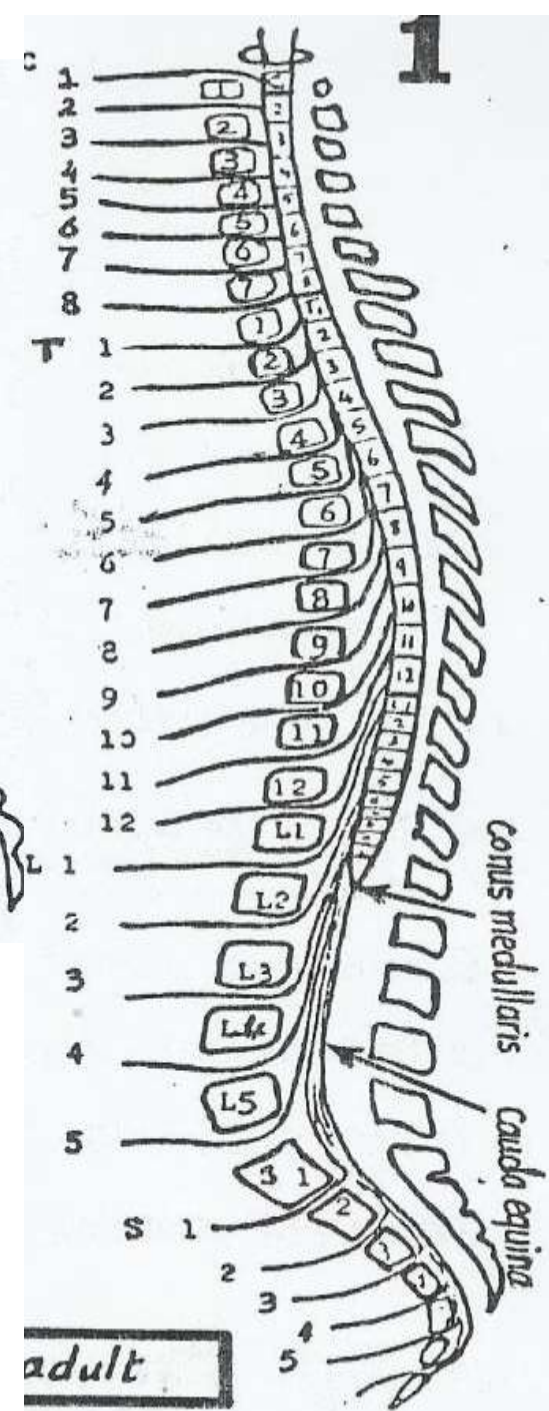
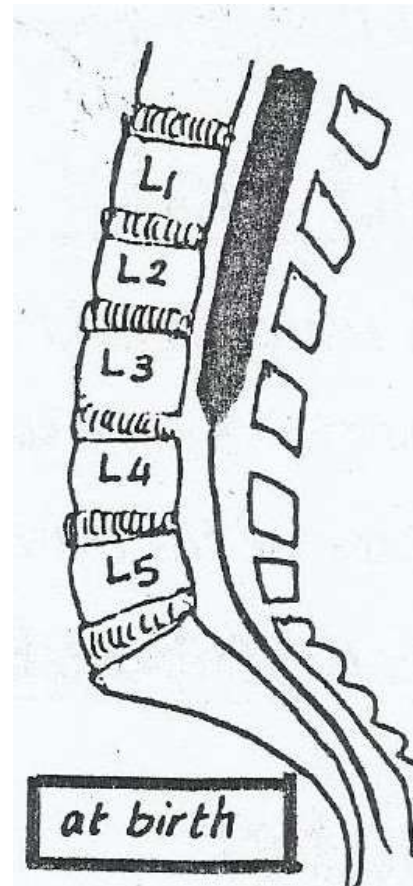
* **In the cervical region** → -1
 (e.g., C6 segment is opposite C5 vertebra).

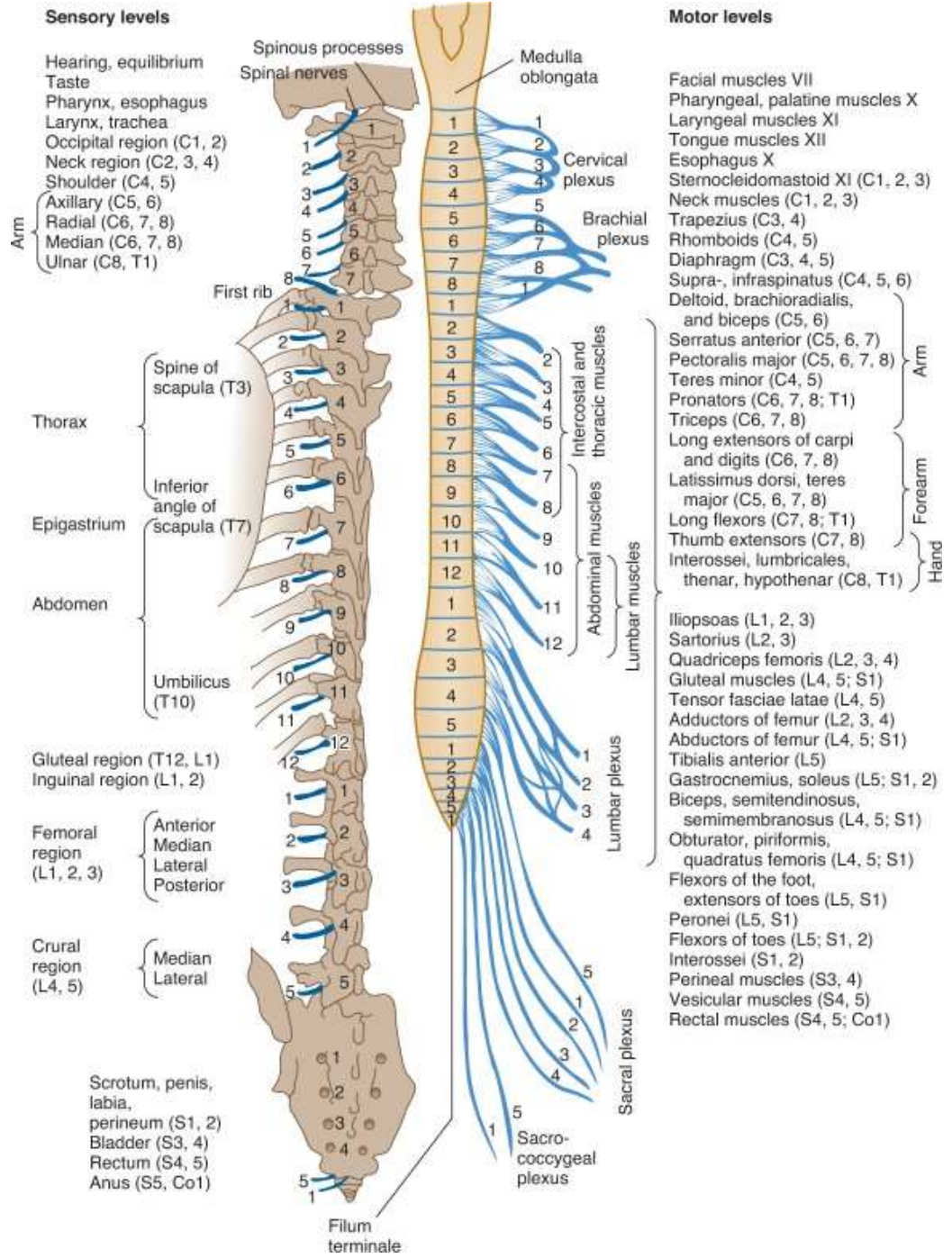
* **In the upper 6 thoracic segments** → - 2 (e.g., T6 segment is opposite T4 vertebra).

* **In the lower 6 thoracic segments** → - 3 (e.g., T12 segment is opposite T9 vertebra).

* **In the lumbar segments** → - 4
 (e.g., L5 is opposite L1 vertebra).

* **All sacral & coccygeal segments**





** Direction of roots:

- C1&2 are horizontal.
- C3-T12 are oblique.
- L1-Co are vertical.

** Exit of spinal nerves from the vertebral canal:

- * C1-7 pass above corresponding vertebrae.
- * C8 passes below C7 vertebra.

* من عنده بدت الأعصاب تعدي من تحت

- * T1-L5 pass below corresponding vertebra. (C2-L5 exit via intervertebral foramina)
- * S1-4 pass via the ant. & post. sacral foramina.

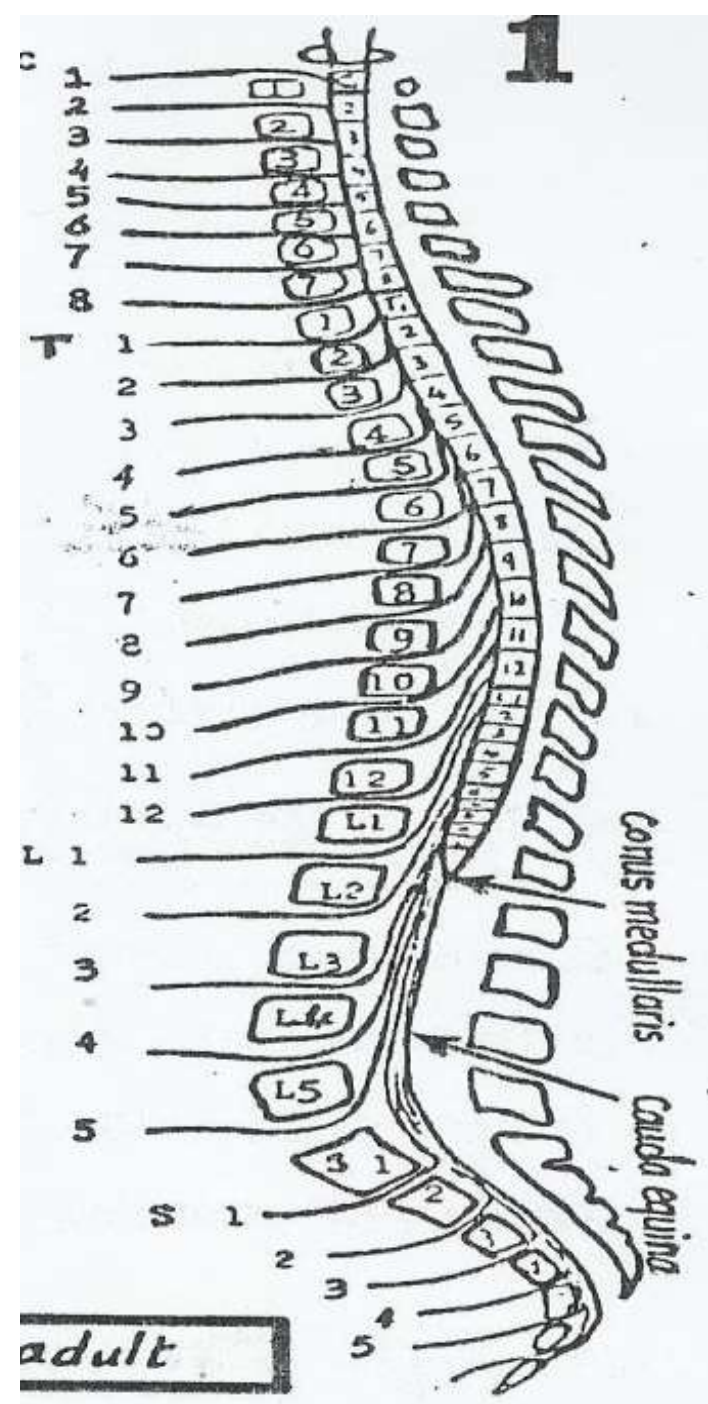
دخلوا ال sacrum وانقسموا جواها لجزء أمامي وجزء خلفي
ال ventral rami يطلعوا من قدام وال Dorsal من ورا

- * S5 & Co pass via the sacral hiatus.

