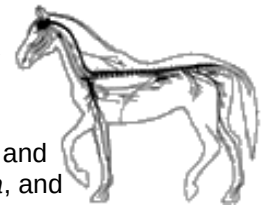
Chapt. 13: The Peripheral Nervous System & Reflex Activity



✳ the **peripheral nervous system** (PNS) includes all neural structures outside the brain and spinal cord, including *sensory receptors*, peripheral *nerves* and their associated *ganglia*, and efferent *motor endings*

Part 1

SENSORY RECEPTORS AND SENSATION

Sensory Receptors

✓ **sensory receptors** = structures specialized to respond to a stimulus

✓ **stimulus** = a change in the environment that evokes a response

✓ define **sensation**:

✓ define **perception**:

Classification by Stimulus Type

The following types of receptors are named according to the activating stimulus. Indicate to what each type responds:

1. **mechanoreceptors**:

2. **thermoreceptors**:

3. **photoreceptors**:

4. **chemoreceptors**:

5. **nociceptors**:

Classification by Location

The following types of receptors are named according to either their location or the origin of the stimulus. Indicate to what each type responds:

1. **exteroceptors**:

2. **interoceptors** (viscероceptors):

3. **proprioceptors**:

Classification by Structural Complexity

Simple Receptors of the General Senses

There is a variety of types of **simple receptors**, which are modified dendritic endings of sensory neurons; note their structure in Table 13.1 (pretty fancy, aren't they?!) and read about them on pages 485 to 485:

✧ **free (naked) nerve endings**
- nearly everywhere, especially in epithelia and CT
- they respond chiefly to what?

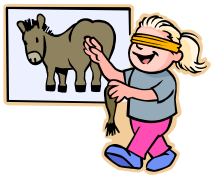
✧ **tactile (Merkel) discs** - lie in the deeper layers of the epidermis and function as what?

✧ **Meissner's corpuscles**, also called tactile corpuscles, are receptors for fine (light) touch

✧ **lamellar (Pacinian) corpuscles**, also called lamellated corpuscles, are scattered deep in the dermis and subcutis; they are stimulated by what?

✧ **bulbous corpuscles** (Ruffini endings) - respond to what?

✧ **Proprioceptors**
allow us to know where our head and limbs are located and how they are moving even if we are not looking at them, so that we can walk, type, or dress without using our eyes



• **muscle spindles**
- they are proprioceptors found in skeletal muscle; what do they detect?

• **tendon organs**
- where are they located?
- they provide information about changes in muscle tension
- when tendon organs are activated by tendons being stretched as muscles contract, what is the effect on the contracting muscle?

• **Joint kinesthetic receptors**
- *kinesthesia* is the perception of body movements
- what do joint kinesthetic receptors monitor?
- so, they monitor joint position and movement *(close your eyes and flex and extend your fingers; you are aware of the movement because of the joint kinesthetic receptors)*

Sensory Integration: From Sensation to Perception

• the **somatosensory system** is that part of the sensory system that serves what?

- it receives inputs from what?

• list and briefly describe the three main levels of neural integration that operate in the somatosensory (or any sensory) system (and examine Fig. 13.2):

• *the book provides more detail about processing at the three levels that you just listed; read them for fun sometime, or skip to the segment on Perception of Pain on p.489, which you may find more interesting, although you are not responsible for it…!*

Part 2

TRANSMISSION LINES: NERVES AND THEIR STRUCTURE AND REPAIR

Nerves and Associated Ganglia

Structure and Classification

• a **nerve** consists of parallel bundles of axons and connective tissue coverings in the peripheral nervous system

• identify the **fascicles** (bundles of axons) of a nerve in Fig. 13.4 and locate these connective tissues:

- **endoneurium** = loose connective tissue that surrounds individual axons within a fascicle
- **perineurium** = dense connective tissue that encloses a group of axons to form a fascicle
- **epineurium** = dense connective tissue that surrounds all of the fascicles to form the nerve

• nerves are classified according to the direction in which they transmit impulses; define the following:

- **mixed nerves:**

- **sensory (afferent) nerves:**

- **motor (efferent) nerves:**

• peripheral nerves are classified as either **cranial nerves** (if they arise from the brain) or **spinal nerves** (if they arise from the spinal cord)

• define **ganglia**:

Regeneration of Nerve Fibers

- this topic is interesting to read when you get a chance…

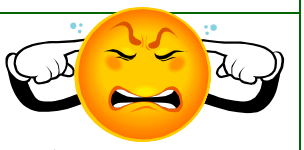
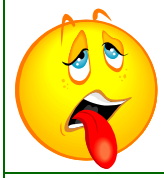
Cranial Nerves

☺ there are how many pairs of cranial nerves?

