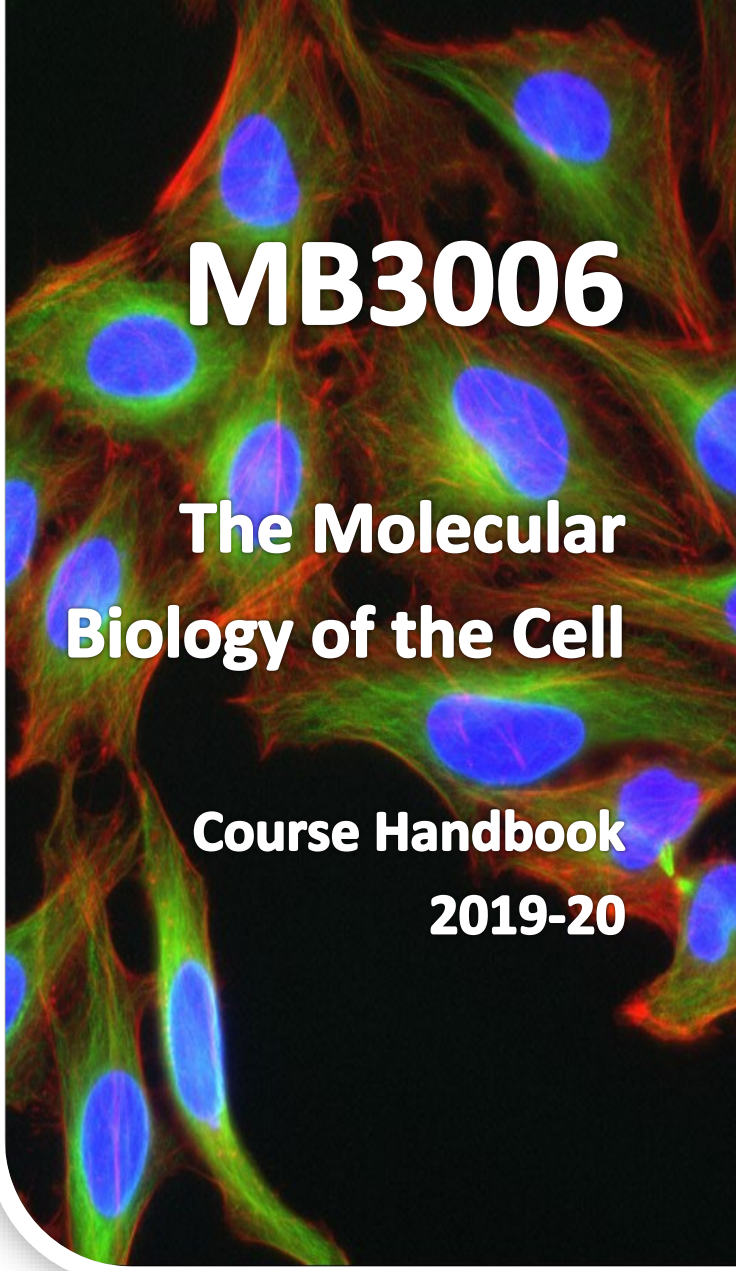
School Of Medicine, Medical Sciences & Nutrition



MB3006

The Molecular Biology of the Cell

Course Handbook

2019-20

UNIVERSITY OF ABERDEEN

Contents

Cover image:
Confocal micrograph of fluorescently labelled HeLa cells.
Nuclei are labelled in blue, tubulin in green and actin fibres in red.

Courtesy of:
Kevin Mackenzie
Microscopy and Histology Core Facility
Institute of Medical Sciences
University of Aberdeen
http://www.abdn.ac.uk/ims/microscopy-histology

Course Summary

The first part of the course deals with the basic biochemistry of genetic material, including an examination of DNA replication, including cell cycle, chromosome organisation, recombination and repair, and mobile genetic elements (transposons).

