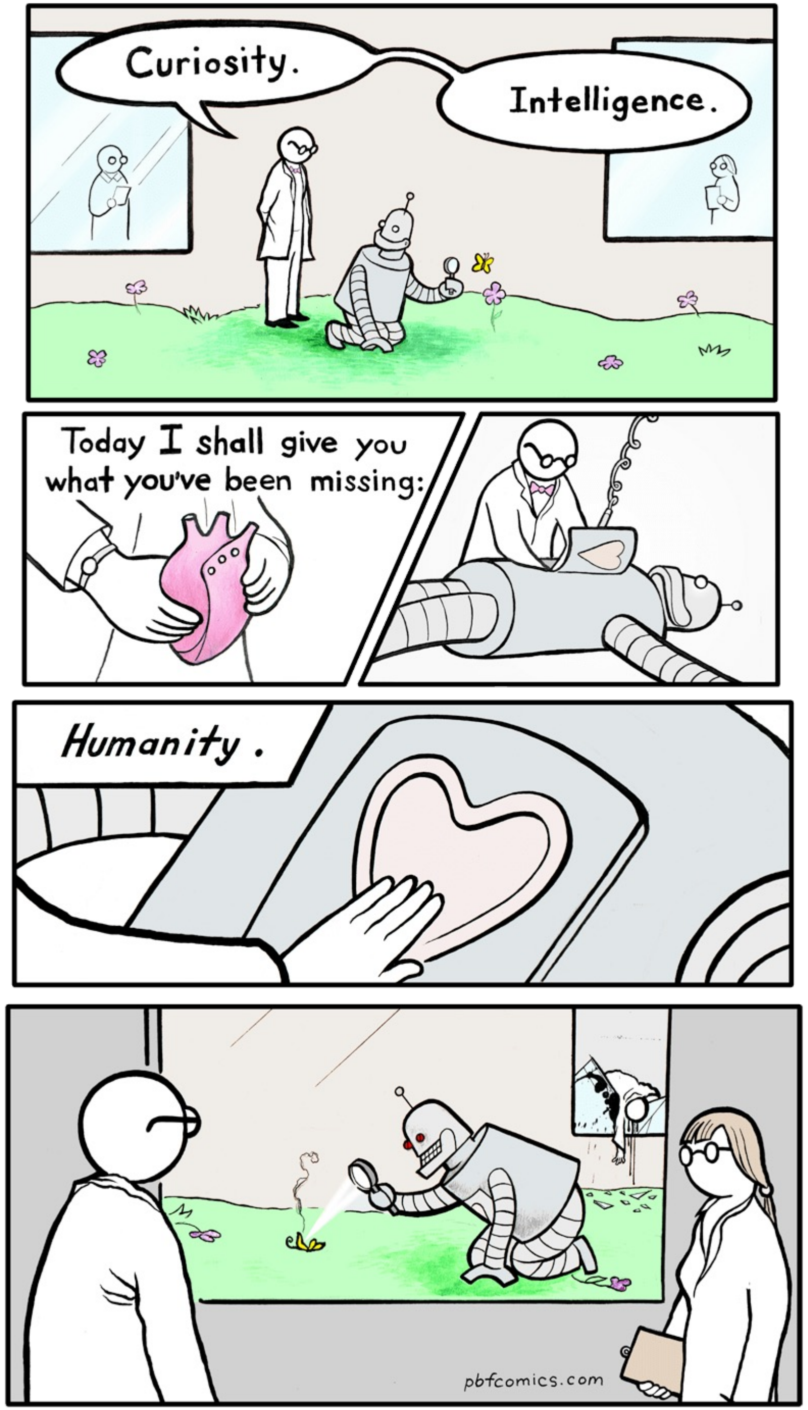
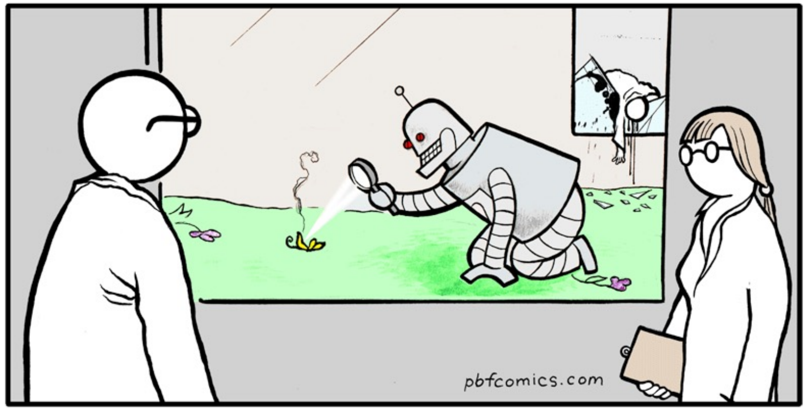
PSYC301: Neuroanatomy I (cells)

Jay Hosking, PhD



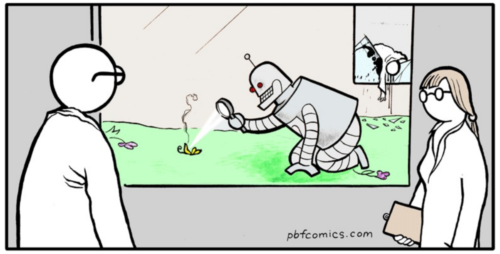
Overview

A. Some basics on the brain
B. Neurons
C. Glia
D. The wonderful world of the cell



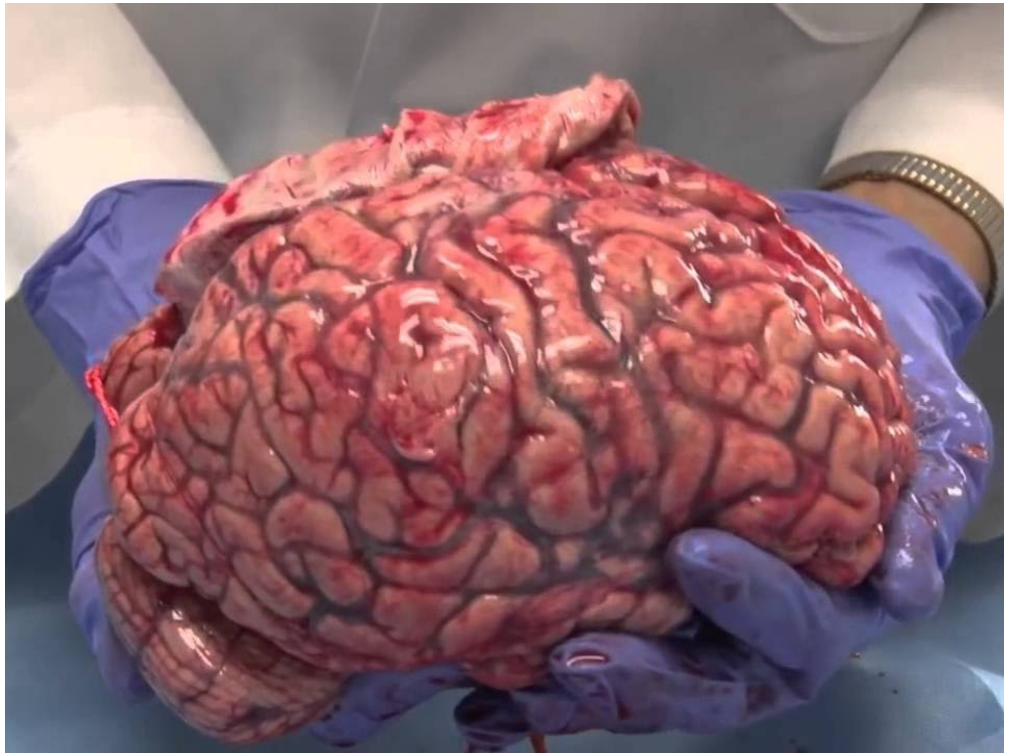
Learning objectives

1. Have a foundational understanding of basic brain facts.
2. Name and describe two general types of cells within the nervous system.
3. Identify three types of staining and the use case for each.
4. Name four types of glial cells and describe some functional roles for each.
5. Explain what is meant by a “tripartite synapse.”
6. Describe the central dogma of molecular biology.
7. Name and describe the function of some key cellular structures. In future, note how these relate to brain dysfunction!
8. Describe the relationship between dendrites and some common brain dysfunctions.
9. (Optional) Read the associated chapter, Pinel & Barnes Ch. 3, up to page 64.



Human brain facts

- 2-3% of body weight, ~3lbs
- Consumes ~20% of your energy!
- Slightly larger in men than women
- Huge individual variation
- Composed of neurons, glia, stem cells, blood vessels
- <100 billion neurons (hard to say), more than half of which are cerebellum
- Consistency of soft tofu (yum)
- Convoluted (wrinkled)
- Cells are not replaced



Adult neurogenesis or no?

- A long history of controversy
- First no, then yes, now no again?

LETTER

doi:10.1038/nature25975

Human hippocampal neurogenesis drops sharply in children to undetectable levels in adults

Shawn F. Sorrells[1,2]*, Mercedes F. Paredes[1,3]*, Arantxa Cebrian-Silla[4], Kadellyn Sandoval[1,3], Dashi Qi[5], Kevin W. Kelley[1], David James[1], Simone Mayer[1,3], Julia Chang[6], Kurtis I. Auguste[2], Edward F. Chang[2], Antonio J. Gutierrez[7], Arnold R. Kriegstein[1,3], Gary W. Mathern[8,9], Michael C. Oldham[1,2], Eric J. Huang[10], Jose Manuel Garcia-Verdugo[4], Zhengang Yang[5] & Arturo Alvarez-Buylla[1,2]

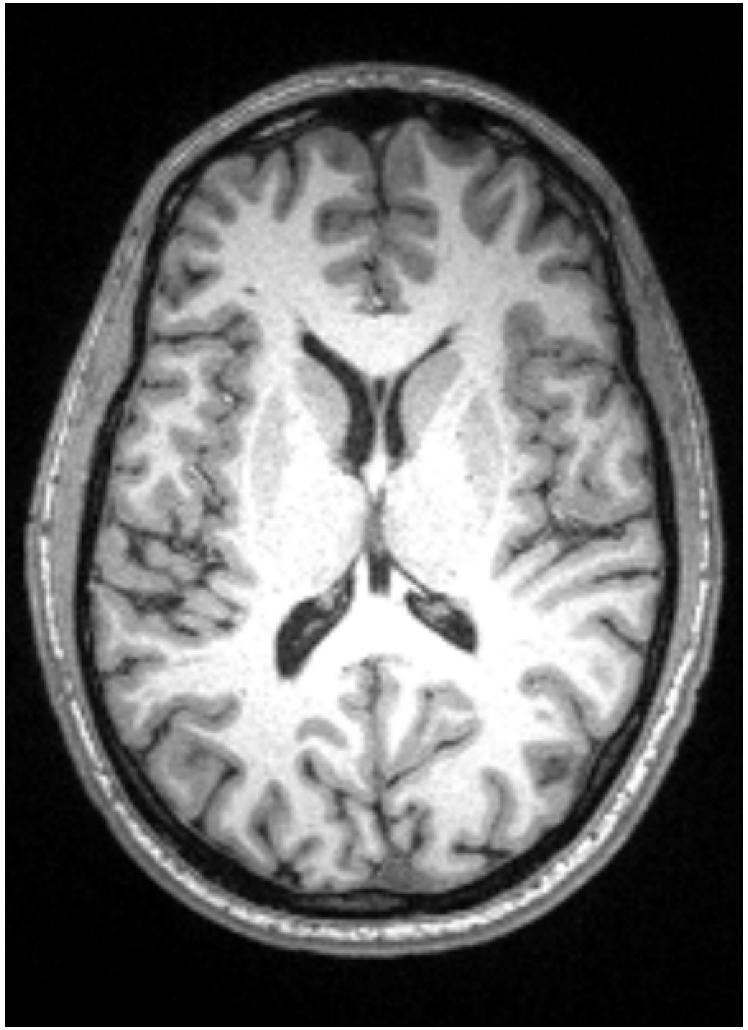
Sorrells *et al.* 2018

See Professor Jason Snyder’s excellent piece on this: http://snyderlab.com/2018/03/07/wtf-no-neurogenesis-in-humans/
We will be reading a great review on this topic for a later lecture!

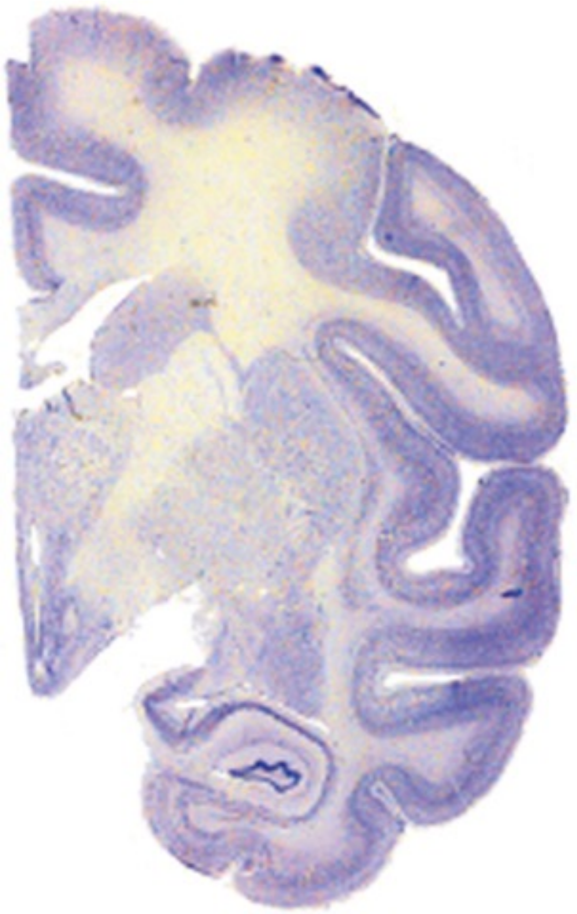
“Matter”

- Gray Matter
- White Matter

Myelin



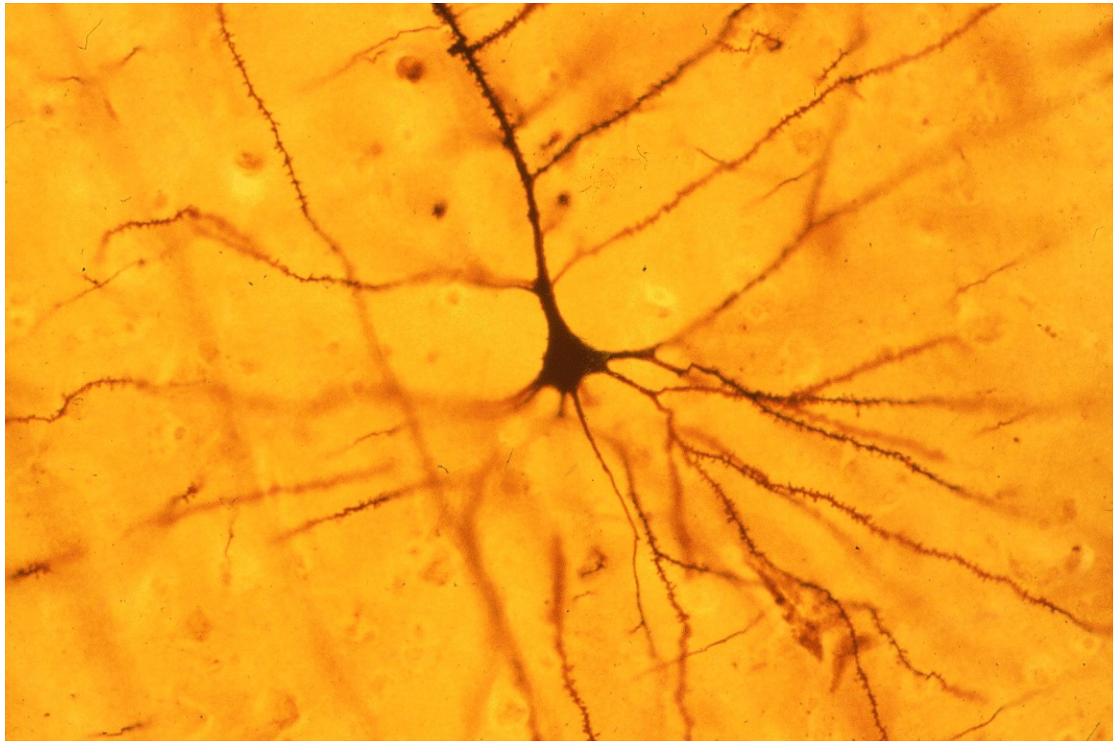
Staining reveals “matter”

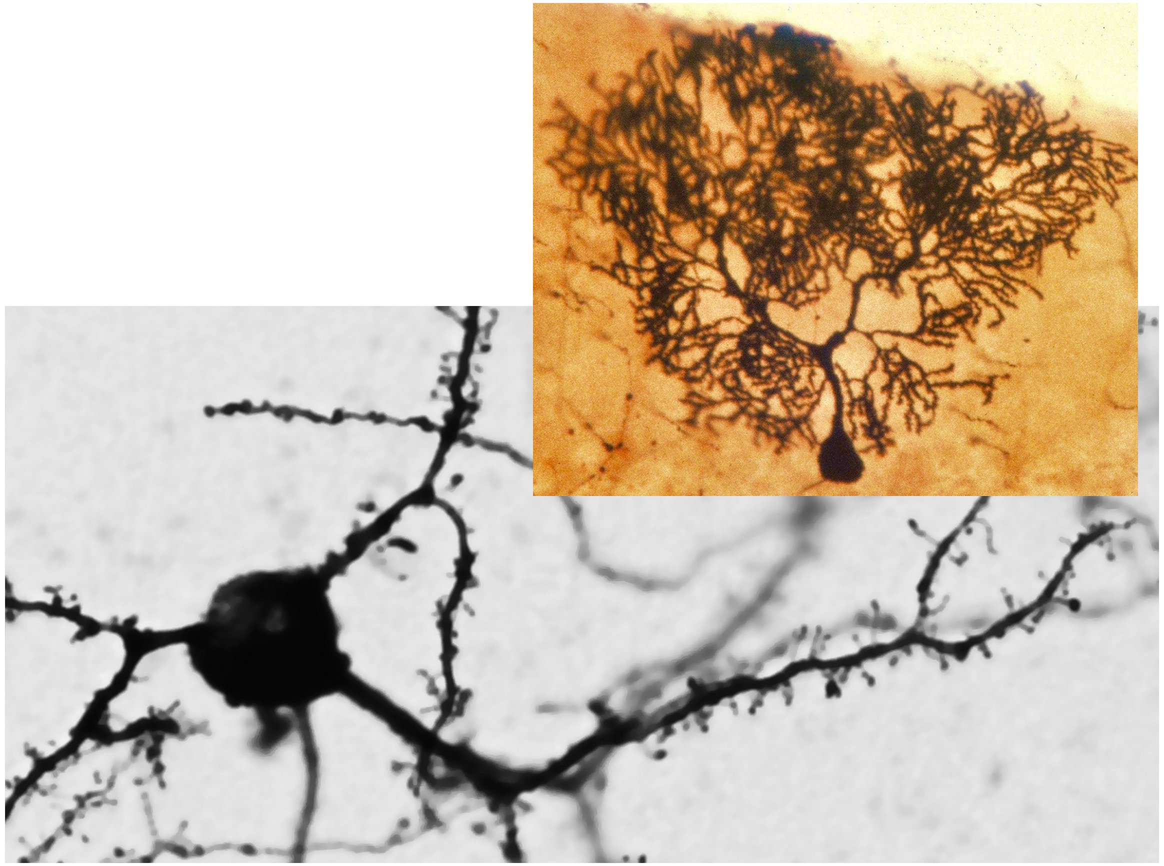

Nissl (cresyl violet) staining


Fiber staining

One of the big challenges with studying humans:
Many neuroscience methods are either invasive
or require postmortem tissue (as here)

