INTRODUCTION TO ANATOMY AND NERVOUS SYSTEM - PART 2 - 2023

CLINICAL - DIFFERENTIAL DIAGNOSIS OF LESIONS IN CNS VS PERIPHERAL NERVE DAMAGE

OUTLINE: INTRODUCTION TO NERVOUS SYSTEM - TERMINOLOGY

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

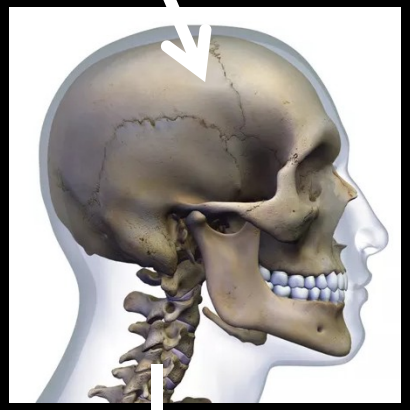
II. SOMATIC AND VISCERAL (AUTONOMIC) NERVOUS SYSTEMS

III. SPINAL NERVES - BASIC STRUCTURES

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

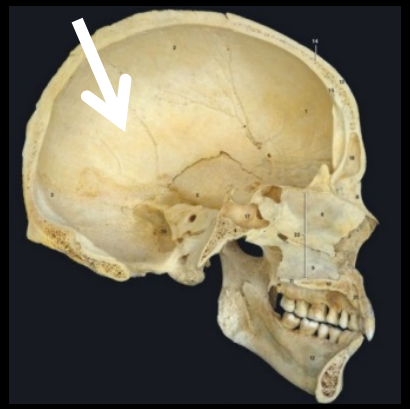
INTRODUCTION TO THE NERVOUS SYSTEM: MAJOR DIVISIONS – CENTRAL NERVOUS SYSTEM

SKULL

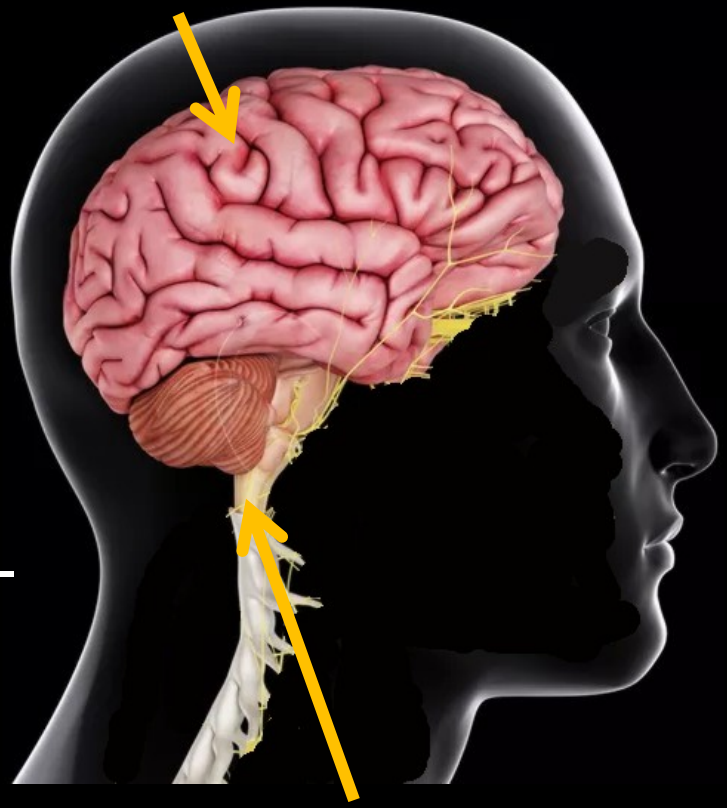


Vertebrae

CRANIAL CAVITY – inside Skull



BRAIN - the 'stuff which dreams are made on'

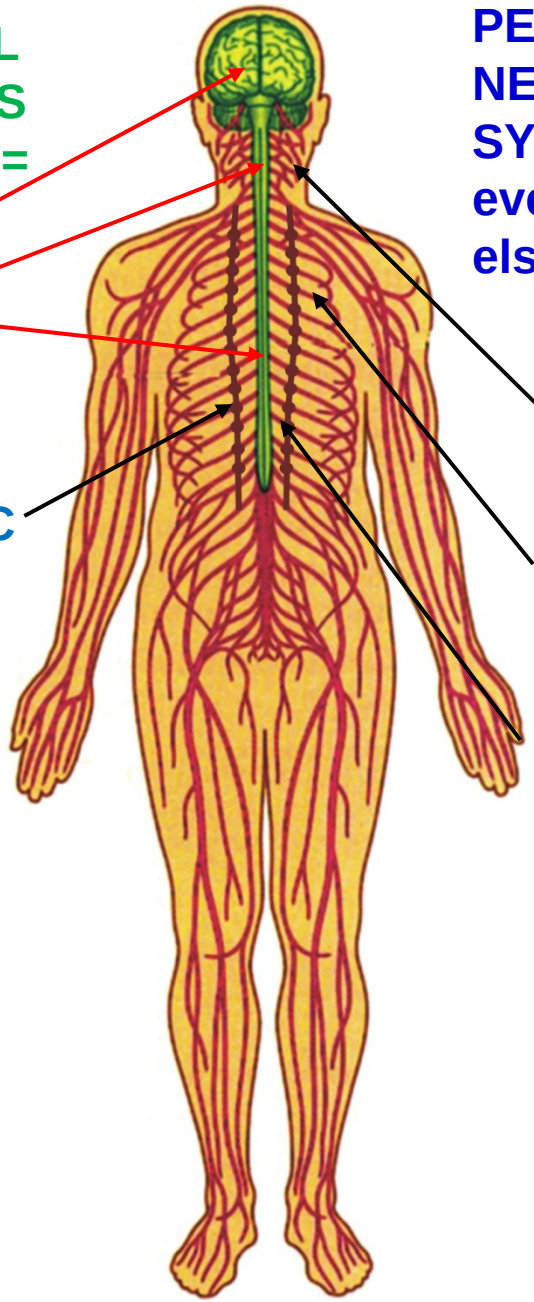


SPINAL CORD

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

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

I, INTRODUCTION: CENTRAL/PERIPHERAL NERVOUS SYSTEMS



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

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

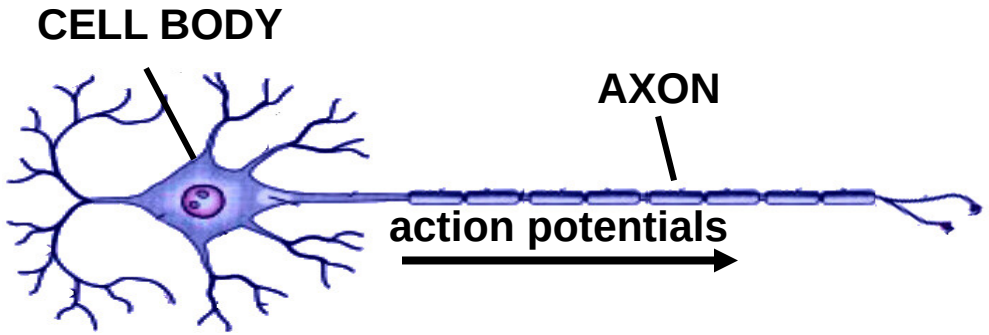
TYPES OF NERVES - CRANIAL NERVES, SPINAL NERVES that carry signals to and from the CNS;

