CLUTCH

www.clutchprep.com

CONCEPT: GENERAL PRINCIPLES OF SENSATION AND SENSORY RECEPTORS

Sensory Receptors and Sensory Receptor Cells:

- **Sensory Receptor Cells** are specialized to transduce a stimulus—touch, temperature, sound, smell, etc.—into APs.
  - □ Must have **sensory receptors**=receptor/ion channels to turn a stimulus into an electrical or chemical (NT) event.
  - □ May actually *be* a neuron, or may just interact with a neuron.
- Two very general types of sensory receptors:
  - □ *Free nerve endings* with sensory receptors (aka stimulus-gated ion channels) that respond to some stimulus.
    - -Mostly for the *somatic* (touch-based) sense—pressure, pain, vibration.
  - □ *Receptor cells* that receive a stimulus and respond by squirting _____ onto a neuron that then carries APs.

EXAMPLE: Free nerve endings vs receptor cells.

Receptor Potentials:

- **Receptor Potential**= name for the *graded potential* generated by activation of sensory receptors.
  - □ This **receptor potential** spreads _____ to the spike-initiating zone to initiate an AP.
    - -The AP travels to the brain, where the stimulus is *perceived*.
  - □ Larger receptor potential→*more* APs→more intense perception.
    - -Larger stimulus does *not* cause "larger" APs—APs are "all-or-none."

EXAMPLE: Light pressure produces a small, brief receptor potential→1 AP. Heavy pressure produces a larger, more prolonged receptor potential→multiple APs.

Receptive Fields:

- **Receptive Field** is the area of space from which a sensory neuron receives _____.
  - □ Stimuli within the receptive field cause a receptor potential in the sensory neuron; stimuli outside do not.
- The size of a receptive field determines the _____ of sensation.
  - □ Small receptive fields mean that two stimuli very close together can be separated.

EXAMPLE: Fingertips have very small receptive fields; the upper back has very large receptive fields.

Lateral Inhibition:

- **Lateral Inhibition** is how sensory neurons inhibit their neighbors, allowing for even better localization of the stimulus.
  - □ Makes the most stimulated neuron at the center of the stimulus fire lots of APs.
  - □ Inhibition of neighboring sensory neurons—which are also a little bit stimulated—makes it more clear where the stimulus is actually occurring.

EXAMPLE: A stimulus activates all three neurons—A, B, and C—but activates B the most. B causes inhibition of A and C, so the brain perceives the stimulus as happening mostly at B.

Tonic vs. Phasic Receptors:

- **Tonic (aka slowly-adapting) Receptors** fire APs continuously ("tonically").
  - □ A change in stimulus causes a change in the *frequency* of the APs fired.
  - □ Usually monitor homeostatic variables—blood pressure, blood pH, etc.

EXAMPLE: Baroreceptors—which measure blood pressure—increase their firing rate when blood pressure increases.

- **Phasic (aka rapidly-adapting) Receptors** fire APs when a sudden _____ occurs, then stop.
  - □ Especially important for somatic senses, like touch.

EXAMPLE: Many mechanoreceptors—pressure sensors—in your skin are phasic. That's why you feel/are aware of your clothes on your skin right after getting dressed, but not 10+ minutes after getting dressed.

PRACTICE 1: Lidocaine is a drug that blocks voltage-gated Na^+ channels. Which of the following types of potentials in neurons will not occur in neurons treated with lidocaine?

a) Receptor potentials.
b) Action potentials.
c) Reaching your peak potentials.

CONCEPT: NERVES

- **Nerves** are cable-like bundles of axons and are part of the PNS
  - □ Has three structures
    - **Endoneurium** is an areolar _____ layer that surrounds each axon
    - **Perineurium** is a dense irregular connective tissue layer that surrounds bundles of axons (**fascicles**)
    - **Epineurium** is a thick dense irregular connective tissue layer that surrounds the _____

EXAMPLE:

- □ Nerves are classified based on where the originate
  - **Cranial nerves** extend from the _____
  - **Spinal nerves** extend from the _____
- □ These nerves can be further classified by what they do
  - *Sensory nerves* transmit signals to the CNS
  - *Motor nerves* transmit signals from CNS
  - *Mixed nerves* contain sensory and motor neurons, but transmit only one information type: sensory/motor

CONCEPT: THE CRANIAL NERVES

● The **Cranial Nerves** are a series of 12 paired nerves that branch off the _____.

