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Medical University of Graz | Chair of Biophysics

Chemo Iontronics: A New Approach for Delivery of Chemotherapeutics to Brain Tumors

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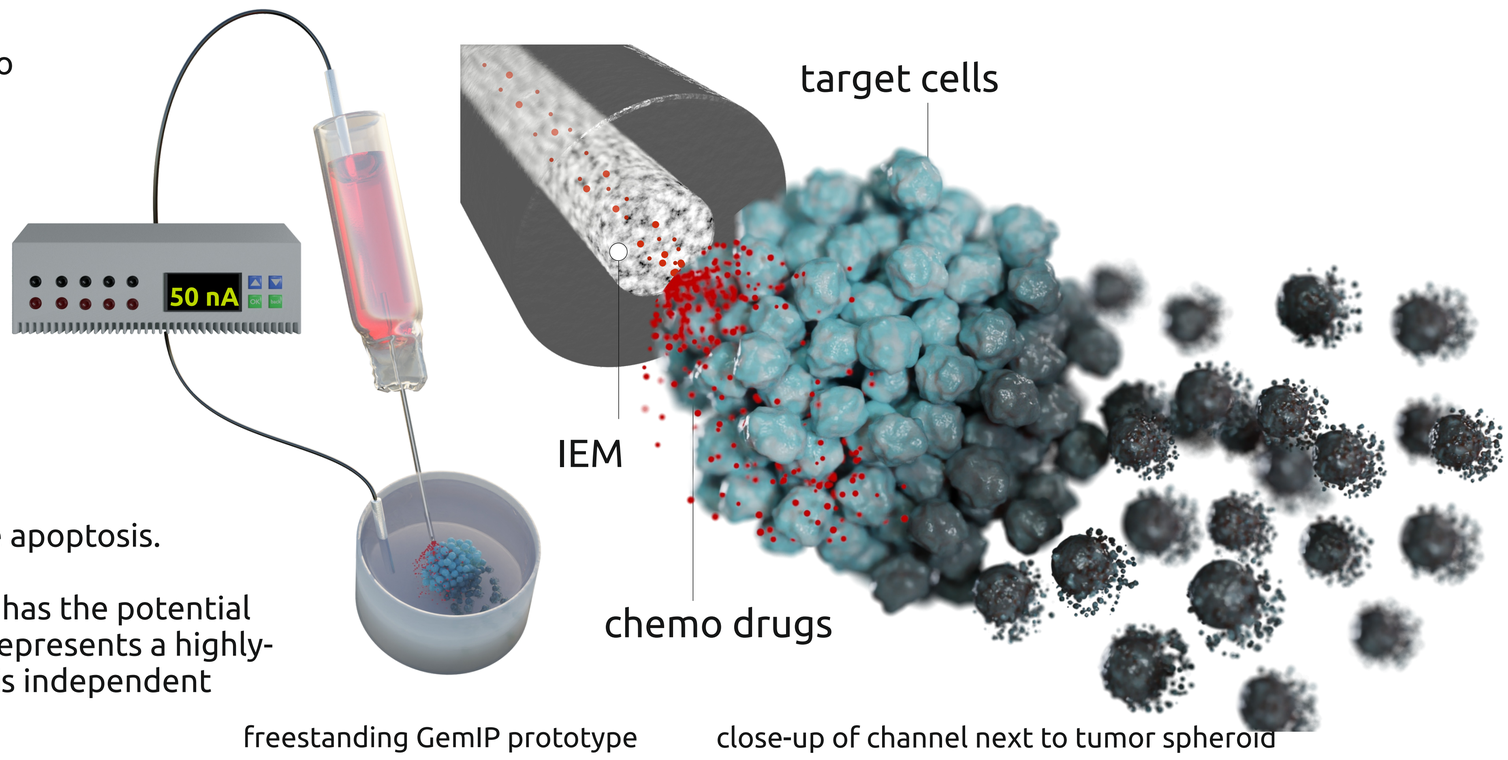
Aggressively growing brain tumors remain incurable due to limited surgical resection posssibilities and hindrance of chemotherapeutic alternatives that are shielded by the blood brain barrier. We present an electrically-driven device able to deliver selected chemo drugs, such as Gemcitabine (Gem).

We show that Gem is a potent chemotherapeutic with special properties suitable for the application in the brain. We can state that Gem effectively kills brain tumor cells but is at the same time harmless to neurons. The engineered Gem ion pumps (GemIPs) are able to administer Gem with pmol*min^{-1} precision at currents in the nanoampere range. Treatment of brain tumor *in vitro* models triggered cell death and microtumor disintegration and shrinkage.
In ongoing experiment, GemIPs seem to be able to reduce tumor size of vascularized tumors and to induce apoptosis.

