

# NEURAXIAL BLOKADE



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Program

# Objectives



- Relevant anatomy and surface landmark for Neuraxial block.
- Differences between spinal and epidural.
- Equipment and local anesthetics.
- Indication and contraindication.
- Side effects, complications and treatment.
- LAST

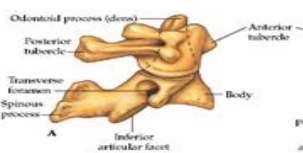
# Knowledge of anatomy for neuraxial blockade is essential!

- 7 cervical vertebrae
- 12 thoracic vertebrae
- 5 lumbar vertebrae
- Sacrum
- Coccyx

# THE VERTEBRAL COLUMN

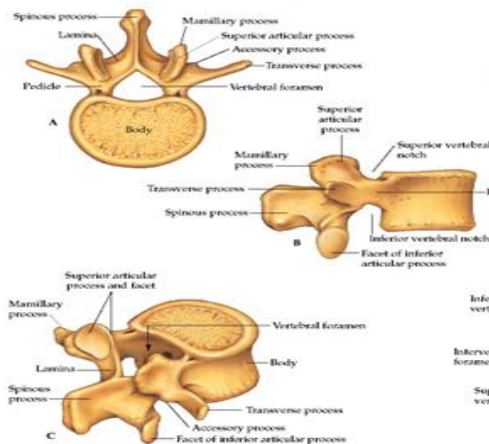
## Atlas and Axis

A—Articulated right lateral view, B—Disarticulated anterior view, C—Articulated posterior superior view

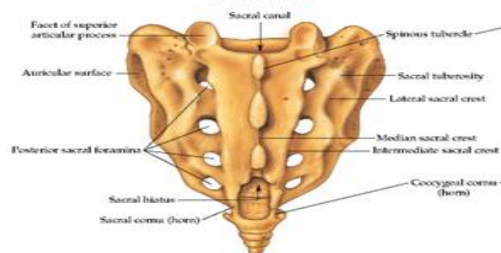


## Second Lumbar Vertebra

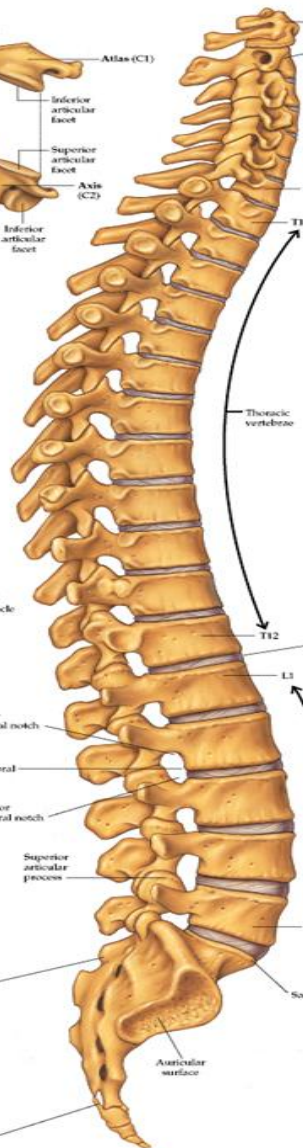
A—superior view, B—Lateral view, C—Posterolateral oblique view



## Sacrum and Coccyx (Dorsal Surface)

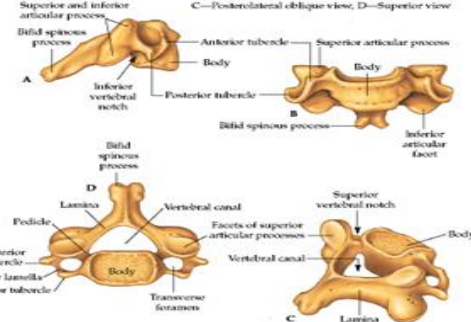


## Vertebral Column (Right Lateral View)



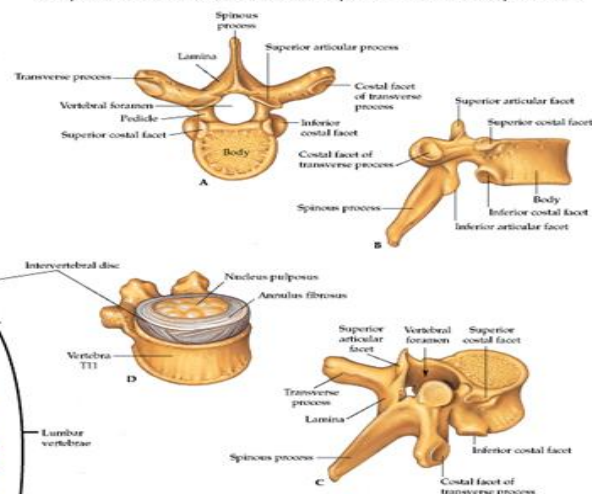
## Fifth Cervical Vertebra

A—Lateral view, B—Anterior view, C—Posterolateral oblique view, D—Superior view

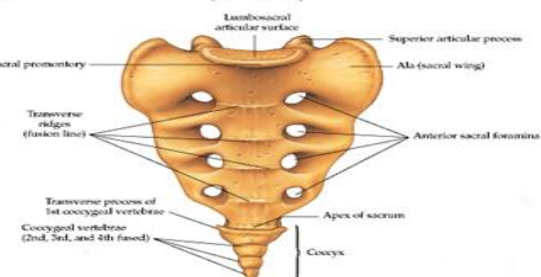


## Seventh and Eleventh Thoracic Vertebrae

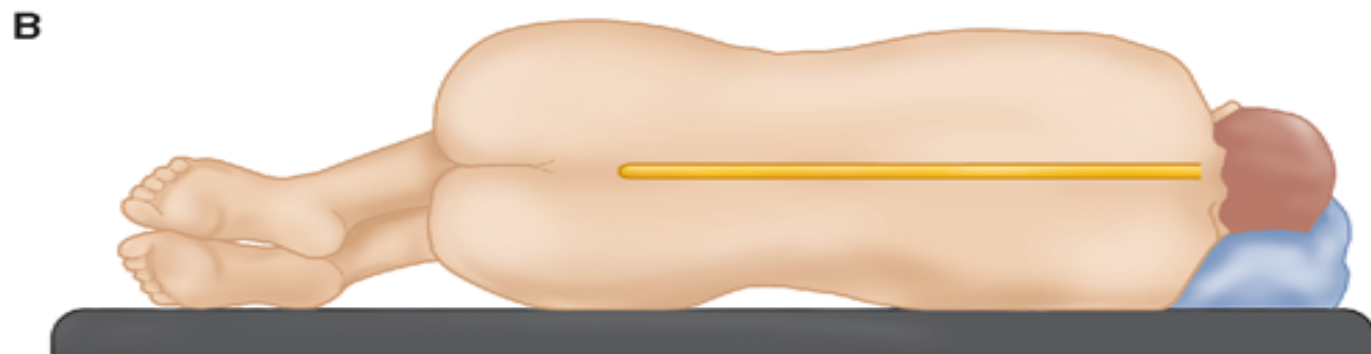
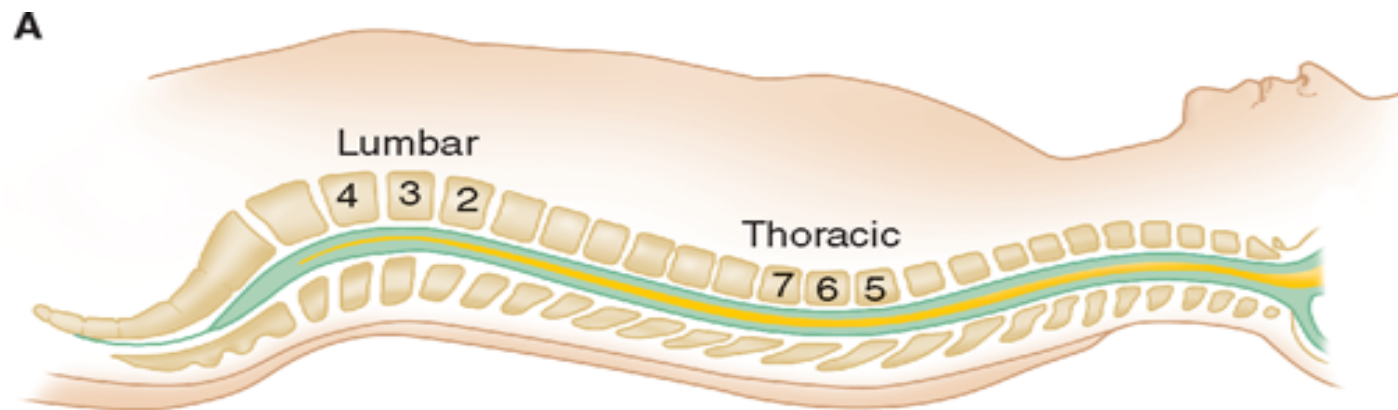
A—Superior view, B—Lateral view, C—Posterolateral oblique view, D—Anterolateral oblique view of T11



## Sacrum and Coccyx (Pelvic Surface)







Source: Butterworth JF, Mackey DC, Wasnick JD: *Morgan & Mikhail's Clinical Anesthesiology*, 5th Edition: [www.accessmedicine.com](http://www.accessmedicine.com)

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# Individual Vertebral Anatomy

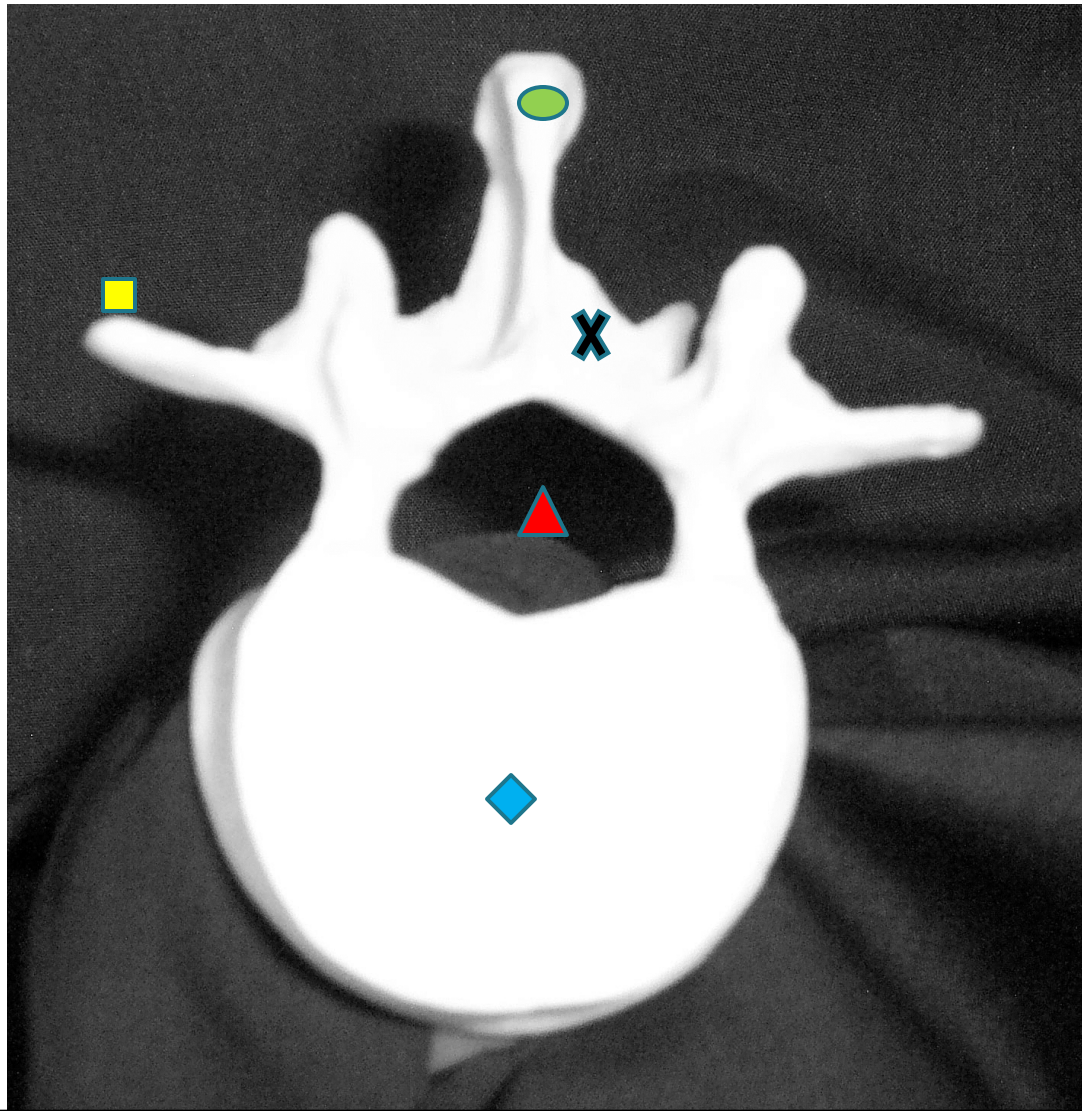
- Each vertebra consists of a pedicle, transverse process, superior and inferior articular processes, and a spinous process.
- Each vertebra is connected to the next by intervertebral disks.
- There are 2 superior and inferior articular processes (synovial joints) on each vertebra that allows for articulation.
- Pedicles contain a notch superiorly and inferiorly to allow the spinal nerve root to exit the vertebral column.

