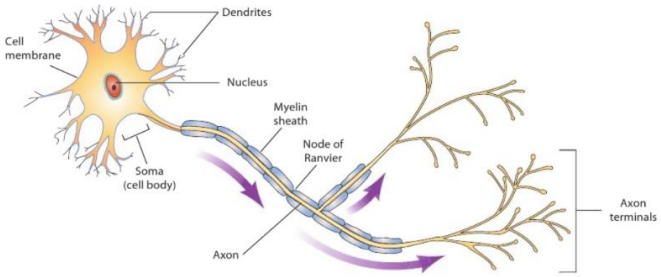
BIOLOGICAL BASES OF MENTAL LIFE AND BEHAVIOUR

- **NEURONS:** are the basic building blocks of the nervous system. They generate electricity that creates nerve impulses and release chemicals (neurotransmitters) that allow them to communicate with other neurons, muscles or glands
- **NERVES**: a group of neurons is called a nerve
- **ANATOMY OF A NEURON**: the neuron consists of 5 main parts.



    1. *CELL BODY*: contains nucleus enclosed in a neuronal membrane
    2. *DENDRITES*: fibers that receive signals from other neurons and can carry those signals to the cell body.
    3. *AXON/AXON TERMINALS:* each neuron has one or more axons that carry signals away from cell body to other neurons, muscles, glands and other parts of the body. Some are short, and some are very long.
    4. *MYELIN SHEATH:* a sheet of white, fatty insulation that surrounds the axon. It makes neural transmissions move more efficiently.
    5. *SYNAPSE*: the space between 2 connecting neurons. Through neurotransmitters, it is possible to send messages from one neuron to the other.

THE ELECTRICAL ACTIVITY OF NEURONS

- **ENVIRONMENT/IONS:** the chemical environment inside the neurons differs from external environment. Ions are electrically charged atoms. In the salty fluid ***outside*** *the neuron there are positively charged sodium ions and negatively charged chloride ions.* ***Inside*** the neuron are largely *negatively charged protein molecules and positively charged potassium ions*.
- **RESTING POTENTIAL:** The internal difference of around 70 mV between the ions outside and inside of neuron. At rest, the neuron is said to be in a state of ***POLARISATION*** (i.e. it has an electrical polarity).
- **ACTION POTENTIAL:** a nerve impulse - which lasts about a millisecond and instantly changes the interior c=voltage of a neuron from -70mV to +40mV. The basic steps of an action potential include:
    1. In the resting state, the neuron's sodium and potassium channels are closed, and the concentration of sodium is 10x higher outside the neuron than inside.
    2. When the neuron is stimulated sufficiently nearby sodium channels open up.
    3. Attracted by the negative protein ions inside, positively charged sodium ions come into the axon, creating a state of DEPOLARISATION.
    4. The interior now becomes positively charged in relation to outside = action potential.

5. To restore to resting potential, the cell closes its sodium channels and positively charged potassium ions flow out of the neuron, and, the escaped potassium ions are recovered.

- **ABSOLUTE REFRACTORY PERIOD**: the membrane is not excitable and cannot discharge another impulse.
- **ALL-OR-NOTHING LAW:** action potentials occur at a uniform and maximum intensity or they do not occur at all.
- **ACTION POTENTIAL THRESHOLD:** for an action potential to occur, the negative potential inside the axon must be changed from -70mV to about -50mV by the influx of sodium ions in the axon because an action potential will be triggered.
- **GRADED POTENTIALS**: changes in the negative resting potentials that do not reach -50mV action potentials. They do not cause an impulse to occur as they are not strong enough.

Concept CHECK

- A neuron is a specialised cell in the nervous system that can receive (through receptors on dendrites and the cell body), initiate (in the cell body), and propel (along an axon, typically myelinated to speed up the process) nerve impulses or action potentials.

