Lecture 1: History of Neuroscience

- Origins of Neuroscience
  - Pre historic ancestors and Ancient Egypt
  - Views of ancient Greeks; Hippocrates
  - Views of Ancient Rome: Galen
- Prehistoric Ancestors: the brain is vital for life
- Cranial surgery: proof of this with trepanation (hole through skull, suggesting that ancestors were trying to treat something through cranial surgery)
  - skulls showed signs of healing

- Views of Ancient Egypt
  - Heart: seat of the soul (conscience and emotions) and of memory
  - Not the head; the brain was removed during mummification, they believed everything was in the heart not the head, brain was removed and thrown in the trash
    - Brain lipids did not conserve well and dissolved readily in the natron used for mummification

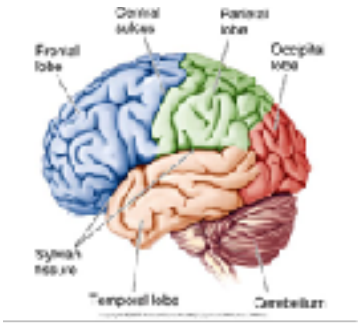
- Views of Ancient Greece; Hippocrates (-460 - -370)
  - correlation between structure and function, brought some form of physiological basis
  - Rejected superstitions and beliefs as causes for disease
  - Theories of bodily humours (fluids) stirred by the heart, the humours displayed personality traits
    - Disease= imbalance of the humours
    - Blood (warm humour); heart, jovial and warm character
    - Pituitary (lymph and phlegm); brain, solid character
    - Yellow bile; liver, anxious character
    - Black bile (cold and dry); spleen, melancholic character
  - Brain; involved in sensation and seat of intelligence
  - <u>Aristotle:</u>
    - Takes a backward step with his theories of duality; the body and the mind are separate things, mind is not related to bodily function, heart; emotions, head; reason

- Views of the Roman Empire: Galen (129 - 200)
  - dissections of human cadavers were forbidden
  - Galen was a physician for gladiators
  - Physician of Marcus Aurelius and Commodus, allowed to perform animal experimentation
  - Explored the roles of the brain, cerebellum and ventricles
  - Galen had access because he was a physician for gladiators so he could analyze
  - He said that because the cerebellum is physically hard it is responsible for controlling muscle and the cerebrum because its soft it was for sensation
  - Ventricles; Contains the 4 humours, whole flow registers sensation and initiates muscle movements, nerves are conduits for the humours

- Saw the massive cavities in the brain, believed that flow of humours through ventricle
- Nerves communicate liquids that contains sensations and muscle commands

- Views of the Renaissance; Vesalius
- in the middle ages, Vesalius performed dissections of human cadavers (1514-1564)
- **Fluid mechanical theory** of brain function; animal spirits moved in the ventricles
- Through our movements were due to liquids pumped from the brain to the muscles
- Philosophical mind- brain problem; divine mind and material brain, solved by **Rene Descartes** the pineal gland is the seat of the soul (i think therefore I am)
- Soul was somewhere un the brain and reasoned that theres a location in the middle of the brain suited to be the seat of the soul (pineal gland) and that the rest of the Brian was more important for other things like moving the body

- Views of the 16th and 17th Centuries
- Description of nerves
- Discarding spirit animals theories, nerves are not tubes
- Distinction between gray and white matter
- White matter is in continuity with nerves therefore white matter contains fibres that shuttles information to or from the gray matter
- White matter= collection of axons
- Grey matter; somas and where information ca be processed



- Views of the Renaissance to the 19th century
- anatomical description of gyri, sulci, and fissures
- Therefore, we went from a bipartite brain (Galen)to the 19th centre when the brain was though of as being composed of 5 parts

- Views of the 19th Century
- Central divisions; central nervous system (CNS), brain, spinal cord
- Peripheral divisions: peripheral nervous system (PNS), cranial nerves, spinal nerves

- <u>19th Century: **Electric Transmission**</u>
- Nerves are cables capable of transmitting electricity, the nervous system can generate electricity 9similar to Leyden jar or electric fish)
- Moving away from the idea that nerves transmit liquids
- But if nerves transmit electricity, in which direction does the electricity travel?

- <u>19th Century: **Nerves**</u>
- Charles Bell (1774-1842) and Francois Magendie (1783-1855)
- Distinction between dorsal and ventral nerve roots; Carry information in opposite directions
- Sectioning dorsal roots; loss of sensation (dorsal roots; nerves connecting to spinal cord from the back)
- Sectioning ventral roots; paralysis (paralysis therefore start to understand directionality)

- 19th Century; **Localization of Function**

- which parts of the Brian are involved with motor function? What about sensory function?
- **Pierre Flourens** (1794-1867); experimental **ablation** methods (rabbits), lesions followed by behavioural testing
  - Found the cerebellum is involved in motor coordination
  - However is ablations were too global
- **Phrenology of Francis Gall** (758-1828)
  - Bumps on the surface of the skull reflect brain surface and related personality traits
  - Based upon measurements of the heads of hundreds of different individuals, immensely popular
  - Shape of the brain determines characteristics
  - Criminals different measurements, he would say that this difference would constitute the part of the brain that controls reason. No correlation between measurements today
- **Broca's Area; Paul Broca**, physician (1824-1880)
  - Observation of a patient having lost the power of speech following an accident to the head
  - Autopsy and localization of the lesion, in doing so he describes an area important for speech
- **Motor Areas:**
  - Fritsch and Hitzig (dog), electrical stimulation generates movement
  - Ferrier (monkey), ablation and paralysis
- **Visual Areas**; Munk (animals), ablations of the occipital lobe, vision loss
- Phineas Gage; railroad foremen, accident with dynamite in 1848, iron rod through his frontal lobe and destruction of the frontal ventromedial area. Very few neurological physiological changes, but drastic personality change. Clue that frontal lobe is for judgement and reason rather than basic physiology

Evolution of the Nervous System:

- natural selection proposed by Darwin 1802-1882)
- Diverse species have a common ancestor, nervous systems of different species may share common mechanisms
- Rationale for "animal models", ex. Transmission of action potential studied in squid, or studies in addiction using rats
- According to Darwin's theory, certain regions of the brain would have adapted to according to the adaptation of certain species to their specific environment
- **Barrelled cortex-** barrels are special areas that force information from whiskers
- Certainly the monkey doesn't have the barrels because they se their eyes more where as rats need them because they use their eyes less and rely on whiskers more

Neuron; Basic Unit

- Cells vs. Reticular network
- Reticular; physical commination, cells are touching, network
- Cellular Network; everything was close but still some operation between cells
- Cellular theory of the nervous system, the concept of a base unit; the nervous cell

Controversy of Neurons vs. Reticular Network

- Camillo Golgi, invented the AgNO3 stain for the brain
- 1/10 neurons completely stained, everything looked connected
- Champion of the hypothesis of a reticular network organization of the nervous system where everything is physically in continuity
- **Ramon Cajal** improved Gogli's technique and drew the anatomy of a nerve cell and championed the cellar hypothesis of the nervous system
  - He proposed **chemical transmission**

The Soup Vs. Spark Controversy

- Eccles; synaptic stimulation is electrical
- Katz and co; synaptic stimulation is chemical
- It was respond by the discovery of post synaptic potentials, post synaptic logan gated channels and the explanation of synaptic transmission and quanta

Neuroscience today takes a reductionist approach

- levels of analysis: molecular, cellular, systems (or networks), behavioural and cognitive
- Neurologist; diagnosis and treatment of diseases of the nervous system
- Psychiatrist; diagnosis and treatment of disorders of mood and personality
- Neurosurgeon; surgery on the brain and the spinal cord
- Neuropathologist; recognize the changes in nervous tissue that result from disease
- Animal models
  - The more basic the process under investigation, the more distant the evolutionary relationship with humans
  - Examples (from simple to more complex) - nematodes, insects, snails, squid, rodents, monkeys, etc.
  - There are some animal models that exhibit extraordinary behaviours, which require solutions to complex problems. Insights about the operation of the nervous system can also be obtained from these animal models
  - Examples: Owl hearing, Dolphin and bat sonar use, Electro-sensation of weakly electric fish Role of animal welfare societies
  - Neuroscientists accept certain moral responsibilities
    - Ensure that experiments are worthwhile and well planned
    - Eliminate or minimize pain and distress to the animal
    - All possible alternatives must be considered first
  - Animal rights
    - Philosophy, Abolition of animal use, Animal rights activists
- Goal of neuroscience: To learn how the nervous system functions
  - Brain's activity reflected in behaviour
  - Computer-assisted imaging techniques
  - New treatments for nervous system disorders
  - Non-invasive methods
  - Experiments in live tissue