MD1A2-30 Integrated Science | Atoms and Molecules

22/23

Department
Warwick Medical School
Level
Undergraduate Level 1
Module leader
Masanori Mishima
Credit value
30
Module duration
6 weeks
Assessment
60% coursework, 40% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

MD1A2-12/MD1A3-12 - Integrated Science Atoms and Molecules

Module web page

Module aims

The module aims to equip students with the conceptual, theoretical and computational skills required for the analysis and engineering of atomic and molecular systems, with an emphasis on biomolecules. Students will learn to solve scientific problems and perform lab practicals in this area by integrating concepts and approaches from different scientific disciplines, including biology, physics, chemistry and computing, with the underlying mathematics serving as a common language.

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.

Block 3 Chemistry of life

Overview
Block 3 is about the molecules of life. We'll look at the physics that holds them together, at the chemistry by which they react in watery solution and at their structures, motions and reactivities. In the lab, we will engineer artificial cytoplasm in different versions, and quantify how good a job each of these viscous solutions does in supporting life-like reactions of different types.

Lectures

- Hierarchical structure of biological molecules
- Role of water in biology
- Rules governing the motions of atoms and molecules in solution
- Reaction kinetics

Labs

- Operating the eduWOSM microscope
- Running experiments in lifelike solutions
- Obtaining the progress curves of reactions
- Analysing data and writing an accurate and compelling paper

Block 4 Self-organisation

Block 4 is about self-organisation. We will discuss a very important phenomenon for all living matter: how to generate large scale and defined structures out of a bunch of individual proteins. This includes the polymerisation of proteins into larger units as well as the self-organisation of such units into larger structures. As an example, we will study actin and myosin, two key components of the cell cytoskeleton, in the classroom as well as in the lab.

Lectures

- Principles of self-organisation and biological examples
- Newton mechanics of biological polymers
- Molecular motors
- Active mechanics and self-organisation in the cell cortex

Labs

- Basics of handling and fluorescent labelling of proteins.
- How to generate actin – myosin networks in vitro.
- Imaging and quantification of actin filament dynamics.

Block 5 Mathematical Skills

This block focuses on revising and extending student's A-level skills in Mathematics, including computational skills required for plotting and fitting data.

Lectures

- Basic statistics
- Calculus
- Trigonometry
- ODEs
- Linear Algebra

Dry Labs

- Formula handling
- Calculus
- Linear Algebra
- Statistics
- Waves

Learning outcomes

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

- Demonstrate the ability to apply creative analytical thinking in order to frame incisive, tractable scientific questions, especially about the structures, functions and mechanisms of the atoms and molecules of living systems
- Demonstrate a grasp of physical law as it applies to the structures, reactivities and behaviours of atoms and molecules, especially biomolecules
- Use mathematical approaches to solve problems relating to biomolecular structures, functions, and reactivities.
- Explain the organisation of biomolecules.
- Describe the mechanisms by which biomolecules self-organise in cells
- Demonstrate the hands-on practical skills required to perform experimental tests of tractable scientific questions, especially about the structures, functions and reactions of the molecular building blocks of living systems.
- Demonstrate the ability to accurately record experimental procedures and results, in appropriate detail, using open source electronic notebooks
- Use computational data analysis techniques and statistical approaches to analyse data
- Access and use the scientific literature effectively
- Interpret and explain experimental data relating to the chemistry of life and the self-organisation of biological molecules.
- Demonstrate the writing skills required to report experimental results in the format of a scientific paper, including the ability to write an abstract, to write a short critical review of the relevant literature, present results in an appropriate format and detail with appropriate statistics, discuss the results and frame a clear conclusion.

Indicative reading list

Molecular cell biology Molecular Biology of the Cell, 2014. Bruce Alberts et al ISBN: 9780815344322

Cell Biology by the Numbers Milo and Phillips, Garland Science (2015), ISBN-10 : 0815345372

Physical Biology of the Cell, Phillips et al, Garland Science (2013), ISBN-10 : 9780815344506

Math notes on Trigonometry, Basic Calculus, Complex Numbers, Taylor Series and Fourier Transform (https://moodle.warwick.ac.uk/course/view.php?id=38600)

View reading list on Talis Aspire

Interdisciplinary

Students will learn to solve scientific problems about atoms and molecules by integrating concepts and approaches from different scientific disciplines, including biology, physics, chemistry and computing, with the underlying mathematics serving as a common language.

Subject specific skills

The ability to apply creative analytical thinking in order to frame incisive, tractable scientific questions, especially about the structures, functions and mechanisms of the atoms and molecules of living systems

A grasp of physical law as it applies to the structures, reactivities and behaviours of atoms and molecules, especially biomolecules

Mathematical skills to solve problems relating to biomolecular structures, functions and reactivities

The ability to explain the organisation of biomolecules

The ability to describe the mechanisms by which biomolecules self-organise in cells

The ability to perform experimental tests of tractable scientific questions, especially about the structures, functions and reactions of the molecular building blocks of living systems, using light microscopy

The hands-on practical skills required to perform experiments

The ability to interpret and explain experimental data relating to the chemistry of life and the self-organisation of biological molecules.

Transferable skills

Usage of mathematical and computational approaches to solve problems

A grasp of safety rules and an ability to work safely in the laboratory environment

The skills to accurately record experimental procedures and results, in appropriate detail

The skills to use computational and statistical approaches to analyse data

The skills to access and use the scientific literature effectively

The writing skills required to report experimental results in the format of a scientific paper

Study

Study time

Type	Required	Optional
Lectures	24 sessions of 2 hours (16%)	
Tutorials	(0%)	6 sessions of 2 hours
Supervised practical classes	24 sessions of 3 hours (24%)	
Private study	102 hours (34%)	
Assessment	78 hours (26%)	
Total	300 hours	

Private study description

Self-directed study and writing lab reports

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 D1

	Weighting	Study time
Laboratory report 1 Written report	20%	20 hours
Laboratory report 2 Written report	20%	20 hours
Laboratory report 3 Written report	20%	20 hours
Written Examinations	40%	18 hours

Feedback on assessment

Written feedback will be provided for all submitted work. Further verbal feedback will be given to students on request.

Past exam papers for MD1A2

Availability

Courses

This module is Core for:

- Year 1 of UMDA-CF10 Undergraduate Integrated Natural Sciences (MSci)