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

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

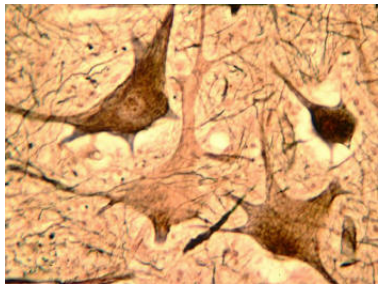
INTRO: DIFFERENCES IN TERMINOLOGY OF GROUPS OF CELL BODIES AND AXONS

STRUCTURE OF NERVE CELL (NEURON)

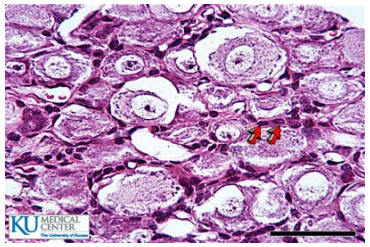


TERMINOLOGY OF GROUPS OF CELL BODIES AND AXONS DIFFERS IN CENTRAL (CNS) AND PERIPHERAL (PNS) NERVOUS SYSTEMS

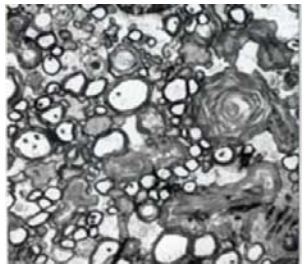
NUCLEI - in CNS



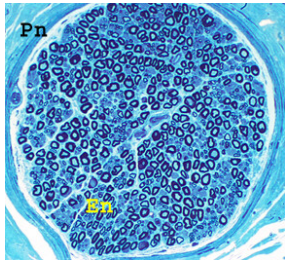
GANGLIA - in PNS



TRACTS - in CNS



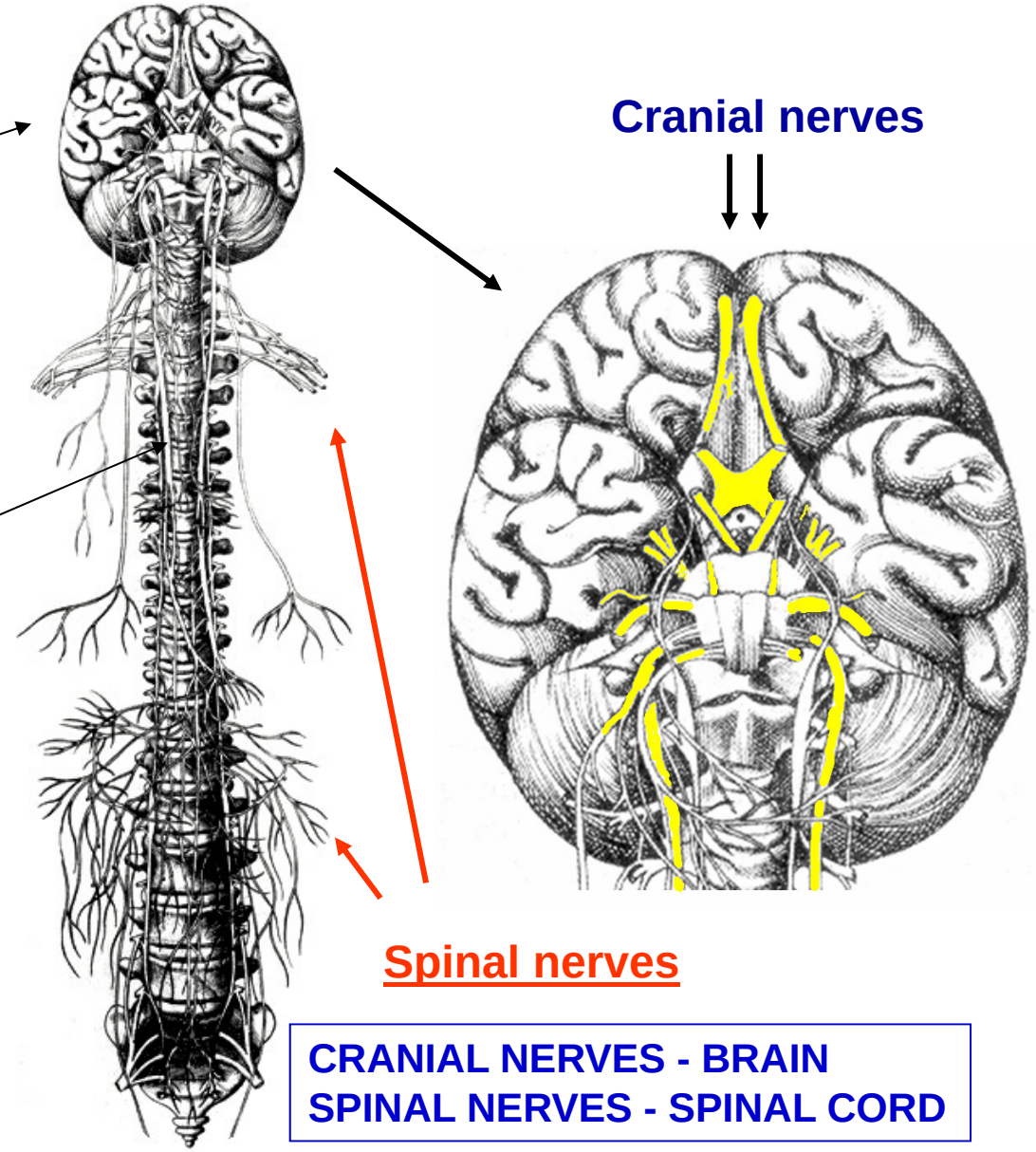
NERVES - in PNS



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

