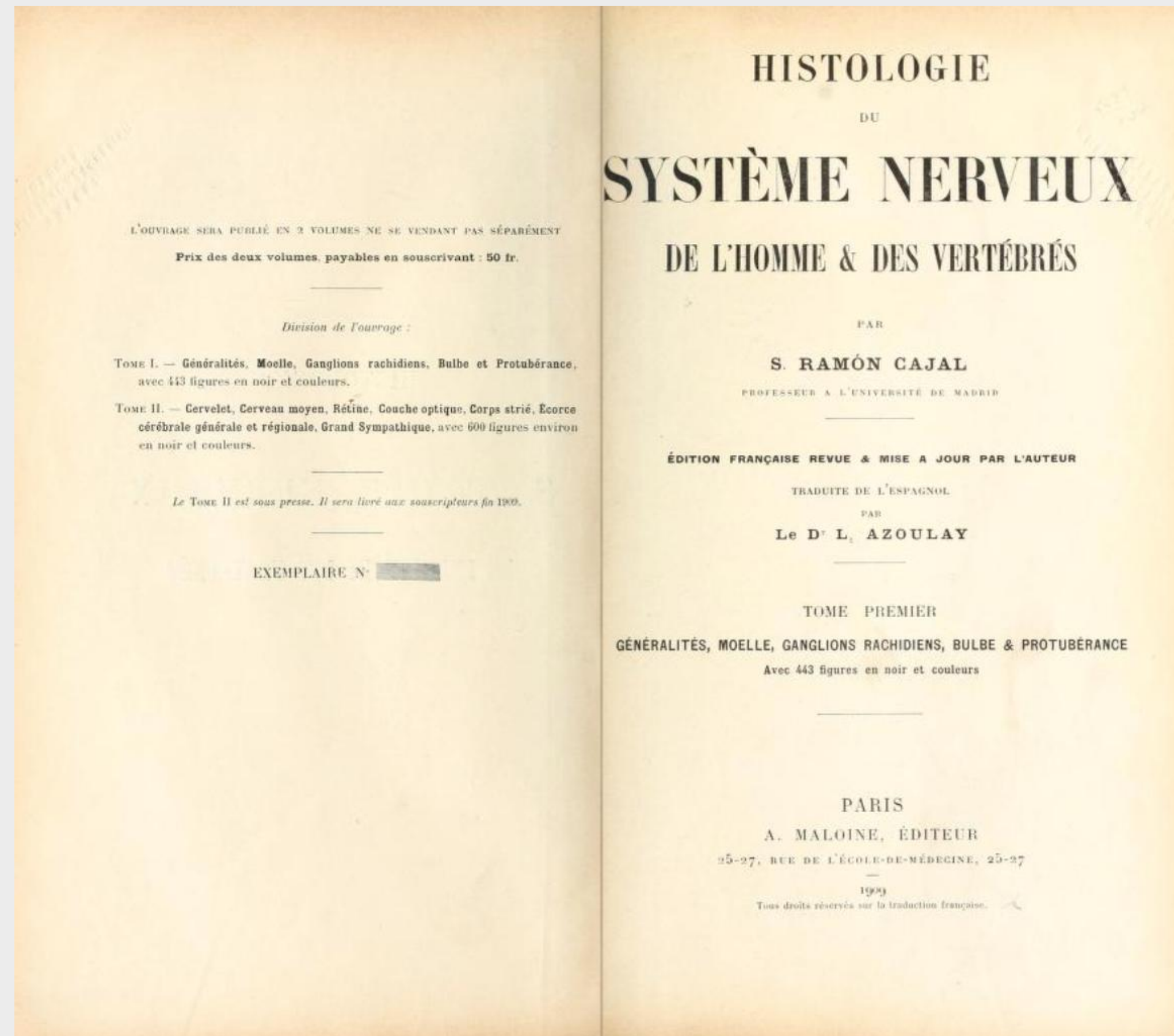
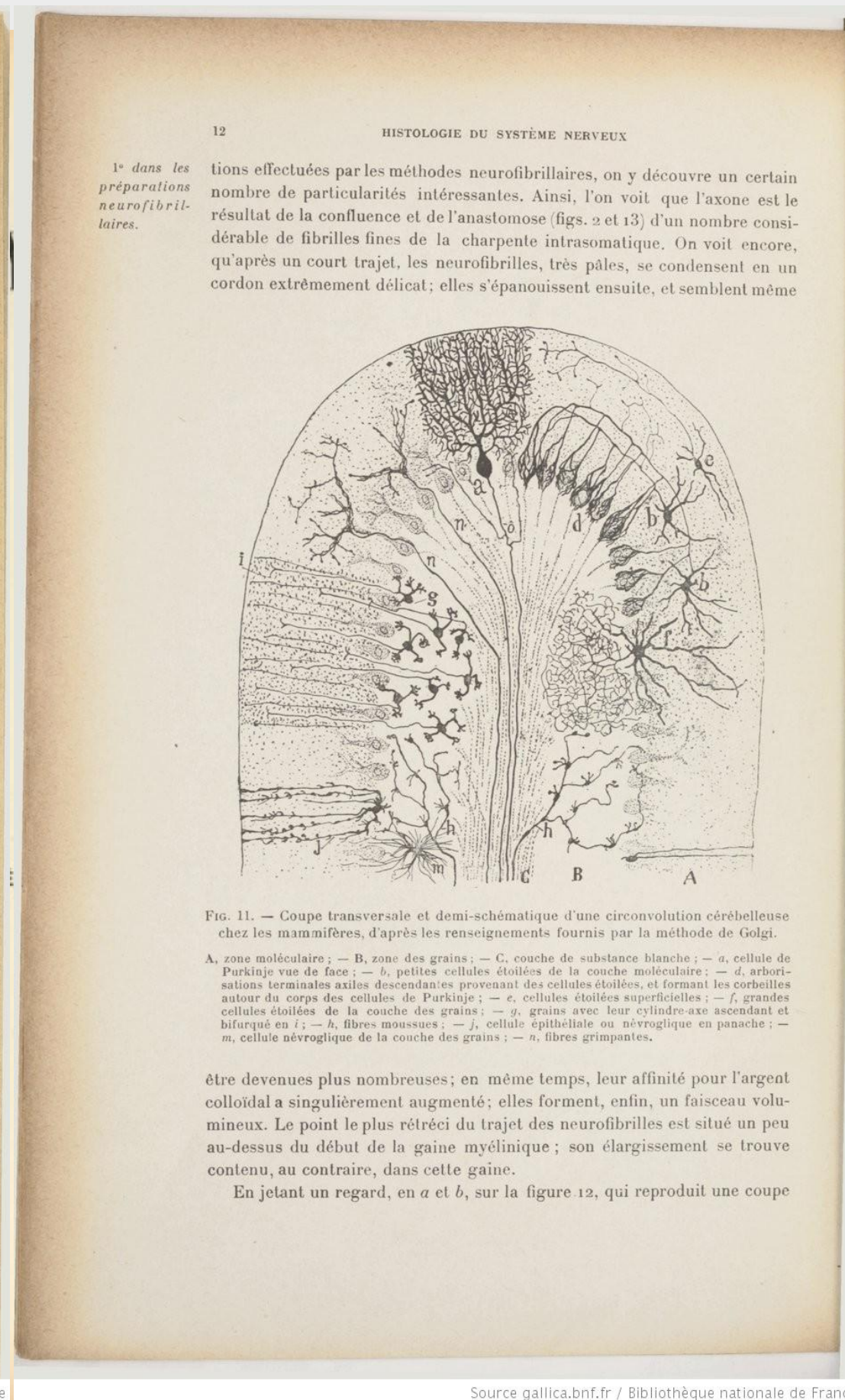
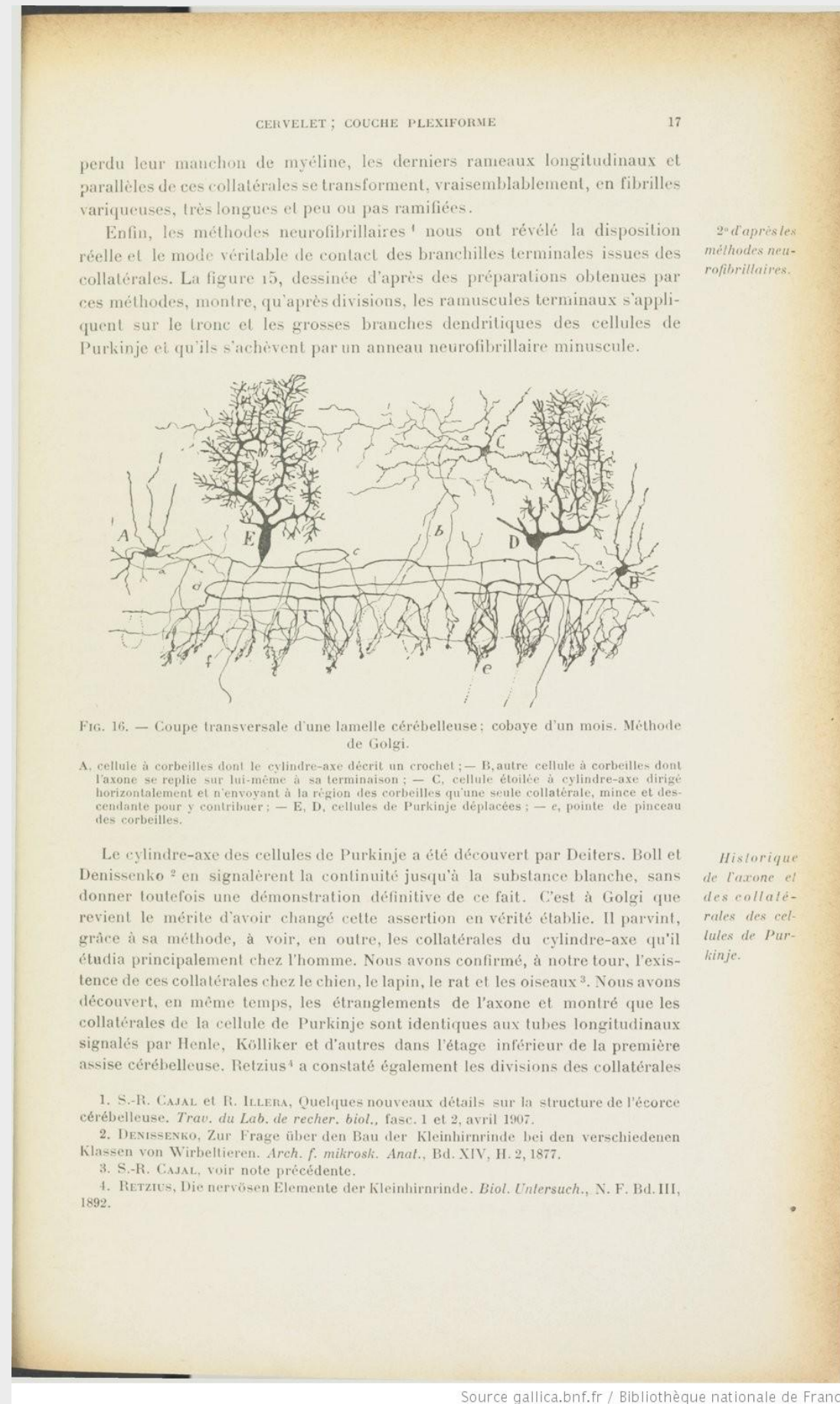


