

## **Course Overview: Introduction to Mathematical Biology for Non-Mathematicians**

This two-week course offers an accessible introduction to the use of mathematical models in biology, designed specifically for students and researchers without a formal background in mathematics. Through a combination of guided lectures, hands-on sessions, and collaborative projects, participants will learn how mathematical tools can be applied to understand complex biological systems.

In Week One, participants will be introduced to ordinary differential equations (ODEs) — one of the most widely used modelling frameworks in biology. The course will cover how to build simple ODE models to describe biological processes such as population growth, disease transmission, and cellular dynamics. Alongside model construction, students will explore both analytical and numerical methods for solving these models, gaining practical experience with software tools for simulation and analysis. The week will conclude with sessions on fitting models to biological data, emphasising interpretation, parameter estimation, and assessing model performance.

Week Two shifts focus to student-led projects, where participants will work in small groups on topics of their choice. Guided by instructors, students will identify a biological question, develop a mathematical model, implement it computationally, and analyze their results. The week will culminate in informal presentations, allowing participants to share findings, discuss challenges, and reflect on their learning.

By the end of the course, students will have a practical understanding of how mathematical models can be applied to biological questions, and the confidence to engage with modelling in their own research. Students will also have one-on-one sessions with course instructors in which they can describe their own research project and gain suggestions and feedback on possible modelling opportunities.

**Dates:** June 1st-12th

**Numbers:** 20-25

**Application:** Should include a brief description of their doctoral research, what they want to learn on the course, and how attending the course will help with their doctorate and / or their future career goals.

**Pre-requisites:** Mathematics A Level, or equivalent

**Monday 1st June**

- 0930-1300 Overview, introductions. What is a model? Tutorial on basic calculus.
- 1400-1730 Introduction to modelling with ODEs - scalar equations with different growth laws. Steady states and linear stability analysis. Practical exercises.

**Tuesday 2nd June**

- 0930-1300 More on scalar equations - multiple steady states, non-dimensionalisation.
- 1400-1730 Model misspecification and connecting models with data.

**Wednesday 3rd June**

- 0930-1300 Modelling with systems of ordinary differential equations - applications, including enzyme kinetics, gene regulatory networks.
- 1400-1730 Phase plane analysis, steady states, linear stability analysis.

**Thursday 4th June**

- 0930-1300 Systems of ordinary differential equations continued - phase planes, steady states, linear stability with applications to SIR modelling, oscillations etc.
- 1400-1730 Back to data - parameter sensitivity analysis and identifiability.

**Friday 5th June**

- 0930-1300 Introduction to agent-based modelling.
- 1400-1730 Introduction to projects, project development, present your ideas to the group.

**Monday 8th June**

- 0930-1300 Project work and drop-in session.
- 1400-1730 Project work and drop-in session.

**Tuesday 9th June**

- 0930-1300 Project work and drop-in session.
- 1400-1730 Research talk (40 mins) and project work.

**Wednesday 10th June**

- 0930-1300 MuSPAN presentation (40 mins) and project work.
- 1400-1730 Research talk (40 mins) and project work.

**Thursday 11th June**

- 0930-1300 Project work and drop-in session.
- 1400-1730 Research talk (40 mins) and project work.

**Friday 12th June**

- 0930-1300 Project work.
- 1400-1730 Project presentations and wrap up.