We progress into the core central dogma by dealing with both prokaryotic and eukaryotic mechanisms for the transcription of DNA into RNA and the subsequent synthesis of proteins encoded in mRNA. The focus then moves first to protein molecules, dealing with protein processing, targeting and turnover, and then to cell biological aspects of protein trafficking, membrane transduction and cell signalling.

Course Aims & Learning Outcomes

The overall general aims of the course are -

- To establish at foundation level a core knowledge of the molecular biology of the cell;
- To establish knowledge of how cellular processes, interact and inter-link to create a functional cell;
- To establish knowledge of how molecular interactions (e.g. protein-protein, nucleic acid-protein) contribute to and regulate cell activities and contribute to whole cell biology;
- To establish knowledge of how complex cell processes (e.g. cell division, transcription or translation) respond to, and are controlled by, the environment in which a cell is located;
- To obtain practical experience at first hand of some methods that are commonly applied in investigating the molecular biology of the cell.

Learning Outcomes:

The course is built around a series of lectures, which provide a starting point for understanding. It is up to you to use this information as a basis for self-motivated learning and education.

The topics covered in the lectures build on your knowledge of nucleic acid biochemistry, protein biochemistry and molecular genetics introduced at more elementary levels in year 1 (SM1501: The Cell) and at year 2 (particularly BI20M3 Molecular Biology of the Gene and BI25M7 Energy for Life). Similar topics taught at level 3 either go into more detail and/or cover material not dealt with in earlier courses. For this reason, you will be expected to be familiar with knowledge and concepts presented to you during level 1 and 2 courses; use Level 1 and 2 material as preparation for the MB3006 lectures.

Subject-Specific Learning Outcomes of the Course:

At the end of the course students should be able to -

- Describe the main features of DNA structure and replication;
- Describe the main features of chromosomal organisation, recombination and repair;
- Describe the structure and propagation of mobile genetic elements (mobile DNA);
- Describe the main features of transcription, including post-transcriptional processing, and translation in both prokaryotes and eukaryotes;
- Describe various selected aspects of protein biochemistry including protein folding, turnover, targeting and trafficking within the cell;
- Describe some aspects of cell signalling in both prokaryotes and eukaryotes. This to include tyrosine kinases, G-proteins, Ras, nuclear receptors, steroids, 2-component systems in microorganisms;
- Describe the complex intracellular architecture of higher eukaryotic cells;

Transferable Skills:

Various transferable skills are fostered in the following elements of the course:

Transferable skill	Lab classes	Writing the lab report	Lectures	Essay writing	Tutorial	Your exam revision programme
Critical reading				X	X	
Abstract information and understanding from complex literature; interpreting information	X			X	X	X
Data analysis and interpretation	X	X				
Clear expression of ideas in writing		X	X	X		
Abstract information and understanding from oral presentation	X		X			
Ability to time manage		X		X	X	X
Practical skills; observation / recording / communication / care / dexterity	X					
Ability to work in a self-directed manner	X	X		X	X	X

Course Teaching Staff

Course Co-ordinator(s):

Dr Jason Holland (**j.holland@abdn.ac.uk**)

Other Staff:

Dr Max Baldassarre (**massimiliano.baldassarre@abdn.ac.uk**)
Prof Anne Donaldson (**a.d.donaldson@abdn.ac.uk**)
Dr Alexander Lorenz (**a.lorenz@abdn.ac.uk**)
Prof Iain McEwan (**iain.mcewan@abdn.ac.uk**)
Dr Berndt Mueller (**b.mueller@abdn.ac.uk**)
Prof Kath Shennan (**k.i.shennan@abdn.ac.uk**)
Prof Ian Stansfield (**i.stansfield@abdn.ac.uk**)

Assessments & Examinations

In-course Assessment (40% of total)

This will be made up of marks from -

Coursework	**Value of Final Mark**	**Date of hand in/sitting**
Essay Analysis Exercise	5%	Monday 24th September
Essay 1	15%	Monday 15th October
Laboratory report	20%	Wednesday 14th November

Assignments must be handed in as specified above. Failure to do so will result in loss of marks.

