M3b: Biology & Neuroscience

September 25, 2021 12:01 PM

Nervous system

Divided into:

- Central Nervous System (CNS)
  - Brain, spinal cord
- Peripheral nervous system (PNS)
  - Nerves going to and from CNS
  - Allows CNS to know what is going on in the environment and to react to it

PNS

Divided into:

- Motor nerves
  - Commands from CNS to muscles
  - Further divided into:
    - Somatic
      - Voluntary movement of skeletal muscles
    - Autonomic
      - Self-regulated actions of organs and glands (involuntary, automatic functions)
      - Further divided into:
        - Sympathetic (arousing)
          - Activates in response to danger, excitement
          - Dilates pupil
          - Accelerates heart
          - Dilates bronchi
          - Digestion stops
          - Intestine, bladder slows down excretion
          - Stimulating ejaculation
        - Parasympathetic (calming)
          - Activates when calm, relaxed
          - Constricts pupil
          - Heart slows down
          - Digestion resumes
          - Excretion resume
- Sensory nerves
  - Commands from body to CNS
  - Allows our brain to know what is going on out in the world

Divisions of the brain

Organized by basic function and simplicity of the areas:

- Hindbrain
  - Region at base of brain, connects brain to spinal cord
  - Most ancient evolutionary structures of the brain
  - Cerebellum, Pons, Medulla
    - Function to support vital bodily processes
- Midbrain
  - Middle region of brain
- Forebrain
  - Uppermost region of brain
  - Largest part of the brain
  - Mostly the cerebrum
  - Thalamus, Hypothalamus, Limbic system

Hindbrain

- Basic life sustaining structures
- Medulla
  - Unconscious body functions (breathing, muscle tone)
  - Connects brain and spinal cord
- Pons
  - Receives information from visual areas
  - Coordinate eye and body movements
  - Controls sleep and wake cycles
  - Sends information to cerebellum, aiding in balance
- Cerebellum
  - Regulates muscle tone
  - Coordinates movement
  - Controls balance
  - Damage makes people act drunk

Midbrain

- Near the center of the brain
- Between cerebral cortex and above the hindbrain
- Controls some reflexes
- Involved in some voluntary movements

Forebrain

- Largest part of the brain
- Cerebrum (the cortex)
- Thalamus
  - Processes and integrates sensory information from all senses (except smell) to higher areas
  - Regulates sleeping
- Hypothalamus

- Amygdala
- Hippocampus

Limbic system

- Connected set of structures in forebrain that are involved in forming memories, controlling emotions, making decisions, motivation, and learning
- Emotions, memories, and sense of smell all connected here
- Amygdala
  - Emotional control center
  - Evaluates threats in the environment
  - When stimulated, demonstrates aggression or fear
- Hippocampus
  - Critical for forming new memories
  - Acts like a barrier for new memories
- Hypothalamus
  - Maintains homeostasis in the body
  - Major control center regulating eating, drinking, sexual behaviour, and sleep
  - Major reward center

Cerebrum

- Includes neocortex
- Consists of two hemispheres, connected by the corpus callosum
- Outer layers of cerebrum are the cerebral cortex
  - Responsible for all complex human behaviours

Cerebral cortex

- Divided into four lobes in each hemisphere:
  - Frontal lobe
    - At the front of the head
    - Responsible for planning, motor behaviour, personality, attention, and problem solving
  - Parietal lobe
    - At the top of the head
    - Manages somatosensory processing, some visual processing
  - Temporal
    - Above ears
    - Processes auditory information and memory
  - Occipital lobe
    - At the back of head
    - Processes visual information

- At the top of the brain, there are two bands spanning the top area
  - Two very specialized areas for motor control and sensation
    - Motor cortex (frontal lobe), somatosensory cortex (parietal lobe)
  - Brain is organized according to crossover

        - Sensations and movements on the right are represented on the left side of the brain and vice versa
    - Different parts of the body have more representation
        - Amount of representation corresponds to the fineness of control on that body part

Techniques to study the brain

- Lesion Technique
    - An early and basic technique
    - Purposely destroying a specific region of the brain in order to compare behaviour before and after surgery
    - Lesion (area of dead neurons) can be created using chemicals, extreme cold, or electricity
    - Allows to understand function of a particular part of the brain
    - Causes permanent damage

- TMS
    - Safer way to stop activity in a particular region of the brain
    - Transcranial Magnetic Stimulation
    - A vacuum-like machine is placed on the skull and the magnet is electrified
    - Interrupts neural communication at the area of the brain over which the TMS is hovering
    - Function returns as soon as the machine is turned off
    - Temporary 'lesion' technique
    - Allows to localize brain function without causing permanent damage
    - Fairly new technique

- Electroencephalogram (EEG)
    - Measure activity across the entire brain
    - Can observe different states of consciousness and other basic processes
    - Participant wears a special electrode cap
    - Brain activity creates magnetic fields, since brain activity involves ions and electrical charges
    - Electrodes in the EEG cap can process magnetic fields to get a sense of what is happening in the brain

- Positron Emission Tomography (PET) Scan
    - More accurately identify particular areas of activity in the brain
    - Allows to see particular areas of the brain that are active by looking at glucose consumption
    - Patients are injected with a radioactive agent that can be identified by the PET scanner

- Magnetic Resonance Imaging (MRI)
    - Can map the structure of the brain
    - MRI machine has a strong magnet that aligns atoms in the brain
    - Signals that emerge can be read to see the shape and location of structures

- Functional Magnetic Resonance Imaging (fMRI)
  - Allows to visualize function and structure
  - Allows to know what different areas of the brain are doing