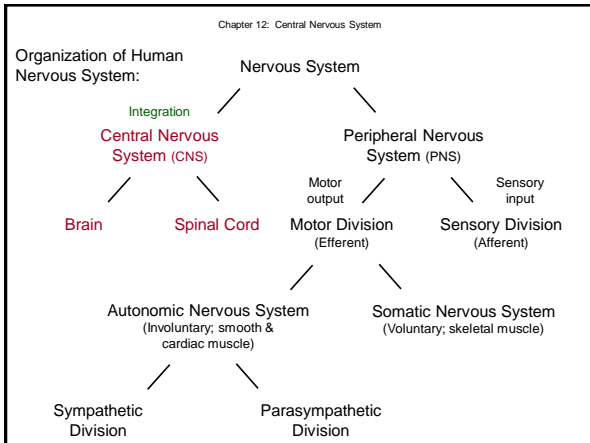


Chapter 12:
Central Nervous System





Chapter 12: Central Nervous System

Terminology to be aware of:

Nuclei: Groups of neuron cell bodies (CNS)
Ganglia: Groups of neuron cell bodies (PNS)

Tracts: Bundles of neuron axons (CNS)
Nerves: Bundles of neuron axons (PNS)

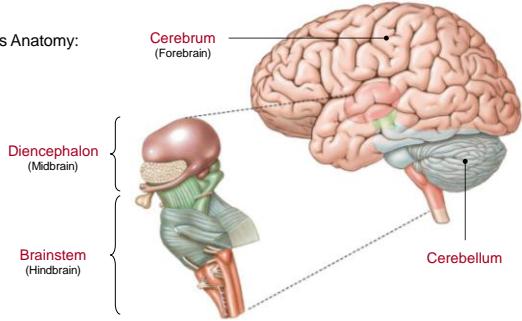
White Matter: Regions of myelinated fibers (CNS)
Gray Matter: Regions of unmyelinated fibers / cell bodies (CNS)

Brain:

- ~ 3.5 lbs (35 billion neurons)
- ♂ brain ~ 10% larger than ♀ brain

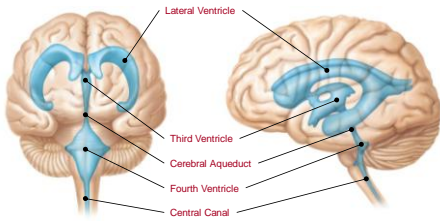
No correlation exists between brain size and intelligence...

Gross Anatomy:



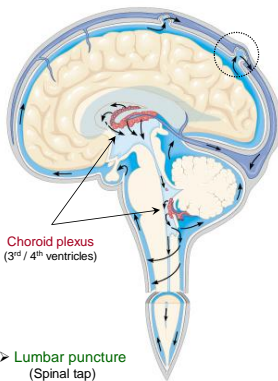
Brain:

A. **Ventricles:** Hollow chambers enclosed within brain (continuous with each other...)

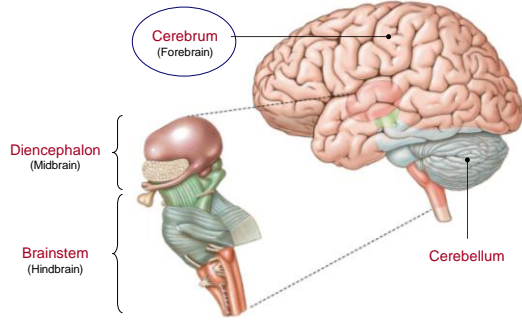


- Contain **cerebrospinal fluid (CSF)**
 - Provides cushioning / support / nutrition for brain (floats brain...)
- Lined with **ependymal cells** (circulate CSF)
 - **Choroid Plexus:** Vascular network; produces CSF (~ 0.5 L / day)

