The Nervous System

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1

PURPOSE

- Why I decided to do this program?
- What is ultimate purpose of coming to these lectures?
- We often answer rationally, broken down in details
- Ultimately how we RESPOND is greatly dependent on nervous system and neurotransmitter balance
- The response is not only superficial "feel good" moment
- Researchers have found that lawyers have the highest incidence of depression in the US. Nearly one in five attorneys suffers from alcohol or substance abuse. They often ignore the early warning signs. Psychology Today, May 2, 2011
- Yale Law professor's study says rates of **mental health** problems among **lawyers** are in line with **doctors**, dentists, and veterinarians

2

SATISFIED MIND

How many times have you heard someone say
"If I had his money, I could do things my way?"
But little they know that it's so hard to find
One rich man in ten with a satisfied mind

Money can't buy back your youth when you're old
Or a friend when you're lonely, or a love that's grown cold
The wealthiest person is a pauper at times
Compared to the man with a satisfied mind

When life has ended, my time has run out
My friends and my loved ones, I'll leave, there's no doubt
But there's one thing for certain, when it comes my time
I'll leave this old world with a satisfied mind

Death and Life… topic I discuss with everyone

3

SATISFACTION

"There are some days when I think I'm going to die from an overdose of satisfaction"

- Salvador Dali

4

LOVE LETTER

There is an extremely powerful force that, so far, science has not found a formal explanation to. It is a force that includes and governs all others, and is even behind any phenomenon operating in the universe and has not yet been identified by us.

This universal force is LOVE.

When scientists looked for a unified theory of the universe they forgot the most powerful unseen force.

Love is Light, that enlightens those who give and receive it.

Love is gravity, because it makes some people feel attracted to others.

Love is power, because it multiplies the best we have, and allows humanity not to be extinguished in their blind selfishness. Love unfolds and reveals.

This force explains everything and gives meaning to life.

For love we live and die.

5

HOW MUCH DO WE KNOW

Neurotransmitters: Elusive glutamate receptors

- Current Biology, Volume 4, Issue 1, 1 January 1994,

Mapping neurotransmitter systems to the structural and functional organization of the human neocortex, 27 October 2022

- Neurotransmitter receptors support the propagation of signals in the human brain. How receptor systems are situated within macro-scale **neuroanatomy** and how they shape emergent function **remain poorly understood**, and there exists no comprehensive atlas of receptors.
- https://www.nature.com/articles/s41593-022-01186-3#author-information

6

NS – A LARGE PICTURE

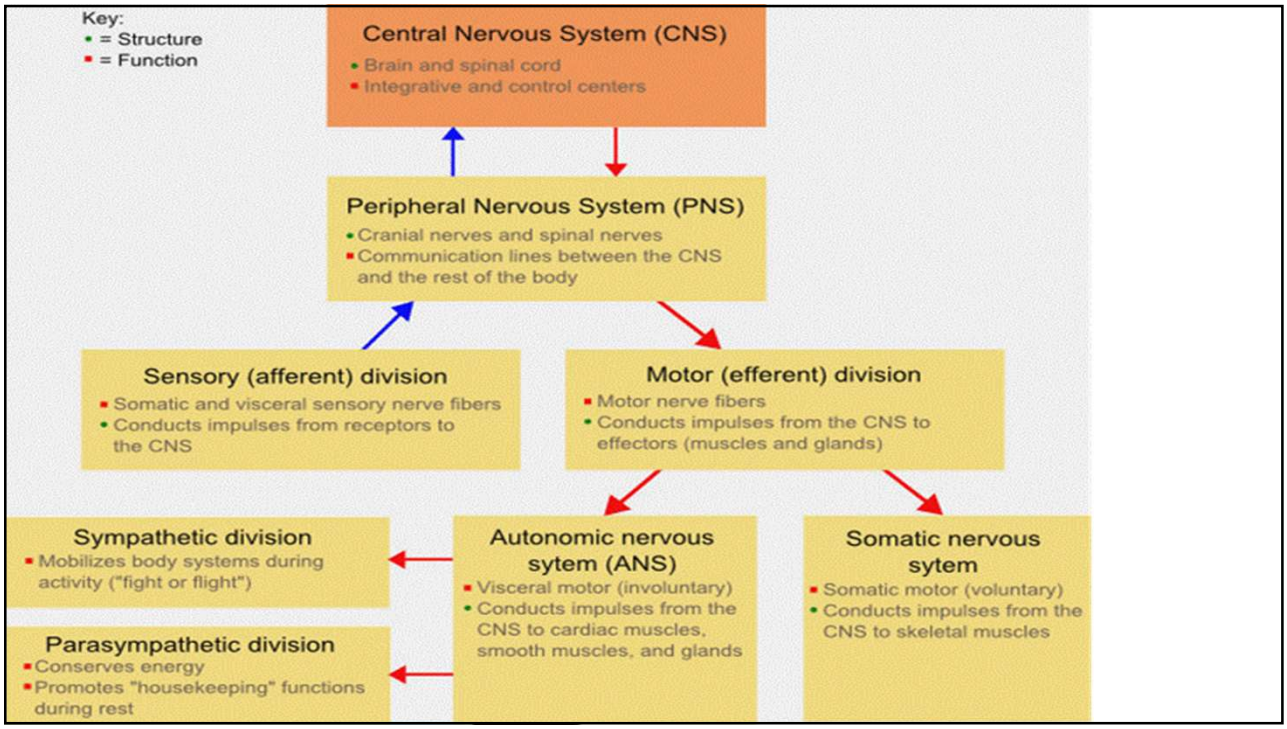
- The nervous system is a **CONTROL SYSTEM.** Most authors use analogy of a computer or electrical wiring. I believe it's more accurate that the computer is patterned to be similar to nervous system.
- **BRAIN** - similar to the software, responsible for making decisions
- **NERVES** - the hardware or wiring that communicates those decisions with the rest of the body.