☺ See Fig. 13-6(a). The pairs of nerves are assigned both a Roman numeral *(in the order that they arise from the brain)* and a name *(that indicates their function or distribution)*. Some are sensory; others are mixed (both sensory & motor). Read "An Overview" on p. 492 and p. 500; it is a helpful overview

☺ **You will need to know the Roman numeral and name of each pair of cranial nerves, as well as their main functions**. To help you learn this, use your textbook to fill in the name of each pair of cranial nerves in the chart on the next pages. The chart is my summary of what you should know, but look at the corresponding Figures on pages 494 to 500 while you work through this to help you picture each nerve!)

Roman Numeral and Name	*sensory or mixed*	*innervations and function(s):*
CN I	sensory	*innervation:* olfactory epithelium *function:* sense of smell 
CN II	sensory	*innervation:* retina of the eye *function:* vision 
CN III 	mixed (mainly motor)	*innervations:* muscles of the upper eyelid; four extrinsic eye muscles; ciliary muscle of the ciliary body and constrictor muscle of the iris *somatic motor function:* movement of upper eyelid and eyeball *somatic sensory function:* proprioception of muscle of upper eyelid and four extrinsic eye muscles *autonomic motor function (parasympathetic):* accommodation of the lens for near vision; constriction of the pupil
CN IV	mixed (mainly motor)	*innervation:* superior oblique muscle *somatic motor function:* movement of eyeball *somatic sensory function:* proprioception from superior oblique muscles
CN V 	mixed	*innervations:* sensory portion has 3 branches: *1.* ophthalmic branch: orbital structures, nasal cavity, skin of the forehead, upper eyelid, eyebrows, part of the nose 2. maxillary branch: lower eyelid, superior lip, gums and teeth, cheek, nose, palate, pharynx 3. mandibular branch - *sensory* : inferior gums, teeth, lips, palate, tongue - *motor:* muscles of mastication *somatic motor function:* chewing *somatic sensory function:* touch, pain and temperature sensations from the parts of the body supplied by the various branches; proprioception from the muscles of mastication
CN VI	mixed (mainly motor)	*innervation:* lateral rectus muscle *somatic motor function:* movement of eyeball *somatic sensory function:* proprioception from lateral rectus muscles

CN VII 	mixed	*sensory innervations:* taste receptors from anterior 2/3 of tongue *motor innervations:* muscles of facial expression, lacrimal gland, submandibular and sublingual salivary glands *somatic motor function:* facial expression *somatic sensory function:* taste; proprioception from facial muscles *autonomic motor function (parasympathetic):* secretion of tears and saliva
CN VIII 	mixed (mainly sensory)	*innervations:* cochlea and vestibule *somatic sensory function:* 1. cochlear branch: conveys impulses for hearing 2. vestibular branch: conveys impulses related to equilibrium *somatic motor function:* adjusts sensitivity of hair cells
CN IX 	mixed	*sensory innervations:* posterior 1/3 of the tongue; pharynx, palate, receptors for blood pressure, pH, O_2, and CO_2 *motor innervations:* pharyngeal muscles and parotid gland *somatic motor function:* elevates pharynx during swallowing and speech *sensory function:* taste; proprioception from swallowing muscles; monitoring of blood pressure; monitoring of O2 and CO2 in blood for regulation of rate and depth of breathing *autonomic motor function (parasympathetic):* stimulates secretion of saliva
CN X 	mixed	*sensory innervations:* visceral sensations (i.e., sensory from the lungs, heart, esophagus, stomach, etc. *motor innervations:* muscles of pharynx and larynx involved in speech and swallowing; muscles of viscera for movement of the heart, lungs, and abdominal organs *somatic motor function:* swallowing, coughing and voice production *sensory function:* visceral sensations (i.e., sensory from the lungs, heart, esophagus, stomach, etc.); proprioception from muscles of pharynx and larynx *autonomic motor function (parasympathetic):* smooth muscle contraction and relaxation in digestive organs; stimulates secretion of digestive fluids; slowing of heart rate
CN XI	mixed (mainly motor)	*innervations:* skeletal muscle of palate, pharynx and larynx ; sternocleidomastoid and trapezius *somatic motor function:* swallowing, movement of head and shoulders *sensory function:* proprioception from skeletal muscles it innervates
CN XII 	mixed (mainly motor)	*innervation:* tongue musculature *somatic motor function:* movement of tongue during speech and swallowing *sensory function:* proprioception