طلع زي ما هو من غير ما ينقسم

- ** The collection of spinal nerves that surround the film terminale below the termination of the spinal cord (i.e., below L2) is called **cauda equina** because it resembles a horse tail. They occupy the lower 1/3 of the vertebral canal & the sacral canal.

ال cauda equina معناها باللاتيني ذيل الحصان لأنها بتشبهه



NUMBERING OF CERVICAL SPINAL NERVES

LEVELS OF SPINAL NERVES

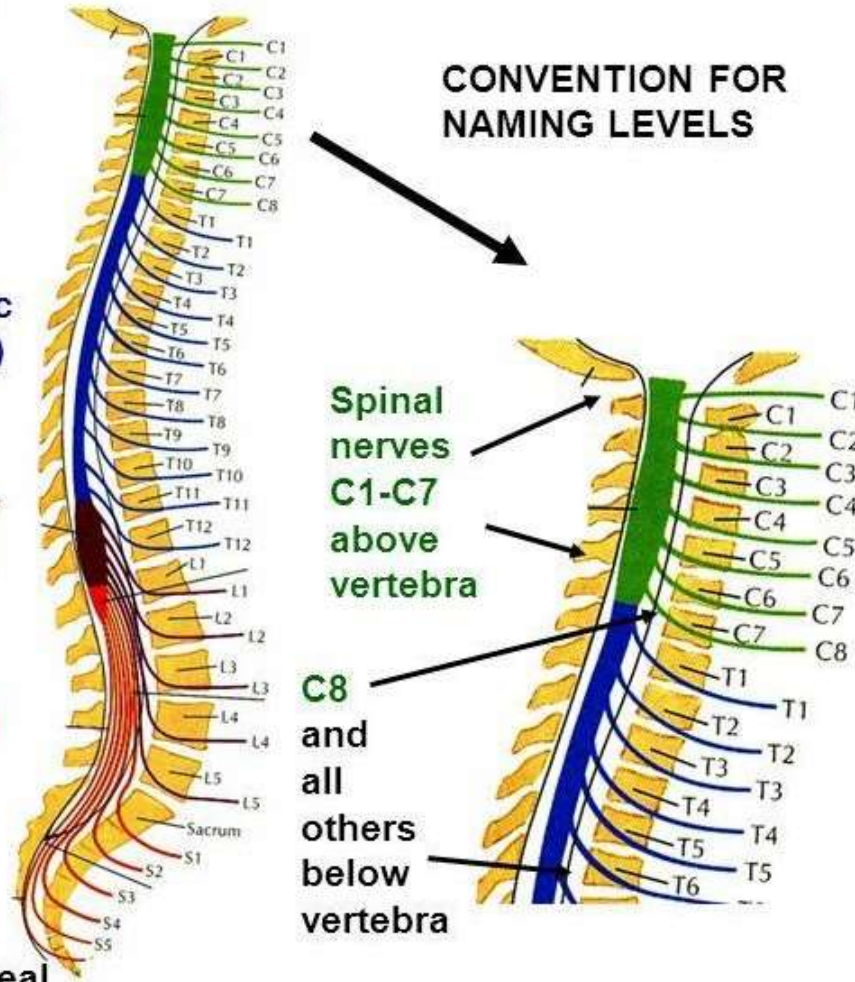
Cervical (C1-C8)

Thoracic (T1-T12)

Lumbar (L1-L5)

Sacral (S1-S5)

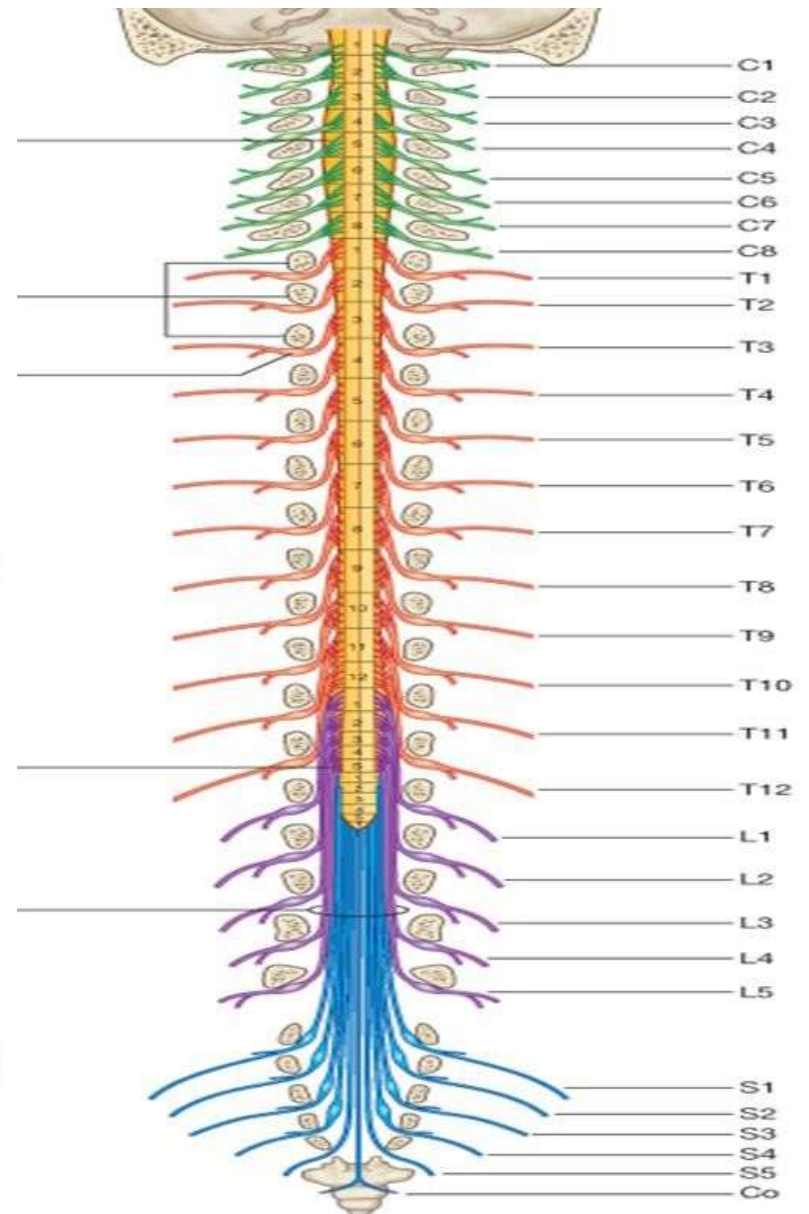
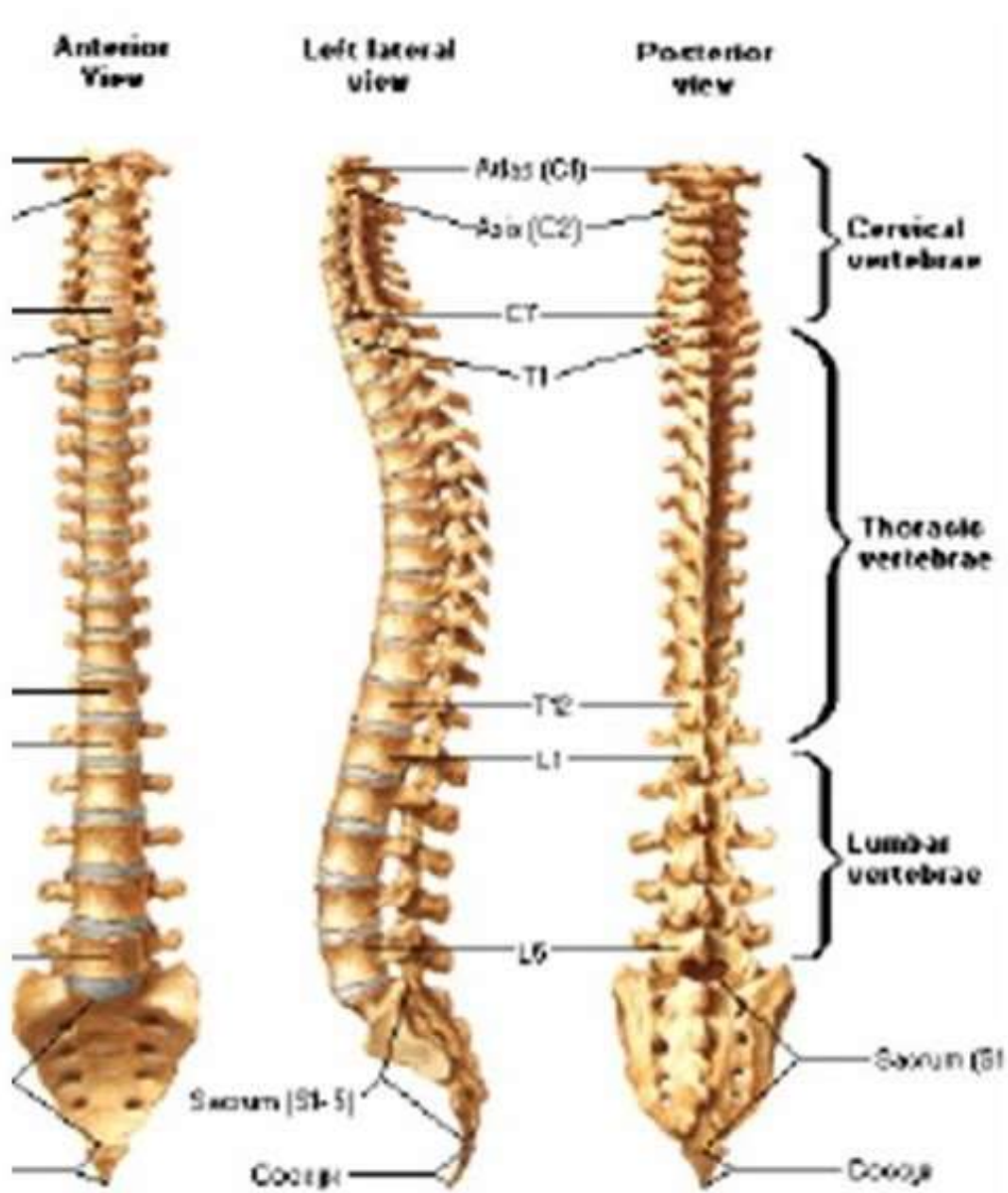
Coccygeal (Co1)



Spinal nerves - arise from/project to spinal cord; there are 31 spinal nerves (8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal).

