The Brain

Neuroimaging Techniques

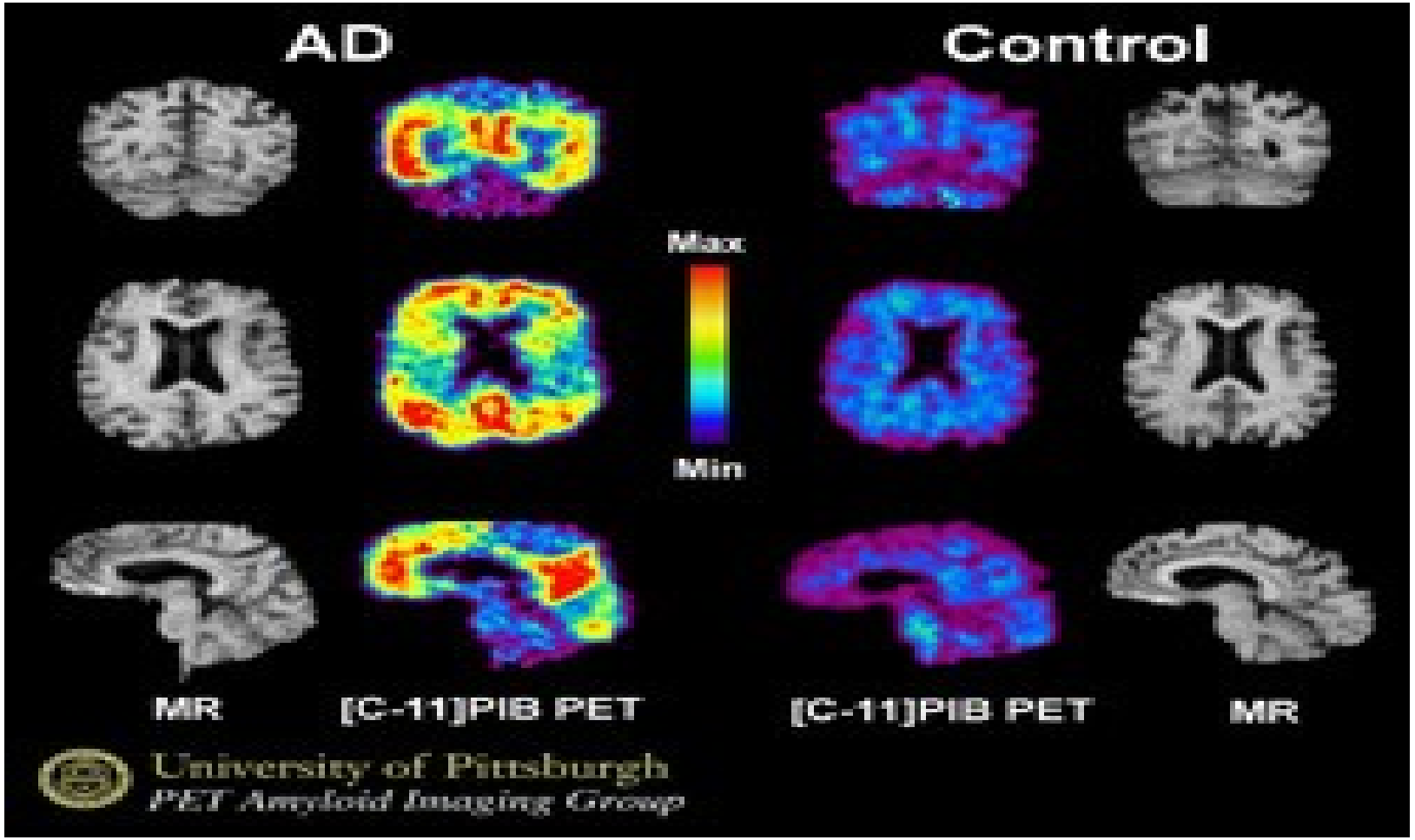
- **PET** – Positron Emission Tomography

  depicts brain activity by showing the consumption of radioactive glucose – area lights up
- **MRI** – Magnetic Resonance Imaging