Staining also reveals cell types

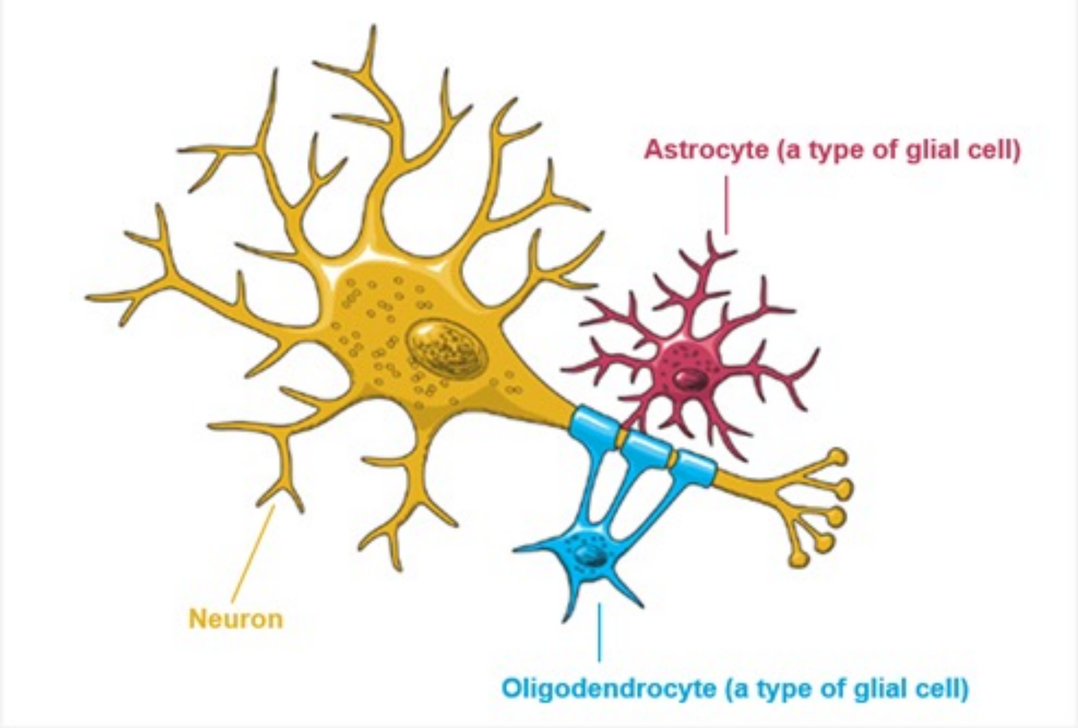




All of these use the Golgi stain

Two basic cell types

- Neurons
- Glia

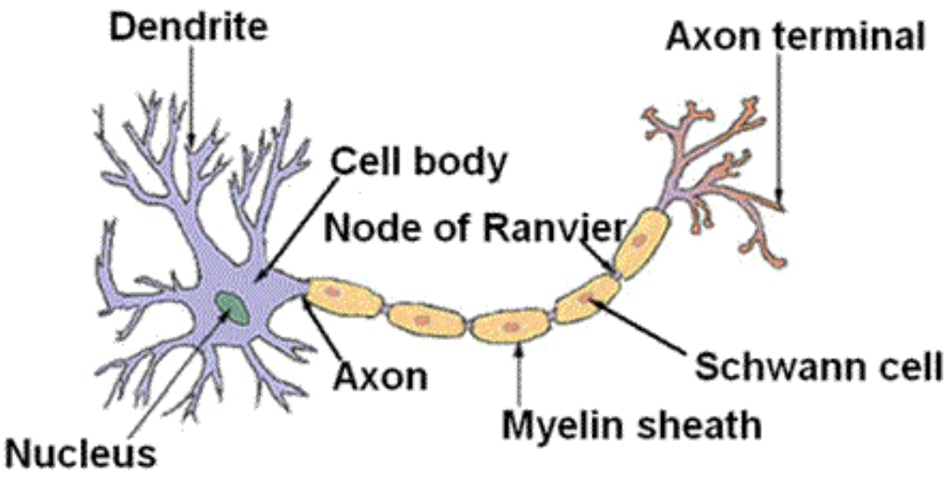


The neuron

- Many types, but similar design
- Dendrite → soma → axon → terminals

flow of signal

input  **output**



The neuron

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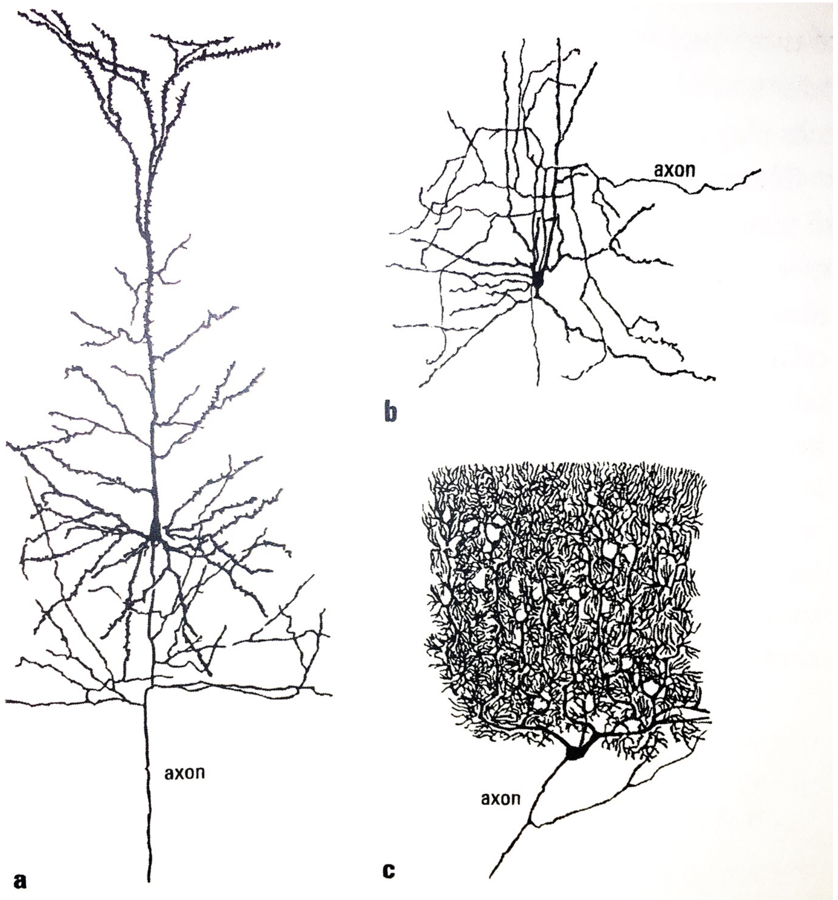
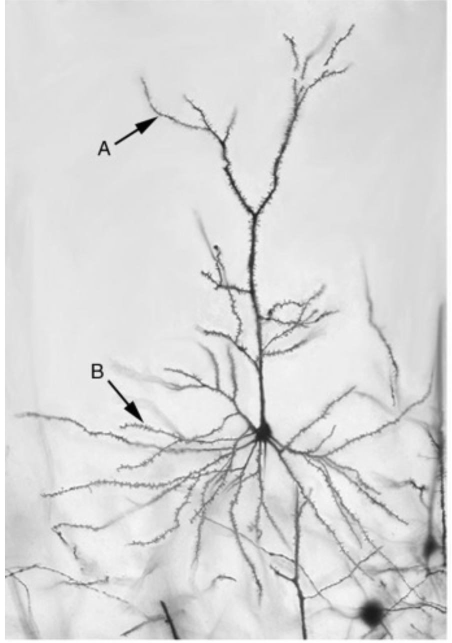
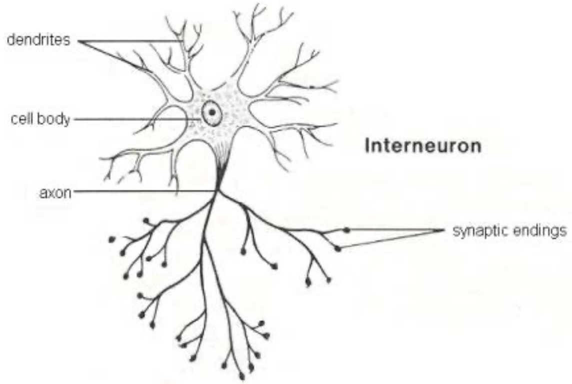


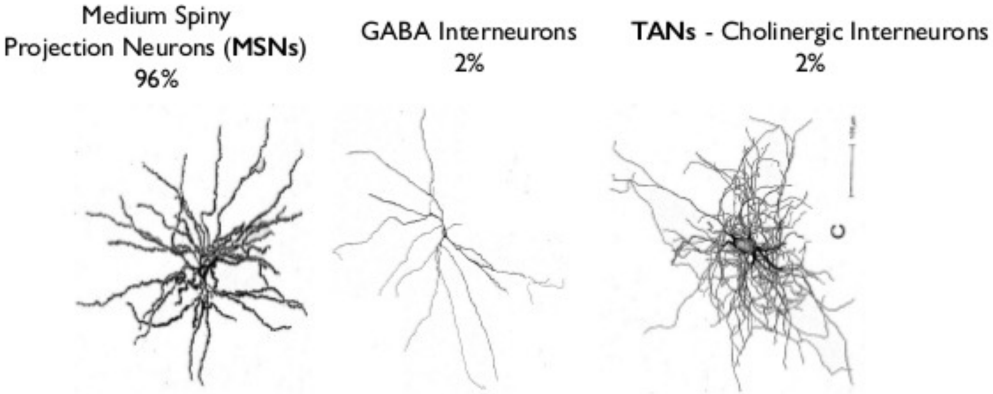
a. Pyramidal
b. Stellate
c. Purkinje

Two basic types of neurons

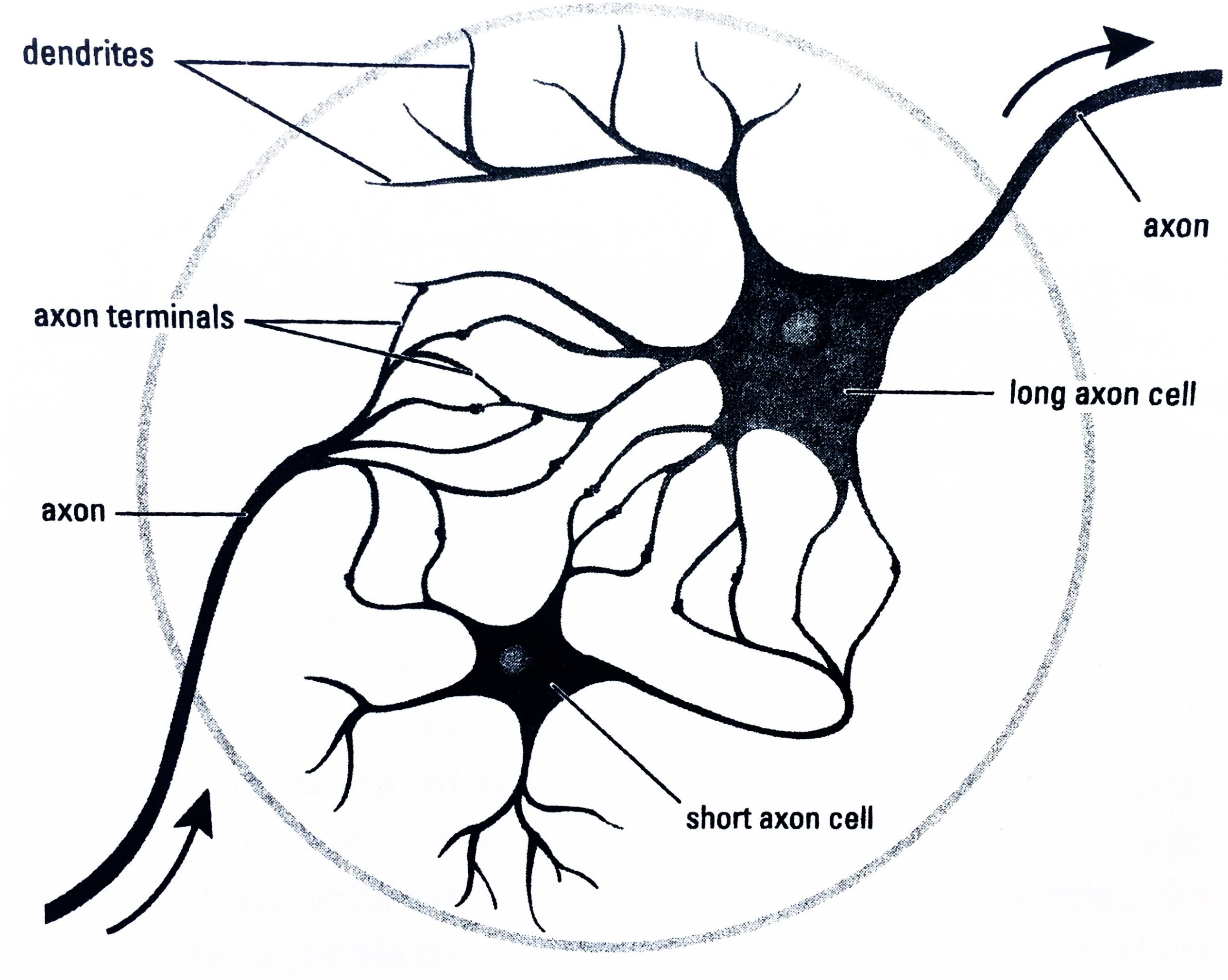
- Projection neurons
- Interneurons



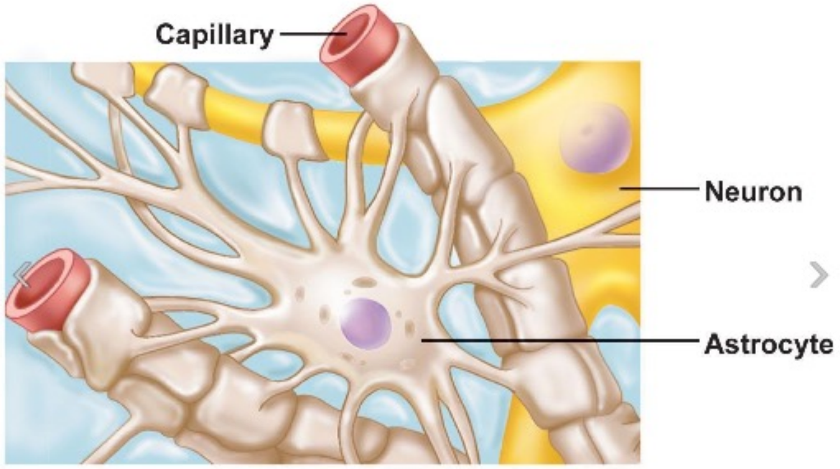




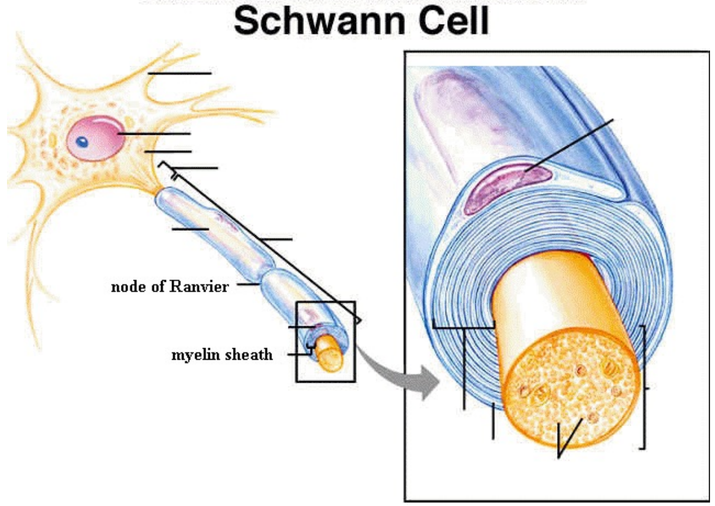
Two basic types of neurons

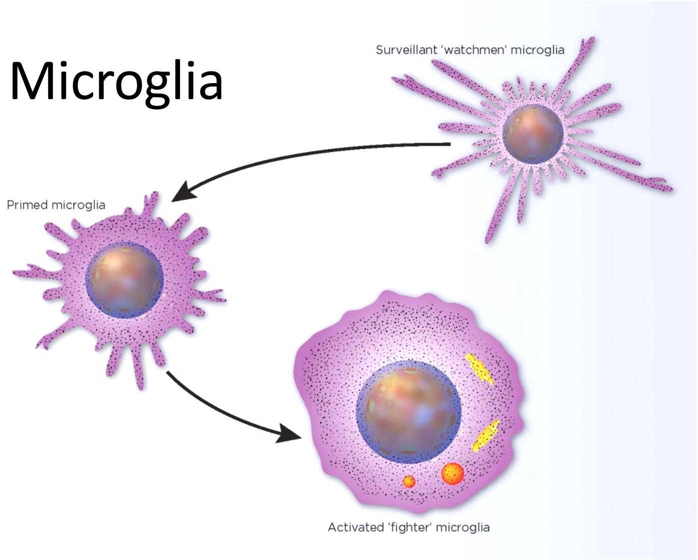


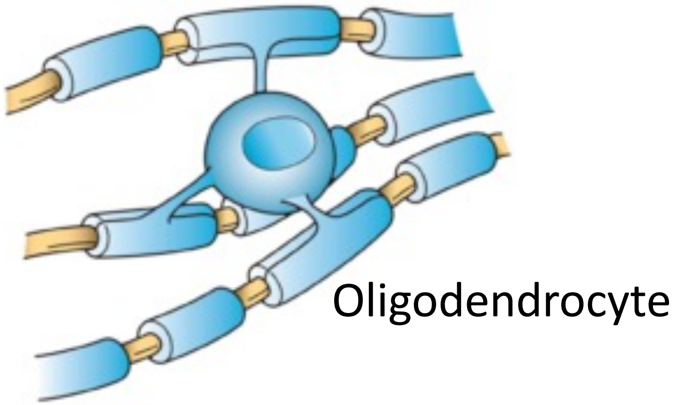
Glial Cells



(a) Astrocytes are the most abundant CNS neuroglia.

