

INTRODUCTION TO ANATOMY AND NERVOUS SYSTEM - two parts

PART 1 - TERMINOLOGY USED IN CLINICAL DESCRIPTIONS - LOCATIONS OF LESIONS

**I. ANATOMICAL POSITION AND PLANES;
ORIENTATION OF CT AND MRI IMAGES, LOCATIONS OF
LESIONS**

PART 2 - INTRODUCTION TO NERVOUS SYSTEM

**I. DIVISIONS OF NERVOUS SYSTEM - CNS AND
PNS, AFFERENT AND EFFERENT NEURONS**

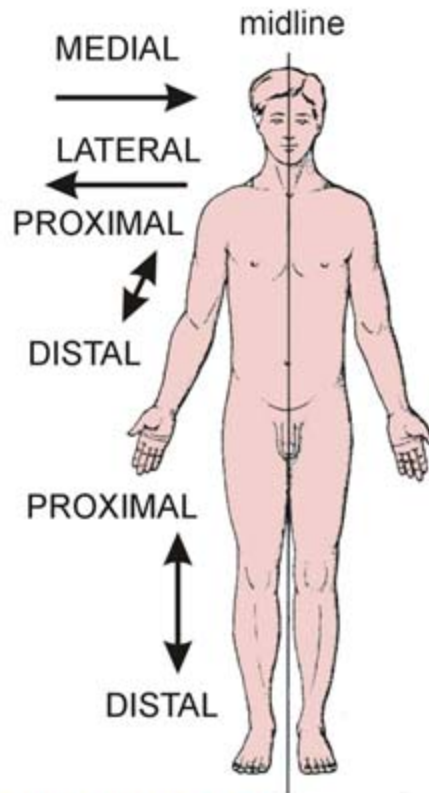
**II. SOMATIC AND VISCERAL (AUTONOMIC)
NERVOUS SYSTEMS**

III. SPINAL NERVES - BASIC STRUCTURES

**IV. REFLEXES AND CLINICAL TESTS OF NERVOUS
SYSTEM FUNCTIONS - SYMPTOMS ARE CONSEQUENCES
OF ANATOMY**

PART 1 - TERMINOLOGY: ANATOMICAL POSITION

ANTERIOR VIEW OF ANATOMICAL POSITION



ANATOMICAL POSITION - Standing erect, feet together, face forward, arms at side, palms forward.

MEDIAL - toward midline

LATERAL - away from midline

ANTERIOR = VENTRAL - front of body (nose is anterior)

POSTERIOR = DORSAL - back of body

SUPERIOR (ROSTRAL) - toward top of head

INFERIOR (CAUDAL) - toward bottom of feet

PROXIMAL - closer to trunk or origin of structure

DISTAL - farther from trunk or origin of structure

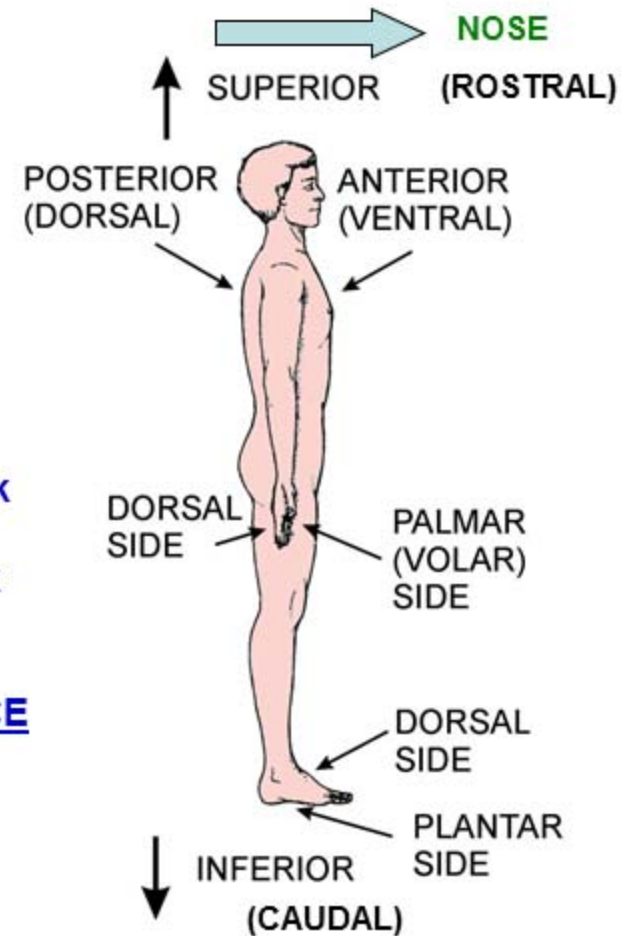
PALMAR (VOLAR) SURFACE OF HAND - palm side

DORSAL SURFACE OF HAND - back side of hand

PLANTAR SURFACE OF FOOT - sole of foot

DORSAL SURFACE OF FOOT - top of foot

LATERAL VIEW OF ANATOMICAL POSITION

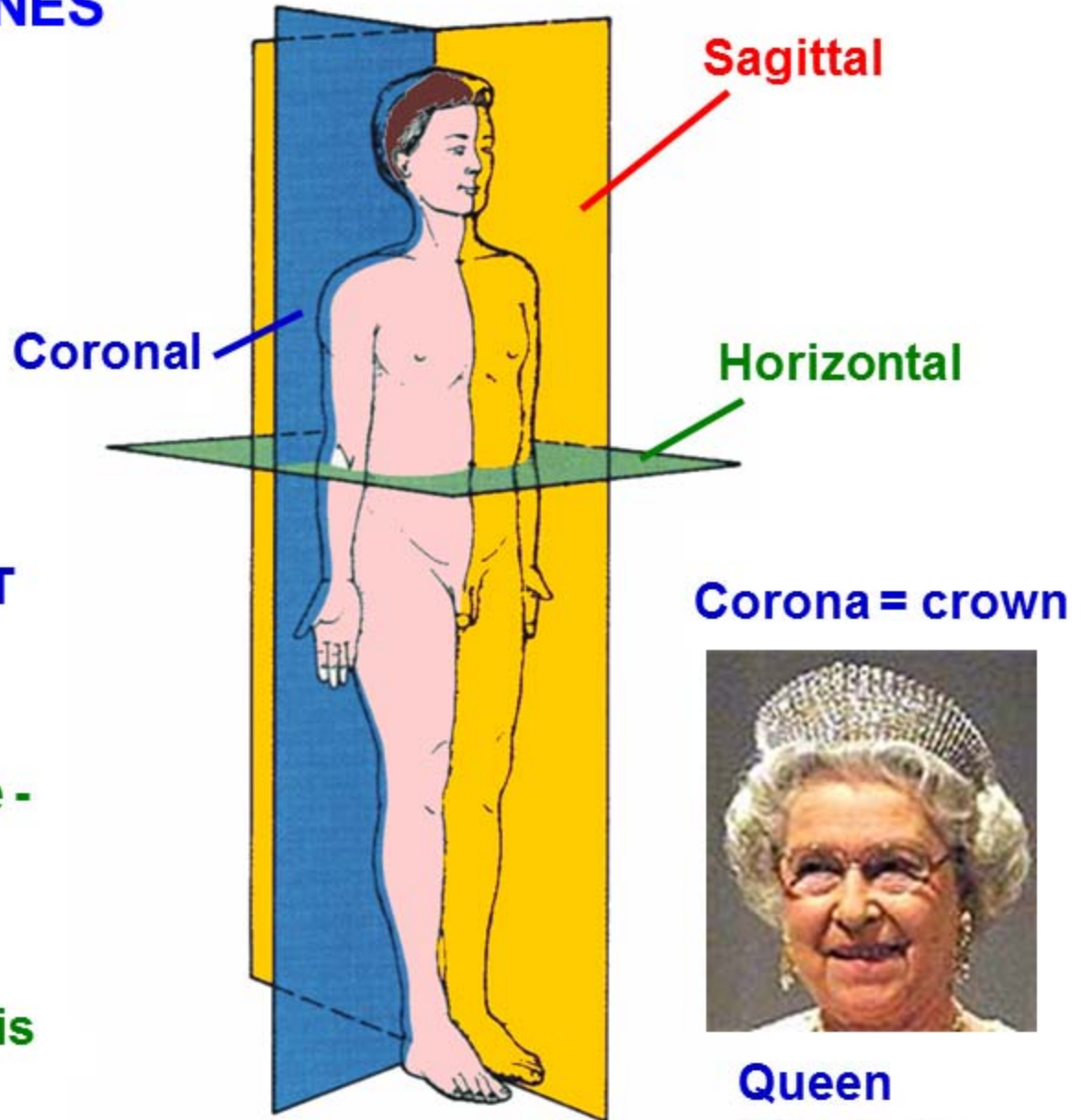


ANATOMICAL PLANES

1) **SAGITTAL PLANE** - divides body in **RIGHT** and **LEFT** parts (Median Sagittal Plane-divides body into right and left halves)

