NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

School of Materials Science and Engineering

Seminar Topic:
Bio-Inspired Solutions to Medical Problems: Blood Vessels and Protein Delivery

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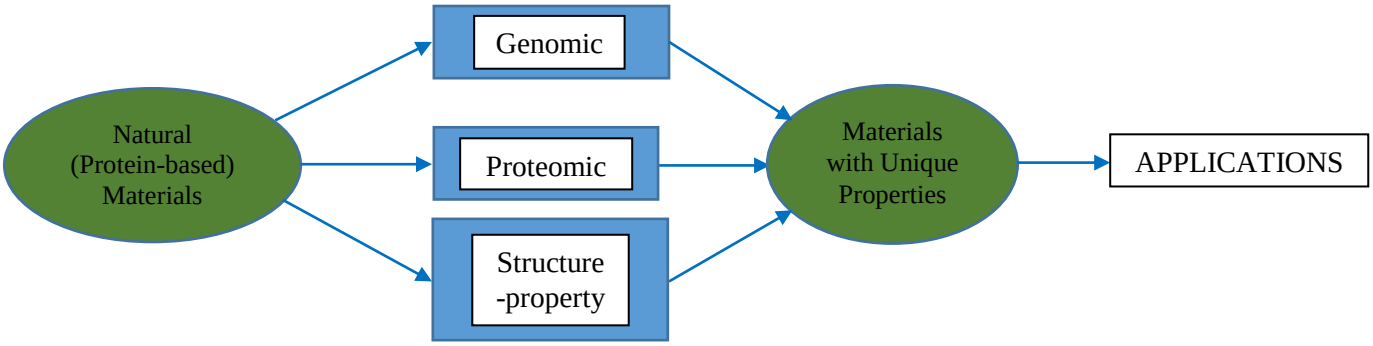
Abstract

Biomimetics or biomimicry is the imitation of the models, systems and elements of nature for the purpose of solving complex human problems. However, traditional research into biomimetic materials follows the following paradigm.



Examples of such research include the classical mussel adhesion and the hydrophobicity of lotus leaves.

In our group, we reverse the process by defining the medical problem to be solved and then explore bio-inspired solutions to the problem. The "solution" may be a material or design. An early example of this approach was demonstrated by Japanese researchers in 2011 on how mosquitos draw blood from humans. They adapted the approach to devise a "painless" injection needle.

A "mosquito-inspired" painless injection needle:
"Realistic imitation of mosquito's proboscis: Electrochemically etched sharp and jagged needles and their cooperative inserting motion", H Izumi, et al, Sensors & Actuators A, 115-123, 2011.

In our laboratory, we have been working on 2 long-standing medical problems – (1) a small-diameter blood vessel, and (2) sustained protein delivery. Small-diameter blood vessels are needed for bypassing blocked arteries in the heart or leg. However, when synthetic materials, such as Teflon, are used to construct these artificial blood vessels, the vessel gets blocked within 1 – 2 years. This is due mainly to "compliance mismatch" between Teflon and the native artery. We are using a design inspired by the human artery to match the dynamic mechanical behaviour more closely, using materials which mimic elastin and collagen.

Our second example involves a carrier system which can encapsulate large amounts of protein and release this protein slowly over time. This is also a long-standing medical need as lack of such systems has hampered widespread use of protein therapeutics. The human cell is able to store and release proteins either slowly or after being externally triggered. By examining the factors which enable the cell to do this (diffusion and partitioning effects), we are able to design a system which can store and release insulin over long periods of time. This system is the "Nanolipogel".

Biography

Professor Subbu Venkatraman has a PhD in Polymer Chemistry from Carnegie-Mellon University. He spent about 15 years in biomedical research and development in USA working with various applications of polymeric biomaterials. He held a senior position in research and development at Alza Corporation (now Johnson & Johnson) prior to joining NTU, Singapore as an Associate Professor in 2000. Since then, he has published extensively in the field of biomaterials with a total of 225 publications, garnering a H-index of 34 and a citation count of 5,060. He also holds 88 granted patents from a total of 171 applications. His work in biomaterials has led to 3 successful spin-off companies, with one of them (Amaranth Medical Pte Ltd) obtaining substantial Series C funding. Professor Venkatraman received the 2014 President's Technology Award together with Professors Freddy Boey and Tina Wong for their innovative application of nanostructures and novel drug delivery approach to combat blindness from glaucoma. He is also the co-founder of Peregrine Ophthlamic Pte Ltd and Amaranth Medical Pte Ltd.

His research group is interested in designing and modifying materials for biomedical applications. In this work, they are closely associated with local hospitals and researchers, including the National Heart Centre, Tan Tock Seng Hospital and the National Cancer Centre. Current interests include the following:

- Nanomedicine
- Localized drug/gene delivery
- Biodegradable polymers
- Injectable implants and nanoparticles
- Bio-inspired solutions to medical problems

Wednesday, 28 February 2018 ǁ Time: 2:00 pm – 3:00 pm
Venue: MSE Meeting Room (N4.1-01-28)
Hosted by: Associate Professor Li Shuzhou

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