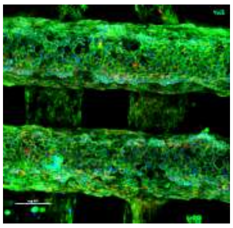
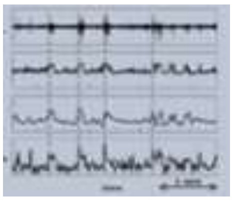
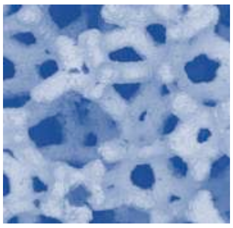
Seminars Series
2020-2021

UNIVERSITY OF TRENTO - Italy
Department of Industrial Engineering

BIOtech Biomedical Technologies







Protein structure development: the sticky situation silk faces

Speaker: Dr. Chris Holland
University of Sheffield
Chair: Prof. Antonella Motta

October 28 2020 2.00-3.00 pm CET
Zoom Platform

Abstract

Successful biomaterial innovation typically requires both an understanding, and control, of biopolymer assembly from the molecule to the material. In the search for inspiration surrounding development of novel biomaterials one often looks to nature for inspiration. Drawing on hundreds of millions of years of evolution through natural selection, or life and death R&D, nature has found many ways to generate seemingly complex hierarchical structures through elegantly simple means of self-assembly. A gold standard in this area is silk, biopolymers that have evolved to be processed by controlled protein denaturation, a process depending on the researchers' background, with similarities to amyloidogenesis for some and flow induced crystallisation for others.

Processing silk in the unspun liquid state has been largely explored over the past 15 years through the use of rheology. In this talk our contributions to this area will be presented and the tools that have been developed to probe structural hierarchies in silk as it self-assembles. Discussing more recent work we will draw on how whole animal and feedstock behaviour have supported new perspectives onto silk hydration, the natural spinning process, improved resolubilisation strategies and silk protein applications. We will conclude there is more to silk than just a fibre and that Nature may in fact hold unique solutions to the current challenges facing not only biomaterials, but the synthetic polymer industry, i.e. routes towards low embodied energy, sustainable wet processing of polymers.

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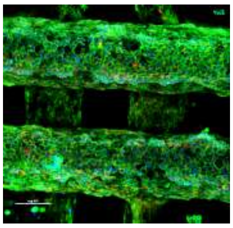

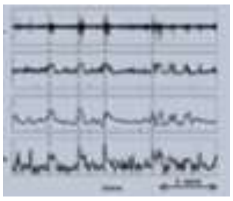

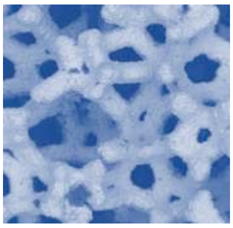

Stem Cells for Skin Regeneration: from Expectations to Reality

Speaker: Alexandra P. Marques
3Bs Institute - University of Minho
Chair: Prof. Antonella Motta

November 4° 2020 2.00-3.00 pm CET
Zoom Platform

Abstract

Skin wound healing main purpose comprehends wound closure by tissue restoration. While this is sufficient to have de novo tissue formation and to re-establish the skin natural barrier function, most of other skin functions are compromised. Even when natural cutaneous healing in adults is successful, non-functional scar tissue is formed. Moreover, as a result of this physiological adaptation neo-skin lacks structures such as skin appendages, nerves, pigmentation, and the lymphatic plexus. This is very serious for patients with massive skin loss, which is often caused by extensive burns or by surgical removal of malignant skin. Equally important, skin repair rather than regeneration has had an impact on the recurrence rates of chronic wounds, reinforcing the fact that current treatments are not yet capable of leading to a satisfying and permanent outcome. Considering the particularly alarming growing number of chronic wounds worldwide because of an increasingly elderly population and chronic healthcare conditions such as hypertension, diabetes, and obesity, as well as the connection between dysfunctional skin tissue healing and lifelong disability, the consequences on patient's quality of life, as well as on economic are catastrophic.