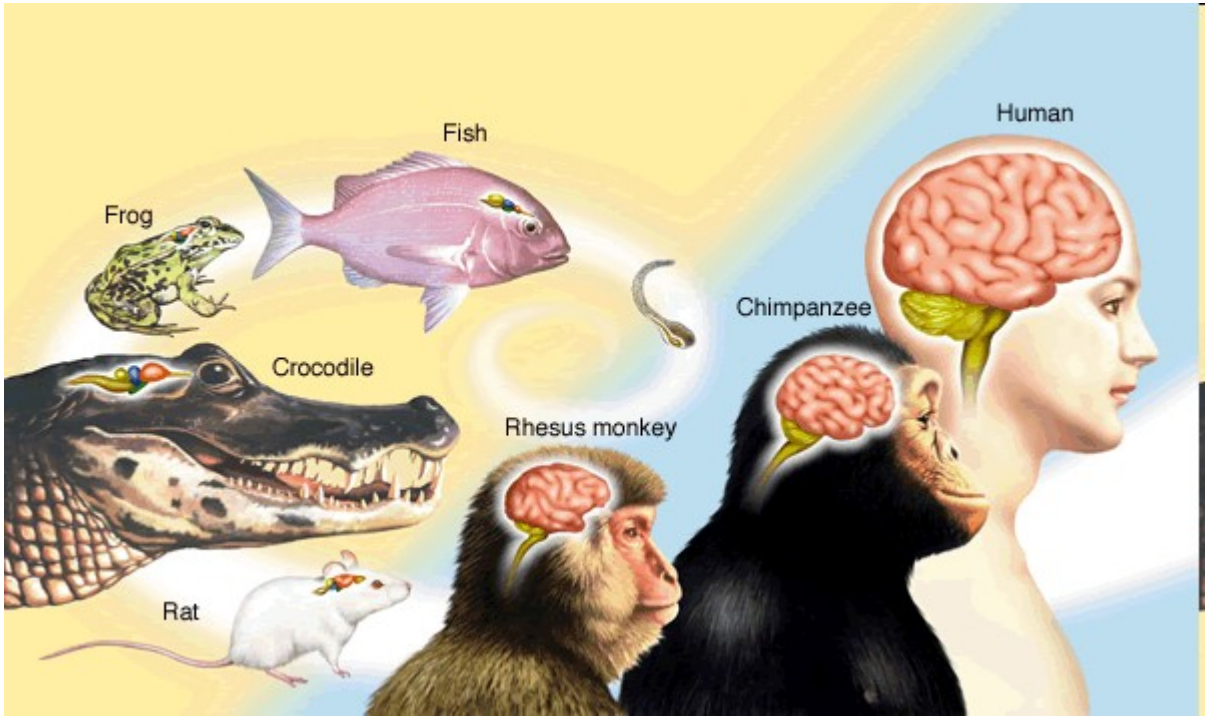
  the head is put in a strong magnetic field, which aligns the spinning protons of brain molecules. Then a radio wave pulse momentarily disorients the protons. When the protons return to their normal spin, they release signals that provide a detailed pictures of the brain's soft tissue.
- **fMRI** – comparing MRI scans taken less than a second apart.