# Vertebral Anatomy- Top View

■ Transverse Process

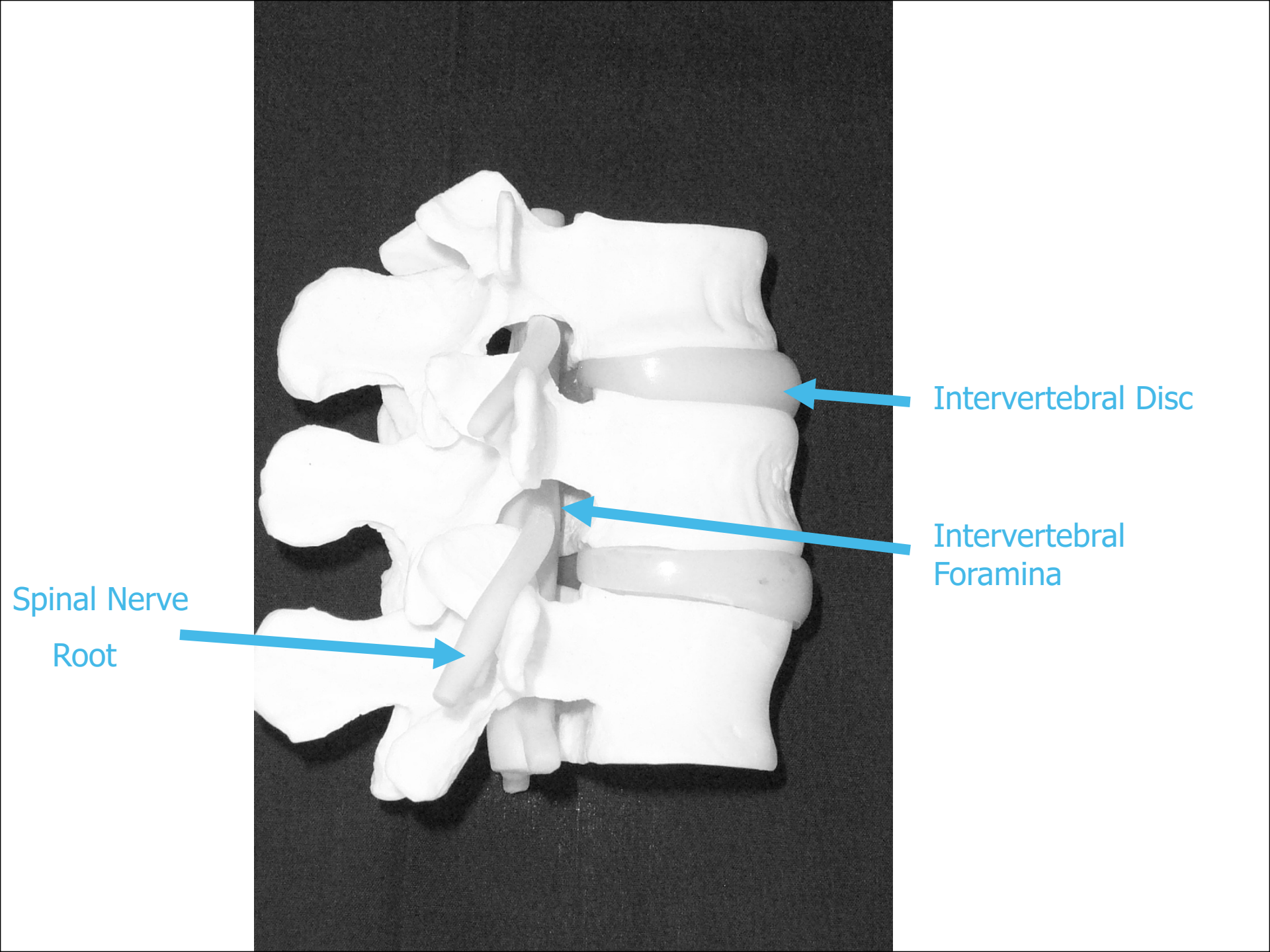
▲ Spinal Canal

◆ Vertebral Body



● Spinous Process

✕ Lamina



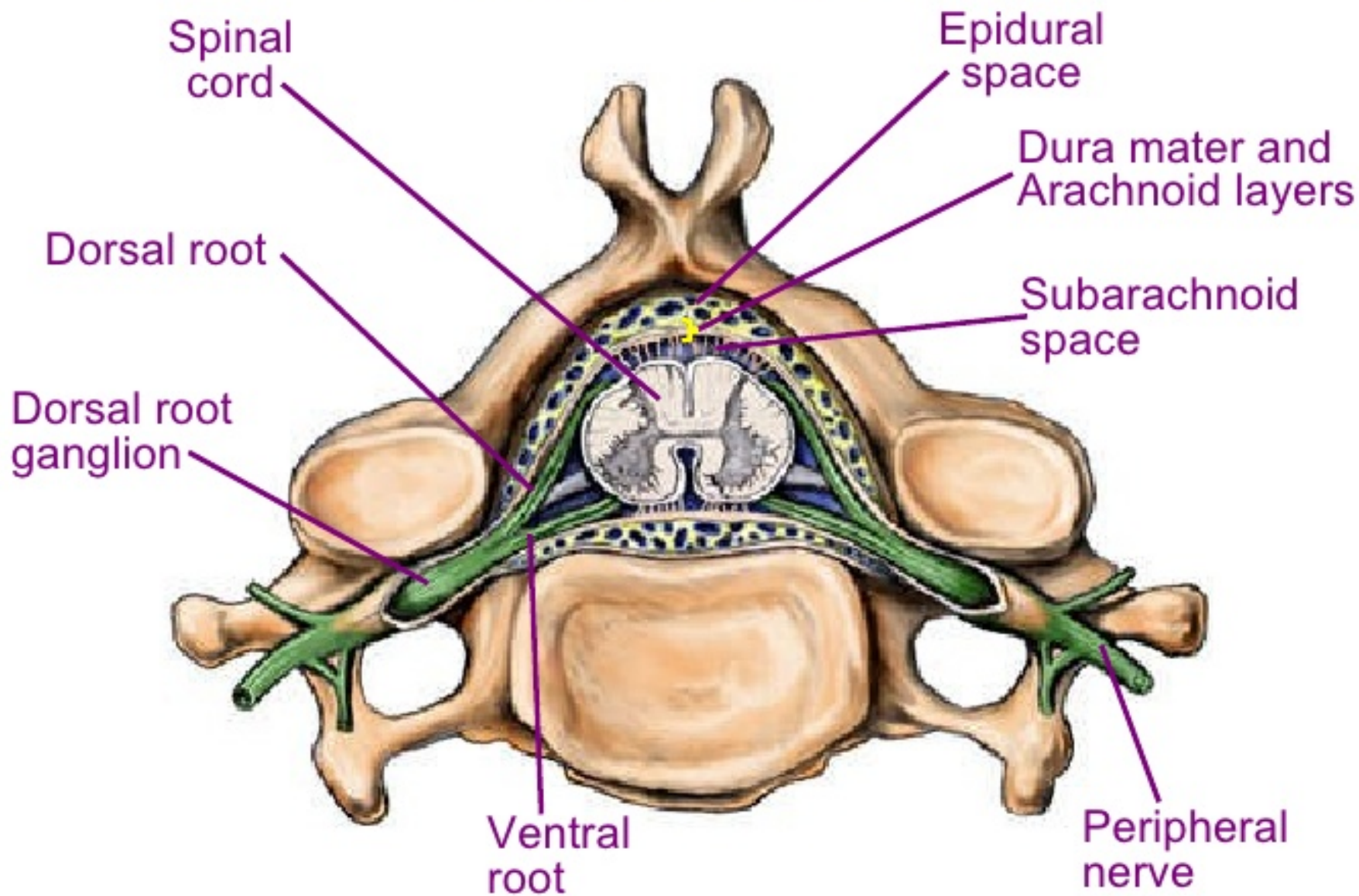
Intervertebral Disc

Intervertebral Foramina

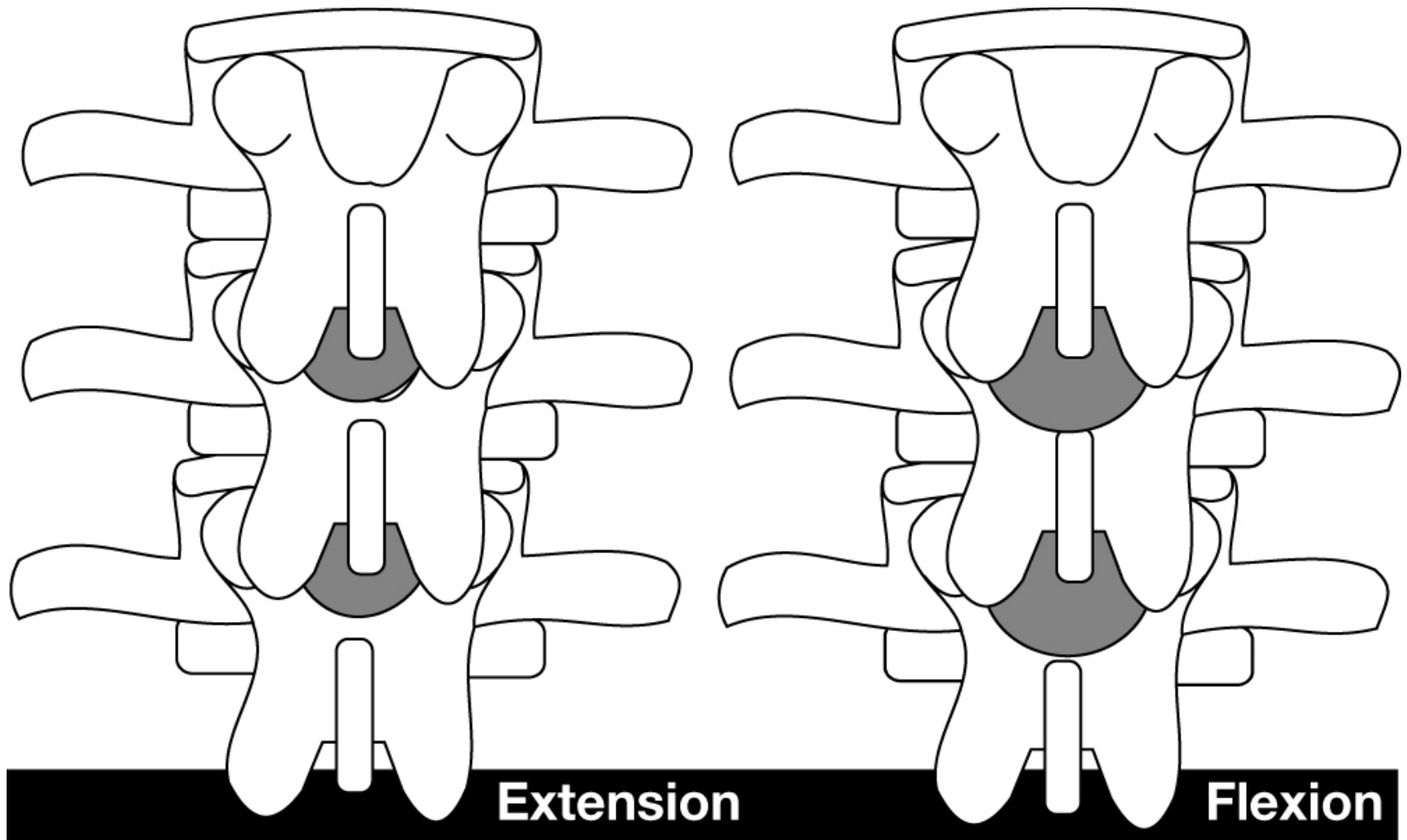
Spinal Nerve Root



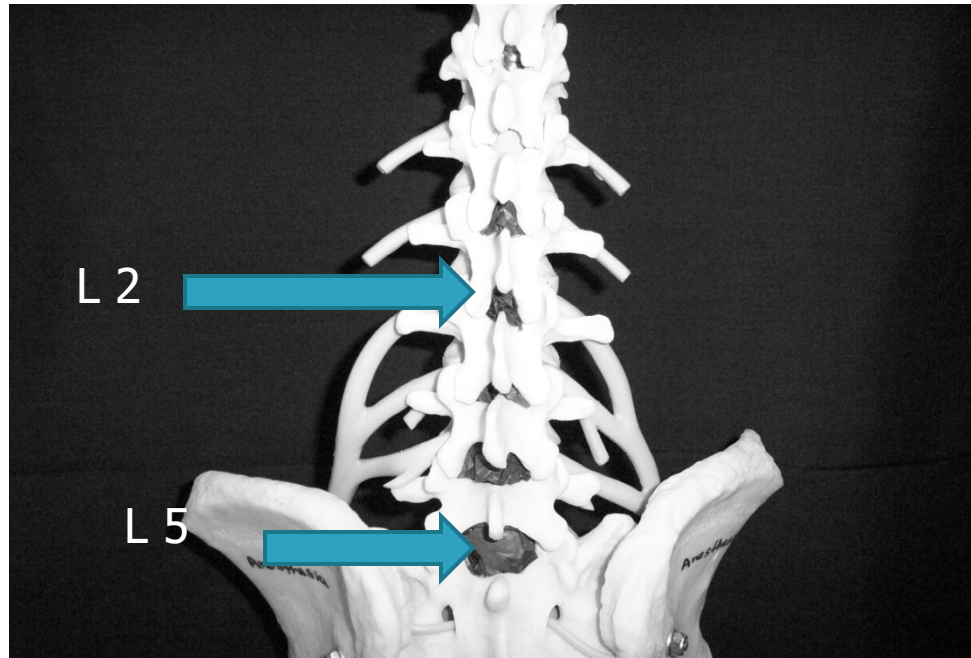
# Spinal Nerves



# Lumbar Extension versus Flexion







Interlaminar spaces are larger in the lower lumbar region. If an anesthesia provider finds it challenging at one level it is important to remember that moving down one space may provide a larger space.

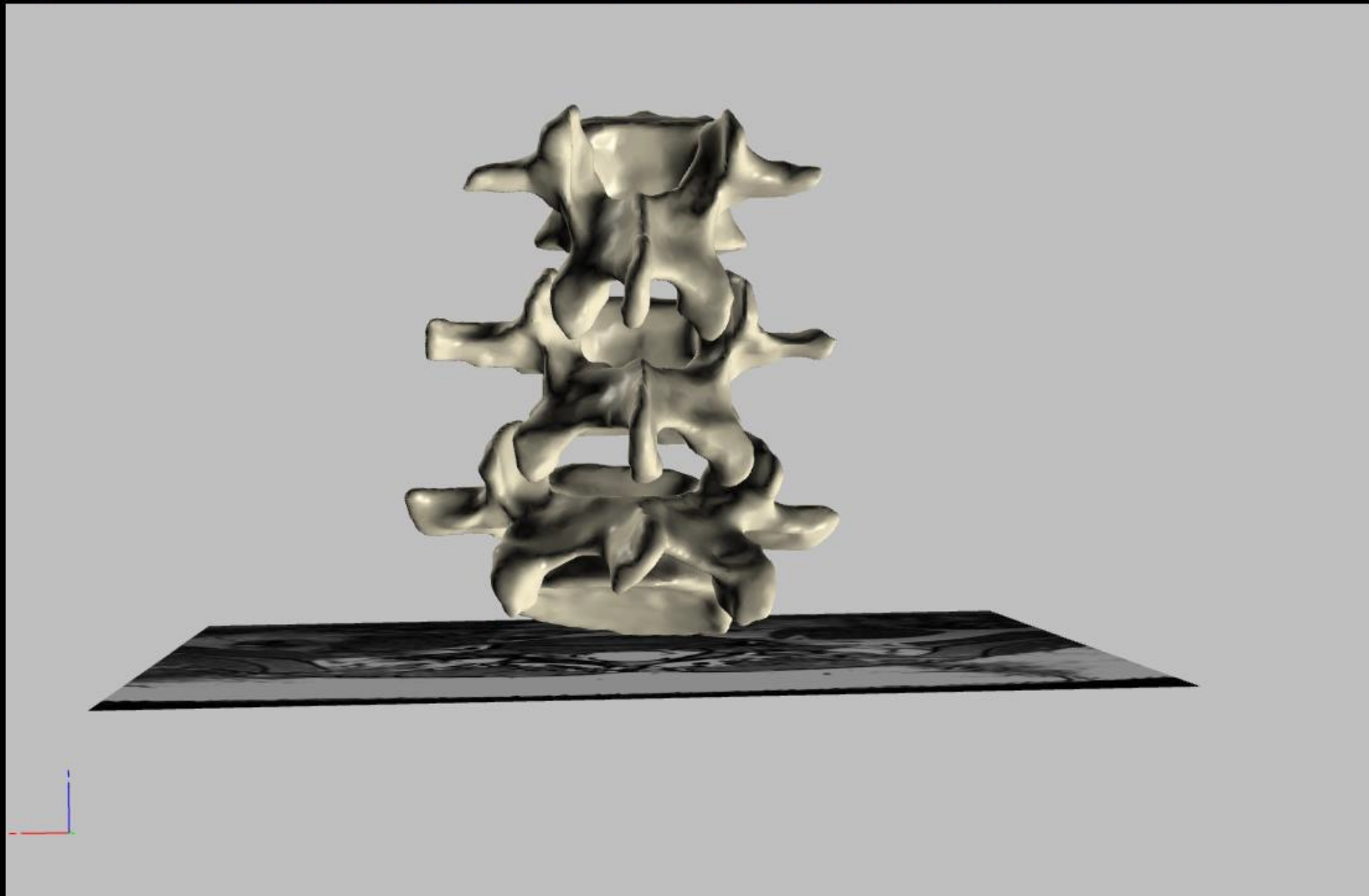


# Virtual Model of the Lumbar Spine 1.0



A. Prats-Galino<sup>1</sup>, M.A. Reina<sup>2</sup>, M. Mavar<sup>1</sup>, A. Puigdel·l·ivol-S·anchez<sup>1</sup>, J. San<sup>3</sup>, J. De Andr·es<sup>4</sup>

<sup>1</sup> University of Barcelona; <sup>2</sup> Madrid-Montep·r·incipe University Hospital; <sup>3</sup> University of Girona; <sup>4</sup> Valencia Gral. University Hospital



Select a structure

Show all

Hide all

Axial  ↑ ↓

Sagittal  ↑ ↓

Coronal  ↑ ↓

Clipping

Axial

Sagittal

Coronal

Offset ↑ ↓

1: General view of the lumbar spine.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Disable Selection



# Virtual Model of the Lumbar Spine 1.0



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Select a structure

Show all

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Axial

Sagittal

Coronal

Clipping

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Coronal

Offset



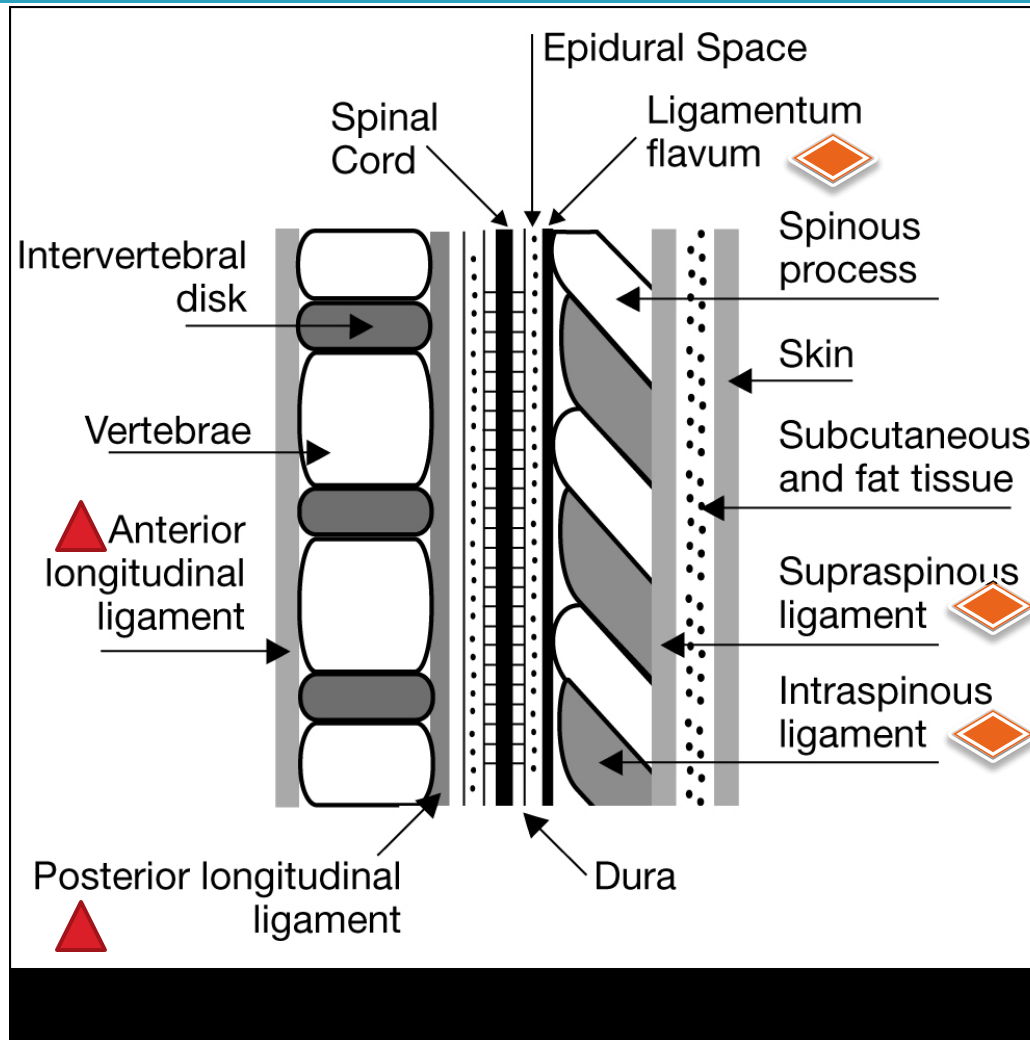
1: General view of the lumbar spine.



