Fifth European Advanced Seminar in the Philosophy of the Life Sciences

Interdisciplinarity in the Life Sciences and Their Philosophy

September 10th –14th, 2018

KLI, Klosterneuburg, Austria

Participating institutions

Egenis, the Centre for the Study of Life Sciences, University of Exeter
Institut d'Histoire et de Philosophie des Sciences et des Techniques,
University of Paris 1 Panthéon-Sorbonne
KLI, Klosterneuburg / Vienna
IUFE, Faculty of Science, University of Geneva
Department of Philosophy, Faculty of Humanities, University of Geneva
Department of Logic and Philosophy of Science, University of the Basque Country,
San Sebastian
Institute for Philosophy, Leibniz University Hannover
Immunology Unit ImmunoConcEpT, CNRS & University of Bordeaux

Directors

Sabina Leonelli (Exeter) & Thomas Reydon (Hannover)

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FACULTÉ DES LETTRES

DÉPARTEMENT DE PHILOSOPHIE

KLI

An Institute for the Advanced Study of Natural Complex Systems

Leibniz Universität Hannover

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Welcome

to the Fifth European Advanced School for the Philosophy of Life Sciences, which is organized by seven top-level European institutions in the philosophy and history of the life sciences. EASPLS aims at fostering research, advancement of students, and collaborations in the field of the philosophy of the biomedical sciences. Meetings are held every other year. After a preliminary meeting in Gorino Sullam (Italy) in 2008, EASPLS met at the Fondation Brocher in Hermance near Geneva in 2010 and 2012, and at the KLI in Klosterneuburg near Vienna in 2014 and 2016. The present meeting is again hosted by the KLI in Klosterneuburg.

This year's seminar topic is "Interdisciplinarity in the Life Sciences and Their Philosophy." The schedule mixes presentations of senior researchers, post-doctoral researchers, and PhD students from fourteen countries and three continents. The best junior papers resulting from the meeting will be published in a thematic issue of an international journal in the field. Submissions will be subject to normal peer review.

We are delighted that you are able to participate in this seminar, and we wish you a productive and enjoyable stay!

Sabina Leonelli (Director EASPLS 2018)
Thomas Reydon (Director EASPLS 2018)
Isabella Sarto-Jackson (Local Organizer EASPLS 2018)

What Is the EASPLS?

The European Advanced School for the Philosophy of the Life Sciences is a biennial event that aims at fostering research, facilitating collaborations, and training students in the field of the philosophy, history, and social studies of the life sciences, broadly conceived. EASPLS is organized by a consortium of the following European top level institutions in the area of philosophy, history and social studies of the life sciences:

- Egenis, the Centre for the Study of Life Sciences; University of Exeter, U.K.
- Institute of Philosophy & Centre for Ethics and Law in the Life Sciences (CELLS); Leibniz University Hannover, Germany
- Institute for the History and Philosophy of Science and Technology (IHPST); University of Paris 1 Panthéon-Sorbonne, France
- Konrad Lorenz Institute for Evolution and Cognition Research (KLI), Klosterneuburg, Austria
- Department of Philosophy, Faculty of Humanities; University of Geneva, Switzerland
- IAS Research Centre for Life, Mind and Society; University of the Basque Country, San Sebastian, Spain
- Conceptual and Theoretical Analysis of Immune Activation and Biological Boundaries Research Group (ImmunoConcEpT); University of Bordeaux, France

The EASPLS is characterized by its unique format: The schedule mixes presentations of senior researchers with presentations by PhD students and young post-doctoral researchers. The summer school includes various forms of participation. The selected participants will be asked to either (1) give a paper on the topic they have proposed with their application, (2) to present a commentary on a senior researcher’s presentation, or (3) to participate in a roundtable discussion moderated by a senior researcher. The organizers aim to publish the best contributions (full-length papers, commentary notes, and discussion notes) in a thematic issue or section in an international journal in the field.

EASPLS 2018 is held at the Konrad Lorenz Institute for Evolution and Cognition Research (KLI; www.kli.ac.at) in Klosterneuburg, a small town about 15 min by train from Vienna. The KLI is an international center for advanced studies in theoretical biology, with a focus on the development and evolution of biological and cultural complexity. The KLI supports theoretical research primarily in the areas of evolutionary developmental biology and evolutionary science. Emphasis is given to projects bridging the natural and social sciences and the humanities. The institute is located in the historical Kremsmünsterhof, a cultural heritage monument where workshops, symposia, and summer schools are hosted. It provides a stimulating and creative environment for fellows, visiting scholars, students, and external faculty.

The Topic of EASPLS 2018: Interdisciplinarity in the Life Sciences and Their Philosophy

EASPLS 2018 focuses on contributions on all aspects of interdisciplinarity in the life sciences, interdisciplinarity between the life sciences and other areas of research (such as engineering and the physical and social sciences), as well as interdisciplinarity in the philosophy of the life sciences (for instance, integrating philosophy with historical or social scientific methods). The aim of the summer school is to bring together graduate students and senior scholars whose work reflects on the nature of interdisciplinary work in the life sciences, on the prerequisites for getting interdisciplinary research projects off the ground, on the role that the philosophy of the life sciences can play in facilitating interdisciplinary scientific research and the “bridging” of disciplines, or on the position that work in the philosophy of the life sciences can occupy as a part of interdisciplinary research projects in the life sciences. The organizers aim to assemble a community of scholars addressing these issues from a wide variety of perspectives and whose research focuses on a diversity of topics. The following areas of work serve to illustrate the sorts of issues that are in focus for the summer school, but it should be emphasized that EASPLS 2018 aims to cover the topic of interdisciplinarity conceived broadly and not limited to the issues mentioned below.

Unity and diversity in the life sciences:

The life sciences constitute a very diverse set of fields of work, including fields such as evolutionary biology, phylogenetic systematics, population genetics, ecology, conservation biology, developmental biology, behavioral biology, crop science, synthetic biology, microbiology, biomedical research, epidemiology, and many more. What binds these fields of work together is their concern with phenomena in the living world. At the same time, they show an enormous diversity with respect to their theoretical underpinnings, their metaphysical commitments, their research aims and questions, and their methodologies, raising the question how (dis-)unified the life sciences in fact are. How large exactly are the theoretical and methodological differences between the various areas of life science? This is not merely a question of theoretical interest, but also one that touches scientific practice, as many research projects in the life sciences rely on contributions from multiple fields of work. What does it take to get interdisciplinary research projects in the life sciences to work? What sorts of obstacles do researchers from different areas of life science encounter when working in interdisciplinary contexts, and how can such obstacles be overcome?

Darwinism bridging disciplines:
Authors such as Daniel Dennett (Darwin's Dangerous Idea, 1995), or Gary Cziko (Without Miracles: Universal Selection Theory and the Second Darwinian Revolution, 1995) have long argued that evolutionary thinking constitutes a powerful scientific tool that can be applied both to biological phenomena and to phenomena outside the biological realm. At present there are several strong movements that attempt to establish evolutionary research programs outside the life sciences, such as economics and organizational science or the philosophy of science. Richard Dawkins, one of the most vocal proponents of Darwinian thinking, however, cautioned against an "uncritical dragging of some garbled version of natural selection into every available field of human discourse, whether it is appropriate or not. Maybe the "fittest" firms survive in the marketplace of commerce, or the fittest theories survive in the scientific marketplace, but we should at the very least be cautious before we get carried away" ('Why Darwin matters', The Guardian, Friday 8 February 2008). This cautioning raises the question what it takes to apply a theoretical framework such as Darwinian evolutionary theory to phenomena outside its original domain of application. What are the conceptual, epistemological and metaphysical requirements that need to be met to construct genuinely evolutionary explanations of phenomena in economics and other non-biological domains? How can evolutionary biology be integrated with areas of work outside biology to create new research programs?

History and philosophy of the life sciences as an interdisciplinary area of study:
Many philosophers working on the life sciences use interdisciplinary methods, drawing on historical or social science methods such as the collection and analysis of archival sources, interviewing, surveys, ethnography and participative observation. What methods best fit the philosophical study of the life sciences and its key subject matter, life itself? What are the philosophical and practical implications of adopting one method over another, and what are the challenges and opportunities involved in building bridges

between philosophy and other branches of scholarship focusing on the study of science (including history, sociology, science and technology studies, anthropology, geography, innovation studies and so forth)?

Philosophy of biology as theoretical biology:

What happens when philosophers become participants in biological research? How does philosophy fit in the workflow and conceptual apparatus deployed by biologists, particularly (but not only) in situations where several branches of biology are involved? And how is the position of biological and medical research within philosophy itself to be conceptualized (a question typically confronted by philosophers who collaborate in scientific projects, and wish their scientific colleagues to appreciate and understand philosophical contributions)? We are hoping for papers that examine the roles that philosophy of biology can play as a contributor to biological research, and the implications that such roles may have on the content of both scientific knowledge and philosophical scholarship; and/or the roles that biology plays within philosophy itself, as a subject matter, provider of empirical resources and evidence, source of conceptual inspiration and constraint on philosophical thinking.

The program at a glance

	Monday 10 Sept.	Tuesday 11 Sept.	Wednesday 12 Sept.	Thursday 13 Sept.	Friday 14 Sept.
Chairs		**Isabella Sarto-Jackson**	**Sidney Carls-Diamante**	**Massimiliano Simons**	**Sabina Leonelli**
9:35 – 10:35		*Student presentations (Methods)* **Chia-Hua Lin** **William Bausman**	*Senior lecture* **Kepa Ruiz-Mirazo** *Commentary* **Benjamin Smart** **Claudio Flores-Martinez**	*Student presentations (Evolution)* **Karim Baraghith** **Azita Chellappoo**	*Senior lecture* **Giovanni Boniolo** *Commentary* **Michal Hladky** **August Martin**
10:35 – 11:00		Break	Break	Break	Break
11:00 – 12:30	*Registration*	*Round Table: Conducting Interdisciplinary Research* **Caroline Angleraux** **Riana Betzler** **Sophie Veigl** (Moderation: **Sabina Leonelli**)	*Student presentations (Cases of interdisciplinary research)* **Dook Shepherd** **Caterina Schürch** **Steve Elliott**	*Round Table: Collaborating with Biologists* **Guglielmo Militello** **Lynn Chiu** **Nina Kranke** **Tomáš Mihulka** (Moderation: **Thomas Reydon**)	General Discussion *Publication plans and farewell* **Isabella Sarto-Jackson**
12:30 – 14:10	Lunch	Lunch	Lunch	Lunch	Lunch
Chairs	**Thomas Reydon**	**Stephen Sanders**	**Ivan Gonzalez Cabrera**	**Auguste Dementaviciene**	
14:10	*Welcome* *Opening address* **Gerd Müller** *Invited lecture* **Gry Oftedal**	*Senior lecture* **John Dupré** *Commentary* **Sophia Rousseau-Mermans** **Hailey Kwon**	*Senior lecture* **Marcel Weber** *Commentary* **Naïd Mubalegh** **Elena Rondeau**	*Senior lecture* **Philippe Huneman** *Commentary* **María Ferreira Ruiz** **Caleb Hazelwood**	
15.15	*Senior lecture* **Maël Lemoine** *Commentary* **Jonathan Najenson** **Stephen Sanders**	*Senior lecture* **Guido Caniglia** *Commentary* **Gregor Greslehner** **Cristina Villegas-Cerredo**	*Senior lecture* **Richard Gawne, James DiFrisco** *Commentary* **Dijana Magđinski** **August Martin**	*Senior lecture* **Thomas Pradeu** *Commentary* **Isobel Ronai** **Suki Finn**	

16:20 – 16:50	Break	Break	Break	Break	
16:50	*Student presentation* *(Applied philosophy of biology)* **Martin Wasmer**	*Student presentation* *(Cases of interdisciplinary research)* **Stefano Canali**	*Student presentation* *(Cases of interdisciplinary research)* **Javier Suarez**	*Student presentation* *(Exchanges between philosophy and biology)* **Özlem Yilmaz**	
Evening session		*Professional development panel: Publishing interdisciplinary research* **Sabina Leonelli (chair), Thomas Reydon, John Dupré, Thomas Pradeu**	*EASPLS Consortium Meeting*	*Dinner & get-together at the KLI*	

Detailed program

Monday, 10 September 2018

11:30 Registration

12:30 Lunch

14:15 Welcome & announcements

14:20 **Gerd B. Müller**

Welcome Address

14:30 **Gry Oftedal**

Opening Lecture

"Converging Philosophy and Life Science in the Framework of Responsible Research and Innovation (RRI)"

15:05 Discussion

15:15 **Maël Lemoine**

"A Populational View on Disease"

15:50 **Jonathan Najenson**

Commentary

16:00 **Stephen Sanders**

Commentary

16:10 Discussion

16:20 Coffee break

16:50 **Martin Wasmer**

"Interpreting European GMO Law – A Case for "Applied" Philosophy of Biology"

17:10 Discussion

Tuesday, 11 September 2018

09:30 Arrive at the lecture room, time for announcements

09:35 **Chia-Hua Lin**

"Migrating Research Tools: The Journey of Formal Language Theory from Mathematics through Computer Science and Linguistics to Cognitive Biology"

09:55 Discussion

10:05 **William Bausman**

“Why Do Biologists Use the Methodologies That They Do?”