7

FOUR FUNCTIONS OF NS

- **1. Control of body's internal environment to maintain HOMEOSTASIS**
  An example of this is the regulation of body temperature.
- **2. Programming of spinal cord REFLEXES**
  An example of this is the stretch reflex. This reflex functions to protect us from injury.
- **3. MEMORY and learning**
  You didn't learn to read or write overnight did you? New movements, especially complex ones, take time for the nervous system to learn.
- **4. VOLUNTARY CONTROL of movement**
  Every voluntary movement that a person performs is under the direct control of the nervous system as the nervous system sends the messages to the particular body parts to move

8



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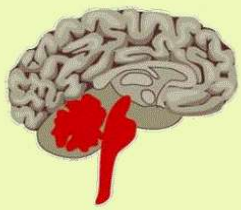
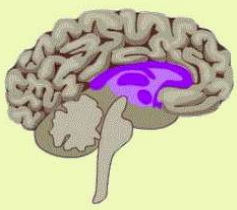
TRIUNE BRAIN

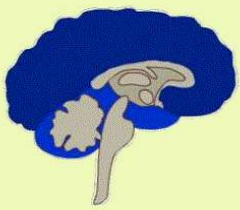
The Three-Parted Brain



Lizard Brain
(Brain stem and cerebellum)
Autopilot
Fight & Flight



Mammal Brain
(Limbic System)
Emotions
Memories
Habits
Attachments



Human Brain
(Neo-Cortex)
Language, abstract thought, imagination, consciousness, reasoning, rationalising

(From Paul D. MacLean's model of the "Triune Brain")

Dr. Sapolsky book "Determined"

Comes to conclusion that human beings have **no free will**

10

Lizard/reptilian brain?

- Lizards and humans share similar brain parts, which they inherited from fish. These parts handle basic body functions like breathing, balance, and coordination, and simple survival urges like feeding, mating, and defense. Together, these parts--the brain stem, cerebellum, and basal ganglia--are casually referred to as your "lizard brain."

11

NOT TRIUNE BRAIN

- The Brain Is Adaptive Not Triune: How the Brain Responds to Threat, Challenge, and Change – FRONTIERS IN PSYCHIATRY
- **Theory impacts how research is conducted.** A popular theory used to conceptualize brain functioning is the triune brain theory. The triune brain theory is an evolutionary theory of brain development that emphasizes three key brain regions consisting of the brainstem, the limbic system, and the cortex that function relatively independently in coping with stress via fight or flight, emotion, and cognition, respectively. However, **modern neuroscience research demonstrates that the triune brain theory does not accurately explain how the brain functions in everyday life** or during the stress response. Specifically, **emotion and cognition are interdependent** and work together, the limbic system is not a purely emotional center nor are there purely emotional circuits in the brain, and the cortex is not a purely cognitive center nor are there purely cognitive circuits in the brain.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9010774/

12

SECTION I
CNS COMPONENTS: 1. BRAIN

The brain has three main parts:

The **cerebrum** fills up most of your skull. It is involved in remembering, problem solving, thinking, and feeling. It also controls movement.

The **cerebellum** sits at the back of your head, under the cerebrum. It controls coordination and balance.

The **brain stem** sits beneath your cerebrum in front of your cerebellum. It connects the brain to the spinal cord and controls automatic functions such as breathing, digestion, heart rate and blood pressure.

13

THE GLYMPHATIC SYSTEM

- **The glymphatic system** is a "pseudo-lymphatic" perivascular network distributed throughout the brain, responsible for replenishing as well as cleansing the brain. Glymphatic clearance is the macroscopic process of convective fluid transport in which harmful interstitial metabolic waste products are removed from the brain intima.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7698404/
- OMEGA 3, EXERCISE
https://www.frontiersin.org/journals/neurology/articles/10.3389/fneur.2022.885020/full
- NAC
- N-acetylcysteine decreases malignant characteristics of glioblastoma cells by inhibiting Notch2 signaling
- https://pubmed.ncbi.nlm.nih.gov/30606241/

14

MSM brain waste removal

- MSM
- Methylsulfonylmethane, or MSM, is an organic compound that contains biologically active sulfur. This is important because sulfur is the fourth most plentiful mineral in the human body, and it's necessary for many critical bodily functions—including detoxification.
- In our bodies, MSM helps facilitate the detoxification process by making cells more permeable, which helps to release built up heavy metals, waste and toxins, while also making it easier for nutrients and water to enter the cells and continue the cleansing process. The sulfur contained in MSM is also an important factor in the production of glutathione, the body's "master antioxidant" and potent detoxifier.

15

BRAIN glymphatic system

- Antioxidants in brain tumors: current therapeutic significance and future prospects
- https://molecular-cancer.biomedcentral.com/articles/10.1186/s12943-022-01668-9
- N-acetylcysteine decreases malignant characteristics of glioblastoma cells by inhibiting Notch2 signaling
- https://jeccr.biomedcentral.com/articles/10.1186/s13046-018-1016-8
- https://www.science.org/content/blog-post/n-acetyl-cysteine-warning-shot
- https://pubmed.ncbi.nlm.nih.gov/17450321/

16

NEUROGENESIS & NEUROPLASTICITY

NEUROGENESIS

- Formation of new neurons, especially important in instances of injury or illness. It was believed neurons decline drastically after birth. New studies are now showing that neurogenesis takes place throughout our lifetime and simply slows down as we age.

