# Nervous System: Spinal Cord & Peripheral Nerves

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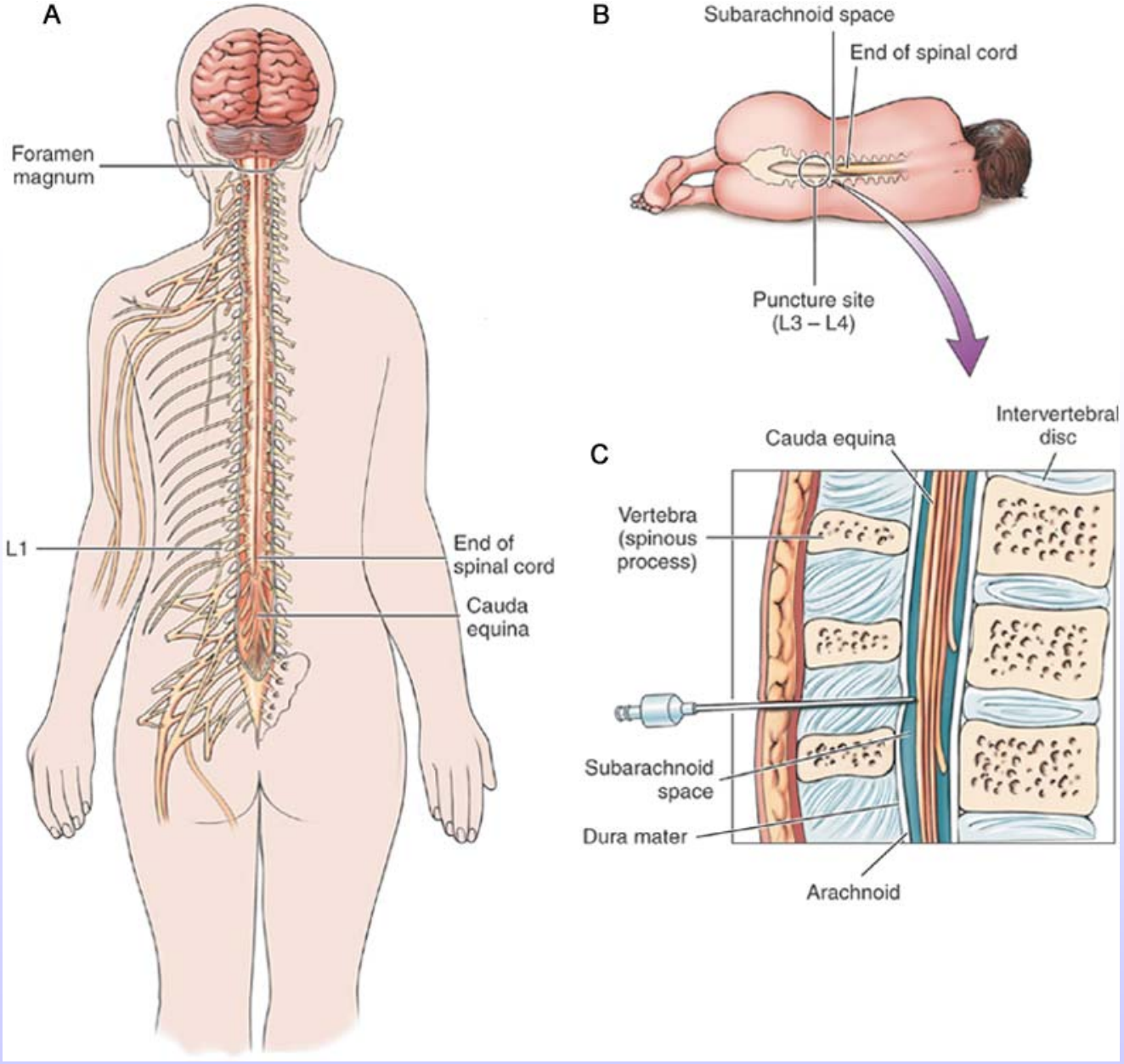
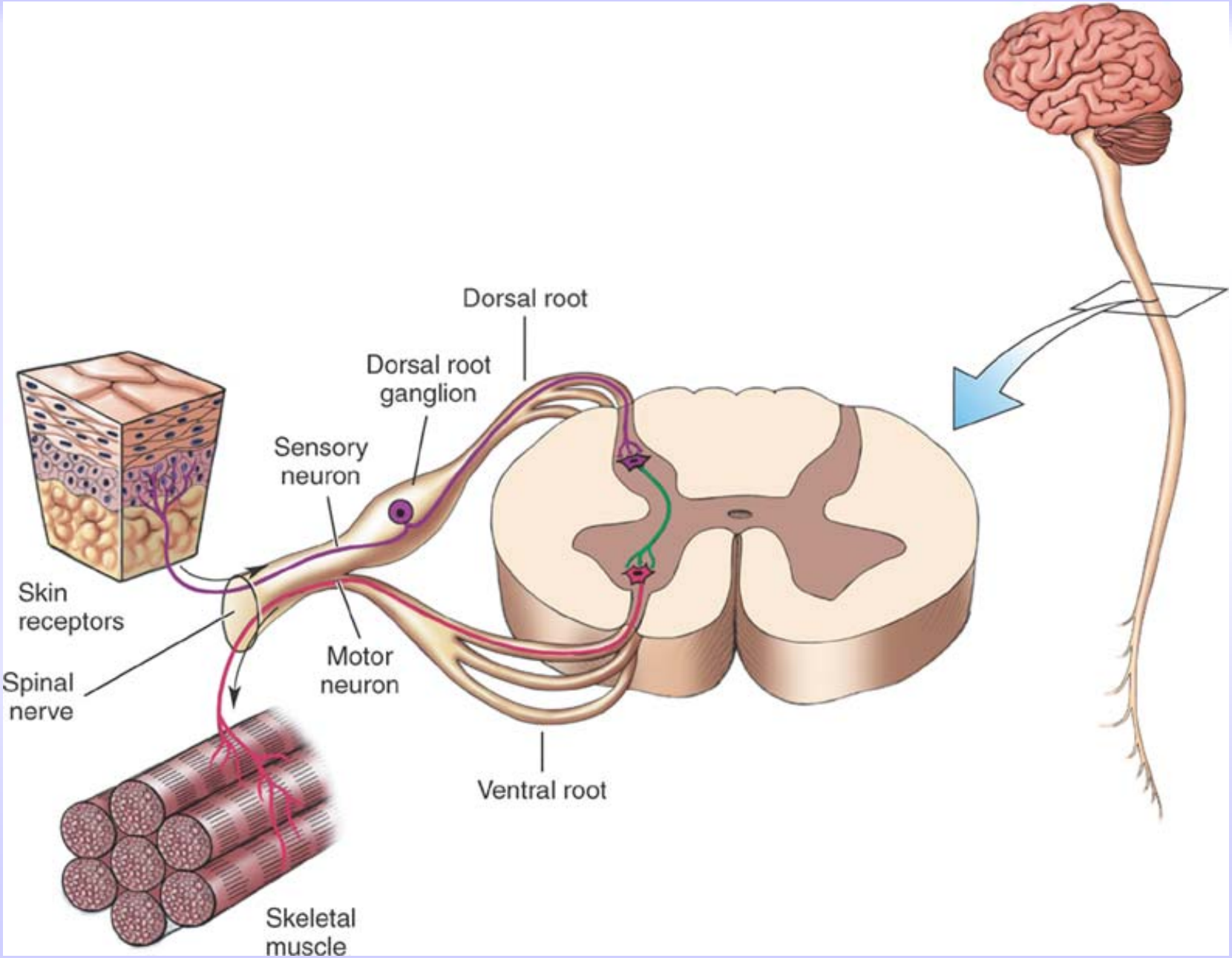
# Spinal Cord