Note: Cervical spinal nerves 1-7 (C1-C7) exit above corresponding vertebrae; Spinal nerve C8 exits below vertebra C7; All other spinal nerves exit below corresponding vertebrae.

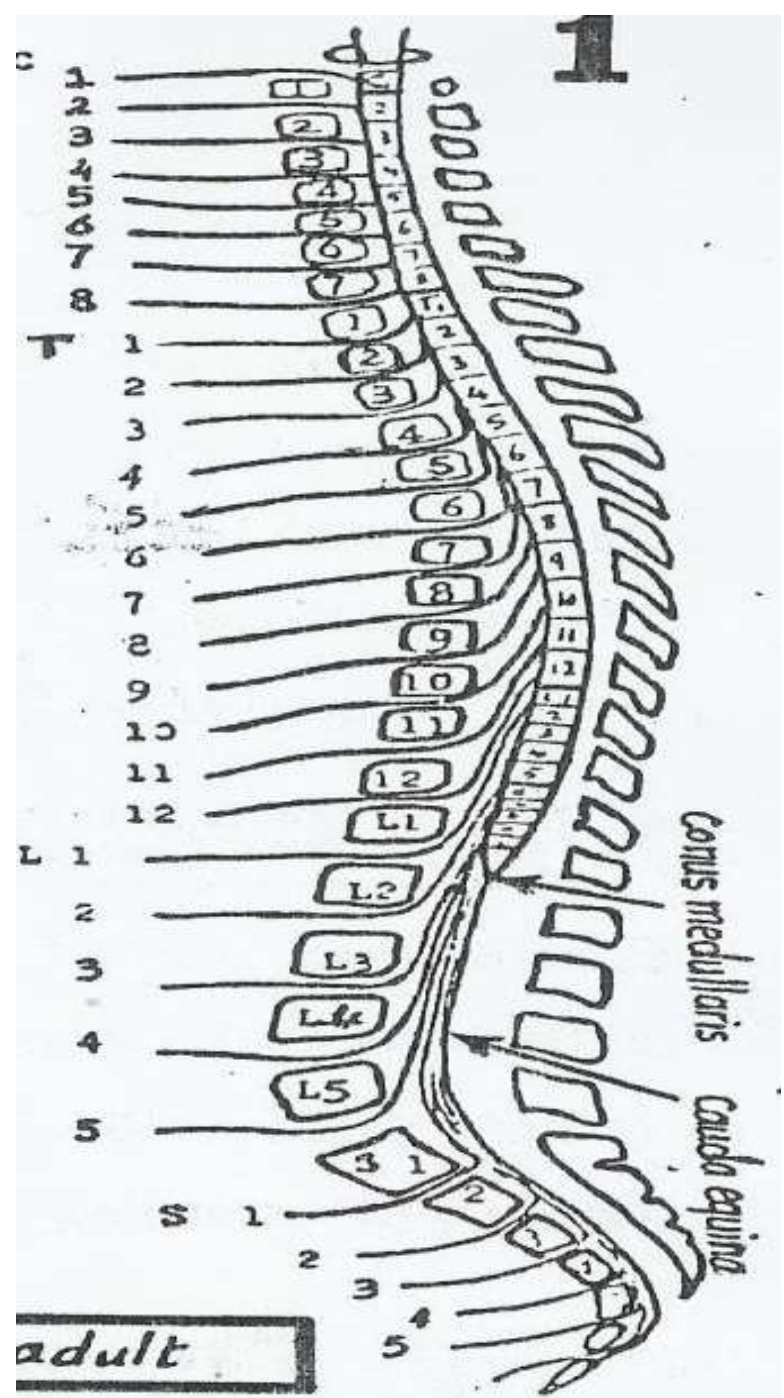
SPINAL NERVE C6 ARISES ABOVE VERTEBRA C6



**** Applied anatomy: Nerve compression:** The size of the spinal nerves increases gradually from above downwards. The largest spinal nerve is the 1st sacral. Meanwhile, the size of the intervertebral foramina decreases from above downwards. The 4th & 5th lumbar nerves are the most liable to compression.

كل ما نزلنا لتحت يكون العصب أثخن ومش بس هيك كمان
الفتحات الي بطلعوا منها بتصير أضيق وكنتيجة للسبين ال
4th & 5th lumbar nerves يكونوا الأكثر عرضة
وبسولنا انزلاق غضروفي خاصة عند النساء الكبار في
العمر الي ينسويه عرق النساء أو ال sciatica

Dr Ashraf Ramzy



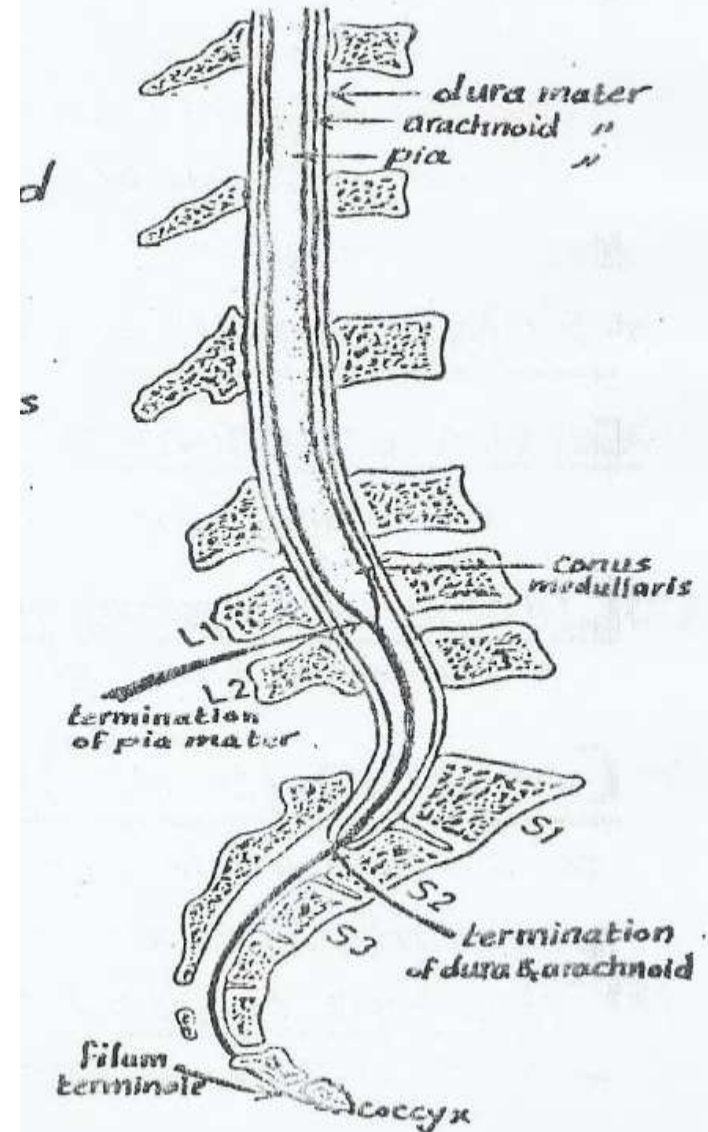
The 3 meningeal coverings of spinal cord

1. The dura mater (outer layer) & arachnoid mater (middle layer): form one tube together. Above, it is continuous with the cerebral meninges at the foramen magnum. Below, it ends opposite S2.

بعملن زي كيس أو tube بتمتد من سحايا الدماغ لحد ال S2

2. Pia mater (inner layer): is adherent to the cord & continuous below as the filum terminale which pierces the tube of dura & arachnoid to be attached to the back of coccyx.

حكينا بتمتد على هيئة خيط رح يخرم الكيس المتكون من الطبقتين
الثانيات ويروح يشبك في ال coccyx



Spaces between meninges

1. **Extradural (epidural) space:** between the dura and walls of vertebral canal. Contains fat, small arteries, venous plexus & lymphatics.

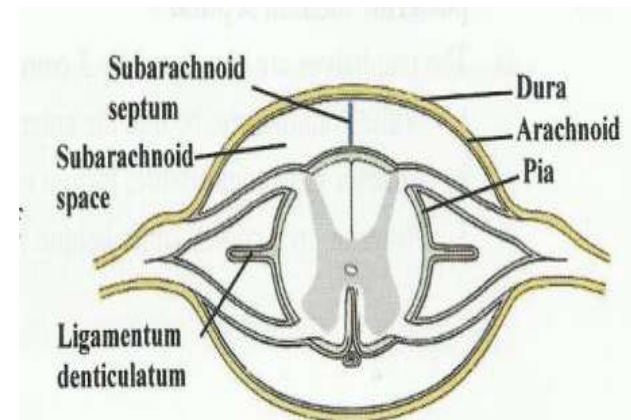
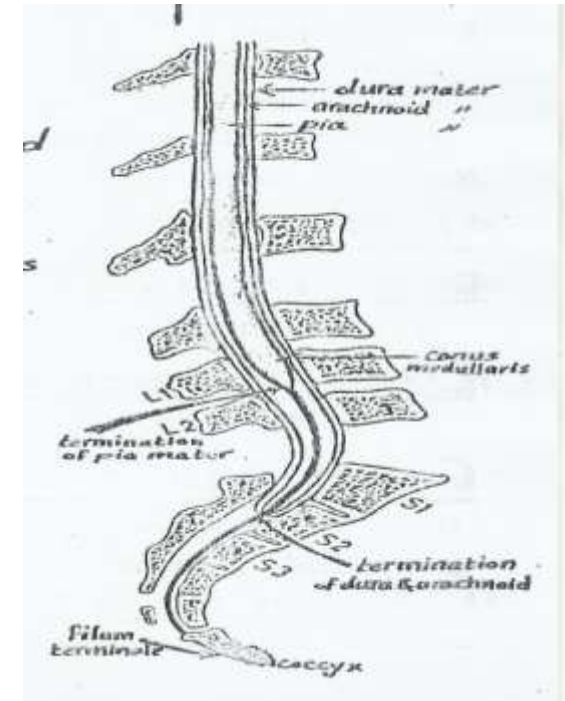
فراغ مش مهم كثير في شوي دهون وأوعية دموية ولمفاوية

2. **Subdural space:** between the dura & arachnoid. Contains a thin film of fluid

برضه مش كثير مهم

3. **Subarachnoid space:** between the arachnoid & pia → contains CSF + 3 ligaments supporting the spinal cord:

الأهم لسببين الأول هو وجود السائل الدماغي والثاني هو وجود 3 أربطة مهمة....