Disable Selection

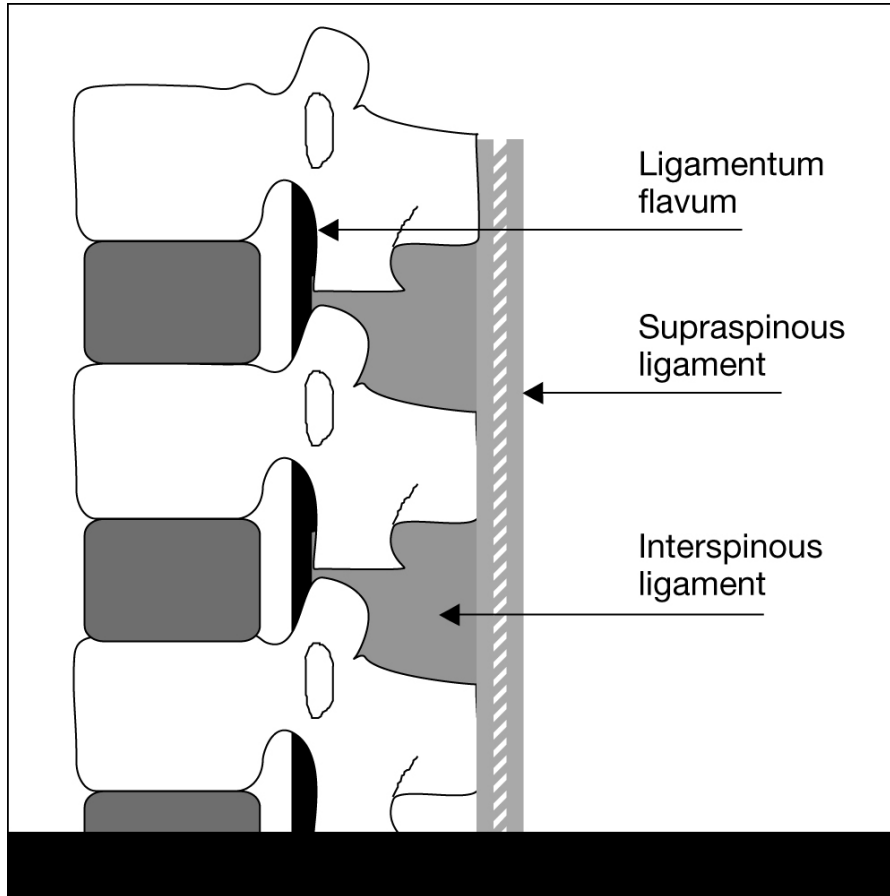
# Ligaments that support the vertebral column

Ventral side:  
Anterior and  
posterior  
longitudinal  
ligaments



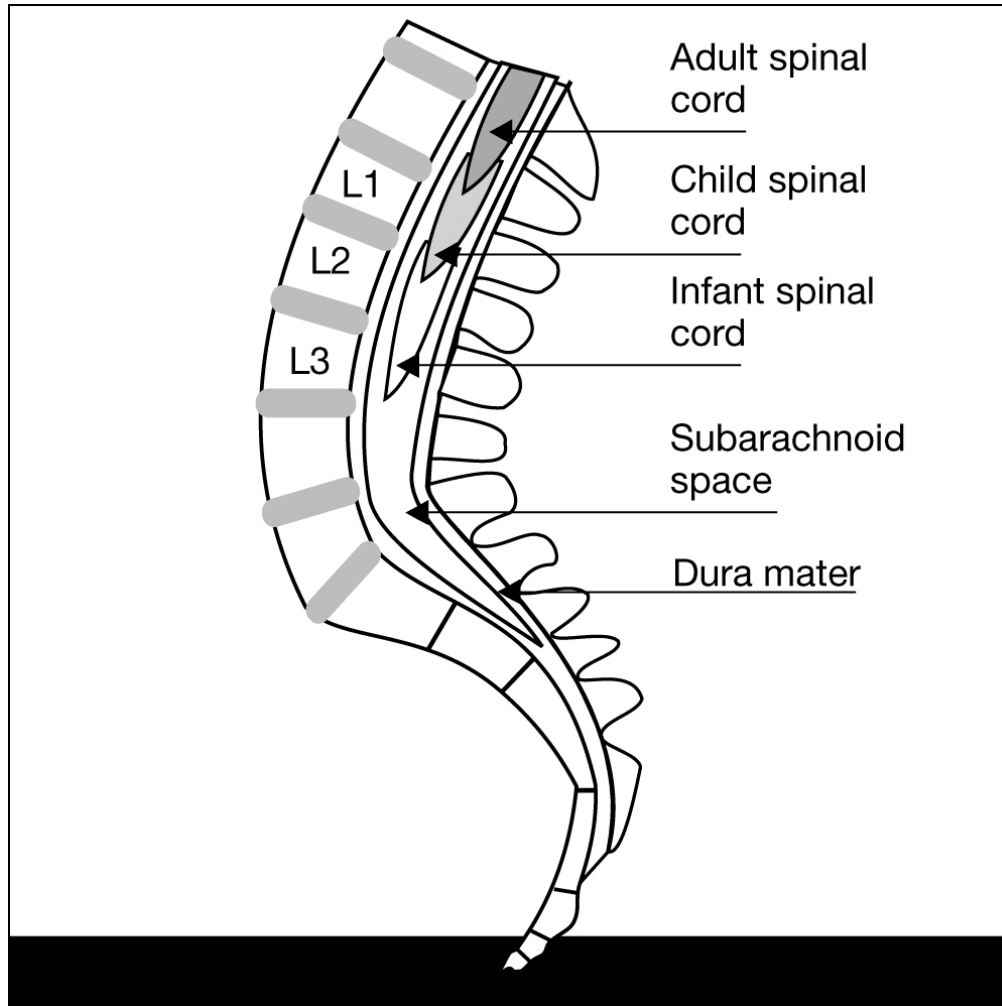
Dorsal  
side:  
Important  
since these  
are the  
structures  
your needle  
will pass  
through!

# Ligaments are identified by tactile sensation (feel)



Dorsal ligaments transversed during neuraxial blockade. With experience the anesthesia provider will be able to identify anatomical structures by “feel”.

# Termination of Spinal Cord

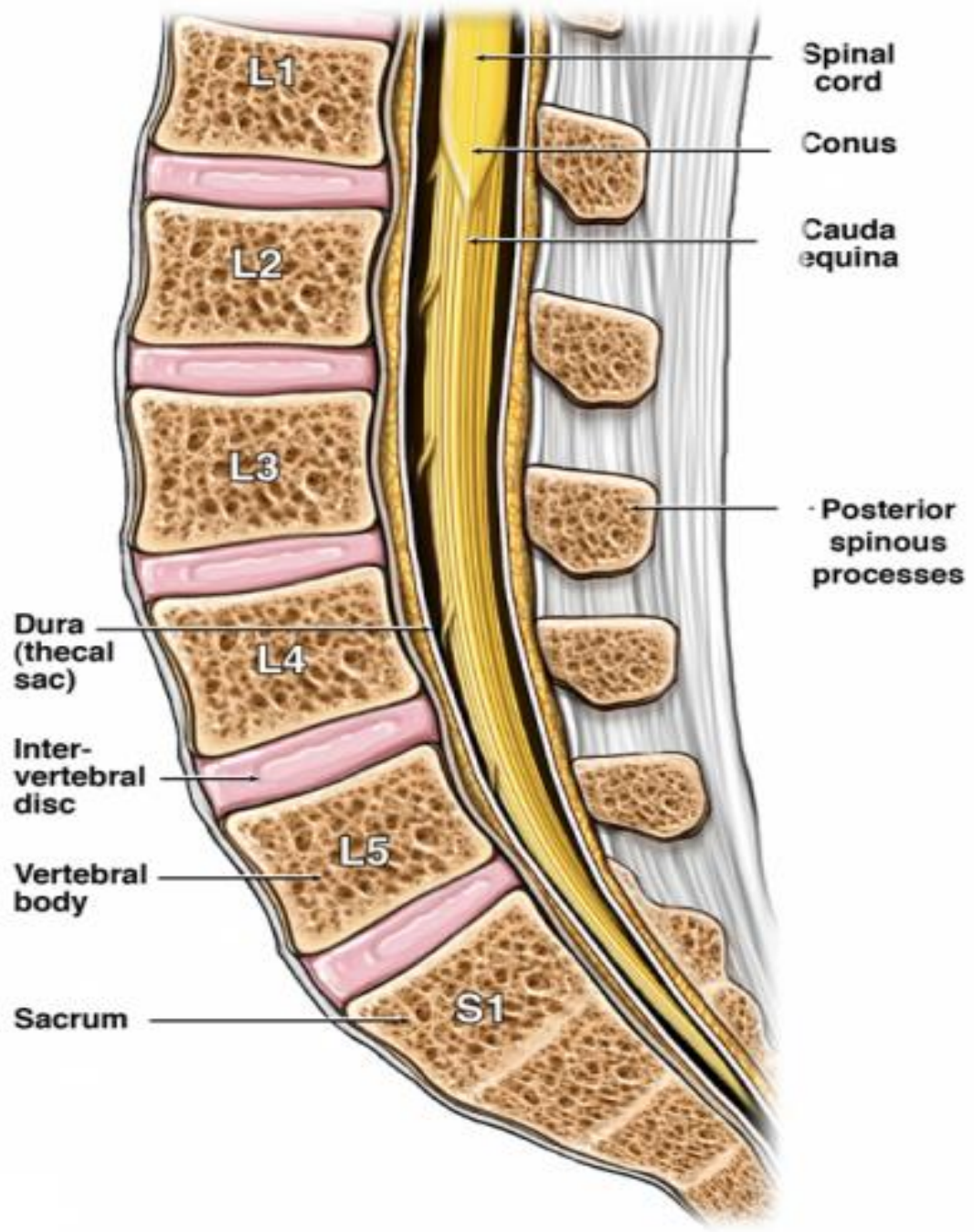


In adults usually ends at L1.

Infants L3

There are anatomical variations. For most adults it is generally safe to place a spinal needle below L2.





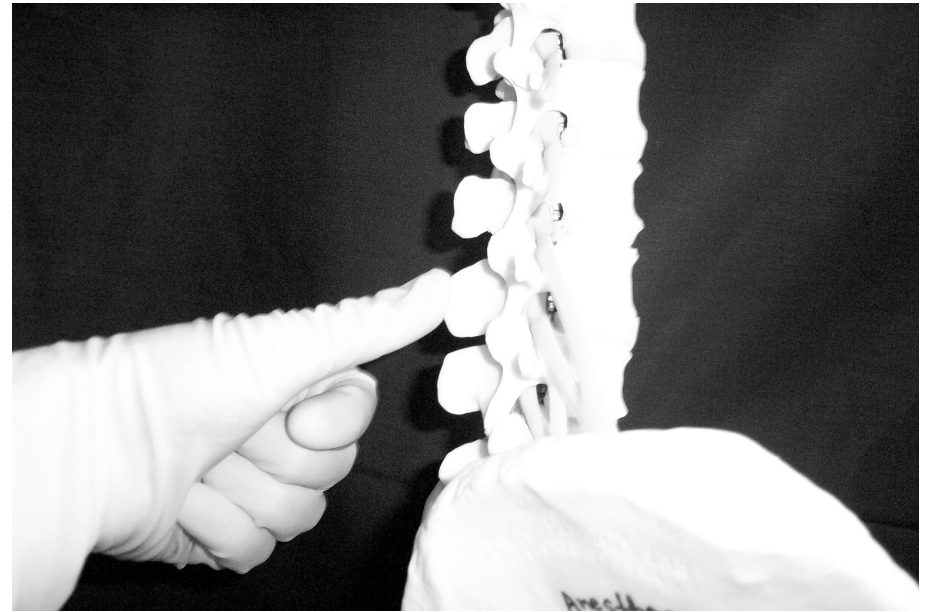
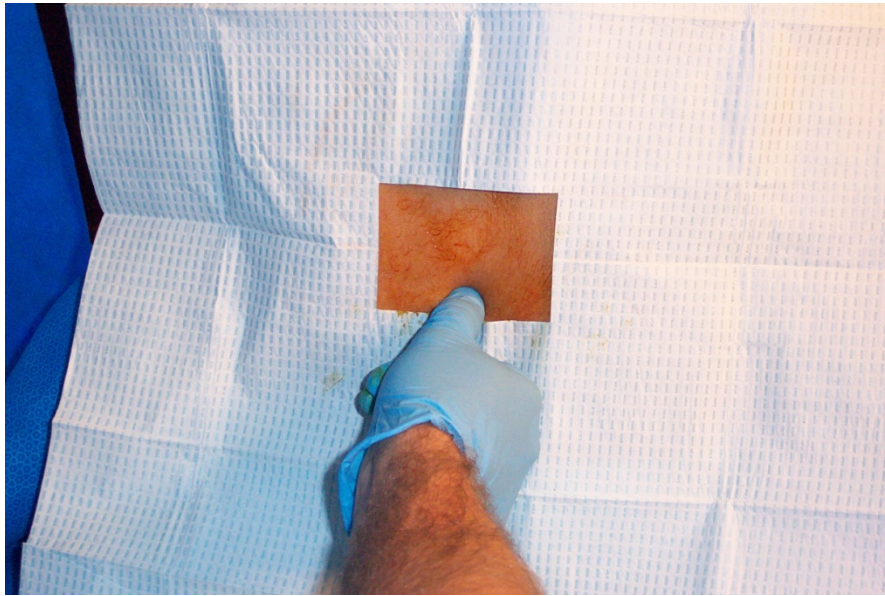


# Surface Anatomy and Landmarks

# Locating prominent cervical and thoracic vertebrae

- C2 is the first palpable vertebrae
- C7 is the most prominent cervical vertebrae
- With the patients arms at the side the tip of the scapula generally corresponds with T7

# Palpation of Spinous Process



# Spinous Processes

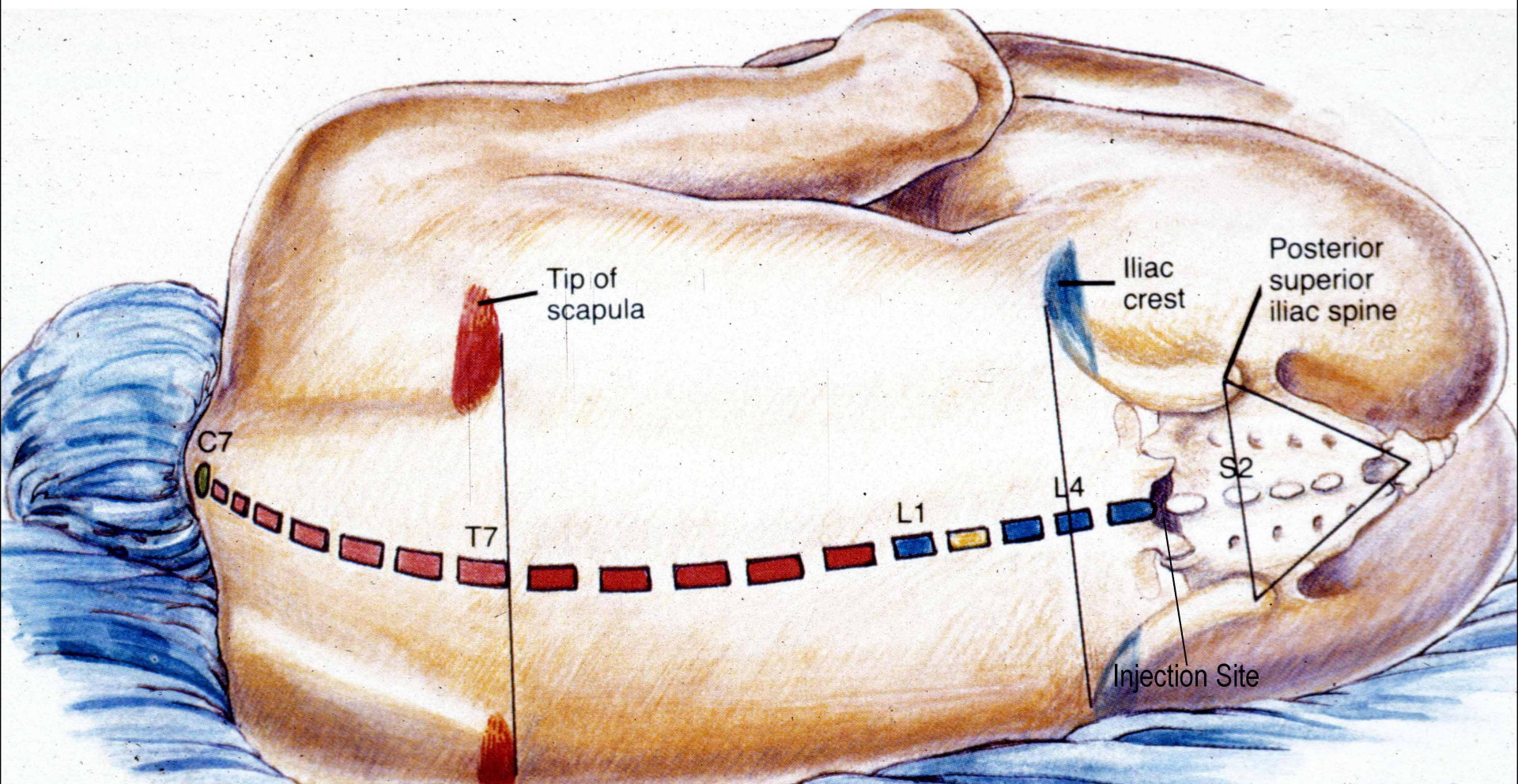
- Generally are palpable to help identify the midline
- If unable to palpate the spinous process one can look at the upper crease of the buttocks and line up the midline as long as there is no scoliosis or other deformities of the spine

# What is Tuffier's Line?

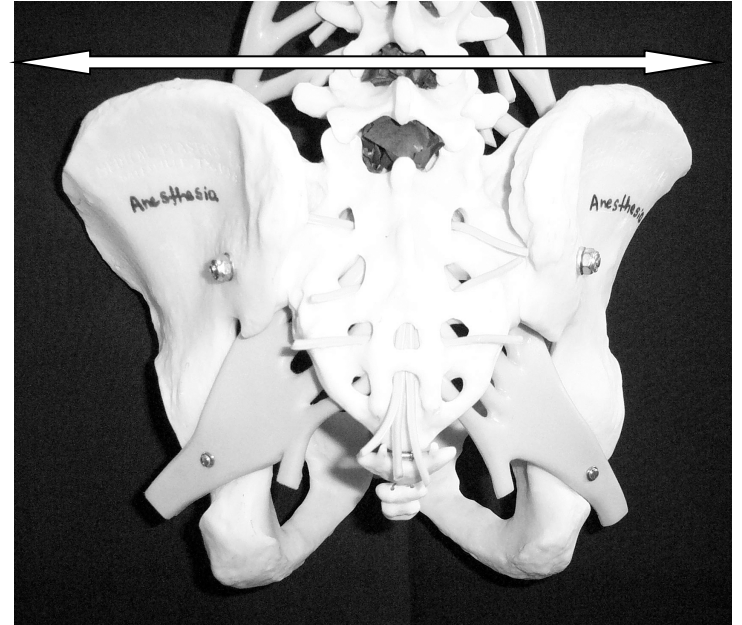



- A line drawn between the highest points of both iliac crests will yield either the body of L4 or the L4-L5 interspace.











# Anatomical Considerations of the Spinal Cord and Neuraxial Blockade.

# The Subarachnoid Space is a continuous space that contains



- CSF
- Spinal cord & nerves

# CSF

- Clear fluid that fills the subarachnoid space
- Total volume in adults is ~100-150 ml (2 ml/kg)
- Volume found in the subarachnoid space is ~45 ml
- Continually produced at a rate of 450 ml per 24 hour period replacing itself 3-4 times

# CSF

- Reabsorbed into the blood stream by arachnoid villi.
- Specific gravity is between 1.003-1.007 (this will play a crucial role in the baricity of local anesthetic that one chooses)
- CSF plays a role the patient to patient variability in relation to block height and sensory/motor regression (80% of the patient to patient variability)
- Body wt is the only measurement that coincides with CSF volume (this becomes important in the obese and pregnant).