- The spinal cord:
  - is a continuation of the brain stem
  - tube-like structure
  - composed of nerve tissue
  - located within the spinal column
  - 17 inches in length & as thick as your thumb
  - extends from the foramen magnum to first lumbar vertebrae
  - protected by vertebrae, meninges & CSF


A
Foramen magnum
L1
End of spinal cord
Cauda equina
B
Subarachnoid space
End of spinal cord
Puncture site (L3 – L4)
C
Cauda equina
Intervertebral disc
Vertebra (spinous process)
Subarachnoid space
Dura mater
Arachnoid

# Composition of the Spinal Cord

- Gray matter:
  - is located in the center in the shape of a butterfly
  - mostly cell bodies & interneurons
  - 2 projection of the gray matter are:
    - dorsal horn & ventral horn
  - in middle of gray matter is opening called central canal which is open from ventricles of brain to subarachnoid space at bottom of cord
  - CSF fluid circulates around brain to spinal cord

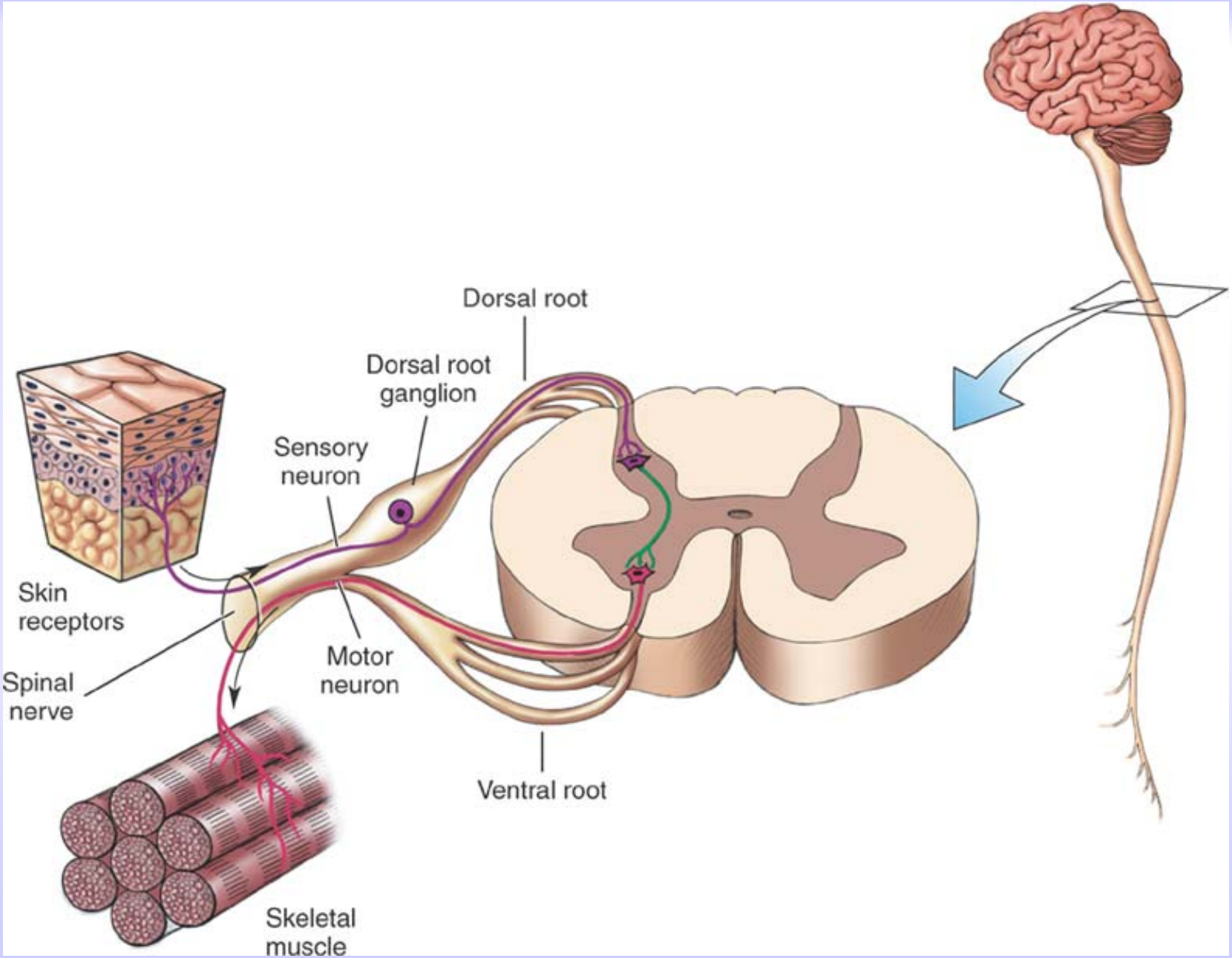

Dorsal root
Dorsal root ganglion
Sensory neuron
Skin receptors
Spinal nerve
Motor neuron
Ventral root
Skeletal muscle

# Composition of Spinal Cord

- White Matter:
  - primarily myelinated axons arranged in nerve tracts
  - Sensory tracts are called ascending tracts; carrying info from spinal cord to brain along the dorsal root
  - Motor tracts are called descending tracts; carry info from the brain to the spinal cord & periphery along the ventral root
  - Descending tracts are:
    - Pyramidal(corticospinal) & extrapyramidal
  - Ascending tracts are:
    - Spinothalamic
    - Dorsal column
    - Spinocerebellar

# Spinal Cord Tracts & Function

- Ascending:
  - Spinothalamic: temperature, pressure, pain, light touch
  - Dorsal column: proprioception, deep pressure, vibration
  - Spinocerebellar: proprioception
- Descending:
  - Pyramidal(corticospinal): skeletal muscle tone, voluntary movement
  - Extrapyramidal: skeletal muscle activity (balance & posture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Sensory neuron
Skin receptors
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Ventral root
Skeletal muscle

