BIO130 Chapter 14 The Brain and Cranial Nerves Lecture Outline

Brain structure
1. Cerebrum
   Hemispheres: left & right
   Cerebral cortex
   Gyri
   Sulci
   Fissures
   Longitudinal fissure
   Corpus callosum
   Lobes
   Central sulcus
   Parietal lobes
   Frontal lobes
   Lateral sulcus
   Frontal lobes
   Temporal lobes
   Parieto-occipital sulcus
   Parietal lobes
   Occipital lobes
   Insula
   Lateral sulcus
2. Cerebellum
   Hemispheres: left & right
   Vermis
   Cerebellar cortex
   Folia
   Primary fissure
   Anterior & posterior lobes
3. Diencephalon
   Epithalamus
   Thalamus
   Hypothalamus
4. Brain stem
   Mesencephalon
   Pons
   Medulla oblongata
5. Ventricles
   Lateral ventricles
   Cerebral hemispheres
   Third ventricle
   Diencephalon
   Fourth ventricle
   Pons & cerebellum
   Central canal
6. Brain protection
   1. Cranial bones
      Occipital
      Frontal
      Sphenoid
      Ethmoid
      Parietals
      Temporals
   2. Cranial meninges
      A. Dura mater
Dural folds
1. Falx cerebri
   Longitudinal fissure
2. Tentorium cerebelli
   Cerebrum & cerebellum
3. Falx cerebelli
   Cerebellar hemispheres
B. Arachnoid
   1. Arachnoid membrane
   2. Arachnoid trabeculae
   CSF
C. Pia mater
   Astrocytes
3. Cerebrospinal fluid (CSF)
   Functions:
   -cushion
   -support
   -diffusion
   Choroid plexus
   Ependymal cells
   Capillaries
   Arachnoid granulations
   Hydrocephalus
4. Blood brain barrier
   Endothelial cells
   Tight junctions
   Astrocytes
   Inflammation
Brain Anatomy: Functional regions
Brainstem
   Medulla oblongata, Pons, Mesencephalon
1. Medulla oblongata
   Functions:
   -Sensory relay
   -Autonomic reflexes
   -Visceral motor
White matter
   Ascending & descending tracts
Gray matter
   1. Sensory & motor nuclei
      Cranial nerves VIII - XII
      motor: pharynx, neck, back
      viscera
      sensory: inner ear
   2. Autonomic nuclei
      1. Cardiovascular centers
         A. Cardiac center
         B. Vasomotor center
      2. Respiratory rhythmicity
         centers
      3. Relay stations
         A. Nucleus gracilis &
         Nucleus cuneatus
         Somatic sensory to
Thalamus
B. Olivary nucleus
Stretch and
Somatic motor to
Cerebellum
C. Solitary nucleus
Visceral sensory to
Autonomic centers

2. Pons
Functions:
- Connection
White matter
Ascending tracts
sensory: medulla to thalamus
Descending tracts
motor: cerebrum & cerebellum to
nerves
Gray matter
1. Relay centers
to/from cerebellum
2. Sensory & motor nuclei
Cranial nerves V - VII
jaw, face, inner ear
3. Apneustic & pneumotaxic centers
respiration

3. Midbrain / Mesencephalon
Functions:
- Process auditory & visual
- Somatic motor reflexes
- Consciousness
White matter
Cerebral peduncles
Descending tracts
voluntary somatic motor
Ascending tracts
sensory to thalamus
Gray matter
1. Superior colliculi
visual
2. Inferior colliculi
auditory
3. Red nuclei & substantia nigra
subconscious motor to upper limbs
4. Reticular formation
Reticular Activating System (RAS)
consciousness
5. Motor nuclei
Cranial nerves III & IV
eyes

4. Diencephalon
Functions:
- Integrate conscious and subconscious
A. Epithalamus
1. Pineal gland
Melatonin
Day/Night
2. Choroid plexus
CSF
B. Thalamus
Functions:
- Relay
- Filter
Thalamic nuclei
- relay sensory to cortex
- relay motor to cortex
- emotion awareness
- memory
- limbic system
C. Hypothalamus
Functions:
- Autonomic functions
- Pituitary hormones
- Emotions
Autonomic centers
visceral activities
Tuberal nuclei
hormones to control pituitary
Supraoptic nucleus
Antidiuretic hormone (ADH)
water retention
Paraventricular nucleus
Oxytocin
smooth muscle
Mammilary bodies
feeding reflexes
Preoptic areas
thermostat
Suprachiasmatic nuclei
circadian rhythms

5. Cerebellum
Functions:
- Balance
- Equilibrium
White matter
1. Arbor vitae
cortex & nuclei to peduncels
2. Superior peduncle
to Midbrain, Diencephalon, Cerebrum
3. Middle peduncle
to Pons
4. Inferior peduncle
to Medulla and cord
Gray matter:
1. Cerebellar cortex
Purkinje cells
2. Cerebellar nuclei
- maintain balance & equilibrium
- coordination
Ataxia
Limbic system
Cerebrum & diencephalon
1. Amygdala
-fear response
-link emotion with memory

2. Hippocampus
-memory & learning

3. Cingulate gyrus
-emotion gestures
-resolve mental conflicts

6. Cerebrum
Functions:
-Interpret sensory info
-Control voluntary motor
-Intellectual & emotional processing

White matter:
1. Association fibers
   same hemisphere
2. Commissural fibers
   between hemispheres
3. Projection fibers
   to lower brain

Gray matter:
1. Basal nuclei (ganglia)
   -muscle tone
   -learned motor

2. Cerebral cortex
   A. Primary motor cortex
      precentral gyrus
   B. Primary somatosensory cortex
      postcentral gyrus
   C. Visual cortex
      occipital lobes
   D. Auditory cortex
      temporal lobes
   E. Olfactory cortex
      temporal lobes
   F. Gustatory cortex
      insula
   G. Association areas
   H. Integrative centers
      1. Wernicke’s area / 
         General interpretive area
         left hemisphere
         -interpretation of visual or
           auditory cues
      2. Broca’s area / Speech center
         left hemisphere
         -motor for speech
      3. Prefrontal cortex
         anterior frontal lobes
         -prediction & estimation

Left hemisphere:
   language, math, logic

Right hemisphere
   sensory interpretation, emotions, spatial
   visualization

Diseases
Epileptic seizure
CEREBRUM
- Conscious thought processes, intellectual functions
- Memory storage and processing
- Conscious and subconscious regulation of skeletal muscle contractions

DIENCEPHALON
THALAMUS
- Relay and processing centers for sensory information

HYPOTHALAMUS
- Centers controlling emotions, autonomic functions, and hormone production

MESENCEPHALON
- Processing of visual and auditory data
- Generation of reflexive somatic motor responses
- Maintenance of consciousness

pons
- Relays sensory information to cerebellum and thalamus
- Subconscious somatic and visceral motor centers

CEREBELLM
- Coordinates complex somatic motor patterns
- Adjusts output of other somatic motor centers in brain and spinal cord

MEDELLA OBLONGATA
- Relays sensory information to thalamus and to other portions of the brain stem
- Autonomic centers for regulation of visceral function (cardiovascular, respiratory, and digestive system activities)

General Properties of Higher Center:
- Headquarters at cerebral cortex
- Motor commands can be issued in the absence of a sensory stimulus
- Responses to stimuli are modified on the basis of planning, memory, and learning
**Functional Parts of the Brain**

**Brainstem** - connects brain and spinal cord
- consists of three parts: Medulla oblongata, Pons & Mesencephalon

![Diagram of brainstem](image)

**Medulla Oblongata**
- Connects to the top of the spinal cord, serves as a relay center for sensory information, controls many autonomic reflexes and many visceral functions

**White matter:**
- ascending and descending tracts, link brain to spinal cord

**Gray matter:** (three groups of nuclei)
1. sensory and motor nuclei of cranial nerves VIII-XII (8-12)
   - motor: to muscles of pharynx, neck, back, visceral organs of thoracic and peritoneal cavities
   - sensory: from inner ear
2. autonomic nuclei controlling visceral activities (autonomic reflex centers)
   a. cardiovascular centers:
      - cardiac center: adjusts heart rate and strength of contraction
      - vasomotor center: adjusts flow of blood through tissues
   b. respiratory rhythmicity centers: sets pace of respiration
3. relay stations along sensory and motor pathways:
   - nucleus gracilis and nucleus cuneatus: transmit somatic sensory (skin, proprioception) info to thalamus (filter and relay center)
   - olivary nuclei: transmit sensory info about muscle stretch and joints and info about somatic motor commands from cerebral motor centers to cerebellum
   - solitary nucleus: integrates and relays visceral sensory info to autonomic centers in medulla and other brain areas
**Pons** (means "bridge")

*Connects the cerebellum to the rest of the brain, connects higher and lower brain centers*

**White matter:**
- conduction pathway between higher and lower brain centers
  - ascending tracts: sensory from medulla (nucleus cuneatus and nucleus gracilis) to thalamus
  - descending tracts: motor from cerebrum or cerebellum to cranial or spinal nerves

