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Advanced Materials 2020- Alginate Sulfate Substrates Control Growth Factor Binding and Growth of Primary Neurons: Toward Engineered 3D Neural Networks

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Abstract

Sulfated glycosaminoglycans (sGAGs) are vital molecules of the extracellular matrix (ECM) of the nervous system known to regulate proliferation, migration, and differentiation of neurons mainly through binding relevant growth factors. Alginate sulfate (AlgSulf) mimics sGAGs and binds growth factors such as basic fibroblast growth factor (FGF-2). Here, thin films of biotinylated AlgSulf (b-AlgSulfn) are engineered with sulfation degrees (DS = 0.0 and 2.7) the effect of polysaccharide concentration on FGF-2 and nerve growth factor (β-NGF) binding and subsequent primary neural viability and neurite outgrowth is assessed. An increase in b-AlgSulfn concentration results in higher FGF-2 and β-NGF binding as demonstrated by greater frequency and dissipation shifts measured with quartz crystal microbalance with dissipation monitoring (QCM-D). Primary neurons seeded on the 2D b-AlgSulfn films maintain high viability comparable to positive controls grown on poly-d-lysine. Neurons grown in 3D AlgSulf hydrogels (DS = 0.8) exhibit a significantly higher viability, neurite numbers and mean branch length compared to neurons grown in nonsulfated controls. Finally, a first step is made toward constructing 3D neuronal networks by controllably patterning neurons encapsulated in AlgSulf into an alginate carrier. The substrates and neural networks developed in the current study can be used in basic and applied neural applications.

Biography:

Georges Kfoury is a biomedical engineering PhD Candidate working in the Biomimetics Engineering Laboratory (BEL) in the American University of Beirut, Lebanon. He acquired his Masters of Engineering degree from the Holy Spirit University of Kaslik (USEK) Lebanon, working on the quantification of multinuclear multivoxel MRS metabolites using a wavelet method. He recently published his first article in Advanced Biosystems volume 4, issue 7 “Alginate Sulfate Substrates Control Growth Factor Binding and Growth of Primary Neurons: Toward Engineered 3D Neural Networks” which is the subject of his presentation. His design was accepted for the inside front cover of the same journal’s issue. He is currently working on a tissue engineered solution for knee osteoarthritis.

Speaker Publications:

1. Al Matari, N.; Deeb, G.; Mshiek, H.; Sinjab, A.; Kadara, H.; Abou-Kheir, W.; Mhanna, R. Anti-Tumor Effects of Biomimetic Sulfated Glycosaminoglycans on Lung Adenocarcinoma Cells in 2D and 3D In Vitro Models. Molecules 2020, 25, 2595
2. W. Malaeb, H. F. Bahmad, W. Abou-Kheir, R. Mhanna, The sulfation of biomimetic glycosaminoglycan substrates controls binding of growth factors and subsequent neural and glial cell growth, Biomaterials Science 2019, 7,4283.
3. Mhanna R, Becher J, Möller S, Schnabelrauch M, Reis RL and Pashkuleva I. Sulfated alginate as a mimic of sulfated glycosaminoglycans: Binding of growth factors and effect on stem cell behaviour. Advanced Biosystems 2017; 1(7): 1-7
4. Mhanna R, Kashyap A, Palazzolo G, and Zenobi-Wong M. Chondrocyte culture in 3D alginate sulfate hydrogels promotes proliferation while maintaining expression of chondrogenic markers. Tissue Engineering Part A 2014; 20(9-10): 1454-1464
5. Mhanna R, Öztürk E, Schlink P, and Zenobi-Wong M. Probing the microenvironmental conditions for induction of superficial zone protein expression. Osteoarthritis and Cartilage 2013; 21(12): 1924-32.