2) **CORONAL PLANE** - divides body into **FRONT** and **BACK** parts

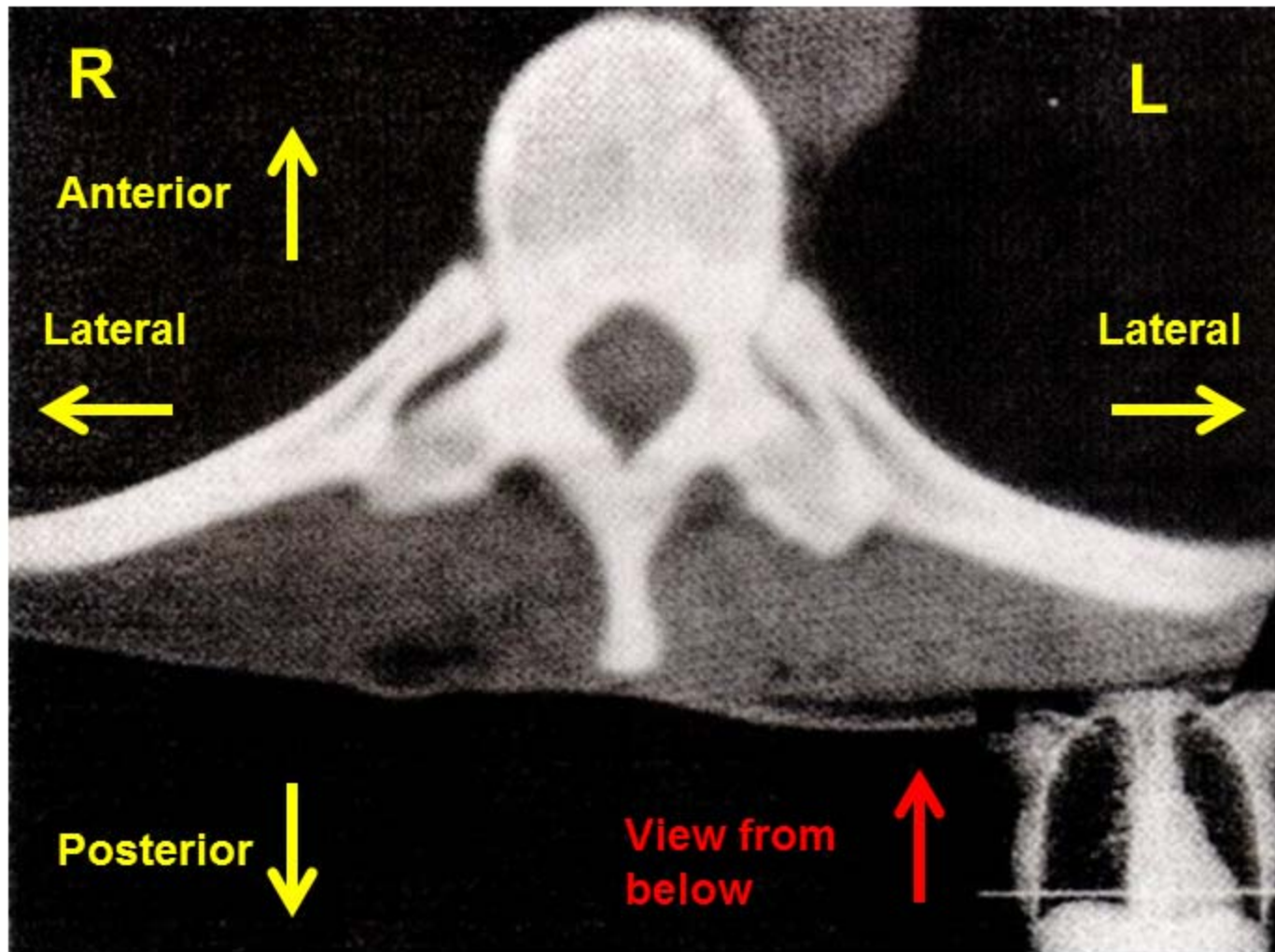
3) **HORIZONTAL PLANE** Plane = transverse plane - cross section- divides body into **TOP** and **BOTTOM** parts perpendicular to long axis of body



(Zillanatomy.com - See Dictionary of Word Roots)

Queen Elizabeth

EXERCISE : CONVENTIONAL CT OF THORACIC VERTEBRA

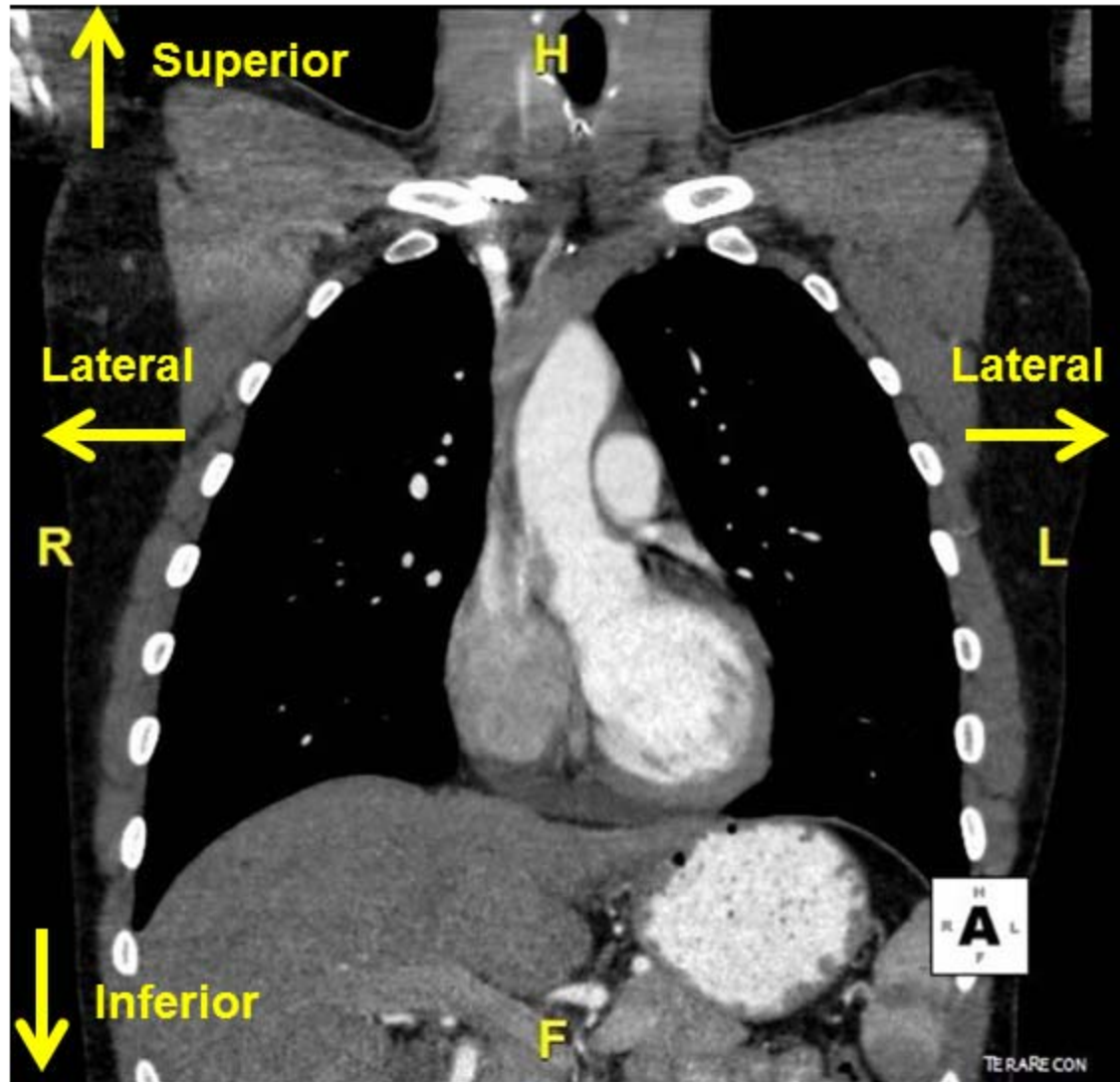


THIS IS A CT
IMAGE
(SECTION)
OF A
THORACIC
VERTEBRA -
convention
sections
viewed from
below

bone and
metal
appear
white, air is
black; soft
tissues
appear grey

QUESTION: LOOK AT THE ORIENTING ARROWS. GIVEN THE ORIENTATION, IN WHAT ANATOMICAL PLANE WAS THE SECTION TAKEN? IN WHICH DIRECTION WOULD THE PATIENT'S NOSE BE POINTING (EX. TOWARD BOTTOM OF IMAGE)?

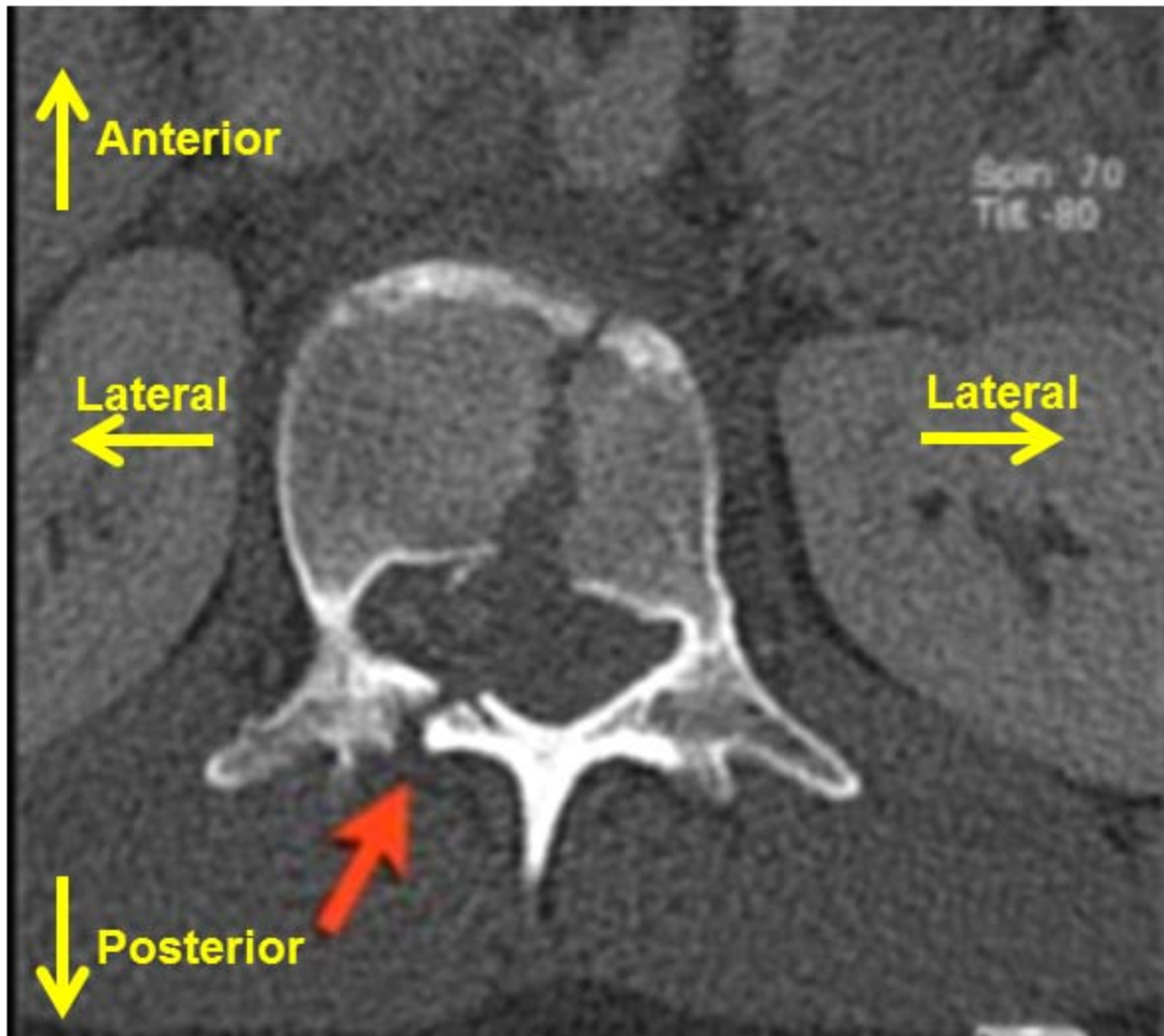
EXERCISE : NON-CONVENTIONAL IMAGE OF THORAX



Note: In radiographic images (CT= Computed Tomography and X rays) bone and metal appear white, air is black; soft tissues appear grey; however, in this image contrast material has been injected to the patients blood stream and swallowed by the patient.