# Spinal Nerves

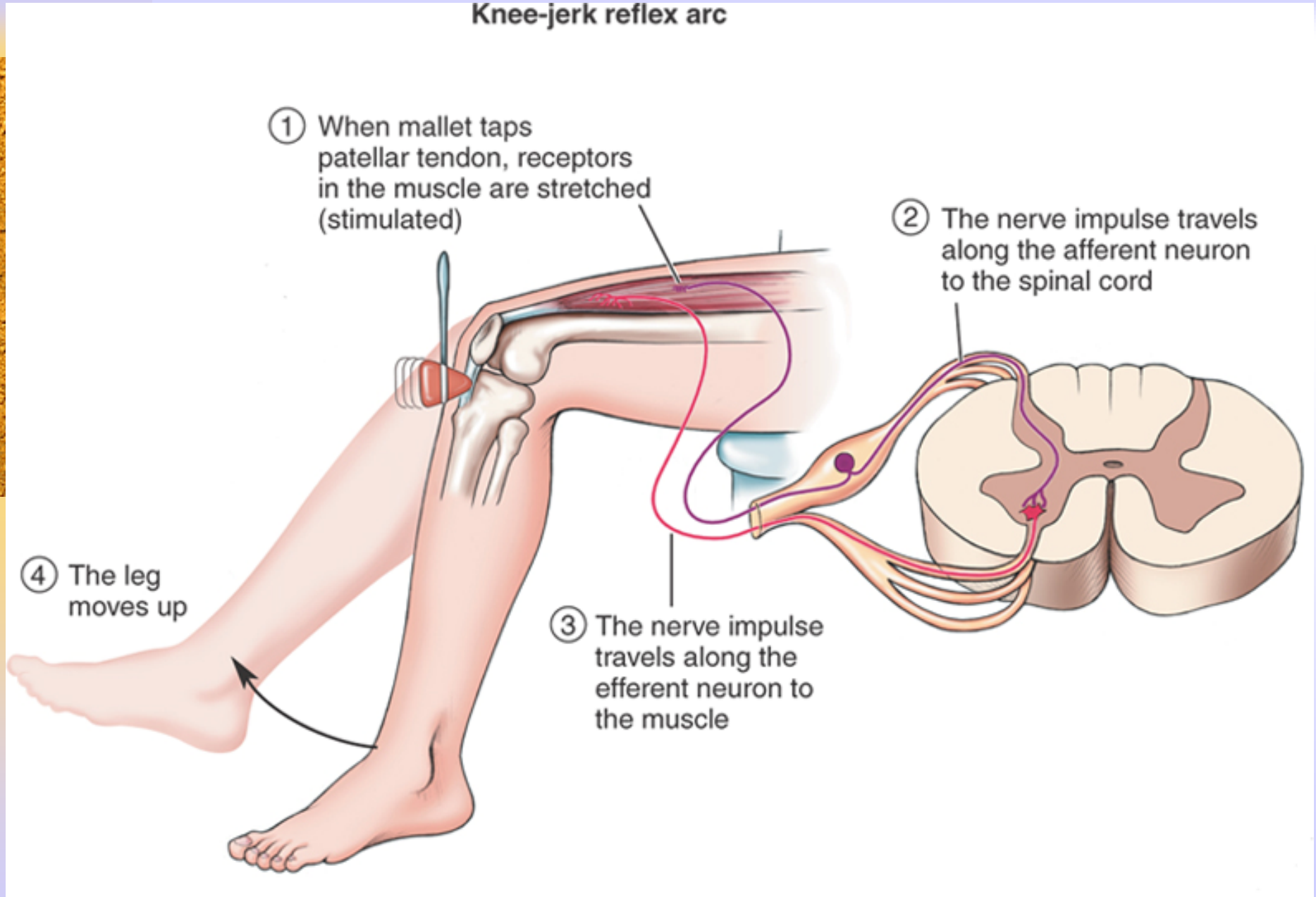
- Spinal nerves:
  - Attached to the cord by two roots: dorsal & ventral
  - All spinal nerves are mixed because they contain both sensory & motor fibers
  - Sensory nerve fibers travel up through the dorsal root
  - Motor nerve fibers travel down the ventral root

# Function of the Spinal Cord

- Sensory pathway: spinal cord provides information from the periphery to the brain
- Motor pathway: spinal cord provides motor information from the brain to the periphery
- Reflex center: reflex is a involuntary response to stimuli that originates in the spinal cord not brain
- Many reflexes occur at the spinal cord level