□ These carry specific *sensory* information to the brain and/or *motor* information from the brain.

□ Most cranial nerves control parts or functions in the head, face, neck, and chest.

● Each cranial nerve has a name and a roman numeral designation.

EXAMPLE: The twelve cranial nerves, their names, types, and functions:

Number:	Name:	Type:	Function:
I	Olfactory	Sensory	Smell from nose
II	Optic	Sensory	Visual from eyes
III	Oculomotor	Motor	Eye movement (voluntary and reflexive)
IV	Trochlear	Motor	More eye movement
V	Trigeminal	Mixed	Sensory from face; motor for chewing
VI	Abducens	Motor	More eye movement
VII	Facial	Mixed	Taste from tongue, motor for facial expression
VIII	Vestibulocochlear	Sensory	Hearing and balance from ears
IX	Glossopharyngeal	Mixed	Touch from mouth; swallowing; salivation
X	Vagus	Mixed	The *major* parasympathetic output nerve (more later)
XI	Accessory	Motor	Muscles of mouth, neck, and shoulder
XII	Hypoglossal	Motor	Tongue muscles.

Mnemonic: Oh, Oh, Oh, To Touch And Feel Very Good Velvet, Ah Happiness!

PRACTICE 1: The "H-Test" is that famous medical test where the tester holds a finger in front of the patient's face and then moves it in an H shape, asking the patient to track the finger's movements by moving their eyes only. If a patient is unable to do this properly, which cranial nerve(s) could be damaged? (Choose all that apply.)

a) CN II (Optic nerve)
b) CN III (Oculomotor nerve)
c) CN IV (Trochlear nerve)
d) CN V (Trigeminal nerve)
e) CN VI (Abducens nerve)

PRACTICE 2: A 18-year-old football player comes off the sidelines complaining that he suffered a big hit in the head during the last play. When you ask him to stick out his tongue, he struggles to do so—only the right half comes out, so that it looks like he's just moving his tongue to the left instead of sticking it out. Which of the cranial nerves was damaged in the hit?

a) CN V (Trigeminal nerve)
b) CN VII (Facial nerve)
c) CN IX (Glossopharyngeal nerve)
d) CN XII (Hypoglossal nerve)

CONCEPT: OLFACTORY NERVE

- The **olfactory nerve (CN I)** is a sensory nerve that conducts olfactory (_____) sensations from nose to brain

□ Pathway and Innervation:

- **Olfactory receptors** innervate the olfactory epithelium (where odor triggered)
- Multiple olfactory receptors form the filaments of the **olfactory nerve**
  - Projects up through the olfactory foramina in the cribriform plate of the _____ bone
  - Synapses on the **olfactory tract** of the **olfactory bulb**
- Olfactory tract transmit the impulse to the central nervous system

□ If the foramina are destroyed, then a person can lose their sense of smell (anosmia)

CONCEPT: OPTIC NERVE

● The **optic nerve (CN II)** is a paired sensory nerve that conducts optic (visual/sight) information from retina to brain

□ Pathway

- Nerve cells in the retina project back to the brain, forming the **optic nerve**
- The optic nerve enters cranium through the **optic canal** of the sphenoid bone
- The left and right optic nerve forms **optic chiasma**
    - X-shaped arrangement where the left and right optic nerves unite and _____
- The **optic tract** travels to thalamus (lateral geniculate nucleus) then to the occipital lobe (visual cortex)

□ Light from the right, is processed in the left portion of each eye, which then travels to the left hemisphere

□ Damage to the optic nerve causes visual defects (anopsia)

CONCEPT: OCULOMOTOR NERVE

● The **oculomotor nerve (CN III)** is a motor nerve that innervates the pupil, lens, and muscles of the eye

□ Pathway and Innervation:

- Arises from the midbrain, leaving cranium through the **superior orbital fissure**
- Innervates extraocular muscles of the eye as well as the pupil
    - The parasympathetic axons travel to ciliary ganglion before traveling to pupil

□ Branches that innervate the extraocular muscles:

1. Superior branch (somatic)

   - Levator palpebrae superioris muscle: opens the eyelid

   - Superior rectus muscle: eye elevation

2. Inferior branch (somatic)

   - Medial rectus muscle: adduction of the eyeball

   - Inferior rectus muscle: depresses the eye

   - Inferior oblique muscle: elevation and abduction of the eye.