10:25 Discussion

10:35 Coffee break

11:00 **Round Table Discussion**

“Conducting Interdisciplinary Research”

Caroline Angleraux

Riana Betzler

Sophie Veigl

Moderated by **Sabina Leonelli**

12:30 Lunch

14:10 **John Dupré**

“Pluralism, Process, and Interdisciplinarity”

14:45 **Sophia Rousseau-Mermans**

Commentary

14:55 **Hailey Kwon**

Commentary

15:05 Discussion

15:15 **Guido Caniglia**

“From Explaining Life to Saving It: Experiments and Evidence in Inter- and Trans-Disciplinary Sustainability Science”

15:50 **Gregor Greslehner**

Commentary

16:00 **Cristina Villegas Cerredo**

Commentary

16:10 Discussion

16:20 Coffee break

16:50 **Stefano Canali**

“Exposome Research in Epidemiology: Interdisciplinarity in Action”

17:10 Discussion

17:30 **Professional development panel**: Publishing interdisciplinary research

Wednesday, 12 September 2018

09:30 Arrive at the lecture room, time for announcements

09:35 **Kepa Ruiz-Mirazo**
“Philosophical Problems About the Origins of Life”

10:10 **Benjamin Smart**
Commentary

10:20 **Claudio Flores-Martinez**
Commentary

10:30 Discussion

10:40 Coffee break

11:00 **Dook Shepherd**
“Interdisciplinary Syzygy – Lessons from the Honeybee”

11:20 Discussion

11:30 **Caterina Schürch**
“Come Together! Interdisciplinary Research Practice, Mechanisms, and the Nature of Integration”

11:50 Discussion

12:00 **Steve Elliott**
“Research Projects in Interdisciplinary Science”

12:20 Discussion

12:30 Lunch

14:10 **Marcel Weber**
“From Reduction to Inter-level Scientific Practice: The Spemann-Mangold Organizer and Molecular Developmental Biology”

14:45 **Naïd Mubalegh**
Commentary

14:55 **Elena Rondeau**
Commentary

15:05 Discussion

15:15 **Richard Gawne & James DiFrisco**
(with Spenser Easterbrook & Stefanie Widder)
“Science Communication in the Modern University”

15:50 **Dijana Magđinski**

Commentary

16:00 **August Martin**

Commentary

16:10 Discussion

16:20 Coffee break

16:50 **Javier Suarez**

“Dysbiosis and the Humoral Conception of Disease: Integrating Biology, History and Philosophy into a New Research Domain”

17:10 Discussion

17:30 **Business meeting** (representatives of EASPLS partner institutions only)

Thursday, 13 September 2018

09:30 Arrive at the lecture room, time for announcements

09:35 **Karim Baraghith**

“The Causal Interactionist Population Concept in Generalized Darwinian Systems”

09:55 Discussion

10:05 **Azita Chellappoo**

“Adaptation without Reproduction: Lessons from Cultural Evolution”

10:25 Discussion

10:35 Coffee break

11:00 **Round Table Discussion**

“Collaborating with Biologists”

Guglielmo Militello

Lynn Chiu

Nina Kranke

Tomáš Mihulka

Moderated by **Thomas Reydon**

12:30 Lunch

14:10 **Philippe Huneman**

"Revisiting the Modern Synthesis: The Case of Ecology"

14:45 **María Ferreira Ruiz**

Commentary

16:55 **Caleb Hazelwood**

Commentary

15:05 Discussion

15:15 **Thomas Pradeu**

"A Plea for Philosophy *in* Science"

15:50 **Isobel Ronai**

Commentary

16:00 **Suki Finn**

Commentary

16:10 Discussion

16:20 Coffee break

16:50 **Özlem Yilmaz**

"Plant Stress Physiology: A Clear Manifestation of Process Philosophy"

17:10 Discussion

17:30 **Get-together** at the KLI (all participants)

Friday, 14 September 2018

09:30 Arrive at the lecture room, time for announcements

09:35 **Giovanni Boniolo**

"Integration and Complexity in Biomedicine"

10:10 **Michal Hladky**

Commentary

10:20 **August Martin**

Commentary

10:30 Discussion

10:40 Coffee break

11:00 **General discussion**

moderated by **Isabella Sarto-Jackson**

12:00 **Discussion of publication plans**

12:30 Farewell lunch

Abstracts

The Haeckelian Monism – When Biology Becomes Philosophy

Caroline Angleraux *(University of Paris 1 Sorbonne)*

In a speech dedicated to the anniversary of Leibniz's death, Emil du Bois-Reymond lists seven riddles of the universe which are impossible to solve, i.e., the nature of matter, the emergence of life and consciousness, the free will issue, etc. In the first chapter of his Welträtsel, Haeckel mentions this discourse and guarantees that each item of this list is solvable with his monistic conception; with reason only, we can reach a clear knowledge of Nature.

To do so, the Haeckelian monism considerers that a spirit-like form always joins matter and that substance is made of matter, energy and sensation. On this basis, the point is to mainly use biology in order to explain big issues such as the emergence of life, the difference between living and unliving entities, the psychic activity in living beings, death and immortality, God, etc. From his updated knowledge of biology, Haeckel links physics, chemistry in order to reach a global understanding of the world. Based on his contemporary biology, Haeckel develops a philosophy that becomes both a science of the universe and a religion.

In a writing such as the Profession de Foi d'un Naturaliste, Haeckel emphasizes for instance that consciousness comes from a mechanic work of the gangliar cells and that such a work is explained by the biochemical and the biophysical processes in plasma. With comparative anatomy and genetics, he adds that consciousness is not specific to humans and he specifies that the different types of consciousness are explainable with the theory of evolution. Haeckel turns a huge diversity of disciplines and topics into a single unique philosophy, Monism.

Thus considering that the monistic formulation results from the multiple knowledge Haeckel has about on philosophy and metaphysics (from the Pythagoreans up to Leibniz, Oken and Goethe), biology (Haeckel both assumes the cell theory and the Darwinian theory of evolution), chemistry, the point is to analyze how Haeckel links a multiplicity of disciplines in order to argue for a global reading of the world.

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The Causal Interactionist Population Concept in Generalized Darwinian Systems

Karim Baraghith *(Heinrich Heine University Düsseldorf)*

It was one of the major achievements of the *modern synthesis* to provide solutions for problems that occurred in the context of Darwin's theory of natural selection both on a theoretical and empirical level. My background assumption is the following: a proper theory of cultural evolution (CE) embedded in the framework of general Darwinism (c.f. e.g. Schurz 2011, Hodgson & Knudsen 2006) should be able to provide something similar concerning the *gap of micro- and macrolevel phenomena* in the social sciences (which are afflicted by a similar divide as the life sciences were before the modern synthesis). This point is interesting from a scientific theoretical perspective. In a nutshell*: A Darwinian theory of cultural evolution could possess the ability to synthesize the social sciences* (cf. Mesoudi 2011).

In order to achieve this, it should at least be possible to classify macrolevel patterns in CE. But the serious doubt is raised whether something like "species" (classes defined by their phylogenetic history and intrinsic reproductive barriers and not merely defined by similarity) in CE. However, since this is a crucial requirement for any evolutionary classification, a macrolevel cluster of a similar sort is necessary to realize the expectation that this paper aims to realize. I will suggest to apply the "Causal Interactionist Population Concept" (CIPC), recently formulated by Millstein (2009, 2015) in the philosophy of biology. According to some critical authors, CE is in need of a valid population concept anyway (Reydon & Scholz 2015). Since CIPC is a non-formal hypothesis, I will also present rudiments of a possible formalization of CIPC using graph-theory and defend the CIPC (for this particular context) against some recent criticism (cf. Stegenga 2016).

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Why Do Biologists Use the Methodologies That They Do?

William Bausmann *(University of Geneva)*

Biology and the social sciences are each home to many research programs investigating parts of the world in different ways. Why is there such diversity in research programs? Why don't all ecologists study the world in the same way? Research programs must link theorizing and experimentation to answer questions by producing evidence for scientific hypotheses. Biologists and philosophers have worked hard to understand how biologists weigh tradeoffs between different modeling strategies. But they have done much less to understand the tradeoffs that exist in the choice between laboratory, field, and natural experiments, and also between statistical methodologies such as Frequentism and Bayesianism.

In my view, the choice of modeling strategy is not independent of the choice of experimental design and so should not be analyzed independently. We do not see all combinations of modeling, experimental, and statistical evidence strategies in practice. Why not? If perhaps some combinations fit together better than others, what are these groupings and why do they fit together?

Because this is such a large and imposing question, to gain traction and to provide the material for a comparative study, I will build from a case in community ecology to similar cases. I will focus on the class of false models which excludes certain processes known to be relevant to the target domain. In ecology, the *neutralists* and the *competitionists* form two programs which both try to understand most of the same things, but which go about it in very different ways. Both start with false models, but with opposite assumptions: neutral models exclude interspecific competition and competition models exclude drift. And where the neutralists make only observation studies of systems like tropical rainforests which resist control, competitionists make almost exclusively lab and field studies with high levels of control. And similarly for the statistical methods. So, why do they use these combinations of methods?

This question could be answered from philosophical, historical, and sociological perspectives. And any perspective must consider many possible factors: disciplinary inertia, quality of data available, mathematical properties of their models, personalities of key scientists, etc. My working hypothesis is that the neutralist and competitionist "home" experimental systems play a very important role structuring the rest of their research programs. One connection within the neutralist program is that their observational studies make conclusions difficult to draw because they cannot contrast their observations with a control group as they would in an experiment. Their assumption of neutrality and exclusion of competition enables the neutral model to be used to describe what a community would be like if competition were not operating, and this operates as the control observational study, transforming it into a natural experiment.

Going forward, I will expand my analysis to similar cases of domains with a plurality of research programs such as evolution, paleobiology, and also economics and linguistics. By characterizing similar programs across domains, the comparative method can be used to understand how the tradeoffs between different strategies hang together and to characterize their conditions of usefulness.

Interdisciplinarity and the Search for “Ecological Validity”

Riana Betzler *(KLI, Klosterneuburg)*

In 1978, the cognitive psychologist Ulric Neisser argued: “If X is an interesting or socially significant aspect of memory, then psychologists have hardly ever studied X” (Neisser quoted in Hyman, http://www.psychologicalscience.org/index.php/publications/observer/2012/may-june-12/remembering-the-father-of-cognitive-psychology.html). Neisser’s worry here is about “ecological validity”—roughly, about whether and how the findings of experimental psychological research translate into real-world contexts. Worries about the ecological validity of research have since become commonplace in the cognitive sciences—in particular in experimental cognitive psychology and neuroscience. The issue of ecological validity is raised in psychology textbooks and introductory courses alongside other forms of validity, such as construct validity, internal validity, and external validity. The concept of ecological validity is also often used within the field to critique studies that use stimuli that are taken to be overly “artificial.” Ecological validity is the central feature of controversy between “laboratory/traditional” psychological research and “everyday/ecological/naturalistic” research in psychology. Although the concept of ecological validity is often tossed about in the psychological and neuroscientific literature, it lacks a precise meaning. On the standard view, calls for ecological validity are about the applicability of psychological findings outside the laboratory, or the generalizability of psychological research to real-world contexts. These kinds of calls for ecological validity can concern either efforts to understand a given phenomenon or efforts to intervene on that phenomenon. For example, in the case of memory, how do tightly controlled experiments using highly “artificial” stimuli—stimuli of a type that we rarely encounter in everyday life—translate into interventions within the classroom? How do such experiments help us to understand more complex phenomena such as childhood amnesia? These kinds of issues within the case of memory are precisely those that Neisser himself was concerned about and are commonly recognized as being “what ecological validity is about.”

In this paper, however, I will argue that concerns about reduction and decomposition, complexity and holism, and how to conduct productive interdisciplinary research—central issues in the philosophy of science—are often embedded in calls for ecological validity, although they are not usually recognized or expressed in those terms. I will demonstrate how recent literature on the neuroscience of empathy and social cognition illustrates this tendency nicely. I will then consider the consequences of couching these concerns in terms of ecological validity. Given that there is no standard way of evaluating ecological validity, while there are established measures of other forms of validity in psychology, what is the concept doing? Is it really a form of validity? Why does the concept of ecological validity have such traction in psychology when it rarely, if ever, appears in other fields with similar philosophical concerns—biology in particular? I will conclude by arguing that bringing psychological and neuroscientific research into greater contact with philosophy of science will greatly help to clarify the worries embedded in calls for ecological validity. In turn, this will help to specify where precisely any barriers to interdisciplinary research and integration of data from multiple sources in psychology and neuroscience might lie.

Integration and Complexity in Biomedicine

Giovanni Boniolo *(University of Ferrara)*

Complexity and integration are longstanding widely debated issues in philosophy of science and recent contributions have largely focused on biology. This talk specifically considers some methodological novelties in cancer research, motivated by various features of tumors as complex diseases, and shows how they encourage some rethinking of philosophical discourses on those topics. An in-depth analysis of the philosophical meaning of iCluster is taken to disclose a totally new way to conceive integration and, through it, to tame cancer complexity for the purpose of precision medicine.

Exposome Research in Epidemiology: Interdisciplinarity in Action

Stefano Canali *(Leibniz University Hannover)*

In this paper, I present current research in epidemiology as a case study for interdisciplinarity. My analysis focuses on the EU-funded project called EXPOsOMICS, which applies the ‘exposome approach’. The exposome is defined as the totality of exposures individuals face during their lifetime, including external and internal aspects. The notion can be considered a synthesis of the traditional focus on external element of exposure and the innovative use of molecular technologies for the study of internal aspects. Through this approach, EXPOsOMICS researchers look for associations between environmental pollutants and disease with the aim of identifying intermediate elements or features that are both retrospectively and prospectively associated.
I want to highlight two main spots where interdisciplinary approaches play a crucial role in EXPOsOMICS. The first is connected to the focus on the internal dimension of exposure, achieved through the use of omic analyses. The use of omics at a large scale requires a markedly interdisciplinary approach, for at least two reasons. Firstly, many omic techniques are still at an early and experimental stage, to the point that EXPOsOMICS is among the first projects using some of these techniques on a large scale. This entails that collaboration with other projects or areas of research is often necessary, EXPOsOMICS researchers have to collaborate to use a specific technique and possibly negotiate with different institutions. At the same time, independently of the specific omic technique or the research institution where these are available, the use omics is connected to interdisciplinarity because it is part of a wider movement in epidemiology and medicine more generally towards molecular approaches that in turn requires expertise that is closer to molecular biology than traditional epidemiology.
Interdisciplinarity is important also for the other end of the spectrum of exposome research, i.e. the collection of environment data. One of the teams in EXPOsOMICS works on Geographical Information Systems (GIS), which are information systems designed to study, analyse and present geographical data. What this team does in EXPOsOMICS is to generate a detailed picture of the kind of environment and chemicals the cohort under study was exposed to, by assigning estimates of pollutants to each participant in the studies. The work of the GIS team comes from a discipline,

geoinformatics, that is evidently quite different from epidemiology — which may sometimes generate misunderstanding and problematic communication — but is what allows for balance between environment and health data. Namely, geo-space modelling is currently considered the best solution to track pollutants such as particulate air matter and have detailed information about exposure to it, as no biomarkers of particular matter in the blood have been discovered so far.

Finally, in the paper I characterize EXPOsOMICS as an instance of the deeply interdisciplinary nature of current epidemiological research. This feature can be seen by the composition of the EXPOsOMICS project, which comprises researchers trained in biology, more traditional epidemiology, medicine, statistics, to the point that calling ‘epidemiologists’ the researchers in the project may lead to an inaccurate description.

From Explaining Life to Saving It: Experiments and Evidence in Inter- and Trans-Disciplinary Sustainability Science

Guido Caniglia *(Leuphana University of Lueneburg & KLI, Klosterneuburg)*

Sustainability science is an emerging research field which aims to contribute to the solution of pressing problems of our time, from loss of biodiversity and climate change to rapid urbanization and pandemics (e.g. Clark & Dickson, 2003). Sustainability problems have been defined as *wicked problems*, because they result from complex causal dynamics, are contentious, and defy simplistic solutions (e.g. Rittel & Webber, 1973). A major aspiration of sustainability science is to go beyond understanding the causes of unsustainability and generate evidence-based knowledge that can support actions and decisions to eventually solve wicked sustainability problems (e.g. Palmer, 2012). There is shared agreement that, if we want to generate this kind of evidence-based knowledge, inter and trans-disciplinary research is a necessity (e.g. Huutoniemi & Tapio, 2014; Perez et al. 2006). However, what does evidence-based mean here? What do we meant when we talk about evidence in inter and trans-disciplinary research for sustainability?

In my talk, I will address epistemological questions dealing with evidence in sustainability science by looking at so-called *real-world sustainability experiments* (e.g. Caniglia et al., 2017). These new kinds of experiments are structured interventions that (a) are driven by the *intention* to create evidence-based solution options to sustainability problems; (b) involve multiple *actors*, from social and natural scientists to practitioners and representatives of the civil society; (c) take place at the science-society interface in complex and uncertain real-world *contexts*. In the talk, I will present a theoretical framework for dealing with evidence-based knowledge in inter and transdisciplinary sustainability experiments. I will argue that *intentions*, *actors*, and *contexts* impacts on what constitutes evidence and how that evidence is generated and utilized. Using the theoretical framework, I will show how to capture the role that intentions, actors, and context play in evidence generation and utilization. I will illustrate my arguments drawing on examples of real-world sustainability experiments from *place-based socio-ecological research for sustainability* (Balvanera et al., 2017).

