

LECTURE TOPICS OUTLINE

NERVOUS SYSTEM II (2 of 3)

PERIPHERAL NERVOUS SYSTEM & REFLEXES

I. NERVES, NERVE FIBERS, AND GANGLIA

A. Anatomy of a Nerve See Hole's TEXT: Figure 11.23, p.397 (10th edition for helpful diagram).

1. A **nerve** is an organ composed of *multiple* nerve fibers bound together by sheaths of connective tissue.
2. The sheath *adjacent to the neurilemma* is the **endoneurium**, which houses blood capillaries that feed nutrients and oxygen to the nerve.
3. In large nerves, fibers are bundled into **fascicles**, and wrapped in a fibrous **perineurium**.
4. The *entire* nerve is covered with a fibrous **epineurium**.

B. Functional Classes of Nerve Fibers and Nerves

1. **Fibers** are classified for the direction in which signals are transmitted (**afferent** and **efferent**), the types of organs they innervate (somatic and visceral), and for how widespread or local the distribution of innervated organs (general or special). Remember **S-A-M-E!**
2. **Mixed nerves** contain both motor and sensory fibers. Sensory nerves (optic and olfactory) contain mostly sensory fibers. Motor nerves contain motor fibers.

C. Ganglia

A **ganglion** is a *cluster* of nerve cell bodies generally **outside the CNS**.

II. THE CRANIAL NERVES

1. The **cranial nerves** emerge from the base of the brain and lead to muscles and sense organs located in the head and neck for the most part. There are **twelve pairs**.
2. Each of the twelve pairs of cranial nerves is listed and described in Hole: **Table 11.9, p. 402**, as mentioned before. (Better: Use website on our 2016 Lecture homepage)

III. THE SPINAL NERVES (See slide 18 in the Ch 11-a Slideshow; AND next page here)

A. There are **31 pairs of spinal nerves**: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal.

B. Proximal Branches

1. Each **spinal nerve** branches into a **dorsal root** and a **ventral root**.
The **dorsal root ganglion** is occupied by **cell bodies** from afferent neurons.
The convergence (coming together) of dorsal and ventral roots forms the **spinal nerve**.
2. The **cauda equina** is formed by the roots arising from segments L2 to Cx of the spinal region.

C. Distal Branches

1. After emerging from the vertebral column, the spinal nerve divides into a **dorsal root**, and **ventral root**, and a small meningeal branch that leads to the meninges and vertebral column.
2. The **dorsal ramus** innervates the **muscles and joints of the spine and the skin of the back**.
3. The **ventral ramus** innervates the **ventral and lateral skin and muscles of the trunk**, *plus gives rise to nerves leading to the extremities*.

D. Nerve Plexuses

The **ventral rami** merge to form **nerve plexuses** (networks) in all areas (except thoracic region). These nerve plexuses are defined on pages 405 (just know as **cervical, brachial, lumbosacral**).

E. Cutaneous Innervation and Dermatomes

Each spinal nerve except C-1 receives sensory input from a specific area of skin (**dermatome**).

Except where noted in the dark black font (no gray-out with the NVCC logo on page 4) the grayed out material is mostly in the slideshow (Part 3) of Chapter 11.

SPINAL CORD

Gives rise to 31 pairs of SPINAL NERVES,
From foramen magnum to 2nd lumbar vertebra;
(end = **conus medullaris**);

Pia mater continues as **filum terminale**; attaches to coccyx.

Spinal nerves extending downward from conus: **cauda equina**.

Two SC bulges: Cervical (nerves to arms), Lumbar (nerves to legs).

Two grooves that extend length of Spinal cord:

1.) **anterior medial fissure** (deeper), 2.) **posterior median sulcus**

Central canal: continuous with brain ventricles (contains CS fluid).

Cross-section of spinal cord (SC): See A on diagram below

Butterfly shape:

gray matter (unmyelinated: cell bodies + axons + dendrites).

Central canal is in the center of the gray matter.

Surrounding gray matter: **white matter** (myelinated axons) .

Spinal Cord Functions: impulse conduction, spinal reflexes.

Impulse Conduction

Ascending tracts: SC to brain.

Descending tracts: brain to SC.

Spinal nerves: to/from body.

SC is divided into 31 segments- each giving rise to a pair of spinal nerves. Each pair (except first) monitors a specific region on surface of body called a **dermatome** (30), Clinically significant: damage to spinal nerves will produce a characteristic loss of sensation in skin.