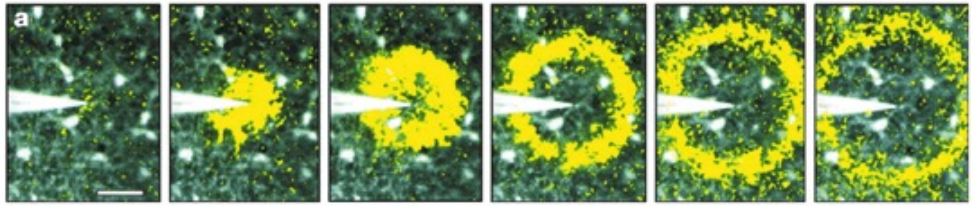


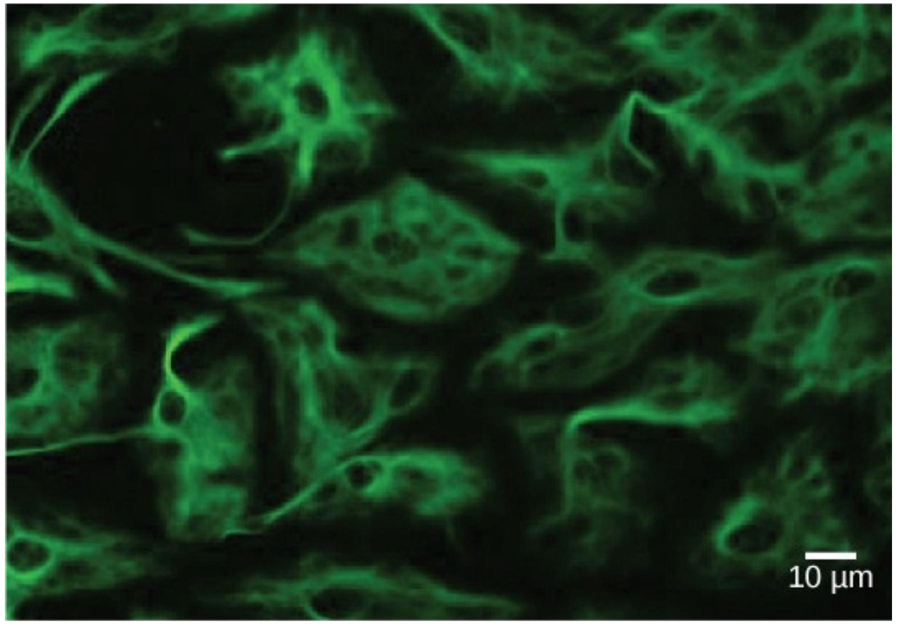


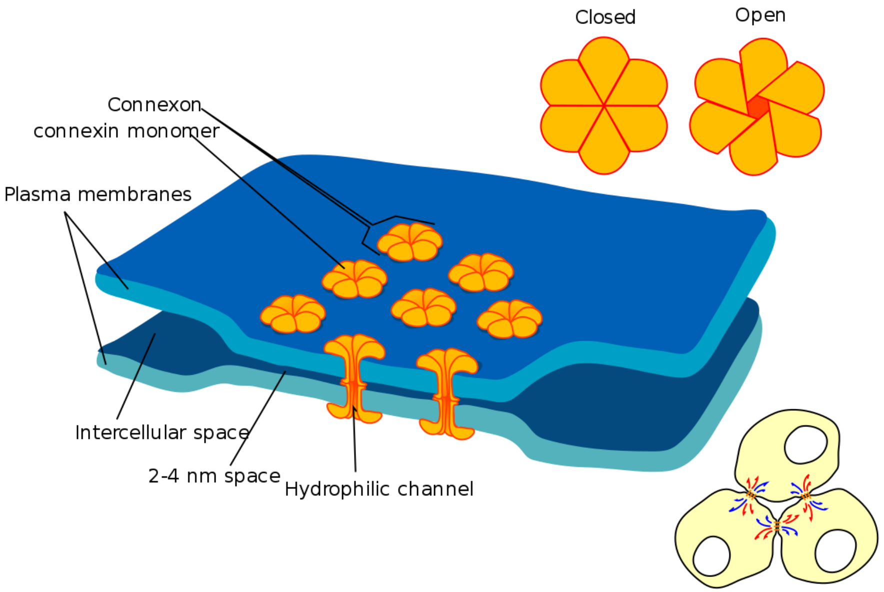


Glial networks (astrocytes)

- Gap junctions
- (Note: some neurons have gap junctions as well!)

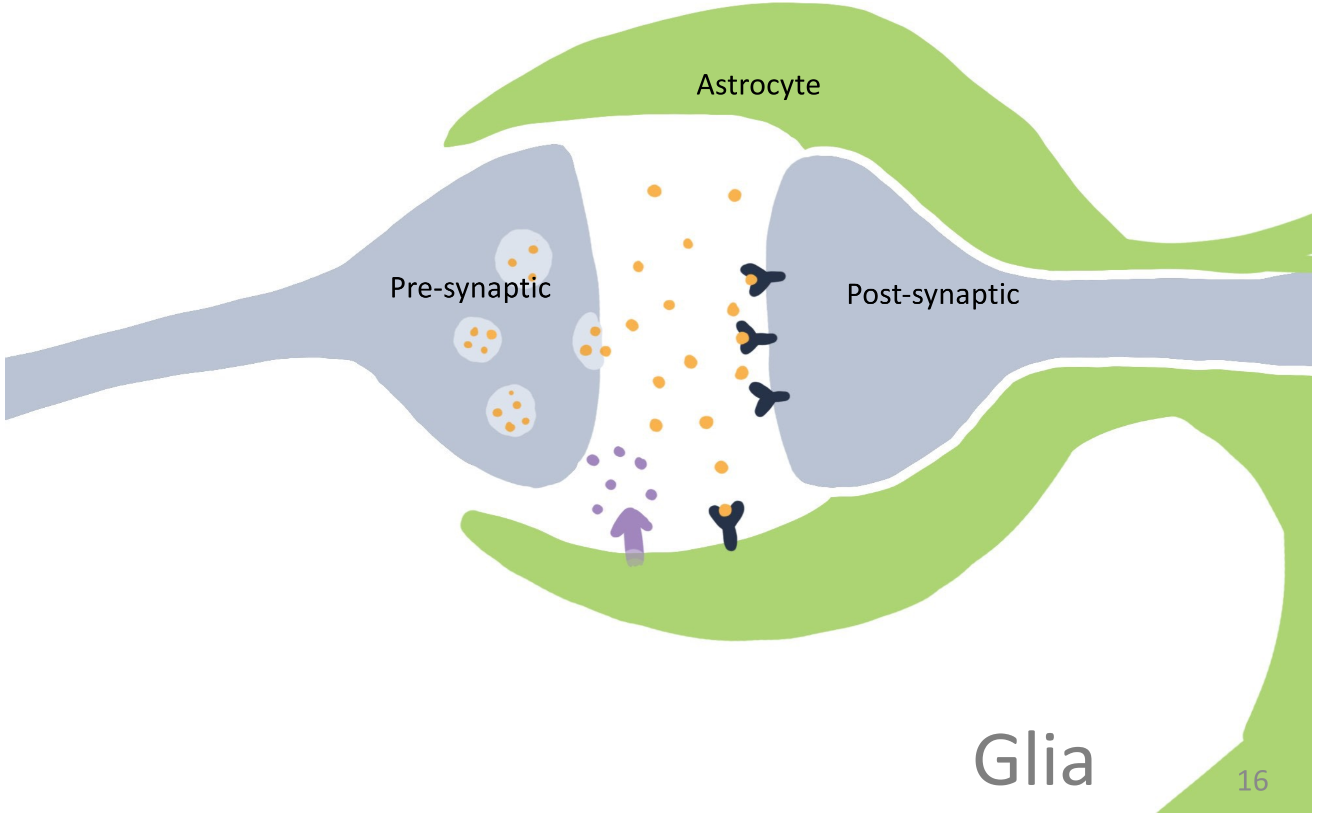




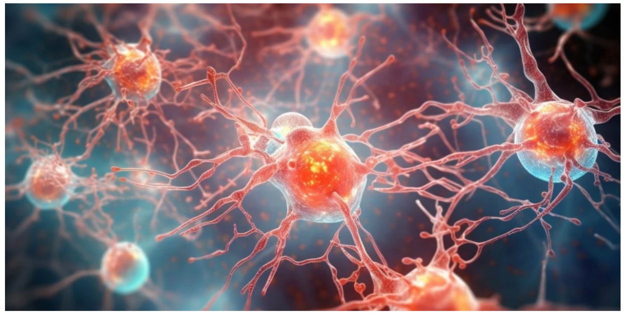


The tripartite synapse

- A conversation of three
- Neurotransmission *and* gliotransmission



Ripped from the headlines



Featured Neuroscience Psychology · June 5, 2023 · 6 min read

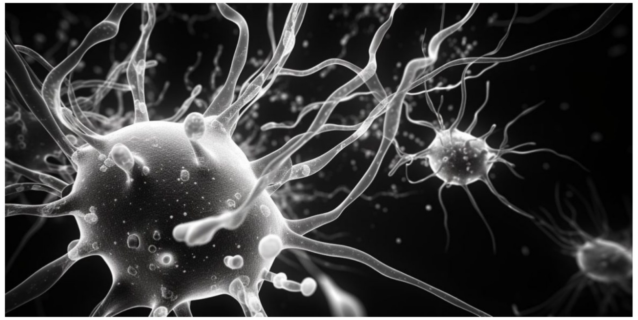
Microglia’s Role in Controlling Anxiety and OCD

A new study reveals how microglia can regulate anxiety and obsessive-compulsive spectrum disorder (OCSD) behaviors. Traditionally overlooked in favor of neurons, specific microglia populations were found to both stimulate and suppress these behaviors, thus acting as both a "brake" and "accelerator".

Featured Neuroscience Psychology · May 22, 2023 · 5 min read

Microglia Less Active in Those With Depression

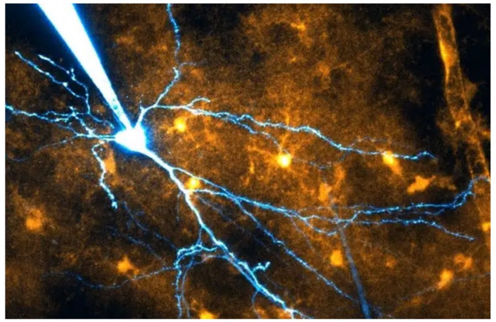
Researchers have uncovered a crucial link between depression and the immune system. A new study reveals microglial cells, a type of immune cell in the brain, are less active in individuals with depression.



Featured Neuroscience · May 15, 2023 · 4 min read

Unique Microglia Subset Crucial for Cognitive Functioning

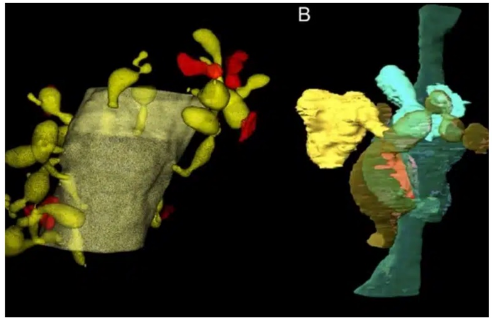
A new study discovered not all microglia are the same, challenging existing beliefs. A unique subset of these cells, the ARG1+microglia, important for proper cognitive functions, were identified in mice, with evidence suggesting a similar subset exists in humans.



Featured Neuroscience · January 10, 2023 · 5 min read

Glial Cells Help Memory Along

Astrocytes play a crucial role in spatial learning, researchers discovered.



