Learning Scenario 4. Non-animal approaches in biomedical research (one term of eight weeks) (course)

There have been substantial developments in non-animal methods, including organs-on-a-chip, organoids, high-throughput systems, induced pluripotent stem cells, and computational modelling that university students are introduced to in this eight-week course. Life science students interested in (bio)medical research are usually mostly taught to use animals to model the disease of interest. Not only for ethical but for scientific reasons it is important to familiarise students with the available human-relevant approaches so that they are adequately equipped to choose the most suitable methods for their research projects.

Subject	**Non-animal approaches in biomedical research**
Author/owner/ possible copyright issues	Dr. Kathrin Herrmann, Johns Hopkins University, Bloomberg School of Public Health https://www.jhsph.edu/faculty/directory/profile/3518/kathrin-herrmann
Topics	1) Introductory lecture: Why use non-animal models? 2) Organ-on-a-chip systems: integrated micro-physiological platforms recapitulating complex human biology. 3) 3D neural models in disease research. 4) Modelling survival in cancer using machine learning and molecular data. 5) Translational research in neurodegenerative disease. 6) Development of human-based computer model of the heart to predict drug safety and efficacy. 7) Modelling atrial fibrillation using human embryonic stem cell-derived atrial tissue. 8) Cardiovascular tissue engineering using 3D printing/ bioprinting technology. 9) Computational approaches in cancer systems biology. 10) In vitro models of blood vessels; application of in vitro blood-brain barrier models.
Eligible student level	University students planning to conduct or conducting biomedical research; undergrad and grad students in the life sciences.
Teaching time	One term (8 weeks).
Examples of online teaching material	A mix of online lectures, interviews with experts (about their career paths and field of work) and discussions on the course material in the online discussion forum. If students are local and want to earn an extra credit it is possible to do a practical supervised by one of the groups at Johns Hopkins University (JHU) who work with *in vitro* and *in silico* models.
Examples of offline teaching material	Practical part: 2 week-internship with one of the groups at JHU.
Helpful resources	
Licenses, certification or accreditation	Part of the R3 (rigor, responsibility and reproducibility) Graduate Science Initiative of good scientific practice at Johns Hopkins Bloomberg School of Public Health, and part of the Humane Sciences and Toxicology Certificate Program. Material is owned by Johns Hopkins but as long as this is indicated it can be used as part of other courses. The plan is to put this course on Coursera soon free of charge (only if students want a certificate, they need to pay a small

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	fee).
Integration in curriculum	The course is strongly recommended by the R3 (rigor, responsibility and reproducibility) Graduate Science Initiative of good scientific practice at Johns Hopkins Bloomberg School of Public Health.
Examination	Midterm exam: Literature search on non-animal methods for a specific research project: 30%. Course participation based on viewing all lecture content, completing quizzes, participating in the discussion forum: 30%. Final exam: Research proposal preparation: 40%.
Aims and learning objectives / outcomes	This course introduces students to several new, non-animal methods and models, including organs-on-a-chip, organoids, high-throughput systems, induced pluripotent stem cells, and computational modelling. It then discusses the potential of their use in (bio)medical research. The course compares the non-animal and animal models in certain areas of (bio)medical research. It addresses the need for human-relevant methods in medical research. The course also discusses how diverse high-tech research opportunities can be adapted to specific research needs. It prepares students who want to use these new approaches by knowledge sharing as well as informing them about available funding sources and research collaborations. Main learning objectives: • Explain several in vitro and in silico methods used in research. • Identify relevant in vitro and in silico methods for their research projects. • Apply innovative, human biology-based methods and models in certain areas of research. • Link scientific questions with the appropriate methods.
Activities/ programme	Combination of lectures, expert interviews, discussions and debates, lab tours and practical laboratory work.
Assignment	Reading the most relevant articles for each of the lectures (3 to 5 articles in preparation for each week's lectures; completing quizzes after each lecture; participating in the discussion forum to discuss the interviews with experts and the lectures.
Student and teacher feedback	Individual feedback from teachers to students via email/appointment and in discussion forum.
Helpful Resources	