**Gray matter:**
- relay centers for info to (sensory) and from (motor) cerebellum
- sensory and motor nuclei of cranial nerves V-VII (5-7)
  - innervate jaw muscles, anterior surface of face, sense organs of inner ear
- apneustic and pneumotaxic centers: nuclei to control rate and depth of respiration, act to modify activity of respiratory rhythmicity center in medulla

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**Midbrain/Mesencephalon**

*Processes visual and auditory input, generates somatic motor reflexes, maintains consciousness*

**White matter:**
- cerebral peduncles, conduction between higher and lower brain centers
  - descending tracts: voluntary somatic motor to cerebellum (via pons) and spinal cord
  - ascending tracts: sensory to thalamus

**Gray matter:**
- superior colliculi: integrate visual info, initiate reflex responses to visual stimuli
- inferior colliculi: integrate auditory info, initiate reflex responses to auditory stimuli
- red nuclei and substantia nigra: house subconscious somatic motor centers to affect upper limb position and control background muscle tone
- reticular formation: contains Reticular Activating System (RAS) headquarters to trigger alertness and attentiveness to maintain consciousness
- houses motor nuclei for cranial nerves III and IV (3-4) eye movements
Diencephalon

Functions in integration of conscious and subconscious sensory info and motor commands, consists of three parts:

Epithalamus
- pineal gland: produces melatonin: regulates day-night cycle & reproductive function
- choroid plexus (top of third ventricle): CSF production

Thalamus: process, relay, and filter sensory info
- thalamic nuclei: function as relay stations
  - relay sensory info to appropriate cerebral cortex for interpretation
  - relay motor info from cerebellum and basal nuclei to somatic motor areas of cerebral cortex
  - connect emotion centers in hypothalamus with frontal cortex of cerebrum for awareness of emotional states
- some memory processing
- houses some parts of limbic system (emotion, motivation, memory)

Hypothalamus: control autonomic functions, controls hormone release from pituitary, produces emotions / drives
- controls subconscious somatic motor to face: facial expressions accompanying emotions
- autonomic centers:
  - control autonomic nuclei in medulla and pons: heart rate, blood pressure, respiration, digestive activity
  - coordinate voluntary and autonomic functions
- tuberal nuclei: releases hormones that control the pituitary gland
  (coordinates activities of the nervous and endocrine systems)
- supraoptic nucleus: produces antidiuretic hormone (ADH): promotes water retention
- paraventricular nucleus: produces oxytocin: controls smooth muscle for labor and delivery, sperm emission
- mammillary bodies: control feeding reflexes
- preoptic areas: regulate body temperature, triggers reflexes in other brain areas to retain or shed heat
- suprachiasmatic nuclei: circadian rhythms (day-night cycles, 24 hr clock)
**Cerebellum**

Maintains balance and equilibrium through motor centers in brainstem, refines learned movement patterns

**White matter:**
- Arbor vitae: connects cortex and nuclei to peduncles
- Superior peduncle: link cerebellum to midbrain, diencephalon, and cerebrum
- Middle peduncle: link cerebellum to pons
- Inferior peduncle: Link cerebellum to medulla oblongata and spinal cord

**Gray matter:**
- Cerebellar cortex consisting of Purkinje cells
- Cerebellar nuclei
  - both function to provide involuntary coordination of ongoing body movements
  - both monitor all proprioceptive, visual, tactile, balance, and auditory sensations to
    1. adjust the postural muscles of the body
    2. coordinate rapid automatic adjustments that maintain balance & equilibrium
    3. program and fine tune movements controlled at the conscious and subconscious levels
    - refine learned movement patterns: regulates activity along motor pathways at the cerebral cortex, basal nuclei, and motor centers in the brainstem
    - compare motor commands with sensory input and performs adjustments to make movements smooth
**Cerebrum**

Localizes and interprets sensory info, controls voluntary and skilled skeletal muscle activity, performs intellectual and emotional processing

**White matter:**
- association fibers: connect neural cortex within same hemisphere
- commissural fibers: connect cortex between hemispheres (most in corpus callosum)
- projection fibers: pass through diencephalon to lower brain centers or cord

**Gray matter:**
- basal nuclei: subconscious somatic motor: control muscle tone and learned movement patterns
- cerebral cortex
  - primary motor cortex: somatic motor: voluntary control of skeletal muscles (in frontal lobes: precentral gyrus)
  - primary somatosensory cortex: somatic sensory: conscious perception of somatic sensory info (in parietal lobes: post central gyrus)
  - visual cortex: sight (in posterior of occipital lobes)
  - auditory cortex: hearing (in temporal lobes)
  - olfactory cortex: smell (medial inside of temporal lobes)
  - gustatory cortex: taste (in insula)
  - association areas: integrate sensory and motor info
  - integrative centers: direct complex motor or analytical functions, collect input from association areas and initiate responses