

Central Nervous System

Brain

one of largest organs in body: 3-3.5 lbs

one of most metabolically active organs in body

comprises only 2% of total body weight it yet

→ gets 15% of blood

→ consumes 20% of our oxygen need at rest
(more when mentally active)

blood flow and O₂ increase to active brain areas

1-2 min interruption of blood flow may impair brain cells

>4 min w/o oxygen → permanent damage

besides O₂ must get continuous supply of glucose
very little in reserve

decrease in glucose:

dizziness

convulsions

unconsciousness

Brain Anatomy

subdivided into 4 major units:

1. Cerebral Hemispheres (60% of brain mass)

- "human" part: thought, creativity, communication

2. Diencephalon

- moods, memory, manages internal environment

epithalamus

thalamus

hypothalamus

3. Cerebellum

- coordinating movement and balance

4. Brain Stem

- oldest and smallest region, basic bodily functions

midbrain

pons

medulla

Some general terminology:

gray matter = thin myelin; mostly cell bodies
dendrites
outer layer of brain
inner layer of spinal cord

White matter = thick insulation; mostly axons
inner layers of brain
outer layer of spinal cord

Medulla

lowest portion of brainstem

continuous with the spinal cord

all ascending and descending tracts from spinal cord and brain = **white matter**

most tracts cross over as they pass through the medulla

helps control several vital functions

→ contains important autonomic reflex centers

cardiac reflex center

rate and force of heartbeat

vasomotor control center

controls diameter of blood vessels

controls the distribution of blood to specific organs

controls blood pressure

respiratory center

regulates the rate and depth of breathing

polio especially affects this center in medulla

→ resp failure (iron lungs)

also contains many nonvital reflex centers (nuclei):

speech

swallowing

vomiting

coughing

sneezing

Pons

just above medulla

bridge connecting spinal cord with brain and parts of brain with each other

contains 2 centers that help to regulate breathing

→ **pneumotaxic center**

→ **apneustic center**

also contains nuclei that affect sleep and bladder control

Midbrain

in the form of 4 lobes above and behind pons= **Corpora Quadrigemina**

upper 2 lobes = **Superior Colliculi**

control center for some visual reflexes:

a. **pupillary reflex**

b. reflex centers for coordinating eye

movement with head and neck movement in response to visual stimuli

lower two lobes = **Inferior Colliculi**

control center for some auditory reflexes:

a. reflex centers for movements of head and trunk in response to auditory stimuli to locate sound

b. startle response to loud noises

also contains Ascending and Descending tracts

a. motor fibers from cortex to pons, medulla and spinal cord

b. sensory fibers from spinal cord to thalamus

Reticular Formation (~Reticular Activation System)

diffuse system of interconnecting fibers extending through several areas of brain including brain stem

comprises a large portion of entire brainstem

extends into spinal cord and diencephalon

interlacing of gray and white matter

Functions - both sensory and motor

- 1. helps regulate muscle tone, balance and posture** during body movements
- 2. Sleep and consciousness**
maintains consciousness and awakens from sleep → alarm clock

drugs that depress RAS decrease alertness and produce sleep eg. Barbiturates
amphetamines stimulate RAS producing wakefulness
general anesthetics may produce unconsciousness by depressing RAS
falling asleep may be caused by specific neurotransmitters that inhibit RAS
- 3. filters flood of sensory input** (=habituation)
highlights unusual signals; disregards rest (99%)

Diencephalon

Epithalamus

includes roof of 3rd ventricle
mainly pineal gland

Thalamus:

4/5ths of diencephalon
1.2" long
forms lateral walls of 3rd ventricle
and intermediate mass

mainly a relay center
→ "Rome of the Nervous System"
or
"gateway to cerebral cortex"

main **relay station for sensory impulses**

that reach cerebral cortex from spinal cord, brain stem and cerebellum

eg. taste, touch, heat, cold, pain, some smell

the only sensory signals that can reach the cortex without going through the thalamus are for sense of smell

crude awareness of sensations

but can't distinguish their location or intensity

Hypothalamus

part of the brain most involved in regulating internal environment

no blood brain barrier

forms floor and part of lateral walls of 3rd ventricle

a. link between “mind” and “body”

controls and integrates activities of autonomic NS;

means by which emotions express themselves by altering body functions

b. relays reflexes related to smell

mammillary region

c. manufactures and transports releasing hormones

from hypothalamus to Master Gland

d. receives impulses from sound, taste, smell

e. regulates body temperature

has receptors that monitor blood temperature

f. regulates food and water intake

has receptors that monitor osmotic pressure
→ thirst center

Limbic System:

diencephalon is main part of a diffuse group of structures called the **Limbic System**

includes thalamus, hypothalamus, hippocampus, midbrain, amygdala (cerebrum)

= the emotional brain
and learning

limbic system perception & output is geared mainly toward the **experience and expression of emotions**

eg. pain, anger, fear, pleasure

continuous back & forth communication between limbic

system and frontal lobes of cerebrum
→ much of the richness of your emotional life
depends on these interactions

all sensory impulses are shunted through the limbic system

crude appreciation of some sensations
eg. pleasure, pain, etc

eg. contains **pleasure center**
-rats pressing bar for stimulation of pleasure center
-ignore sleep, food, water, sexual partners
-continue until exhausted (50-100x's/min)

in humans stimulates erotic feelings

is site of action of many addictive drugs

Cerebellum

2nd largest part of brain

just below and posterior to cerebrum

only other part of brain that is highly folded

consists of 2 hemispheres

grey matter outside
highly folded

white matter inside= **arbor vitae** (tree of life)

Functions:

helps to coordinate voluntary muscles
but does not send impulses directly to muscles

1. acts with cerebrum to **coordinate different groups of muscles**

smooths and coordinates complex sequences of muscular activity
needed for body movements

2. controls skeletal muscles to **maintain balance**

receives input from proprioceptors in muscles,

tendons and joints and equilibrium receptors and eyes

3. **learning and storing motor skills**

diseases of cerebellum produce **Ataxia**

eg. tremors

speech problems

difficulty with equilibrium

NOT paralysis

Cerebral Hemispheres

largest portion of brain (~60% of brain mass)

two hemispheres joined by tracts = **corpus callosum**

heavily convoluted: **gyri** and **sulci**

folding allows greater area of cortex in smaller

space (area = 2,500 cm² = 4.5 textbook pages or 1 keg of beer)

largest grooves = **fissures**

each hemisphere:

a. outer **gray matter** = cerebral **cortex** (2-4mm)

b. inner **white matter** = **tracts**

→ bundles of myelinated axons

c. **nuclei** = islands of gray matter in interior of brain

→ cell bodies and sometimes dendrites

eg. basal nuclei (=basal ganglia)

clusters of gray matter around thalamus (5)

help direct movements

damage causes Parkinson's disease

→ lack of Dopamine

cerebral cortex:

is responsible for our most "human" traits

conscious mind

abstract thought

memory
awareness

→ *most of these will be discussed later under integration*

each hemisphere is mainly concerned with sensory and motor functions of the opposite side of the body

eg. left hemisphere controls right hand

Lateralization of Hemispheres

on top of this is "**lateralization**":

a division of labor

Left Hemisphere:

1. does all the talking
 - repository of language
 - processes many aspects of language: syntax, semantics
 - also analytical skills, math, logic

Right Hemisphere:

1. mainly concerned with **visuospatial tasks**
 - nonverbal but interprets more subtle aspects of language: metaphor, allegory, ambiguity
2. also concerned with emotions, intuition

largest grooves = **fissures**: divide each hemisphere into 4 regions

named after bones they lie under:

1. **frontal**
 - personality
 - control of voluntary movement
2. **parietal**
 - touch, stretch
 - perception of somatic sensations
3. **occipital**
 - processing of vision
4. **temporal**
 - processing of sound and speech
 - awareness of equilibrium

Lobes of Cerebrum:

1. Frontal (& prefrontal)

elaboration of thought
intelligence
motivation
personality
abstract ideas
judgement
planning
“civilizing behaviors”

directs conscious individual muscle contractions

Olfactory Cortex

small area just above orbits
perception of odors, smells

2. Parietal Lobe

sensory processing areas

receives information from skin sensors
spatial discrimination

motor and sensory cortex, like other areas are malleable

eg. learning Braille

the area representing touch in the finger used in
somatosensory cortex expands into areas previously devoted
to neighboring fingers

Gustatory Cortex

conscious awareness of taste stimuli

3. Occipital Lobe

visual processing areas

analyzes image in terms of its elementary features
orientation
color
texture
depth
presence of movement

interprets and associates with past visual experiences
→ recognize people, flowers, etc

4. Temporal Lobe

interprets sounds: pitch, rhythm, loudness
awareness of balance

Spinal Cord

located in the spinal canal of the vertebral column

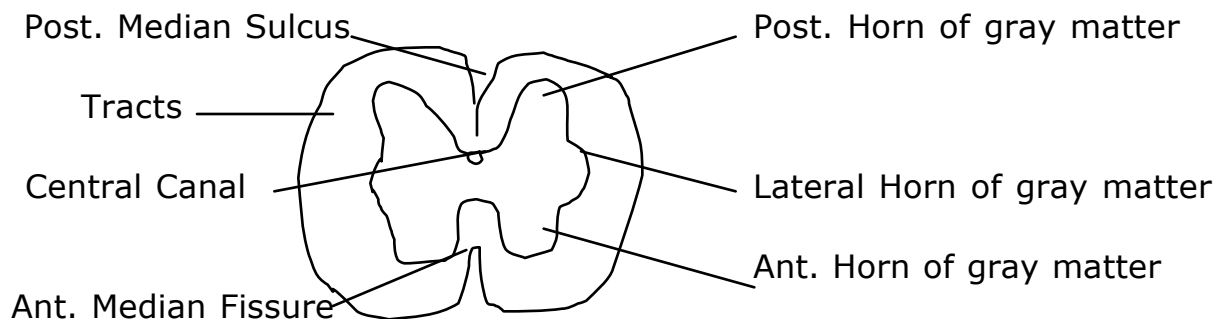
17 – 18 inches long

extends from foramen magnum to lower border of 1st lumbar vertebrae

subdivided into cervical, thoracic, lumbar, sacral regions

spinal cord terminates in a bundle of nerves
= **cauda equina**

Cross Section of Spinal Cord:



white matter: myelinated, divided into columns and tracts; “highways”

gray matter: unmyelinated, cell bodies & dendrites, synapses

Nerve Tracts

numerous tracts can be identified in the spinal cord

spinal cord tracts serve as 2-way conduction paths
between peripheral nerves and brain

each tract is composed of bundles of axons
ascending tracts & descending tracts