Written Examinations (60% of total)

Exams will be held in the December diet of examinations. The written examination paper (3 h) will be divided into 2 sections (A and B). You will be asked to answer three questions from section A. There is a single compulsory data-handling question in section B that you must answer.

Data handling questions; The data handling question in section B will be like the ones you will practice in the course workshops. There will also be data handling questions on the MyAberdeen Blackboard site to enable you to practice and get feedback through the provision of model answers.

Examination Results:

The results will be posted on the student portals early in the New Year once the exam board meeting has taken place. The criteria used in marking examination questions are given on the following page of the manual. Similar considerations apply to marking your other assessed written work.

The re-sit examination will be based on the written paper as above and the previous continuous assessment marks achieved during the course. If you are absent with good cause from all continuous assessment components of the course, you will be required to complete a re-sit assessment component at the end of the course based upon the material taught in the continuous assessment course components.

Helping your learning; assessing your own understanding

Computer assessments; you will be given the chance to complete two straightforward computer assessments, of a multiple-choice question style. The computer assessments can be completed in your own time and are accessed through the MyAberdeen site.

Subject coverage for the computer assessments will be as follows;

Computer assessment 1	**Computer assessment 2**
DNA replication and chromosome organisation (Prof Donaldson)	Protein folding (Prof McEwan)
	Translation (Prof Stansfield)
Mobile DNA (Prof Stansfield)	Protein trafficking (Prof. Shennan)
Cell cycle/growth (Dr Holland/Dr Lorenz)	Membranes, signal transduction (Dr Mueller)
Prokaryotic transcription (Dr Holland)	Cell architecture (Dr Baldassarre)
Eukaryotic transcription (Prof Shennan)	

Class Representatives

We value students' opinions in regard to enhancing the quality of teaching and its delivery; therefore, in conjunction with the Students' Association we support the Class Representative system.

In the School of Medicines, Medical Sciences & Nutrition we operate a system of course representatives, who are elected from within each course. Any student registered within a course that wishes to represent a given group of students can stand for election as a class representative. You will be informed when the elections for class representative will take place.

What will it involve?

It will involve speaking to your fellow students about the course you represent. This can include any comments that they may have. You will attend a Staff-Student Liaison Committee and you should represent the views and concerns of the students within this meeting. As a representative you will also be able to contribute to the agenda. You will then feedback to the students after this meeting with any actions that are being taken.

Training

Training for class representatives will be run by the Students Association. Training will take place within each half-session. For more information about the Class representative system visit **www.ausa.org.uk** or email the VP Education & Employability **vped@abdn.ac.uk**. Class representatives are also eligible to undertake the STAR (Students Taking Active Roles) Award with further information about this co-curricular award being available at: **www.abdn.ac.uk/careers**.

Problems with Coursework

If students have difficulties with any part of the course that they cannot cope with alone they should notify the course coordinator immediately. If the problem relates to the subject matter general advice would be to contact the member of staff who is teaching that part of the course. Students with registered disabilities should contact Mrs Jenna Reynolds (**medsci@abdn.ac.uk**) in the Medical Sciences Office (based in the Polwarth Building, Foresterhill), or Mrs Sheila Jones (**s.jones@abdn.ac.uk**) in the Old Aberdeen office associated with the teaching laboratories, to ensure that the appropriate facilities have been made available. Otherwise, you are strongly encouraged to contact any of the following as you see appropriate:

- Course student representatives
- Course co-ordinator (Dr Jason Holland)
- Convenor of the Medical Sciences Staff/Student Liaison Committee (Professor Gordon McEwan)
- Personal Tutor
- Medical Sciences Disabilities Co-ordinator (Dr Derryck Shewan)

All staff are based at Foresterhill and we strongly encourage the use of email or telephone the Medical Sciences Office. You may have a wasted journey travelling to Foresterhill only to find staff unavailable.

If a course has been completed and students are no longer on campus (i.e. work from second semester during the summer vacation), coursework will be kept until the end of Freshers'

Week, during the new academic year. After that point, unclaimed student work will be securely destroyed.