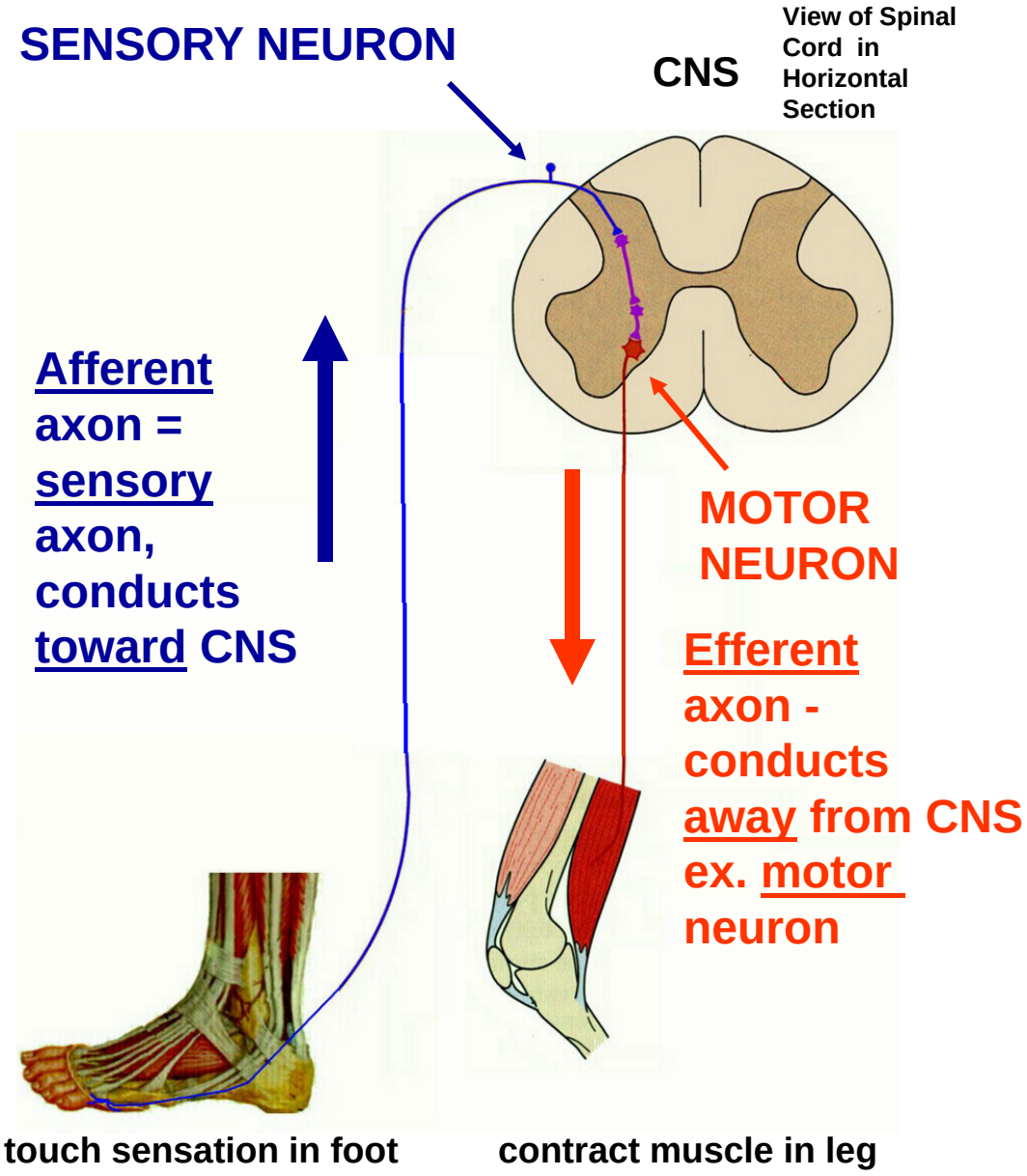


CRANIAL NERVES - BRAIN
SPINAL NERVES - SPINAL CORD

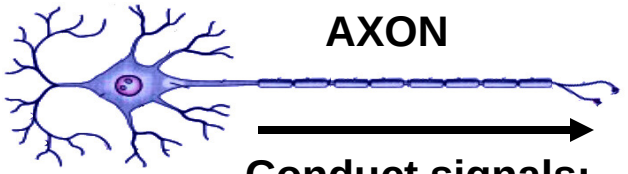
Spinal nerves and Cranial nerves are named for regions of nervous system they arise from/project to.

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



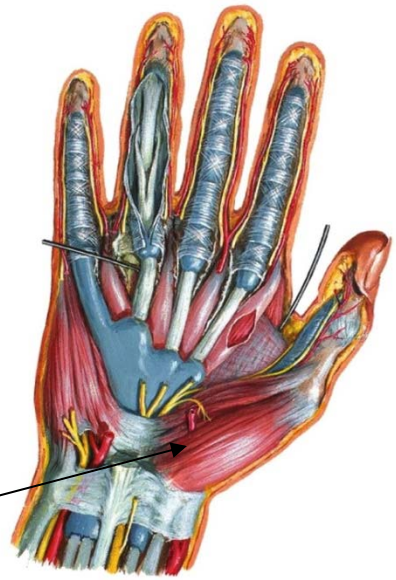
a. Sensory axons (Afferents) axons of sensory neurons that conduct signals **toward CNS** (ex. sensory neurons signaling touch, taste, pain, etc.)

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

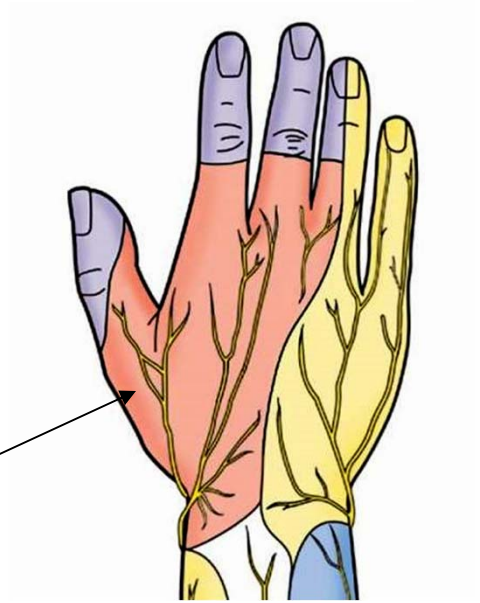
SOMATIC MOTOR NEURONS - motor axons to skeletal muscles

