Engineering Tripos Part IIA, 3G5: Biomaterials, 2017-18

Module Leader

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Lecturers

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lab Leader

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Timing and Structure

Michaelmas term. 16 lectures.

Aims

The aims of the course are to:

- Develop an understanding of the materials issues associated with man-made and naturally-derived materials for medical purposes. Specific case studies will be considered in addition to the general framework.

Objectives

As specific objectives, by the end of the course students should be able to:

- Identify the mechanism by which medical devices and implants come to market.
- Know about the classes of materials used in medical materials and the associated reasons.
- Understand the requirements for materials used in the body and assess potential for implant-body interactions.
- Perform quantitative evaluations of drug delivery.
- Identify appropriate implants and tissue engineering approaches for tissue and body function replacements.
- Understand bioethics and safety regulations associated with medical devices and implants.

Content

Introductory concepts (1L)

- History of biomaterials
- Five therapies for missing organs
- Classes of Biomaterials overview

Synthetic polymers for tissue engineering applications (2L)

- Introduction to polymers
- Synthetic biodegradable polymers

Host response to implants (1L)

- Wound repair
- Innate immunity
- The biological response to biomaterials

Using cells in tissue engineering (1L)

- What happens when biomaterials fail
- Cell therapy
- Combining cells with scaffolds
- Working with biology - implant integration and vascularisation

Naturally derived polymers for tissue engineering application (1L)

Drug delivery and diffusion (2L)

- Drug delivery systems
- Diffusion controlled systems in drug delivery

Orthopaedic Implants - Hip Replacement (2L)

- Types of implant fixation
- Materials in hip implants
- Surface engineering approaches
- *In vivo* loading of hip joint

Cardiovascular Stents (2L)

- Balloon expandable & self expanding stents
- Materials in ?stents
- Stent mechanics and design

Biomaterials as integral parts of medical devices (1L)

Biocompatibility; sterilisation techniques (1L)

- Sterilisation techniques
- Choosing a technique

Sector analysis and regulatory affairs (1.5L)

- Market analysis
- Role of standards
- EU and US approval process

Advanced medical devices and biomaterials of the future (0.5L, non-examinable)

Further notes

Examples papers

Example papers are available on Moodle.

Coursework

Full Technical Report:

Students will not have the option to submit a Full Technical Report.

Booklists

Biomedical Engineering: Bridging Medicine and Technology by W. Mark Saltzman

Biomaterial Science: An Introduction to Materials in Medicine. Edited by Ratner et al.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [4] standard:

Toggle display of UK-SPEC areas.

GT1

Develop transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD.

IA1

Apply appropriate quantitative science and engineering tools to the analysis of problems.

KU1

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

KU2

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

D1

Wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations.

S1

The ability to make general evaluations of commercial risks through some understanding of the basis of such risks.

S4

Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues.

S5

Understanding of the need for a high level of professional and ethical conduct in engineering.

E1

Ability to use fundamental knowledge to investigate new and emerging technologies.

E2

Ability to extract data pertinent to an unfamiliar problem, and apply its solution using computer based engineering tools when appropriate.

P1

A thorough understanding of current practice and its limitations and some appreciation of likely new developments.

P3

Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc).

P7

Awareness of quality issues.

US1

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

US3

An understanding of concepts from a range of areas including some outside engineering, and the ability to apply them effectively in engineering projects.

US4

An awareness of developing technologies related to own specialisation.

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