

# Neuroscience: Past, Present, and Future

## Introduction

- Neuroscience is a term that largely arose during the formation of the Society for Neuroscience in 1970
- Neuroscience is interdisciplinary and draws from medicine, biology, psychology, physics, chemistry, mathematics, and computer science
- Neuroscience focuses on understanding how the nervous system works and requires knowledge about many things

## Origins of Neuroscience

### Prehistoric and Ancient Egypt

- Trepanation (boring holes in the skulls) is documented as early as 7000 years ago (about 5000 BC)
- Symptoms of brain damage were noted in ancient Egypt about 3000 BC; however, the heart was considered to be the seat of the soul and the repository of memories

### Ancient Greece

- Hippocrates (460-379 BC) stated that the brain is involved in sensation and is the seat of intelligence
- Aristotle (384-322 BC) stated that the heart is the center of intelligence, and that the brain cools the blood

### Roman Empire

- Galen (130-200 AD) was very involved with dissections and proposed that:
  - The soft cerebrum is the recipient of sensations
  - The less soft cerebellum controls muscles
  - The ventricles contain humors that move to and from the brain through hollow nerves

### Renaissance to 19<sup>th</sup> Century

- Vesalius (1514-1564) provided additional detail of brain structure but stated that the ventricles were the location of brain function (like Galen).
- Descartes (1596-1650) was the chief advocate for the fluid-mechanical view of brain function:
  - Hollow nerves from the eyes project to the brain ventricles and valves control the movement of animal spirits through nerves that inflate the muscles
  - However, Descartes proposed that although the brain controlled behavior that is beast-like, uniquely human behaviors were controlled by the “mind.”

- Others on the 17<sup>th</sup> and 18<sup>th</sup> century began to look at the substance of the brain leading to descriptions of:
  - The central nervous system, including gray matter, white matter, gyri, sulci, fissures, lobes:
  - The spinal cord including horns, columns, and roots
  - The peripheral nervous system and nerves

### **Nineteenth Century views of the Brain**

- Brain injury can disrupt sensations, movement and thought
- The brain communicates with the body via nerves
- The brain has different identifiable parts which likely perform different functions
- The brain operates as a machine

### **Nerves as wires**

- Benjamin Franklin (1751) heralded a new understanding of electricity
- Luigi Galvani and Emil du Bois-Reymond ( $\approx$ 1800) showed that muscles can be caused to contract when nerves are stimulated electrically; and that the brain itself generates electricity.
- These observations gave rise to the new concept that nerves are wires that conduct signals to and from the brain.
- Charles Bell and Francois Magendie ( $\approx$ 1810) showed that cutting only the ventral roots of the spinal cord caused muscle paralysis; and that cutting only the dorsal roots blocked sensory information from getting into the spinal cord.

### **Localization of Specific Functions**

- Charles Bell (1811) proposed that the origin of motor fibers is the cerebellum and that the destination of sensory fibers is the cerebrum (like Galen).
- Marie-Jean-Pierre Flourens (1823) used ablation methods in birds and found support for Bell's proposal.
- Franz Joseph Gall (1809) was convinced that bumps on the skull correlated with differences in brain function and behavior
- Paul Broca (1861) described a patient who could listen to and understand language, but could not speak; upon autopsy the patient had a lesion in the left frontal lobe. Other patients provided supporting evidence for Broca's area and its role in speech production.

### **The Neuron**

- Theodore Schwann (1839) proposed the cell theory, where all tissues are composed of cells.
- Although there was considerable debate whether nerves cells were the basic unit of the brain, by 1900 the neuron was recognized to be basic functional unit of the nervous system.

# Neuroscience Today

## Levels of Analysis

### Molecular Neuroscience

- Is concerned with molecules of the nervous system that include:
  - Chemical messengers that allow neurons to communicate with each other.
  - Transport proteins that control what substances can enter or leave neurons
  - Nerve growth factors

### Cellular Neuroscience

- Is concerned with how molecules work together to give neurons their special properties.
- Study differences in function of different types of neurons.
- Asks questions such as how do neurons influence other neurons, become wired together, and perform calculations?

### Systems Neuroscience

- Focuses on the assemblies of neurons that form complex circuits to perform a common function.
- Asks questions such as how do circuits analyze sensory information, form perceptions, make decisions and execute movements?

### Behavioral Neuroscience

- Asks questions such as how do neural systems work together to produce integrated behavior?
  - Are different types of memories accounted for by different systems?
  - Where is the action of mind-altering drugs in neural systems involved in mood and behavior?
  - Why do we sleep and where do dreams come from?

### Cognitive Neuroscience

- Is concerned with neural mechanisms responsible for human mental activity, self awareness, mental imagery, and language.

### The scientific Process

- Observation from experimentation designed to test a particular hypothesis, from carefully watching the world, from introspection, from human clinical; cases.
- Replication by repeating the experiment, or making similar observations on different subjects.
- Interpretation of the findings that depend on the state of knowledge at the time
- Verification through reproduction by other scientists.