The here exemplified electrically-driven chemotherapy has the potential to increase the efficacy of brain tumor treatment and represents a highly-targeted and locally-controlled drug delivery tool that is independent from systemic delivery

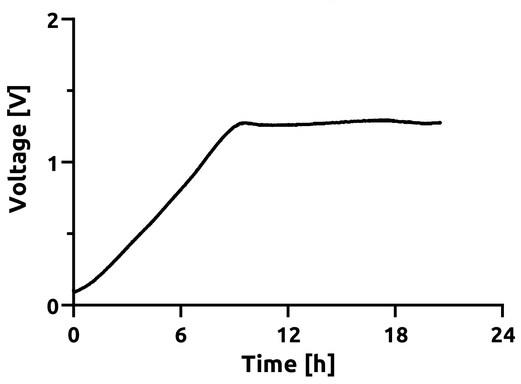
Gemcitabine Ion Pumps



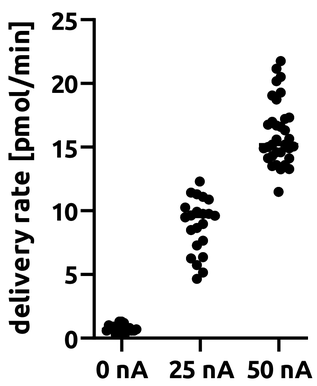
freestanding GemIP prototype close-up of channel next to tumor spheroid

