Overview of the Nervous System

The Brain and Behavior

First

- All parts are interrelated.
- Thus, you need all parts to function normally.
- Neurons = Nerve cells

The Nervous System is Composed of Two Parts

- Central Nervous System
  - Consists of all neurons (nerve cells) located in the brain and spinal cord
- Peripheral Nervous System
  - Consists of all neurons (nerve cells) located outside the brain and spinal cord.

Peripheral Nervous System

- Two divisions
  - Somatic
  - Autonomic

Somatic System

- Two parts
  - 1. Afferent neurons
    - Are sensory in nature.
    - Receive information from sensory receptors (structures) and sends that information toward the central nervous system
Efferent neurons
- Are motor in nature
- Gets information from the central nervous system and sends it to the muscles of the body.

Autonomic System
- Consists of neurons that go to and from various internal organs.
- Regulates heart rate, blood pressure, digestion, etc.
- Has two parts
  - Sympathetic nervous system
  - Parasympathetic nervous system

Think of What Happens When a Lion Chases You
- Sympathetic
  - Increases Heart Rate
  - Increases Respiration
  - Decreases Digestion
- Parasympathetic
  - Decreases Heart Rate
  - Decreases Respiration
  - Increases Digestion

Central Nervous System
- Consists of
  - Brain
  - Spinal Cord

Brain
- Has 100 billion neurons or nerve cells
- Neurons are the functional element of the brain.
- Also has approximately 120 billion Glial cells

Glial
- Has many functions
  - Acts as a glue
  - Provides nutrients
  - Helps Regulate Brain Activity
  - Eliminates Wastes
  - Breaks down Neurotransmitters
  - Makes Myelin
Best way to conceptualize the brain is how it develops through evolution

Hind Brain
- Also called Reptilian Brain
- Consists of three structures: Medulla, Pons, Cerebellum

Medulla
- Controls breathing, heart rate, digestion, blood pressure, temperature and other things
- Is the structure that keeps you alive. You can damage other parts of the brain and live, if you damage the medulla, you usually will die

Pons
- Is responsible for wakefulness or the sleep cycle

Cerebellum
- Is behind the medulla and pons
- Helps control muscle tone, body balance
- In general, it helps coordinate voluntary muscle movement
- Also smoothes out muscle movement so it is not jerky.
- Is extremely important for controlling rapid movement such as startle responses
- Is also important for maintaining body balance
Midbrain

Two major sets of structures
1. Superior and Inferior Colliculi
   - superior means above
   - inferior means below
   - Thus, the superior colliculi is above the inferior colliculi
2. Reticular formation

Superior Colliculi

• Superior means above
• Function
  • Receives fibers from the retina of the eye and sends information to the cerebral cortex.
  • Is important for controlling eye movements (especially tracking).

Inferior Colliculi

• Receives information from the cochlea of the ear and sends to the cortex.
• Has a role in organizing auditory stimuli.

Reticular Formation

• Is another part of the midbrain
• Are sets of fibers that go from the lower brain stem (all structures in the hind and mid brain) and extends to the Thalamus.
• Thus, has fibers in both the hind and mid brain

Functions

Is important for controlling your state of arousal
May play a role in sleep.
Has an important role in focusing attention and acting as a filter.

Allows you to concentrate on important things while ignoring unimportant things (buzz of a light)

BRAIN STEM

• People talk about the brain stem.
• Consists of all structures in both the Hind and Mid Brain
Forebrain

- Consists of several structures in two major areas
  - Diencephalon (inter brain)
  - Telencephalon (end brain)

Encephalon = Brain

Diencephalon

- Consists of many structures
  - Thalamus
  - Hypothalamus
  - Others (you do not have to know about)

Thalamus

Is basically a relay station from sensory structures to the cortex and back.
Is a major center for collecting and integrating information
  e.g., 80% of all fibers from the optic nerve of the eye goes to the thalamus before going to the occipital lobe (other 20% go to the superior colliculi).
Also has a role in memory formation
**Hypothalamus**
- Is in charge of several things
- Is smaller than the thalamus and is located in front of and below the thalamus (hypo = below).

**Functions**
- Governs eating, drinking, and sexual behavior
- Regulates endocrine activity (helps with a variety of hormones)
- Is involved with emotion

**Telencephalon**
- These structures have increased the most as evolution has progressed.
- Has several major groups of structures.