Course Reading List

Each student should own a personal copy of at least one book from this list; the course cannot be studied satisfactorily from lecture notes alone.

Lodish H et al.; Molecular Cell Biology
Freeman, 7th edition (2012)
ISBN 0716743663

Books strongly recommended for reference and for further reading; on selected aspects of the course; Students taking the Biochemistry 3rd year courses and intending to proceed to Honours should consider buying some of these books during the year. These books supplement the information given in the book listed above, and will provide the basis of your professional Library

Alberts et al., Molecular Biology of the Cell
Garland, 4th edition (2002)
ISBN 0815340729

Berg, Tymoczko & Stryer, Biochemistry
Freeman, 5th edition (2002)
ISBN 0716746840

Nelson, D.L. and Cox, M.M., Lehninger Principles of Biochemistry, Freeman, 4th edition (2004)
ISBN 0716743396

Other relevant textbooks available in the library are -

Latchman, D., Gene Regulation: a eukaryotic perspective

Lindsay, D., A guide to Scientific Writing

Lecture Synopsis

The first part of the course deals with the basic biochemistry of genetic material, including an examination of DNA replication, including cell cycle, chromosome organisation, recombination and repair, and mobile genetic elements (transposons). We progress into the core central dogma by dealing with both prokaryotic and eukaryotic mechanisms for the transcription of DNA into RNA and the subsequent synthesis of proteins encoded in mRNA. The focus then moves first to protein molecules, dealing with protein processing, targeting and turnover, and then to cell biological aspects of protein trafficking, membrane transduction and cell signalling. The course concludes with a discussion of cell structure and cell death. Laboratory work, assignments and tutorials are designed to complement and extend the lecture topics. Additional learning opportunities are provided in the staged series of Workshops, which allow you the opportunity to actively employ your understanding of a topic in a workshop/small group learning environment.

Subject - Nucleic Acids: DNA replication & Repair, Chromosome Organization
No. of lectures - 6
Lecturer - Prof A Donaldson

The aim of these lectures is to investigate how cells organize their DNA within the cell nucleus and replicate it during cell division to produce two new copies of the genome. Cellular processes to repair damaged DNA will also be covered.

- The mechanism of DNA replication will be discussed, covering the structure of the replication fork, how cells select sites of replication initiation, and how they control whether and when to replicate DNA
- The reaction mechanism catalysed by DNA polymerases causes difficulty in replicating the ends of linear DNA molecules. Various methods have evolved to solve this 'end-replication problem'. The most common involves the use of an unusual reverse transcriptase, called telomerase
- We will discuss genome organization: introns, exons, satellites, repetitive DNA etc
- How is the huge amount of genomic DNA packaged to fit within the cell nucleus, whilst keeping specific sequences accessible for transcription? We will discuss the structure of the nucleosome and higher levels of chromatin organization and packaging
- DNA is often damaged under normal environmental conditions. How can cells repair their genome and what are the consequences if they cannot?

Subject - Growth and the cell cycle
No. of lectures - 4
Lecturers – Dr J Holland (bacterial cell cycle), Dr A Lorenz (eukaryotic cell cycle)

The aim of these lectures is to examine the mechanisms that lead to the coordinated control of cell growth and cell division in bacteria and eukaryotes.

In bacteria the regulation of cell division in relation to growth rate will examined and will include discussion of overlapping cell cycles and the regulation of the initiation of DNA replication and cytokinesis by the fts genes. The eukaryotic cell cycle will be illustrated mainly using examples of yeasts and will discuss regulation of entry in S (DNA synthesis) and M (mitosis) by the cyclin dependent kinase(s) (cdk) and the control of cdk's by cyclin synthesis and by phosphorylation. Regulation of the cell cycle by cell size and environmental factors will be discussed and the loss of control over the cell cycle mentioned in terms of carcinogenesis.

