The University Of Sheffield.

Department of Molecular Biology & Biotechnology

MBB6325 The World of RNA

Module Handbook 2019-20

Coordinator: **Prof Stuart A. Wilson (ext 22849; stuart.wilson@sheffield.ac.uk)**
Other staff: **Dr Phil Mitchell, Dr Daniel Bose, Dr Emma Thomson.**

MBB6325 is a 15-credit module, taught in semester 1B which, may normally be studied only by students who have passed MBB267

Module Description

This module will analyse the vital roles that RNA plays in the life of a cell and how RNA is increasingly used as a tool to understand biology. The module will cover the following 'cutting edge' research topics: RNA interference, CRISPR Genome Editing, non-coding RNAs, together with the latest work on well known RNA based activities. These include transcription, RNA splicing, RNA stability, RNA export and translation and how all these processes are coupled in the cell to ensure efficient, quality-controlled gene expression. The module aims to present the latest innovations and discoveries in the RNA world and their application.

Module Aims

A1: build upon the substantial knowledge already acquired from earlier core modules to provide an advanced treatment of the many roles of RNA in the cell, covering topics such as mRNA transcription, processing, stability, export and translation in eukaryotic cells;

A2: provide a detailed understanding of the role of different RNA types in gene expression and cellular function and the use of RNA as a tool in functional genomics;

A3: cover recent advances in the field of RNA biology.

Learning Outcomes

By the end of the module, a student will be able to:
LO1: describe and critically evaluate the roles that RNA plays in the cell
LO2: define and evaluate how the processing of RNA in the cell is interconnected and quality controlled
LO3: appraise and demonstrate how RNA can be used as a tool to understand gene function
LO4: acquire, evaluate and analyse subject-related information contained in primary literature

Syllabus

The following topics are covered in the modules and, by the end you should be able to demonstrate a critical understanding of the following:

- Understand how mRNA is produced and processed in eukaryotic cells and how the processing steps are coupled together
- Understand how CRISPR/Cas genome editing works and how this could be applied as a tool in a variety of contexts
- Understand how the cell controls the quality of the RNA it makes in the cell and how it destroys RNAs which fail quality control
- Understand emerging models for how different lncRNAs function in gene regulation and development
- Understand the techniques, which allow the analysis of non-coding RNAs and RNA protein interactions on a transcriptome/genome-wide scale and how these technologies are informing our view of RNA and its uses in the cell
- Understand how RNA is transported from the nucleus to the cytoplasm in cells and how this goes wrong in various human diseases
- Understand the process of RNA interference including how miRNAs are made and used in the cell
- Use the knowledge gained form this course to formulate approaches to answer a wide range of biological problems using cutting edge molecular biology techniques such as CRISPR and RNA interference

Detailed Syllabus

Lecture Summaries

Prof Stuart Wilson

Lecture 1: Coupling of mRNA processing to transcription

Mechanisms of reciprocal coupling of mRNA processing to transcription

Lecture 2: Alternative mRNA processing
Mechanisms of alternative splicing and 3’ end formation and how this changes coding potential and mRNA stability

Lecture 3: Mechanisms for RNA localisation in eukaryotes.
mRNA transport from the nucleus to the cytoplasm and how this is coupled with earlier stages in mRNA processing. Human disease and RNA processing/export.

Lecture 4: RNA Interference – miRNAs,other small RNAs and their use in functional genomics
Biogenesis of miRNAs and piRNAs and their roles in the cell. Genome wide screens for gene function using RNA interference.

Dr Daniel Bose

Lecture 5: Editing the genome: Mechanisms of CRISPR-Cas9
Provides a detailed mechanistic understanding of CRISPR-Cas9 machinery and the role played by RNA in CRISPR-Cas9 systems.

Lecture 6: What are lncRNAs and how do we study them?
Provide details of the discovery of and unique features of lncRNAs and insights into the challenges faced when studying lncRNAs. Detail the practical methods for studying lncRNA functions in mammalian cells.

Lecture 7: Emerging concepts of lncRNA function
Describe current theories for lncRNA function, illustrated with specific examples and the experimental evidence for each.

Dr Emma Thomson

Lecture 8: Protein-RNA crosslinking techniques and applications

Description of the RNA-protein crosslinking techniques CLIP and CRAC. Variant forms of these two procedures will be presented and examples of applications given.

Lecture 9: Mechanisms of Translation regulation

Mechanism of canonical and non-canonical translation regulation including IRES-mediated translation will be presented.

Lecture 10: Ribosome profiling

The RNA-sequencing based technique of ribosome profiling and its applications will be described. Examples of how this technique has impacted our understanding of gene expression and translation will be provided.

Dr Phil Mitchell

Lecture 11: The role of RNA degradation in gene expression
Experimental evidence supporting rapid degradation of a fraction of nuclear RNA and its impact on gene expression.

Lecture 12: Cytoplasmic mRNA quality control mechanisms
Mechanisms for degrading mRNAs where translation elongation has stalled or where translation termination occurs inefficiently.

Lecture 13: The cell's armoury of exonucleases
A snapshot of the key enzymes that mediate RNA degradation.

SW, DB, ET, PM

Lecture 14 and 15: Question and answer sessions on past papers and the course content with an emphasis on how to draw together the information from all parts of the course.

