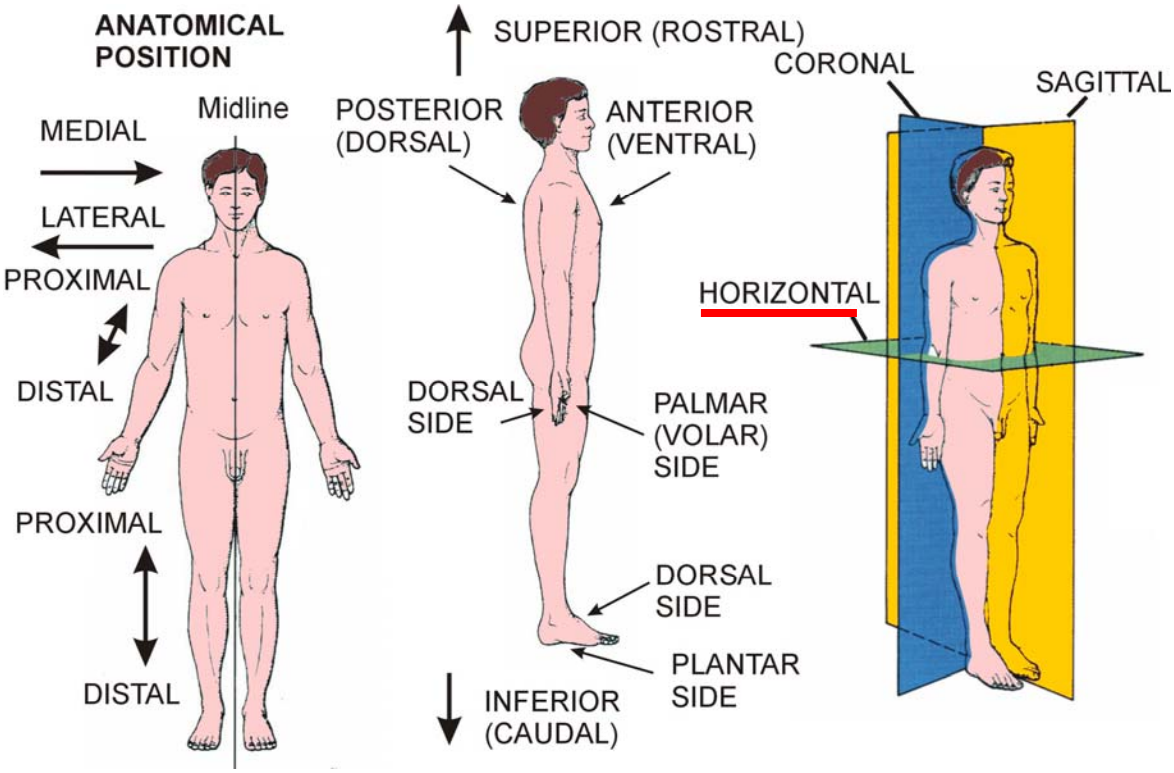
INTRODUCTION TO GROSS ANATOMY AND NERVOUS SYSTEM: PART 1 - ANATOMY: TERMINOLOGY OF ANATOMICAL POSITION AND PLANES



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

ANATOMICAL TERMS
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

ANATOMICAL PLANES
SAGITTAL PLANE - divides body into left right parts
MEDIAL SAGITTAL PLANE - divides body in left right halves
CORONAL (FRONTAL) PLANE - divides body into front and back parts
HORIZONTAL (TRANSVERSE) PLANE - * TYPICAL PLANE OF CT AND MRI IMAGES - plane perpendicular to the body long axis; divides body in top and bottom parts

INTRODUCTION TO GROSS ANATOMY AND NERVOUS SYSTEM. Part 2 - Nervous System

I. INTRODUCTION/DIVISIONS OF NERVOUS SYSTEM - The nervous system is the most complex system in the human body; required for human consciousness and behavior; irreversible cessation of function of nervous system is legal definition of death.

A. Major divisions of nervous system – Central nervous system and Peripheral nervous system

1. Central nervous system (**CNS**) - definition is precise; consists of **Brain** (contained in cranial cavity) and **Spinal Cord** (contained in vertebral canal).
2. Peripheral nervous system (**PNS**) = **everything else**; all of nervous system outside cranial cavity and vertebral canal; consists of 1) nerves (spinal nerves and cranial nerves) that carry signals to and from the CNS; 2) ganglia (collections of nerve cell bodies), 3) sense organs (eye, inner ear, etc.)

B. Difference in Terminology in CNS and PNS

1. Groups of nerve cell bodies – called Nuclei in CNS, Ganglia in PNS.
2. Groups of axons of nerve cells – called Tracts in CNS, Nerves in PNS

C. Types of 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 31 spinal nerves –

D. Terminology - axons in (peripheral) nerves.

1. Sensory axons (Afferents) - axons of sensory neurons that conduct signals TOWARD CNS (ex. sensory neurons signaling touch, taste, pain, etc.)
2. Motor axons (Efferents) - axons of neurons that conduct signals away from CNS; most motor axons that cause contractions of skeletal muscles; Other axons are Visceral Motor (= AUTONOMICS, see below; pathway more complicated.)