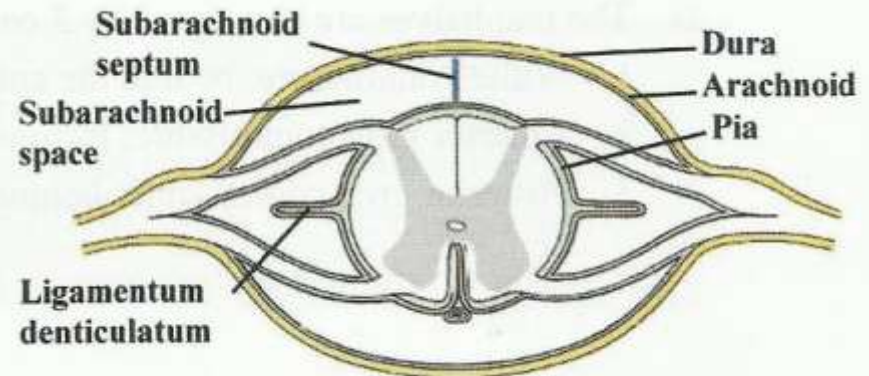
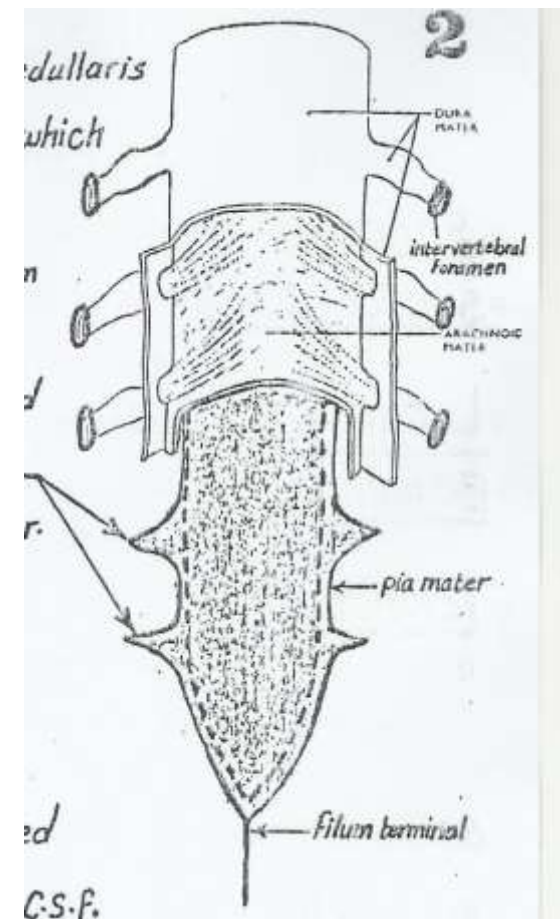


a. **Filum terminale.** الي حكيينا عنه.

b. **Ligamentum denticulatum:**
one on each side of the cord, extending laterally between the anterior and posterior roots of spinal nerves. Laterally, it has 21 teeth connecting the pia (on one side) to the arachnoid and dura (on the other side).

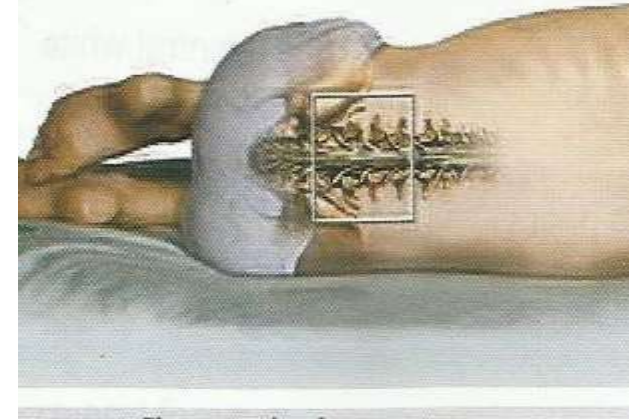
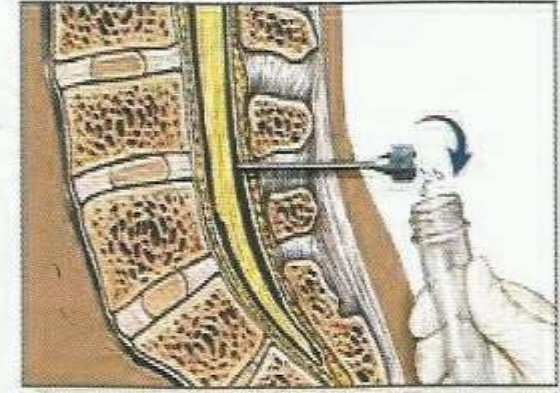
معناها الرباط المسنن أو الي فيه اله أسنان وسموه هيك لأنه عبارة عن بروزات بتشبه الأسنان وعددها 21 سن... عند كل عصب وفي المنطقة الواقعة ما بين ال Anterior وال posterior roots تبرز ال pia mater وتروح تشبك بالطبقتين الثنات

c. **Subarachnoid septum:**
extends from the posterior median septum to the arachnoid mater.



Applied: Lumbar Puncture

إبرة بتحقن في المنطقة الى يكون ال Spinal cord فيها خلص والي هي المنطقة الى فيها ال Cauda equina والأعصاب الى رايحة للأطراف السفلية ..وحتى نحدد هذا المكان الى هو فوق أو تحت ال spine لتبعت ال L4 بنوصل بخط تخيلي ما بين أعلى نقطة في ال iliac crest الجهتين



**** A needle** is introduced to the spinal subarachnoid space below the end of the spinal cord

**** Site:** Just above or just below the tip of 4th lumbar spine (which lies opposite an imaginary line connecting the highest points of iliac crests).

**** Uses:**

1. Diagnostic: to measure CSF pressure, obtain sample for analysis (meningitis), or inject air for contrast X-ray (air encephalography).

بطلنا نستخدم آخر استخدام لأنه صار في MRI \ CT

2. Therapeutic: to remove some CSF to relieve increased intracranial tension, or to inject antibiotics or spinal anesthesia.

تذكر إنه كل الأعصاب الى رايحة للأطراف السفلية موجودة هون فلو بديأعمل عملية بأصبع اجري قليش أعمل تخدير كامل ؟ أو لو المرأة الى بتولد ولادة طبيعية ولازم تظل صاحبة حتى تدفع البيبي وتساعد بالولادة فمش حقدر أستعمل التخدير الكلي

INTERNAL STRUCTURE

**** The spinal cord is formed of a central H-shaped grey matter surrounded by white matter.**

**** Grey matter:**

*** Parts:**

1. Anterior horn [motor]
2. Posterior horn [sensory]
3. ± Lateral horn [autonomic]

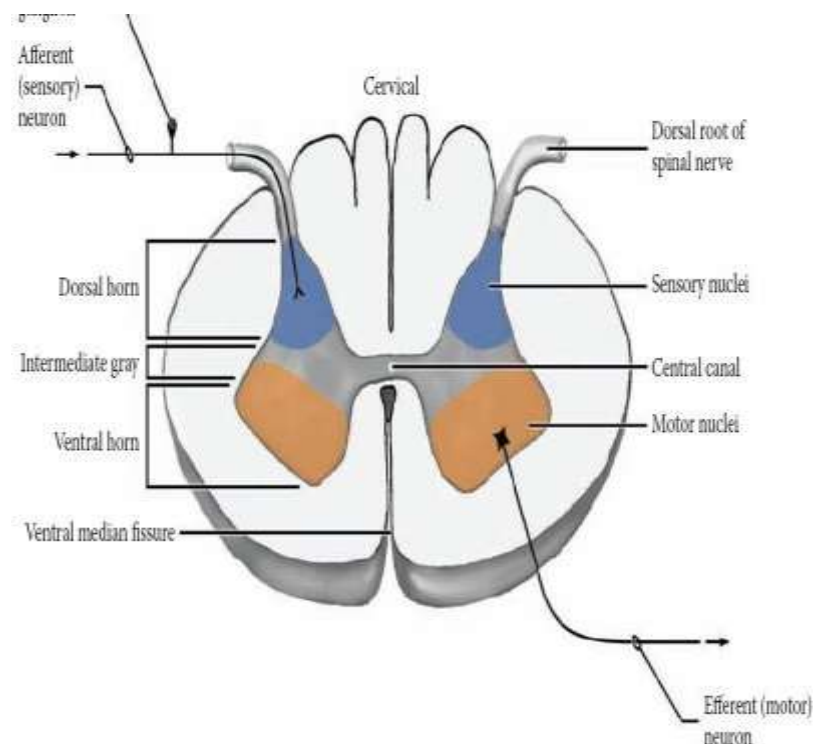
مش في كل ال Segments طبعًا

*** Structure:**

1. Nerve cells (nuclei).

عشان هيك اللون رمادي لأنه فش Mylin

1. Unmyelinated nerve fibers.
2. Neuroglia.
3. Capillaries.



**** White matter:**

*** Parts:**

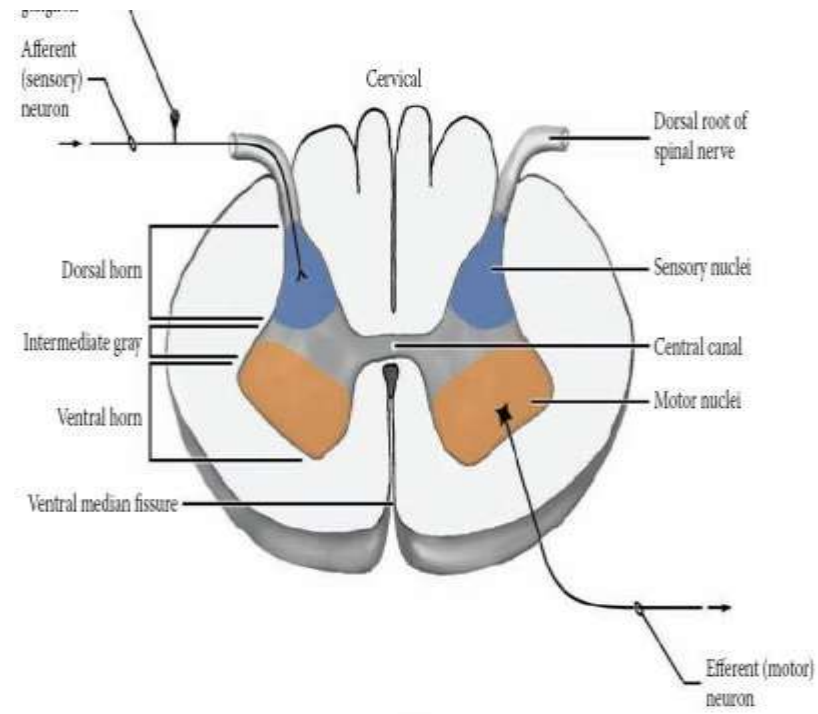
- 1. Anterior column (funiculus).**
- 2. Lateral column (funiculus).**
- 3. Posterior column (funiculus).**

كيف قسمناهن؟

الجزء الواقع ما بين ال Ventral fissure وال Anterior root نعتبره الجزء الامامي والجزء الواقع ما بين ال 2 roots نعتبره الجزء ال Lateral أخيرا الجزء الواقع خلف ال dorsal نعتبره الجزء الخلفي