ex. muscles of hand



SOMATIC SENSORY NEURONS - sensory axons to skin ; also joints, body position

ex. skin of hand



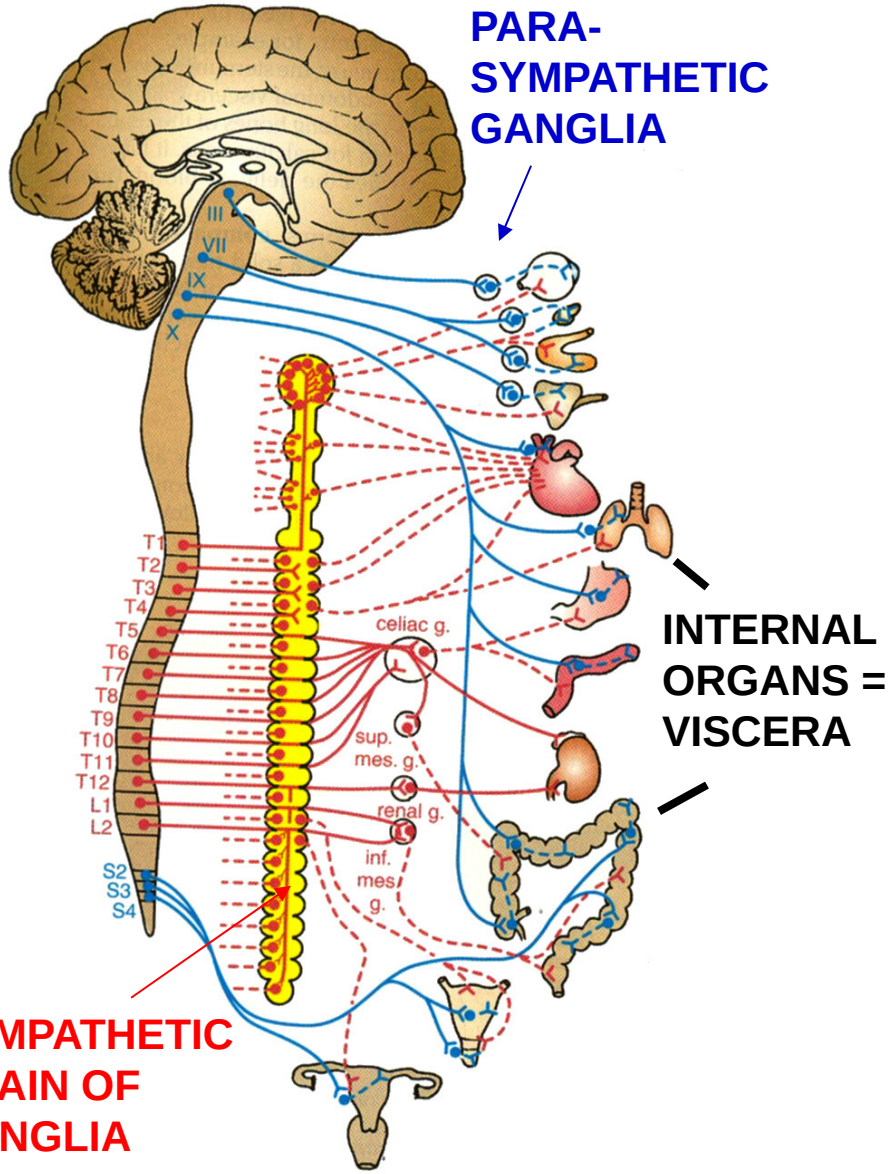
Major divisions of nervous system - SOMATIC AND VISCERAL - terminology based upon function but very confusing

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

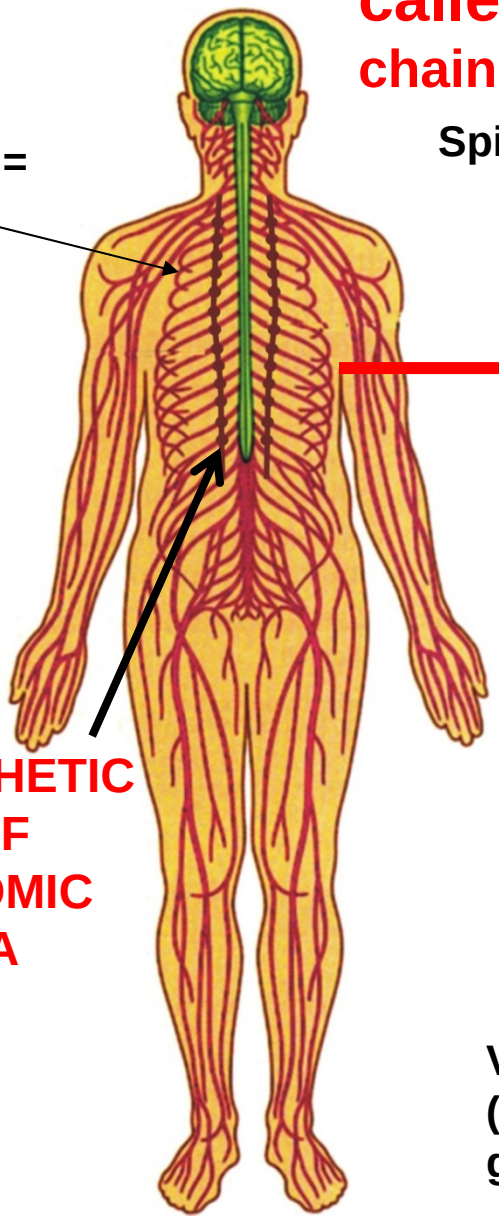


Autonomic Nervous system = Visceral nervous system - involuntary, unconscious part of nervous system; (autonomic means self-regulating or AUTOMATIC).

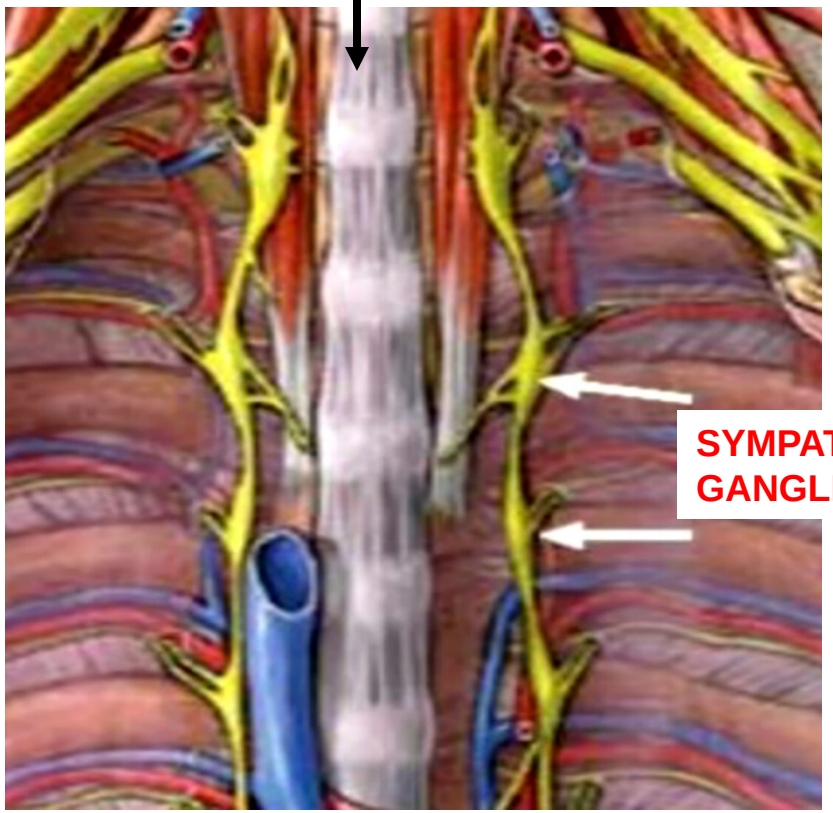
a. Visceral Motor (parasympathetic and sympathetic) - control smooth and cardiac muscle, glands and internal organs; largely unconscious actions

