NCM 116: CARE OF CLIENTS WITH NEUROLOGIC DISORDERS (ALTERATION IN PERCEPTION)

MEDICAL SURGICAL NURSING

2ND Semester I Academic Year 2024-2025 I Mr. Romualdo Redoña Jr., RN I May 2025

OUTLINE:

REFERENCES:

- **(1) Textbook of Medical-Surgical Nursing** by Brunner and Suddarth (14th Edition)

THE NERVOUS SYSTEM

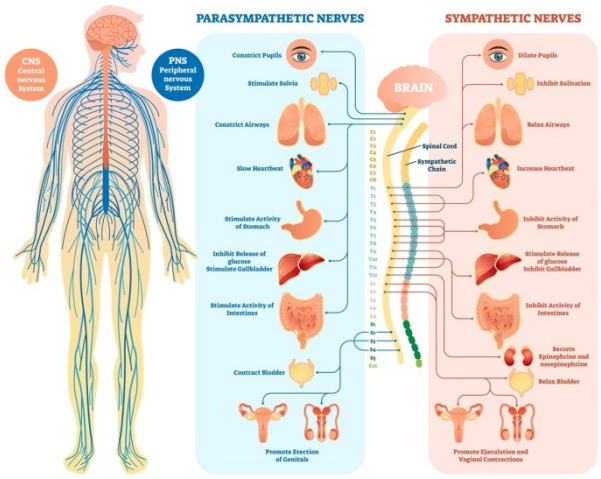
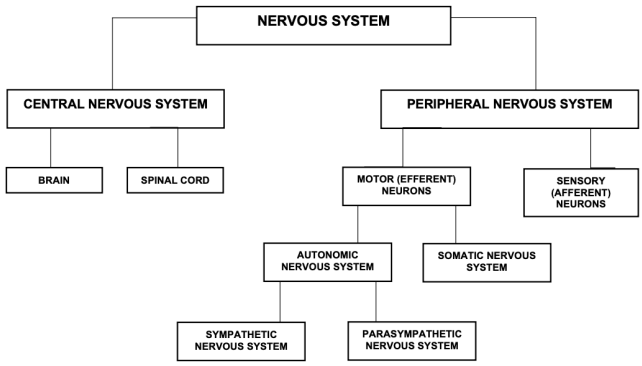


Figure 1. **The Nervous System**

- The nervous system is the body's command center
- It monitors and controls the functions of the different organ system, and coordinates the body's response to changes in its internal and external environment
- None of the body system is capable of functioning alone. All are interdependent and work together as one unit so that normal conditions within the body may prevail.
- Control of the body's billions of cells is accomplished mainly by two **communication systems**: the nervous system and the endocrine system. Both systems transmit information from one part of the body to another, but they do it in different ways.
- The nervous system **transmits information very rapidly by nerve impulses conducted from one body area to another**
- The endocrine system transmits information more slowly by chemicals secreted by ductless glands into blood steam and circulated from glands to other parts of the body
- The nervous system serves as the chief coordinating agency. Some major functions of the nervous system are:
  - Receiving sensory input
  - Integrating information
  - Controlling muscles and glands
  - Maintaining homeostasis
  - Establishing and maintaining mental activity

DIVISION OF THE NERVOUS SYSTEM



PERIPHERAL NERVOUS SYSTEM (PNS)

- The PNS is the communication link between the CNS and the various part of the body
- The PNS carries information about the different tissues of the body to the CNS and delivers commands to alter body activities

SUBDIVISION OF THE PERIPHERAL NERVOUS SYSTEM

1. **Sensory (afferent) division**- carry sensory signals impulses from the sense organs (receptors- ears, eyes, nose, and tongue) to the Central Nervous System (CNS)

2. **Motor (efferent) division**- transmits impulse from the CNS; the efferent or motor division transmits impulses from the CNS out to the muscle or glands (effectors) to cause an effect or action

SUBDIVISION OF THE MOTOR DIVISION

1. **Somatic Nervous System-** Transmit action potential from the CNS to skeletal muscles. It is associated with the voluntary control of the body movements via the use of skeletal muscles. It controls voluntary commands e.g. moving, or talking.

2. **Autonomic Nervous System-** Transmit action potential from the CNS to the cardiac muscle, smooth muscle, and glands. It regulates involuntary physiologic processes including heart rate, blood pressure, respiration, digestion, and sexual arousal. It controls involuntary commands e.g. digestion and heartbeat.

SUBDIVISION OF THE AUTONOMIC NERVOUS SYSTEM

1. **Sympathetic Nervous System-** It functions to produce localized adjustments (such as sweating as a response to an increase in temperature) and reflex adjustments of the cardiovascular system. Known as the "**fight or flight**" system of the body, it increases the alertness, and prepares the body for quick response.

2. **Parasympathetic Nervous System-** The parasympathetic nervous system predominates in quiet "rest and digest" conditions. Known as the "**rest and response**" system of the body as it conserves energy and controls sedentary activities such as digestion. The main purpose of the PNS is to conserve energy to be used later and to regulate bodily functions like digestion and urination.

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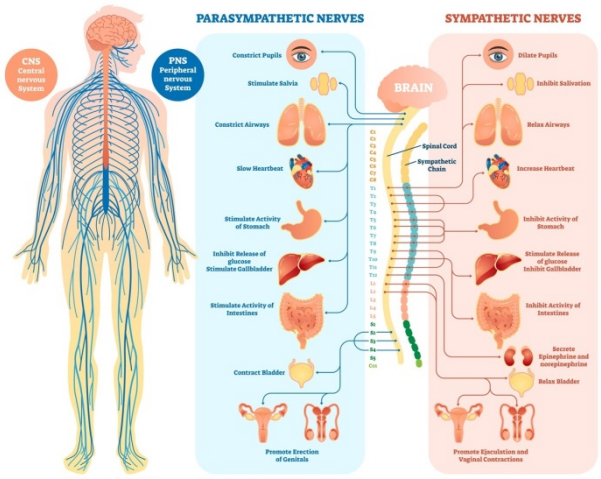

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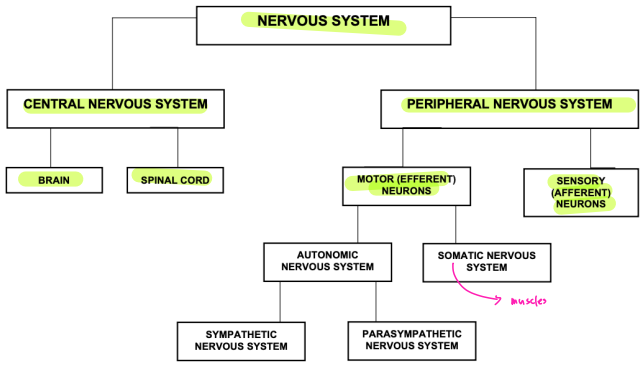

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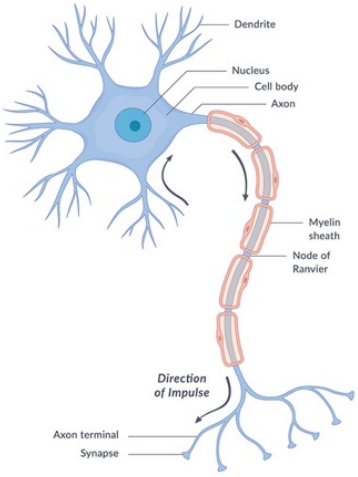
ENTERIC NERVOUS SYSTEM (ENS)

- It is a unique part of the PNS
- Contains both sensory and motor neurons contained in the digestive tract
- The ENS can function without input from the CNS or other parts of the PNS

THE CELLS OF THE NERVOUS SYSTEM

- The two types of cells that make up the nervous system are:
  - Neurons
  - Glial cells (neuroglia)

A. NEURONS



- It is also known as **nerve cells**; the functional unit of the nervous system + receive stimuli, conduct action potential, and transmit signals to other neurons or effector organs. **Nerve** is known as grouped neurons.
- Three parts of neurons:
  - **Dendrites-** short branches that receive information that transmit the message to the cell body
  - **Cell Body**- also called ***Soma*** or ***Cyton***; contains nucleus, mitochondria and other cellular organisms
  - **Axon-** long and less branched process that conducts information away from the body. **Axon hillock** is the area where the axon leaves the neuron cell body. Axon of sensory neuron conduct action potentials toward the CNS, and axons of motor neurons conduct action potential away from the CNS.
    - **Collateral Axon**- an axon may be unbranched or may branch to form the collateral axon

A1. TYPES OF NEURONS

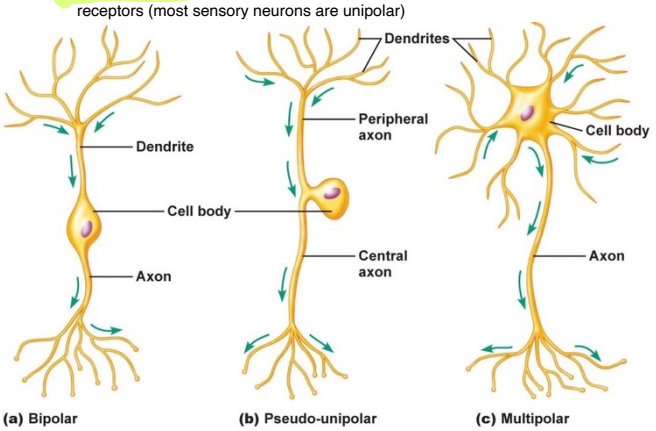
- Neurons can be classified **structurally** and **functionally**

A1a. TYPES OF NEURONS ACCORDING TO THEIR FUNCTION

- **Sensory Neuron** (*afferent neuron*)- carries messages from skin, eyes, nose, etc. to the muscles and glands
- **Motor Neuron** (*efferent neuron*)- receives information from the nerve center and transmits it to the muscle and glands
- **Interneurons** (*central or connecting neuron*)- found only in the Central Nervous System they connect sensory neuron to a motor neuron

A1b. TYPES OF NEURONS ACCORDING TO THEIR STRUCTURE

- **Multipolar Neuron**- 99% of our neurons are of this kind. Have many dendrites and a single axon; most of the neurons in the CNS are of this kind.
- **Bipolar Neuron-** has two processes: one dendrite and one axon. This neuron is pretty rare and found only in a few sensory receptors like the retina of the eye.
- **Pseudo-unipolar Neuron-** appears to have an axon and no dendrites –most sensory neuron
- **Unipolar Neuron-** Only one process extends, found mostly in your sensory receptors (most sensory neurons are unipolar)



B. GLIAL CELLS

- Glial cell aka **neuroglia** does not specialize in transmitting impulses. Instead, glial cells carry out different activities that enhance neuron function and maintain normal conditions within nervous tissue.
- Their name is appropriate because it is derived from Greek word *glia* meaning "**glue**"
- Neuroglia provides support, nutrition, insulation, and help with signal transmission in the nervous system
- Most glial cells retain the ability to divide, whereas neurons do not
- The types of glial cells are different in the CNS versus the PNS

GLIAL CELL TYPES	
CENTRAL NERVOUS SYSTEM	**PERIPHERAL NERVOUS SYSTEM**
ASTROCYTES • Most abundant and versatile glial cells, which provides structural support; regulate neuronal signaling; contribute to blood-brain barrier; help with neural tissue repair. • Astrocytes can stimulate or inhibit the signaling activity of the nearby neurons • Astrocyte participate with the blood vessel endothelium to form a permeable membrane known as the **blood-brain barrier** between the blood and the CNS	**SATELLITE CELLS** • Support neurons, providing nutrients; protect neurons from heavy-metal poisons such as lead and mercury.
MICROGLIAL CELLS • Immune defense against invading microorganism; become phagocytic in response to inflammation	**SCHWANN CELLS** • Produce an insulating barrier called the **myelin sheath** around the axon
EPENDYMAL CELLS • Create, secrete and circulate cerebrospinal fluid. Some produces choroid plexuses which produces CSF.	
OLIGODENDROCYTES • Produce an insulating barrier called the **myelin sheath** that surrounds the axon.	

MYELIN SHEATH

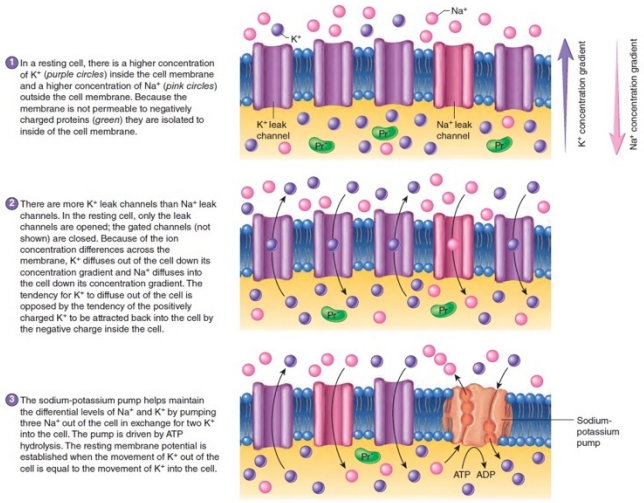
- Myelin sheaths are specialized layers that wrap around axons of some neurons; axons with myelin sheath are called **myelinated axons**
- Myelin is an excellent insulator that prevents almost all ion movement across the cell membrane
- Myelination of an axon increases the speed and efficiency of action potentials generation along the axons
- Gaps in the myelin sheath called **nodes of Ranvier**

ORGANIZATION OF NERVOUS TISSUE

- The nervous tissue varies in color due to the location and arrangement of the parts of neurons and glial cells
- Nervous tissue exists as gray matter and white matter
- **Gray matter**- forms the cortex and nuclei in the brain and ganglia in the PNS
- **White matter**- forms nerve tracts in the CNS and nerves in the PNS

ELECTRICAL SIGNALS AND NEURAL PATHWAYS

A. RESTING MEMBRANE POTENTIAL



- Cells of the body have electrical properties. These properties are evident at the cell membrane, a boundary that prevents the free movement of ions into and out of the cell.
- There are two basic types of ion channels:
  - **Leak channels** are always open; thus, ions can "leak" across the membrane, down their concentration gradient
  - **Gated channels** are closed until opened by specific signals; **chemically gated channels** are opened by specific chemicals; **voltage-gated channels** are opened by a change in the electrical property of the cell membrane
- When we consider the "sides" of the cell membrane, the inside of most cell membranes is negatively charged compared to the outside of the cell membrane, which is positively charged
- This uneven charge distribution across the cell membrane means that the membrane is **polarized**
- The inside of the cell membrane can be thought of as the negative pole of a battery and the outside of the cell membrane can be thought of as the positive pole
- Thus, a small voltage difference, called the **potential**, can be measured across the cell membrane
- In an unstimulated (or resting) cell, we refer to this as the **resting membrane potential**

IN CAPSULE

Imagine your **cell** is like a little house, and the **cell membrane** is its door and wall. Inside the house, there are some **potassium ions (K^+)** and **negative things** (like grumpy stuffed animals that don't leave). Outside the house, there are lots of **sodium ions (Na^+)**.

Now, there are **tiny doors (ion channels)** in the wall. Some doors are always a little open (leak channels), and some are locked until something special opens them (gated channels).

Potassium likes to leave the house through these open doors because there's more room outside. But when too many potassium ions leave, the inside gets more negative (like it's too sad and lonely). Since opposite charges attract, some potassium comes back in.

So it's like a tug-of-war:
- Potassium wants to go out because there's less of it outside
- But it also wants to come back in because the inside is negative

Eventually, the pushing and pulling **balance out** — and that balance is called the **resting membrane potential**. It's like the cell saying, "I'm calm and ready, just waiting for something to happen!"

To keep everything just right, the cell also uses a special pump (the **sodium-potassium pump**) that works like a doorman. It pushes sodium back out and pulls potassium back in, using energy like eating food (ATP).

B. NEURON COMMUNICATION

- Neurons as well as muscle cells are excitable cells meaning that the resting membrane potential changes in response to stimuli
- In muscle cells, this change in the resting membrane potential results in contraction; but in the neurons, this change is a means by which cell communicates with other cells

B1. ACTION POTENTIAL STARTS (THE MESSAGE BEGINS)

- Normally, a neuron is quiet and resting (this is called the resting membrane potential — it's like the neuron is waiting)
- Then something exciting happens — like a touch or sound!
- This stimulus tells the neuron, "Wake up!"
- Special doors (called gated ion channels) open, and sodium (Na^+) rushes into the neuron
- The inside of the neuron goes from negative to positive — this is called **depolarization**
- If this excitement is strong enough, it starts a big signal called an **action potential** — like pressing "send" on a message!

B2. THE MESSAGE TRAVELS (ACTION POTENTIAL CONDUCTION)

- Now the message travels down the long part of the neuron called the **axon**
- If the axon has no myelin (a fat covering), the signal walks step-by-step — like a kid walking heel-to-toe; this is continuous conduction
- If the axon has myelin, the signal jumps over the myelin and only stops at the gaps called **nodes of Ranvier** — like a kid skipping. This is saltatory conduction (saltatory means "jumping")
- Jumping is much faster

B3. MESSAGE REACHES THE END (THE SYNAPSE)

- At the end of the axon is a place called the **synapse**
- The neuron releases chemicals (neurotransmitters) that jump across the tiny gap to the next cell (like a baton in a relay race)
- That next cell gets the message — and it might move a muscle, make you feel pain, or think a thought

IN CAPSULE

Neurons send stronger messages not by making bigger signals, but by sending more signals in a row — like knocking faster on a door!

The Synapse: How Neurons Pass Messages!
Your brain cells (neurons) **don't touch** each other — there's a tiny **gap** between them called a **synapse**. But they've figured out a clever way to talk!
Let's break it down:

1. Three Parts of the Synapse
- **Presynaptic terminal**: The **end** of the first neuron (sender)
- **Synaptic cleft**: The **tiny space** between the two cells
- **Postsynaptic membrane**: The **start** of the next cell (receiver)

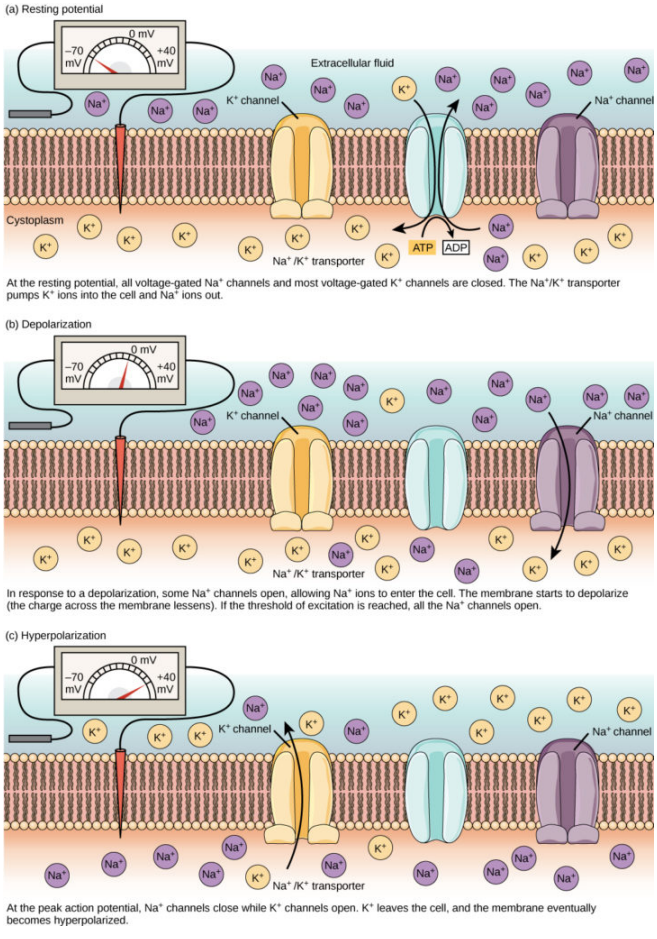
2. How the Message Travels
Imagine it like sending a secret message in a bottle:
1. An **action potential** (electrical message) **arrives** at the end of the neuron (the presynaptic terminal)
2. This **opens calcium (Ca^{2+}) doors**, and calcium rushes in
3. Calcium tells little sacs called **vesicles** to **release chemicals** called **neurotransmitters**
4. The neurotransmitters **float across** the synaptic cleft
5. On the other side, the neurotransmitters **land on special "locks"** (receptors) on the next cell
6. These locks **open special gates** for ions like **Na^+, K^+, or Cl^-**
   - If **Na^+ goes in**, the next cell gets excited (depolarized) — a new action potential can happen

- If **K^+ or Cl^- moves**, the cell stays calm (hyperpolarized) — no action potential

3. Cleaning Up the Messengers
The chemicals don't stay forever:
- They are **broken down** by enzymes (like **acetylcholinesterase** for acetylcholine)
- Or they are **taken back** by the first neuron (like norepinephrine)
- This makes sure the message is **quick and clear**, not stuck on repeat!