- **CT (roentgen-ray computed tomography)** A beam of x-rays is shot straight through the brain. As it comes out the other side, the beam is blunted slightly because it has hit dense living tissues on the way through. Blunting or "attenuation" of the x-ray comes from the density of the tissue encountered along the way. Very dense tissue like bone blocks lots of x-rays; grey matter blocks some and fluid even less. X-ray detectors positioned around the circumference of the scanner collect attenuation readings from multiple angles. A computerized algorithm reconstructs an image of each slice. (example)
- **MRI (magnetic resonance imaging)** When protons (here brain protons) are placed in a magnetic field, they become capable of receiving and then transmitting electromagnetic energy. The strength of the transmitted energy is proportional to the number of protons in the tissue. Signal strength is modified by properties of each proton's microenvironment, such as its mobility and the local homogeneity of the magnetic field. MR signal can be "weighted" to accentuate some properties and not others. When an additional magnetic field is superimposed, one which is carefully varied in strength at different points in space, each point in space has a unique radio frequency at which the signal is received and transmitted. This makes constructing an image possible. It represents the spatial encoding of frequency, just like a piano. (example). More details of MR here.
- **SPECT/PET (single photon/positron emission computed tomography)** When radiolabeled compounds are injected in tracer amounts, their photon emissions can be detected much like x-rays in CT. The images made represent the accumulation of the labeled compound. The compound may reflect, for example, blood flow, oxygen or glucose metabolism, or dopamine transporter concentration. Often these images are shown with a color scale. (example) Next
- **Contributed by Sam Patz, Ph.D.** http://www.med.harvard.edu/AANLIB/sigsors.html

The left two columns are of a brain with Alzheimer's disease. The right two columns show a brain without Alzheimer's disease. PET scans are flanked by MRI scans. The color gradient reflects levels of amyloid density.



