

**AACBIS**  
American Academy for the Certification  
of Brain Injury Specialists

CERTIFICATION EXAM PREPARATION COURSE  
**Chapter 3: Understanding the Brain and  
Brain Injury**

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**MODULE OBJECTIVES**

- Identify basic brain structures and functions.
- Describe brain-behavior relationships.
- Describe how an injury to the brain can result in various behaviors and challenges.

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**INTRODUCTION**

The brain is the main organ of learning.

- It makes it possible for us to think, communicate, act, behave, move about, and create.



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### MECHANISMS OF TRAUMATIC BRAIN INJURY

After a sudden jolt or bang, the result can be...

- **Coup-Contracoup:** Injury at the site of impact and on the opposite side from the movement of the brain against the skull (either front to back or side to side)



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### MECHANISMS OF TRAUMATIC BRAIN INJURY

After a sudden jolt or bang, the result can be...

- Diffuse Axonal injuries: Delicate nerve tissues rip, tear, and stretch
- Swelling: Brain tissue swells preventing blood and CSF circulation
  - Hematoma: Accumulation of blood causing pressure
  - Hydrocephalus: Blockage of CSF causing pressure
- Anoxia & Hypoxia: Oxygen deprivation from suffocation, drowning, blood loss, or cardiac failure that kills brain cells
- Hemorrhages: Major bleeding from when the brain rubs against the inside of the skull, which is ragged with sharp bony ridges



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### WHEN THE BRAIN IS INJURED

A brain injury is often the result of two injuries:

- A “**primary injury**” caused by the initial blow or insult to the brain
- A “**secondary injury**” caused by the swelling, bleeding, compression and contusions (bruises) to the brain.

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## SEVERITY OF BRAIN INJURIES

**Glasgow Coma Score (GSC)**

- Is a measure of brain injury severity.
- Measures *Eye Response + Verbal Response + Motor Response = Total Score*
- Scores range between 3 and 15
  - The **lower** the score, the more severe the brain injury

**Glasgow Coma Scale**

| Eye Opening                     | Verbal Response                           | Motor Response               |
|---------------------------------|---|------------------------------|
| 4 Spontaneous                   | 5 Oriented to person, place, month & year | 6 Obeys commands             |
| 3 Eye opening to verbal command | 4 Confused                                | 5 Localizes pain             |
| 2 Eye opening to pain           | 3 Inappropriate words                     | 4 Withdraws to pain          |
| 1 No eye opening                | 2 Sounds, but words not understandable    | 3 Abnormal flexion to pain   |
|                                 | 1 No verbal response                      | 2 Abnormal extension to pain |
|                                 |   | 1 No motor response          |

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## SEVERITY OF BRAIN INJURIES

**Severity Definitions**

| Mild Brain Injury  | Moderate Brain Injury  | Severe Brain Injury  |
|--|--|--|
| <ul style="list-style-type: none"> <li>• Loss of consciousness for less than 30 minutes (possibly no loss of consciousness).</li> <li>• Glasgow Coma Scale of 13-15.</li> <li>• Post-traumatic amnesia less than 24 hours.</li> <li>• Temporary or permanently altered mental or neurological state.</li> <li>• Post-concussion symptoms.</li> </ul> | <ul style="list-style-type: none"> <li>• Coma more than 20-30 minutes, but less than 24 hours.</li> <li>• Glasgow Coma Scale of 9-12.</li> <li>• Possible skull fractures with bruising &amp; bleeding.</li> <li>• Signs on EEG, CAT or MRI scans.</li> <li>• Some long term problems in one or more areas of life (i.e., home, work, community).</li> </ul> | <ul style="list-style-type: none"> <li>• Coma longer than 24 hours, often lasting days or weeks.</li> <li>• Glasgow Coma Scale of 3 to 8.</li> <li>• Bruising, bleeding in brain.</li> <li>• Signs on EEG, CAT or MRI scans.</li> <li>• Long term impairments in one or more areas of life (i.e., home, work, community).</li> </ul> |

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## SEVERITY OF BRAIN INJURIES

Post concussion symptoms of cognitive and psychiatric nature that may or may not persist include:

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|--|--|
| headache<br>dizziness<br>vomiting<br>sleep disturbance<br>irritability | changes in personality<br>memory problems<br>depression<br>difficulty problem solving<br>diminished attention span |
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## ANATOMY OF THE BRAIN

The brain . . .