**Olfactory System**
- Is involved with smell

**Limbic System**
- Has several structures
  - Septal area
  - Amygdala
  - Hippocampus
  - Parahippocampus

**Septal Area**
- Is involved with controlling aggression and pleasure
Amygdala
- Is involved with controlling rage behavior and aggression
- When destroyed, the organism attacks anything

Hippocampus and Parahippocampus
- Has a major role in memory formation
- When damaged, you cannot form any new memories

Hypothalamus
- Is involved with emotional behavior
- May be involved with pleasure, pain, and anger
- Is also categorized in two groups. Diencephalon and Telencephalon

In general, the limbic system controls animal instinctive behavior

Basal Ganglia
- Has several structures as well.
  - Caudate Nucleus
  - Lenticular Formation
  - Putamen
  - Red Nucleus
  - Substantia Nigra

Like the Cerebellum
- Is involved with controlling movement.
- While cerebellum controls rapid movement;
- Basal Ganglia helps with
  - Controlling slower movements
  - Starting and stopping movement
  - Balance
In General

• The basal ganglia controls the direction and amplitude of movement; especially postural movement.

When Damaged

Causes problems with posture, walking, etc.
Get a lot of tremors, jerks, twitching, etc.

Parkinson’s syndrome
  – Classic symptom: tremor at rest.
  – Once you move the tremor stops until in later stages of the disease, then you always have tremors.

Occurs because the Substantia Nigra degenerates.

Causes

• In the past, it was thought to be genetic or viral
• Today, we know that it can be environmentally caused

Example 1

• MPTP
  • MPTP is converted to MPP+ by the body
  • MPP+ is selectively toxic to the Substantia Nigra
• Causes rigidity - like a stone
• Major source of MPTP in the environment is Parquet
• Parquet is a herbicide

Example 2

• Punch Drunk Syndrome
  Boxers are hit on the head
• Ultimately, the brain swells and basal ganglia degenerates.
  Result - Same problem as Parkinsons
  Tremor at rest, talking problems etc.
• Ali
• Can occur with other sports as well where head contact occurs.
  – Soccer

Neocortex

Also called Cortex or Pallium
Is the most developed in Humans
Has many folds and fissures
- The folds of tissue are called gyri or a gyrus (single)
- The fissures or valleys are called sulci or a sulcus (single)

Is what you see when you look at a brain from the outside

Structures are divided into several section or lobes.
Each lobe has a different function
Cortex is separated in half by a fissure called the central fissure
Splits the brain into left and right halves called hemispheres

Hemispheres
- Left Hemisphere controls the right side of the body
- Right Hemisphere controls the left side of the body
- Each hemisphere contains 4 lobes
  - Frontal
  - Parietal
  - Temporal
  - Occipital

Lobes
- Each lobe is separated by a fissure or a sulcus. For us three are important
  - Central Sulcus
    Separates the Frontal and Parietal lobe
  - Lateral Sulcus
    Separates the Temporal lobe from the Frontal and Parietal lobe
  - Parietal Occipital Sulcus
    Separates the Parietal lobe from the Occipital lobe
Lobes of the Brain

- Frontal
- Parietal
- Temporal
- Occipital

Frontal Lobe

- Contains a variety of structures
- Precentral Gyrus  Also called Area 4
  - Is responsible for voluntary motor movement
- Areas 6 and 8
  - Are responsible for muscle tone
  - Gets muscles ready to fire

To Get Movement

- Areas 6 and 8 prepare muscle to contract
- Area 4 causes the muscle to contract

Basal Ganglia, Cerebellum, and other structures help smooth out the movement.

Broca’s Area

Is located at the bottom of area 4, 6 & 8.
Is concerned with speech
When damaged, the person can understand speech, but they cannot talk well.
Called Broca’s Aphasia
Association Area

- Remainder of the Frontal Lobe
- Is important for thought processes, memory formation and problem solving.
- When damaged have problems with memory

Parietal Lobe

- Also contains a variety of structures
- Somatosensory area (Area 3)
  - Is concerned with sensory functioning.
  - Is where you feel pain, temperature etc.
- Area 1, Area 2, and association cortex
  - Interprets what is happening in Area 3

Temporal Lobe

- Is below the Lateral Sulcus
- Is concerned with hearing and patterning of sound (speech).
- Wernicke's Area
  - Is a sub-area of the Temporal Lobe
Wernicke's Area

• Is concerned with the integration and comprehension of speech.
• Also receives information from other areas such as the occipital lobe
• When damaged, you can speak fluently but the content is Nonsense
  Called Wernicke’s Aphasia
• When damaged, it is also hard to comprehend and understand written stimuli (reading).

Arcuate Fasiculus

• Is a set of fibers that look like an arc
• These fibers connect Wernicke’s area with Broca’s Area
• When damaged, the symptoms look like Wernicke’s Aphasia

Occipital Lobe

• Is concerned with vision
• Area 17
  – Is the primary visual cortex
  – Is where visual information goes first
• Areas 18 and 19
  – Helps with organization of visual stimuli

  Information is then sent to other lobes

Island of Reil

• Also called the Insular Lobe
• Is located under the lateral Sulcus
• Is concerned with smell

Conclusion

• The brain has lots of structures
• Each structure is involved with lots of functions
• Is very resistant to damage
• When damaged, individuals can have lots of problems
• Problems can identify where the brain is damaged.