# SCIENTIFIC CONCEPTS & METHODS

Yearly teaching course in Master in Pharmaceutical Sciences
Institute of Pharmaceutical Sciences, ETH Zurich, Campus Hönggerberg HCI E2

## Abstract

The module is an introductory course fostering critical thinking about scientific concepts and methods in the natural sciences, particularly in pharmaceutical and biomedical research. Central concepts and issues from philosophy of science regarding the role of, for instance, scientific discovery, experiments, models, images, and quantification will be illustrated and reflected upon. The principles, strengths and limitations of advanced scientific methods such as computational imaging, medical transcriptomics and precision medicine will be presented and discussed. These two focuses will be linked and put into discussion with each other. Students are encouraged to actively participate in the discussions. They will also engage in close reading and will learn how to analyse the scientific concepts and methods used in landmark papers within the research fields introduced during the course as well as in their own project work.  This course is part of ETH's Critical Thinking Initiative (CTETH).

| | Monday 19.2.18 | Tuesday 20.2.18 | Wednesday 21.2.18 | Thursday 22.2.18 | Friday 23.2.18 |
|---|---|---|---|---|---|
| **8.45h – 10.30h** (2x45min)<br><br>**Input Philosophy of Science** | **Elvan Kut** Introduction<br><br>**Norman Sieroka** Concepts I<br>- What is science?<br>- Scientific reasoning<br><br>*Reflections on 1. research project* | 08:00h – 09:30h **Sieroka** Concepts II<br>- The roles and types of experiments<br>- The role of images in science<br><br>*Reflections on 1. research project* | **Kut & Sieroka** Concepts III<br>-The role of geometry and arithmetics in natural sciences<br>- Quantising the human body<br><br>*Reflections on 1. research project* | **Sieroka** Concepts IV<br>- Shifts, changes, crises in science<br>- The values of basic vs. applied research<br><br><br>*Reflections on 1. research project* | 08:45h – 10:00h **Gerd Folkers (ETH)** Concepts V<br>- Shifting concepts and methods in pharmaceutical sciences<br>- Economization of Science |
| | | 09:45h – 11.15h **Markus Rudin (ETH-UZH)** Methods II<br>- How is a fMRI image produced?<br>- How do I interpret an image?<br>- Examples from research and clinic | | | 10:15-11:30h **Mattias Ivarsson (Inositec)** Methods V<br>- Bringing academic insights to market (Virtual biotech company) |
| **10.45h – 12.30h** (2x45min)<br><br>**Input Science** | **Michael Detmar (ETH)** Methods I<br>- Chances and limitations of animal studies in drug development<br>- Reproducibility and explanatory power of preclinical studies in mice | | **Gunnar Rätsch (ETH)** Methods III<br>- Explorative, hypothesis-driven and predictive approaches in medical genomics<br>- Machine Learning | **Gerhard Rogler (USZ)** Methods IV<br>- How do novel methods change concepts of diseases?<br>- The role of microbiota in health and novel approaches in gastroenterology | |
| | | 11:30h – 12.15h Buzz Groups Discussion with philosophy Speaker 1 & 2 | | | 11:45h – 12:30h Breakout Groups Discussion with philosophy Speaker 1 & 2 |
| Lunch | | | | | |
| **13.45h – 14.30h** (45min) | Buzz Groups Discussion with philosophy Speaker 1 & 2 | Working groups (Paperanalysis) | Buzz Groups Discussion with philosophy Speaker 1 & 2 | Buzz Groups Discussion with philosophy Speaker 1 & 2 | 13.45h – 14:45h Working groups (Paperanalysis) |
| **14.45h – 16.30h** (2x45min) | Workshop Close reading | | Working groups (Paperanalysis) | Working groups (Paperanalysis) | 15:00h – 17:00h **Kut, Otto, Sieroka** Presentations, ideas from the working groups, conclusions of the week |

**Objectives**

Students

- have the ability to explain and reflect upon core themes in philosophy of science and cutting edge methods that are relevant in modern pharmaceutical and biomedical research.
- are able to explain the role experiments, models, images, and quantifications play in the formation of a theory, and the constitution and illustration of a scientific fact.
- are able to actively engage in a critical discussion about scientific concepts, methods and approaches in the field of biomedical research and philosophy of science.
- are able to critically evaluate the basic scientific assumptions, concepts and approaches underlying their own research project.
- have learned how to "closely read" and analyse a scientific paper and are able to present their paper analysis to an audience that is not expert in the research field.

**Content**

- General concepts and issues in relation to scientific research – including heuristics of scientific reasoning, standards of reproducibility, and aims of explanation.
- Power and limitations of in vivo models in drug development.
- The role that different types of experiments, models and techniques play in the formation of a theory, testing of a hypothesis, and establishment and interpretation of scientific findings.
- Principles and procedures underlying the current methods in computational imaging (e.g. functional and molecular imaging) and their use in biomedical research and diagnostics.
- Quantification in the life sciences and the use of biomedical informatics for the analysis of vast amounts of data (e.g. computational analysis of large amounts of genetic or physiological patient data).
- Overview on social factors influencing the production of knowledge (e.g. paradigm shifts) and the debated difference between basic and applied research.
- Novel methods in RNA sequencing and new concepts in understanding gastroenterological diseases.
- Chances and risks of the economization of scientific research.
- Bringing academic findings to market and the value of applied research for society.

**Module coordinators/Main lecturers**

PD Dr. Dr. Norman Sieroka, Philosophy (D-GESS) and Turing CentreD-GESS and D-PHYS, ETH Zurich

Dr. Elvan Kut, Institute of Pharmaceutical Sciences, ETH Zurich

PD. Dr. Vivianne Otto, Institute of Pharmaceutical Sciences, ETH Zurich

**Guest lecturers**

Prof. Dr. Michael Detmar, Institute of Pharmaceutical Sciences, ETH Zurich

Prof. Dr. Markus Rudin, Institute of Biomedical Engineering, UZH and ETH Zurich

Prof. Dr. Gunnar Rätsch, Biomedical Informatics Lab, ETH Zurich

Prof. Dr. Gerd Folkers, Critical Thinking Initiative, ETH Zurich

Dr. Mattias Ivarsson, Inositec AG, Zurich