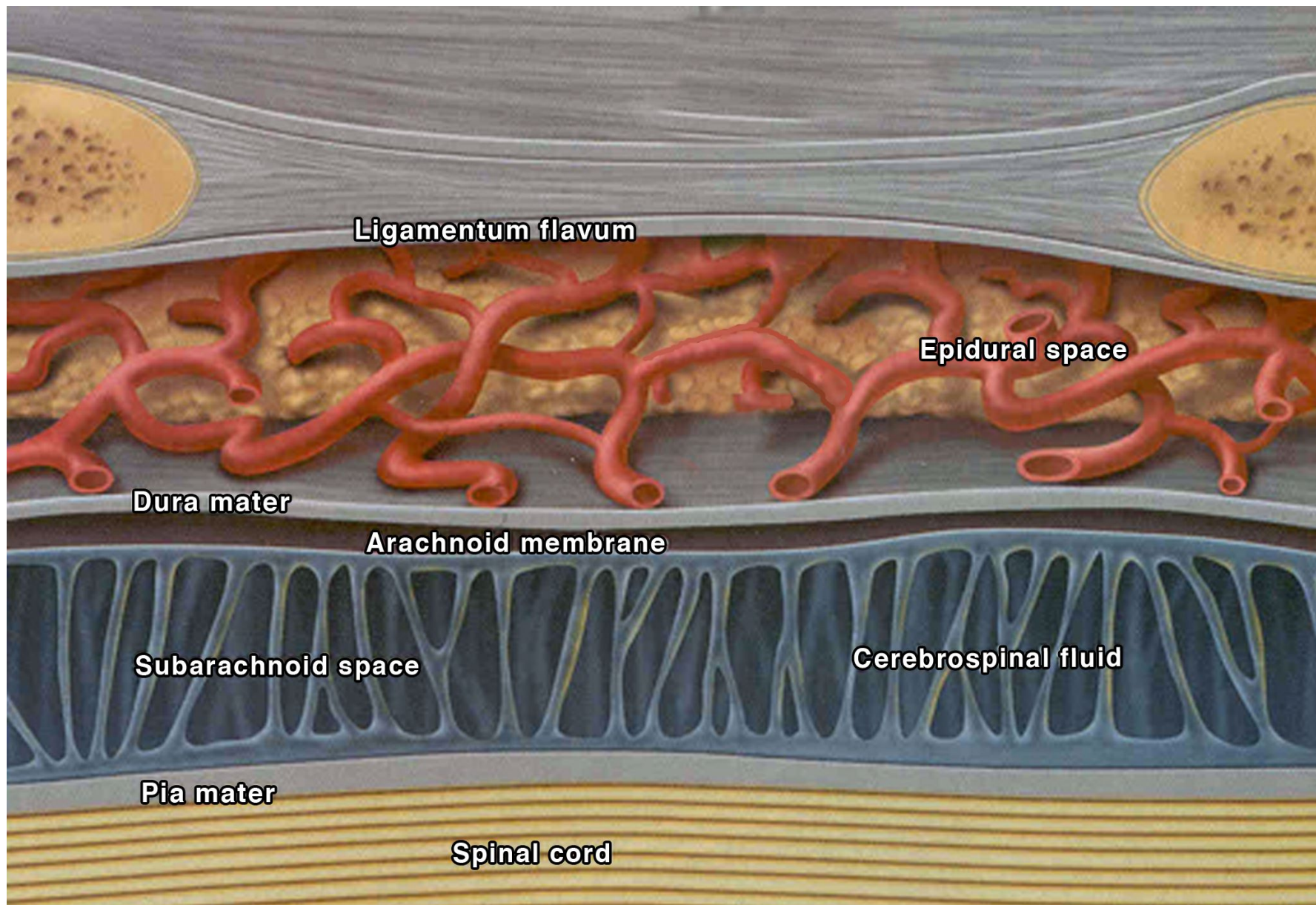
# Membranes that surround the spinal cord

- **Pia mater**- highly vascular, covers the spinal cord and brain, attaches to the periosteum of the coccyx ( Filum terminalis)
- **Arachnoid mater**- non vascular and attached to the dura mater. Principal barrier to the migration of medications in and out of the CSF.
- **Dura mater** (“tough mother”)- extension of the cranial dura mater, extends from the foramen magnum to S2.

# Filum Terminale



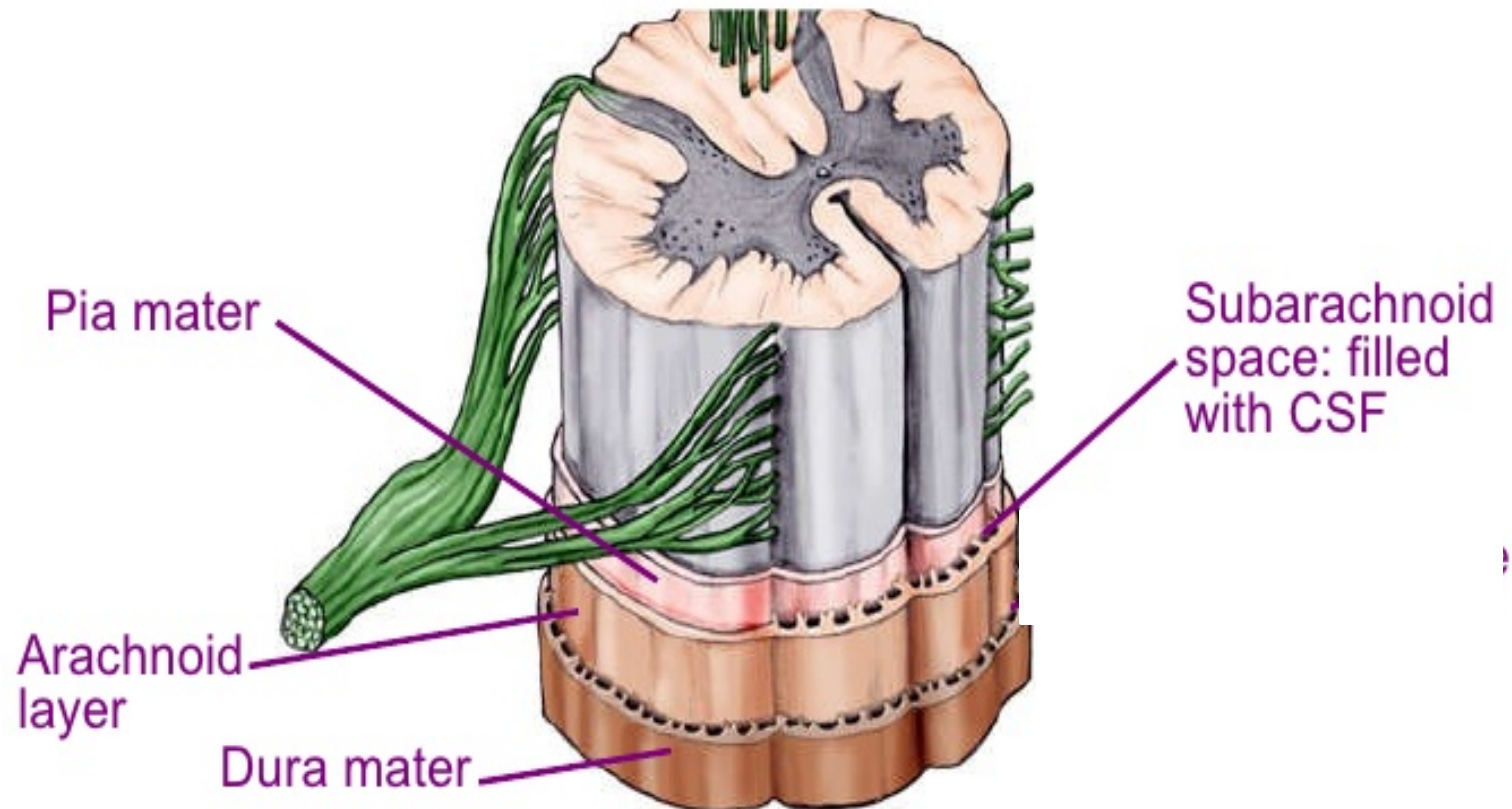
- An extension of the pia mater that attaches to the periosteum of the coccyx.



# Meninges

Within the spinal canal, the spinal cord is surrounded by the **EPIDURAL SPACE**, filled with fatty tissue, veins, and arteries. The fatty tissue acts as a shock absorber.

The spinal cord is covered by **MENINGES** which has three layers.

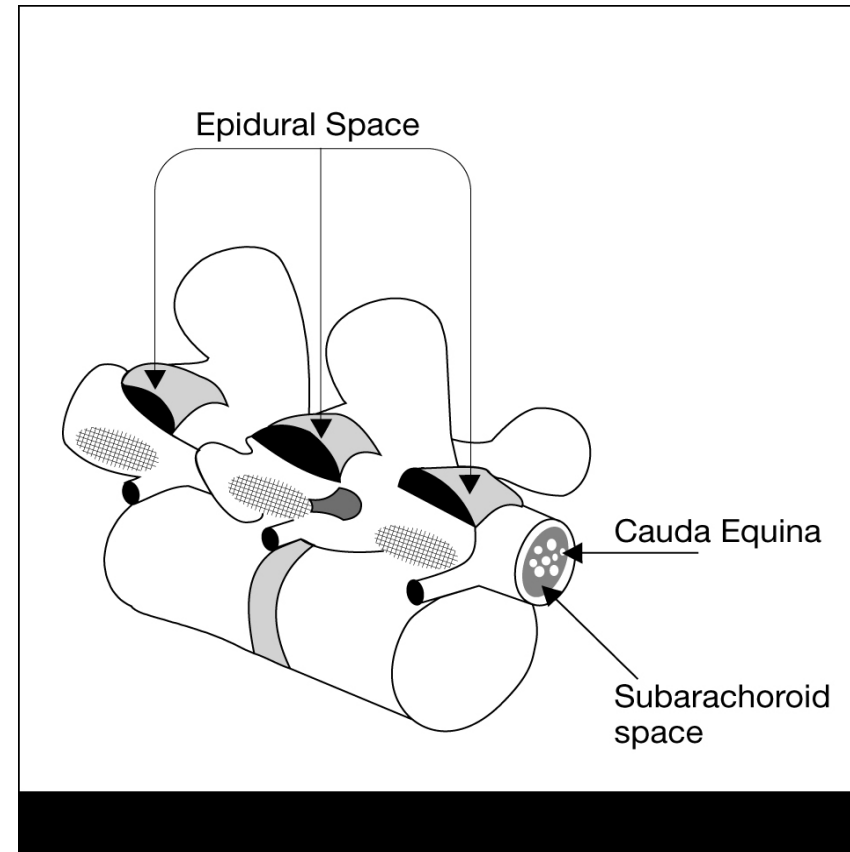




# Epidural Space Anatomy

# Epidural Space Anatomy

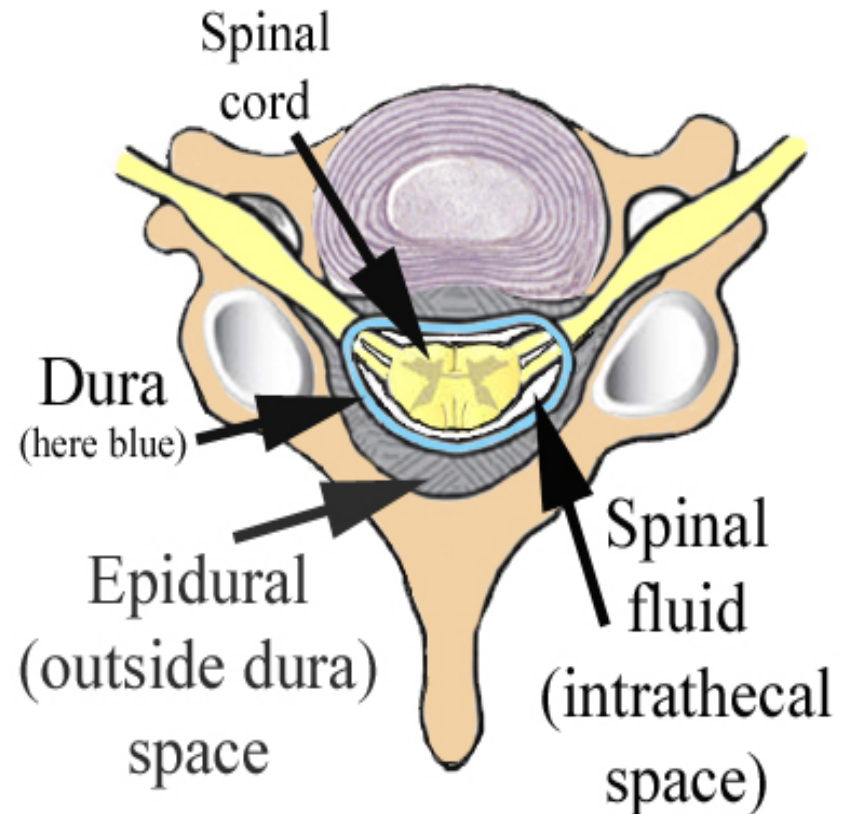
- Extends from the foramen magnum to the sacral hiatus





# Epidural Space Anatomy

- The epidural space surrounds the dura mater anteriorly, laterally, and most importantly to us posteriorly.

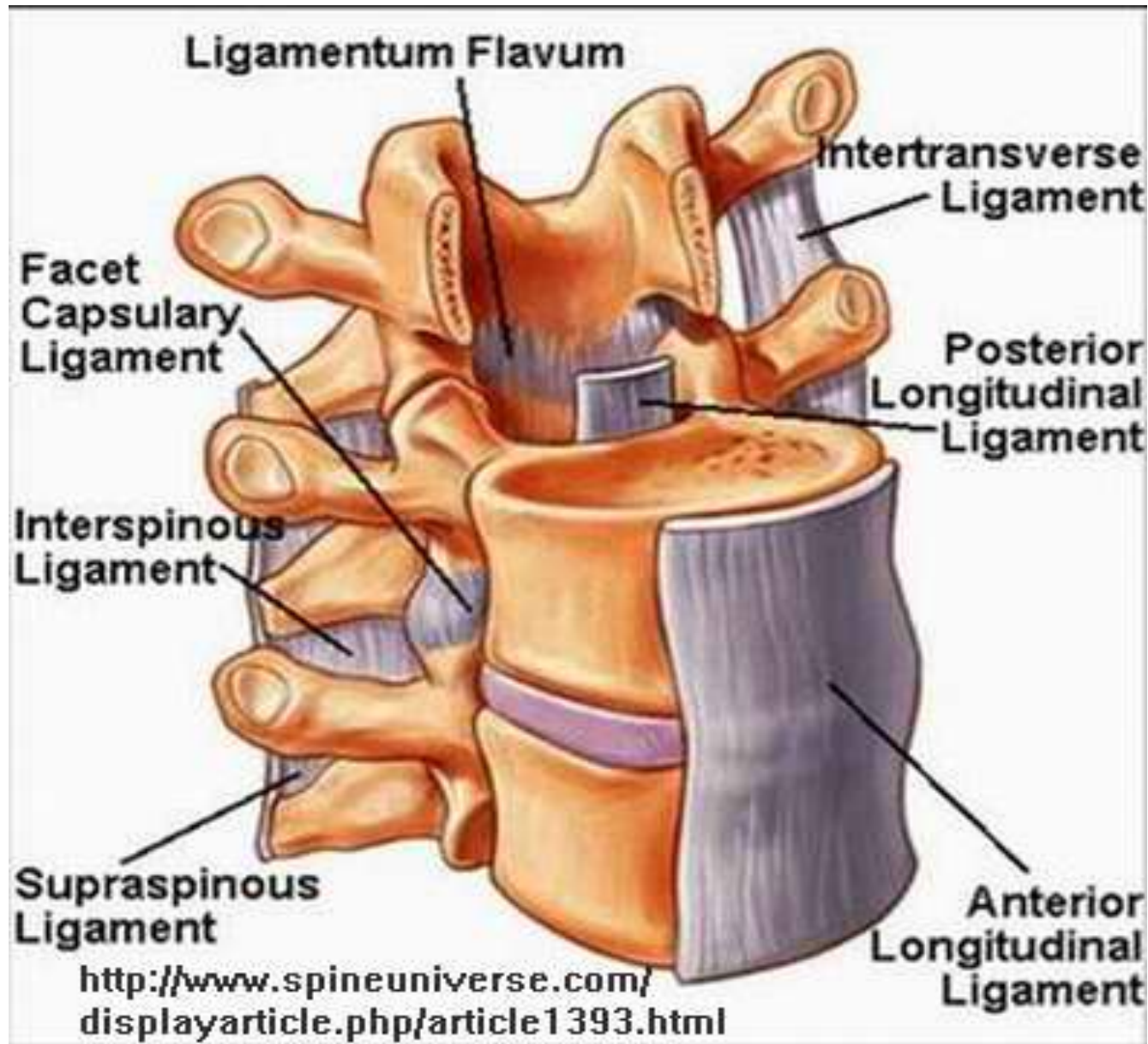


# The Bounds of the Epidural Space are as follows:

- Anterior- posterior longitudinal ligament
- Lateral- pedicles and intervertebral ligaments
- Posterior- ligamentum flavum

# Ligamentum Flavum

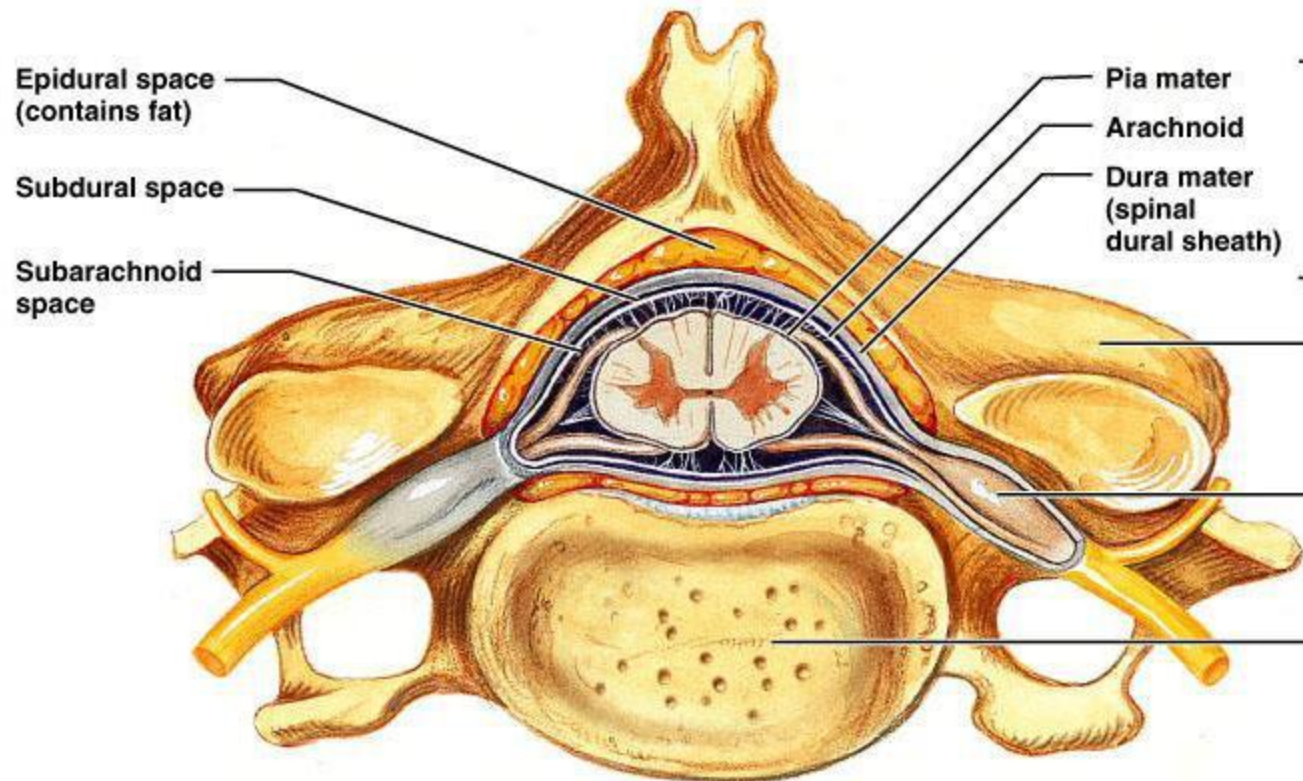
- Posterior to the epidural space
- Extends from the foramen magnum to the sacral hiatus
- Distance from skin to ligament varies from 3-8 cm in the lumbar area. It is 4 cm in 50% of the patients and 4-6 cm in 80% of the patients.
- Thickness of the ligamentum flavum also varies. In the thoracic area it can range from 3-5 mm and in the lumbar it can range from 5-6 mm



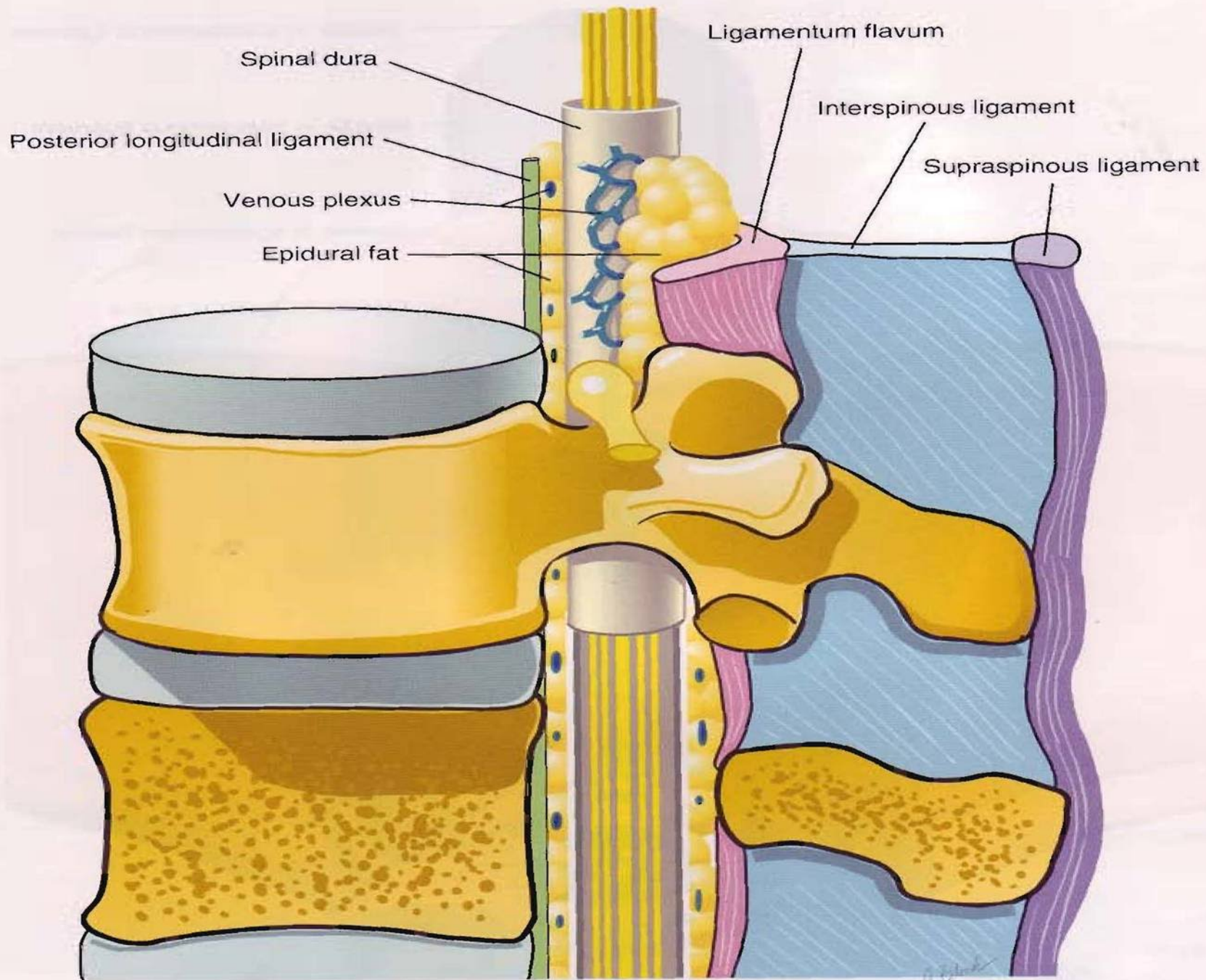
# Contents of the Epidural Space

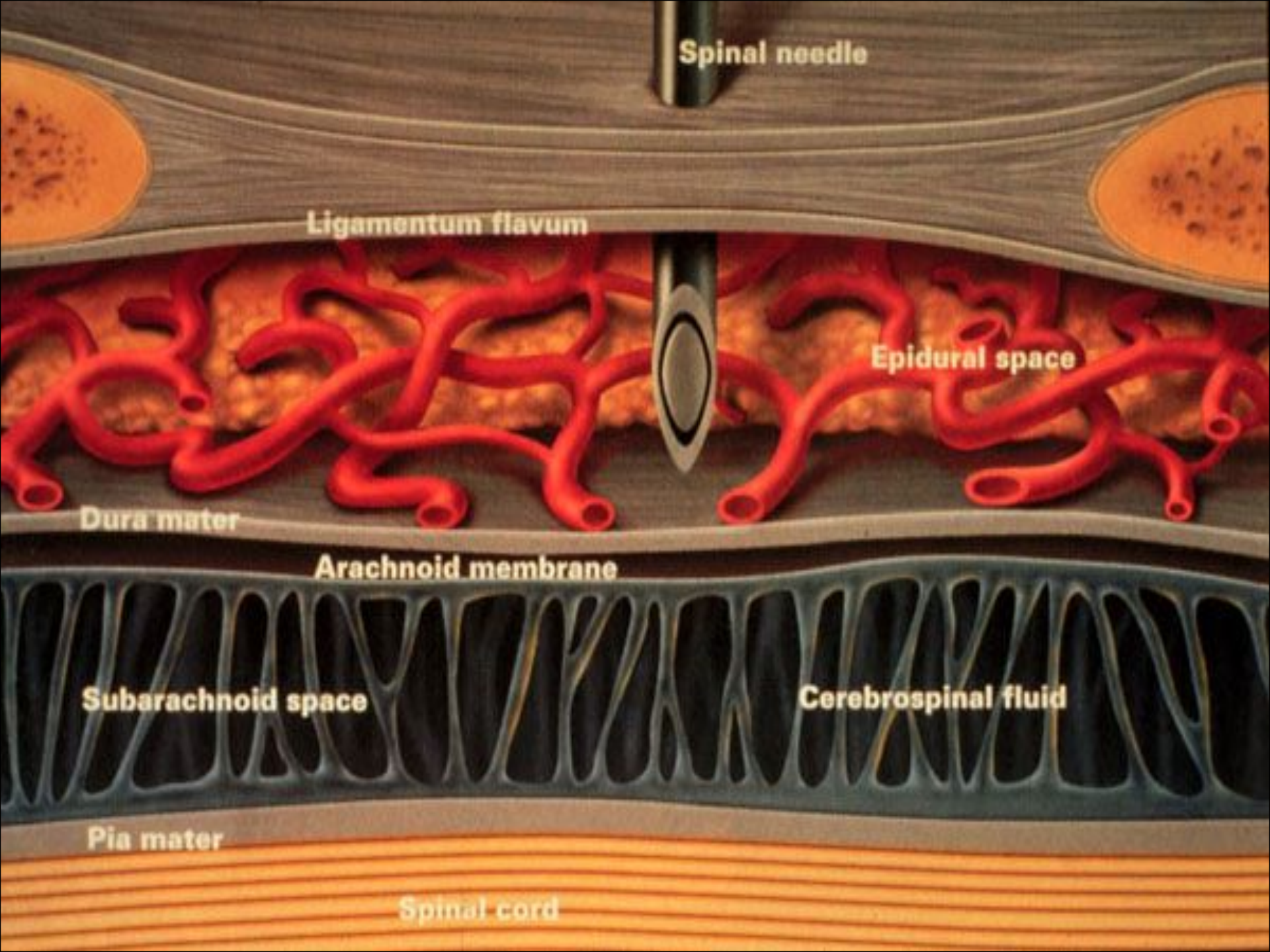


- Fat
- Areolar tissue
- Lymphatics
- Blood vessels including the Batson venous plexus









**Spinal needle**

**Ligamentum flavum**

**Epidural space**

**Dura mater**

**Arachnoid membrane**

**Subarachnoid space**

**Cerebrospinal fluid**

**Pia mater**

**Spinal cord**



# Definition

## **Spinal anesthesia :**

Injection of small amounts ( 2-3 ml) of local anaesthetics into the CSF at the level below ( L2 ) ,where the spinal cord ends, anesthesia of the lower body part below the umbilicus is achieved.

## **Indication**

Operations below the umbilicus: hernia repairs, gynaecological, urological operation, orthopedics,  
Any operation on the perineum or genitalia.

# Spinal Anesthesia

## □ Contraindications

### ▣ Absolute:

- Refusal
- Infection
- Coagulopathy & anticoagulated patient
- Severe hypovolemia
- Increased intracranial pressure
- Severe aortic or mitral stenosis

### ▣ Relative:

- Use your best judgment



Canon

**Sterility**





Sitting Vs. Lateral decobitus



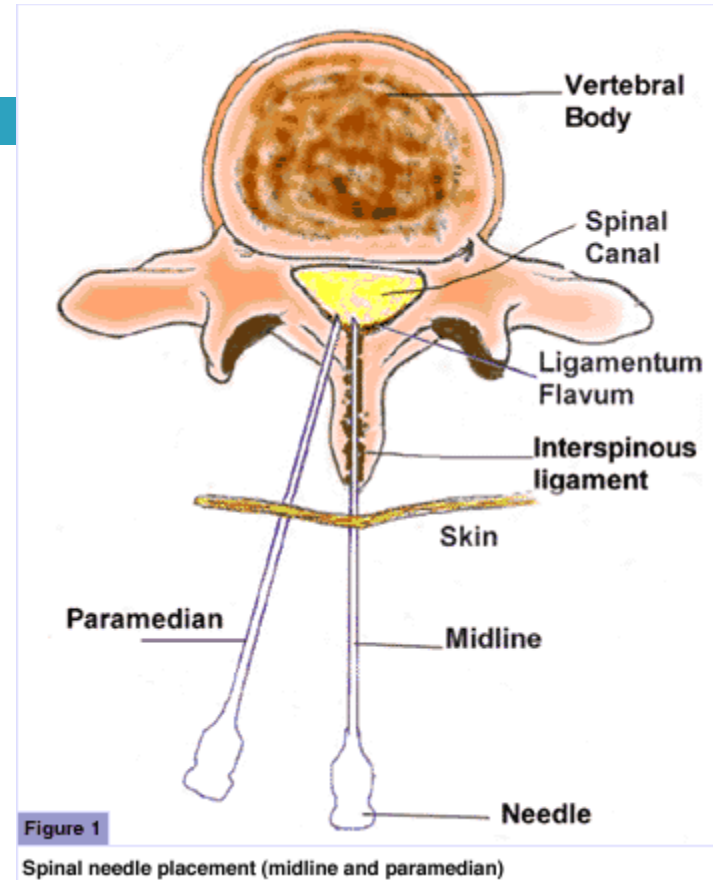
# Spinal Technique

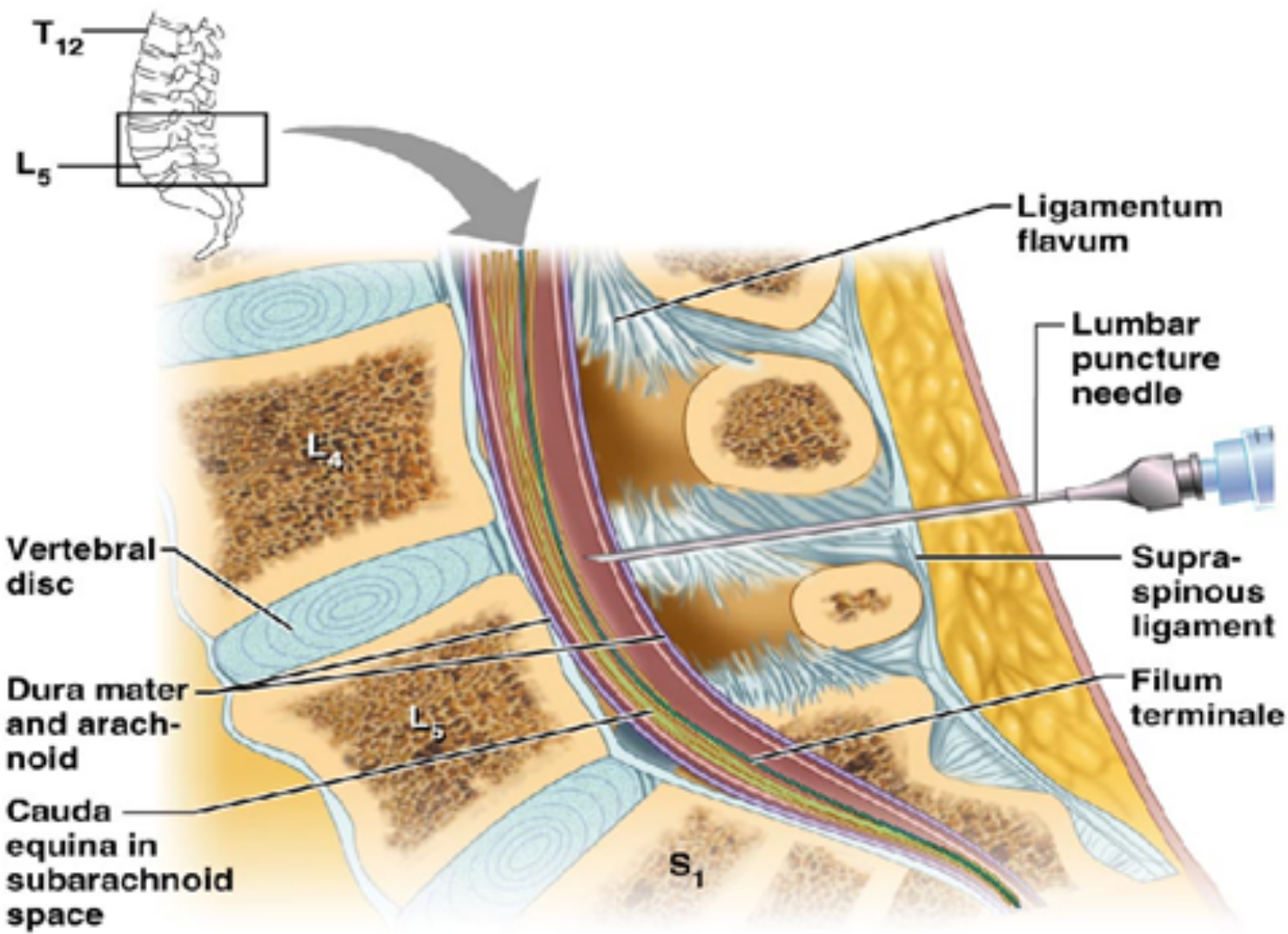
## □ Midline Approach

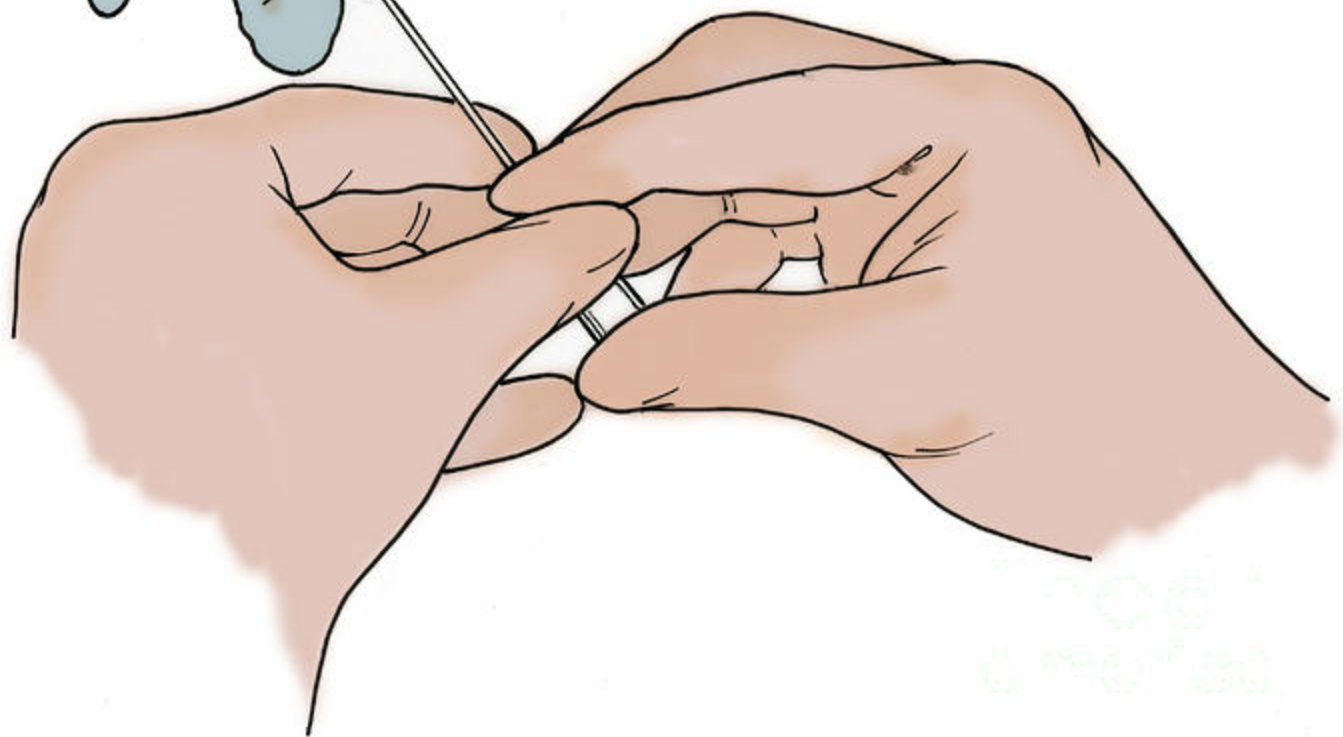
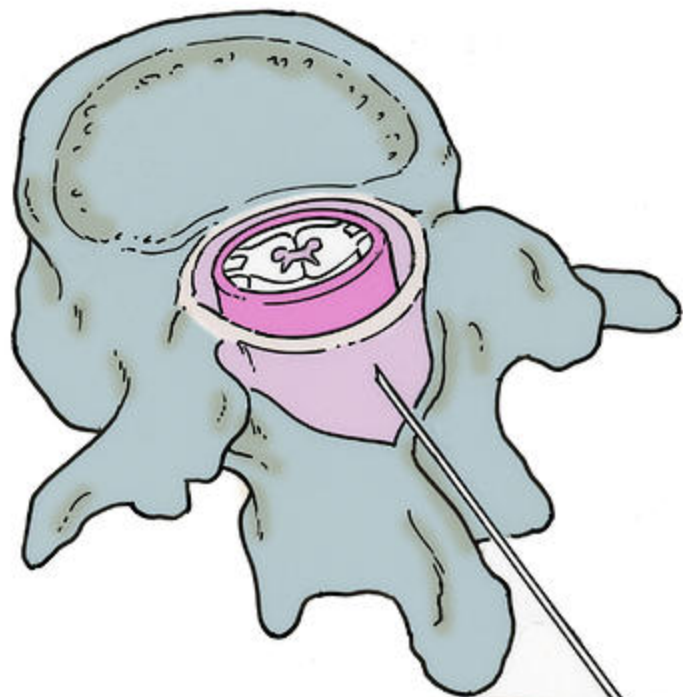
- Skin
- Subcutaneous tissue
- Supraspinous ligament
- Interspinous ligament
- Ligamentum flavum
- Epidural space
- Dura mater
- Arachnoid mater