Spinal Nerves

◦ there are how many pairs of spinal nerves?

◦ each contains how many nerve fibers (axons)?

◦ they arise from the spinal cord and supply what?

◦ all spinal nerves are mixed nerves

◦ because the spinal cord is shorter than the vertebral column, spinal nerves that arise from the lower regions of the spinal cord do not leave the vertebral column at the same level that they arise from the spinal cord. Instead, they pass through the vertebral canal for some distance, then emerge through the intervertebal foramina. (Flip back to Fig. 12.26(a) on page 465 which shows this.)

- remember that the roots of these spinal nerves in the vertebral canal are collectively are called the **cauda equina**.

◦ examine Fig. 13.7 and note that the spinal nerves and named and numbered according to where the spinal nerves leave the vertebral canal and emerge through the intervertebral foramina.

◦ list the 5 types of spinal nerves and indicate how many pairs of each type there are:

◦ ***a review from Chapter 12:***

✯ each spinal nerve has two main connections to the spinal cord called **roots** (see Fig. 13.8), which then break up into numerous tiny roots where they attach to the cord:

1. **ventral (anterior) roots** of spinal nerves contain axons of motor (efferent) neurons that conduct impulses from the CNS to effectors
2. **dorsal (posterior) roots** contain axons of sensory (afferent) neurons that conduct impulses from sensory receptors in the skin, muscles, and internal organs into the CNS

✯ the dorsal and ventral roots unite to form a spinal nerve at the intervertebral foramen
- spinal nerves are mixed nerves, which means they contain parts of sensory and motor neurons

◦ ***branches of spinal nerves***

• about how long is a spinal nerve?

• from their attachments to the spinal cord, spinal nerves each emerge through an intervertebral foramen and divide into **branches** called **rami** (**ramus** is singular)

Innervation of Specific Body Regions

- **dorsal rami**
  - supply the deep muscles and skin of the dorsal surface of the trunk
- **ventral rami**
  - supply the muscles and structures of the upper and lower limbs and the skin of the lateral and ventral surface of the trunk
- except for T2 to T12, all ventral rami branch and join one another lateral to the vertebral column, forming what?

  - nerve plexuses occur in what regions?

✯ within a plexus, fibers (axons) from various ventral rami criss-cross one another and become redistributed so that what two things happen?

(1)

(2)

- so, nerves then emerge from each of the plexuses to supply specific parts of the body
- the names of these nerves are often descriptive of the general regions they serve or the course they take; each nerve, in turn, may have several branches named for the specific structures they innervate

- locate the 4 nerve plexuses shown on the left side of the body in Fig. 13.7

Cervical Plexus and the Neck

- what is the cervical plexus buried deep to?
- the cervical plexus is formed by the ventral rami of what spinal nerves *(✯see Figure 13.9 to find this information) ?*
- the cervical plexus supplies the skin and muscles of the head, neck, and superior part of the shoulders and chest
- note the various nerves that arise from the cervical plexus shown in Figure 13.9
- the single most important nerve from this plexus is what nerve?
  - what does the phrenic nerve supply?

