

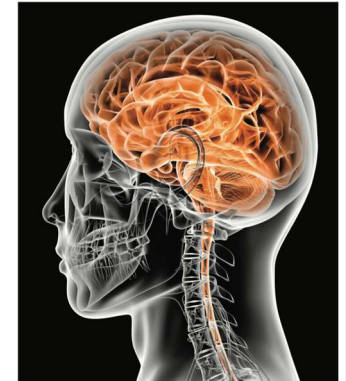
PY211 General psychology

Biological Perspective

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Overview

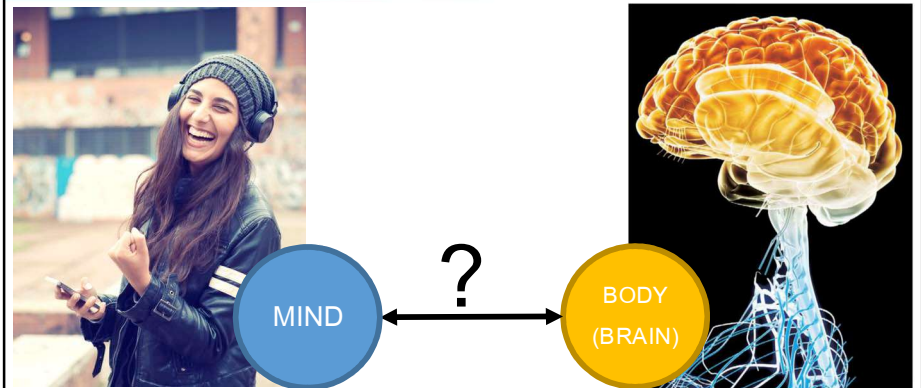
- The Nervous System
 - Major subdivisions
 - Neurons: Types & communications
 - The Human Brain: Key structures & functions
 - The Methods used for studying the brain
- The Endocrine System



Learning objectives

- Identify and describe the structure and functions of the nervous system / endocrine system.
- Explain the process by which neural communication occurs within a neuron / between neurons.
- Differentiate the roles played by major neurotransmitters in supporting physical functioning and psychological experience.
- Associate key structures in / regions of the brain with important aspects of physical and psychological functioning.
- Differentiate the methods used to study the brain for our understanding of behaviours.
- Differentiate the process by which hormones influence psychological experience and behaviour from neurotransmission.

Why do we need to know about the brain?



Why do we need to know about the brain?

To be able to explain how we...

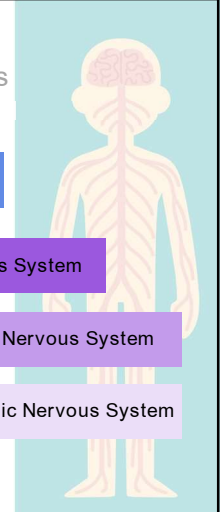
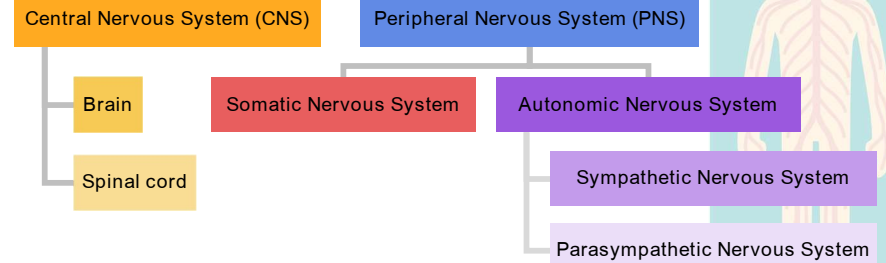
- Sense / Perceive
- Think
- Feel
- Act (Behaviour)

“How we experience (the world around us)”