NEUROPLASTICITY

- Brain's own ability to reorganize itself by creating new connections.
- Neurogenesis and neuroplasticity refer to entirely different concepts that often act independent of each other.

17

NEUROGENESIS

- **Neurogenesis in the Hippocampus**
- During the late 1990s, researchers at Rockefellers University in New York City conducted studies in which marmoset monkeys were injected with a tracer chemical that could differentiate between slow-dividing mature brain cells and fast-dividing new ones.1
- They found that the hippocampus (a brain region associated with memories, learning, and emotions) continued to create new cells without the constraint of age or time.
- Later studies using carbon-14 dating (which evaluates the age and process of cellular development) confirmed that cells in the hippocampus, while continually dying, were quickly replaced by new ones. It is only by the formation of these cells that the hippocampus can maintain its central functions.2

18

BRAIN AGING PREVENTION

- Curcumin anti-oxidative property, prevents rapid aging of the brain
- Caloric restriction diet can influence brain plasticity and preclude the decline of memory.
- Exercise can increase brain-derived growth factor (BDGF), vascular endothelial growth factor (VEGF0)
- With the same intensity and time duration of exercise, resistance training did not increase in BDGF in the long run, whereas running and aerobic exercise significantly improved BDGF
- Synapsin one, and tyrosine kinase activity that can expand the size of the brain, enhance the plasticity and neurogenesis.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7586385/

19

NEUROGENESIS – BDNF

- **Exercise-Mediated Neurogenesis in the Hippocampus via BDNF**
- Exercise is known to have numerous neuroprotective and cognitive benefits, especially pertaining to memory and learning related processes. One potential link connecting them is exercise-mediated hippocampal neurogenesis, in which new neurons are generated and incorporated into hippocampal circuits.
- https://www.frontiersin.org/journals/neuroscience/articles/10.3389/fnins.2018.00052/full

20

NEUROPLASTICITY

- Brain constantly thinks negative thoughts about the future and has a negative bias. The bias and discernment developed because it made man more cautious and safer
- Past research shows that people who maintain an optimistic attitude live longer and lead healthier lives than those who do not. The study suggested that being positive-minded can increase the likelihood of seeing your **85th birthday**. This is because optimistic attitudes can lead to better decisions, which leads to better overall health.
- Some studies have shown that positive thinking can reduce the risk or severity of illness and boost your **immune system**. These studies link psychological stress to immune changes brought by stress, where there is existing vulnerability, such as HIV infection.
- Furthermore, positive thinking has been shown to magnify the effects of **serotonin, dopamine, and endorphins** in our brains, which is especially helpful in reducing depression.
- One of the most important benefits of practicing positive thinking is that, when you consciously practice it, it actually becomes a **habit** over time and eventually can even become your new natural reaction to negative or difficult situations

21

NEUROPLASTICITY

- You can CHANGE YOUR MIND
- Think of other people and what you like and love about them
- The most difficult people, God loves them… what does He love about them?
- Think of you in terms of potential who you can become, as SEE YOURSELF as you are already there.
- People who are ILLOGICALLY STUBBORNLY POSITIVE, USUALLY SUCCEED
- Neuroplasticity: The Power of Positive Thinking and the Fascinating Ability of the Brain to Change Itself.
- NEUROPEPTIDES can modulate the activity of co-released neurotransmitters to either increase or decrease the strength of synaptic signaling. Within the periphery, neuropeptides can function similar to peptide hormones and modulate nearly all bodily functions.

22

SYNAPSINS, TYROSINE KINASE

SYNAPSIN

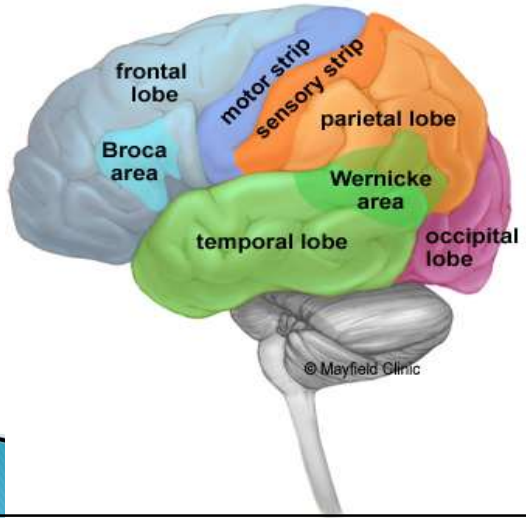
- Synapsins belong to a class of neuron-specific phosphoproteins and comprise ~1% of the total brain proteins, making them one of the most abundant families of synaptic proteins. They have been recognized to be significantly involved in synaptogenesis and neuronal plasticity, including the regulation of synapse development, modulation of neurotransmitter release, and formation of nerve terminals
- Synapsin genes have been associated with several neurological disorders such as schizophrenia, bipolar disorder (BD), AD, MS, Huntington's disease (HD), and epilepsy, as demonstrated by both genetic and functional studies.

TYROSINE KINASE

- A tyrosine kinase is an enzyme that can transfer a phosphate group from ATP to the tyrosine residues of specific proteins inside a cell. It functions as an "on" or "off" switch in many cellular functions.
- Tyrosine kinases belong to a larger class of enzymes known as protein kinases which also attach phosphates to other amino acids such as serine and threonine. Phosphorylation of proteins by kinases is an important mechanism for communicating signals within a cell (signal transduction) and regulating cellular activity, such as cell division.