4. What About Drugs?
Some drugs mess with this system:
- **Cocaine & amphetamines**: Make neurons release **more** norepinephrine and **stop it from coming back** — overstimulating the brain
- **Antidepressants (like SSRIs)**: Block the return of **serotonin**, helping improve mood

Real-Life Analogy:
It's like kids playing telephone with walkie-talkies:
- One kid talks (presynaptic)
- The signal travels across the air (synaptic cleft)
- The next kid hears it and responds (postsynaptic)
- But someone must clear the air (enzymes or reuptake) before the next message can come in!



THE SYNAPSE

- A synapse is a junction where the axon of one neuron interacts with another neuron or with cells of an effector organ, such as muscle or gland.
- *How does the axon of one neuron make functional contact with the membrane of another neuron?*
- This is accomplished by the synapse. Synapse came from the Greek word meaning "*to clasp*". Synapses are point at which a neuron can transfer an impulse to another cell. Synapse is the tiny space between two neurons.

WHEN DESCRIBING THE STRUCTURE OF A SYNAPSE, WE IDENTIFY THREE MAJOR COMPONENTS:

1. The end of an axon forms a **presynaptic terminal**
2. The membrane of the dendrite or effector cell is the **postsynaptic membrane**
3. The space separating the presynaptic and postsynaptic membrane is the **synaptic cleft**

NEUROTRANSMITTERS

- Chemical substances manufactured in the neuron that aid in the transmission of information throughout the body
- They either excite or stimulate an action in the cells (excitatory) or inhibit or stop an action (inhibitory)
- These neurotransmitters fit into specific receptor cells embedded in the membrane of the dendrite, just like a certain key shape fits into a lock; acts as a chemical signal to stimulate the next cell and is stored in synaptic vesicles in the presynaptic terminal
- After neurotransmitters are released into the synapse and relay the message to the receptor cells, they are either transported back from the synapse to the axon to be stored for later use (reuptake) or metabolized and inactivated by enzymes, primarily **monoamine oxidase (MAO)**
- ***Epinephrine***, also called **adrenaline**; a related compound, ***norepinephrine***, or ***noradrenaline***; and ***acetylcholine*** are the most known neurotransmitter.
- ***Acetylcholine*** (Ach) is the neurotransmitter released at the neuromuscular junction, the synapse between a neuron and a muscle cell. All three of the above neurotransmitters function in the **autonomic nervous system**.
- Neurotransmitters are grouped into categories:
  - Amines
  - Cathecolamines
  - Amino Acids
  - Polypeptide

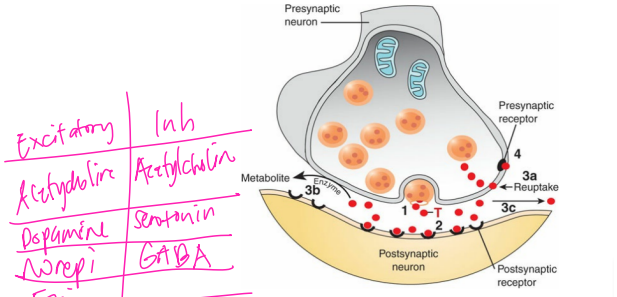


FIGURE 2.3. Schematic illustration of (*1*) neurotransmitter (*T*) release; (*2*) binding of transmitter to postsynaptic receptor; termination of transmitter action by (*3a*) reuptake of transmitter into the presynaptic terminal, (*3b*) enzymatic degradation, or (*3c*) diffusion away from the synapse; and (*4*) binding of transmitter to presynaptic receptors for feedback regulation of transmitter release.

Excitatory | Inh
Acetylcholine | Acetylcholin
Dopamine | Serotonin
Norepi | GABA
Epi

NEUROTRANSMITTERS		
TYPE	**MECHANISM OF ACTION**	**PHYSIOLOGIC EFFECTS**
AMINES		

ACETYLCHOLINE	Excitatory or Inhibitory	• Dietary precursor is **choline**
		• Controls sleep and wakefulness cycle; signals muscles to become alert
		• Important role in learning and memory
		• Peripherally activates muscles and its major neurochemical in the autoimmune system
		• The principal neurotransmitter at the neuromuscular junction, the peripheral ganglia and many synapses of the CNS
		• Acetylcholine activates two different type of receptors:
		  ○ Muscarinic
		  ○ Nicotinic
		• Chief transmitter of parasympathetic nervous system

SEROTONIN	Inhibitory	• Dietary precursor is **tryptophan** • Controls food intake, sleep and wakefulness, temperature regulation, pain control, sexual

		behaviors, regulation of emotions • Proposed role in the control of appetite, sleep, mood states, hallucinations, pain perception and vomiting
CATHECOLAMINES		
DOPAMINE	Excitatory	• Dietary precursor is tyrosine • Controls complex movements, motivation, cognition; regulates emotional response • Involved in involuntary motor movement and fine movement • Some role in mood states, pleasure components in reward systems, and complex behaviors (e.g. judgement, reasoning, insight)
NOREPINEPHRINE (NORADRENALINE)	Excitatory	• Dietary precursor is tyrosine • Causes changes in attention, learning and memory, sleep and wakefulness, mood • Proposed role in learning and memory, attributing value in reward systems, fluctuates in sleep and wakefulness • Major component of sympathetic nervous system responses, including "fight or flight" • Chief transmitter of sympathetic nervous system
EPINEPHRINE (ADRENALINE)	Excitatory	• Controls fight or flight
AMINO ACIDS		
HISTAMINE	Neuromodulator	• Controls alertness, gastric secretions, cardiac stimulation, peripheral allergic responses
NEUROPEPTIDES	Neuromodulators	• Enhance, prolong, inhibit, or limit the effects of principal neurotransmitters
GLUTAMATE	Excitatory	• Results in neurotoxicity if levels are too high
y-AMINOBUTYRIC ACID	Inhibitory	• Modulates other neurotransmitters

A. ACETYLCHOLINE

- It is the primary cholinergic neurotransmitter that is found in the greatest concentration in the PNS, ACh provides the basic synaptic communication for the parasympathetic neurons and part of the sympathetic neurons, which send information to the CNS
- It is an excitatory neurotransmitter that is found throughout the cerebral cortex and limbic system
- It arises primarily from cell bodies in the basal forebrain constellation, which provides innervations to the cerebral cortex, amygdala, hippocampus, and thalamus as well as from the dorsolateral tegmentum of the pons that projects to the basal ganglia, thalamus, hypothalamus, medullary reticular formation, and deep cerebellar nuclei
- These connections suggest that ACh is involved in higher intellectual functioning and memory
- Individuals who have Alzheimer disease or Down syndrome often exhibit patterns of cholinergic neuron loss in regions innervated by these pathways (e.g., the hippocampus), which may contribute to their memory difficulties and other cognitive deficits
- Acetylcholine is a neurotransmitter found in the brain, spinal cord, and peripheral nervous system, particularly at the neuromuscular junction of skeletal muscle
- It can be excitatory or inhibitory
- It is synthesized from dietary choline found in red meat and vegetables and has been found to affect the sleep–wake cycle and to signal muscles to become active
- Studies have shown that people with Alzheimer disease have decreased acetylcholine secreting neurons, and people with myasthenia gravis (a muscular disorder in which impulses fail to pass the myoneural junction, which causes muscle weakness) have reduced acetylcholine receptors

B. DOPAMINE

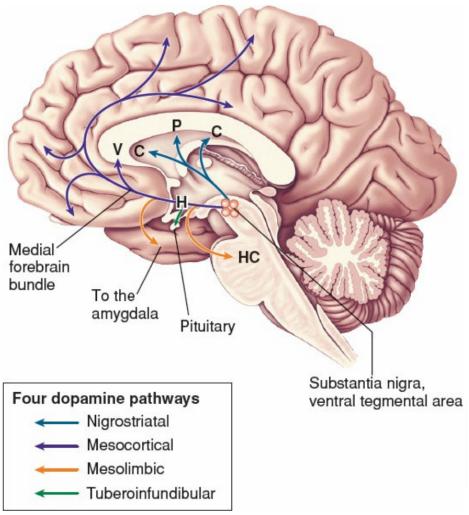
- Excitatory neurotransmitter found in the distinct regions of the CNS and is involved in cognition, motor, and neuroendocrine functions
- Stimulates the body's natural "feel good" reward pathways, producing pleasant euphoric sensation under certain conditions
- Involved in the regulation of action, emotion, motivation, and attention
- Dopamine levels are decreased in Parkinson disease, and abnormally high activity of dopamine has been associated with schizophrenia
- The dopamine pathways are distinct neuronal areas within the CNS in which the neurotransmitter dopamine predominates
- Three major dopaminergic pathways have been identified:

B1. MESOCORTITAL AND MESOLIMBIC PATHWAY

- Originate in the ventral tegmental area and project into the medial aspects of the cortex (mesocortical) and the limbic system inside the temporal lobes, including the hippocampus and amygdala (mesolimbic)
- Sometimes they are considered to be one pathway and at other times two separate pathways
- The mesocortical pathway has major effects on cognition, including functions such as judgment, reasoning, insight, social conscience, motivation, the ability to generalize learning, and reward systems in the human brain
- It contributes to some of the highest seats of cortical functioning
- The mesolimbic pathway also strongly influences emotions and has projections that affect memory and auditory reception
- Abnormalities in these pathways have been associated with schizophrenia

B2. NIGROSTRIATAL PATHWAY

- This influences the extrapyramidal motor system, which serves the voluntary motor system and allows involuntary motor movements
- Destruction of dopaminergic neurons in this pathway has been associated with Parkinson disease



B3. TUBEROINFUNDIBULAR PATHWAY

- The final dopamine pathway originates from projections of the mesolimbic pathway and continues into the hypothalamus, which then projects into the pituitary gland
- Therefore, this pathway, called the tuberoinfundibular pathway, has an impact on endocrine function and other functions, such as metabolism, hunger, thirst, sexual function, circadian rhythms, digestion, and temperature control
- Dopamine, a neurotransmitter located primarily in the brain stem, has been found to be involved in the control of complex movements, motivation, cognition, and regulation of emotional responses
- It is generally excitatory and is synthesized from tyrosine, a dietary amino acid
- Dopamine is implicated in schizophrenia and other psychoses as well as in movement disorders such as Parkinson disease
- Antipsychotic medications work by blocking dopamine receptors and reducing dopamine activity

C. NOREPINEPHRINE

- An excitatory neurochemical that plays a major role in generating and maintaining mood states

- Decreased norepinephrine has been associated with depression, and excessive norepinephrine has been associated with manic symptoms
- Because norepinephrine is so heavily concentrated in the terminal sites of sympathetic nerves, it can be released quickly to ready the individual for a fight-or-flight response to threats in the environment
- For this reason, norepinephrine is thought to play a role in the physical symptoms of anxiety
- Nerve tracts and pathways containing predominantly norepinephrine are called noradrenergic and are less clearly delineated than the dopamine pathways
- In addition, norepinephrine appears to be involved in the process of reinforcement, which facilitates learning
- Noradrenergic pathways innervate the hypothalamus and thus are involved to some degree in endocrine function
- Anxiety disorders and depression are examples of psychiatric illnesses in which dysfunction of the noradrenergic neurons may be involved
- Norepinephrine, the most prevalent neurotransmitter in the nervous system, is located primarily in the brain stem and plays a role in changes in attention, learning and memory, sleep and wakefulness, and mood regulation
- Norepinephrine and its derivative, epinephrine, are also known as noradrenaline and adrenaline, respectively
- Excess norepinephrine has been implicated in several anxiety disorders; deficits may contribute to memory loss, social withdrawal, and depression
- Some antidepressants block the reuptake of norepinephrine, while others inhibit MAO from metabolizing it
- Epinephrine has limited distribution in the brain but controls the fight or flight response in the peripheral nervous system

D. SEROTONIN

- An excitatory neurochemical that plays a major role in generating and maintaining mood states
- Serotonin (also called **5-hydroxytryptamine** or 5-HT) is primarily an excitatory neurotransmitter that is diffusely distributed within the cerebral cortex, limbic system, and basal ganglia of the CNS
- Serotonergic neurons also project into the hypothalamus and cerebellum
- Serotonin plays a role in emotions, cognition, sensory perceptions, and essential biologic functions, such as sleep and appetite
- During the rapid eye movement (REM) phase of sleep, or the dream state, serotonin concentrations decrease, and muscles subsequently relax
- Serotonin is also involved in the control of food intake, hormone secretion, sexual behavior, thermoregulation, and cardiovascular regulation
- Some serotonergic fibers reach the cranial blood vessels within the brain and the pia mater where they have a vasoconstrictive effect
- The potency of some new medications for migraine headaches is related to their ability to block serotonin transmission in the cranial blood vessels
- Descending serotonergic pathways are important in central pain control
- Whereas depression and insomnia have been associated with decreased levels of 5-HT, mania has been associated with increased 5-HT
- Some of the most well-known antidepressant medications, such as Prozac and Zoloft, function by raising serotonin levels within certain areas of the CNS
- Melatonin, which is derived from serotonin, is produced by the pineal gland and plays a role in sleep, aging, and mood changes

E. AMINO ACIDS

- Amino acids, the building blocks of proteins, have many roles in intraneuronal metabolism
- In addition, amino acids can function as neurotransmitters in as many as 60% to 70% of the synaptic sites in the brain
- Amino acids are the most prevalent neurotransmitters
- Virtually all of the neurons in the CNS are activated by excitatory amino acids, such as glutamate, and inhibited by inhibitory amino acids, such as gamma-aminobutyric acid (GABA) and glycine
- Many of these amino acids coexist with other neurotransmitters

F. HISTAMINE

- Histamine, derived from the amino acid histidine, has been identified as a neurotransmitter
- Its cell bodies originate predominantly in the hypothalamus and project to all major structures in the cerebrum, brain stem, and spinal cord
- Its functions are not well known, but it appears to have a role in autonomic and neuroendocrine regulation
- Many psychiatric medications can block the effects of histamine post-synaptically and produce side effects such as sedation, weight gain, and hypotension

G. GAMMA-AMINOBUTYRIC ACID

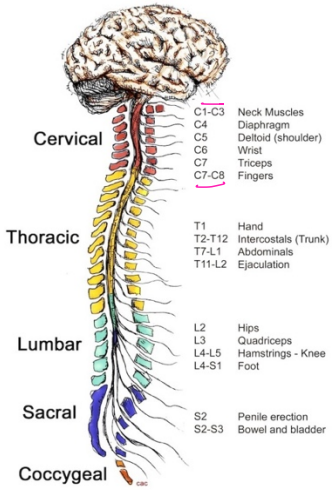
- GABA is the primary inhibitory neurotransmitter for the CNS
- The pathways of GABA exist almost exclusively in the CNS, with the largest GABA concentrations in the hypothalamus, hippocampus, basal ganglia, spinal cord, and cerebellum
- GABA functions in an inhibitory role in control of spinal reflexes and cerebellar reflexes. It has a major role in the control of neuronal excitability through the brain
- In addition, GABA has an inhibitory influence on the activity of the dopaminergic nigrostriatal projections
- GABA also has interconnections with other neurotransmitters
- For example, dopamine inhibits cholinergic neurons, and GABA provides feedback and balance
- Dysregulation of GABA and GABA receptors has been associated with anxiety disorders, and decreased GABA activity is involved in the development of seizure disorders

H. GLUTAMATE

- Glutamate, the most widely distributed excitatory neurotransmitter, is the main transmitter in the associational areas of the cortex
- Glutamate can be found in a number of pathways from the cortex to the thalamus, pons, striatum, and spinal cord
- In addition, glutamate pathways have a number of connections with the hippocampus
- Some glutamate receptors may play a role in the long-lasting enhancement of synaptic activity
- In turn, in the hippocampus, this enhancement may have a role in learning and memory
- Too much glutamate is harmful to neurons, and considerable interest has emerged regarding its neurotoxic effects
- Conditions that produce an excess of endogenous glutamate can cause neurotoxicity by overexcitation of neuronal tissue
- This process, called **excitotoxicity**, increases the sensitivity of glutamate receptors, produces overactivation of the receptors, and is increasingly being understood as a critical piece of the cascade of events involved in physical symptoms of alcohol withdrawal in dependent individuals
- Excitotoxicity is also believed to be part of the pathology of conditions such as ischemia, hypoxia, hypoglycemia, and hepatic failure
- Damage to the CNS from chronic malfunctioning of the glutamate system may be involved in the psychiatric symptoms seen in neurodegenerative diseases such as Huntington, Parkinson, and Alzheimer diseases; vascular dementia; amyotrophic lateral sclerosis; and acquired immune deficiency syndrome (AIDS)–related dementia
- Degeneration of glutamate neurons is implicated in the development of schizophrenia

THE CENTRAL NERVOUS SYSTEM (CNS)

- The Central Nervous System (CNS) as its name implies is centrally located. This part of the Nervous system known as the control center that processes and coordinates all incoming sensory information and outgoing motor commands.
- The CNS comprises the brain, the spinal cord, and associated nerves that control voluntary acts. Structurally, the brain consists of the cerebrum, cerebellum, brain stem, and limbic system.
- **ORGANS:**
  - Brain (Encephalon)
  - Spinal Cord



SPINAL CORD

- Extends from foramen magnum (brainstem connects to the spinal cord) down to the lumbar vertebra; it receives messages from different parts of the body. The spinal cord acts as connection between the brain and other parts of the body. It is also a place where simple responses, known as *reflexes* can be coordinated even without involving the brain.
- A cross section reveals that the spinal cord consists of a superficial white matter portion and a deep gray matter portion.
- The white matter consists of myelinated axons, and the gray matter is mainly a collection of neuron cell bodies
- The white matter in each half of the spinal cord is organized into three columns:
  - Dorsal column (posterior)
  - Ventral column (anterior)
  - Lateral column
- Each column of the spinal cord contains ascending and descending tracts or pathways
- **Ascending tracts** consists of axons that conduct action potentials toward the brain
- **Descending tracts** consists of axons that conduct action potentials away from the brain

REFLEX

- Reflexes is an involuntary reaction in response to a stimulus applied to the periphery and transmitted to the CNS
- A complete pathway through the nervous system from stimulus to response is termed a reflex arc
- This is the basic functional pathway of the nervous system
- The parts of a typical reflex arc are:

1. **Sensory receptor**- the end of a dendrite or some specialized receptor cell, as in a special sense organ, that detects stimuli
2. **Sensory neuron** *(afferent neuron)*- a cell that transmits impulses toward the CNS
3. **Central neuron** *(interneurons)*- a cell or cells within the CNS. These neurons may carry impulses to and from the brain, may function within the brain, or may distribute impulses to different regions of the spinal cord
4. **Motor neuron** *(efferent neuron)*- a cell that carries impulses away from the CNS
5. **Effector organ**- a muscle or a gland outside the CNS that carries out a response

At its simplest, a reflex arc can involve just two neurons, one sensory and one motor, with a synapse in the CNS.