Teaching/Learning Activities

The module will be presented in 13 lectures, each of 50-minutes followed by two 50 Minute question and answer sessions where past paper questions will be introduced and discussed. Students may consult the module lecturers via email or at the end of a lecture. Supplementary materials will be provided on the MOLE page for the module.

Each student will be expected to spend at least eight hours per week clarifying and extending their understanding of the content of the module, by reading and collating lecture notes, consulting module information on the Web, reading and noting information in the suggested sources. The University's notional total time for learning and assessment in a 10-credit module is 100 hours.

It is departmental policy to make lectures available via Encore. However, this is not always possible technically and individual lecturers may have reasons for not recording some sessions.

Five top tips on how to use lecture capture effectively.

1. Attend lectures – students who attend tend to get better grades.
2. Use the captures to supplement your studies. Dip into the parts you need to enhance your knowledge and understanding.
3. Don't wait until a few days before the examination to use the captures. Space your learning throughout the semester to enhance your knowledge and understanding.
4. Don't binge watch! Again, spacing your learning across the semester is a more effective approach.
5. Watch at normal speed (if you speed the recording up you might miss key information).

Nordmann et al 2018 Lecture capture: practical recommendations for students and lecturers, Preprint DOI: 10.31234/osf.io/sd7u4

Self-Assessment

A specimen paper will be available from the module MOLE webpage. Students can attempt these questions and send their answers to the module coordinator who will then provide feedback with help from the other four course providers.

Examination

Assessment will be based on a two-hour examination, held at the end of Semester 1, in which students will be expected to answer a set of short questions in Part A and a single essay in part B chosen from two questions. The section B essay will be synoptic in nature, with students expected to draw information from across the course in their answer.

Coursework

The coursework will involve the preparation and delivery of an 8 Minute Powerpoint presentation on a specific RNA molecule which will be assigned to you. We expect you to introduce this RNA molecule and its protein binding partner(s) and discuss its biological role in the cell. You will be expected to strictly adhere to the timing for your presentation. Following the presentation there will be a short time period for questions from the audience, which will comprise of the other students in your group and the lecturer leading the session. You will be assessed on both your own presentation and your participation in the questions to other students during the session. This coursework will be worth five credits. You will be assigned your RNA in the first semester and the presentations will be in the second semester, Friday 6th March (13:00 start). 1 week before the presentation, you will be expected to submit a PDF of your Powerpoint via Turnitin. Appended to this PDF you should also include a document, maximum of 1 page of A4, which summarises the sources of the information of your slides and how each source contributed to your presentation. On the day of your presentation you should arrive at the session with your talk on a memory stick or upload it onto google drive.

The subject RNAs will be the following and you will be told in Semester 1, which is your particular RNA:

1. Enhancer RNA (eRNA)
2. microRNA (miRNA)
3. small nuclear RNA (snRNA)
4. XIST
5. 7SK
6. HOTAIR
7. Small nucleolar RNA (snoRNA)
8. Signal recognition particle RNA
9. Telomerase RNA (TERC)
10. Piwi-interacting RNA (piRNA)
11. Ribonuclease P RNA

The entire presentation session will last approximately 3 hours with a short break. To see which subject RNA you have been assigned, see the table on the next page.

Dr Bose	Dr Mitchell	Dr Thomson	Prof Wilson	Subject RNAs
Aimme Aragon Garcia	Alexandru Chelu	Binyu Wu	Amal AlGhamdi	**1. Enhancer RNA (eRNA)**
Alexandria Green	Anna Hunting-Young	Danyi Huang	Beatrice Berardini	**2. microRNA (miRNA)**
Charlea Murphy	Athanasios Goumenos	David Lyanov	Beichang Zhang	**3. small nuclear RNA (snRNA)**
I-hsuan Chiu	Danielle Crosby	Eleanor Gander	Chien Yi Koay	**4. XIST**
Jasmin Abi Haidar	Haijun Chen	Iris Pasniceanu	Ciara Woodcock	**5. 7SK**
Kaineng Qiu	Ibrahim Sumaily	Jiawei Wu	Imogen Gatehouse	**6. HOTAIR**
Mehtap Bal	Jingyuan Wang	Mona Babtain	Jing Xu	**7. Small nucleolar RNA (snoRNA)**
Nor Affini Binti Zakaria	Shanice Allen	Mwila Kasanyinga	Kamrun Patel	**8. Signal recognition particle RNA**
Nourhan Moustafa	Tanyaradzwa Muzembe	Nicholas Larsen	Karema Al Fyture	**9. Telomerase RNA (TERC)**
Thomas Wright	Yuqing Chen	Zipeng Chen	Ning Guo	**10. Piwi-interacting RNA (piRNA)**
			Nitchakarn Kaokhum	**11. Ribonuclease P RNA**
Bartolome House DB09	Bartolome House DB10	Bartolome House DB11	Bartolome House DB12	
	Room			

All sessions are scheduled to take place between 13:00 – 16:00 Friday 6th March 2020.

Reading List

The textbook “Molecular Biology of RNA” by David Elliott and Michael Ladomery provides a good introduction to this course and there are copies of this textbook available in the library. Alternatively see https://www.amazon.co.uk/Molecular-Biology-RNA-David-Elliott/dp/0199671397/ref=dp_ob_title_bk

Module Timetable

Your timetable can be viewed by clicking on My Timetable from the All Services menu in MUSE. You can also view your timetable via the iSheffield app. Remember to update the app regularly to ensure you are viewing the most up-to-date information.