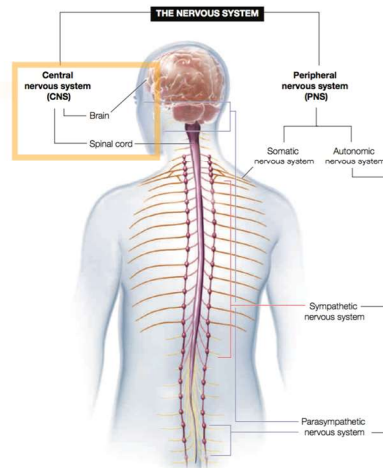
→ to understand how our “mind” works based on neural functioning

The Nervous system: Major subdivisions



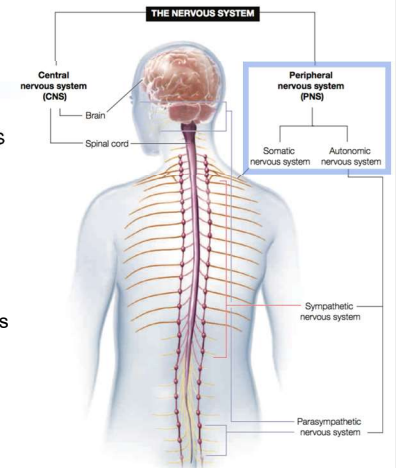
Central Nervous System

- **CNS = Brain + Spinal cord**
 - Brain:
 - Spinal cord: connect the brain to nerves throughout the body + control reflexes
- CNS is encased + protected by bones
- CNS communicates with the rest of the body by the PNS.



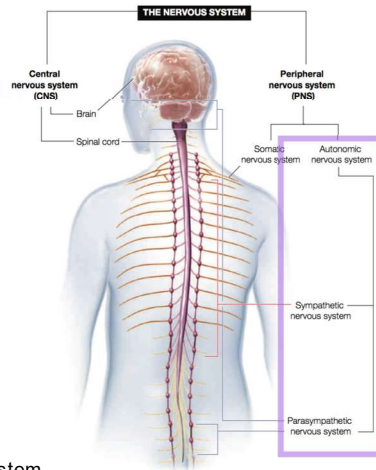
Peripheral Nervous System

- **PNS = nerve tissue / fibres** that connects the CNS to the rest of the body.
 - Somatic NS: control voluntary muscles, convey sensory info' to the CNS.
 - Autonomic NS: control involuntary actions of smooth muscles e.g. heart, lungs, stomach, intestines, other internal organs.

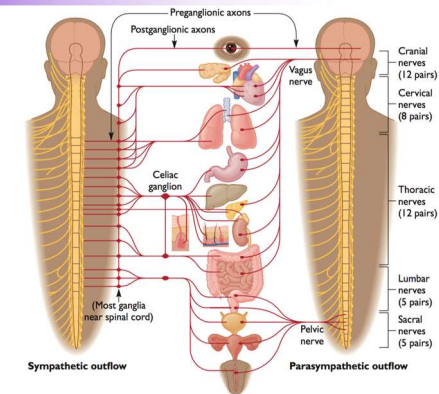


Autonomic Nervous System

- Sympathetic NS: **uses much energy**
 - Fight-or-Flight activities
 - e.g. **▲ heart rate, ▼ digestion**
- Parasympathetic NS: **conserves energy**
 - Promotes resting and digesting
 - e.g. **▼ heart rate, ▲ digestion**
- These two systems are antagonistic.
- Autonomic NS also influences the endocrine system



Autonomic Nervous System

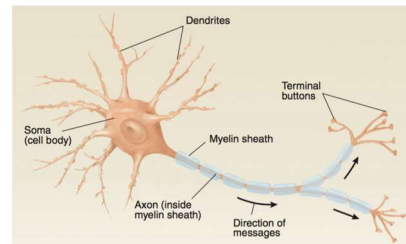


Neurons (Nerve cells)