*** Structure:**

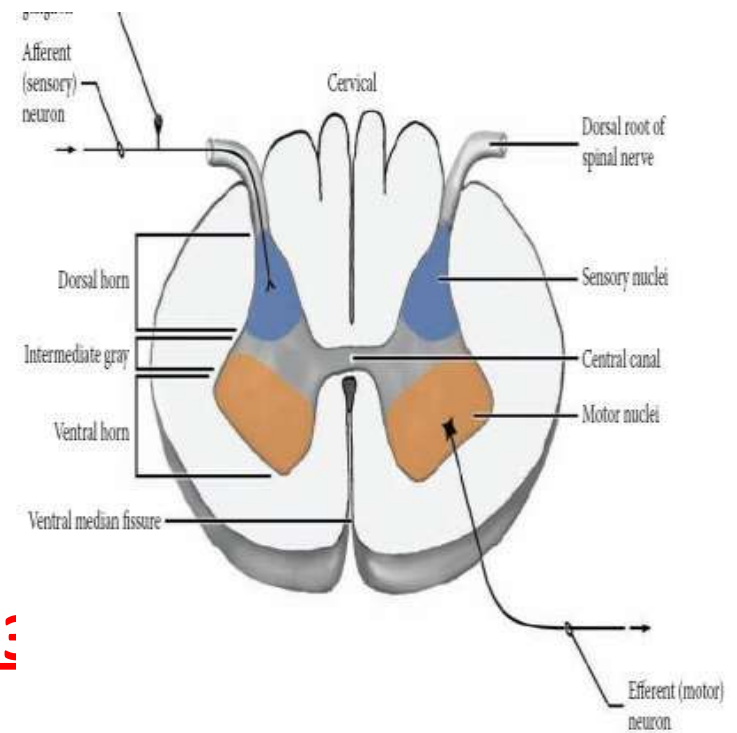
- 1. Myelinated nerve fibers (tracts).** عشان هيك اللون ابيض
- 2. Neuroglia.**
- 3. Capillaries.**



**** Its center contains a narrow central canal (in the gray mater) extending throughout the length of spinal cord.**

**** The cord is divided into right & left halves by an anterior median sulcus & a posterior median septum.**

**** The two halves are connected by : commissures:**



أول واحد أبيض (شوية المادة البيضاء الواقعة خلف الفنترال فيشر)...

والثنين الثانيات رماديات واحد قدام ال Central Canal وواحد خلفها

1. White commissure: behind the anterior median sulcus.

2. Anterior grey commissure: in front of the central canal.

3. Posterior grey commissure: behind the central canal.

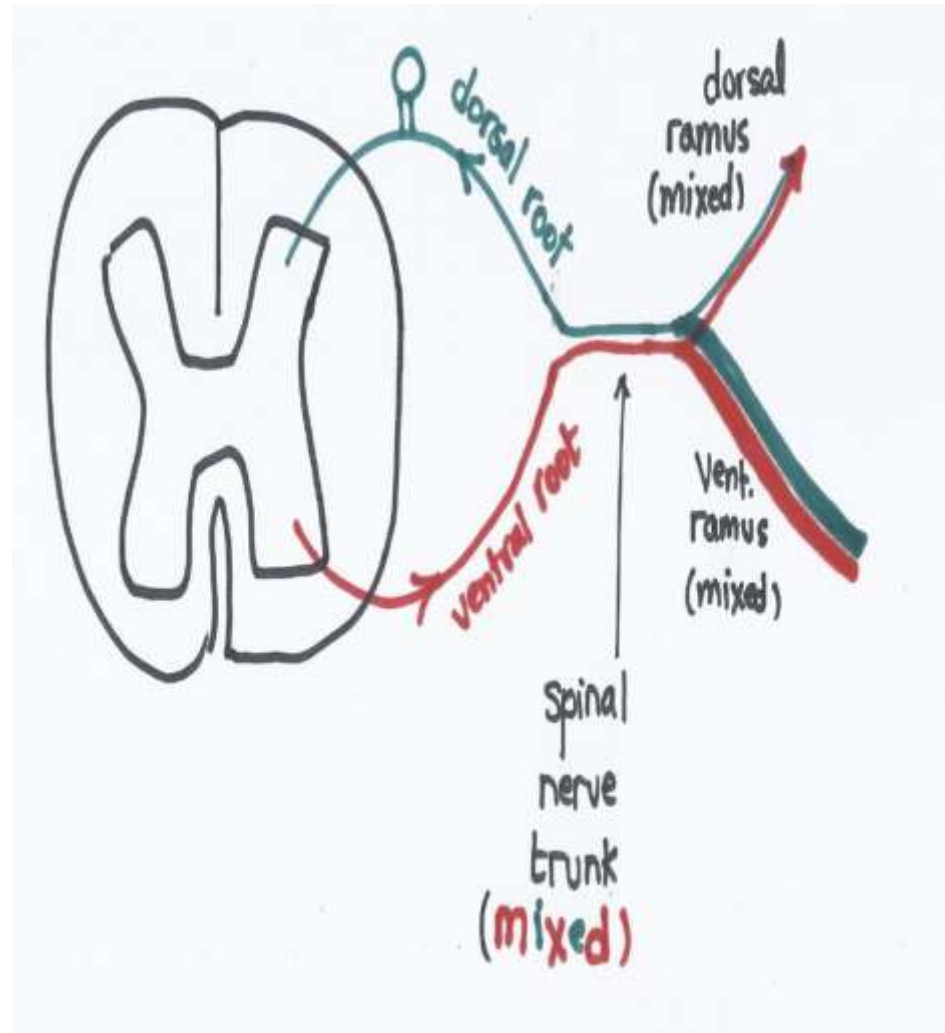
ATTACHMENT OF SPINAL NERVES

A. Each spinal nerve arises from a spinal cord segment by 2 roots:

1. Anterior root: contains
 - Motor fibers (from the anterior horn)
 - ± Autonomic fibers (from the lateral horn).
2. Posterior root: purely sensory. It carries post. root ganglion (spinal ganglion) containing pseudounipolar neurons.

أحد أنواع النيرونز الي حكينا عنهم المحاضرة الماضية وقلنا رح يكون عنده أگسون واحد بس رح ينقسم لنصين جزء رح يروح لل spinal cord وجزء رح يروح peripherally

Their peripheral processes (dendrites) pass peripherally, while their central processes (axons) enter the cord at the posterolateral sulcus.



B. Both roots unite forming a mixed nerve, which exits the vertebral canal through the intervertebral foramen (IVF) and soon divides into 2 rami (both are mixed):

1. Anterior ramus (large):

* All anterior rami form plexuses except the 12 thoracic (intercostal nerves).

* كل ال 31 رح يتشابكوا مع بعض ويعملولنا Plexuses ما عد ال 12 الثوراسيك كل واحد منهم بظل مستقل ويتشابكش مع البقية ..

* Only 14 anterior rami (12 thoracic + upper 2 lumbar) send white rami communicants [preganglionic] to sympathetic ganglia.

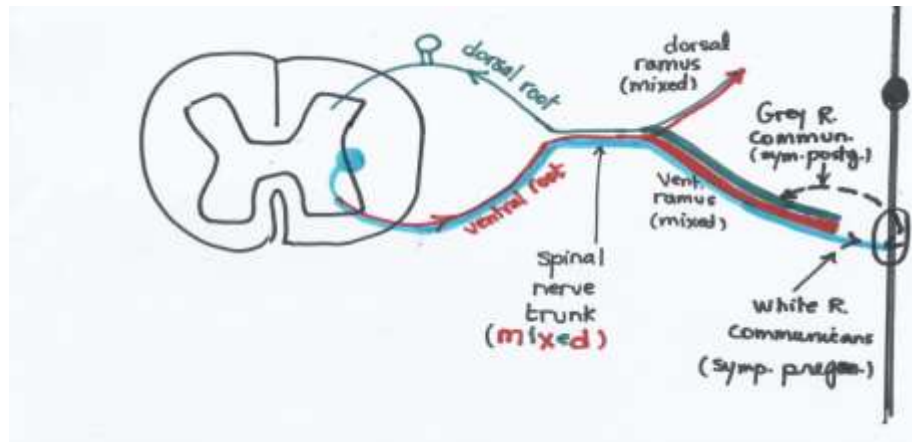
زي ما بنعرف إنه السيمباثيتيك بطلعوا من Thoracolumbar

* All 31 anterior rami receive grey rami communicants [postganglionic] from sympathetic ganglia.

* بينما ال ganglia تعطي grey rami communicants لكل ال segments ..