Arachnoid granulations



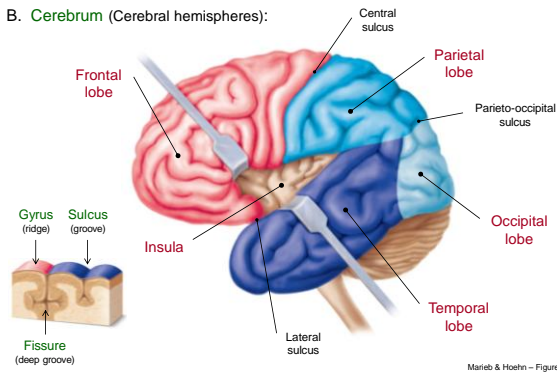
Hydrocephalus



85% of brain mass

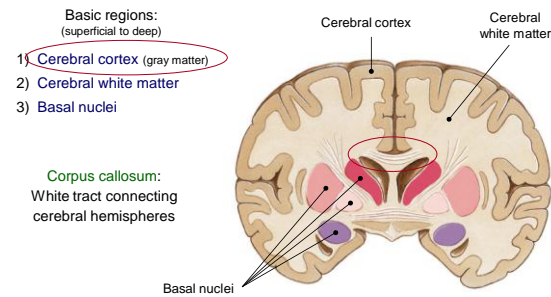
Brain:

B. Cerebrum (Cerebral hemispheres):



Brain:

B. Cerebrum (Cerebral hemispheres):



Brain:

B. Cerebrum (Cerebral hemispheres):

1) Cerebral cortex:

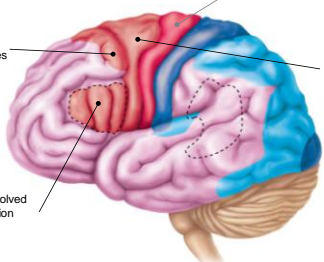
• Motor Areas:

Frontal eye field
Controls voluntary movement of the eyes

Broca's area
Controls muscles involved in speech production

Primary motor cortex
Conscious control of skeletal muscle movements

Premotor cortex
Controls learned motor skills of repetitious or patterned nature (e.g., typing)



Brain:

B. Cerebrum (Cerebral hemispheres):

1) Cerebral cortex:

• Sensory Areas:

Gustatory cortex
Receives / interprets sensations of taste

Primary auditory cortex
Receives auditory information

Auditory Association area
Integrates / interprets auditory inputs (e.g., music / thunder)

Olfactory cortex
Receives olfactory information

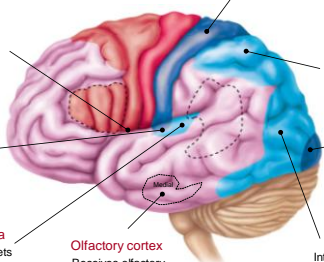
Primary somatosensory cortex
Receives information from sensory receptors in skin & proprioceptors in joints

Spatial discrimination

Somatosensory association cortex
Integrates / interprets somatosensory inputs (e.g., temp. / pressure)

Primary visual cortex
Receives visual information

Visual association area
Integrates / interprets visual inputs (e.g., color / form)



Brain:

B. Cerebrum (Cerebral hemispheres):

Locations where sensations, thoughts, and emotions become conscious

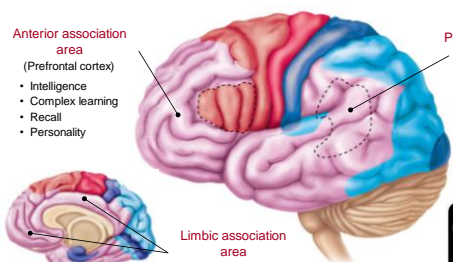
1) Cerebral cortex:

• Association Areas (multimodal):

Anterior association area
(Prefrontal cortex)
• Intelligence
• Complex learning
• Recall
• Personality

Posterior association area
• Pattern recognition
• Spatial recognition
• Sensory grouping
• Language centers
(Wernicke's area)

Limbic association area
Processes emotions related to personal / social interactions



