3H MATHEMATICAL BIOLOGY

Lectures: Wednesday(odd wks), Thursday, Friday 10:00–11:00am, Math 416

`Instructor: Professor Xiaoyu Luo`

`E-mail: x.y.luo@maths.gla.ac.uk` `Office No. Math 507`
`Website: http://moodle.gla.ac.uk/fims/moodle`

General description

The subject of Mathematical Biology is expanding rapidly and covers a very wide range. In this course, three topics will be considered. These are Propagation of Signals in Nerve Cells, Morphogenesis and Turing Instability, and the Growth of Tumours. The theories for these problems are well-established but are still the subject of much research. The mathematical methods used will include the use of phase planes, eigenvalue methods, traveling waves, reaction-diffusion equations and ODE's with moving boundaries.

Prerequisites

No optional courses are prerequisites for Mathematical Biology but a knowledge of vector calculus and ordinary differential equations is needed.

Recommended reading

1. L. Edelstein-Keshet, Mathematical Models in Biology, SIAM Classics in applied mathematics, 2005, ISBN 0-89871-554-7.

2. J.D. Murray, Mathematical Biology, Springer-Verlag (2nd Ed), 1989.

3. D.S.Jones & B.D. Sleeman, Differential Equations and Mathematical Biology, Chapman & Hall, 2003

Aims

To introduce mathematical modelling in biology and to give examples of mathematical techniques that are widely used in the field.

Course Contents

Phase plane methods (*4 lectures*)

Phase plane methods for 2 coupled ODEs. Review of Nullclines. Linearization and eigenvalues problems.

(this part can be cut to one hour if MB is in semester two)

Conduction in Nerve Axons (*7 lectures*)

Modelling of unmyelinated nerve fibres leading to the Hodgkin-Huxley equations. The simplified FitzHugh-Nagumo equations. Excitability, periodic signals and travelling waves.

Morphogenesis and the Turing Instability (*8 lectures*)

Morphogenesis and the concept of pre-patterning. Reaction-diffusion equations. The Law of Mass Balance. Linearisation and the analysis of Turing instabilities. Examples of pattern formation in animals.

(This part will not be taught)

Growth of Solid Tumours (*6 lectures*)

Tumour physiology. Greenspan's model for a solid tumour. Growth of spherical tumours. Diffusion limited growth. Angiogenesis, vascularisation and metastasis.