QUESTION: LOOK AT THE ORIENTING ARROWS. GIVEN THE ORIENTATION, IN WHAT ANATOMICAL PLANE OF THE SECTION? EXTRA CREDIT: WHAT ARE THE BLACK AREAS WITH SMALL WHITE DOTS IN THEM?

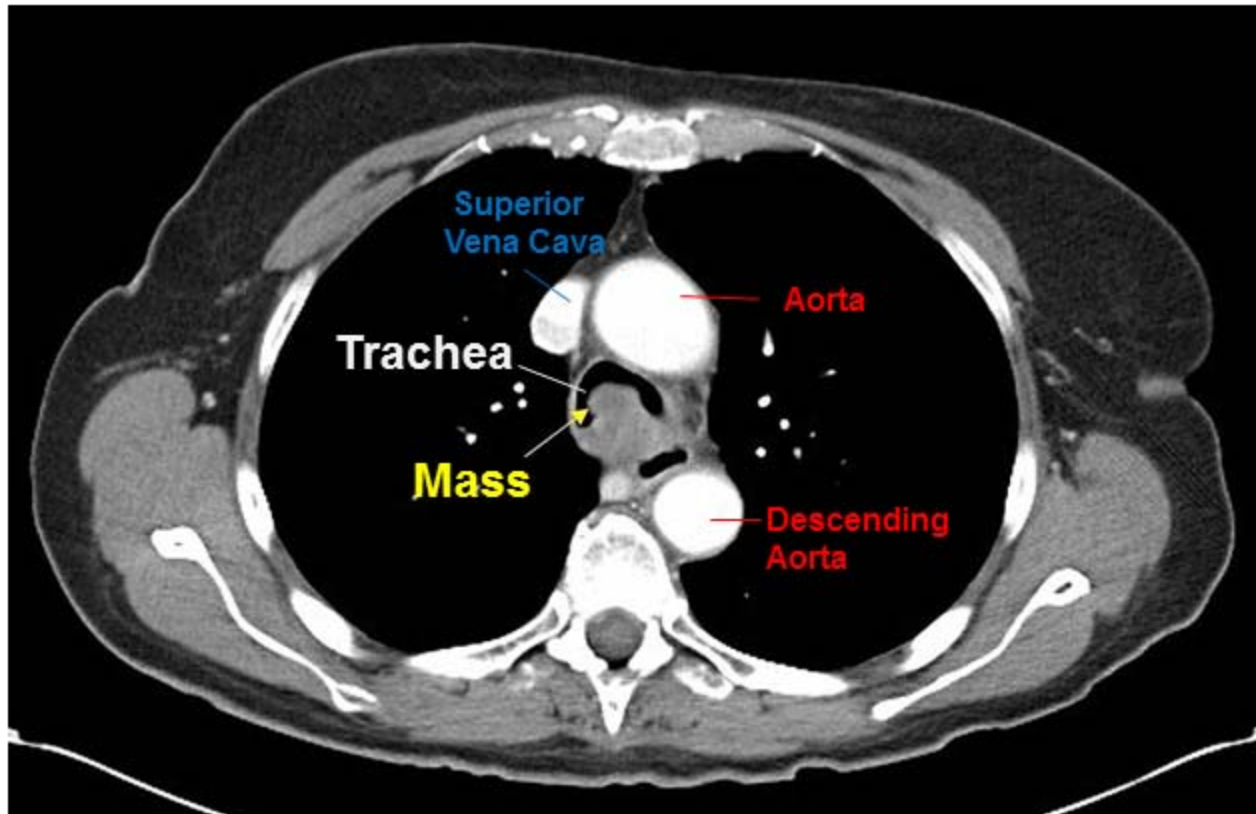
EXERCISE : IMAGE OF FRACTURE SPINE



This is a CT of a vertebra in a patient with a fractured spine. The fracture is indicated by the red arrow but it extends through the entire vertebra.

QUESTIONS: LOOK AT THE ORIENTING ARROWS. GIVEN THE ORIENTATION, WHAT IS ANATOMICAL PLANE OF THE CT IMAGE (NOT THE FRACTURE)?

EXERCISE: COMPLETE THE CLINICAL DESCRIPTION OF LOCATION OF AN ADENOCARCINOMA OF TRACHEA



This is an image of the thorax in the conventional view of CT - Complete the following statement: The mass is located in the _____ wall of the trachea, _____ and _____ to the Descending aorta. (Choices for ____: anterior, posterior, medial, or lateral)

PART 2 - INTRODUCTION TO THE NERVOUS SYSTEM: MAJOR DIVISIONS – CENTRAL NERVOUS SYSTEM

SKULL

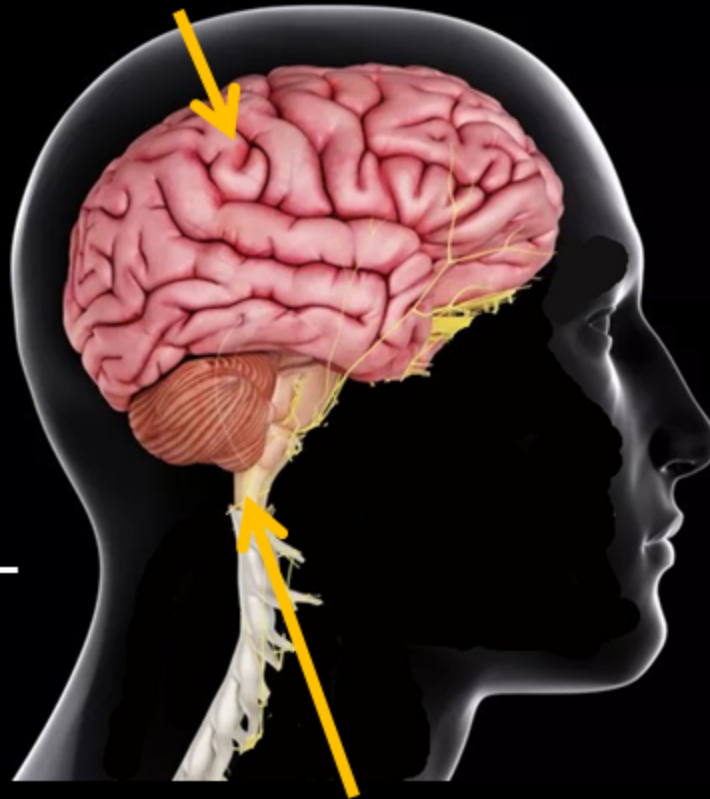


Vertebrae

**CRANIAL CAVITY –
inside Skull**



BRAIN - the 'stuff which
dreams are made on'

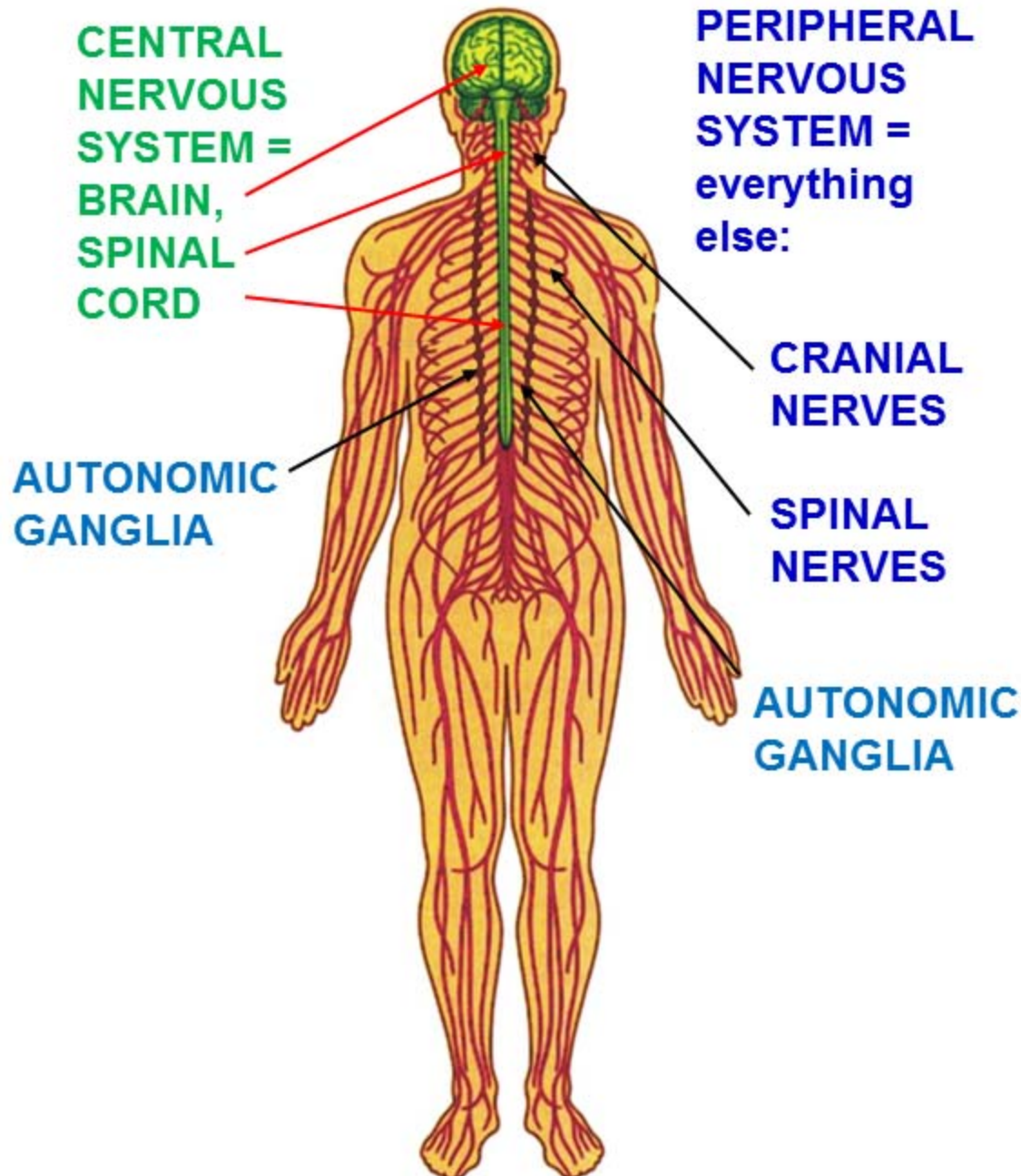


SPINAL CORD

**Most complicated system
in human body; cessation of function = death**

**CENTRAL
NERVOUS
SYSTEM (CNS)** -
definition is
precise; consists
of **BRAIN**
(contained in
cranial cavity of
skull) and **SPINAL
CORD** (contained
in vertebral canal
inside column of
vertebrae [back
bones]).