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Adaptation without Reproduction: Lessons from Cultural Evolution

Azita Chellappoo *(University of Cambridge)*

Reproduction is a universally shared property of biological organisms: whether sexual or asexual, involving reproductive machinery of other organisms or reproduction of whole groups, the ways in which organisms replicate, reproduce or perpetuate themselves are enduring features of the biological landscape. Although reproduction appears to occupy a central role in biological evolution, is it necessary for evolution by natural selection in general?

The important question here is not simply whether selection could operate on populations without reproduction in principle, but whether selection can act cumulatively in these populations, generating complex adaptations. Authors such as Okasha (2006) and Dawkins (1982) claim that, although reproduction may not be necessary for marginal or weak selection, it is necessary for the kinds of creative adaptation-building that characterizes much of the selection on biological organisms.

My central claim is that cumulative adaptive evolution is possible without reproduction. Although in the biological world reproduction is ubiquitous, the project of building a generalized, domain-neutral evolutionary theory necessitates abstracting away from the particulars of biological entities to get at the heart of the machinery of natural selection. This involves separating the functions of reproduction necessary for cumulative evolution from the aspects shaped by the contingent histories of biological life. I argue that considering evolution in cultural populations clarifies the manner in which selection explains adaptation.

The strongest arguments for the necessity of reproduction for cumulative adaptation come from its role in ensuring multiplication and production of novelty. I separate out two functions of multiplication: to prevent the extinction of the population through the winnowing action of selection, and to provide more opportunities for the production of novelty. Both these functions can be achieved without multiplication itself. Considering evolution in cultural groups illustrates the possibility of cumulative evolution in a population of groups whose number remains constant over time, but variants themselves spread and go extinct, and where production of novelty is divorced from multiplication. Factors such as the hierarchical structure of a group, or willingness of group members to adopt new norms, can be more important than multiplication in determining the likelihood of novel adaptive variants arising.

The production of novelty itself is needed, as well as preservation of the novel adaptive variants that arise. However, these features can be achieved in populations without reproduction. This can be seen when considering how novelty is produced in cultural groups, where group reproduction has little effect on how novel variants arise or are preserved. Humans are creative, adaptive agents: we continuously produce, reproduce, and modify our cultural environment. Unlike in biological organisms, novelty can be introduced at any point in the development of a cultural group, including novel variants which provide opportunities for reorganization or wholesale change.

Not only does cultural evolution inform how we think about adaptation-generating selection, but reciprocally, what is required for adaptive evolution carries important implications for Darwinian approaches to culture. Advocates of a Darwinian view of culture, such as Richerson and Boyd (2005) or Henrich (2015), need cultural entities (whether they be groups, individuals, artefacts, or ideas) to be the kinds of entities that can undergo cumulative adaptive evolution. The explanatory power of selection-based approaches to culture comes from the capacity for cultural selection to be of the 'interesting', adaptation-building, creative kind. Critics of these approaches take the lack of a plausible reproduction process in most cultural cases to be a worrying limitation. However, if we can get adaptation without reproduction, these concerns lose their force. Therefore, the conclusion that reproduction is not necessary for cumulative adaptive evolution is not only an important clarification of a generalized, domain-neutral evolutionary theory, but also crucially affects Darwinian approaches to culture, as well as debates within biological evolution, such as the viability of clade selection.

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Situated Philosophy at the Frontiers of Emerging Scientific Programs

Lynn Chiu *(University of Bordeaux / CNRS)*

How can philosophers of science be useful for scientists? In this paper, I argue that philosophers can find welcomed work at the cutting-edge frontiers of emerging scientific programs. Emerging scientific communities such as niche construction theory (NCT), the extended evolutionary synthesis (EES), hologenome theory, as well as psychoneuroimmunology, have a set of common challenges. New *conceptual frameworks* are confronted with harsh resistance from the status quo, with reactionaries constantly demanding "what's new?" New *interdisciplinary fields* are in want of internal and external justification of "what's unique?" to warrant the establishment of their own societies, institutes, and identities.

I argue that philosophers and historians can fruitfully help analyze "what's new" and "what's unique" for scientists creating new research programs. Built on my experience working with scientists in the aforementioned areas, I offer a non-exhaustive list (with examples) of the types of work particularly helpful for emerging scientific programs: (1) historical work that revisits the justifications for abandoning past frameworks and philosophical arguments for the revival of helpful frameworks that were neglected out of pragmatic limitations, (2) philosophical work that examines the entrenchment of paradigms due to feedbacks between methods and conceptual frameworks, (3) philosophical work on research questions, explanatory principles, and fundamental concepts unique to an area, and finally, (4) pluralistic analyses that place different research programs on a continuum of explanatory strategies.

I will explore the case for "crisis philosophers" that can identify emerging programs to enter, engage, participate, with the emerging area of psychoneuroimmunology in Europe and the Extended Evolutionary Synthesis program as examples. Crisis philosophers can conduct "philosophy without borders" with a toolkit that can help scientists work out "what's new" and "what's unique" about new frameworks or interdisciplinary integration. For instance, crisis philosophers should be recognized as generalists capable of recognizing an emerging area even though they are not trained as experts in those sciences. They have expertise in philosophy of science, especially issues associated with shifts between research program, and know how to ask for and understand core literature, methods, and most importantly, the pressures that demand answers to what’s new and unique. To achieve such expertise and knowledge, scholars trained in philosophy of science should have the opportunity to situate themselves in a scientific environment that will serve as their extended minds and resources. Labs, in turn, should make themselves available for such engagements and have the motivation to think through their concerns from a philosophical light.

Body Enhancement Technologies: Demigods and New Political Order

Auguste Dementavičiene *(Vilnius University)*

The new technologies of body enhancement are rapidly transforming cultural and political understanding of body, self, normality, sexuality, and interaction between each other. These technologies have become a dynamic site of interest across various disciplinary boundaries. Nowadays it is not enough to study one discipline; questions are floating from one to another. It is really hard to understand phenomenona without an interdisciplinary approach.

In this presentation I want to discuss the problems which occur by developing body enhancement technologies and using them in everyday life. The main question is whether these processes will change the humanity itself. Whether our understanding of the self, bodies, and society is changing, when we are starting to use these technologies, whether we want to change the understanding. If so, we have to understand that these changes will inevitably change the concept of what is political and what could or could not be done politically.

The state of demigod is traditionally understood as being in between man and God. As all states which are between something, demigod has a lot of different ways of being and becoming: from reaching this status (hard work, special strengths, remarkable skills and so on) to getting this status from parents (one is a God). Being in between is always very risky (G. Agamben) because both ideal types are not satisfied of the demigod which in different ways endangers their being. We can find a lot of Greek and other Antic myths where the biggest catastrophes were created to destroy all demigods (like Trojan War, floods, and others). Also we can find a lot of stories when people are afraid of somebody who has special skills and try to kill him / her, or proclaim him / her to be abnormal and exclude him / her from society.

On the other hand, being demigod could become a new norm. In 2017, E. Musk said: humans must become cyborgs if they want to stay economically relevant and do not want to become “home cats”. That is very interesting and also quite dangerous idea that could be very important in future. If using body enhancement technologies (all forms of it) becomes a norm, than a man, according to Musk, becomes even to an animal. And also a man becomes the type of being in between demigods and animals. We can find the third type of thinking in D. Haraway´s writings who suggests to see cyborg as the opportunity to change everything and to destroy thinking of dualisms, try to find completely new ways of thinking, and understanding humanity.

Life sciences and their influence to the changing political environment, in my opinion, are quite often missed or underrated in the philosophical analyses. I am using a metaphor of demigod, because it is very helpful to show new and less analyzed important aspects of the new state of being. Also the metaphor of the demigod lets me include quite different enhancement technologies, for example, not only way of cyborgization but also chemical, plastic, genetic, and even virtual understanding of creating, improving, and changing a human body and through it the political system.

Pluralism, Process, and Interdisciplinarity

John Dupré *(University of Exeter)*

This talk will explore the obstacles to, and benefits from, interdisciplinary research in the light of a pluralist epistemology and a processual ontology. The former has a fairly obvious role in promoting interdisciplinarity by insisting on the diversity of scientific conceptualisations potentially relevant to a subject matter. Processualism has a more indirect relevance. By insisting on the entanglement of the researcher and the subjects of research, a processual perspective not only makes sense of the familiar ways in which science constructs its research objects, but also stresses the plastic and developing nature of the researcher. This, finally, allows a vision of interdisciplinarity as an opportunistic openness of research process to the greatest number of possible resources. I illustrate these ideas with a very brief account of an interdisciplinary project I have recently been engaged with.

Research Projects in Interdisciplinary Science

Steve Elliott *(Arizona State University)*

An unanalyzed notion of "research project" lies at the intersection of everyday or actual practices of science and studies of those practices. Scientists ubiquitously describe their own work as that of conducting research projects, a practice that partly leads to, and then is partly reinforced by, a general cognitive structure for research funding in which agencies solicit and review proposed projects and fund the ones they prefer. This notion has become especially prevalent among those seeking tools to explicate the conduct of interdisciplinary science (Pohl et al. 2007). Furthermore, philosophers who study scientific practices often presuppose some notion of research projects, as in Sabina Leonelli and Rachel Ankeny's account of repertoires, in which repertoires of practices can develop out of and be shared across research projects (Ankeny and Leonelli 2016; Leonelli and Ankeny 2015). While philosophers have developed accounts for social and epistemic units of science that are large (paradigms, traditions) and medium-sized (programmes, repertoires) in social scale, they've developed fewer such accounts for smaller, more localized research settings that may prove fruitful for contextualizing and understanding many scientific practices. One such useful account is Nancy Nersessian's account of laboratories as distributed cognitive and cultural systems (Nersessian et al. 2003; Nersessian 2006). However, a single lab can pursue multiple research projects, and research projects can cut across multiple labs. A clear account of research projects would thus help us better understand repertoires, laboratories, their inter-relations, and interdisciplinary science. Here I sketch an account of research projects. I argue that they share a general epistemology or rationale that complements the general epistemologies of larger-scale socio-epistemic units. Research projects exists in space and time, they're conducted by individuals or teams, and they have many types of outputs, including articles, protocols, theories, models, and research systems or repertoires. Scientific products like models and theories relate not just to the evidence used to (dis)confirm them, as in larger socio-epistemic units, but they also relate to highly specified phenomena, problems, questions, and epistemic aims. Scientists evaluate research projects on how well they ameliorate the problems, address the questions, and satisfy the epistemic aims. I illustrate the account with Greg

Wray's evolutionary developmental biology lab at Duke University in the US, which partially decomposes into several distinct research projects. For a given project, focused on sea urchins, I show how the team identified a series of research questions pursued them over multiple years. I also indicate how Wray's team developed a research system and contributed to a repertoire, both of which enable further biological research. Further development of this account of research projects will aid empirical studies of scientific practice, interdisciplinary research, and systems of scientific funding and rewards.

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From Specificity to Information and Back

María Ferreira Ruiz *(University of Buenos Aires & University of Geneva)*

Informational language is ubiquitous in biology, but it has been questioned and challenged (Oyama 1985, Maynard Smith 2000, Griffiths 2001). Some have resisted it on the grounds that it leads to an overestimation or distorted view of the role of genes; while others believe that informational concepts play no clear theoretical/epistemic role in biology, and that these are merely metaphorical. Yet, others consider that there is a literal sense of information in biology that needs to and can be analyzed and explicated. Various accounts of biological information have been proposed thus far, with no agreement upon what is the best kind of approach to date.

A recent approach argues that most informational talk in biology is *nothing but* specificity talk (Griffiths et al. 2015, Stotz and Griffiths 2017, Griffiths 2017, Calcott et al. forthcoming, Pocheville et al. forthcoming). On this view, specificity is analyzed as fine-grained influence (Woodward 2010) and then shown to be measurable by means of the standard formalism of information theory. Against claims that, in biology, 'information' is meaningless, only a metaphor, or cannot be rigorously accounted for, proponents of the Specificity Account of Biological Information (SAI) set out to provide a robust, substantive concept of information, and argue that it generalizes to entities other than genes, thereby providing a theory of biological information.

I contend that SAI fails to provide a robust, substantive account of its nature and rather suggests arguments for the elimination of the concept of information in biology. First, even if much of the informational talk in biology refers to nothing but causal relations of high specificity, this does not tell us why it is correct to apply the concept of information apart from mere customary use. It might be objected against this that the basis for SAI's claim to solve the problem of biological information is its use of information theory; however, the theory plays no clarificatory or "substance-giving" role in the account. Rather, it is used in an instrumental manner, not different from its use in ecology for measuring species diversity in a given community (Begon et al. 2006). Second, if an account of informational talk in biology succeeds in explicating the notion of information by showing that it is *nothing but* specific causation, then this proves, in the absence of further argument, is that we can do without such informational talk. In examining what a substantive notion of information for biology would be, I conclude that more attention is needed to clarify the structure of the relevant philosophical problem and articulate the criteria of adequacy that must be met for any account of biological information to be satisfactory.

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The Metaphysics of Pregnancy

Suki Finn *(University of Southampton)*

Consider the following two philosophical questions about pregnancy: When does a new organism start to exist? (call this the Timing Question) and; What is the metaphysical relationship between the mother and foetus? (call this the Relationship Question). These questions have great relevance with regard to our personal identity and they impact significantly on bioethical issues regarding reproduction. Despite their importance, answers to these questions have been at worst under-explored in metaphysics, and at best conflated or presupposed elsewhere in philosophy. The aims of this paper are to clarify, distinguish, and connect these questions about pregnancy, to then outline rival models of pregnancy that result from the various combinations of answers to such questions.

In this paper I argue that the Timing and Relationship Questions are separate, and that any answer to each is compatible with any answer of the other. I take the two questions to be unrelated unless connected via a 'Maximality' condition (such as 'Proper parts of an F are not themselves Fs' which serves to make 'being a human' and 'being a proper part of a human' mutually exclusive), and must be kept separate to understand the rival models of the metaphysics of pregnancy. I articulate these models based on the different combinations of answers to the above questions in order to provide (some of) a map of the logical space of the metaphysics of pregnancy, and to show that an answer to the Timing Question will not dictate an answer to the Relationship Question (and vice versa).

The Timing Question is related to biological individuality and how we count organisms (as a type of biological individual). In order to say when an organism starts to exist, we need to be able to identify the biological individual that starts to exist. So when we look at a pregnancy, instead of asking (across time) when an organism comes into existence, we can ask (at a time) how many organisms there are in existence at that time. There are many accounts for how we individuate biological entities and thus for how we count them. What I want to point out is that whatever account of biological individuality we take, it will help us to answer the Timing Question but will be independent of the Relationship Question. So, say that at a time in the pregnancy our account of biological individuality counts just one individual. Is this enough to conclude that the foetus is a proper part of the mother? No – the foetus may not qualify as a biological individual yet, but may still be merely contained by the mother. Say that at another time in the pregnancy our account of biological individuality counts two individuals. Is this enough to conclude that the mother merely contains the foetus? No – the mother (a biological individual) may have the foetus (another biological individual) as a proper part. Unless we hold that no biological individual can be a proper part of another biological individual, I argue that the issues are unrelated.

“Bildersprache” – The Relationship between Lorenz’ Hypothetical Realism and Schopenhauer’s Transcendental Idealism from the Perspective of Predictive Processing

Claudio Flores Martinez *(University of Hamburg)*

Konrad Lorenz occupied the academic chair of Kant at the University of Königsberg during the 1940s. In a famous 1941 essay Lorenz criticized Kant’s “transcendental” or “critical” idealism dealing with the pre-conditions, the a priori, of how our representation (“Anschauung”) of the world is constructed and, by its very nature, differs from the unknowable, metaphysical thing-in-itself (“Ding an sich”) that is underlying its very existence. On the basis of a deepening understanding and appreciation that the human brain is needed for constructing an animal’s representation of the outside world, Lorenz argued that Kant’s categories of perception (“Anschauungsformen”) are to be understood as evolved organismal adaptations in the (neo-)Darwinian sense. As such, Lorenz posited, evolved nervous and sensory systems are capable of mediating more or less accurate representations of the outside world that are needed for a particular organism’s survival. He summarized his epistemic view on the natural world in his main work “Behind the mirror: A search for a Natural History of Human Knowledge” and termed it “hypothetical realism” (“hypothetischer Realismus”). To him it was a preposterous claim to suggest that the outside world is dependent on a perceiving subject (“Erkennendes Subjekt”), a notion that is one of the hallmarks of transcendental idealism. One of the often overlooked proponents of the transcendental idealist tradition is Arthur Schopenhauer, who, unbeknownst to most academics, is a natural philosopher of the highest rank, especially when it comes to the relationship between nervous system function and perception. He was a philosophical disciple of Kant and elaborated on his epistemological stance regarding a constitutive relationship between a perceiving subject and objective reality. Schopenhauer, however, did not view the perceiving subject as an evolved entity but rather as an “objectified” (“objektiviert”), or embodied, expression of an all pervasive metaphysical principle, the Will (“Wille”). Modern-day evolutionists would quickly dismiss Schopenhauer’s philosophy as a long overcome mystifying branch of natural philosophy (“Naturphilosophie”). In their view, of course, the perceiving subject (or any type of cognitive agent for that matter) is the product of an evolutionary process that spanned billions of years. Some researchers, however, are beginning to re-examine the predictive processing paradigm of cognition from a Neo-Kantian perspective. They claim that many features of this framework can be interpreted from a "transcendental" perspective, especially the focus on top-down generation of percepts, the role of so-called "hyperpriors", the constructional function of "generative models", the process of "analysis-by-synthesis" and, finally, the important role of imagination in perception. In a nutshell, our view of the organic world can be cast as a nervous-system mediated "generative model" that does not necessarily depict an accurate image of ultimate reality. Quite provokingly, if we agree with some interpretations of predictive processing, we are forced to view the evolutionary process rather in terms of a "language of images" ("Bildersprache") and not as objective truth. Schopenhauer used this term to describe processes in Earth's history that were not observable by any cognitive agent or perceiving subject and were retrofitted into the "world of representation" ("Welt als Vorstellung") once that animal life emerged as an embodiment of the metaphysical Will. Here we attempt a reconciliation of Lorenz' hypothetical realism and Schopenhauer's transcendental idealism by infusing recent insights from cognitive science pertaining to the predictive processing paradigm with a Neo-Kantian interpretation of these scientific findings.

Science Communication in the Modern University

Richard Gawne (*KLI, Klosterneuburg)**, Spenser Easterbrook** (New York Law School)**,***
Stefanie Widder *(Medical University of Vienna)****, & James DiFrisco*** *(KLI, Klosterneuburg)*

In this talk, we present the preliminary results of a large-scale bibliometric project that analyzes the flow of scientific information within the modern university. The goal of this project is to measure the extent to which scientific knowledge is communicated to non-scientific disciplines. Using analytic philosophy as our focal non-scientific discipline, we analyzed the type (neuroscience, psychology, biology, etc.) and frequency of scientific citations in seven philosophy journals during a recent six-year window. We also analyzed the age of the scientific papers cited, and constructed a series of social networks to determine whether researchers in the non-scientific discipline tend to cite the same scientific papers. Additionally, we investigated the possibility that philosophers are effectively punished for being interdisciplinary by their peers. Preliminary analysis of the data seems to suggest that this is the case – philosophers who cite numerous scientific papers have fewer pair-wise connections within the network than their peers who primarily or exclusively cite the work of philosophers. If this result is confirmed, it would demonstrate the existence of a professional barrier that might prevent scientific knowledge from being communicated within the modern university.
Dataset Parameters: The dataset contains over 31,000 references mined from approximately 2,200 philosophy papers published in 7 journals during a 6-year focal window. Using the journal titles (˜2000 unique entries) of each item cited as a proxy for its field of origin, the data have been classified as belonging to one of 28 different scientific and humanistic fields.

Molecular Biology: An Interdisciplinary Past and an Open Future

Gregor Greslehner *(University of Salzburg)*

The origins of molecular biology have received much attention from historians and philosophers of science. The multiplicity of stories being told indicates that there is no single origin of molecular biology, but various roots that converged to form a new discipline in the first half of the twentieth century. Various "founding documents" have been suggested: the so-called "three-man paper" or "green pamphlet" (Timoféeff-Ressovsky et al., 1935), Niels Bohr's Light and life (Bohr, 1933), and, perhaps most famously, Erwin Schrödinger's What is Life? (Schrödinger, 1944). Apart from such foundational myths, furnished with prestigious physicists, a sober view at the historical origins of molecular biology reveals the importance of its interdisciplinarity—a central asset of molecular biology up to this date. The term 'molecular biology' was introduced by the mathematician Warren Weaver from the Rockefeller Foundation in 1938, broadly conceived to cover a field "in which delicate modern techniques are being used to investigate even more minute details of certain life processes" (Weaver, 1970, p. 582).
One distinctive feature of molecular biology has been its interdisciplinarity. Ever since its beginning, the disciplinary identity of molecular biology has been called into question. Within a very narrow and limited scope, the status of molecular biology as a unified scientific discipline could indeed be seen as rather doubtful. However, as a look at the historical origins of molecular biology reveals, it was originally conceived as a broad approach to the processes of living systems (Olby, 1990).
By looking at the origins of molecular biology and its most recent trends today, I will argue that—although there are practical reasons for demarcating certain areas of research and education as disciplines—for the sake of advancing our knowledge of living systems it is rather an obstacle to have barriers between disciplines.
What is the situation of molecular biology today? Are we witnesses of a new revolution taking place with the emergence of systems biology, synthetic biology, and post-genomic big data? I want to argue that these recent developments within the life sciences fit into the broader conception and program of molecular biology as it was originally understood. Systems biology and synthetic biology are the natural extensions of molecular biology.

In the light of this interdisciplinary dynamics within biology, Hans-Jörg Rheinberger has suggested “that we turn away from the perspective of a more or less well-defined disciplinary matrix for twentieth-century biology” (Rheinberger, 1997, p. 34). This is all the more so true for the twenty-first century.

In a nutshell, molecular biology has had an interdisciplinary past and is facing an open future, in which new methods and techniques from other disciplines will be continued to be incorporated and applied. Thus, it is a prime example of interdisciplinary research, currently transforming with systems biology, synthetic biology, and big data biology as its most recent trends.

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The Species Category as a Scientific Kind

Caleb Hazelwood *(Georgia State University)*

Discussions about natural kinds have historically branched under two domains: a naturalist metaphysical account, and an account grounded in the activities of science. The latter domain branches once more, however, into the theoretical activities of science versus the practical activities of science (Kendig, 2016). In other words, one might pursue an account of natural kinds motivated by what scientists think or by what scientists do. As a consequence, it is unsurprising that philosophers of science will arrive at different conclusions about whether something is or isn't a natural kind. I resituate the debate about species eliminativism in contemporary practice-based accounts of natural kinds to illustrate this point.

Marc Ereshefsky's project of eliminative pluralism (1992, 1998) is simply stated in two theses: 1) In light of the myriad mechanisms of speciation legitimized by scientific practice, we ought to be pluralistic realists about species taxa, and 2) as there is no unifying feature among all species taxa, we ought to doubt the existence of the species category. I argue that one potential strategy for saving the species category is to conceive of it as a natural kind after the practice turn. I pursue this by situating the species category within Ereshefsky's and Thomas Reydon's account of "scientific kinds" (2014). Scientific kinds are legitimate natural kinds. They enforce ontological boundaries, not merely epistemic ones. Most importantly, they recognize boundaries drawn from the lab and the field, not only from the armchair.

According to an account of scientific kinds, the species category is perfectly real by virtue of the same principles that legitimize various species concepts: it is a category determined by the epistemic aims, methodologies, and classificatory practices of our best science. The species category does explanatory work in scientific practice, so a practice-based account of kinds has reason to recognize it. In a recent paper, Adrian Currie demonstrates this point with a case study of paleobiology (2016). Currie mounts a defense of the species category based on the discipline's agnosticism about species concepts in its taxonomy. When establishing new species, paleobiologists use a set of criteria that are entirely indifferent to the specifications that delimit one species concept from another. That is, their explanatory pursuits range across a spectrum of species concepts. No one species concept motivates taxonomic practices in paleobiology; instead, the species category itself does a significant amount of explanatory heavy lifting.

In using Currie's observations on the species category to situate it as a scientific kind, I aim to highlight a point of contention between theory-based and practice-based accounts of natural kinds. When the species eliminativist says the species category possesses no theoretical utility and, consequently, cannot be defended as a natural kind, they are neglecting its practical utility—i.e., how it motivates what scientists do. If the implications of contemporary practice-based accounts are taken seriously, and if observations such as Currie's are reflective of the species category's role in taxonomic endeavors, then its candidacy as a natural kind is not so easily undermined.

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Neuroscience, Neuromorphic Computing, and Their Philosophical Implications

Michal Hladky *(University of Geneva)*

The 21st century is marked by a convergence of nano-, bio-, info- and cognitive technologies. The research in neuroscience is closely linked to the various developments of information technologies, increasing computational power and innovation in architectures. In the EU flagship Human Brain Project (HBP), the interdisciplinary approach is built-in directly to the overall research strategy and the expected scientific and technological outputs. Modeling and simulation of the complex structures and processes of the brain ($86x10^9$ neurons with 1750 synapses on average) imposes considerable requirements to the established digital electronic computer architectures. On the other hand, the brain has a natural capacity to deal with large amounts of complex data in an efficient way and serves as an inspiration for neuromorphic computing based on novel algorithms and computer architectures that part from the traditional information processing.

The HBP explores three main approaches to neuromorphic computation – the deterministic supercomputers for realistic simulations (Blue Brain Project), the many-cores Spiking Neural Network Architecture (SpiNNaker) and the neuromorphic hardware combining physical model within wafers and digital inter-wafer communication layer (Facets/BrainScaleS).

The traditional computation can be characterized by components with defined discrete states that undergo changes according to definite transitions rules. Basic components, usually transistors are interconnected to perform basic logical operations. These discrete elements are aggregated into processing units and memory block containing the programs and inputs. They are interconnected by a bus and their operations are synchronized by a clock. Although the realistic simulations of the brain (Subproject 6) are conducted on a super-computer, the simulation of a sample of about 10^4 neurons takes around 100-1000 times longer than the biological process and increases linearly with the number of neurons. In contrast to this standard approach the SpiNNaker links million cores, each simulating thousand neurons that are communicating via digital packets. Furthermore, this architecture does not rely on synchronization of processes, neither on determinism to perform computations. SpiNNaker aims at simulating up to 10^9 simple neurons at speeds comparable to biological processes. The BrainScaleS system is based on 20 wafers, each containing 384 High Input Count Analog Neural Network chips (HICANNs) allowing for specification of properties of up to 512 neurons and their interconnections. Each wafer allows to simulate up to 196,608 neurons and 44 million synapses with speeds 1000 to 10'000 times faster than in biological substrates. Outside the HBP, various neuromorphic architectures are being developed. Strategies range from the modification of standard components like transistors to memristors allowing for signal integration before transmission, deposition of layer of biological neurons on electronic circuits to fabrication of self-assembled nanowires with in-built plasticity of their connections dependent on the amount of current passing through them.

Finally, the neuromorphic computing can also be understood as development of software tools that mimic biological processes. The standard examples are the neural networks or evolutionary algorithms that can be executed on standard digital computers. From this perspective, simulations performed in the HBP can also be interpreted as a special case of neuromorphic computing. Digital computers were also used to simulate the behaviour of the hardware of the SpiNNaker system in order to advance the development of software before the entire platform was built.

These examples clearly illustrate that progress of neuroscience, the neuromorphic computing and related software tools is strongly dependent on an interdisciplinary approach.

What are the implications for the philosophy of science?

First, it seems that a strong distinction between biological and technological functions can't be maintained without making reference to the underlying biological or artificial substrate that enables its physical instantiation. But even this characterization is undermined by systems combining biological neurons and electronic substrates.

Second, in philosophical literature, scientific models are often characterized as representational entities linking the source and target systems. This view precludes the use of more formal relation of isomorphism to characterize model relations. The argument is based on the incompatibility of the directionality of representation relation and the symmetry of isomorphisms. The examples from the HBP illustrate, that the success of scientific research is based on relation that allows for symmetry for two distinct reasons. In case of brain simulations, the brain is first used as a source for building of the simulation system and only then it is used as a target system. Therefore, the underlying mind-independent relation has to allow for symmetry. A similar point can be made about the construction of neuromorphic hardware and its use to understand brain processes.

The third philosophically interesting impact of the research in neuromorphic computing is on the notion of computation itself. As pointed out, the standard notion of computation is based on discrete states of discrete components at given times (synchronized by clocks) and definite transition rules (stored in memory). To mark the distinction, one can speak about the physical or natural computation in case of neuromorphic, analogue or quantum systems. But in case of physically generated networks of nano-wires with interconnections exhibiting plasticity, it is not clear what the computed functions are. It seems that neuromorphic computing may change the question from how do we compute a function to what function is computed? This broad understanding of computation might lead to the acceptance of the pan-computational thesis.

Revisiting the Modern Synthesis: The Case of Ecology

Philippe Huneman *(CNRS / University of Paris 1 Sorbonne)*

Ecology is in principle tied to evolution, since communities and ecosystems result from evolution, and ecological conditions determine fitness values and ultimately evolution by natural selection. Yet, the two disciplines of evolution and ecology were not unified along the 20th century. The Modern Synthesis intended to invest ecology, but in fact, the major ideas of the Synthesis, namely the privileged role of selection and the key role of gene frequencies in evolution, did not directly or immediately translate into ecological science. Yet, the architects of the Synthesis, starting with Huxley, constantly pushed for such integration. In this paper I'll consider four stages through which the MS got integrated into ecology, and distinguish between various ways in which a possible integration was gained. I start with Elton's animal ecology (1927), consider successively Ford's ecological genetics in the 1940s, the major textbook *Principles of animal ecology* edited by Allee and colleagues (1949), and then the debates over the role of competition in population regulation in the 1950s, ending up with McArthur and Wilson's *Principles of Island biogeography* (1967) viewed as a formal transposition of the MS explanatory schemes. I'll emphasize the key role of founders of the Synthesis at each stage of this history.

Evolutionary Medicine – Integration without Interdisciplinarity?

Nina Kranke *(Westfälische Wilhelms University Münster)*

Interdisciplinarity is often understood as the integration of two or more disciplines focused on a common problem which applies in particular to complex problems that consist of many interrelated questions. Explaining and controlling human diseases caused by parasites can be seen as an example for such a complex explanatory problem. While medical researchers and practitioners customarily seek to explain medical conditions by studying mechanisms which cause diseases, within the last two decades, evolutionary approaches to understanding diseases have become increasingly significant. Many evolutionary explanations of diseases are generated within the realm of Evolutionary Medicine, an emerging approach that uses evolutionary theory to explain health and disease and to understand medically relevant ongoing evolutionary processes. To be sure, Evolutionary Medicine is situated at the intersection of medicine and evolutionary biology, but it is characterized as a conceptual framework that provides novel approaches to studying and understanding diseases rather than an interdisciplinary field. Interestingly, most proponents of Evolutionary Medicine explicitly mention integration as a goal of this approach, but many of them do not see a necessity for interdisciplinary collaboration to achieve integration. It is true, that there are some interdisciplinary projects and institutions such as the Institute of Evolutionary Medicine (IEM) in Zurich and academic societies like the International Society for Evolution, Medicine & Public Health that aim at bringing together medical researchers, practitioners, and evolutionary biologists. However, most research projects with the label ‘Evolutionary Medicine’ are carried out either in the disciplinary realm of biology or in the realm of medicine. A closer look at the use of the term ‘integration’ reveals why this is the case. Advocates of Evolutionary Medicine seem to understand integration as a one-way-street, namely as integration of concepts from evolutionary biology into medical research, not as an integration of evolutionary biology and medicine. This import of concepts from biology often results in an impoverished view of adaptation and evolutionary processes that manifests as adaptationism, circular reasoning, or reference to unspecified evolutionary processes as mere add-ons to the explanantia of mechanistic explanations. Accordingly, evolutionary explanations in medicine are criticized by medical researchers and science scholars for being speculative, not trustworthy, and irrelevant for medical practice. There are various possible solutions to this problem. Medical researchers could avoid evolutionary explanations altogether, evolutionary biology could be taught at medical school, or medical researchers could collaborate with (evolutionary) biologists and researchers from other disciplines such as anthropology in interdisciplinary projects that aim at producing truly integrative knowledge. While some science scholars seem to favor the first option, some proponents of Evolutionary Medicine see the solution in including evolutionary biology in the medical curriculum. I believe, that at least some research fields in biology and medicine would benefit from establishing more interdisciplinary projects. This is particularly true for research that aims at understanding host-parasite coevolution and host-parasite interactions, because medical researchers are focused on the human host while biologists can provide knowledge about parasites and (co-)evolutionary processes in general. Successful interdisciplinary projects, however, require the desire to cooperate and understand differences between the disciplines. Currently, interdisciplinarity in Evolutionary Medicine is hampered by the medical researchers' fear of losing their independence due to the biologization of medical research and the inability to overcome the disciplinary differences on several levels, e.g. aims, practices, values, conceptualization of parasites and hosts, standards of explanatory adequacy.

CRISPR as a Case Study for Object-Centered Philosophy of Science

Hailey J. Kwon *(University of California, San Diego)*

CRISPR-Cas 9 (Clustered Regularly Interspaced Short Palindromic Repeats and CRISPR-associated protein 9) has become the focus of ethical discussion since the 2010s. But CRISPR was the focus of scientific research for a couple decades before then. How did CRISPR, a naturally occurring genome editing system in archaea and bacteria, transform into the CRISPRCas9 laboratory technology which became the focus of ethics? The philosophy of science can be helpful in addressing this question, but only by altering the focus of philosophy of science from theoretical knowledge to the objects of study. Then one can understand how an object as a natural phenomenon becomes a tool of interventions by humans, and thus a focus of ethical discussion. Such refocusing of philosophy of science has been advocated by Hans-Jörg Rheinberger, who has introduced the useful language of “epistemic things” and “technical things”. The essence of epistemic things is their potential for surprise, and thus our understanding of epistemic things is characteristically vague and transitory. By contrast, technical things are designed with a specific goal and their mechanisms are clearly known. Epistemic and technical things mutually depend on each other; as Rheinberger contends, the ongoing dialectic between epistemicity and technicity is the driving force of productive science. My goal is to explore the utility of this perspective by applying it to the history of the CRISPRCas9 system and to explore how this history can enrich a philosophy of science that prioritizes scientific objects above theories.

In his case study of the ‘chicken tumor I agent’, Rheinberger (1995) follows the history of a tumor-causing agent discovered by Peyton Rous at the Rockefeller Institute in 1910, demonstrating that the entity constantly escaped fixation. For 40 years, the chicken tumor agent underwent a series of unprecedented events: It once successively signified a virus, an enzyme-like endogenous component of the cell, a “transmissible mutagen”, a factor regulating normal cell growth but having escaped control, a microscopic cellular organelle, i.e., the mitochondrion, a submicroscopic “microsome,” and finally an extraneous structure probably able to duplicate within the cell. Similarly, CRISPR research took a series of unexpected turns. The repeat sequences now known as CRISPR were initially discovered in E. coli genome in 1987, but their function as a defense against bacteriophages was not elucidated until two decades later, 2007. After its biochemical characterization in 2012, the epistemic thing was successfully harnessed for genome editing in eukaryotic cells in 2013, officially gaining the status of a technical thing. In sum, I investigate how CRISPR underwent those transformations and show that it lends support for Rheinberger's framework, which offers an alternative way of looking at scientific progress that is distinct from the traditional view (e.g. Kuhn and Chang). The case of CRISPR further demonstrates that technical things are laden not only with epistemic challenges but also with ethical challenges. Just when scientists begin to realize that an epistemic thing could be turned into a technical thing, the scientific object takes on an enormous, unanticipated ethical valence. This, I claim, is an unanticipated "overflow" (or "excesses" in Rheinbergerian terminology) from epistemic things. Thus, I conclude that an object-centered approach ultimately enables interdisciplinary science studies work, e.g., by bridging science to its social implications.

A Populational View on Disease

Maël Lemoine *(CNRS / University of Bordeaux)*

What is disease? Instead of asking which properties do all individual disease entities have in common, an implicitly essentialist approach to disease, the present paper takes a populationist view of the pathological phenomenon. In populations, diseases are a cause of death. A foundational discipline to the study of disease is therefore biodemography, the study of lifespan in various species, but mostly the human population, in which diseases are the major cause of death and are best known. Biodemography struggles with two conceptual issues, namely, the distinction between 'intrinsic' and 'extrinsic' factors of death, and the distinction between diseases and ageing itself. The paper establishes reasons why 'intrinsic' should be defined not as controllable via interventions on the environment, but as 'age-dependent', and ageing should be defined not as the result of pathological phenomena in a broad sense, but as a physiological process on its own. These points clarified, biodemography provides a wealth of basic concepts that prove necessary in the explication of what diseases consist in as biological phenomena.

Migrating Research Tools: The Journey of Formal Language Theory from Mathematics through Computer Science and Linguistics to Cognitive Biology

Chia-Hua Lin *(KLI, Klosterneuburg)*

Research projects and programs involving researchers from multiple disciplines are a growing trend as part of scientific practice. An example of such a rising, interdisciplinary research program is computational cognitive biology (CCB), which emerges from the development of formal language theory in computer science and linguistics. The use of formal language theory in CCB, as both a theoretical and an experimental component, presents a rich source for philosophers of science to understand the expansion and limitation of a research tool's capacity in knowledge production. I thus present an analysis of the cross-disciplinary use of formal language theory in the context of cognitive biology, a phenomenon that I call 'tool migration'.

One advocate of CCB, Tecumseh Fitch (2014), proposes a conceptual change that urges cognitive scientists to embrace research approaches that take formal or mathematical models as primary and leave behind pre-scientific intuitions, metaphors, or analogies. Essential to Fitch's proposal is the use of formal language theory. Having roots in computational theory and Turing machine (Turing 1936), formal language theory is the study of mathematically defined languages. Combined with generative grammars (e.g., Chomsky 1956, 1965), a classification was established to classify languages based on the generative power of their grammars and the computing power of the automaton/machine that is required to parse the expressions. Both formal language theory and the classification, now known as Chomsky hierarchy, have been applied in various kinds of research, including recently the design of experiments for probing the cognitive infrastructures in human and nonhuman animals (e.g., Fitch and Hauser 2004; ten Cate and Okanoya 2012).

The migration of formal language theory makes a rich case to philosophers of science. On the one hand, one may ask: How has an invention in mathematics become the backbone of computing technologies, the groundwork of early linguistics, and now a promising bridge, as Fitch argues, that links comparative cognitive biology, neuroscience, and cognitive science? On the other hand, even though formal language theory is regarded as a well-established theoretical component in computer science, it is far from clear whether the reliability of the tool gets carried over when it takes part as an experimental component in cognitive biology.

My analysis of tool migration shows that research tools do not simply work magically in multiple disciplinary contexts. The concept of ‘tool migration’ captures both the ‘situated-ness’ of a research tool that was established in a native discipline and the effort it takes to ‘re-situate’ the tool in a foreign discipline (à la Morgan). Naturally, in the process of uprooting a research tool, significant contextual details may be stripped away, including implicit expertise or background assumptions. Similarly, during re-situation, new features may be introduced to the tool. Due to the possibility of losing or introducing significant contextual details, or both, a cross-disciplinary migration may undermine the effectiveness of the migrating tool, e.g., leading to a misinterpretation of the research result or failure to produce genuine knowledge.

To close up, I present my findings of the diverse applications of formal language theory. While Fitch argues against metaphors and analogies as research approaches, my findings suggest that both the machine metaphor and the mathematical analogy are indispensable aspects to the construction and development of formal language theory.

Publish or Perish! What's EVO Got to Do with It?

Dijana Magđinski *(University of Bielefeld)*

A number of scholars have pursued evolutionary considerations when it comes to the study of science and its issues. Some (e.g., Hull, 1988) have provided an evolutionary framework in the study of development of scientific theories. More recently, Smaldino and McElreath (2016) have demonstrated that scientific methods also evolve following Darwinian logic. This paper will focus on evolutionary explanations of scientific methods used in a rising "publish or perish" culture within scientific community.

A phrase "publish or perish" has recently gained a lot of popularity in academic circles, since it perfectly captures a common phenomenon in contemporary scientific environment. In a nutshell, in order to advance in one's career, one has to frequently publish own work. This pressure to publish can have a positive impact on one's motivation to produce novel findings, since such findings are more publishable. However, it can also lead to unhealthy competition among scientists and have detrimental effects on scientific objectivity and integrity, possibly resulting in shoddy science. Negative effects seem to be especially evident in the so-called replicability crisis, that is, the inability to replicate many of the published scientific studies, which indicates their serious flaws, especially when it comes to the research methods used.

After giving a brief introduction to the "publish or perish" phenomenon and to its consequences, I will consider requirements that need to be met in order to apply the cultural evolutionary framework to the study of it. Namely, I will consider scientific methods as units that evolve in the "publish or perish" environment and investigate whether the approach of applying the cultural evolutionary framework fulfills three Darwinian conditions: variation, selection, retention. Finally, I will look into the practical value of such an approach. While applying the cultural evolutionary framework can improve our understanding of matter at issue, it can also offer possible solutions and directions in which to go if we want to overcome current problems in scientific practice.

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Toward a Methodological Pluralism of Biological Individuals: A Lasting Basis for Interdisciplinarity and Integration in the Biological Sciences

August W.M. Martin *(Leiden University)*

Hull (1992), Pradeu (2010), and Clarke (2017) argue that our concepts of biological individuals must be grounded in a scientific theory, but they disagree on the role of specific theories. Hull and Clarke maintain that evolutionary theory enjoys a priority that entails the explanatory centrality, if not exclusivity, of the evolutionary individual. Pradeu maintains that other theories in biology can and should have a role in grounding concepts of biological individuals. Immunological theory grounds a concept of physiological individual, for instance. I argue that the historical relationship of cell theory (Nyhart and Lidgard 2011) and biological individuality already suggests that multiple theories have an integral role in the problem. In addition, I propose that we reevaluate the nature of theoretical grounding in our concepts of biological individuals. Recently (2017), O'Malley and Clarke have proposed opposing views on the priority of evolution, but they both implicitly agree that a resolution to biological individuality is beholden to biological ontology. That is, concepts of biological individuals are units of individuation that single out objects to which some theory is ontologically committed. I propose that concepts of biological individuals can also be theoretically grounded in virtue of a theory's epistemic impingement on the objects singled out by concepts. For instance, the concept of a genetic individual picks out a wide range of objects under the criterion of genetic uniformity. I suggest that although no theory is ontologically committed to the objects singled out by this concept, evolutionary theory, immunological theory, and other theories impinge, epistemically, on these objects. This makes the concept of a genetic individual an epistemic unit of individuation that singles out explanatorily and theoretically relevant conceptual individuals. By contrast, evolutionary theory is ontologically committed to the evolutionary individual, which serves as both an ontological and epistemic unit of individuation that singles out ontological individuals. This distinction between epistemic impingement and ontological commitment, and the concomitant distinction between ontological and conceptual individuals, affords us a wider range of resources than a proposed account of biological individuality limited to the latter is able to provide. I propose that we accept both forms of theoretical grounding as integral to a future consensus on an account of biological individuality. The pluralism that results from these distinctions is methodological rather than metaphysical, although it is capable of accommodating metaphysical pluralism in particular subproblems of the problem of biological individuality: The SAI debate, the organism problem, the debate over individuality in viruses. This methodological pluralism has enormous integrative potential, all the more so because it emphasizes, while being grounded in, epistemic and ontological concerns: Ontological individuation as the objective reality of an object's individuality in nature, and epistemic individuation as the cognitive or experimental act of fixing on or isolating an object in thought or research, whether ontological or conceptual. This methodological pluralism underpins a compromise between Hull and Clarke's view of evolutionary theory's priority on the one hand and Pradeu's view that multiple theories are relevant on the other hand. It is also better equipped to capture all of the diverse research interests and needs of distinct areas of biological research and subfields (Kovaka 2016).

Selfish Neuron

Thomáš Mihulka *(Charles University, Prague)*

Selection on the level of the brain, neurons, and further have been proposed by Gerald Edelman who articulated the theory called Neural Darwinism (Edelman 1987). It also came to be also known as "neuronal group selection". Which should, according to him, work on same basis and undergo the same processes as the somatic immunity selection. Also Daniel C. Dennett expressed endorsement (Dennett 2013) of the neuronal selection theory. On the other hand, there are some critics of this approach. And some of them also try to provide their own view of neuronal selection. E.g., the process of replication in the brain was examined by Eors Szathmary and Chrisantha Fernando (Fernando et al. 2012), and called it Evolutionary Neurodynamics.

This presentation wants to examine the topic of somatic selection on the level of the brain, show some main limitations of this theory, and most importantly try to summarize experimental data which we have in support of this theory. For example, I will refer to an interesting paper about somatic genetic mutations, which are more likely to occur in brain cells (Lodato et al. 2015). This process can play a key role in the selection of the brain by the given environment.

At the end, I want to show some possible consequences, which this approach may have for artificial neural networks and the future of evolution outside of biological realm.

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Functional Integration in the Endosymbiotic Origin of Mitochondria

Guglielmo Militello *(University of the Basque Country, Donostia-San Sebastián)*

Functional integration is broadly defined in life sciences as the causal interdependence among the subsystems forming an organism. Since the concept of 'functional integration' is based on a common sense (physiological) view of organisms, it appears vague and unable to provide a stringent criterion for biological individuality (Pradeu 2010). Although functional integration plays an important role in most of functional explanations, neither systemic (Cummins 1975; Craver 2001; Davies 2001), nor etiological (Wright 1973; Millikan 1984, 1989; Neander 1991), nor dispositional (Bigelow and Pargetter 1987) approaches to biological functions have taken it into account. The organizational perspective, by contrast, interprets functional integration as the mutual dependence of the constitutive constraints that collectively maintain the whole biological organization by allowing it to exhibit biological individuality (Moreno and Mossio 2015).
It is highly debated whether functional integration is an important requirement for defining the biological individuality of symbiotic organisms (e.g., holobionts), because the mutual dependence among the functions of different organisms in many cases does not lead to an 'integrated' individual (Skillings 2016; Queller and Strassman 2016). This talk aims at investigating how the endosymbiotic relationship between the proto-mitochondrion and a proto-eukaryotic cell has led to a more integrated biological organization and a new biological individual (i.e., the eukaryotic cell) by means of a functional redefinition of both the endosymbiont and the host. Two theoretical questions will be addressed: first, how did the endosymbiont and the host achieve a functionally integrated organization? second, what were its evolutionary consequences?
The functional redefinition of the bioenergetic systems of the proto-mitochondrion and protoeukaryote will be examined by analyzing three phenomena: first, the selective loss of biochemical pathways both in the endosymbiont and in the host (Gabaldón and Huynen 2007; Martin et al. 2015); second, the appearance of the translocase of inner membrane (TIM) and outer membrane (TOM) of the mitochondrion (Cavalier-Smith 2006, 2007; Dolezal et al. 2006); finally, the control of the redox poise of the electron transport chain (Allen 1993; Allen and Raven 1996; Lane 2005, 2007, 2015).

These three phenomena suggest that the functional redefinition of bioenergetic systems contributed to not only the metabolic co-dependency between the host and the endosymbiont, but also a dramatic transformation of both organisms that led to a new biological individual (i.e., the eukaryotic cell). Thus, the functional redefinition of the systems involved in energy production was a key factor for the functional integration between a proto-mitochondrion and a proto-eukaryotic cell.

It will be argued that, in the case of eukaryogenesis, the concept of ‘functional integration’ is intimately connected with those of ‘biological novelty’ and ‘biological individuality’, insofar as the emergence of a more integrated symbiotic organization has led, by means of functional redefinition of the host and the endosymbiont, to new biological functions and a new biological structure exhibiting a specific kind of individuality. This talk also aims at underlining how a philosophical analysis of data and theories of evolutionary biology may help to clarify a very important concept of biology, namely biological individuality.

Assessing (Neo-)Darwinism: Do Biologists “Minimize Influences That Are External” to Biology and Historians of Ideas “Go to the Other Extreme”?

Naïd Mubalegh *(University of Lisbon & University of Paris 1 Sorbonne)*

Claims that (Neo-)Darwinism is not as politically neutral as it ought to be appeared as soon as *The Origin of Species* got published. In Russia, anarchist Piotr Kropotkin (1902) and fellow men of science meant to have identified, in the scientific theory exposed by Charles Darwin, the influence of the political economy that was prevailing in the UK by that time, and with which they disagreed. Darwin himself (1887) explicitly acknowledged the inspiration he had received from his reading of Thomas Malthus.

Historian of ideas Daniel P. Todes identified two elements in the early Russian criticism of Darwinism: one “anti-Malthusian” element, that had to do with an aversion for what was identified as a British acknowledgement of competition as a major component of interhuman relationship, and whose antithesis was the model of the peasant commune, which allowed “everyone without exception to take his place at the table”. Todes also identified a “non-Malthusian” element, or “the failure of Malthusian perceptions to resonate with Russian experience with nature” (1987).

One century later, Ernst Mayr observed that “Biologists, on the whole, tend to minimize external influences [from outside biology], while non-biologists, historians of ideas, and social historians tend to go to the other extreme [invoking arguments from outside biology]”. According to him “all the serious Darwin students who have thoroughly analyzed the sources of Darwin's theory [...] agree that Malthus's influence on Darwin was very limited […] and highly specific”, indeed purely mathematical: “What Darwin and Wallace had taken from Malthus was the ‘populational arithmetic’, but not his political economy. The Marxist claims ‘that Darwin and Wallace were extending the laissez-faire capitalist ethos from society to all nature to make a Weltanschauung out of the new captains' of industry's utopia of progress through unfettered struggle’ is not supported by any evidence whatsoever” (1982). Yet, a couple of years later, paleontologist and theorist of biology Stephen J. Gould underlined the topicality of Kropotkin’s criticism for Biology in an article entitled “Kropotkin was no Crackpot” (1988). And, in the meanwhile, borrowings from economics, from the neoclassical tradition in particular, have been nourishing the development of a unified theory for evolutionary biology. The neoclassical tradition in Economics, usually acknowledged as “mainstream,” is now subject to criticism from economists and social scientists who present arguments for the benefits of pluralism in economics.

We want to question the relevance for today of the distinction drawn by Ernst Mayr between the way biologists relate to “external influences” (external to “pure biology,” if such a thing exists), and the way historians of ideas and social historians invoke elements that seemingly stem from outside. Indeed, some scholars who are well-read in Evolutionary Biology (for instance: Julio Muñoz Rubio (2003), Sylvia Wynter (2015)) do claim nowadays that the Malthusian, non-neutral heritage and posterior inputs from economics (a) are present in the current theorization of biology and (b) raise nontrivial issues from the point of view of social sciences. We would like to present some of their arguments – part of which are historical - and examine their relevance from the point of view of Biology and Philosophy of Biology.

Memory Offload - An Integrative Hypothesis for the Sciences of Memory

Jonathan Najenson *(The Hebrew University of Jerusalem)*

Memory plays a critical role all over the living world. The ability to recall a nest location or how previous social interactions have turned out are decisive for survival. Memory is a wide-ranging phenomenon which can be described as any instance where information from the past can alter present behavior. Such characterization may capture the multiple ways in which information is preserved, but appears overly broad, as it applies to phenomena such as homeostatic activity and even fatigue and intoxication. The myriad ways in which experience changes behavior do not seem to fit in a unified theoretical framework. This disunity has led to claims that a general theory is untenable as memory is not a natural kind. It has been argued that the 'received view', according to which any state or process that results from the sequential stages of encoding, storage, and retrieval is inadequate for explaining the difference between memory and other behavioral states and should be rejected along with many states described as memory (Klein 2015).

In this paper I aim to show that by focusing on the places where the 'received view' breaks down, we can gain a better understanding of what memory is. By looking at where one of these stages operates to a limited extent or even, sometimes, delegated to external objects, one can start delineating the phenomena that concerns memory. I propose to call this aspect of memory - 'offload', thus designating the various ways in which organisms opt for other external or internal means for remembering instead of internally retaining information. Focusing on the way that systems offload we can see that memory may operate in different ways in different systems. Organisms use the environment and external objects to store and recall information, their cognitive systems are built to retain specific types of information and discard others, when context provides reliable cues they rely on external information rather than preserving it, and so on.

Two examples, one from evolutionary biology and the other from neurophysiology, are presented to motivate this claim. A major strain in current evolutionary thinking concerns how organisms manipulate their learning environments thus changing their selection pressures. By looking at hominid tool-making development, I show how environmental modifications facilitate the acquisition of information by structuring learning to enhance skill automation. A second case concerns efference copies, the predicted sensation of motor acts. In many organisms there are no systems specialized for memory that are separated from perceptual and motor systems. Recently, it has been suggested that this neural reenactment is a way in which memory can be stored and retrieved (Godfrey-Smith 2016). I will argue that efference copies are a way in which organisms use physical action to alter information processing requirements so as to allow flexibility and reliability in storing and retrieving memory. On the view offered here, memory is essentially surrogative. Organisms have no designated parts for encoding, storing or retrieving information, but use external and internal means to remember.

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Converging Philosophy and Life Science in the Framework of Responsible Research and Innovation (RRI)

Gry Oftedal *(University of Oslo)*

“Responsible Research and Innovation” (RRI) is increasingly adopted as a framework for life science research at EU, national, and university levels. Simultaneously, interdisciplinarity and convergence in life sciences are promoted and rewarded through various funding schemes bringing forward new research group constellations. I will describe and discuss my experience as a philosopher of science taking part in such interdisciplinary research groups in the life sciences, gathered partially as the result of particular funding schemes with interdisciplinarity and RRI as key elements. I will discuss the interactions of externally imposed research frameworks and researcher-initiated activities and how philosophers of science may fit into interdisciplinary research groups working within an RRI framework. I will address the role of the philosopher from two main viewpoints: (1) research group dynamics: how to take part in an interdisciplinary research group as a philosopher of science, and (2) contribution to research: what kind of research contributions and researcher roles can and should philosophers have in life science research projects? My presentation will be based on my participation in the Norwegian national research project NANOCAN (Biodegradable Nanoparticles in Cancer Diagnosis and Therapy) and the Oslo Life Science convergence project “Programmable Cell-Like Compartments”.

A Plea for Philosophy *in* Science

Thomas Pradeu *(CNRS / University of Bordeaux)*

Most of philosophy of science constitutes a discourse on science; it takes science as its object of study, but does not aim at making a contribution to science itself. In contrast, a minority of philosophers have been part of a trend that I suggest to call “philosophy *in* science” (PinS) – a form of philosophy that has tight connections with science and whose objective is to advance science. Here I attempt to characterize what philosophy in science is and how it differs from seemingly close approaches (such as complementary science and philosophy of science in practice), and I make a plea for more “philosophy in science”.

How the Techniques of Molecular Biology Are Developed from Natural Systems

Isobel Ronai *(University of Sydney)*

Molecular biology is principally concerned with explaining the complex molecular phenomena underlying living processes by identifying the mechanisms that produce such processes. In order to access the causal structure of molecular mechanisms it is necessary to manipulate the components of the mechanism and to observe the resulting effects with sophisticated molecular techniques. These techniques generate knowledge that cannot be obtained by any other means. Therefore, scientific knowledge in molecular biology advances in a distinctive way compared to other areas of biology: progress is driven by the introduction and use of novel techniques. However, what drives the development of molecular biology techniques?

A striking characteristic of the highly successful techniques in molecular biology, which biologists themselves often highlight, is that they are derived from natural occurring systems. These techniques are not developed through 'rational design' nor do they merely mimic nature. In this paper, I examine eight contemporary techniques that are derived from natural systems and are the most scientifically successful. These eight techniques have been patented, produced landmark scientific articles, and been the subject of a Nobel prize. The scientific community sees these techniques as significant advances. In chronological order these techniques are: restriction enzymes; DNA sequencing, polymerase chain reaction (PCR); gene targeting; fluorescent proteins (such as, green fluorescent protein); RNAi; induced pluripotent stem cells (iPS); and clustered regularly interspaced short palindromic repeats-CRISPR associated 9 (CRISPR-Cas9). Throughout this paper I use RNAi as my detailed case study and this technique utilises a mechanism that evolved in eukaryotes to destroy foreign nucleic acid.

I propose that natural molecular mechanisms are exploited by biologists for their effectors' (protein or nucleic acid) activity and biological specificity (protein or nucleic acid can cause precise reactions). I also show that the developmental trajectory of novel techniques in molecular biology, such as RNAi, is four characteristic phases. The first phase is discovery of a biological phenomenon. The second is identification of the mechanism's trigger(s), the effector and biological specificity. The third is the application of the technique. The final phase is the maturation and refinement of the molecular biology technique. I conclude the paper by discussing the implications of deriving techniques from nature for molecular biology. The development of new molecular biology techniques from nature is crucial for both biological and biomedical research.

Understanding Cancer Progression and Its Control: The (Im)balance between Tissue Construction, Destruction, and Reconstruction?

Elena Rondeau *(University of Bordeaux)*

Cancer research as a multi-dimensional endeavor**:**

The current challenge of exhaustively describing cancer is associated with diverse types of biological explanations, research fields, medical specialties and study levels.
Ongoing progress is in fact contributing to an improved understanding of the spatial and temporal complexity of tumor progression, thus supplementing our thorough appreciation of the genetic and cell-intrinsic properties of transformation. This has led to a now well-established recognition of the crucial (yet variable) role played by the stromal, matrix and immune components of the “tumor microenvironment”, at different stages of the disease.
Although still awaiting full characterization, this conceptual progress has significantly benefited the attempts to better define cancer progression, such as those based on the mechanistic similarities found with certain physiological processes known to occur in a healthy organism, namely tissue repair and organogenesis. Indeed, tumor-associated inflammation and stroma remodeling have been assimilated to “unresolved healing”, while other (or partially overlapping) arguments linked to spatial organization and cell plasticity may illustrate a partial reactivation of developmental pathways, pointing towards the vision of tumors as “abnormal organs”.

Investigating the conceptual articulation between scientific descriptions of cancer**:**

The explanatory strength of such descriptions is nevertheless limited by the undeniably dysregulated dynamics of malignancy, as the organized sequence orchestrating both repair and development is dangerously altered in cancer, where tissue architecture and functionality can be severely perturbed.
The main conceptual challenge of our project is to analyze the scientific use of these analogies, in an attempt to evaluate their relevance, complementarity, and articulation. Despite the observed diversity of cancer types, to what extent (and how) can tumor progression be accurately characterized in terms of tissue construction, destruction, and reconstruction? How might this type of conceptual framework contribute to our

understanding of cancer as an increasingly plastic and resistant entity that progressively loses its connection to the initial organ?

An interdisciplinary approach to analyze tumor progression:

Our project combines extensive bibliographical work and conceptual discussions, coupled to an experimental approach focused on the comprehension of metastasis causality in a mouse model of breast cancer known to specifically disseminate to the lungs.

Indeed the issue of characterizing long-distance communication, central to the functionality of tissue (re)construction systems, also arises when studying inter-organ signaling and cell migration in cancer. Notably, investigating the immune system's dual role in oncogenesis fits this perspective, as the heterogeneity of cell types and activities directly contributes to the complexity of tumor progression.

Our experimental aim is to analyze the implication of a subset of pro-tumoral myeloid cells in disease evolution, as they are known to inhibit immune-mediated resolution and are hypothesized to colonize pre-metastatic sites before the arrival of malignant cells from the primary tumor. The phenotypical, functional, and migratory characteristics of these cells are examined through the course of cancer progression and in differential environments, in order to dissect their local characteristics and their contribution to invasion and metastatic tropism.

As a whole, this interdisciplinary proposal stems from a promising dialogue between experimental oncoimmunology and conceptual analyses of cancer description, in an attempt to better understand the mechanisms underlying tumor progression and its control.

Keystone Species, Predation, and “Pristine” Ecological Communities

Sophia Rousseau-Merman *(University of Paris 1 Sorbonne)*

Keystone species have been first defined by the ecologist Robert Paine as native top-predatory species whose preferential predation on a dominant prey is necessary for a historical (or “pristine”) ecological community, to which the keystone species historically belong, to maintain overtime. However, from Paine’s definition to current days, the keystone species concept has been used to refer to different kind of species (e.g. prey, mutualist or folk biological species) with different effects on community structure and/or ecosystem functioning. This fuzziness has thus led ecologists and conservationists, for quite various and different reasons, to question its relevancy for ecology and conservation.

