The Central Nervous System

- The brain is a center for:
- 1. registering sensations
- 2. correlating with stored information
- 3. making decisions
- 4. taking action.



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- Major parts of the brain cerebrum, cerebellum, brainstem
 - brain weighs about 3 pounds, more in anatomy students



- Longitudinal fissure separates 2 cerebral hemispheres
 - Fissures are deep grooves
 - sulci the shallow grooves
 - gyri are the elevated folds
 - surface layer of gray matter is called the cortex, squash, noodle

Cranial Meninges

- Dura mater -- outermost, tough membrane
 - outer periosteal layer against bone
 - forms dural venous sinuses draining blood from brain
 - supportive structure formed by dura mater
 - falx cerebri
- Arachnoid mater is spider web filamentous layer
- Pia mater is a thin vascular layer adherent to contours of brain
- The brain has a PAD around it that is continuous with the _____

Cranial Meninges



Brain Ventricles

Ventricles are Internal chambers within the CNS



Cerebrospinal Fluid

- Clear liquid fills ventricles and canals, it flows in the subarachnoid space
- Functions
 - buoyancy -- floats brain so it neutrally buoyant
 - protection -- cushions from hitting inside of skull
 - chemical stability -- rinses away wastes

Flow of Cerebrospinal Fluid

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- 1 CSF is secreted by choroid plexus in each lateral ventricle.
- 2 CSF flows through interventricular foramina into third ventricle.
- 3 Choroid plexus in third ventricle adds more CSF.
- 4 CSF flows down cerebral aqueduct to fourth ventricle.
- 5 Choroid plexus in fourth ventricle adds more CSF.
- 6 CSF flows out two lateral apertures and one median aperture.
- (7) CSF fills subarachnoid space and bathes external surfaces of brain and spinal cord.
- 8 At arachnoid villi, CSF is resorbed into venous blood of dural venous sinuses.

- Superior sagittal sinus Subarachnoid space Arachnoid villus
 - Choroid plexus
 - 7 ventricle Cerebral aqueduct Lateral aperture

- Median aperture

Central canal of spinal cord Subarachnoid space of spinal cord

- CSF is formed by the choroid plexuses and
- circulates through the: ventricles,
- down central canal of spinal cord to
- subarachnoid space of cord and brain,
- up to be absorbed by the arachnoid villi of the dural

Clinical

- If CSF cannot circulate or drain properly a condition called *hydro-cephalus* (water on the brain) develops.
 - fluid buildup causes increased pressure on the brain, either internally or externally
 - Surgically draining the ventricles and diverting the flow of CSF by an implanted shunt reduces the pressure

Blood-Brain Barrier

- Most materials entering CSF from the blood cannot leak through the tight junctions between the surrounding ependymal cells
 - permeable to lipid-soluble materials (alcohol, O2, CO2, nicotine and anesthetics)
- These constitute the *Blood-Brain barrier*, which permits certain substances to enter the fluid but excludes others thereby protecting the brain and spinal cord from harm

Brain Stem

Medulla Pons Midbrain Etc.

Medulla Oblongata

- Cranial nerves (IX- XII)
- Heart rate, respiratory rate
- Adjusts blood vessel diameter



• Reflex centers for coughing, sneezing, gagging, swallowing, vomiting, and hiccupping.

Pons

- Anterior bulge in the brainstem
- Pathways between cerebellum



- **Relays** nerve impulses related to voluntary skeletal movements from the cerebral cortex to the cerebellum
- Cranial nerves V- VIII

Midbrain



• <u>Substantia nigra sends inhibitory signals to thalamus</u> (degeneration leads to tremors of Parkinson disease)

Cerebellum



- Connected to brainstem
- Arbor vitae (tree of life) visible in sagittal section
- Sits atop the 4th ventricle

Cerebellum

- The cerebellum functions in the coordination of skeletal muscle contractions and in the *maintenance of normal muscle tone, posture, and balance.*
 - It compares motor output of the primary motor area to sensory data from body (proprioceptors, vision, cochlea, etc.)

Reticular Activating System (RAS)

• Throughout pons, midbrain & medulla

- Regulate balance
- & posture
- <u>Regulates sleep</u>
- & conscious attention
 - injury leads to irreversible coma





Thalamus, Hypothalamus and Epithalamus (houses pineal glanc The pineal secretes melatonin to influence diurnal cycles.8

THALAMUS

- Thalamus is located superior to the midbrain and serves as <u>relay station</u> for all sensory impulses, <u>except smell</u>, to the cerebral cortex
 - 1) medial geniculate (hearing),
 - 2) lateral geniculate (vision)

Hypothalamus

- Hypothalamus is found inferior to the thalamus
 - Is a relay station for *smell*.
 - Major regulators of homeostasis
 - It controls and integrates the autonomic nervous system, which regulates contraction of smooth muscle, cardiac muscle, and secretions of many glands.
 - Seat of rage & aggression, body temperature. hunger and the satiety, thirst,
 - Maintains the waking state and sleep patterns