Subject - Transcription
No. of Lectures - 7
Lecturers – Dr J Holland (prokaryote transcription), Prof K Shennan (eukaryote transcription)

The aim of this series of lectures is to illustrate mechanisms by which prokaryotic and eukaryotic cells regulate gene expression primarily at the level of transcription. The basic principles of transcription will be described, emphasising the similarities and differences between the eukaryotic and prokaryotic systems, and highlighting the important events that contribute to the overall control of gene expression. The lectures on prokaryotic transcription regulation will also emphasize, using specific examples, the integration of gene expression with the metabolism of the cell.

Introduction to transcription in prokaryotes

- Subunit structure of RNA polymerase (RNAP) enzyme.
- Promoter architecture.
- Interaction of the RNAP with promoter sequences.
- Role of sigma factor(s) in control of gene expression, discussion of sporulation in B. subtilis.

Regulated transcription: trans-acting factors

- Positive and negative control of gene expression, discussion of the lac operon (lacI, CAP) and catabolite repression: allosteric regulation and phosphorylation.

Regulated transcription: Two-component system

- Regulation of gene expression in response to nitrogen starvation. The role of the nitrogen sensor protein, the allosterically regulated uridyl transferase enzyme, in the control of transcription of genes that encode proteins involved in nitrogen assimilation.

Transcription termination

- Intrinsic signals for termination
- Rho-dependent termination
- Anti-termination as a mechanism for regulating gene expression

Eukaryotic transcription: cis-acting elements & trans-acting factors

- Assembly of preinitiation complex.
- Upstream promoter elements and enhancers.
- Modular nature of transcription factors.
- Modulating gene expression.
- Inducible response elements: steroid hormone and heat shock.
- Mechanisms of activation and repression.
- Influence of chromatin structure on transcription initiation.
- Post-transcriptional processing.
- Addition of "caps and tails".
- RNA degradation.
- Splicing of RNA: formation of spliceosomes; mechanism of splicing; alternate splicing.

Subject - Translation
No. of lectures - 5
Lecturer - Prof I Stansfield

The aim of these lectures is to describe in detail the process of protein synthesis, whereby a messenger RNA is translated by the ribosome in the cytoplasmic compartment. The parallels and differences between eukaryote and prokaryote translation will be considered. As well as constituting a central component of the machinery of the cell, translation is also an important point at which control over gene expression is exerted at the post-transcriptional level in response to environmental and cell-cell signals; these control mechanisms will also be considered.

- Kozak's scanning hypothesis. Initiation of translation in prokaryotes vs. eukaryotes.
- Translation initiation factors. Key control points.

- Structural components of RNA that can affect translation and RNA degradation.
- Elongation; factors and mechanisms; the role of GTP; maintenance of the translational reading frame; the three-site model of elongation.
- Termination; factors and mechanisms; molecular mimicry hypothesis; post-termination events and the closed loop model of eukaryote translation.
- Functional RNAs in translation - tRNA and rRNA; ribosome structure and function - rRNA as a catalyst; ribosome biogenesis and rRNA processing; tRNAs - modification and charging; tRNA decoding, the genetic code and translational accuracy.

Subject - Proteins: folding, processing, targeting and turnover
No. of lectures - 4
Lecturer - Prof I McEwan

- These lectures will consider the folding of newly-synthesised proteins, including the formation of disulphide bonds, correct folding and stabilisation being essential for biological activity. The emphasis will be on mechanisms common to prokaryotes and eukaryotes, with some information specific to prokaryotes.
- Protein structure, with emphasis on the need for both stability and flexibility, so that the protein can undergo subtle conformational change and form larger functional assemblies.
- Folding pathways; chaperones.
- How the cell deals with unwanted or misfolded proteins; the ubiquitin system and the proteasome.
- Protein disulphide isomerases; protein folding and disulphide formation in the bacterial periplasm.

Subject - Proteins – targeting and trafficking
No. of Lectures - 4
Lecturer - Prof K Shennan

The aim of this series of lectures is to illustrate how proteins are targeted to the correct cellular location to ensure the appropriate biological activity. Most lectures will cover the eukaryotic secretory pathway where similarities to the secretion of proteins from prokaryotic cells will be highlighted. We will also briefly consider how nuclear, chloroplast and mitochondrial proteins become localised.