3. Parasympathetic fibers via short ciliary nerves of ciliary ganglion

   - Pupillary constrictor muscle: contracts pupils

   - Ciliary muscle: accommodated lens

□ Damage to this nerve causes eyelid droop (ptosis), eye muscle paralysis, double vision (diplopia), etc…

Oculomotor, Trochlear and Abducens Nerves: Schema

SEE ALSO PLATES 81, 126, 153

CONCEPT: TROCHLEAR NERVE

● The **trochlear nerve (CN IV)** is a motor nerve that contracts the superior oblique to cause extreme gaze downward

□ Pathway:

- Arises from posterior midbrain, leaving cranium through the superior orbital fissure → eye

□ Innervation:

- Innervates the superior oblique muscle

□ If the nerve is damaged then it can lead to double vision (diplopia) and non-parallel eyes (strabismus)

CONCEPT: TRIGEMINAL NERVE

● The **trigeminal nerve (CN V)** is the largest nerve; a mixed nerve giving rise to 3 divisions

□ Pathway and Innervation:

- Pons → **trigeminal ganglion** in trigeminal cave, the 3 branches arise from this ganglion

1. Ophthalmic Division (V1): purely sensory

   - Exists the cranium through the superior orbital fissure

   - Innervates the skin of forehead, eyebrows, eyelids and nose

2. Maxillary Division (V2): purely sensory

   - Exists the cranium through the foramen rotunda → pteragoid fossa → infraorbital foramen

   - Innervates the lower eyelids, node, cheek, and upper lip

3. Mandibular Division (V3): sensory and motor

- Exists the cranium through the foramen ovale into infratemple fossa
- Innervation:
    - Motor: muscles of mastication
    - Sensory: skin of temples, gums, teeth, salivary gland, and anterior portion of tongue
- Anterior branches are motor and involved in chewing; posterior branches are sensory (generally)
    - 1 anterior branch that travels into the cheek and teeth for sensory (exception)
    - 1 posterior branch that travels into the mylohyloid muscle, which is motor (exception)

CONCEPT: ABDUCENS NERVE

● The **abducens nerve (CN VI)** is a motor nerve that contracts the lateral rectus for eye _____ (looking away)

□ Pathway and Innervation

- Arises from the pons and travels through the superior orbital fissure

- Innervates the lateral rectus muscle only

□ If the nerve is damaged then it can lead to paralysis of the muscle and double vision

CONCEPT: FACIAL NERVE

● The **facial nerve (CN VII)** is a mixed nerve that controls taste, facial expressions, and glands

□ Facial nerve arises at the Pons → internal acoustic meatus → geniculate ganglion → 3 branches

1. The **facial nerve proper**:

   □ Pathway: down the facial canal→ stylomastoid foramen → through the parotid gland → 5 branches

   - Branches include: temporal, zygomatic, buccal, mandibular, cervical

   □ Innervation:

   - Motor: facial expression muscles

2. The **chorda tympani nerve**:

   □ Pathway: tympanic membrane → exits at the petrotympanic fissure → runs with V_3 → tongue and glands

   □ Innervation:

   - Sensory: special sensation of taste to anterior 2/3rd of tongue

   - Parasympathetic: to submandibular and sublingual salivary glands to produce saliva

3. The **greater petrosal nerve**:

   □ Pathway: base of skull → palatine branches → runs along with V2 then V1 → lacrimal gland

   □ Innervation:

   - Parasympathetic: innervates the lacrimal gland to produce tears

CONCEPT: VESTIBULOCOCHLEAR NERVE

● The **vestibulocochlear nerve (CN VIII)** is a special sensory nerve responsible for hearing and equilibrium