KNEE-JERK REFLEX

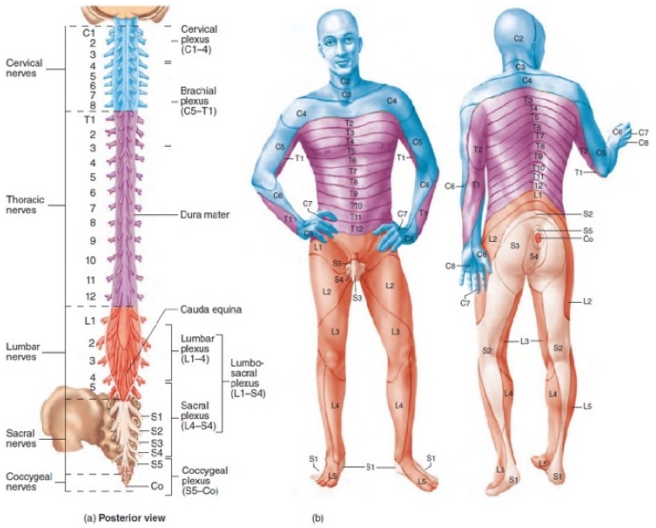
- The simplest reflex is the stretch reflex
- A stretch reflex occurs when muscles contract in response to a stretching force applied to them
- The knee-jerk reflex, or **patellar reflex**, is a classic example of the stretch reflex involving the spinal cord
- Clinicians use the knee-jerk reflex to determine the higher CNS centers that normally influence this reflex are functional

WITHDRAWAL REFLEX

- The function of the withdrawal reflex, or **flexor reflex**, is to remove a limb or another body part from a painful stimulus
- The sensory receptors are pain receptors, and stimulation of these receptors initiates the reflex

SPINAL NERVES

- The spinal nerves arise along the spinal cord from the union of the dorsal roots and ventral roots
- All spinal nerves contain axons of both sensory and somatic motor neurons and thus are called **mixed nerves**
- Some spinal nerves also contain parasympathetic or sympathetic neurons
- Spinal nerves are categorized by the region of the vertebral column from which they emerge –cervical (C), thoracic (T), lumbar (L), sacral (S), and coccygeal (Co)
- The spinal nerves are also numbered (starting superiorly) according to their order within that region
- The 31 pairs of spinal nerves are therefore C_1-C_8, T_1-T_{12}, L_1-L_5, S_1-S_5, and Co
- The spinal nerves are organized into three major **plexuses** (braids) where neurons of several spinal nerves come together and intermingle
- The three major plexuses:
  - **Cervical plexuses**
  - **Brachial plexuses**
  - **Lumbosacral plexuses**
- In addition to the major plexuses, the small **coccygeal plexuses** supplies motor innervation to the muscles of the pelvic floor and sensory cutaneous innervation to the skin over the coccyx



CERVICAL PLEXUSES

- Originates from spinal nerves C_1 and C_4
- Branches from this plexus innervates several of the muscles attached to the hyoid bone, as well as the skin of the neck and posterior portion of the head
- One of the most branches of the cervical plexus is the **phrenic nerve**, which innervates the diaphragm
- Contraction of the diaphragm is largely responsible for our ability to breathe

BRACHIAL PLEXUSES

- Originates from spinal nerves C_5 and T_1
- Five major nerves emerge from the brachial plexus to supply the upper limb and shoulder
- The **axillary nerve** innervates two shoulder muscles and the skin over part of the shoulder
- The **radial nerve** innervates all the muscles in the posterior arm and forearm as well as the skin over the posterior surface of the arm, forearm, and hand
- The **musculocutaneous** (muscle + skin) **nerve** innervates the anterior muscles of the arm and the skin over the radial surface of the forearm
- The **ulnar nerve** innervates two anterior forearm muscles and most of the intrinsic hand muscles. It also innervates the skin over the ulnar side of the hand. The ulnar

nerve can be easily damaged where it passes posterior to the medial side of the elbow. The ulnar nerve at this location is called the "funny bone."
- The **median nerve** innervates most of the anterior forearm muscles and some of the intrinsic hand muscles. It also innervates the skin over the radial side of the hand.

LUMBOSACRAL PLEXUSES

- Originates from spinal nerves L_1 and S_4
- Four major nerves exit the lumbrosacral plexus to supply the lower limb
- The **obturator nerve** innervates the muscles of the medial thigh and the skin over the same region
- The **femoral nerve** innervates the anterior thigh muscles and the skin over the anterior thigh and medial side of the leg
- The **tibial nerve** innervates the posterior thigh muscles, the anterior and posterior leg muscles, and most of the intrinsic foot muscles. It also innervates the skin over the sole of the foot.
- The **common fibular nerve** innervates the muscles of the lateral thigh and leg and some intrinsic foot muscles. It also innervates the skin over the anterior and lateral leg and the dorsal surface (top) of the foot.
- The tibial and common fibular nerves are bound together within a connective tissue sheath and together are called the **sciatic nerve**

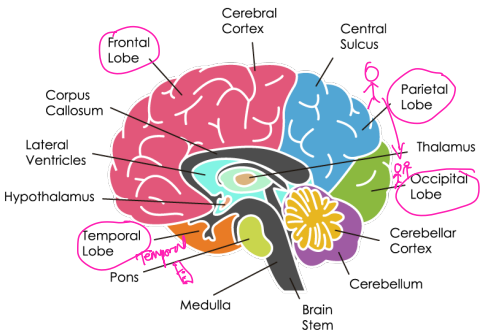
HOW MANY BRANCES DOES THE SPINAL CORD HAVE?

- In humans there are 31 pairs: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal. Each pair connects the spinal cord with a specific region of the body
- Any organism with a major nerve cord is classified as a **chordate**

TABLE 8.3 Plexuses of the Spinal Nerves (see figure 8.20)

Plexus	Origin	Major Nerves	Muscles Innervated	Skin Innervated
Cervical	C1-C4		Several neck muscles	Neck and posterior head
		Phrenic	Diaphragm	
Brachial	C5-T1	Axillary	Two shoulder muscles	Part of shoulder
		Radial	Posterior arm and forearm muscles (extensors)	Posterior arm, forearm, and hand
		Musculocutaneous	Anterior arm muscles (flexors)	Radial surface of forearm
		Ulnar	Two anterior forearm muscles (flexors), most intrinsic hand muscles	Ulnar side of hand
		Median	Most anterior forearm muscles (flexors), some intrinsic hand muscles	Radial side of hand
Lumbosacral	L1-S4	Obturator	Medial thigh muscles (adductors)	Medial thigh
		Femoral	Anterior thigh muscles (extensors)	Anterior thigh, medial leg, and foot
		Tibial	Posterior thigh muscles (flexors), anterior and posterior leg muscles, most foot muscles	Posterior leg and sole of foot
		Common fibular	Lateral thigh and leg, some foot muscles	Anterior and lateral leg, dorsal (top) part of foot
Coccygeal	S5 & Co		Pelvic floor muscles	Skin over coccyx

THE BRAIN

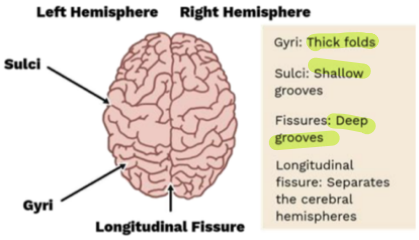


- Primary organ of the Central Nervous System (CNS) contained within the skull
- It is the control center for emotion, and movement
- The brain contains 100 billion cells
- A complex organ that controls thought, memory, emotion, touch, motor skills, vision, breathing, temperature, hunger and every process that regulates our body

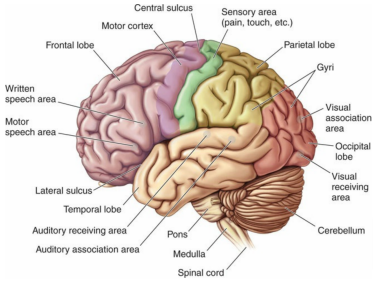
A. MAJOR DIVISIONS OF THE BRAIN

A1. CEREBRUM

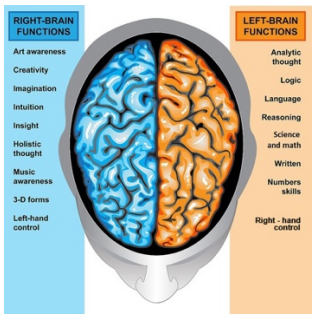
- Also known as the ***Forebrain*** which is the largest part of the brain, it is responsible for intelligence and reasoning
- The largest region of the human brain
- The cortex, or outermost surface of the cerebrum, makes up about 80% of the human brain
- The cortex is four to six cellular layers thick, and each layer is composed of cell bodies mixed with capillary blood vessels
- This mixture makes the cortex gray brown (thus the term ***gray matter***) this "wrinkling" allows for a large amount of surface area to be confined in the limited space of the skull
- The increased surface area allows for more potential connections among cells within the cortex
- **Convolutions** or **gyri**, are the ridges and the grooves are called **sulci**
  - These are the grooves or indentations on the surface of the cerebral cortex
  - They are the elevated areas between the sulci
- The deepest sulci are called **fissures;** the longitudinal fissure divides the cerebrum into right and left halves or hemispheres
  - They are the depression between the gyri
- The two hemisphere are connected by the **corpus callosum**, a bundle of neuronal tissue that allows information to be exchanged quickly between the right and left hemispheres



- **CORPUS CALLOSUM**- the one who connects the two hemisphere of the cerebrum. A large bundle of more than 200 million myelinated nerve fibers that connect the two brain hemispheres, permitting communication between the right and left sides of the brain. Abnormalities within the corpus callosum have been identified in maltreated children.

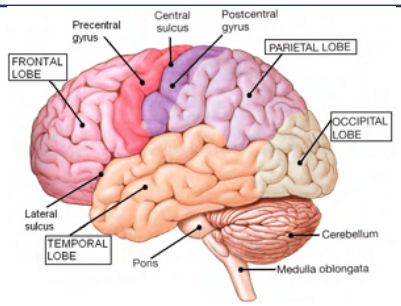


A1a. CEREBRUM IS DIVIDED INTO TWO HEMISPHERES:



1. **Left Hemisphere**- it controls the right side of the body and the center for logical reasoning and analytic functions such as reading, writing, and mathematical tasks

2. **Right Hemisphere**- it control the left side of the body and the center for creative thinking, intuition, and artistic abilities



A1b. CEREBRAL HEMISPHERES ARE DIVIDED INTO FOUR LOBES

- The lateral surface of each hemisphere is further subdivided into four lobes: **frontal**, **parietal**, **temporal**, and **occipital lobes**
- The lobes work in coordinated ways, but each is responsible for specific functions
- An understanding of these unique functions is helpful in understanding how damage to these areas produces the symptoms of mental illness and how medications that affect the functioning of these lobes can produce certain effects

FRONTAL LOBE

- The **precentral gyrus**, the gyrus immediately anterior to the central sulcus, contains the primary motor area, or **homunculi**
  - Controls voluntary motor activity (precentral gyrus or motor cortex)
- Damage to this gyrus or to the anterior neighboring gyri causes spastic paralysis in the opposite side of the body
- The frontal lobe also contains **Broca area,** which controls the motor function of speech. Damage to Broca area produces **expressive aphasia**, or difficulty with the motor movements required for speech.
  - Expressive (motor) speech is the ability to speak clearly
  - Damage to the area of the Broca's leaves the client unable to speak clearly known as **expressive** or **motor aphasia**
- The frontal lobes are also thought to contain the highest or most complex aspects of cortical functioning, which collectively make up a large part of what we call personality
- **Working memory** is an important aspect of frontal lobe function, including the ability to plan and initiate activity with future goals in mind
- Insight, judgment, reasoning, concept formation, problem-solving skills, abstraction, and self-evaluation are all abilities that are modulated and affected by the actions of the frontal lobes. These skills are often referred to as **executive functions** because they modulate more primitive impulses through numerous connections to other areas of the cerebrum.
- When normal frontal lobe functioning is altered, executive functioning is decreased, and modulation of impulses can be lost, leading to changes in mood and personality
- The importance of the frontal lobe and its role in the development of symptoms common to psychiatric disorders are emphasized in later chapters that discuss disorders such as schizophrenia, attention-deficit hyperactivity disorder (ADHD), and dementia

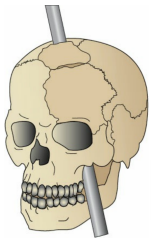
PARIETAL LOBE

- The **postcentral gyrus**, immediately behind the central sulcus, contains the primary somatosensory area
  - Sensory perception (tactile sensations like temperature, touch, pain, pressure)
- Concept formation
- Spatial orientation and awareness of size and shapes (**stereognosis**) and body positions (**proprioception**) is the function of the right parietal lobe
- Left-right orientation and mathematics is the function of the left parietal lobe
- The parietal lobes contribute to the ability to recognize objects by touch, calculate, write, recognize fingers of the opposite hands, draw, and organize spatial directions (e.g., how to travel to familiar places)

FRONTAL LOBE SYNDROME

In the 1860s, Phineas Gage became a famous example of frontal lobe dysfunction. Mr. Gage was a New England railroad worker who had a thick iron-tamping rod propelled through his frontal lobes by an explosion. He survived, but suffered significant changes in his personality. Mr. Gage, who had previously been a capable and calm supervisor, began to show impatience, labile mood, disrespect for others, and frequent use of profanity after his injury.

Similar conditions are often called **frontal lobe syndrome**. Symptoms vary widely from individual to individual. In general, after damage to the dorsolateral (upper and outer) areas of the frontal lobes, the symptoms include a lack of drive and spontaneity. With damage to the most anterior aspects of the frontal lobes, the symptoms tend to involve more changes in mood and affect, such as impulsive and inappropriate behavior.



The skull of Phineas Gage, showing the route the tamping rod took through his skull. The angle of entry of the rod shot it behind the left eye and through the front part of the brain, sparing regions that are directly concerned with vital functions like breathing and heartbeat.

TEMPORAL LOBE

- The temporal lobes contain the primary auditory and olfactory areas
- **Wernicke area**, located at the posterior aspect of the **superior temporal gyrus**, is primarily responsible for receptive speech
  - Wernicke's area facilitates understanding language
  - Damage to this area results to **receptive** or **auditory aphasia**
- The temporal lobes also integrate sensory and visual information involved in control of written and verbal language skills as well as visual recognition
  - Auditory association areas such as ability to store spoken language memories (left temporal); sound memories that are not language (music, various animal sounds, other noises)
- The **hippocampus**, an important structure lies in the internal aspects of each temporal lobe and contributes to memory
  - **Short term (recent) memory** is lost after seconds or minutes
  - **Intermediate memory** lasts days to weeks and eventually lost it
  - The hippocampus assist in the conversion of short-term memory into the intermediate and long-term memory in the thalamus
- Other internal structures of this lobe are involved in the modulation of mood and emotion

OCCIPITAL LOBE

- The primary visual area is located in the most posterior aspect of the occipital lobes
  - Visual receptive (interpretation) area
  - Visual association areas for storage of visual memories; contributes to the ability to visually recognize and understand the environment
- Visual speech center enables a person to read; damage to this area leaves the client unable to read known as **alexia**
- Damage to this area results in a condition called **cortical blindness** in other words, the retina and optic nerve remain intact, but the individual cannot see
- The occipital lobes are involved in many aspects of visual integration of information, including color vision, object and facial recognition, and the ability to perceive objects in motion

FISSURES OF THE CEREBRAL CORTEX	
PARTS	**FUNCTION**
Fissure of Rolando *aka* **Central Sulcus**	Separates the frontal lobe from the parietal lobe
Sylvian Fissure	Separates the frontal lobe from the temporal lobe
Parieto-occipital Fissure	Separates the parietal lobe from the occipital lobe

BRAIN STEM

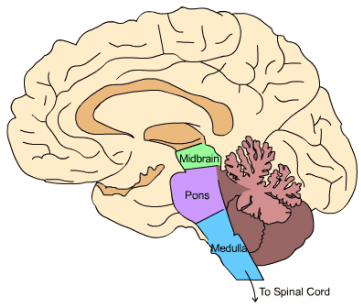
MPM
Midbrain, Pons, Medulla

- The brain stem, which is located beneath the thalamus and composed of the midbrain, pons, and medulla, has important life-sustaining functions
- Nuclei of numerous neural pathways to the cerebrum are located in the brain stem
- It connects the spinal cord and controls involuntary actions
- Brainstem is the bottom, stalk-like portion of your brain. It connects your brain to your spinal cord. Your brainstem sends messages to the rest of your body to regulate balance, breathing, heart rate and more.

- They are significantly involved in mediating symptoms of emotional dysfunction. These nuclei are also the primary source of several neurochemicals, such as serotonin, that are commonly associated with psychiatric disorders.

A. THREE PARTS OF THE BRAINSTEM

- The brainstem connects the spinal cord to the remainder of the brain
- The brainstem contains several nuclei involved in vital body functions, such the control of heart rate, blood pressure, and breathing
- Damage to the small areas of the brainstem can cause death, whereas damage to relatively large areas of the cerebrum or cerebellum often do not
- Nuclei for all but the first two cranial nerves are located in the brainstem
- It consists of three parts:
    - Medulla oblongata
    - Pons
    - Midbrain



A1. MIDBRAIN

- Topmost structure of the brainstem and is the smallest region
- Integrates visual and auditory reflexes
- The dorsal part of the midbrain consists of four mounds of tissue called the **colliculi**
    - The two inferior colliculi are major relay centers for the auditory nerve pathways in the CNS
    - The two superior colliculi are involved in visual reflexes and receive touch and auditory input
- For example: If a person sees a wasp flying toward him, he ducks or twists away (visual reflexes) or if someone is turning the head (ear) to a sound (auditory reflex)
- The midbrain contains nuclei involved in coordinating eye movements and controlling pupil diameter and lens shape
- The midbrain is also responsible for righting reflexes, those that keep the head upright and maintain balance or equilibrium
- The midbrain also contains a black nuclear mass, called the **substantia nigra**, which is part of the basal nuclei and is involved in regulating general body movements

A2. PONS

- Below the midbrain is the pons (bridge)
- Contains ascending and descending nerve tracts, as well as several nuclei
- The nuclei in the pons relay information between the cerebrum and cerebellum
- Not only is the pons a functional bridge between the cerebrum and cerebellum, but on the anterior surface it resembles an arched footbridge
- Two-way between areas of the brain and other regions of the body; influences respiration
- Contains two (2) respiratory centers that promote normal rhythm of breathing
    - The **apneustic center** prolongs inhalation
    - The **pneumotaxic center** contributes to exhalation

A3. MEDULLA OBLONGATA

- Lowermost portion of the brainstem and is continuous with the spinal cord
- Contains ascending and descending nerve tracts, which convey signals to and from other regions of the brain
- Contains discrete nuclei with specific functions such as regulation of heart rate and blood vessel diameter, breathing, swallowing, vomiting, coughing, sneezing, balance, and coordination
    - Contains cardiac centers that regulate heart rate
    - Contains vasomotor centers that regulate blood pressure
    - Contains respiratory centers for coughing, sneezing, swallowing, and vomiting

CEREBELLUM

- The cerebellum is in the posterior aspect of the skull beneath the cerebral hemispheres
- This large structure controls movements and postural adjustments
    - It controls balance (equilibrium) and posture
    - It controls voluntary (purposeful) motor activities and position of the body parts
- It lies under the occipital lobe of the cerebrum and is the second largest part of the brain that controls muscle coordination, normal muscle tone and coordinates balance
- To regulate postural balance and positioning, the cerebellum receives information from all parts of the body, including the muscles, joints, skin, and visceral organs, as well as from many parts of the CNS

LIMBIC SYSTEM

- The limbic system is essential to understanding the many hypotheses related to psychiatric disorders and emotional behavior in general
- The limbic system is called a "**system**" because it comprises several small structures that work in a highly organized way
- These structures include the hippocampus, thalamus, hypothalamus, amygdala, and limbic midbrain nuclei
- Basic emotions, needs, drives, and instinct begin and are modulated in the limbic system. Hate, love, anger, aggression, and caring are basic emotions that originate within the limbic system.
- Not only does the limbic system function as the seat of emotions, but because emotions are often generated based on our personal experiences, the limbic system also is involved with aspects of memory
- Hypothesized changes in the limbic system play a significant role in many theories of major mental disorders, including schizophrenia, depression, and anxiety disorders

A. DIENCEPHALON

- The diencephalon is the part of the brain between the brainstem and the cerebrum
- Its main components are:
    - Thalamus
    - Epithalamus
    - Hypothalamus

A1. HIPPOCAMPUS

- The hippocampus is involved in storing information, especially the emotions attached to a memory
- Our emotional responses to memories and our associations with other related memories are functions of how information is stored within the hippocampus
- Although memory storage is not limited to one area of the brain, destruction of the left hippocampus impairs verbal memory, and damage to the right hippocampus results in difficulty with recognition and recall of complex visual and auditory patterns
- Deterioration of the nerves of the hippocampus and other related temporal lobe structures found in Alzheimer disease produces the disorder's hallmark symptoms of memory dysfunction