- Is a soft organ, like the consistency of gelatin
- Weighs less than **1** lb. at birth and grows to about **3** lbs.
- Sits inside a rough and bony skull and is bathed in a **cerebrospinal fluid (CSF)**
- Receives oxygen and glucose through a sophisticated system of blood vessels that carry blood to and from the heart



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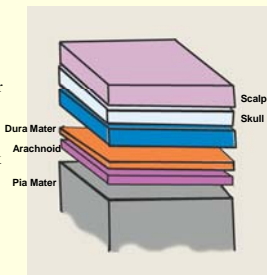
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## ANATOMY OF THE BRAIN

Three membranes or **meninges** cover the brain:

- The outer **dura mater** or hard matter, which is like a heavy plastic covering.
- The **arachnoid**, which is like a spider web that bridges the brain's many wrinkles and folds.
- The **pia mater** or tender matter, which molds around every tiny crook and crevice on the brain's surface.
- Between the pia mater and the arachnoid, there is 145cc of cerebrospinal fluid.



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## ANATOMY OF THE BRAIN

There are four **ventricles** which make, store, and circulate cerebrospinal fluid.

- The fluid helps cushion the brain and protect brain tissue when swelling occurs.

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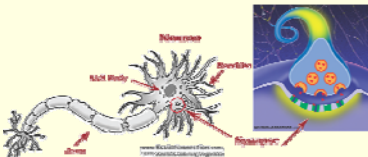
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## NEURONS

- Neurons: the billions and billions of tiny brain cells making up the nervous system
- **Glial** ("glue"): non-communicating cells support and nourish the neurons.
- Three main parts of the neuron:



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## NEURONS

- The neurons communicate with each other via a unique "electro-chemical" process.
- **Neurotransmitters** are chemical messengers that relay the electrical signal of one nerve cell to the next.
- Neurochemical transmitters leap the **synaptic gaps**.
- After a person sustains a brain injury, many of the neuron pathways may be torn apart or stretched so that information processing is no longer possible.

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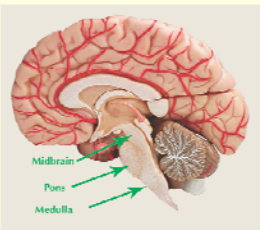
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## BRAIN STEM



- **Midbrain**
  - Alertness & arousal
  - Elementary forms of seeing & hearing
- **Pons**
  - Facial movement & sensation, hearing, & coordinating eye movements
- **Medulla**
  - Basic living functions
  - Vital to life and death
  - Controls involuntary functions like breathing, heart-rate, blood pressure, swallowing, vomiting and sneezing.

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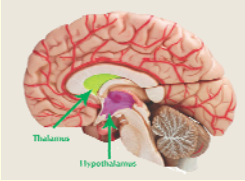
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## DIENCEPHALON

- Thalamus
  - Major relay station for incoming and outgoing sensory information
  - The input for every sense (except smell) travels through the thalamus
- Hypothalamus
  - Control center for hunger, thirst, sexual response, endocrine level & temperature regulation.
  - Controls complex responses like anger, fatigue, memory and calmness.



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## LIMBIC SYSTEM



- Limbic System
  - Houses basic elemental drives, emotions and survival instincts.
  - Injury to the limbic system can result in serious problems with basic emotional perceptions, feelings & responses.
  - Behavior and mood can be very erratic

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## LIMBIC SYSTEM

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|--|---|
| <ul style="list-style-type: none"> <li>■ Amygdala                             <ul style="list-style-type: none"> <li>■ Fight or flight structure</li> <li>■ The front door to our emotions</li> <li>■ When perceptions reach the cerebral cortex, it is transmitted to the amygdala to be evaluated for emotional content</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>■ Hippocampus                             <ul style="list-style-type: none"> <li>■ Associated with memory functions</li> <li>■ Injury can result in problems with short term memory, and turning short term memories into long term memories</li> <li>■ Disrupts the encoding and retrieval of long term memory</li> </ul> </li> </ul> |
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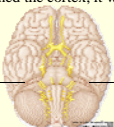
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## THE CEREBRAL CORTEX

