Programme

9:00 - **Welcome with coffee**

9:30 - **Introduction**
Sylviane Muller - IBMC, CNRS, USIAS Chair of Therapeutic Immunology, University of Strasbourg

9:45 - **The concept of cooperation in evolutionary theory: a historical overview**
Johan Hoebeke - CNRS Research Director (em.), IBMC, Strasbourg.

10:15 - **Towards adaptive chemistry**
Jean-Marie Lehn - ISIS, USIAS Chair of Chemistry of Complex Systems, University of Strasbourg

10:45 - **Coffee break**

11:00 - **Cooperation among RNA molecules promotes group replication**
Niles Lehman - Professor of Chemistry, Portland State University

12:00 - **Lunch**

14:00 - **Endosymbiosis: cooperation generating novel taxa at the highest level**
William Martin - Professor of Botany, Heinrich Heine Universität, Düsseldorf

15:00 - **Modelling the evolution of social complexity and order**
Dirk Helbing - Professor of Sociology, in particular of modeling and simulation, ETH, Zürich

16:00 - **Coffee break**

16:15 - **Uniquely prosocial human other-regarding concerns**
Keith Jensen - Professor of Psychology, University of Manchester

17:15 - **Discussion**

17:45 - **Drinks**

Cooperation as a pillar of biological evolution

For more information: **www.usias.fr/cooperation**

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Conference

Cooperation as a pillar of biological evolution

Wednesday
1st October 2014
Auditorium ISIS
8 allée Gaspard Monge - Strasbourg - France

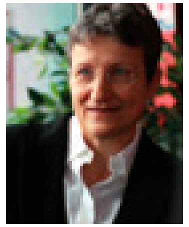
USIAS Conference

Cooperation as a pillar of biological evolution

Darwinian evolution is based on natural selection of random variants, better adapted to their environment and whose adaptive traits are heritable. While classical darwinism stresses the importance on individual variability, more and more evidence suggests that cooperative behaviour seems to be crucial for the process of evolution, allowing it to continue towards ever-greater complexity.

Increasingly, cooperation is found to be an important factor in key phases of evolution, potentially starting already at the very origin of life itself, the step from chemistry to biology through "cooperation" of biomolecules. The passage from prokaryotic life towards eukaryotic life as well as the passage from unicellularity towards multicellularity seems impossible to understand without cooperation of the lower level organisms. Finally, the human ability to cooperate even with abstract, anonymous persons at large distances allows the kind of large-scale cooperation seen uniquely in humans, taking the process of natural evolution to the process of cultural evolution.

In order to increase our understanding of the relationship between evolution and cooperation, six world-renowned experts studying different aspects of this relationship will be gathered in Strasbourg to share and discuss their insights and to jointly reflect on possible implications.

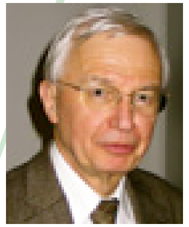


Sylviane Muller is research director at CNRS and director of the CNRS Laboratory of Therapeutic Immunology and Chemistry at the Institute of Molecular and Cellular Biology in Strasbourg (IBMC). She currently holds the Chair of Therapeutic Immunology at the University of Strasbourg Institute for Advanced Study (USIAS)

Johan Hoebeke was Research Director at the IBMC until his retirement in 2006. His Ph.D. was obtained at the Katholieke Universiteit of Leuven (Belgium). After five years teaching at the University of Kinshasa (DRC), he joined the company Janssen Pharmaceutica (Beerse, Belgium). Returning to an academic carreer, he first was senior researcher at the Vrije Universiteit of Brussels before joining the CNRS continuing his research in molecular immunology in Paris, Göteborg, Tours and finally Strasbourg. Since his retirement, he has resumed his interest in the history of evolutionary theories.

The concept of cooperation in evolutionary theory: a historical overview

Although Darwin himself was aware of the importance of cooperative behaviour, as mentioned in his 'Descent of Man', this was completely forgotten by his social-darwinian successors although it continued to be proposed by 'heterodox' evolutionists. By the centenary of the 'Origin of Species' and the triumph of the synthesis between Darwinisms and genetics as exemplified in T. Dobzhansky's third edition of his 'Genetics and the Origin of Species' (1958), cooperation was no more mentioned. The introduction of kin selection by W.D. Hamilton (1964), following J.B.S. Haldane's studies on population genetics, the models of reciprocal altruisms proposed by W. Trivers (1971) and the application of game theory in behavioural evolution by J. Maynard-Smith (1973) concomitant with the theory of the origin of eukaryotes by the endosymbiotic theory of L. Margulis (1970) again brought cooperation as an evolutionary mechanism in the foreground. This overview will try to bridge the gap between Darwin's insight and the reappearance of cooperation as a major factor of biological evolution.



Jean-Marie Lehn holds the Chair of Chemistry of Complex Systems at the University of Strasbourg Institute for Advanced Study (USIAS). He is Honorary Professor at the Collège de France in Paris and Emeritus Professor at the University of Strasbourg, His early work focused on the chemical basis of "molecular recognition", which plays a fundamental role in biological processes. Over the years these studies led to the definition of a new field of chemistry, which he called "supramolecular chemistry". In 1987, Jean Marie Lehn was awarded the Nobel Prize in Chemistry, together with Donald Cram and Charles J. Pedersen. In 2002 he founded the Institut de Science et d'Ingénierie Supramoléculaires (ISIS) in Strasbourg. Author of more than 900 scientific publications and 2 books, he has received numerous international honours and awards.