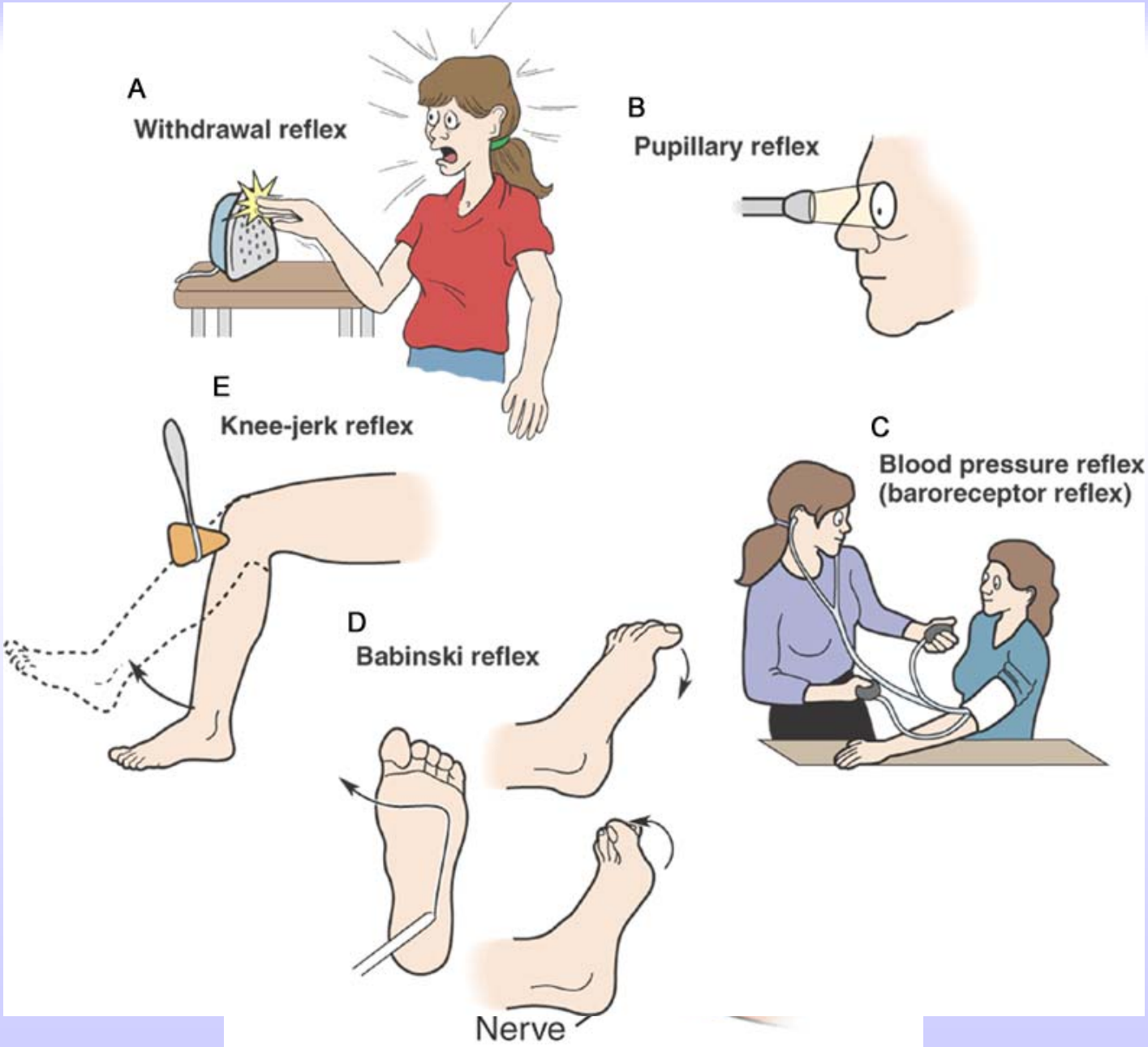
# Reflexes

- Reflex Arc has 4 components:
  - Sensory receptor: stimulus
  - Sensory neuron: carries nerve impulse to spinal cord
  - Motor neuron: carries nerve impulse from spinal cord
  - Effector organ: response organ


Knee-jerk reflex arc
1 When mallet taps patellar tendon, receptors in the muscle are stretched (stimulated)
2 The nerve impulse travels along the afferent neuron to the spinal cord
3 The nerve impulse travels along the efferent neuron to the muscle