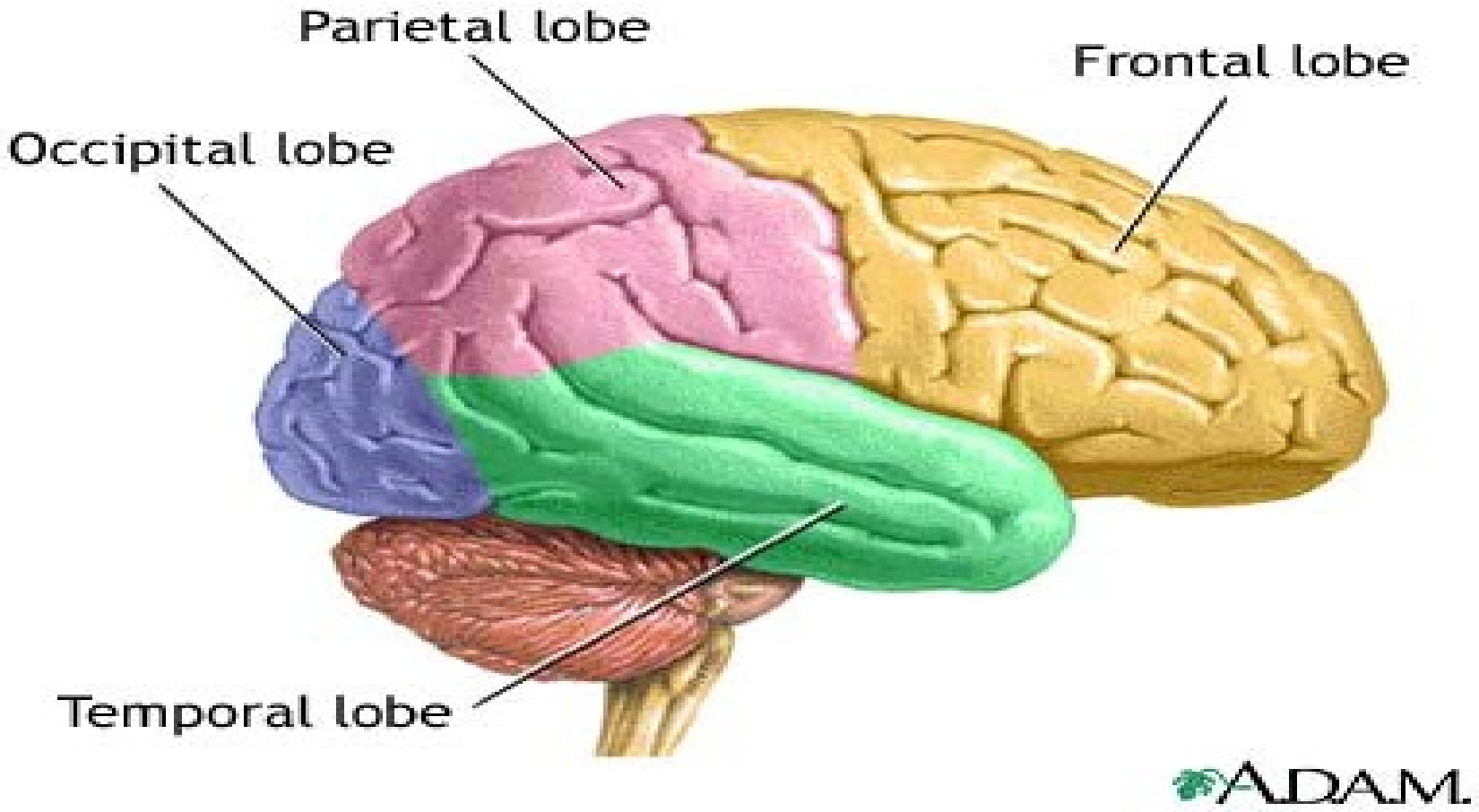
Evolution of the brain

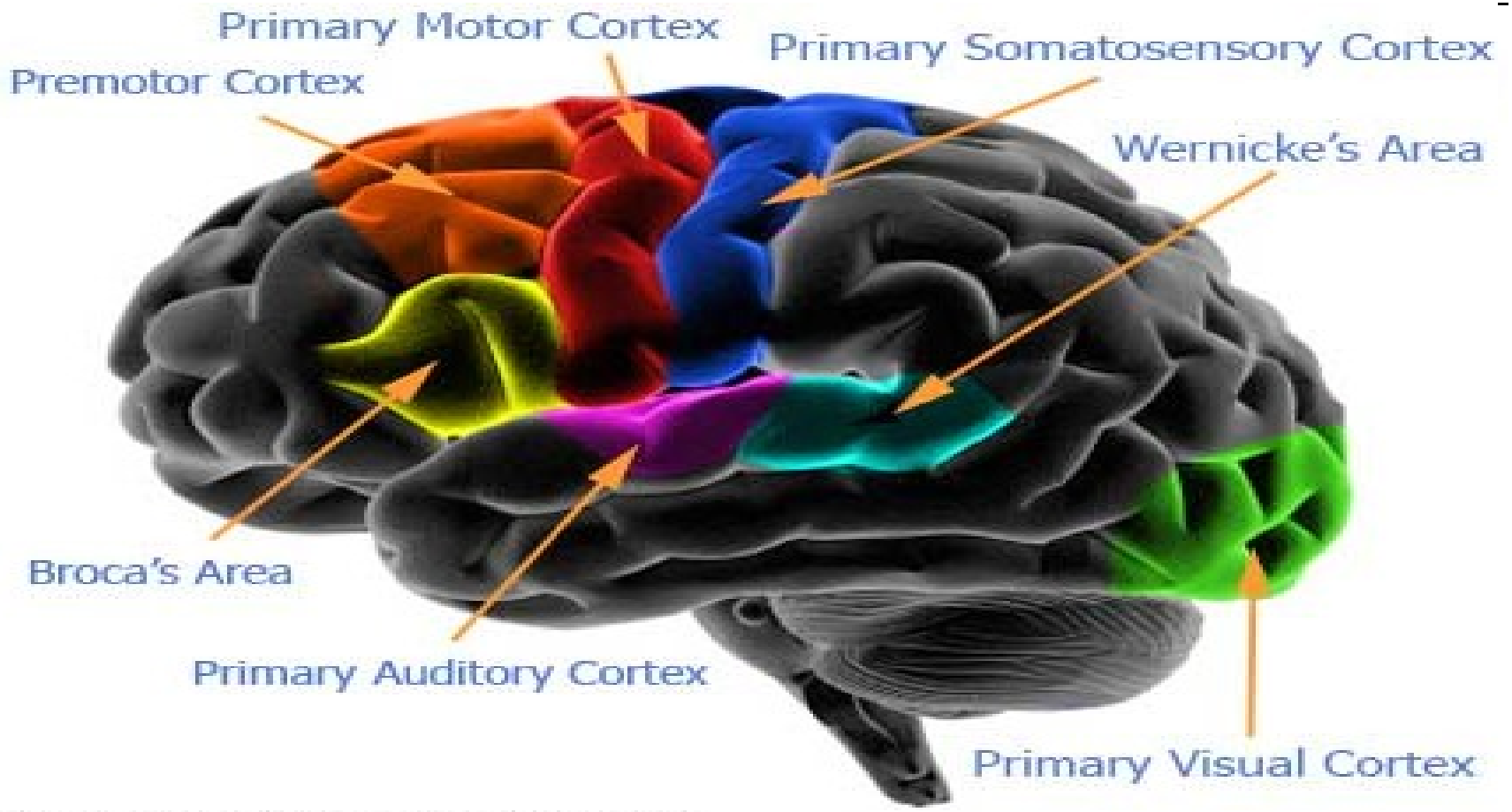


The Cerebral Cortex
Forebrain

Neurons and Glial cells

- Frontal Lobe
- Parietal Lobe
- Temporal Lobe
- Occipital Lobe


