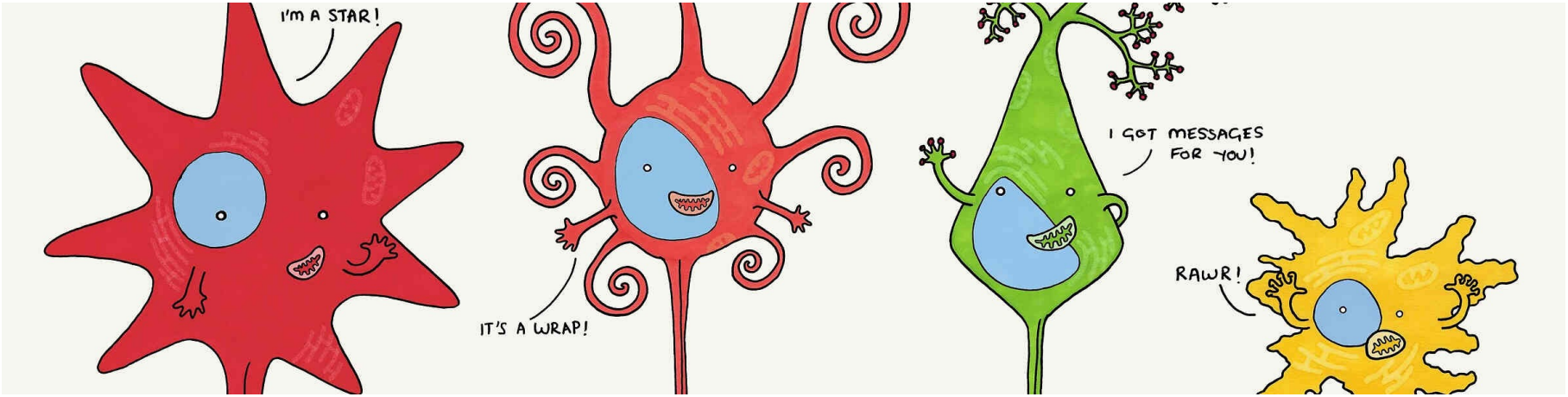
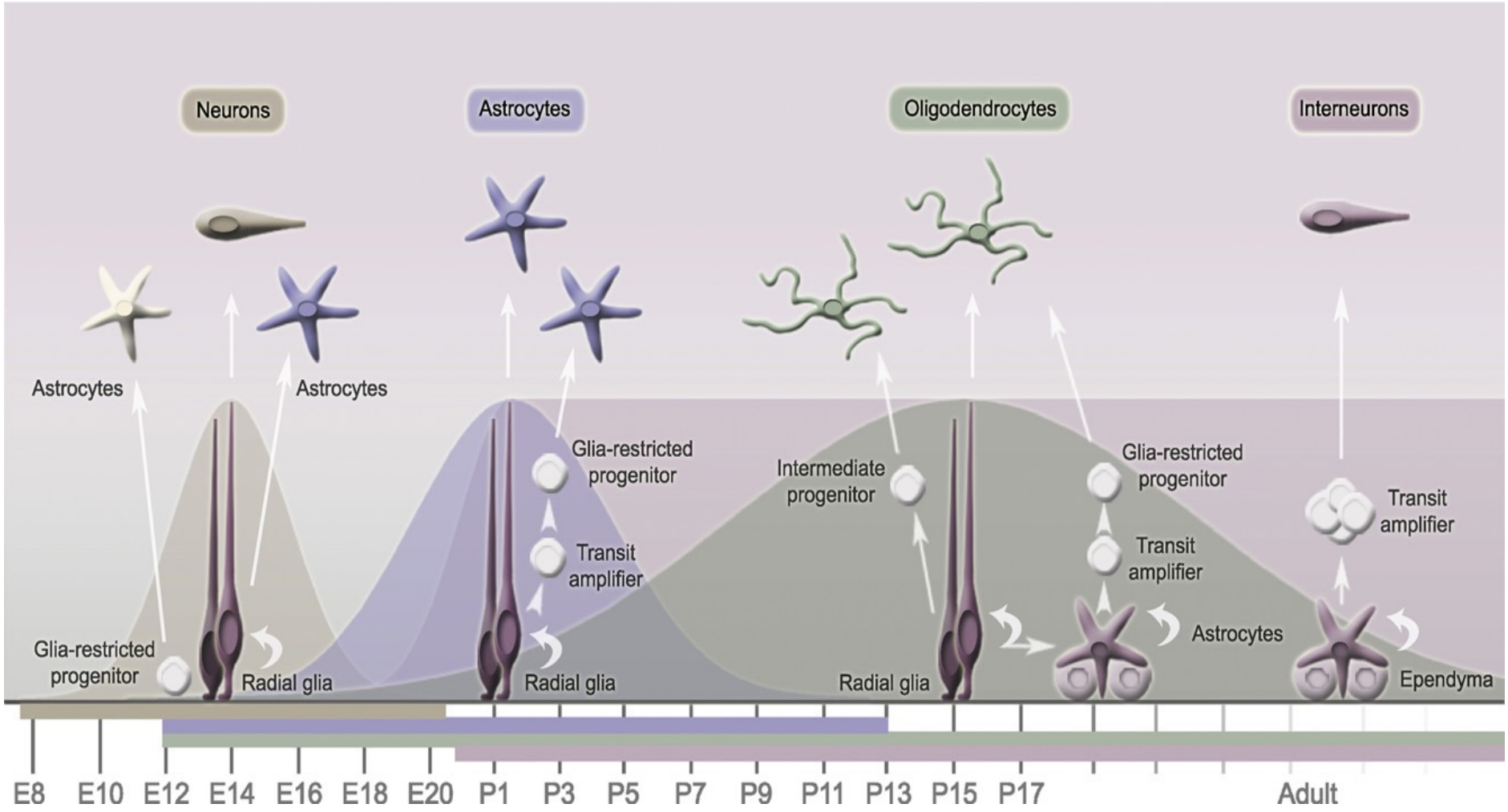



# GLIA – oligodendrocytes - radial glia –NG2

# Developmental origin

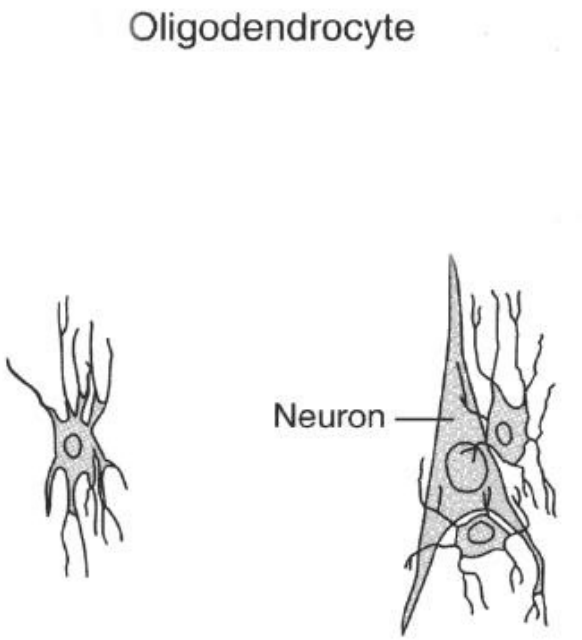


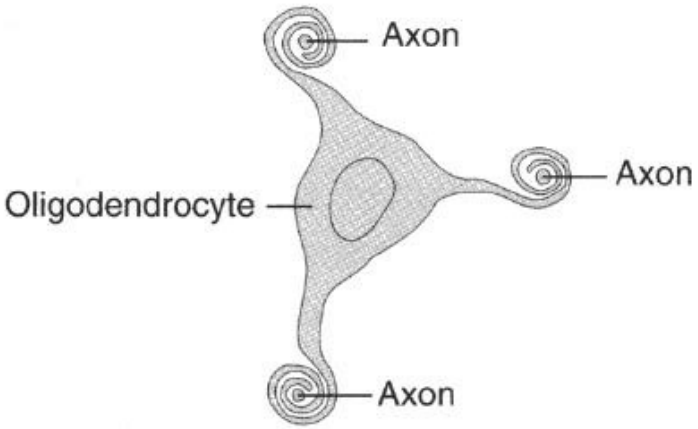
# Types of glial cells: Oligodendrocytes

**Oligodendrocytes** Produce Myelin in Central Nervous System

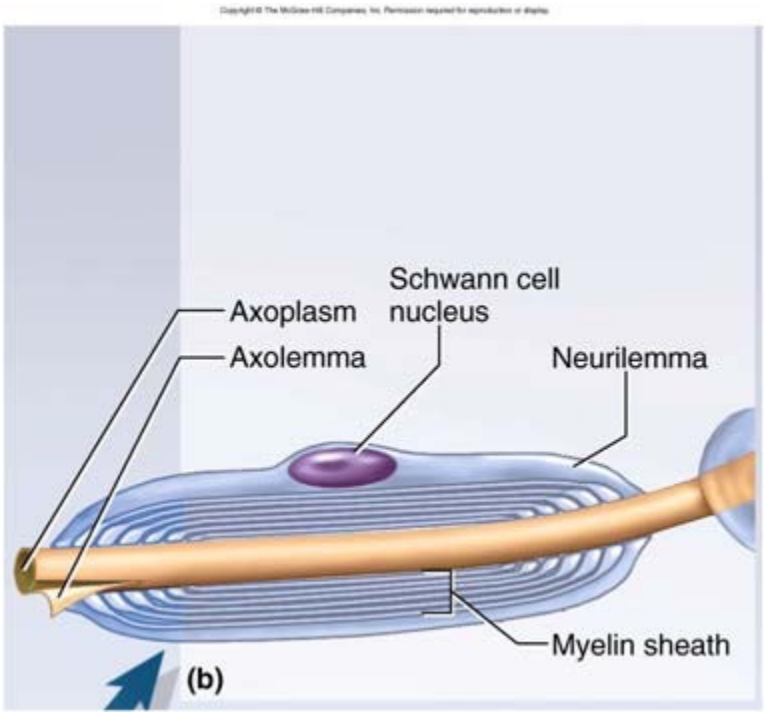
Form myelin sheaths around axons in the CNS