E. Major divisions of nervous system – Somatic and Visceral - terminology based upon function but can be confusing

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

b. Somatic Sensory (Afferents) - sensory neurons that innervate skin, joints; provide precise conscious sensation of touch, pressure, pain etc to skin; also provide sense of body position.

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

2. Autonomic Nervous system = Visceral nervous system - involuntary, unconscious part of nervous system

a. Visceral Sensory - sensory neurons that innervate internal organs, blood vessels; only provide imprecise localization of sensation and dull sense of pressure, pain, etc.

b. Visceral Motor - control **smooth and cardiac muscle**, glands and internal organs; largely unconscious actions (autonomic means self-regulating or automatic)

Note: The Autonomic Nervous system will be covered in a number of lectures. It consists of Sympathetic and Parasympathetic divisions. The Sympathetic ganglia are located adjacent to the bodies of the vertebrae (called Paravertebral ganglia) inside the thorax (chest cavity).

II. SPINAL CORD AND SPINAL NERVES - spinal cord is located within vertebral canal and is continuous with the brain

A. Internal organization – Spinal cord has inner Grey Matter surrounded by outer 'White Matter'

1. 'Grey Matter' – contains cell bodies and dendrites including motor neurons that innervate muscles, interneurons (cells with processes completely in CNS)

2. White matter – axons of tracts in CNS (why white? myelin (surrounding axons) is white.

B. Formation of a Spinal Nerve - spinal nerve forms from dorsal and ventral roots.

1. Dorsal root of spinal nerve - forms from series of dorsal rootlets; contains afferent (sensory) axons.
2. Dorsal root ganglion - cell bodies of all sensory neurons (somatic and visceral) are located at dorsal root ganglia; ganglia look like swellings attached to the dorsal root.
3. Ventral root of spinal nerve - forms from ventral rootlets; contains efferent (motor) axons.

III. REFLEXES - Reflexes are automatic reactions of nervous system (but can be modified)

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

B. Flexor Reflex - Sensory Stimulus - foot steps on nail
Motor Response - lift leg before foot is impaled by nail

PATHWAY
1. Sensory neurons (cutaneous) detects pain in skin
2. Interneurons in CNS - transmit signal
3. Motor neurons - activate Flexor muscles to lift leg

C. Stretch Reflex – When a muscle is stretched rapidly, a stretch reflex (automatic reaction) is evoked that causes the stretched muscle to contract; clinically, the reflex is test by tapping on a muscle tendon, which produces a brief, rapid stretch of the muscle**.**

Sensory Stimulus - stretch of a muscle.
Motor Response - muscle that is stretched contracts.

PATHWAY - no interneurons necessary; connection of sensory receptor to motor neuron is direct (monosynaptic)

1) Sensory neurons detects muscle stretch - Muscle spindle (sensory endings inside muscle) detect stretch

2) Motor neurons - motor neurons to muscle that is stretched are activated, causing muscle to contract**.**

Clinical - Stretch reflexes are clinically used to evaluate nervous system function. Stretch reflexes (also termed Deep Tendon Reflexes) are tested by **tapping on a muscle tendon** THIS CAUSES A BRIEF, RAPID STRETCH OF THE MUSCLE).

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

IV. DIFFERENCES BETWEEN LESIONS (DAMAGE) TO PNS AND CNS - EXAMPLES

1. **DAMAGE PNS** - EXAMPLE: Compression of spinal nerve - spinal nerves can be compressed (ex. 'Slipped' disc which is actually displacement (herniation) of intervertebral disc between vertebrae

STRUCTURES THAT CAN BE AFFECTED: 1) Motor Neurons and 2) Sensory neurons; spinal nerves contain both sensory and motor axons.

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) **DECREASE STRETCH REFLEXES** (HYPOREFLEXIA) OR NO REFLEXES (AREFLEXIA)

2. **DAMAGE CNS** - EXAMPLE: Stroke - compression of spinal nerve - spinal nerves can be compressed (ex. 'Slipped' disc which is actually displacement (herniation) of intervertebral disc between vertebrae.

STRUCTURES THAT CAN BE 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 REFLEXES** (HYPERREFLEXIA)

3) MANY OTHER SYMPTOMS

<u>CLINICALLY IMPORTANT NOTE</u>: Stretch reflexes are REDUCED or ELIMINATED by damage to PNS (peripheral nerves); Stretch reflexes can be INCREASED by damage to tracts in CNS.

V. SUMMARY OF DEFINITIONS AND CHART

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: INTRODUCTION TO LESIONS OF PNS AND CNS – Major symptoms and causes - Symptoms are a direct consequence of Anatomy.

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)