I, INTRODUCTION: CENTRAL/PERIPHERAL NERVOUS SYSTEMS



A. 1. CENTRAL NERVOUS SYSTEM (CNS) – BRAIN and SPINAL CORD

2. PERIPHERAL NERVOUS SYSTEM (PNS) = EVERYTHING ELSE INCLUDING:

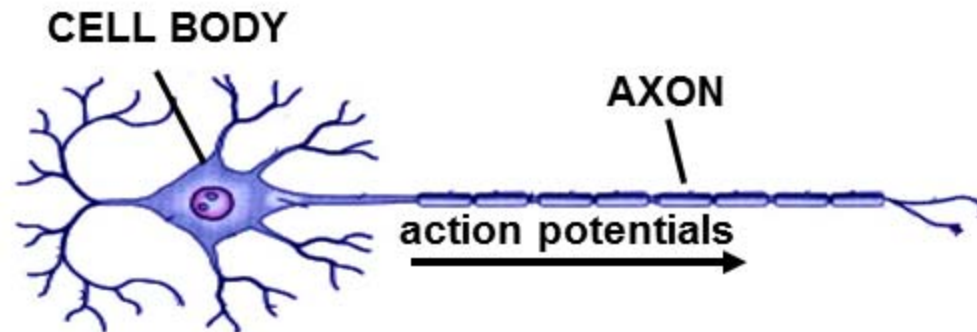
TYPES OF NERVES - CRANIAL NERVES, SPINAL NERVES that carry signals to and from the CNS;

GANGLIA - collections of nerve cell bodies, including GANGLIA OF AUTONOMIC NERVOUS SYSTEM

SENSE ORGANS – ex. eye, sensory endings in skin, etc.

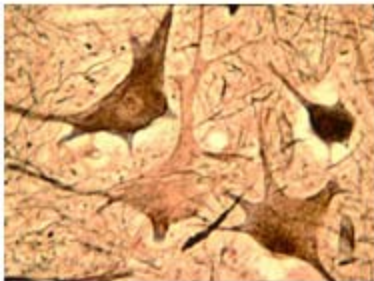
INTRO: DIFFERENCES IN TERMINOLOGY OF GROUPS OF CELL BODIES AND AXONS

STRUCTURE
OF NERVE
CELL (NEURON)

