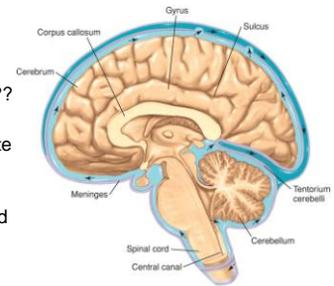


Chapter 8 outline

- ▶ Structural organization of the brain
- ▶ Cerebrum
- ▶ Diencephalon
- ▶ Midbrain and hindbrain
- ▶ Spinal cord tracts
- ▶ Cranial and spinal nerves

▶ CNS: Consists of ?????

- ▶ Receives input from ????? neurons
- ▶ Directs activity of ????? neurons
- ▶ ????? neurons integrate sensory and motor activity
 - ▶ Perform learning and memory



8-2

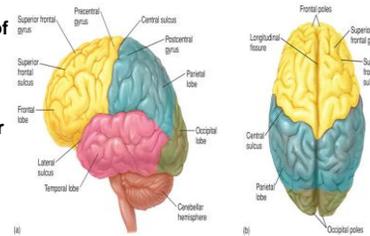
8-4

CNS

- ▶ CNS composed of gray and white matter
 - ▶ Gray matter
 - ▶ White matter
- ▶ Adult brain weighs ?????
 - ▶ Contains 100 billion neurons
 - ▶ Receives 20% of blood flow to body

Cerebrum

- ▶ Is largest part of brain (80% of mass)
- ▶ Responsible for higher mental functions

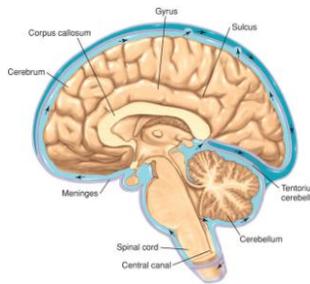


8-5

8-12

Cerebrum

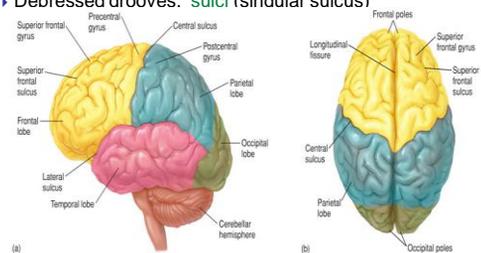
- ▶ right and left hemispheres interconnected by corpus callosum



8-13

Cerebral Cortex

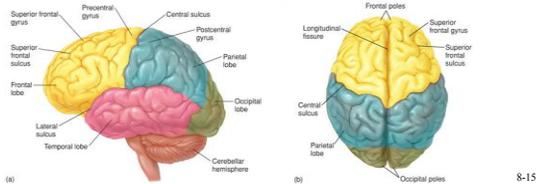
- ▶ Thin outer area of grey matter surrounding cerebrum
- ▶ Highly convoluted
 - ▶ Elevated folds: **gyri** (singular gyrus)
 - ▶ Depressed grooves: **sulci** (singular sulcus)



8-14

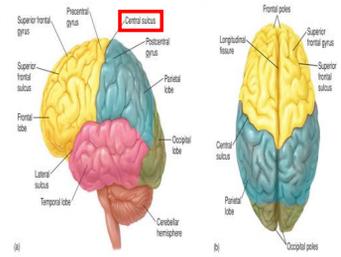
Cerebral Cortex

- ▶ Each cerebral hemisphere has 5 lobes:
- ▶ **Frontal** – voluntary motor control; higher processes
- ▶ **Parietal** – Somesthetic sensory; speech understand/interp
- ▶ **Temporal** – Auditory sensations; memory of auditory/visual
- ▶ **Occipital** - Vision; visual experiences; eye movement
- ▶ **Insula** - Memory encoding, integrates sensory info (pain)

