

Hydrogel in der Neurowissenschaft

Description

Eigel, D., Werner, C., & Newland, B.. (2021). Cryogel biomaterials for neuroscience applications. Neurochemistry International

Plain numerical DOI: 10.1016/j.neuint.2021.105012

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“Biomaterials in the form of 3d polymeric scaffolds have been used to create structurally and functionally biomimetic constructs of nervous system tissue. such constructs can be used to model defects and disease or can be used to supplement neuronal tissue regeneration and repair. one such group of biomaterial scaffolds are hydrogels, which have been widely investigated for cell/tissue culture and as cell or molecule delivery systems in the field of neurosciences. however, a subset of hydrogels called cryogels, have shown to possess several distinct structural advantages over conventional hydrogel networks. their macroporous structure, created via the time and resource efficient fabrication process (cryogelation) not only allows mass fluid transport throughout the structure, but also creates a high surface area to volume ratio for cell growth or drug loading. in addition, the macroporous structure of cryogels is ideal for applications in the central nervous system as they are very soft and spongy, yet also robust, which makes them a user-friendly and reproducible tool to address neuroscience challenges. in this review, we aim to provide the neuroscience community, who may not be familiar with the fundamental concepts of cryogels, an accessible summary of the basic information that pertain to their use in the brain and nervous tissue. we hope that this review shall initiate creative ways that cryogels could be further adapted and employed to tackle unsolved neuroscience challenges.”

Aurand, E. R., Lampe, K. J., & Bjugstad, K. B.. (2012). Defining and designing polymers and hydrogels for neural tissue engineering. Neuroscience Research

Plain numerical DOI: 10.1016/j.neures.2011.12.005

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“The use of biomaterials, such as hydrogels, as neural cell delivery devices is becoming more common in areas of research such as stroke, traumatic brain injury, and spinal cord injury. when reviewing the available research there is some ambiguity in the type of materials used and results are often at odds. this review aims to provide the neuroscience community who may not be familiar with fundamental concepts of hydrogel construction, with basic information that would pertain to neural tissue applications, and to describe the use of hydrogels as cell and drug delivery devices. we will illustrate some of the many tunable properties of hydrogels and the importance of these properties in obtaining

reliable and consistent results. it is our hope that this review promotes creative ideas for ways that hydrogels could be adapted and employed for the treatment of a broad range of neurological disorders. © 2011 elsevier ireland ltd and the japan neuroscience society."

Wu, X., He, L., Li, W., Li, H., Wong, W. M., Ramakrishna, S., & Wu, W.. (2017). Functional self-assembling peptide nanofiber hydrogel for peripheral nerve regeneration. *Regenerative Biomaterials*

Plain numerical DOI: 10.1093/rb/rbw034

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"Peripheral nerves are fragile and easily damaged, usually resulting in nervous tissue loss, motor and sensory function loss. advances in neuroscience and engineering have been significantly contributing to bridge the damage nerve and create permissive environment for axonal regrowth across lesions. we have successfully designed two self-assembling peptides by modifying rada 16-i with two functional motifs ikvav and rgd. nanofiber hydrogel formed when combing the two neutral solutions together, defined as rada 16-mix that overcomes the main drawback of rada16-i associated with low ph. in the present study, we transplanted the rada 16-mix hydrogel into the transected rat sciatic nerve gap and effect on axonal regeneration was examined and compared with the traditional rada16-i hydrogel. the regenerated nerves were found to grow along the walls of the large cavities formed in the graft of rada16-i hydrogel, while the nerves grew into the rada 16-mix hydrogel toward distal position. rada 16-mix hydrogel induced more axons regeneration and schwann cells immigration than rada16-i hydrogel, resulting in better functional recovery as determined by the gait-stance duration percentage and the formation of new neuromuscular junction structures. therefore, our results indicated that the functional sap rada16-mix nanofibrous hydrogel provided a better environment for peripheral nerve regeneration than rada16-i hydrogel and could be potentially used in peripheral nerve injury repair."

Sunwoo, S. H., Han, S. I., Joo, H., Cha, G. D., Kim, D., Choi, S. H., ... Kim, D. H.. (2020). *Advances in Soft Bioelectronics for Brain Research and Clinical Neuroengineering*. Matter

Plain numerical DOI: 10.1016/j.matt.2020.10.020

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"Recent advances in bioelectronics, such as skin-mounted electroencephalography sensors, multi-channel neural probes, and closed-loop deep brain stimulators, have enabled electrophysiological brain activities to be both monitored and modulated. despite this remarkable progress, major challenges remain, which stem from the inherent mechanical, chemical, and electrical differences that exist between brain tissues and bioelectronics. new approaches are therefore required to address these mismatches between biotic and abiotic systems. here, we review recent technological advances that minimize such mismatches by using unconventional soft materials, such as silicon/metal nanowires, functionalized hydrogels, and stretchable conductive nanocomposites, as well as customized fabrication processes and novel device designs. the resulting novel, soft bioelectronic devices provide new opportunities for brain research and clinical neuroengineering. advances in bioelectronics for neuroscience and neuroengineering have enabled continuous monitoring of

electrophysiological signals and feedback modulation of abnormal brain activities. despite such progress, there remain issues in terms of long-term high-quality neural interfacing, mainly owing to inherent mechanical, chemical, and electrical mismatches between the device and the brain tissue. new approaches, therefore, are required to address these discrepancies between the biotic and abiotic system. this review introduces technological advances that potentially solve such issues by using soft materials and devices. specifically, we summarize recent progress in soft materials, such as nanoscale materials, conductive polymers, functionalized hydrogels, and stretchable conductive nanocomposites. these unconventional materials, combined with customized processing techniques and device designs, provide novel soft device solutions for brain science and clinical neuroengineering. techniques for recording and modulating neural activities are essential for brain science and clinical neuroengineering. this review introduces recent progress on unconventional soft materials and their processing techniques for the fabrication of soft bioelectronic devices. such approaches could reduce the inherent discrepancies, including mechanical, chemical, and electrical mismatches, between the bioelectronic device and the brain tissue. as a result, the soft bioelectronic devices have successfully enabled high-quality neural interfacing in vivo ...”

Liu, S., Zhao, Y., Hao, W., Zhang, X. D., & Ming, D.. (2020). Micro- and nanotechnology for neural electrode-tissue interfaces. *Biosensors and Bioelectronics*

Plain numerical DOI: 10.1016/j.bios.2020.112645

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“Implantable neural electrodes can record and regulate neural activities with high spatial resolution of single-neuron and high time resolution of sub-millisecond, which are the most extensive window in neuroscience research. however, the mechanical mismatch between conventional stiff electrodes and soft neural tissue can lead to inflammatory responses and degradation of signals in chronic recordings. although remarkable breakthroughs have been made in sensing and regulation of neural signals, the long-term stability and chronic inflammatory response of the neural electrode-tissue interfaces still needs further development. in this review, we focus on the latest developments for the optimization of neural electrode-tissue interfaces, including electrode materials (graphene fiber-based and cnt fiber-based), electrode structures (flexible electrodes), nano-coatings and hydrogel-based neural interfaces. the parameters of impedance, charge injection limit, signal-to-noise ratio and neuron lost zone are used to evaluate the electrochemical performance of the devices, the recording performance of biosignals and the stability of the neural interfaces, respectively. these optimization methods can effectively improve the long-term stability and the chronic inflammatory response of neural interfaces during the recording and modulation of biosignals.”

Millet, L. J., & Gillette, M. U.. (2012). Over a century of neuron culture: From the hanging drop to microfluidic devices. *Yale Journal of Biology and Medicine*

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“The brain is the most intricate, energetically active, and plastic organ in the body. these features extend to its cellular elements, the neurons and glia. understanding neurons, or nerve cells, at the cellular and molecular levels is the cornerstone of modern neuroscience. the complexities of neuron structure and function require unusual methods of culture to determine how aberrations in or between

cells give rise to brain dysfunction and disease. here we review the methods that have emerged over the past century for culturing neurons in vitro, from the landmark finding by harrison (1910) – that neurons can be cultured outside the body – to studies utilizing culture vessels, micro-islands, campenot and brain slice chambers, and microfluidic technologies. we conclude with future prospects for neuronal culture and considerations for advancement. we anticipate that continued innovation in culture methods will enhance design capabilities for temporal control of media and reagents (chemotemporal control) within sub-cellular environments of three-dimensional fluidic spaces (microfluidic devices) and materials (e.g., hydrogels). they will enable new insights into the complexities of neuronal development and pathology. © 2012.”