MD1A6-30 Embryos and Organisms (MD1A6-30)

23/24

Department
Warwick Medical School
Level
Undergraduate Level 1
Module leader
John R James
Credit value
30
Module duration
6 weeks
Assessment
70% coursework, 30% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

MD1A6-30 - Integrated Science Embryos and Organisms
The module aims to equip students with the conceptual, computational and practical skills required for the analysis and engineering of prokaryotic and eukaryotic organisms and their development.

Module web page

Module aims

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.

With indicative outcomes, including material explored in more detail during lab practicals in each block.

B11 Chemical Biology
This all about seeing biology as macromolecular chemistry.

Lec1 | Arrow pushing 1

- Examine the electronic structure of reactants Harness open source software to display and examine molecular structures
  Lec2 | Arrow pushing 2
- Predicting reaction mechanisms
  Lec3 | Reaction kinetics 1
- Assemble rate equations for chemical reactions
  Lec4 | Reaction kinetics 2
- Assemble rate equations for chemical reactions
  Lec5 | Polynucleic acids
- Purines, pyrimidines, H-bonds, DNA structure, RNA structure
  Lec6 | higher order structure of proteins
- biomolecular secondary, tertiary & quaternary structure
  Lec7 | supramolecular interactions of biomolecules
- how macromolecules can interact
  Lec 8 | Cryprotection
- Molecules that modulate phase changes in liquids

Labs: labs will allow students to design and assemble carbohydrate mimetics of proteins using a thermocycler

B12 Development | Aparna Ratheesh
Spatial control of gene expression, mechanical forces, cell motility
How are embryos organized?
Lec1 | Biological patterns – development: Discerning differences between cells - methods for detecting differences in gene expression between cells, epigenesis vs. predeterminism, overview of metazoan embryology

- Sketch the main large scale organisational events in early metazoan development
  Lec2 | Worm fate map: Lineage, fate decisions, and noise in C. elegans vulval development
- Access and harness wormbase.org
  Lec3 | A-P axis in Drosophila embryo: Maternal effect/gap/segment polarity genes, morphogens, useful transgenic techniques
- Describe the major large scale events in Drosophila melanogaster development
  Lec4 | Worms II: Connectome, EM reconstruction, network properties
- Describe the major large scale events in C. Elegans development
  Lec5 | Classical genetics: Genes, alleles, sex, meiosis, mapping, screens
- Explain the difference between a gene and an allele
- Explain the practicalities of a genetic screen
  Lec6 | Molecular genetics I: Mutant selection, epistasis, chromosome elements, manipulation
- Design a genetic screen in C. Elegans
  Lec7 | Molecular genetics II: Diploids, transgenesis, CRISPR

- Describe the design logic of a CRISPR experiment
- Use open source software to design CRISPR guides RNAs
  Lec8 | Genomics: Sequencing, assembly, homology, BLAST
- Demonstrate an ability to run BLAST searches

B13 | Immunity | John James
Mechanisms and mathematics of the immune response
How do organisms recognise non-self?

Lec1 | Overview of Immune System

- Overview of mammalian immune system and its role in maintaining our dynamic relationship with our environment
  Lec2 | Innate Immune Response
- Discuss the importance of inheritance for immunity
  Lec3 | Adaptive Immune Response
- Discuss why we need an adaptive (learned) response for life-long immune memory and the parallels with evolutionary selection
  Lec4 | Generating Receptor Diversity
- Outline of how receptor diversity is generated for the BCR and TCR, along with the selection mechanisms used to filter it
  Lec5 | Immune Cell Signalling
- Overview of the signalling pathways used by T and B cells, including what signals “1, 2 and 3” and why they are important
  Lec6 | Co-evolution of the Immune System
- Describe mechanisms by which pathogens avoid detection by the immune system, along with a discussion of acute vs chronic infections
  Lec7 | Autoimmunity and the Cancer Immune Response
- Discuss how the immune system can be the “enemy within”. What drives auto-immunity, genetic disposition, treatments for it
  Lec8 | Therapeutic manipulation of the immune system
- Overview of how new drugs and cell-based therapies are being used to retarget our immune system to treat normally intractable diseases including cancer

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 structure, organisation and dynamics of embryos and organisms.
- Demonstrate a grasp of physical law as it applies to the properties and behaviours of living embryos and organisms.
- Use mathematical approaches to solve problems relating to the behaviours and interactions of embryos and organisms.
- Describe and discuss how embryos are organised and the forces that drive these processes.
- Describe and discuss how organisms use an immune system to recognise non-self.

- Demonstrate the hands-on practical skills required to perform experimental tests of tractable scientific questions, especially about the structure and dynamics of embryos and organisms
- Harness 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 organisation and development of embryos, and the migration of immune cells,.
- 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.
- Describe and interpret quantitatively how chemical biology can be used to interrogate the mechanisms of life.
- Demonstrate the ability to accurately record experimental procedures and results in appropriate detail.
- Operate safely within a laboratory environment.

Indicative reading list

Physical biology of the cell / Rob Phillips, Jane Kondev, Julie Theriot, Hernan G. Garcia
Gastrulation : from cells to embryo / edited by Claudio D. Stern
Biological Physics of the Developing Embryo / Gabor Forgacs, Stuart A. Newman
Janeway's Immunobiology (Ninth Edition) / Kenneth Murphy & Casey Weaver
Basic Immunology: Functions and Disorders of the Immune System / Abul K. Abbas

View reading list on Talis Aspire

Interdisciplinary

Students will learn to solve scientific problems about embryos and organisms 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

Appreciate that biology is just macromolecular chemistry, and therefore the rules of chemistry apply to biological systems too.
Use critical thinking to frame tractable scientific questions about the structure, organisation and dynamics of embryos and organisms.
Manipulate, observe and record results pertaining to experiments on model organisms in a laboratory setting using specialised equipment.
Use a microscope and microfluidic devices to visualise movement of living cells.
Write code to automate the tracking of cellular migration from recorded images.
A grasp of physical law as it applies to the structures, morphogenesis, cell-cell communication and host-pathogen interactions in cells and embryos.

Transferable skills

Proficient in the use mathematical approaches to scientific solve problems.

A grasp of Good Laboratory Practice and an ability to work safely in the lab environment.

The ability to accurately record experimental procedures and results, in appropriate detail, using open source electronic notebooks.

Harness computational data analysis techniques and statistical approaches to analyse data.

Access and use the scientific literature effectively.

Study

Study time

Type	Required
Lectures	18 sessions of 1 hour (6%)
Tutorials	18 sessions of 1 hour (6%)
Supervised practical classes	18 sessions of 3 hours (18%)
Private study	130 hours (43%)
Assessment	80 hours (27%)
Total	300 hours

Private study description

130 hours self-directed study.

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 D2

	Weighting	Study time	Eligible for self-certification
Assessment component			
2 x laboratory reports	50%	20 hours	No

	Weighting	Study time	Eligible for self-certification

Laboratory reports will be written in the form of a scientific manuscript. each laboratory report will consist of 1500 words

Reassessment component is the same

Assessment component

Assessment of laboratory skills	20%	54 hours	No

Assessing the proficiency in laboratory techniques, observing good laboratory practice, engagement and contribution to group experiments.

Reassessment component

Exemption			No

Under ‘Principles and Scope’ in the University’s Examination and Assessment Policies, laboratory-based assessments are exempt from the right to remedy (1.3.2) as set out in Regulation 8-3 (iv) - “(if an appropriate standard in any required laboratory tests has not been achieved) candidates may be required to withdraw from their course”.

Assessment component

Written Examination	30%	6 hours	No

Reassessment component is the same

Feedback on assessment

Laboratory reports - submission annotated and returned, general comments/'what was good'/'what could be improved' alongside marking rubric.

Assessment of laboratory skills - at the end of each two-week laboratory session, block leads will provide comments on proficiency, Good Laboratory Practice (GLP) and engagement/group contribution that arise. Due to the volume of feedback, stock phrases will be provided to the block leads, which may be amended or expanded at the lead's discretion. Further verbal feedback will be given to students on request.
In terms of practicalities, following GLP, executing the laboratory protocol, attaining proficiency in techniques taught and engaging/contributing to group activities (where required) will be based at 62 on the 20-point University scale. Exceptional attainment/contributions will grade higher,

whereas disengagement, not observing GLP, and an unwillingness to acquire lab proficiency will score lower. Marks will not take into account whether a student achieved a desired experimental result or not. The block lead will work with the laboratory technician in observing and recording these across the cohort. Feedback will be provided biweekly at the end of each block.

Past exam papers for MD1A6

Availability

Courses

This module is Core for:

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