Κατηγορίες Νευρώνων Δομή και Λειτουργία

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Ιατροδικαστής



Santiago Ramón y Cajal: Morphological criteria



Why classification is important?

1. Reproducibility
2. Genetic Access (eg viral vectors)
3. Discovery (new categories)
4. Understanding Development
5. Studying disease (some diseases affect specific types of neurons)

Obstacles to neuronal classification

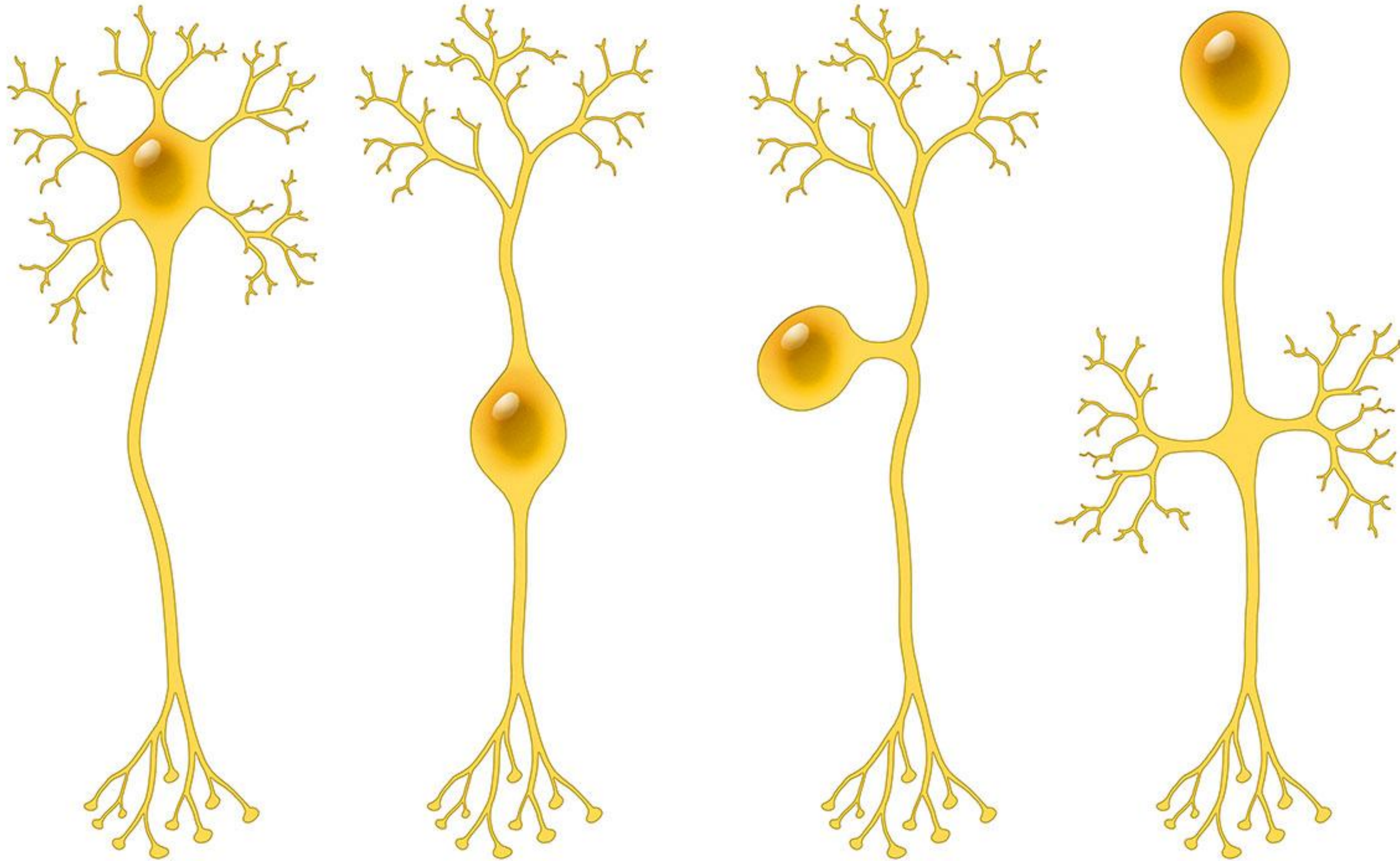
1. Technical: Until very recently most methods were (at best) semi-quantitative (problems of variance).
2. Conceptual: Each neuron is different from every other neuron; coarse distinctions (eg "pyramidal cells") are of little value for many experimental purposes. So is neuronal classification ephemeral?

Today

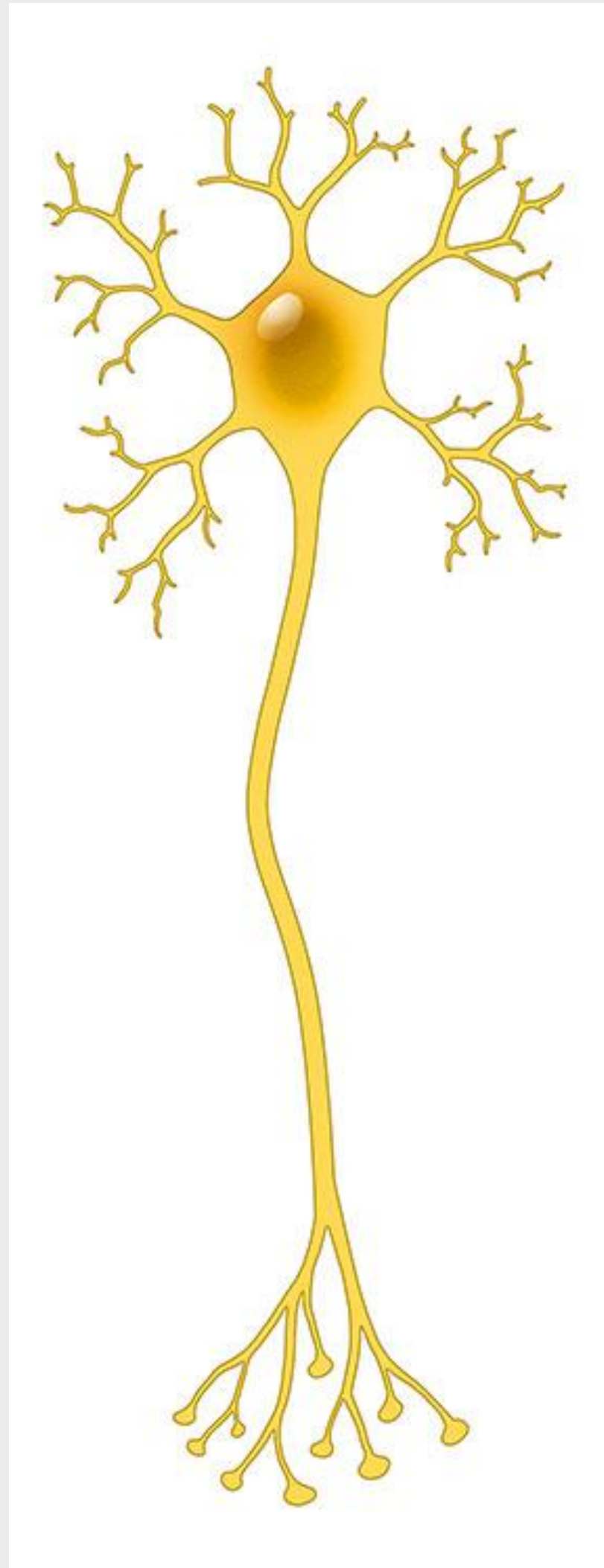
Combination of criteria:

- Structural
- Functional
- Molecular

Morphological criteria



Morphological criteria



Multipolar neurons:

- single axon
- one or more dendritic branches emerging from all parts of the cell body
- vary in the number and length of their dendrites and the length of their axons
- the number and extent of dendritic processes depend on the number of synaptic contacts that other neurons make onto it.
- Eg a spinal motor cell receives about 10,000 a purkinje cell receives up to 150,000 contacts from other neurons.

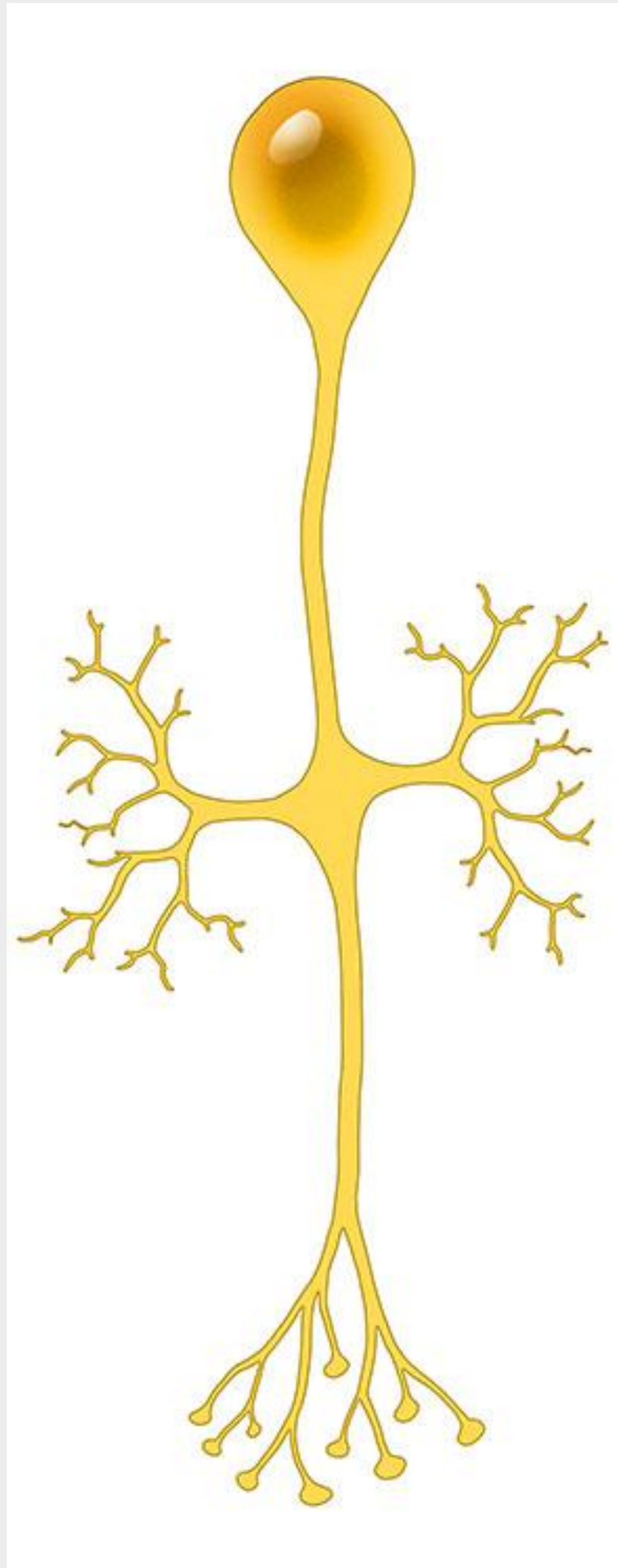
Morphological criteria



Bipolar neurons:

- two processes emerging from the cell soma:
- a peripheral process or dendrite which conveys information from the periphery and
- a central process, the axon, which carries information toward the brain.
- these cells have mainly sensory functions: retina, olfactory epithelium

Morphological criteria



Unipolar neurons:

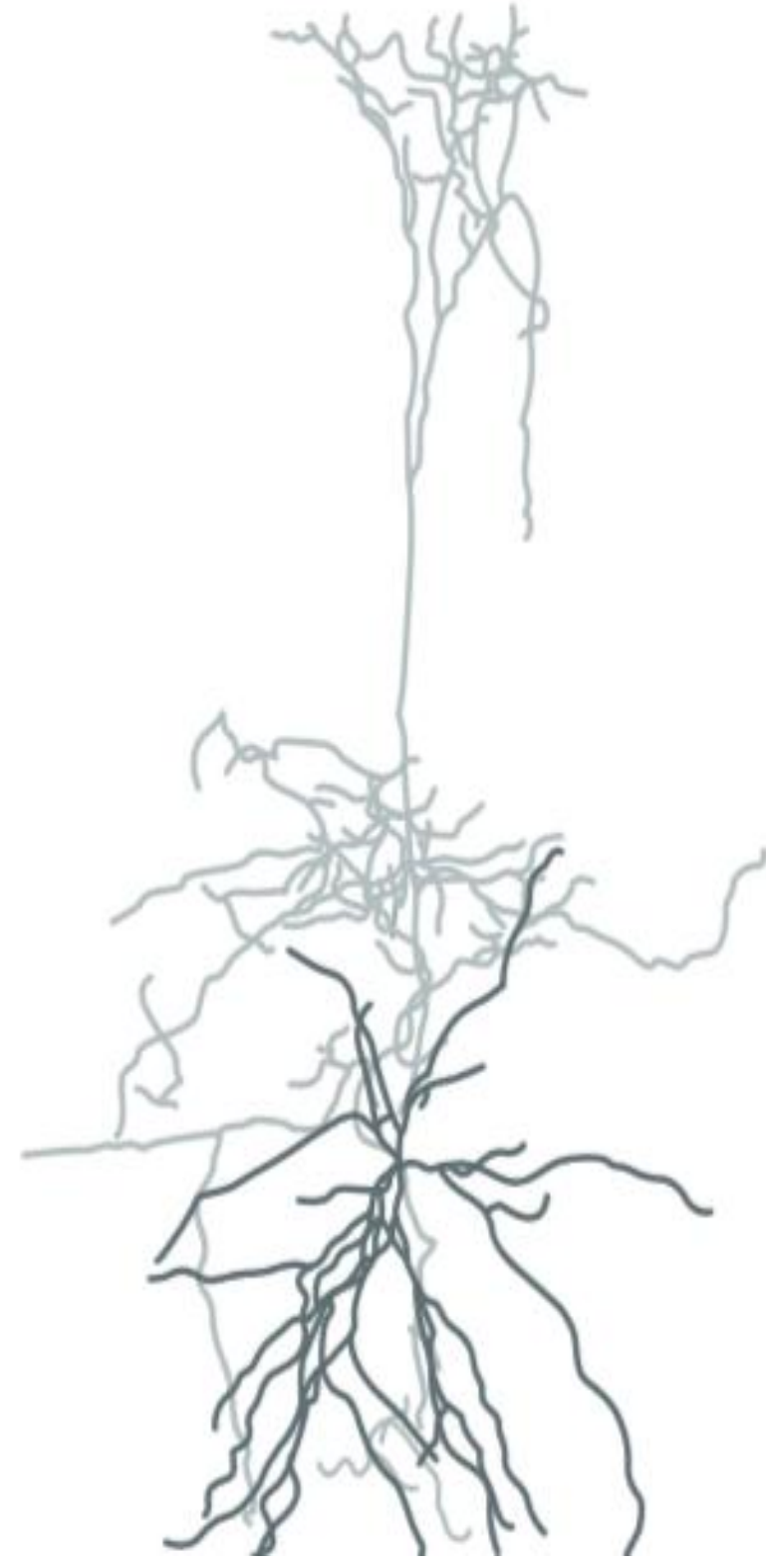
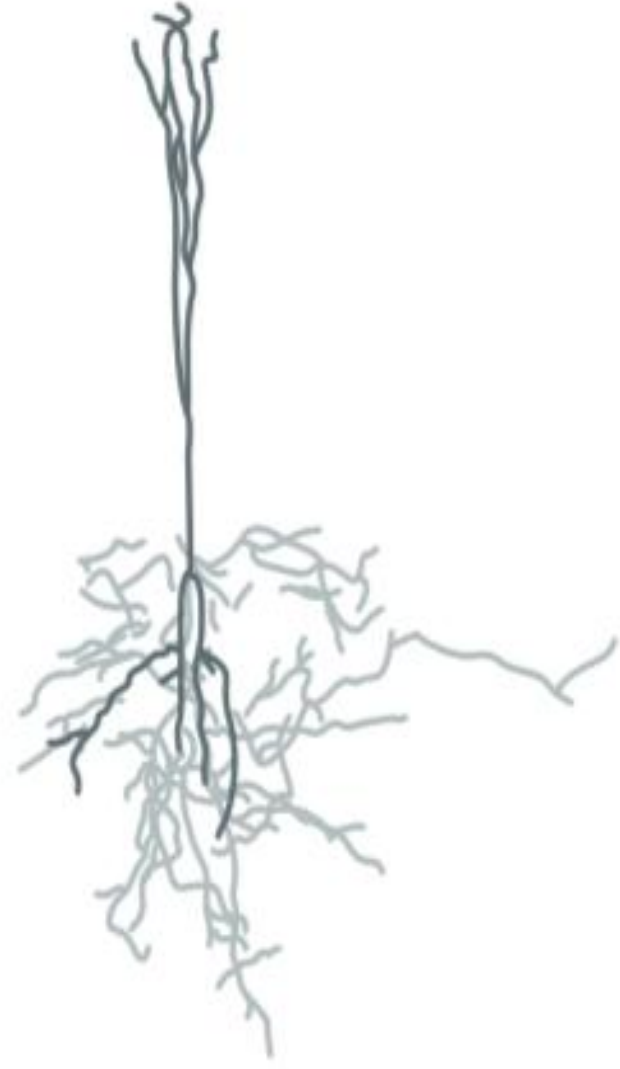
- They have one primary process that gives rise to several branches.
- One of these is the axon and the rest serve as dendritic receiving structures.
- Unipolar cells have no dendrites arising directly from the cell's soma.
- These cells occur in certain ganglia of the autonomic nervous system of vertebrates.

Morphological criteria

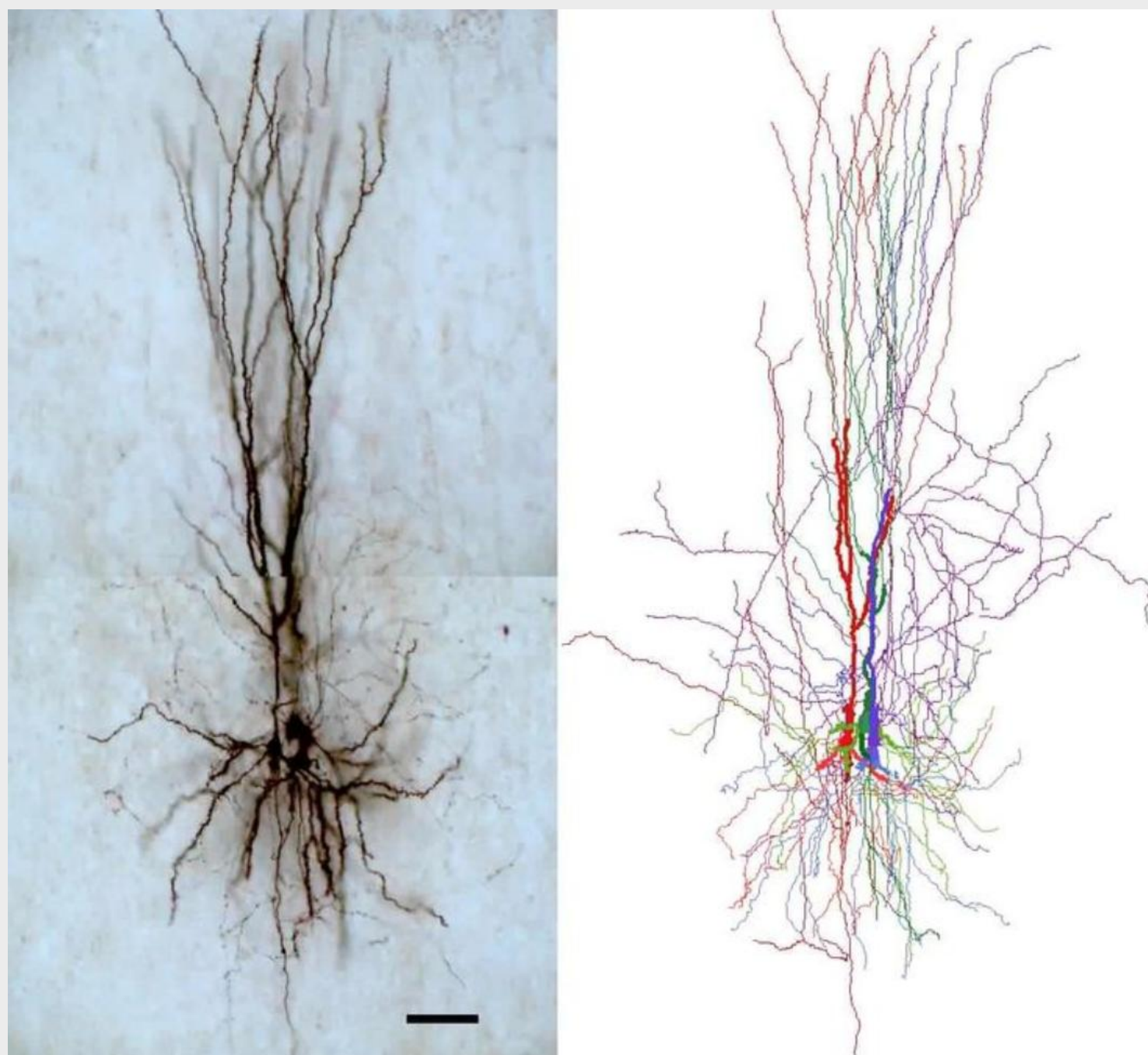


Pseudo-unipolar neurons:

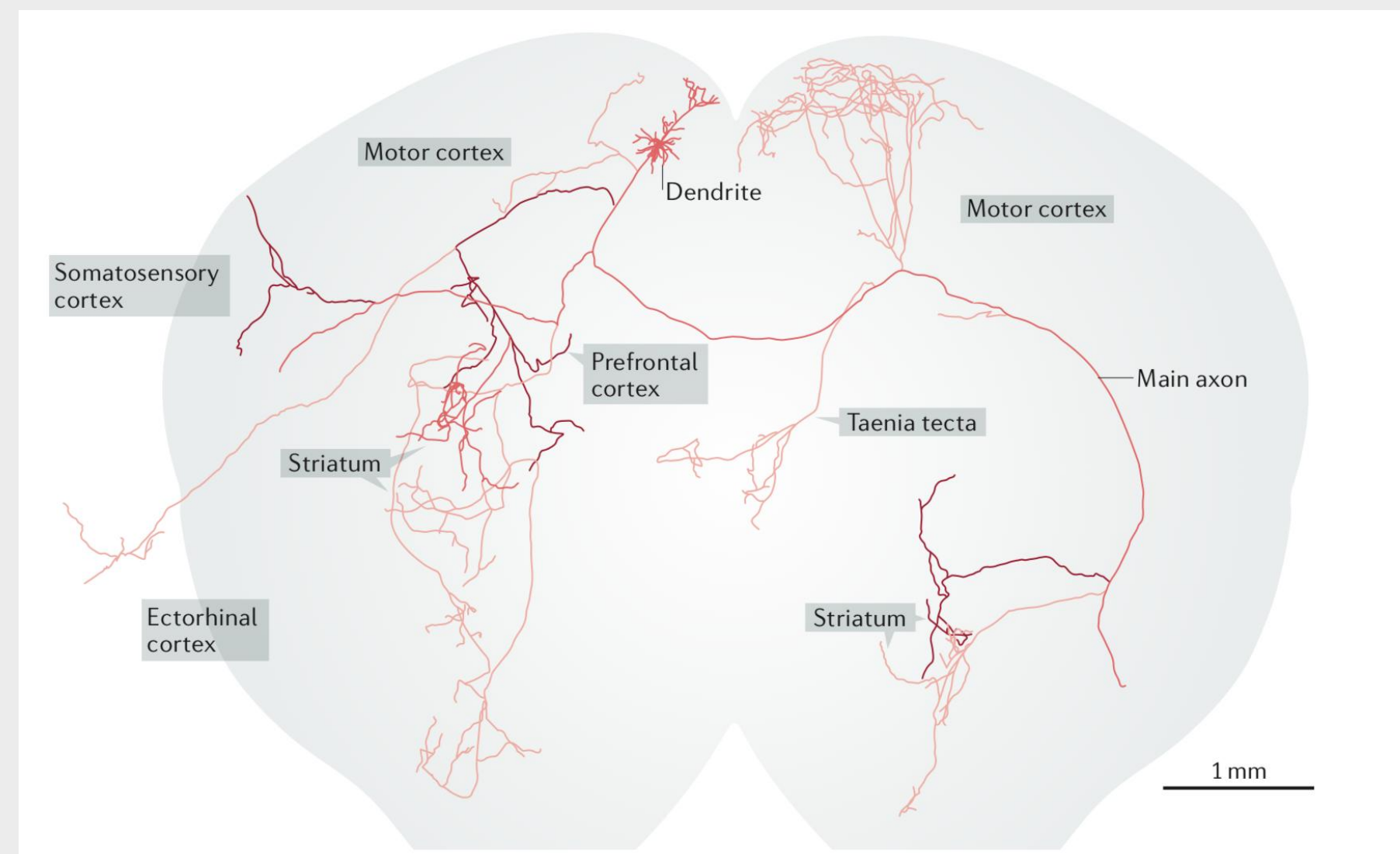
- They have a single process that splits into one branch that runs to the peripheral tissues and a second branch that leads to the spinal cord.
- These sensory neurons are an exception to the typical neuron, in that they do not have separate dendrites and an axonal process, but rather one branched process that serves both functions.
- Typically found in the dorsal root ganglia and in the sensory ganglia of cranial nerves V, VII, IX and X, all mixed-cranial nerve



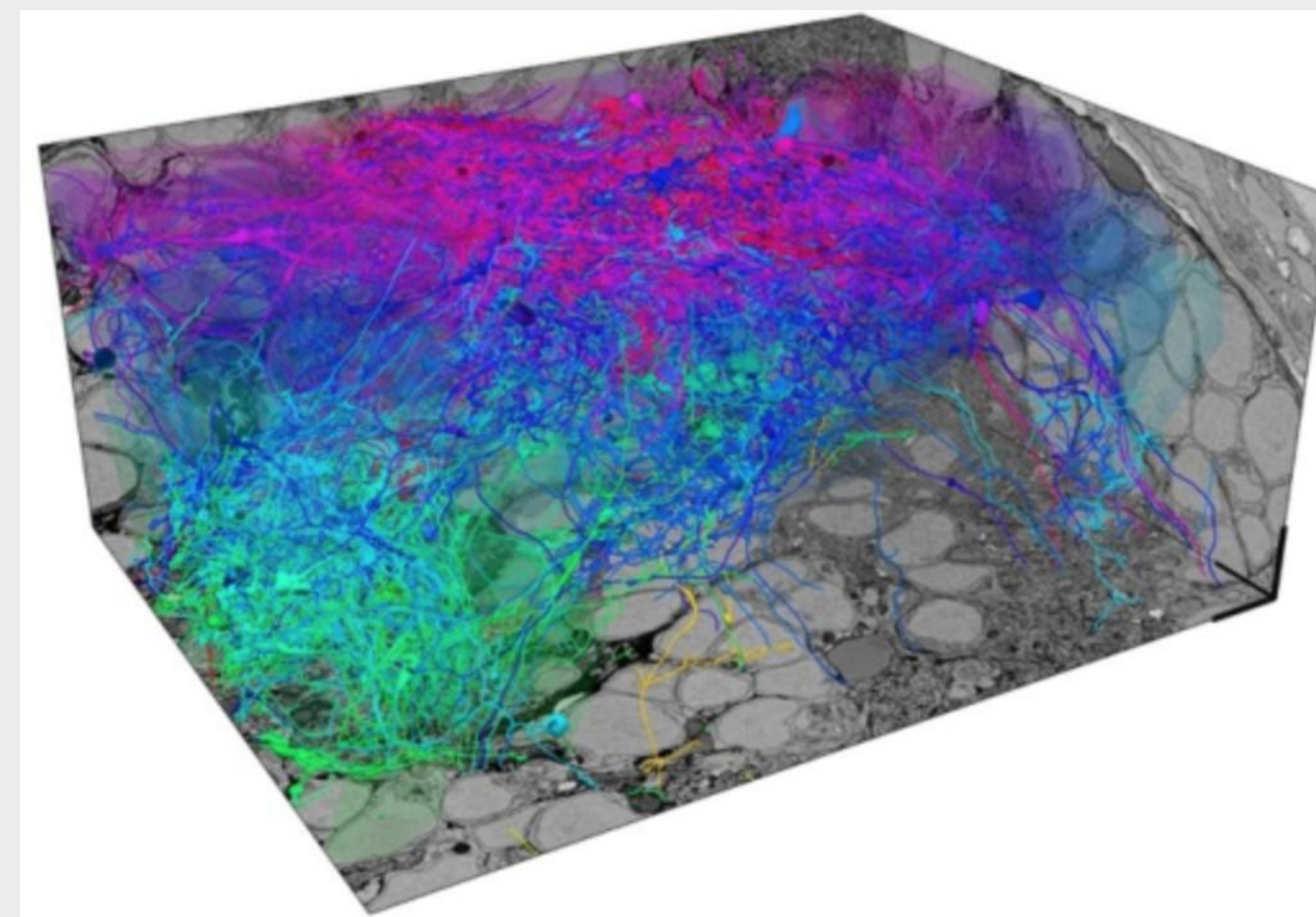
Advanced morphological methods



3D reconstructions using imaging tools (eg Neurolucida) and accurate quantitative data.



High-throughput fluorescence light microscopy enables imaging of large tissue volumes (such as whole mouse brains) at high resolution.



High-throughput electron microscopy combines methods for automated sectioning, imaging and reconstruction (segmentation) to reveal details of neuronal morphology and synaptic connectivity

Functional criteria

1. Sensory Neurons

- Sensory receptor cells (Rods and cones in the retina of the eye, Olfactory receptors in the nasal cavity, etc)
- Sensory afferent neurons of the PNS etc

2. Projection Neurons (Motor neurons of the spinal cord, cortical pyramidal neurons etc)

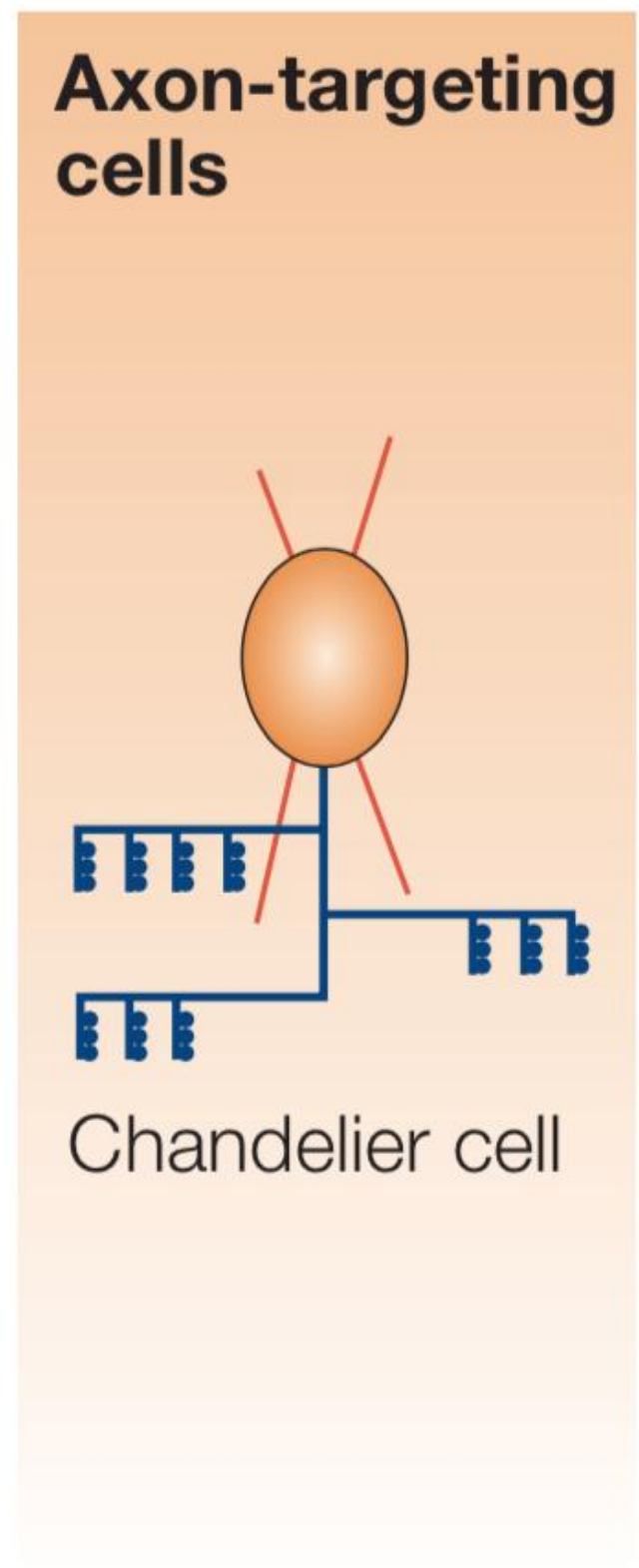
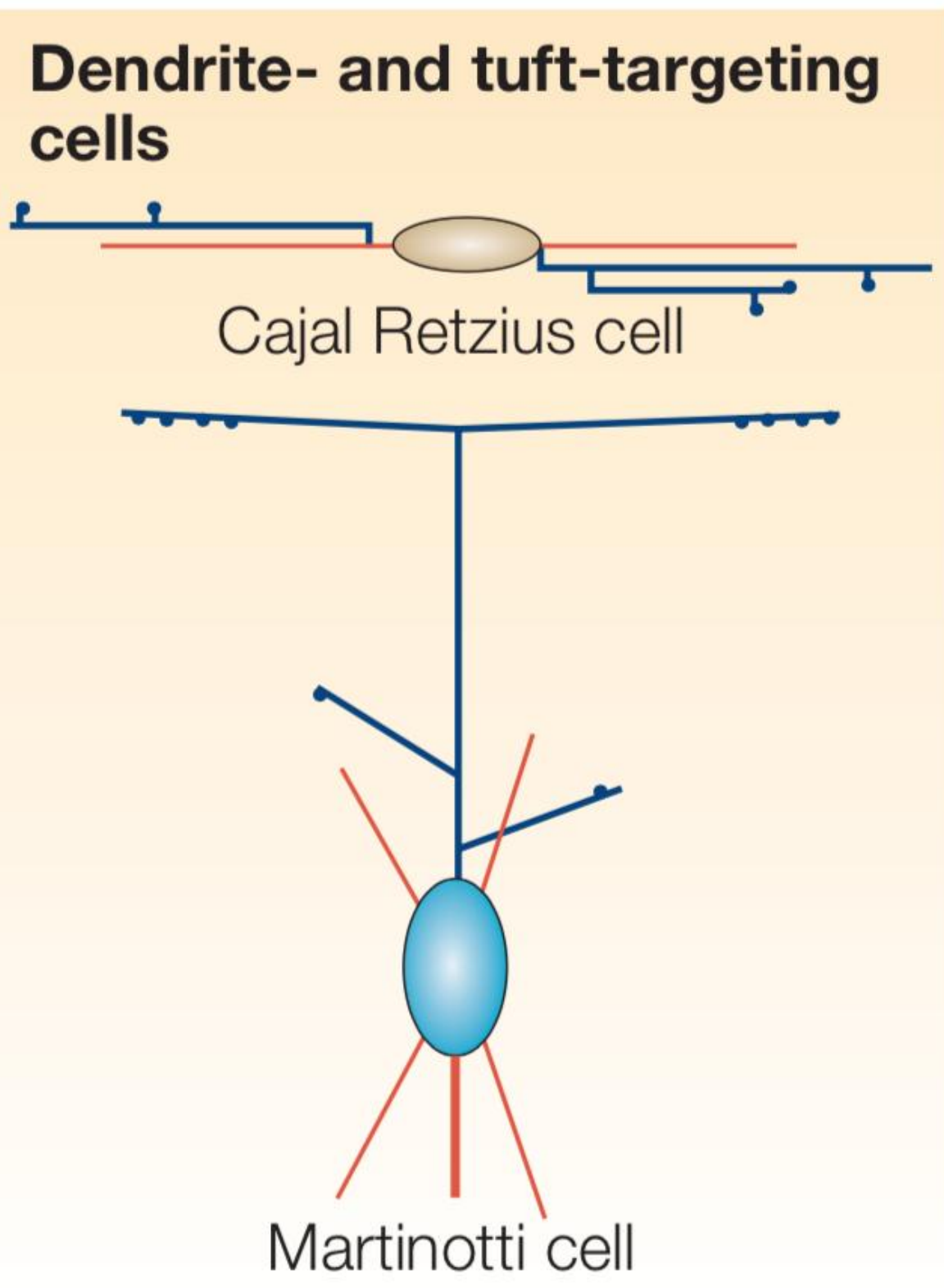
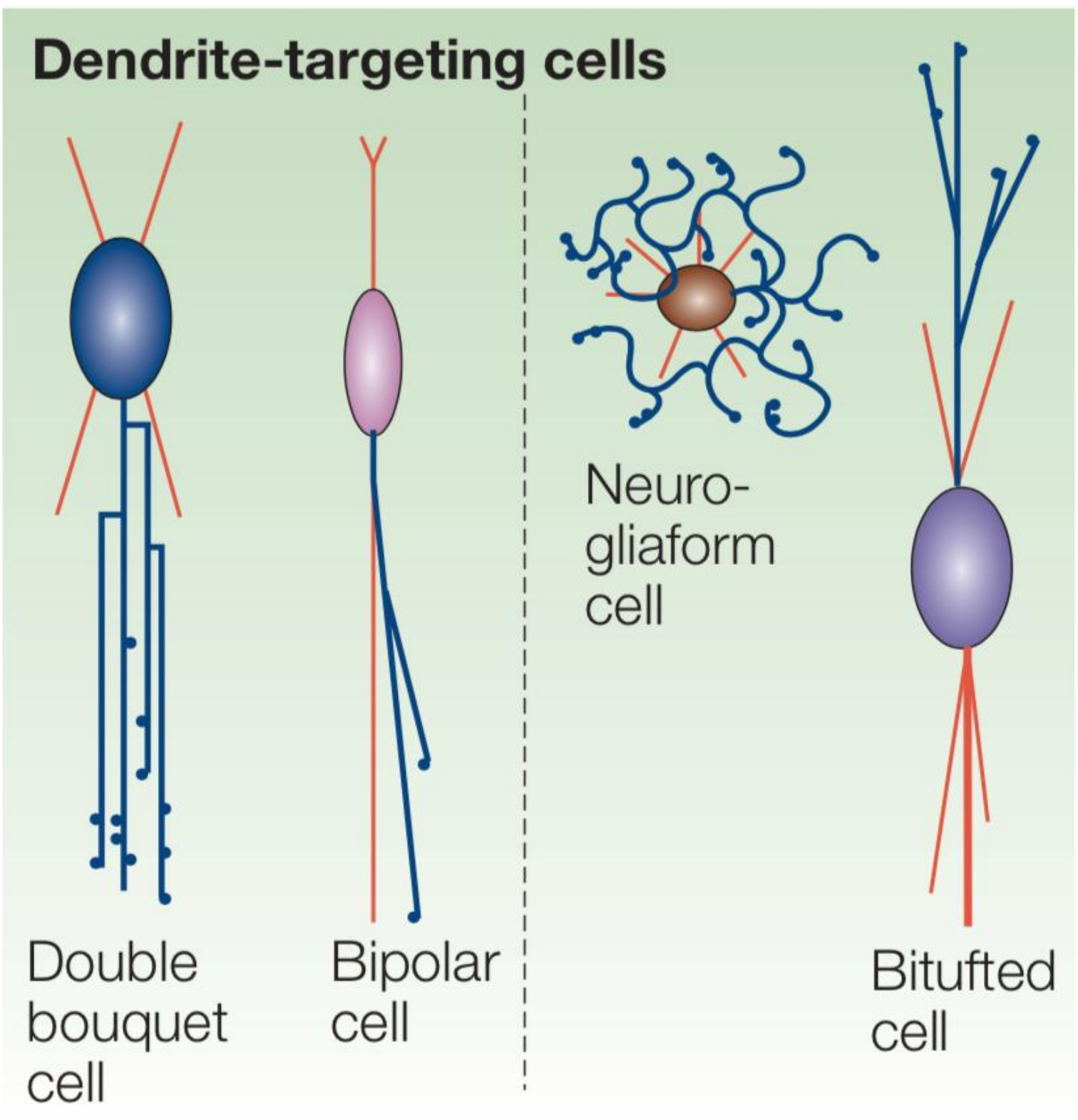
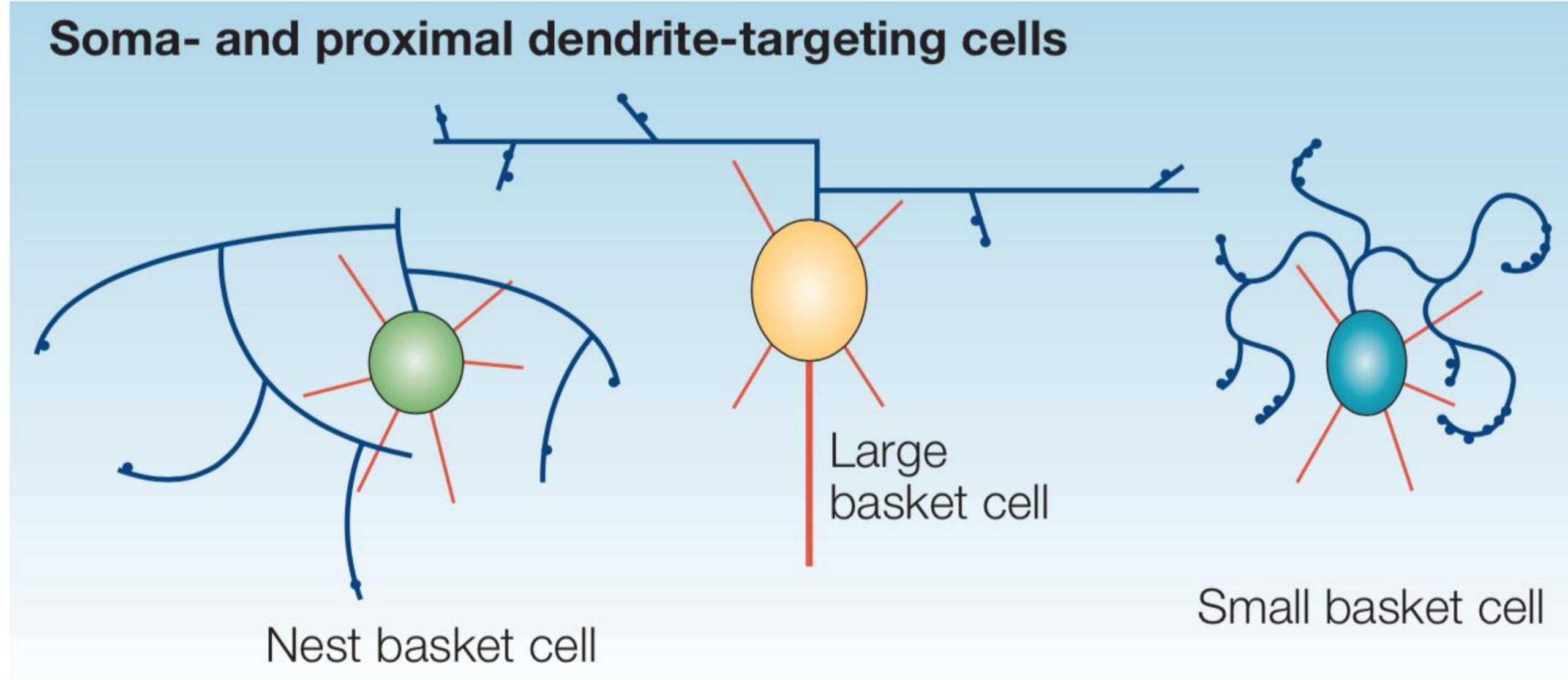
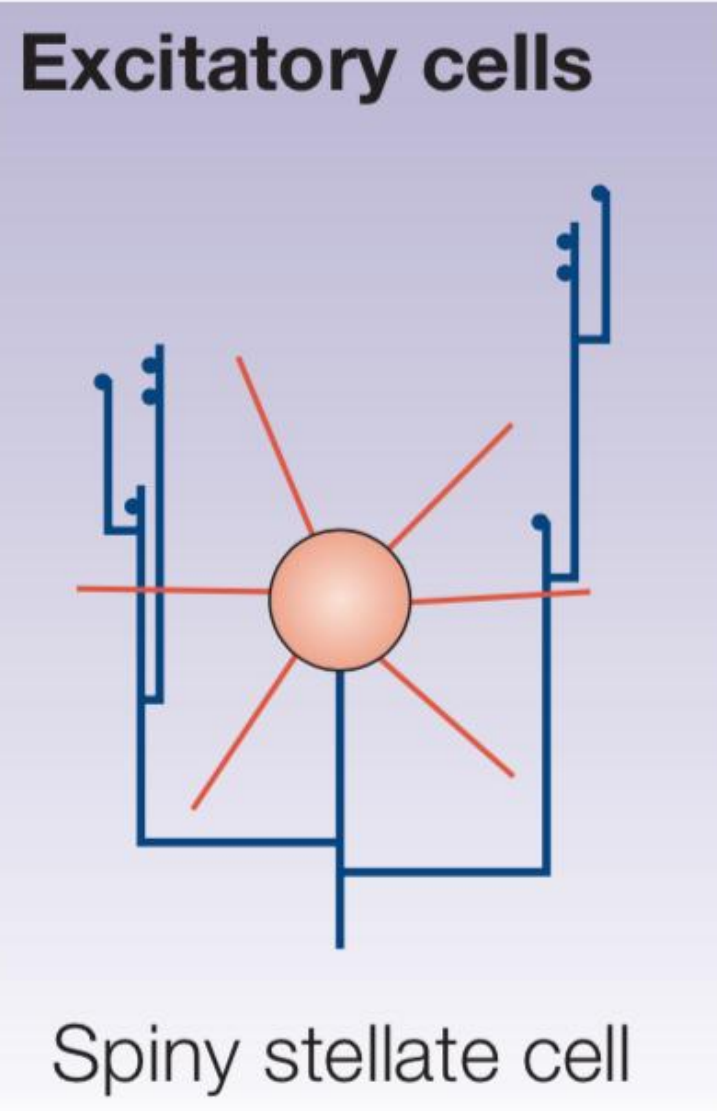
3. Interneurons or local circuit neurons (Inhibitory interneurons of the cortex etc)

Functional criteria: interneurons

The 20–30% of neocortical neurons are interneurons

Despite this diversity, interneurons have many common features, some of which distinguish them from projection neurons:

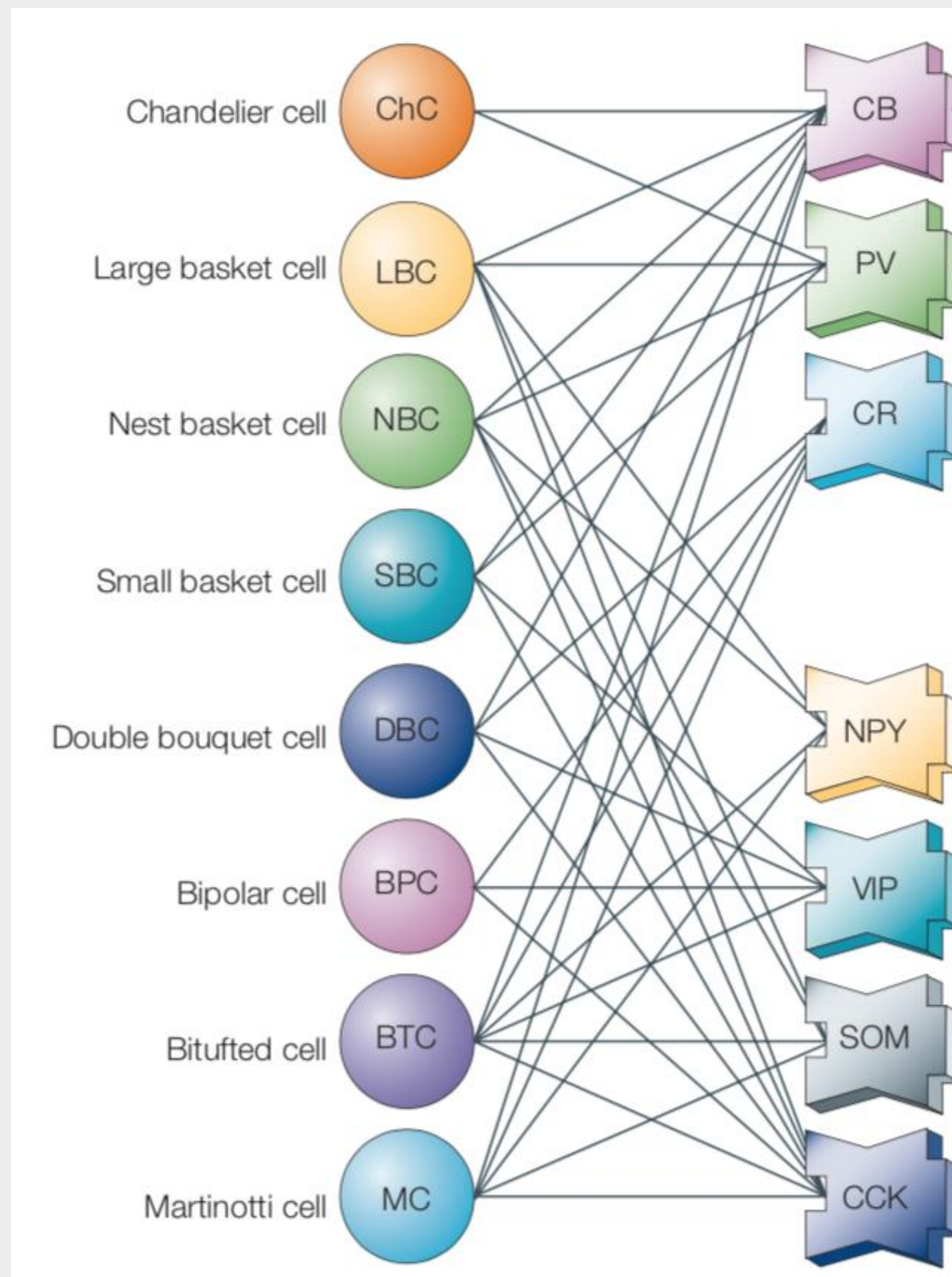
- Can be either excitatory (glutamate) or inhibitory (GABA)
- most mature inhibitory interneurons have aspiny dendrites
- the axons of inhibitory neurons usually arborize within a cortical column and can project laterally across columns, but do not typically project down into the white matter to contact distant brain regions
- different types of inhibitory neuron seem to be especially capable of targeting different subdomains of neurons (dendritic regions, soma or axon)



Molecular criteria

1. Protein composition (IHC)
2. mRNA composition (in-situ hybridization and increasingly RNA sequencing)

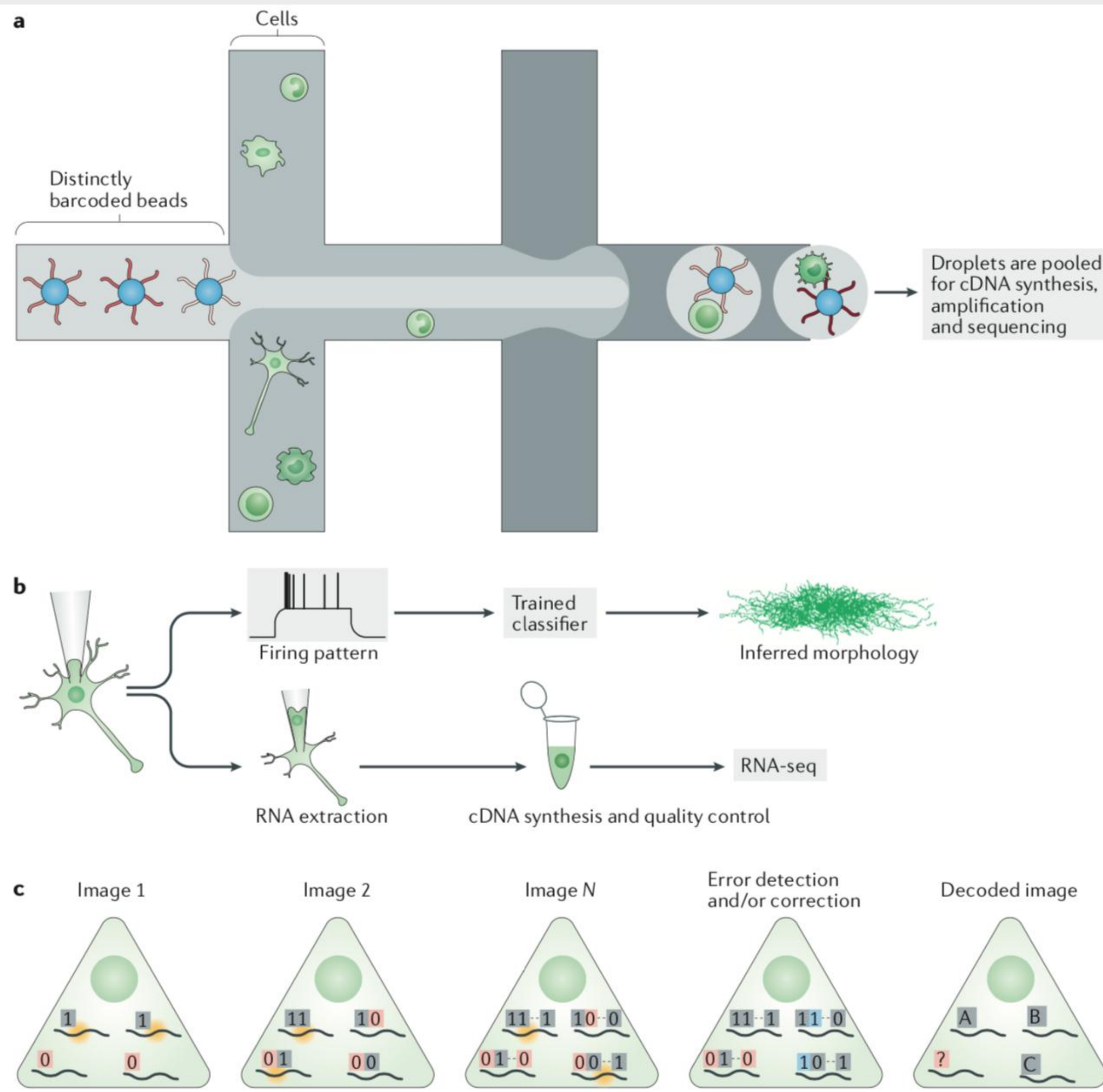
Molecular criteria IHC



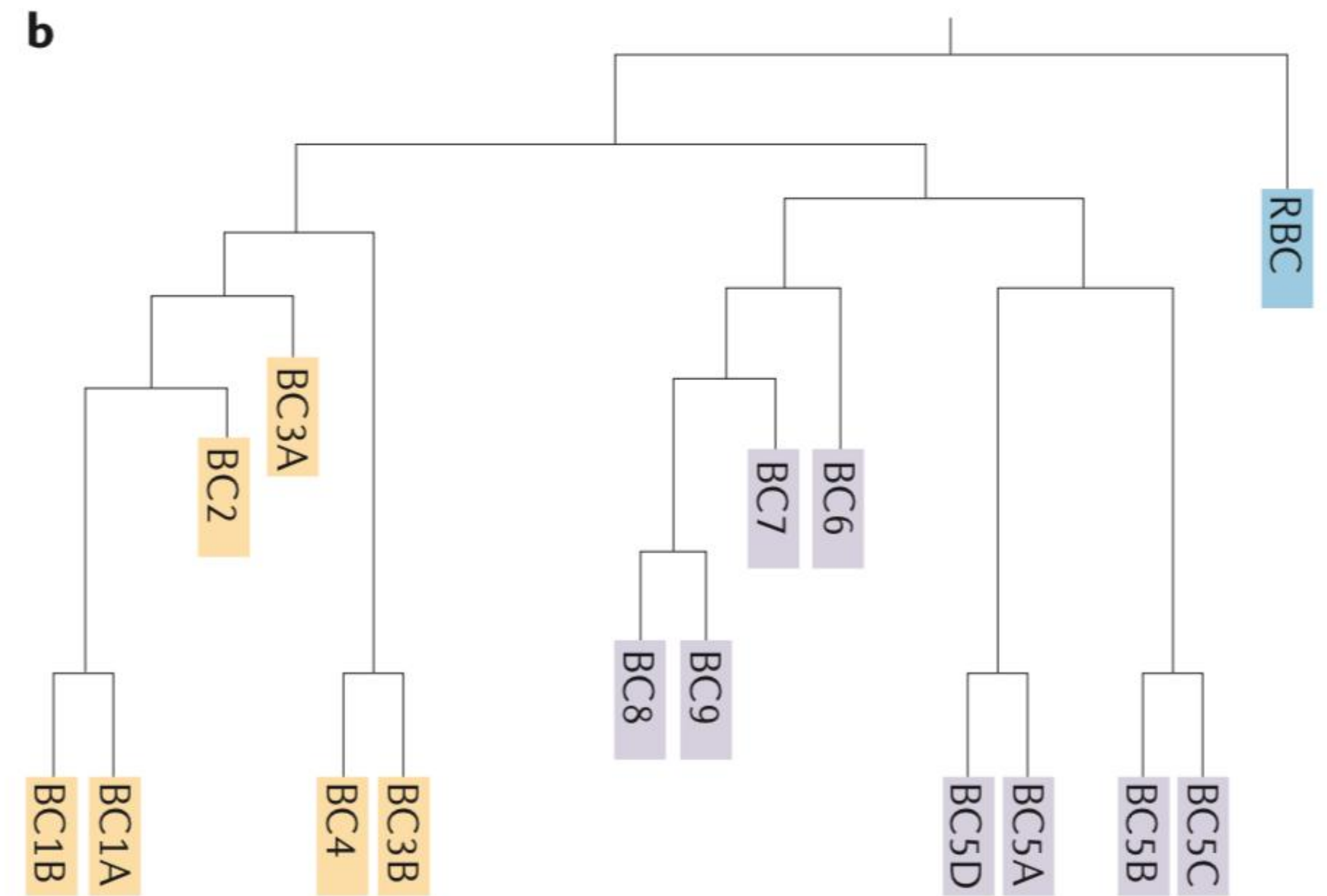
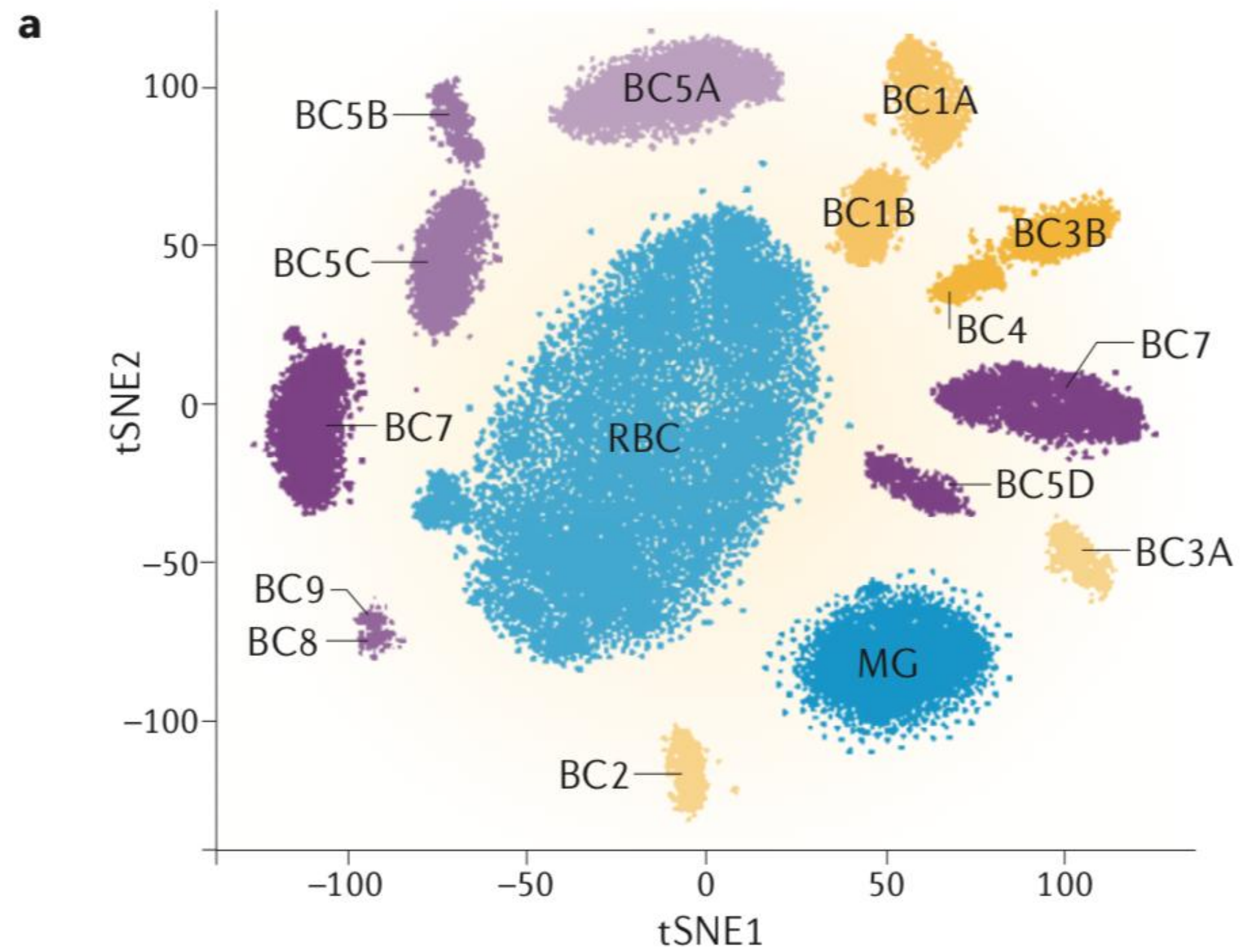
Expression of calcium-binding proteins (CBPs) and neuropeptides in interneurons.

Expression profiles of the CBPs calbindin (CB), parvalbumin (PV) and calretinin (CR) and the neuropeptides neuropeptide Y (NPY), vasoactive intestinal peptide (VIP), somatostatin (SOM) and cholecystikinin (CCK) by different morphological types of interneurons.

Molecular criteria (sc-RNA seq)



Molecular criteria (retinal bipolar cells)



Combination of all the criteria for retina bipolar cells

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