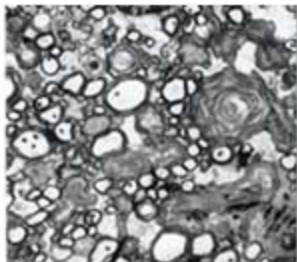


TERMINOLOGY OF GROUPS OF CELL BODIES AND AXONS DIFFERS
IN CENTRAL (CNS) AND PERIPHERAL (PNS) NERVOUS SYSTEMS

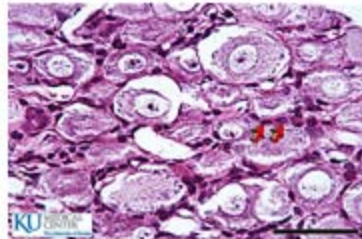
NUCLEI - in CNS



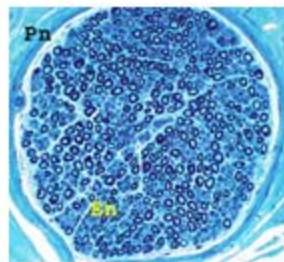
TRACTS - in CNS



GANGLIA - in PNS



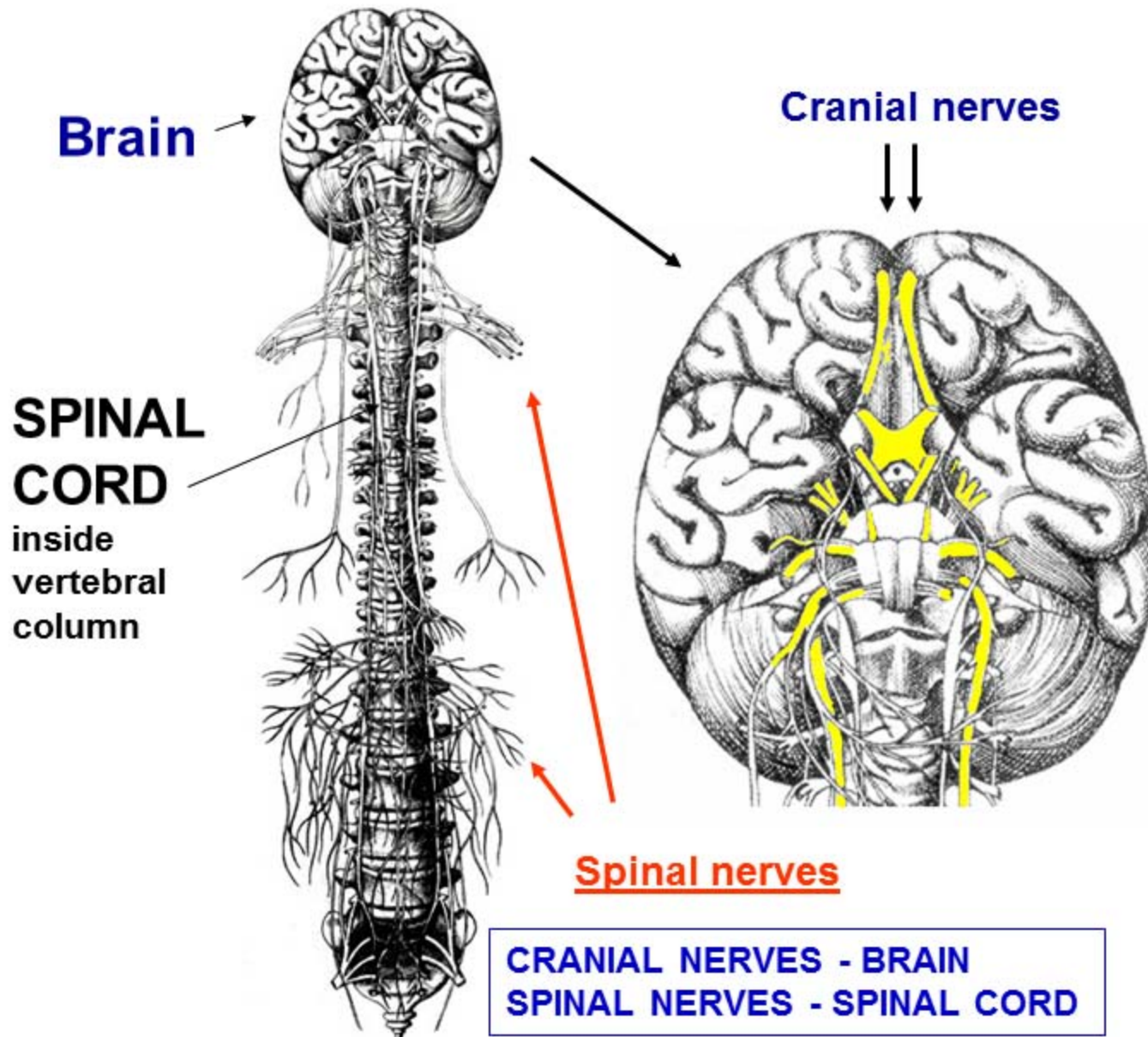
NERVES - in PNS



Groups of nerve
cell bodies are
called
NUCLEI in CNS
GANGLIA in PNS

Groups of axons
are called
TRACTS in CNS
NERVES in PNS

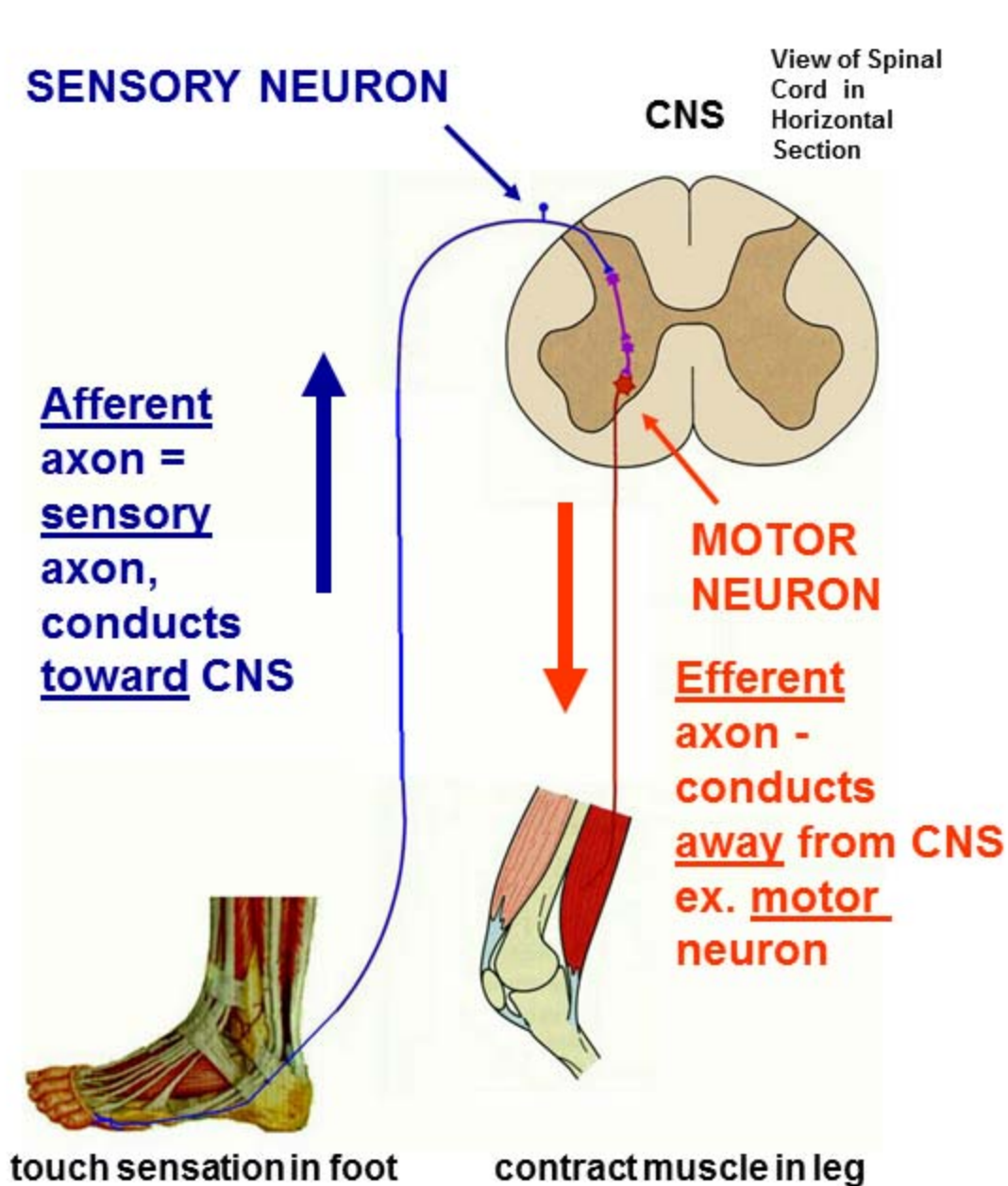
TERMINOLOGY - TYPES OF NERVES: CRANIAL NERVES AND SPINAL NERVES



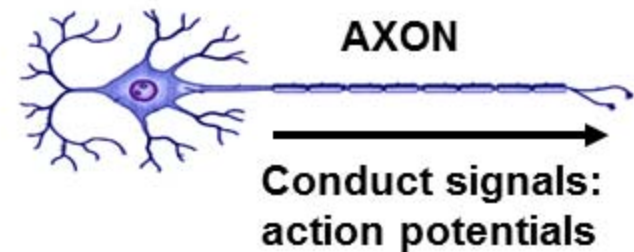
Spinal nerves and Cranial nerves are named for regions of nervous system they arise from/project to.

1. Cranial nerves - arise from/project to brain; there are 12 Cranial nerves
2. Spinal nerves - arise from project to spinal cord; there are typically 31 Spinal Nerve

TERMINOLOGY: AXONS IN PERIPHERAL NERVES



NEURON = nerve cell



a. Sensory axons

(Afferents) axons of sensory neurons that conduct signals **toward CNS** (ex. sensory neurons signaling touch, taste, pain, etc.)

b. Motor axons (Efferents) - axons of neurons that conduct signals **away from CNS**; most motor axons that cause contractions of skeletal muscles; **OTHER AXONS Visceral Motor (= AUTONOMICS**; pathway more complicated).

TERMINOLOGY - MAJOR DIVISIONS OF NERVOUS SYSTEM

SOMATIC MOTOR NEURONS -

motor axons to skeletal muscles

ex. muscles of hand



SOMATIC SENSORY NEURONS -

sensory axons to skin ; also joints, body position

ex. skin of hand



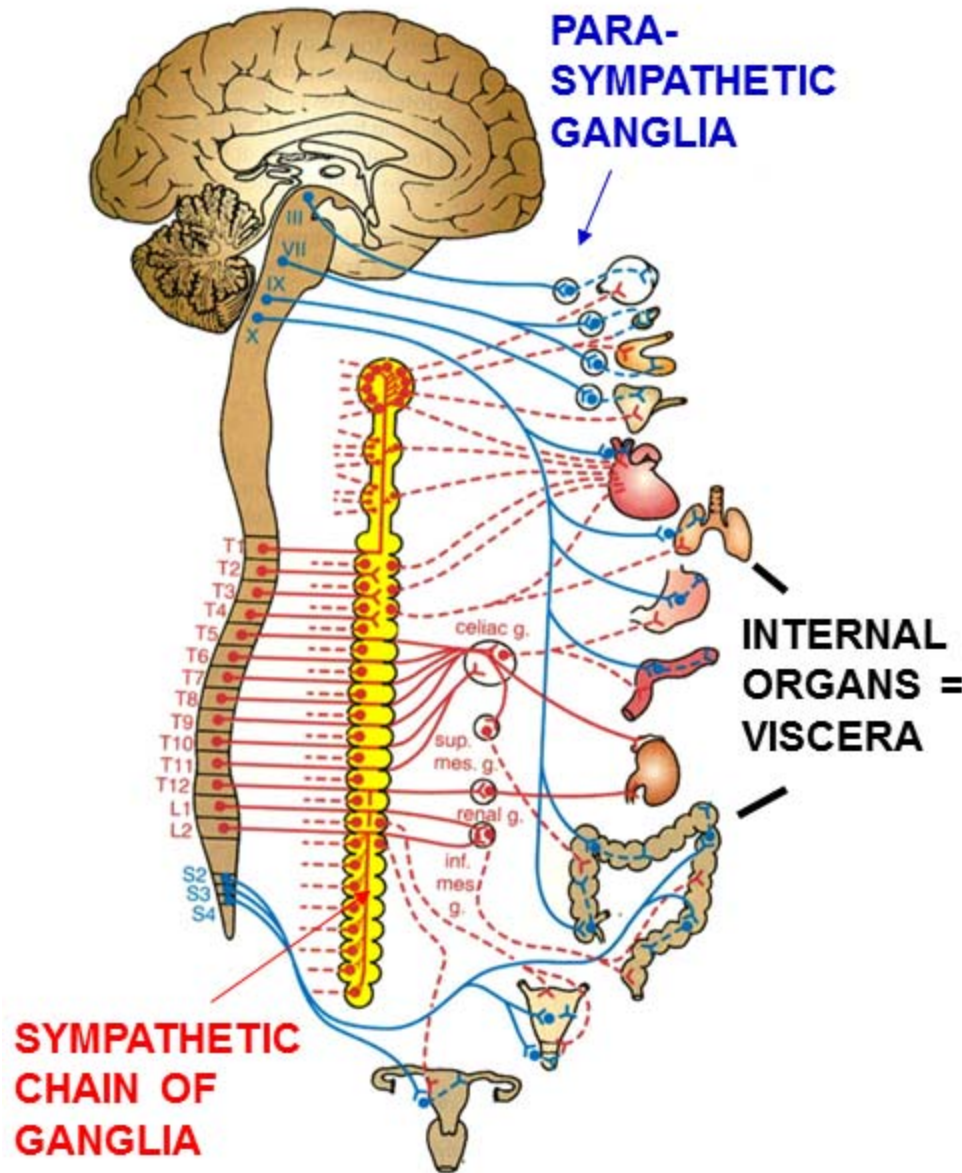
Major divisions of nervous system - **SOMATIC AND VISCERAL** - terminology based upon function but very confusing

1. **Somatic Nervous system** - **voluntary, conscious** part of nervous system

a. **Somatic Motor** - control skeletal muscle; voluntary activities (ex. limb or eye movements, walking); voluntary actions.

b. **Somatic Sensory** - sensory neurons that innervate skin, joints; provide conscious sensation of touch, pressure, pain etc.

TERMINOLOGY - AUTONOMIC = VISCERAL NERVOUS SYSTEM



Autonomic Nervous system = Visceral nervous system - **involuntary, unconscious** part of nervous system; (autonomic means self-regulating or AUTOMATIC).

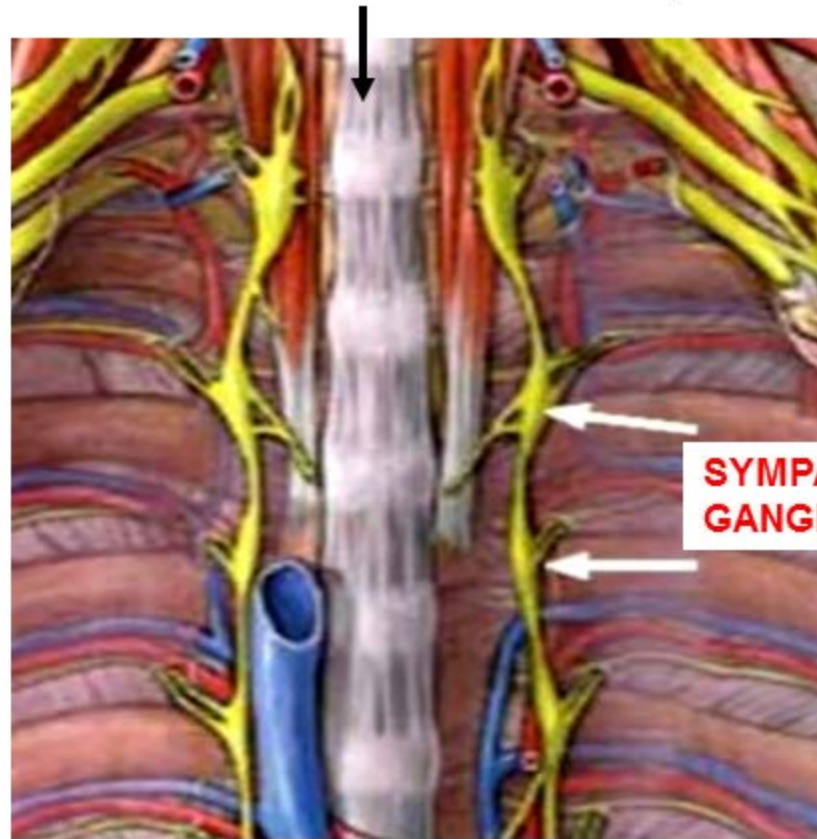
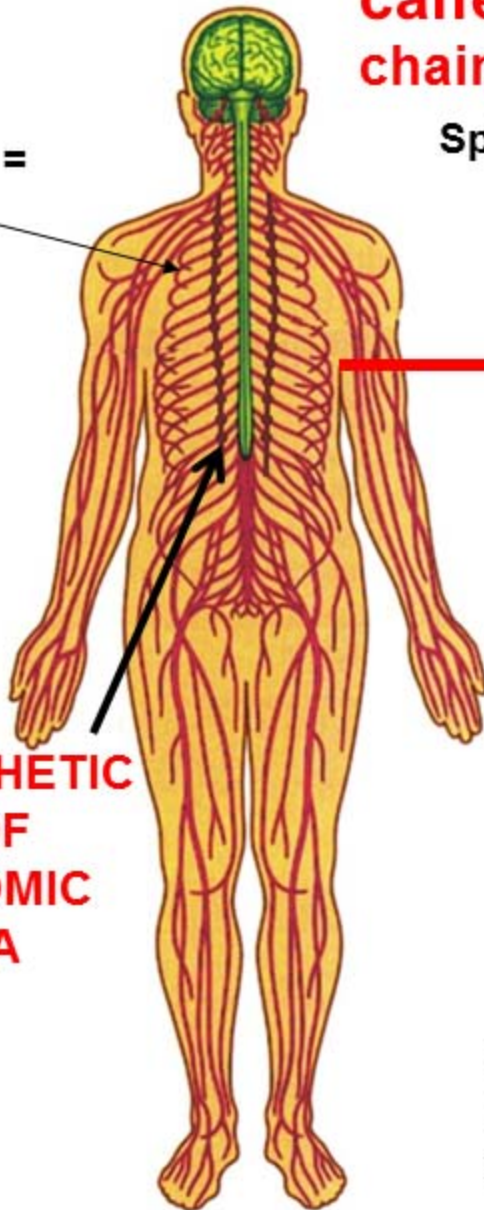
- a. Visceral Motor (parasympathetic and sympathetic) - control **smooth and cardiac muscle**, glands and internal organs; largely unconscious actions
- b. Visceral Sensory - sensory neurons that innervate internal organs, blood vessels; only provide imprecise localization of sensation and dull sense of pressure, pain, etc.

SYMPATHETIC CHAIN OF GANGLIA - called Paravertebral Ganglia – (NOTE: chain is OUTSIDE of CNS; therefore, in PNS)

Spinal cord located inside of vertebrae (vertebral canal)

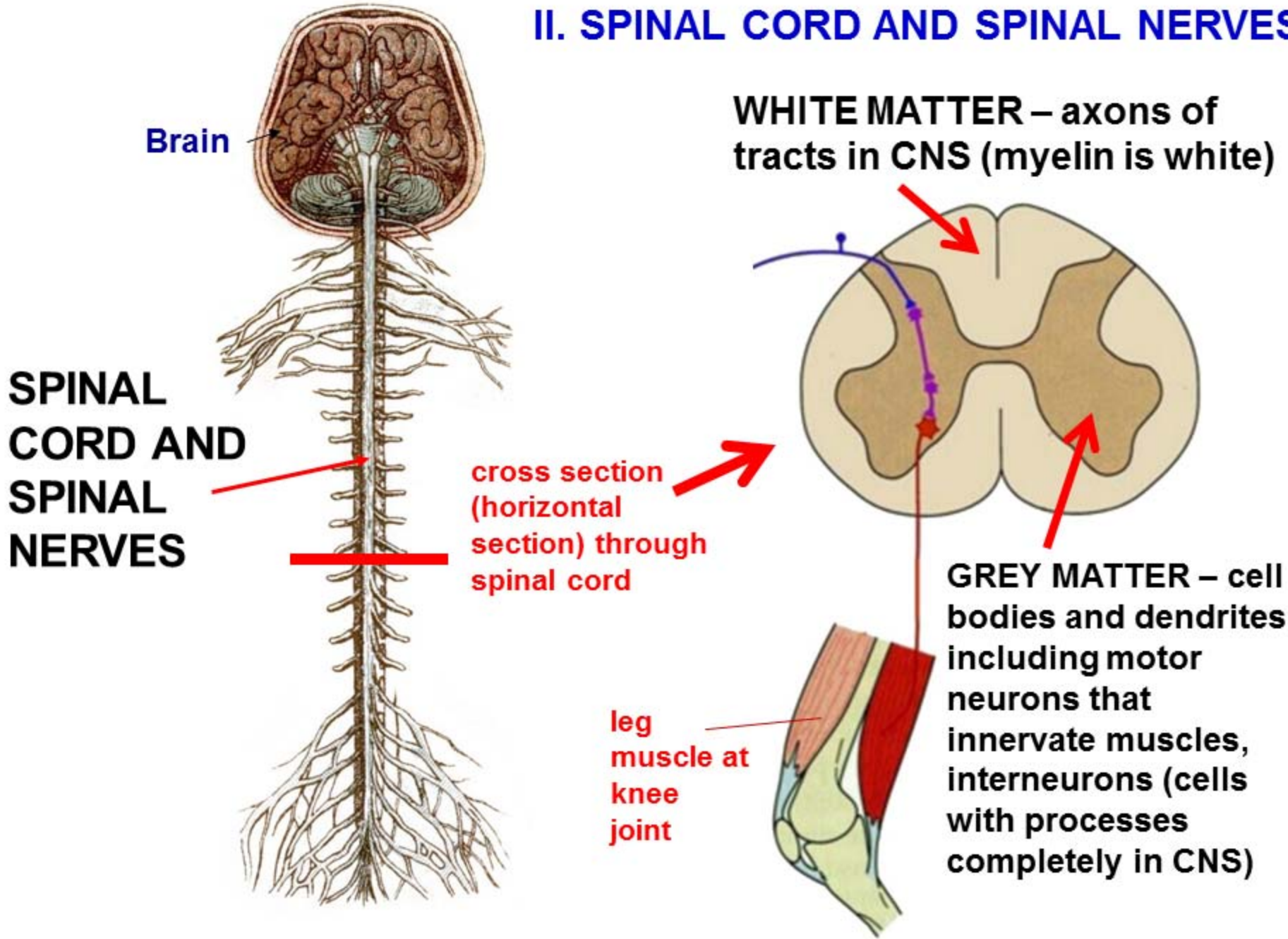
THORAX =
CHEST

SYMPATHETIC
CHAIN OF
AUTONOMIC
GANGLIA

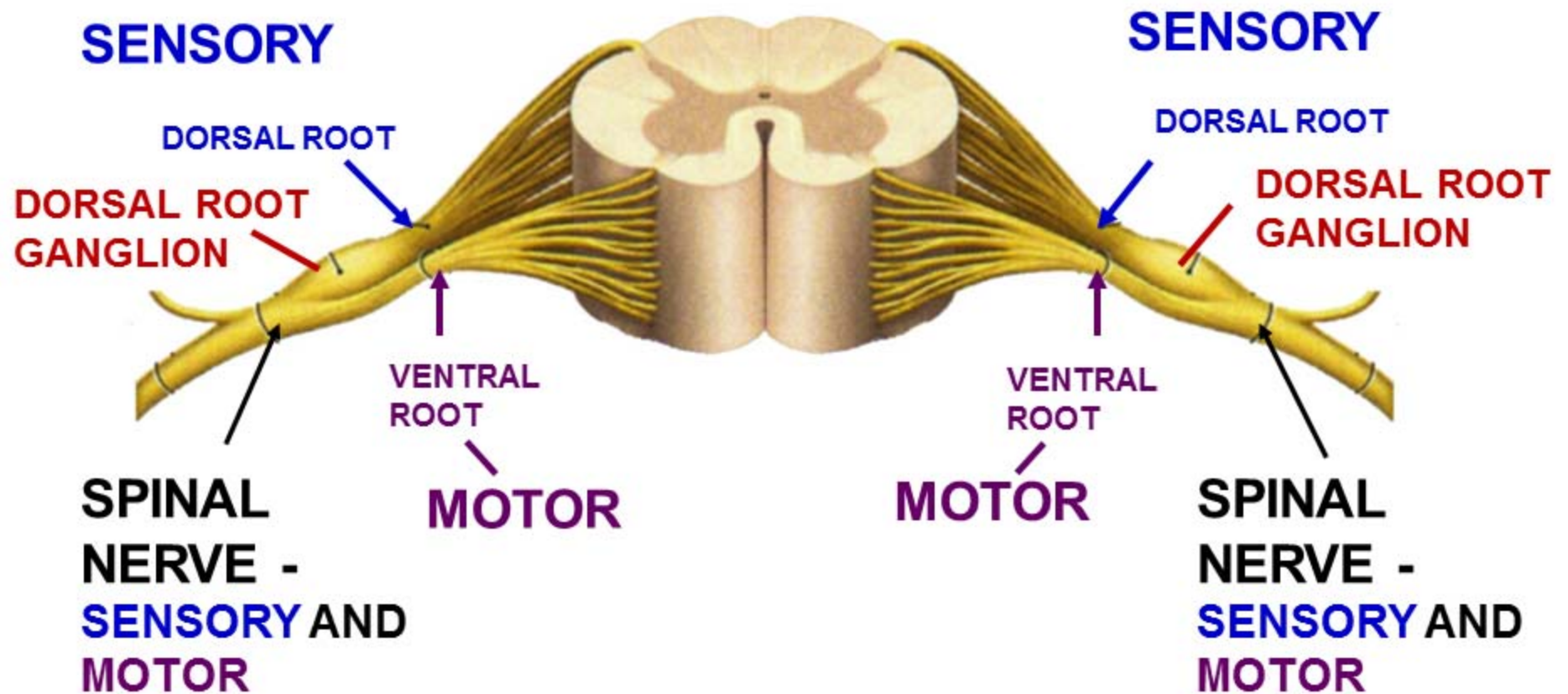


View of the anterior side (front) of vertebrae (back bones) inside the thorax (chest cavity); chain of ganglia are on sides of vertebrae (paravertebral)

II. SPINAL CORD AND SPINAL NERVES



SPINAL NERVE FORMED FROM SENSORY AND MOTOR ROOTS



- Dorsal Roots; contain **sensory (afferent)** axons
- Ventral Roots; contain **motor (efferent)** axons

- Dorsal and Ventral roots unite to form a Spinal Nerve; which contains **sensory** and **motor axons**

- **DORSAL ROOT GANGLION** – contains cell bodies of sensory neurons

III. SPINAL REFLEXES

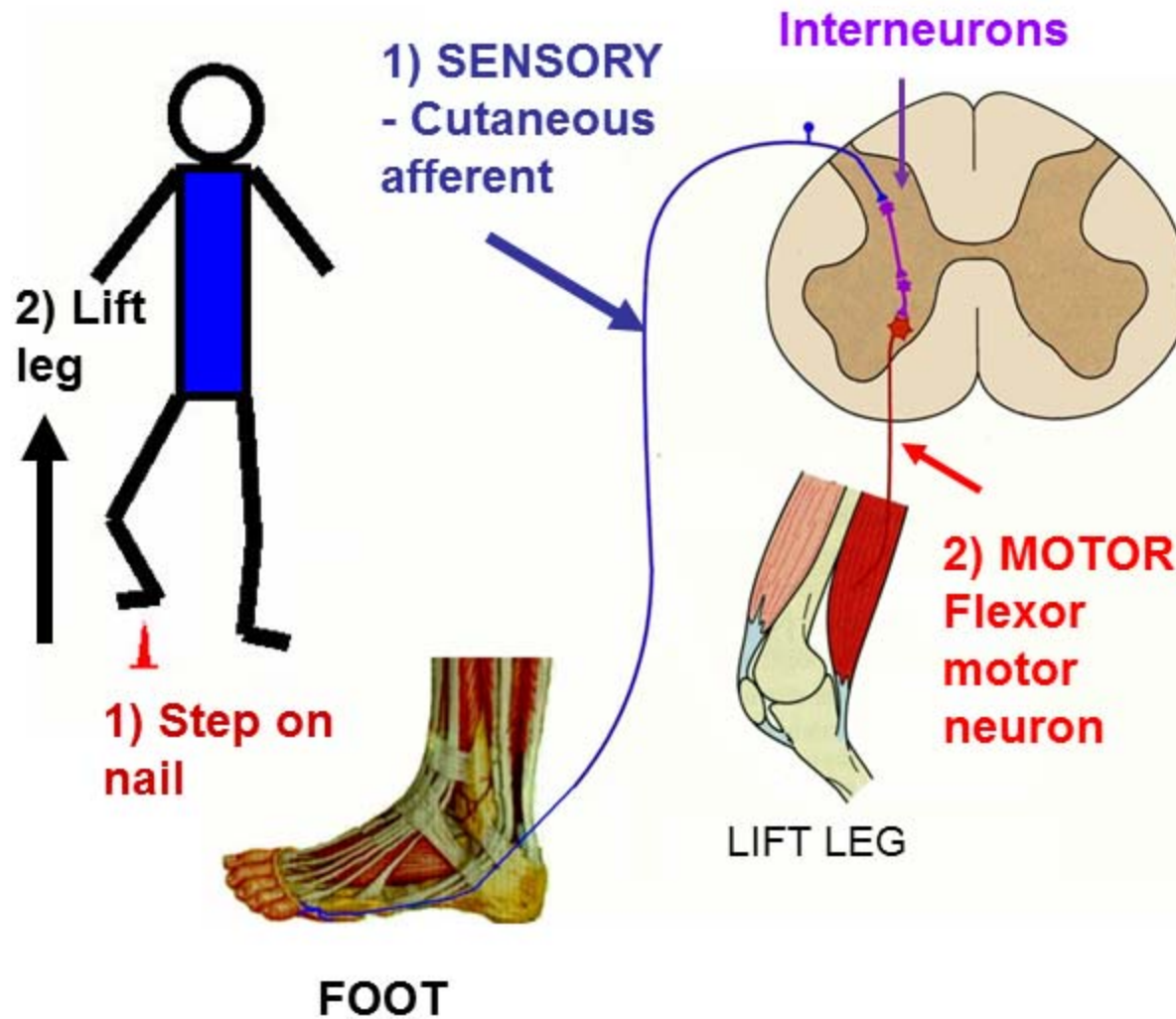
**SENSORY
STIMULUS**



**MOTOR
RESPONSE**

Definition of a Reflex - stereotyped motor response to a specific sensory stimulus

1) FLEXOR REFLEX: STEPPING ON A NAIL



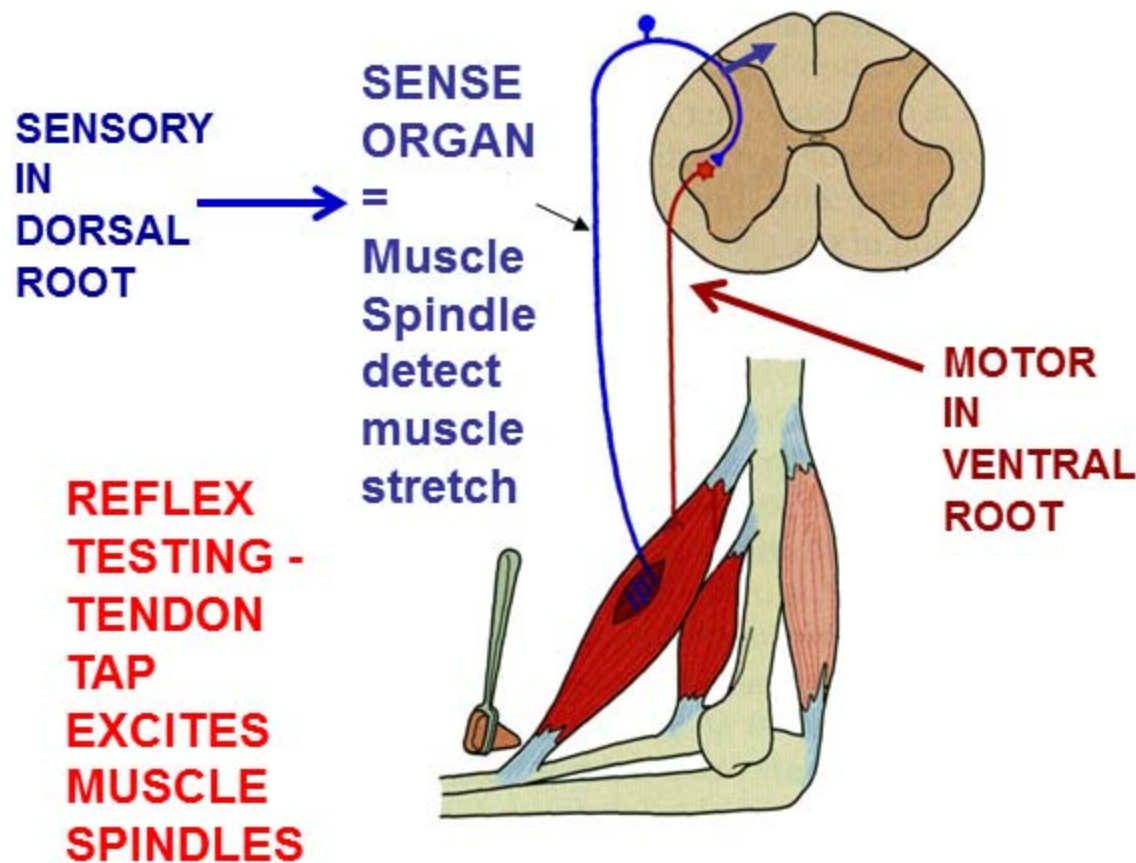
FLEXOR REFLEX

- 1) SENSORY STIMULUS - foot steps on nail
- 2) MOTOR RESPONSE - lift leg before foot is impaled by nail

PATHWAY

- 1) SENSORY NEURONS IN SKIN (CUTANEOUS) detects pain
- 2) INTERNEURONS IN CNS - transmit signal
- 3) MOTOR NEURONS - activate Flexor muscles to lift leg

2) STRETCH (DEEP TENDON) REFLEXES - tapping on the tendon of a muscle stretches the muscle and reflexively causes it to contract – **CLINICALLY IMPORTANT**



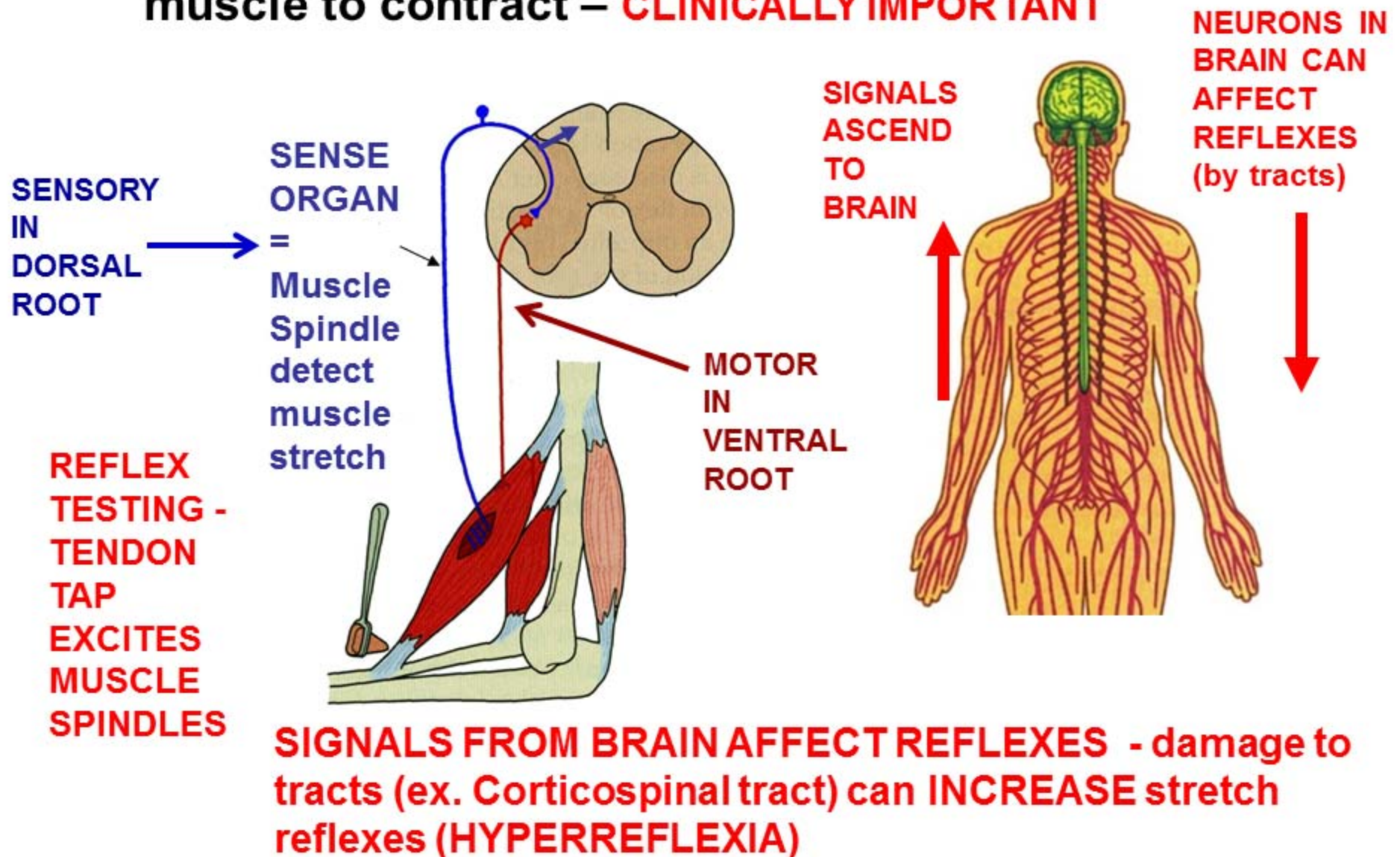
STRETCH (DEEP TENDON) REFLEX

- 1) SENSORY STIMULUS - stretch of muscle
- 2) MOTOR RESPONSE - contract muscle that is stretch