A2. THALAMUS

- Just superior to the hypothalamus is a dumbbell-shaped section or largely gray matter called the **thalamus**
- Sometimes called the "**relay-switching center of the brain**," the thalamus functions as a regulatory structure to relay all sensory information, except smell, sent to the CNS from the PNS
- From the thalamus, the sensory information is relayed mostly to the cerebral cortex
- The Thalamus serves as central relay point for incoming nervous message
- The thalamus relays and regulates by filtering incoming information and determining what to pass on or not pass on to the cortex
- In this fashion, the thalamus prevents the cortex from becoming overloaded with sensory stimulus
- The thalamus is thought to play a part in controlling electrical activity in the cortex because of its primary relay function, damage to a very small area of the thalamus may produce deficits in many cortical functions, thus, causing behavioral abnormalities

A3. HYPOTHALAMUS

- Located inferior to the thalamus
- Hypothalamus regulates homeostasis; it has regulatory areas for thirst, hunger, body temperature, water balance, and blood pressure
- It links the Nervous System and Endocrine System
- Hypothalamus is a crucial part of the mechanism for maintaining body temperature
- In addition, this important center is involved in functions such as the regulation of water balance; sleep cycles, and the control of appetite and many emotions involved in pleasure, fear, anger, sexual arousal, and pain
- Basic human activities, such as sleep–rest patterns, body temperature, and physical drives such as hunger and sex, are regulated by another part of the limbic system that rests deep within the brain and is called the **hypothalamus**
- Dysfunction of this structure, whether from disorders or as a consequence of the adverse effect of drugs used to treat mental illness, produces common psychiatric symptoms, such as appetite and sleep problems
- Nerve cells within the hypothalamus secrete hormones, for example, antidiuretic hormone (ADH) which when sent to the kidneys, accelerates the reabsorption of water; and oxytocin, which acts on smooth muscles to promote contractions, particularly within the walls of the uterus
- Because cells within the nervous system produce these hormones, they are often referred to as **neurohormones** (hormones that are produced by cells within the nervous system) and form a communication mechanism through the bloodstream to control organs that are not directly connected to nervous system structures
- The pituitary gland, often called the **master gland**, is directly connected by thousands of neurons that attach it to the ventral aspects of the hypothalamus
    - Together with the pituitary gland, the hypothalamus functions as one of the primary regulators of many aspects of the endocrine system
    - Its functions are involved in control of visceral activities, such as body temperature, arterial blood pressure, hunger, thirst, fluid balance, gastric motility, and gastric secretions
- Deregulation of the hypothalamus can be manifested in symptoms of certain psychiatric disorders
    - For example, in schizophrenia, patients often wear heavy coats during the hot summer months and do not appear hot
    - Before the role of the hypothalamus in schizophrenia was understood, psychological reasons were used to explain such symptoms
    - Now it is increasingly clear that such a symptom relates to deregulation of the hypothalamus's normal role in temperature regulation and is a biologically based symptom

A4. AMYGDALA

- The amygdala is directly connected to more primitive centers of the brain involving the sense of smell
- It has numerous connections to the hypothalamus and lies adjacent to the hippocampus
- The amygdala provides an emotional component to memory and is involved in modulating aggression and sexuality
- Impulsive acts of aggression and violence have been linked to dysregulation of the amygdala, and erratic firing of the nerve cells in the amygdala is a focus of investigation in bipolar mood disorders

A5. LIMBIC MIDBRAIN NUCLEI

- The limbic midbrain nuclei are a collection of neurons (including the ventral tegmental area and the locus coeruleus) that appear to play a role in the biologic basis of addiction
- Sometimes referred to as the **pleasure center** or **reward center** of the brain, the limbic midbrain nuclei function to chemically reinforce certain behaviors, ensuring their repetition
- Emotions such as feeling satisfied with good food, the pleasure of nurturing young, and the enjoyment of sexual activity originate in the limbic midbrain nuclei
- The reinforcement of activities such as nutrition, procreation, and nurturing young are all primitive aspects of ensuring the survival of a species
- When functioning in abnormal ways, the limbic midbrain nuclei can begin to reinforce unhealthy or risky behaviors, such as drug abuse
- Exploration of this area of the brain is in its infancy but offers potential insight into addictions and their treatment

A6. PINEAL BODY

- Located above and medial to the thalamus called **epithalamus**
- Because the pineal gland easily calcifies, it can be visualized by neuroimaging and often is a medial landmark
- Its functions remain somewhat of a mystery despite long knowledge of its existence
- It contains secretory cells that emit the neurohormone **melatonin** and other substances
- These hormones are thought to have a number of regulatory functions within the endocrine system
- Information received from light–dark sources controls release of melatonin, which has been associated with sleep and emotional disorders
- In addition, a modulation of immune function has been postulated for melatonin from the pineal gland

REGION	LOCATION/ ORIGIN	MAJOR STRUCTURES	KEY FUNCTIONS
DIENCHEPALON	Forebrain (Prosencephalon)	• Thalamus • Hypothalamus • Epithalamus (pineal gland) • Subthalamus	• Sensory relay to cortex (Thalamus) • Autonomic & endocrine regulation (Hypothalamus) • Sleep-wake cycles & circadian rhythm (Pineal gland)
MYELENCEPHALON	Hindbrain (from Rhombencephalon)	• Medulla oblongata	• Vital centers (respiration, heartbeat, BP) • Reflexes: swallowing, coughing, vomiting • Motor and sensory pathway crossover
RHOMBENCEPHALON *(includes Myelencephalon)*	Hindbrain	• Metencephalon (pons & cerebellum) • Myelencephalon (medulla oblongata)	• Coordination & balance (cerebellum) • Motor control & communication (pons) • Vital functions (medulla oblongata)

STRUCTURES OF THE BRAIN AND BRAINSTEM	
PARTS	**FUNCTION**
BRAIN STEM	
Medulla Oblongata	Two-way conduction pathway between the spinal cord and higher brain centers; cardiac, respiratory, and vasomotor control center.
Pons	Two-way conduction pathway between areas of the brain and other regions of the body; influences respiration.
Midbrain	Two-way conduction pathway; relay for visual and auditory impulse.
DIENCEPHALON	
Hypothalamus	Regulation of body temperature, water balance, sleep cycle control appetite, and sexual arousal.
Thalamus	Sensory relay station from various body areas to cerebral cortex; emotions and alerting or arousal mechanisms.
CEREBELLUM	Muscle coordination; maintenance of equilibrium and posture.
CEREBRUM	Sensory perception, emotions willed movements, consciousness, and memory.

SENSORY FUNCTIONS

ASCENDING TRACTS

- The spinal cord and brainstem contain a number of ascending (sensory) tracts, or pathways, that transmit information via action potentials from the periphery to various parts of the brain
- Each tract is involved with a limited type of sensory input, such as pain, temperature, touch, position, or pressure, because each tract contains axons from specific sensory receptors specialized to detect a particular type of stimulus
- Tracts are usually given composite names that indicate their origin and termination
- The names of ascending tracts usually begin with the prefix ***spino-***, indicating that they begin in the spinal cord
    - For example, the spinothalamic tract begins in the spinal cord and terminates in the thalamus
- Most ascending tracts consist of two or three neurons in sequence, from the periphery to the brain
- Almost all neurons relaying information to the cerebrum terminate in the thalamus. Another neuron then relays the information from the thalamus to the cerebral cortex
- Two examples of ascending tracts are (1) the **spinothalamic tract** and (2) the **dorsal column tract**

- The spinothalamic tract transmits action potentials dealing with sensations such as pain and temperature to the thalamus and on to the cerebral cortex
- The dorsal column transmits action potentials dealing with sensations such as touch, pressure, and proprioception, or body position
- Sensory tracts typically cross from one side of the body in the spinal cord or brainstem to the other side of the body. Thus, the left side of the brain receives sensory input from the right side of the body, and vice versa.
- Ascending tracts also terminate in the brainstem or cerebellum
- The anterior and posterior spinocerebellar tracts, for example, transmit information about proprioception to the cerebellum

SENSORY AREAS OF THE CEREBRAL CORTEX

1. **Primary Sensory Areas = Where you feel or sense things**
   - These are specific spots in your **cerebral cortex** where **sensory messages** from your body arrive and are first **perceived**

SENSE	PRIMARY AREA LOCATION	WHAT IT DOES
Touch, Pain, Temp, Pressure	**Primary Somatosensory Cortex** in the **Parietal Lobe** (just behind the central sulcus)	• Feels body sensations
Vision	**Visual Cortex** in the **Occipital Lobe**	• Sees what the eyes detect
Hearing	**Primary Auditory Cortex** in the **Temporal Lobe**	• Hears sounds
Taste	**Taste Area** in the **Insula** (deep inside the brain)	• Tastes food
Each body part sends its info to a **specific spot** on the somatosensory cortex — forming a **body map** called the **somatotopic map** (like a mini body on your brain!)		

2. **Association Areas = Where you make sense of what you feel or sense**
   - These brain areas are located **next to** each primary sensory area
   - They help you **understand**, **recognize**, or **give meaning** to what you sense

ASSOCIATION AREA	NEXT TO…	WHAT IT DOES
Visual Association Area	Visual Cortex	• Recognizes what you see ("Do I know this face?")
Auditory Association Area	Auditory Cortex	• Understands what you hear ("Is that music or a fire alarm?")
Somatosensory Association Area	Somatosensory Cortex	• Makes sense of touch sensations ("Is this smooth or rough?")
You **see a face** ➡ Info goes to **visual cortex** ➡ Then to the **visual association area**, which compares it to stored memories and decides **if you recognize the face** or not.		

Easy Analogy:
Think of it like this:
- **Primary areas** = Receiving messages
- **Association areas** = Understanding the messages

SOMATIC MOTOR FUNCTIONS

TYPE	DESCRIPTION	EXAMPLES
Involuntary	Automatic, without conscious control	• Reflexes, posture, balance
Voluntary	Controlled consciously to achieve a goal	• Walking, typing, smiling
Even voluntary actions often become automatic **after practice** (e.g., typing or walking), thanks to internal brain/spinal cord circuits.		

Key Brain-Spinal Circuit: 2-Neuron Pathway for Voluntary Movement

1. **Upper Motor Neurons (UMN):**
   - Location: **Cerebral cortex**
   - Function: Initiate voluntary movement
   - Path: Axons travel down through **descending tracts** to the spinal cord or brainstem
2. **Lower Motor Neurons (LMN):**
   - Location: **Ventral horn of spinal cord** or **cranial nerve nuclei**
   - Function: Directly control skeletal muscles
   - Path: Axons leave CNS via **spinal or cranial nerves** to reach the muscles

IN CAPSULE

Upper Motor Neurons = Brain to Spinal Cord
Lower Motor Neurons = Spinal Cord to Muscle

Extra Roles of the Somatic Motor System:
- Maintains posture and balance
- Controls head, trunk, limbs, tongue, and eyes
- Enables facial expressions and speech
- Coordinates learned complex tasks (e.g., typing) through automatic motor programs

B. MOTOR AREAS OF THE CEREBRAL CORTEX

- These regions control **voluntary movement** and planning of actions:

B1. PRIMARY MOTOR CORTEX

- **Location**: Posterior frontal lobe, just in front of the central sulcus
- **Function**: Sends action potentials to initiate voluntary skeletal muscle movement
- Has a topographic body map (homunculus):
  - Specific brain regions control specific body parts
  - Head = lower part, feet = upper part

B2. PREMOTOR AREA

- **Location**: Frontal lobe, in front of the primary motor cortex
- **Function**: Plans and organizes movements before they happen
  - Decides which muscles to use, in what order, and how strongly
- Sends plans to primary motor cortex, which executes them

B3. PREFRONTAL AREA

- **Location**: **Anterior** (frontmost) part of frontal lobe
- **Function**:
  - Motivation
  - Emotional control
  - Foresight and planning
- Highly developed in humans
  - Linked to our ability to plan ahead, regulate mood, and make decisions

DESCENDING TRACTS (MOTOR PATHWAYS)

- Descending tracts carry motor commands from the brain to the body (spinal cord or brainstem) to control voluntary and involuntary movements

TYPES OF DESCENDING TRACTS		
TRACT TYPE	**DESCRIPTION**	**PATH**
Direct (Pyramidal)	Begins in the cerebral cortex → goes directly to lower motor neurons	• E.g. Corticospinal tract
Indirect (Extrapyramidal)	Starts in the brainstem and is indirectly influenced by the cortex, basal nuclei, and cerebellum	• E.g., Reticulospinal, Rubrospinal

KEY TRACTS AND FUNCTIONS		
TRACT	**LOCATION**	**MAIN FUNCTION**
Lateral Corticospinal Tract	Lateral column	• Precise, skilled limb movements (especially hands)
Ventral (Anterior) Corticospinal Tract	Ventral column	• Controls trunk and proximal muscles
Reticulospinal Tract	Ventral column	• Maintains posture and balance
Other Indirect Tracts (e.g., Rubrospinal)	Vary	• Reflexes, coordination, and tone

THE PERIPHERAL NERVOUS SYSTEM (PNS)

- The nerves connecting the brain and the spinal cord to other parts of the body constitute the peripheral nervous system (PNS)
- These nerves form the communication network between CNS and the body parts
- This system includes cranial and spinal nerves that connect the brain and spinal cord, respectively, to peripheral structures such as the skin surface and the skeletal muscles

A. TYPES OF NERVES IN THE PERIPHERAL NERVOUS SYSTEM (PNS)

A1. CRANIAL NERVES

- Cranial nerves are nerves that are attached to the brain
- Cranial nerves send electrical signals between your brain, face, neck and torso
- Your cranial nerves help you taste, smell, hear and feel sensations, they also help you make facial expressions, blink your eyes and move your tongue
- There are 12 pairs of cranial nerves (henceforth, when a cranial nerve is identified, a pair is meant)
- They are numbered according to their connection with the brain; the first 9 pairs and the 12th pair supply structures in the head

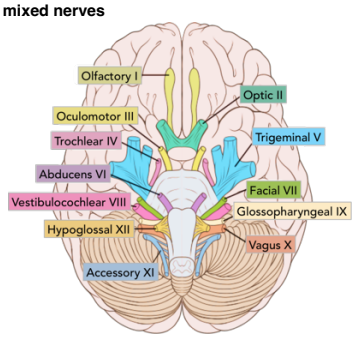
IN CAPSULE

General Functions of the Cranial Nerves
From the functional point of view, cranial nerves handle:

- *Special sensory impulses*, such as for smell, taste, vision, and hearing
- *General sensory impulses*, such as those for pain, touch, temperature, deep muscle sense, pressure, and vibrations
- *Somatic motor impulses* resulting in voluntary control of skeletal muscles
- *Viscera motor impulses* producing involuntary control of glands and involuntary muscles (cardiac and smooth muscle)
- These motor pathways are part of the autonomic nervous system, parasympathetic division

NAMES AND FUNCTIONS OF THE CRANIAL NERVES

- The 12 cranial nerves are always numbered according to the traditional Roman style
- **Sensory fibers** are cranial nerves– I, II, and VIII
- **Motor fibers** are cranial nerves– III, IV, VI, XI and XII
- The remainder–V, VII, IX, and X– contain both sensory and motor fibers; they are known as **mixed nerves**



I. The **olfactory nerve** enables your olfactory system (the sensory system used for smelling aka *olfaction*) and sense of smell.
II. The **optic nerve** is critical to your vision. It's an extension of your central nervous system, which includes your brain and spine.
III. The **oculomotor nerves** this nerve has somatic motor and general visceral (parasympathetic) motor fibers. It allows movement of the eye muscles, constriction of the pupil, focusing the eyes and the position of the upper eyelid.
IV. The **trochlear nerve** enables movement in the eye's superior oblique muscle. This makes it possible to look down. The nerve also enables you to move your eyes toward your nose or away from it.
V. The **trigeminal nerve** is the great sensory nerve of the face and head. It has three branches that transport general sense impulses (e.g., pain, touch, temperature) from the eye, the upper jaw, and the lower jaw. The third branch is joined by motor fibers to the muscles of mastication (chewing).
VI. The **abducens nerve** is a purely somatic motor nerve, it has no sensory function. It innervates the lateral rectus muscle, an extraocular muscle of the eye, which is responsible for the abduction of the eyes on the same (ipsilateral) side.
VII. The **facial nerve** control facial movement and expression. The facial nerve also carries nerves that are involved in taste to the anterior 2/3 of the tongue and producing tears (lacrimal gland).
VIII. The **vestibulocochlear nerve** handles balance and equilibrium, while the cochlear nerve is responsible for hearing. The vestibulocochlear nerves originate in the monitoring receptors of the internal ear—the vestibule and cochlea. This nerve is also called the *auditory* or *acoustic* nerve.
IX. The **glossopharyngeal nerve** provides motor, parasympathetic and sensory information to your mouth and throat. Among its many functions, the nerve helps raise part of your throat, enabling swallowing.
X. The **vagus nerve** is the longest cranial nerve, its name means "wanderer". Also known as the vagal nerves are the main nerves of your parasympathetic nervous system. This system controls specific body functions such as your digestion, heart rate and immune system.
XI. The **accessory nerve** (formerly called the *spinal accessory nerve*) is a motor nerve with two branches. Controls the movement of certain neck muscles –the trapezius and sternocleidomastoid. It is coiled in appearance. It is divided into spinal and cranial divisions, but its cranial part is often disregarded.
XII. The **hypoglossal nerve** enables tongue movement. It controls the *hyoglossus*, *intrinsic*, *genioglossus* and *styloglossus* muscles. These muscles help you speak, swallow and move substances around in your mouth

Genioglossus muscles, which push the tongue forward. **Hyoglossus** muscles that pull the tongue back and flatten it. **Intrinsic** muscles that change the tongue's shape, including curving and narrowing. **Styloglossus** muscles, which move the tongue up and down.

EASY MEMORIZATION!

Ooh, **O**oh, **O**oh, **T**o **T**ouch **A**nd **F**eel **V**ery **G**ood **V**elvet. **S**uch **H**eaven!

Each initials stand for each cranial nerve according to their order

EASY MEMORIZATION!

Some **S**ay **M**arry **M**oney **B**ut **M**y **B**rother **S**ays **B**ig **B**rains **M**atter **M**ore

Each initials stand for what kind of fibers does each cranial nerve have

Table 1. **Functions and dysfunctions of the cranial nerves**

Cranial nerve name (number)	Type	Function	Associated dysfunction(s)
Olfactory (I)	Sensory	Sense of smell	• Unilateral or bilateral loss of sense of smell • Loss of taste
Optic (II)	Sensory	Vision	• Loss of vision
Oculomotor (III)	Motor	Movement of the eyeball and upper eyelid	• Eye-movement problems
	Parasympathetic	Pupil constriction	
Trochlear (IV)	Motor	Movement of the eyeball	• Eye-movement problems
Trigeminal (V)	Sensory	General sensation in face, scalp, corneas, and nasal and oral cavities	• Loss of facial sensation
	Motor	Chewing	
Abducens (VI)	Motor	Movement of the eyeball	• Eye-movement problems
Facial (VII)	Sensory	Taste	• Loss of taste
	Motor	Facial expression	• Inability to close eye
	Parasympathetic	Secretion of tears and saliva	
Vestibulocochlear (VIII)	Sensory	Hearing and balance	• Loss of hearing and balance
Glossopharyngeal (IX)	Sensory	Taste and sensation from back of tongue	• Inability to swallow • Hoarse voice
	Motor	Swallowing and speech	
	Parasympathetic	Secretion of saliva	
Vagus (X)	Sensory	Taste and sensation from epiglottis and pharynx	• Inability to swallow • Hoarse voice • Delayed gastric emptying
	Motor	Swallowing and speech	
	Parasympathetic	Muscle contraction of thoracic and abdominal organs and secretion of digestive fluids	
Accessory (XI)	Motor	Head and shoulder movement	• Inability to move head and raise shoulders
Hypoglossal (XII)	Motor	Movement of the tongue muscles	• Inability to move tongue

Source: Bayram-Weston (2020)

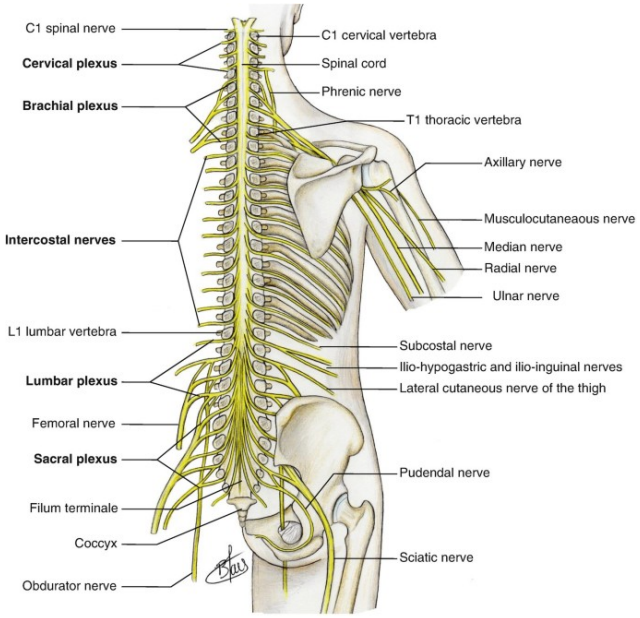
A2. SPINAL NERVES

- Spinal nerves are bundles of nerve fibers connected to the spinal cord that carry information to and away from the spinal cord
- There are 31 pairs of spinal nerves, each pair numbered according to the level of the spinal cord from which it arises
- Each nerve is attached to the spinal cord by two roots; the **dorsal root** and the **ventral root**

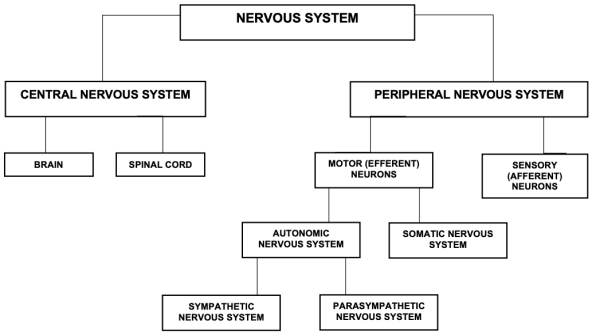
A2a. BRANCHES OF THE SPINAL NERVES

- Each spinal nerve continues only a very short distance away from the spinal cord and then branches into small posterior divisions and rather large anterior divisions
- The larger anterior branches interlace to form networks called **plexuses**, which then distribute branches to the body parts

- The three main plexuses are described as follows:
    - The **cervical plexuses** supply motor impulses to the muscles of the neck and receive sensory impulses from the neck and the back of the head. The phrenic nerve, which activates the diaphragm, arises from this plexus.
    - The **brachial plexus** sends numerous branches to the shoulder, arm, forearm, wrist, and hand. The radial nerve emerges from the brachial plexus.
    - The **lumbosacral plexus** supplies nerves to the lower extremities. The largest of these branches is the sciatic nerve, which leaves the dorsal part of the pelvis, passes beneath the *gluteus maximus* muscle, and extends down the back of the thigh. At its beginning it is nearly 1 inch thick, but it soon branches to the thigh muscles; near the knee it forms two subdivisions that supply the leg and the foot.



