MC3504
Molecular Microbiology
Course Handbook
2016-17
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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 course is concerned with modern aspects of molecular microbiology including examination of the regulation of the growth of viruses, bacteria and fungi and the molecular determination of virulence in pathogenic microorganisms. The role of the immune system and the use of antimicrobial drugs in combating infection is also considered in detail. New insights into the phylogenetic relationships between microorganisms based on molecular systematics are also discussed. Medical aspects of Molecular Microbiology are supplemented with studies on microbial interactions in the environment. Together this information provides an in-depth description of how the growth and interaction between microorganisms and the environment as well as the human host is regulated at the molecular level.

Course Aims & Learning Outcomes

Aims
The aims of the course are to enable students:

(a) To establish a broad coverage of modern aspects of microbiology reflecting areas of high profile and research activity;
(b) To establish an understanding of in the principles underlying modern molecular mechanisms related to medical microbiology and environmental microbiology; and
(c) To obtain direct experience of practical work that reflects research topics of special interest to the research staff in the School of Medical Sciences and the general disciplines of Microbiology.

Learning Outcomes
The subject-specific learning outcomes are such that, at the end of the course, students should be able to:

(a) To describe and understand the major features of fungal pathogens of plants and animals;
(b) To understand the basic features of virus replication of animal viruses at the molecular level;
(c) To describe how micro-organisms interact with their environment to both grow and survive external stress;
(d) To describe at the molecular level how pathogenic bacteria interact with their host cells. To understand how these bacteria adhere to the host cell and survive within the host cell. To understand the mechanisms by which chronic bacterial infections can develop.
(e) To understand the mechanisms by which bacteria can survive extreme environmental conditions.
(f) To describe how micro-organisms interact with each other when growing in mixed populations and to describe positive and negative signalling between micro-organisms in the environment;
To understand how bacteria grow and develop including the process of cell division and spore formation.

To understand the process of DNA replication and how the process is regulated in complex intracellular environments.

To describe the general principals of antimicrobial drug action and how these can target specific aspects of bacterial and fungal growth and metabolism as a means of treatment.

Students will also develop practical skills in data interpretation, communication as well as interpersonal and team-working skills. These represent transferable skills that will benefit students across a range of disciplines.

The aims of the course will be achieved through a combination of lectures, tutorial and practical classes.

**Course Teaching Staff**

**Course Co-ordinator:**
Dr Sam Miller (SM) sam.miller@abdn.ac.uk

**Other Staff:**
Dr Judith Bain (JB)
Dr Alex Brand (AB)
Dr Delma Childers (DC)
Prof Ken Forbes (KF)
Prof Neil Gow (NARG)
Dr Karolin Hijazi (KH)
Dr Donna MacCallum (DMacC)
Dr Stefania Spanò (SS)
Dr Alan Walker (AW)
Dr Duncan Wilson (DW)

**Assessments & Examinations**

**Assessment**
The course is assessed by two means which are continuous assessment and written examination. The continuous assessment represents 35% of the total mark and is made up of marks from the written reports of your laboratory work and the essay. The practical carries 25% of the final mark. The essay carries 10% of the marks.

**Examination**
The written examination provides 65% of the total mark and is of three hours duration and will be held at the end of the 12 week second half-session in May/June. The examination paper
will contain 7 questions of equal weighting, from which you must answer 4. Details regarding
time and place will be given to you in plenty of time.

A resit examination in the same format as the main examination will be provided for those
students who are unsuccessful in the June examination. This resit examination may contain
material from both the practical and lecture components of the course.

The total assessment of the course, recorded as a single GSS grade, is based on two elements
of the course as follows: Continuous assessment marks contributing 35% of the total and the
written examination contributing 65%. To achieve an overall pass for the course you MUST
obtain a CGS score of D3 or better for the entire course AND you must pass the written
examination with a score of D3 or better. Failure to pass the written examination will mean a
fail for the course.

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 Medicine, Medical Sciences and 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 (j.reynolds@abdn.ac.uk) in the School 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
- Convenor of the Medical Sciences Staff/Student Liaison Committee (Professor Gordon McEwan, g.t.a.mcewan@abdn.ac.uk)
- Personal Tutor
- SMMSN Disabilities Co-ordinator (Dr Derryck Shewan, d.shewan@abdn.ac.uk)

All staff are based at Foresterhill and we strongly encourage the use of email or telephone to contact the SMMSN Office or the member of staff you want to speak to. 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**

The recommended text for this course is:

Each student should own a personal copy of the following book; the course cannot be studied satisfactorily from lecture notes alone.


The following books are strongly recommended for reference and for further reading on selected aspects of the course. Many of these books are available from the University library.

Lecture Synopsis

**Fungal pathogens of plants and animals - Prof N A R Gow**

Lecture 1-2:  The first two lectures will cover the life cycles and virulence traits of plant pathogens as well as the resistance mechanisms that are employed by plants such as the hypersensitive response and the gene-for-gene hypothesis of pathogen recognition.

Lecture 3-4:  These two lectures of human fungal pathogens will mention the main agents of superficial and systemic fungal disease, their virulence traits and the ways in which antifungal drugs inhibit their growth. Similarities and differences between plant and animal pathogenic fungi will be underlined.

**Molecular Virology - Dr K Hijazi**

The aim of these lectures is to look at the principle mechanisms employed by DNA and RNA viruses to infect human cells and subvert the host metabolism for viral replication.

Lectures 1-2:  Viral replication strategies. The general mechanism of replication for animal viruses will be described. The replication strategies of viruses possessing DNA and RNA genomes is described since, although viruses with DNA genomes replicate using mechanisms similar to those found in eukaryotic cells, the RNA viruses show diverse replication strategies dependent upon the nature of the virus genome.

Lectures 3-4:  Molecular pathogenesis of human viruses. The strategies used to investigate virus pathogenesis at the molecular level will be discussed and reviewed.

**Bacterial Cell Stress and Survival - Dr S Miller**

The aim of these lectures is to examine the mechanisms that bacterial cells such as *Escherichia coli* have evolved to enable survival of a diversity of stresses.

Lectures 1-4:  Bacterial cells are able to survive a diversity of stresses such as changes in external pH, osmolarity and exposure to toxic compounds. The series of four lectures will summarise the mechanisms that bacteria, for example *E. coli*, have evolved to enable cell
growth despite diverse environmental challenges. We will study the nature of environmental signals that are sensed by cells that allow them to respond to stressful environments, the mechanisms cells use to combat such stresses and the integration of signals.

**Bacterial Molecular Pathogenesis - Prof K Forbes**

The aim of these lectures is to look at a number of bacterial pathogens and compare and contrast the mechanisms they have evolved to adhere to, invade and survive within, human, host cells.

Lectures 1-4: This series of four lectures will deal with molecular aspects of the interactions between bacterial pathogens and the human host, including: The conflicts between the pathogens and their host and how these affect the ability of the pathogens to survive. Model systems to study pathogenesis. Colonization, adherence and pili. Intracellular lifestyles: benefits, gaining access and staying alive. The bacterium’s manipulation of its environment: toxins. Getting complex proteins out of bacterial cells: secretion systems.

**Bacterial growth and development - Dr S Miller**

*E. coli* undergoes a simple cell cycle of growth and division. Other bacteria have a more complex cell cycle leading to differentiated cell types. The objective of these lectures is to review bacterial developmental processes in particular the signals that lead to the choice of a developmental pathway. To illustrate how developmental choices are made we will study a range of processes.

Lecture 1: Adaptation of form and function – cell shape and cell division

Lecture 2: The option of dormancy, sporulation in *Bacillus subtilis*.

Lecture 3: The simplest developmental choice of all. How does bacteriophage lambda decide whether to go lytic or lysogenic?

Lecture 4: Stochastic switches. Unprogrammed developmental choices; phase variation in *Neisseria*. Opa proteins, cell tropisms, adherence and escaping the immune response.

**Invasive bacterial pathogens – Dr S Spanò**

The aim of these lectures will be understanding the strategies that different bacterial pathogens evolved to survive and replicate within host cells.

We will examine and compare these strategies in important human pathogens and model organisms, such as *Salmonella enterica*, *Mycobacterium tuberculosis*, and *Legionella pneumophila*.

**Copying the genome and maintaining its integrity - Dr A Lorenz**
The aim of these lectures is to investigate the problems associated with DNA replication in the complex environments found within cells and to examine the mechanisms that organisms employ to overcome barriers to DNA replication in order to enable faithful chromosome segregation. All organisms have evolved effective molecular machines to catalyse accurate replication of their genetic material. However, no biochemical process occurs in isolation and DNA replication must be coordinated with other essential metabolic processes, like transcription and DNA repair. These lectures will analyse the nature of barriers to DNA replication, and the consequences of blocks to DNA replication in terms of genome stability and cell viability. The multiple accessory systems that are needed to support DNA replication in complex intracellular environments will be outlined, and the close interplay between DNA replication, repair, recombination, and transcription will be highlighted.

**Microbial Interactions - Dr A Walker**

Microbes do not normally exist in isolation in nature. As a result microbes have evolved a fascinating range of mechanisms to interact with each other, in both antagonistic and cooperative ways. These lectures will explore some of these interactions in detail, including themes such as competitive production of antimicrobial compounds (e.g. bacteriocins), synergistic cross-feeding and metabolic cooperation that allows microbes in partnership to utilise nutrients they would be unable to access alone, and the ability of bacteria to communicate with each other through small ‘hormone-like’ organic signalling compounds. The lecture series will also highlight how manipulation of these microbial interactions in the human body can have therapeutic potential.

**Secondary metabolism/antimicrobial agents - Dr D MacCallum**

Secondary metabolites are produced by many microbial species at certain stages of growth and can be associated with changes in morphology or help to promote survival of the microbe. These lectures will discuss the synthesis of secondary metabolites by microbes; some of which are antibiotics. These naturally produced agents, synthetic modifications, their modes of action and antimicrobial resistance mechanisms will also be discussed.


Practical Work

Laboratory Work
As part of the course all students will follow a single practical exercise which is spread over the eight weeks of the course. The practical will involve the genetic manipulation to disrupt specific gene(s) in *Candida albicans*, a diploid yeast. During the practical students will have the opportunity of applying the techniques of genetic manipulation and examining the resulting changes in phenotype outcome of the genetic manipulations. Full details of the practical exercise will be provided during the course. An important aspect of the practical in this course is that students are expected to maintain a detailed laboratory notebook to record protocols and data as required. At the end of the practical the work will be written up in the format of a typical research paper. The work will be assessed on the basis of the final written presentation as well as the laboratory notebook written and maintained during the practical classes.

For details on practical content please consult the MC3504 Practical Manual available on MyAberdeen.

Students are asked to make themselves familiar with the information on key institutional policies which have 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 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’s Infohub webpage or by visiting the Infohub.

The information included in the institutional area for 2016/17 includes the following:

- Absence
- Academic Appeals & Complaints
- Assessment (Common Grading Scale)
- Codes of Practice on Student Discipline (Academic and Non-Academic)
- Class Certificates
- Recording of Lectures
- Exam Results
- Transcripts
- MyAberdeen
- TurnitinUK
- Feedback
- Communication
- Aberdeen Graduate Attributes
- The Co-Curriculum
TUTORIAL 1

FUNGAL VIRULENCE FACTORS
Dr Judith Bain & Dr Delma Childers

Objective: The objective of this tutorial is to encourage you to consider the concept of “virulence” in fungi and to realize how different this concept in bacteria, viruses and fungi.

Instructions: A review from Genome Biology is provided [Odds, Gow & Brown (2001) Genome Biology 2(3): 1009.1-1009.4]. This provides an overview of virulence attributes of a number of medically important fungi. Read this short paper and prepare your responses to the following questions prior to the tutorial. You may want to scan a general microbiology textbook to remind yourself about the features of some of the key bacterial and viral pathogens for comparison.

Questions:

1. Provide a definition of a “virulence factor” of microbial pathogens.

2. Provide a list of virulence factors for a number of different fungal species, noting any points of similarity or difference with those for bacteria.

3. In your opinion is Aspergillus fumigatus a fungal pathogen or a saprophyte?

4. How would you determine whether a candidate gene of a fungus encoded a virulence factor? Consider any controls you may want to include in your proposed experiments.

5. Would you consider that any gene that is essential for growth of a fungus or bacterium should be considered a virulence factor? How would you modify your definition of virulence to distinguish genes that are simply required for growth from those that are require to cause disease?

6. What experimental variables may affect the virulence of a fungus being tested in an animal model of infection. For example what factors may influence the inoculum that would be used to inoculate an animal in a virulence test?

7. Do you think evolution selects for virulent organisms? If not why are there some fungi and bacteria that are so aggressively pathogenic?

8. What is the “gene-for-gene” hypothesis and how does this concept apply to virulence of plant pathogens?
9. Do you think the gene-for-gene hypothesis has any relevance in medical mycology?

10. How would you attempt to identify an “avirulence gene” in a medically important fungus?

Be prepared to come to the tutorial to argue your point of view. There is no one correct answer to some of the above questions!

**TUTORIAL 2**

**BIOSYNTHESIS OF OPIOIDS IN BUDDING YEAST**

Dr Alexander Lorenz and Dr Donna MacCallum


Engineers make narcotics with yeast. Is home-brewed heroin next? National Public Radio (npr.org)

http://tinyurl.com/npw26m3

**Introduction and Background**

Advances in biotechnology and synthetic biology have enabled us to produce all kind of compounds in heterologous systems (e.g. insulin made in bacteria, enzymatic activities for industry in yeast or filamentous fungi). This has several distinct advantages, such as getting very pure compounds under controlled conditions, high reproducibility, and scalability. The recent reconstruction of the complete opioid biosynthesis pathway potentially provides distinct advantages over opiates sourced from opium poppies (*Papaver somniferum*) for medical applications, but also results in a range of safety issues in conjunction with genetically modified organisms.

**Assignment**

You should read the information provided in the references above, and then prepare to contribute towards a discussion on the technical and ethical issues raised by heterologously produced opioids in yeast. The following are possible, but not exclusive, topics that are open to discussion.

1. Initially, what were the technical challenges in re-constructing the complete opioid biosynthesis pathway?
2. Which technical challenges must still be overcome to make this economically viable?
3. What are the major safety concerns? Are these truly relevant issues, and if yes, how could they be mitigated?
TUTORIAL 3

ANALYSIS OF A NOVEL E. coli TOXIN

Dr Sam Miller and Dr Stefania Spanò

In advance of the tutorial you should carefully read the following paper.


The key outcomes of the study will be discussed during the tutorial. The discussion will be based on a consideration of the following questions.

1. What are the 2 essential bacterial cytoskeletal proteins found in Escherichia coli? Describe their roles in cells.
2. What is a toxin-antitoxin (TA) system?
3. How did the authors demonstrate the activities of the TA system studied in this paper?
4. How does the TA system interact with the cytoskeletal elements of cells? How was this shown in vivo and in vitro?
5. What is novel about this TA system?
6. What mechanisms do the authors suggest regulate toxin activity?
7. Why do you think bacterial cells possess toxin-antitoxin systems?
ESSAY TITLES

Each student will complete a 1500 word essay (main text, not including references and figure legends) to be submitted the day stated in the timetable. Further information about essay styles can be found in this manual. The essays will be allocated to students via blackboard. The assignments will be confirmed by e-mail. Students should locate the reference provided and then use that as the starting point for their reading for the essay. When you research information for your essay you should go beyond the initial key reference in obtaining your facts. This information should be drawn from publications prior to the key reference as well as more recent publications. Guidance on carrying out a literature search will be provided during the computer-based session on bibliographic searching. Essays should be submitted double-spaced via Turnitin. Computer failure is not an accepted excuse for late submission of essays.

Titles:

1. ‘The role of virus receptor recognition in the determination of pathogenesis.’ – Dr K Hijazi

2. ‘“Anti-virulence” genes have been discovered in a number of pathogens. As mutations in these genes result in hypervirulence of the mutants, the normal role of these genes must be to reduce pathogen virulence.’
   Discuss. – Prof K Forbes

3. ‘The stress response in bacterial cells is an exaggerated normal response.’
   Discuss. – Dr S Miller
4. ‘Microorganisms can utilise a number of different mechanisms to introduce variation into their cell surfaces.’
Write an essay describing how microbial pathogens generate diversity at their surfaces and how this may contribute to pathogenesis and immune evasion. Give specific examples with a special emphasis on fungal pathogens. – Prof C Munro


5. ‘Discuss the mechanisms which human pathogenic fungi use to secure essential trace metals such as iron and zinc.’ – Dr D Wilson


6. ‘Describe recent progress on the understanding of structural features and evolutionary relationships of the type IV secretion system.’ – Dr S Spanò


7. ‘Drug resistance and the need for new antifungal drugs.’
There are only a few classes of antifungal agents available to treat fungal infections. Discuss the mechanisms associated with acquired resistance to clinical antifungal agents. In addition, novel antifungal agents with alternative fungal cellular target should be discussed. - Dr D MacCallum


8. ‘Microbes rarely exist in isolation. Describe some of the mechanisms, both cooperative and competitive, that microbes use to interact with each other.’ – Dr A Walker


9. ‘Why do we need DNA replication origins? Discuss DNA replication mechanisms without defined origins.’ – Dr A Lorenz


GUIDE TO ESSAY WRITING AND ASSESSMENT

Students should refer to "A Guide to Scientific Writing" by David Lindsay (Longman Cheshire) for more general guidance on writing essays. What follows is not meant as a substitute for reading the above book, but gives general guidance on what the various terms in the assessment table mean.

While the School strives for a common approach to assessment of work, differences may arise from the simple fact that each member of staff is an individual. In particular, it will be difficult to translate performance directly into the final mark, for example while a line of ticks at the left hand box for each category should result in a first class mark it will not equate with 100%. Similarly, when there is a mix of tick positions you will need to discuss with the marker how they have reached the final mark. This form is primarily an attempt only to ensure that when a mark is arrived at the student has some feedback on the merits and faults contained in their written work. At the same time the form arises from the collective wisdom of several members of staff and, therefore, the major points raised are meant to be indicators of what constitutes good style in scientific writing.

CONTENT and PRESENTATION: Each essay will be judged not only for its content but also for its style of presentation. 70% of the marks will be allocated for content and 30% for style.

Knowledge: it is expected that any essay will contain a substantial body of facts gleaned from appropriate literature that should be cited within the text (Citations). The length of the essay will dictate how many facts can be given in support of a given statement and allowance will be made for this by the staff.

Analysis: students are expected to develop their analytical skills and this is most readily demonstrated by use of carefully selected examples, which show a good understanding of the material. Remember that examples may be either supportive or undermine an argument. A balanced essay will consider the relative strengths of the arguments for or against a particular point of view (Viewpoint).

Structure: a good essay will be clearly structured by division into appropriate sections, including an introduction, which provides a clear and concise statement of the issue to be discussed, and a conclusion, which briefly sums up the issues discussed.

Viewpoint: students should form a view on the subject that they are writing about and should be able to support their views with balanced use of appropriate examples.

