9.01 Introduction to Neuroscience
Fall 2007

Chapter 1 Review

Trepanation as cure (7000 B.C.)
Egyptian writings (5000 B.C.)

Heart vs. brain debate (400s B.C. Greece; Aristotle vs. Hippocrates)
Ventricular localization of function (200s A.D. Rome; Galen discovered ventricles, CSF)
Fluid mechanical theory (1500s; Descartes, mind separate from brain)

Nerves as wires (1700s; Ben Franklin discovers electricity; Galvani, de Bois Reymond test nerves)
- Bidirectional? (1810; Bell/Magendie determine ventral roots = motor; dorsal roots = sensory)

Discoveries in neuroanatomy (Vesalius, etc.)
- Gray matter (cell bodies) vs. white matter (axons)
- CNS (brain, spinal cord, retina) vs. PNS (everything else)
- Bumps (gyri) and grooves (sulci and fissures)

Localization of function (1800s; experimental ablation method = destroying parts of brain to test their function; Bell/Magendie, Flourens, Fritsch/Hitzig, Ferrier; Munk)
- Phrenology = correlating structure of head with personality traits (1809, Gall)
- Flourens was huge critic of Gall and localization of function
- Broca (1861; Broca's Area)

Evolution of nervous systems (1859; Darwin) = use of animal models
Neurons (1800s, microscopy advances, cell theory)

Chapter 2 Review

Neurons vs. glia (10x more glia than neurons; glia insulate and support; ~100 billion neurons)

Visualize the neuron = harden the brain (formaldehyde), slice it (microtome), stain
- Nissl stain (all cells stained; only nucleus, membrane, rER; distinguish between neurons, glia; study cytoarchitecture)
- Golgi stain (small percentage stained in entirety, can see soma and neurites)

Cajal v. Golgi
- Neuron Doctrine (Cajal) = neurons communicate by contact
- Reticular Theory (Golgi) = neurons communicate by continuity
- Final proof had to wait until development of electron microscope in the 1950s

Neural anatomy (**see http://www.brown.edu/Courses/BN01/images/review/neuron.pdf**)
- Soma = cell body = perikaryon (cytosol, organelles, cytoplasm)
    - Nucleus (DNA, chromosomes, genes)
    - Rough endoplasmic reticulum (ER with ribosomes; protein synthesis)
    - Ribosomes (on ER or free) vs. polyribosomes (free ribosomes attached by mRNA)
    - Smooth endoplasmic reticulum (variety of functions)
    - Golgi apparatus (sorting of proteins)
    - Mitochondria (site of cellular respiration; creates ATP)
    - Remember: DNA is transcribed → mRNA is translated → Protein
- Neuronal membrane (barrier; proteins as receptors, channels, etc.)

- Cytoskeleton ("internal scaffolding")
    - Microtubules (longitudinally down neurites; tubulin protein braided together; MAPs)
    - Microfilaments (attached to membrane in neurites; fibrous like web; thin braids of actin)
    - Neurofilaments (intermediate size; mechanically very strong)

- Neurites = axons and dendrites

Axons

- No rER, few free ribosomes
- Uniform width; travels long distances; "wires"; branches (or collaterals) at right angles
- Speed of action potential conduction depends on diameter (thicker = faster) and myelination
- Axon terminal or terminal arbor; synapse is point of contact with other cells
- Cytoskeleton, mitochondria

Synapse (presynaptic, postsynaptic, synaptic cleft, synaptic transmission); electrical → chemical → electrical

Axoplasmic transport (movement of proteins, materials up and down axons)

- Remember: no ribosomes in axons; if cell bodies removed, axons would die (Wallerian degeneration)
- Proteins, material enclosed in vesicles, are "walked down" microtubules
- Protein "legs" = kinesin (anterograde transport, soma to axon); dynein (retrograde, axon to soma)
- Process uses ATP
- Retrograde transport can be exploited by scientists and viruses
    - Horse-radish peroxidase (used by scientists to trace connections in the brain)
    - Oral type of herpesvirus
    - Rabies virus

Dendrites

- Taper; short in length; "antennae"
- Branches at acute angles
- Of a single neuron = dendritic trees
- Cytoskeleton; mitochondria
- Spines; polyribosomes located under spines → synaptic transmission directs local protein synthesis

Classifying neurons

- No. of neurites (uni-, bi-, multi- polar)
- Shape of dendritic tree (stellate or pyramidal, page 45)
- Spiny or aspinous
- Connections (sensory, interneurons, motor neurons)
- Axon length (extend to other parts of brain or project locally; Golgi Type I and Type II)
- Neurotransmitter (see Ch. 6)

Glia

- Astrocytes (most numerous glia; insulation; support; regulating chem. content of extracellular space)
- Myelinating glia (provides myelin for axons; myelin sheath; node of Ranvier)
    - Oligodendroglial (CNS)
    - Schwann cells (PNS)
- Ependymal cells (lines fluid-filled ventricles of brain)
- Microglia (phagocytes)