23

Lobes of the brain



24

GUT – BRAIN relationship

- Microbiome is intricately and powerfully connected to the function of the brain.
- Where is actually a decision made? Who is the boss?
- Mystery about this connection.
- Gut often referred as the SECOND BRAIN

25

SECTION I

CENTRAL NERVOUS SYSTEM (CNS)

COMPONENTS

2. SPINAL CORD - 31 segments. A pair of spinal nerves come out of each segment. Both motor and sensory nerves are located in the spinal cord.

They **INTEGRATE INFORMATION** from the peripheral nervous system and respond automatically or make **decisions on actions** that should be taken. CNS acts as the 'head office' of the body, it works consciously and subconsciously to control all activities within the body.

26

CNS COMPONENTS

3. THE MENINGES: three layers of **membranes** that cover the brain and the spinal cord. The outermost layer is the **dura mater**. The middle layer is the **arachnoid**, and the innermost layer is the **pia mater.** The meninges offer protection to the brain and the spinal cord by acting as a barrier against bacteria and other microorganisms.

4. The cerebrospinal fluid (CSF) circulates around the brain and spinal cord. It protects and nourishes the brain and spinal cord.

27

CNS COMPONENTS

5. MYELIN: The fatty layer of extracellular connective tissue which covers nerve axons. It provides insulation and promotes nerve transmission along the nerve axon in the brain and in the periphery. The brain is reliant on **healthy fatty acid balance for myelin and for nerve membrane function**.

Nutrients: EFA, antioxidants (esp. fat soluble)

28

CNS COMPONENTS

6. GLIALS:

- The connective tissue cells of the brain.
- Do not produce electrical impulses
- 10 times more glials than nerve cells.
- Types: Astrocytes, Microglia, Oligodendrocytes.

Function:

- Structural support for the nerve cells
- Regulatory control
- Nutrient delivery
- Waste removal
- Myelin production and distribution
- Immunity
- Neurodegenerative disorders are often diseases of the glial cells

29

NEURONS

- The neuron is the basic unit in the nervous system, found in the brain, spinal cord and the peripheral nerves. It acts as a **conductor** responsible for the transport and uptake of neurotransmitters - chemicals that relay information between brain cells.
- Depending on its location, a neuron can perform the job of a sensory neuron, a motor neuron, or an interneuron, sending and receiving specific neurotransmitters.

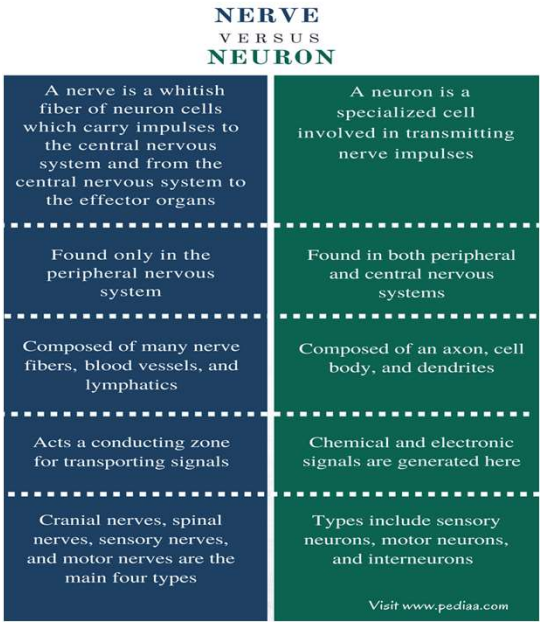
- 3 parts of the neuron:
  - Cell body
  - Dendrites (carry a nerve impulse into the cell body)
  - Axon (carries impulses away from the cell body to another neuron or tissue)

30

NERVE vs NEURON

- They sound similar but are different. Nerves are actual projections of neurons.
- Neuron is an individual specialized cell which are primarily involved in transmitting information through electrical and chemical signals. Neuron is also known as the nerve cell. There are two types of neurons – sensory neurons and motor neurons. A group of neurons form a nerve.
- Nerve is an enclosed, cable-like bundle of axons and nerve fibers found in the peripheral nervous system. There are three types of nerves **autonomic nerves, motor nerves, and sensory nerves.**

31



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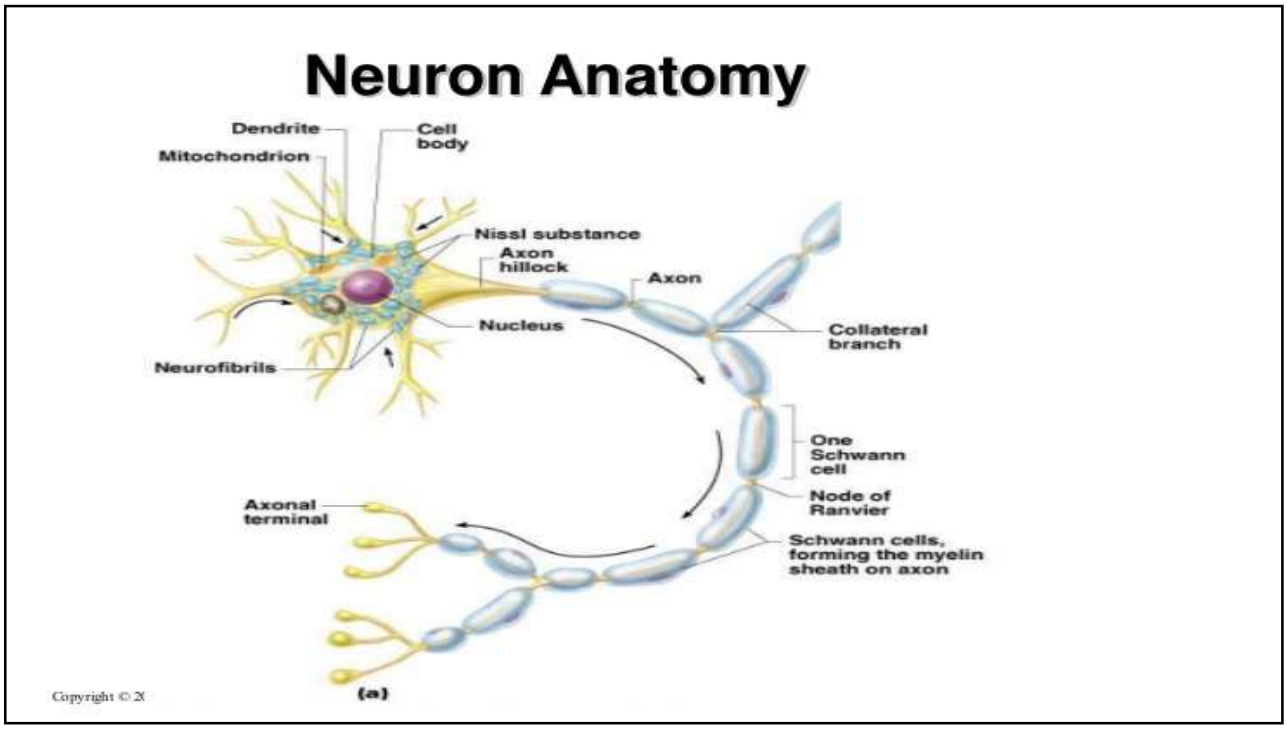


33

ARABINOGALACTANS

Allergy-Protective Arabinogalactan Modulates Human Dendritic Cells via C-Type Lectins and Inhibition of NF-Kb

Protection of the brain through supplementation with larch arabinogalactan in a rat model of vascular dementia

- The results of this study support our hypothesis that cell wall polysaccharides consisting of arabinose are effective at protecting white matter injury, regardless of their origin. Moreover, LAG has the potential for development as a functional food to prevent vascular dementia.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5621360/
- Nutrition research and practice, 2007

34

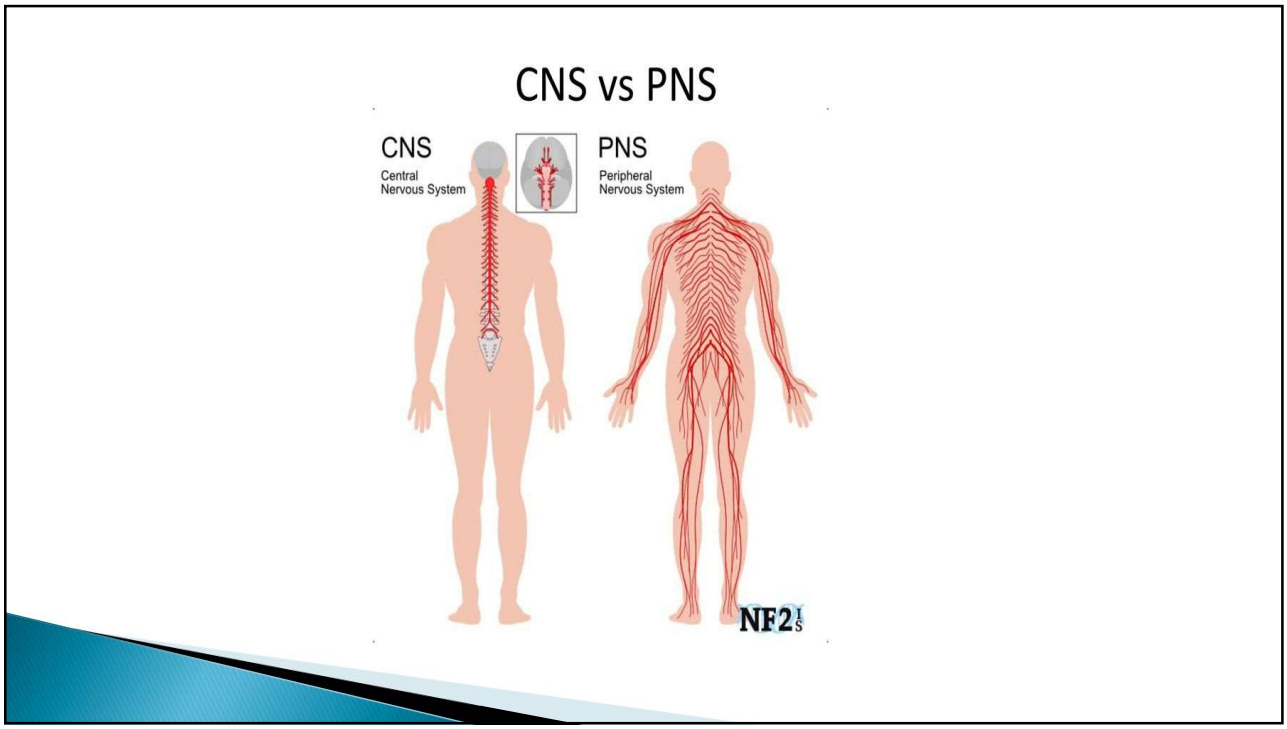
NEURAL CONNECTIONS

- Neurons send signals to other cells through axons
- Causes neurotransmitters to be released at synapses'
- Over 100 trillion neural connections in the average brain; the number and location can vary. Proceedings of the National Academy of Sciences, Jan 2018: out of the 160 participants studied, the brains of **highly creative people have more connections among three specific regions of the brain than less creative thinkers.**
- https://www.livescience.com/61428-brain-connections-creativity.html

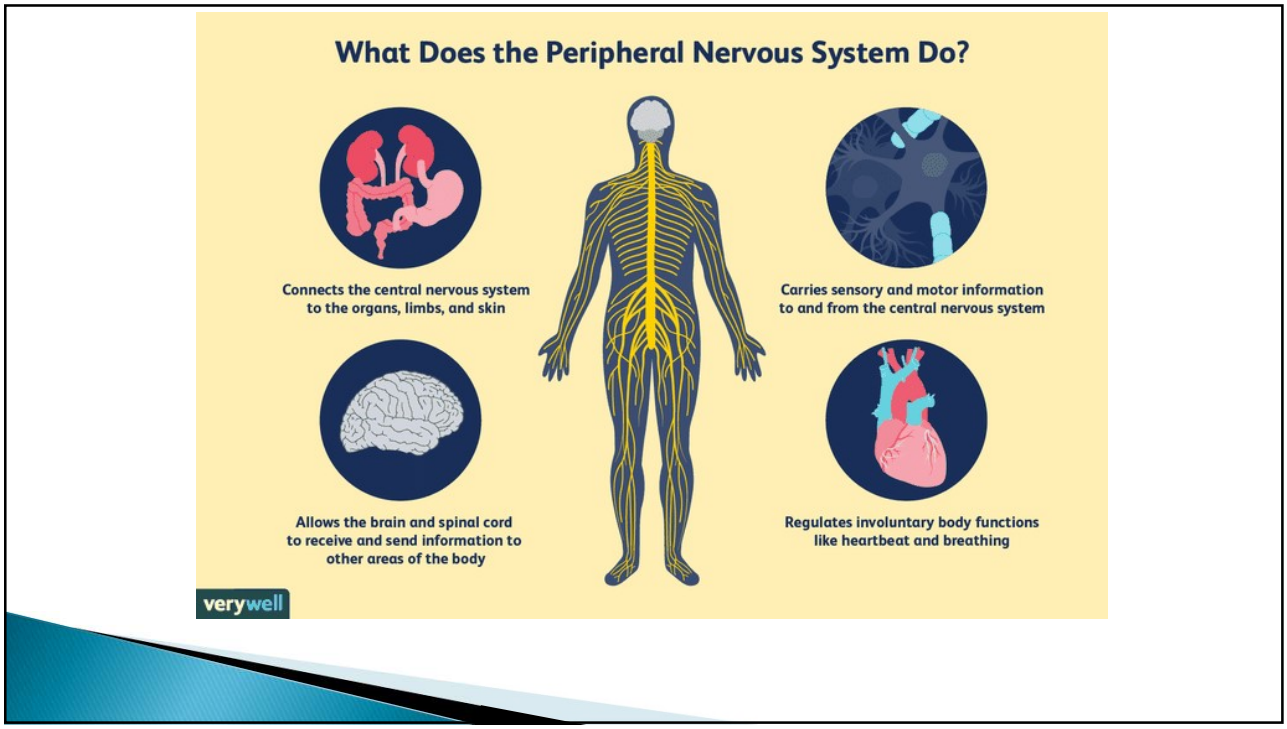
35

- "You have these three different systems that are all located in different parts of the brain, but they are all co-activated at once," said lead study author Roger Beaty, a postdoctoral fellow studying cognitive neuroscience at Harvard University. "People who are **better able to co-activate them [came] up with more-creative responses**."
- A synapse gives a command to the cell and the entire communication process typically takes only a fraction of a millisecond. Signals travel along an alpha motor neuron in the spinal cord **268 mph** (431 km/h); the fastest transmission in the human body, according to Discover magazine.

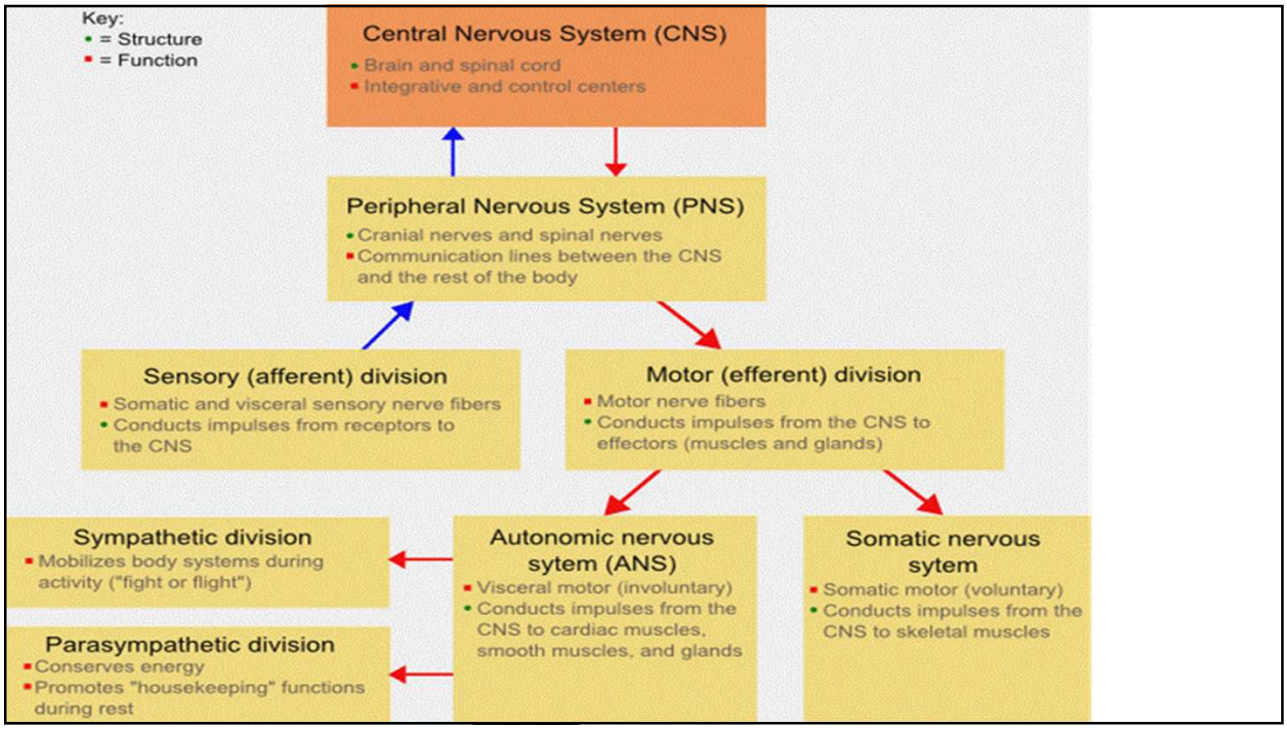
36


CNS vs PNS
CNS
Central
Nervous System
PNS
Peripheral
Nervous System
NF2

37


What Does the Peripheral Nervous System Do?
Connects the central nervous system to the organs, limbs, and skin
Carries sensory and motor information to and from the central nervous system
Allows the brain and spinal cord to receive and send information to other areas of the body
Regulates involuntary body functions like heartbeat and breathing
verywell

38



39

SECTION II

PERIPHERAL NERVOUS SYSTEM (PNS)

1. SENSORY-SOMATIC NS
2. AUTONOMIC NS

40

SENSORY-SOMATIC NS

- The sensory-somatic nervous system is made up of **cranial and spinal nerves** and contains both **sensory** and **motor** neurons.
- **Sensory neurons** transmit sensory information from the skin, skeletal muscle, and sensory organs to the CNS.
- **Motor neurons** transmit messages about desired movement from the CNS to the muscles to make them contract. Without its sensory-somatic nervous system, an organism would be unable to process any information about its environment (what it sees, feels, hears, and so on) and could not control motor movements.
- Unlike the autonomic nervous system, which has two synapses between the CNS and the target organ, sensory and motor neurons have only one synapse—one ending of the neuron is at the organ and the other directly contacts a CNS neuron. **Acetylcholine** is the main neurotransmitter released at these synapses.
- Humans have **12 cranial nerves**, nerves that emerge from or enter the skull (cranium), as opposed to the **spinal nerves**, which emerge from the vertebral column.

41

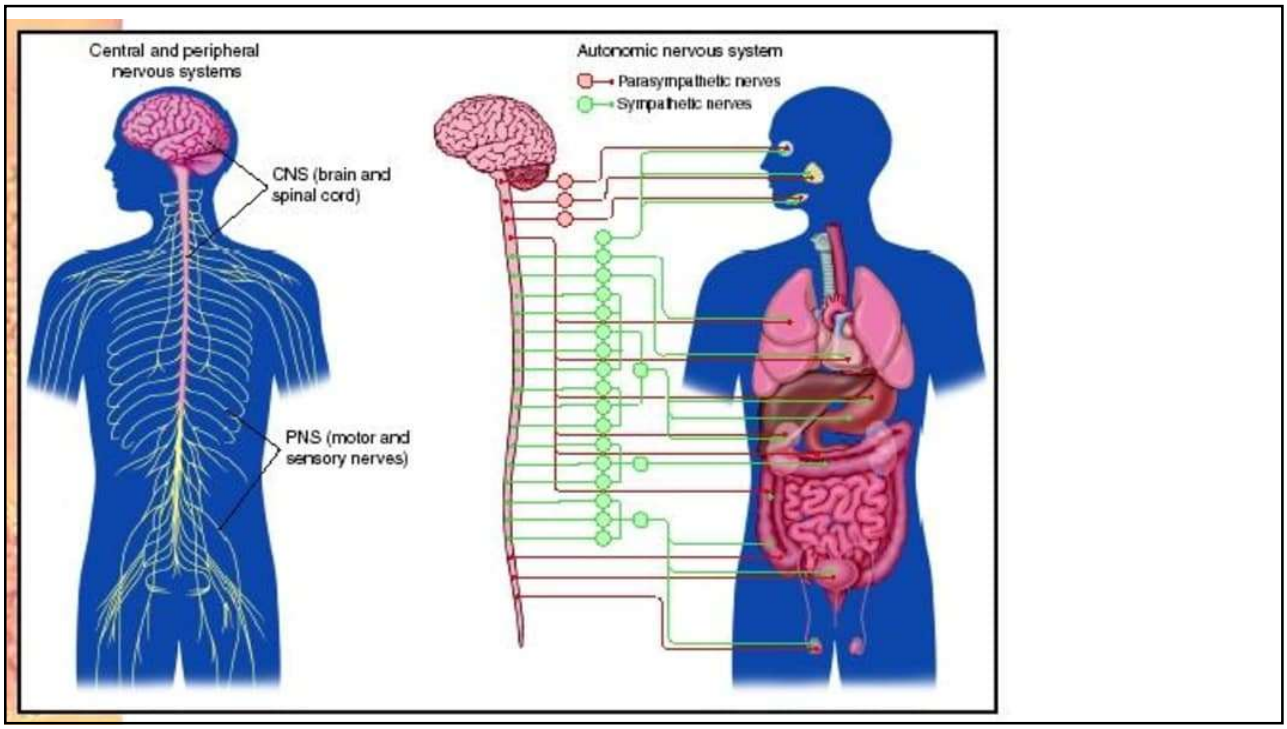
AUTONOMIC NS

- Controls the involuntary/unconscious activities, which regulate the organs, glands, circulation, smooth muscle activity and visceral responses.