4 The leg moves up

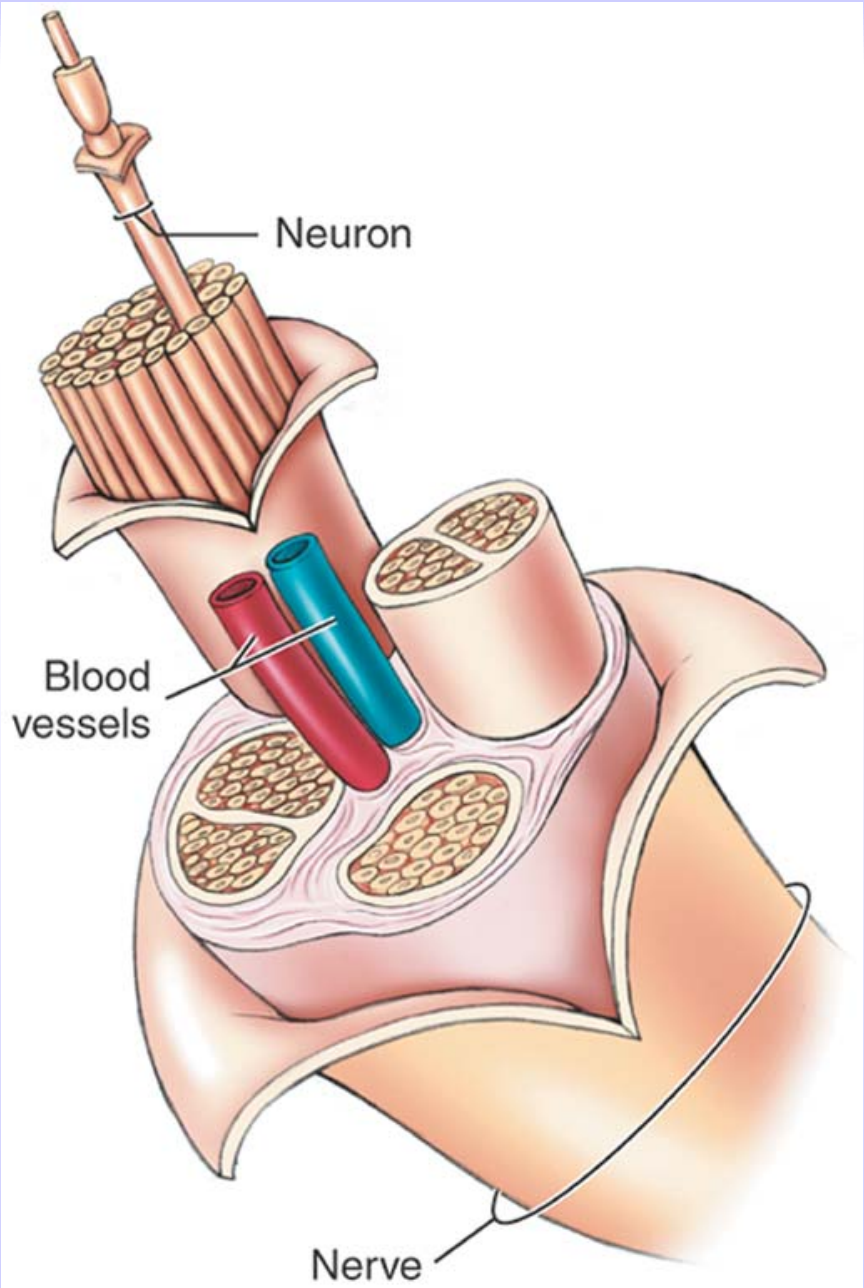
# Reflexes

- Reflexes include:
  - Withdrawl reflex: protects from injury
  - Pupillary reflex
  - Baroreceptors reflex: as BP changes; heart & blood vessels respond in order to restore BP
  - Babinski reflex: positive in adults is indicative of CNS pathology
  - Patellar reflex: tap the patellar tendon for reflex
  - Achilles tendon reflex: tap the achilles tendon to elicit a reflex


