Peripheral Nervous System
Cranial nerves and spinal nerves

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Cranial Nerves

• 12 pairs
  - arise from the inferior aspect of the brain
  - 2 from the forebrain
  - 10 from the brain stem

• Functions
  - Sensory
  - Motor
  - ....or both
I. Oh
II. Oh
III. Oh
IV. To
V. Touch
VI. And
VII. Feel
VIII. Very
IX. Good
X. Velvet
XI. A
XII. H
Roots

- axon fibers passing directly to and from the spinal cord
- pure sensory or motor
- \textbf{posterior} = sensory
- \textbf{anterior} = motor
ganglia

- Posterior Root Ganglia (dorsal root ganglia) contain cell bodies of sensory neurons
Spinal Nerves

- Connect CNS to muscles, glands, receptors
- Anterior rootlets from spinal cord form anterior root (motor)
- Posterior rootlets from spinal cord form posterior root (sensory)
- Anterior and posterior roots merge to form mixed spinal nerves
Spinal nerves

- 31 pairs
- Pass through the intervertebral foramina
  - 8 pairs Cervical
  - 12 pairs Thoracic
  - 5 pairs Lumbar
  - 5 pairs Sacral
  - 1 pairs Coccygeal
Branches of spinal nerves

- Nerves split after passing through intervertebral foramina
- Branches are called rami (s, ramus)
- **Anterior (ventral) rami** form several branches and innervate anterior, lateral trunk, upper & lower limbs
  - Some form nerve plexus
- **Posterior (dorsal) rami** split into 2 branches innervating deep muscles and skin of back
- **Rami communicantes**
  - Associated with spinal nerves
  - Part of autonomic nervous system
PLEXUS: regions where spinal nerves merge and rebranch
Sites of injection of local anesthetics

- Spinal nerve block
  - Into subarachnoid space in spinal canal
- Paravertebral nerve block
- Epidural or peridural nerve block
- Caudal block
Epidural space

- Surrounds dural sac
- Contains areolar CT, fat, lymphatics, arteries, nerve plexus and spinal nerve roots

- Boundaries
  - Anterior = posterior longitudinal ligament
  - Posterior = ligamentum flavum and periosteum of the laminae
  - Lateral = pedicles of spinal column and intervertebral foramina
Epidural in childbirth

• 16-19G needle is inserted into the epidural space in lumbar region
• Epidural catheter is attached
• Anesthetic infused into epidural space
  - Pregnancy increases susceptibility to local anesthetic toxicity
  - Commonly used anesthetics include:
    • Bupivicaine (g, Marcaine)
    • Ropivicaine (g, Naropin)
    • Levobupivicaine (g, Chirotcaine)

Note: There is currently no safe way of introducing anesthetic through a tattoo. Therefore, those with lower back tattoos cannot have an epidural.
A Reflex Arc:

- Control on a local level
- anatomical and functional connection between sensory and motor activities
- Examples:
  - Patellar reflex
  - Flexor reflex
  - Crossed extensor reflex
Reflex arc
Patellar reflex

- Monosynaptic
- Ipsilateral
- Monosegmental
Flexor reflex

- Multisynaptic
- Ipsilateral
- Multisegmental
Crossed extensor reflex

- Multisynaptic
- Contralateral
- Multisegmental
The Autonomic Nervous System:

• “involuntary”
• function to modulate ongoing automatic activities
• target tissues
  - smooth muscle
  - cardiac muscle
  - glands
• Examples:
  - heart rate
  - ventilation
  - digestive tract activity
ANS is a two-neuron system.

1. Preganglionic neuron
2. Postganglionic neuron
Autonomic nervous system

- preganglionic fibers
  - exit the CNS and terminate onto autonomic ganglia

- postganglionic fibers
  - exit the autonomic ganglia and terminate onto the target
ACh: excitation (contraction) of skeletal muscle

ACh or NE: excitation (contraction) or inhibition of smooth muscle or cardiac muscle, or excitation (stimulation) or inhibition of glandular secretion
Sympathetic division (thoracolumbar)

- Sympathetic chain
- Preganglionic fibers synapse on postganglionic fibers very close to the CNS and far away from effector organs
Sympathetic division

- **Sympathetic chain**
  - Aka: paravertebral ganglia or lateral ganglia
  - Location: either side of vertebral column
  - Innervate effectors in body wall, inside thoracic cavity
- **Collateral ganglia**
  - Aka: prevertebral ganglia
  - Location: between sympathetic chain and organ
  - Innervate tissues & organs of abdominopelvic cavity
- **Adrenal medulla**
Collateral ganglia

- **Celiac ganglion**
  - Stomach, duodenum, liver, pancreas, spleen, gallbladder

- **Superior mesenteric ganglion**
  - Small intestines, beginning of large intestines

- **Inferior mesenteric ganglion**
  - Kidney, bladder, reproductive organs, large intestines
Adrenal medulla
Adrenal medulla

- Sympathetic preganglionic neurons enter adrenal medulla and stimulate postganglionic neurons
- Chromaffin cells respond and release adrenalin (80% epinephrine, 20% norepinephrine)
  - Cells are derived from neural crest tissue
parasympathetic (craniosacral)

- “rest and repose”
- involves cranial nerves: III, VII, IX and X
- preganglionic fibers extend from the CNS to the target
- Terminal ganglia located within the target organ
- postganglionic fibers
  - Short
  - within the target organ
PARASYMPATHETIC NERVES
“Rest and digest”

- Constrict pupils
- Stimulate saliva
- Slow heartbeat
- Constrict airways
- Stimulate activity of stomach
- Inhibit release of glucose; stimulate gallbladder
- Stimulate activity of intestines
- Contract bladder
- Promote erection of genitals

SYMPATHETIC NERVES
“Fight or flight”

- Dilate pupils
- Inhibit salivation
- Increase heartbeat
- Relax airways
- Inhibit activity of stomach
- Stimulate release of glucose; inhibit gallbladder
- Inhibit activity of intestines
- Secrete epinephrine and norepinephrine
- Relax bladder
- Promote ejaculation and vaginal contraction
Visceral reflexes

• Polysynaptic
• Can be modified by higher centers
• Examples
  - Parasympathetic
    • Consensual light reflex
    • Swallowing reflex
  - Sympathetic
    • Pupillary reflex
    • Vasomotor reflexes