□ Pathway and Innervation:

- Arises from the cochlear and vestibular nuclei located between the pons and medulla oblongata

- Enters the internal acoustic meatus of the temporal bone, splits into two branches

  - Vestibular nerve: innervates the semicircular canals, is responsible for equilibrium

  - Cochlear nerve: innervates the cochlear, responsible for detecting auditory stimuli for hearing

CONCEPT: GLOSSOPHARYNGEAL NERVE

● The **glossopharyngeal nerve (CN IX)** is a mixed nerve with both sensory and motor branches

□ Pathway and Innervation:

- Arises at the sensory and motor nuclei of the medulla oblongata → exists cranium through jugular foramen
  - Parasympathetic branch goes through the optic ganglion and then to the _____ gland to stimulate secretion
  - _____ branch:
    - Sensory: Goes to the posterior portion of tongue for taste and carotid bodies to monitor information
    - Motor Branch: Goes to the pharyngeal muscles for contraction

CONCEPT: VAGUS NERVE

- The **Vagus nerve (CN X)** is a large mixed nerve with both sensory and motor branches

□ Pathway:

- Arises from medulla oblongata motor nuclei → exits the jugular foramen → extensive branching

□ Innervation:

- Sensory:
    - Receives visceral information from eardrum, laryngopharynx and pharynx and visceral organs
- Motor:
    - Somatic: controls pharynx and all larynx muscles
    - Parasympathetic: Smooth muscle of thoracic and of abdominal organs, innervates the organs

CONCEPT: ACCESSORY NERVE

● The **accessory nerve (CN XI)** is a motor nerve that innervates cervical vertebrae and neck muscles

□ Pathway:

- Spinal root: spinal cord nucleus → through the foramen magnum → merges with cranial root
- Cranial root: medulla oblongata nucleus → joins spinal root → exists cranium through jugular foramen

□ Innervation:

- Spinal root innervates sternocleidomastoid and trapezius muscles
- Cranial root divides from the spinal root to join CN X; innervates the soft palate, pharynx, vocal cord

CONCEPT: HYPOGLOSSAL NERVE

● The **hypoglossal nerve (CN XII)** is a motor nerve that moves the tongue

□ Pathway and Innervation:

- Medulla oblongata → travels through the hypoglossal canal → inferior mandible and inferior tongue

□ Provides voluntary motor control over tongue movements

CONCEPT: REVIEW OF CRANIAL NERVES

- There are two mnemonic devices to remember the order and classification of the 12 cranial nerves
  - -To remember the order: Oh, Oh, Oh To Touch And Feel Very Good Velvet, AH
  - - Sensory or Motor: Some Say Marry Money, But My Brother Says Big Brains Matter More

Sensory only	Motor only	Both
CN I Olfactory	CN III Oculomotor	CN V Trigeminal
CN II Optic	CN IV Trochlear	CN VII Facial
CN VIII Vestibulocochlear	CN VI Abducens	CN IX Glossopharyngeal
	CN XI Accessory	CN X Vagus
	CN XII Hypoglossal	

CONCEPT: THE SPINAL NERVES—DERMATOMES AND MYOTOMES

The Spinal Nerves:

● Recall that the spinal cord is divided into segments—cervical, thoracic, and lumbar—with spinal nerves leaving the spinal cord at each segment.

● There are _____ spinal nerve roots per side and per segment.

□ **Dorsal root** is axons of sensory neurons with their cell bodies in the dorsal root ganglion.

□ **Ventral root** is axons of *motor neurons* with their cell bodies in the ventral horn.

EXAMPLE: The dorsal and ventral roots and a sample neuron in each.

Dermatomes and Myotomes:

- The dorsal root of each spinal segment receives sensory information from a specific, predictable part of the body.
  - □ A spinal segment's **dermatome** is the region of the body that sends that segment sensory information.
- The ventral root of each spinal segment sends motor information to a specific, predictable part of the body.
  - □ A spinal segment's **myotome** is the group of muscles that receives motor commands from that segment.

EXAMPLE: A map of dermatomes and an example of myotomes in the arm.