- Translocation of secretory proteins into the endoplasmic reticulum (ER) – signal hypothesis. Parallels with bacterial protein secretion. Post-translational modifications within the ER – signal peptide cleavage, glycosylation and lipid modification.
- Forward transport to Golgi apparatus or retention in ER. Bi-directional transport between ER and Golgi.

- Post-translational modification in Golgi – further glycosylation, limited proteolysis (subtilisin family of endoproteases, carboxypeptidase), amidation
- Sorting at level of trans-Golgi network (TGN). Sorting to lysosomes (similarity to sorting to yeast vacuole), secretion or retention in Golgi.
- Exocytosis – vesicle flow between TGN and cell surface, SNARE hypothesis, docking and fusion. Endosomal pathway.
- Localisation to other cellular organelles.

Subject - Membranes and signal transduction
No. of Lectures - 4
Lecturer - Dr B Mueller

The aim of these lectures is to provide an outline of a variety of molecular signalling scenarios which living cells use to interact with their environment.

Higher eukaryotic signal transduction scenarios, membrane receptor molecules – G-protein coupled receptors, receptor tyrosine kinases and downstream events, nuclear receptors and steroids. 2-component systems in microorganisms; chemotaxis, trans-membrane transporters.

Subject - Cell architecture
No. of Lectures - 3
Lecturer – Dr Max Baldassarre

The aim of these lectures is to illustrate the complex intracellular organisation of higher eukaryotic cells. We will consider the structure, biogenesis and brief function of organelles that are separate to the secretory pathway discussed previously that is the nucleus, mitochondrion, chloroplast and peroxisome. We will also discuss the cytoskeleton and its role in maintaining cell shape and cell motility

- Nuclear organisation: nucleolus, nuclear membrane and nuclear pore complex.
- Mitochondria and chloroplasts: overview of structures, consideration of evolutionary origin, organelle genome.
- Actin filaments – organisation of cytosol, myosin – molecular motor; functions in muscle and non-muscle cells.
- Microtubules and intermediate filaments, kinesin as a molecular motor, role in cilia and flagella movement.

Practical/Lab/Tutorial Work

The course will comprise a formal lecture course (as indicated in the Lecture Synopses above), which will include a series of practical Workshops, two essay-type assessments, two computer

assessments of course work, and a practical course. All course work will be examined in the degree examination. The written assessments and the practical course will form the continuous assessment element of the course.

Class Practical

The practical will give you the opportunity to apply the knowledge and understanding gained in the course thus far. It comprises a series of in-lab sessions, followed by the production of a written report (see separate Practical Manual).

“Responding to amino acid starvation: regulation of gene expression at the level of translation in baker’s yeast”

University Policies

Students are asked to make themselves familiar with the information on key institutional policies which been made available within MyAberdeen (**https://abdn.blackboard.com/bbcswebdav/institution/Policies**). These policies are relevant to all students and will be useful to you throughout your studies. They contain important information and address issues such as what to do if you are absent, how to raise an appeal or a complaint and indicate how seriously the University takes your feedback.

These institutional policies should be read in conjunction with this programme and/or course handbook, in which School and College specific policies are detailed. Further information can be found on the **University[1]s Infohub webpage** or by visiting the Infohub.

The information included in the institutional area for 2019/20 includes the following:

- Absence
- Appeals & Complaints
- Student Discipline
- Class Certificates
- MyAberdeen
- Originality Checking
- Feedback
- Communication
- Graduate Attributes
- The Co-Curriculum

Medical Sciences Common Grading Scale

Grade	Grade Point	Category	Honours Class	Description
A1	22	Excellent	First	• Outstanding ability and critical thought • Evidence of extensive reading • Superior understanding • The best performance that can be expected from a student at this level
A2	21			
A3	20			
A4	19			
A5	18			
B1	17	Very Good	Upper Second	• Able to argue logically and organise answers well • Shows a thorough grasp of concepts • Good use of examples to illustrate points and justify arguments • Evidence of reading and wide appreciation of subject
B2	16			
B3	15			
C1	14	Good	Lower Second	• Repetition of lecture notes without evidence of further appreciation of subject • Lacking illustrative examples and originality • Basic level of understanding
C2	13			
C3	12			
D1	11	Pass	Third	• Limited ability to argue logically and organise answers • Failure to develop or illustrate points • The minimum level of performance required for a student to be awarded a pass
D2	10			
D3	9			
E1	8	Fail	Fail	• Weak presentation • Tendency to irrelevance • Some attempt at an answer but seriously lacking in content and/or ability to organise thoughts
E2	7			
E3	6			
F1	5	Clear Fail		• Contains major errors or misconceptions • Poor presentation
F2	4			
F3	3			
G1	2	Clear Fail/ Abysmal	-	• Token or no submission
G2	1			
G3	0			

Course Timetable MB3006: 2019-2020

Date	Time	Place	Subject	Session	Staff
Week 7					
Mon 9 Sep					
Tue 10 Sep	14:00-15:00	ZG18 LT	Course Introduction	Lecture	JH
Wed 11 Sep					
Thu 12 Sep					
Fri 13 Sep	14:00-16:00	A21 (Taylor Building)	Writing Skills	Lecture	HG
Week 8					
Mon 16 Sep	15:00-16:00	C11 Taylor	DNA Replication (1) chromosome structure	Lecture	AD
Tue 17 Sep	09:00-10:00	Auris LT	DNA Replication (2) chromosome replication	Lecture	AD
	10:00-11:00	Auris LT	DNA Replication (3) chromosome replication continued	Lecture	AD
Wed 18 Sep					
Thu 19 Sep					
Fri 20 Sep	14:00-16:00	A21 (Taylor Building)	Prokaryotic transcription (1& 2) mechanisms, sigma factors	Lecture	JH
Week 9					
Mon 23 Sep	15:00-16:00	C11 Taylor	Prokaryotic transcription (3) lac and trp operons	Lecture	JH
Tue 24 Sep	09:00-10:00	Auris LT	Prokaryotic transcription (4) termination	Lecture	JH
	14:00-16:00	ZG11	*Workshop*: Transcription	Workshop	JH/IS
Wed 25 Sep					
Thu 26 Sep					
Fri 27 Sep	14:00-16:00	A21 (Taylor Building)	Chromosome Organisation (1+2) packing	Lecture	AD
Week 10					
Mon 30 Sep	15:00-16:00	C11 Taylor	Chromosome Organisation (3) - domains	Lecture	AD
Tue 1 Oct	10:30-12:00	ZB03	Workshop: Chromosome organisation	Workshop	AD/IS
	12:00-13:00	Auris LT	Translation (1) initiation in prokaryote	Lecture	IS
	13:00-14:00	Auris LT	Translation (2) initiation in eukaryotes	Lecture	IS
Wed 2 Oct					
Thu 3 Oct					
Fri 4 Oct	14:00-16:00	A21	Cell cycle/growth (1&2) - bacterial cell cycle	Lecture	JH
Week 11					
Mon 7 Oct	15:00-16:00	C11 Taylor	Cell cycle/growth (3) yeast cell cycle and growth	Lecture	AL
Tue 8 Oct	09:00-10:00	Auris LT	Cell cycle/growth (4) yeast cell cycle and growth	Lecture	AL
	14:00-16:00	ZG11	*Workshop*: Cell Cycle	Workshop	JH/AL
Wed 9 Oct					
Thu 10 Oct					
Fri 11 Oct	14:00-16:00	A21 (Taylor Building)	Translation (3) elongation Translation (4) termination	Lecture	IS
Week 12					
Mon 14 Oct	14:00-17:00	ZB03	*Practical Session 1*	Practical	IS
Tue 15 Oct	09:00-10:00	ZB03	*Practical Session 2*	Practical	IS

	14:00-17:00	ZB03			IS
	13:00-14:00	Auris LT	Translation (5) mRNA stability	Lecture	IS
Wed 16 Oct					
Thu 17 Oct					
Fri 18 Oct	14:00-16:00	A21 (Taylor Building)	Eukaryotic transcription (1) RNA polymerase activity	Lecture	KS
			Eukaryotic transcription (2) transcriptional regulation		
Week 13					
Mon 21 Oct	14:00-17:00	ZB03	*Practical Session 3*	Practical	IS
Tue 22 Oct	09:00-10:00	ZB03	Practical Session 4	Practical	IS
	14:00-17:00	ZB03			IS
	13:00-14:00	Auris LT	Eukaryotic transcription (3) mRNA processing during transcription	Lecture	KS
Wed 23 Oct					
Thu 24 Oct					
Fri 25 Oct	14:00-16:00	A21 (Taylor Building)	Protein Folding (1+2) folding, primary to final structure: chaperones and their function	Lecture	IM
Week 14					
Mon 28 Oct	15:00-16:00	C11 Taylor	Protein Folding (3) disulphide bonds and proline isomerisation	Lecture	IM
	16:00-17:00	C11 Taylor	Protein Folding (4) dealing with misfolded proteins	Lecture	IM
Tue 29 Oct	09:00-12:00	ZG11	*Workshop*: Translation	Workshop	IS
	13:00-14:00	Auris LT	Protein Trafficking (1) nuclear import	Lecture	KS
	15:00-16:00	ZG18	Protein Trafficking (2) mitochondrial import	Lecture	KS
Wed 30 Oct					
Thu 31 Oct					
Fri 1 Nov	14:00-15:00	A21	Protein Trafficking (3) import into the ER	Lecture	KS
	15:00-16:00	A21	Protein Trafficking (4) transport with the secretory pathway	Lecture	KS
Week 15					
Mon 4 Nov					
Tue 5 Nov	10:00-16:00	ZB03	*Practical Session 5*	Practical	IS
Wed 6 Nov					
Thu 7 Nov					
Fri 8 Nov	14:00-16:00	ZB03	*Workshop*: Protein Folding and Trafficking	Workshop	IM/KS
Week 16					
Mon 11 Nov	14:00-15:00	Auris LT	Membranes, signal transduction (1) components	Lecture	BM
	15:00-16:00	Auris LT	Membranes, signal transduction (2) cell-cell interactions	Lecture	BM
Tue 12 Nov	09:00-10:00	Auris LT	Membranes, signal transduction (3) cell signalling	Lecture	BM
	13:00-14:00	Auris LT	Membranes, signal transduction (4) cell signalling	Lecture	BM
Wed 13 Nov					
Thu 14 Nov					
Fri 15 Nov	14:00-16:00	A21 (Taylor Building)	Cell Architecture (1) cell organelles; Cell Architecture (2) the cytoskeleton: cytoskeleton dynamics	Lecture	MB

Week 17					
Mon 18 Nov					
Tue 19 Nov	09:00-10:00	Auris LT	Cell Architecture (3) the cytoskeleton: cytoskeleton dynamics	Lecture	MB
	14:00-16:00	ZB03	*Workshop*: Signal Transduction and Cell Architecture	Workshop	BM/MB
Wed 20 Nov					
Thu 21 Nov					
Fri 22 Nov					
Week 18 - No teaching during this week REVISION WEEK					
Mon 25 Nov					
Tue 26 Nov	14:00-17:00	ZB03	*Workshop*: Structured revision session*: course closing and feedback*	REVISION	JH
Wed 27 Nov					
Thu 28 Nov					
Fri 29 Nov					

Staff

JH - Dr Jason Holland, Course Co-ordinator
MB - Dr Max Baldassarre
AD - Prof Anne Donaldson
HG - Prof Helen Galley
AL - Dr Alexander Lorenz
KS - Prof Kath Shennan
IM - Prof Iain McEwan
BM - Dr Berndt Mueller
IS - Prof Ian Stansfield