A
Withdrawal reflex
B
Pupillary reflex
E
Knee-jerk reflex
C
Blood pressure reflex
(baroreceptor reflex)
D
Babinski reflex
Nerve

# Peripheral Nervous System

- PNS consists of nerves & ganglia located outside the CNS
- Nerves contain the fibers of many neurons bundled together with blood vessels & are wrapped in connective tissue
- Types of Nerves:
  - Sensory: composed of sensory neurons
  - Motor: composed of motor neurons
  - Mixed: composed of both: most are mixed


Neuron
Blood vessels
Nerve

# Peripheral Nervous System

- Classified in structure & function
- Structural classification divides nerves into two categories:
  - Cranial & Spinal
- Cranial:
  - 12 pairs
  - has Roman numeral indicating the order the nerve exits the brain
  - Has name related to the anatomical area served by nerve

# Peripheral Nervous System

- Function of Cranial Nerves:
  - Carry sensory information for special senses: smell, taste, vision & hearing
  - Carry sensory information for pressure, pain, temperature & vibration
  - Carry motor information resulting in voluntary skeletal muscle control
  - Carry motor information resulting in secretion of glands & contraction of cardiac & smooth muscle

# Cranial Nerves

- I Olfactory nerve:
  - Function: SMELL; carries info from nose to brain
  - sensory nerve
  - Assess: smell various scents, i.e. vanilla
- II Optic nerve:
  - Function: SIGHT; carries visual information from eyes to brain
  - sensory nerve
  - Assess: eye chart

# Cranial Nerves

- III Oculomotor nerve
  - mixed nerve; mostly motor
  - Function: affects eyeball movement, raises eyelid, constricts pupils
  - Assess:  follow object in visual fields & convergence with object to nose, pupillary reaction with pen light
- IV Trochlear nerve
  - mixed nerve; mostly motor
  - Function: movement of eyeball
  - Assess: follow object

# Cranial Nerves

- V Trigeminal Nerve:
  - Function: chewing food, sensation in face, scalp & teeth
  - Mixed nerve
  - Assess: corneal reflex with cotton wisp, open mouth & move jaw, test sensation with cold, hot & sharp object
- VI Abducens Nerve:
  - Function: movement of  eyeball
  - Mixed nerve; mostly motor
  - Assess: follow object

# Cranial Nerves

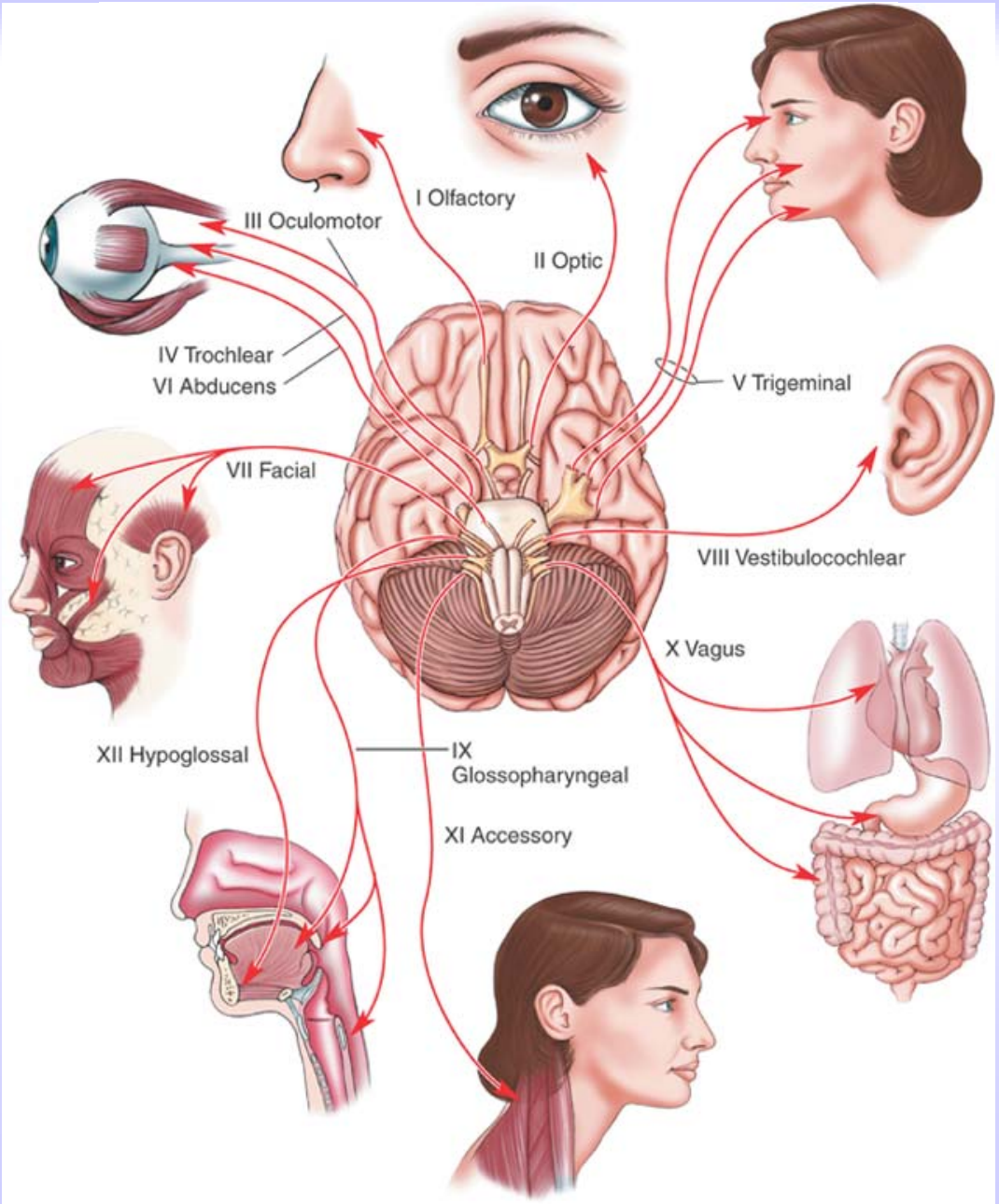
- VII Facial nerve:
  - Function: facial expression, secretion of saliva & tears & taste
  - Mixed nerve
  - Assess: smile, wrinkle forehead, test taste , use ammonia fumes to produce tears
- VIII Vestibulocochlear Nerve:
  - Function: Hearing & Balance
  - Sensory nerve
  - Assess: tuning fork