PATHWAY

- 1) SENSORY Muscle spindle (sensory endings inside muscle) detect stretch
- 2) MOTOR NEURONS- activate motor neurons to muscle that is stretched

2) STRETCH (DEEP TENDON) REFLEXES - tapping on the tendon of a muscle causes the muscle to contract – **CLINICALLY IMPORTANT**



NORMAL STRETCH (DEEP TENDON) REFLEXES - ELICIT BY TAPPING ON MUSCLE TENDON - CAUSES MUSCLE TO CONTRACT

NORMAL PATIENT



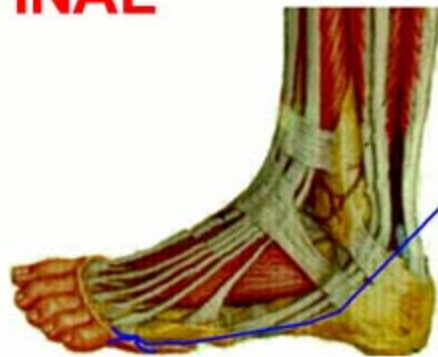
download videos from Zillanatomy: https://www.zillanatomy.com/Pandemic_anatomy.htm

DAMAGE (LESION) OF PNS

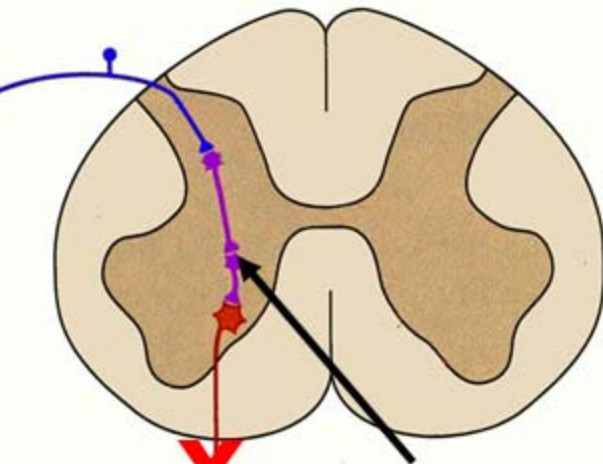
ex. COMPRESS
SPINAL NERVE



DAMAGE SPINAL
NERVE

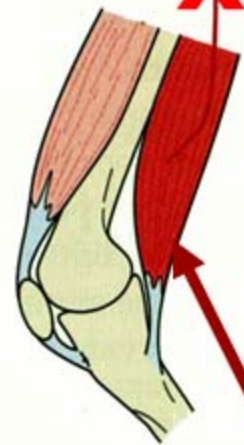


SENSORY



INTERNEURON(S)

MOTOR



MUSCLE

SPINAL NERVE DAMAGE CAN AFFECT SENSORY AND
MOTOR NEURONS

DAMAGE (LESION) OF PNS

ex. COMPRESS
SPINAL NERVE



**DAMAGE SPINAL
NERVE**

STRUCTURES AFFECTED:

- 1) Motor Neurons
- 2) Sensory neurons

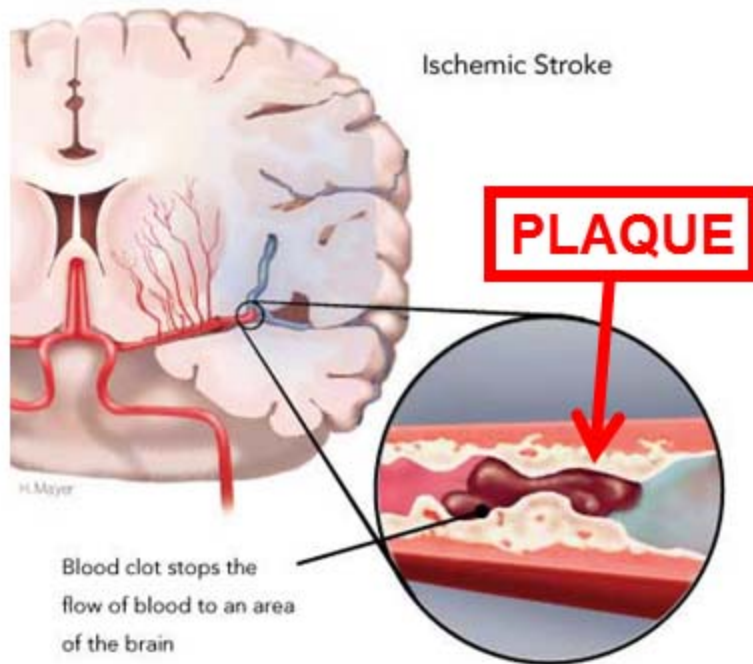
SYMPTOMS

- 1) Muscle is completely paralyzed (Flaccid Paralysis) or partially paralyzed (weakness)
- 2) Sensory loss is complete (total numbness) or partial (paresthesia = 'pins and needles' sensation)
- 3) **DECREASED (HYPOREFLEXIA) OR NO (AREFLEXIA) STRETCH REFLEXES**

**SPINAL NERVE DAMAGE CAN AFFECT SENSORY
AND MOTOR NEURONS**

DAMAGE (LESION) OF CNS

ex. **STROKE** – blood supply to brain interrupted or reduced



Note: this illustrates an Ischemic stroke caused by a clot; other strokes are Hemorrhagic, caused by bleeding

STRUCTURES AFFECTED:

Neurons and tracts in CNS; (tracts that generate voluntary muscle contractions also called Upper Motor Neurons; ex. Corticospinal Tract)

SYMPTOMS

Disrupt voluntary control of movement and regulation of reflexes (remove inhibition):

1) No or weakened voluntary movements

2) **INCREASE STRETCH (DEEP TENDON) REFLEXES (HYPERREFLEXIA)**

3) **MANY OTHER SYMPTOMS**

Causes - Example - Stroke

(interruption of blood supply to brain – can damage Corticospinal tract)

STRETCH (DEEP TENDON) REFLEXES - ELICIT BY TAPPING ON MUSCLE TENDON - CAUSES MUSCLES TO CONTRACT

ABNORMAL - CHILD WITH CNS LESION (STROKE) - REFLEXES HYPERACTIVE ON RIGHT SIDE



MAJOR TAKE- HOME POINTS FROM THIS LECTURE

1- Know definitions of terms in Summary

2- Damage Spinal Nerve - Spinal nerves contain axons of sensory AND motor neurons; **damage** can produce Sensory deficits (numbness or paresthesias (tingling sensation) **AND** motor deficits (paralysis, weakness) depending upon extent of lesion. Also, spinal reflexes can be **DECREASED** or eliminated.

3- Damage Central Nervous system tracts - Can **decrease or eliminate voluntary movements**; however, spinal reflexes can still be elicited; damage to descending tracts (Corticospinal tract) can **INCREASE** spinal stretch reflexes (hyperreflexia).

SUMMARY DEFINITIONS OF TERMS

Definitions of Terms

Central nervous system (CNS) = brain and spinal cord

Peripheral nervous system (PNS) = all nerves, ganglia, sense organs outside CNS

Cranial nerves = nerves that arise from brain (there are 12 cranial nerves)

Spinal nerves = nerves that arise from spinal cord (there are 31 spinal nerves)

Afferent axons = axons of sensory neurons (conduct toward CNS)

Efferent axons = axons of motor neurons, neurons of autonomic nervous system; (conduct away from CNS)

Somatic = voluntary

Somatic efferents - axons innervate skeletal muscle;

Somatic afferents - sensory neurons innervate skin, joints muscles (also oral cavity and nasal cavity); sensory perception is precise

Visceral = involuntary

Visceral efferents (= AUTONOMICS) - innervate smooth muscle, glands, gut, blood vessels

Visceral afferents - sensory neurons innervate internal organs; sensory perception is imprecise

Reflex - a stereotyped motor (muscle) response to a specific sensory signal.

Flexor Reflex - sensory - stepping on nail; motor - lift leg

Stretch (Deep Tendon Reflex - sensory - stretch muscle (tap on tendon) activates Muscle Spindle sensor neurons; motor - muscle contracts.

SUMMARY CHART: LESIONS OF PNS AND CNS - Symptoms are a direct consequence of Anatomy

SUMMARY: INTRODUCTION TO LESIONS OF PNS AND CNS – Major symptoms and causes

Lesion	Structures Affected	Symptoms	Causes (Examples)
DAMAGE PNS (ex. Peripheral nerve injury, Flaccid Paralysis)	1) Motor Neurons = Motor neurons with axons that innervate skeletal muscles (also called Lower (Alpha) Motor Neuron Lesion, 2) Sensory neurons	1) Muscle is completely paralyzed (Flaccid Paralysis) or partially paralyzed (weakness) 2) Sensory loss is complete (total numbness) or partial (paresthesia = 'pins and needles' sensation) 3) STRETCH REFLEXES ARE REDUCED OR ABSENT	1) Compression of spinal nerve 2) MANY OTHER CAUSES
DAMAGE CNS (ex. Stroke = interrupt blood supply to parts of CNS)	Neurons and tracts in CNS - Descending tracts that generate voluntary muscle contractions are also called Upper Motor Neurons (ex. Corticospinal Tract)	Disrupt voluntary control of movement and regulation of reflexes (remove inhibition): 1) No or weakened voluntary movements 2) STRETCH REFLEXES CAN BE INCREASED (Hyper-reflexia) 3) MANY OTHER SYMPTOMS	Example - Stroke (interruption of blood supply to brain – can damage Corticospinal tract)

Note: Some diseases damage both CNS and PNS - (ex. ALS Amyotrophic Lateral Sclerosis)