

Marieb's Human Anatomy and Physiology

Marieb ♦ Hoehn

Chapter 13 Peripheral Nervous System And Reflex Activity Lecture 20

1

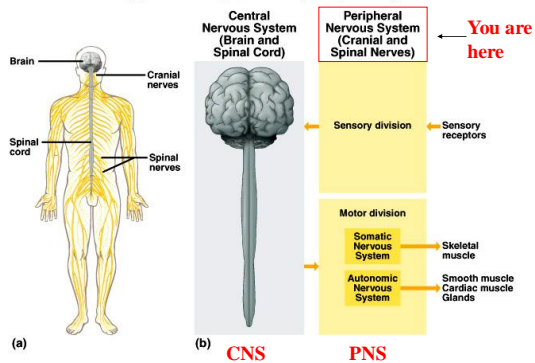
Lecture Overview

- Cranial nerves (And the tale of Old Opie...)
- Structure of nerves
- Functional classification of nerves
- Spinal nerves
- Nerve plexuses
- Reflexes

2

Divisions of the Nervous System

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



3

Peripheral Nervous System

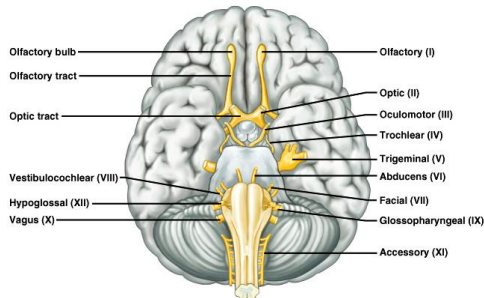
- **Cranial nerves** arising from the **brain**
 - Somatic fibers connecting to the skin and skeletal muscles
 - Autonomic fibers connecting to viscera

- **Spinal nerves** arising from the **spinal cord**
 - Somatic fibers connecting to the skin and skeletal muscles
 - Autonomic fibers connecting to viscera

4

Cranial Nerves

Paired. Numbered (roughly) in the order of their occurrence from anterior to posterior. Abbreviated using N or CN.



5

The Cranial Nerves

Numeral	Name	Function	Sensory, Motor, or Both (Mixed Nerve)
I	OLFACTORY (OLD)	OLFACTION/SMELL	SENSORY (SOME) ←
II	OPTIC (OPIE)	VISION	SENSORY (SAY) ←
III	OCULOMOTOR (OCCASIONALLY)	MOVE EYE	MOTOR (MARRY)
IV	TROCHLEAR (TRIES)	MOVE EYE (superior oblique)	MOTOR (MONEY)
V	TRIGEMINAL (TRIGONOMETRY)	CHEWING, MASTICATION AND SENSORY FROM FACE (MAJOR SENSORY NERVE OF FACE)	BOTH (BUT)
VI	ABDUCENS (AND)	MOVE EYE	MOTOR (MY)
VII	FACIAL (FEELS)	FACIAL EXPRESSION (MAJOR MOTOR NERVE OF FACE)	BOTH (BROTHER)
VIII	VESTIBULOCOCHLEAR (VERY)	HEARING AND EQUILIBRIUM	SENSORY (SAYS) ←
IX	GLOSSOPHARYNGEAL (GLOOMY)	MOVE MUSCLES OF TONGUE AND PHARYNX	BOTH (BIG)
X	VAGUS (VAGUE)	INNERVATE VISCERA/VISCERAL SMOOTH MUSCLE IN THORAX/ABDOMEN; MOTOR FOR SPEECH/SWALLOWING	BOTH (BOOBS)
XI	ACCESSORY (AND)	MOVE NECK MUSCLES	MOTOR (MATTER)
XII	HYPGLOSSAL (HYPOACTIVE)	MOVE TONGUE	MOTOR (MOST)

You should know this table

6

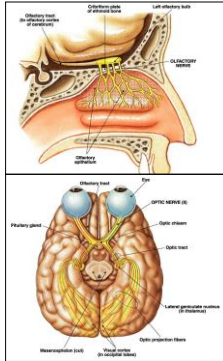
Cranial Nerves I and II

Olfactory (I)