CONCEPT: CERVICAL PLEXUS

● A **nerve plexus** is an interconnected group of anterior rami arranged in a network

□ The anterior rami of some spinal nerves create different _____ plexuses

- Cervical plexuses
- Brachial plexuses
- Lumbar plexuses
- Sacral plexuses

□ Although the anterior rami of other spinal cord nerves form plexuses, the thoracic spinal nerves do not

● The **cervical plexus** is a nerve plexus with anterior rami of spinal nerves _____

□ The nerves in the cervical plexus are found deep side the neck and innervate:

- Anterior neck muscles, skin of neck, and certain regions of the head and shoulders

EXAMPLE:

Anterior Rami	Nerve	Innervation
Motor branches – delivers motor information to skeletal muscle		
C1 C2	Superior root – ansa cervicalis	Geniohyoid, Thyroid muscles
C2 C3	Inferior root – ansa cervicalis	Sternothyroid, omohyoid, sternohyoid
C1-C4	Segmental branches	Anterior and middle scalenes
Cutaneous Branches – delivers sensory infromation from the skin		
C2 C3	Greater auricular	Ear skin, and paraotid gland covering
C2	Lesser occipital	Scalp skin – superior and posterior to ear
C3 C4	Supraclavicular	Superior chest and shoulder skin
C2 C3	Transverse cervical	Anterior neck skin
Motor, Sensory, and sympathetic		
C4 C3	Phrenic nerve	Diaphragm

CONCEPT: BRACHIAL PLEXUSES

- The **brachial plexus** is a nerve plexus with anterior rami of spinal nerves C5-T1
  - □ The nerves in the brachial plexus innervate:
    - Pectoral girdle and upper limb
  - □ The anterior rami merge to form the **superior** (C5,C6), **middle** (C7), and **inferior** (C8,T1) **trunks**
    - Each branches into an anterior and posterior division and innervate the anterior and posterior upper limb
  - □ The divisions come together to form three **posterior** (C5-T1)**, medial** (C8-T1), and **lateral** (C5-C7) **cords**

EXAMPLE:

□ The three cords branch again into 5 **terminal branches**

Nerve Branch	Innervation	Sensory Information	Cord
Axillary Nerve	Deltoid, teres minor	Superolateral arm	Posterior cord
Median Nerve	Anterior forearm muscles – palmaris longus, flexor carpi radialis, other flexor muscles, thenar muscles, lateral two lumbricals	Palmar and lateral/dorsal side of thumb, fingers 1,2, and lateral half of finger 4	Medial and lateral cord
Musculocutaneous Nerve	Anterior arm muscles – biceps brachii, brachialis, coracobrachialis	Lateral surface of forearm	Lateral cord
Radial Nerve	Posterior arm and forearm muscles – triceps brachii, brachioradialis, extensors	Posterior arm and forarm, dorsolateral side of hand	Posterior cord
Ulnar Nerve	Anterior forearm muscles (flexors), intrinsic hand muscle, hypothenar muscles, palmar and dorsal interossei, medial two lumbricals	Dorsal and palmar aspect of medial pink and ring fingers	Medial cord

EXAMPLE:

CONCEPT: INTERCOSTAL NERVES

- **Intercostal nerves** refers to the anterior rami of spinal nerves _____
  - □ These bilateral nerves travel in the intercostal space of two ribs
  - □ The innervation pattern includes:
    - T1: a branch of it travels into the first intercostal space, the rest helps form brachial plexus
    - T2: innervates the second intercostal muscles, transmits sensory information from the skin
    - T3-T6: innervates intercostal muscles and registers sensation from anterior and lateral chest wall
    - T7-T12: innervate inferior intercostal spaces and abdominal muscle and its skin

EXAMPLE:

CONCEPT: LUMBAR PLEXUS

- The **lumbar plexus** is a nerve plexus with anterior rami of spinal nerves L1-L4
  - □ It runs along the _____ muscle in the posterior abdominal wall
  - □ Innervates: Inferior abdominals, anterior and medial thigh, and skin of medial leg