# Cranial Nerves

- IX Glossopharyngeal nerve:
  - Function: swallowing, secretion of saliva, taste, sensory for reflex regulation of blood pressure
  - Mixed nerve
  - Assess: gag reflex, speech & cough, taste
- X Vagus nerve:
  - Function: visceral muscle movement & sensation, movement & secretion of digestive system, reflex regulation of BP
  - Assess: gag reflex & speech

# Cranial Nerves

- XI Accessory Nerve:
  - Function: swallowing, head & shoulder movement, speaking
  - Mixed nerve; mostly motor
  - Assess: Shrug shoulders, rotate head side to side
- XII Hypoglossal Nerve:
  - Function: Speech & swallowing
  - Mixed nerve; mostly motor
  - Assess: stick out tongue, note deviation in position


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

# Spinal Nerves

- 31 pairs spinal nerves emerge from the spinal cord & are numbered & named according to the area of the spinal cord they originate from
  - 8 pairs of cervical
  - 12 pairs of thoracic
  - 5 pairs of lumbar
  - 5 pairs of sacral
  - 1 pair of coccygeal

# Spinal Nerves

- They conduct impulses between the spinal cord & parts of the body not supplied by cranial nerves
- All are sensory & motor (Mixed) allowing movement & sensations
- Nerves leave the spinal cord seperate & then converging at points called Nerve plexus
- Three major nerve plexuses sort out the many fibers & sends the to specific areas in the body:
  - Cervical plexus—brachial plexus—lumbosacral plexus

# Spinal Nerves

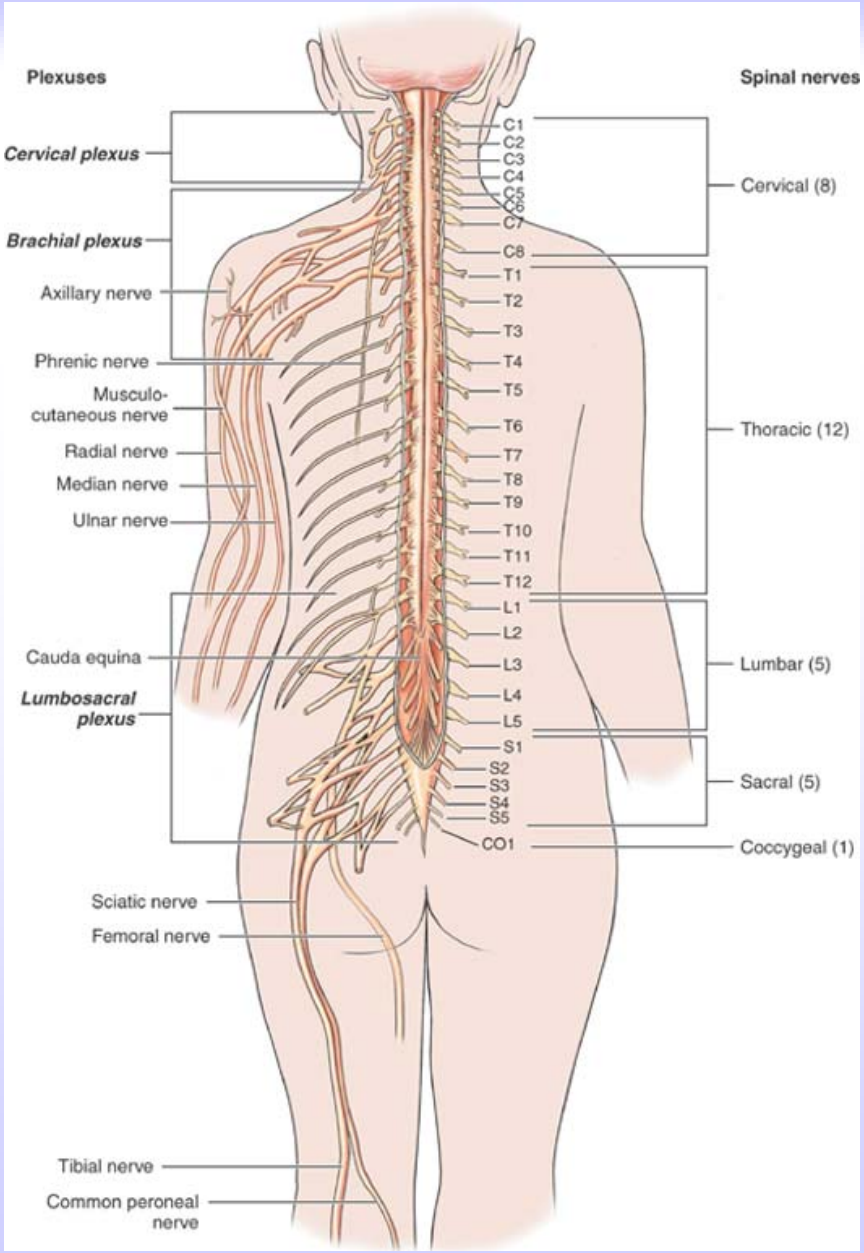
- Cervical plexus:
  - C1 to C4
  - innervates the skin & muscles of the neck, shoulder & diaphragm
  - major nerve from plexus is Phrenic nerve
  - If phrenic nerve damaged result is impaired breathing

