MD991-10 Physical Biology of the Cell

20/21

Department
Warwick Medical School
Level
Taught Postgraduate Level
Module leader
Darius Koester
Credit value
10
Module duration
10 weeks
Assessment
60% coursework, 40% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

Module web page

Module aims

1. To provide a physical science perspective on cellular biology. The module explores the basic physical concepts underlying the behaviour of biomolecules, dynamic cell processes, cellular structure and signalling events.
2. To equip postgraduate students with the intellectual tools necessary for a research career at the interface of biology and physics. Students will learn how to estimate sizes, speed and energy requirements for a variety
of biological processes and build simple explicit models to fit experimental data from cell biology experiments.
3. To provide students with opportunities to problem solve, and to work in groups.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

1. Fermi problems
   Estimation of quantities, such as molecule numbers, densities, forces, velocities etc and how to put different entities into relation to each other.

2. Scales and sizes
   Concentrations, sizes and partitioning of biomolecules, mass and energy budget to build the cell: counting molecules, Poisson distribution, time: conformational changes, cell cycle, diurnal clocks.

3. Moving inside the cell
   Brownian motion, diffusion, on/off rates, thermal fluctuations, beating the diffusion speed limit by active transport, and ratchet models.

4. Structures inside the cell
   DNA and cytoskeletal filaments: mechanical properties, bending, buckling, twisting, beam theory.

5. Motor proteins
   Discussion of motor proteins and other molecular machineries.

6. Biological electricity
   Ion permeability and pumping by the membranes, ion channels, action potential, Nernst equation, Hodgkin-Huxley model. Electrostatics in water. Electrostatic intermolecular forces in cytoplasm.

7. Cell swimming
   Cilia, flagella, sperm tails. Formation of cilia, flagella, beating, physics of swimming and fluid flow, chemotaxis.

8. Cell division
   Pushing and pulling by microtubules, oscillation of kinetochores, time series analysis, actin ring constriction.

9. Biological membranes
   Physics of lipid membranes, membrane tension, bending rigidity, mobility of proteins in membranes.

10. Mechanosensing and tissue formation
    Stiffness of tissues, extracellular substrate deformation (traction force), forces between cells, control of cell division by density and forces, catch-bonds in focal adhesions, molecular motors.

Learning outcomes

By the end of the module, students should be able to:

- 1. Apply fundamental analytical and technical skills to investigate the physical biology of the cell.
- 2. Analyse and quantify physical biological properties and behaviours of living systems.
- 3. Formulate scientific questions by harnessing the core concepts of physical biology.

- 4. Design and articulate experimental approaches that effectively address scientific questions.

Indicative reading list

Phillips.,R, Kondev, J., Theriot, J, Garcia, H (2012) “Physical Biology of the Cell”, 2nd edition, pub: Garland
Nelson, P (2014) “Physical Models of Living Systems”, pub: WH Freeman
Milo, R., Phillips, R (2015) “Cell Biology by the Numbers” pub: Garland

Interdisciplinary

This module combines Physics, Chemistry and Biology and displays elements of these disciplines that are important to understand living organisms, organism development and disease.

Subject specific skills

Sound understanding of subject
Critically evaluate
Reflection

Transferable skills

Numeracy
Thinking and problem solving
Written communication
Oral communication
Teamwork
Organisation & time management
Use of tools and technology
Independence and initiative
Adaptability/Flexibility

Study

Study time

Type	Required
Seminars	20 sessions of 1 hour (20%)
Practical classes	10 sessions of 1 hour (10%)
Private study	40 hours (40%)
Assessment	30 hours (30%)
Total	100 hours

Private study description

40 hours self-directed study- Reading material in preparation for next session; solving assessed coursework problems and be preparing for the written exam.
Students will be advised to dedicate 50% of their time towards the assessed coursework, 30% of their time to prepare for the written exam and 20% of their time to prepare for the seminars.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time
Problem-solving assignments and reports	60%	20 hours

Assessed coursework (5 X Problem-solving assignments): to assess the student's ability to use analytical
skills to solve particular problems in biophysics. Each of the 5 problem-solving assignments will have the equal weighting in the assessed coursework final average mark.

Taken the problem solving assignemnts and the exam together, an average pass mark of 50% must be obtained. if not, the students can resit the part of the tasks that were failed. If a particular problem solving assignment was failed, this will be resit. If the exam was failed, then the exam will be resit. If both, exam and problem-solving assignments were failed, then the exam and the assignments that were failed have to be resit.
This Is necessary to ensure that learning outcomes were met by the student.

Written Examination	40%	10 hours

2.5 hours open book exam.

Taken the problem solving assignemnts and the exam together, an average pass mark of 50% must be obtained. if not, the students can resit the part of the tasks that were failed. If a particular problem solving assignment was failed, this will be resit. If the exam was failed, then the exam will be resit. If both, exam and problem-solving assignments were failed, then the exam and the assignments that were failed have to be resit.
This Is necessary to ensure that learning outcomes were met by the student.

Feedback on assessment

The session leads will mark the coursework. Marks and individualized feedback on each piece of coursework will be moderated by the Module Lead, in line with WMS assessment criteria (including submission for plagiarism). Feedback will be available to students throughout the module. The exam will be doubled marked by Session leads and the Module Lead. The Module Lead will agree marks and feedback (including individualized feedback). Any student failing an element of assessment will be offered an appointment with the module lead or a session lead for face-to-face feedback.

Past exam papers for MD991

Availability

Courses

This module is Core for:

- Year 1 of TMDA-B91Z Postgraduate Taught Interdisciplinary Biomedical Research