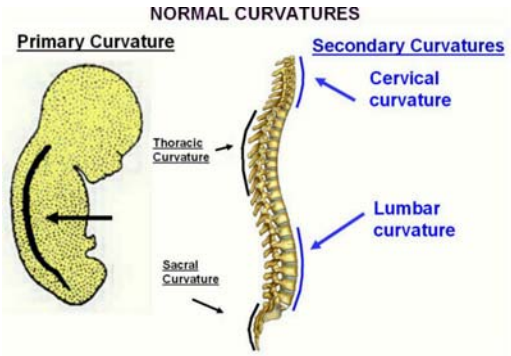
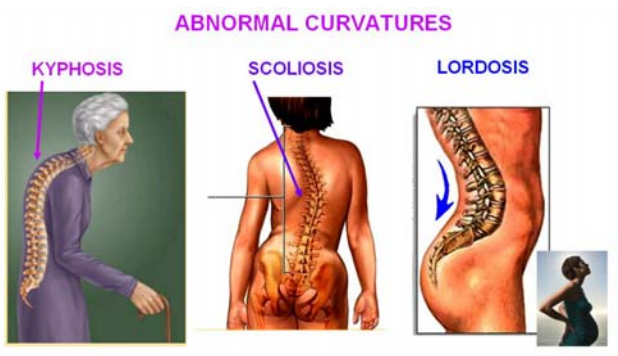
CLINICAL ANATOMY OF VERTEBRAE, SPINAL NERVES, REFLEXES

1) VERTEBRAE - NORMAL SPINAL CURVATURES: Primary = Concave Anterior - (fetal curvature); preserved in adult Thorax, Sacrum
Secondary = Concave Posterior (develop in childhood) - Cervical (support head), Lumbar (support body)

ABNORMAL CURVATURES - all can cause pain from compression of spinal nerves

	Curvature	Location (Most common)	Cause
Kyphosis	Exaggerated Concave **Anterior**	Often in **Thoracic Region (Hump back)**	**Osteoporosis**, etc. - loss of bone in bodies of vertebrae
Scoliosis	Exaggerated **Lateral**	**Thoracic, Lumbar** most common	**Hemivertebra** (half of vertebral body does not form in development), etc.
Lordosis	Exaggerate Concave **Posterior**	**Lumbar** (normal in pregnancy)	**Obesity, etc**.

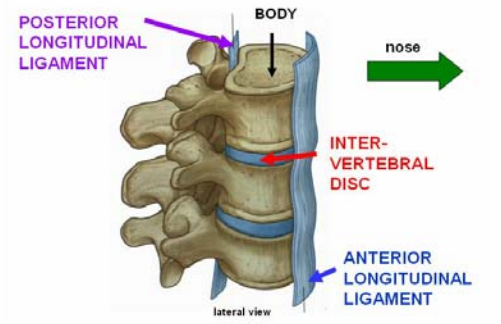


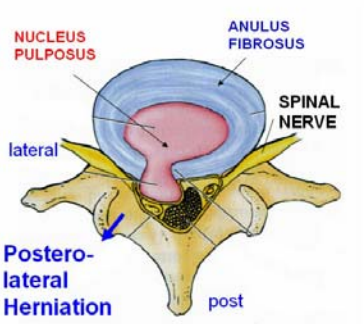


SUMMARY OF LIGAMENTS OF VERTEBRAE AND DISC HERNIATION – Discs are referred to by the adjacent vertebrae (ex. Disc C3-C4)

Ligament	Connects	Clinical
Anterior Longitudinal Ligament	Anterior side of bodies of vertebrae	Broad band; **Prevents disc herniation anteriorly**
Posterior Longitudinal Ligament	Posterior side of bodies of vertebrae (inside canal)	Narrow band; (**intervertebral discs herniate in postero-lateral direction, lateral to ligament**)
Ligamenta Flava	Elastic layer connecting Laminae of vertebrae	Last layer penetrated by needle in **Epidural anesthesia**; (Note: **Dura is last** in **Lumbar Puncture** spinal tap)
Interspinous and Supraspinous ligaments	Spines of vertebrae	Thickened in neck to form **Ligamentum nuchae** (extends from Ext. Occipital Protuberance to C7)

Note: **Herniation of Nucleus pulposus = 'Slipped Disc'** - Nucleus pulposus bulges out through Annulus fibrosus; usually in\a **Posterolateral direction** (lateral to the Posterior Longitudinal Ligament); **Most common at levels L4-L5 or L5-S1**.
Note: **Cervical Intervertebral Disc Herniation** - Second most common region for disc herniation; **Lower cervical disc hernation** - **Symptoms in Upper Extremity, if below C4 (Brachial Plexus C5-C8, T1)**

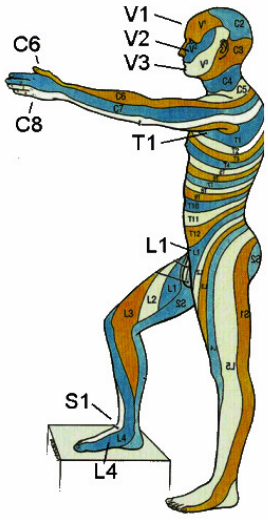




SUMMARY OF SOME FEATURES OF VERTEBRAE ON CT, LANDMARKS AND SOME CLINICAL SIGNS

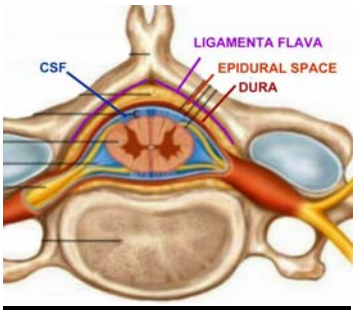
Vertebra	ID Features on CT	Clinical, Associated Structures on CT
Cervical (7)	**Foramina Tranversaria transmit Vertebral Artery** (C1-C6) **C1** = Atlas - **no body** **C2** = Axis - **dens** C7 = Vertebra prominens (long palpable spine)	1) **Damage to vertebral artery** - brainstem symptoms (**can be related to neck rotation**) **2) Upper cervical fracture** (C1 or dens of C2) - **Quadriplegia**; **3) Disc Herniation in Lower Cervical Vertebrae** - symptoms in upper extremity (Brachial plexus)
Thoracic (12)	**Ribs abut bodies** (head of rib), **transverse processes** (tubercle of rib);	**Landmark: Thoracic aorta** anterolateral to bodies
Lumbar (5)	**Large bodies; No surrounding bones**	**Landmarks: Erector spinae** posterior; **Psoas major** lateral; **IVC** and **Abdominal aorta** anterior to bodies

2) GROSS ANATOMY OF SPINAL CORD AND SPINAL NERVES

Syndrome/ Procedure	Anatomy	Structures	Clinical, ID Features on CT
Spinal Nerve Compres-sion	**Convention**: Cervical spinal nerves **C1-C7 exit Above** corresponding vertebrae; **C8 and All other spinal nerves exit Below** vertebrae	**Dermatomes** - area of distribution of single nerve root to skin; **Reference list: learn when discussed in lecture** **[V1 - Face (above eyes *)** **V2 - Face (below eyes*)** **V3- Face (below mouth)*]** **C5 - Shoulder** **C6 - Thumb** **C8 - Little finger** **T1 - Armpit** **T4 - Nipple** **T7 - Xiphoid** **T10 - Umbilicus** **L1 - Inguinal lig.** **L4 - Big toe** **S1 - Little toe** **[* Note: V - also Oral, Nasal Cav., Cranial Dura Mater - headache]**	**Symptoms of compression of nerve root - Paresthesia, pain, sensory loss, hyporeflexia, muscle weakness**  **Note:** overlap of dermatomes in region of trunk: sensory loss in trunk only with Two Thoracic spinal roots
Lumbar Puncture	Inferior end of Spinal Cord = **Conus medullaris**	Conus medullaris at 1. In **Newborn**, vertebral level **L3** 2. In **Adult**, conus at vertebral level **L1**	**Lumbar Puncture** done below Conus Medullaris (region of Cauda Equina); Level: **1. Children** - **L4-L5** **2. Adult** - **L3-L4 or L4-L5**
Metastasis to Vertebral Column	**Epidural Space** (outside Dura) Dura is separated from inner side of vertebral canal; Note: in Skull, there is no epidural space	**Internal Vertebral Venous plexus** - inside vertebral canal in Epidural Space; drains to **External Venous plexus** (outside vertebrae) by Radicular and Intervertebral veins	**Disease processes (ex. cancer) can spread to vertebrae** and spinal cord v**ia anastomoses of Vertebral venous plexus and intervertebral veins** with **Lumbar veins** (ex. carcinoma of prostate can metastasize to vertebral column) .