- sensory
- fibers transmit impulses associated with **smell**

Optic (II)

- sensory
- fibers transmit impulses associated with **vision**



Figures from:
Martini,
*Anatomy &
Physiology*,
Prentice Hall,
2001

7

Cranial Nerves III, IV, and VI

Oculomotor (III)

- primarily motor
- origin in midbrain
- motor impulses to muscles that

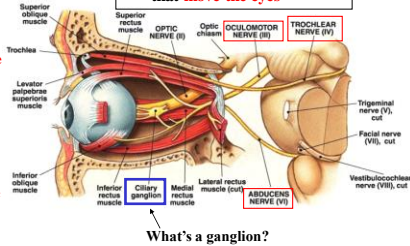
- raise eyelids
- move the eyes
- focus lens
- adjust pupil size

Trochlear (IV)

- primarily motor
- origin in midbrain
- motor impulses to the **superior oblique (SO)** muscles that move the eyes

Abducens (VI)

- primarily motor
- origin in pons
- motor impulses to the **lateral rectus (LR) muscles** that move the eyes



What's a ganglion?

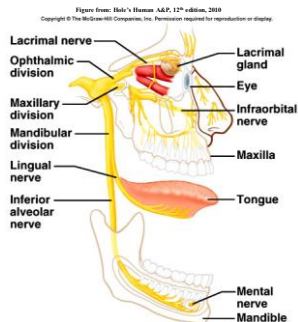
Figure from: Martini, *Anatomy & Physiology*, Prentice Hall, 2001

8

Cranial Nerve V

Trigeminal (V)

- both sensory and motor
- origin in pons
- **ophthalmic division**
 - sensory from surface of eyes (cornea), tear glands, scalp, forehead, and upper eyelids
- **maxillary division**
 - sensory from upper teeth, upper gum, upper lip, palate, and skin of face
- **mandibular division**
 - sensory from scalp, skin of jaw, lower teeth, lower gum, and lower lip
 - motor to muscles of mastication and muscles in floor of mouth



Major **sensory** nerve of face

9

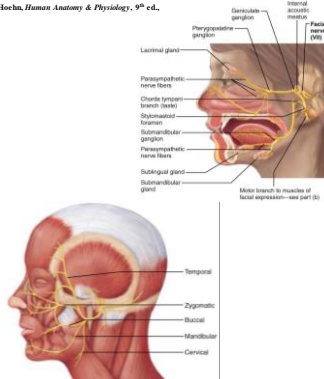
Cranial Nerve VII

Figures from: Marieb & Hoehn, *Human Anatomy & Physiology*, 9th ed., Pearson, 2012

Facial (VII)

- both sensory and motor
- origin in pons
- sensory from taste receptors (ant. 2/3 tongue)
- motor to muscles of facial expression, orbicularis oculi, tear glands, and submandibular and sublingual salivary glands

Major MOTOR nerve of face



10

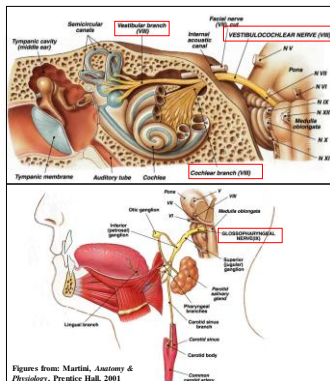
Cranial Nerves VIII and IX

Vestibulocochlear (VIII)

- sensory
- origin in pons
- sensory from equilibrium receptors of ear
- sensory from hearing receptors

Glossopharyngeal (IX)

- both sensory and motor
- origin in medulla
- sensory from pharynx, tonsils, tongue (post. 1/3), and carotid arteries
- motor to parotid salivary gland and muscles of pharynx