B. THE DIVISION OF THE PERIPHERAL NERVOUS SYSTEM



B1. SENSORY (AFFERENT) DIVISION

- Carry sensory signals impulses from the sense organs (ears, eyes, nose, and tongue) to the Central Nervous System (CNS)

B2. MOTOR (EFFERENT) DIVISION

- Transmit impulse from the CNS
- The efferent or motor division transmits impulses from the CNS out to the muscle or glands (*effectors*) to cause an effect or action
- The motor division is subdivided into two system:
    - Somatic Nervous System
    - Autonomic Nervous System

B2a. SOMATIC NERVOUS SYSTEM

- The somatic nervous system is a component of the peripheral nervous system associated with the voluntary control of the body movements via the use of skeletal muscles
- It controls *voluntary* commands e.g. moving, or talking

B2b. AUTONOMIC NERVOUS SYSTEM

- The autonomic nervous system is a component of the peripheral nervous system that regulates involuntary physiologic processes including heart rate, blood pressure, respiration, digestion, and sexual arousal
- It controls *involuntary* commands e.g. digestion and heartbeat
- The autonomic nervous system is subdivided into two systems:
    - Sympathetic Nervous System
    - Parasympathetic Nervous System

B2b1. SYMPATHETIC NERVOUS SYSTEM (ADRENERGIC)

- The sympathetic nervous system is a division of the nervous system that functions to produce localized adjustments (such as sweating as a response to an increase in temperature) and reflex adjustments of the cardiovascular system
- Known as the "**fight or flight**" system of the body, it increases the alertness, and prepares the body for quick response
- The neurotransmitter for the postganglionic synapse of the SNS is **norepinephrine**

B2b2. PARASYMPATHETIC NERVOUS SYSTEM (CHOLINERGIC)

- The parasympathetic nervous system predominates in quiet "rest and response" conditions
- Known as the "**rest and digest**" system of the body as it conserves energy and controls sedentary activities such as digestion
- The main purpose of the PNS is to conserve energy to be used later and to regulate bodily functions like digestion and urination
- The neurotransmitter for the postganglionic synapse of the PNS is **acetylcholine**

EFFECTS OF THE SYMPATHETIC AND PARASYMPATHETIC NERVOUS SYSTEM

ORGAN SYSTEM	SYMPATHETIC NERVOUS SYSTEM	PARASYMPATHETIC NERVOUS SYSTEM
Heart	Increased heart rate	Decreased heart rate
Blood vessels	Constricts visceral and brain vessels	Dilates visceral and brain vessels
Lungs	Dilates bronchi and ↑ RR	Constricts bronchi and ↓ RR
Gastrointestinal	Decreases peristalsis	Increases peristalsis
Anal sphincter	Closes anal sphincter	Opens anal sphincter
Urinary	Relaxes bladder and closes sphincter	Contracts bladder and opens sphincter
Eye	Dilates pupils and accommodates far vision	Constricts pupils and accommodates near vision
Skin and sweat glands	"Goose flesh", pallor, diaphoresis	
Gastric and Salivary Secretions	Decreases gastric and salivary secretions	Increases gastric and salivary secretions
Liver	Stimulates glycogenolysis (↑ blood glucose)	
Pancreas	Diminishes secretion of pancreatic enzymes	Increases secretion of pancreatic enzymes
Adrenal medulla	Stimulates production of norepinephrine	
Penis	Promotes ejaculation	Causes erection

IN CAPSULE:
Comparison between the Sympathetic Nervous System (SNS) and Parasympathetic Nervous System (PNS)

	SYMPATHETIC NERVOUS SYSTEM	PARASYMPATHETIC NERVOUS SYSTEM
Origin	Thoraco-lumbar segment of spinal cord	Sacral segment of the spinal cord
Hormone released	Norepinephrine	Epinephrine
Concepts	**EVERYTHING** is **HIGH** and **FAST** but GI/GU are **SLOW**	**EVERYTHING** is **LOW** and **SLOW** but GI/GU are **FAST**
	Necessary for survival	
	DILATE:	**CONSTRICT**:

	• Pupils • Bronchial Tree • Coronary blood vessels	• Pupils • Bronchial Tree • Coronary blood vessels
	CONSTRICT: • Peripheral blood vessels	**DILATE**: • Peripheral blood vessels
Applications in Pharmacology	**Anticholinergic**	**Cholinergic**
	Beta agonists: BRONCHODILATORS	**Beta blockers: ANTIHYPERTENSIVES**

PROTECTIVE AND NUTRITIONAL STRUCTURES

CRANIUM AND VERTEBRAL COLUMN

- The cranium is composed of eight bones that fuse in early childhood; the fused junctions are called **sutures**
- The vertebral column consists of 7 cervical vertebrae, 12 thoracic vertebrae, 5 lumbar vertebrae, 5 sacral vertebrae fused into a sacrum, and 4 coccygealvertebrae fused into a coccyx

MENINGES

- Consists of 3 membranes that envelope the brain and the spinal cord, these are the **pia mater**, **arachnoid** and the **dura mater**
  - The **pia mater** is a vascular layer of connective tissues, it supports blood vessels passing through the tissues of the brain and spinal cord
  - The **arachnoid** is a thin layer of connective tissues. The space between the arachnoid and the pia mater is called **subarachnoid space**. Cerebrospinal fluid (CSF)flows through this space.
  - The cranial **dura mater** is a tough, non-stretchable vascular membrane. The subdural space is the potential space between the inner dura mater and the arachnoid. The **epidural space** is between the dura mater and the periosteum.

REFLEX MECHANISMS

- Reflex responses are the conscious automatic responses to the internal and external stimuli
- The reflex centers are the spinal cord (flexion and extension) and the brain stem (heart rate, breathing, blood pressure, swallowing, sneezing, coughing and vomiting)

CEREBROSPINAL FLUID AND THE VENTRICULAR SYSTEM

- CSF is a clear, colorless fluid. Approximately 100 to 160 mL in amount
- The CSF is primarily produced by the choroid plexus of the lateral ventricles (2/3 of the CSF)
- Approximately, 500 ml. of CSF is produced per day, but normally, it is absorbed in the blood at the same rate at which it is formed
- The ventricular system is a series of cavities within the brain

CSF FLOW

Lateral Ventricles
↓
Foramen of Monro
↓
Third ventricle
↓
Aqueduct of Sylvius
↓
Fourth ventricle
↓
Foramina of Luschka
Foramen of Magendie
↓
Subarachnoid space (Cisterna Magna) behind medulla,
Below the cerebellum
↓
Brain and spinal cord
CSF circulates upward into the superior sagittal sinus where it is absorbed across the arachnoid villi

- **Blood - brain barrier** is a layer of least permeable capillaries that limit the free movement of substances from the blood to the brain tissues. The barrier is selective, allowing entry of fluid, gases and small molecular substances while preventing the entry of toxic substances, plasma protein and large molecules.
- The CSF has the following functions:
  - Cushions the brain and protects it from jarring against the skull
  - Nourishes the brain
  - Removes metabolites from the brain
  - Regulates the intracranial pressure
- The spinal cord has an H-shaped central gray matter surrounded by white matter. The white matter is divided into three columns or funiculi follows:
  - Anterior/ventral
  - Lateral
  - Posterior/dorsal columns
- Each contains ascending and descending tracts
- The spinal cord is also the site of reflex pathways. A reflex. action consists of specific stereotyped motor response to an adequate sensory stimulus. It does not require relay to the brain for action.
- The meninges which cover the nervous tissue in the brain and spinal cord help support, protect and nourish the brain and the spinal cord. The outermost layer is the dura mater, the middle layer is the arachnoid and the innermost is the pia mater.
- There are three potential spaces associated with the meninges which are as follows: **epidural** (external to the dura); **subdural** (between dura and arachnoid); and **subarachnoid** (between arachnoid and pia mater)

CARE OF PATIENT WITH NEUROLOGIC DYSFUNTION

ALTERED LEVEL OF CONSCIOUSNESS

- The PNS is the communication link between the CNS and the various part of the body

INCREASED INTRACRANIAL PRESSURE

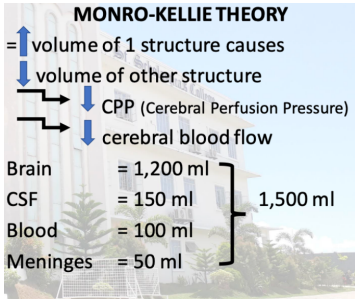
- In the adult, the rigid cranial cavity created by the skull is normally filled to capacity with three essentially noncompressible elements:
  - Brain (80%)
  - CSF (8%)
  - Blood (12%)
- A state of dynamic equilibrium exists: If the volume of any of the three components increases, the volume of the others must decrease to maintain normal pressures within the cranial cavity known as the **Monro-Kellie hypothesis**
- **Normal:** 0 to 10 mmHg or 15 mmHg (upper limit of normal)
- Increased intracranial pressure (IICP) *aka* intracranial hypertension is sustained elevated pressure within the cranial cavity
- The factors that may increase the blood supply to the brain are cerebral hemorrhage, thrombosis, embolism, aneurysm, arteriovenous malformation (A-V mal)
- The factors that increase the bulk of CSF are obstruction to the flow of CSF caused by brain tumor or ventricular system defects (hydrocephalus); or overproduction of CSF caused by tumor in the choroid plexus
- Increased ICP causes cerebral hypoxia

MONRO-KELLIE'S THEORY ON INCREASED INTRACRANIAL PRESSURE

- The **Monro-Kellie Hypothesis** *aka* **Doctrine** explains the dynamic equilibrium of cranial contents
- The hypothesis states that because of the limited space for expansion within the skull, an increase in any one of the components causes a change in the volume of the others
  - Brain Tissue
  - CSF
  - Blood
- The brain tissue has limited space to expand, compensation typically is accomplished by displacing or shifting CSF, increasing the absorption or

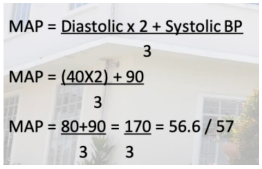
diminishing the production of CSE, or decreasing cerebral blood volume. Without such changes, ICP begins to rise.

- Under normal circumstances, minor changes in blood volume and CSF volume occur constantly as a result of alterations in intrathoracic pressure (coughing, sneezing, straining), posture, blood pressure, and systemic oxygen and carbon dioxide levels



CEREBRAL PERFUSION PRESSURE

- Net pressure gradient that drives oxygen delivery to cerebral tissue
- Normal: 60-100 mmHg
- Formula: MAP – ICP = CPP
  - BP = 90/40 mmHg
  - ICP = 19
  - CPP = MAP – ICP
  - CPP = 57 – 19 = 38



PATHOPHYSIOLOGY

↑ Pressure inside the head
↓
Compression of the brain and blood vessels
↓
Decreased CBF and CBV
↓
Decreased O2 delivered to the brain tissue
(Manifestation of earliest sign of increased ICP: ALOC (Altered Level of Consciousness e.g. restlessness, confusion, irritable, and decreased LOC)
↓
Cerebral hypoxia
↓
Increased CO2
↓
Triggers vasodilation

Systemic vasoconstriction
(for the purpose of increasing the BP to allow increase cerebral blood flow and to improve brain tissue perfusion)
↓
Increased Blood Pressure
*One of the three signs and symptoms of Cushing's Triad
↓
Trigger reflex bradycardia (↓ HR)
(The Vagus nerve detects that there is an increase BP, as a compensatory mechanism triggers bradycardia and vasodilation to decrease BP)
*This doesn't occur as the goal of the body is to maintain the blood perfusion towards the brain
↓
Further compresses the brainstem
(Respiratory center located here affecting the respiratory rate causing ↓ RR)
*Cheyne's Stokes
↓
Presence of Cushing's Triads
↓
Brain Tissue Herniates
↓
Brain tissue squashes the brain stem
↓
Ataxic respiration (severely irregular or **Agonal respiration**)
(Severe Hypercapnia resulting to vasodilation = ↑ cerebral blood volume aggravating patient's ICP)

IN CAPSULE

Your Brain's Home: A Tight Space

Imagine your brain is living in a hard helmet called the **skull**. Inside this helmet, there are **three things**:

1. **Brain tissue**
2. **Blood**
3. **Cerebrospinal fluid (CSF)** – this cushions the brain like a shock absorber

These 3 things **share the same small space**, so they must stay balanced. If one grows too much, something else has to shrink—or there'll be trouble!

What is IICP?
IICP (Increased Intracranial Pressure) happens when there's too much pressure inside the skull
It's like pumping too much air into a basketball—it starts to press on the inside walls!

What Can Cause IICP?

- A **tumor or swelling** in the brain
- Too much **fluid (CSF)**
- **Bleeding** in the brain
- **Injury** causing brain swelling

All of these **squeeze** the brain and make it harder for it to work properly.

How Blood Flow Works
Your brain needs a **constant supply of blood** to get **oxygen and sugar (glucose)** to keep it alive and working.
But if there's **too much pressure**, blood can't flow properly. This can cause parts of the brain to **starve** and **get damaged** (we call that **ischemia**).

The Brain Tries to Help (Autoregulation)
Your brain is smart! It tries to fix the problem by:

1. **Squeezing blood vessels** (like turning off a faucet) to stop too much blood from entering.
2. **Moving extra fluid** (CSF) away to the spine.
3. **Changing the size of vessels** when certain chemicals (like CO_2 or acid) build up. For example:
   - Too much **CO_2** or acid = brain opens vessels to get more blood
   - Too little **CO_2** = brain squeezes vessels shut

But this only works **up to a point**.

When the Brain Can't Cope Anymore
If the pressure keeps building and **gets too high**, your brain can't fight back:

- Blood stops flowing well
- Brain cells get damaged and die
- It becomes **life-threatening**

This is called **intracranial hypertension**—very dangerous and needs urgent treatment.

The Big Idea:
Your brain is inside a tight space. If something adds more pressure (like swelling, fluid, or blood), it becomes harder for your brain to get the oxygen and blood it needs. It tries to adjust, but if pressure keeps rising, it can be very harmful or deadly.

CAUSE OF ICP FLUCTUATION

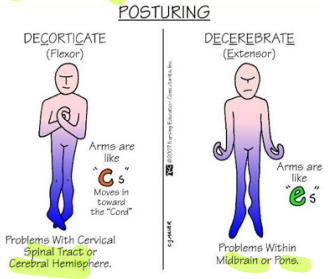
- **Hyperthermia**
  - Hyperthermia causes vasodilation and promotes relaxation, with vasodilation it ↑ blood flow and cerebral blood flow and ↑ cerebral blood volume = ↑ or affects ICP
  - This is the reason why in managing patient with increased ICP you have to prevent hyperthermia because it can worsen the clinical outcome of the patient due to cerebral vasodilation
- **O_2 and CO_2 levels**
  - In patient with hypoventilation
  - ↓ O_2 and ↑ CO_2 or buildup (the one responsible for our breathing mechanism and is a potent **vasodilator**)
  - The vasodilation leads to ↑ blood flow and cerebral blood flow and ↑ cerebral blood volume = ↑ or fluctuation of the ICP
  - This is the reason why in managing patient with increased ICP you have to avoid hypoventilation because of its effect that worsen the patient's condition
  - Instead, an initial non-pharmacologic intervention with increased ICP's patient we encourage the patient to have **mild hyperventilation** as with this it causes the opposite (vasoconstriction) and therefore ↓ cerebral blood volume
- **Body position**
  - When you are lying down flat, normally the ICP ↑
  - That's why in patient with increased ICP, flat on the bed is contraindicated at least 30 degrees head of the bed elevated
  - Flexing of the neck and hip is contraindicated because it increases ICP
- **Increased in Intraabdominal Pressure (IAP)** and **Thoracic Pressure**
  - Valsalva maneuver
  - Bending of the body, neck, and knees
  - Coughing
  - Sneezing
  - Constipation

CAUSES OF SUSTAINED INCREASED ICP

- Head Trauma
- Increase CSF (e.g. Hydrocephalus, and meningitis)
- Bleeding
- Hematoma (pulling of blood outside tissue causing edema)
- Tumor
- Infection (e.g. meningitis

MIND CRUSHED MNEMONICS

- **Mental Status Changes**
  - ALOC (early signs)
  - Because the neurons of the cerebral cortex are most sensitive to oxygen deficit, changes in cortical function are the most sensitive indicator of neurologic change
- **Irregular Respiration**
  - Cheyne-Stokes Breathing (late signs)
  - A breathing pattern characterized by alternating periods of hyperventilation (fast, deep breaths) and apnea (no breathing)
- **Nuchal Rigidity**
  - Stiff neck due to brain stem involvement
  - Seen in patient with meningitis but can be seen in patient with ICP due to irritation of the meninges limiting movement for the patient
- **Nerve Changes**
  - Optic nerve (CN_2) and Oculomotor nerve (CN_3)
  - Blurred vision and the movement of the eyes due to compression
  - The eye is one of the first to be affected by the increased ICP affecting the pupils (fixed, dilated, and unequal)
- **Decorticate and Decerebrate**
  - Decerebrate is more dangerous
  - Decorticate is M_3 in GCS
  - Decerebrate is M_2 in GCS



- **Cushing's Triad**
  - Increased Systolic Blood pressure
  - Decreased Heart Rate
  - Irregular Respiration (Cheyne's Stoke)

↑BP ↓HR ↓RR

- **Reflex (+ Babinski reflex)**
  - Due to the damage of the brainstem (involuntary movements)
  - Normal in baby (up to 2 yrs old)
  - Fanning out of the toes when apply pressured by a blunt object
  - Late signs
- **Unconscious**
  - Late signs
- **Seizure and coma**
- **Headache**
  - Considered early sign due to increased intracranial pressure
- **Emesis (Projectile vomiting without nausea)**
  - Generally an early signs
- **Deterioration of motor functions**
  - Late sign

CLINICAL MANIFESTATIONS

- **Restlessness**
  - The initial sign of increased ICP
- **Headache** is due to traction on pain-sensitive brain structures and on cranial nerves
- **Nausea and vomiting**
  - Due to pressure at the medulla oblongata
  - Vomiting may be projectile
- **Diplopia** (double vision)
  - Due to pressure on the cranial nerve VI (abducens), which controls the lateral rectus muscle of the eye
  - Cranial nerve VI is the longest intracranial nerve, therefore, it is very vulnerable to compression
- **Altered level of consciousness**
  - Due to affectation of ascending reticular activating system (ARAS)
- **Vital sign changes**
  - Due to stimulation of the Cushing's reflex in response to cerebral hypoxia
  - The **Cushing's triad** are as follows:

BLOOD PRESSURE

- Systolic pressure is elevated due to increased force of cardiac contractility, the body's attempt to increase cerebral tissue perfusion and oxygenation
- Diastolic pressure remains normal or decreased due to longer time required for the heart to relax
- Widening of pulse pressure more than 40 mmHg
  - Pulse pressure is the difference between systolic pressureand diastolic pressure: S - D = pulse pressure
  - Normalpulse pressure is 30 to 40 mmHg

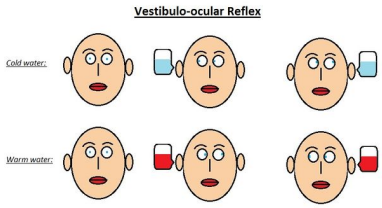
PULSE RATE

- Bradycardia (slow bounding pulse) occurs

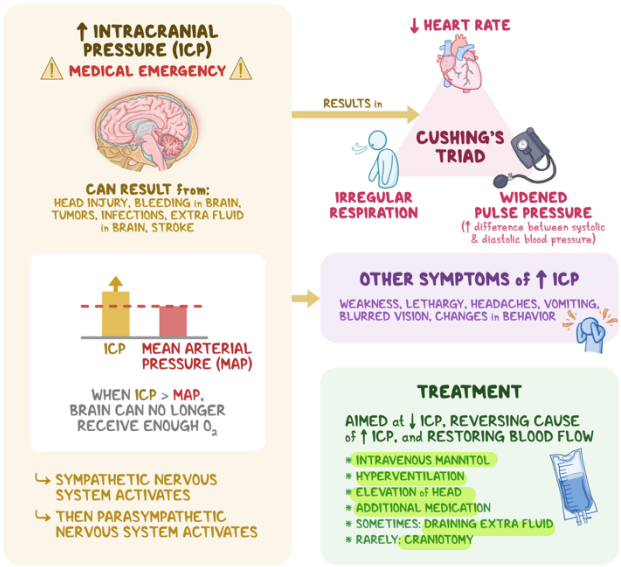
RESPIRATORY RATE

- Respiratory rate is slow, due to involvement of the medulla oblongata and pons

- The other vital sign changes are as follows:
  - Body temperature such as hyperthermia or hypothermia may occur due to the involvement of the hypothalamus
- Pupillary Changes
  - **Anisocoria** (unequal pupil) due to Cranial nerve III (oculomotor) compression; there is ipsilateral (same side of brain affectation) pupil dilatation
  - Pinpoint pupils indicate pons involvement
  - Fixed, dilated pupils indicate uncal/brain herniation; this causes compression of the brainstem that results to cardiopulmonary arrest (The uncus is the pointed part of the temporal lobe located immediately above the brainstem)
- Papilledema (choked disc) due to the compression of the optic nerve
- **Lateralizing Sign** this is contralateral (opposite side) loss of motor function due to decussation (crossing) of motor fibers at the level of medulla oblongata, e.g., left brain affectation leads to **right hemiplegia** (paralysis of the right lateral half of the body); right brain affectation leads to **left hemiplegia** (paralysis of the left lateral half of the body)
- Brainstem Function Impairment
  - **Doll's Eye sign**. Dysconjugate movement of the eyes as the head is moved to one side.
  - **Decortication** (flexion, adduction and internal rotation of upper extremities. Lower extremities are extended). This indicates involvement above the midbrain.
  - **Decerebration** (extension, adduction, and internal rotation of the arms and extension of lower extremities). This indicates involvement of the brainstem. This indicates poor prognosis. The client may have cardiopulmonary arrest, anytime.
  - **Oculovestibular Test (Caloric Ice water test)**. Dysconjugate movement of the eyes occur in response to irrigation of the ear with cold water.
    - Normal result: **COWS** (cold, opposite, warm, same)
    - The eyes of the patient goes to the cold side

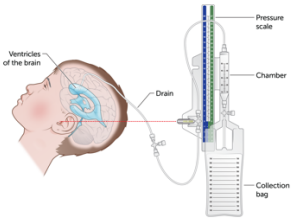


- Alterations in:
  - Sensory function (agnosia)
  - Motor function (seizures)
  - Language and Speech (expressive aphasia, receptive aphasia, alexia)
  - Bowel and bladder function (retention or incontinence)



DIAGNOSTIC PROCEDURES

- CT Scan (Computed Tomography)
- MRI (Magnetic Resonance Imaging)
- Ventriculostomy or EVD (External Ventricular Drain)
  - Diagnostic tool and monitoring + therapy
  - Indicated with CSF problem



- Lumbar puncture
  - Contraindicated because when doing lumbar puncture, when not done expertly it can remove the CSF very rapidly to the point that it promotes the herniation of the ventricles

MEDICAL MANAGEMENT

a. **Mannitol**
- Aggressive therapy due to the poor prognosis
- **Route**: ~~IV~~ (fast drip/bolus)
- **Type:** Osmotic diuretic (concentrated sugar) which pulls water from the brain to the circulation to reduce the brain swelling
- **Monitor for:**
  - Kidney function and BP of the patient
  - Fluid volume deficit (E.g., sunken eyes, hyperthermia, hypotension)
  - Fluid volume overload (E.g., congestive heart failure, pulmonary edema, hypothermia, and hypertension)

b. **Hypertonic IVF**
- 3% or 5% NaCl

c. **Corticosteroid**
- To reduce the inflammation
- **Dexamethasone**

d. **Sedatives**
- Midazolam (Benzodiazepine) uses to lower brain metabolism
- Pentobarbital (Barbiturates) used as last resort when all the drugs are already failing

e. **Antiseizures**
- Phenytoin (Dilantin)

f. **Antihypertensives**
- Labetalol
- Nicardipine

DILANTIN (PHENYTOIN)
- If given p.o. (per orem / by mouth) → give after meals to prevent GI upset
- If given IV → prepare 10mls. NS (Normal Saline) to flush the IV line before and after Dilantin IV administration
- Dilantin crystallizes in the veins. (5 mL NS → Dilantin → 5 mL NS)

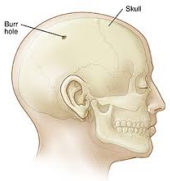
Side effects or adverse effects of Dilantin
- GI upset
- Sedation
- Red urine
- Gum hyperplasia (overgrowth of gingival tissues)swelling of gums)
- Ataxia
- Nystagmus
- Bone marrow depression → aplastic anemia (monitor weekly CBC)

Nursing Interventions to prevent gum hyperplasia
- Good oral care
- Use soft bristled toothbrush
- Massage gums
- Regular dental check-up

Critical to Remember:
Opiates (narcotics) and sedatives are contraindicated to the client with increased ICP. These drugs may cause respiratory depression that leads to acidosis. Acidosis increases ICP. Benzodiazepines (e.g., Valium, Ativan) are usually avoided in the management of patients with increased ICP because of the hypotensive effect.

SURGICAL MANAGEMENT

- **Burr Hole**
  - Minimally invasive
  - Drill hole into the skull to relieve pressure to drain fluid such as blood and pus to decrease ICP



- **Craniotomy**
  - A piece of skull (called the bone flap) is temporarily removed to access the brain and remove the tumor, bleeding, abscess
  - The bone is put back after the surgery

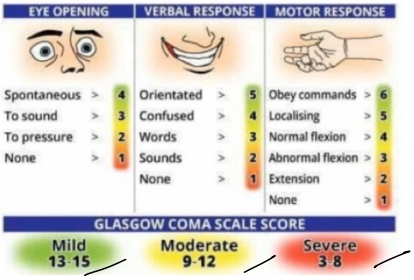
- **Decompressive Craniotomy**
  - A large part of the skull is removed because we want to allow the brain to swell or expand without herniation
  - Done by the physician when there is a dangerous amount of pressure
  - The bone flap is stored either in the abdomen or in the freezer (cryopreservation) as the option
  - In the abdomen, the bone flap is sterile, it keeps the bone alive by providing nutrients and prevention of drying or brittle
- **CSF Shunt Replacement**
  - VP (ventriculoperitoneal) Shunt from the ventricles to the peritoneum
    - The preferred as the peritoneum has higher capacity to absorb excess CSF compared to the VA
  - VA (ventriculoartria) Shunt from the ventricles to the atria

NURSING MANAGEMENT (PRESSURE MNEMONIC)

Nurse Alert: Increased ICP is an emergency. The cerebral cortex can tolerate hypoxia only for 4 to 6 minutes. The medulla oblongata can tolerate hypoxia only for 10 to 15 minutes.

- **Position Head of Bed**
  - Semi-Fowler or lateral position
  - Position HOB at 15-30° angle to promote cerebral venous drainage from the subarachnoid space of the brain to the spinal cord
  - This position also promotes maximum lung expansion and improves cerebral tissue oxygenation

  - If the HOB is too high it would compromise the perfusion of the blood to the brain
  - Do not elevate 90° angle as this may cause brain herniation
  - Neck should be in the midline
  - Hip should be midline
- **Respiration**
  - ABG monitoring
  - Normally, O2: 95-100 mmHg & CO2= 35-45 mmHg
  - Try to maintain a lower PaCO2 between 30-35 mmHg to maintain the mild hyperventilation causes vasoconstriction until the patient is fully stable
  - Adequate oxygenation helps promote acid-base balance, as acidosis and alkalosis may cause increase in ICP
- **Elevated temperature**
  - Prevent hyperthermia as it causes vasodilation causing ↑ blood flow and cerebral blood flow and ↑ cerebral blood volume = ↑ or affects ICP
- **Straining**
  - Avoid as it increases intraabdominal and intrathoracic pressure
  - If coughing and sneezing should not be avoided, follow through with open mouths
- **Systems to monitor**
  - Ventriculostomy
  - Glasgow Coma Scale

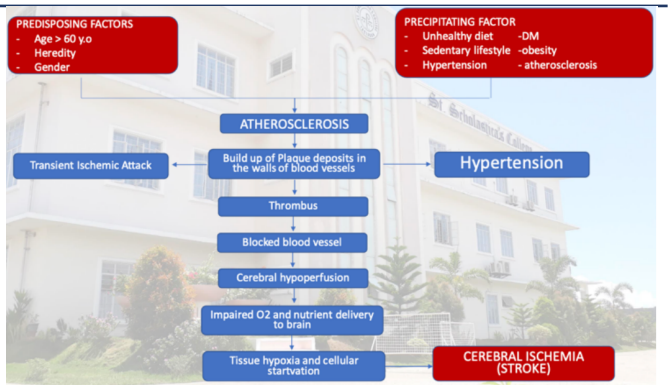


    - 3-8 severe
    - 9-12 moderate
    - 13-14 mild
  - **Doll's Eye Reflex** *aka* **Oculocephalic Reflex**
    - Assessing the brainstem
    - Assessing the cranial nerve 3, 4, and 6dty
- **Unconscious Patient (Care)**
  - Assess for skin breakdown
  - GI tube care
  - Eye care
  - ABC monitoring
  - Passive ROM exercise
- **RX (Prescription)**
- **Edema Management**
  - Mannitol
  - Restrict fluid intake to 1,200-1,500 mL/day to reduce CSF production

CARE OF PATIENT WITH CEREBROVASCULAR DISORDERS

STROKE

- **Cerebrovascular accident** is an umbrella terms that refers to a functional abnormality of the CNS that occurs when there is disruption of blood flow towards the brain
- An emergency condition in which neurologic deficits result from a sudden decrease in blood flow to a localized area of the brain
- Strokes may be **ischemic** (when blood supply to a part of the brain is suddenly interrupted by a thrombus, embolus, or blood vessel stenosis), or **hemorrhagic** (when a blood vessel ruptures, spilling blood into spaces surrounding neurons)
- **Strokes can be divided into major categories:**
  - Ischemic
  - Hemorrhagic



A. ISCHEMIC STROKE

- There is blockage causing decreased blood flow to the brain
- May be caused by clots
  - **Thrombotic** (caused by an actual clot in the artery of the brain) or **embolic** (dislodged clot from other parts of the body)
- Can be caused by stenosis
  - Narrowing of the blood vessels called **atherosclerosis**

A1. TRANSIENT ISCHEMIC ATTACK (TIA)

- Brief disruption of blood flow to the brain
- It is considered a "**mini stroke**" but is considered as a warning sign that a major more problematic stroke may occur
- Usually resolves within 1-24 hours
- Commonly occurring deficits include contralateral numbness or weakness of the leg, hand, forearm, and corner of the mouth, aphasia, and visual disturbances such as blurring. The patient may also experience a visual disturbance called **amaurosis fugax** (a fleeting blindness of one eye, described as a shade coming down over vision in the affected eye)
  - Amaurosis fugax is a temporary loss of vision in one or both eyes due to a lack of blood flow to the retina
  - It can be one (monocular) or both eyes (binocular)
- Needs immediate evaluation + take home medications such as antiplatelet (aspirin) and anticoagulants (warfarin)

A2. LARGE VESSEL (THROMBOTIC) STROKE

- Caused by occlusion of a large cerebral vessel by a thrombus (blood clot)
- Most often occur in older people who are resting or sleeping
- The blood pressure is lower during sleep, so there is less pressure to push the blood through an already narrowed arterial lumen, and ischemia may result
- Thrombi tend to form in large arteries that bifurcate and have narrowed lumens as a result of deposits of atherosclerotic plaque
- The plaque involves the intima of the arteries, causing the internal elastic lamina to become thin and frayed with exposure of underlying connective tissue
- This structural change causes platelets to adhere to the rough surface and release the enzyme **adenosine diphosphate**. This enzyme initiates the clotting sequence, and a thrombus forms.
- A thrombus may remain in place and continue to enlarge, completely occluding the lumen of the vessel, or a part of it may break off and become an embolus
- These strokes commonly affect a single cerebral artery supplying the cerebral cortex, causing aphasia, neglect syndrome, and/or visual field defects

A3. SMALL VESSEL STROKE (LACUNAR INFARCT)

- Thrombotic strokes affecting the smaller cerebral vessels are called **lacunar (small vessel) strokes**, because the infarcted areas slough off, leaving a small cavity or "lake" in the brain tissue
- They occur in the deeper parts of the brain or the brain stem from occlusion of small branches of large cerebral arteries; most often the middle cerebral and posterior cerebral arteries
- Manifestations include motor hemiplegia, sensory hemiplegia, and dysarthria

A4. CARDIOGENIC EMBOLIC STROKE

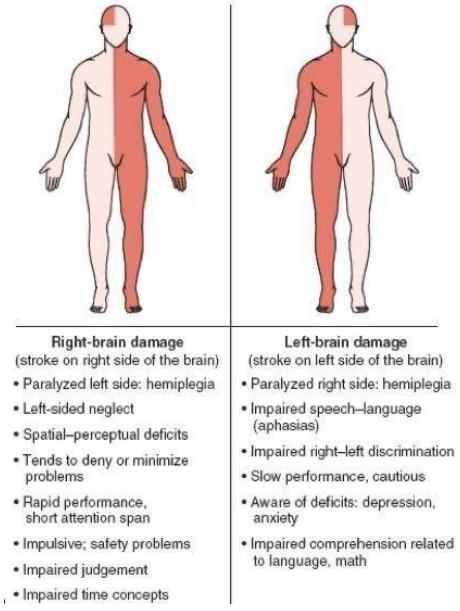
- A cardiogenic embolic stroke results when a blood clot from atrial fibrillation, ventricular thrombi, myocardial infarction, congestive heart disease, or atherosclerotic plaque (and other sources) enters the circulatory system and becomes lodged in a cerebral vessel too narrow to permit further movement. The blood vessel is then occluded.
- The most frequent sites of cerebral emboli are at bifurcations of vessels, particularly those of the middle cerebral artery

B. HEMORRHAGIC STROKE

- A hemorrhagic stroke, or intracranial hemorrhage, occurs when a cerebral blood vessel ruptures
  - Aneurysm
  - HTN
  - Old age (arteries become weak)
- There are two types of hemorrhagic strokes:
  - **Intracerebral hemorrhage** often occurs in older adults with sustained increase in systolic-diastolic blood pressure
  - **Subarachnoid hemorrhage** commonly seen in younger people
- As a result of rupture of the blood vessel, blood enters the brain tissue, the cerebral ventricles, or the subarachnoid space, compressing adjacent tissues and causing blood vessel spasm and cerebral edema
- Blood in the ventricles or subarachnoid space irritates the meninges and brain tissue, causing an inflammatory reaction and impairing absorption and circulation of cerebrospinal fluid (CSF)

SIGNS AND SYMPTOMS (FAST MNEMONIC)

- **F-** Facial drooping
- **A-** Arm weakness
- **S-** Slurred Speech
- **T-** Time (the onset)



Right-brain damage (stroke on right side of the brain)	Left-brain damage (stroke on left side of the brain)
• Paralyzed left side: hemiplegia	• Paralyzed right side: hemiplegia
• Left-sided neglect	• Impaired speech–language (aphasias)
• Spatial–perceptual deficits	• Impaired right–left discrimination
• Tends to deny or minimize problems	• Slow performance, cautious
• Rapid performance, short attention span	• Aware of deficits: depression, anxiety
• Impulsive; safety problems	• Impaired comprehension related to language, math
• Impaired judgement	
• Impaired time concepts	

Other signs:

- **Aphasia** – difficulty in talking/understanding
  - **Expressive Aphasia** (Broca's)- intelligence is intact but the problem is on expression
  - **Receptive Aphasia** (Wernicke)- intelligence is no longer intact but speech is effortless
- **Agnosia** – difficulty in recognizing one or more subjects that were previously familiar; agnosia may be visual, tactile, or auditory
- **Apraxia** – difficulty in voluntary movement
- **Agraphia** – difficulty in writing
- **Alexia** – difficulty in reading
- **Agnosia** – becoming ignorant (e.g. uses toothbrush to brush hair)
- **Dysphagia** – difficulty in swallowing
- **Dysarthria** – difficulty in articulation/speaking
- **Hemianopsia** – aka ***hemianopia*** is the loss of half of the visual field of one or both eyes; when the same half is missing in each eye, the condition is called **homonymous hemianopia**
- **Hemiparesis** – weakness of the half body
- **Hemiplegia** – paralysis of the half body

DIAGNOSTIC TEST/PROCEDURE

- CT scan & MRI
  - To rule out bleeding
  - For ischemic stroke the patient is given **Tissue Plasminogen Activator (TPA)**
  - **Indication**: Given within 3 hours due to one complication of ischemic stroke is bleeding and eventually transform into hemorrhagic stroke
  - **Route**: IV
  - **MOA**: Thrombolytic (dissolves clot)
  - **Examples**: "*plase*" alteplase, reteplase, tenecteplase
  - TPA is contraindicated to hemorrhagic stroke = dissolves the clot (activates fibrinolysis) = given within 4.5 hours = given to patient with normal clotting time, INR = for patient with no recent anticoagulants

SURGERY

- Thrombectomy to remove clot
- Angioplasty to repair and open blood vessels

FOR HEMORRHAGIC STROKE

- Craniotomy to remove blood and repair blood vessels
- Antihypertensive to increase BP and decreases strain on BV such as beta blockers and ACE inhibitors
- Vitamin K increases clotting factor

NURSING INTERVENTION

- Vital signs + neuro stats
- Assess for increased ICP
  - 1st sign = altered LOC
  - Classic sign: **CUSHING TRIAD** (high BP, low RR, low HR)
- Glasgow Coma Scale
- Hemianopsia
  - Scan: side-to-side
- Fall precaution
  - Approach: unaffected
  - Belongings: unaffected
  - Call light within reach in unaffected side
  - Bed (low): resting
  - Bed (comfy height) transfer
- Vomiting (projectile)
- POSITION: low-fowler's
- O2 and suction at bedside
- Mech vent (PaCO2 = maintain 30-35 mmHg to maintain low PEEP)
- Assess pupil for Papilledema (swelling of optic nerve)
- Assess for swallowing
- Assess bladder and bowel
- Assess the skin/ limb = instruct patient to touch the skin/limb every 2 hours to stimulate sensation (prevents NEGLECT SYNDROME)
- HEMIANOPSIA– teach patient to do scanning
- Coordinate with speech pathologist
- Assess gag reflex and ability to swallow = instruct patient to tuck chin to chest
- APHASIA: MGT. = talk slowly, show pictures

MEDICATIONS: 1. MANNITOL - promotes excretion of Na+, Cl +, H2O to decrease fluids in the brain = hold if BP is < 90 2. STEROIDS – to manage inflammation 3. Anti-coagulants 4. Platelet Aggregate Inhibitors 5. Anti-hypertensive drugs

SEIZURE

- An abnormal, sudden, excessive discharge of electrical activity within the brain
- Episodes of abnormal motor, sensory, autonomic, or psychic activity (or a combination of these) that results from sudden excessive discharge from cerebral neurons
- This abnormal neuronal activity, which may involve all or part of the brain, disturbs skeletal motor function, sensation, autonomic function of the viscera, behavior, and/or consciousness
- **Epilepsy** is a disorder characterized by chronic seizure activity, recurring, excessive, and self-terminating electrical discharge from neurons
  - Epilepsy is characterized by recurring seizures accompanied by some type of change in behavior
  - The time period between seizures may range from minutes to years

- **Status Epilepticus** involves rapid succession of epileptic spasms without intervals of consciousness; it is a potential complication that can occur with any type of seizure, and brain damage may result
- **Causes**: genes, trauma, tumor, toxicity, infection

PHASES OF SEIZURE

PHASES OF SEIZURE	
PRODROMAL	• Happens hours to days before the seizure • Mood changes, unexplained anxiety, confusion, depression
AURA or **OMINNOUS**	• Happens a few seconds to minutes before the seizure • Sensory warning sign (vision, smell, taste, hearing) • Symptoms are same every time
ICTAL	• The actual seizure • **PRIORITY**: aside from airway and safety • **DOCUMENTATION**: Time and Duration • Normal duration of seizure is 1 to 3 minutes • If 5 minutes or longer: **STATUS EPILEPTICUS** which may cause permanent brain damage or death
POSTICTAL	• Patient will feel tired, sleepy, and confused, and will have no memory of the event

PATHOPHYSIOLOGY

- Seizures occur when there is an excessive imbalance in excitation and inhibition in either focal areas of the cerebral cortex (causing focal seizures) or over the entire cerebral cortex (causing generalized seizures)
- Either a focal or a generalized increase in the excitability of neurons may result from energy failure of neurons, producing either transient depolarization or lack of local inhibition
- Seizures may also result from alterations in membrane potentials that increase the risk of hypersensitive neurons responding abnormally to changes in the cellular environment
- All people have a seizure threshold; when this threshold is exceeded, a seizure may occur. In some people, the seizure threshold may be abnormally low, increasing their risk for seizure activity; in other people pathologic processes may alter the seizure threshold.
- The hypersensitive neurons that initiate seizure activity are called the **epileptogenic focus**
- The epileptogenic focus generates a large number of discharges that are either enhanced or minimized, depending on the active neurotransmitter present on the postsynaptic membrane
- **Secondary epileptogenic foci** may be induced in the same hemisphere through synapses or may spread to involve the opposite hemisphere through connecting pathways
- People who have epilepsy often have experience triggers that provoke a seizure
- Triggers may be individualized, such as specific music or odors, and flashing lights
- General triggers include fatigue, hypoglycemia, fever, alcohol consumption, constipation, hyperventilation, and menstruation

MANIFESTATIONS

- Although seizures may be categorized in several different ways, the classification developed by the International League Against Epilepsy is the most useful clinically
- In this classification, seizures are divided into:
  - **Partial** (affect only part of the brain)
  - **Generalized** (affect all of the brain)
  - **Mixed seizures** contains both type

A. PARTIAL SEIZURES

- Partial seizures involve the activation of only a restricted part of one cerebral hemisphere
- A partial seizure in which consciousness is not altered is called a **simple partial seizure**; one in which consciousness is impaired is called a **complex partial seizure**

A1. SIMPLE PARTIAL SEIZURES

- Manifestations depend on the involved are of the brain
- Typically the motor portion of the cortex is affected causing recurrent muscle contractions of the face or a contralateral part of the body such as the finger and hand
- This motor activity may stay confined to one area or spread sequentially to adjacent parts, a phenomenon known as a **Jacksonian march** or **Jacksonian seizure**
- Manifestations of a simple partial seizure involving the sensory portion of the brain may include abnormal sensations or hallucinations

IN CAPSULE

- Patient is aware
- Aura
- Seizure: < 2 mins
  - Occipital area of the brain is affected

A2. COMPLEX PARTIAL SEIZURES

- Consciousness is impaired and the person may engage in repetitive, nonpurposeful activity such as lip smacking, aimless walking, or picking at clothing these behaviors are known as **automatisms**
- During the seizure, the person loses conscious contact with the environment; amnesia is common after the seizure, and several hours may elapse before the patient regains full consciousness
- Usually originate in the temporal lobe and may preceded by an **aura**, a warning sign of an impending seizure such as unusual smell, a sense of déjà vu or sudden intense of emotion

IN CAPSULE

- Temporal area of the brain is affected
- S/sx: AUTOMATISM
  - Automatic motor symptoms
  - Lip smacking, unconscious rubbing of hands, fidgety, numbness

B. GENERALIZED SEIZURES

- Generalized seizures involve both hemispheres of the brain as well as deeper brain structures, such as the thalamus, basal ganglia, and upper brainstem
- Consciousness is always impaired with generalized seizures
- Absence and tonic-clonic seizures are the common forms of generalized seizure activity

B1. ABSENCE SEIZURES (PETIT MAL)

- Also known as **little sickness**
- Absence (petit mal) seizures are characterized by a sudden brief cessation of all motor activity accompanied by a blank stare and unresponsiveness
- The seizure typically lasts only 5 to 10 seconds, although some may last for 30 seconds or more
- Movements such as eyelid fluttering or automatisms such as lip smacking may occur during an absence seizure
- No motor involvement
- **Hallmark sign**: ***Staring spell (daydreaming)***
- Does not respond
- Duration 10 to 20 seconds
- No memory of the seizure
- Common in children which they can be outgrown or develop another type of seizure

IN CAPSULE

- Not preceded by aura
- Little or no tonic-clonic movements
- Sudden cessation of ongoing physical activities

B2. TONIC-CLONIC SEIZURES (GRAND MAL)

- The most common type of seizure activity in adults
- This types of seizure activity follows a typical pattern
- A warning aura may precede generalized seizure activity
    - Aura is a premonition of impending seizure; it may be a flashing lights, smells, spots before the eyes, diziness
- The aura may be a vague sense of uneasiness or an abnormal gustatory, visual, auditory, or visceral sensation (such as a metallic taste in the mouth, a smell of burning rubber, or seeing a bright light)
- Often, however, the seizure occurs without warning
- The seizure begins with a sudden loss of consciousness and sharp tonic muscle contractions (the tonic phase of the seizure)
- Postural control is lost, and the patient falls to the floor in the opisthotonic posture
- The **tonic phase** lasts an average of 15 seconds, although it may persist for up to a minute
- The **clonic phase**, which follows the tonic phase, is characterized by alternating contraction and relaxation of the muscles in all the extremities along with hyperventilation
- The entire tonic-clonic portion of the seizure generally lasts no more than 60 to 90 seconds
- Following the clonic phase of seizure activity, the person remains unconscious and unresponsive to stimuli this period is known as the **postictal period** or **phase**
- The person is relaxed and breathes quietly; he or she regains consciousness gradually and may be confused and disoriented on waking

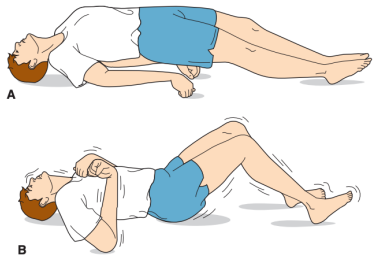


Figure 42–4 ■ Tonic-clonic seizures in grand mal seizures. *A*, Tonic phase. *B*, Clonic phase.

IN CAPSULE

- Most common
- Manifests aura
- Loss of consciousness
- ***Tonic*** (stiffening of the body): 10-20 sec (groan, foaming, apnea)
- ***Clonic*** (jerking movement): 30 sec (relax, spasms)
- Post-ictus (asleep, headache, confused)
- PRIORITY: TIME & DURATION

STATUS EPILEPTICUS

- A type of seizure occurring in rapid succession and full consciousness is not regained between seizures
- Brain damage may occur secondary to prolonged hypoxia and exhaustion
- The client is often in coma for 12 to 24 hours or longer, during which time recurring seizures occur
- The attack is usually related to failure to take prescribed anticonvulsants
- The repetitive seizures may be of any type, although they are usually generalized tonic-clonic

NURSING RESPONSIBILITIES

SEIZURE PRECAUTION

- O2 and suction at bedside
- IV access
- Padded siderails, and pillows
- Avoid restrictive clothing
- Don't put anything inside the mouth
- Assessing patient history of seizure
    - Ask the aura
    - Time and duration
    - Maintenance drugs
    - Type of seizure

DURING THE SEIZURE

- Stay with the patient
- Avoid restraint
- Don't put anything inside the mouth
- Avoid restrictive clothing
- Note TIME & DURATION

AFTER SEIZURE

- Side lying position
- Suction as needed
- Assess vital signs and neurological assessment
- Document
- Schedule and EEG to assess brain activity

PATIENT WITH NEUROLOGIC INFECTIONS, AUTOIMMUNE DISORDERS AND NEUROPATHIES

INFECTIOUS NEUROLOGIC DISORDERS

MENINGITIS

- Inflammation of the meninges (protective membranes that surround the brain and spinal cord)
- Meningitis is an inflammation of the pia mater and arachnoid membranes that surround the brain and the spinal cord
- The subarachnoid space between these two meninges contains CSF that may reflect the signs and symptoms of meningitis
- Meningitis is an infectious process of the central nervous system caused by bacteria or viruses that may be acquired as a primary disease or as a result of complications of neurosurgery, trauma, infection of the sinuses or ears, or systemic infections
- The two main types of meningitis are:
    - Bacterial
    - Viral

BACTERIAL MENINGITIS

- An acute inflammation of the meningeal tissues surrounding the brain and the spinal cord
- Meningitis specifically refers to infection of the arachnoid mater and the CSF
- Bacterial meningitis is considered a medical emergency
- Untreated bacterial meningitis has a mortality rate of 100%
- The organism usually gain entry to the CNS through the upper respiratory tract or the bloodstream, but they may enter by direct extension from penetrating wounds of the skull or through fractured sinuses in the basal skull fracture
- *Streptococcus pneumoniae* and *Neisseria meningitides* are the leading causes of bacterial meningitis
- The inflammatory response to the infection causes increased ICP

PATHOPHYSIOLOGY

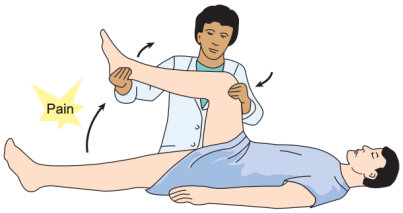
Causative agent enters the bloodstream
↓
Crosses the blood-brain barrier
↓
Proliferates in the CSF
↓
Release of cell wall fragments and lipopolysaccharides of microorganism
↓
Inflammation of the subarachnoid space and pia matter
↓
As CSF through the subarachnoid space, the inflammatory cellular materials from the affected meningeal tissue enter and accumulate

- From the nasopharynx, the microorganism goes to the bloodstream
- Once in the bloodstream, the microorganism causes petechiae formation (pin point red spots on the skin)

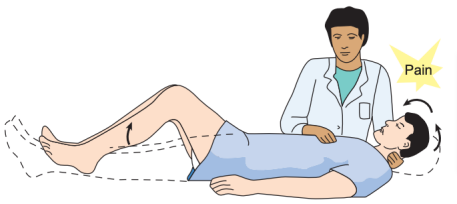
- From the bloodstream, microorganism goes to the meninges and irritates them
  - There is inflammation of the meninges and accumulation of substances in the meninges
- This results into increased Intracranial Pressure (ICP) o Increased ICP leads to:
  - Severe headache
  - Projectile Vomiting
  - Two (2) to three (3) feet away from patient
- Management involves turning patient to side
  - Position kidney basin about two (2) to three (3) feet away
  - Altered Vital Signs
    - Increased Temperature
    - Decreased Pulse Rate
    - Decreased Respiratory Rate
  - Increase in Systolic Blood Pressure and Normal Diastolic Pressure
    - This results in the widening of the Pulse Pressure
- Convulsions (seizures)
- Diplopia
  - Due to choking of optic discs
  - Double vision but not crossed eyed
  - Determined by finger counting
- Altered level of consciousness

CLINICAL MANIFESTATIONS

1. **Nuchal Rigidity**
   - Aka *stiff neck*
     - An early sign, and any attempts at flexion of the head are difficult because of spasms in the muscles of the neck
     - Usually, the neck is supple, and the patient can easily bend the head and neck forward
     - No flexing of the neck
     - No hyperextending of the neck
     - No turning from side to side
2. **Positive Kernig's sign**
   - Place patient in supine position with the thigh flexed on the abdomen, the leg cannot be completely extended
   - When Kernig sign is bilateral, meningeal irritation is suspected
   - If pain is present, the patient is said to be positive (+) for Kernig's Sign or difficulty of extending the leg



3. **Positive Brudzinki sign**
   - The patient's neck is flexed (after ruling out cervical trauma or injury), flexion of the knees and hips is produced; when lower extremity of one side is passively flexed, a similar movement is seen in the opposite extremity
   - Brudzinki sign is a more sensitive indicator of meningeal irritation than Kernig signs
   - If there is no reaction, the patient is said to be negative (-) for Brudzinski's Sign
   - If there is INVOLUNTARY DRAWING UP of the LEGS / HIP upon flexion of the neck, the patient is said to be positive (+) for Brudzinski's Sign



4. **Photophobia**
   - Extreme sensitivity to light; this finding is common due to irritation of the meninges especially around the diaphragm sellae

DIAGNOSTIC TESTS

1. **Lumbar puncture**
   - CSF is the specimen used
     - Assess for the color of the CSF
   - Bacterial infection is present if:
     - CSF is yellowish, turbid, cloudy
   - Viral infection is present if:
     - CSF is clear
   - CSF laboratory examination would show:
     - Protein levels in the CSF are elevated
     - Glucose levels in the CSF are decreased
     - WBC in the CSF are polymorphonuclear cells

CONCEPT

- If caused by bacteria, do Culture and Sensitivity test
  - This is done to know what bacteria caused the infection
  - This is also done to determine what drug will be used to kill the offending microorganism

IMPORTANT CONCEPT!

- If caused by bacteria, do Culture and Sensitivity test
- In patients with HIGHLY INCREASED INTRACRANIAL PRESSURE due to CNS infection, lumbar puncture or aspiration of the CSF is CONTRAINDICATED
  - This will bring about HERNIATION OF THE BRAIN and would eventually lead to death
  - Therefore, it is important that the nurse performs Physical Assessment before doing a lumbar tap

2. **Blood culture**
   - Done because microorganism can travel to the bloodstream

INTERPROFESSIONAL COLLABORATIVE MANAGEMENT

- Bed rest
  - A darkened room and a cool cloth over the eyes to relieve photophobia
- IV Fluids
- Antibiotics
  - If the causative agent is a bacteria
  - Ampicillin, penicillin, cephalosporin
- If with inflammation
  - Give corticosteroid in the form of **dexamethasone**
  - Never give **prednisone** as this does not cross the blood-brain barrier; it causes sodium retention and retains CSF
- If with excess CSF
  - Give osmotic diuretic in the form of **mannitol**
  - Check blood pressure before administration as it causes hypotension
  - Monitor the intake and output to evaluate the effectiveness of mannitol
  - Expect that after two (2) to three (3) hours, the urine output must increase by thirty (30) to fifty (50) mL
  - If no changes in urine output occurs, then mannitol is not effective
  - Refer this to the physician
- If there are convulsions due to CNS infection
  - Give anticonvulsants such as
    - Dilantin
    - Phenytoin

DILANTIN ADMINISTRATION

- Per IV
  - Sandwich dilantin with NSS
  - NSS-Dilantin-NSS
  - This is also done to prevent dilantin from crystallizing
- Per Orem
  - Do frequent oral care
  - Do gum massage
  - As dilantin causes gingival hyperplasia or overgrowth of the gums

MYASTHENIA GRAVIS

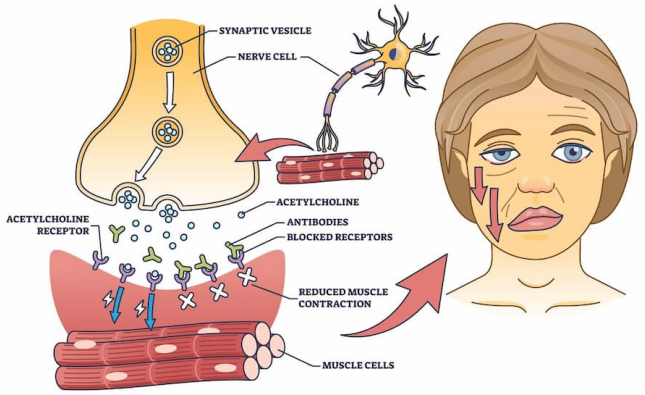
- Descending (mind to ground)
- An autoimmune disease affecting the skeletal muscles (voluntary movement)
  - A neuromuscular disorder characterized by failure of transmission of nerve impulses at the myoneural junction

- ***Myasthenia*** refers to **muscle weakness** that worsens with activity and improve with rests (**HALLMARK SIGN OF MYASTHENIA GRAVIS**)
- ***Gravis*** meaning **grave**

CAUSE

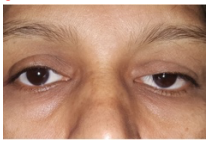
- Unknown
- **ACETYLCHOLINE**
  - An excitatory neurotransmitter
  - In the case of the patient in MS, it particularly affects the **contraction of the muscle**
  - The body needs acetylcholine to excite or stimulate the receptors to cause muscle movement without it weakness occurs
  - The acetylcholine is not able to attach to the neuroreceptors due to the presence of antibodies, this result to the unstimulated receptors, eventually resulting to absence of contraction with activity leading to muscle weakness (no paralysis but general and severe muscle weakness present)
- **THYMUS GLAND**
  - Produces antibodies (Helper T Cells)
  - Normally, by the age of 18 years old our thymus gland has already shrunk and soft making it nonfunctional
  - Supposedly by 18 the thymus gland has already produced enough antibodies for the rest of our life
  - In patient with MG, the thymus gland is still hyperactive (e.g. tumor causing it to be hyperactive)

Presence of antibodies at the neuroreceptors sites
↓
The acetylcholine is not able to bind at the receptors
↓
Unstimulated receptors
↓
Absence of contraction with muscles
↓
Muscle weakness

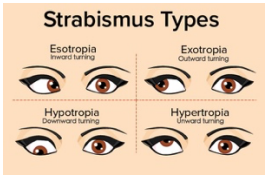


CLINICAL MANIFESTATION (WEAKNESS MNEMONIC)

- **W**eakness of the face, arms, neck
  - Some patient would use neck brace to support the neck and to make sure they are able to swallow properly, to prevent obstruction
- **E**yelid drooping (**ptosis**)
  - The first sign of the disease



- **A**ppearance (mask-like)
  - There is no muscular contraction causing the diminished or absence of facial expression
  - Snarl like expression
- **K**eep on choking and gagging
  - Dysphagia
  - Drooling
- **N**o energy
  - Due to the absence of muscular contraction
- **E**xtraocular muscle issues
  - Strabismus *or* lazy eye (*duling*)
  - Ptosis
  - Diplopia (double vision)



- **S**lurred speech
  - Dysarthria (difficulty speaking)
  - Impaired speech
- **S**hortness of breath
  - Respiratory muscles involvement
  - Respiratory difficulty

PRIORITY INTERVENTION (5As):

- **A**irway precaution
- **A**spiration precaution
- **A**mbulation
- **A**llow rest
- **A**ssess vision