3 Basic parts of a neuron

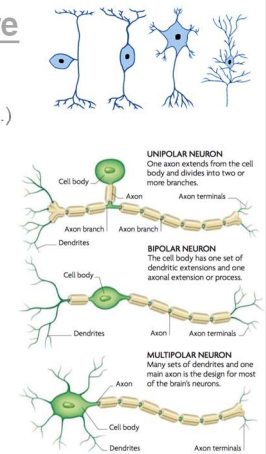
- Soma (Cell body): which contain nucleus and other organelles
- Dendrite = **receive** messages (Input)
- Axon = **send** messages
(Output via Action Potentials)

Myelin sheaths = supporting salutatory conduction



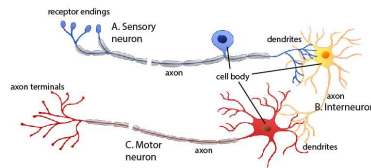
Neurons: distinguished by structure

- **Unipolar neurons:** in somatosensory system (touch, pain etc.)
- **Bipolar neurons:** primarily found in visual, auditory, olfactory, and gustatory system
- **Multipolar neurons:** common in CNS
- **Pyramidal neurons:** found in the forebrain structures



Neurons: distinguished by functions

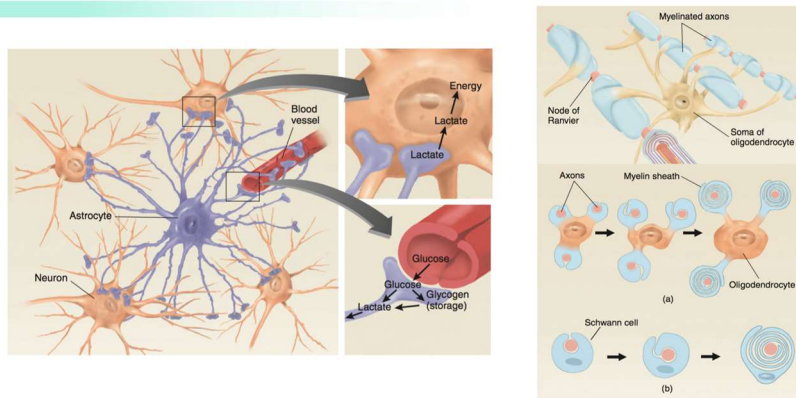
- **Sensory neurons (Afferent)** = transmit sensory info' from receptors to the CNS.
- **Motor neurons (Efferent)** = transmit motor info' from the CNS to the muscles.
- **Interneurons** = found between other neurons
+ located predominantly in the CNS



Glial cells: Supporting cells in Nervous System

- Approx. 85% of the cells in the brain
 - **Oligodendrocytes**: In **CNS** – it primarily form myelin sheath for axon.
 - **Schwann cells**: In **PNS** – function equivalent to **Oligodendrocytes** in **CNS**.
 - **Astrocytes (Astroglia)**
 - Support - Nutrition and Structure
 - Regulate the chemical composition of the extracellular fluid (e.g. K^+)
 - Clean up debris (uptake of neurotransmitters, phagocytosis the dead nerve cells)
 - Macrogliia – acts as phagocytes + protects the brain from invading microorganisms

Glial cells: Supporting cells in Nervous System



Neural Communication

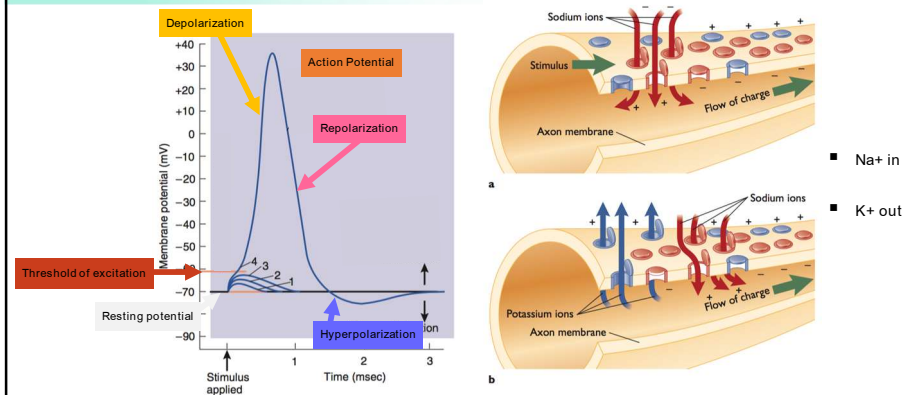
- Communication within a neuron:
 - Action Potential**
- Communication between neurons:
 - Synapses + Neurotransmitters**