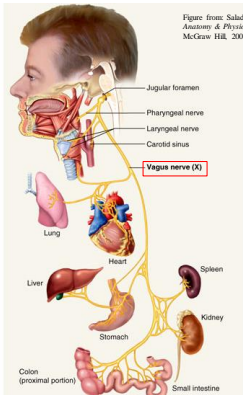


11

Cranial Nerve X

Vagus (X)

- both sensory and motor
- origin in medulla
- somatic motor to muscles of speech and swallowing
- autonomic motor (parasympathetic) to viscera of thorax and abdomen
- CVS and respiratory reflexes
- sensory from pharynx, larynx, esophagus, and viscera of thorax and abdomen



12

Cranial Nerves XI and XII

Accessory (XI)

- primarily motor
- origin in medulla/spinal cord
- motor to muscles of soft palate, pharynx, larynx, neck (sternocleidomastoid), and back (trapezius)

Hypoglossal (XII)

- primarily motor
- origin in medulla
- motor to muscles of the tongue
- imp't in speech, mastication, and deglutition

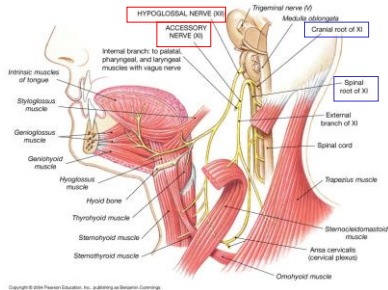
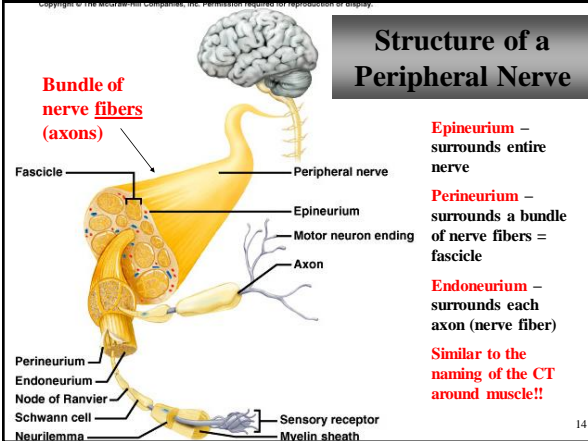


Figure from: Martini, *Fundamentals of Anatomy & Physiology*, Pearson Education, 2004

13

Structure of a Peripheral Nerve



- Epineurium** – surrounds entire nerve
- Perineurium** – surrounds a bundle of nerve fibers = fascicle
- Endoneurium** – surrounds each axon (nerve fiber)
- Similar to the naming of the CT around muscle!!**

14

Classification of Nerve Fibers

Class	Description
Afferent fibers	Carry sensory signals from receptors to the CNS
Efferent fibers	Carry motor signals from the CNS to effectors
Somatic fibers	Innervate skin, skeletal muscles, bones, and joints
Visceral fibers	Innervate blood vessels, glands, and viscera
General fibers	Innervate widespread organs such as muscles, skin, glands, viscera, and blood vessels
Special fibers	Innervate more localized organs in the head, including the eyes, ears, olfactory and taste receptors, and muscles of chewing, swallowing, and facial expression

- SAME: Sensory = Afferent, Motor = Efferent
- SOMATIC**
- Skin
- Bones
- Muscles
- Articulations

Table from: Saladin, *Anatomy & Physiology*, McGraw Hill, 2007

15

Spinal Nerves

- mixed nerves
- 31 pairs
 - 8 cervical (C1 to C8)
 - 12 thoracic (T1 to T12)
 - 5 lumbar (L1 to L5)
 - 5 sacral (S1 to S5)
 - 1 coccygeal (Co)

THIRTY ONEderful flavors of spinal nerves!