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)

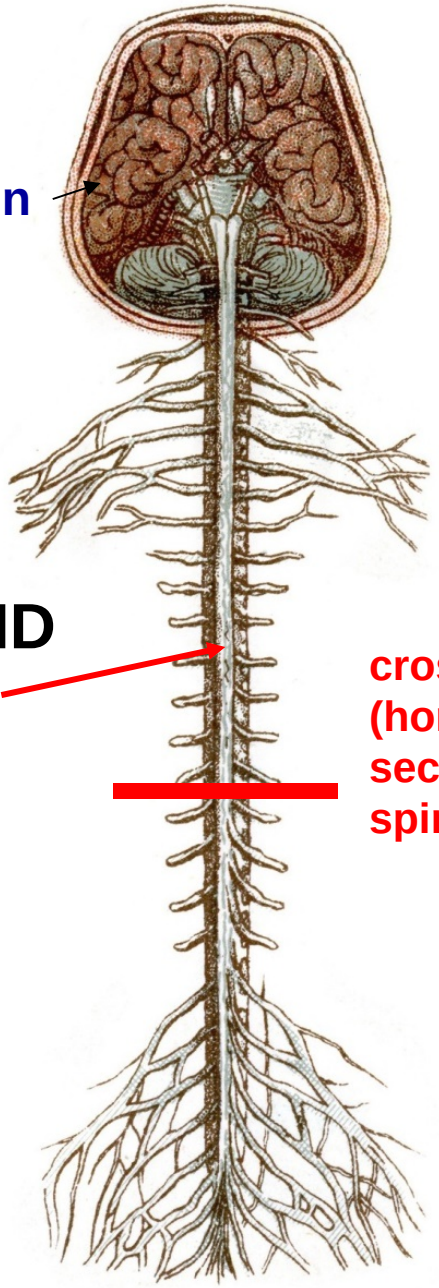


Spinal cord located inside of vertebrae (vertebral canal)



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

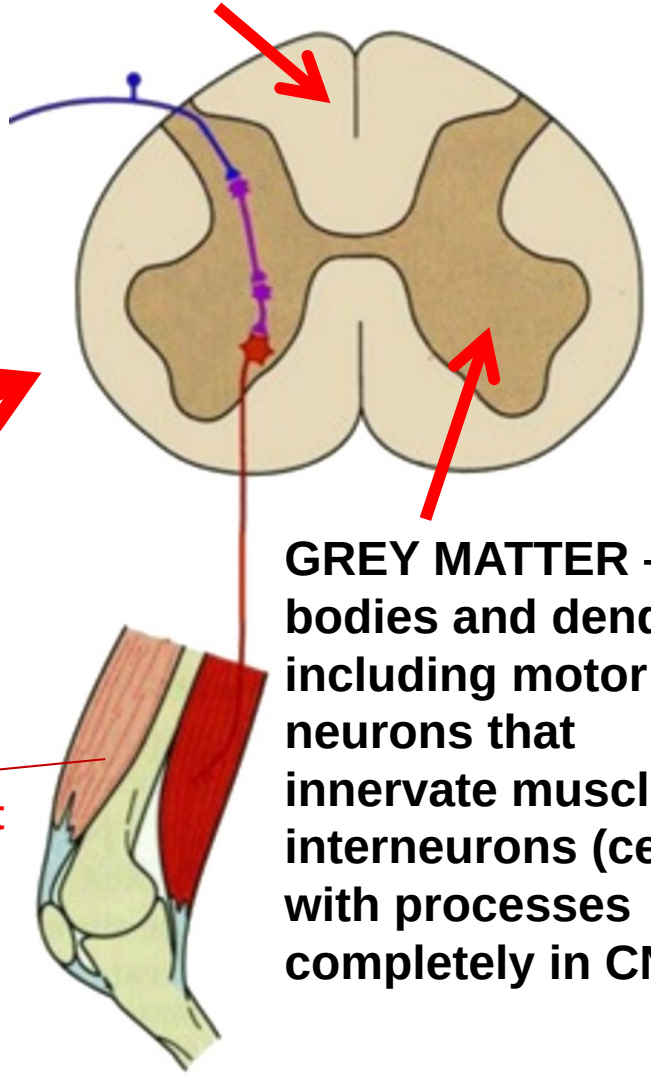
II. SPINAL CORD AND SPINAL NERVES



SPINAL CORD AND SPINAL NERVES

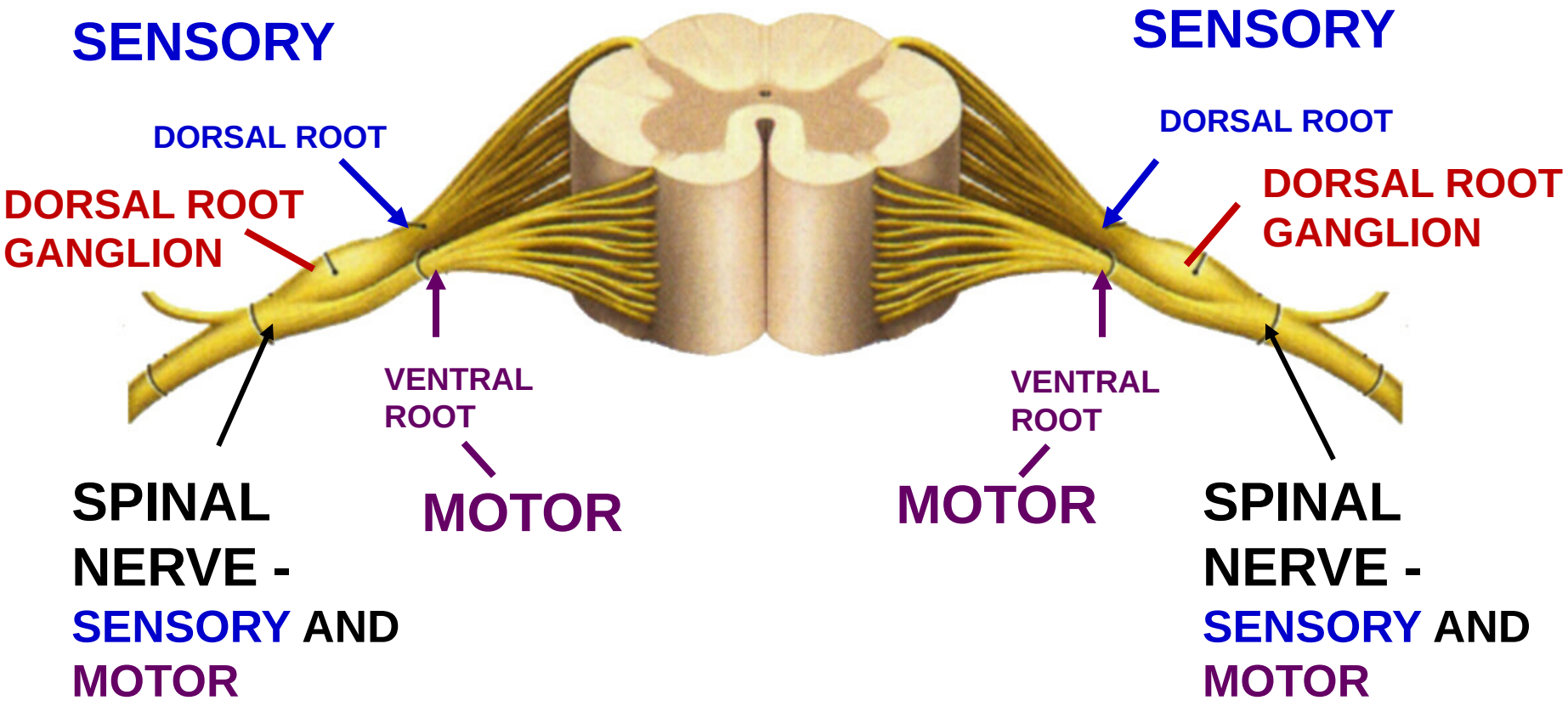
cross section (horizontal section) through spinal cord

WHITE MATTER – axons of tracts in CNS (myelin is white)



GREY MATTER – cell bodies and dendrites including motor neurons that innervate muscles, interneurons (cells with processes completely in CNS)

SPINAL NERVE FORMED FROM SENSORY AND MOTOR ROOTS



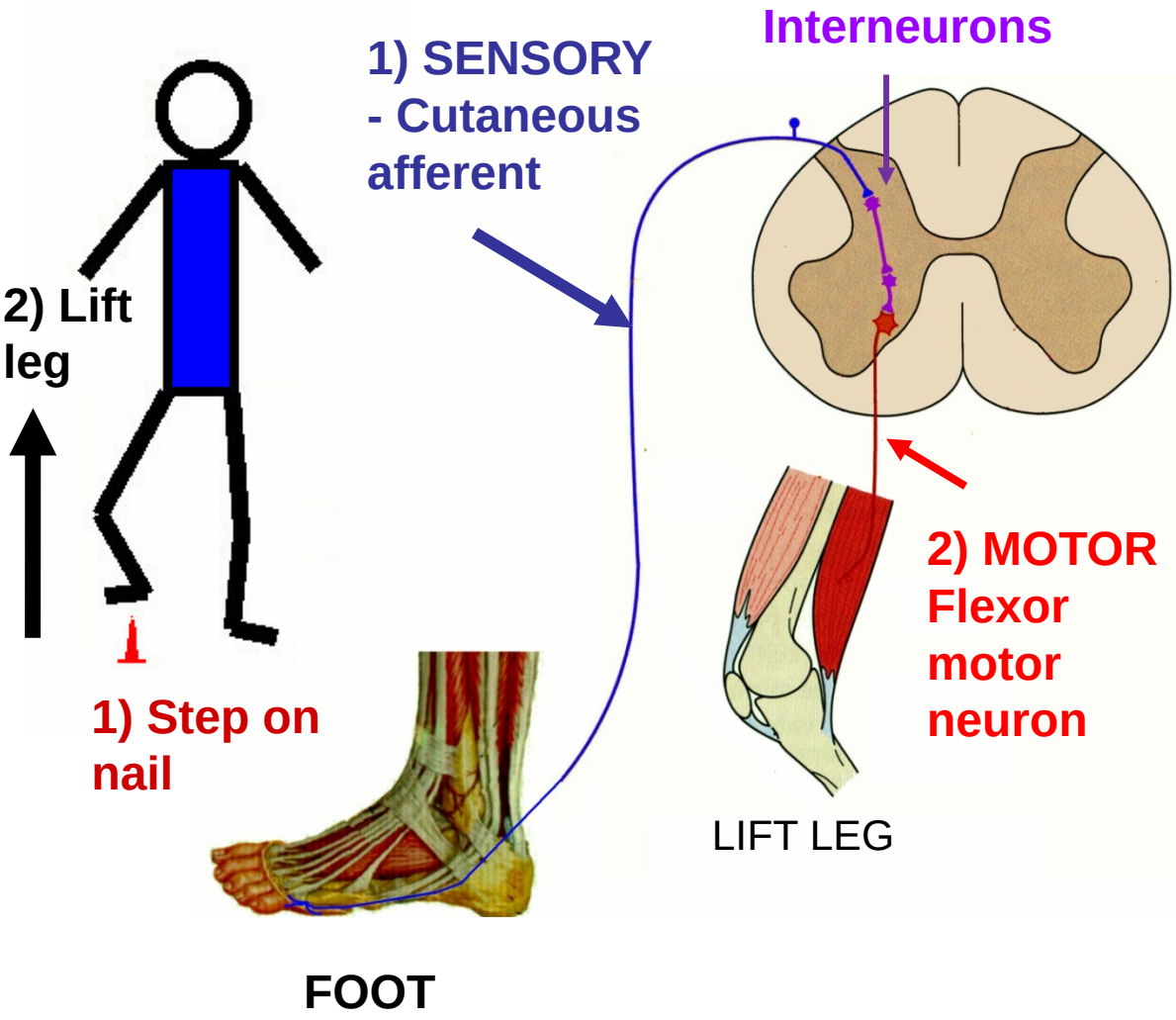
- Dorsal Roots; contain sensory (afferent) axons
- Ventral Roots; contain motor (efferent) axons
- Dorsal and Ventral roots unite to form a Spinal Nerve; which contains sensory and motor axons
- DORSAL ROOT GANGLION – contains cell bodies of sensory neurons

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

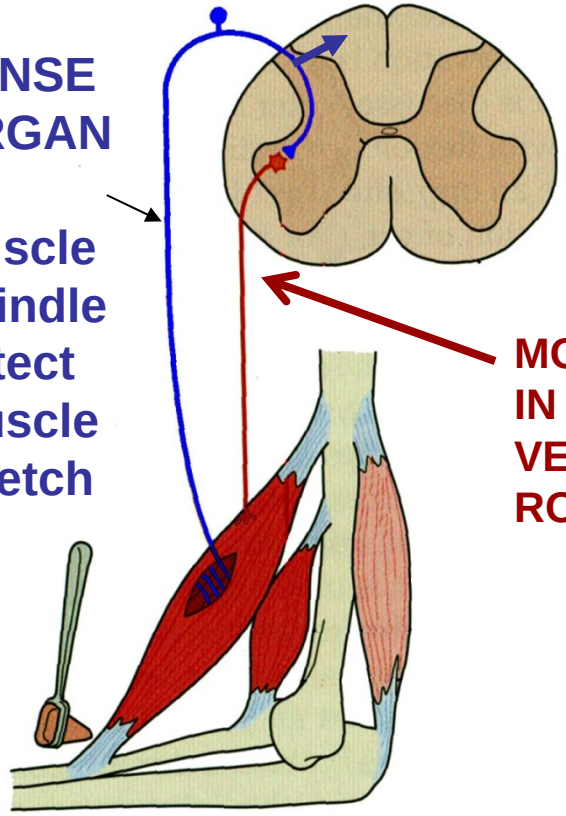
2) INTERNEURONS IN CNS - transmit signal

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

SENSORY IN DORSAL ROOT

SENSE ORGAN = Muscle Spindle detect muscle stretch



MOTOR IN VENTRAL ROOT

REFLEX TESTING - TENDON TAP EXCITES MUSCLE SPINDLES

STRETCH (DEEP TENDON) REFLEX

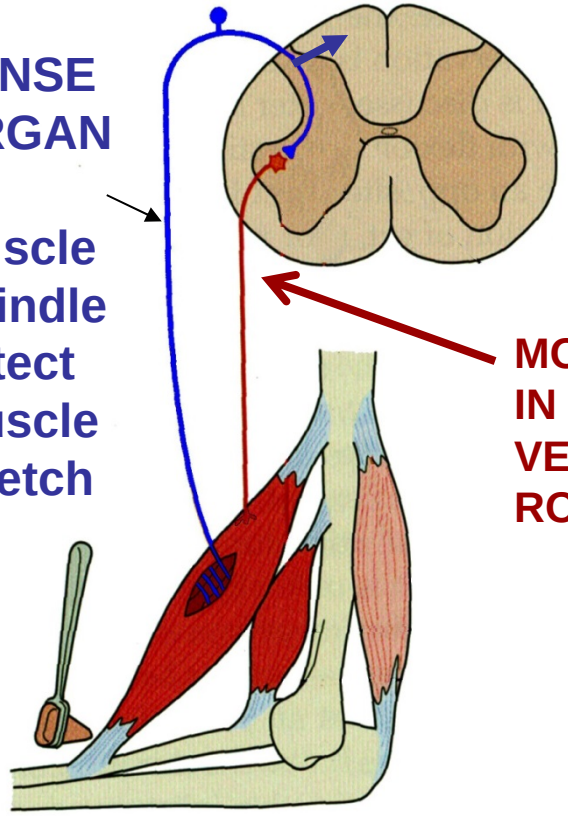
1) SENSORY STIMULUS - stretch of muscle
2) MOTOR RESPONSE - contract muscle that is stretch

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

SENSORY IN DORSAL ROOT

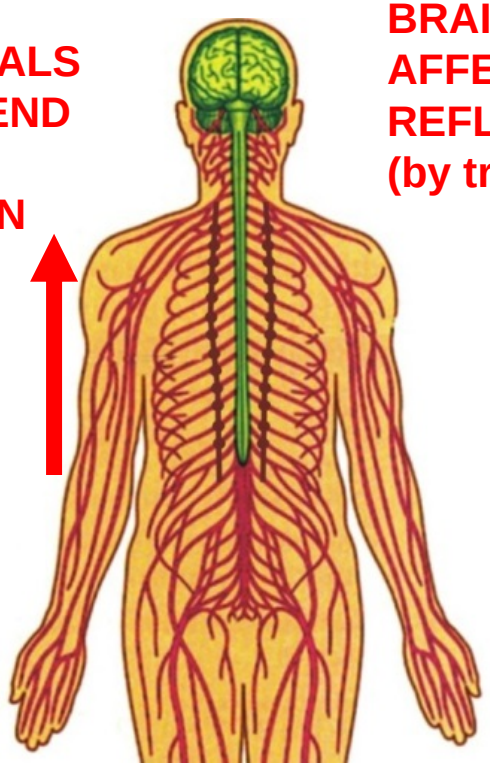
SENSE ORGAN = Muscle Spindle detect muscle stretch



MOTOR IN VENTRAL ROOT

SIGNALS ASCEND TO BRAIN

NEURONS IN BRAIN CAN AFFECT REFLEXES (by tracts)



REFLEX TESTING - TENDON TAP EXCITES MUSCLE SPINDLES

SIGNALS FROM BRAIN AFFECT REFLEXES - damage to tracts (ex. Corticospinal tract) can INCREASE stretch reflexes (HYPERREFLEXIA)

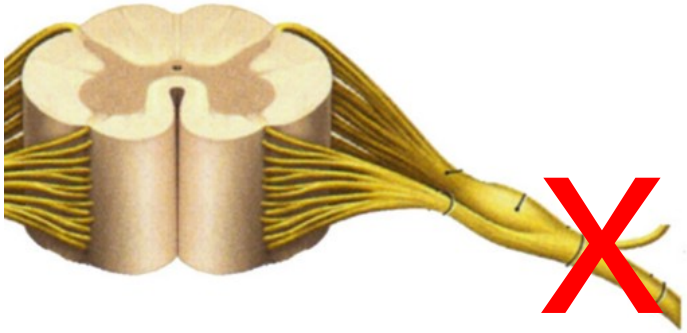
NORMAL STRETCH (DEEP TENDON) REFLEXES - ELICIT BY TAPPING ON MUSCLE TENDON - CAUSES MUSCLE TO CONTRACT