Nerve Branch	Innervation - Motor	Innervation – Skin	Division
Main branches			
Femoral Nerve	Quadriceps, iliopsoas, Sartorius, Pectineus	Anterior and inferomedial thigh, medial leg, medial foot	Posterior
Obturator Nerve	Medial thigh muscles – adductors, gracilis, pectineus, abturator externus	Superiomedial thigh	Anterior
Smaller branches			
Iliohypogastric	Abdominal muscles (partial)	Gluteal region – superior lateral and inferior abdominal	Posterior
Ilioinguinal	Abdominal muscles (partial)	Inferior abdominal, scrotum (male) labia majora (female)	Posterior
Genitofemoral		Anterior superior thigh, scrotum (male) labia majora (female)	Anterior
Lateral femoral cutaneous		Anteriorlateral thigh	Posterior

EXAMPLE:

LUMBAR PORTION OF SYMPATHETIC
TWELFTH THORACIC
FIRST LUMBAR
NERVE TO QUADRATUS LUMBORUM
TWELFTH THORACIC
TRANSVERSALIS
OBLIQUUS INTERNUS
OBLIQUUS EXTERNUS
SECOND LUMBAR
ILIOHYPOGASTRIC
THIRD LUMBAR
ILIAC BRANCH OF ILIOHYPOGASTRIC
ABDOMINAL BRANCH OF ILIOHYPO.
FOURTH LUMBAR
FIFTH LUMBAR
ILIOINGUINAL
LATERAL FEMORAL CUTANEOUS
OBTURATOR NERVE
EXTERNAL SPERMATIC BRANCH OF GENITOFEMORAL
LUMBOINGUINAL BRANCH OF GENITOFEMORAL
POSTERIOR BRANCH OF LATERAL FEMORAL CUTANEOUS
ANTERIOR BRANCH OF LATERAL FEMORAL CUTANEOUS
APONEUROSIS OF EXTERNAL OBLIQUE
DORSAL NERVE OF PENIS
ILIOHYPOGASTRIC
ILIOINGUINAL
GENITOFEMORAL
RAMUS COMMUNICANS
LAT. FEMORAL CUTANEOUS
GENITOFEMORAL
EXTERNAL SPERMATIC BRANCH
LUMBOINGUINAL BRANCH
RT. CRUS OF DIAPH.
AORTA
COMMON ILIAC
COM. ILIAC
FEMORAL N.
LUMB. SAC. CORD
RECTUM
BLADDER
SPERMATIC CORD
SAPHENOUS VEIN

CONCEPT: SACRAL PLEXUS

- The **sacral plexus** is a nerve plexus with anterior rami of spinal nerves L4-S4
  - □ The nerves in the sacral plexus are divided into _____ regions that innervate:
    - Anterior: flexor muscles of the lower limb
    - Posterior: extensor muscles of the lower limb

EXAMPLE:

Superior gluteal
Pudendal
Nerve to obturator internus
Post. fem. cutaneous
Perineal branch
Descending cutaneous
Tibial
Common peroneal
Med. sural cutaneous
Peroneal anastomotic
Tibial
Medial calcaneal
PIRIFORMIS
Greater Troch.
Tuber Ischii
QUAD. FEM.
BICEPS FEMORIS
SEMI-TENDIN.
SEMI-MEM.
TIB. POST.
FLEX. DIG. LONG.
FLEX. HALL. LONG.

PATELLAR BRANCH OF SAPHENOUS NERVE
COMMON PERONEAL NERVE
SUPERFICIAL PERONEAL NERVE
SAPHENOUS NERVE
EXT. LONGUS DIGITORUM
PERONEUS LONGUS
TIBIALIS ANTERIOR
DEEP PERONEAL NERVE
CUTANEOUS BRANCH OF SUPERFICIAL PERONEAL
EXT. PROPRIUS HALLUCIS
PER. TERTIUS
LATERAL BRANCH OF DEEP PERONEAL
MEDIAL TERMINAL BRANCH
DIGITORUM
SURAL NERVE
BRANCHES OF SUPERFICIAL PERONEAL