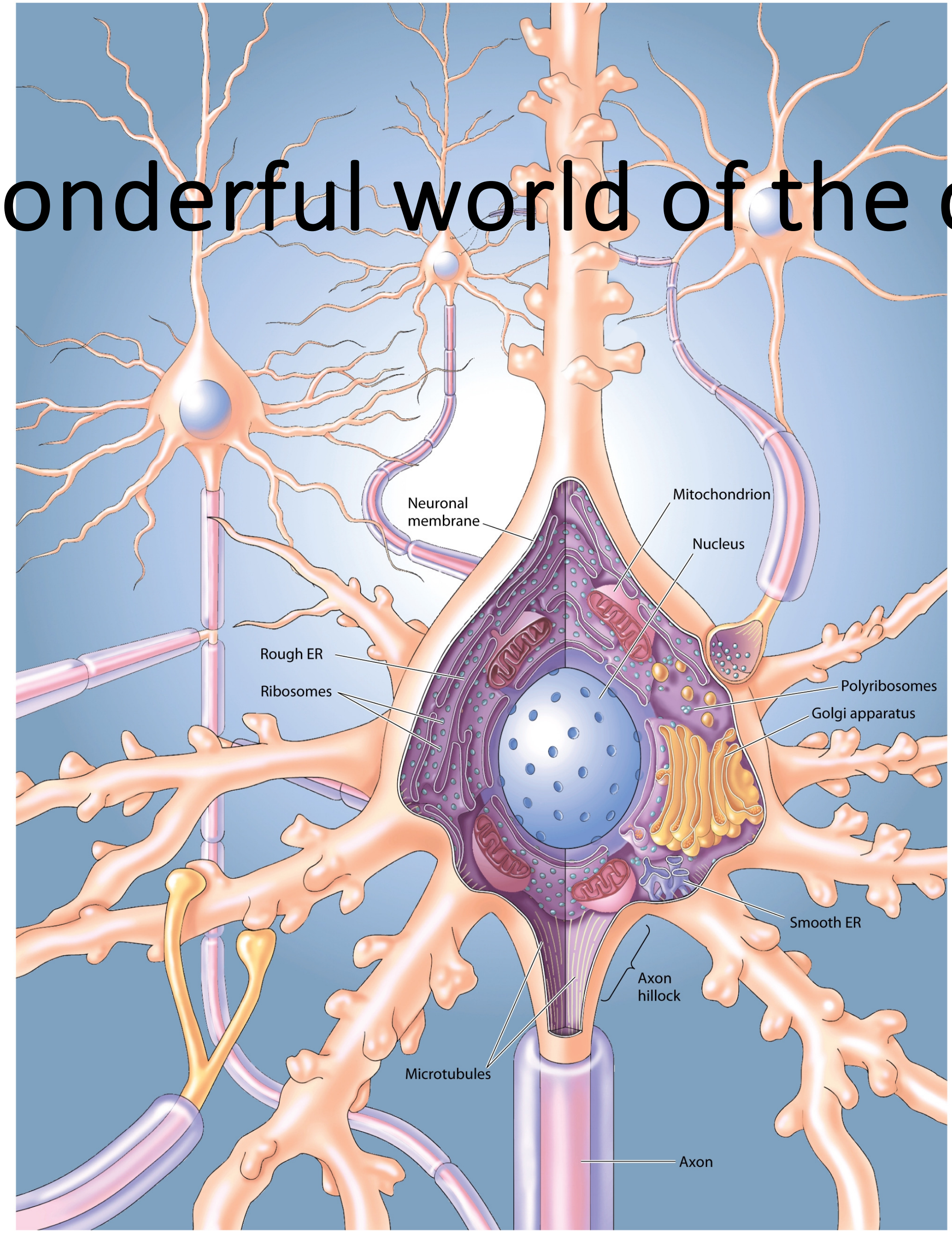
Featured Neuroscience · November 2, 2022 · 4 min read

Glial Cells Eating of Synapses May Enhance Learning and Memory

Bergmann glial cell synaptic engulfing in the cerebellum was enhanced during motor learning in mice.

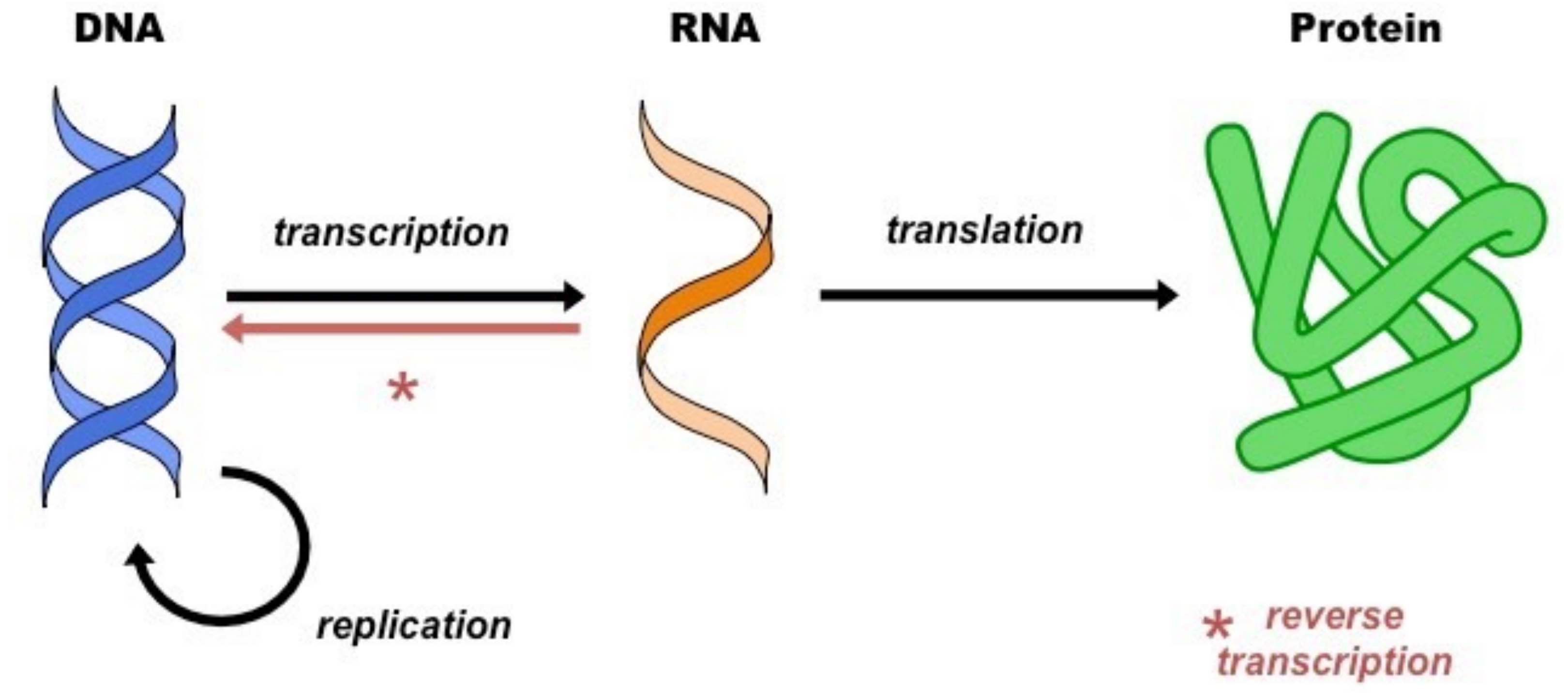
- Glia play a key role in brain function, and we will hardly talk about them throughout this course

The wonderful world of the cell

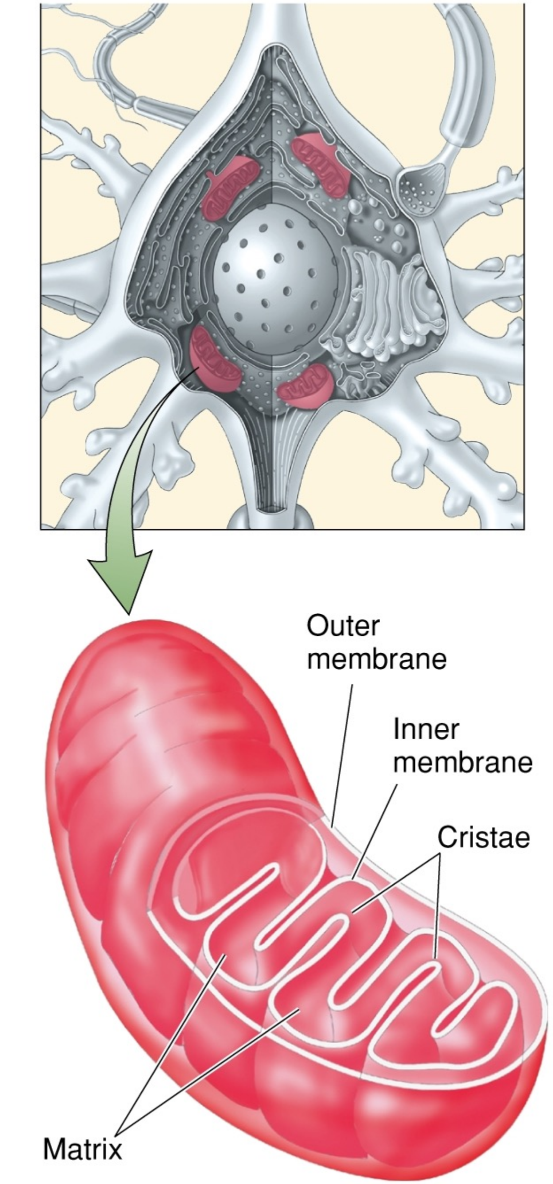


The central dogma of molecular biology:

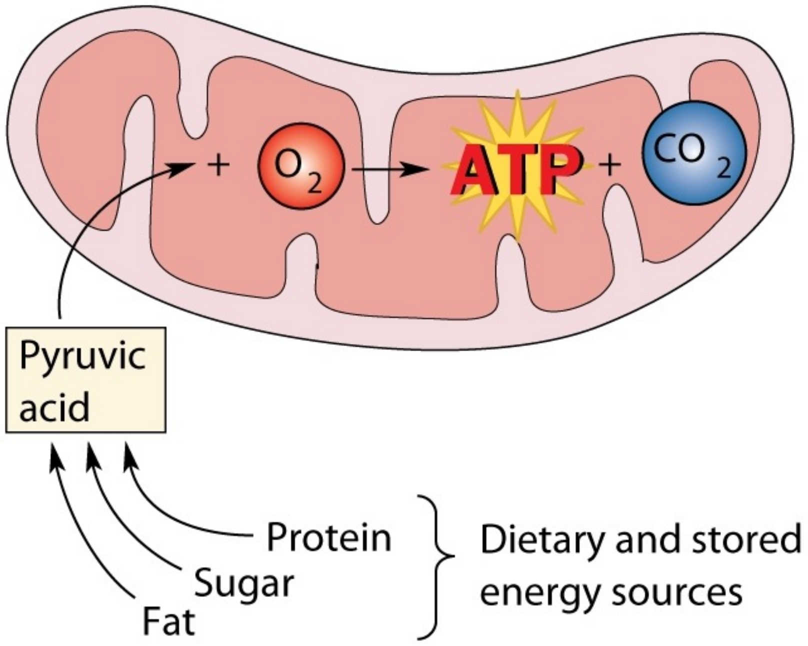
DNA → mRNA → Protein



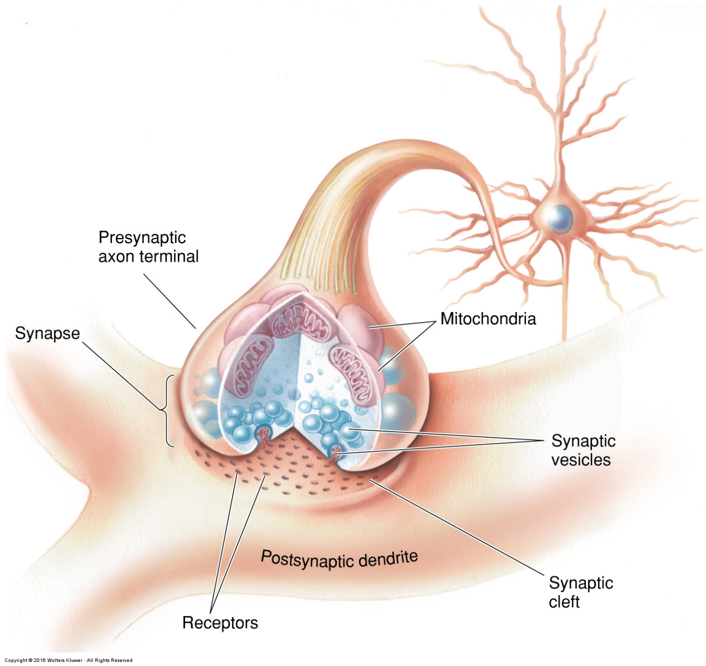
Soma (and elsewhere): Mitochondria



(a)

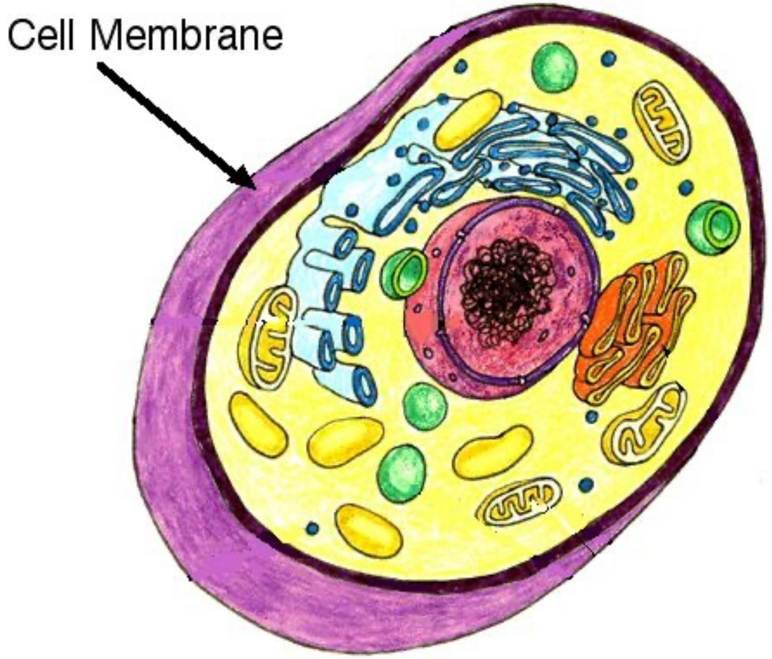


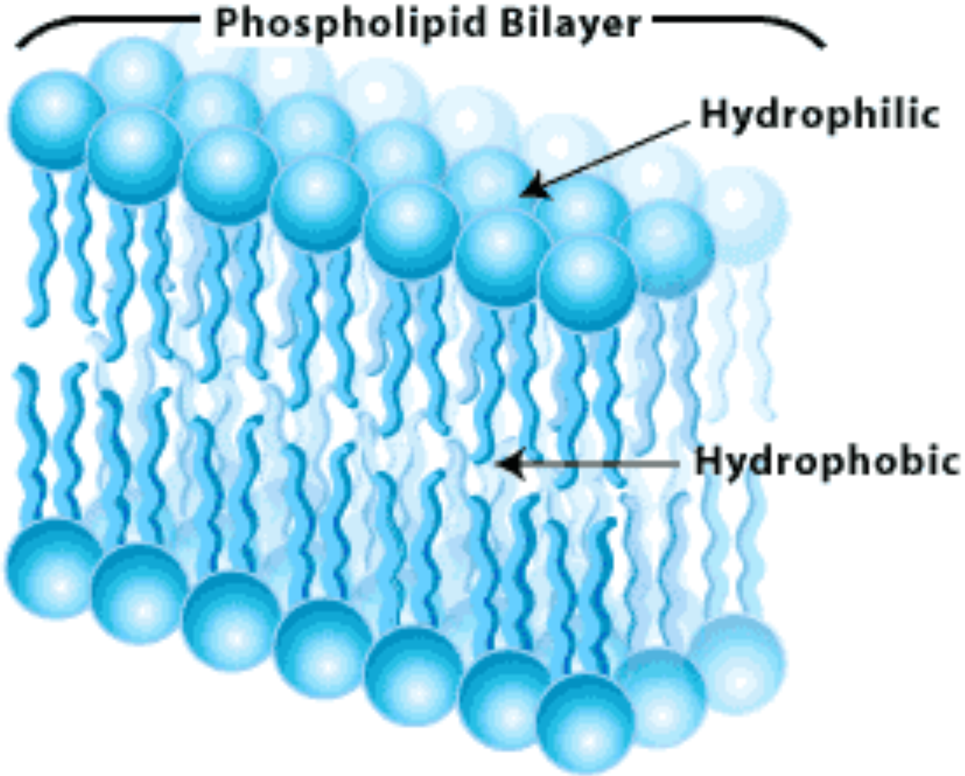
(b)

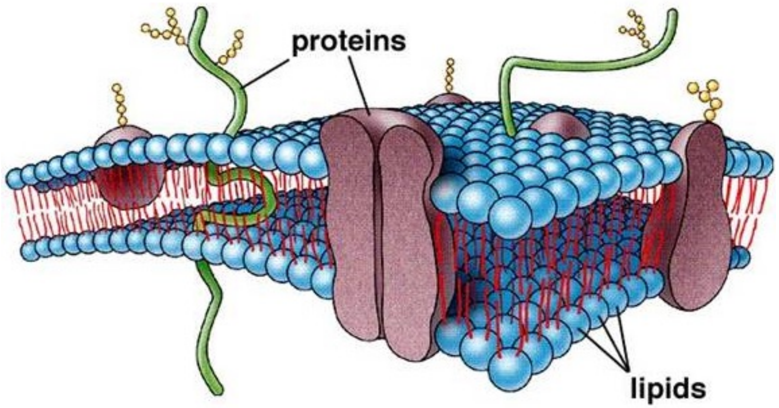


- Engulfed bacteria?
- mtDNA
- Mitochondrial Eve?

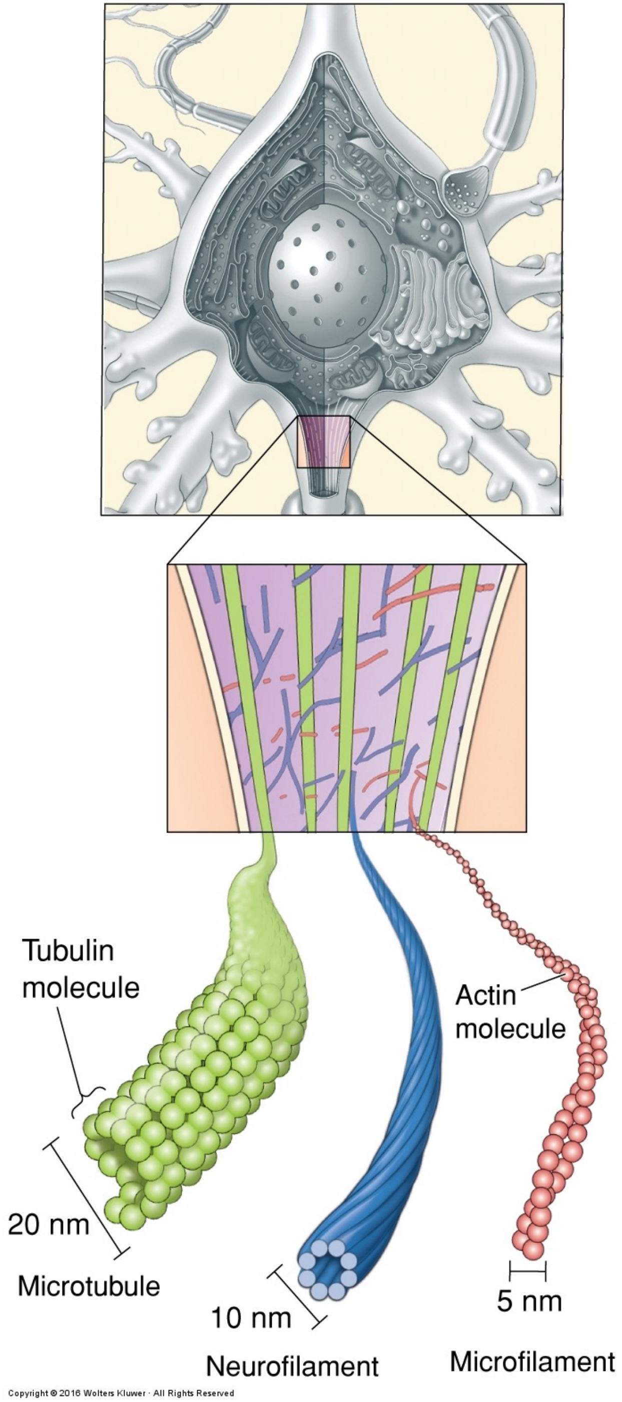
The cell membrane

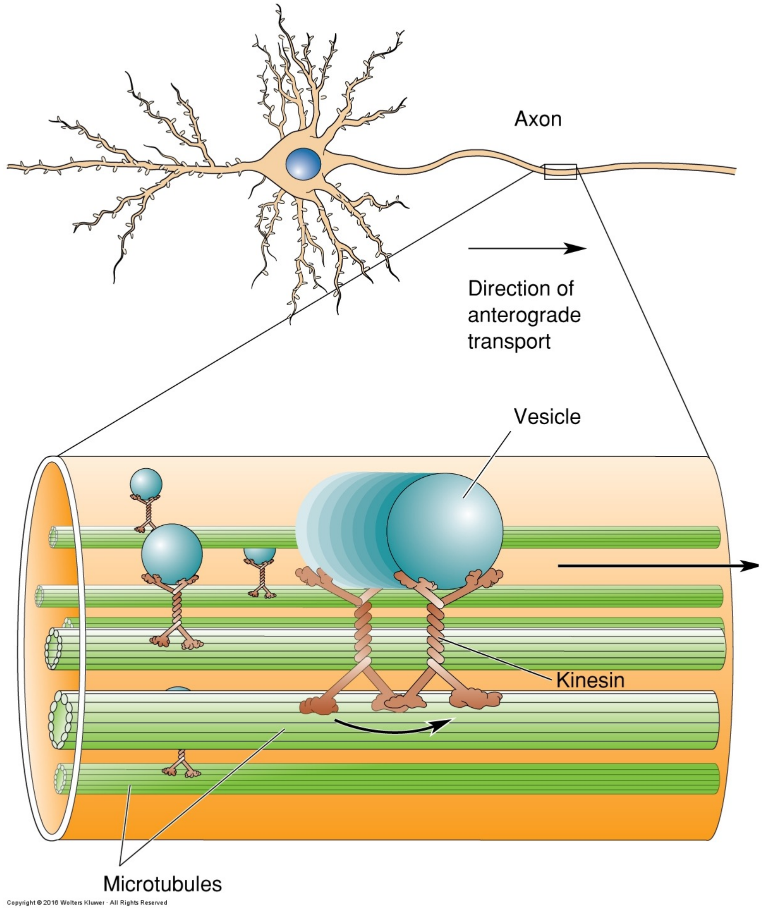






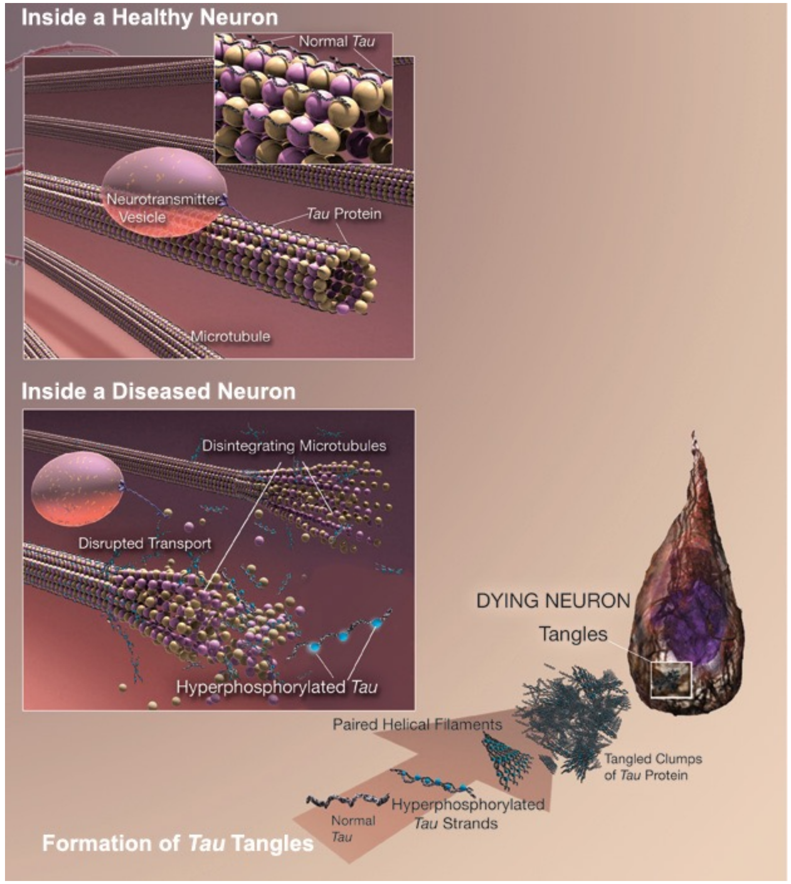
The cytoskeleton



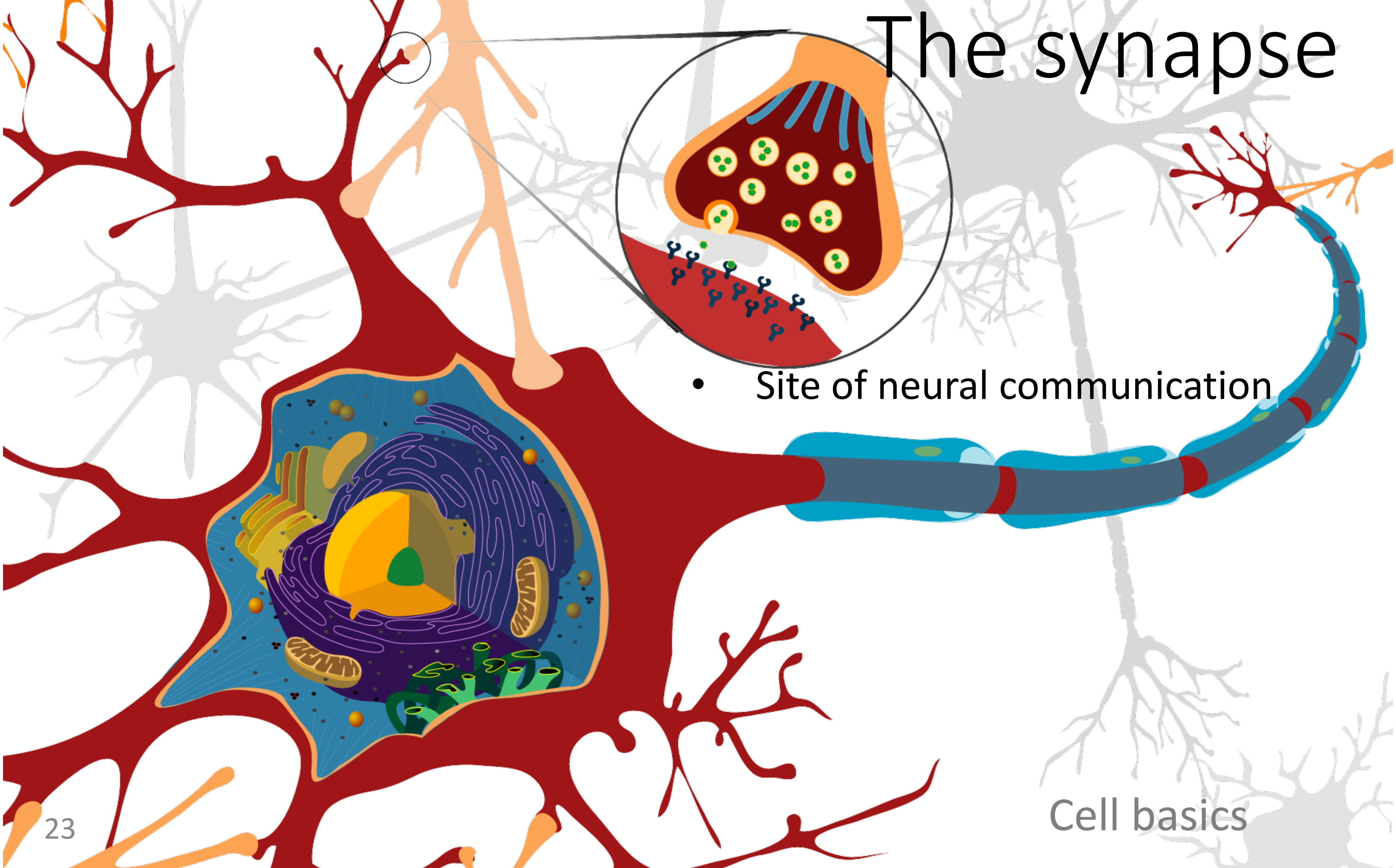


Kinesin: anterograde transport
Dynein: retrograde transport

Alzheimer's disease

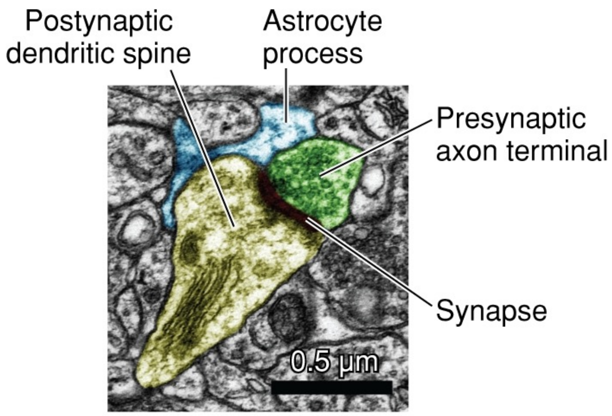


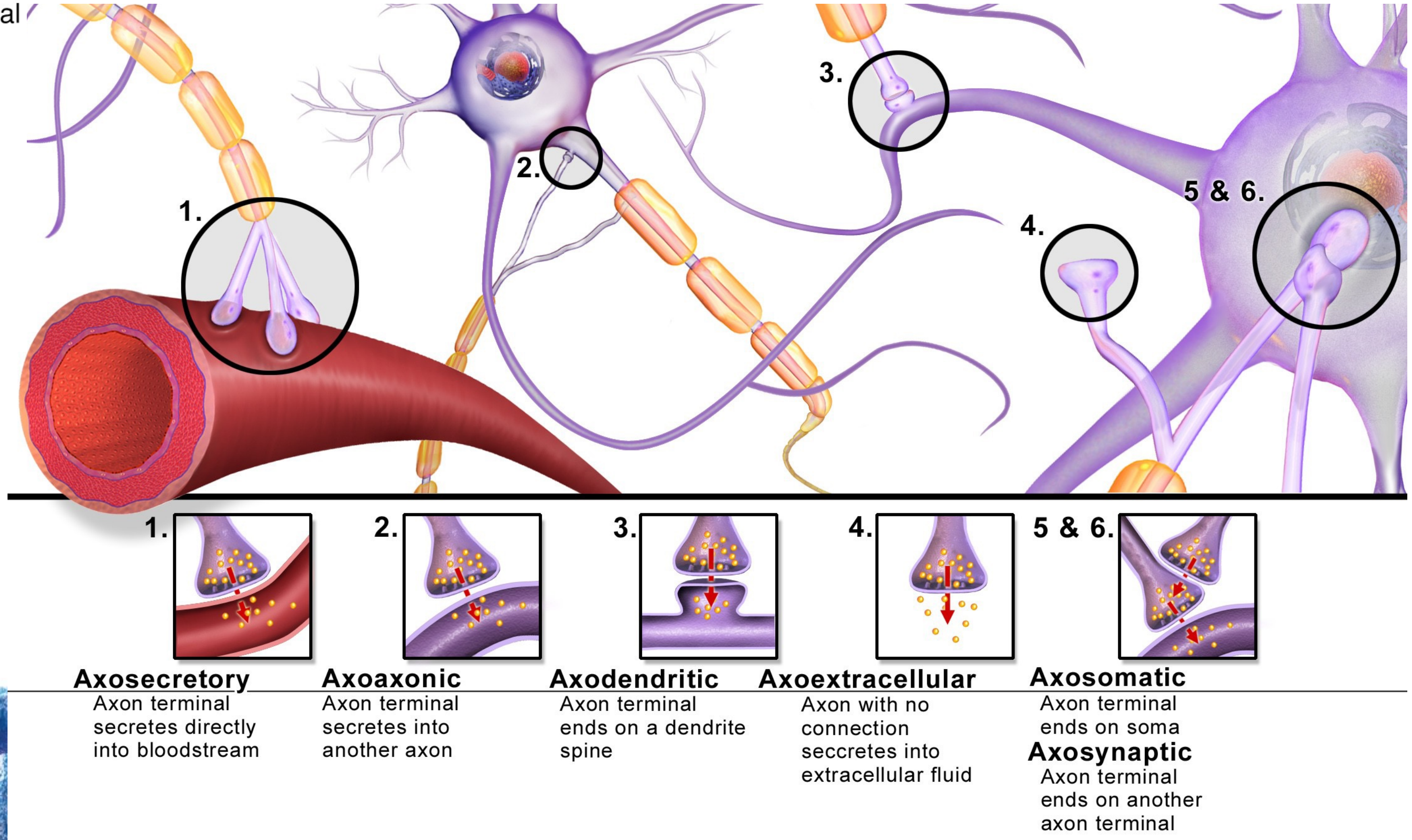
The synapse

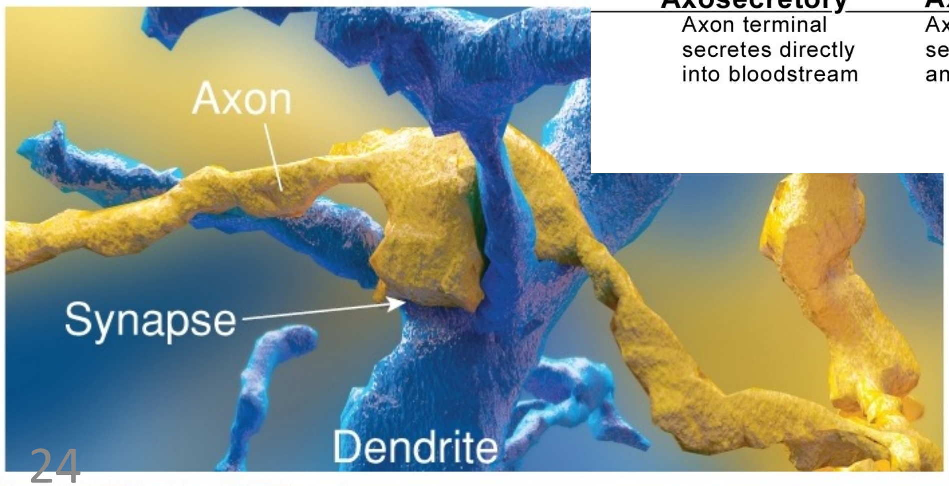


- Site of neural communication

The synapse

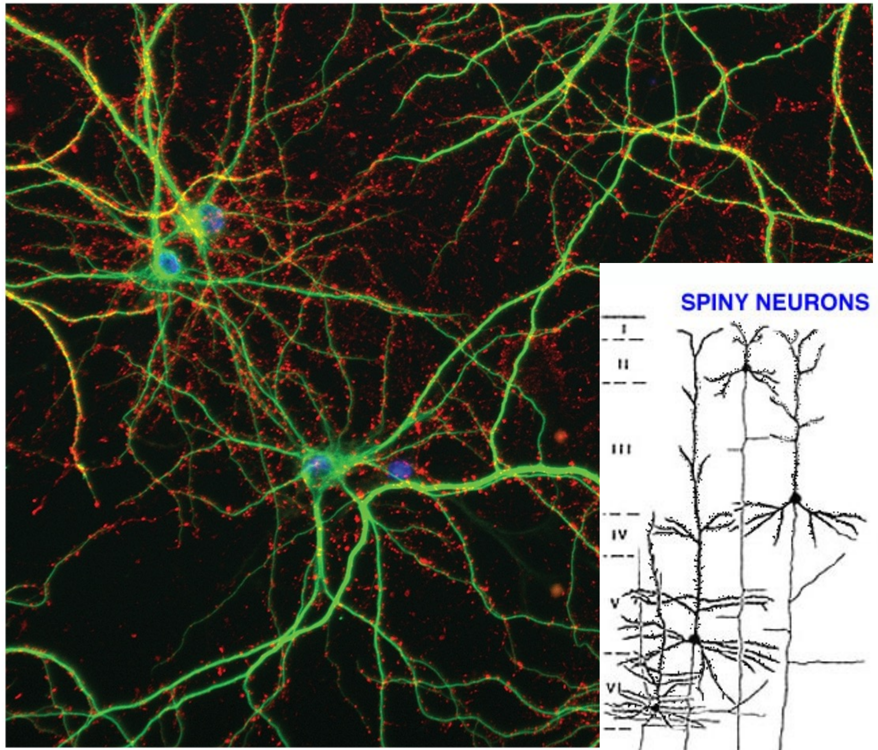






- The reality is often harder to understand than the diagrams

The dendrites



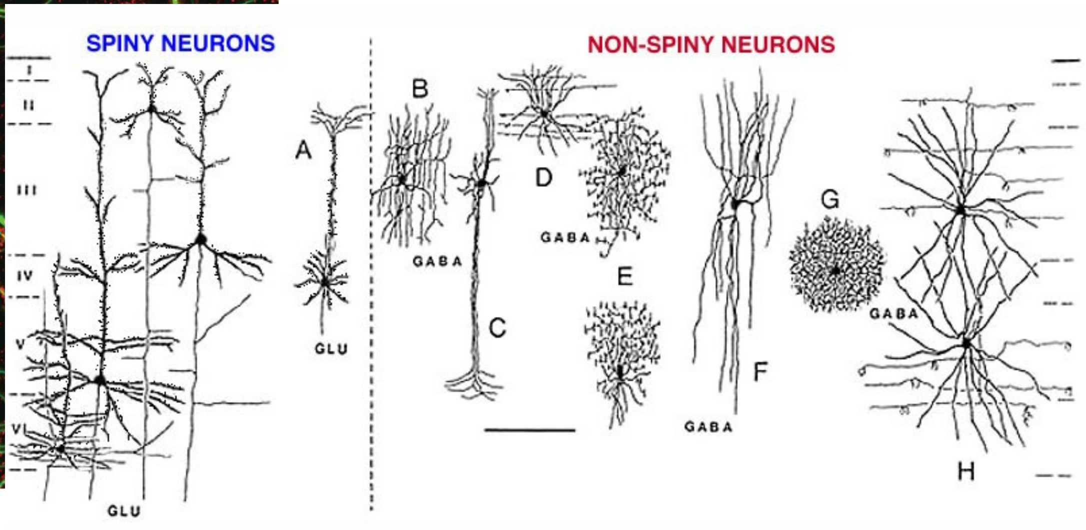
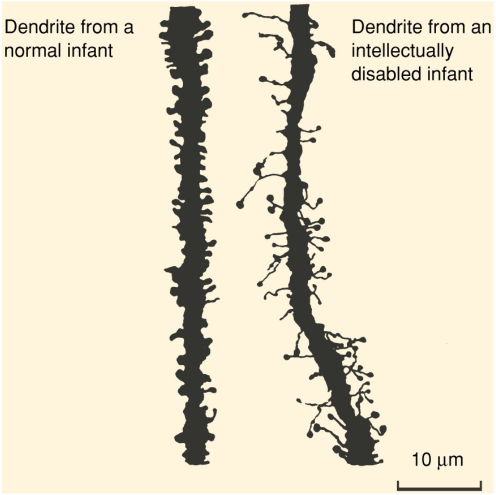


Figure 12. Basic cell types in the monkey cerebral cortex. Left: spiny neurons that include pyramidal cells and stellate cells (A). Spiny neurons utilize the neurotransmitter glutamate (Glu). Right: smooth cells that use the neurotransmitter GABA. B, cell with local axon arcades; C, double bouquet cell; D, H, basket cells; E, chandelier cells; F, bitufted, usually peptide-containing cell; G, neurogliaform cell.



You are your synapses

