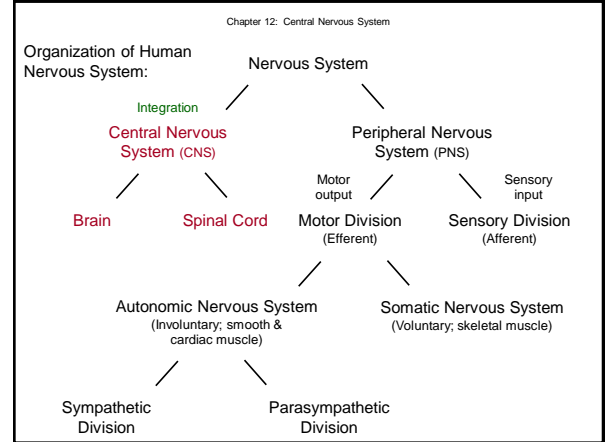


Chapter 12:
Central Nervous System



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)

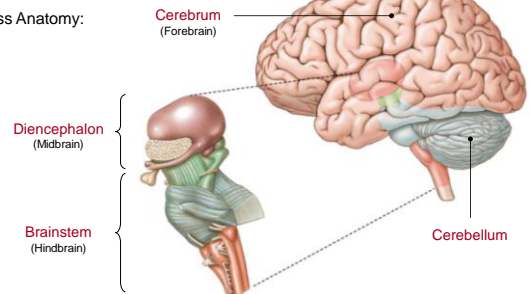
White Matter: Regions of myelinated fibers (CNS)
Gray Matter: Regions of unmyelinated fibers / cell bodies (CNS)

Chapter 12: Central Nervous System

Brain:

- ~ 3.5 lbs (35 billion neurons)
 - ♂ brain ~ 10% larger than ♀ brain
- No correlation exists between brain size and intelligence...

Gross Anatomy:

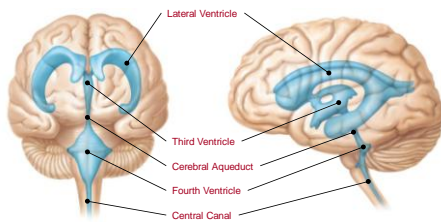


Chapter 12: Central Nervous System

Marieb & Hoehn - Figure 12.5

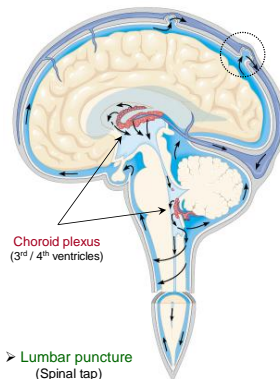
Brain:

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)

Chapter 12: Central Nervous System



Arachnoid granulations

Choroid plexus
(3rd / 4th ventricles)

➤ Lumbar puncture
(Spinal tap)



Hydrocephalus

Chapter 12: Central Nervous System
Marieb & Hoehn – Figure 12.8

Brain:
B. **Cerebrum** (Cerebral hemispheres):

1) **Cerebral cortex:**

- **Motor Areas:**

Primary motor cortex
Conscious control of skeletal muscle movements

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

Frontal eye field
Controls voluntary movement of the eyes

Broca's area
Controls muscles involved in speech production

Chapter 12: Central Nervous System
Marieb & Hoehn – Figure 12.8

Brain:
B. **Cerebrum** (Cerebral hemispheres):

1) **Cerebral cortex:**

- **Sensory Areas:**

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)

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 visual cortex
Receives visual information

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

Chapter 12: Central Nervous System
Marieb & Hoehn – Figure 12.8

Brain:
B. **Cerebrum** (Cerebral hemispheres):

1) **Cerebral cortex:**

- **Association Areas** (multimodal):

Locations where sensations, thoughts, and emotions become conscious

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

Chapter 12: Central Nervous System
Marieb & Hoehn – Figure 12.22

Brain:
B. **Cerebrum** (Cerebral hemispheres):

1) **Cerebral cortex:**

- **Memory:**
Storage and retrieval of information

Amnesia:
Memory loss due to trauma / disease

Stages of Memory:

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

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

Memory Consolidation

Chapter 12: Central Nervous System

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

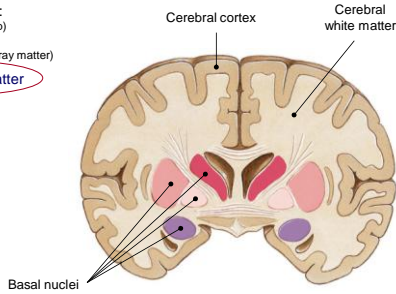
Chapter 12: Central Nervous System

Brain:

B. Cerebrum (Cerebral hemispheres):

Basic regions:
(superficial to deep)

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



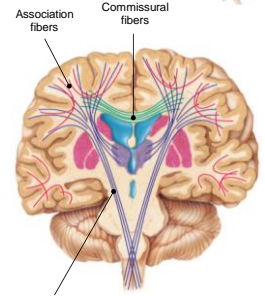
Brain:

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



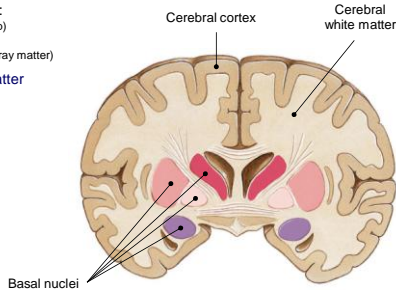
Marieb & Hoehn - Figure 12.10

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):

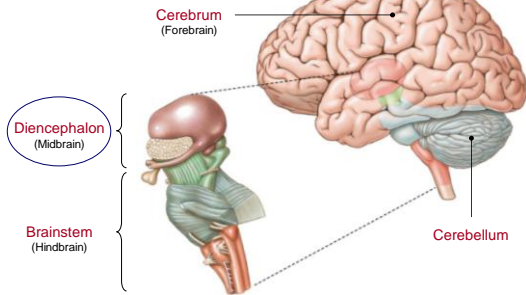
3) Basal nuclei:

- 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



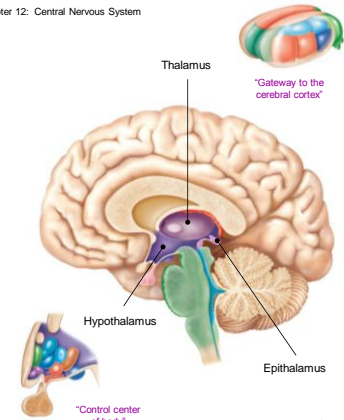
Brain:

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

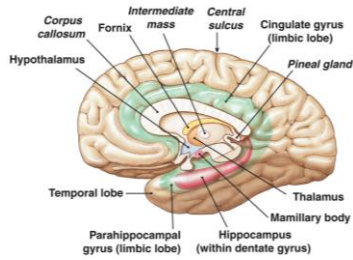
- Epithalamus:**
- Houses pineal gland (melatonin) and choroid plexus (forms CSF)



Marieb & Hoehn - Figure 12.12 / 12.13

Limbic System (Functional brain system):

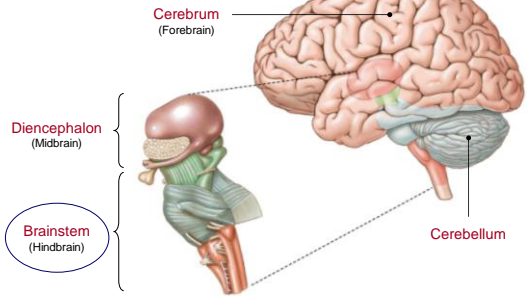
"Motivational System"



➤ **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:

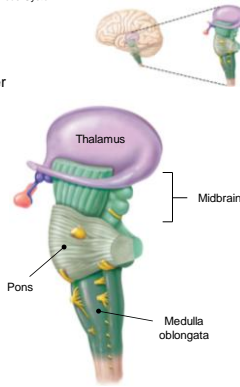
- Visual / auditory reflex centers

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.

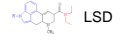
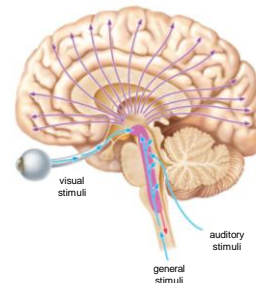


Marieb & Hoehn – Figure 12.15

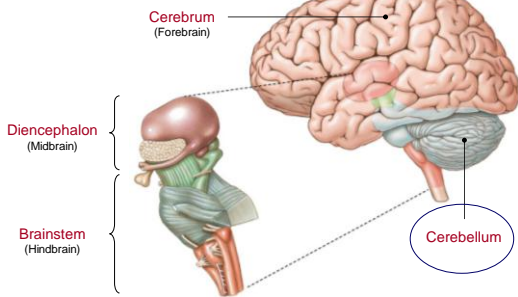
Reticular Activating System (RAS – Functional brain system):



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...)

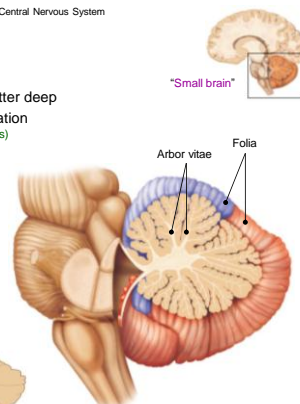
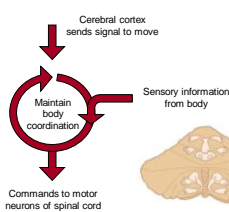


Brain:

E. Cerebellum:

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

Cerebellar Processing:



Marieb & Hoehn – Figure 12.17

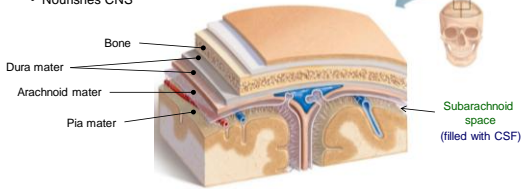
Protection of the Brain:

- 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



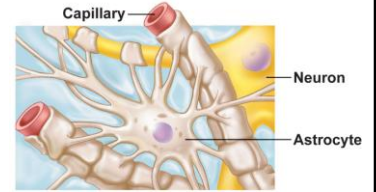
Marieb & Hoehn – Figure 12.24

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)

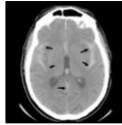
Marieb & Hoehn – Figure 11.3

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

Leading cause of accidental death in North America

- 2) **Cerebrovascular accident**

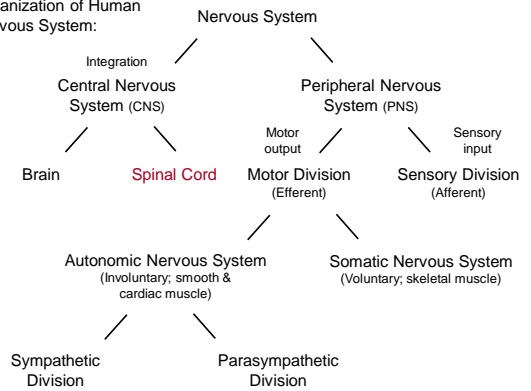


Third leading cause of death in North America
Ischemic stroke
Blockage of blood supply to brain due to blood clot
• May be transient

- 3) **Degenerative brain disorders**

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

Organization of Human Nervous System:

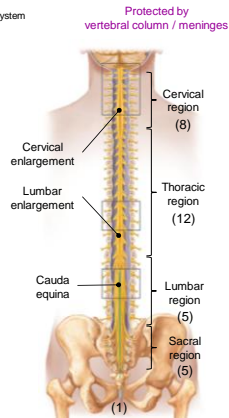


Spinal Cord:

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

Gross Anatomy:

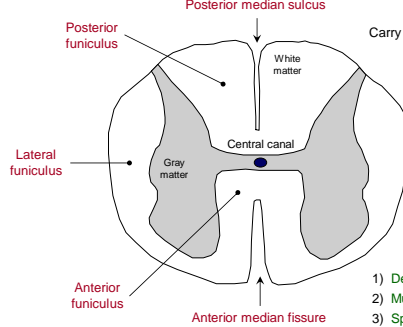
- ~ 18 inches long (via vertebral foramen)
- Two enlargements (cervical / lumbar)
 - Innervation of limbs
- Cord proper ends at L1
 - **Cauda equina** ("horse's tail")
- Spinal nerves (31 pairs)



Marieb & Hoehn – Figure 12.29

Spinal Cord:

Cross-sectional Anatomy:



- Ascending tracts:**
Carry information to brain
- Descending tracts:**
Carry information from brain
- Transverse tracts:**
Carry information across cord

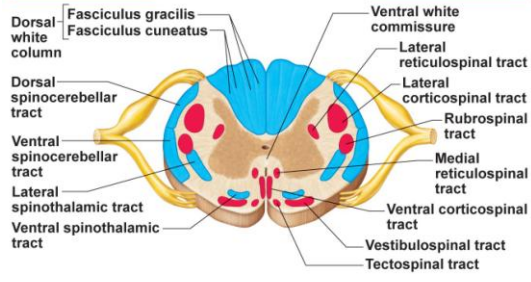
- Characteristics:**
- 1) Decussation present
 - 2) Multi-neuron pathways
 - 3) Spatial relationships
 - 4) Symmetrical arrangement

Spinal Cord:

Spinal Cord Tracts:

Ascending tracts

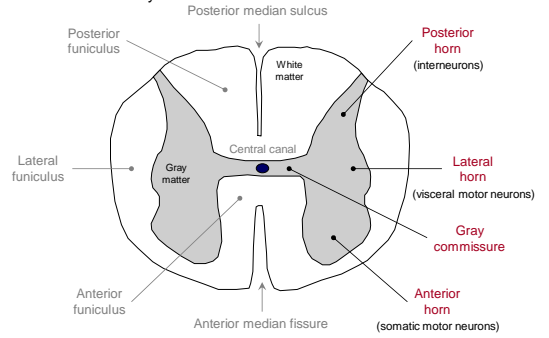
Descending tracts



Marieb & Hoehn - Figure 12.33

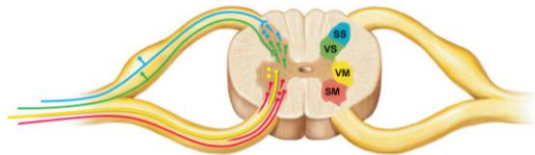
Spinal Cord:

Cross-sectional Anatomy:



Spinal Cord:

Organization of Gray Matter:

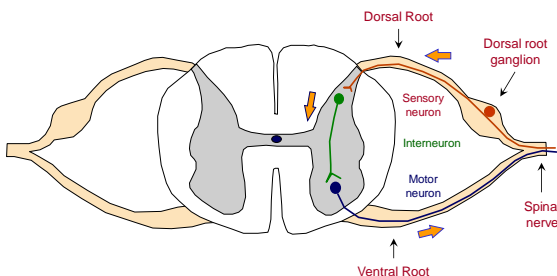


- IS: Interneurons receiving input from somatic sensory neurons
- VS: Interneurons receiving input from visceral sensory neurons
- VM: Visceral motor (autonomic) neurons
- SM: Somatic motor neurons



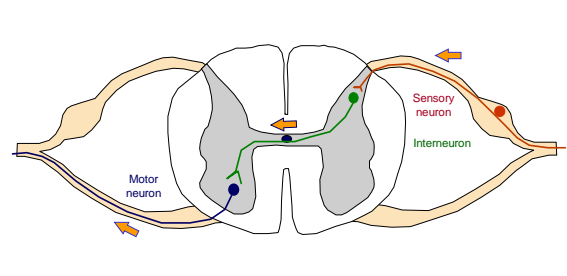
Spinal Cord:

Cross-sectional Anatomy:



Spinal Cord:

Cross-sectional Anatomy:



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)



Lou Gehrig's disease
Progressive destruction of ventral horn motor neurons (autoimmune?)