Nerve Branch	Travels to…	Innervation – Muscle	Innervation – Skin
Sciatic Nerve			
- Tibial Nerve	Posterior thigh, leg, and foot	THIGH: Hamstrings, Adductor magnus (extensor)	THIGH: none
		LEG: Plantarflexors of foot and toe flexors	LEG: none
		FOOT: Plantar muscle	FOOT: Heel
- Common Fibular Nerve (Common peroneal)	Lateral knee → around fibular neck → splits into deep and superficial branches	Short head of biceps femoris	
○ Deep	Anterior leg and foot dorsum (in between toes 1 and 2)	LEG: Tibialis anterior, Extensor hallucis longus, Extensor digitorum longus, Fibularis tertius	LEG: none
		FOOT: Extensor hallucis brevis, Extensor digitorum brevis	FOOT: Between toes 1 and 2
○ Superficial	Lateral leg → anterior ankle → foot dorsum	LEG: Fibularis longus, Fibularis brevis	LEG: Anterior leg
		FOOT: none	FOOT: Dorsum

CONCEPT: OVERVIEW OF REFLEXES

- **Reflexes** are rapid, _____ muscle or gland responses to a stimulus
  - □ A reflex is processed in 5 steps
    1. Some stimuli activates a sensory receptor (ex: temperature, pressure, etc..)
    2. Sensory neuron is activated and transmits information to CNS
    3. CNS interneurons process the information from the sensory neuron
    4. A motor neuron responds to the signal by transmitting information from CNS to effector
    5. The muscle responds to the motor nerve signal
  - □ A reflex response is rapid, preprogrammed, and involuntary

EXAMPLE:

CONCEPT: TYPES OF REFLEXS

- There are several different types of reflexes classified based on what executes the reflex
  - □ **Spinal reflex** and **cranial reflex** is identified by and processed in the CNS (spinal cord or brain)
  - □ **Somatic reflex** and **visceral reflex** is classified by what type of muscle is the _____
    - Somatic: Skeletal muscle
    - Visceral: Gland, Cardiac or Smooth muscle
  - □ **Monosynaptic reflex** and **polysynaptic reflex** is classified by the number of neurons
    - Mono: only one sensory and one motor neuron is involved; most rapid
    - Poly: has 1+ interneurons in between the sensory and motor neuron
  - □ **Ipsilateral reflex** and **contralateral reflex** is classified by which side of the body the neurons are on
    - Ipsilateral reflexes: receptor and effector organ are located on the same side of the body
    - Contralateral reflexes: receptor and effector organ are located different sides of the body
  - □ **Innate reflex** or **acquired reflex** is classified by whether you are born with the reflex, or it developed after birth

EXAMPLE:

CONCEPT: SPINAL REFLEXES

- There are 4 main types of spinal reflexes
  - □ The **stretch reflex** is a muscle contraction due to muscle _____
    - A **proprioceptor** is a sensory receptor in a muscle that detects changes in structure (ex: stretching)
      - The **muscle spindle** is the proprioceptor for the stretch reflex; made of muscle fibers & neurons
    - Muscle spindle stretched → spinal cord → motor neuron → muscle spindle → muscle contraction
    - **Reciprocal inhibition** is the inhibition of the antagonistic muscle by interneurons

EXAMPLE:

□ The **golgi tendon reflex** prevents muscles from excessively contracting

- The **golgi tendon organ** is the _____ for the golgi tendon reflex
- Muscle contracts → tendon stretches → activates golgi tendon organ → sensory neurons → interneurons in spinal cord → inhibit motor neurons in muscle → muscle relaxes
- **Reciprocal activation** is the activation of antagonistic muscles by interneurons

EXAMPLE:

□ The **withdrawal reflex** contracts muscle to move the body away from something painful

- Instead of proprioceptors, pain receptors (nociceptors) detect the painful stimulus

- Pain receptor → sensory neuron → spinal cord → internerurons → motor neurons → flexor muscle

EXAMPLE:

□ The **crossed-extensor reflex** occurs with the withdrawal reflex to maintain _____while withdrawing

- Withdrawal sensory neurons send info to spinal cord → crossed-extensor reflex → motor neurons in opposite limb → contract antagonistic muscles

EXAMPLE: