How Do We Get From To This...

To This?

Cells of the Nervous System – It Starts Here

- Neurons (nerve cells)
  - specialized cells that receive information and transmit it to other cells
- Glia (Greek for “glue”)
  - provide physical and functional support to neurons
  - do not transmit information over long distances as neurons often do
  - outnumber neurons in the brain by almost 10:1
  - on average, 1/10th the size of a neuron

Cells of the Nervous System – Structure

Advice for a Young Investigator by Ramón y Cajal

“As with the lover who discovers new perfections every day in the woman he adores, he who studies an object with an endless sense of pleasure finally discerns interesting details and unusual properties...”

Features of a Typical Neuron

Flow of Information in Neurons

Flow of Information: Afferent to Efferent

Representative Types of Neurons (based on structure)

The Structure of a Neuron is Related to Its Function

- The shape of a neuron determines its connects with other neurons, and thus how it contributes to overall function of the system
- Widespread dendritic branches
  - good for integrating large amounts of incoming information
- Short branches on dendrites
  - pool input from only a few sources

Representative Types of Neurons
Representative Types of Neurons

Representative Types of Neurons

The Synapse (Greek “to join together”)

Types of Synapses (Sometimes classified based on structure):

• Axo-dendritic
• Axo-somatic
• Axo-axonic

Types of Synapses (Sometimes classified based on function and neurotransmitter used):

• Examples:
  – Excitatory - Glutamate
  – Inhibitory - GABA
  – Modulatory - Adrenergic

Glia: Supporting cells of the Nervous System

• Oligodendrocytes: form myelin sheath in the central nervous system
• Schwann cells: form myelin in the peripheral nervous system
• Astrocytes: provides structural support for neurons of the central nervous system; provide pathways for movement of nutrients between blood vessels and neurons; regulate the chemical composition of extracellular fluid; contribute to healing damaged brain tissue (glial scar)
• Microglia: act as phagocytes to protect the brain from invading microorganisms
• Ependyma: line the ventricles and other cavities around the brain, act as a barrier - may secrete small amount of cerebrospinal fluid

Oligodendrocytes and Schwann Cells

Oligodendrocytes and Schwann Cells

Multiple Sclerosis

• In the brain
  – On pathways bringing sensory information to the brain
  – On pathways taking commands to muscles
  – Loss occurs in patches
  – Scarring frequently left in affected areas

Astrocytes in the Brain

The Blood-Brain Barrier
27 The Blood-Brain Barrier
- Regulates the chemicals that can enter the CNS from the blood
- Is weak in a region of the brain called the area postrema - poisons can be detected there and vomiting initiated

28 The Blood-Brain Barrier
- BBB is selectively permeable
  - Small uncharged molecules (Ex. oxygen and carbon dioxide), and molecules that can dissolve in the fats of the capillaries wall (most psychoactive active drugs are fat soluble) cross the barrier passively
  - Other molecules must be actively transported from blood into brain (glucose etc.)
  - Examples of what DOES cross from blood into the brain:
    - Glucose; nicotine; alcohol; oxygen; heroin (10X more readily than morphine)
  - Examples of what DOES NOT cross from blood into the brain:
    - Dopamine; most viruses and bacteria; penicillin

29 Astrocytes in the Brain
- May help to synchronize associated axons
  - They wrap presynaptic terminals of several axons (a functionally related group?)
  - Take up chemicals released by axons and release them later
  - Helps to synchronize activity of the axons, enabling to send messages in waves

30 Microglia in the Brain
31 Ependymal Cells
32 Brain Tumors
- Grow from glia or other supporting cells
  - Gliomas (from glial cells)
  - Meningiomas (attach to the covering of the brain)
  - Metastatic (from other locations)

33 Brain Tumors
- Treatment:
  - Usually surgery
  - Radiotherapy
  - Chemotherapy
  - Less successful in treating brain tumors - difficult to get the chemicals across the blood brain-barrier