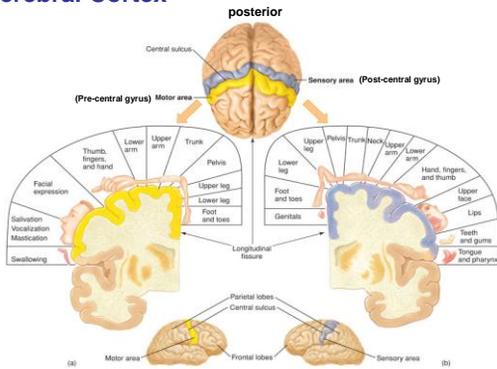


Cerebral Cortex

- ▶ Frontal lobe is separated from parietal by **central sulcus**
- ▶ **Precentral gyrus** = motor control
- ▶ **Postcentral gyrus** = somesthetic sensation (cutaneous, muscle, tendon, joint receptors)



Cerebral Cortex



Lobotomy of Phineas Gage

- ▶ severe injury with metal rod
- ▶ injury to both frontal lobes
- ▶ extreme personality change
- ▶ prefrontal cortex functions
 - ▶ planning, moral judgment, and emotional control



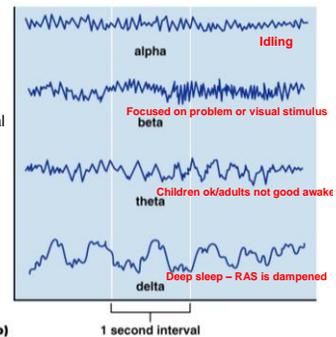
14-10

Electroencephalogram (EEG)

- ▶ Measures electrical activity of **cerebral cortex**
 - ▶ 1-2 mm of cerebral cortex = > 100,000 neurons
- ▶ Used to diagnose brain activity, death, diseases

Types of Brain Waves

- **Alpha waves** (parietal & occipital lobes) with person awake, relaxed, eyes closed
- **Beta waves** (strongest from frontal lobes) evoked by visual stimuli and mental activity
- **Theta waves** temporal & occipital lobes
- **Delta waves** (cerebral cortex)
 - adult sleep and in awake infants
 - awake adult indicates brain damage

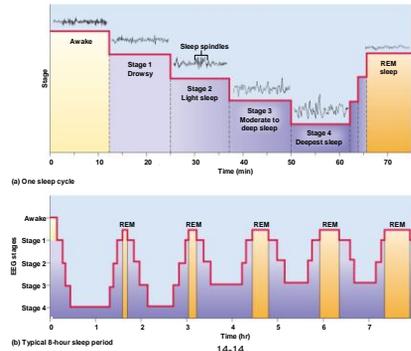


8-24

Sleep

- ▶ 2 types of sleep are recognized
 - ▶ **REM - rapid eye movement**
 - ▶ EEGs are similar to awake ones (nonsynchronized)
 - ▶ Dreams
 - ▶ Hypothalamus does not thermoregulate
 - ▶ Loss of tone of skeletal muscles
 - ▶ **Non-REM** has delta waves
 - ▶ Appears to be crucial for consolidation of short- into long-term memory??
 - ▶ EEG synchronized – lots of brain activity

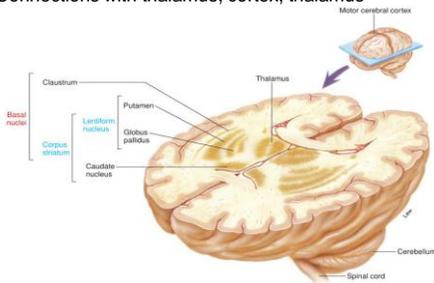
Sleep Stages



8-27

Basal Nuclei (ganglia)

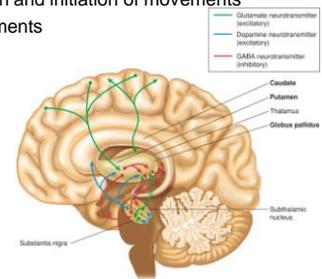
- ▶ Distinct masses of cell bodies located deep inside cerebrum
- ▶ **Function in control of voluntary movement**
- ▶ Connections with thalamus, cortex, thalamus



8-29

Basal Nuclei – Motor Control

- ▶ BN receive input from **motor cortex** areas
- ▶ Send info back to cortex via thalamus
- ▶ Assists cortex in selection and initiation of movements
- ▶ Inhibits unwanted movements



8-30

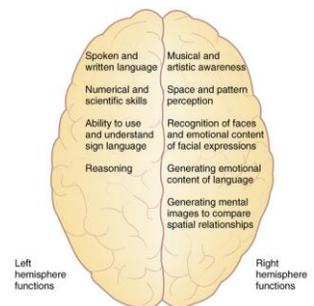
- ▶ Each cerebral hemisphere controls movement on opposite side (contralateral) of body
 - ▶ And receives sensory info from opposite side of body
 - ▶ i.e. decussation of fibers (crossing over)
- ▶ Hemispheres communicate thru the **corpus callosum** which contains about 200 million fibers

8-31

Cerebral Lateralization

Specialization of each hemisphere for certain functions

- ▶ **In fact each lobe has functions that same lobe on opposite side does not possess**
- ▶ **Left hemisphere possesses language and verbal skills**
- ▶ **Right hemisphere is best at spatial skills**

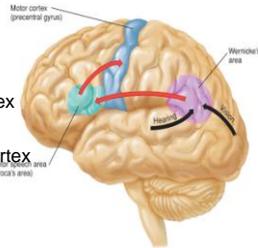


8-32

Language

- ▶ **Wernicke's area** is involved in language comprehension
- ▶ **Broca's area** is necessary for speech

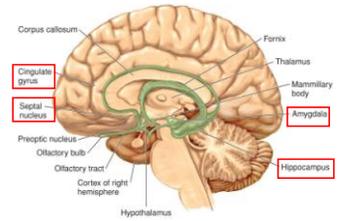
- ▶ Words originate in Wernicke's
- ▶ It receives info from visual cortex
- ▶ It receives info from auditory cortex
 - ▶ To speak – sent to Broca's
 - ▶ Broca's sends info to motor cortex (controls jaw muscles)



8-33

Limbic System (The Emotional Brain)

- ▶ **Forebrain nuclei & fiber tracts that ring brain stem**
- ▶ **Influences rage, aggression, fear, feeding, sex, envy, jealousy goal-directed behaviors**
- ▶ **No connection w/ cerebral cortex:**
 - ▶ why no conscious control of emotions???
- ▶ **Fibers do connect with hypothalamus**



8-34

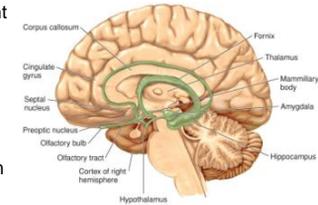
Learning & Memory

- ▶ Includes **short- and long-term memory**
 - ▶ Involves many brain regions
 - ▶ Long-term memory requires RNA/protein synthesis
- ▶ **Short term:** 7 – 12 pieces of info. Easily "lost" if not used
 - ▶ Working memory (is short term) – bits of info that can be used – i.g., look both ways
- ▶ **Two types of long-term memory:**
 - ▶ **Non-declarative (reflexive or implicit):** memories of simple skills and conditioning – doesn't require conscious processes. e.g., tie a shoelace – chop sticks – rolling a joint!
 - ▶ **Declarative (Explicit) memory:** requires conscious thought

8-36

Declarative Memory

- ▶ **Hippocampus** is critical for acquiring new recent memories
 - ▶ And consolidating short- into long-term memory
- ▶ **Amygdala** involved in fear memories
- ▶ Storage of memory is in cerebral hemispheres
- ▶ Higher order processing and planning occur in **prefrontal cortex**

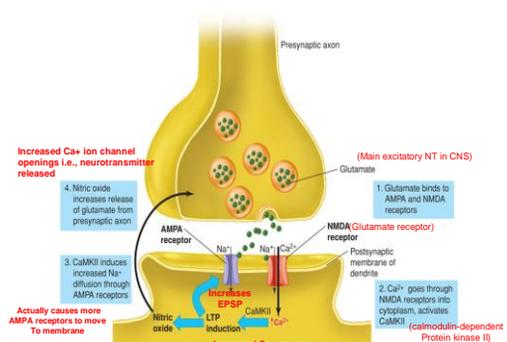


8-37

Long-Term Potentiation (LTP)

- ▶ Persistent increase in synaptic strength (believed to underly memory)
- ▶ During learning (animal studies)
 1. transcription (mRNA) protein synthesis
 2. dendritic spines change shape (post-synaptic)
 3. No. and size of presynaptic receptors increases
 4. More neurotransmitter released by Presyn.

Long-Term Potentiation (LTP) (Hippocampus)



8-38

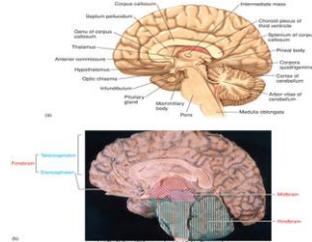
8-38

Brain Structures and their Functions

8-41

Thalamus and Epithalamus

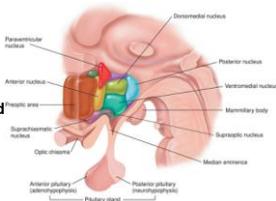
- ▶ Located at base of cerebral hemispheres
- ▶ **Thalamus** : a relay center thru which all sensory info (except olfactory) passes to cerebrum
- ▶ **Epithalamus** contains the **choroid plexus** which secretes CSF
 - ▶ Also contains **pineal gland** which secretes **melatonin**



8-42

Hypothalamus

- ▶ Controls homeostasis
- ▶ Contains nuclei for hunger, thirst, body temperature
- ▶ Regulates sleep, emotions, sexual arousal, anger, fear, pain and pleasure
- ▶ Controls hormone release from anterior pituitary w/ releasing and inhibiting hormones
- ▶ Produces ADH and oxytocin
- ▶ Coordinates sympathetic and parasympathetic actions



8-43

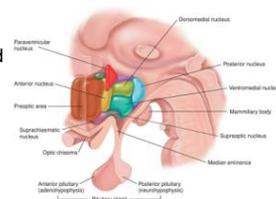
Circadian Rhythms

- ▶ Body's daily rhythms
- ▶ Regulated by (**suprachiasmatic nucleus SCN**) of hypothalamus
 - ▶ SCN is the master clock
 - ▶ Adjusted daily by light from eyes
 - ▶ Controls **pineal gland** secretion of **melatonin** which regulates circadian rhythms

8-45

Pituitary Gland

- ▶ Is divided into anterior and posterior lobes
- ▶ **Posterior pituitary** (neurohypophysis) stores and releases **ADH (vasopressin)** and **oxytocin**
- ▶ **Anterior pituitary** adenohypophysis) 6 hormones



8-44

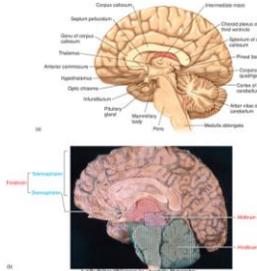
Midbrain (mesencephalon)

- ▶ Contains:
 - ▶ **Corpora quadrigemina**:
 - **Superior colliculi** -- relay for visual reflexes
 - **Inferior colliculi** -- relay for auditory reflexes
 - ▶ **Cerebral peduncles** (anterior to cerebral aqueduct)
 - **Red nucleus** and **substantia nigra** -- involved in motor coordination

8-46

Hindbrain

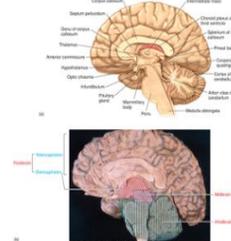
- Contains pons, cerebellum and medulla
- Brain stem = midbrain, medulla oblongata, & pons



8-48

Cerebellum

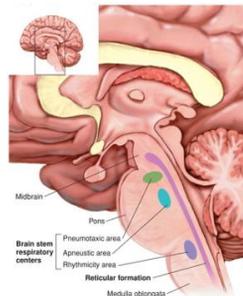
- 2nd largest structure in brain containing 50 billion neurons!!
- Receives sensory input from proprioceptors (joint, tendon and muscle receptors from body) and receptors from inner ear
- Involved in coordinating skeletal muscle movements
 - receives input from cerebrum



8-50

Respiratory Control Centers in Brain Stem

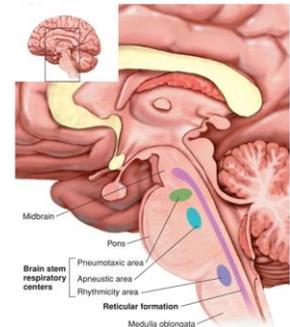
- Contains several nuclei of cranial nerves
- And 3 important respiratory control centers
 - Apneustic and pneumotaxic centers in pons
 - Rhythmicity center in medulla oblongata



8-49

Medulla oblongata

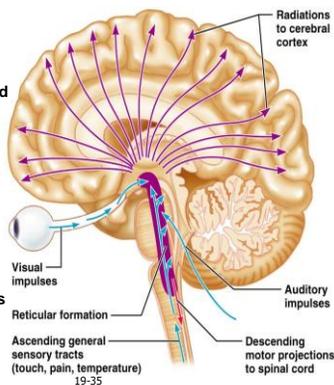
- Contains all tracts that pass between brain and spinal cord
 - nuclei of cranial nerves
 - Respiratory nuclei
 - Cardiovascular nuclei (vital centers)



8-51

Reticular Formation

- RAS** – information sent to Cerebral cortex
- Keeps brain conscious and alert
 - Arousal
 - Muscle tone
 - Breathing
 - BP
 - Pain modulation
- Filters out repetitive and weak stimuli
- Cholinergic (Ach) neurons - keep CC awake
- GABA inhibits - sleep



19-35

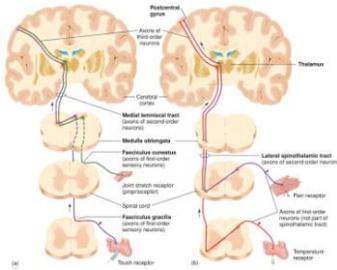
Spinal Cord Tracts

- Sensory info from body travels to brain in **ascending spinal tracts**
 - cutaneous receptors
 - proprioceptors
 - visceral receptors
- Motor activity from brain travels to body down **descending tracts**

8-54

Ascending Spinal Tracts

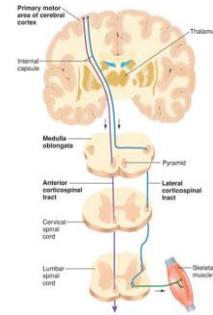
- ▶ Ascending sensory tracts **decussate** (cross)
- ▶ Same for most descending motor tracts from brain



8-55

Descending Spinal Tracts

- ▶ Are divided into 2 major groups:
 - ▶ Pyramidal
 - ▶ Non-pyramidal
- 1. **Pyramidal (corticospinal) tracts** descend from cerebral cortex to spinal cord without synapsing
 - ▶ Originate in **motor cortex**
 - ▶ Function in control of fine movements



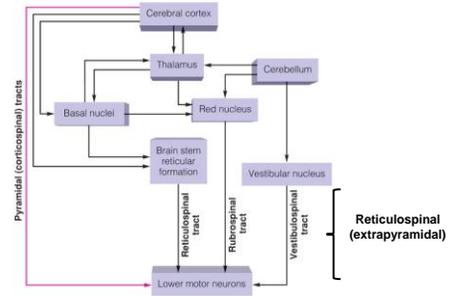
8-56

Descending Spinal Tracts

- Extrapyramidal (Reticulospinal) tracts** descend with many synapses
 - do not travel thru pyramid
 - controlled by motor circuits of basal nuclei
 - ▶ Influence movement indirectly

8-57

Descending Spinal Tracts



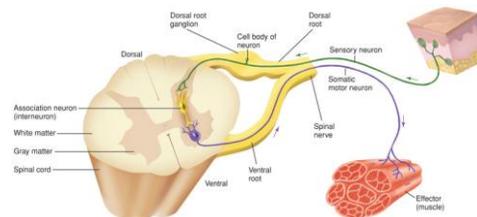
8-58

Peripheral Nervous System (PNS)

- ▶ Consists of nerves that exit from CNS and spinal cord, and their **ganglia**, and **sensory receptors**
- ▶ Cranial Nerves (Part of PNS)
- ▶ Consists of 12 pairs of nerves
 - ▶ 2 pairs arise from neurons in forebrain
 - ▶ 10 pairs arise from midbrain and hindbrain neurons
 - ▶ Most are mixed nerves containing both sensory and motor fibers

8-61

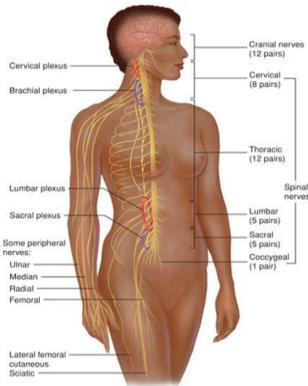
- ▶ Are mixed nerves that separate next to spinal cord into dorsal and ventral roots
 - ▶ **Dorsal root** composed of sensory fibers
 - ▶ **Ventral root** composed of motor fibers



8-62

Spinal Nerves

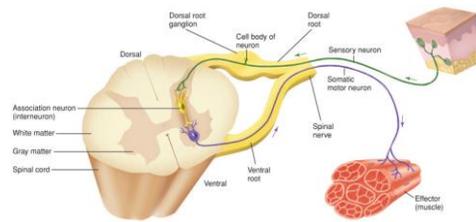
- ▶ There are 31 pairs:
- ▶ 8 cervical pairs,
- ▶ 12 thoracic pairs,
- ▶ 5 lumbar pairs,
- ▶ 5 sacral pairs,
- ▶ 1 coccygeal pair



8-63

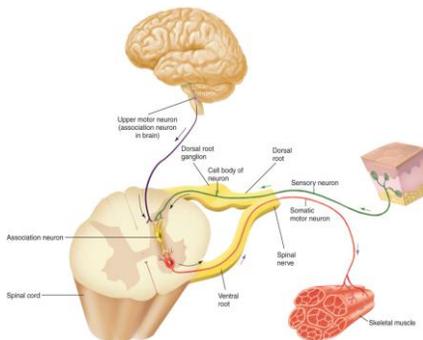
Spinal Reflex Arc

- ▶ Simple sensory input, motor output circuit involving only peripheral nerves and spinal cord
- ▶ Sometimes arc has an association neuron between sensory and motor neuron

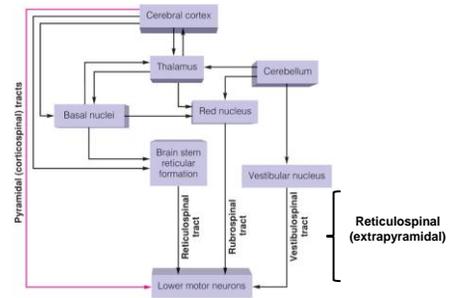


8-64

Activation of Somatic Motor Neurons



Descending Spinal Tracts



8-58