1. PARASYMPATHETIC nerves promote “rest and digest” function; vegetative state. Parasympathetic ganglions throughout the body and near innervated organ

2. SYMPATHETIC promotes the “fight-or-flight” response and arousal of the NS. Sympathetic ganglions are along the spine.

42

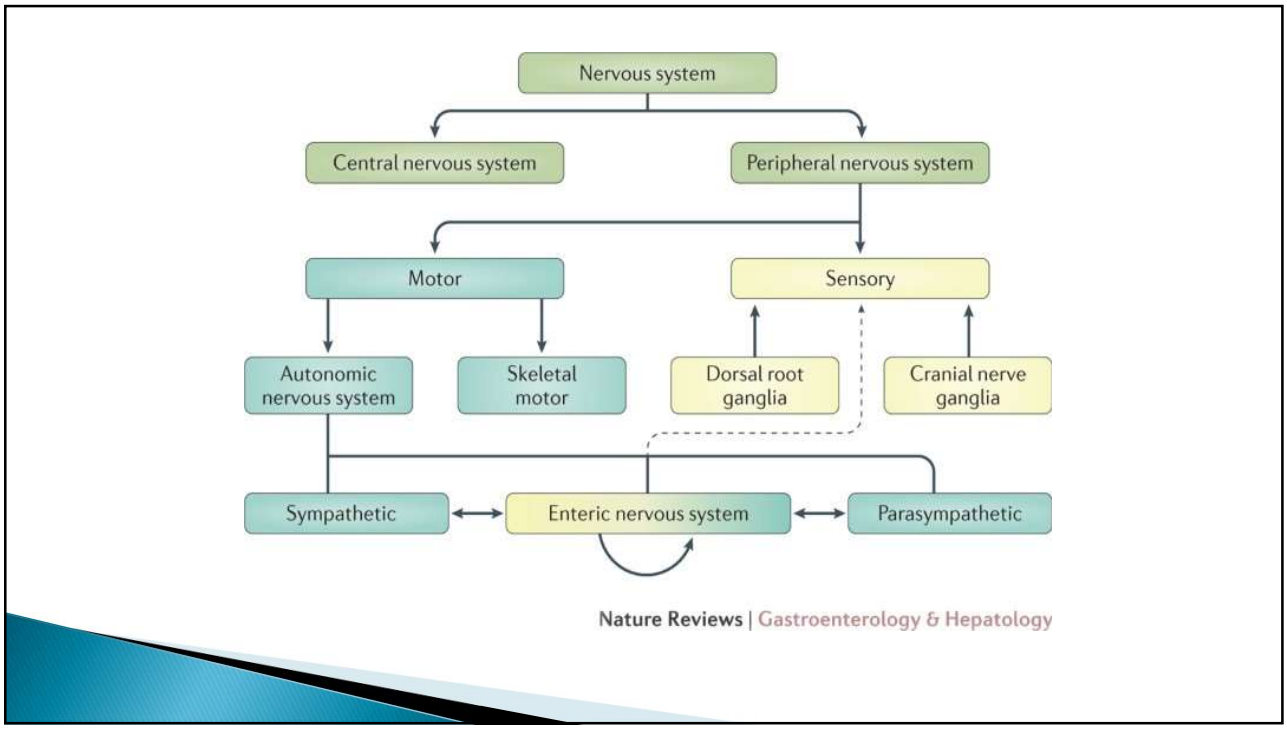


43

ENTERIC NERVOUS SYSTEM (ENS)

- ENS is a coprocessor to the CNS, which controls digestive system.
- The enteric **nervous system** (**ENS**) is a **quasi** autonomous part of the **nervous system** and includes a number of neural circuits that control motor functions, local blood flow, mucosal transport and secretions, and modulates immune and endocrine functions.
- Receives input from Parasympathetic vagus nerve CN10

44



45

NUTRITION AND BBB

- A FUNCTIONAL BARRIER between the blood and the CNS. Composed of astrocytes and the endothelial wall of the capillaries found in the arachnoid layer of the meninges.
- The endothelial cells forms tight junctions to control many substances from entering the brain. Astrocytes provide nutrients, remove waste.
- BBB can become too constricted or too porous. The brain can also harbor microorganisms, viruses, parasites, toxins.

46

BRAIN NUTRITION – GENERAL

- Fats, carbohydrates, protein, Fiber
- Water, low surface tension, deuterium free
- IAG
- MSM
- Probiotics
- BioGlycozyme Forte multi 2=3 daily F
- Tyrosine
- Phytonutrients,
- Glandular tissues, Cytozyme B etc
- BIOMEGA 1000
- Phosphatidyl Serine, choline

47

SYMPATHETIC DOMINANCE

- BIO GGG-B 2-4
- Phosphatidylserine 1-2
- Phosphatidylcholine 2-4
- TAURINE 1-2
- DE-STRESS 1-2
- BIO CMP
- Mg Zyme
- Li Zyme Forte
- Mn Zyme

48

PARASYMPATHETIC DOMINANCE

- BIO 3BG 2-4
- Super Phosphozyme 1-2 bid
- L-Tyrosine 1-2
- DHEA
- Bio Drive 2-4
- Cytozyme AD

49