

Engineering Tripos Part IIB, 4G6: Cellular & Molecular Biomechanics, 2018-19

Module Leader

[Prof V Deshpande](#) [1]

Lecturers

Prof V Deshpande and Prof N Fleck

Timing and Structure

Lent term. 14 lectures + 2 examples classes. Assessment: 100% exam

Prerequisites

3C7 useful.

Aims

The aims of the course are to:

- deal with the relation between microstructure of and properties such as strength, stiffness and actuation capability of natural materials such as cells and tissues and their properties, including stiffness.

Objectives

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

- understand the relation between micro-structure of soft biological materials and their mechanical properties.
- have a working understanding of the various components within plant and animal cells with a more detailed knowledge of the cytoskeletal components.
- understand the origins of the mechanical forces generated due to the polymerization of cytoskeletal proteins and derive the key equations.
- develop an understanding of muscles as actuators at the tissue, cell and protein length scales.

Content

Overview Lecture (Prof N. A. Fleck 1L)

The microstructure of the cell – animal cells, plant cells and the sub-cell building materials.

Mechanical Properties of Soft Solids (4L) (Prof. N A Fleck)

- The mechanical properties of natural materials – property maps
- Bending versus stretching micro-structures and entropic networks
- The notion of persistence length
- Models of stiffness and strength

- Mechanics of skin: stress v. strain responses, toughness and skin injection

The cytoskeleton (4L) (Prof.V. Deshpande)

- Review of basic thermodynamics and kinetics
- Introduction to cytoskeletal components and basics mechanics of the filaments
- Re-organization of the cytoskeletal filaments: polymerization, force generation and an introduction to motility

Muscle Mechanics (5L) (Prof.V. Deshpande)

- Twitch and tetanus and the Hill model
- Structure of the muscle: fibers, fibrils and contractile proteins
- Sources of energy in the muscle- Lohmann reaction
- Huxley Sliding filament model
- Models of myosin

Further notes

Further details and online resources:-

<http://www-g.eng.cam.ac.uk/lifesciences/courses.html> [2]

Booklists

Please see the [Booklist for Group G Courses](#) [3] for references for this module.

Examination Guidelines

Please refer to [Form & conduct of the examinations](#) [4].

UK-SPEC

The [UK Standard for Professional Engineering Competence \(UK-SPEC\)](#) [5] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the '[Accreditation of Higher Education Programmes' \(AHEP\) document](#) [6] which sets out the standard for degree accreditation.

The [Output Standards Matrices](#) [7] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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Links

[1] <mailto:vsd20@cam.ac.uk>

[2] <http://www-g.eng.cam.ac.uk/lifesciences/courses.html>

[3] <https://www.vle.cam.ac.uk/mod/book/view.php?id=364101&chapterid=56111>

[4] <http://teaching.eng.cam.ac.uk/content/form-conduct-examinations>

[5] <http://www.engc.org.uk/ukspec.aspx>

[6] <http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahp/>

[7] <http://teaching.eng.cam.ac.uk/content/output-standards-matrices>