Objectives:

1. Recognize the 6 brain regions & their primary functions.

2. Brain Blood Supply, Blood-Brain Barrier, and Brain Injuries

3. Brain Imaging Techniques Used in Medicine

Anatomy Review!

CNS = brain & spinal cord
(where majority of neurons located).

PNS = other nervous tissue outside CNS
Part 1. Six Brain Regions & Their Functions

Anatomy Review!

1. _______________________
2. _______________________
3. _______________________
4. _______________________
5. _______________________
6. _______________________

Fig. 8.1

Ques:
What 3 brain regions make up the “brainstem”

__________________, ________________, ________________

Region 1: Cerebrum (Forebrain)

Fig 8.6
Region 1: Cerebrum (Forebrain)

6 Cerebral Lobes and their major cortices

1. Frontal Lobe:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

2. Parietal Lobe:

___________________________________________________________________________

3. Temporal Lobe:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

4. Occipital Lobe:

___________________________________________________________________________

5. Insula Lobe:

___________________________________________________________________________

Precentral gyrus = primary motor cortex of frontal lobe which has motor control of body.

Postcentral gyrus = primary somatosensory cortex of parietal lobe that receives sensory info from body (dermatome)

DO NOT need to memorize figure!
**Cerebrum & Language**

- **Broca’s area:**
  - 
  - 
  - 

- **Wernicke’s area:**
  - 
  - 
  - 

**Aphasias** = communication disorder that results from damage or injury to language parts of the brain.

**Broca’s aphasia** = (non-fluent aphasia)

**Wernike’s aphasia** = (fluent aphasia)
Cerebrum & Sleep

2 Sleep Categories:
1. non-REM = stages 1 – 4 (80% of sleep)

2. REM = stage 5 (20% of sleep)
   - Limbic (emotional) system remains active
   - GABA inhibition of:
     a. awareness of unimportant stimuli
     b. skeletal muscle (voluntary) movement

During sleep the reticular activating system (RAS) can arouse you with excitatory neurotransmitters if important stimuli sensed. (see RAS later)

Cerebral Basal Nuclei (Ganglia) & Motor function:
- Nuclei located deep within the cerebrum
- Frontal motor cortex neurons communicate with basal nuclei
- Basal nuclei send inhibitory signals to thalamus which send signals back to frontal motor cortex.

Fig 5.11
Cerebral Basal Nuclei (Ganglia) & Motor function:

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**MOTOR Effects of cerebral basal nuclei:**
- Maintaining purposeful motor activity but inhibit unwanted activity
- Monitor & coordinate slow sustained muscle contractions

1. Claustrum: ______________________________________________
2. Putamen: _______________________________________________
3. Globus pallidus: __________________________________________
4. Caudate nucleus: _________________________________________

[Degeneration of neurons here associated w/ *Huntington’s Chorea*]
Cerebral basal nuclei & Emotions : The limbic system
Cerebral nuclei work with hypothalamic and thalamus nuclei to process primal emotions & behavioral drives.

**Papez Circuit** = flow of info between cerebral nuclei & diencephalon (thalamus, & hypothalamus)

Limbic effects of cerebral nuclei:
**Amygdala** : __________________________________________

**Cingulate gyrus** (above corpus callosum) = __________________________

**Septal nuclei** (below corpus callosum) = __________________________

Diencephalon structures:
**Hypothalamus** = has nuclei for the 4 F’s 1. ________________, 2. ________________, 3. ________________, 4. ________________.

**Thalamus** = __________________________


Review

Brain Region 1: Cerebrum
- Cerebral lobe cortexes and their functions
  (frontal, parietal, temporal, occipital, and insula)
- Cerebral division of motor and sensory perception in body
  (precentral an postcentral gyrus.
- Cerebrum & language (broca's and wernike's areas, and aphasias
- Cerebrum & sleep
- Cerebral nuclei & motor function
- Cerebral nuclei, diencephalon, & emotions (limbic system)

Brain Region 2: Diencephalon (forebrain)
- Thalamus = relay station that receives and sorts sensory (ascending) info & relays to appropriate cerebral cortex.
- Hypothalamus = has many neurons with many functions!
Brain Region 2: Diencephalon (forebrain)

Hypothalamus nuclei & functions:
- Link between nervous & endocrine systems
- Controls pituitary gland
- Controls autonomic sympathetic response of body - adrenal medulla's production of epinephrine during fight/flight.
**Hypothalamus nuclei & functions:**

*Has nuclei that functions in homeostasis:*

**Supraoptic & Paraventricular nuclei** both produce:

> _________________________________
> _________________________________

**Anterior nucleus:** regulates body temp (thermoregulation)

**Ventromedial nucleus:**

> _________________________________
> the 4 F’s: ____________, ______________, ____________, & _______________

**Lateral nucleus:** = ______________________________

**Preoptic nucleus:** = ______________________________

**Suprachiasmatic nucleus:** = ______________________________

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**Brain Region 3: Midbrain**

1. **Superior colliculus** = ______________________________
2. **Inferior colliculus** = ______________________________

3. **Red nucleus** = motor coordination of postural muscles.

4. **Substantia nigra:**
   > Nigrostantial dopamine system for
   > ______________________________
   > Mesolimbic dopamine for
   > ______________________________

5. Part of RAS
Brain Regions 4 & 5: Pons & Medulla (hindbrain)

Pons
- Some of RAS
- 2 autonomic respiratory centers:
  - ______________________
  - ______________________

Medulla oblongata
- Some of RAS
- regulates involuntary sneezing, swallowing, gagging, and vomiting
- Primary site for crossover of motor control (decussation of pyramids)

- Has 3 autonomic life-support centers:
  1. ______________________________
  2. ______________________________
  3. ________________________________

The reticular activating system (RAS)
The reticular activating system (RAS)

= system that distinguishes between unimportant and important (ex. life-threatening or saving) stimuli.

> In Midbrain, Pons, and Medulla (brainstem), thalamus & hypothalamus.

> Involves 4 neurotransmitters to arouse or inhibit cerebrum:

**Excitatory (wakefulness or awareness)**
1. ACh
2. Monoamines (dopamine & norepinephrine)
3. Hypocretin-1

**Inhibitory (promotes sleep or decreased awareness)**
4. GABA

Read Clinical App Pg 139 and **ONLINE**: The effect of drugs on RAS.

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**Clinical Applications**

Abused drugs may produce positive reinforcement through the activation of the mesolimbic dopamine system, causing dopamine to be released in the nucleus accumbens. **Nicotine** from tobacco stimulates dopamine-releasing neurons by means of its stimulation of nicotinic ACh receptors (chapter 4). **Heroin and morphine** activate the dopamine-releasing neurons by means of their interaction with **opiod receptors** in these neurons. **Cocaine** and **amphetamines** act in the nucleus accumbens to inhibit the reuptake of dopamine into presynaptic axon terminals (chapter 4). Ironically, drug abuse can desensitize neurons to dopamine, and so lessen the rewarding effect of dopamine release. This can lead to drug tolerance, so that higher amounts of the drug are needed to get a reward.

Online Clinical App also discusses Valium, Benadryl, Claritin.
Many drugs act on the RAS to promote either sleep or wakefulness. Amphetamines, for example, enhance dopamine action by inhibiting the dopamine reuptake transporter, thereby inhibiting the ability of presynaptic axons to remove dopamine from the synaptic cleft. This increases the effectiveness of the monoamine-releasing neurons of the RAS, enhancing arousal. The antihistamine Benadryl, which can cross the blood-brain barrier, causes drowsiness by inhibiting histamine-releasing neurons of the RAS. (The antihistamines that don’t cause drowsiness, such as Claritin, cannot cross the blood-brain barrier.) Drowsiness caused by the benzodiazepines (such as Valium), barbiturates, alcohol, and most anesthetic gases is due to the ability of these agents to enhance the activity of GABA receptors. Increased ability of GABA to inhibit the RAS then reduces arousal and promotes sleepiness.

Brain Region 6: Cerebellum (also hindbrain)

- Receives sensory info from proprioceptors (in joints & muscles) to coordinate muscle movement for balance & posture.
- Stores learned motor patterns (“muscle memory”)

Read Clinical App Pg 138: Damage to cerebellum and ataxia.
Cerebella ataxia

Clinical applications

Damage to the cerebellum produces ataxia—a lack of coordination resulting from errors in the speed, force, and direction of movement. The movements and speech of a person with ataxia may resemble those of someone who is intoxicated. A person with damage to the cerebellum may reach and miss an object, and then attempt to compensate by moving the hand in the opposite direction. This can produce back-and-forth oscillations of the arm.

= “intention tremors”

https://youtu.be/ZkM-1MLn0_A?t=1

Review

- **6 Brain Regions**
  - Know cortices of cerebrum, wernike’s and broca’s areas.
    > aphasia
  - **Diencephalon** (Thalamus & hypothalamus functions)
  - **Midbrain & nuclei**
    - superior/inferior colliculus
    - Red nucleus
    - Substantia nigra
    - RAS
  - **Pons** (pneumotaxic and apneustic centers, RAS)
  - **Medulla oblongata** (cardiac, vasomotor, respiratory centers & RAS)
  - **Cerebellum**
### CNS Meninges

CNS Meninges = membranes the cover the brain & spinal cord.

#### 3 Meninges:

1. Dura mater = ______________________

2. Arachnoid mater = ______________________

3. Pia mater = ______________________

### Common drugs that are lipid-soluble & cross BBB...

- Ethanol
- Nicotine
- caffeine
- Tetrahydro-cannabinol (THC)
- anesthetics

### Brain blood supply:

- Uses 15% of arterial blood supply
- Uses 50% of blood glucose!
- Few minutes of “ischemia” = brain tissue death!

- **Ischemia** = interruption in blood flow to an organ or tissue.
- **Stroke** = loss of blood flow to brain

Necrosis typical of Ischemic stroke
Acute Cerebral Hemorrhage (Hematoma)

Blunt force blow to head can rupture small blood vessels (hemorrhage) causing formation of hematoma (blood pocket).

Fluid buildup causes damaging pressure necrosis.


Blunt force injury to brain and hemorrhage and/or brain swelling

Ex. Coup-Contrecoup brain injury:

Blunt force blow to one part of head causes brain to bounce within cranial cavity, hitting opposing side of skull.

Hard cranial bone damages soft brain tissue and can also cause hemorrhaging and hematomas.
Coup-Contrecoup brain injury:  https://youtu.be/BCDBs8RvIRg

1) X-Ray = single x-ray beams sent through body part, which produces image showing high density tissue (bone or contrast media) as white and lower density tissues (soft tissue) as variations of gray, and air spaces as black.
   • Relatively cheap (national average for chest x-ray = $100, but depending on city and insurance can be more or less)
   • Best for viewing bone
   • Poor for viewing soft tissue

READING ASSIGNMENT
Part 3. Brain Imaging Techniques
2) CT Scan = multiple x-ray beams sent through body, and tissue of different densities are analyzed by a computer to produce high quality images of tissues. Can show “slices” through a tissue. (computed tomography)

- Expensive (national average cost = $1,200, but depending on city and insurance can be more or less)
- Good for viewing soft tissue

3) MRI Scan = uses a powerful magnetic field and pulses of radio wave energy to make pictures of tissues. (magnetic resonance imaging)

- VERY expensive (national average cost = $2,600, but depending on city and insurance more or less)
- BEST for viewing high detail in soft tissue
- Not safe for use in patients with cochlear or pacemaker implants (etc...)
4) **PET scan** = uses radioactive glucose tracer to determine how tissues are working. (positron emission tomography)

- VERY expensive (national average cost = $1,600 – 4,000, but depending on city and insurance more or less)
- Can tell you if tissues or organs are functioning normally

5) **EEG** = Brain neuron activity measured with electrodes placed on scalp. (electroencephalogram)
Review

CNS meninges

Blood flow to brain

Hematomas and coup-contracoup brain injuries

Brain imaging techniques
- X-Ray
- CT scan
- MRI scan
- PET scan
- EEG

Part 4. Spinal chord structure, spinal roots, and spinal nerves.

The Spinal Chord
- is part of CNS

- Has 4 paired regions:
  1. Cervical (C1-C8)
  2. Thoracic (T1-T12)
  3. Lumbar (L1 – L5)
  4. Sacral (S1 – S5)
  5. Coccygeal (1 pair)

Solid spinal cord ends ~L2 and branches into bundle of separate Lumbar & Sacral nerves called cauda equina (horse’s tail).
White matter = myelinated neurons in brain and spinal cord. Functions to transmit info from one place to another.

- In brain – white matter found interior
- In spinal chord – white matter exterior

Gray matter = pigmented neurons found in brain & spinal cord. Function as integration centers where info is interpreted and motor commands made.

- In brain – gray matter in outer cortexes and cerebral nuclei center.
- In spinal chord – gray matter in center marks end of CNS, has butterfly shape.

Dorsal horn of spinal cord = receives sensory (afferent) info from body.
Ventral horn of spinal cord = delivers motor (efferent) commands to muscles/glands

> horns lead to dorsal & ventral roots (outside cord), which is start of PNS.
- dorsal root has enlarged ganglion – where cell bodies of sensory neuron cell located.
> Roots merged into mixed spinal nerves (contain both sensory & motor info.)
Dorsal spinal roots receive sensory info. 
**Dermatome** = Skin’s sensory body map.

1. **Cervical (C1-C8)**
   - back of head
   - neck & shoulders
   - dorsal & lateral arms

2. **Thoracic (T1 – T12)**
   - torso

3. **Lumbar (L1 – L5)**
   - lower back
   - anterior legs

4. **Sacral (S1 – S5)**
   - groin & anus
   - posterior legs

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**Dermatome & Shingles**

“Shingles” = painful skin blisters & rashes that develop, usually on one side of body due to childhood exposure to chickenpox virus (varicella zoster), which lies dormant in dermatome.

**Virus** lies dormant in dermatome for years, reactivated later in life or w/immunosuppression.

There is now a Shingles vaccine.
Ascending & Descending Tracts of Spinal Cord

• Tracts of axons carry information between spinal nerves and brain

1. Ascending tracts
   – carry sensory information up to the brain
   • Originate in spinal cord
   • Sorted at thalamus
   • End in somatosensory cortex (postcentral gyrus)
   – **Ex. spinothalamic tracts**
     • Carry signals to thalamus

Clinical App: Babinski reflex – in normal infants or adults with corticospinal tract damage.

Fig 5.17

2. Descending tracts
   – carry motor commands from brain to motor neurons
   – **Corticospinal (pyramidal) tracts**
     • Originate in primary motor cortex (precentral gyrus)
     • Sorted at thalamus
     • End in spinal cord
     • Important for complex voluntary movements.
   – **Extrapyramidal tracts**
     • Originate from various locations

Fig 5.18
The Babinski reflex is dorsiflexion (splaying) of toes when plantar surface of foot is stroked. Normal in babies, but abnormal in adults.

In adults, plantarflexion (curling) of toes is normal when stroke plantar surface of foot. Babinski reflex is abnormal.

**Review**

- **Spinal cord structure, spinal roots, and spinal nerves.**
  - diff division of white and gray matter between brain & spinal cord.
  - spinal cord has dorsal & ventral horn (sensory Vs motor info)
  - spinal horns give rise to spinal roots
  - dorsal root of spinal cord provides “dermatome”

- **Ascending & Descending tracts of spinal cord.**