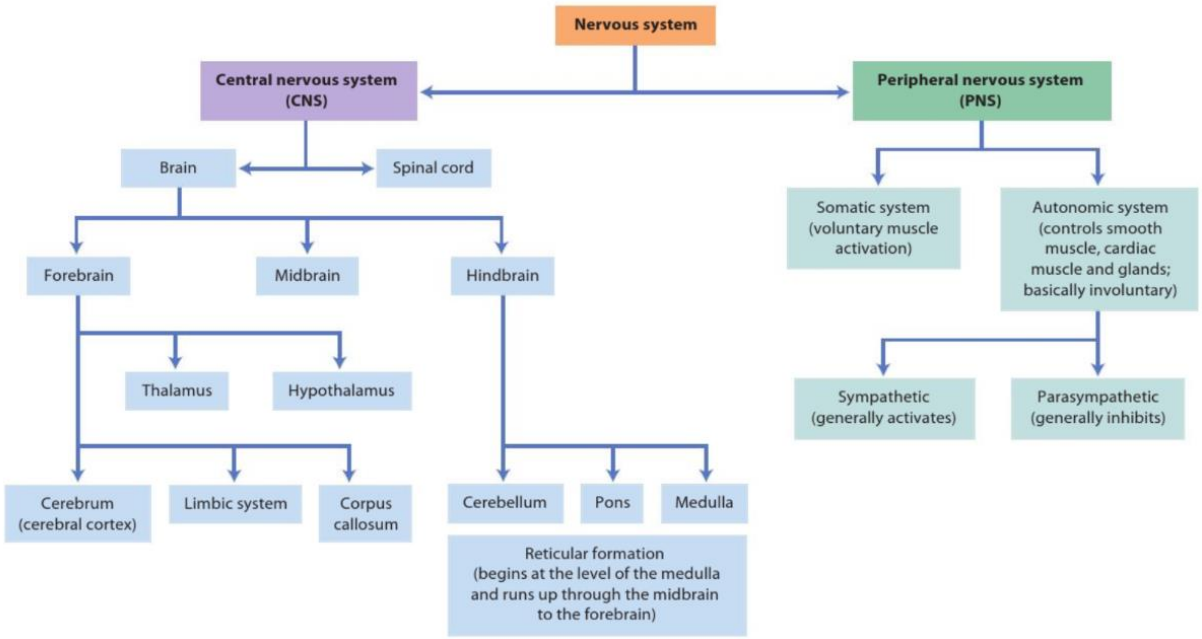
HOW NEURONS COMMUNICATE: SYNAPTIC TRANSMISSION

- **WHAT**: the nervous system operates as a giant communication network and its action requires the transmission of nerve impulses from one neuron to another.
- **SYNAPTIC SPACE**: a tiny gap between the axon and the next neuron.
- NEUROTRANSMITTERS: are chemical substances that carry messages across the synaptic space to other neurons, muscles or glands. This involves 5 stages:
    1. Synthesis
    2. Storage
    3. Release
    4. Binding
    5. Deactivation
- **DOPAMINE:** what is dopamine:
    1. *Is an excitatory neurotransmitter. That is, when it binds to the receiving side of another neuron, it opens up sodium channels to the reviewing neurons causing graded or action potentials.*
    2. *It is involved in voluntary movement, emotional arousal, learning and plays a part in the reward pathways*
    3. *Dopamine plays a part in addiction (marijuana and heroin increase dopamine)*
    4. *An undersupply of this is implicated in Parkinson's disease and depression.*
    5. *An oversupply of this has been implicated in schizophrenia spectrum disorders. Too much dopamine = hallucinations and delusions.*

- **GABA**: what is GABA?
    1. *GABA (gamma aminobutyric acid) is the major inhibitory neurotransmitter. It causes neurons to work harder to try and fire an action potential. Dampens down activity.*
    2. *It is involved in learning, memory and sleep*
    3. *GABA is particularly important in regulating anxiety*
    4. *An undersupply of GABA may cause a highly reactive nervous system (patients with panic attacks have 22% lower concentration of GABA)*
    5. *Many anti-anxiety drugs bind to GABA receptors.*

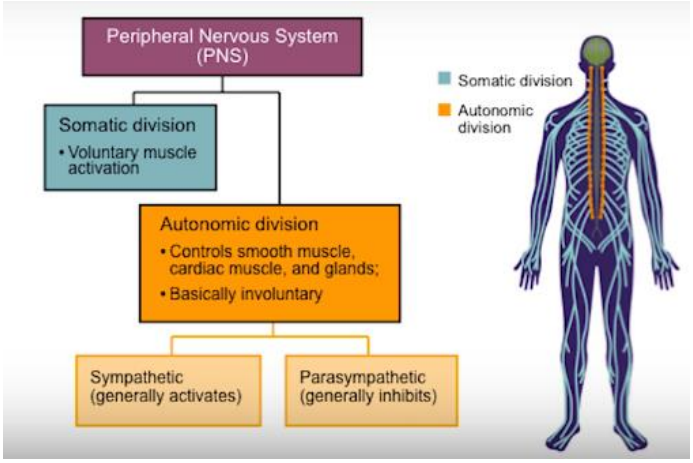
THE NERVOUS SYSTEM

- **THE MAJOR NEURONS:** there are 3 major types of neurons that carry out the system's input, output and integration functions:
    1. *SENSORY NEURONS*: carry input messages from the sense organs to the spinal cord and the brain.
    2. *MOTOR NEURONS:* transmit output impulses from the brain and spinal cord to the body's muscles and organs
    3. *INTERNEURONS*: link the input and output functions, they outnumber sensory and motor neurons and perform connective or associative functions within the nervous system.
       For example: interneurons would allow us to recognize a friend by linking the sensory input from the visual system with the memory of that person's characteristics stored elsewhere in the brain.

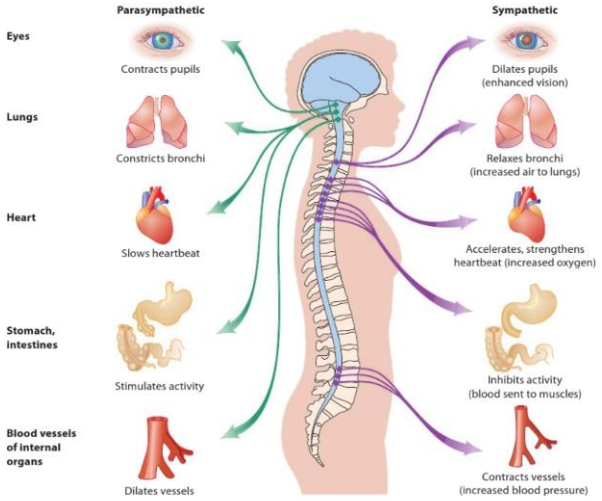


THE PERIPHERAL NERVOUS SYSTEM

- **WHAT:** controls all the neural structures that lie outside the brain and spinal cord.
- **DIVISIONS:** the PNS is divided into 2 major divisions:



1. ***SOMATIC:*** consists of sensory neurons that are specialized to transmit messages from the eyes, ears and other sensory receptors and motor neurons that send messages from the brain and spinal cord to the muscles that *control voluntary movements*. It allows you to sense and respond to your environment.
2. ***AUTONOMIC***: this senses the body's internal function and controls glands and the smooth (*involuntary*) muscles that form the heart, blood vessels and the lining of the stomach and intestines.it is largely concerned with involuntary functions such as respiration, circulation and digestion. It is also involved in many aspects such as motivation, emotional behaviour and stress response. This also consists of 2 divisions that typically affect the same organ/gland in opposing ways
   - ***SYMPATHETIC:*** has an activation or arousal function and it tends to act as a total unit (fight response)
   - ***PARASYMPATHETIC:*** far more specific in its opposing actions, affecting one or few organs at a time. It slows down the body processes and maintains a state of tranquility (*flight response*)



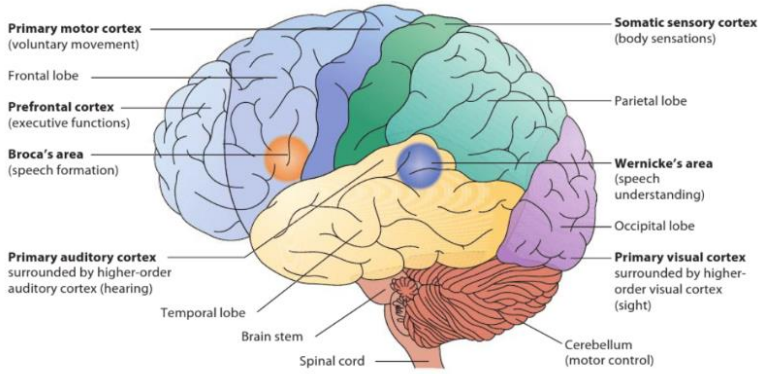
THE CENTRAL NERVOUS SYSTEM

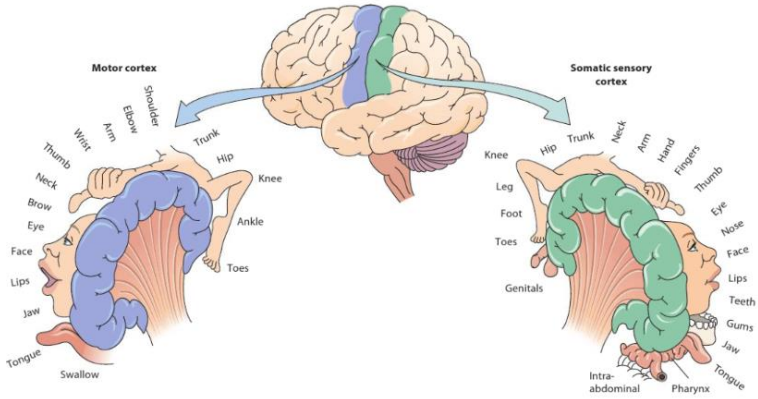
- **WHAT**: the CNS is composed of neurons and support cells that help the neuron to function properly with the brain and the spinal cord. The CNS is almost like the chief executive officer in a company - the CNS receives information, processes it and determines what actions should result
- **CNS:** composed of the brain and spinal cord. The spinal cord is the primary means for transmitting messages between the brain and the rest of the body.