In this presentation, I want to question the theoretical roles and (non) epistemic values that can be associated to the keystone species concept through the analysis of three fundamental aspects of Paine’s historical approach. I will argue that those historical role and values must guide ecologists and conservationists in their current uses and amendments of the keystone species concept. The first aspect concern the application of Paine’s keystone species concept to top-predatory species whose predation indirectly impact other species interactions, notably competition relationships, but also can substitute to abiotic ecological factors with regards to their larger effect on community structure. How much predation is fundamental to the definition of keystone species will be thus the first question I will attempt to reply in this presentation. The second and third aspects relate to the evolutionary and human-free dimensions of Paine’s keystone species concept. Keystone species were taken by Paine to be native species which belong to undisturbed communities, as free of human influence, where they were sharing relationships with prey species over evolutionary times. I will question the theoretical and practical relevancy of this relationship for ecology and conservation, notably in a context of climate change and increasing ecological destruction along with species extinction.

Philosophical Problems about the Origins of Life

Kepa Ruiz-Mirazo *(University of the Basque Country, Donostia-San Sebastián)*

Current scientific research sees the origin of life as a set of processes that, together, would explain how, starting from a world dominated by purely physical-chemical principles, it has been possible that life begun. Namely, how a specific set of molecules organized themselves in such a way that they developed a phased process, in which this initial organization has been able to bring forth new and increasingly complex forms of organization, till governing its own variability and deploying an undefined complexity and sustainability. This shared view, however, is full of scientific debates and puzzles, many of them attracting philosophers´ attention. Yet, philosophers should ask too, which are the most fundamental issues beyond these debates, namely which are the questions that lie behind the different research programs that drive and unify the field. In this talk, I will present a tentative list of four fundamental questions: the question of the specificity of the relation between matter and form; the emergence of functions; the emergence of individuality and agency; and the significance of unlimited evolvability.

Rethinking Cultural Evolution

Stephen Timothy Sanders *(Michigan Technological University)*

In recent decades there has been much discussion of cultural evolution: of whether cultural units undergo a process akin to biological natural selection (Lewens, 2013). If we are to discern whether cultural evolution is a misnomer of bona fide evolutionary process, it is essential that we have a detailed, rigorous account of cultural units. In my paper I will provide such an account.

First, I will briefly outline notable accounts of cultural units – namely, Memetics, (Blackmore, 1998; Dawkins, 1982), Ingold's (2001) account of cultural transmission qua *enskillment*, Lyman and O'Brien's account of cultural transmission qua *recipes*, and Dan Sperber's epidemiological account of culture / epidemiology of representations (1985, 1990, 1996, 2001; Sperber & Hirschfield, 1999). In doing so, I will outline their respective strengths and weaknesses, and argue that Sperber's theory offers the best conceptual tools. However, I will further argue that Sperber's account is unduly anthropocentric, and currently too coarse-grained to guide empirical inquiry apropos cultural evolution. I will then present my attempts to improve upon Sperber's theory, which – I believe – will not only contribute to discussion of cultural evolution but also to discussions of cultural niches in particular (Laland & O'Brien, 2012) and ecological niches more generally (Pocheville, 2015; Schoener, 1986). Specifically,

1. Sperber's account of public products as the intended and unintended effects of intentional human actions is unto itself insufficient to map the entirety of extra-mental human culture; i.e., culture "outside the head." Note that per Sperber's arguments public representation – public cultural units – is de facto a subtype of public product.
2. Following 1., I will propose that we conceptualize public products as the intended or unintended effects of intentional action sui generis, just in case we are not the only species capable of intentional action (Allen, 1998; Dennett, 1996). Precisely, a public product is any physical object or any alteration to an object's physical properties for which the intentional action of one or more organism is a contributing (causal) condition. Many such actions might be unnecessary and

unto themselves insufficient. That is, public products may be the effects of multiple causation / synergy (Corning, 2005). Hence “contributing” conditions.

3. Following 1, I will propose public byproduct as a means of conceptualizing the effects of the *unintended* behaviors of organisms sui genris. Precisely, a public byproduct is any physical object or any alteration to an object’s physical properties for which the unintended bodily state or bodily event of one or more organism is a contributing (causal) condition.
4. Cultural units should be conceptualized as such and demarcated into kinds per their *functions*. Admittedly, this presupposes an account of functions per se (Frassen, Lokhorst, & Poel, 2013).
5. As Sperber argues, cultural units can be private/mental or public. Like Sperber, I advocate a cognitivist account of human culture. However, I hold that culture as a concept must be broad enough to encompass all public products required for the transmission of representations between minds. Sperber’s account of human culture is too simple, insofar that it limits culture to (mental and public) representational units and thereby pays insufficient attention to the *means* whereby those units are transmitted.
6. Following 5, we can and should differentiate between semiotic products (e.g., a message) and the vehicles of such (e.g., the soundwaves that “carry” a message). Vehicles can be intentionally produced or unintentionally produced, insofar that semiotic products and semiotic byproducts both require vehicles. Public representations are here taken to be a subtype of semiotic product. They are semiotic products that are widely distributed throughout a population.
7. Following 7, vehicles can be varyingly complex. Compare the soundwaves of an utterance to the infrastructure and utilities required to send an email.
8. We can identify complex – oftentimes hierarchically organized – representational units per their respective functions. For instance,

    The Quran can be understood as a cultural unit unto itself. It also contains personages/creatures, symbolisms, and purported events which can be, and oftentimes are, demarcated from the text and serve as lone cultural units. It further consists of sentences/passages which can be, and oftentimes are, demarcated from the text and serve as lone cultural units.

("Lone" here refers to transmissibility and is used in a non-technical sense. Obviously, personages/creatures, symbolisms, purported events, and passages from *the Quran* are conceptualized as such, i.e., understood – at least in part – in terms of their belonging to *the Quran*.) Finally, *the Quran* consists of Arabic words, which are organized in accordance with Arabic grammar, and which further consist of Arabic letters: all of which can and do function as cultural units unto themselves.

9. Following 8. and 9., any discussion of cultural evolution will have to specify the scale of analysis, e.g., whether one is speaking of a small-scale unit (such as an Arabic letter) or a larger unit (such as *the Quran*). It is, I think, likely that such discussions will bear similarity to those concerning the units and levels of biological selection (Lloyd, 2007).

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Come Together! Interdisciplinary Research Practice, Mechanisms, and the Nature of Integration

Caterina Schürch *(Ludwig-Maximilians-University Munich)*

This paper focuses on interdisciplinary research practice. It understands interdisciplinarity as the integration of research problems and methods from different disciplines; achieved either through interfield experts or through the direct collaboration of researchers from different disciplines. My theses about the nature and promise of integration are based on the analysis of three historical research projects in which problems and methods from the biological sciences were integrated with problems and methods from the physical sciences. A prominent recent philosophical account of integration in the life sciences was suggested by the new mechanists: interfield integration is promoted by mechanism research because various methods are required to establish a mechanism's evidential constraints. Thus, putting forward an acceptable mechanism model requires the combination of expertise from different disciplines. This argument nicely connects explanatory goals with abstract research strategies and institutional realities. So far, however, its promise has not been fully explored. The debate suffers from a lack of insight into the theoretical, material, and social preconditions of actual mechanism research and theory integration: We do not know how researchers assessed whether problems, methods, and concepts from different disciplines can actually be combined. Moreover, it is not clear why researchers from the physical sciences were interested in contributing to the elucidation of biological mechanisms.

I will discuss historical research projects concerned with the mechanisms of vision, hormone action, and the biogenesis and heredity of anthocyanins. All projects emerged in the 1920s and 1930s – a time when publication platforms, chairs, and laboratories were established for researchers who "aim at explaining life from the physico-chemical constitution of living matter". The calls for the import of physical and chemical methods and concepts into biology were generally accompanied by calls for interdisciplinary cooperation. To achieve their goals, it was argued, biologists and researchers from the physical sciences must join forces.

The historical analysis of these cases of interdisciplinary research will help to answer the following two questions: (1) What motivated these researchers to cross disciplinary boundaries? In other words: why did they decide to work on biochemical or biophysical research problems after all? (2) How was integration achieved? What theoretical and social, institutional, and material conditions did these research projects depend on? Analysing historical actors' planning and coordinating of their joint research allows to identify the interfield theories and methodological norms that suggested interdisciplinary research. I take scientists' research actions to be geared towards solving their epistemic problems. And I assume that to explain these actions, we need to know scientists' goals, capacities (i.e. skills, resources), and the norms they associated with acceptable solutions. I will argue that researchers consider collaboration with practitioners with the relevant capacities whenever they are not equipped to solve their problems adequately. Interdisciplinary cooperation is particularly appealing if the parties involved mutually depend on each other in order to attain acceptable solutions: Interdisciplinary is the most appropriate choice when the parties involved "sink or swim together."

Besides, the argument from goal-interdependence applies to my own methodological choice too: I believe that to adequately account for interdisciplinary research practice in the life sciences, we need to combine historical and philosophical methods. The better one attends the local material, social, and institutional conditions of (past) research practice, the better one can identify the more global methodological norms. And the more we know about these norms, the better we understand the actions scientists performed to solve their problems – which, in the life sciences, often involves the integration of several disciplinary practices.

Interdisciplinary Syzygy – Lessons from the Honeybee

Dook Shepherd *(University of Adelaide)*

This research is situated within the broader multidisciplinary project, 'Organisms & Us', which explores the relationships and understandings between human and model organisms. My primary research concerns the utilization of foundational (yet intellectually vexed) concepts in cognitive scientific praxis and explanation. I focus in particular on 'representation', 'information', 'computation' and 'communication' in honeybees as a model case study. Honeybee research has a rich history across dozens of independent scientific disciplines. Some of their targets such as intelligent behavior and communication have been studied across disciplines as varied as ethology, cognitive science, neuroscience, genetics, evolutionary biology, philosophy, even apiary. Each discipline brings different suppositions and ontologies, is directed towards different levels of abstraction, and this generates a vast array of different scientific models and interpretations. But understanding the nature of communication and intelligent behaviour is more fruitful when these disparate disciplines are connected. We therefore see growing interdisciplinary collaboration in actual bee research, with bees themselves even collaborating with us as actors in some cases. Most importantly, interdisciplinary collaboration allows for researchers' interpretative processes to be co-informed by a wider body of knowledge beyond the limits of their own disciplines. Understanding the nature of bee communication, navigational behavior, and seeing the bee as a model for developing theories about the evolution of consciousness, are all examples of interdisciplinary collaboration in past and current research programs.

In this paper, I will first provide an overview of the breadth and depth of the history of interdisplinarity in bee research. Then I will discuss how the honeybee as a shared material object of study across disciplines means it acts as a common stable structure from which we can calibrate / precisify our conceptual repertoire itself. Grounding concepts employed in the cognitive sciences (e.g. 'representation') is important, given their current vexed status, with researchers' acceptance and use of them ranging from trying to naturalize them, or agnostically working 'along side' them, to analyzing them away all together and searching for new conceptual alternatives. From concrete instances like honeybee communication, we might find a stable ground from which to extend our concepts' application to other putative cases. Such kinds of active interdisciplinary collaboration can align in a kind of syzygy, where we may learn something novel, not just about the original material object or organism, but about our disciplines and methods, their concepts and classes of phenomena. The combined epistemic resources from ethology, cognitive/neuroscience, philosophy of representation, and even aesthetics, together yield novel insights into the nature and applicability of 'representation' in cognitive explanation, as well as insights into bee communication itself -its status as a 'symbolic language' and arguably the determination of public and private representational content for the bees, which I will discuss with reference to both literature and my primary ethnographic fieldwork.

What Is the ‘Engineering’ in Bio-Engineering?

Massimiliano Simons *(KU Leuven)*

One of the recent developments within the life sciences, exemplified by a field such as synthetic biology, is the blurring between the line of science and engineering. More and more state of the art scientific research is found in fields focused on the construction, manipulation, and design of novel artefacts, often also referred to as ‘bio-engineering’. This has led some to argue that one should understand this shift as science becoming (or always was) ‘technoscience’. By this re-identification, however, it enters the field of another big philosophical topic, namely modern technology. Several recent scholars have therefore attempted to mobilize resources from the philosophy and history of technology to understand the contemporary life sciences.

This presentation aims to do two things. First of all, it aims to criticize a too simplistic notion of technoscience and its problematic link with philosophy of technology. Synthetic biology is not biology being taken over by a focus on technology. Any account to understand contemporary technosciences such as synthetic biology has to take into account the intermediary figure of the engineer. Secondly, it aims to map the specific identity of contemporary techosciences such as synthetic biology by mobilizing the still dormant philosophy and history of engineering. Rather than seeing technology or engineering as a fixed juggernaut invading science and society, the specific nature and history of engineering will be highlighted.

Four exploratory attempts to characterize the nature of synthetic biology as a technoscience will be made: (a) engineering must be seen as a different type of rationality being transported to fields such as biology; (b) engineering has experienced a historical ‘academic drift’, allowing it to be smuggled into traditional sciences such as biology; (c) contemporary life sciences are faced with new types of tools, such as computer simulations, requiring engineers to handle them; or (d) we are located in a new societal regime of knowledge production, focused on societal benefits and transdisciplinarity, resulting in a shift in biology towards interdisciplinarity, a context in which engineering can thrive.

Understanding Individuality: The Problem of Intrinsic Teleology and Degrees of Organisation

Benjamin C. Smart *(University of Exeter)*

Recent debates on the problem of individuality have insisted that individuality should be conceived as a predicate admitting degrees, i.e., "something is more or less individual" (Pepper & Herron, 2008; Godfrey-Smith, 2009; Pradeu, 2016a). This extends to the biological objects individuated by physiologists, the 'organism', which is generally conceived to be an object with integrative functions. Yet the concept of functional integration is a vague criterion to sufficiently ground the organism (Pradeu, 2012; Godfrey-Smith, 2013); additional methodological and epistemological grounds seem to be required to supplement and preserve the understanding of the organism as a unity of functional integrity.

The recent resurgence of scholarship on Kant's philosophy of biology (e.g. Huneman, 2007, 2014; Zammito, 2007; Breitenbach, 2014) may prove a fruitful opportunity for the development of these debates, offering interdisciplinary insights at the intersection of two bodies of literature: Kant scholarship and philosophy of biology. Kant's concept of the organism was pivotal in the history of biology ([1790] 2000 §65; Pradeu, 2012, 2016b). Though critical, his writings on teleology provided a distinct method for developments in physiology and morphology (Russell, [1916] 1982). A teleology explains changes in nature with reference to ends or purposes, but one should distinguish between intrinsic teleology (part/whole relations) and extrinsic teleology (means/end relations).

