

<b>Module</b>	<b>Mathematical Modelling</b>
<b>Code</b>	V5_2
<b>Degree Programme</b>	Master of Science in Life Sciences (MSLS)
<b>ECTS Credits</b>	5 ECTS
<b>Workload</b>	150 h: Contact and exercises 60 h; Self-study 90 h
<b>Module Coordinator</b>	<p><b>Name</b> Part I: Dr. Matthias Nyfeler; Part II: Dr. Maria Anisimova</p> <p><b>Phone</b> +41 (0) 58 934 51 16 and +41 (0) 58 934 58 82</p> <p><b>Email</b> <a href="mailto:nyfe@zhaw.ch">nyfe@zhaw.ch</a> and <a href="mailto:anis@zhaw.ch">anis@zhaw.ch</a></p> <p><b>Address</b> ZHAW Zürcher Hochschule für Angewandte Wissenschaften Life Sciences and Facility Management Schloss 1 CH-8820 Wädenswil</p>
<b>Lecturers</b>	<ul style="list-style-type: none"> <li>• Dr. Matthias Nyfeler</li> <li>• Dr. Victor Garcia</li> </ul>
<b>Entry Requirements</b>	<p>Basic knowledge of the following topics:</p> <ul style="list-style-type: none"> <li>• Mathematical analysis (particularly ordinary differential equations)</li> <li>• Linear algebra basic knowledge</li> <li>• Probability theory and statistical inference</li> <li>• Programming (preferably R and Python)</li> </ul>
<b>Learning Outcomes and Competences</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• Describe a suitable model for the analysis of typical data from life sciences</li> <li>• Formulate research questions from life sciences into formal mathematical models using differential equations or stochastic processes</li> <li>• Practice simulation as an integral part of mathematical modelling process</li> <li>• Validate a model and study its major properties</li> <li>• Evaluate model fit to given data</li> <li>• Formulate hypotheses and test them based on a specific model purpose</li> <li>• Interpret the model estimates within the context of a given study</li> <li>• Understand the limitations of each given model</li> <li>• Know most frequent applications of modelling approaches in life sciences</li> <li>• Recognize the opportunity for an application of standard models</li> <li>• Describe a mathematical modelling study in a formal scientific report</li> <li>• Critically review a scientific publication regarding the applied modelling methods</li> </ul>
<b>Module Content</b>	<p>The module focuses on two major mathematical modelling strategies: based on differential equations (part I) and using stochastic processes (part II) and then applied in case studies.</p> <p>The course is structured in three sections:</p> <p>A. Mechanistic Modelling (part I):</p> <ul style="list-style-type: none"> <li>• Basic principles in modelling and simulation</li> </ul>

	<ul style="list-style-type: none"> <li>• Modelling with ordinary and partial differential equations</li> <li>• Multiphysics simulations (eg, computational fluid dynamics, heat transfer, diffusion, reaction)</li> <li>• Reaction kinetics and process optimization</li> </ul> <p>B. Stochastic Modelling (part II):</p> <ul style="list-style-type: none"> <li>• 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</li> <li>• Modelling evolutionary change in species and populations</li> <li>• Computational genomics and –omics (eg, gene annotation)</li> </ul> <p>C. Case studies</p> <ul style="list-style-type: none"> <li>• Individual project work on pre-defined case studies on mechanistic and stochastic modelling.</li> <li>• Written reports and code are submitted in the format of a scientific publication.</li> </ul>
<b>Teaching / Learning Methods</b>	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.
<b>Assessment of Learning Outcome</b>	<ul style="list-style-type: none"> <li>• Written exam on theory section A and B (50%)</li> <li>• Individual written report for a case study (50%)</li> </ul>
<b>Bibliography</b>	<p>Selected original papers and monographs depending on the individual case study.</p> <ul style="list-style-type: none"> <li>• S. Karlin and H.M. Taylor. A First Course in Stochastic Processes, edition 3, Academic Press, New York, 1998</li> <li>• E. Bodin, S. Lenhart, L. Gross, Mathematics for the Life Sciences, Princeton, 2014</li> </ul>
<b>Language</b>	English
<b>Comments</b>	-
<b>Last Update</b>	16.04.2026