

## 1.1 Prehistoric

- A million years or more, people have been interested in the brain. Archaeological evidence shows that skulls are bashed in (jagged, not precise). As a result, the person dies, and therefore the brain is vital to life.

## 1.2 7000 Years Ago

- New holes in the brain, but these holes show signs of healing. Therefore, these new holes are intended to help the person who is suffering. The fancy name is trephination.
- The theory for these holes is that they were drilled to cure the person. In other words, to relieve a person of a wicked spirit.

## 1.3 5000 Years Ago

- *Egyptian* physicians show that they were aware of brain damage through their writings.
- Complications arise because they thought the heart contained the soul—you need it to live and emotions effect it.

## 1.4 Ancient Greece—4th Century, BC

### 1.4.1 *Hippocrates*

- Ponder the correlation between structure and function. Now, extend this thought to the brain/head.
- The brain is the place where sensation and intelligence reside. Not the heart.

### 1.4.2 *Aristotle*

- Clung to the idea of the heart being the one in charge.
- Figured the brain was a radiator. That is, we would send heated blood to the brain for it to be cooled off. This “heated blood” arose from our emotions. Thus, humans are more rational because we have a lot of cooling when compared to other animals.



## 1.5 Roman Empire—*Galen* 2nd Century, AD

- Galen is a physician to gladiators.
- Thought the cerebellum was for motor control (because the cerebellum is hard, like muscles) and the cerebrum is for memory because it is soft, and you can “write on it.”
- Noticed there were large spaces (called “ventricles,” or “spaces”) that were filled with fluid.
- From here, we get the four humors (fluids).
- Galen thought that these fluids are what control the brain, NOT the brain structure itself. Think of the purpose of canned vegetables. The tin container does not actively contribute to the liquid / vegetables; rather, it is disposable.
- These ideas were jumpstarted by the invention of aqueducts. The movement of water was so important from aqueducts, so the idea this idea was extended to the brain.

## 1.6 Analysis by Analogy—17th Century

- *French* developed hydraulically controlled machines.
- Again, this is adding to the idea that liquids (which can flow through things and cause movements) are responsible for the brain’s functionality.

## 1.7 *René Descartes*—1596-1650

- Believed that non-humans—what he called animals—are controlled by fluid.
- From this, he posited that the human body is a material entity functioning as a machine (like animals)—these are known as reflexes.
- But, the mind is nonmaterial and free from the laws of the universe and was uniquely human.
- Question: How does the nonmaterial part of the body (the mind) communicate with the material part of the body? Through the pineal gland! This gland would move around like a joystick and would manipulate the fluid that came from the third ventricle.

## 1.8 The Mind/Body Problem

- What is the basic relationship between mental events and physical events?
- *Dualism*—The mind exists independently of the brain and exerts some control over it.



- Strengths: Commonsense view.
- Weaknesses: The universe is composed of matter or energy.
- Modern neuroscientific explanation: Everything the body does rests on the events taking place in specific, definable parts of the nervous system—the “mind” is the product of the nervous system activity.

## 1.9 The Scientific Method—17th and 18th Century

- A new world view at the end of the Renaissance.
  - Replace *Rationalism* with *Scientific Method*.
- Closer look at the substance of the brain:
  - Gray and white matter change the way we look at the brain. That is, why would these parts of the brain that are clearly different, be different if the brain is used just to move fluids around.
  - Also, everyone has the same brain structure, so these bumps and groves must mean something.

## 1.10 Electricity

- *Isaac Newton* showed it is possible to electrically stimulate nerves.
- Then, *Luigi Galvani* and *Emil du Bois-Reymond* showed that electricity can make muscles contract.
- Later on, *Hermann von Helmholtz* showed that the speed of nerve conduction is not instantaneous.
- This important distinction shows that these nerves are not like wires—such as *Luigi Galvani* and *Emil du Bois-Reymond* thought.
- *Bell* and *Magendie* showed that the dorsal nerve root and the ventral nerve root are different.
  - Specifically, Bell showed that the ventral nerve root is for motor information, and Magendie showed that the dorsal nerve root is for sensory information.
- The dorsal nerve root is for sensory information, and the ventral nerve root is for motor information.
- *Dorsal* = *Sensory*: Think of the dorsal fin of a shark sensing vibrations in the water.
- *Ventral* = *Motor*: Think of a vent (like a car exhaust) pushing out movement.



- *Johannes Müller* came up with the doctrine of *Specific Nerve Energies*.
  - This doctrine states that the nature of a sensation depends on which nerve is stimulated, not on how the nerve is stimulated.
  - For example, if you stimulate the optic nerve, you will see something. If you stimulate the auditory nerve, you will hear something.
- Spawned the *Great Debate*: Is the brain a homogenous mass or is it made up of different parts?

## 1.11 The Great Debate

- *Franz Joseph Gall* and *Johann Spurzheim* thought the bumps and grooves on the head were due to the size of the brain parts.
- They concluded that the size of the brain parts was correlated to the use of that part.
- This is known as *phrenology*.
- *Localization of Functions*—brain function can be localized to regions, pathways, or neurons.
  - Basically, if you cut out a piece of brain, and the animal (a pigeon) is no longer able to do a specific task, then that part of the brain is responsible for that task.
  - However, it turns out that these pigeons were able to relearn the task, so the brain is not as localized as we thought (this research is from Flourens).
- *Aggregate Field Theory*—the brain is a homogenous mass.
  - Complex brain functions emerge from the collective interactions of numerous simple neuronal activities.
  - Unlike localizationist models, this theory emphasizes the distributed nature of cognitive processes across neural networks.
- *Pierre Flourens* (1794–1867)
  - Studied the effect of brain damage with pigeons and supported the Aggregate Field Theory.
- *Paul Broca* (1824–1880)
  - Found a patient who *could speak* but could *not understand language*.
  - After the patient died, Broca found a lesion in the *left frontal lobe*.
  - This area is now known as *Broca's area*.
  - This area is responsible for *speech production*.
  - These results put us back into the realm of Localization of Function.



- In comes *Carl Wernicke* (1874)
  - Found a patient who *could understand language* but could *not produce language*.
  - After the patient died, Wernicke found a lesion in the *left temporal lobe*.
  - This area is now known as *Wernicke's area*.
  - This area is responsible for *language comprehension*.
- Then, we have *Gustav Fritsch* and *Eduard Hitzig* (1870)
  - Similarly to *Luigi Galvani* and *Emil du Bois-Reymond*, they electrically stimulated the brain.
  - They found that the *motor cortex* is responsible for *movement*.
- *Shepherd Ivory Franz* (in D.C. from 1907–1924)
  - Found that people are able to relearn tasks after brain damage.

## 1.12 Same Resolution?

- *Modified Aggregate Field Theory*
  - *Karl S. Lashley* (1890-1958)
    - *The Principles of Mass Action*
      - Complex behavior—such as learning—is dependent on the total mass of the brain.
    - *Equipotentiality*
      - Specialization of function is not tied to specific brain regions.
      - All parts of the cortex contribute equally to complex behavior.
    - *Vicarious functioning*
      - If one part of the brain is damaged, another part can take over.

## 1.13 Analysis

1. **Prehistoric:** Recognition of the brain's vital role in life through skull injuries. No scientific theories yet.
2. **7000 Years Ago:** Trephination (skull drilling) practiced to release “evil spirits,” indicating early medical intervention.
3. **5000 Years Ago:** Egyptians documented brain damage but prioritized the heart as the seat of the soul.
4. **Ancient Greece—Hippocrates (4th Century BCE):** Proposed the brain as the center of sensation/intelligence, countering heart-centric views.



5. **Ancient Greece—Aristotle:** Defended the heart as the command center, viewing the brain as a blood-cooling “radiator.”
6. **Roman Empire—Galen (2nd Century CE):** Linked cerebellum to motor control and cerebrum to memory; emphasized ventricular fluids (humors) over brain structure.
7. **17th Century (Analysis by Analogy):** Hydraulic systems inspired fluid-based brain theories.
8. **René Descartes (1596–1650):** Dualism (mind vs. body); proposed pineal gland as the mind-body interface.
9. **17th–18th Century (Scientific Method):** Shift to empirical study; recognition of gray/white matter differences.
10. **Electricity Discoveries:** Newton (nerve stimulation), Galvani/du Bois-Reymond (muscle contraction via electricity), Helmholtz (nerve conduction speed), Bell/Magendie (sensory/motor nerve roots), Müller (specific nerve energies).
11. **The Great Debate:**

Table 1.1: Key Figures in the Great Debate: Localization vs. Aggregate Theory

Localization	Aggregate Theory
Johannes Müller	Pierre Flourens
Franz Joseph Gall	Shepherd Ivory Franz
Paul Broca	
Carl Wernicke	
Gustav Fritsch	
Eduard Hitzig	

12. **Modified Aggregate Theory:** Karl Lashley emphasized mass action and equipotentiality.

Table 1.2: Key Scientists and Contributions

Scientist	Contributions
Hippocrates	Brains as seat of sensation/intelligence
Aristotle	Heart as command center; brain as radiator
Galen	Cerebellum (motor), cerebrum (memory); humors
René Descartes	Mind-body dualism; pineal gland
Isaac Newton	Early nerve stimulation via electricity
Luigi Galvani	Electricity-induced muscle contraction
Emil du Bois-Reymond	Same as Galvani
Hermann von Helmholtz	Measured nerve conduction speed
Charles Bell	Ventral nerve = motor
François Magendie	Dorsal nerve = sensory
Johannes Müller	Doctrine of specific nerve energies
Franz Joseph Gall	Phrenology (brain localization)
Johann Spurzheim	Promoted phrenology
Pierre Flourens	Aggregate theory
Paul Broca	Localized speech production (Broca's area)
Carl Wernicke	Localized language comprehension (Wernicke's area)
Gustav Fritsch	Mapped motor cortex
Eduard Hitzig	Same as Fritsch
Shepherd Ivory Franz	Relearning post-brain damage
Karl S. Lashley	Mass action, equipotentiality

## 3.1 Neuroanatomy

Neuroscience is the study of the nervous system. Behavioral neuroscience is understanding the nervous system's underlying behavior.

### 3.1.1 Nervous System Structure

#### Structural Nervous System

*How are neurons organized into systems?*

- **Central Nervous System (CNS)**
  - Brain
  - Spinal Cord
- **Peripheral Nervous System (PNS)**

#### Functional Nervous System

*What are the 'jobs' of the nervous system?*

- *Somatic Nervous System*
  - Skeletal Muscles (Striated)
  - Sensory information in
  - Voluntary motion out
- *Autonomic Nervous System*
  - Uses smooth muscles
  - Glands
  - Sympathetic Nervous System
    - Fight or Flight
    - Heart rate, blood pressure, respiration, and alertness.
  - Parasympathetic Nervous System
    - Rest and Digest
  - *Enteric Nervous System*





- A mesh-like system of neurons that governs the function of the gastrointestinal system.
- AKA: ‘Second Brain’
- GI problems are correlated with psychological disorders.
- The GI track houses a lot of our microbiota.
- Fecal Microbiota Transplant
  - Rat studies showed that when a skinny rat has a fecal transplant from a fat rat, the skinny rat becomes fat. This works in reverse too.
  - Therefore, the microbiota change the *behavior* of the rat.
- Elevated Plus Maze
  - A test to measure anxiety in rats.
  - The rats with the fecal transplant from the anxious rats were more anxious.
  - **This is huge!** This shows that the microbiota can change if a rat is anxious or not!

Starting a new list because I don’t know where to put this. But we are starting with Meninges.

## 3.2 Meninges

- Cover the outside of the nervous system.
  - Three for the CNS and two for the PNS.
  - The PNS does not use the arachnoid mater.
- *Dura Mater*
  - “Hard Mother”
  - The outermost layer.
  - Tough and fibrous.
  - Contains blood vessels.
  - Early anatomists called it “pachymeninges” because similar to elephant skin.
- *Arachnoid Mater* = “Spider Mother”
  - Middle layer.
  - Web-like structure.
  - Contains blood vessels.
  - Subarachnoid Space
    - Between the arachnoid and Pia mater.



- Contains cerebrospinal fluid (CSF).
- Arachnoid trabeculae
  - Web-like structures that connect the arachnoid mater to the Pia mater.
  - Allows for the subarachnoid space to be filled with CSF.
- *Pia Mater* = “Soft Mother”
  - Innermost layer.
  - Thin and delicate.
  - Flows over every sulcus (grooves), fissure (deep indentations), and gyri (bumps).
  - Follows the contours of the brain and spinal cord.
- *Meningitis*
  - Inflammation of the meninges.
  - Can cause symptoms such as headache, fever, a stiff neck, or hallucinations.

### 3.3 Cerebrospinal Fluid (CSF)

- Similar to blood plasma.
- Functions of CSF
  - Protection
    - Failures:
      - Brain is injured.
      - AND even Contrecoup—when the brain is injured on the opposite side of the impact—injuries.
      - *Chronic Traumatic Encephalopathy (CTE)*
        - Old name: Dementia Pugilistica (boxer’s dementia).
        - Symptoms (not exhaustive): Memory loss, confusion, impaired judgment, impulse control problems, aggression, depression, Parkinson’s-like symptoms, insomnia, and progressive dementia.
        - Causes ventricular enlargement. In other words, the larger your ventricles, the less brain matter you have.
        - Also causes atrophy of the fornix. The fornix is a C-shaped bundle of nerve fibers in the brain that acts as the major output tract of the hippocampus.
        - Tau are abnormally phosphorylated aggregate into tangles. They accumulate both inside neurons and even released into extracellular space.
  - The CSF also moves neurotransmitters, waste, hormones, nutrients, and other substances from one place to another.



- For example, the CSF moves  $\beta$ -amyloid (in-between cells) from the brain to the blood.
- *Choroid Plexus*
  - *Ependymal cells*
    - Lines the lateral ventricles.
    - These are the cells that produce the CSF.
  - If the choroid plexus is not working properly, it can cause hydrocephalus.
  - *Hydrocephalus*
    - “Water on the brain”
    - Swelling of the brain due to the accumulation of CSF.
  - Derives from the Pia mater.

### 3.3.1 Flow of CSF

- *Lateral ventricles*
  - CSF is produced here and flows through the interventricular foramen.
- *Third Ventricle*
  - Looks like a duck’s head.
  - Is connected to the *pituitary gland* through the *infundibulum*.
- The CSF routed through the medial longitudinal fissure and into the *Superior Sagittal Sinus*.
- *Interpeduncular Fossa*
  - The space between the two cerebral peduncles.
- *Interventricular Foramen*
  - Connects the lateral ventricles to the third ventricle.
- *Cerebral Aqueduct*
  - Connects the third and fourth ventricles.
- *Central Canal*
  - Connects the fourth ventricle to the spinal cord.
  - For remembering purposes, the *cerebral* aqueduct is in the *brain* and the central canal is in the spinal cord.
- *Subarachnoid Space*
  - Foramen of Magendie (Medial) and Luschka (Lateral)
    - Two tiny little holes in the fourth ventricle.



### 3.3.2 Dumping of CSF

- Arachnoid Villi/Granulations
  - Absorbed into blood stream from the superior sagittal sinus.

### 3.3.3 Getting Some CSF Out -or- Putting Something Into It

- Where would you have them stick that needle?
  - *Dural Sac*
    - Enlarged space in the lumbar region.
    - Testing and introduction of anesthetic agents.
    - Epi = Something in
  - *Lumbar Puncture*
    - AKA: Spinal Tap.
    - Tap = Taking something out

## 3.4 Cranial Nerves

#	Name	Type	Information Carried
I	Olfactory	S	Smell
II	Optic	S	Vision
III	Oculomotor	M	Eye movement, pupil constriction
IV	Trochlear	M	Eye movement
V	Trigeminal	B	Touch to face, motor control of mandibles
VI	Abducens	M	Eye movement
VII	Facial	B	Taste and facial expression
VIII	Auditory (Vestibulocochlear)	S	Hearing
IX	Glossopharyngeal	B	Taste and swallowing
X	Vagus	B	Taste and sensation from neck, thorax, abdomen, swallowing, control of larynx, parasympathetic nerves to heart and viscera
XI	Spinal Accessory	M	Movement of shoulders
XII	Hypoglossal	M	Movement of tongue

#### 3.4.1 Mnemonic for Cranial Nerves

Old Opie occasionally tries trigonometry and feels very gloomy, vague, and hypoactive.



## 3.5 Terms

- Santiago Ramon y Cajal (1911)
  - Used the Golgi stain to show that neurons are separate cells.
- *Soma* – Cell Body
- *Dendrites* – “Branches”
  - Purpose is to increase the surface area of the neuron, so it can receive the most amount of information.
- *Axon terminal button* – The ends of the neuron that send information.
- *Glial cells* – Support cells by insulating the axon for better communication.
- *Myelin sheath* – Insulates the axon.
- *Unmyelinated axons* are called grey matter.
- *Ganglion* – A collection of cell bodies in the PNS.
- *Nerve* – A collection of axons in the PNS.
- *Nucleus* – A collection of cell bodies in the CNS.
- *Tract* – A collection of axons in the CNS.

Grey Matter	White Matter
Cell bodies	Myelinated axons
Dendrites	
Unmyelinated axons	

Table 3.1: Gray vs White Matter

CNS	PNS
Nucleus	Ganglion

Table 3.2: Gray Matter Division



BNS	PNS
Tract	Nerve

Table 3.3: White Matter

## 3.6 Brainstem

### 3.6.1 Hindbrain

- *Myelencephalon*
  - *Medulla Oblongata*
    - Enlargement of the cord.
    - Lots of gray matter.
    - *Reticular Formation*
      - A network of nuclei.
      - Regulates sleep, wakefulness, and arousal.
      - Also regulates heart rate, blood pressure, respiration, and skeletal muscle tone.
    - *Pyramids*
      - Two ridges on the ventral surface.
      - Voluntary motor system.
    - *Olivives*
      - Audition and motor learning.
      - Located on the lateral surface.
- *Metencephalon*
  - *Pons* – “Bridge”
    - White matter on the outside and gray on the inside.
    - *Locus Coeruleus*
      - Produces norepinephrine.
      - The norepinephrine is sent to the forebrain.
  - *Cerebellum*
    - Caudal portion of the brain.
    - Balance, hand/eye coordination, soothes movements.
    - Shifting attention between vision and hearing, sensory timing (judging rhythms), language, emotional control, and reward valuation.
    - Cerebellar agenesis – the cerebellum is not developed.



### 3.6.2 Midbrain

#### Mesencephalon

- *Tectum* = “Roof”
  - *Superior Colliculus* – Visual Reflexes
    - Pupils opening and closing in response to light.
  - *Inferior Colliculus* – Auditory Reflexes
  - Colliculus = “Little Hill”
  - *Pineal Gland* – Melatonin
- *Tegmentum* = “Floor”
  - *Substantia Nigra* = “Black substance.”
    - Get its black coloring from the creation of dopamine.
    - Clearly, this brain structure makes a majority of dopamine (1 of 3).
  - *Red Nucleus* – Motor coordination.
    - Get its red color from iron oxidation.
    - Connects to the cerebellum for that motor coordination.
  - *Periaqueductal Gray Area* – Opioids.
    - Peri = around, so peri-aqueductal = around-the cerebral aqueduct.
    - Handles endogenous pain relief.

### 3.6.3 Forebrain

#### Diencephalon

- *Thalamus*
  - Massa Intermedia = intermediate mass. This connects the two halves together.
  - Made up of many specific relay nuclei.
    - *Lateral Geniculate Nucleus* – Vision
    - *Dorsal Medial Nucleus* – Pain
      - Routes the pain from the thalamus to the prefrontal cortex.
  - ...and of non-specific relay nuclei.
    - *Nucleus Reticularis* – Promotes wakefulness.
      - Goes to different parts of the brain, not just one specific part like the specific relay nuclei.
- *Hypothalamus*
  - Irregular shape, size of a thumbnail.



- Encases the ventral part of the third ventricle.
- **Survival of the individual**
  - Eating
  - Drinking (water)
    - Salt regulation
  - *Suprachiasmatic Nucleus*
    - Circadian rhythms
    - Daily fluctuations of temperature
- **Survival of the species**
  - Territoriality
  - Sexual activity
  - Reproduction
- **Integration of information**
  - Endocrine system
  - Autonomic nervous system

## Telencephalon

- *Corpus callosum*
  - Connects the two hemispheres.
  - Remember that the neurons in this structure go from lateral to lateral, and not from dorsal to ventral.
  - Creates the roof of the lateral ventricles.
  - Agenesis of the cc
    - AKA: Callosal Agenesis
    - Vision impairments,
    - hypotonia,
    - poor motor coordination,
    - delays in motor milestones,
      - (Such as sitting and walking.)
    - cognitive disability,
      - (Disability in complex problem solving.)
    - and social difficulties.
      - (Missing subtle social cues maybe cause of impaired fair processing.)
  - *Corpus Callosotomy* – Split brain surgeries.
    - Used to treat epilepsy.
    - Gives information about lateralization of hemispheres.





- **Left Hemisphere**
  - language
  - serial events
- **Right Hemisphere**
  - creativity
  - synthesis
- *Basal Ganglia*
  - **Function:**
    - Initiation of Voluntary Movements.
    - [Click here for Parkinson's continuation.](#)
  - Curls laterally around the thalamus.
  - *Striatum*
    - *Caudate Nucleus* = “Nucleus with a Tail”
      - Obsessive Compulsive Disorder (OCD)
        - MIXED RESULTS
          - Too much activity, too large.
      - Romantic Love
        - Fisher, Aron, and Brown
          - Anthropologist used fMRI with a picture of neutral and romantic partners.
          - The CN activity was increased for loved one.
      - Larger in folks with incredible episodic memories (superior autobiographical memory).
        - How large? 7-8 SDs larger.
    - *Putamen* = “Shell”
    - *Nucleus Accumbens*
      - Nucleus Accumbens Septi = “Nucleus leaning against the septum.”
        - Where the head of the caudate and the most anterior portion of the putamen come together.
        - Plays an important role in reinforcement, pleasure, and addiction.
    - *Globus Pallidus* = “Pale Globe”
    - *Note:* When people mention the putamen and the globus pallidus, they call it the lentiform nucleus.
  - *Limbic System*
    - *Hippocampus*
      - In charge of moving memories from short-term to long-term.



- Emotion, selective attention, learning, and memory.
- *Amygdala*
  - In charge of emotions.
  - Fear and aggression, territoriality, odor processing, and sexual activity.
  - **Amygdala and Fear**
    - 1930's.
    - Lesions to amygdala in monkeys.
    - Many things happened...
      - Exploratory behavior of objects (put in mouth–hyperorality).
      - Hypersexuality.
      - Loss of fear.
        - Freezing, increased heart rate, hair standing on end, etc.
        - Lost their fear of the human experimenters.
  - *Kluver-Bucy Syndrome*
    - Damaging the anterior temporal lobes.
    - Herpes encephalitis and trauma.
    - Loss of normal fear and anger responses.
  - Facial mimicry
    - Seeing fear in others lead to fear expression.
    - AND has amygdala activity.
  - **Other things**
    - Social networks (Bickart et al., 2010)
      - Size and complexity of social network + correlated with amygdala size.
      - MAYBE: More effectively identify, learn about, and recognize socioemotional cues.
    - Political views (Rees et al., 2011)
      - Took extreme liberals and extreme conservatives and found that the more extreme conservatives had a larger amygdala than the extreme liberals.
  - **How burnout is related to your brain...**
    - Worse at suppressing negative emotions.
    - Big amygdala & weak connection to frontal lobe.
- *Cingulate Gyrus*
  - Selective attention.
  - Love (like the cingulate gyrus)
    - Same studies show increased activity for loved ones.
  - Pain.
    - Serves as alarm for distress



- Association of the emotional components and the sensory components of pain.
- Sympathetic pain (empathy).
- Social rejection.
  - Eisenberger (1990s)
  - Cyberball
    - A computer game where you play catch.
    - The other players stop throwing the ball to you.
    - The cingulate gyrus lights up.
- *Fornix*
- *Mammillary Bodies*
- *Septal Nucleus*

## Cerebral Cortex

- Cortex = “bark”
- Many convolutions
  - Sulci/fissures
  - Gyri
- Gray matter.
- 6 Layers
- Four lobes
  - *Frontal Lobe*
    - Executive functions, motor control, and language production (Broca’s area).
  - *Parietal Lobe*
    - Lips, toes, and spacial awareness.
  - *Temporal Lobe*
    - Memory, hearing, and language comprehension (Wernicke’s area).
  - *Occipital Lobe*
    - Vision
  - **How they are separated:**
    - Frontal ↔ Parietal: *Central Sulcus*
    - Parietal ↔ Occipital: *Parieto-Occipital Sulcus*
    - Temporal ↔ Frontal/Parietal: *Lateral Sulcus (Sylvian Fissure)*
- *Nucleus Accumbens*



## 3.7 Parkinson's Disease

- *Bradykinesia*
  - Slowness of movement.
- *Akinesia*
  - Difficulty initiating voluntary movements.
- *Rigidity*
  - Increased muscle tone.
- *Tremors*
  - Involuntary shaking of hands and jaw most prominent at rest.

## 3.8 Alzheimer's Disease

- Progressive memory loss.
- Affects the cortex and hippocampus.
- Suffers from both retrograde and anterograde amnesia.

## We're starting with three studies:

### 1. Study 1: Blinking:

- Three levels of blinking:
  - Reflexive blinking. Ex: When a puff of air is directed at the eye.
  - Voluntary blinking. Ex: When you're asked to blink.
  - Endogenous blinking. Meaning: "originating from or due to internal causes."
- *Endogenous blinking* is the focus of this study.
  - Endogenous blinks occur during reading or speaking and reflect changes of attention and changes in thought processes. The more attention required by a visual task; the fewer endogenous blinks occur.
  - More attention required is associated with fewer endogenous blinks. Especially for visual tasks.
  - **The harder the tasks → the fewer the blinks.**
  - Even when a task is not visual, there is a decrease in endogenous blink rate (EBR) during a difficult task followed by flurry of blinks when task is over.
  - **But wait!**
    - EBR has been shown to increase when a cognitive secondary task is performed concurrently, and the cognitive task does not involve visual attention.
  - **WHY?**
    - EB is a dopaminergic activity.
    - Dopamine plays a big role in selective attention.
- Through this study, we learned that endogenous blinking (DV) is affected by cognitive load (IV)

### 2. Study 2: Cartoon Judgement:

- Group 1 and 2 membership.
- Follow group instructions then rate the 3 cartoons that follow on scale from 1-10.
  - 1 is NOT funny
  - 10 is VERY funny
  - Answers (Lips = Pen in lips; Teeth = Pen in teeth):



Groups	Pic 1	Pic 2	Pic 3	Average
Lips	3	3	4	$3\frac{1}{3}$
Teeth	4	4	3	$3\frac{2}{3}$
Stretch	4	5	6	5
J. Jacks	4	2	3	3

- **Facial Feedback Hypothesis**

- Selective activation or inhibition of facial muscles has a strong impact on emotional responses to stimuli.
- Zygomatic major muscle.
  - When we had the pen in our teeth, we were activating the zygomatic major muscle.
  - This muscle is responsible for smiling.
- Our data supported this hypothesis with a probability of  $p < 0.02$ .

- **Arousal**

- Increased heart rate in many emotions.
- Heart rate and attraction
  - 1973 Dutton and Aron
    - Shaky high bridge vs. low stable bridge.
    - Woman on the other side who is asking questionnaire questions (faux DV).
    - She gave her phone number to the guys once they got done answering the questions.
    - The actual DV was the amount of phone calls she received and the sexual content in questionnaire answers.
    - The high bridge group had more sexual content in their messages.
  - 15 minutes of physical activity, then rate attractiveness of potential mates.

- 

**Psychophysiology:** Behavioral, cognitive, emotional, and social events are all mirrored in physiological processes.

The idea is that we can get a peep into your psychology by looking at what your biology is doing.

**Sleep:** EEG (Electroencephalogram; measuring brain activity), EOG (Electrooculogram; measuring eye movement), EMG (Electromyography; measuring muscle movement), ERP (measuring event-related potential).

Respiration, GSR (EDA), Blood flow, Blood pressure, heart rate

## 1.1 ~~~~~

**Directions:** For short answer questions, write your response in the space provided. Most of the short answer questions should be only a sentence or two long. For multiple choice questions, circle the letter of the correct response. For fill-in-the-blank questions, write your response in the space provided. For matching questions, write the letter of the correct response in the space to the right. For true or false questions, write “True” if the statement is true, and if the statement is false, *explain why* the statement is false. Lastly, the sections (1.1, 1.2, etc.) are provided to break the exam into smaller sections. Don’t worry about having to fill them in. Good luck!

**Q1.1.1 Short Answer:** Define neuroscience.

*Answer:*

**Q1.1.2 True or False:** Behavioral neuroscience involves understanding the nervous system’s underlying behavior.

*Answer:*

**Q1.1.3 Fill in the Blank:** The Central Nervous System (CNS) is composed of the \_\_\_\_\_ and the \_\_\_\_\_.

**Q1.1.4 Matching:** Match the following systems with their primary functions.

### Choices

- (i) Voluntary motor control and sensory input.
- (ii) Involuntary control of the gastrointestinal system.
- (iii) Involuntary control of smooth muscle and glands.

- (a) Somatic Nervous System ..... \_\_\_\_\_
- (b) Autonomic Nervous System ..... \_\_\_\_\_
- (c) Enteric Nervous System ..... \_\_\_\_\_



**Q1.1.5 True or False:** The autonomic nervous system regulates the body's fight-or-flight AND rest-and-digest response.

*Answer:*

**Q1.1.6 Short Answer:** How does the flight-or-flight response affect your body?

*Answer:*

**Q1.1.7 Fill in the Blank:** In the fecal microbiota transplant study, researchers found that the microbiota change the \_\_\_\_\_ of the mice.

**Q1.1.8 True or False:** In the elevated plus maze study, rats that underwent a fecal transplant from anxious mice became less anxious.

*Answer:*

## 1.2 ~~~~~

**Q1.2.1 Short Answer:** What is the primary function of the meninges?

*Answer:*

**Q1.2.2 Multiple Choice:** Which of the following is the outermost meningeal layer?

(A) Arachnoid Membrane

(B) Dura Mater

(C) Pia Mater

(D) Subarachnoid Space

**Q1.2.3 Short Answer:** Why did early anatomists call the outermost meningeal layer “pachymeninges”?

*Answer:*

**Q1.2.4 Fill in the Blank:** *Dura Mater* is sometimes called “\_\_\_\_\_” because of its tough, fibrous nature.

**Q1.2.5 True or False:** The Peripheral Nervous System uses all three layers of the meninges.

*Answer:*

**Q1.2.6 Fill in the Blank:** Arachnoid \_\_\_\_\_ are web-like structures that connect the Arachnoid Membrane to the *pia mater*

**Q1.2.7 True or False:** The subarachnoid space is filled with cerebrospinal fluid.

*Answer:*

**Q1.2.8 Short Answer:** What is meningitis?

*Answer:*





**Q1.2.9 Multiple Choice:** Which is NOT a symptom of Meningitis?

- (A) Headache (B) Fever  
(C) Hallucinations (D) None of the above

### 1.3 ~~~~~

**Q1.3.1 Short Answer:** List two functions of CSF.

*Answer:*

**Q1.3.2 True or False:** CSF is similar in composition to blood plasma.

*Answer:*

**Q1.3.3 Fill in the Blank:** CSF is produced by the \_\_\_\_\_ cells lining the lateral ventricles.

**Q1.3.4 Fill in the Blank:** A contra-coup injury is an injury that occurs on the \_\_\_\_\_ side of the brain from the impact site.

### 1.4 ~~~~~

**Q1.4.1 Matching:** Match the location with its description.

#### Choices

- (i) Connected to the pituitary gland via the infundibulum.
- (ii) Production of CSF and connection to the third ventricle via the interventricular foramen.
- (iii) Connects the third and fourth ventricles.

- (a) Lateral Ventricles ..... \_\_\_\_\_
- (b) Third Ventricle ..... \_\_\_\_\_
- (c) Cerebral Aqueduct ..... \_\_\_\_\_

**Q1.4.2 True or False:** The central canal connects the fourth ventricle to the spinal cord.

*Answer:*



## 1.5 ~~~~~

**Q1.5.1 Short Answer:** Where is CSF absorbed into the bloodstream?

*Answer:*

**Q1.5.2 Fill in the Blank:** \_\_\_\_\_ is caused by swelling of the brain due to a blockage in the CSF flow.

**Q1.5.3 True or False:** The *Interventricular Foramen* connects the lateral ventricles to the third ventricle.

*Answer:*

## 1.6 ~~~~~

**Q1.6.1 Fill in the Blank:** The term “*epi*” means \_\_\_\_\_ and the term “*tap*” means \_\_\_\_\_.

**Q1.6.2 Multiple Choice:** A lumbar puncture is sometimes called a:

- |               |                     |
|---------------|---------------------|
| (A) Brain Tap | (B) Spinal Tap      |
| (C) CSF Drain | (D) Ventricular Tap |

**Q1.6.3 Fill in the Blank:** The needle for a lumbar puncture is typically inserted into the \_\_\_\_\_ sac in the lumbar region.

## 1.7 ~~~~~

**Q1.7.1 Matching:** Match the cranial nerve number with its function.

<b>Choices</b>
----------------

- |   |
|---|
| (i) Facial sensation or motor control of the mandible |
| (ii) Vision   |
| (iii) Smell   |

(a) I ..... \_\_\_\_\_

(b) II ..... \_\_\_\_\_



(c) V .....

**Q1.7.2 True or False:** Cranial nerve IV controls pupil constriction and eye movement.

*Answer:*

**Q1.7.3 Short Answer:** What is the function of cranial nerve X?

*Answer:*

**Q1.7.4 Fill in the Blank:** There are \_\_\_\_\_ cranial nerve(s) that modulate eye movements, and \_\_\_\_\_ cranial nerve(s) that control the sense of vision.

**Q1.7.5 True or False:** The term “*glossal*” means “taste”.

*Answer:*

**Q1.7.6 Fill in the Blank:** For the following table, fill in the blanks with the correct name.

Cranial Nerve	Name	Cranial Nerve	Name
I	_____	VII	_____
II	_____	VIII	_____
III	_____	IX	_____
IV	_____	X	_____
V	_____	XI	_____
VI	_____	XII	_____

## 1.8 ~~~~~

**Q1.8.1 Short Answer:** What does the term *Soma* refer to?

*Answer:*

**Q1.8.2 True or False:** The term “*nucleus*” refers to a collection of cell bodies in the PNS.

*Answer:*

**Q1.8.3 Fill in the Blank:** Fill in the following table for the terms that match its definition.

Term	Definition
Tract	_____
_____	The ends of the neuron that send information.
_____	Extends surface area of the neuron.
_____	A collection of axons in the PNS.



**Q1.8.4 True or False:** *Ganglion* and *Nuclei* are both collections of axons.

*Answer:*

**Q1.8.5 Short Answer:** What is the function of the myelin sheath?

*Answer:*

## 1.9 ~~~~~

**Q1.9.1 Short Answer:** Name two principal structures of the hindbrain.

*Answer:*

**Q1.9.2 Short Answer:** What vital functions are regulated by the Reticular Formation in the Medulla Oblongata?

*Answer:*

**Q1.9.3 Short Answer:** Describe the role of the Pons in the brainstem.

*Answer:*

**Q1.9.4 Fill in the Blank:** The \_\_\_\_\_ (specific) is a structure in the pons that produces norepinephrine.

**Q1.9.5 True or False:** The norepinephrine produced by the Locus Coeruleus is sent primarily to the hind brain.

*Answer:*

**Q1.9.6 Short Answer:** What is the primary function of the cerebellum?

*Answer:*

**Q1.9.7 Bonus Short Answer:** Can you name every function of the cerebellum? (There's 8!)

*Answer:*

**Q1.9.8 Fill in the Blank:** The rare malformation wherein the cerebellum is not developed is called \_\_\_\_\_.

**Q1.9.9 Multiple Choice:** Which of the following midbrain structures is primarily responsible for visual reflexes?

(A) Olives    (B) Pyramids    (C) Superior Colliculus    (D) Substantia Nigra

**Q1.9.10 Fill in the Blank:** The \_\_\_\_\_ in the midbrain is critical for motor coordination.



**Q1.9.11 Short Answer:** What does the *periaqueductal gray area* produce?

*Answer:*

**Q1.9.12 True or False:** The medulla oblongata contains the reticular formation which regulates vital functions like heart rate and respiration.

*Answer:*

**Q1.9.13 Fill in the Blank:** The midbrain's \_\_\_\_\_ Colliculus is important for visual reflexes, while the \_\_\_\_\_ Colliculus is involved in auditory reflexes.

**Q1.9.14 Multiple Choice:** The *substantia nigra* is known for its role in:

- (A) Serotonin production
- (B) Dopamine production
- (C) GABA production
- (D) Acetylcholine production

## 1.10 ~~~~~

**Q1.10.1 Short Answer:** What is the role of the thalamus in the brain?

*Answer:*

**Q1.10.2 Fill in the Blank:** Fill in the following table with the correct terms.

Thalamic Relay Nuclei	Description
_____	Vision
_____	Pain
_____	Promotes wakefulness

**Q1.10.3 Fill in the Blank:** The *Massa Intermedia* connects the left \_\_\_\_\_ half with the right half.

**Q1.10.4 Multiple Choice:** Which of the following is NOT a function of the hypothalamus?

- (A) Survival of the individual
- (B) Survival of the species
- (C) Regulation of pain
- (D) Integration of information

**Q1.10.5 True or False:** The *Suprachiasmatic Nucleus* is responsible for circadian rhythms.

*Answer:*



**Q1.10.6 True or False:** The hypothalamus is involved in both individual survival functions (like eating and drinking) and species survival functions (such as reproduction).

*Answer:*

**Q1.10.7 Matching:** Match the following telencephalic structures with their functions.

**Choices**

- (i) Sensory integration and spatial awareness.
- (ii) Executive functions, motor control, language production.
- (iii) Memory, hearing, language comprehension.
- (iv) Vision

- (a) Frontal Lobe ..... \_\_\_\_\_
- (b) Temporal Lobe ..... \_\_\_\_\_
- (c) Parietal Lobe ..... \_\_\_\_\_
- (d) Occipital Lobe ..... \_\_\_\_\_

**Q1.10.8 Fill in the Blank:** The *Corpus Callosum*'s neurons go from \_\_\_\_\_ to \_\_\_\_\_ and not from \_\_\_\_\_ to \_\_\_\_\_.

**Q1.10.9 Multiple Choice:** Which of the following is NOT a symptom of Callosal Agenesis?

- (A) Impaired motor coordination
- (B) Impaired language comprehension
- (C) Impaired spatial awareness
- (D) Impaired executive functions

**Q1.10.10 True or False:** The *Basal Ganglia* is involved in the regulation of voluntary motor control.

*Answer:*

**Q1.10.11 Fill in the Blank:** The *Striatum* consists of the \_\_\_\_\_, \_\_\_\_\_, and the \_\_\_\_\_. (*Note: The Globus Pallidus is not a viable answer here.*)

**Q1.10.12 True or False:** When people mention the Nucleus Accumbens and the Globus Pallidus, they call it the lentiform nucleus.

*Answer:*



**Q1.10.13 True or False:** Participants in Rees et al.'s (2011) study showed extreme liberals had a larger amygdala than extreme conservatives.

*Answer:*

**Q1.10.14 Short Answer:** What is the function of the hippocampus?

*Answer:*

**Q1.10.15 Short Answer:** What is the left hemisphere of the brain responsible for? And the right hemisphere? (2 each)

*Answer:*

**Q1.10.16 Matching:** Arrange the following structures in the brain in the right order.

**Choices**

- (i) Tectum
- (ii) Medulla Oblongata
- (iii) Limbic System
- (iv) Hypothalamus

- (a) Telencephalon ..... \_\_\_\_\_
- (b) Diencephalon ..... \_\_\_\_\_
- (c) Mesencephalon ..... \_\_\_\_\_
- (d) Myelencephalon ..... \_\_\_\_\_

**Q1.10.17 Short Answer:** What is *Klüver-Bucy Syndrome*?

*Answer:*

**Q1.10.18 True or False:** The *Limbic System* is involved in the regulation of emotions, memory, and motivation.

*Answer:*

**Q1.10.19 Fill in the Blank:** Selective attention, love, and pain are all functions of the \_\_\_\_\_.

**Q1.10.20 Short Answer:** What lobes make up the *Cerebral Cortex*?

*Answer:*



**Q1.10.21 Short Answer:** We learned that the *Temporal Lobe* is responsible for hearing and language comprehension. Who was the scientist that discovered this? Similarly, we learned that the *Frontal Lobe* is responsible for language production. Who was the scientist that discovered this?

*Answer:*

**Q1.10.22 Multiple Choice:** In a study by Eisenberger (1990) called the Cyberball study, participants who were excluded from the game showed increased activity in the:

- (A) Amygdala (B) Hippocampus  
(C) Anterior Cingulate Cortex (D) Septal Nucleus

**Q1.10.23 Bonus Fill in the Blank:** Fill out the following table with the correct terms.

Major Divisions	Ventricle	Subdivision	Principal Structures
Forebrain	Lateral	Telencephalon	_____
			_____
			_____
Midbrain	_____	Diencephalon	_____
			_____
			_____
_____	Fourth	Mesencephalon	_____
			_____
			_____
_____	Fourth	Myelencephalon	_____
			_____
			_____

## 1.11 ~~~~~

**Q1.11.1 Multiple Choice:** Which of the following is NOT a typical symptom of Parkinson's Disease?

- (A) Bradykinesia (B) Rigidity (C) Tremors (D) Hyperactivity

**Q1.11.2 Short Answer:** Name one symptom associated with Alzheimer's Disease.

*Answer:*

**Q1.11.3 True or False:** Only retrograde amnesia is observed in Alzheimer's Disease.

*Answer:*