Module	**Mathematical Modelling**
Code	MSLS_V5_2
Degree Programme	Master of Science in Life Sciences (MSLS)
ECTS Credits	5
Workload	150 h: Contact and exercises 60 h; Self-study 90 h
Module Coordinator	**Name** Part I: Dr. Matthias Nyfeler; Part II: Dr. Maria Anisimova **Phone** +41 (0) 58 934 51 16 and +41 (0) 58 934 58 82 **Email** nyfe@zhaw.ch and anis@zhaw.ch **Address** ZHAW Zürcher Hochschule für Angewandte Wissenschaften Life Sciences and Facility Management Schloss 1 CH-8820 Wädenswil
Lecturers	• Dr. Matthias Nyfeler • Dr. Maria Anisimova
Entry Requirements	The basics knowledge of the following topics: • Mathematical analysis (particularly ordinary differential equations) • Linear algebra basic knowledge • Probability theory and statistical inference • Programming (preferably R and Python)
Learning Outcomes and Competences	After completing the module students should have a solid grasp of basic theoretical concepts in mathematical modelling and a good understanding of its role in life sciences. Precisely, at the end of the course students are able to: • Describe a suitable model for the analysis of typical data from life sciences • Formulate research questions from life sciences into formal mathematical models using differential equations or stochastic processes • Practice simulation as an integral part of mathematical modelling process • Validate a model and study its major properties • Evaluate model fit to given data • Formulate hypotheses and test them based on a specific model purpose • Interpret the model estimates within the context of a given study • Understand the limitations of each given model • Know most frequent applications of modelling approaches in life sciences • Recognize the opportunity for an application of standard models • Describe a mathematical modelling study in a formal scientific report • Critically review a scientific publication regarding the applied modelling methods
Module Content	The module focuses on two major mathematical modelling strategies: based on differential equations (part I) and using stochastic processes (part II).

	The course is structured in three sections: A. The theory of mathematical modelling: • Basic principles in modelling and simulation • Modelling with ordinary and partial differential equations • Fundamental classes of stochastic processes: continuous /discrete-time Markov chains and processes over continuous/discrete state space, Poisson processes, Brownian motion and general Random Walk B. Applications of mathematical modelling: • Multiphysics simulations (eg, computational fluid dynamics, heat transfer, diffusion, reaction) • Reaction kinetics and process optimization • Modelling evolutionary change in species and populations • Computational genomics and –omics (eg, gene annotation) C. Case studies • Individual project work on pre-defined case studies on mechanistic and stochastic modelling. • Written reports and code are submitted in the format of a scientific publication.
Teaching / Learning Methods	Basic knowledge is acquired through a combination of lectures, exercise sessions and group work/discussions. In order to apply and extend the acquired knowledge, students carry out individual assignments developing a solution for a case study. Throughout the course students are required to read and discuss relevant scientific literature in groups and as individual self-study.
Assessment of Learning Outcome	• Written exam on theory section A (40%) • Individual written report for a case study (45%) • Project presentation (15%)
Bibliography	Selected original papers and monographs depending on the individual case study. • S. Karlin and H.M. Taylor. A First Course in Stochastic Processes, edition 3, Academic Press, New York, 1998 • E. Bodin, S. Lenhart, L. Gross, Mathematics for the Life Sciences, Princeton, 2014
Language	English
Comments	
Last Update	23.03.2022