Translational Nanomedicine:

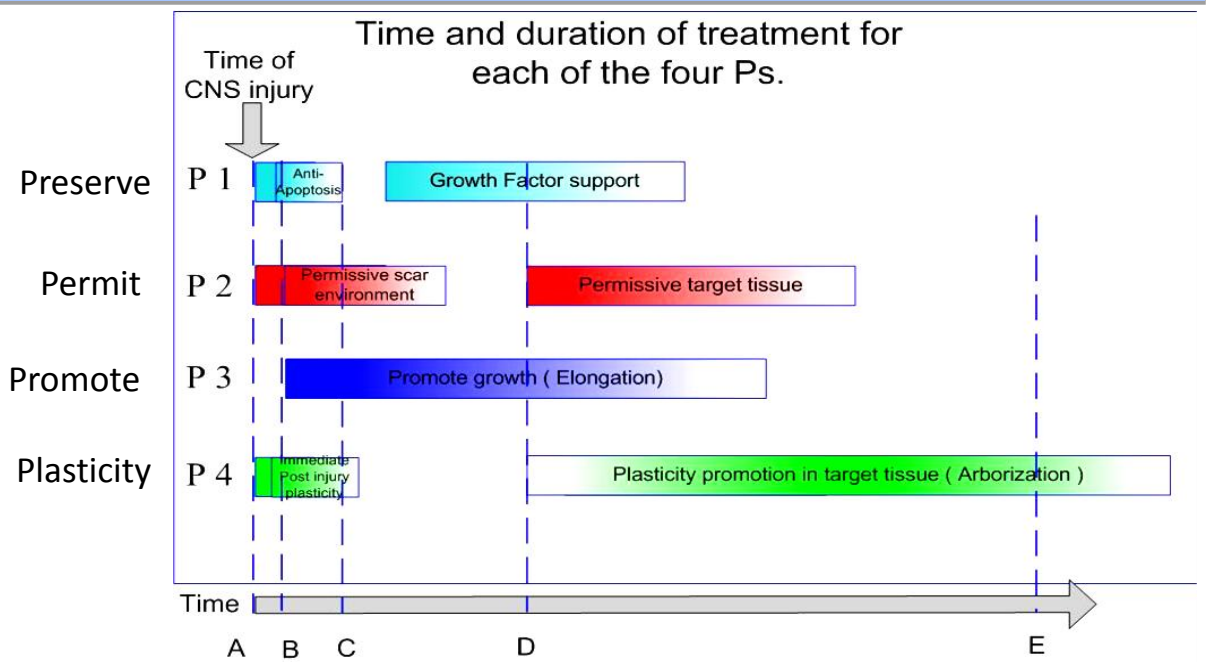
Central Nervous System Regeneration

4P's – New Framework for Therapy

The 4 P's of CNS Regeneration is an engineering framework I designed to speed up the regeneration process, lessening the time from injury to return of function.

"Nanotechnology has been put to a new use in biomedicine."

- *The Lancet Neurology* (2006) May; 5(5): 386-387



Each of the four P's of regeneration is represented by horizontal bars depicting the time of treatment and the duration the treatment must remain active. P1 is preserving cells and is broken down into two parts: the anti-apoptosis and anti-necrosis treatment and the growth factor support during elongation. P2 is also broken into two parts: the first treatment is to create a permissive environment around the site of injury; then the target tissue must be made permissive to the reinnervating axons. P3 is the promotion of growth of the axons in an elongation mode. P4, plasticity, has two parts: the immediate post-injury plasticity must be reduced so filling-in is minimal and, while axons are reconnecting in the target tissue, plasticity must be upregulated. This function can be accomplished by factors or training. Timeline runs from left to right and starts at the time of injury. **A** is the time of injury, **B** is 24-hours post injury, **C** is 72 to 96 hours post injury, **D** is 2 weeks to 4 months and can extend longer, and **E** is years.

Ellis-Behnke, R.G. Nano Neurology and the 4 Ps of CNS Regeneration: Preserve, Permit, Promote and Plasticity. Medical Clinics NA 91-5: 937–962 (2007).

UMM UNIVERSITÄTSMEDIZIN MANNHEIM

UMM Universitätsmedizin Mannheim, 68167 Mannheim

Medizinische Fakultät Mannheim der Universität Heidelberg

Universitätsklinikum Mannheim

Nanomedicine Translational Think Tank

Direktor: Dr. Rutledge Ellis-Behnke

rutledge@medma.uni-heidelberg.de