DORSAL ROOT: axons of sensory neurons

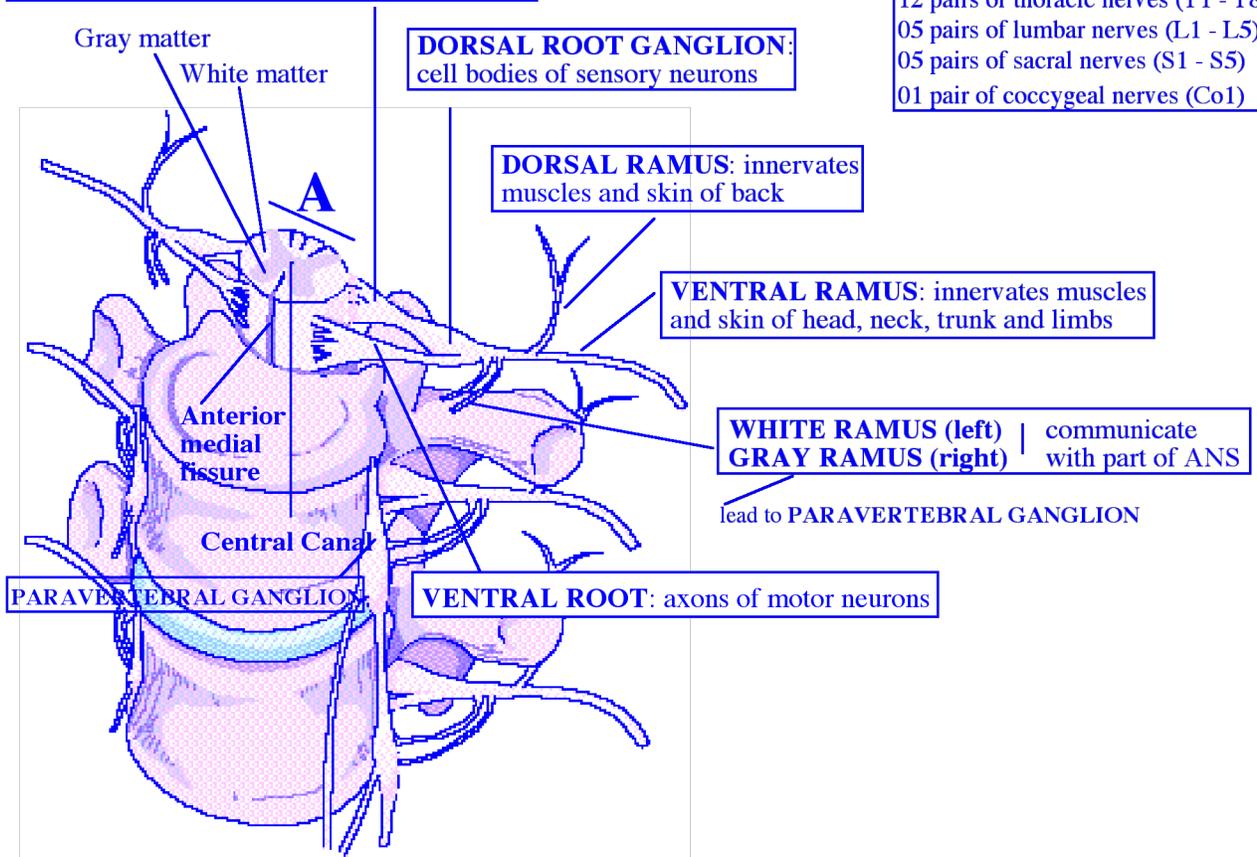
08 pairs of cervical nerves (C1 - C8)

12 pairs of thoracic nerves (T1 - T8)

05 pairs of lumbar nerves (L1 - L5)

05 pairs of sacral nerves (S1 - S5)

01 pair of coccygeal nerves (Co1)



DORSAL ROOT GANGLION:
cell bodies of sensory neurons

DORSAL RAMUS: innervates
muscles and skin of back

VENTRAL RAMUS: innervates muscles
and skin of head, neck, trunk and limbs

WHITE RAMUS (left) | communicate
GRAY RAMUS (right) with part of ANS

lead to **PARAVERTEBRAL GANGLION**

PARAVERTEBRAL GANGLION

VENTRAL ROOT: axons of motor neurons

IV. SOMATIC REFLEXES (Examples)

A. The Nature of Reflexes

1. **Reflexes** are quick, involuntary, stereotyped reactions of **peripheral effectors** to stimulation.
2. A spinal reflex is made up of a **reflex arc**, including *somatic receptors, afferent nerve fibers, interneurons (association neurons), efferent nerve fibers, and skeletal muscles*.