Despite the limitations of current products, skin tissue engineering (TE) strategies remain as one of the strongest alternative and most promising way to attain full skin regeneration. The possibility of *off-the-shelf* availability and the option of producing, in a relatively short period of time, stem cell-based constructs capable of responding to the full biological signaling complexity, as well as providing environmental cues to attain permanent wound closure is envisioned. Moreover, massive skin loss cases or chronic wounds, especially if associated to pathological conditions that determine the healing environment, where current treatments are yet not capable of reaching a satisfying tissue response and a permanent outcome, are also of major focus of the field.

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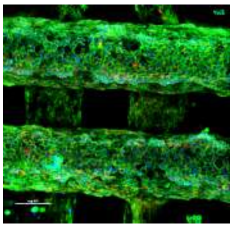

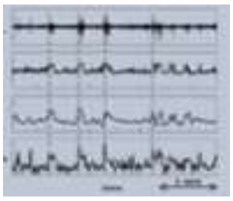

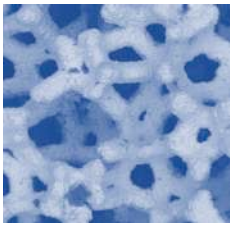

Tissue Engineering the Human brain

Speaker: David Lee Kaplan
TUFTS University
Chair: Prof. Antonella Motta

November 18th 2020 4.00-5.00 pm CET
Zoom Platform

Abstract

Neurological control of human health and well-being are central to how we think, feel, act and progress. Yet these are areas where insights, treatments and improved patient outcomes remain limited. This prompts the need for new experimental tools with which to gain fundamental and applied directions towards treatments, repair and regeneration of damaged or diseased neurological tissues. To address this need, we are pursuing tissue engineering strategies related to brain tissue structure-function. The bioengineering strategies employed, the routes to exploit these systems to study disease, damage and treatments, and future prospects for these systems will be discussed.

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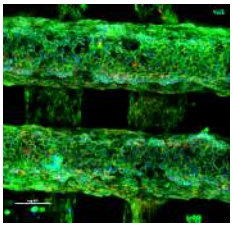

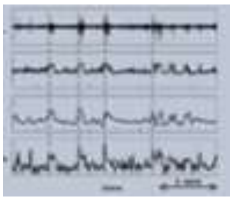

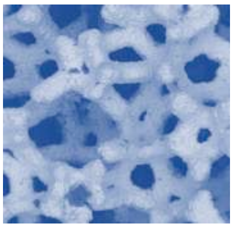

Field-based biofabrication of multi-layer complex structures

Speaker: Prof. Utkan Demirci
University of Stanford
Chair: Prof. Antonella Motta

December 2nd 2020 5.00-6.00 pm CET
Zoom Platform

Abstract

Micro- and nano-scale technologies can have a significant impact on medicine and biology in the areas of cell manipulation, diagnostics and monitoring. At the convergence of these new technologies and biology, we research for enabling solutions to the real-world problems at the clinic. Emerging nano-scale and microfluidic technologies integrated with biology offer innovative possibilities for creating microfluidic devices that could transform diagnostics and monitoring in cancer, infectious diseases and fertility. In this talk, we will present an overview of our laboratory's work in these areas focussed on applications in biofabrication, 3-D cellular assembly and label free sorting of extracellular vesicles.

Cells consist of micro- and nano-scale components and materials that contribute to their fundamental magnetic and density signatures. Previous studies have claimed that magnetic levitation can only be used to measure density signatures of nonliving materials. Here, we demonstrate that both eukaryotic and prokaryotic cells can be levitated and that each cell has a unique levitation profile. Furthermore, our levitation platform uniquely enables ultrasensitive density measurements, imaging, and profilingof cells in real-time at single-cell resolution. This method has broad applications, such as the label-free identification and sorting of CTCs and CTM with broad applications in drug screening in personalized medicine.