* لو ما فهمتوا هاي القصة فعادي رح تنعاد بالتفصيل لقدام

2. Posterior ramus (small): supplies muscles & skin of the back.



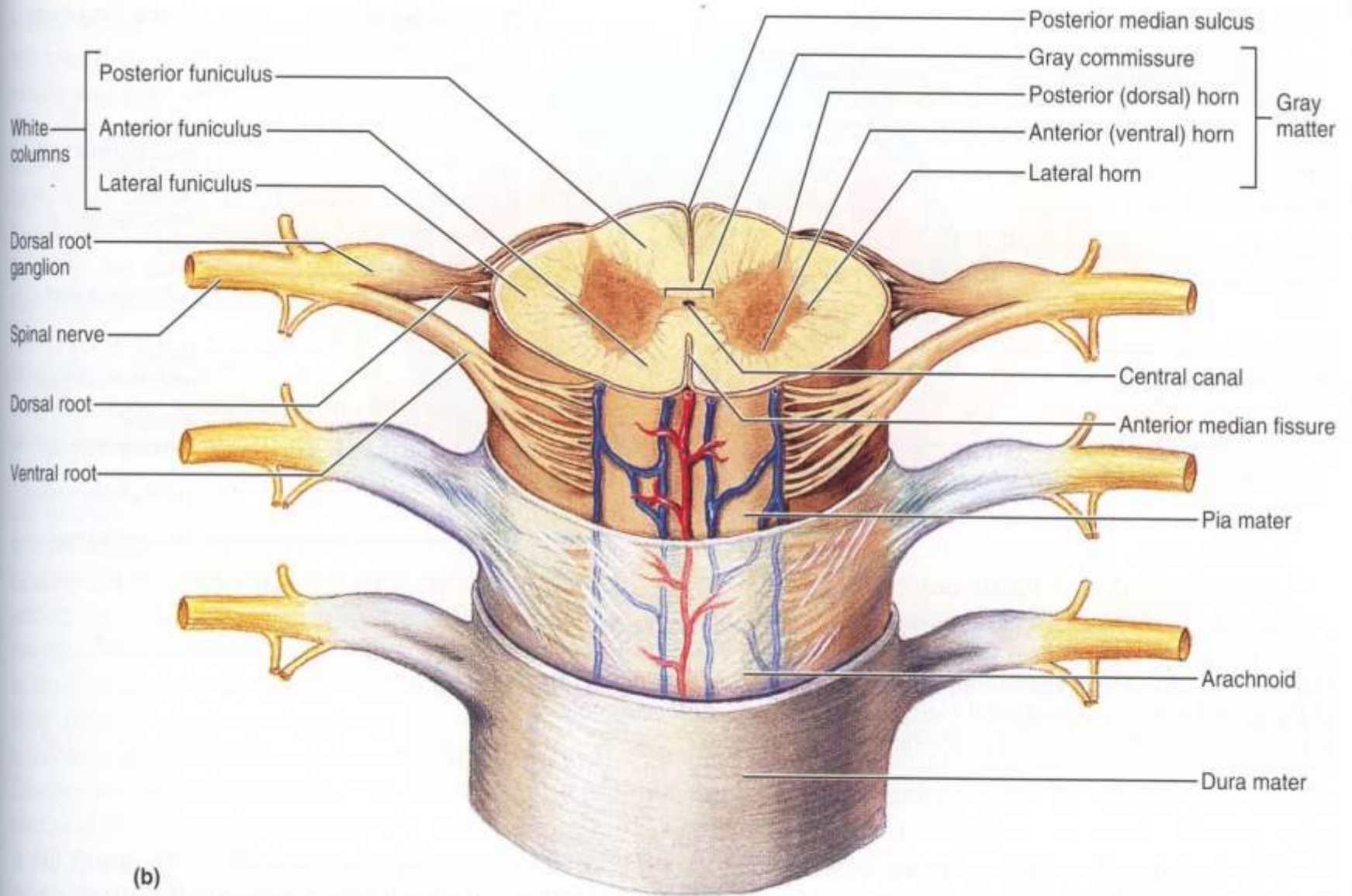


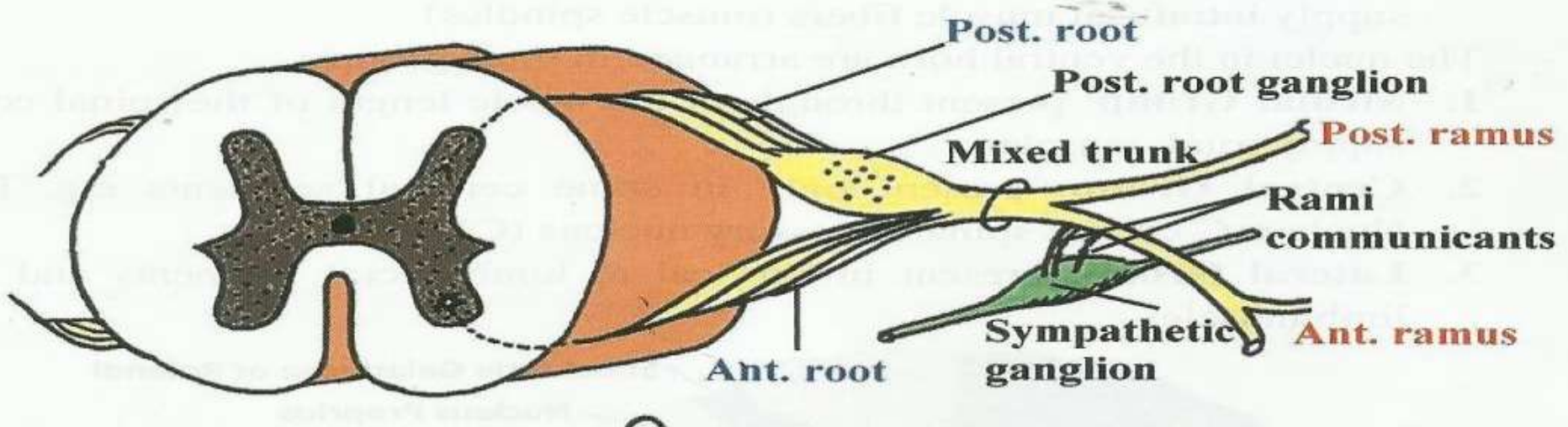
FIGURE 12.27 (Continued) Anatomy of the spinal cord. (b) Three-dimensional view of the adult spinal cord and its meningeal coverings.

**** N.B: * Both rami of C1 spinal nerve are purely motor.**

بينما في بقية ال Segments تكونوا Mixed

*** Recurrent meningeal nerve:** It is the first branch of the mixed spinal nerve, just outside IVF. It re-enters the spinal canal via IVF to supply the dura, periosteum, blood vessels & I.V. discs. It plays a role in referred pain or occipital headache.

بعد ما يطلع رح يرد يدخل وبلعب دور في الألم الي مصدره مكان ورح ينحس بمكان ثاني وبالصداع في المنطقة الخلفية من الراس..



Nuclei of Grey matter of Spinal Cord

A. In Dorsal Horn: * Nuclei are mainly sensory:

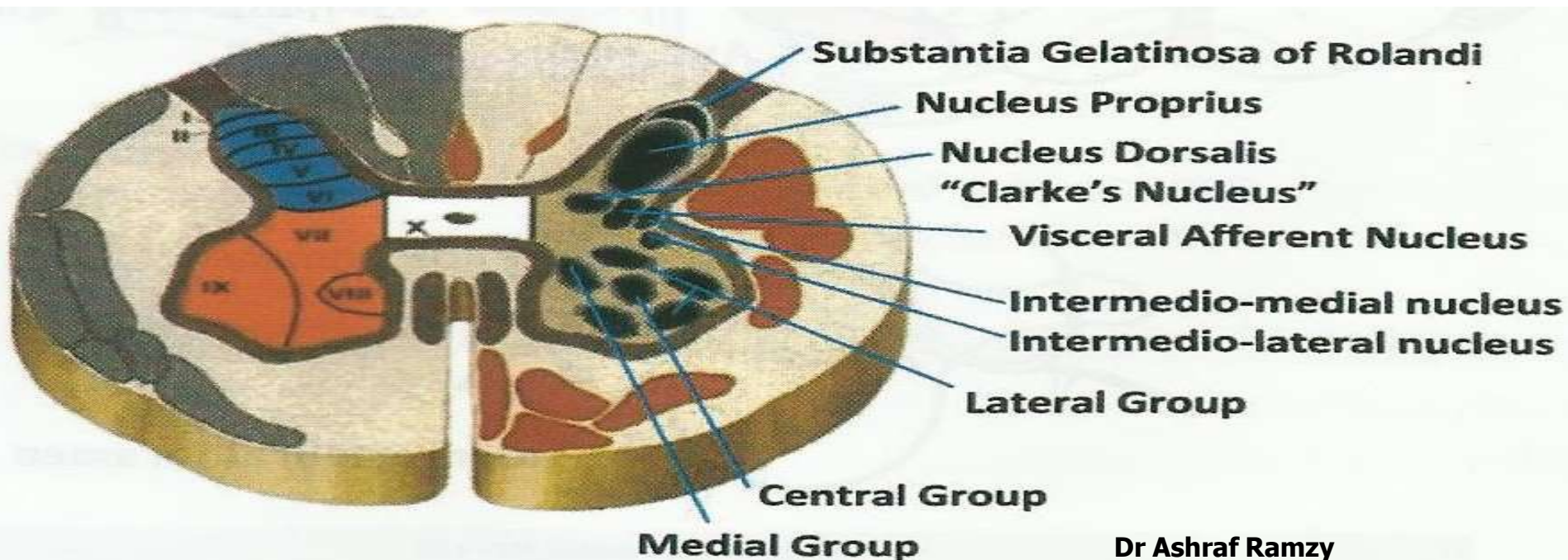
1. Substantia Gelatinosa of Rolandi: Present at tip of dorsal horn in all segments of spinal cord.

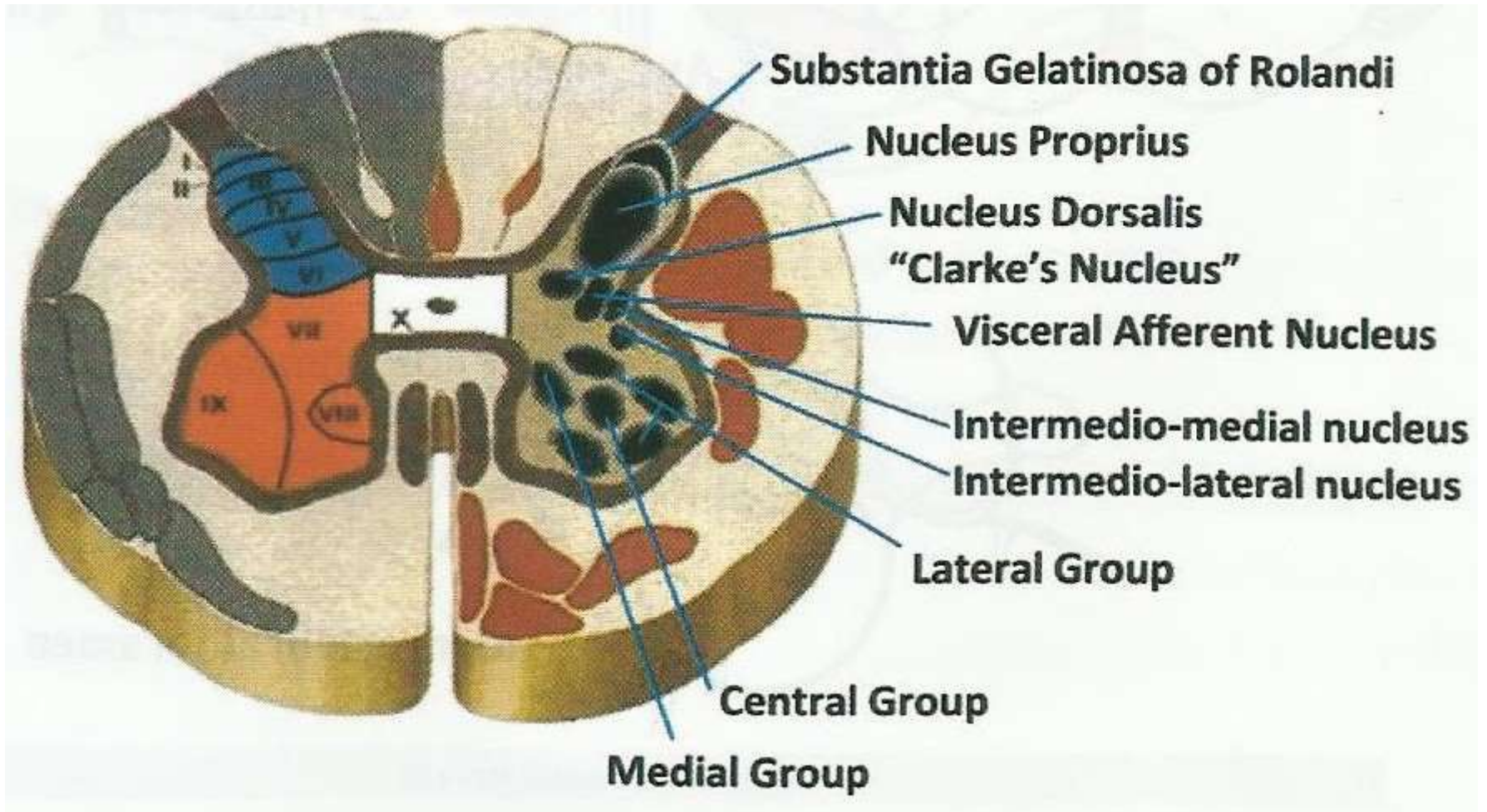
* Function: pain modulation.