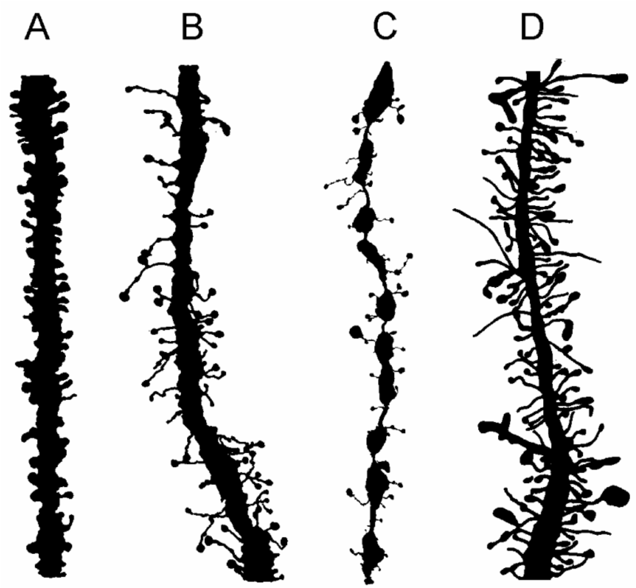
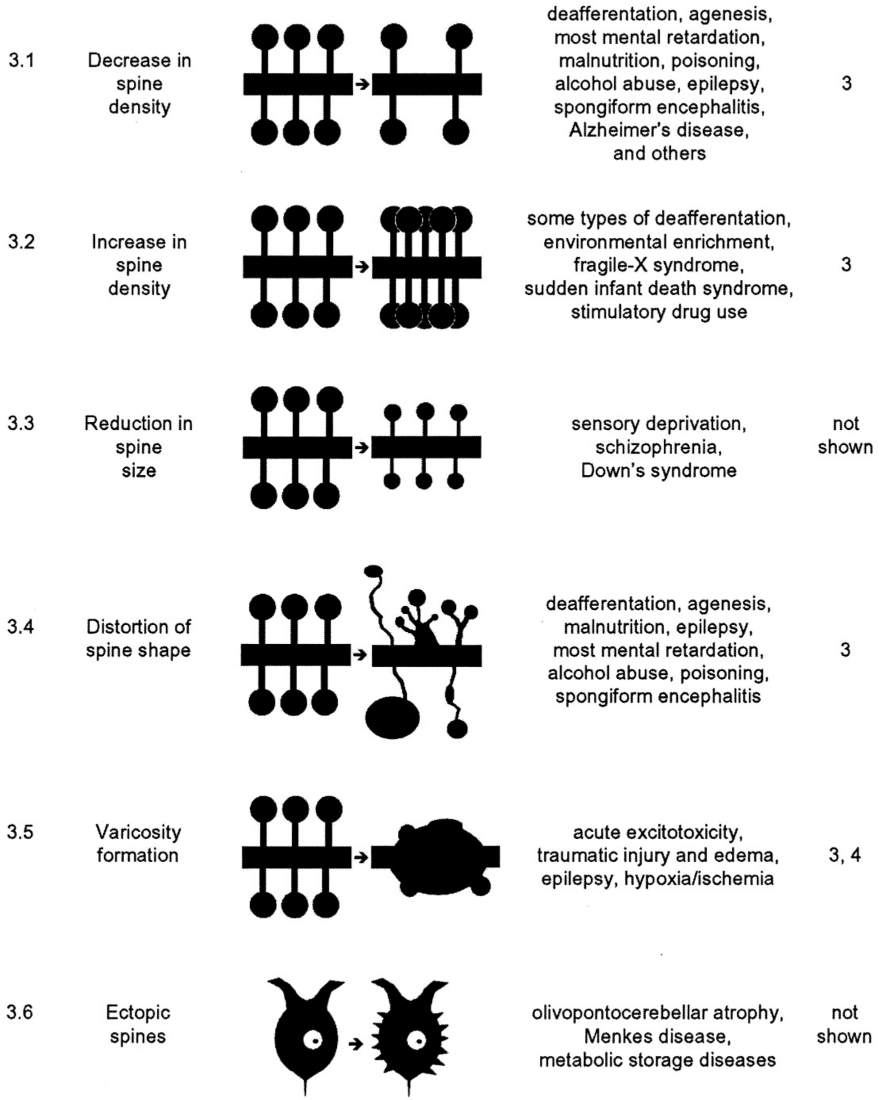


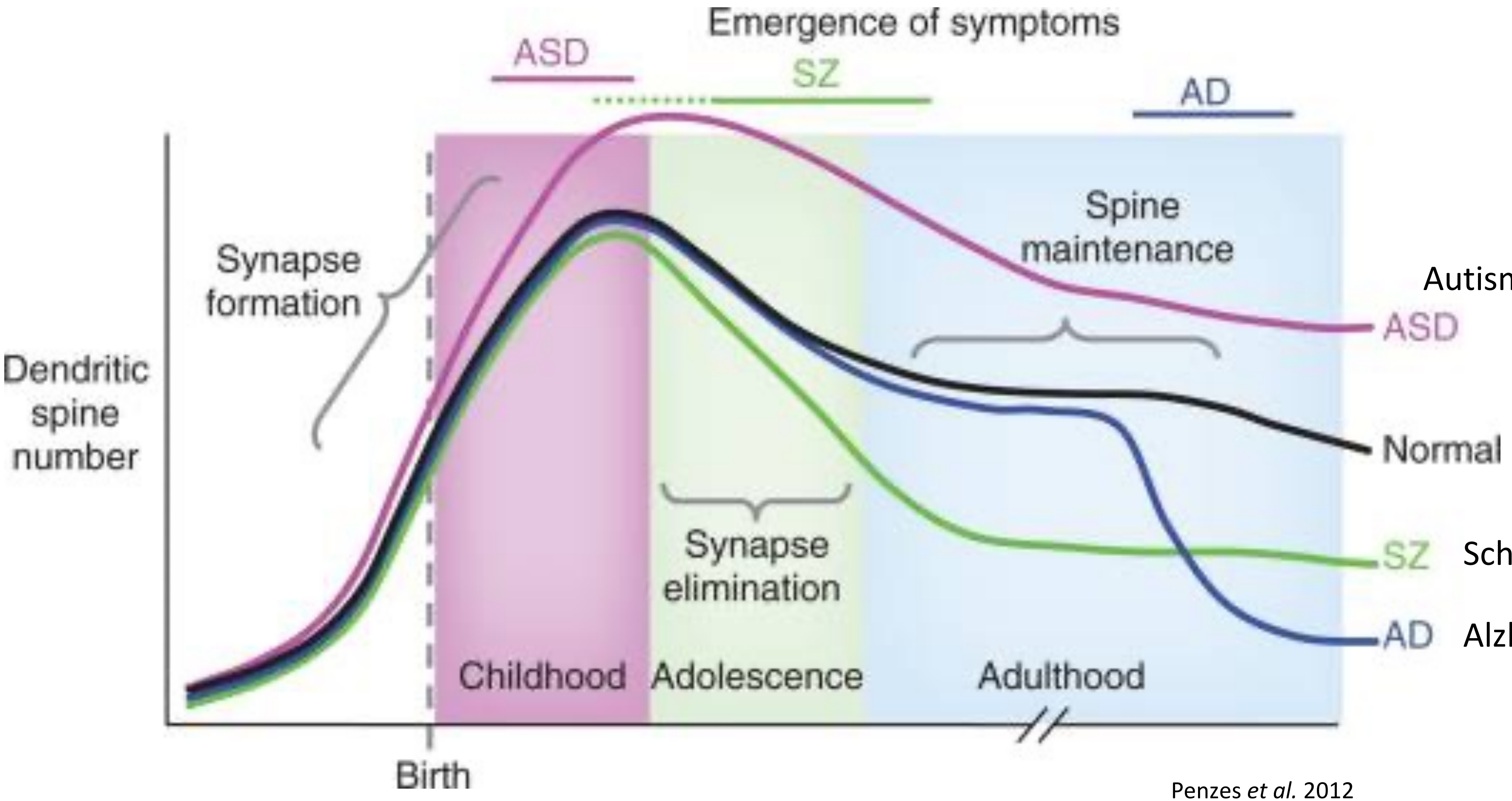
Fig. 3. Camera lucida drawings of apical dendrites of pyramidal cells from human cerebral cortex. A dendrite from normal 6-month-old infant with no history of neurological disorder (A) has a large number of spines, while an analogous dendrite from a retarded 10-month-old child (B) shows long, tortuous spines. (Reprinted with permission from Ref. [211]. Copyright 1974 American Association for the Advancement of Science). A dendrite from a 5.5-month-old child with severe neurobehavioral failure (C) shows numerous varicosities and long, thin spines. (Reprinted with permission from Ref. [212]. Copyright 1982 Elsevier Science). A dendrite from an adult case of fragile X syndrome (D) has a high density of elongated and enlarged spines. (Reprinted with permission from Ref. [297]. Copyright 1991 Wiley-Liss, Inc., a subsidiary of John Wiley & Sons, Inc.).

Fiala *et al.* 2002



Fiala *et al.* 2002

You are your synapses



Autism spectrum disorder

Schizophrenia

Alzheimer's disease

Penzes *et al.* 2012