LAYERS PENETRATED IN EPIDURAL ANESTHESIA/LUMBAR PUNCTURE (superficial to deep)

1. Skin, 2. Superficial Fascia, (3. Supraspinous ligament, 4. Interspinous ligament)
5. Ligamentum Flavum (sudden yield, first 'pop') - now in Epidural space
6. <u>Epidural Space - STOP HERE FOR EPIDURAL ANESTHESIA</u>
7. Dura Mater (sudden yield, second 'pop')
(8. Arachnoid - adherent to inner side of dura mater)
9. **<u>Subarachnoid Space (Lumbar Cistern) - STOP HERE FOR LUMBAR PUNCTURE/CSF</u>**



<u>3) GENERAL ANATOMY OF AUTONOMIC NERVOUS SYSTEM: DIVISIONS</u> – most Autonomic pathways have 2 neurons that synapse in a ganglion: 1) presynaptic neuron – in Lateral Horn of Spinal cord or brainstem; 2) post-synaptic neuron – in ganglion, joins peripheral nerves via (Grey) Communicating Ramus.

DIVISION	LEVEL OUT CNS – presynaptic neuron	LOCATION OF GANGLION	GENERAL DESCRIPTION OF ACTION	IMPORTANT NOTE/EXCEPTIONS
Sympa-thetic	Thoraco-lumbar	Usually Near CNS	'Fight or Flight'	Sympathetic more widely distributed - Innervate SKIN, sweat glands, peripheral blood vessels; function in Thermoregulation (Sympathetics go to 'body wall')
Para-sympathet ic	Cranio-sacral	Near Target Organ	'Rest/Digest'	Parasympathetics do not innervate SKIN, sweat glands, peripheral blood vessels (Parasympathetics DO NOT innervate body wall) Parasympathetic can have highly specific functions (ex. parasympathetics to eye)

<u>4) SUMMARY OF PROPERTIES OF MUSCLE SENSORY RECEPTORS</u>

Sense Organ	Innervates	Signal	Activated by tendon tap in Clinical Test of Stretch reflex
Muscle Spindle Primary Ia	All spindle muscle cells (fast and slow contracting)	Body position and movement – Muscle length and movement velocity	Yes – Fire intensely
Muscle Spindle Secondary II	Only slow contracting spindle muscle cells	Body position - ONLY Length NOT velocity	Yes – Fire intensely
Golgi Tendon Organ Ib	Muscle tendon at junction with muscle cells	Muscle Force	No – do not fire in clinical test

5) SPINAL REFLEXES AND CLINICAL DIAGNOSIS LESIONS

REFLEX	STIMULUS/SENSE ORGAN(S) EXCITED	RESPONSE	CLINICAL/ABNORMAL RESPONSES
Stretch (Myotatic, Deep Tendon) Reflex	Rapid Stretch of muscle (test: tap on muscle tendon) Excites Muscle Spindle Primary (Ia) and Secondary (II) sensory neurons (NOT Golgi Tendon Organ)	Stretched muscle contracts rapidly (monosynaptic connection); also excite synergist and Inhibit antagonist Note: Gamma motor neurons can enhance stretch reflexes; tell patient to relax before test)	Hyporeflexia - decrease in stretch reflexes occurs in Lower Motoneuron Diseases, Muscle atrophy etc. Hyperreflexia - (increase) - characteristic of Upper Motor Neuron lesions (ex. spinal cord injury, damage Corticospinal tract); note: Clonus = hyperreflexia with repetitive contractions to single stimulus
Autogenic Inhibition (Inverse Myotatic Reflex)	Large force on tendon excites Golgi Tendon Organ Ib (test: pull on muscle when resisted)	Muscle tension decreases; Also inhibit synergist muscles; excite antagonist muscles	Clasped Knife Reflex - occurs in Upper Motor Neuron lesions - forceful stretch of muscle is first resisted then collapses
Flexor Reflex	Sharp, painful stimulus, as in stepping on nail; Excites - Cutaneous and pain receptors	Limb is rapidly withdrawn from stimulus; protective reflex; also inhibit extensors of same limb and excite extensors of opposite limb (Crossed Extensor Reflex)	Babinski sign- toes extend (dorsiflex) to cutaneous stimulus of sole of foot (normally plantar flex); characteristic of Upper Motor Neuron lesion