SSCP26 PROGRAM

The University of California San Diego, the University of Oslo,

and Simula Research Laboratory welcome you to the joint

2026 Summer School in Computational Physiology

Models, Tools, and Techniques for Excitable Tissues

Course website: www.simula.no/sscp

Oslo, Norway 15 - 26 June 2026

Simula Research Laboratory: Kristian Augusts gate 23

General Schedule:

June 14th: Python tutorial (evening session)

16:00-19:00

June 15th-24th: Theory

09:00 - 12:00 – lectures
12:00 - 13:00 – lunch break
13:00 - 17:00 – lectures, programming lab work

June 25th-26th: Project work

There is no set schedule for project work. It is, however, expected that project teams take full advantage of this time. At least one advisor for each project will be available from 9:00-16:00 during this interval.

SSCP26 lectures will take place at Simula (Kristian Augusts gate 23), HPL Lecture Hall (8th floor).

Sunday June 14

Evening session (16:00 – 19:00)

Python Tutorial (Alessandro Gatti)

- *Encouraged for newcomers to Python and/or programming*
- *Pizza will be served for dinner*

Monday June 15

Morning session (9:00 – 12:00)

Course introduction and overview (Nickolas Forsch)

- *Preliminaries for software and overall course layout*
- *Expectations and assessment*

L1: Keynote (Daniel Beard, University of Michigan Department of Molecular and Integrative Physiology)

L2: Physical chemistry and electrochemistry (Maria Hernandez Mesa)

- *Mass action*
- *Gibbs energy*
- *Enzyme kinetics and cooperativity*
- *Reaction rates and equilibria – code-based exercise*

Afternoon session (13:00 – 17:00)

L3: Mass transport and membrane biophysics (Maria Hernandez Mesa)

- *Diffusion and Fick's law*
- *Planck's equation and Nernst equilibrium*
- *Membrane potential*
- *The passive cell membrane – code-based exercise*

SOCIAL EVENT

17:30 MONDAY, 15 June: SSCP26 Opening Dinner
Simula Canteen

Tuesday June 16

Morning session - *N.B. lectures moved to Nordmarka room on the 2nd floor*

L4: Ion channel gating (Nicolai Haug)

- *Two-state channels*
- *Channels with multiple subunits*
- *Rate constants as probabilities*
- *Waiting time and channel dynamics*
- *Modelling sodium channel gating properties – code-based exercise*
- *Stochastic and deterministic ion channel behavior – code-based exercise*

L5: Building modern ion channel models (Nicolai Haug)

- *Markov models of ion channel function*
- *Parameterizing ion channel models to experimental data – code-based exercise*
- *Major ion current formulations in the heart*

Afternoon session

L6: Combining ion transporter models to simulate the action potential (Nicolai Haug)

- *Tissue-specific cell models (model lineages)*
- *Building an AP model by combining channel models – code-based exercise*

L7: Electrical conduction in biology (Molly Maleckar)

- *Derivation of the cable equation*
- *Passive flow in neurons*
- *Active flow in excitable cells*

L8: Modelling electrical conduction in cardiac tissue (Molly Maleckar)

- *Simulating an excitable cable – code-based exercise*
- *Simulating reentry – code-based exercise*
- *Refractoriness and restitution*

Wednesday June 17

Morning session

L9: Quantitative aspects of calcium handling (Maria Hernandez Mesa)

- *Calcium in excitation-contraction coupling*
- *The sarco-endoplasmic reticulum calcium ATPase*
- *The sarcolemmal Na^{+}-Ca^{2+} exchanger*
- *Calcium flux balance – code-based exercise*

Afternoon session

L10: Fundamental cardiac mechanics (Andrew McCulloch)

- *Ventricular Function*
- *Cardiac Muscle*
- *Nonlinear Biomechanics*

Thursday June 18

Morning session

L10 continued: Fundamental cardiac mechanics (Andrew McCulloch)

- *Statistical Shape Atlases*
- *Network Modelling*

L11: Myofilament Dynamics (Joakim Sundnes)

- *Building a simple crossbridge model - code-based exercise*
- *Exploring more complex models of myofilament mechanics (Rice Model)*

Afternoon session

L12: The Finite Element Method (Joakim Sundnes)

- *Introduction to the finite element method — code-based exercise*
- *Introduction to FEniCS – code-based exercise*

Friday June 19

Morning session

L13: Mechanics Applications in FEniCS (Joakim Sundnes)

- *Continuum mechanics — code-based exercise*

Afternoon session

***L14:* Electrophysiology Applications in FEniCS (Hermenegild Arevalo)**

- *Cable equation in FEniCS*
- *2-dimensional dynamics (spiral waves) – code-based exercise*

Monday June 22

Morning session

***L15:* EMI 101 (Ada Ellingsrud)**

- *Mathematical foundations*
- *Building a system with two cells - code-based exercise*
- *Ephaptic coupling - code-based exercise*

Afternoon session

Project group work - initial meetings

Branched curriculum –
Tuesday through Wednesday (June 23-24)

Stream 1: Modeling cardiac tissue (Microcard collaboration)