Parietal lobe
Frontal lobe
Occipital lobe
Temporal lobe
A.D.A.M.



- Frontal Lobe

  speaking, muscle movements, planning and making judgements

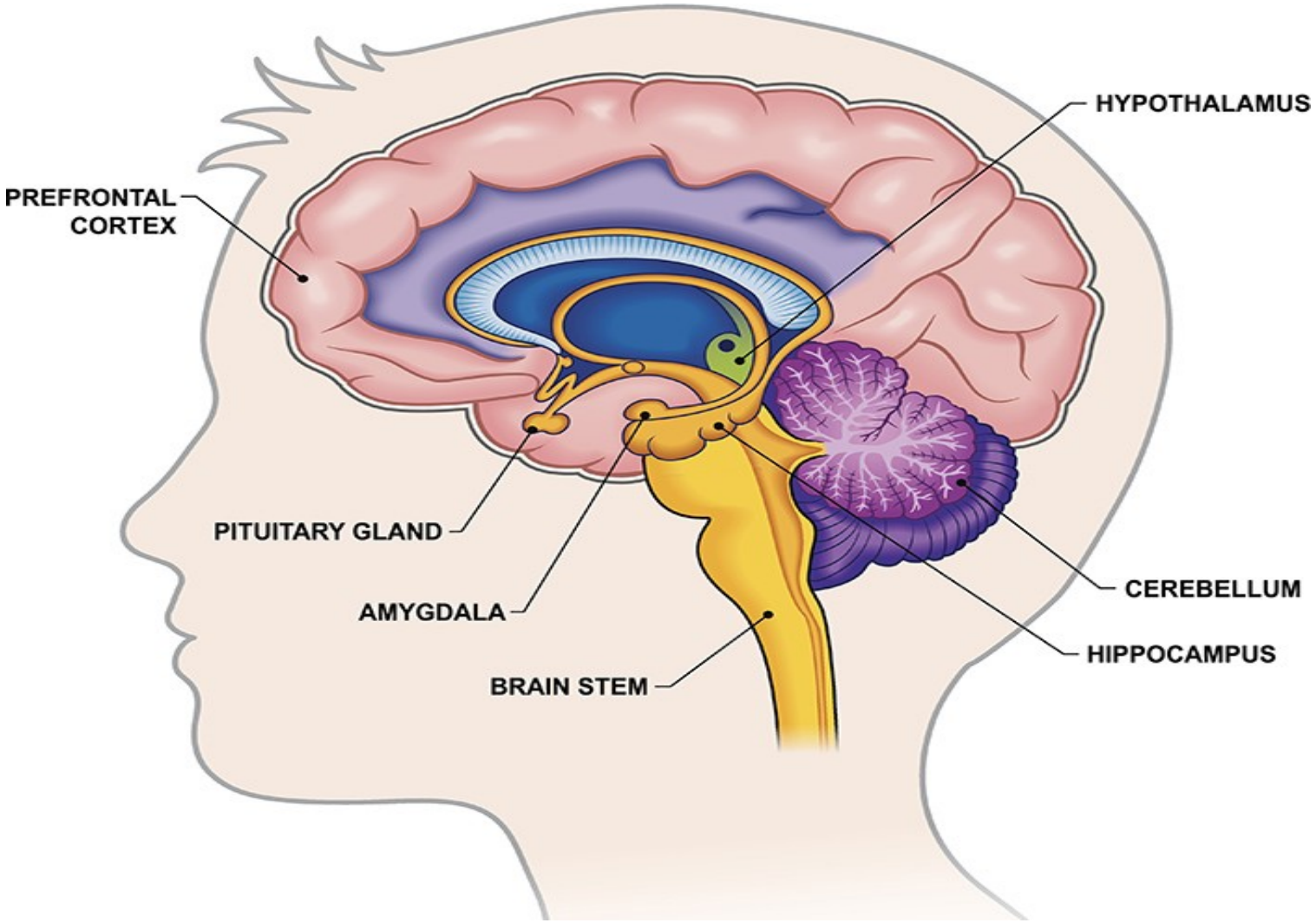
  motor cortex – controls movements of body parts

