# Faculty of Science
# School of Mathematics & Statistics

# MATH6781
# Biomathematics
# Semester 2, 2017

***Last revised: 13th July 2017***

Cricos Provider Code: 00098G

# MATH6781 – Course Outline

# Information about the course

**Course Authority:** Dr. Christopher Angstmann

**Lecturer:** Dr. Christopher Angstmann
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**Consultation:** Consultation is by appointment and are best arranged via email.

**Credit**: This course counts for 6 Units of Credit (6UOC)

**Prerequisites**: 12 units of credit in Level 2 Mathematics courses including:- MATH2120 or MATH2130, OR both MATH2019 and MATH2089, OR both MATH2069 and MATH2099.

**Exclusions**: MATH2280, MATH2281.

**Lectures:** There are three hours of lectures per week; lectures will run from week 1 through 12

Mondays: 12pm - 1pm RC 4082

Wednesday: 12pm -2pm RC 4082

**Tutorials:** There is one tutorial/lab class per week; this will run from week 1 through 12

Fridays: 2pm-3pm RC G12C

# Course aims

This course provides an introduction to mathematical modelling and data analysis for biological and biomedical systems. Examples include: the formation of animal coat patterns, the spread of diseases through the community, the interaction between pathogens and the immune system of the body, the growth of tumours, nerve cell signaling, population dynamics, pharmacokinetics and bacterial growth. The emphasis in this course is on the development of the governing model equations and on computer simulations of the model equations rather than on mathematical methods for solving the model equations.

## Relation to Other Mathematics Courses

Mathematics may be divided into the broad categories of analysis (calculus), algebra, geometry and logic.

This subject fits largely into the calculus category and follows on from material you will have learned in first year and from other related courses you may have taken, although algebra and areas will also be involved.

This course is very useful for those majoring in Applied Mathematics, those planning to teach, or those students of Mathematics who are interested in the application of mathematical techniques to real-world problem solving.

### Relation to Graduate Attributes

The above outcomes are related to the development of the Science Faculty Graduate Attributes, in particular:

1. Research, inquiry and analytical thinking abilities.

4. Communication.

6. Information literacy.

## Teaching strategies underpinning the course

New ideas and skills are introduced and demonstrated in lectures, and then students develop these skills by applying them to specific tasks in tutorials and assessments.

### Rationale for learning and teaching strategies

We believe that effective learning is best supported by a climate of enquiry, in which students are actively engaged in the learning process. To ensure effective learning, students should participate in class as outlined below.

We believe that effective learning is achieved when students attend all classes, have prepared effectively for classes by reading through previous lecture notes, in the case of lectures, and, in the case of tutorials, by having made a serious attempt at doing for themselves the tutorial problems prior to the tutorials.

Furthermore, lectures should be viewed by the student as an opportunity to learn, rather than just copy down lecture notes.

Effective learning is achieved when students have a genuine interest in the subject and make a serious effort to master the basic material.

The art of logically setting out mathematics is best learned by watching an expert and paying particular attention to detail. This skill is best learned by regularly attending classes.

# Assessment

Assessment in this course will use problem-solving tasks of a similar form to those practiced in tutorials, to encourage the development of the core skills underpinning this course and the development of analytical thinking.

In tests and exams, marks will be awarded for correct working and appropriate explanations and not just the final answer.

**Class tests will be held in weeks 4, 7, and 11, each worth 10% of your final mark.**

The tests will give students feedback on their progress and mastery of the material.

There will be short answer questions in which correct answers are sought and there will be some longer questions requiring clear and logical presentation of correct solutions as well as some written explanations.

The tests will be held in Lectures.

You may bring your own non-programmable hand-held Scientific Calculator to the test. Calculators will not be provided for you.

If you are absent from a test due to illness or misadventure you must provide appropriate documentation, e.g. a medical certificate. In such cases, after reviewing the documentation, the course authority will determine the appropriate recourse.

**An assignment, worth 10% of your final mark.**

This will be given out by the end of week 4, and due at the end of week 6. Assignments handed in late will incur a 10% reduction in the mark per late day. Assignments handed in more than 7 days late will not be marked.

**The final exam (2 hours) and is worth 60% of your final mark.**

The final examination will assess student mastery of the material covered in the lectures.

## Outcomes

We believe that effective learning is best supported by a climate of inquiry, in which students are actively engaged in the learning process. Hence this course is structured with a strong emphasis on problem-solving tasks in lectures, in tutorials and in assessment tasks and students are expected to devote the majority of their class and study time to the solving of such tasks.

New ideas and skills are first introduced and demonstrated in lectures, and then students develop these skills by applying them to specific tasks in tutorials and assessments. Computing skills are developed and practiced in regular computer practical sessions/web-based tutorials/attempting assessment tasks.

This course has a major focus on research, inquiry and analytical thinking as well as information literacy. We will also explore capacity and motivation for intellectual development through the solution of both simple and complex mathematical models of biological systems, and the interpretation and communication of the results.

# Course Evaluation and Development

The School of Mathematics & Statistics evaluates each course each time it is run. Feedback on the course is gathered, using among other means, UNSW's myExperience survey. Student feedback is taken seriously, and continual improvements are made to the course based in part on such feedback.

# Syllabus

Outline lecture notes, and other materials, for this course will be made available via the Moodle web site, via http://telt.unsw.edu.au/

They are not a substitute for attendance at lectures and tutorials.

The course will include material from the following topics. This is not an extensive list of the material to be covered and should only serve as a guide. The course content is ultimately defined by the material covered in lectures.

Population models

- Models for population growth, Exponential, Logistic, and Gompertz.
- Interacting populations, Predator-prey, Lotka-Volterra, and food webs.

Epidemics

- SIR modelds and their generalisations, e.g. SIRS, SIS.
- Vaccination, and Herd Immunity.

Compartmental Modelling & Pharmacokinetics

Chemical Interactions

- Law of Mass Action.
- Michaelis-Menten Kinetics and Enzymatic Reactions.
- Chemical Master Equations.

Mathematical Models of Biological Diffusion

- Brownian Motion, Random Walks, and Fick's Law.
- Diffusion with Advection and Chemotaxis.
- Reaction- Diffusion Equations.

Simple Models of Nerve Cells

- Hodgkin-Huxley Equations.
- The Cable Equation.
- Rall's Model for the Dendritic Tree.

Turing Patterns and Reaction-Diffusion Models for Pattern Formation

- Animal Coat Patterns.
- Phyllotaxis.
- *Min* proteins and *e. coli* Cell Division.

Tumour Growth Models

## Additional References


- Mathematical Models in Biology, L. Edelstein-Keshet, 1988 Random House.
- Mathematical Biology 1: An Introduction. J. D. Murray 2002 3rd ed, Springer-Verlag.
- Essential Mathematical Biology, N.F. Britton, 2003 Springer- Verlag.

# SCHOOL OF MATHEMATICS AND STATISTICS, UNSW

**IMPORTANT INFORMATION FOR STUDENTS**

## School Rules and Regulations

Full details of the general rules regarding attendance, release of marks, special consideration etc. are available via the School of Mathematics and Statistics Web page at
`http://www.maths.unsw.edu.au/currentstudents/assessment-policies`

## Plagiarism and academic honesty

Plagiarism is the presentation of the thoughts or work of another as one's own. Issues you must be aware of regarding plagiarism and the university's policies on academic honesty and plagiarism can be found at `http://www.lc.unsw.edu.au/plagiarism` and
`http://www.lc.unsw.edu.au/plagiarism/plagiarism_STUDENTBOOK.pdf`.