- *The EMI Model and applications in cardiac tissue*
- *Electrophysiological modelling in cardiac tissue with OpenCARP*
- *Image-based mesh generation*

Stream 2: Machine Learning/ NeuroAI *(Nicolai Haug, Nickolas Forsch, Giulia Monopoli)*

- *Introduction to machine learning in physiological systems*
- *Exploring PyTorch through augmentations and loss functions (code based exercises)*
- *Real and artificial neurons*
- *Reverse mode automatic differentiation (code based exercises)*
- *Deep learning (code based exercises)*

Thursday through Friday (June 25-26)

Supervised project work in teams will take place in assigned workspaces. Please note that there may be some guest lectures during this period.
The school will finish at 2 pm on Friday 26 June.

Example Projects:
Project 1: Arrhythmia generation and maintenance in an ischemic pig heart
Project 2: Computational models of cardiac microtissues for drug side effects
Project 3: Modelling the role of glial cells in cortical spreading depression
Project 4: Describing brain dynamics with neural fields
Project 5: Mechanisms of tissue perfusion under strain
Project 6: Mechanisms of cardiac contraction and mechanics
Project 7: Machine learning tools to uncover ischemic markers in a population of image-based virtual hearts

SOCIAL EVENT
18:00 THURSDAY, 25 June: SSCP2026 Closing Dinner

San Diego, USA // 3-11 August, 2026

University of California San Diego: La Jolla, USA

General Schedule:

Unless otherwise noted, the schedule will generally run from **9:00 am to 5:00 pm**.
All lectures and workshops will take place in the Powell-Focht Bioengineering building.

Meals:

Breakfast, lunch and dinner are served at the following times (subject to change):

Breakfast 8:00 - 8:45 am
Lunch: 11:45 am - 12:30 pm
Dinner 6:15 - 7:00 pm

Map:

Interactive map available here: act.ucsd.edu/maps/

Required Materials:

Laptop computer and power outlet adaptors.

Assessment:

All students will be required to present their project work in journal club format on the 13th of August at UCSD. Following the presentation will be a Q&A session, in which professors, examiners and other students can ask about the project.

Students seeking credits at the PhD level will additionally be required to submit a final report (8-12 pages) detailing their project work. This report should take the form of brief scientific paper (Background, Methods, Results, Discussion and Conclusions), and is to be submitted no later than midnight (CET) September 1, 2025. You are welcome to collaborate on the reports and submit one per group.

Monday 3 August

Location: PFBH room 161 (ground floor of bioengineering building)

Time: 9:00 am – 9:30 am
Welcome to UCSD (Andrew McCulloch)
Expectations for part 2 (Nickolas Forsch)

Time: 9:30 am – 4:30 pm
Group project work with scientific advisors. *Boxed lunches will be provided.*

Optional evening social event, 5:00 pm

Walk from campus along the La Jolla coastline (~45 mins) and enjoy dinner and drinks provided by Simula.
If not joining the walk, plan to meet at Shore Rider at 5:30 pm (2168 Avenida De La Playa)

Tuesday 4 August

Location: PFBH room 161 (ground floor of bioengineering building)
Time: 9:00 am - 12:00 pm
Workshop: **"Effectively Communicating Your Research (1)" - Nature Masterclass**

Boxed lunches provided at PFBH Lobby, 12:00

Optional campus tour by Maria
~1:00pm, Meet outside PFBH

Wednesday 5 August

Location: PFBH room 161 (ground floor of bioengineering building)
Time: 9:00 am - 12:00 pm
Workshop: **"Effectively Communicating Your Research (2)" - Nature Masterclass**

Boxed lunches provided at PFBH Lobby, 12:00

Location: PFBH Fung Auditorium (ground floor of bioengineering building)
Time: 2:00 - 3:00 pm
Guest Lecture: Professor Leighton Izu, University of California Davis, Department of Pharmacology. "A Mathematician Meditates on a Chocolate Chip Cookie: Understanding the Mechanisms Underlying Contraction Autoregulation"

Thursday – Monday (6 -10 August)

In general these three days will be used for project work in assigned workspaces at UC San Diego from 9:00-16:00. There will also be guest lectures scheduled during this time to introduce you to current research endeavours at UCSD, taking place at PFBH Fung Auditorium:

- ***Friday 7 August, 1:00 pm*** - Professor Padmini Rangamani, University of California, San Diego, Departments of Pharmacology and Department of Mechanical and Aerospace Engineering
- ***Monday 10 August, 1:00 pm*** - Professor Ye Chen-Izu, University of California, Davis Department of Pharmacology. "The Heart Is a Smart Pump: autoregulation of cardiac excitation-Ca2+ signaling-contraction dynamic system"

Tuesday 11 August

Location: Fung Auditorium (ground floor of bioengineering building)
Time: 9:00 am - 12:30 pm
Final exam in the form of presentations with 12 minutes per project team plus questions

SOCIAL EVENT
13:00 TUESDAY, 11 August (after presentations are finished)
Farewell Celebration
Taco Beach Party at La Jolla Shores