COMPLICATIONS

- **Myasthenic Crisis**
  - Severe form of myasthenia gravis
  - **Too little acetylcholine** resulting to worsen muscle weakness
  - Respiratory failure due to the worsen level of acetylcholine
    - Ambu bag
    - Intubation
    - Ventilation
  - Worsen dysphagia
    - NGT
- **Cholinergic Crisis**
  - **Too much acetylcholine**
  - Overdose of medication
  - The remaining receptors that is not occupied by the antibodies gets overstimulated due to too much free floating or available acetylcholine (e.g. There are five receptors of which three are occupied by the antibodies, the remaining two receptors will be stimulated nonstop by the acetylcholine eventually causing the receptors to get tired resulting to the inhibited function)
  - Same signs and symptoms to the myasthenic crisis

DIAGNOSTIC TEST

- **Tensilon Test** *aka* **Edrophonium Test**
  - The diagnostic test to know the cause between myasthenic crisis or cholinergic crisis
  - A medication known as **anticholinesterase medications**; what it does is that it tries to increase ACh
  - Short and rapid-acting anticholinesterase drug simply used to diagnose myasthenia gravis and to differentiate myasthenic crisis and cholinergic crisis
  - Edrophonium prevents breakdown of ACh
    - Tensilon is administered IV (2 mg first then 8 mg)
    - Positive tensilon test is observed as improvement in muscular strength and muscle weakness returns in 3 to 5 minutes
    - The client should not be informed that the medication is given to obtain true results
  - ***Cholinesterase*** is an enzyme that works by breaking down excess acetylcholine; in patient with myasthenia gravis we give anticholinesterase to prevent the breakdown of the neurotransmitter (as ACh is already low)
  - **TEST RESULT:**
    - In myasthenic crisis (too little ACh) → improve the condition
    - In cholinergic crisis (too much ACh) → worsen the condition
    - Administer **atropine sulfate** (anticholinergic drug) to stop cholinergic activity in patient with cholinergic crisis

INTERPROFESSIONAL COLLABORATIVE MANAGEMENT

- Assess swallowing and gag reflex before feeding the client to prevent aspiration

- Administer medications 20 - 30 minutes before meals to improve ability to swallow and prevent choking
- Administer medications at an exact time to prevent myasthenic crisis that results to respiratory distress
- Protect the client from falls due to muscle weakness
- Implement aspiration precaution
- Start meal with cold beverage to contract muscles of the throat and improve ability to swallow
- Promote adequate ventilation to relieve respiratory difficulty
- Avoid infections as infections may trigger exacerbations of MG
- Provide adequate rest with alternating activity
- **Plasmapheresis** involves separation of antibodies from the plasma to inhibit autoimmune response

PHARMACOLOGICAL MANAGEMENT

a. **Anticholinesterase** *or* **Acetylcholinesterase inhibitors (Cholinesterase inhibitors)**
   - Increasing ACh by preventing its breakdown; these medications transmit neuromuscular impulses by preventing the destruction of acetylcholine, therefore, there is increased muscle strength
   - Given before meal or any activity
   - Typically given in the morning
   - Peaks one hour after administration
     - Pyridostigmine (Mestinon)
     - Neostigmine (Prostigmin)
     - Rivastigmine
     - Ambenomium (Mytelase)

- **Nursing interventions for acetylcholinesterase inhibitors**
  - Monitor improvement of muscle strength and respirations
  - Observe the client for signs and symptoms of cholinergic crisis caused by overdosing of the drug - muscle weakness, increased salivation, sweating, tearing, and miosis
  - Have readily available on antidote for cholinergic crisis (Atropine Sulfate)
  - Encourage the client to wear Medic-Alert bracelet that indicates the health problem and the drug taken
  - Instruct the client to take the medication before meals for best drug absorption
  - Observe and report possible side effects and adverse reactions:
    - Nausea, vomiting, diarrhea, abdominal cramps
    - Increased salivation
    - Tearing
    - Miosis (constriction of pupils)
    - Possible hypertension

b. **Corticosteroids**
   - Given to suppress the immune system for anti-inflammatory effects

CAUTION!

- The following drugs should be avoided by the clients with MG:
  - Muscle relaxants
  - Barbiturates
  - Morphine sulfate
  - Tranquilizers
  - Neomycin

These drugs potentiate muscle weakness because of effect on myoneural junction

SURGICAL MANAGEMENT

- **Thymectomy** (surgical removal of the thymus gland)
- 25% of people with MG have been found to have thymoma (tumor of the thymus gland)
- The surgery achieves remission for 5 to 10 years

MAJOR COMPLICATIONS OF MYASTHENIA GRAVIS

A. MYASTHENIC CRISIS

- Undermedication or delayed medication
- Severe form of myasthenia gravis
- Too little acetylcholine resulting to worsen muscle weakness
- **Clinical manifestations**:
  - Sudden marked rise in BP due to hypoxia
  - Increased heart rate
  - Severe respiratory distress and cyanosis
  - Absent cough and swallowing reflex
  - Increased secretions, increased diaphoresis and increased lacrimation (tearing)
  - Restlessness, dysarthria
  - Bowel and bladder incontinence
- **Interventions for myasthenic crisis:**
  - Increased doses of cholinergics as long as the client responds positively to edrophonium treatment
  - Possible mechanical ventilation of respiratory muscle paralysis is acute

B. CHOLINERGIC CRISIS

- Excessive medication
- **The clinical manifestations**:
  - Weakness with difficulty swallowing, chewing, speakingand breathing
  - Apprehension, nausea and vomiting
  - Abdominal cramps and diarrhea
  - Increased salivation and secretions
  - Sweating, lacrimation, fasciculations, and blurred vision
- **Interventions for the patients with cholinergic crisis are as follows:**
  - Discontinue all cholinergic drugs until cholinergic effectsdecrease
  - Provide adequate ventilator support
  - Atropine 1 mg/IV may be necessary to counteract severe cholinergic reactions

SURVIVAL GUIDE FOR CLIENTS WITH MG

- Reschedule daily task to prevent weakness
- Secure "handicapped" parking sticker
- Frequent rest periods
- Have alarm clock available - to take medications on time this prevents myasthenic crisis
- Patch each eye alternately for diplopia (double vision)
- Start meal with cold beverage to contract muscles of the throat and prevent aspiration
- Avoid factors that affect respiratory functions and may cause respiratory infections:
  - Very hot or very cold weather
  - Aerosol, pesticides, cleaners.Alcohol, tonic water, cigarette smoke.

PARKINSON'S DISEASE

- Also known as **paralysis agitans**
- Neurodegenerative disease (neurons are affected) that affects movement sometimes referred as a **motor disorder** due to loss of **dopamine**
  - A degenerative disease that affects the extrapyramidal system (EPS) causing decreased dopamine production
- Dopamine is released by a dopaminergic neuron, in this diseases the neuron that produces dopamine degenerates and the cause is unknown leading to loss of dopamine
- **IMBALANCE OCCUR**
  - Normally ACh = Dopamine
  - ACh is an excitatory neurotransmitter (+) and Dopamine is an inhibitory neurotransmitter (-)
  - One counters the other
  - In Parkinson's disease: (↑) ACh [muscle contraction] and (↓) Dopamine [accuracy of movement and mood]
- > 60 years old onset

CLINICAL MANIFESTATION (TRAMPS MNEMONICS)

MOTOR SIGNS AND SYMPTOMS

- **T**remors
  - The initial sign e.g. pill rolling tremors, to and fro tremors of the head
  - Resting tremors (non-intention tremors) shaking are more severe when the client is not performing physical activities
  - Due to increased ACh and the decreased dopamine
- **R**igidity of muscles
  - Cogwheel rigidity and absence of arm swing when walking

- Due to decreased dopamine production
- Dopamine is a neurotransmitter that promotes muscle relaxation

- **A**kinesia (absence of muscle movement) *or* **bradykinesia** (slow muscle movement)
- **M**ask-like face
  - Flattened affect
- **P**ostural instability
  - Stooped posture
- **S**huffling gait
  - The characteristic gait of the client is shuffling, festinating gait
  - This is tiptoe walking, starting at a slow pace which keeps on increasing until the client assumes a running pace
  - The client is unable to stop until obstruction is met

MOOD SIGNS AND SYMPTOMS

- Labile mood
- Depression

- In Parkinson's disease, there is no intellectual impairment, no true paralysis, no loss of sensation

INTERPROFESSIONAL COLLABORATIVE MANAGEMENT

- Thickened liquid diet to soft diet for dysphagia
- Firm bed to prevent contractures
- Aspiration precaution; keep client in upright position when feeding
- Increase fluid intake and fiber in the diet to prevent constipation

PHARMACOLOGIC MANAGEMENT

a. **Anticholinergics**- reduce rigidity and some of the tremors in Parkinson's disease
   - Artane (Trihexyphenidyl)
   - Cogentin (Benztropine)
   - Akineton (Biperiden)
   - Kemadrin (Procyclidine)
   - Parsidol (Ethopropazine)
   - Norflex (Orphenadrine)

- **Nursing Interventions for Anticholinergic therapy**
  - Monitor VS, urine output and bowel sounds. Increased pulse rate, urinary retention and constipation are side effects of anticholinergics
  - Observe for involuntary movements
  - Advise the client to avoid alcohol, cigarette, caffeine and aspirin to decrease gastric irritation
  - **Prevent and relieve side effects of anticholinergics:**
    - Relieve dry mouth with hard candy, ice chips or sugarless chewing gum. Anticholinergics decrease salivation.
    - Suggest that the client use sunglasses in direct sun because of possible photophobia
    - Advise the client to void before taking the drug to minimize urinary retention
    - Advise the client to have routine eye examinations to determine the presence of increased intraocular pressure which indicates glaucoma. **Clients who have glaucoma should not take anticholinergics**.

b. **Dopaminergics**- these drugs improve muscle flexibility
   - Levodopa
   - Carbidopa with Levodopa (Sinemet)
   - Dopamine cannot cross blood-brain barrier
   - Levodopa, a precursor of dopamine can cross the blood-brain barrier
   - The enzyme ***dopa decarboxylase*** converts levodopa to dopamine in the brain. However, this enzyme is also found in the peripheral nervous system, thereby allowing 99% of levodopa to be converted to dopamine before it reaches the brain (1% reaches the brain). Therefore, a higher dose is required to achieve therapeutic effect of the drug. Because of high doses, many side effects occur including nausea, vomiting, dyskinesia, orthostatic hypotension, cardiac dyshythmias and psychosis.

- **Levodopa-Carbidopa (Sinemet)**
  - Drug of choice
  - Levodopa increases dopamine
  - Carvidopa works by protecting and preventing breakdown of dopamine
  - This medication darken secretions e.g. sweat, saliva, and urine
  - The medication should be taken on low protein diet (this is normal)
    - Protein decrease the absorption of the medication, as the body would always choose protein over the medication
  - Taken before meal (30 minutes -1 hour before)

- **Nursing Interventions in Carbidopa-Levodopatherapy**
  - Monitor the client's vital signs and ECG; orthostatic hypotension may occur.
  - Check for weakness, dizziness or syncope, which indicate orthostatic hypotension
  - Advise client to practice gradual change of position to prevent orthostatic hypotension
  - Inform the client that urine may discolor and will darken (reddish brown) with exposure to air. Perspiration may also be discolored. Both are harmless but clothes may be stained.
  - Symptoms of dyskinesia (impaired voluntary movement) may take weeks or months to be controlled
  - Advise client to avoid the following drugs:

a. Phenothiazines, pyridoxine (Vit. B6). Reserpine; these block the effects of Levodopa

b. Monoamine oxidase inhibitors (MAOI)
  - Marplan (Isocarboxacid)
  - Parnate (Tranylcypromine)
  - Nardil (Phenelzine)
  - MAOIs enhance norepinephrine activity
  - MAOIs + Carbidopa-Levodopa = Hypertensive crisis

c. Aldomet (methydopa). This potentiates effect of Carbidopa - Levodopa

  - Avoid the following foods when on Carbidopa-Levodopa therapy:
    - Vitamin B6- rich foods block effects of Levodopa e.g., tuna, pork, dried beans, salmon, beef liver
    - Tyramine-rich foods these foods may cause hypertensive crisis among clients on Levodopa therapy (these foods are proteins, aged, smoked and fermented)
      - Cheese
      - Cream
      - Yogurt
      - Coffee
      - Chocolate
      - Bananas
      - Raisins
      - Liver
      - Pickled herring
      - Sausage
      - Soy sauce
      - Yeast
      - Beer
      - Red wine
      - Italian green beans
  - Prevent and relieve the following side effects of Levodopa:
    - Nausea and vomiting
    - Orthostatic hypotension
    - Insomnia, Agitation
    - Mental confusion
    - Renal damage
  - Dopamine Agonists/ Antiviral Drugs. These medications in symptoms of Parkinsonism.act on the dopamine receptors and produce improvement
    - Symmetrel (Amantadine HCl)
    - Parlodel (Bromocriptine Mesylate)
    - Requip (Ropinirole HCl)
    - Antiviral / Dopamine Agonists

- **Nursing Intervention in dopamine agonists therapy**
  - Advise the client to report signs of skin lesions, seizures or depression (Amantadine)
  - Suggest to the client to report lightheadedness when changing positions (Bromocriptine)
  - Avoid alcohol
  - Advise client not to abruptly stop the drug without notifying the health care provider

- Other drugs for Parkinson's disease
  - **Monoamine oxidase-B inhibitor**- inhibits breakdown of dopamine, thus prolonging action of Levodopa
    - Eldepryl (Selegiline HCl)
  - **Catechol-O-methyltransferase (COMT) inhibitors**- when taken with Levodopa, increases the amount of Levodopa concentration in the brain
    - Tasmar (Tolcapone)
    - Comtan (Entacapone)

- **Aspiration pneumonia** is the common cause of death in Parkinson's disease
- As the disease progresses patient may also develop dysphagia and affects muscle for swallowing

PRIORITY INTERVENTION (5As):

- **A**irway precaution
- **A**spiration precaution
- **A**mbulation
- **A**llow rest
- **A**ssess vision

MEDICAL MANAGEMENT

- **Benztropine (Cogentin)**
  - Anti-acetylcholine to decrease tremors

-
- A neuromuscular disorder characterized by failure of transmission of nerve impulses at the myoneural junction
- A chronic disease of the neuromuscular junction in which an autoimmune process destroys a variable number of acetylcholine (ACh) receptors at the postsynaptic muscle membrane
- The hallmarks of the disease are fatigability and fluctuating muscle weakness of selected voluntary muscle distribution, particularly those innervated by motor nuclei of the brain stem (i.e., extraocular, mastication, facial, swallowing and speech)
- Patients experience periods of remission and exacerbation, and mild forms of the disorder exist
- MG may be caused by decreased functioning of acetylcholine receptor sites
- It is also associated with autoimmune disorders

PATHOPHYSIOLOGY

- Normally, a chemical impulse precipitates the release of acetylcholine from vesicles on the nerve terminal at the myoneural junction
  - The acetylcholine attaches to receptor sites on the motor endplate and stimulates muscle contraction
  - Continuous binding of acetylcholine to the receptor site is required for muscular contraction to be sustained
- In myasthenia gravis, antibodies directed at the acetylcholine receptor sites impair transmission of impulses across the myoneural junction, therefore, fewer receptors are available for stimulation, resulting in voluntary muscle weakness that escalates with continued activity
  - These antibodies are found in 85% of people with myasthenia gravis
  - Of people with myasthenia gravis, most have either thymic hyperplasia or a thymic tumor, and he thymus gland is believed to be the site of antibody production
  - In patients who are acetylcholine receptor antibody negative, other antibodies appear to target a protein in the myoneural junction
  - In most patients with MG, the thymus gland, which is usually inactive after puberty, continues to produce antibodies because of hyperplasia of the gland or because of tumors
  - It is believed that the thymus is a source of an autoantigen that triggers an autoimmune response in MG

• The clinical manifestations of MG are as follows:
" Muscle weakness associated with activity relieved by rest, c.g., dyspnea, dysphagia, decreased physical activity.
- Fatigue
- Ptosis, diplopia, strabismus
- Impaired speech

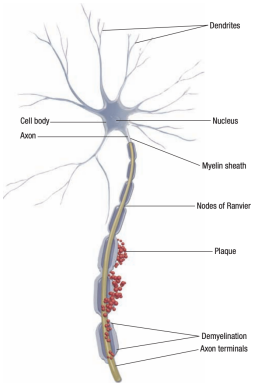
Snarl smile, mask-like facial expression

MULTIPLE SCLEROIS

- Also known as **disseminated sclerosis**
- An immune-mediated, progressive demyelinating (refers to destruction of myelin resulting in impaired transmission of nerve impulse), and scarring (**gliolis**) disease of CNS
- An autoimmune and neurodegenerative disease that is characterized by remissions and exacerbations
- The pathological hallmark of chronic MS is the demyelinated lesions or plaques which are sharply demarcated areas easily distinguishable from surrounding white matter
- Schwann's cells of the myelin sheath are destroyed, this results to interruption and distortion of impulse (slowed or blocked)
- **The four main clinical forms are:**
  - Remitting-relapsing multiple sclerosis (RRMS)
  - Secondary progressive
  - Primary progressive
  - Progressive-relapsing

PATHOPHYSIOLOGY

- Demyelination refers to the destruction of the myelin, the fatty and protein material that covers certain nerve fibers in the brain and spinal cord
- Demyelination results in disordered transmission of nerve impulses
- Inflammatory changes lead to scarring of the affected nerve fibers
- Cause is unknown but may possibly be related to autoimmune dysfunction, genetic susceptibility, or an infectious process
- More prevalent in the northern latitudes and among whites



FOUR MAIN CLINICAL FORMS OF MULTIPLE SCLEROSIS

A. REMITTING-RELAPSING (RR) MULTIPLE SCLEROSIS

- Clearly defined acute attacks evolve over days to weeks
- Partial recovery of function occurs over weeks to months

- Average frequency of attacks is once every 2 years and neurologic stability remains between attacks without disease progression
- **Characterized by periodic remission and exacerbation of manifestations**

B. SECONDARY PROGRESSIVE (SP) MULTIPLE SCLEROSIS

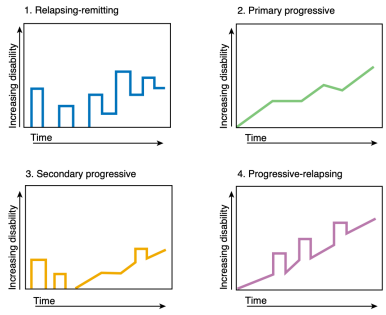
- Characterized by steady progression of disability from onset without exacerbations and remissions
- More prevalent among males and older individuals
- Worst prognosis for neurologic disability
- **Gradual deterioration with or without relapses**

C. PRIMARY PROGRESSIVE (PP) MULTIPLE SCLEROSIS

- Always begins as RR but clinical course changes with increasing relapse rate, with a steady deterioration in neurologic function unrelated to the original attack
- **Almost continuous neurologic deterioration from onset of manifestations**

D. PROGRESSIVE RELAPSING (PR) MULTIPLE SCLEROSIS

- The same as PP except that patients experience acute exacerbations along with a steadily progressive course (rarest form)
- **Gradual progression of neurologic deterioration with super-imposed relapses**



CLINICAL MANIFESTATIONS

- **S**canning Speech

CHARCOT'S NEUROLOGIC TRIAD

- **S**canning Speech
  - Due to the dysarthria (staccato speech) affecting also our speech
- **I**ntention tremors
  - Muscle weakness
  - Spasms
  - Ataxia
  - Paralysis
- **N**ystagmus
  - Cranial nerve 2 and 3 affected
  - C3 affected: Painful eye movement
  - C2 affected: Blurriness of vision and diplopia; this may worsen causing blind spot (scotoma) leading to vision loss due to the inflammation of the Optic nerve called **optic neuritis**

DIAGNOSTIC TESTS

- **MRI**
- **Lumbar puncture**

FOCAL ONSET SEIZURE

- Focal or partial seizures are thought to originate within a localized area of the brain

GENERALIZED ONSET SEIZURE

- Generalized seizures occur in and rapidly engage bilaterally distributed networks

UNKNOWN ONSET SEIZURE

- Unknown onset seizures can be described as "unclassified," so termed because of incomplete data surrounding the event, but they may also be described from their clinical features

A. PATHOPHYSIOLOGY

- Focal or partial seizures are thought to originate within a localized area of the brain

-------- END OF TRANSCRIPTION --------