Biothermodynamics: Bridging life, natural and engineering sciences

University: TUM
Level: BA4, MA1, MA2, MA3, MA all years, PhD
Teaching mode: completely online
Instructor(s): Prof. Urs von Stockar; Prof. Mirjana Minceva; Dr. Marko Popovic

Description

Full description of the course (max 1500 characters)

Biothermodynamics is a fast growing discipline, increasingly required in both academia and industry. The course comprises a micro-credential, giving students from various disciplines insight into physical mechanisms of life phenomena. The focus is on biological interpretations and practical use, not on mathematical rigor. The main objective is to promote quantitative thermodynamic perspective on life phenomena, giving students both deep understanding and practical skills.

The course covers the basics and latest progress in biothermodynamics

Introduction/basic concepts

First law and energy balance of a cell

Calculation exercise

Biological calorimetry and Kleiber's law

Biological order, second law and Gibbs energy

Calculation exercise

Growth reactions and driving force

Nonequilibrium thermodynamics, growth rate and growth curves

Calculation exercise

Photosynthesis, plants and soil

COVID-19 and thermodynamics: Interactions between organisms

Thermodynamics of molecules

Opening the black box - Thermodynamics of metabolism

Astrobiology and the emergence of life

The program consists of online lectures and calculation exercises. where the lecturers will present solving practical problems. To promote engagement and collaboration, students will write an essay and make a short video on a biothermodynamic topic, graded by students and lecturers. The final grade will be a combination of the short video, essay and quizzes given after each lecture.

Learning outcomes

1. Students will gain a mechanistic perspective of biological systems. Students' knowledge of physics and biology will be unified, making qualitative life phenomena quantified.
2. Using simple equations of classical and nonequilibrium thermodynamics, students will be able to describe and predict the outcome of biological processes.
3. Students will be able to design and perform calorimetric experiments in life sciences, as well as to analyze and interpret experimental data.
4. Students will be able to use the quantitative framework of thermodynamics to solve problems in virology, systems biology, omics, photosynthesis, soil, biotechnology, astrobiology, as well as to understand the physical background and driving forces of interactions between organisms and interactions of organisms with their environment.
5. Students will learn about the development of biothermodynamics and the latest findings.
6. Students will be able to communicate scientific concepts and findings, as well as to understand the perspective of colleagues with different scientific and cultural backgrounds.

General information

Contact hours per week:	2.85
Total workload:	140
ECTS credits:	5
Language:	English
Course start date:	15/10/2021
Course end date:	31/03/2022
Weekly teaching day/time:	Each week, the students will receive video lecture material, consisting of optional introductory videos and lecture videos. The introductory videos cover topics that are pre-requisite to understand the lecture videos and are optional.
Time zone:	CET (Denmark, Germany, France, Netherlands, Switzerland, Czech Republic)
Further information:	

Prerequisites:	no prerequisites
Activities and methods:	Lectures, Self-study, Exercises, Writing an essay and making a short video presentation
Presence on campus:	not required

Final examination

Form:	project
Date:	01/03/2022
Location:	online
Re-sit possibility:	no
Transcript available:	TUM will issue an official certificate indicating the number of ECTS, grade and workload instead of a transcript of records.
Add. info/requirements:	The final examination consists of writing a 3 to 5-page essay and making a short video presentation on a biothermodynamic topic. Topics will be provided by the lecturers, along with the literature. But the students are also free to propose their own topics.

Registration

To register for this course, follow the registration requirements of your **home university** as specified here: www.euroteq.eu/courses-registration.

Administration

Number of places:	50
Internal course code:	
Contact:	EuroteQ.Incoming.zv@tum.de

Technion. Students from these universities can participate in the offered courses. It is the responsibility of the student to check if you fulfil the requirements to participate in a specific course. Students are also advised to check with their home institution how to get recognition of the ECTS credits gained in courses of the EuroTeQ course catalogue. For further information about EuroTeQ Engineering University, visit www.euroteq.eu or get in touch with the above-mentioned point of contact.