Synthesis and characterization of biocompatible and bioactive hydrogels

Description

Cells are embedded in extracellular matrix gels whose molecular composition and material properties differ from organ to organ. These gels not only accommodate cells to construct functional tissues but also provide physiochemical and physiological biological cues to the cells to ensure their activity and optimal function[1]. Epithelia are covered with mucus, which provides hydration and lubrication and protects us from invaders such as bacteria and viruses. mucus has different properties of gel forms from different organs. Mucins, the main non-aqueous components, are multifunctional.

We have revealed that the structural integrity of mucin molecules and the material properties of synthetic mucin gels affect their functions and biomedical applications. For example, mucin integrity is critical for lubricating various surfaces;[1] synthetic 'mucus-like' gel that mimics the strain-weakening and self-healing properties of native mucus is critical for both lubrication and prophylaxis against invaders such as HIV-1 and HSV-2 by several mechanisms;[3] synthetic stable mucin gels obtained by robust 'clickable' cross-linking chemistry are resistant to enzymatic degradation *in vivo* [5]. These mucin gels are also immunologically active, due to the dense glycosylation of mucins used as building blocks and the presentation of glycans to cells, depending on how the gels are crosslinked [3-8]. Their biocompatibility and insensitivity to the immune system have been demonstrated by their ability to accommodate fragile tissues such as human pancreatic islets and support their glucose-responsive insulin secretory function [4], non-toxic to mammalian cells, suppress immune cell activation upon viral exposure [3] and human complement system activation [4] immune cell recruitment and activation in immunocompetent mice, and circumvent fibrotic isolation.[3] The applications of these gels are directed toward lubricants with prophylactic effects against infections [3] and microencapsulation of cell clusters and microtissues for injectable constructs for transplantation.[4]

Methods

Conjugation chemistry is carefully designed to achieve selectivity and high yield. The degree of modification is characterized using advanced technologies, including attenuated total reflectance-fourier transform infrared spectroscopy (ATR-FTIR). Nuclear magnetic resonance spectroscopy (NMR). Material properties are characterized by rheometer and electron microscopy. Biocompatibility and bioactivity of gels will be characterized using a human cell line and primary cell model.

Environment

You will be hosted in the Department of Medical Cell Biology, Uppsala University (Uppsala, Sweden).

Requirements MSc students

We are looking for enthusiastic, motivated students, who enjoy working as part of a team as well as independently. Ideally, candidates have some previous practical lab experience or are interested in learning methods in organic chemistry and hydrogel for biomedical applications.

Please send us a short description of your relevant work experience, your CV, and your motivation if you are interested in doing a research project in this program for your degree. Please also indicate the period during which you are available.

Contact

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References

[1]M. Marczynski et al (2021) *Colloids and Surfaces B: Biointerfaces,* **187**:29,614; [2]**H. Yan** et al (2018) *Langmuir*, **34**, 45, 615; [3]M Kretschmer et al and **H. Yan*** (2022) *Adv. Sci*, 2203898; [4]**H. Yan*** et al (2021) *Adv. Func. Mater*, **31**:42,2203898; [5]**H. Yan** et al (2019) *Adv. Func. Mater*, **29**:46,1902581; [6]**H. Yan** et al (2021) *ACS Appl. Mater. Interfaces.*12:17, 324; [7]J. Kun, **H. Yan** et al (2021) *Adv. Func. Mater*, **31**:10, 2008428. [8]S. Chen et al **H. Yan*** (2023) Bioact. Mater. **25:**176