Below cervical spine, each spinal nerve leaves **inferior** to the same numbered vertebra

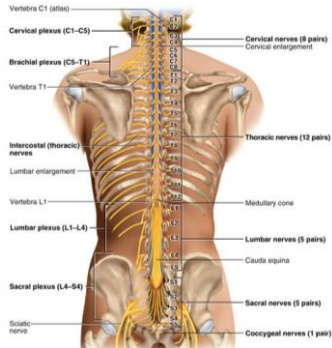
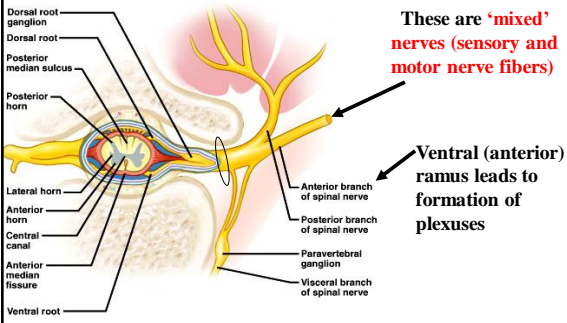


Figure from: Saladin, *Anatomy & Physiology*, McGraw Hill, 2007 16

Spinal Nerves



Spinal nerves are named according to the level of the spinal cord from which they exit.

17

Cervical Plexus

Nerve plexus – complex network formed by anterior (ventral) branches of spinal nerves; fibers of various spinal nerves are sorted and recombined

Contains both sensory and motor fibers

Cervical Plexus

- C1-C4
- lies deep in the neck
- supplies muscles and skin of the neck
- contributes to phrenic nerve (diaphragm); C3-4 (and C5)

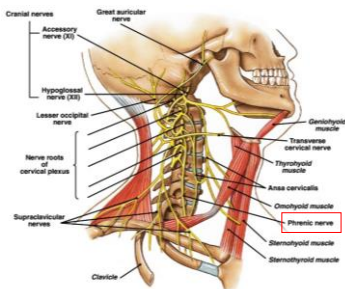


Figure from: Martini, *Anatomy & Physiology*, Prentice Hall, 2001

18

Brachial Plexus

- **C5-T1**
- lies deep within shoulders
- **supplies shoulder and upper limbs**
- **musculocutaneous nerves**
 - **flexor** muscles of forearm and skin of forearms
- **median nerves**
 - **flexors** of anterior forearm
 - lateral palm, fingers
 - skin of hand/fingers
- **ulnar nerves**
 - **flexors** of forearms and hands
 - supply skin of hands
- **radial nerves**
 - **extensor** muscles of arms and skin of forearms and hands
- **axillary nerves**
 - supply **muscles and skin** of superior, lateral, and posterior **arms**

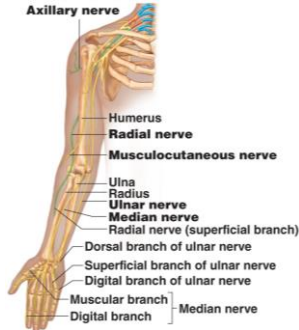
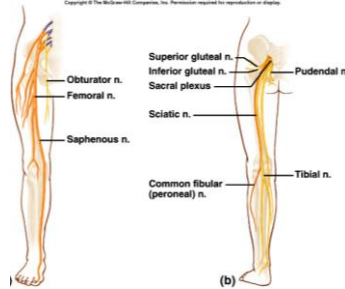


Figure From: Martini & Hoehn, *Human Anatomy & Physiology*, 9th ed., Pearson, 2013

19

Lumbosacral Plexus

- **L1 – S5**
- **supplies pelvis and lower limbs**
- extend from lumbar region into pelvic cavity
- **obturator nerves (lumbar plx)**
 - supply **adductors** of thighs
- **femoral nerves (lumbar plx)**
 - supply **muscles and skin** of thighs and legs
- **saphenous (lumbar plx)**
 - **skin/fascia** of knee, leg, foot
- **sciatic nerves (sacral plx)**
 - supply **muscles and skin** of thighs, legs, and feet
- **puddental (sacral)**
 - **skin/muscles perineum**



May be separated into lumbar (L1-L4), sacral (L4-S3,4), pudental (S2-S4) [Coccygeal (S5-Co1) plexus]