Communication within a neuron

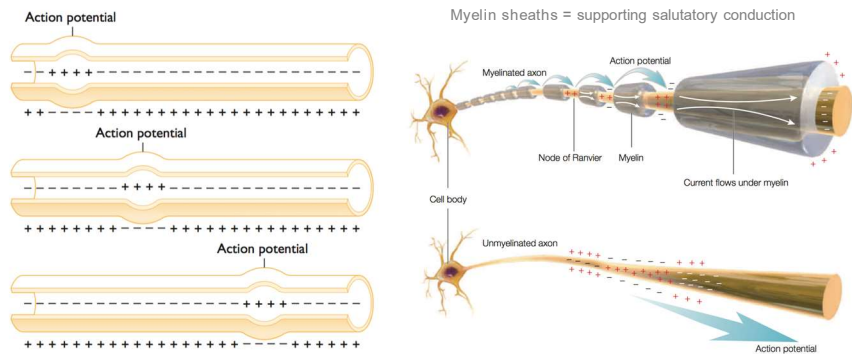
★ The **action potential** occurs when the membrane potential of an axon reaches the **threshold of excitation** (around -55 to -65 mV), All-or-none law.

- Resting potential (-70mV) → ★ → **Depolarization** (up to +40mV) → **Repolarization** → **Hyperpolarization** (lower than -70mV) → Resting potential (-70mV)
- Although the action potential is electrical, it is caused by the flow of sodium and potassium ions through voltage-dependent ion channels in the membrane.

Communication within a neuron



Communication within a neuron

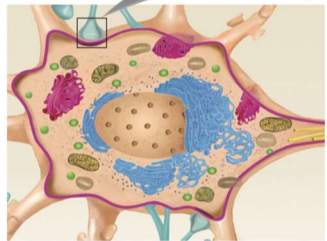


Communication between neurons

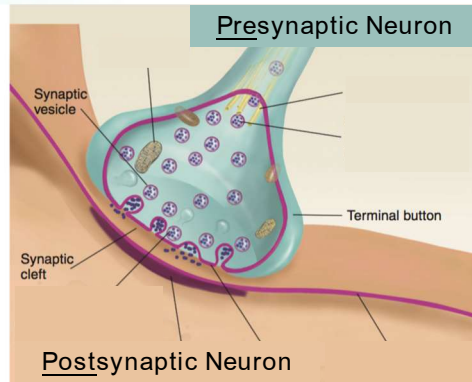
- Neurons communicate by means of **synapses**, which enable the **presynaptic neuron** to produce **excitatory** or **inhibitory** effects on the **postsynaptic neuron**.
- When an **action potential** reaches the end of an axon (presynaptic neuron), it causes some synaptic vesicles to release a **neurotransmitter** into the synaptic cleft.
- Molecules of the neurotransmitter attach themselves to receptors in the postsynaptic membrane.

Communication between neurons

Detail of Synapse



Neuron



Major Neurotransmitters I

Neurotransmitter	Behaviours influenced by the neurotransmitter
Acetylcholine (ACh)	<ul style="list-style-type: none"> ▪ Movement (muscle action) ▪ Learning, Memory ▪ Autonomic nervous system function
Epinephrine (Adrenalin)	<ul style="list-style-type: none"> ▪ Arousal
Norepinephrine (Noradrenalin)	<ul style="list-style-type: none"> ▪ Arousal, Alertness, Vigilance
Dopamine	<ul style="list-style-type: none"> ▪ Movement ▪ Planning ▪ Reward, Pleasurable emotion ▪ Learning

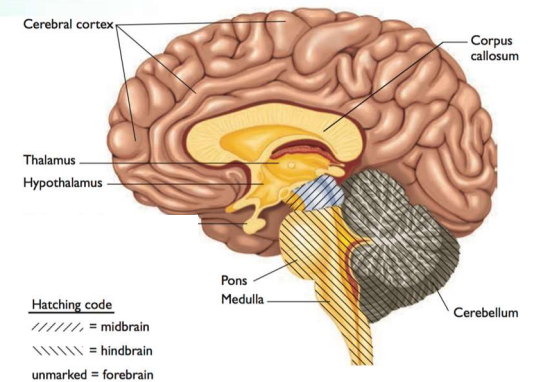
Major Neurotransmitters II

Neurotransmitter	Behaviours influenced by the neurotransmitter
Serotonin	<ul style="list-style-type: none"> ▪ Mood ▪ Appetite (Hunger) ▪ Sleep
Glutamate	<ul style="list-style-type: none"> ▪ Excitation of brain activity ▪ Memory
GABA (Gamma-aminobutyric acid)	<ul style="list-style-type: none"> ▪ Inhibition of brain activity
Endorphins	<ul style="list-style-type: none"> ▪ Pleasure ▪ Pain

The Human Brain

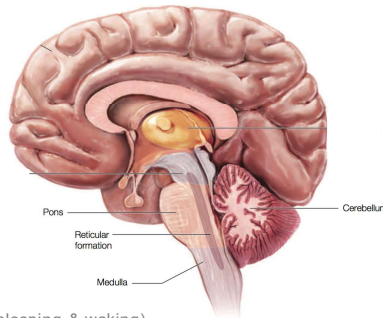
3 basic subdivisions

- Forebrain
- Midbrain
- Hindbrain



Hindbrain

- The Medulla: regulates vital functions
 - breathing, heartbeat, and blood pressure.
- Pons: connect cerebellum to the rest of the brain
 - Reticular formation: regulates arousal & alertness (sleeping & waking).
- Cerebellum: helps maintain posture, balance, coordinates body & skilled movements.

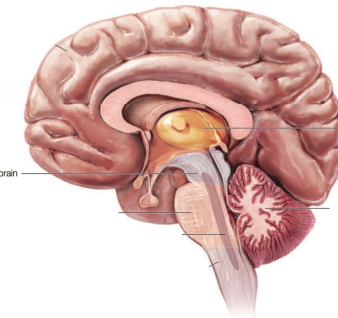


Midbrain

Involved in sensory reflexes, movement, and pain

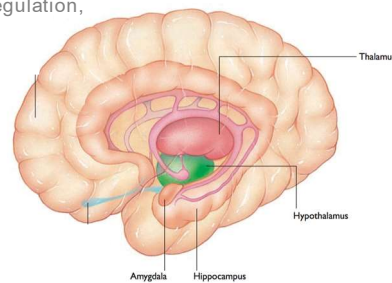
- Inferior colliculi: Auditory reflexive behaviors
- Superior colliculi: Visual reflexive behaviors
- Periaqueductal grey: Pain

Brain stem: Midbrain + Pons + the Medulla

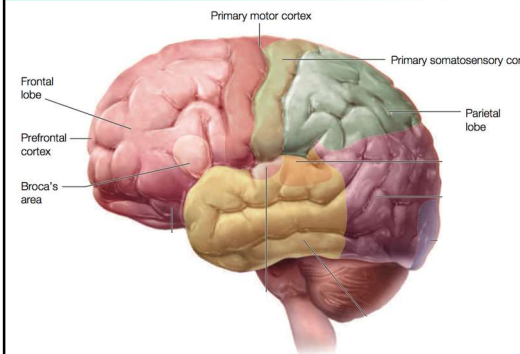


Forebrain: Subcortical structures

- Thalamus: “gate way to the cortex” of every senses (but olfactory)
- Hypothalamus: hunger, thirst, temperature regulation, sexual and other motivated behaviours
- Limbic System
 - Amygdala: Emotion (particularly, fear and anger)
 - Hippocampus: Long-term Memory Consolidation

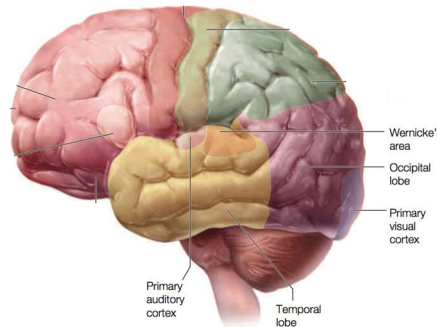


Forebrain: Cerebral cortex



- **Frontal lobe:** Cognitive functions
 - Prefrontal cortex: Thinking, Planning, Working memory
 - Broca's area – speaking language
 - Primary motor cortex
- **Parietal lobe:** Body sensations
 - Primary somatosensory cortex

Forebrain: Cerebral cortex



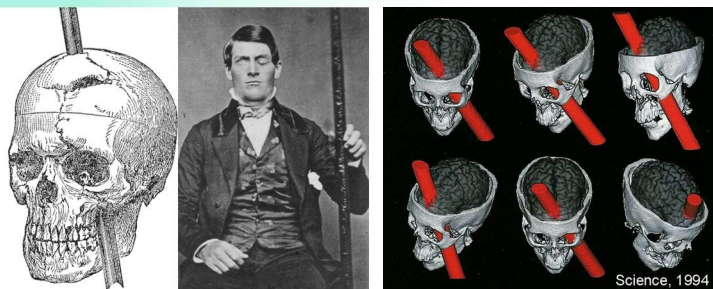
- **Temporal lobe:** Hearing
 - Primary auditory cortex
 - Wernicke's area – understating language
- **Occipital lobe:** Vision
 - Primary visual cortex

Methods used for studying the brain

A number of methods have been devised for studying brain structure and function.

- Clinical Case Study / Lesion
 - Neuroimaging Techniques
 - CT / CAT Scan
 - PET
 - MRI / fMRI
 - EEG
 - MEG
- As we cover each of these, try to evaluate them according to the following properties:
- ✓ Core feature
 - ✓ Non-invasive vs. Invasive
 - ✓ Structure alone vs. Structure + Function

Clinical Case study: Phineas Gage



- His case demonstrated that brain damage could lead to dramatic changes in behaviours.
- Polite, well-mannered American railroad foreman → Bad-tempered, mean-spirited and vulgar person

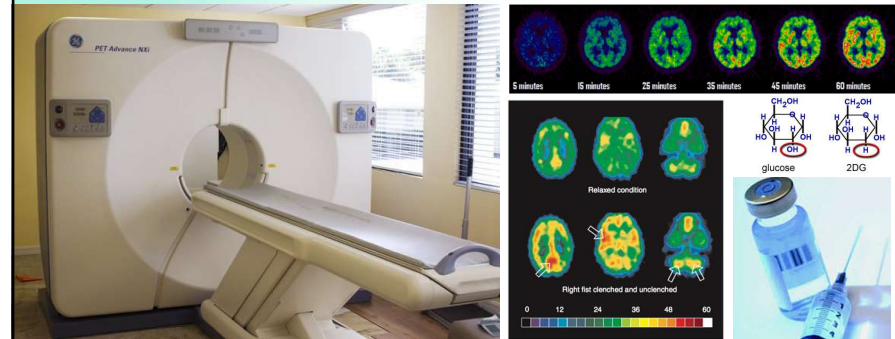
CT / CAT scan



CT / CAT scan

- CAT scan = Computed Axial Tomography / CT = Computerized Tomography
- X-ray: Amount of radioactivity → 2D brain images reconstructed by computer showing hard and soft tissues
- Non-invasive (although radiation can accumulate in brain with repeated use)
- Shows structure.