Brain:

B. Cerebrum (Cerebral hemispheres):

1) **Cerebral cortex:**

Memory:

Storage and retrieval of information

Stages of Memory:

- 1) **Short-term Memory (working memory):**
 - Short-lived; rapid recall; finite
- 2) **Long-term Memory:**
 - Long-lived; slow recall; infinite

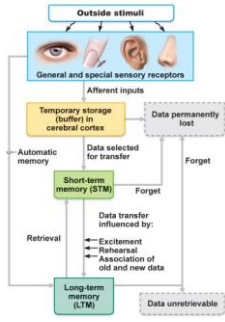
Memory Consolidation



Categories of Memory:

- 1) **Fact Memory:** Specific information
- 2) **Procedural Memory:** Patterned behaviors
- 3) **Motor Memory:** Learned motor behaviors
- 4) **Emotional Memory:** Learned emotional responses

Amnesia:
Memory loss due to trauma / disease



Brain:

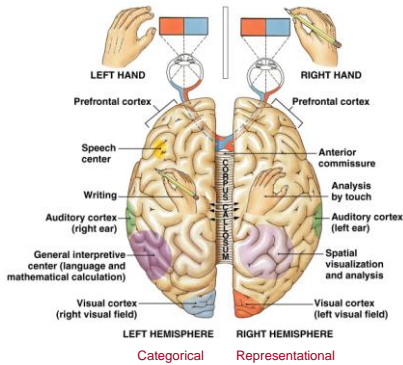
B. Cerebrum (Cerebral hemispheres):

1) **Cerebral cortex:**

- Contains 3 types of functional areas
- **Contralateral control** (e.g., left brain controls right body)
- **Lateralization** (i.e., hemisphere specialization)

The cerebral cortex is the seat of conscious behavior

Only 2 - 4 mm thick but comprises 40% of the brain's mass
2.5 ft² of surface area

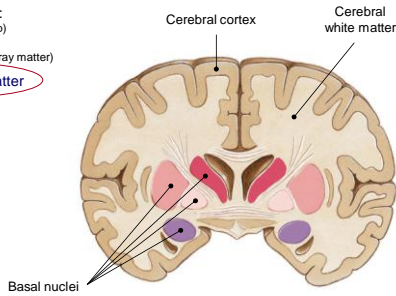


Brain:

B. Cerebrum (Cerebral hemispheres):

Basic regions:
(superficial to deep)

- 1) Cerebral cortex (gray matter)
- 2) Cerebral white matter
- 3) Basal nuclei



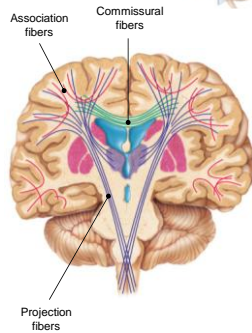
Brain:

B. Cerebrum (Cerebral hemispheres):

2) Cerebral white matter:

Fiber tracts responsible for communication between cerebral areas and lower CNS

- A) **Commissural Fibers:**
 - Interconnect cerebral hemispheres
- B) **Association Fibers:**
 - Interconnect areas of neural cortex within a single hemisphere
- C) **Projection Fibers:**
 - Interconnect cerebral hemispheres with other regions of the brain



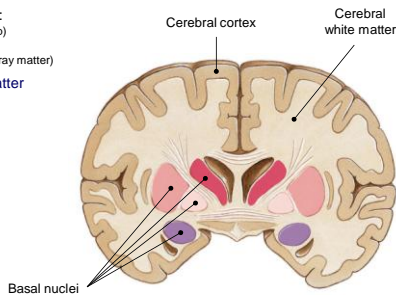
Marieb & Hoehn - Figure 12.10

Brain:

B. Cerebrum (Cerebral hemispheres):

Basic regions:
(superficial to deep)

- 1) Cerebral cortex (gray matter)
- 2) Cerebral white matter
- 3) Basal nuclei



Brain:

B. Cerebrum (Cerebral hemispheres):

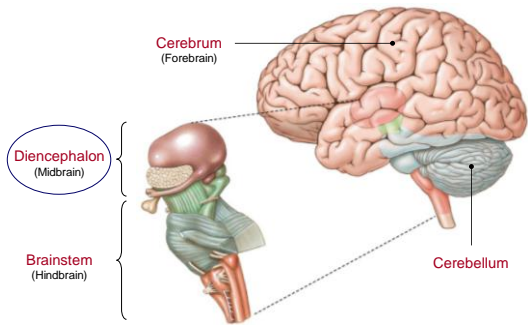
3) Basal nuclei:

- Composed of gray matter (neuron cell bodies)
- Function: 1) Subconscious control of skeletal muscle tone
2) Control stereotypical motor movements (e.g., arm swing)
 - Regulate intensity / inhibit unnecessary movements

Parkinson's Disease:
Increased muscle tone due to overactive basal nuclei (cause = loss of dopamine neurons)



Marieb & Hoehn - Figure 12.11



Brain:

C. Diencephalon:

Thalamus:

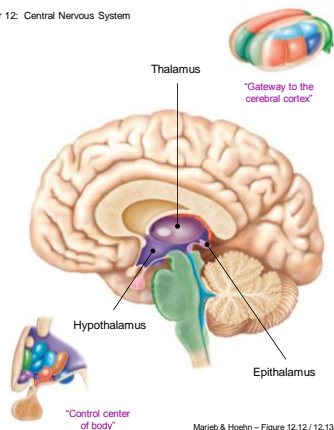
- Composes 80% of diencephalon
- Relay station for all information entering the cerebral cortex

Hypothalamus:

- Autonomic control center
- Center for emotional response
- Body temperature regulation
- Regulation of food / water intake
- Regulation of sleep-wake cycles
- Control of endocrine system

Epithalamus:

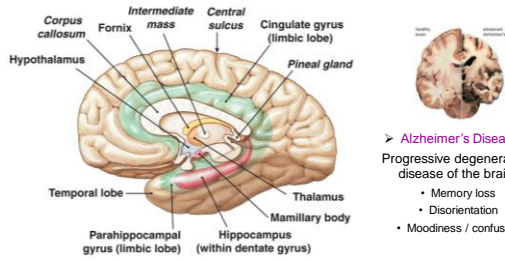
- Houses pineal gland (melatonin) and choroid plexus (forms CSF)



Marieb & Hoehn - Figure 12.12 / 12.13

Limbic System (Functional brain system):

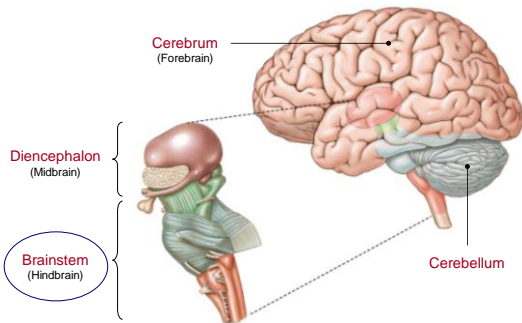
"Motivational System"



> **Alzheimer's Disease:**
 Progressive degenerative disease of the brain

- Memory loss
- Disorientation
- Moodiness / confusion

- Control emotional states (e.g., fear) / behavioral drives (e.g., sex drive)
- Link conscious (cerebral cortex) with unconscious function (brain stem)
- Long-term memory storage / retrieval



Brain:

D. Brain stem:

- Deep gray matter; superficial white matter
- Produce rigidly programmed, autonomic behaviors necessary for survival
- Conduction pathways between higher and lower brain centers

Midbrain:

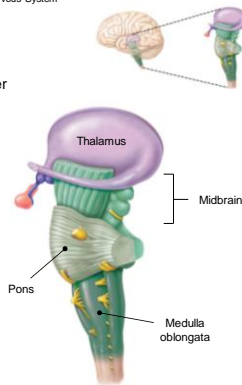
- Visual / auditory reflex centers

Pons:

- Regulate respiration rate / depth

Medulla oblongata:

- Location where fiber tracts from spinal cord cross over (**decussation**)
- Autonomic reflex center
 - Heart rate / blood pressure
 - Respiratory rhythm
 - Vomiting / hiccupping / etc.