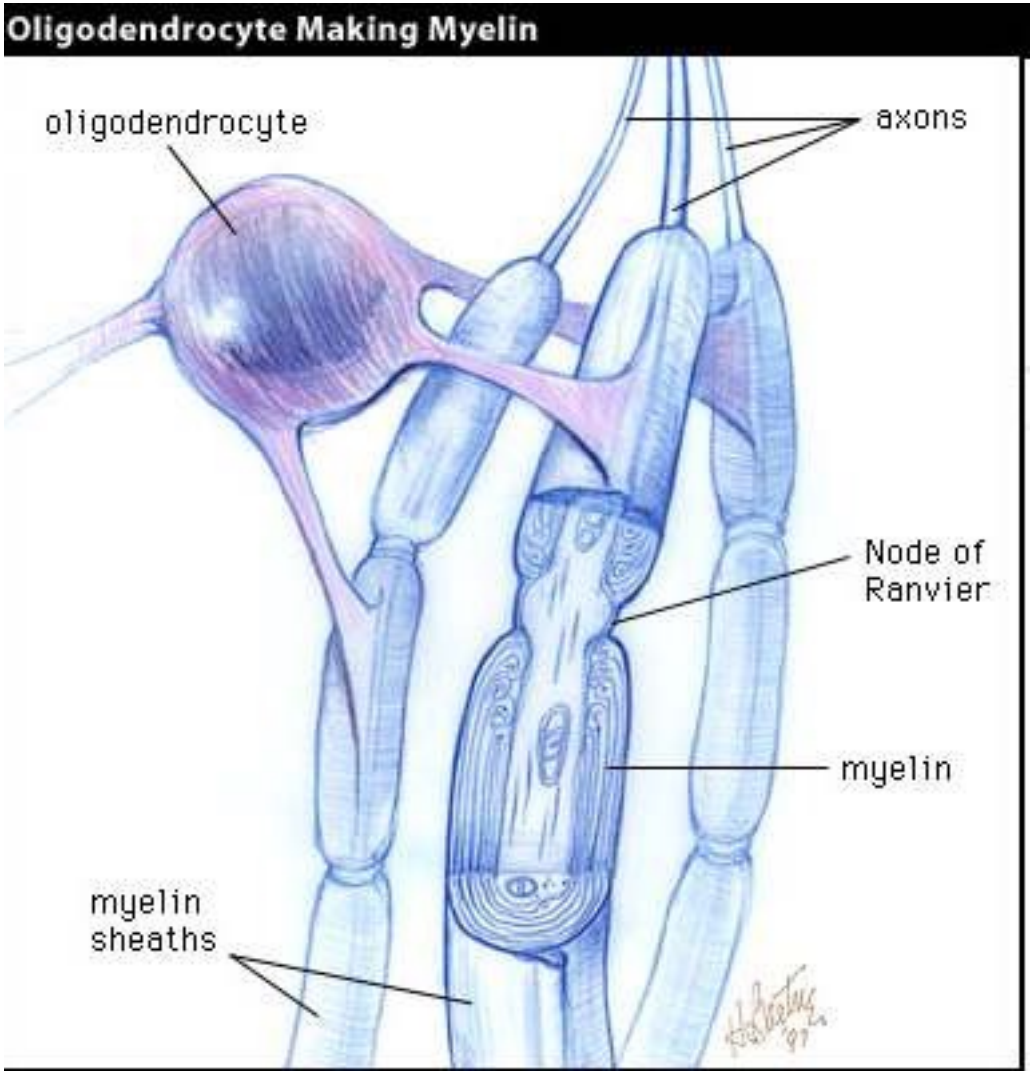
- Sheath multiple internodes & multiple axons
- Small cell body & relatively fewer processes
- Electrical insulation
- Speeds conduction of action potential