NORMAL PATIENT

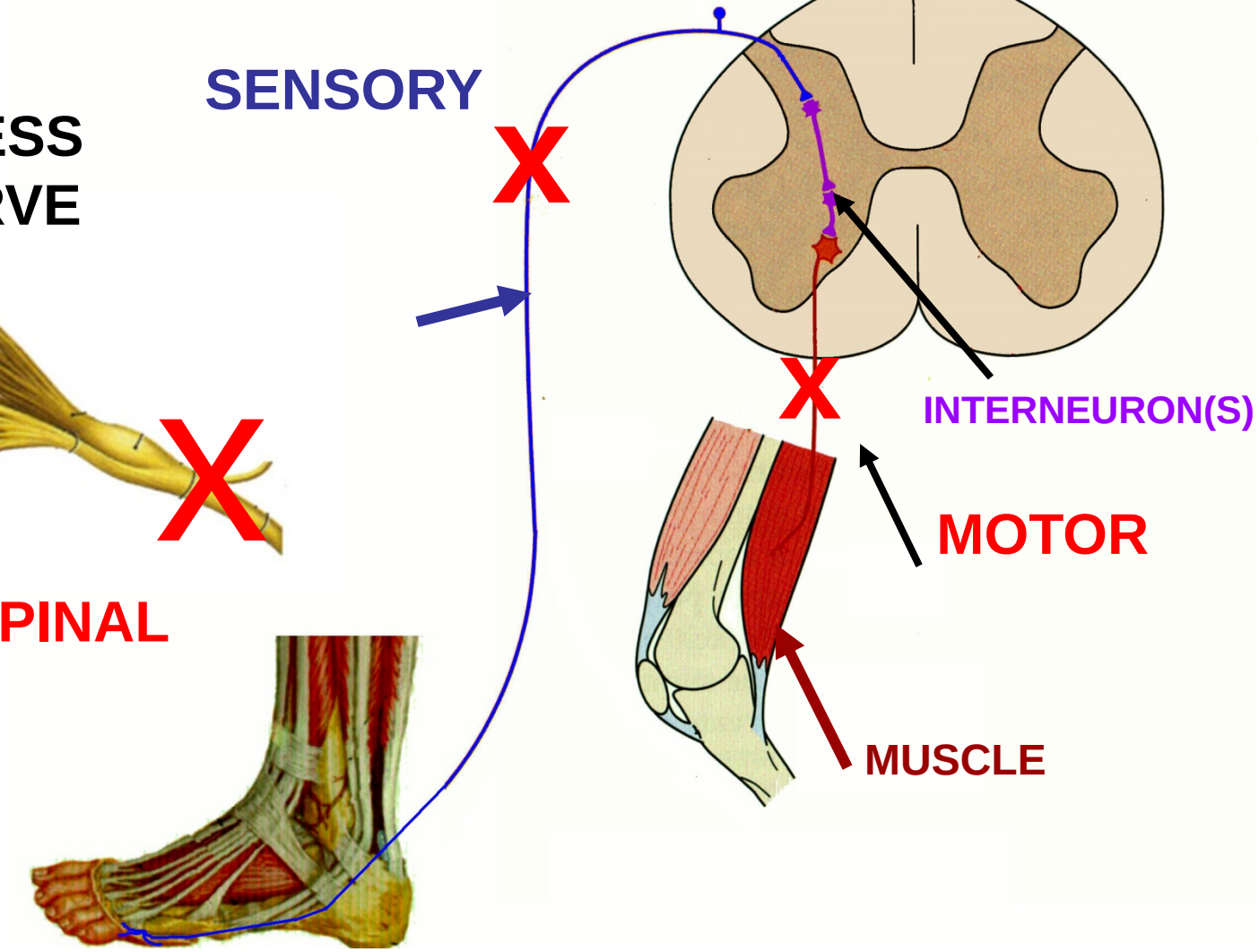
download videos from Zillanatomy: https://www.zillanatomy.com/Pandemic_anatomy.htm

DAMAGE (LESION) OF PNS

ex. COMPRESS SPINAL NERVE



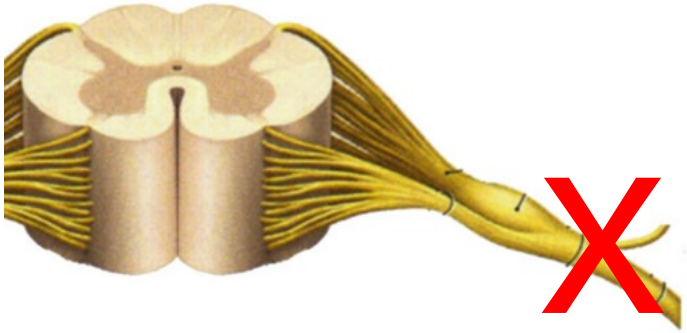
DAMAGE SPINAL NERVE



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

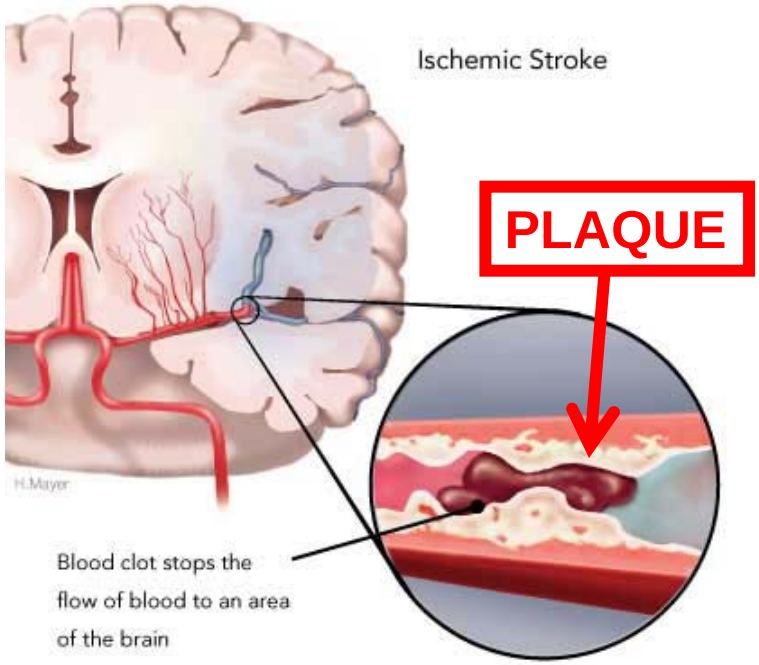
SYMPTOMS

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 (ARELFEXIA) 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

<u>STRUCTURES AFFECTED</u>:
Neurons and tracts in CNS; (tracts that generate voluntary muscle contractions also called Upper Motor Neurons; ex. Corticospinal Tract)

<u>SYMPTOMS</u>
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.

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)