  fingers and mouth – more cortical space
- Neural Prosthetics

- Parietal Lobe – sensory cortex – receives input from the skin senses & movement of body parts

  sensitive body parts are represented more
- Temporal Lobe – auditory cortex
- Occipital Lobe – visual cortex
- crossover

Mid Brain


HYPOTHALAMUS
PREFRONTAL CORTEX
PITUITARY GLAND
AMYGDALA
BRAIN STEM
CEREBELLUM
HIPPOCAMPUS

The Limbic System

- Hypothalamus
- Amygdala
- Pituitary Gland
- Hippocampus

- Hypothalamus: below thalamus
- Hunger, thirst, body temperature, sexual behavior
- Pleasure center – Experiment by Olds & Milner (1954)
- Talwar & colleagues (2000)

- Amygdala: seat of emotion

  1939 – lesioned a monkey's brain

  Aggression, Fear

- Hippocampus: explicit memory

- Pituitary Gland: Master Gland controls endocrine system

Hind Brain

- The Brainstem: central core
- Medulla - heartbeat & breathing
- Pons – co-ordinate movements

Crossover Point – where nerves to and from each side of the brain connect with the opposite side of the body

The Thalamus: top of the brainstem –

- brain’s sensory switchboard

  receives information sends it to higher brain regions

  gets replies and sends it to the medulla and cerebellum

The Cerebellum:

- Co-ordinates voluntary movements
- Memory, discriminate sounds and textures, judge time

Neurotransmitters

- Acetylcholine muscle action learning memory
- Dopamine movement learning emotion
- Serotonin mood hunger sleep arousal
- Norepinephrine alertness arousal
- GABA inhibitory role
- Glutamate excitatory role

- Brain’s Plasticity
- Hemispherectomies – opposite limb movements are compromised

- Deaf
- Blind

- Corpus Callosum: wide band of axon fibres connecting two hemispheres
- Severing it
- Experiment by Gazzaniga (1967)

HE*ART

- When asked what they had seen – they said Art

- When asked to point out what they had seen – their left hand pointed to He

- Left hemisphere – language processing
- Right hemisphere – perceptual tasks, inferences