Figures: an argument can often be supported by Figures or Tables that present information in a coherent form. Figures and Tables should not be an add on, but must be an integral feature of the text and must be described and discussed. A poor or inappropriate figure or table will usually detract from the essay.
Citations: papers and reviews used as source material should be cited in the text and direct quotes should be indicated by quotation marks. A consistent style of citation is essential and a list of citations should be presented at the end of the essay.

Techniques: scientific information is derived from experimentation. It is important to understand how information is derived. For example what technique was used, how was the experiment conducted etc. This information is particularly essential for major essays and theses, but should also inform your views in minor essays.

Sentence construction, spelling, grammar: it is expected that students should be able to spell correctly, use sentences of suitable length and complexity, and should understand the basic rules of grammar.

Organisation: An essay is easier to read if it is attractively set out on the page. For this reason the School encourages the use of word processors and the University provides facilities for students for this purpose. An essay is easier to read and mark if it is formatted to give double spacing between lines of text and if the font is 12 point.

Note that computer failure is not accepted as a reason for late submission – it is good practice to maintain at least two copies of computer files.

Figures and Tables: Figures drawn by the student are preferred to reproduction of complex diagrams from other people's work. Published figures often contain more information than is required for a student essay. In addition the task of reproducing a diagram is good discipline for understanding its content. Tables should be set out neatly using either simple lined paper or using the various packages found as part of the word processing package.

Specific comments: this section is provided for the staff to make comments that amplify the box assessments in the top half of the form.
## SCHOOL OF MEDICAL SCIENCES - MOLECULAR MICROBIOLOGY MC3504

**Student:**  
**Essay title:**

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<th>LOW</th>
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<td>rambling, confused, poorly focused</td>
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<tr>
<td>Knowledge</td>
<td>Deep, thorough, detailed knowledge</td>
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<td>Analysis</td>
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<tr>
<td>Viewpoint</td>
<td>Clearly expressed</td>
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<tr>
<td>Figures</td>
<td>Well integrated with text</td>
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<tr>
<td>Citations</td>
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<td>citations lacking, format inconsistent</td>
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<tr>
<td>Techniques</td>
<td>Clear recognition of how information derived</td>
<td></td>
<td>no technical insight</td>
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<tr>
<td>Conclusions</td>
<td>Concise and reflecting content of essay</td>
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### PRESENTATION

<table>
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<th>Good, readability high</th>
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<td>untidy, badly organised, illegible</td>
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<td>Figures &amp; Tables</td>
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Specific Comments

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Punctual delivery?   Yes/No
### Medical Sciences Common Grading Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Grade Point</th>
<th>Category</th>
<th>Honours Class</th>
<th>Description</th>
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| A1    | 22          |               |               | • 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          | Excellent     | First         |                                                                                                                                            |
| 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          |               | Upper Second  |                                                                                                                                            |
| 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    | Not used for Honours | • Contains major errors or misconceptions  
• Poor presentation |
<p>| F2    | 4           |               |               |                                                                                                                                            |
| F3    | 3           |               |               |                                                                                                                                            |
| G1    | 2           | Clear Fail/ Abysmal |            | • Token or no submission                                                                                                                    |
| G2    | 1           |               |              |                                                                                                                                            |
| G3    | 0           |               |              |                                                                                                                                            |</p>
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<td>Mon 16 Jan</td>
<td>14:00-15:00</td>
<td>1M:001</td>
<td>Introduction to the course</td>
<td>Lecture</td>
<td>SM</td>
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<td>Tue 17 Jan</td>
<td>10:00-17:00</td>
<td>ZB13</td>
<td>Practical 1</td>
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<td>DW</td>
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<td>Wed 18 Jan</td>
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<td>Thu 19 Jan</td>
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<td>Fri 20 Jan</td>
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<td><strong>Week 25</strong></td>
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<tr>
<td>Mon 23 Jan</td>
<td>14:00-15:00</td>
<td>1:154</td>
<td>Fungal Pathogens of plants and animals – 1</td>
<td>Lecture</td>
<td>NARG</td>
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<td>15:00-16:00</td>
<td>1:154</td>
<td>Fungal Pathogens of plants and animals – 2</td>
<td>Lecture</td>
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<td>Tue 24 Jan</td>
<td>10:00-13:00</td>
<td>ZB13</td>
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<td>Wed 25 Jan</td>
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<td>1:154</td>
<td>Fungal Pathogens of plants and animals – 3</td>
<td>Lecture</td>
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<td>Thu 26 Jan</td>
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<td><strong>Week 26</strong></td>
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<td>Mon 30 Jan</td>
<td>14:00-15:00</td>
<td>1:154</td>
<td>Fungal Pathogens of plants and animals – 4</td>
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<td>15:00-16:00</td>
<td>1:154</td>
<td>Molecular Virology I</td>
<td>Lecture</td>
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<td>Tue 31 Jan</td>
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<td>Wed 1 Feb</td>
<td>09:00-10:00</td>
<td>1:154</td>
<td>Molecular Virology II</td>
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<td>10:00-11:00</td>
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<td>Molecular Virology III</td>
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<td>Thu 2 Feb</td>
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<td>Fri 3 Feb</td>
<td>14:00-15:00</td>
<td>1:155/156</td>
<td>Molecular Virology IV</td>
<td>Lecture</td>
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<td><strong>Week 27</strong></td>
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<td>Mon 6 Feb</td>
<td>14:00-15:00</td>
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<td>Bacterial Cell Stress and Survival – 1</td>
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<td>15:00-17:00</td>
<td>1M:001 &amp; 1:154</td>
<td>Tutorial 1</td>
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<td>Tue 7 Feb</td>
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<td>Wed 8 Feb</td>
<td>09:00-10:00</td>
<td>1:154</td>
<td>Bacterial Cell Stress and Survival – 2</td>
<td>Lecture</td>
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<td>Thu 9 Feb</td>
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<td>Fri 10 Feb</td>
<td>14:00-15:00</td>
<td>1:155/156</td>
<td>Bacterial Cell Stress and Survival – 3</td>
<td>Lecture</td>
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<td><strong>Week 28</strong></td>
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<td>Mon 13 Feb</td>
<td>14:00-15:00</td>
<td>1M:001</td>
<td>Bacterial Cell Stress and Survival – 4</td>
<td>Lecture</td>
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<td>Tue 14 Feb</td>
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<td>Practical 5</td>
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<tr>
<td>Wed 15 Feb</td>
<td>09:00-10:00</td>
<td>1:154</td>
<td>Bacterial Molecular Pathogenesis – 1</td>
<td>Lecture</td>
<td>KF</td>
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<td>Thu 16 Feb</td>
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<td>Fri 17 Feb</td>
<td>14:00-15:00</td>
<td>1:155/156</td>
<td>Bacterial Molecular Pathogenesis – 2</td>
<td>Lecture</td>
<td>KF</td>
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<td><strong>Week 29</strong></td>
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<td>Mon 20 Feb</td>
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<td>Bacterial Molecular Pathogenesis – 3</td>
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<td>Tue 21 Feb</td>
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<td>Wed 22 Feb</td>
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<td>Bacterial growth and development-1</td>
<td>Lecture</td>
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<td>Thu 23 Feb</td>
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<td>Fri 24 Feb</td>
<td>14:00-15:00</td>
<td>1:155/156</td>
<td>Bacterial Molecular Pathogenesis – 4</td>
<td>Lecture</td>
<td>KF</td>
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<td>Week 31</td>
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<tr>
<td>Mon 27 Feb 14:00-15:00</td>
<td>1M:001</td>
<td>Bacterial growth and development – 2</td>
<td>Lecture</td>
<td>SM</td>
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<tr>
<td>15:00-17:00</td>
<td>1M:001 &amp; 1:154</td>
<td>Tutorial 2</td>
<td>Tutorial</td>
<td>AL/DMacC</td>
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<td>Tue 28 Feb 10:00-17:00</td>
<td>2B13</td>
<td>Practical 7</td>
<td>Practical</td>
<td>DW</td>
<td>AB</td>
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<tr>
<td>Wed 1 Mar 09:00-10:00</td>
<td>1:154</td>
<td>Bacterial growth and development – 3</td>
<td>Lecture</td>
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<td>Thu 2 Mar</td>
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<td>Fri 3 Mar 14:00-15:00</td>
<td>1:155/156</td>
<td>Bacterial growth and development – 4</td>
<td>Lecture</td>
<td>SM</td>
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| Week 32 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Mon 6 Mar 14:00-15:00 | 1M:001 | Invasive Bacterial Pathogens - 1 | Lecture | SS |
| Tue 7 Mar 10:00-12:00 | CR2 | Report writing workshop | Practical | DW|AB |
| 14:00-15:00 | 1:154 | Invasive Bacterial Pathogens - 2 | Lecture | SS |
| Wed 8 Mar 09:00-10:00 | 1:154 | Invasive Bacterial Pathogens - 3 | Lecture | SS |
| Thu 9 Mar | | | | |
| Fri 10 Mar 14:00-15:00 | 1:155/156 | Invasive Bacterial Pathogens - 4 | Lecture | SS |

| Week 33 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Mon 13 Mar 14:00-15:00 | 1M:001 | Copying the genome and maintaining its integrity – DNA replication in eukaryotes and prokaryotes | Lecture | AL |
| 15:00-17:00 | 1M:001 & 1:154 | Tutorial 3 | Tutorial | SM|SS |
| Tue 14 Mar 09:00-10:00 | 1M:001 | Copying the genome and maintaining its integrity - Dealing with clashes between replication and transcription | Lecture | AL |
| Wed 15 Mar 09:00-10:00 | 1:154 | Copying the genome and maintaining its integrity - Accidental and programmed replication fork blocks | Lecture | AL |
| Thu 16 Mar | | | | |
| Fri 17 Mar 14:00-15:00 | 1:155/156 | Microbial Interactions I | Lecture | AW |

| Week 34 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Mon 20 Mar 14:00-15:00 | 1M:001 | Microbial Interactions II | Lecture | AW |
| Wed 22 Mar 09:00-10:00 | 1:154 | Microbial Interactions III | Lecture | AW |
| Thu 23 Mar | | | | |
| Fri 24 Mar 14:00-16:00 | 1:155/156 | Practical 8: Mini-symposium | Practical | DW|AB |

| Week 35 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Mon 27 Mar 14:00-15:00 | 1M:001 | Secondary Metabolism/antimicrobial agents – 1 | Lecture | DMacC |
| Tue 28 Mar 13:00-14:00 | 1:154 | Secondary Metabolism/antimicrobial agents – 2 | Lecture | DMacC |
| Wed 29 Mar 09:00-10:00 | 1:154 | Secondary Metabolism/antimicrobial agents – 3 | Lecture | DMacC |
| Thu 30 Mar | | | | |
| Fri 31 Mar 14:00-15:00 | 1:155/156 | Secondary Metabolism/antimicrobial agents – 4 | Lecture | DMacC |
| 15:00-16:00 | 1:155/156 | Practical feedback and Course wrap-up | Lecture | DW|AB|SM |
Staff
- Dr Judith Bain (JB)
- Dr Alex Brand (AB)
- Dr Delma Childers (DC)
- Prof Ken Forbes (KF)
- Prof Neil Gow (NARG)
- Dr Karolin Hijazi (KH)
- Dr Alexander Lorenz (AL)
- Dr Donna MacCallum (DMacC)
- Dr Sam Miller (SM)
- Dr Stefania Spanò (SS)
- Dr Alan Walker (AW)
- Dr Duncan Wilson (DW)

Venues
ZB13 is in the Zoology Building, Old Aberdeen
All other venues are located in the Polwarth Building, Foresterhill site