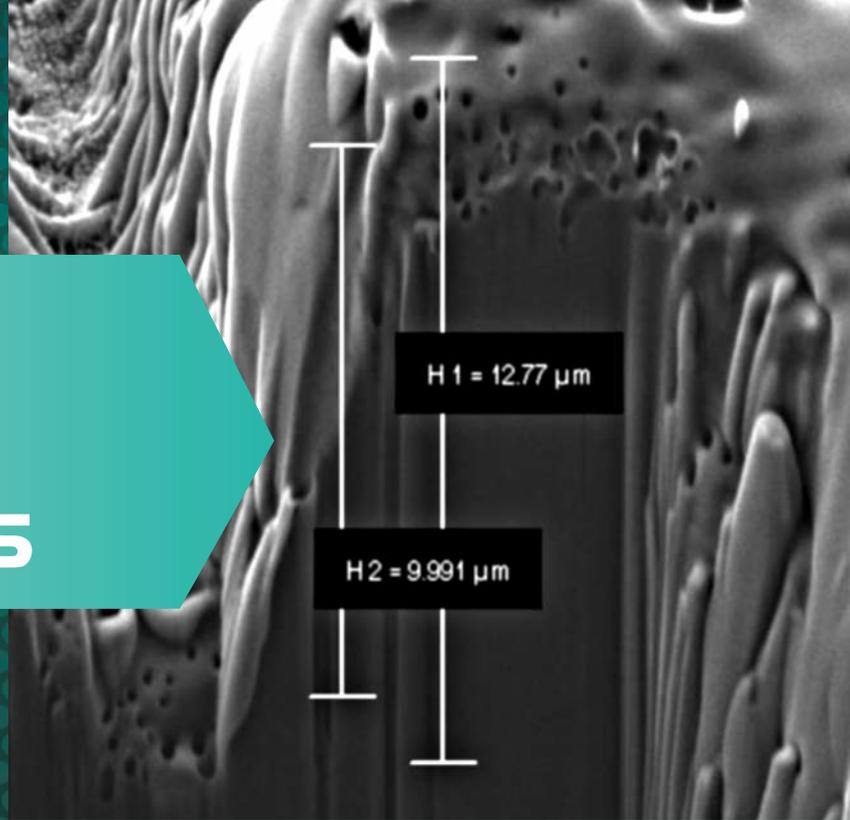




Materials Science & Biomaterials



Why study this module?

Take this module if you wish to be well informed of the technological, conceptual and ethical challenges associated with implanting devices into humans. Best practices in design, production, testing and monitoring of biomaterials are comprehensively covered.

Module content

The understanding of biomaterials encompasses fundamental knowledge of medicine, biology, chemistry and material science. The biomaterials field rests on a foundation of engineering principles. There is also a compelling human side to the therapeutic and diagnostic application of biomaterials. This course addresses the fundamental properties and applications of biomaterials (synthetic and natural) that are used in contact with biological systems.

Learning outcomes

On completion of this module you will be able to describe:

- Issues surrounding biocompatibility and ethics in the use of biomaterials
- Molecular and physiological features of biomaterials, including biomechanical properties, particularly in relation to orthopaedic applications
- Fundamentals of biopolymers - their structure, synthesis and characterisation

- Applications of biomaterials in orthopaedics and cardiovascular medicine

Who is the target audience?

In addition to the inquisitive graduate scientist and engineer, this module should appeal to R & D Engineers, Quality Engineers and Managers working in the medical device, regulatory and pharmaceutical sectors. It should also be of interest to those wishing to gain a grounding in what is becoming an increasingly sought-after area of expertise.

Module facts

Course level: Level 9

Module credit: 5 ECTS. Gain transcript or use towards PG Cert/PG Dip/MSc qualification in Biomedical Science

Duration: Over one semester

Entry Requirements: Please refer to the application section of the programme brochure

Fees: €1,000

Applying: www.nuigalway.ie/apply

Closing date: 2 – 8 weeks prior to module start date

Module topics

Biomaterial basics

- History and global perspective
- Polymers and Gels
- Metals and ceramics
- Linear and branched polymers
- Graft polymers, dendrimers
- Polymer configurations and states
- Crystallinity
- Glass transition and melting temperature

Biomedical Polymers

- Biodegradable polymers
- Mechanisms of degradation
- Bioresorbable materials
- Hydrogels as biomaterials

Metallic Implant Materials

- Structure, dislocation, grain size
- Strengthening of metals
- Types of metallic implant
- Properties of metallic implants
- Stainless steels
- Titanium-based alloys
- Dental metals
- Biocompatibility of metals

Inflammation and Wound Healing

- Injury response
- Inflammation and cytokines
- Tissue response to implanted biomaterial
- Haptotaxis
- Fibrosis, capsule, tissue repair
- Protein adsorption
- Competitive adsorption (Vroman Effect)

Surface Analysis

- Surface versus bulk characteristics
- Surface free energy
- Physical and chemical factors involved in cell-biomaterial interaction
- Evaluation of surface composition
- Microdomain and micromechanical analyses
- Nano hardness and nano indentation
- Contact angles and wettability

Implant-associated infection

- Bacterial colonisation of tissue .vs. implant
- Biofilms and implants
- How to limit implant-associated infection
- Sterilisation and crystallinity
- Microstructure evolution
- Standards for sterilisation of medical devices
- In vitro and in vivo testing of biocompatibility

Drug delivery from implanted devices

Student testimonials



Yvonne Brennan

Current Position:

Process Quality Engineer, Process Development Endoscopy

“Understanding the interactions at a cellular level between foreign materials and the body has been for me, one of the highlights of the course. It has allowed me to make more technical contributions to the projects I work on. Sharing this knowledge raises the bar for everyone involved. And it was also highly relevant to my thesis, which involved materials in the manufacturing area in which I work. The content of this module is fundamental to the knowledge base of anyone working in the biomedical implants area.”



Philip Lonergan

Current Position:

Technical Quality Manager, Abbott Diabetes Care, Donegal

Position held while completing module:

Senior Project Engineer, Boston Scientific, Letterkenny

“The best thing about the Materials Science and Biomaterials module was that it brought me up to date with the very latest developments in biomaterials, including polymers and metals, and their practical application in biomedical applications. The course also introduced me to biocompatibility testing and cytotoxicity testing of biomaterials and their relevance for human use applications such as cardiovascular implants. I found this information particularly useful in understanding the testing regimes required for some medical devices that I have worked with such as coronary catheters and stents.”

Would you recommend this module to others?

Yes

If yes, to whom would you recommend it?

I would recommend this module to any Design engineers or Quality engineers or scientists working in designing sterile medical devices or implants or working in design transfers/design changes for those devices.



Module Director

Dr. Yury Rochev

Dr. Yury Rochev obtained an honours Master of Science degree in Physics (1984) at Moscow State University, Biophysical Department, Russia. In 1990 he was awarded a Doctorate in Biophysics from the Institute of Biological Physics, the Soviet academy of Science, at

Pushchino (Moscow region). He worked at the Institute of Biological Physics at the Soviet Academy of Science, Pushchino, (later the Institute of Theoretical and Experimental Biophysics, the Russian Academy of Science), Pushchino State University, from 1984 to 1998. His appointments include holding posts of Institute Deputy Director, Vice Rector for Academic affairs, and Chair of Advanced Biomaterials and Tissue engineering. In 1998, he took up a research fellowship position at the Department of Chemistry, NUI Galway, before taking up his present appointment as Senior Researcher in the Biomaterials Cluster, at the National Centre for Biomedical Engineering Science (NCBES) at NUI Galway. He was appointed as a Lecturer in Biomedical Science at the NCBES in 2007. Currently, he is Director of the M.Sc. in Biomedical Science course. Yury's current research interests include design and development of new smart biomaterials, polymer-based drug delivery systems, tissue engineering products, as well as nano- and micro-scale characterisation of biomaterials and medical devices. As the Biomaterials senior researcher he has managed the research activities of the Biomaterials cluster since 2002. He has published more than 120 journal articles, book chapters, conference and workshops abstracts and papers. Dr. Rochev is involved in several national and international collaborative research projects in biomaterials and tissue engineering. Dr. Rochev is involved in a number of industrial research collaborations, including a major collaborative research program with Boston Scientific Ireland.

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