Ramon y Cajal

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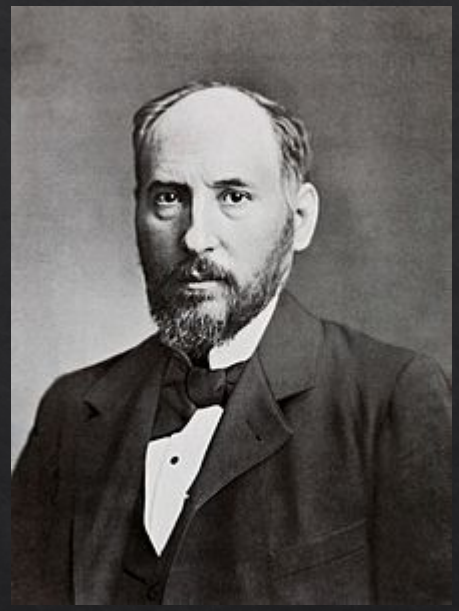
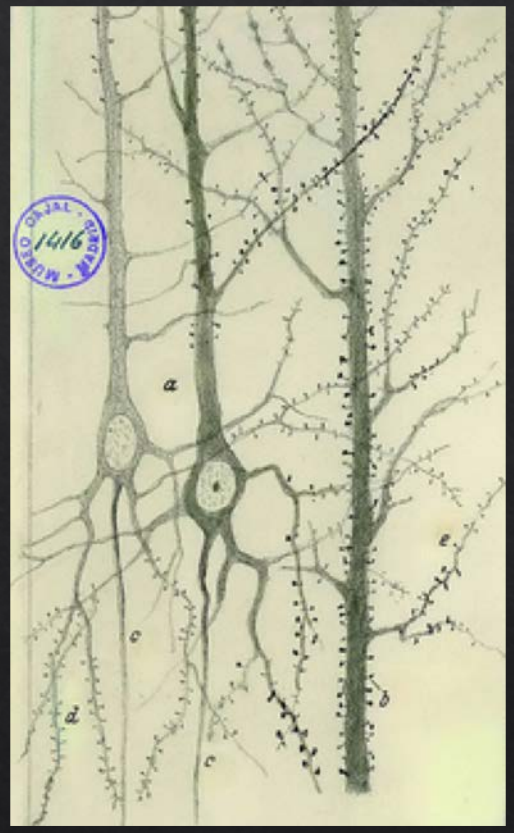
Biography

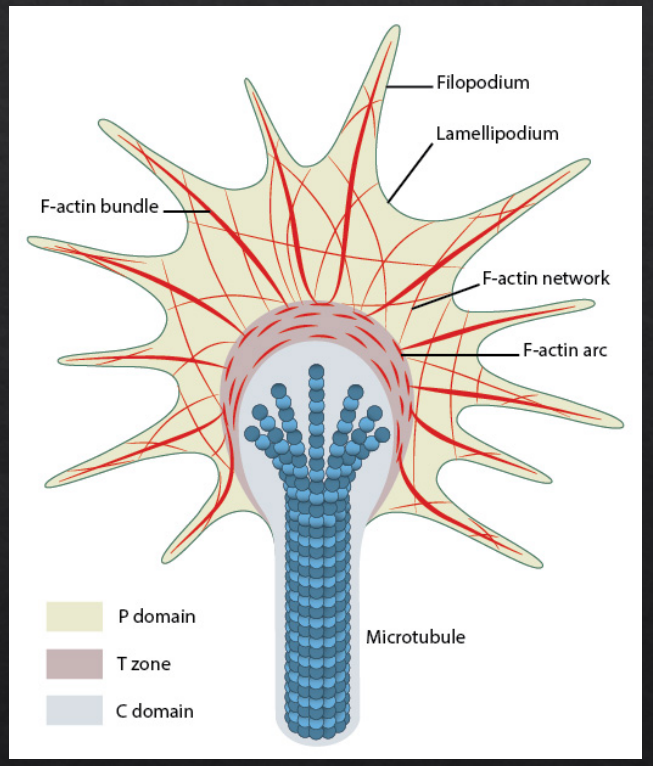
- Santiago Ramón y Cajal (1 May 1852 – 17 October 1934) was a Spanish neuroscientist and pathologist, specializing in neuroanatomy, particularly the histology of the central nervous system.
- The Father of Modern Neuroscience



Nerve cells as independent entities

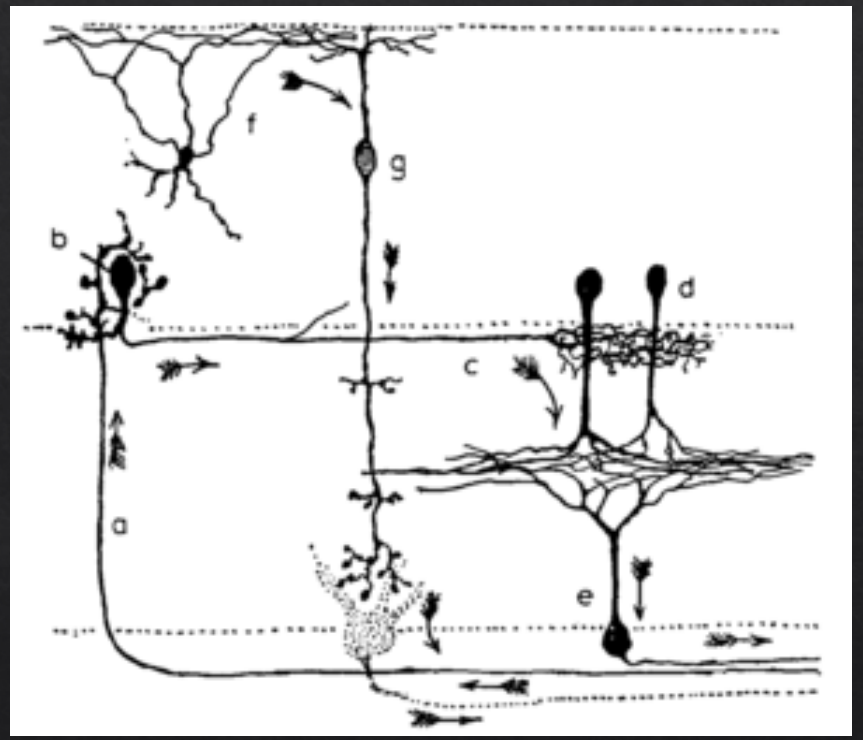
- a continuous network of interconnected fibers (continuity) → axons terminate freely in the cerebellum and retina (contiguity)
- Dendritic spines: sharp thorn-like structures in dendrites
- Axonal growth cone: an amoeboid-like structure at the end of the axon of developing nerve cells





The law of dynamic polarization

- The processes of nervous cells comparable to the dendrites are oriented towards the “external world” and they have evidently conduction of the nervous impulse toward cellular body; meanwhile the axon is oriented towards the nervous centers
- **Theory of axipetal polarization**: The dendrites and the cellular body have conduction toward the axon; whereas the axon has conduction comes from the dendrites or the cellular body



the retina of birds

- Hypothesis: Oft-used neural pathways would see their connections reinforced
- Speculation: Learning requires the formation of new connections between neurons

Neuron doctrine

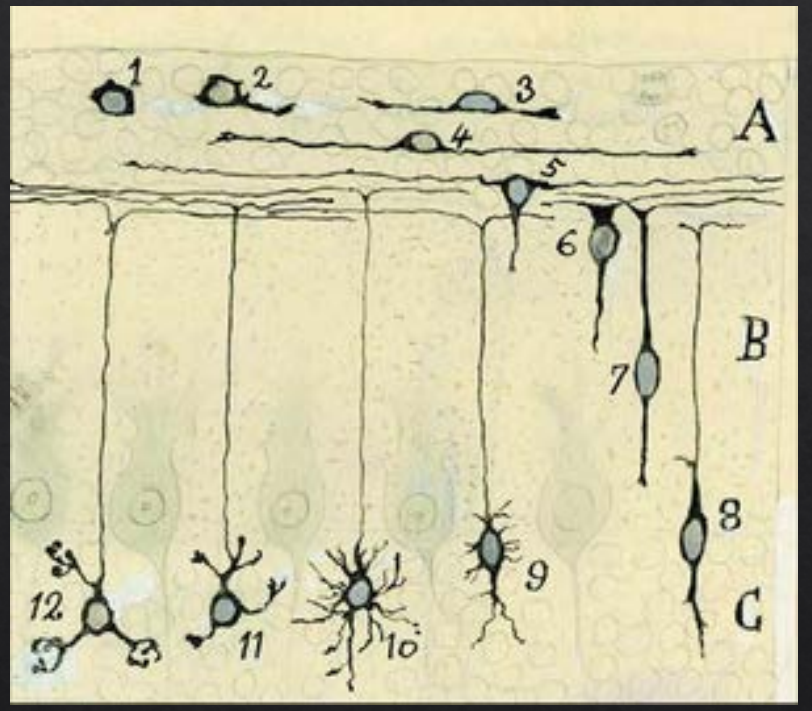
- **1.** The neuron is the structural and functional unit of the nervous system.
- **2**. Neurons are individual cells, which are not anatomically continuous to other neurons.
- **3**. The neuron has three parts: dendrites, soma (cell body) and axon. The axon has several terminal arborizations, which make close contact to dendrites or the soma of other neurons.
- With its physiological corollary:
- **4**. Conduction of nerve impulses is directional and follows the theory of axipetal polarization.
- According to Cajal, the polarization of the nerve impulse is due to the pre-established relations between the neurons and the initial position of the excitation.

The neuron doctrine today

- Some neurons are connected by gap junctions
- Action potentials can travel backward from the axon and soma regions into the dendrites
- Two-way communication between neurons and glial cells

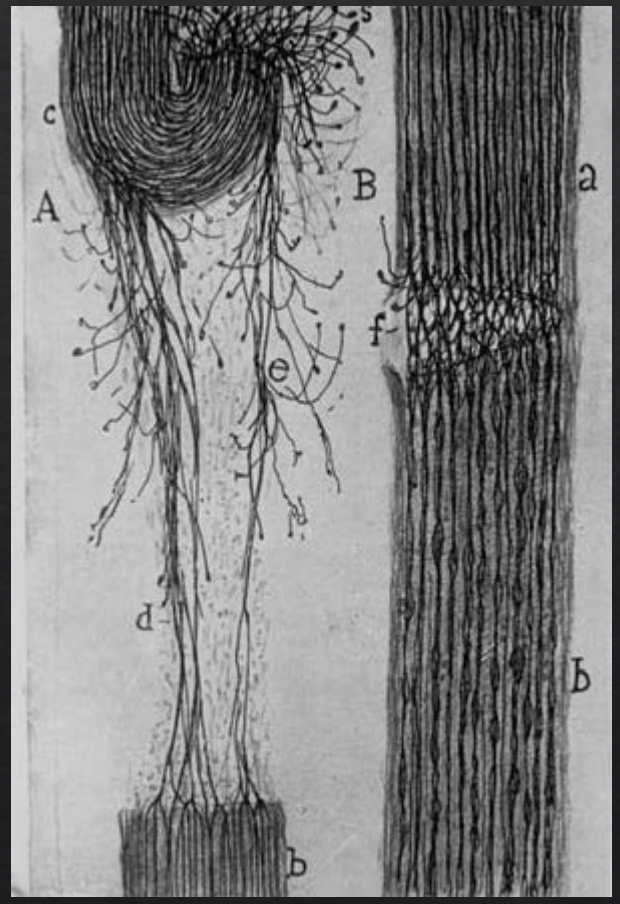
Chemotaxis

- Several stages: An ovoid shape and no projections -->thin extensions (axon and dendrites)
- A precise connectivity pattern
- (Propose) Axonal guidance is based on gradients of chemoattractive substances guiding the growth cones toward their final targets
- A same molecule could attract or repel a growth cone depending on the battery of receptors expressed by the neuron or its metabolic state.



Degeneration and regeneration of the neurons and axons

- Damage repair would be more difficult than during normal development
- Both growth and proper guidance were needed to effectively repair severed connections
- Regeneration after injury vs adult neurogenesis



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