2. Nucleus Proprius (Main sensory nucleus): Present anterior to Substantia Gelatinosa in all segments of spinal cord.

* Function: relays exteroception.

* الاحساس بالواصلة من ال Skin الحسي اللمس أو الحرارة





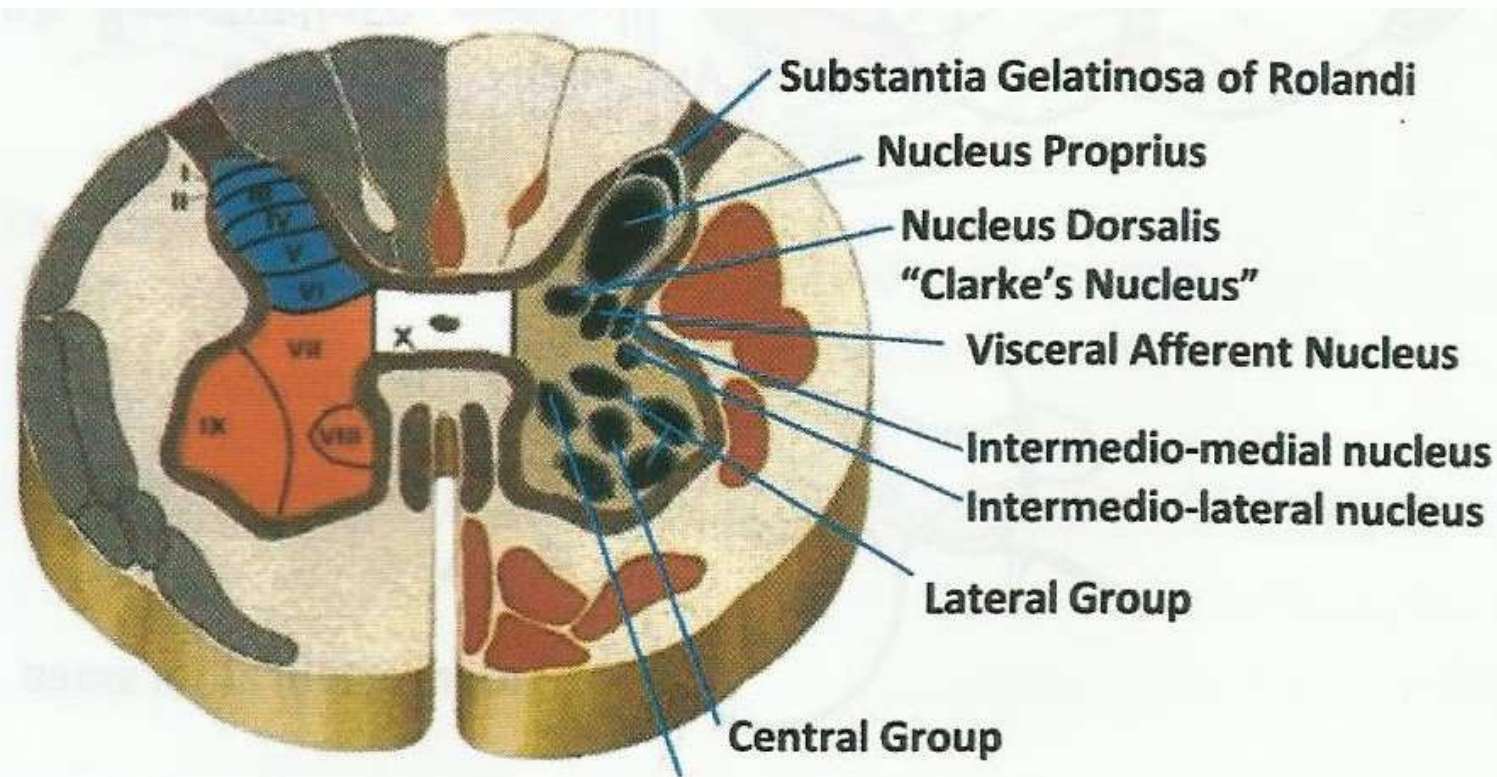
3. Nucleus Dorsalis “Clarke’s Nucleus”: Present at the base of dorsal horn in C8 to L3 segments (not in all segments) of the spinal cord.

* **Function:** relays unconscious proprioception. (Sensation of muscles and joints)

4. Visceral Afferent Nucleus: Present in C8 to L3 segments of the spinal cord lies lateral to Clarke’s Nucleus.

* **Function:** relays visceral sensations.

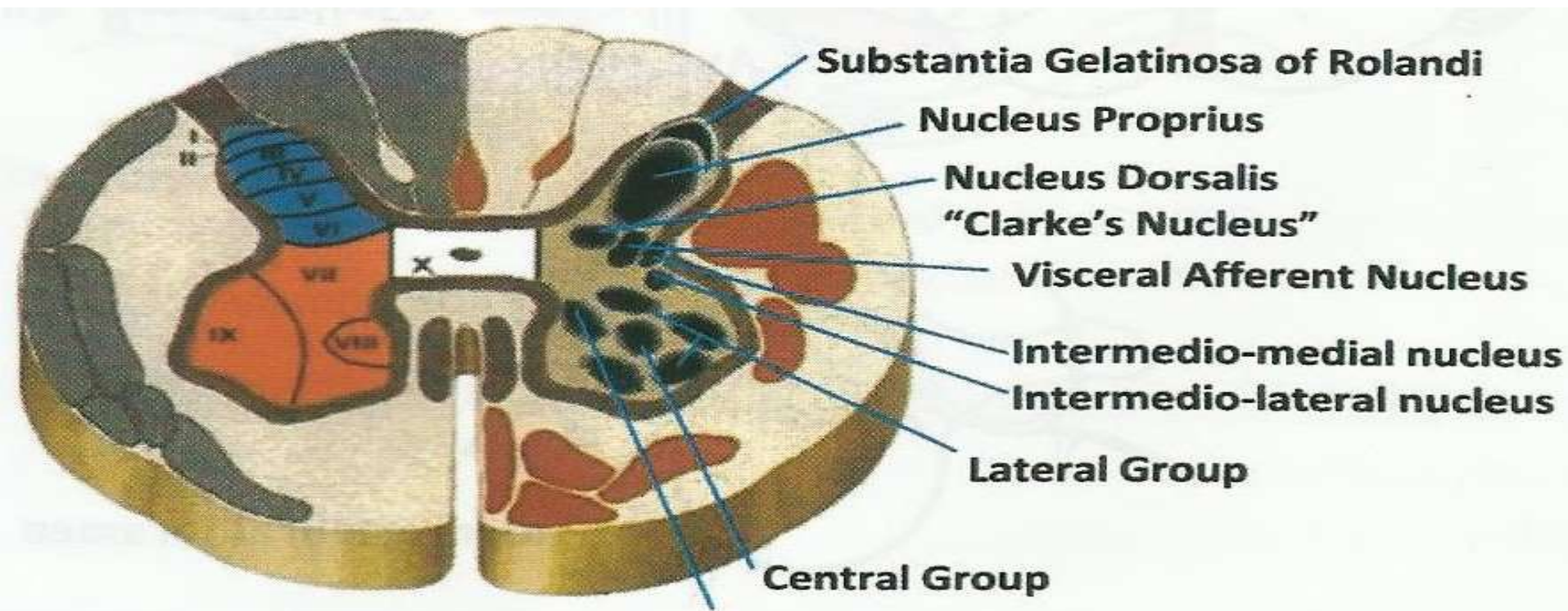
* أحاسيس الاحشاء زي المغص



B. In Lateral Horn:

- * Contains the intermediate nucleus present in thoracic & upper 3 lumbar segments (**sympathetic**). It is further divided into Intermedio-medial & intermedio-lateral nuclei. These are sympathetic neurons whose axons pass in the ventral root of the corresponding spinal nerves to reach the ganglia of the sympathetic trunk.
- * A similar group of autonomic neurons “Sacral Parasympathetic” is present in S2,3,4 segments of the spinal cord but these do not form a lateral horn.