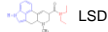
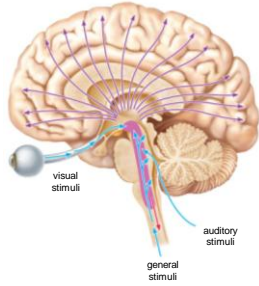


Marieb & Hoehn - Figure 12.15

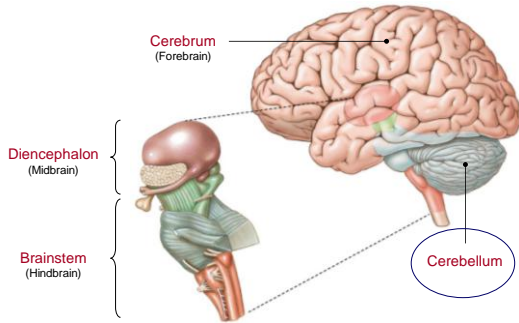
Reticular Activating System (RAS - Functional brain system):



Twisting of brain stem can lead to irreversible coma



- Maintains cerebral cortical alertness (e.g., on / off switch)
- Filters out repetitive stimuli (~ 99% of stimuli filtered...)



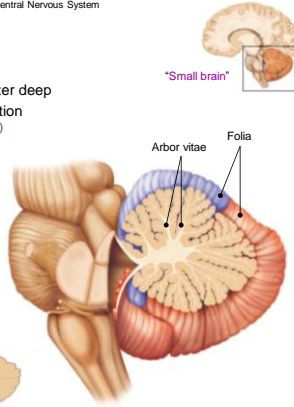
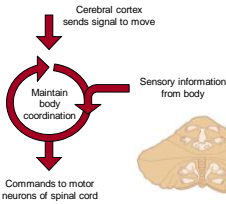
Brain:

E. Cerebellum:

- Gray matter superficial; white matter deep
- Precise timing of muscle coordination (balance, posture, repeated movements)
- All activity subconscious

"Small brain"

Cerebellar Processing:



Protection of the Brain:

1) **Bone** (Skull – cranium portion)

2) **Meninges** (specialized connective tissue membranes)

A) **Dura mater** ("tough mother")

- Fibrous outer coating (2 layers)
- Protects CNS

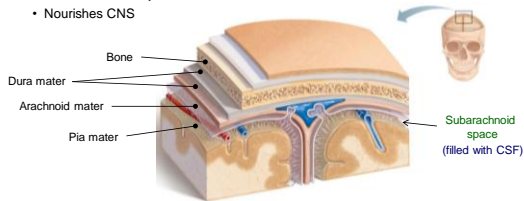
B) **Arachnoid mater** ("spider mother")

- Delicate middle layer
- Nourishes CNS

C) **Pia mater** ("gentle mother")

- Thin inner membrane
- Contains blood vessels

Meningitis:
Inflammation of the meninges



Marieb & Hoehn – Figure 12.24

Protection of the Brain:

1) **Bone** (Skull – cranium portion)

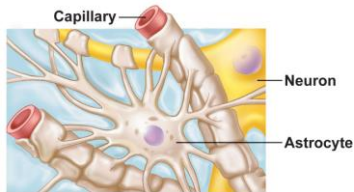
2) **Meninges** (specialized connective tissue membranes)

3) **Blood-brain barrier:** Astrocyte-maintained barrier lining blood capillaries

Tightly regulate substances bathing brain:

In: glucose, amino acids, selected electrolytes

Out: metabolic waste (urea), proteins, toxins, drugs



- Displays differentially permeable (e.g. vomit center → brain stem)

Marieb & Hoehn – Figure 11.3

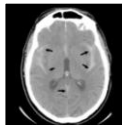
Homeostatic Imbalances of the Brain:

1) **Traumatic brain injury**



Concussion

Alteration in brain function following blow to head



Subdural hemorrhage

Bleeding into subarachnoid space via ruptured vessels



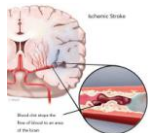
Cerebral edema

Swelling of the brain

2) **Cerebrovascular accident**

3) **Degenerative brain disorders**

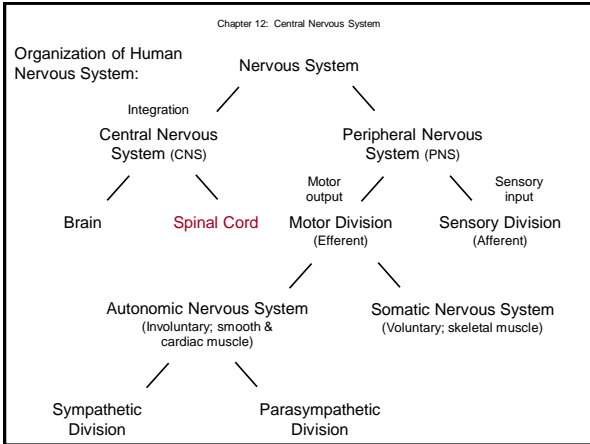
- Alzheimer's disease
- Parkinson's disease
- Huntington's disease



Leading cause of accidental death in North America

Third leading cause of death in North America

Ischemic stroke
Blockage of blood supply to brain due to blood clot
• May be transient



Chapter 12: Central Nervous System

Spinal Cord:

- Provides conduction pathway to / from brain
- Contains major reflex centers
- Independently initiates patterns of motor activity (e.g., walking)

Gross Anatomy:

- ~ 18 inches long (via vertebral foramen)
- Two enlargements (cervical / lumbar)
 - Innervation of limbs
- Cord proper ends at L1
 - **Cauda equina** ("horse's tail")
- Spinal nerves (31 pairs)

Protected by vertebral column / meninges

Figure 12.29: Marieb & Hoehn

Chapter 12: Central Nervous System

Spinal Cord:

Cross-sectional Anatomy:

Ascending tracts: Carry information to brain

Descending tracts: Carry information from brain

Transverse tracts: Carry information across cord

Characteristics:

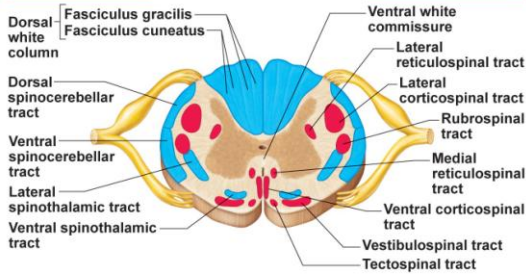
- 1) Decussation present
- 2) Multi-neuron pathways
- 3) Spatial relationships
- 4) Symmetrical arrangement

Spinal Cord:

Spinal Cord Tracts:

Ascending tracts

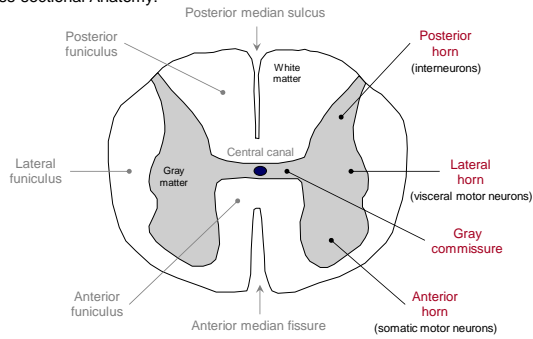
Descending tracts



Marieb & Hoehn - Figure 12.33

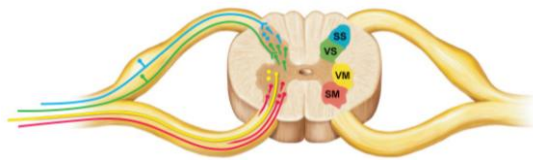
Spinal Cord:

Cross-sectional Anatomy:

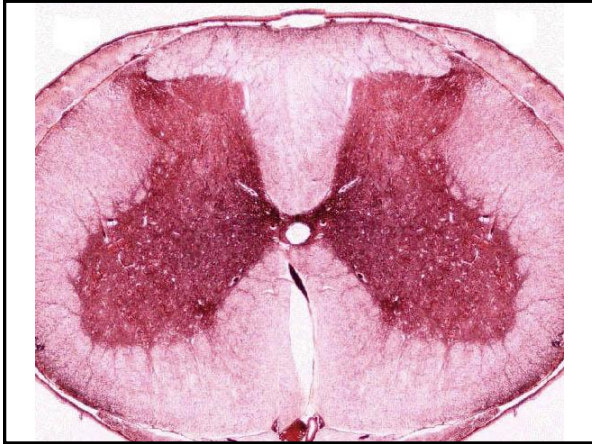


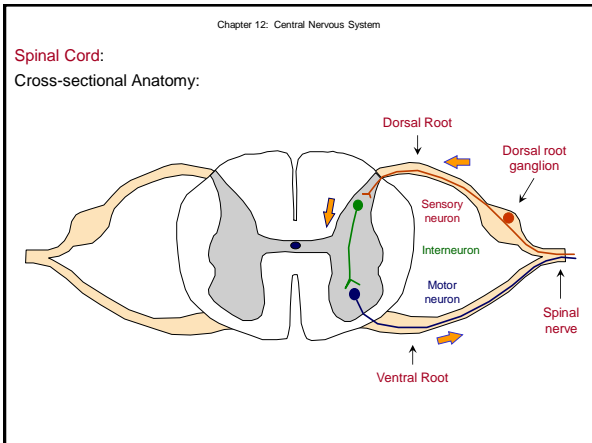
Spinal Cord:

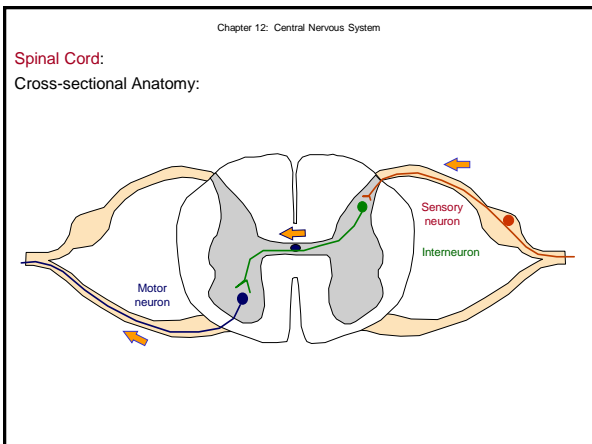
Organization of Gray Matter:



- SS** Interneurons receiving input from somatic sensory neurons
- VS** Interneurons receiving input from visceral sensory neurons
- VM** Visceral motor (autonomic) neurons
- SM** Somatic motor neurons







Homeostatic Imbalances of the Spinal Cord:

1) Spinal cord trauma



Paralysis / Paresthesias
Damage to spinal cord leading to functional / sensory loss



Paraplegia
Transection of spinal cord between T1 and L1



Quadriplegia
Transection of spinal cord between C4 and C7

2) Poliomyelitis



Destruction of ventral horn motor neurons by poliovirus



3) Amyotrophic lateral sclerosis (ALS)



Progressive destruction of ventral horn motor neurons (autoimmune?)



Lou Gehrig's disease