PET (invasive)



PET

- PET = Positron Emission Tomography
- Injected or inhaled radioactive chemicals ✦ (positron-emitting isotopes)
- ✦ bind to glucose / oxygen taken up by active brain cells → Break down of ✦ produces positrons
- Invasive
- Shows both structure and function

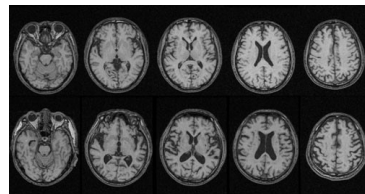


Structural & Functional MRI



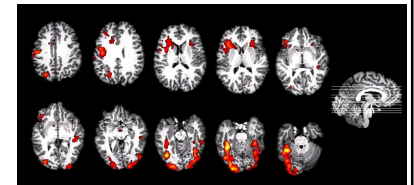
Structural MRI

- MRI = Magnetic Resonance Imaging / Structural MRI (sMRI)
- Use magnetism, radio waves, and computer to construct 3D brain images
- Non-invasive
- Shows structure *not* function

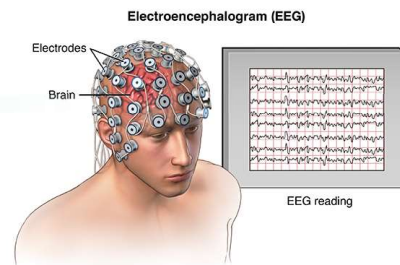


Functional MRI

- fMRI = Functional MRI
- Use magnetism to track the changes in blood oxygen due to local brain activity
- Non-invasive
- Shows both structure (from MRI) and function

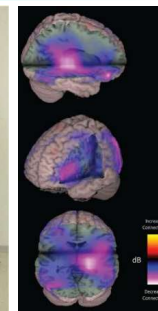


EEG



- EEG = Electroencephalogram
- Measure: electrical activity of the brain using electrodes placed on the scalp
- Non-invasive
- Shows function

MEG



- MEG = Magnetoencephalogram
- Measure: magnetic field outside the head produced by active brain cells
- Non-invasive
- Shows both structure and function

The Endocrine System



Hormones: are chemicals **released** by endocrine glands.

- Hypothalamus: hormones that control pituitary gland
- Pituitary gland: hormones that control other glands +
 - **Growth Hormone** = stimulate growth and regeneration,
 - **Oxytocin** = breastfeeding and human bonding (predominately female),
 - **Vasopressin** = water retention and human bonding (predominately male)
- Pineal gland: **Melatonin** control sleepiness

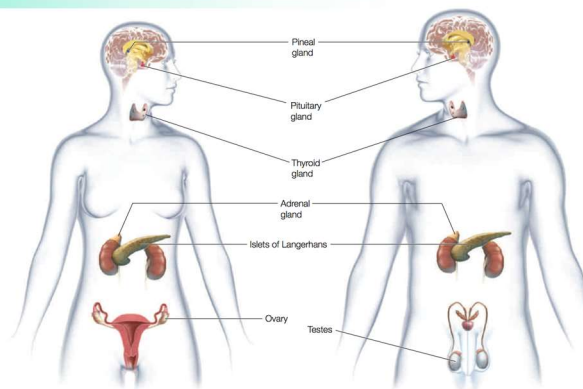


The Endocrine System



- Thyroid: control metabolic rate
- Parathyroid: control Ca²⁺ in blood
- Adrenal gland: helps trigger fight-or-flight response
 - (**Epinephrine / Norepinephrine**)
- Islets of Langerhans: regulates glucose storage (**Insulin**) / use (**Glucagon**).
- Ovary/Testes: control sexual behaviors

The Endocrine System



The Endocrine System

Hormones has actions similar to those of neurotransmitters:

- They bind with and activate receptors on or in their target cells (organs).

However, ...

- It is distributed to the body through blood stream (circulatory system).
- The process of sending messages takes significantly longer, but the effect last longer too.