20

Nerves Plexuses

Nerve plexus – complex network formed by **anterior (ventral) branches** of spinal nerves; fibers of various spinal nerves are sorted and recombined

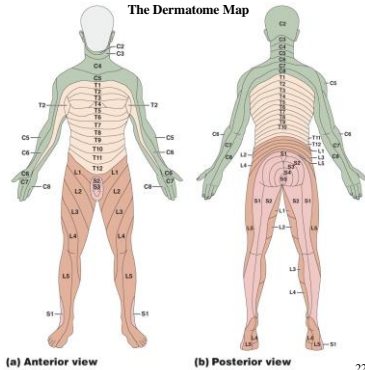
Contains **both sensory and motor fibers**

Name of Plexus	Spinal nerves	Major nerves/innervation	Major actions
Cervical	C1 - C4	To muscle skin of neck	Head movement
		Phrenic nerve	Controls diaphragm
Brachial	C5 - T1	Musculocutaneous	Flexion arm/forearm/hand
		Median	
		Ulnar	
		Radial	
		Axillary	Muscles/skin shoulder
Lumbosacral	L1 - S5	Obturator (Lumbar Plexus)	Muscles/skin of thighs and leg
		Femoral (Lumbar Plexus)	
		Saphenous (Lumbar Plexus)	
		Sciatic (Sacral plexus)	Muscles/skin thigh, leg, and foot
		Pudental (Sacral plexus)	Muscles of perineum

21

Dermatomes

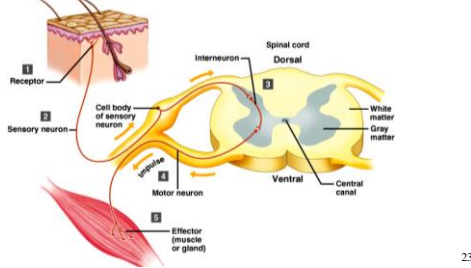
- specific areas of skin that are supplied with nerves (innervated) by the cutaneous branches of a single spinal nerve
- all spinal nerves except C1
- useful in pinpointing damaged nerves in spinal cord injuries



Somatic Reflex Arcs

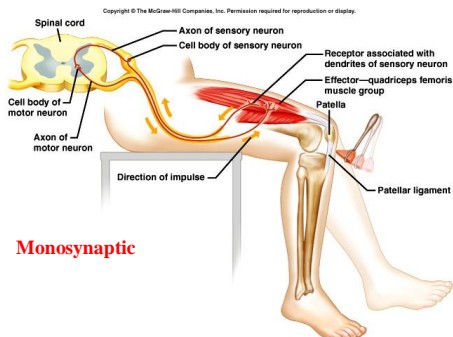
Reflexes – automatic, subconscious, quick, stereotyped responses to stimuli either within or outside the body; for protection, postural tone, visceral function

They occur in both the somatic and autonomic divisions



Knee-jerk Reflex (Ipsilateral)

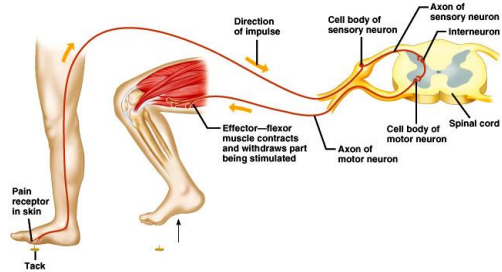
• helps maintain posture



Withdrawal Reflex (Ipsilateral)

- protective

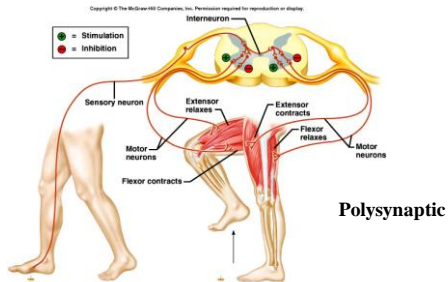
Polysynaptic



25

Crossed-Extensor Reflex (Contralateral)

- flexor muscles contract
- flexor muscles on opposite side inhibited
- extensor muscles on opposite side contract for balance