B. The Stretch Reflex

1. When a muscle is stretched, it contracts to maintain **tone**. This is the stretch reflex.
2. The **tendon reflex** (knee jerk) is an example of a **monosynaptic reflex arc**.

C. The Golgi Tendon Reflex

1. **Golgi tendon organs** are located at the junction of a muscle and its tendon.
2. Golgi tendon organs produce an inhibitory response called the Golgi tendon reflex *when muscle contracts too tightly*. This prevents damage to the tendon.

The additional ANS SLIDESHOW (part C of this chapter) is VERY helpful. Review it FIRST!!!! ☺

V. THE AUTONOMIC NERVOUS SYSTEM: INTRODUCTION AND ANATOMY

A. General Properties

1. The visceral reflexes are mediated by **the autonomic nervous system (ANS)**, which has two branches (**sympathetic** and **parasympathetic**).
2. Its target organs are *glands, cardiac muscle, and smooth muscle*; it operates to maintain homeostasis.
3. Control over the ANS is, for the most part, **involuntary**.
4. The ANS differs structurally from the somatic nervous system in that there are **two neurons** leading from the *ANS to the effector*: a **preganglionic neuron** and a **postganglionic neuron**.

B. Divisions

1. **Sympathetic** branch prepares the body for "**fight or flight**" situations.
2. **Parasympathetic** branch functions to maintain normal operating conditions ("**resting and digesting**").

C. Anatomy of the Sympathetic Division

1. The **sympathetic division** is also called the *thoracolumbar division* because of the spinal nerves it employs.
2. **Paravertebral ganglia** are close to the vertebral column. **Preganglionic neurons** are *short*, while **postganglionic neurons**, traveling to their effector, are *long*.
3. When one preganglionic neuron fires, it can excite multiple postganglionic fibers that lead to different **target** organs (mass activation).

D. The Adrenal Glands

1. The pyramid-shaped **adrenal glands** lie *atop each kidney* and consist of a glandular adrenal cortex surrounding an adrenal medulla made of modified sympathetic neurons.
2. When stimulated, the **adrenal medulla** produces **catecholamines** (as hormones) that *complement* the action of sympathetic postganglionic neurotransmitters.

E. Anatomy of the Parasympathetic Division

1. The **parasympathetic division** is also referred to as the **craniosacral division** because its fibers travel in some cranial and sacral nerves

CONT.....

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VI. THE AUTONOMIC NERVOUS SYSTEM: PHYSIOLOGY

A. Neurotransmitters and Receptors

1. The autonomic nervous system has **cholinergic fibers** that secrete ACh, and **adrenergic fibers**, that secrete **norepinephrine (NE)**.
Preganglionic fibers of *both divisions* are **cholinergic**, as are the **postganglionic fibers** of the **parasympathetic branch**.
Postganglionic fibers of the *sympathetic branch* are usually **adrenergic**.
2. **Cholinergic Receptors**
 - a. ACh binds to **muscarinic** and **nicotinic receptors**.
 - b. **Nicotinic receptors** occur on all ~~postganglionic somas of the ANS, on the adrenal medulla, and at neuromuscular junctions.~~
 - c. **Muscarinic receptors** occur on all ~~postganglionic cholinergic receptors of the ANS.~~
3. **Adrenergic Receptors**
 - a. Different receptors account for the *different effects* of norepinephrine at its targets cells.
 - b. Binding to **alpha-adrenergic receptors** is usually excitatory.
binding to **beta-adrenergic receptors** is usually inhibitory.

B. Dual Innervation

1. Both divisions have nerves leading to most of the visceral organs (dual innervation).
2. The sympathetic and parasympathetic branches may have **antagonistic** effects or **cooperative** effects.

C. Control Without Dual Innervation

Control of organ function can be achieved *without* dual innervation. Impulses from sympathetic fibers can increase vasoconstriction, while cessation of impulses slows contractions.

D. Central Control of Autonomic Function

1. Control of the ANS is accomplished by *several* levels of the CNS.
2. **Cerebral Control**
Conscious processes in the cerebrum can produce autonomic effects.
3. **Hypothalamic Control**
 - a. The **hypothalamus** is the *most important area for integrating autonomic function*.
 - b. It has **centers (nuclei)** for numerous functions, such as **sweating, vasodilation, and cardiac and pulmonary function, among others**.
4. **Brainstem Control**
The reticular formation contains centers for cardiac, vasomotor, respiratory, and gastrointestinal function.
5. **Spinal Control**
Urination and defecation reflexes are centered in the *spinal cord*.