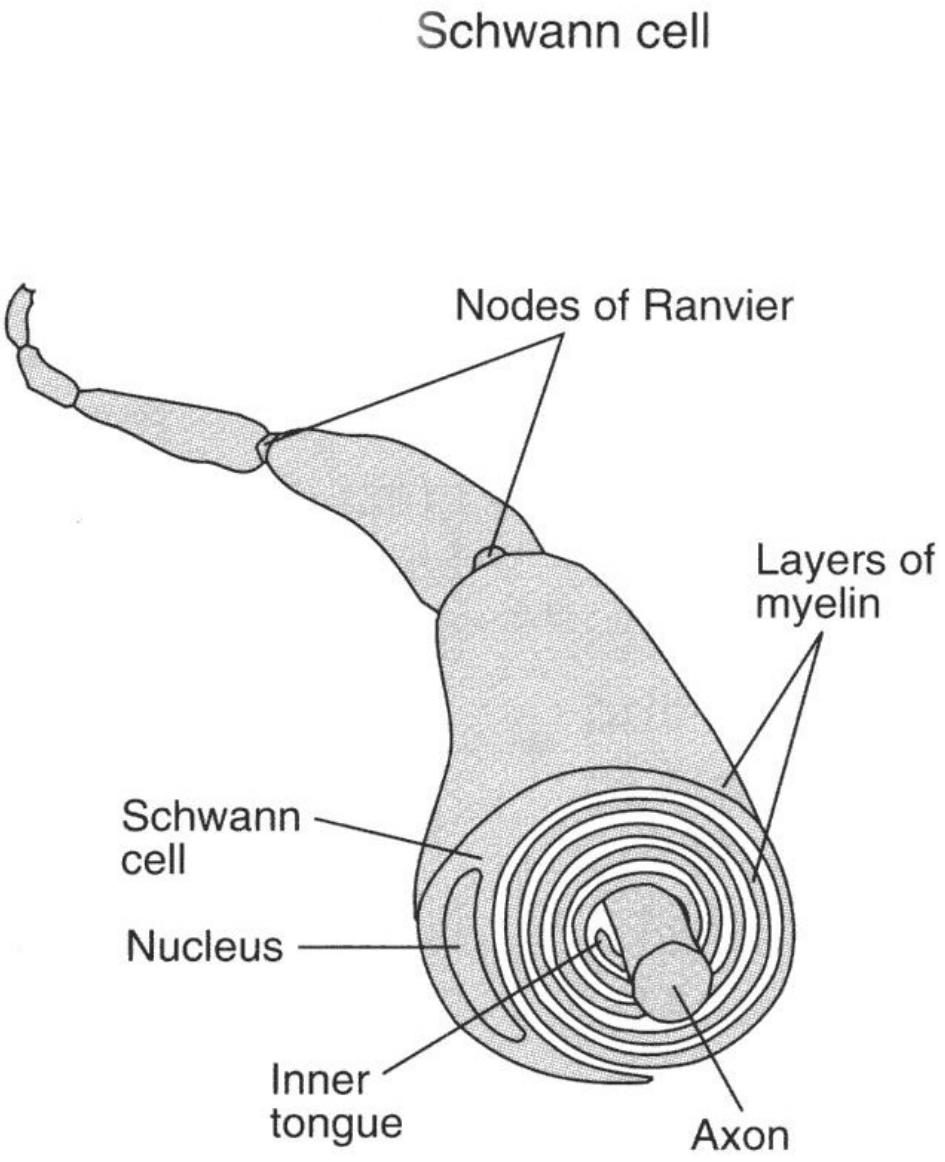
# Myelin Sheath



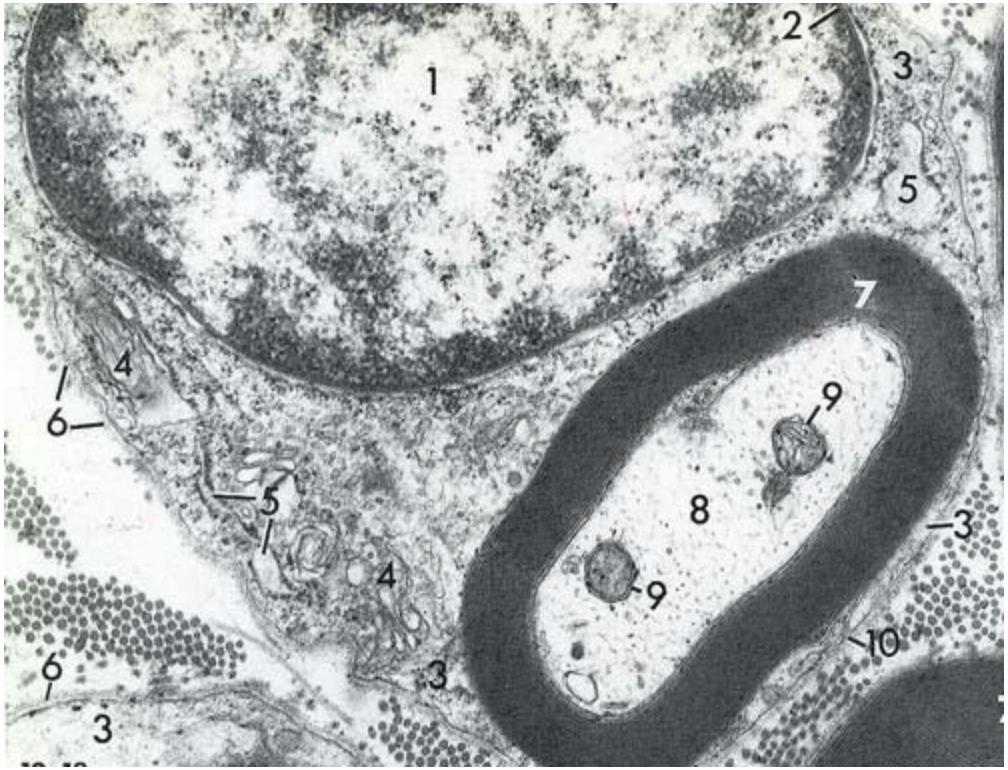
# Schwann Cells

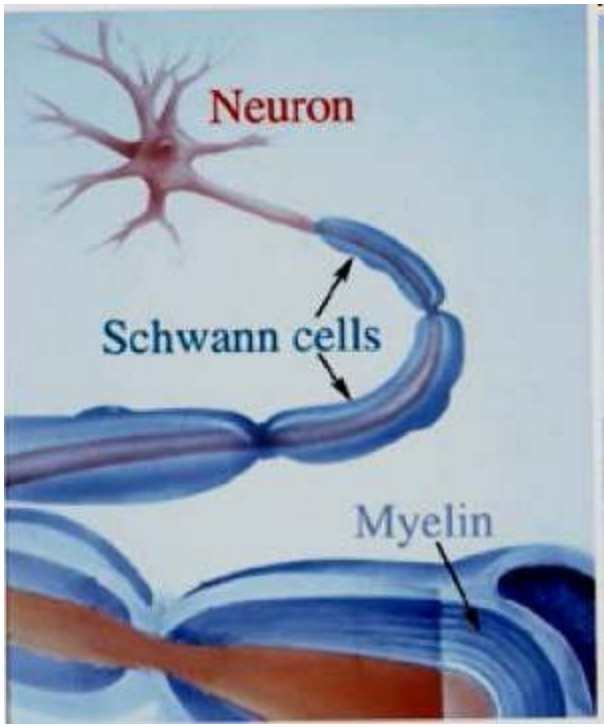
Produce Myelin in Peripheral Nervous System

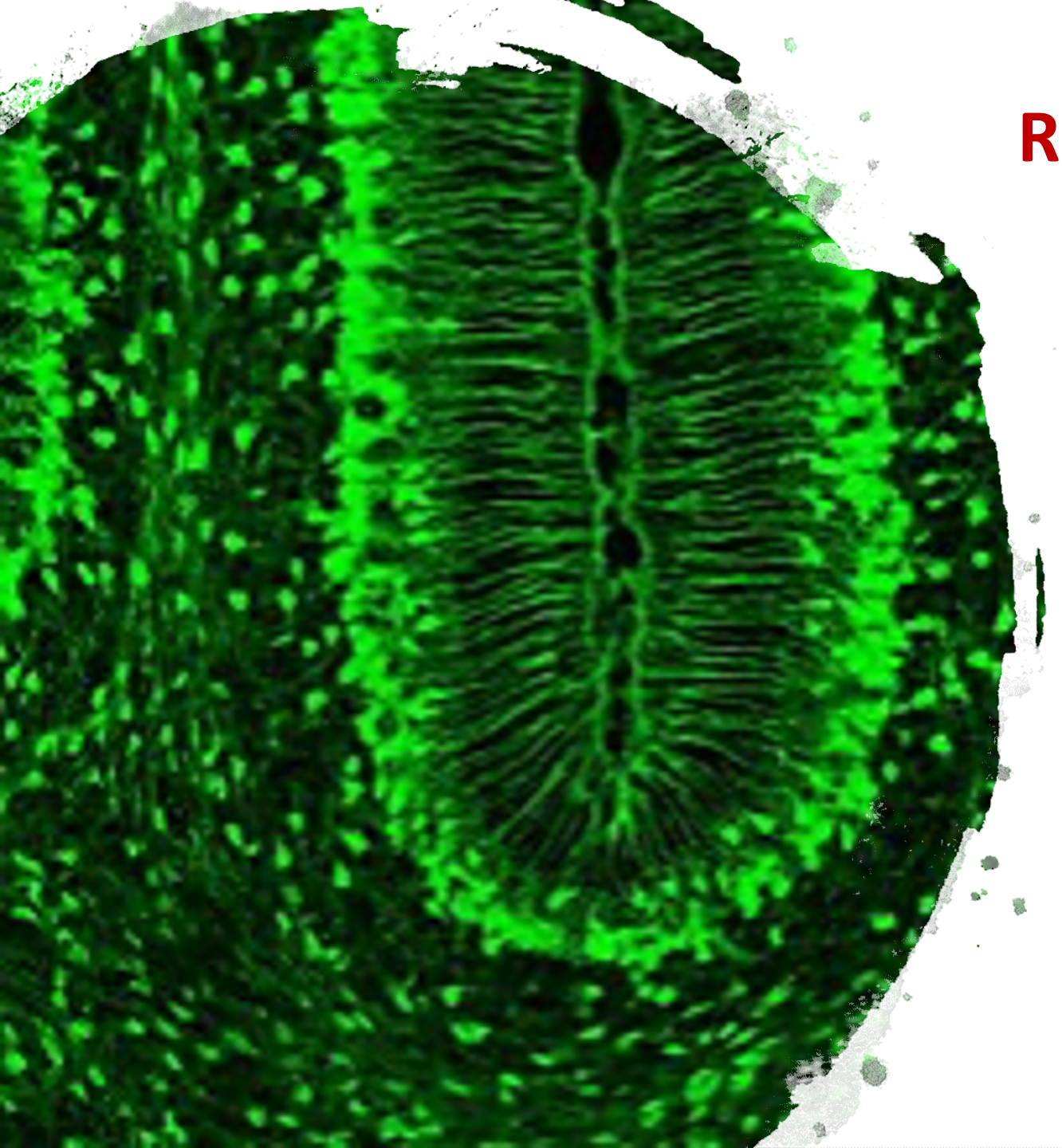


# Schwann Cells

- Form myelin in PNS
- One Schwann cell / internode / axon
- Electrical insulation
- Speeds conduction of action potential

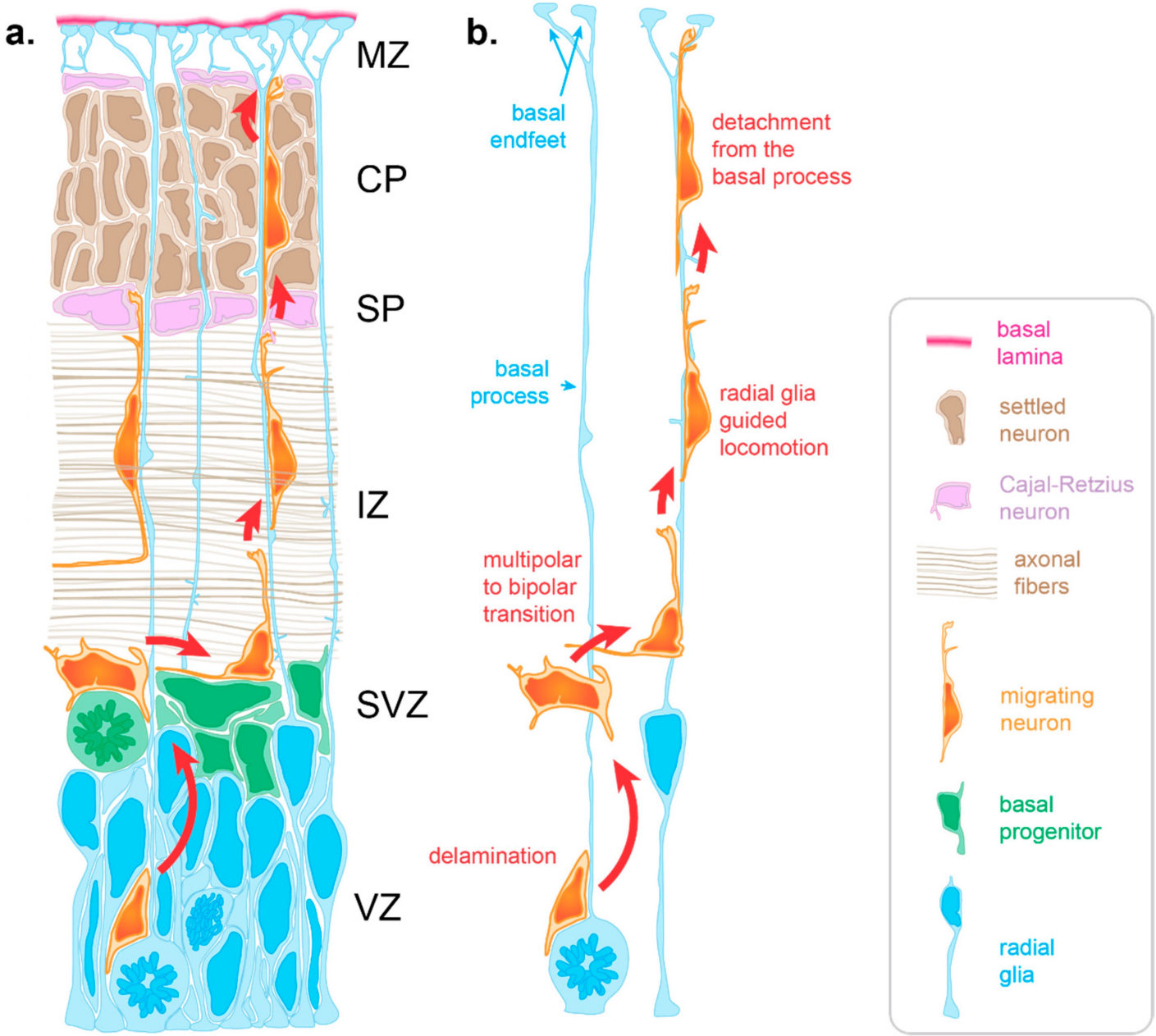




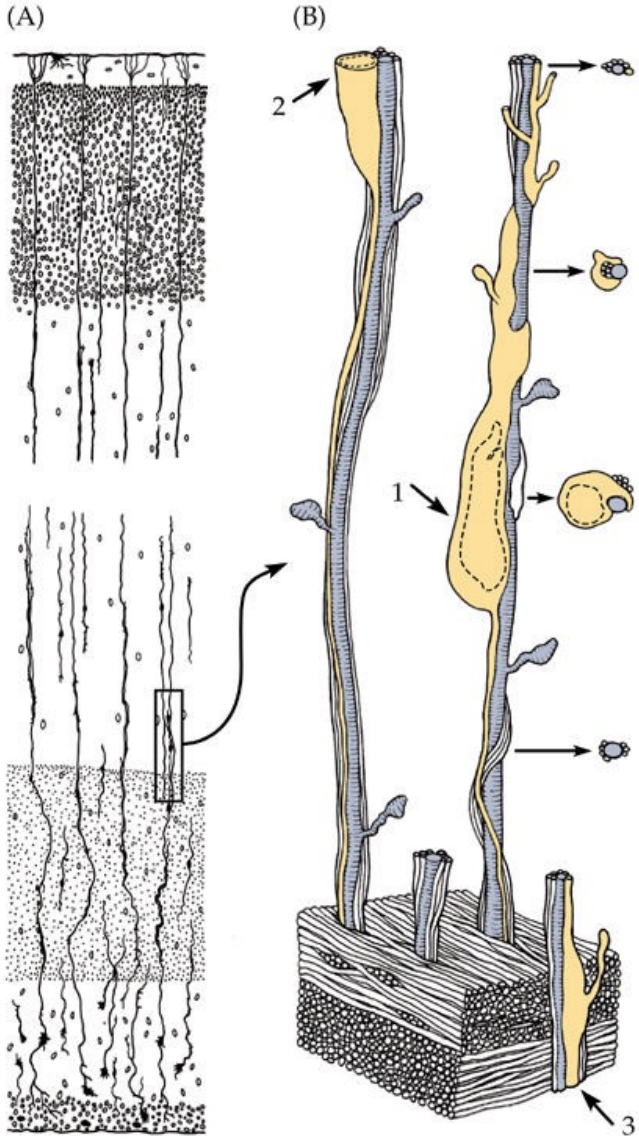
# Radial Glia

# Radial Glia guide development



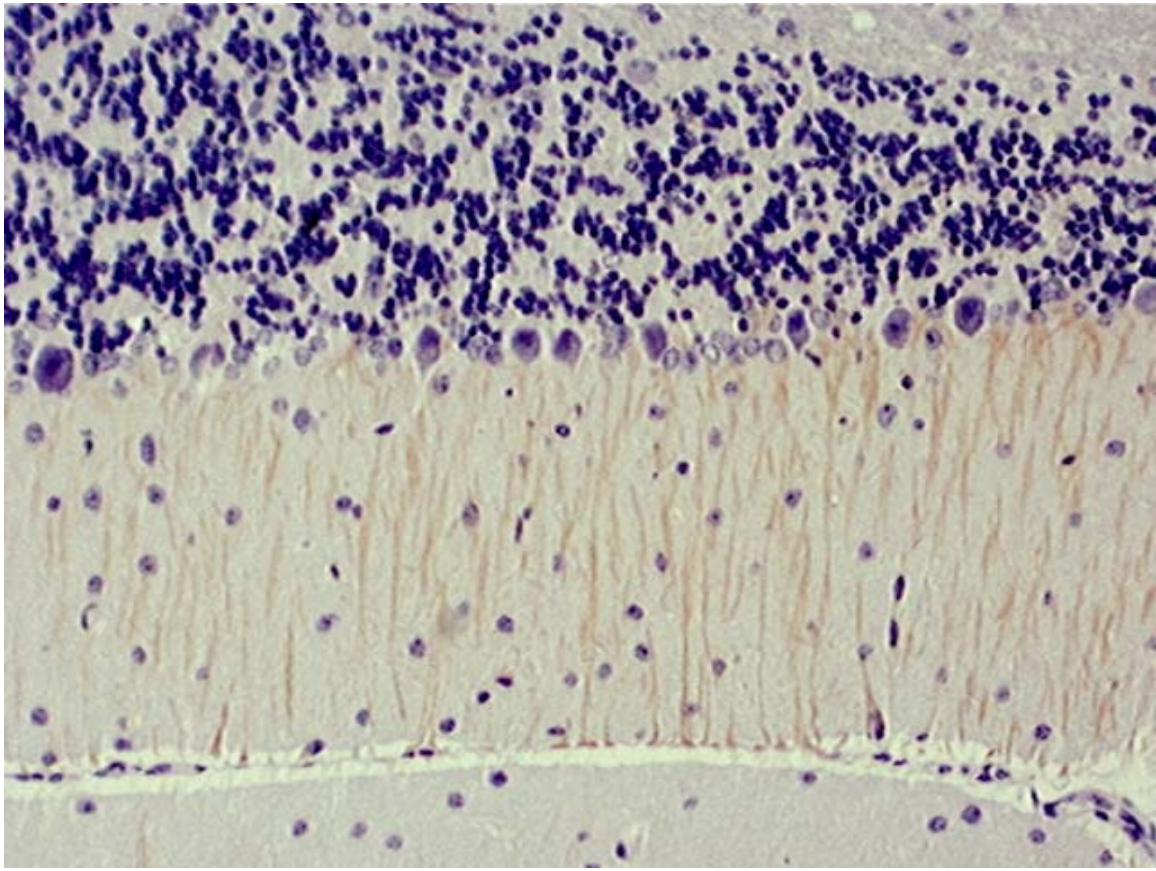
# Radial Glia guide development

**Radial glia** extend an apical “foot” to the ventricular basement membrane and a longer basal process that traverses all the layers of the cerebral wall to terminate underneath the pial surface of the brain.



# Radial Glia guide development

- In the developing brain, neurones are often formed far from their final site
- Development involves neuronal migration
- Radial glia plays a major role in neuronal migration



**Radial glia**

multipotent self-renewing stem cells

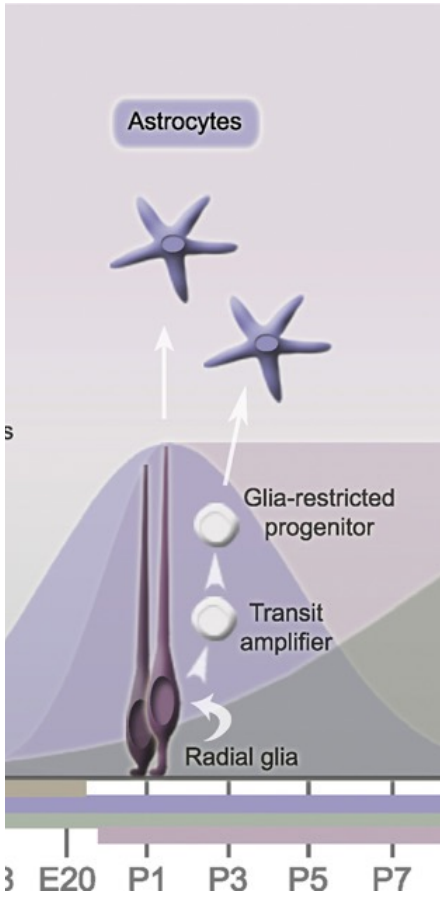
persist in cerebellum (Bergmann glia) and in retina (Muller cells)

# Radial Glia guide development

At the end of gestation in rodents of radial glia (in 1-3 days):

- looses neurogenetic capacity
- is transformed into parenchymal astrocytes

1. detachment of apical feet from the VZ and translocation of cell body to the cortex
2. shape change from bipolar to multipolar
3. change in fate of radial glial cell progeny from neurons to astrocytes.



# Radial Glia and Adult Neurogenesis

**In the adult mammalian brain most radial glia disappears and neurogenesis persists only in few niches, those where radial glia-like cells (= neural stem cells) are still present**

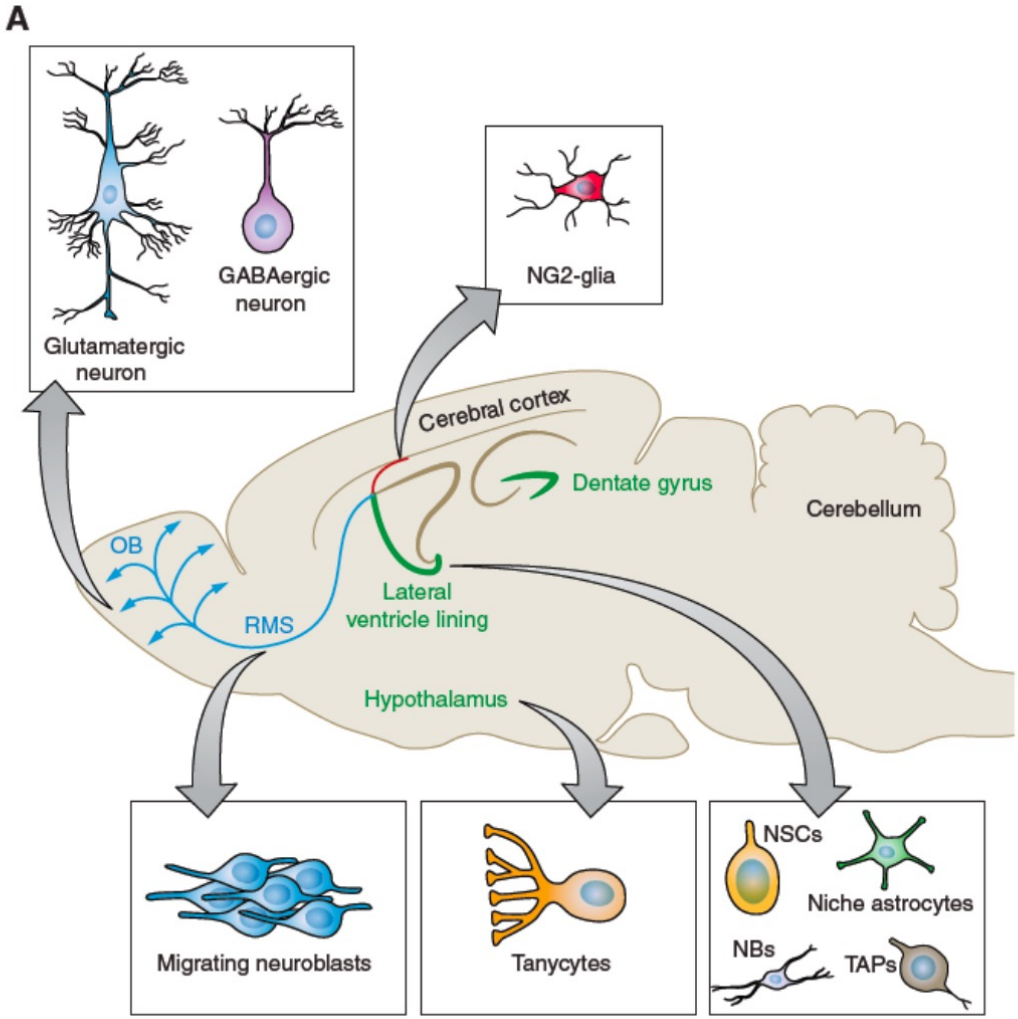


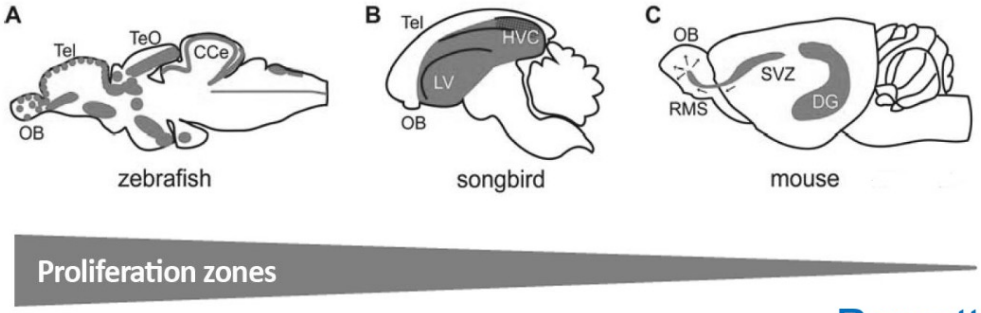

**FIGURE 3.** Glial cells as stem and progenitor cells in the healthy adult brain. *A*: endogenous neurogenesis still persists in the adult mammalian brain in few niches like the subependymal zone in the lateral wall of the lateral ventricle, the subgranular zone in the dentate gyrus, and the hypothalamus. Radial glial cells at the subependymal zone of the lateral ventricle divide and generate fast proliferating transit-amplifying progenitors (TAPs) and neuroblasts (NBs) that proliferate while they migrate through the rostral migratory stream (RMS) to their final destination, the olfactory bulb (OB), where they can differentiate to different neuronal types.

**Leda Dimou and Magdalena Götz**

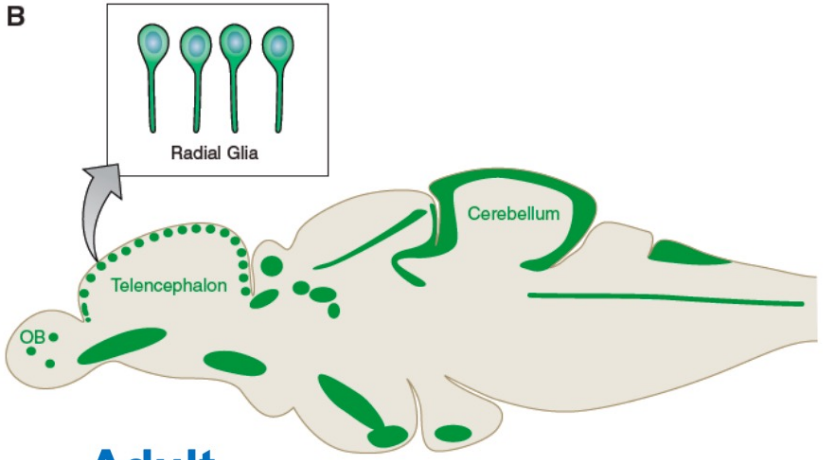
*Physiol Rev* 94: 709–737, 2014
doi:10.1152/physrev.00036.2013

# Radial Glia and Adult Neurogenesis

**In many non-mammalian vertebrates (fish, amphibians and reptiles) radial glial cells remain abundantly present in a widespread manner in the adult CNS**




Pomatto et al., 2013




**Adult zebrafish**

*B*: radial glia cells in the adult zebrafish are more widespread than in mammals and are located along the ventricle. The zebrafish telencephalon is everted, with the ventricle lying between and above the two telencephalic hemispheres. Proliferating cells (green, based on data summary in Ref. 89) are located in distinct regions along the entire anterior-posterior axis.

**Leda Dimou and Magdalena Götz**

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# Types of glia: NG2 cells (polydendrocytes)

# Types of glia: NG2 cells (polydendrocytes)

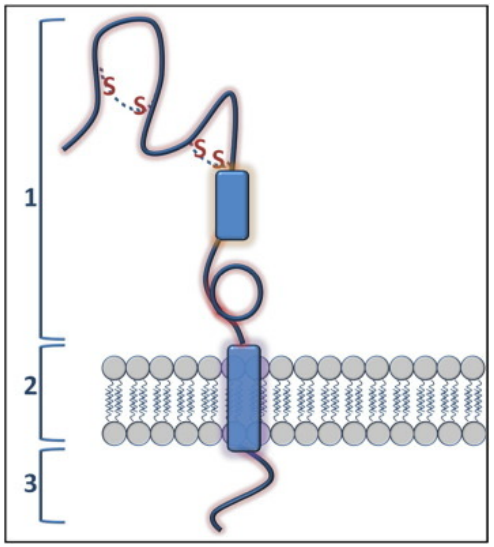
- Distinct from neurons, mature oligodendrocytes, astrocytes, microglia
- Identified by the expression of the proteoglycan NG2, have a highly branched morphology
- Distributed throughout the grey and white matter.

- Differentiate into oligodendrocytes

***Oligodendrocyte precursor cells or Multipotential cells that can give rise also to neurons and astrocytes*?**

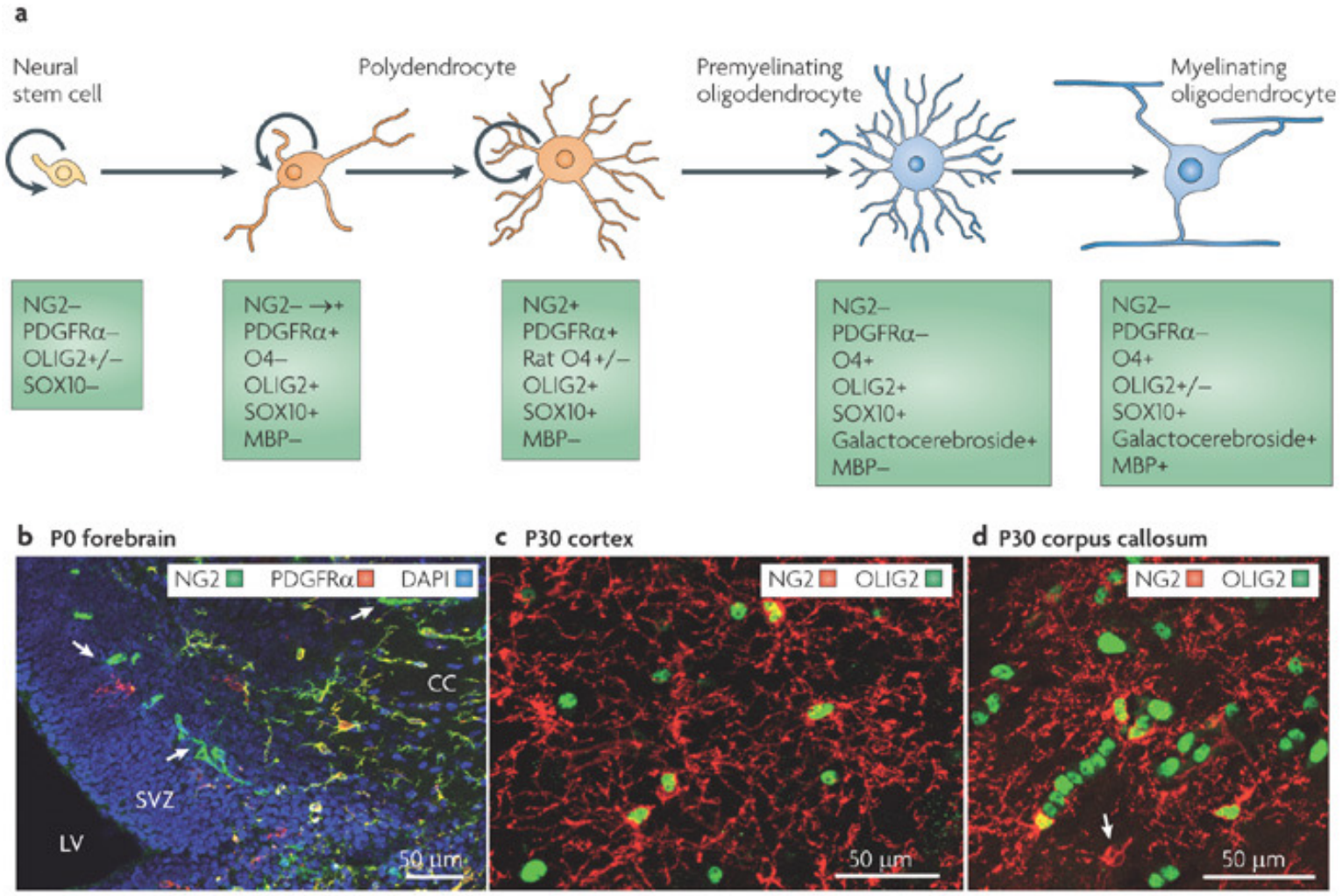
- Receive synaptic input from neurons

***Are they integrated in the neural network?***

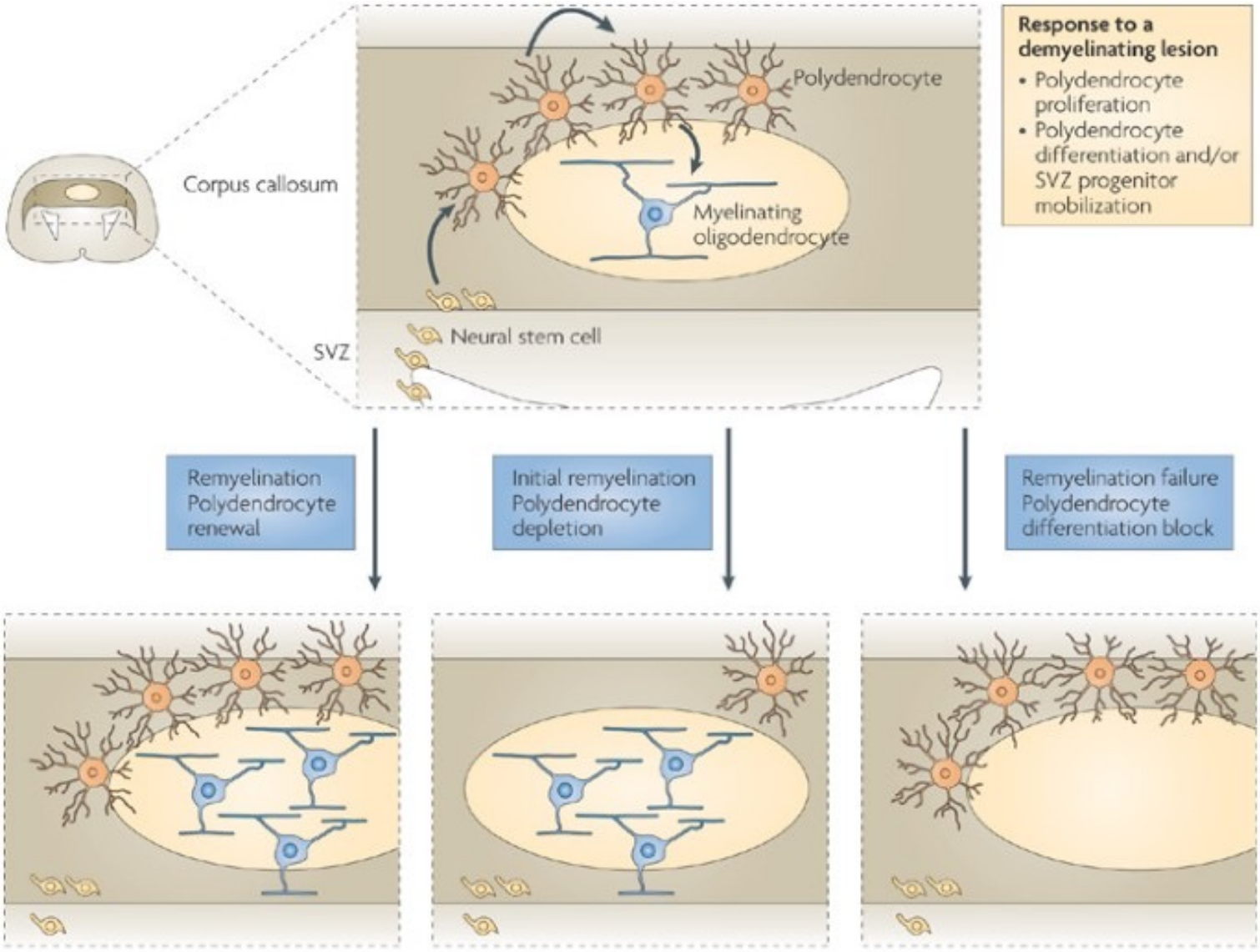


# NG2 cells (polydendrocytes)

**Progenitor cells expressing the proteoglycan NG2 approximately 5% of the total cells in the adult brain,**



# NG2 cells and remyelination

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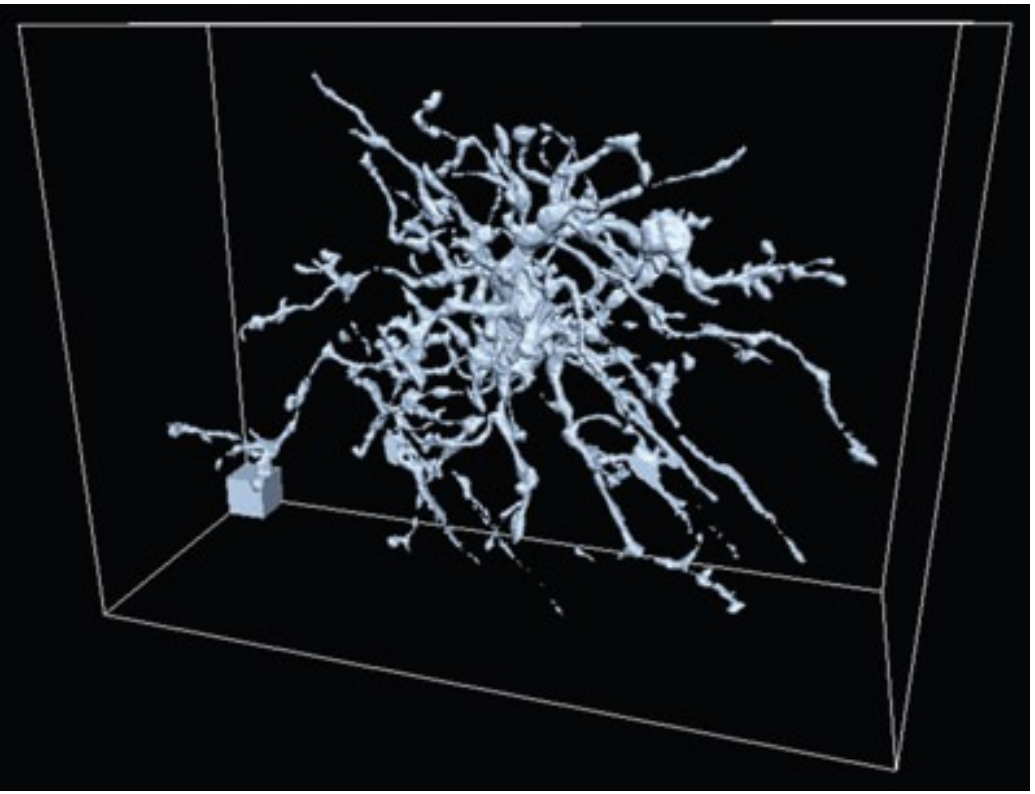
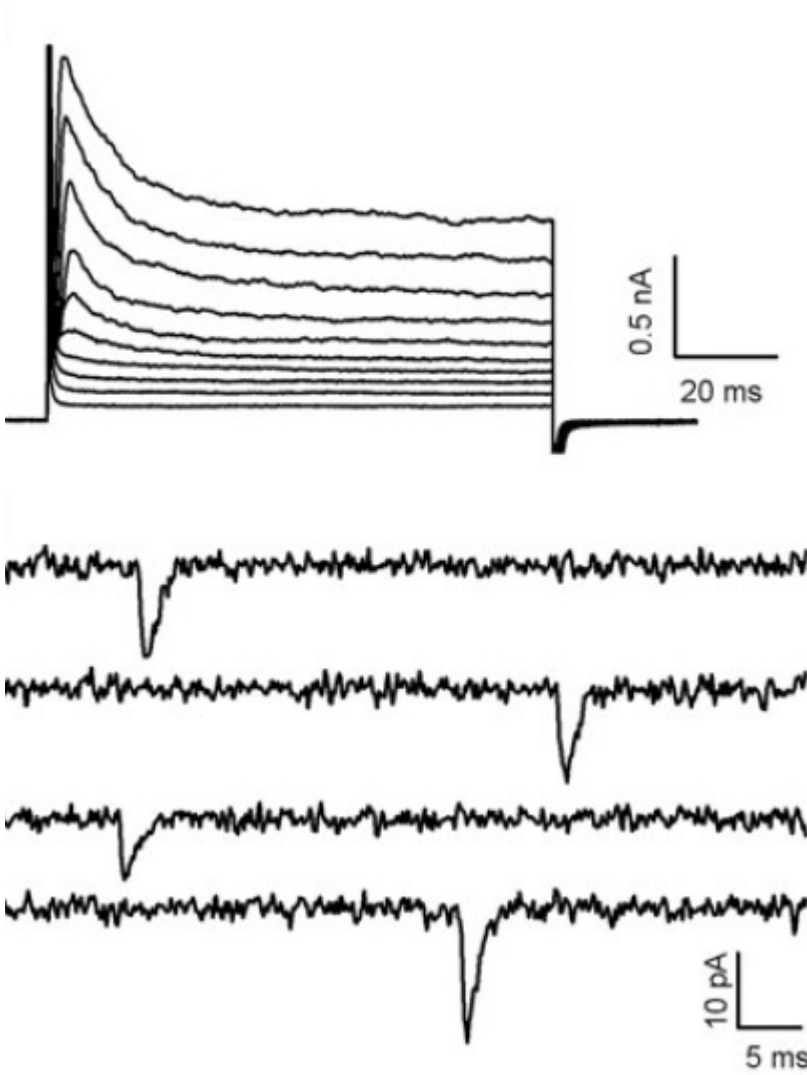
# NG2 cells respond to NT



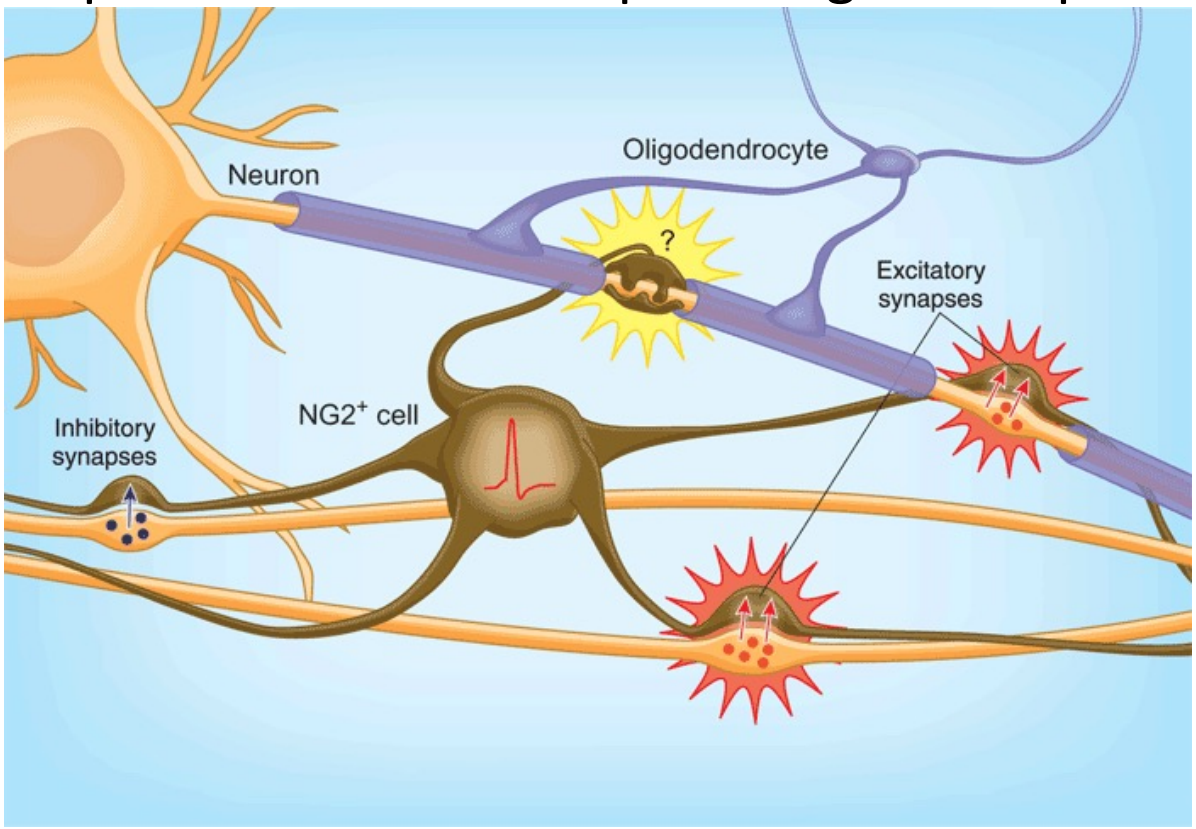



The majority of NG2+ progenitors exhibit a stellate morphology with small cell body and many radial processes

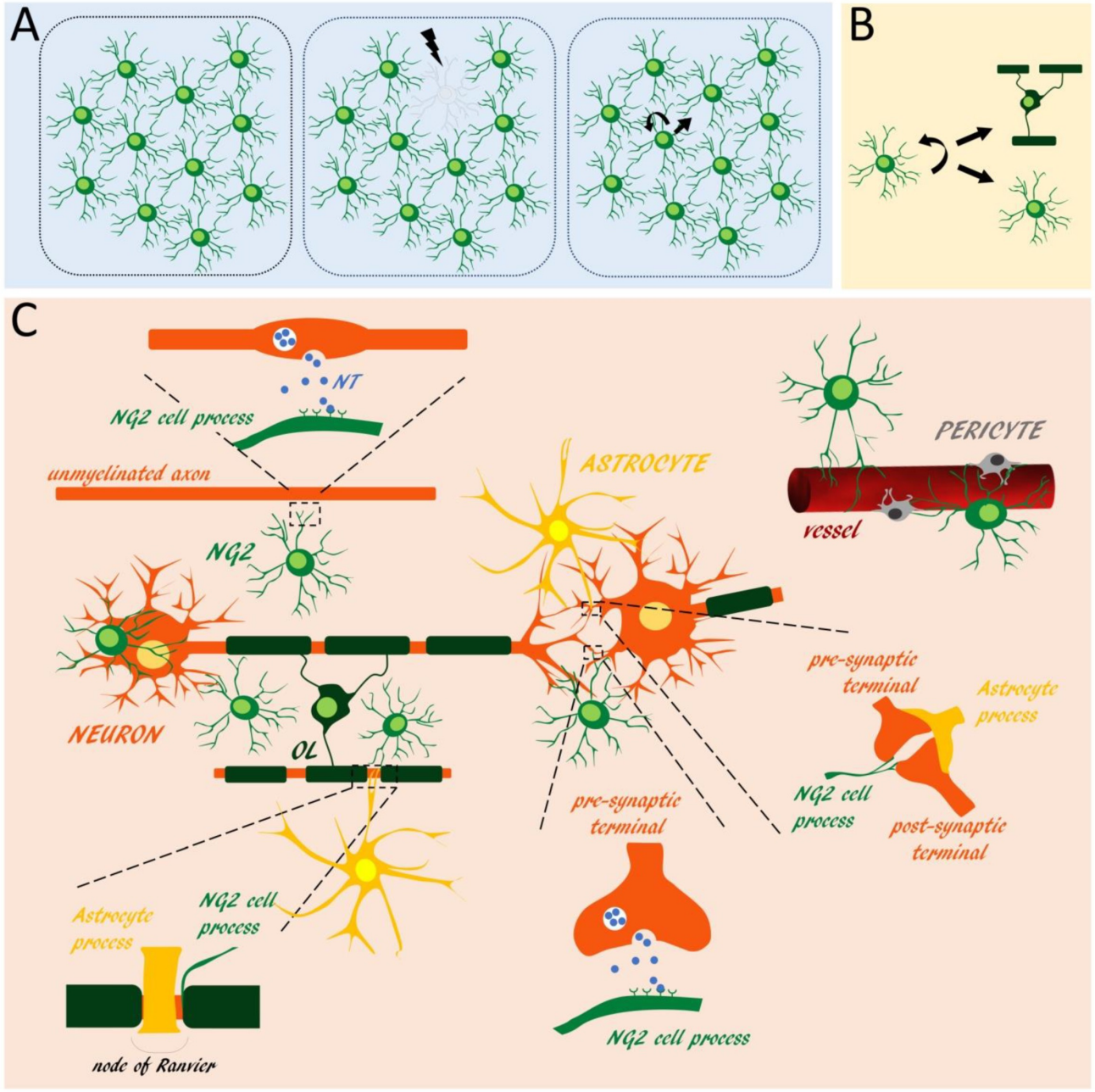
# NG2 cells can fire action potentials

$NG2^+$ glia can be induced to fire action potentials by excitatory synaptic input from myelinated or unmyelinated axons.

- The physiological role of $NG2^+$ cell excitability is not yet clear (transition of $NG2^+$ cells into myelinating oligodendrocytes?)
- $NG2^+$ cells processes wrap nodes of Ranvier-optimizing nodal spacing or stability



# NG2 cells interactions

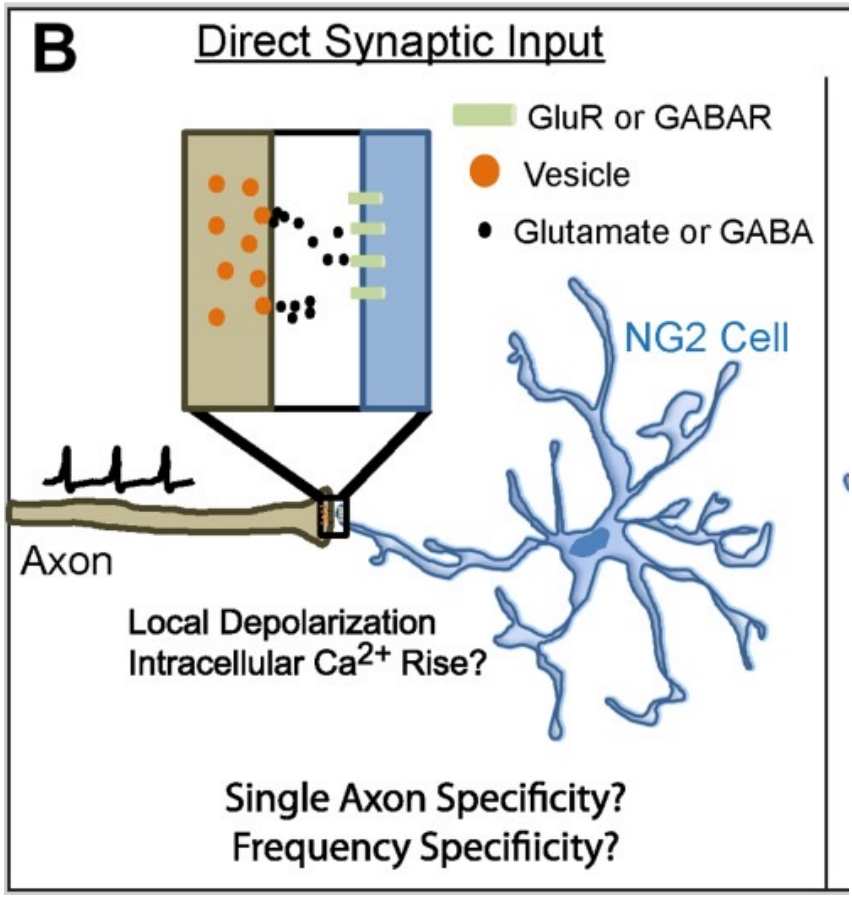


# NG2 –neurons interactions

**Neuron–polydendrocyte synapses.**

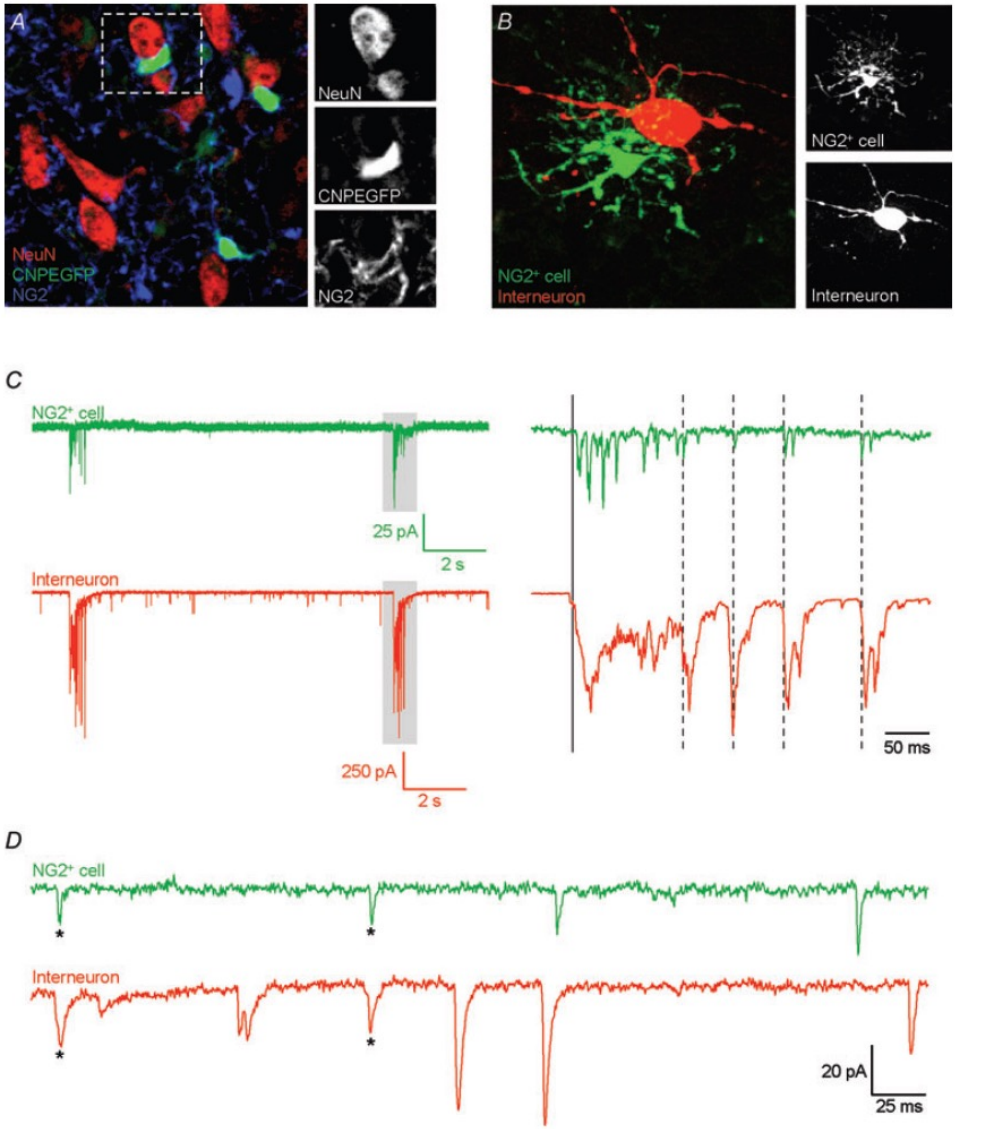
**In grey matter, presynaptic terminals** can form synapses with both neuronal dendrites and polydendrocytes.

- Most neuronal AMPA receptors contain Ca2+-impermeable GluR2 subunit
- Polydendrocytes have Ca2+permeable AMPA receptors



# NG2 –neurons interactions

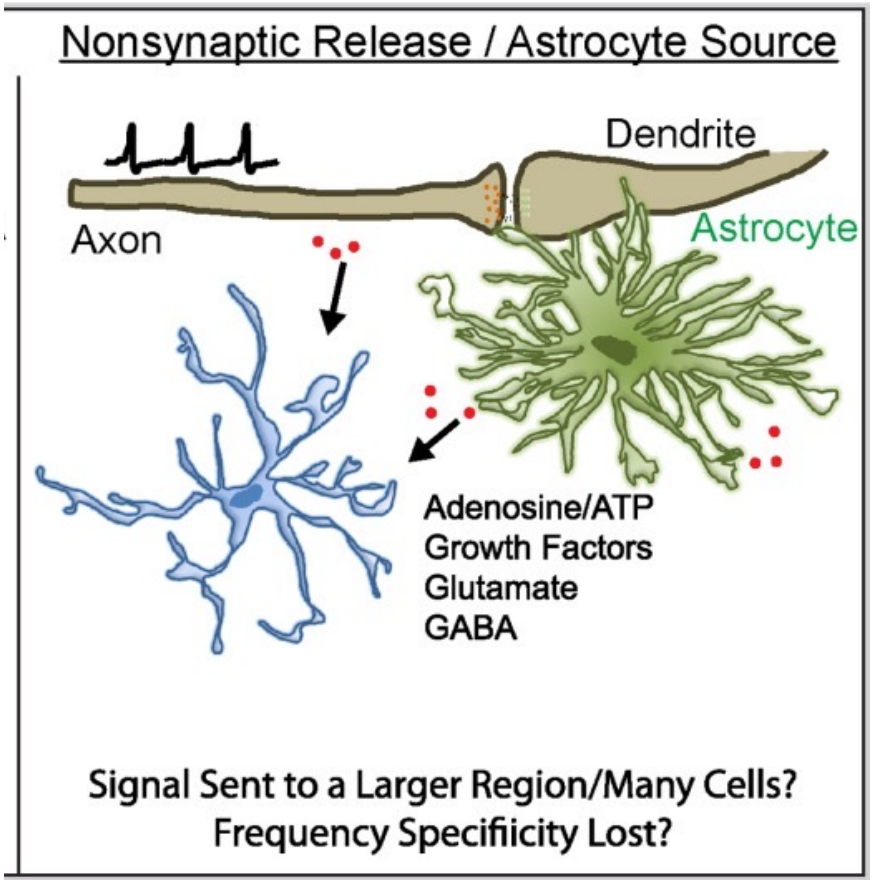




# NG2 – neurons – astrocytes interactions

**In white matter, polydendrocytes receive** glutamate released from unmyelinated axons.

- Astrocytes, express glutamate transporters but not AMPA receptors
- Polydendrocytes express AMPA receptors but not glutamate transporters *The consequences of depolarization and increased intracellular Ca2+ in polydendrocytes are not known.*
- Secretion of trophic factors or regulation of proliferation/differentiation



# Significance of neuron–polydendrocyte synapses.

*What are the consequences of depolarization in polydendrocytes?*
Depolarization is too small to elicit action potentials.
Depolarizing spikes, sensitive to tetrodotoxin, were detected in polydendrocytes from the early postnatal mouse cerebral cortex.
***transient phenomenon? functional significance?***

Ca2+ permeable AMPA receptors: glutamate signalling might trigger
- **release of neurotrophins and neurotransmitters**.
- **cascade of signalling pathways that regulate proliferation, differentiation or migration**