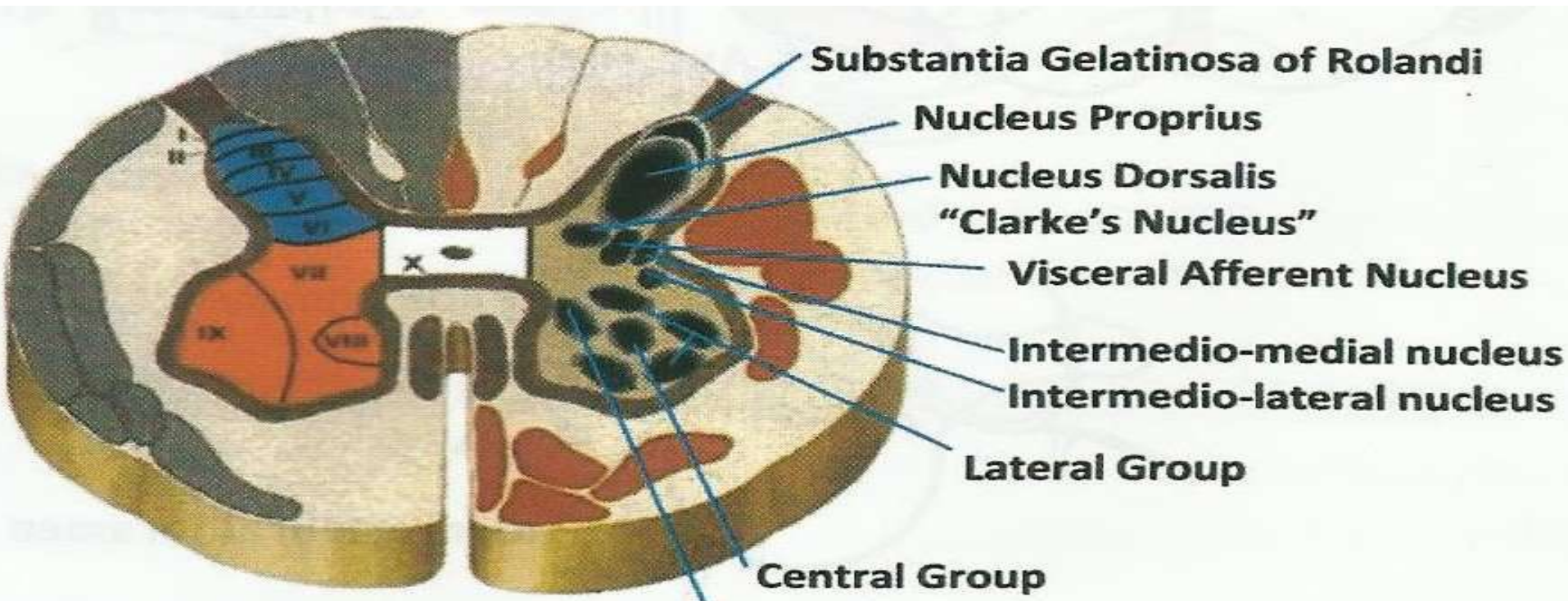
* مش كبار لدرجة يعملوا horn



C. In Ventral Horn:

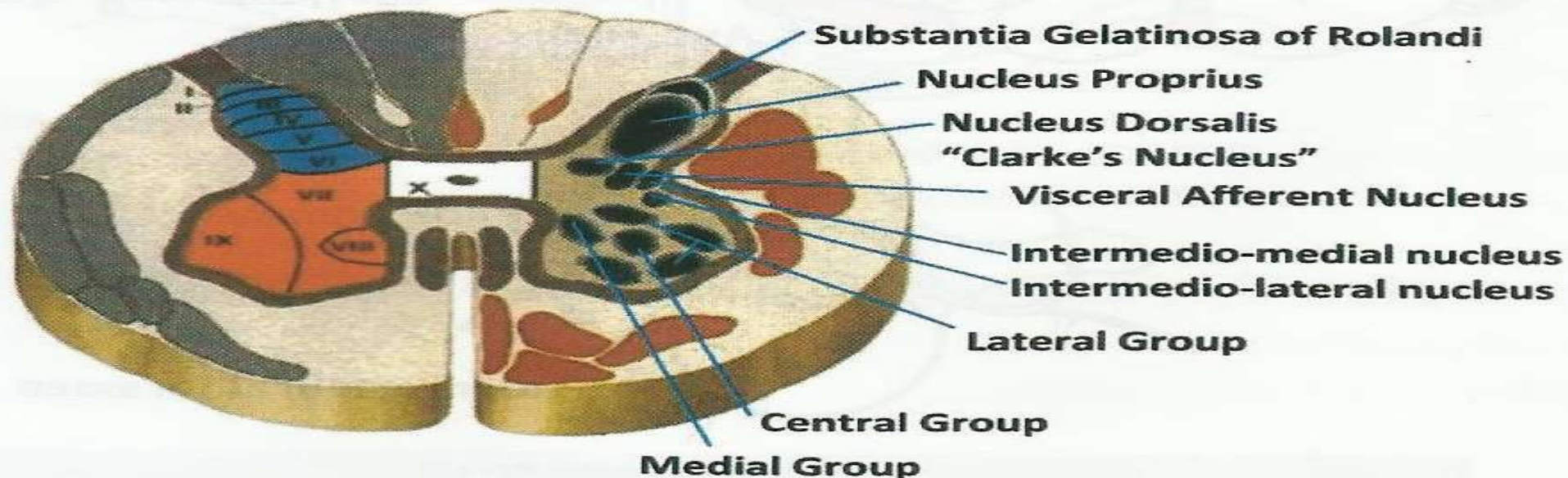
* Nuclei are mainly motor neurons which are either:

1. Alpha-motor neurons (anterior horn cells- AHC): Large, their axons pass in ventral root to supply extrafusal muscle fibers (fibers that contract) .
2. Gamma- motor neurons: Small, their axons also pass in ventral root to supply intrafusal muscle fibers (muscle spindles). (Extra note : Muscle spindles are stretch receptors within the body of a muscle that primarily detect changes in the length of the muscle)



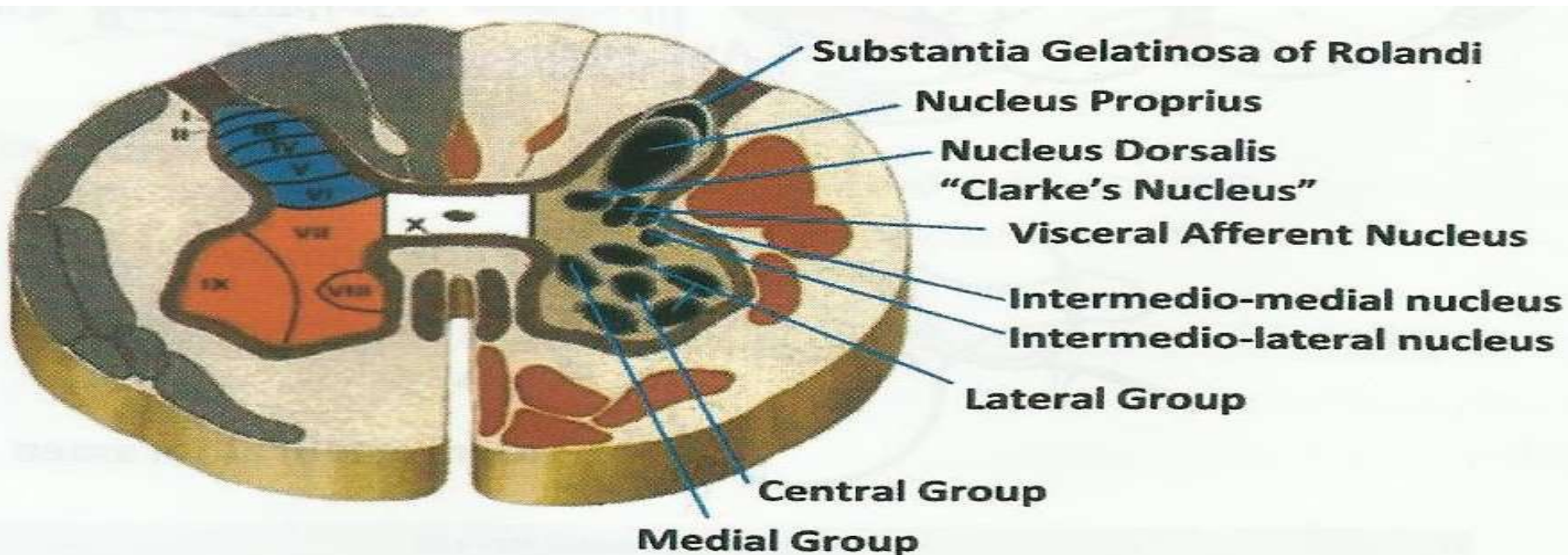
*** The nuclei in the ventral horn are arranged in three groups:**

- 1. Medial Group** (2 nuclei , ventromedial & dorsomedial): present throughout the whole length of the spinal cord and supply trunk muscles.
- 2. Central Group:** present only in some cervical segments e.g. Phrenic Nucleus C3,4,5 (that will supply diaphragm) & spinal accessory nucleus (C1-5) (will give rise to spinal accessory nerve which is the only cranial nerve that rise from spinal cord (will discussed later in details)).
- 3. Lateral Group** (3 nuclei , ventrolateral,dorsolateral & retrodorsolateral): present in cervical & lumbosacral segments and supply limb muscles.

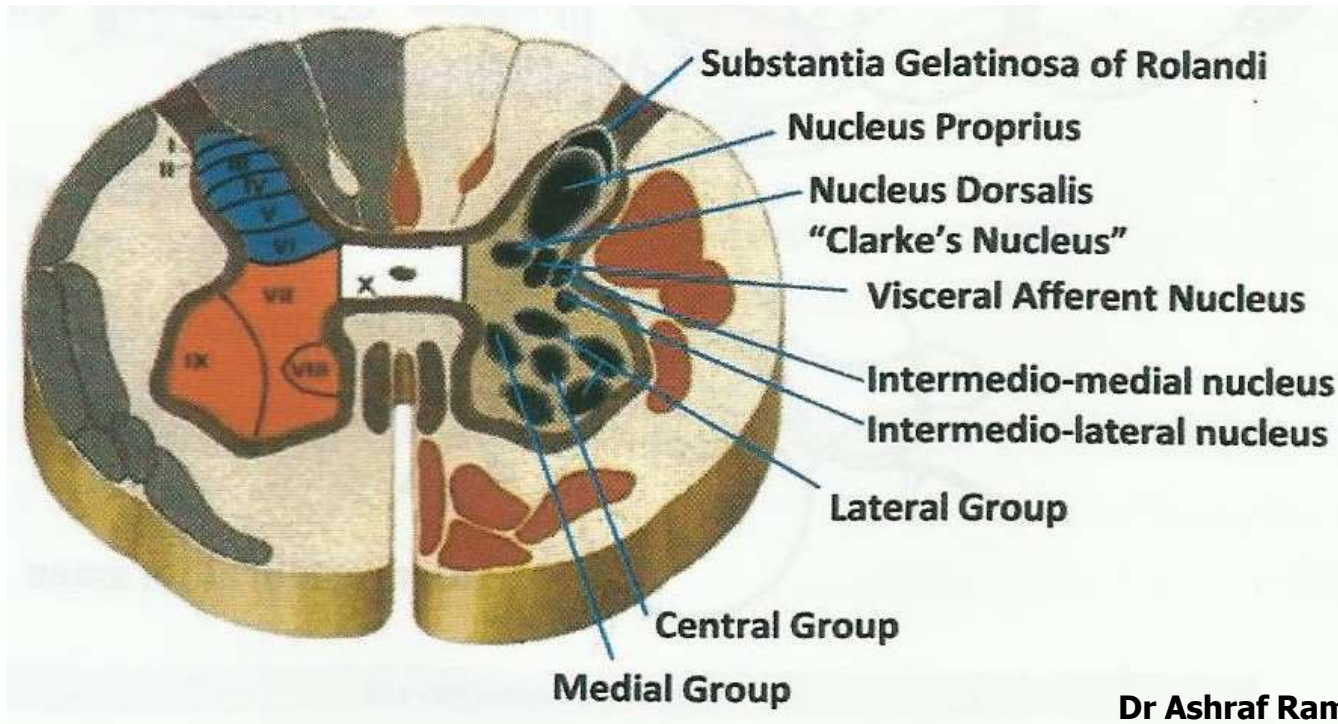


Grey matter Laminae “of Rexed”

- ** **Rexed (1964)**: described 10 laminae in the grey matter of the spinal cord depending on: neurons size, density, shape & cytological features.
- ** **Laminae I -VI**: are sensory & occupy posterior horn.
- * **L I** → marginal layer of Waldeyer.
- * **L II + part of LIII** → Substantia gelatinosa of Rolandi.
- * **The rest of LIII + L IV** (sometimes they also add V & VI) → Main sensory nucleus.



- * **Lamina VII** → occupies the lateral horn & extends into the middle part of the anterior horn.
- * It contains: 1. Clarke's nucleus. 2. Lateral horn nuclei (intermediolateral & internediomedial). 3. Middle part of anterior horn (between L VIII & IX), contains Renshaw cells.
- * **Laminae VIII- IX** → occupy the anterior horn. L IX is lateral. It contains the motor neurons. LVIII is medial. It controls the muscle tone. (مقدار انقباض العضلة)
- * **Lamina X** → surrounds the central canal.



**THANK
YOU**