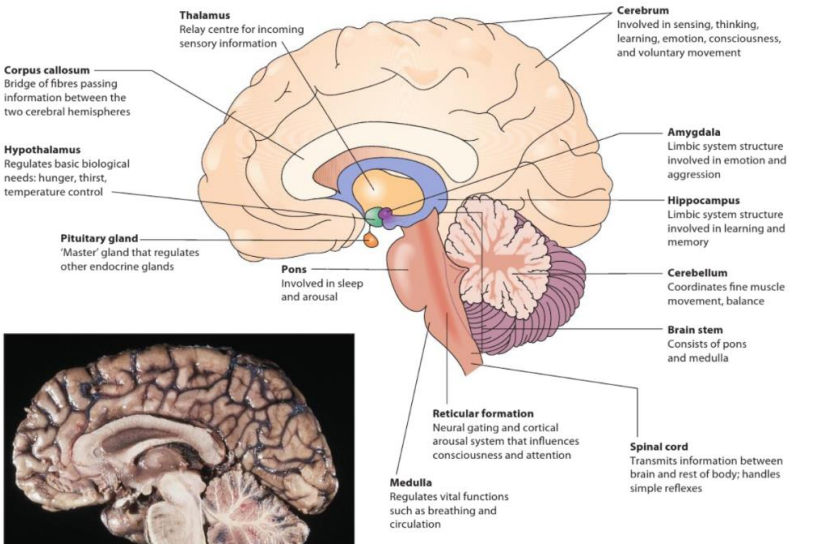
- **SPINAL REFLEXES:** when a receptor is stimulated it sends a message to the CNS where the brain coordinates the response. But sometimes, a very quick response is needed, one that doesn't need the involvement of the brain - this is a reflex action.

STRUCTURES AND BEHAVIOURAL FUNCTIONS OF THE BRAIN

- **FOREBRAIN**: broadly, the brain is made up of the forebrain, which includes an outer layer called the cerebral cortex, under which lie a number of core subcortical structures. Together, the forebrain sits on top of the midbrain and brainstem, behind which lied the cerebellum.
- **CEREBRAL CORTEX**: a 1/2 cm thick sheet of grey cell that form the outermost layer of the human brain, consisting of 2 large hemispheres - a left side and right side.
- 4 LOBES: of the brain are:
    1. FRONTAL
    2. PARIETAL
    3. OCCIPITAL
    4. TEMPORAL
- **MOTOR CORTEX**: control the 600+ muscles involved in voluntary body movements.
- **HYPOTHALAMUS:** plays a major role in many aspects of motivation and emotion, including sexual behaviour, temperature regulation, sleeping, eating, drinking and aggression. Damage to the hypothalamus can disrupt all these behaviour
- **MIDBRAIN:** the midbrain contains clusters of sensory and motor neurons. Is important in relaying centers for the visual and auditory systems. here, nerve impulses from the eyes and ears are organized and sent to the forebrain structures involved in







visual and auditory perception, the midbrain also contains motor neurons that control eye movements.

- **RETICULAR FORMATION**: acts as a kind of sentry, both alerting higher centers of the brain that messages are coming and then either blocking those messages or allowing them to go forward.
- **BRAIN STEM**: support vital life functions. Included are the pons and medulla
    1. PONS: lies at the top of the brain stem and carries nerve impulses between higher and lower levels of the nervous system they help regulate sleep and control vital functions such as respiration. Damage can produce death.
    2. MEDULLA: plays an important role in vital body functions such as heart rate and respiration.
- **CEREBELLUM:** is concerned primarily with muscular movement coordination and maintaining balance and posture, but it also plays a role in learning and memory.
- **CORPUS CALLOSUM**: is a broad band of white myelinated nerve fiber that connects the left and right cerebral hemispheres, aiding communication between the 2 halves of the brain. Even though they normally act in concert, there are important differences between the psychological functions of the 2 cerebral hemispheres. Years ago, neuroscientists found that by cutting the nerve fiber of the corpus callosum, they could prevent the seizures from spreading from one hemisphere to the other.
- **LATERALISATION:** refers to the relatively greater localization of a function in one hemisphere than the other. The deficits observed in people with damage to either the left or right hemispheres suggest that, for most people, verbal abilities and speech are localized in the left hemisphere, as are mathematical and logical abilities. It appears that mental imagery, musical and artistic abilities, and the ability to perceive and understand spatial relations are primarily right-hemisphere functions.

LIMBIC SYSTEM: MEMORY, EMOTION AND GOAL-DIRECTED BEHAVIOUR

- **WHAT:** a set of deep structures lying deep within the cerebral hemisphere. The limbic system is involved in the processing of emotions, motivation and learning and memory.
- **HIPPOCAMPUS:** involved in formulating and retrieving memories.
- **AMYGDALA:** organizes motivational and emotional response patterns, particularly those linked to aggression and fear. Electrically stimulating certain areas of the amygdala causes animals to snarl and assume aggressive postures.