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…”

Golgi-stained hemisphere of a mouse brain
Nissel-stained section of a monkey brain

Features of a Typical Neuron

Flow of Information in Neurons
Flow of Information: Afferent to Efferent
Representative Types of Neurons
(based on structure)
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
(based on function)

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 or 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

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### Oligodendrocytes and Schwann Cells

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### 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

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### Astrocytes in the Brain

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### 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

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### 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:

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• Dopamine; most viruses and bacteria; penicillin

31 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

32 Microglia in the Brain
33 Ependymal Cells
34 Brain Tumors
Most primary brain tumors grow from glia or other supporting cells
- Gliomas (from glial cells)
- Meningiomas (attach to the covering of the brain)
Metastatic (start with cells from another location)

35 Brain Tumors
Treatment:
- Usually surgery
- Radiotherapy
- Chemotherapy
  . Often less successful in treating brain tumors - difficult to get the chemicals across the blood brain-barrier