- **Cerebral Cortex:** the most complicated structural component of the brain
- Made up of two hemispheres: the right hemisphere and left hemisphere
- Dedicated to the highest levels of thinking, moving, and acting.
- Each hemisphere is divided into **four lobes** – frontal, parietal, temporal, and occipital
- The cortex is full of wrinkles and folds.
  - If you took out and flattened the cortex, it would be the size of a **pillowcase**.

Left Hemisphere



Right Hemisphere

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## THE CEREBRAL CORTEX

- The two hemispheres of the brain have unique ways of processing information.
  - The right hemisphere is more holistic, visual-spatial, and intuitive.
  - The left hemisphere processes language and is more linear, verbal-analytic, and logical.
  - The cerebral hemispheres control **opposites** sides of the body.
- The cerebral hemispheres communicate to each other a thousand times a second through the **corpus callosum** (the 4 inch long, pencil thick band of complex nerve fibers).

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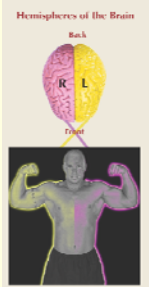
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## LATERALIZED SKILLS OF THE BRAIN

- The brain is divided into two hemispheres
  - The left hemisphere controls the right side of the body.
  - The right hemisphere controls the left side of the body
- The two hemispheres control input and regulate output



Hemispheres of the Brain

Back

FRONT

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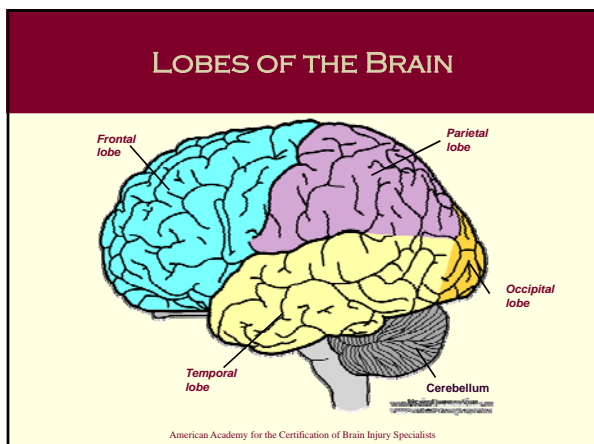
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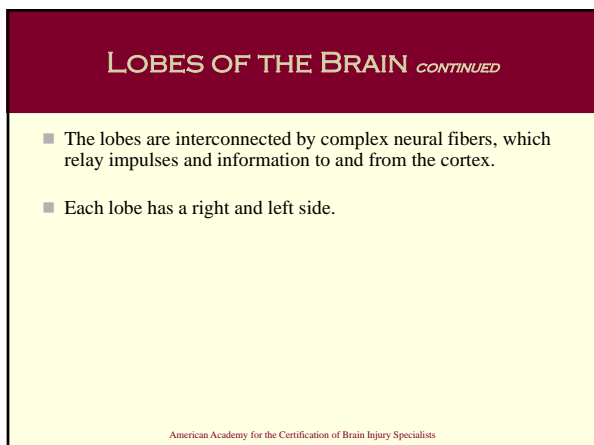
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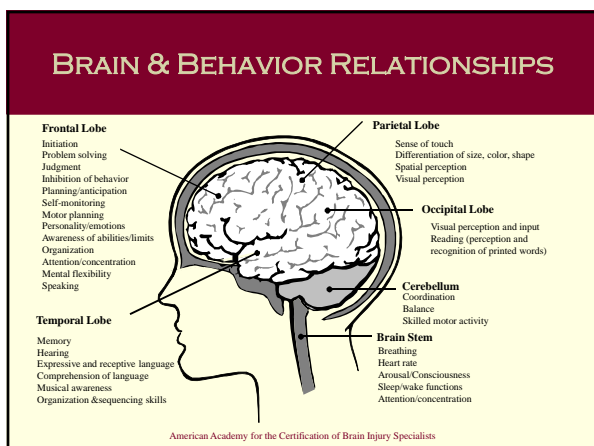
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## FRONTAL LOBES

- Vulnerable to injury since they sit just inside the front of the skull near a rough bony area
- Have extensive connections with many brain regions, especially with the *parietal* lobe and the *limbic system* (emotions).
- Includes the *motor strip*
  - Sends signals to the muscles of the body, telling them what to do
- *Prefrontal cortex*: located at the very front part of the frontal lobes
  - Helps hold information in memory for several minutes (referred to as *working memory*)
  - Regulates *emotional responses*, motivation, executive functions, working memory
  - Responsible for teaching a person to learn from *consequences*

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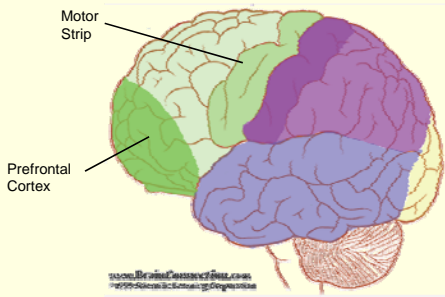
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## FRONTAL LOBES



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## FRONTAL LOBE INJURY

Injury damages an individual's ability to . . .

- Synthesize signals from the environment
- Assign priorities
- Make decisions
- Initiate actions
- Attend to tasks
- Control emotions
- Behave and interact socially
- Make plans

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## FRONTAL LOBE INJURY IN CHILDREN

- Prefrontal lobe injuries in young children sometimes go *unnoticed*
  - Parents and teachers typically function as their frontal lobes—they organize, plan, and direct their children’s lives.
  - As the child gets older and enters early adolescence, they are expected to be more independent and learn to manage themselves over time.
- In the child with a brain injury, the capability for more independent frontal lobe functioning has been diminished.



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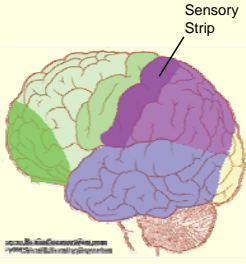
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## PARIETAL LOBE

- Situated behind *the frontal* lobes
- Includes the *primary sensory cortex* which is posterior to the motor strip.
  - The first part of the brain to consciously register physical sensations.
- Regulates responses to touch, heat, cold, pain, and body awareness



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## PARIETAL LOBE INJURY

- When one side of the lobe is injured, a person may not recognize that anything is wrong with movement on the *other side of the body*.
- Even more complex functions like attention can be affected by damage to the parietal lobes.

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## OCCIPITAL LOBE

- Located in the lower back part of the brain
- The primary *visual* center of the brain
- Involves the visual cortex
  - Connected to the eyes by *optic nerves*
  - Optic nerves carrying signals meet at a "crossing" called the *optic chiasm*
  - The left optic track carries signals from the right-side field of vision, and the right optic track takes signals from the left so that both sides of the brain "see" the same thing.
- Most of what a person "sees" derives its meaning from prior learning and symbolic representations.



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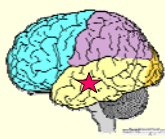
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## TEMPORAL LOBES

- Rest on both sides of the brain
- The centers for language & hearing
  - Broca's Area
    - located in the lower portion of the motor cortex in the left frontal-temporal lobe
    - Controls muscles of the face and mouth and enables the *production* of speech
  - Wernicke's Area
    - located left temporal-parietal lobe
    - Governs a person's *understanding* of speech
- With their connections to the *hippocampus*, the temporal lobes help in the long-term storage of permanent memories.



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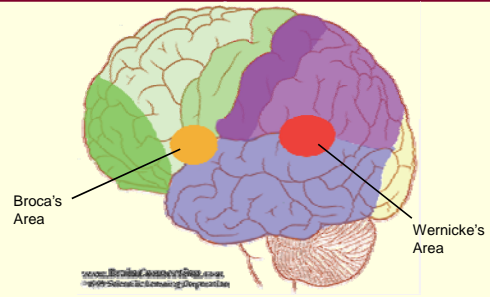
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## TEMPORAL LOBES



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