26

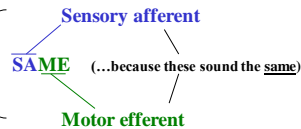
Life-Span Changes

- Brain cells begin to die before birth
- Over average lifetime, brain shrinks 10%
- By age 90, frontal lobe has lost half its neurons
- Number of dendritic branches decreases
- Decreased levels of neurotransmitters
 - Fading memory
 - Slowed responses and reflexes
 - Changes increase risk of falling
 - Sleep problems common

27

Review

- The **peripheral nervous system (PNS)** consists of
 - Cranial nerves
 - Spinal nerves
- The PNS can be divided into two systems
 - Sensory
 - Motor
 - Somatic
 - Autonomic



28

Review

- Nerves are bundles of axons surrounded by several layers of CT
- Nerves can be **classified** by
 - Whether they are **special** (smell, sight, taste, equilibrium, and hearing) or **general** (everything else except special)
 - Whether they are part of the **somatic or visceral NS**
 - The **types of impulses** they conduct
 - Sensory (afferent)
 - Motor (efferent)
 - both (mixed)

29

The Cranial Nerves

Numeral	Name	Function	Sensory, Motor, or Both (Mixed Nerve)
I	OLFACTORY (OLD)	OLFACTION/SMELL	SENSORY (SOME) ←
II	OPTIC (OPIE)	VISION	SENSORY (SAY) ←
III	OCULOMOTOR (OCCASIONALLY)	MOVE EYE	MOTOR (MARRY)
IV	TROCHLEAR (TRIES)	MOVE EYE (superior oblique)	MOTOR (MONEY)
V	TRIGEMINAL (TRIGONOMETRY)	CHEWING, MASTICATION AND SENSORY FROM FACE (MAJOR SENSORY NERVE OF FACE)	BOTH (BUT)
VI	ABDUCENS (AND)	MOVE EYE	MOTOR (MY)
VII	FACIAL (FEELS)	FACIAL EXPRESSION (MAJOR MOTOR NERVE OF FACE)	BOTH (BROTHER)
VIII	VESTIBULOCOCHLEAR (VERY)	HEARING AND EQUILIBRIUM	SENSORY (SAYS) ←
IX	GLOSSOPHARYNGEAL (GLOOMY)	MOVE MUSCLES OF TONGUE AND PHARYNX	BOTH (BIG)
X	VAGUS (VAGUE)	INNERVATE VISCERA/VISCERAL SMOOTH MUSCLE IN THORAX/ABDOMEN; MOTOR FOR SPEECH/SWALLOWING	BOTH (BOOBS)
XI	ACCESSORY (AND)	MOVE NECK MUSCLES	MOTOR (MATTER)
XII	HYPGLOSSAL (HYPOACTIVE)	MOVE TONGUE	MOTOR (MOST)

You should know this table

30

Review

- There are **31 pairs of spinal nerves**
 - 8 C, 12 T, 5 L, 5 S, 1 Co
- A **spinal nerve** is a **mixed nerve** formed by the junction of nerves from the
 - **Dorsal root** (sensory) } **Doris got kicked in the behind and screamed**
 - **Ventral root** (motor) } **The motor is in the front (anterior, ventral) of the car**
 - Somatic
 - Autonomic
- A **dermatome** is an area of skin that the sensory nerve fibers of a particular spinal nerve innervate

31

Review

- A **Nerve plexus** is a complex network of nerves
 - formed by anterior branches of spinal nerves
 - fibers of various spinal nerves are sorted and recombined
 - There are **3 nerve plexuses** (See summary table)
 - Cervical (neck); C1-C4
 - Brachial (shoulder and upper limbs); C5-T1
 - Lumbosacral (pelvis and lower limbs); T12-S5

32

Review

- **Reflexes** are automatic, subconscious responses to stimuli
- Some **spinal reflexes** include
 - Knee-jerk
 - Withdrawal
 - Cross-extensor reflex

33