Functions of Cerebrum Lobes

- Frontal contains voluntary motor for planning, mood, smell and social judgement
 Motor is in FRONT of a car
- Parietal integrates
 - it com-pairs
- Occipital is optical
- **Temporal** contains areas for hearing, emotional behavior, learning, memory, smell 21





- Masses of gray matter deep to cerebral cortex
- Involved in motor control & inhibition of tremors
- Great names for new born



- Loop of cortical structures surrounding deep brain
 amygdala, hippocampus, fornix & cingulate gyrus
- Amydala important in <u>emotions</u> and hippocampus in memory – the rest we are not sure about 23

EEG and Brain Waves





- Electroencephalogram (EEG) graphs brain waves
 - May be used to diagnose epilepsy and other seizure disorders
 - It may also provide useful information regarding sleep and wakefulness.
 - Can diagnosis brain death (two EEGs 24 hours apart) 24

Accidental Lobotomy of Phineas Gage

- Accidental destruction of both <u>frontal lobes</u>
- Personality change to an irreverent, profane person
- Neuroscientists believe planning, moral judgement, and emotional control are functions of the frontal lobe



Memory

- Information management requires learning, memory & forgetting (eliminating the trivia)
 - anterograde amnesia -- can not store new data
 - retrograde amnesia -- can not remember old data
- Hippocampus is important in organizing sensory & cognitive information into a memory
 - lesion to it causes inability to form new memories
- Cerebellum helps learn motor skills
- Amygdala important in emotional memory

Sensory Homunculus

• Demonstrates that the area of the cortex dedicated to the sensations of various body parts is proportional to how sensitive that part of the body is.



Motor Homunculus



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Language

- Includes reading, writing, speaking & understanding words
- Wernicke's area permits recognition of spoken & written language
- **Broca's area** generates motor program for larynx, tongue, cheeks & lips transmits that to primary motor cortex for action
- The *Gnostic* area (parietal lobe) integrates sensory interpretations with *memories* from most of the brain to formulate a common thought and devise a single response to the incoming information.

Language Centers



Aphasia

- <u>An impairment of the ability to use or comprehend</u> words usually due to stroke or brain injury.
- Lesions in Wernicke's & Broca's areas (usually on the left) are common types:
- Lesion to **Broca's** = Motor (nonfluent) aphasia
 - they know what they want to say but can't say it
 - Inability to coordinate the muscles controlling speech
 - (Your Boca Broka?)
- Lesion to **Wernicke's** = fluent aphasia
 - words are easily spoken but those used are incorrect
 - (Words are key)
- Anatomic aphasia (Inability to recognize anatomy) = temporary affliction of anatomy professors 31

PET Scans during a Language Task

Primary auditory cortex

Premotor area

Primary motor cortex





area





cortex 1 The word car is seen in the visual

cortex.

2. Wernicke's area conceives of the verb drive to go with it.

Broca's area

3.

compiles a

program to

speak the

word drive.

motor

Broca's area The primary motor cortex executes the program and the word is spoken.

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Cerebral Lateralization

- Left hemisphere is categorical hemisphere
 - specialized for spoken & written language, math & science
- Right hemisphere is representational hemisphere
 - perceives information more holistically, music and artistic skill
- Highly correlated with handedness
 - 91% of people right-handed with left side is categorical
- Lateralization develops with age
 - trauma more problems in males since females have more communication between hemisphere (corpus callosum is thicker posteriorly)
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CRANIAL NERVES

12 pairs of nerves from the brain

Numbering the Nerves

- In classic anatomy we use Roman numerals to number the cranial nerves:
- *I* is one, *II* is two, *III* is three, *IV* is four, *V* is five, *VI* is six, *VII* is seven, *VIII* is eight, *IX* is nine, *X* is ten, *XI* is eleven and *XII* is twelve
- The modern way of numbering the cranial nerves is by using CN followed by an Arabic number. For example: VIII is written CN 8.

I - Olfactory Nerve



- Provides sense of smell
- Damage causes impaired sense of smell
- Test with coffee grounds, spice **not** perfume, Why?
- Test for smell NOT recognition of smell. (Ch. 16) 36

II - Optic Nerve



• Damage causes blindness in visual field

III - Oculomotor Nerve



- <u>Provides eye movement</u>, opening of eyelid
- Damage causes ptosis (drooping eyelid), double vision

IV - Trochlear Nerve



- Moves eye down and out
- Damage causes double vision & inability to look down and out

VI - Abducens Nerve



- Moves eye laterally (ABduction)
- Damage results in inability to move eye _





- Main sensory nerve to face (touch, pain and temperature) and muscles of mastication
- Damage produces loss of sensation & impaired chewing or can cause increased pain = trigeminal neuralgia 42

VII - Facial Nerve



- Provides facial expressions, sense of taste on anterior 2/3's of tongue, salivary glands and tear, nasal & palatine glands
- Damage produces sagging facial muscles & disturbed sense of taste (missing sweet & salty) called Bell's Palsy

VIII - Vestibulocochlear Nerve



- Provides hearing & sense of balance
- Damage produces deafness, dizziness, nausea, loss of balance & nystagmus

IX - Glossopharyngeal Nerve



- Provides control over swallowing, salivation, gagging, sensations from posterior 1/3 of tongue, control of BP and respiration
- Damage results in loss of bitter & sour taste & impaired swallowing.

X - Vagus Nerve



- The wonderer
- Provides swallowing, speech, regulation of 2/3 of GI tract
- Damage causes impaired voice, swallowing and digestion

XI - Accessory Nerve



- Contracts upper trap muscles (I don't know)
- Damage causes impaired shoulder movement

XII - Hypoglossal Nerve



- Provides tongue movements of speech, food manipulation & swallowing
- <u>Damage results in inability to protrude tongue</u>, TEST – Stick tongue out and it points right then the _____ XII is broken 48

CN 1-12 (Summary)

(Know the number and the nerve)

- On Old Olympus Towering Tops A Famous Vocal German Viewed Some Hops
- CN 1- Smells like an old factory.
- CN2- Two eyes see
- <u>CN 3, 4, 6- moves the eyes</u>
- CN 5- Trigeminal, three finger on face
- CN7- Facial, closes eye lids
- CN 8 Vestibulocochlear, ear
- <u>CN 9 Glossopharyngeal</u>, G looks like a nine
- CN 10 Vagus, two Vs
- <u>CN 11 Accessory- Trapezius muscle</u>, shoulders up

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• CN 12 Hypoglossal

Cranial Nerves function

- <u>Some cranial nerves (I, II, and VIII) contain</u> <u>only sensory fibers.</u>
- The rest are mixed nerves because they contain both sensory and motor fibers.

CLINICAL

Conditions related to the brain and nervous system

Brain Trauma

- Lapse in memory is one of many effects resulting from brain injuries
 - Commonly associated with head injuries
- Various degrees of brain injury are described by the terms;
 - 1) *concussion* (temporary consciousness and or memory loss),
 - 2) contusion (brain bruising, with longer term losses), and
 - 3) *laceration* (brain tissue tearing with intracranial bleeding and increased pressure).

TIA (Transient Ischemic Attack)

- An episode of *temporary* cerebral dysfunction caused by impaired blood flow to the brain.
 - Symptoms include:
 - dizziness, weakness, numbness, or paralysis in a limb or in half of the body, drooping of one side of the face, loss of vision or double vision.
 - Onset is sudden and a TIA usually persists for only a few minutes, rarely lasting as long as 24 hours.
 - Causes: blood clots, atherosclerosis
 - TIAs commonly are forerunners of future CVAs.

CVAs (Brain heart attack)

- 1. CVAs (Cerebral Vascular Accidents) are classified into two principal types:
 - a. ischemic (the most common type), due to a decreased blood supply, or
 - b. hemorrhagic, due to a blood vessel in the brain that bursts.
- 2. Common causes of CVAs are;
 - a. intracerebral hemorrhage,
 - b. emboli, and
 - c. atherosclerosis.
- 3. CVAs are characterized by abrupt onset of persisting neurological symptoms that arise from destruction of brain tissue (infarction).

Headache

- Causes: Vertebral subluxation and:
 - Brain tumors, blood vessel abnormalities, inflammation of the brain or meninges, decrease in oxygen supply to the brain, damage to brain cells, and infections of the eyes, ears, nose, or sinuses,
 - *Tension headaches* are associated with stress, fatigue, and anxiety and usually occur in the occipital and temporal muscles
 - *Migraine headaches* sometimes respond to drugs that constrict the blood vessels

Brain tumor

- Any benign or malignant growth within the cranium.
 - Symptoms from the increased intracranial pressure from the growing tumor or accompanying edema, and can include;
 - headaches, altered consciousness, vomiting, seizures,
 - visual problems, cranial nerve abnormalities,
 - hormonal syndromes,
 - personality changes, dementia, and sensory or motor deficits.

Cerebral palsy (CP)

- Refers to a group of motor disorders resulting in muscular in coordination and loss of muscle control.
 - Caused by damage to the motor areas of the brain during fetal life, birth, or infancy.
 - This damage may result from;
 - a. German measles infection of the mother during the first trimester,
 - b. radiation during gestation,
 - c. temporary lack of oxygen during birth, or
 - d. hydrocephalus during infancy.

Dyslexia

- Impairment of the brain's ability to translate images received from the eyes into understandable language.
 - Reads IUD as DUI
 - Causes seem related to lack of proper development i.e. crawling
 - Treatment: cross crawl exercise

Cerebellar Impairment

- ATAXIA: uncoordinated and jerky movements, slurred speech
- INTENTION TREMOR- shaking during voluntary movement
- <u>TEST: Finger to nose, finger to finger, tandem</u> <u>walk</u>
- FIELD TRIP
 - CEREBELLUM damage
 - Tour of Ft. Lauderdale's ____