# Spinal Nerves

- Brachial Plexus:
  - C5 to C8 & T1
  - Innervates skin & muscles of upper extremities
  - Major nerves include:
    - Axillary nerve serves muscles of shoulder; damage causes crutch palsy
    - Radial nerve serves posterior arm, forearm, hand, thumb & first two finger; damage causes wrist drop
    - Median nerve serves forearm & muscles of hand; damage cause inability to pick up small objects
    - Ulnar nerve serves wrist & hand; damage causes inability to open hand (clawhand)
    - Musculocutaneous nerve serves the skin & muscle

# Spinal Nerves

- Lumbosacral Plexus:
  - T12, L1-L5, S1 to end
  - Innervates skin & muscle of lower abdominal wall , external genitalia, buttocks & lower extremities
  - Major nerves include:
    - Femoral nerve serves lower abdomen, anterior thigh, medial leg & foot; damage causes inability to extend leg & flex hip
    - Sciatic nerve serves lower trunk, posterior thigh & leg & foot; damage causes inability to extend hip and flex knee
    - Obturartor nerve serves anterior thigh & leg
    - Pudendal nerve serves perineal area; damage causes perineal pain


Plexuses
Spinal nerves
Cervical plexus
Brachial plexus
Axillary nerve
Phrenic nerve
Musculo-cutaneous nerve
Radial nerve
Median nerve
Ulnar nerve
Cauda equina
Lumbosacral plexus
Sciatic nerve
Femoral nerve
Tibial nerve
Common peroneal nerve
C1
C2
C3
C4
C5
C6
C7
C8
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4
S5
CO1
Cervical (8)
Thoracic (12)
Lumbar (5)
Sacral (5)
Coccygeal (1)

# Spinal Nerves

- Dermatome:
  - area of the skin a nerve innervates
  - used to determine impairment
  - Example Dr. will examine an area, if the patient has loss of sensation in a particular area the Dr. can determine if there is an issue with a particular vertebrae

# Peripheral Nervous System

- Functional Classification of the PNS include:
  - Somatic nervous system:
    - Somatic afferent nerves: bring sensory information from skin & muscles to CNS
    - Somatic efferent nerves: bring motor information from the CNS to the skeletal muscles throughout the body
  - Autonomic nervous system: composed of nerves that supply the organs & glands
    - Two parts: sympathetic & parasympathetic

# Autonomic Nervous System

- Autonomic nervous system:
  - Regulates involuntary functions
  - Supplies motor activity to heart, smooth muscle of hollow organs & glands
  - Two divisions:
    - Sympathetic & parasympathetic nervous system
  - An organ receives fibers from both divisions
  - Stimulation of one division causes a specific effect whereas stimulation of the opposite creates an opposing affect

# Autonomic Nervous System

- Sympathetic
- "Fight or flight"
- Active under stress
- Manifested by:
  - ↑ HR & contraction
  - Dilation of bronchial tubes
  - Dilate pupils
  - Constrict blood vessels
  - Stimulate sweat glands
  - ↓ GI motility
  - Stimulate epinephrine & norepinephrine
  - Stimulate thick secretions

- Parasympathetic
- "Feed & Breed"
- Normal conditions
- Manifested by:
  - ↓ HR
  - Constricted bronchial tubes
  - Smaller pupils
  - No vessel constriction
  - No stimulation of sweat glands
  - Stimulation of GI motility
  - No affect on epi or norepi
  - Stimulates watery secretions