## □ Paramedian or Lateral Approach

- Same as midline excluding supraspinous & interspinous ligaments







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CME

# Spinal needles type

Actual photograph magnified 21 times



**Gertie Marx<sup>®</sup>**

26 Gauge



**Sprotte**

25 Gauge



**Whitacre**

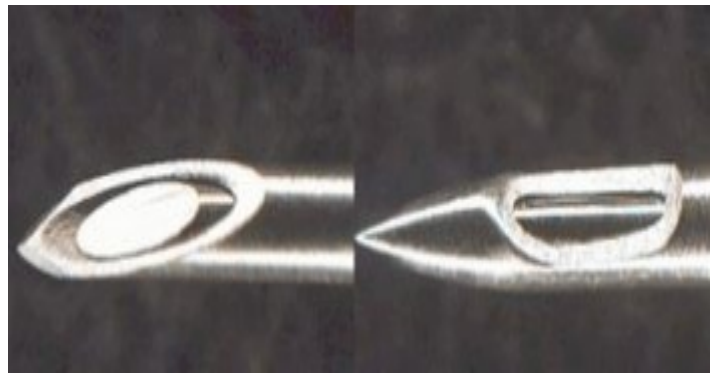
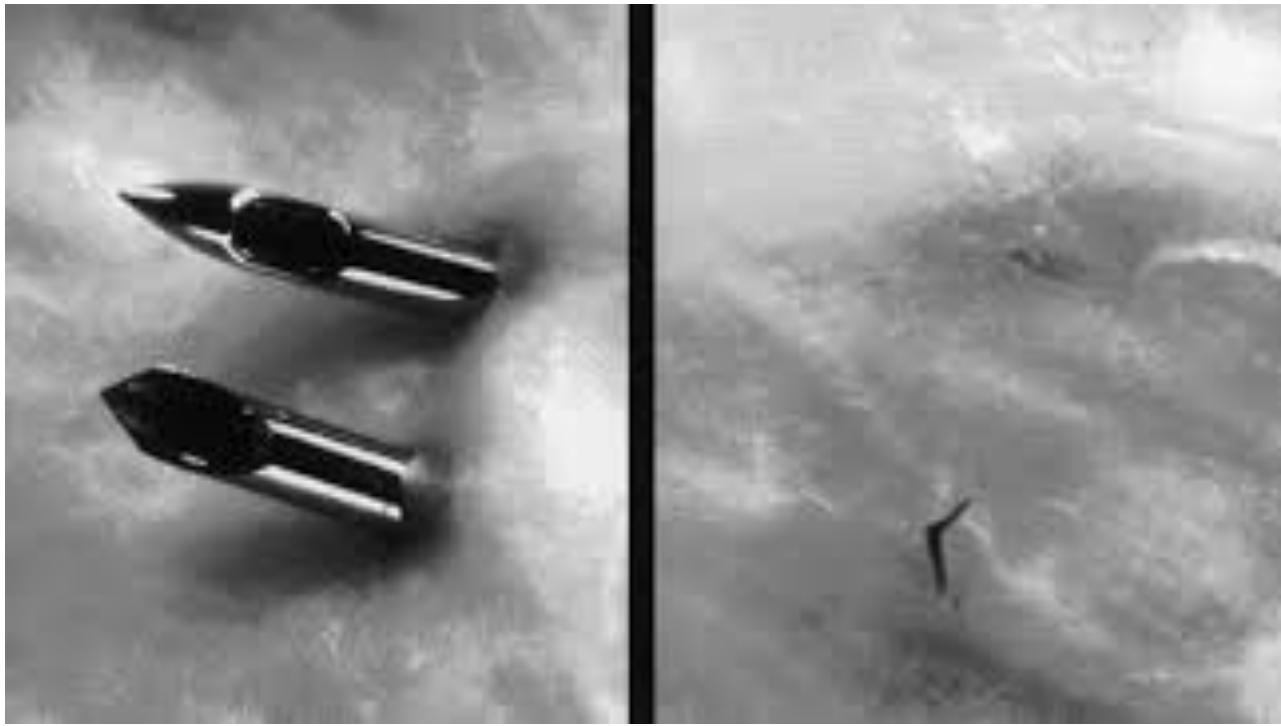
25 Gauge



**Quincke**

25 Gauge



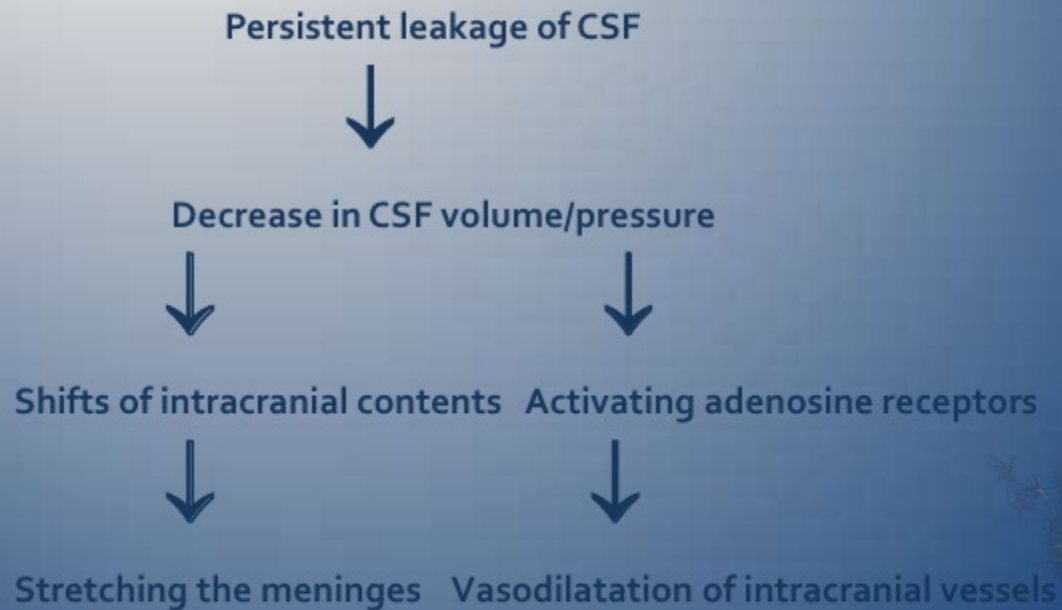


# PDPH

- Develop 12-48 hours after spinal anesthesia.
- Headache improve when lying supine.



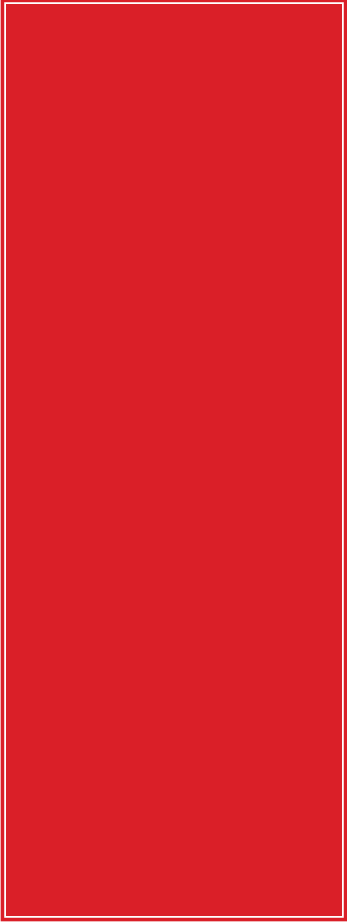
# Mechanisms of PDPH



# Differential Diagnosis

- Meningitis
- Sinusitis
- Migraine
- Pregnancy related hypertension
- Intracranial Pathology (sol)
- Dural Venous thrombosis,
- Pneumocephalus,
- Spontaneous intracranial hypotension.

# PDPH; Treatment

- 
- Conservative.
  - Epidural blood patch.

# Spinal anesthesia; single shot technique



# Factors Affecting the Level of Spinal Anesthesia

## Most Important Factors

- Baricity
- Position of the patient
  - During and immediately after injection
- Dosage
- Site of injection

## Other Factors

- Age
- CSF
- Curvature of the spine
- Drug volume
- Intraabdominal pressure
- Needle direction
- Patient height
- Pregnancy



# Baricity( a concern only in spinal anesthesia)

- Hyperbaric
  - ▣ Typically prepared by mixing local with dextrose
  - ▣ Flow is to most dependent area due to gravity
  - ▣ Very predictable spread
- Hypobaric
  - ▣ Prepared by mixing local with sterile water
  - ▣ Flow is to highest part of CSF column
- Isobaric
  - ▣ Neutral flow that can be manipulated by positioning
  - ▣ Increased dose has more effect on duration than dermatomal spread
- Note: Be cognizant of high & low regions of spinal column



Hyperbaric bupivacaine is prepared by mixing it with dextrose

**Sterile, clear**  
**Preservative free**  
**3 ml ampoules**  
**See the expiry date**  
**Be sure it is bupivacaine??**



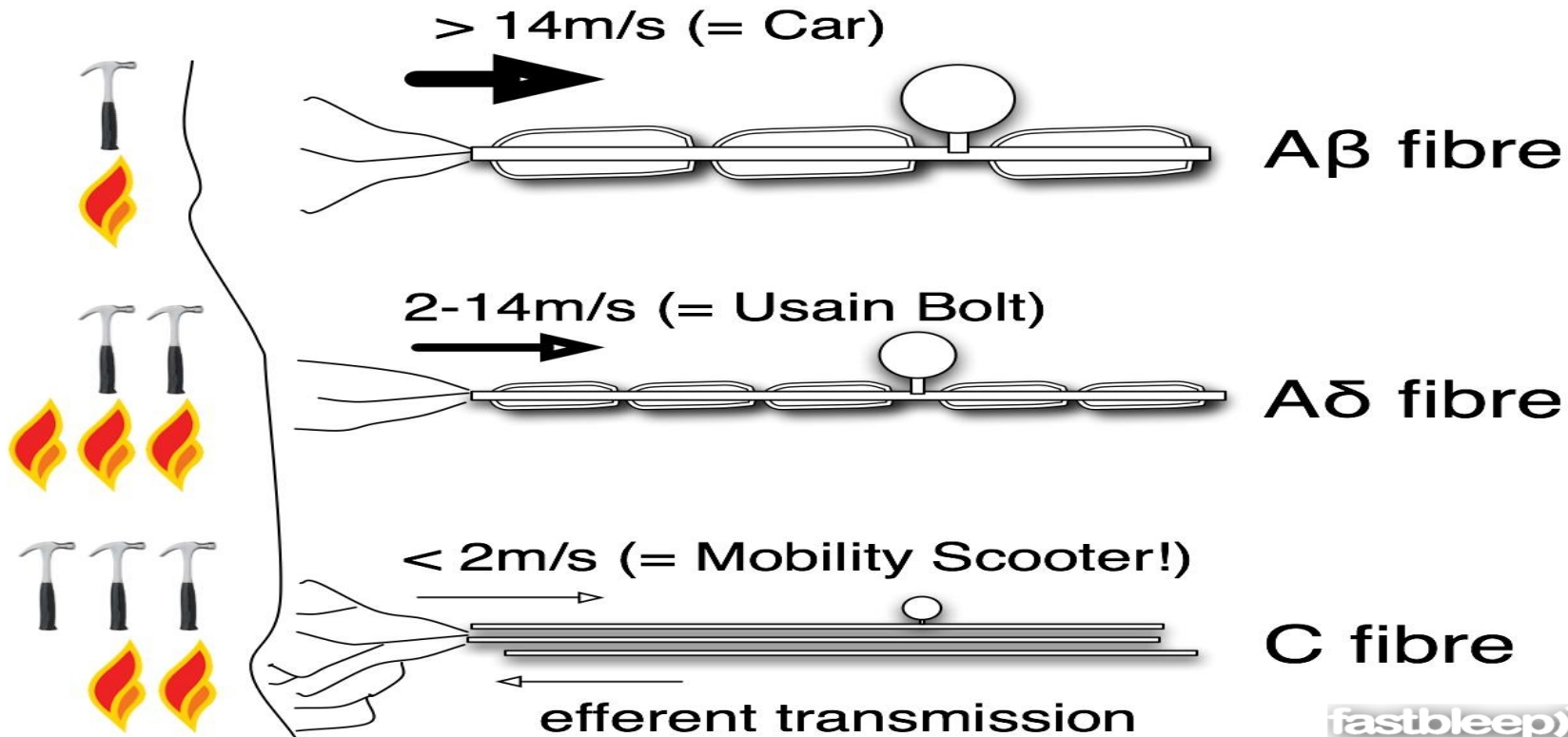
# Classification of nerve fibers

## C. Classification of nerve fibers (in humans)

Fiber type	Function according to fiber type (Lloyd and Hunt types I-IV)	Diameter ( $\mu\text{m}$ )	Conduction rate (m/s)
A $\alpha$	Skeletal muscle efferent, afferents in muscle spindles (Ib) and tendon organs (Ib)	11 - 16	60 - 80
A $\beta$	Mechanoafferents of skin (II)	6 - 11	30 - 60
A $\gamma$	Muscle spindle efferents	1 - 6	2 - 30
A $\delta$	Skin afferents (temperature and "fast" pain) (III)		
B	Sympathetic preganglionic; visceral afferents		
C	Skin afferents ("slow" pain); sympathetic postganglionic afferents (IV)	0.5 - 1.5 (unmyelinated)	0.25 - 1.5

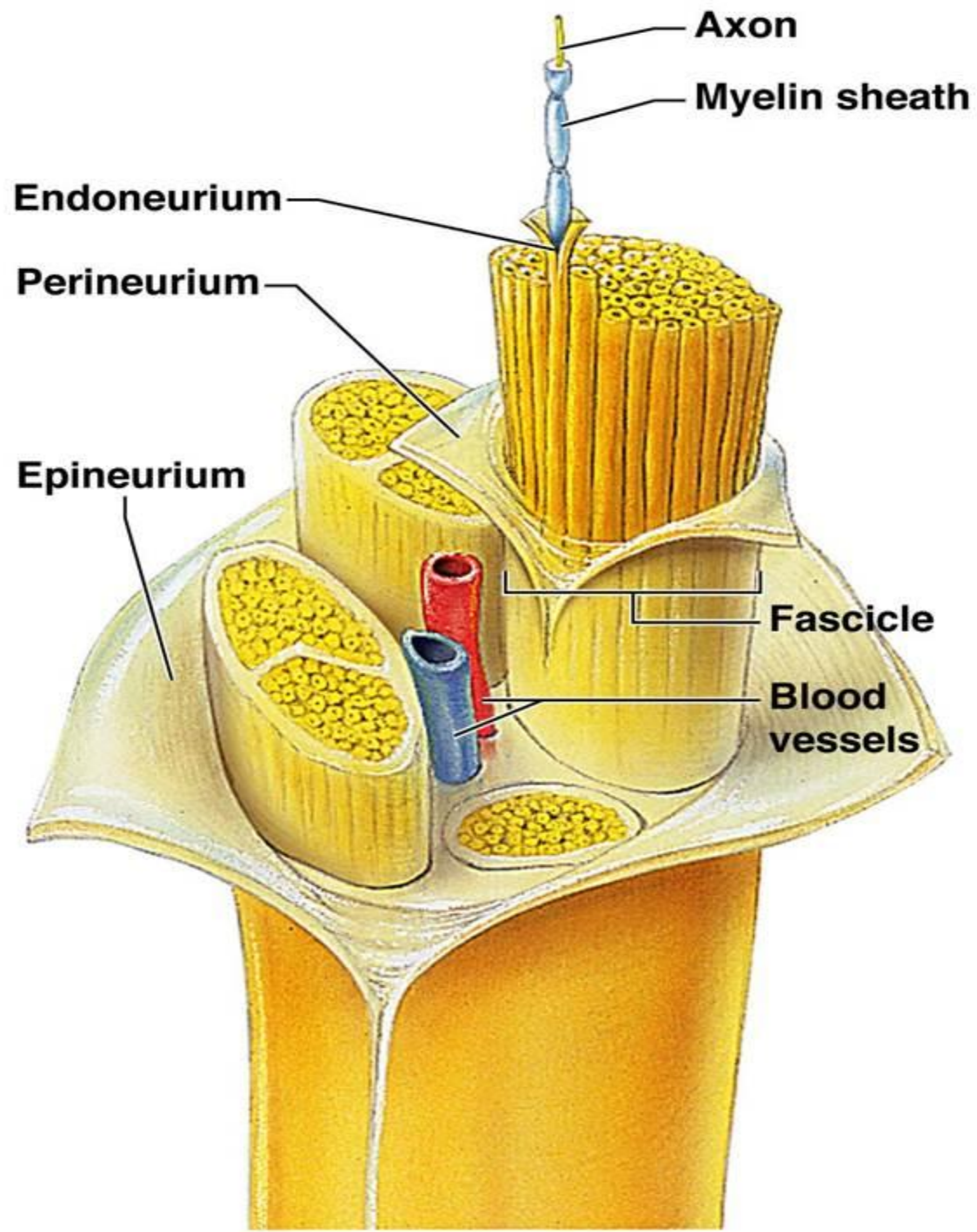
(After Erlanger and Gasser)

Stimulus intensity required for activation



**Table 3: Types of neurons blocked with local anesthetics**

<b>Neuron type</b>	<b>Function</b>	<b>Myelination</b>	<b>Order of Blockade</b>	<b>Signs of Blockade</b>
A alpha	Motor -skeletal muscle	Myelinated	Fifth	Loss of motor function
A beta	Sensory – touch, pressure	Myelinated	Fourth	Loss of sensation to touch and pressure
A gamma	Motor - muscle spindles proprioception	Myelinated	Third	Loss of proprioception
<b>A delta</b>	<b>Fast pain temperature</b>	<b>Myelinated</b>	<b>Second</b>	<b>Pain relief, loss of temperature sensation</b>
B	Autonomic, Pre-ganglionic sympathetic	Myelinated	First	Increased skin temperature
<b>C</b>	<b>Slow pain, autonomic, postganglionic sympathetic, polymodal nociceptors</b>	<b>Unmyelinated</b>	<b>Second</b>	<b>Pain relief, loss of temperature sensation</b>



# Sympathetic, Sensory & Motor Blockade

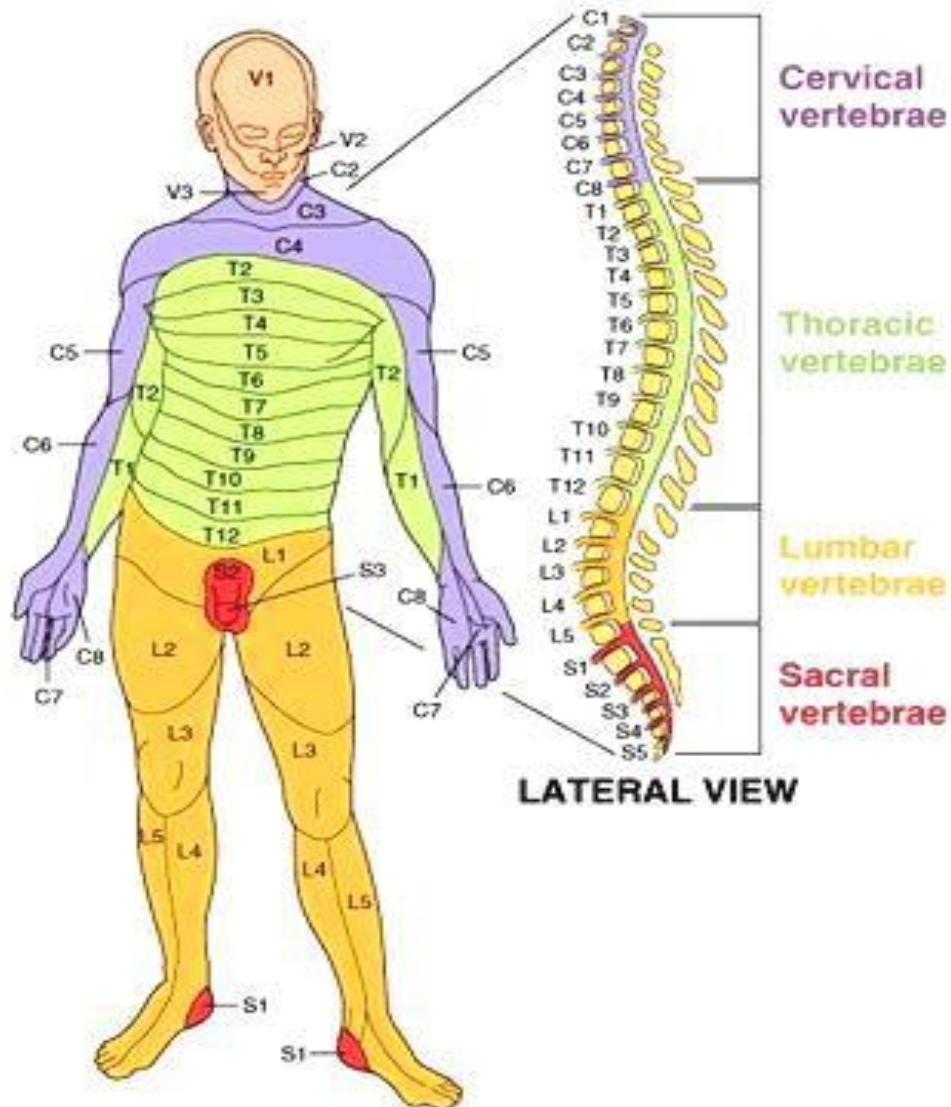
## □ Spinal Injection

- ▣ Sympathetic block is 2 dermatomes higher than sensory block
- ▣ Motor block is 2 dermatomes lower than sensory block
- ▣ Detect the sensory level by cold sensation test,  
( Ice cubes).

Block order  $B > C = A$   $\delta > A$   $\beta > A$   $\alpha$



# Dermatomes of the Body





# Spinal Anesthesia Levels

## Spinal Anesthesia Levels (*You must know dermatomes*)

<b>Dermatome</b>	<b>Application</b>
C <sub>4</sub> (clavicle)	Chest surgery
T <sub>4</sub> - T <sub>5</sub> (nipples)	upper abdominal surgery
T <sub>6</sub> - T <sub>8</sub> (xiphoid)	intestinal surgery, appendectomy, gynecologic pelvic surgery, and ureter and renal pelvic surgery
T <sub>8</sub> (lower border of ribcage)	Abdominal surgery
T <sub>10</sub> (umbilicus)	transurethral resection, obstetric vaginal delivery, and hip surgery
L <sub>1</sub> (inguinal ligament)	transurethral resection, if no bladder distension, thigh surgery, lower limb amputation
L <sub>2</sub> - L <sub>3</sub> (knee and below)	foot surgery
S <sub>2</sub> - S <sub>5</sub> (perineal)	perineal surgery, hemorrhoidectomy, anal dilation

# Spinal Anesthesia

- Complications
  - ▣ Failed block
  - ▣ Back pain (most common)
  - ▣ Spinal head ache
    - More common in women ages 13-40
    - Larger needle size increase severity
    - Onset typically occurs first or second day post-op
    - Treatment:
      - Bed rest
      - Fluids
      - Caffeine
      - Blood patch

# Spinal Anesthesia

- Complications
  - Epidural hematoma
  - Epidural abscess
  - Meningitis
  - Cauda equina
  - Neurological deficit
  - TNS
  - Bradycardia--- Cardiac arrest

# Hypotension

## □ Treatment

- ▣ Best way to treat is physiologic not pharmacologic

- ▣ Primary Treatment

  - Increase the cardiac preload

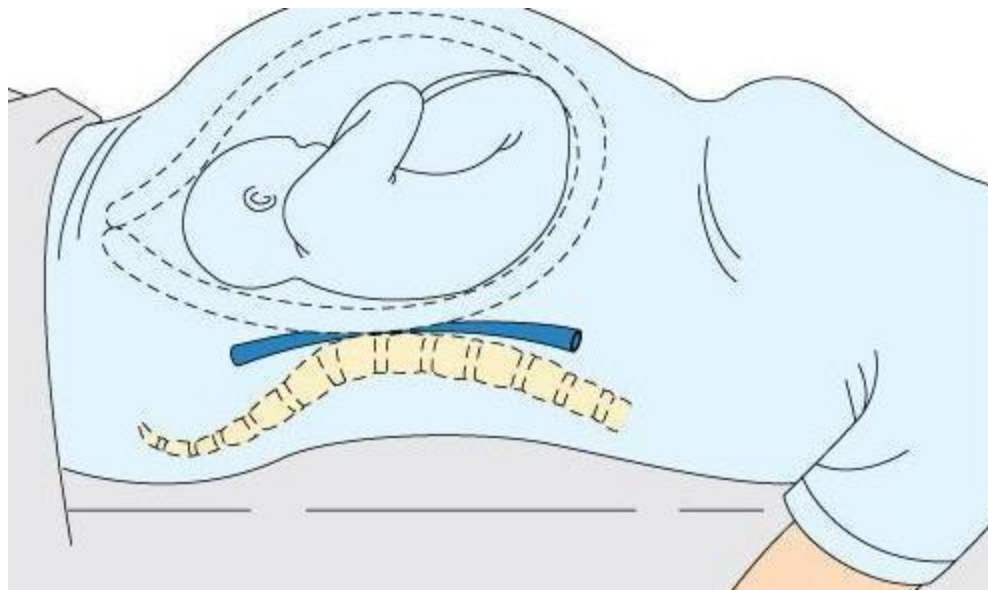
    - Large IV fluid bolus within 30 minutes prior to spinal placement, minimum 1 liter of crystalloids

- ▣ Secondary Treatment

  - Pharmacologic

    - Ephedrine

# IVC syndrome ( pregnancy)



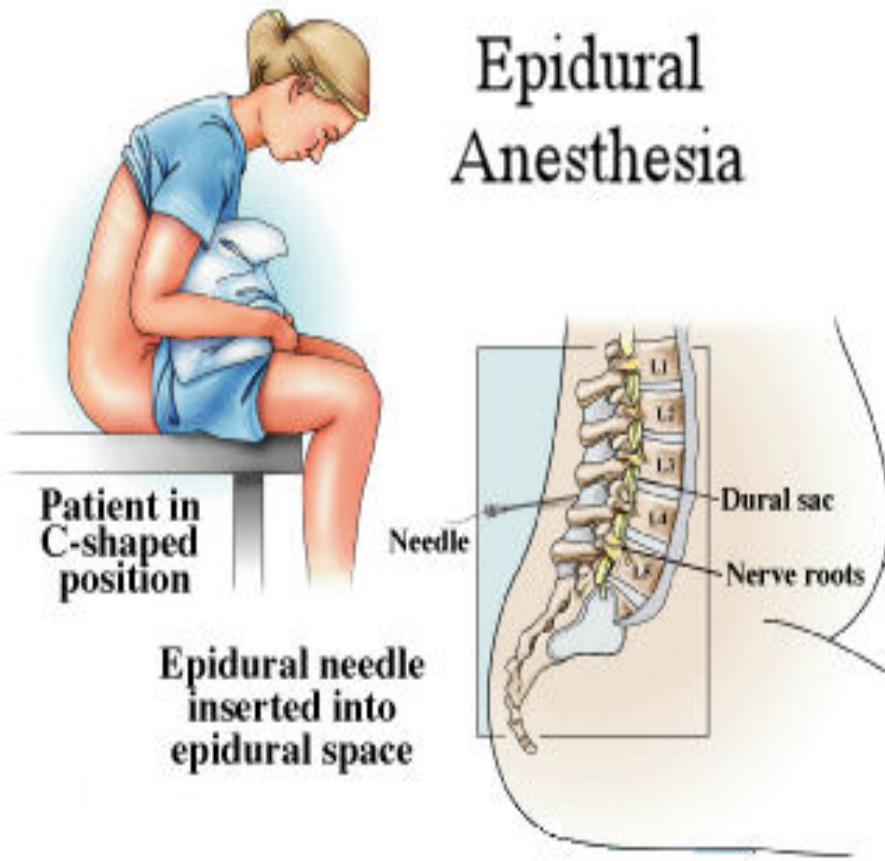


# EPIDURAL ANESTHESIA



## EPIDURAL ANESTHESIA

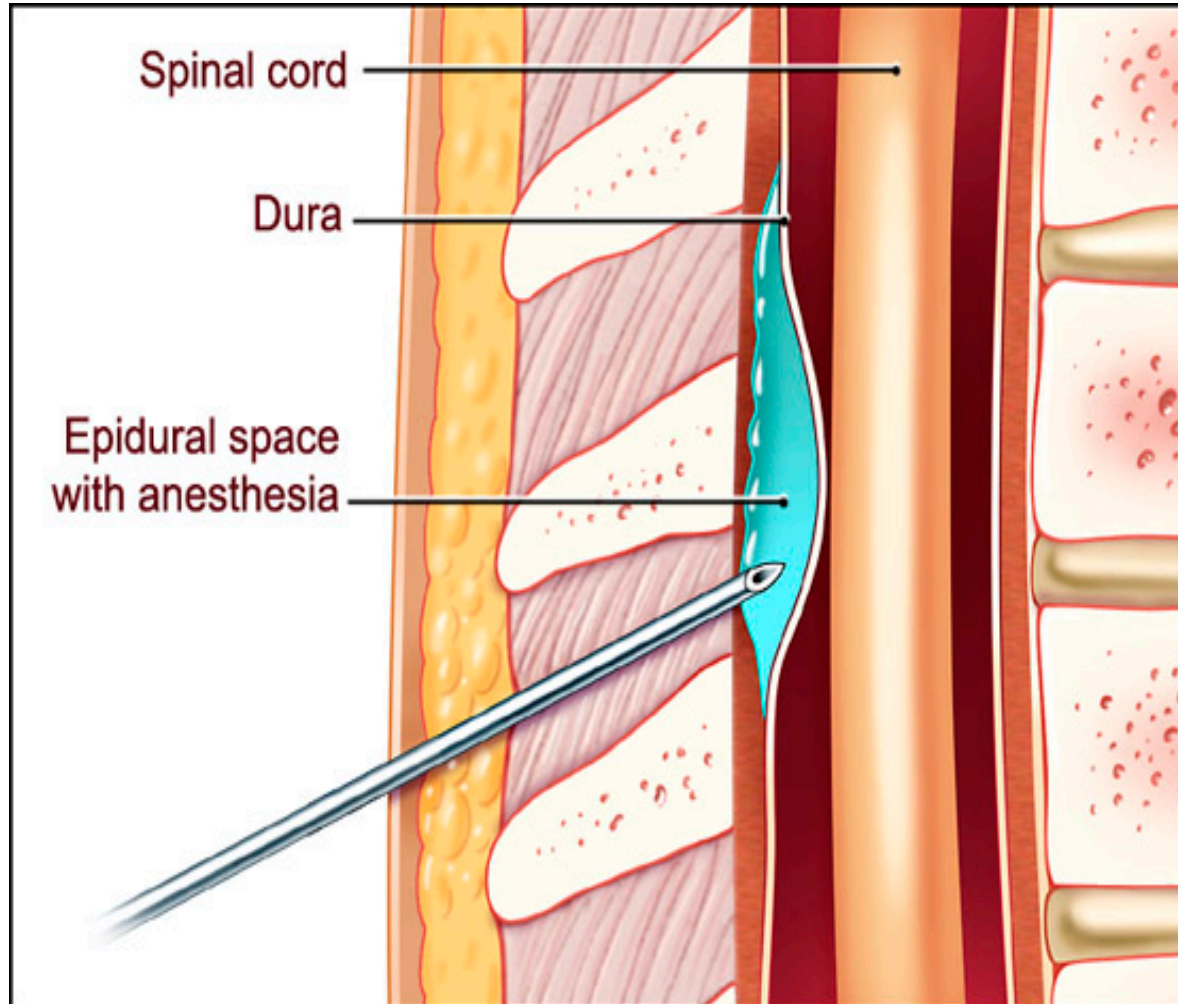
# Epidural anesthesia; catheter technique



# Isobaric bupivacaine (20 ml)



# Slow onset (30 min), less dense block



# Touhy needle



BUFFED  
HEEL FOR  
ADDED  
SAFETY



10MM CALIBRATIONS



WEISS-STYLE  
WINGED  
LUER LOCK  
HUB WITH  
STYLET

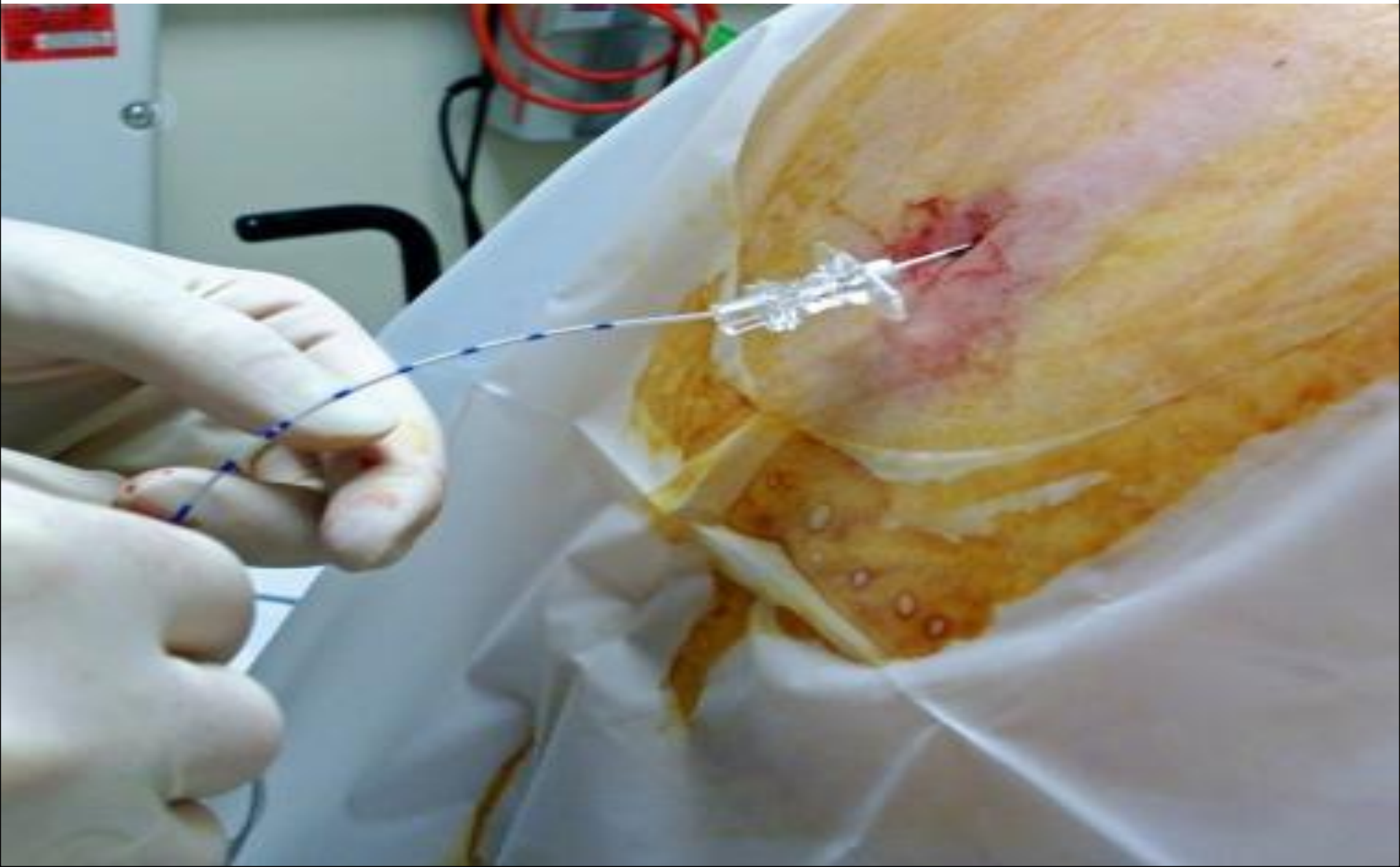
STERILE DISPOSABLE



# Loss of resistance technique

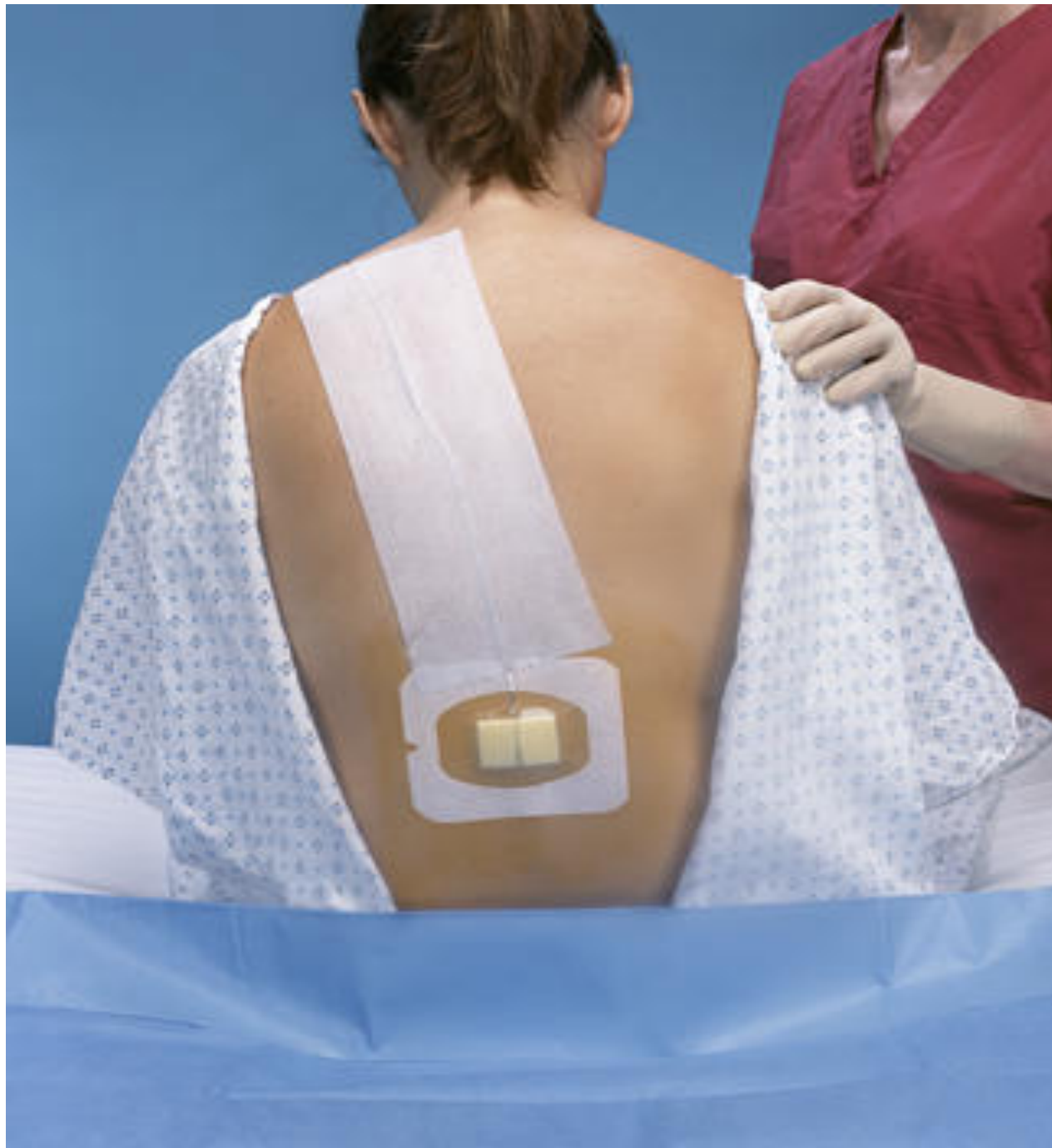


# Catheter technique

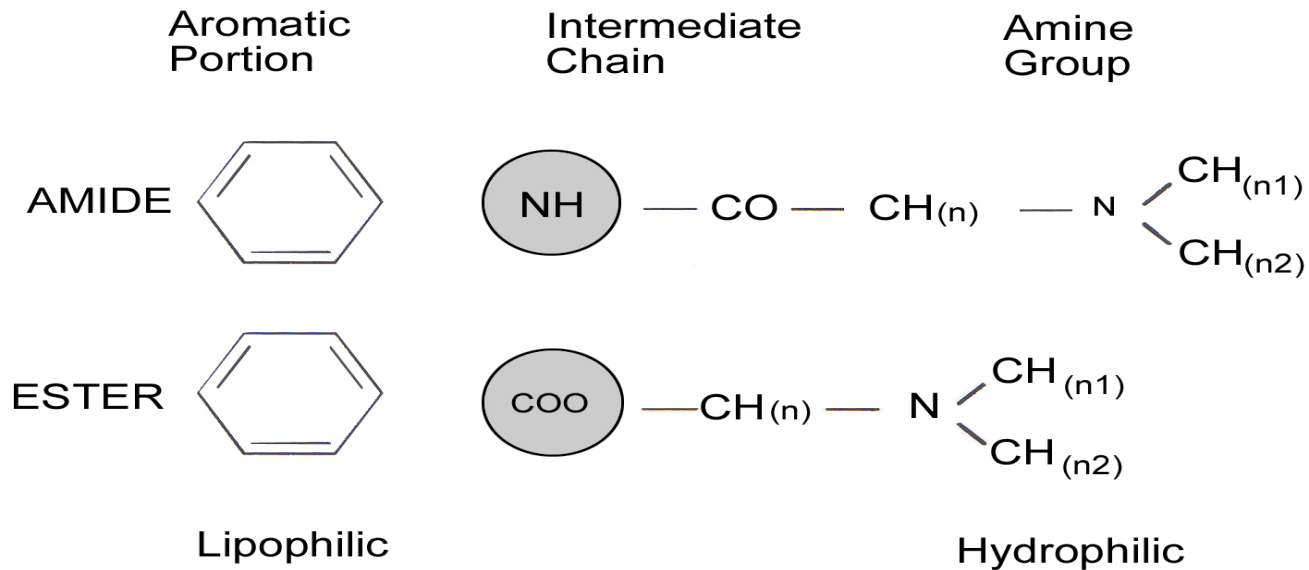


# Epidural Test dose


- After checking the catheter
- Careful aspiration, NO blood or CSF
- 3 ml Lidocaine 1.5% mixed with epinephrine 5 micg/ml
- With careful monitoring, give the epidural injection 15-20 ml bupivacaine in allequete.



# Local anesthetics



CH<sub>(n)</sub> = Hydrocarbon chains

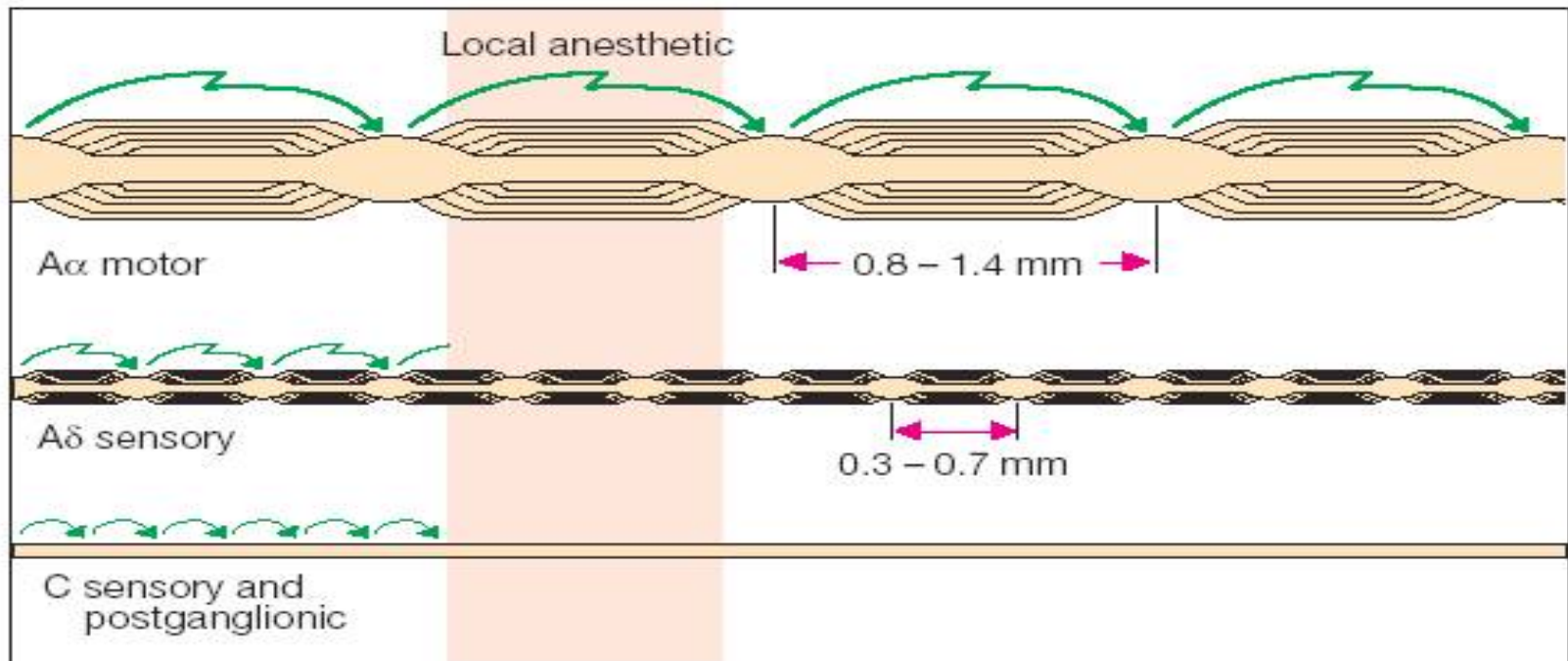
 { COO = Ester Linkage  
NH = Amide Linkage



**TABLE 2. Local anesthetics**

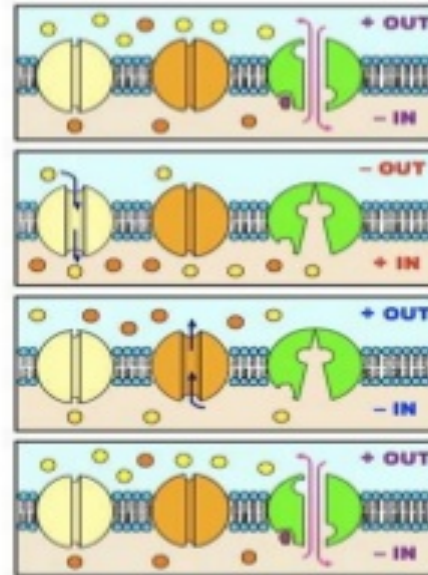
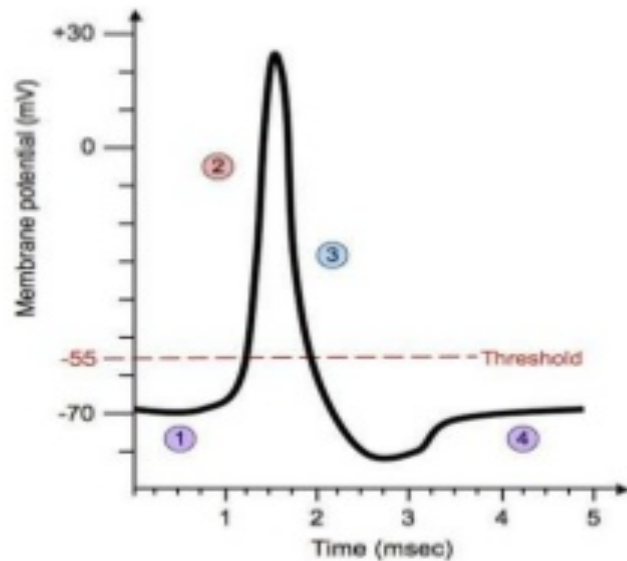
<b>AMIDE GROUP</b>	<b>ESTER GROUP</b>
Lidocaine	Cocaine
Mepivacaine	Procaine
Bupivacaine	Chloroprocaine
Etidocaine	Tetracaine
Prilocaine	





**B. Inhibition of impulse conduction in different types of nerve fibers**

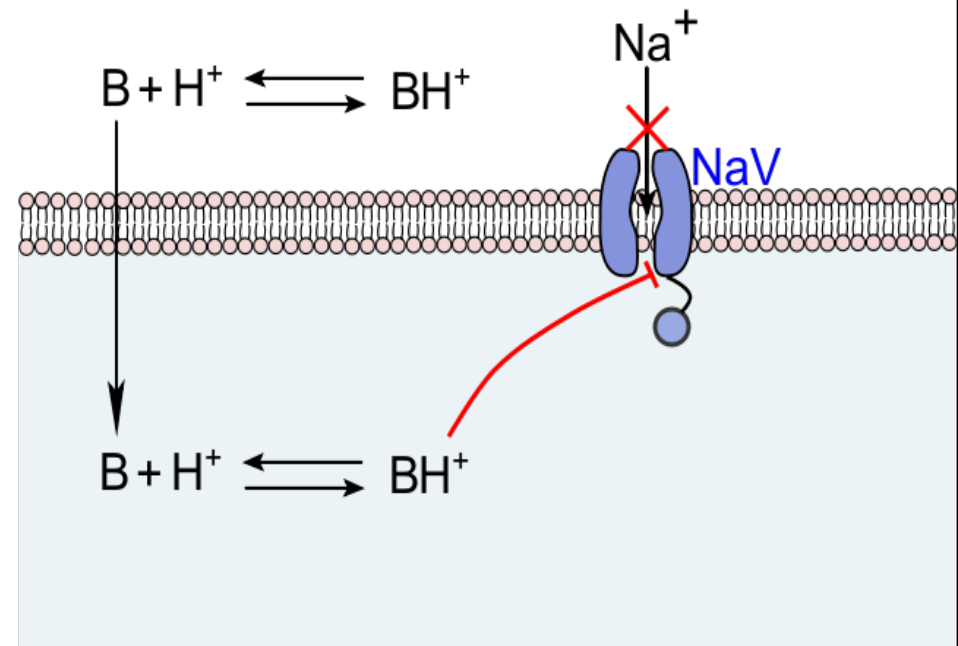
# Nerve impulse



- 1 Resting Potential**  
Na<sup>+</sup>/K<sup>+</sup> pump
- 2 Depolarisation**  
Voltage-gated Na<sup>+</sup> channel
- 3 Repolarisation**  
Voltage-gated K<sup>+</sup> channel
- 4 Resting Potential**  
Na<sup>+</sup>/K<sup>+</sup> pump

# Mechanism of Action

- Un-ionized local anesthetic diffuses into nerve axon & the ionized form binds the receptors of the Na channel in the inactivated state





## □ Duration of Action

- The degree of protein binding is the most important factor
- Lipid solubility is the second leading determining factor
- Greater protein bound + increase lipid solubility = longer duration of action



## □ Toxicity & Allergies

- ▣ Esters: Increase risk for allergic reaction due to para-aminobenzoic acid produced through ester-hydrolysis
- ▣ Amides: Greater risk of plasma toxicity due to slower metabolism in liver

# LAST



- ❑ Exceeding the maximum safe dose( Bupivacaine 2mg/kg), Lidocaine (5mg/kg)
- ❑ Intravascular injection



# LAST(CNS)

## BOX 1 *Manifestations of Systemic Toxicity*

### Minor (Associated With Low Plasma Levels)

- Perioral numbness
- Facial tingling
- Restlessness
- Tinnitus
- Metallic taste
- Vertigo
- Slurred speech

### Major (Associated With High Plasma Levels)

- Sudden loss of consciousness
- Tonic-clonic seizures
- Cardiovascular collapse
- Cardiac arrest

# LAST (CVS)



- Tachycardia & Hypertension
- Hypotension
- Wide QRS
- VF
- Cardiac arrest

# LAST; Management

## Recognition of Severe Toxicity

- Alteration in mental status
- Cardiovascular collapse
- May occur some time after initial injection

## Immediate Management

- Call for help
- Stop LA administration
- Maintain airway
- Confirm or establish IV access
- Control seizures (benzodiazepines)
- Start IV lipid emulsion

## Circulatory Arrest Not Present

- Conventional therapy for hypotension and arrhythmias
- Continue IV lipid emulsion

## Circulatory Arrest Present

- Start CPR and ACLS (low-dose epinephrine)
- Continue IV lipid emulsion
- Avoid lidocaine for arrhythmia management
- Consider cardiopulmonary bypass

## Follow-Up

- Admission to intensive care unit
- Close monitoring until sustained recovery achieved

# References

- Brown, D.L. (2005). Spinal, epidural, and caudal anesthesia. In R.D. Miller *Miller's Anesthesia, 6<sup>th</sup> edition*. Philadelphia: Elsevier Churchill Livingstone.
- Burkard J, Lee Olson R., Vacchiano CA. (2005) Regional Anesthesia. In JJ Nagelhout & KL Zaglaniczny (eds) *Nurse Anesthesia 3<sup>rd</sup> edition*. Pages 977-1030.
- Kleinman, W. & Mikhail, M. (2006). Spinal, epidural, & caudal blocks. In G.E. Morgan et al *Clinical Anesthesiology, 4<sup>th</sup> edition*. New York: Lange Medical Books.
- Warren, D.T. & Liu, S.S. (2008). Neuraxial Anesthesia. In D.E. Longnecker et al (eds) *Anesthesiology*. New York: McGraw-Hill Medical.