Brachial Plexus and Upper Limb

- where is the brachial plexus situated?
- the brachial plexus innervates the shoulders and upper limbs
- it is formed by the ventral rami of what spinal nerves *(✯see Figure 13.10(a) for the answer)?*

- list the 5 important nerves that arise from the brachial plexus (see Fig. 13.9 and page 506):

Lumbosacral Plexus and Lower Limb

Lumbar Plexus

- the lumbar arises from the ventral rami of what spinal nerves?
- it innervates the anterolateral abdominal wall muscles, external genitals, and part of the thigh
- note the nerves that arise from the lumbar plexus and their distribution to the lower limb in Fig. 13.11(b)

Sacral Plexus

- the sacral plexus arises from the ventral rami of what spinal nerves?
- it innervates the buttocks, perineum, and lower limbs
- note the nerves that arise from the sacral plexus and their distribution to the lower limb in Fig. 13.12(b)
- the sciatic nerve, the thickest and longest nerve in the body, supplies what?

Intercostal Nerves

- most of the thoracic spinal nerves do not form plexuses. They form the **intercostal nerves** that innervate the structures of the intercostal spaces.

Innervation of Skin: Dermatomes

✧ define **dermatome**:

✧ the trigeminal nerve (CN V) and every pair of spinal nerves except C1 have sensory innervation from a specific region of the skin, which is depicted in Fig. 13.13.

Innervation of Joints

✧ what does Hilton's law say?

Part 3
MOTOR ENDINGS AND MOTOR ACTIVITY

(Read this section some other day…maybe for A&P III)

Part 4
REFLEX ACTIVITY

The Reflex Arc

- a **reflex** is a fast automatic response to a change (stimulus) in the internal or external environment
- read about an ***inborn (intrinsic) reflex*** and a ***learned (acquired) reflex***. Can you think of an example of each?

✓ in a **spinal reflex**, integration takes place in the gray matter of the spinal cord

✓ in a **cranial reflex**, integration takes place in the brainstem

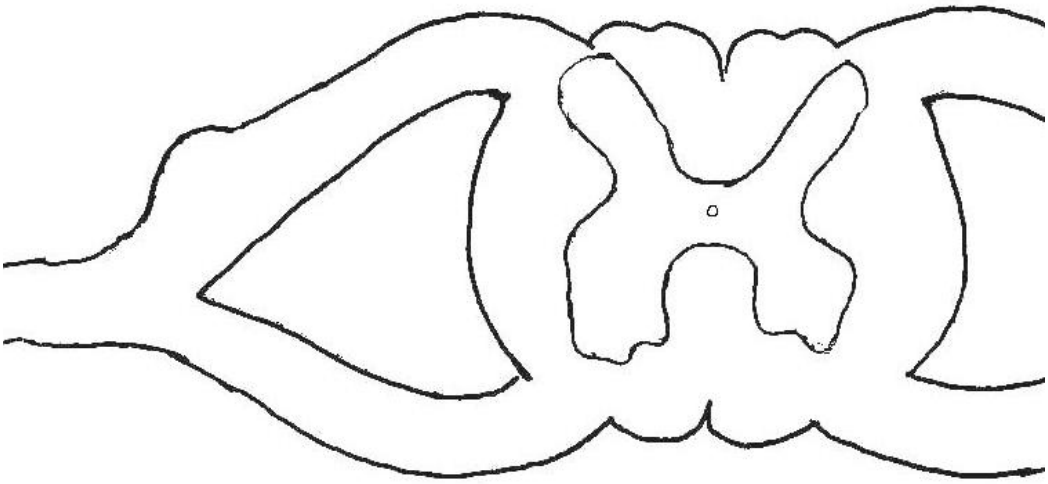
✓ **somatic reflexes** involve contraction of skeletal muscles

✓ **autonomic (visceral) reflexes** involve responses of smooth muscle, cardiac muscle, and glands; they are generally not consciously perceived

Components of a Reflex Arc

• list and define the 5 essential components of a reflex arc (and observe these components in Fig. 13.15):

We will use this drawing in class to illustrate the components of a reflex arc:



The Stretch Reflex

◦ a **stretch reflex** causes contraction of a skeletal muscle in response to stretching of that muscle (detected by receptors in the muscle called **muscle spindles)** so that it stays at a set length

- the stretch reflex is important for maintaining muscle tone and posture

- read about the **patellar (knee-jerk) reflex** on page 515 and outline the events of a patellar reflex given in Fig. 13.18 on page 516:

The Tendon Reflex

◦ what do **tendon reflexes** produce (page 517)?