Nonetheless, there seems to be an incongruence here, as it is difficult to reconcile an intrinsic teleology of the organism with the notion that organisms vary in degrees of organisation. Borderline cases of organised beings make it problematic to determine whether an entity is part of a greater organic whole or an organism in its own right. For instance, we can consider the more contemporary issue of determining the sufficient criteria that permit us to distinguish an organelle from an endosymbiont (Keeling & Archibald, 2008; Nowack, 2014). *Paulinella chromatophora* for example, is a eukaryote microbe with photosynthetic properties, which result from its endosymbiosis with an incorporated cyanobacteria; it was thought that chromatophores could reveal some basic principles of endosymbiotic integration, allowing us to better understand the transformation from endosymbiont to organelle. The received view tells us that, unlike endosymbionts, organelles have transferred genes to their host and depend on a targeting system to reimport their protein products (Cavalier-Smith & Lee, 1985). Chromatophores however challenge this criterion, since it has been inferred from the pattern of their genome that it must be both dependent on its host (e.g., nutrition), but also much more independent when compared with the organellogenesis of plastids (Keeling & Archibald, 2008; Nowack, 2014).

In examining Kant's critique of the methodology of teleology, his concept of the organism, and recent cases of organisational puzzles, I argue for the incompatibility of an intrinsic teleology with the concept of physiological individuality that admits degrees. I illustrate my case with the example of *Paulinella chromatophora*. In fact, if we are to think of the organism in this way, it is necessary to understand the organism as setting a boundary that separates its organic parts from the means, opportunities and limits, that the environment offers to the organism extrinsically.

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Dysbiosis and the Humoral Conception of Disease: Integrating Biology, History, and Philosophy into a New Research Domain

Javier Suárez *(University of Exeter)*

The acknowledgment of the importance and variety of the symbiotic microorganisms (bacteria, viruses, fungi, etc.) that constitute the human mirobiome led some biologists to launch, ten years ago, the "Human Microbiome Project" (Turnbaugh et al. 2007; https://hmpdacc.org/). The main objective of the project was to characterize the microorganisms that are found in the human microbiome and, furthermore, explore their implications for human health. In this context, the term "dysbiosis" became popular among biomedical researchers. Even if the concept had already been introduce in the 19th century by biologists such as Élie Metchnikoff and Elliott Furney, among others (Hooks & O'Malley 2017), it is with the development of the new and sophisticated techniques of gene sequencing, data analysis, etc. that the term became popular among scientific researchers and "dysbiotic thinking" started gaining support.
"Dysbiosis" has since then been defined in different ways, but it has usually been associated with an imbalanced/shifting state in the human microbiome that is correlated with disease states. Dysbiotic states have been correlated particularly with gut diseases, such as inflammatory bowel disease, colitis or colorectal cancer, and other body states such as obesity or asthma (Tamboli et al. 2004; Blaser & Falkow 2009; Ferrer et al. 2017). The main hypothesis driving dysbiosis research is that the alterations in the normal microbial flora in humans led to disease states. Those disease states are sometimes believed to be correlated with the increase in the presence of certain key pathogenic species (e.g. Lewis et al. 2015), and others are believed to be the consequence of a mere imbalance between the normal species that populate the human microbiota (e.g. Jones et al. 2014).
Even if the evidence for dysbiosis and the particular direction (if any) of the correlation between dysbiotic states and human disease remains stills scientifically unclear (whether dysbiosis *causes* the disease or the disease *causes* the dysbiosis), dysbiotic research is philosophically intriguing for at least two reasons: first, because it questions some of the basic assumptions of the germ theory of disease; second, because in doing so, it prompts new questions about the division inside/outside in human health.

Dysbiosis challenges the germ theory of disease because, if (some) infectious diseases turn out to be a consequence of imbalanced microbiome states, then their cause might not be a particular pathogen that is producing the disease, but a whole community of interacting microorganisms whose interrelations are altered (diseases would be a consequence of altered microbial interrelations). Second, it questions the divide between the inside and the outside, as the disease would be generated "from within" our own bodies, as the microbiome is contained within our physical boundaries. Those two elements were already present in "humorism," according to which diseases are consequences of impaired internal states produced by an imbalance between the four humours. I argue that exploring some of the conceptual foundations of humorism might shed some light in recent debates about dysbiosis, being this area therefore a unique research context for exploring the connections between biology, philosophy and history of medicine. In this sense, an interdisciplinary approach to dysbiosis, that combines concepts, methods and discoveries from different types of research might help to clarify some of the debates surrounding dysbiosis research.

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The Sociology of Scientific Pluralism

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Scientific Pluralism has become an increasingly popular term in the philosophy of science and in the philosophy of biology in particular. There are many different versions of this notion, certainly not all of them are compatible. A pluralist claim might be normative, descriptive or both. It is an open question how resonant these claims are with the field they approach. Thus, one might ask: 1) Do specific versions of scientific pluralism provide a useful description of their field of study? 2) Are pluralist aims and goals compatible with the field's aims and goals? Although pluralism bears significant implications for scientific practice and theorizing, these questions are usually not addressed. Thus, the "analysts" of science often forget about their actors.

These actors define and comprise the field the analysts are studying. Researchers are the gatekeepers for both the emergence as well as the decline of plurality. Thus, the role of scientists in this philosophical program should find acknowledgment. To address this issue, a sociology of scientific pluralism is required. Such a program has several goals, one is to test and feedback on claims philosophers advance about pluralism in the sciences. On the other hand it can inform scientific pluralism with concepts that can only be found through field-work. In this paper, I will demonstrate the promise of such a program with a case study on small RNAs, their inheritance, and their impact on organismal evolution.

I will exemplify how scientific pluralism can be brought from the arm-chair to the bench, and back again. As a first step, I will discuss the phenomenology of small RNA inheritance and propose a pluralist interpretation. Small RNAs are a class of biomolecules that are responsive to environmental stimuli and can transmit this information to subsequent generations. Partly operating through a use/disuse paradigm they present as an instance of Lamarckian inheritance, on the mechanistic level. Therefore, I propose a plurality of theories of inheritance as well as a plurality of explanations for phenotypes. As a second step, I will contrast my claims with the perspective of the core-set of investigators. This survey comprises interviews with the leading small RNA biologists. By discussing my empirical data, I will point to some preliminary results: 1) Philosophical concepts (like "explanation", or "mechanism") do not necessarily refer to scientist's categories. 2) Certain issues and problems of scientific pluralism, raised by scientists, are not included in philosophical discussions. In a third step, I will exemplify how my sociological approach can offer a new perspective on these discussions. I will do this by addressing one much-debated topic amongst scientific pluralists: How do theories relate? Are they alternatives, or are they integratable? I propose that the relevant set of actors decides on how theories are related, and which theories are accepted for constituting plurality. As a consequence, I will introduce an actor-based model for the emergence and decrease of plurality within one scientific field. Thereby I hope to provide a better understanding of the term scientific pluralism and the several ways it configures in research fields.

Dispositions and Chance in Evolution: A Propensity Approach to Evolvability

Cristina Villegas Cerredo *(Complutense University of Madrid)*

The debate on the role of chance in evolution has experienced an intense revival coming from the theoretical and empirical advances undergone by evolutionary biology in the last few decades and the integration of these new research agendas into a new extended evolutionary synthesis. In the search for integrating a diversity of biological disciplines into a general explanatory schema, the extended synthesis deals with the concepts and methods of evolutionary developmental biology (evo-devo), which seem to demand a revision of some of the commitments implied in the received notion of evolutionary chance.

Although the central role of genetics and adaptationism has usually inclined the discussion on evolutionary chance towards the narrow question of whether or not mutational mechanisms can direct evolution in a Lamarckian fashion, this talk will deal with the more general challenges that the evo-devo research program poses to the idea of random variation in evolution. I will argue that partisans of the Modern Synthesis' view of chance have retreated to a too restrictive definition of the concept that cannot deal with some of the ideas coming from the field of evo-devo, especially those of variability and evolvability. In particular, I will defend that the origination and development of evo-devo can only be understood as a reaction against the tacit and widespread move from a restricted notion of evolutionary chance to more general claims about the negligible causal role of the mechanisms generating variation in the evolutionary process.

I will present a generalised definition of evolutionary chance that makes explicit the major underlying assumptions of the received, restricted (anti-Lamarckian) one, and argue that the introduction of developmental probabilistic dispositions, or propensities, into the explanatory structure of evolutionary theory challenges in crucial ways its applicability. In order to illustrate such assumptions, I will lean on their historical roots, both in conceptual discussions in biology and in the philosophy of chance and probability. I will defend that distinguishing between chancy or probabilistic phenomena – namely the production of phenotypic variation – and the dispositions that explain such phenomena illuminates how variability and evolvability are in conflict with the general ideas of evolutionary chance received in the frame of the Modern Synthesis.

In this respect, how the notion of chance is understood has implications for the ongoing debate about the integration and explanatory scope of the Modern Synthesis, insofar as understanding chance in a dispositional way switches the focus towards a higher explanatory level.

Interpreting European GMO Law – A Case for “Applied” Philosophy of Biology

Martin Wasmer *(Leibniz University Hannover)*

The European Directive 2001/18/EC regulates the deliberate release of genetically modified organisms (GMOs), such as GMO-crops in agriculture. Its legal definition of GMO depends on the interpretation of the phrase “altered in a way that does not occur naturally” (Bobek, 2018), a wording that is vague and invites debate. However, this phrase decides which organisms do or do not fall under the regulatory obligations of the GMO Directive (Bobek, 2018) with far reaching implications for what is planted on fields and is served on our plates – a topic that has mobilized considerable public interest in the past decades. At present, it is unclear which organisms bread by new biotechnologies such as genome editing do fall under this GMO definition, if any, since they often cannot be distinguished from naturally occurring variants. Two main issues challenge a straightforward application of the GMO definition to organisms bread with such new technologies: (1) First, the naturalness criterion could apply to either the process (the “way”) or the product (the “end result”) or to both (Kahrmann et al., 2017). (2) Second, in order to be used as determinant definition in law the question is how to operationalize the criterion of naturalness, i.e., to inquire what sorts of mutations can be considered reasonably probable to occur naturally. Both of the above issues require philosophical methods and the integration of knowledge from law and biology for clarification and subsequent operationalization: (1’) To answer the first question of process vs. product, different contradicting concepts of naturalness can be distinguished (following Siipi, 2008; Siipi & Ahteensuu, 2016) and the decision between those has to be based on the goal the definition. (2’) To answer the second, a theory of biological modalities is necessary for the operationalization of the concept of natural possibilities (following Huber, 2017). Once these theoretical issues are clarified, the GMO definition can be operationalized for application in regulatory practice.

Note that legal methods alone do not suffice to interpret the application of the GMO definition to new technologies, because a) there are no precedents in the case of new scientific developments and b) the need for interpretation precisely emanates from underdetermination of the concept in the relevant legal body. Also scientific methods alone do not suffice: c) It is not an empirical question to decide whether naturalness has to be understood in term of process only or outcome only or both. d) In the practice of life sciences terms (e.g. "gene") are used more or less intuitively to indicate categories of common reference, but they are not sharply defined and their meaning changes over time and between various contexts (COGEM, 2010). For the purposes of practice in life sciences, an exact definition is probably neither relevant nor useful.

Instead, the concept of naturalness and other debated concepts from the life sciences have been a longstanding topic in philosophy. Consequently, in such cases philosophical considerations at the intersection of science and law might develop considerable normative bearing on pressing societal issues.

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From Reduction to Inter-level Scientific Practice: The Spemann-Mangold Organizer and Molecular Developmental Biology

Marcel Weber *(University of Geneva)*

The relationship between classical genetics and molecular biology has been widely discussed, mostly under the rubric of "reduction", a supposed inter-theory explanatory relation. By contrast, classical experimental embryology and its relation to molecular developmental biology has been largely ignored. In this paper, I present an analysis of the case of the Spemann-Mangold organizer, which was discovered by transplantation experiments on amphibian embryos in the 1920s. What kind of knowledge did the classical approach exemplified by this famous experiment produce, and how is it related to more recent advances about the molecular mechanisms of development?

The Spemann-Mangold experiment involved a transplantation of embryonic tissue removed from the blastopore lip of newt blastulae. When grafted to the ventral part of another embryo at about the same stage, this material induced a whole new body axis and resulted in a secondary embryo attached to the larger embryo. According to the standard interpretation at the time, the blastopore lip tissue has the potential of organizing dividing embryonic cells such that they will form a new body axis, hence the term "organizer". However, the exact explanation of this phenomenon and its implications for normal development remained largely controversial until the 1980s. In particular the finding that many substances including dead tissue can have the same or similar effects called the whole organizer concept in question.

It was eventually shown by molecular studies that the organizer tissue secretes numerous growth factor antagonists that prevent the induction of epidermis in embryonic tissues that had previously been committed for the neural pathway. Classical embryologists had always thought that it was the other way around, i.e., that the neural pathway was induced while epidermis was the default state. Thus, it is unclear if we can say that molecular biologists identified the molecular realizers of a previously known causal role, as current metaphysical thinking would have it.

We could argue at length whether the classical embryologists' knowledge was explanatory and whether it has more recently been reduced to the molecular level, however, it would be a mistake to focus exclusively on its explanatory achievements.

Taking a practice-oriented approach, I will show that the most important contribution was due to the fact that this kind of knowledge about the effect of certain manipulations such as the Spemann-Mangold experiment could be successfully integrated into the investigative strategies of molecular biology during the 1980s and 90s, strategies which led to the identification of numerous genes and proteins that specify the main body axes in early development. Molecular developmental biologists thus created a kind of inter-level experimental practice combining techniques and investigative strategies from classical embryology and from molecular biology. I show here that within these inter-level practices the classical experimental techniques played the role of measurements that were used to determine the biological activities of embryonic tissues as well as of isolated molecules.

Plant Stress Physiology: A Clear Manifestation of Process Philosophy

Özlem Yilmaz *(KLI, Klosterneuburg)*

We use many concepts in Plant Stress Physiology area that deal with very complex phenomena and are in close interaction with other areas like: Molecular Biology, Genetics, Epigenetics, Agricultural Engineering, and Climate Science. Several plant scientists have already pointed out a need for a clarification of the concepts in this area (Blum 2015; Gaspar et al. 2002; Mickelbart et al . 2015; Forsman 2015). Although their analyses were very important contributions to the field, I argue these papers were missing a major ground. So, in my current work I am doing this analysis through process metaphysics (following Dupré 2012). I think this work is a very nice example of how in fact biology and philosophy are interrelated, how philosophy can contribute to biology and how biology provides empirical resources and inspiration to philosophy. Process thinking is everywhere in plant stress physiology research. I will give examples on how we can easily trace this processual character through descriptions, measurement methods, and experiment designs.

There is always a dynamic interaction between an organism (a plant) and its environment and organisms express themselves through this interaction. Plants face stress conditions, when there is a stimulus which is very different than the 'usual' changes in environment. The stressor stimuli, which can be biotic (some species of bacteria or fungi, etc.) or abiotic (drought, high or low temperature, high light, etc.), are not like daily or seasonal changes and they cause much more 'altered' phenomes which even may be called as 'injured'. There is a degree of injury (or death) in the stressed organisms depending on the resistance ability of the individual organism to the stressor and the wider context in which the organism encounters the stressor.

Following Dupré (2012), I see world as a "manifold of nested and interrelated processes that collectively constitute a dynamic continuum" (Dupré and Nicholson, 2018). A plant is one of the processes in the world. A stressor is also a part of this world and at a certain temporal point/period of this continuum, it encounters with the plant in question. Their interrelatedness becomes direct. The encounter, so the flow of stress related processes in the plant, cause the plant becoming different than its previous self (before the encounter). This difference in stability is very big; that’s why we need the concept of stress.

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Notes: