The outgrowth of axons during neuronal development, as well as their regeneration after injury, of the adult nervous system is controlled by specific extracellular cues which are diffusible, or bound to cell membranes or extracellular matrix.

JNK1-Dependent Phosphorylation of GAP43 Serine 142 is a Novel Molecular Marker for Axonal Growth [1)]

Regrowth inhibitory molecules prevent axon regeneration in the adult mammalian central nervous system (CNS).

In addition to chemotrophic and contact guidance theories that explain how long projection neurons weave intricate patterns of connectivity within developing or regenerating neuronal networks, there has been recent interest in mechanisms that guide axons by actively constraining, inhibiting or repelling axon growth cones. Developmental boundaries are especially important in regions where large numbers of growing axons must change direction in order to remain on course towards their potential targets. Regenerative boundaries can also have severe pathological consequences since they limit the potential for axon regrowth following injury or diseases. Some of the molecular mechanisms that generate repulsive environments in the embryo are re-expressed in the adult following injury. In the developing retina, a chondroitin sulfate-proteoglycan appears to play an essential role in controlling the sequence of ganglion cell differentiation and initial direction of axons. In several lesion models, re-expression of a chondroitin sulfate-proteoglycan by reactive astrocytes limits regeneration through glial scars; conversely, in experiments where boundary molecules have been manipulated by chondroitinase digestion, axons are stimulated to regrow or re-route to inappropriate pathways [2)].

1)
Okada M, Kawagoe Y, Takasugi T, Nozumi M, Ito Y, Fukusumi H, Kanemura Y, Fujii Y, Igarashi M. JNK1-Dependent Phosphorylation of GAP-43 Serine 142 is a Novel Molecular Marker for Axonal Growth. Neurochem Res. 2022 Mar 26. doi: 10.1007/s11064-022-03580-6. Epub ahead of print. PMID: 35347634.
2)
Silver J. Inhibitory molecules in development and regeneration. J Neurol. 1994 Dec;242(1 Suppl 1):S22-4. Review. PubMed PMID: 7535345.