GemIP performance and treatment

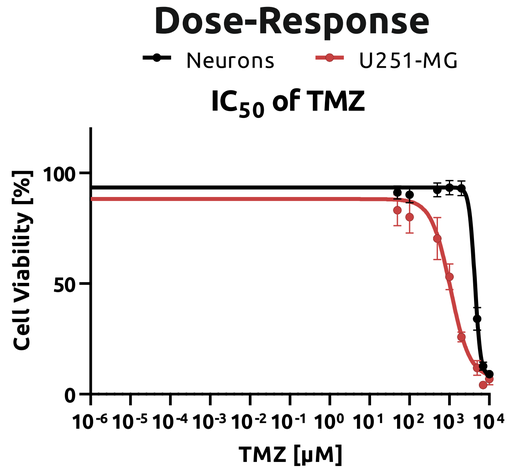
channel loading at 25 nA

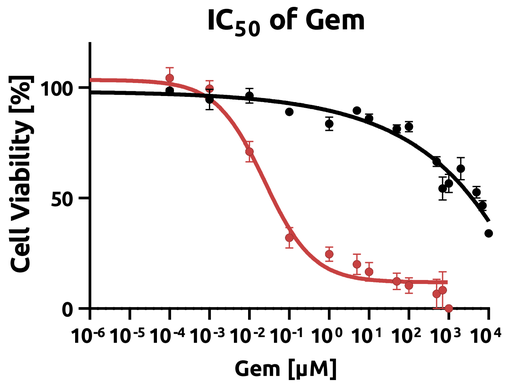


Gem delivery

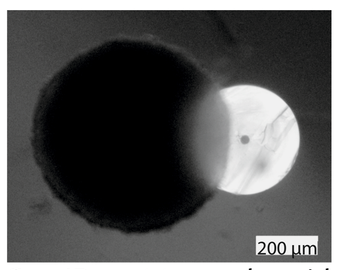


Dose-Response

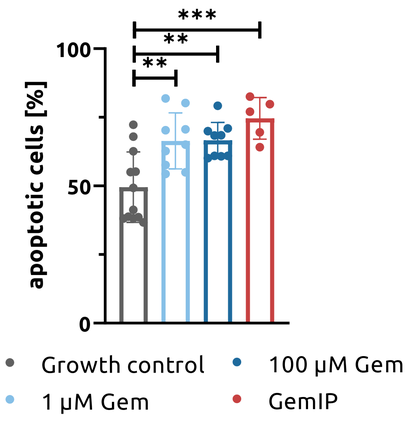


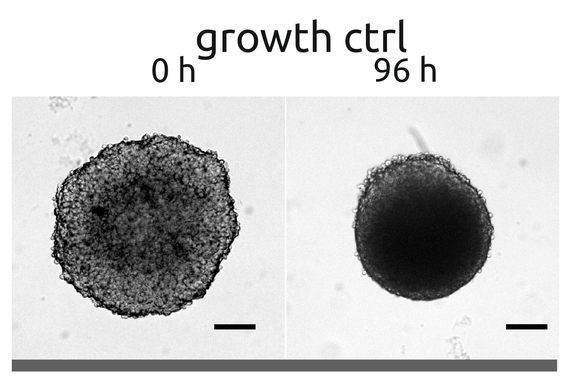


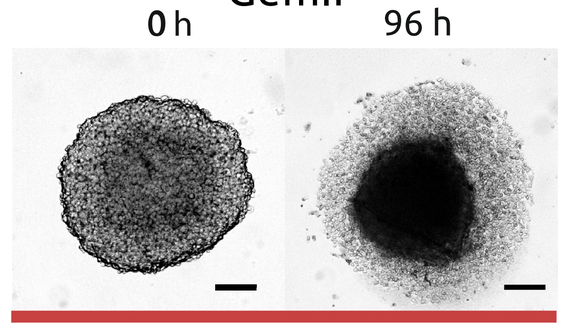
GemIP treatment of GBM spheroids



GemIP next to a spheroid

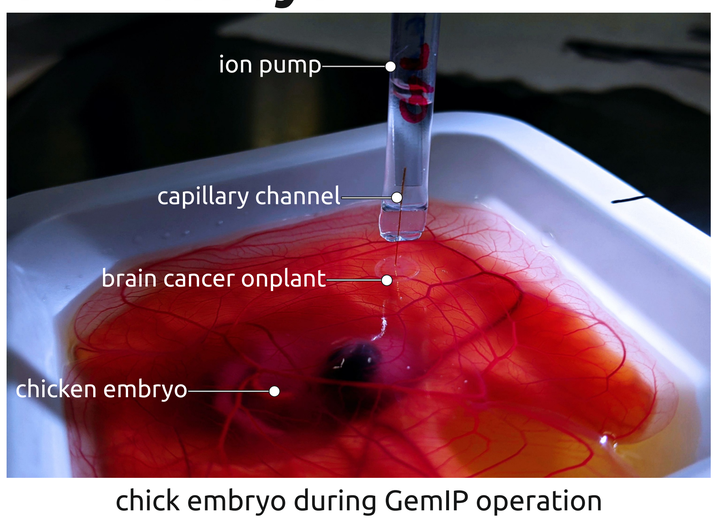




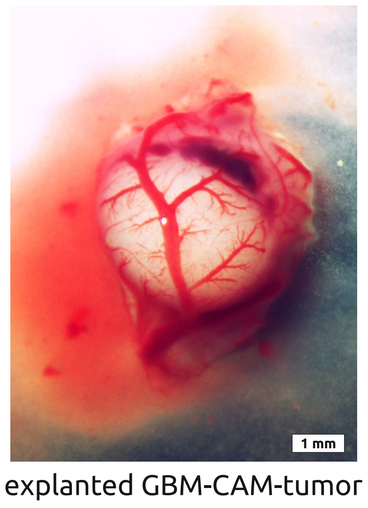


scale bar = 200 µm

CAM assays



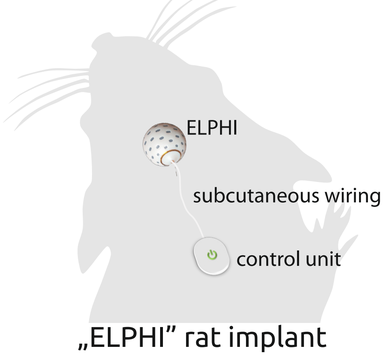
chick embryo during GemIP operation



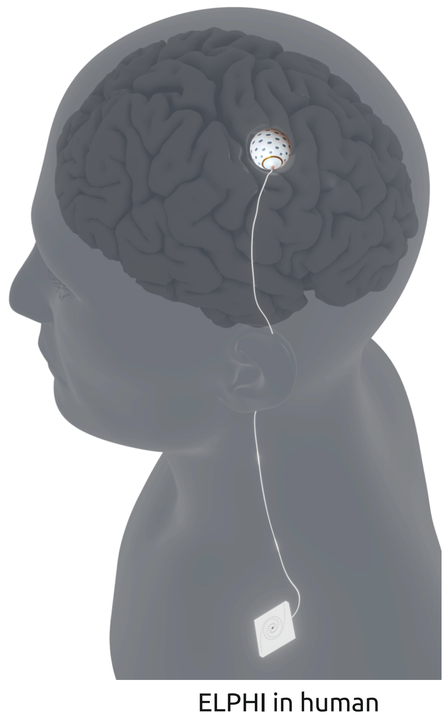
explanted GBM-CAM-tumor

Outlook

„ELectroPHoretic Implant”



„ELPHI” rat implant



ELPHI in human

Waldherr et al. 2021
Adv. Mater. Technol.