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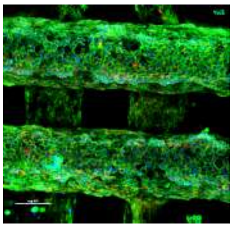

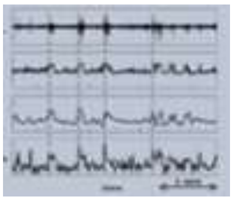

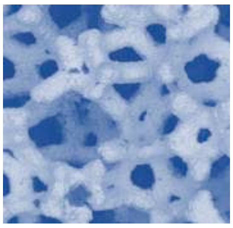

Engineering in Precision Medicine

Speaker: Prof. Ali Khademhosseini
Terasaki Institute
Chair: Prof. Antonella Motta

December 9 2020 5.00-6.00 pm CET
Zoom Platform

Abstract

Engineered materials that integrate advances in polymer chemistry, nanotechnology, and biological sciences have the potential to create powerful medical therapies. Dr. Khademhosseini’s group is interested in developing ‘personalized’ solutions that utilize micro- and nanoscale technologies to enable a range of therapies for organ failure, cardiovascular disease and cancer. In enabling this vision he works closely with clinicians (including interventional radiologists, cardiologists and surgeons). For example, he has developed numerous techniques in controlling the behavior of patient-derived cells to engineer artificial tissues and cell-based therapies. His group also aims to engineer tissue regenerative therapeutics using water-containing polymer networks called hydrogels that can regulate cell behavior. Specifically, he has developed photo-crosslinkable hybrid hydrogels that combine natural biomolecules with nanoparticles to regulate the chemical, biological, mechanical and electrical properties of gels. These functional scaffolds induce the differentiation of stem cells to desired cell types and direct the formation of vascularized heart or bone tissues. Since tissue function is highly dependent on architecture, he has also used microfabrication methods, such as microfluidics, photolithography, bioprinting, and molding, to regulate the architecture of these materials. He has employed these strategies to generate miniaturized tissues. To create tissue complexity, he has also developed directed assembly techniques to compile small tissue modules into larger constructs. It is anticipated that such approaches will lead to the development of next-generation regenerative therapeutics and biomedical devices.

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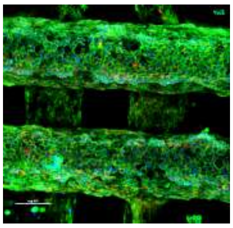

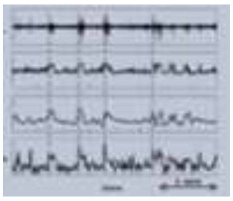

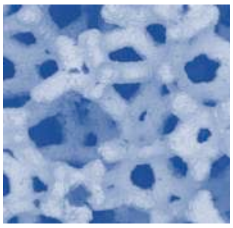

Nature-derived polymers in TE: how to move faster to the market

Speaker: Prof. Antonella Motta
Biotech Research Center
Chair: Prof. Devid Maniglio

December 16 2020 2.00-3.00 pm CET
Zoom Platform

Abstract

Advances in biotechnology can be implemented by starting from natural systems, that are typically multifunctional, dynamic, environment-responsive, have low energy consumption, produce minimum waste and no pollution, and sustainable (ex. polymers from food waste or textile industries). Using "green" procedures, starting from raw materials isolated from different organisms, biopolymers can be manipulated in composition and structure to obtain the multi-functional systems required for cellular regeneration.

There is a growing clinical interest in natural polymers in order to generate novel properties and functionalities in biomaterial applications. In this context, nature-derived materials, mainly polymers, are receiving a great interest in the TE field because of their multi-functionality, sustainability, and biocompatibility. A significant effort has been directed towards developing techniques that can enhance biopolymers processability and bioactivity. In particular, new challenges including green chemistry, fabrication method cost, environmental sustainability to develop successful products.

Among them, silk fibroin is largely used in the field thanks to its high degree of flexibility and because it offers a unique insight into structure-function designs from nature from which novel polymer designs and engineering can ensue. Precision biomaterials can be obtained from silk to improve specificity and biological performances. Silks family can be considered a model system from which to generate significant insights and principles to drive a broader development of nature-derived based medical products.

The lecture regards basic concepts on the (re)use of nature-based polymers, eventually derived from waste or genetically modified organisms, for the fabrication of bioactive medical devices, using silk as case study. However, the transition toward medical needs with protein-based materials, requires a deeper quality control starting from silk sources, biological safety, processing technologies and scalability, sustainability.

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