Towards adaptive chemistry

Chemistry has traditionally been concerned with studying molecules. Supramolecular chemistry studies of supramolecular entities, which possess features as well-defined as those of molecules themselves.
Supramolecular chemistry can perhaps be seen as a sort of "molecular sociology": non-covalent interactions define the intercomponent bond, the action and reaction, the behaviour of the molecular individuals and populations: their "social" structure as an ensemble of individuals having its own organisation; their stability and their fragility; their tendency to associate or to isolate themselves; their selectivity, their "elective affinities" and class structure, their ability to recognize each other; their dynamics, fluidity or rigidity of arrangements and of castes, tensions, motions and reorientations; their mutual action and their transformations by each other.
Chemistry is progressively unravelling the processes that underlie the evolution of matter towards states of higher complexity and the generation of novel features along the way by self-organization under the pressure of information. The implementation of dynamic features and of selection has led to the emergence of an "adaptive and evolutive chemistry". Accessing higher-level functions such as training, learning, and decision making represent future lines of development for adaptive chemical systems.

Niles Lehman is Professor of Chemistry at Portland State University. His research group is part of the Center of Life in Extreme Environments (CLEE). He and his group work on the biochemical and genetic issues involved with the origins of life on the Earth, pursuing the hypothesis that recombination was a critical feature of nascent life, and may have been the defining element of the chemistry to biology transition some 4 billion years ago. Niles Lehman is Editor-in-Chief of the Journal of Molecular Evolution.

Cooperation among RNA molecules promotes group replication

The origins of life on the Earth occurred some four billion years ago. The transition from chemistry to biology has traditionally been viewed as the advent of self-replicating genetic polymers that are subject to evolutionary forces. However, currently an alternative to this model is explored: an abiogenesis that relies on intermolecular cooperation rather than the selfish replication of distinct genotypes. The origins of life on Earth required the establishment of self-replicating chemical systems capable of maintaining and evolving biological information. It has been established that mixtures of RNA fragments spontaneously form cooperative catalytic cycles and networks, which seems to have been crucial for the origin of life. This "molecular cooperation" is a key factor in the origin of life. Polymers that assembled with other polymers might have been better protected against hydrolysis, for example, and as a result, started growing in number. Over time, these chemical systems could have "evolved" to be more stable and more complex. As more species of molecules joined the interactions, they may have created chemical networks that began to take on functions. Applying the principles of game theory to empirical chemical systems for perhaps the first time, it can be seen that cooperation, even at the molecular level, was a key feature of the origins of life.

William Martin is Professor and head of the Institute of Molecular Evolution at the University of Düsseldorf. He studies endosymbiosis, organelles, anaerobic mitochondria, gene transfer, and early evolution. Currently he is working on the use of network approaches to modelling non-treelike processes in evolution, genome evolution in eukaryotic microbes and early biochemical evolution.

Endosymbiosis: cooperation generating novel taxa at the highest level

The "Hydrogen hypothesis" proposes that the first eukaryotic cell resulted from a symbiotic, cooperative relationship between a hydrogen-dependent archaeon (the host), with a primitive eubacterium, the future mitochondrion, based on one cell living from the metabolic endproducts of the other. The origin of eukaryotes is a crucial evolutionary transition because it enabled the evolution of genuinely complex life forms. Endosymbiosis and its corollary mechanism, gene transfer from organelles to the nucleus, have played a central and possibly decisive mechanistic role in that major evolutionary transition. Eukaryotes are not the only example of massive gene transfer between the archaebacterial and eubacterial domains giving rise to novel taxa at higher levels. Increasingly it is becoming clear that processes of physical interaction (cooperation) of cells and the unidirectional transfer of genetic material have been an important factor in the emergence of novel taxa at the highest level.

Dirk Helbing is Professor of Sociology, in particular of Modelling and Simulation, at ETH Zurich. He is known for his work on pedestrian crowds, vehicle traffic, and agent-based models of social systems, globally networked risks and how to respond. He is coordinator of the FuturICT Initiative, which focuses on the understanding of techno-socioeconomic systems, using Smart Data. Within the ERC Advanced Investigator Grant "Momentum" he works on social simulations based on cognitive agents. His current research focuses on norms and conflict, and the role of success-driven motion for the establishment of cooperation among selfish individuals.

Modelling the evolution of social complexity and order

What are the principles that keep our society together? The social challenges of humanity in the 21st century ranging from the financial crises to the impacts of globalization, require us to make fast progress in our understanding of the underlying forces and evolution of our society, and how our future can be managed in a resilient and sustainable way. Based on simple evolutionary models of social interactions, one can gain surprising insights into the social, macro-level outcomes and dynamics resulting from individual micro-level interactions. The consideration of randomness, spatial or network interdependencies, and nonlinear feedback effects turns out to be crucial to get fundamental insights into how social patterns and dynamics emerge. Depending on the nature of these interactions, they may imply the spontaneous formation of social conventions and social cooperation, but also their sudden breakdown. Applying state-of-the-art modelling enables to capture complex interaction dynamics at the macro-level and shows that increasingly complex forms of cooperation are an important driver of the evolution of society.

Keith Jensen is Professor of Psychology at the University of Manchester, working on the evolution and psychological underpinnings of sociality and the nature of other-regarding concerns in governing our social behaviour. To investigate how people come to know and care about the welfare of others, he uses ideas from game theory and methods from experimental economics, as well as standard psychological approaches, to study nonhuman primates and children.

Uniquely prosocial human other-regarding concerns

The fact that humans cooperate with non-kin is something we take for granted, but this is an anomaly in the animal kingdom. Our species' ability to behave prosocially may be based on human-unique psychological mechanisms. We argue here that these mechanisms include the ability to care about the welfare of others (other-regarding concerns), to "feel into" others (empathy), and to understand, adhere to, and enforce social norms (normativity). We consider how these motivational, emotional, and normative substrates of prosociality develop in childhood and emerged in our evolutionary history. Moreover, we suggest that these three mechanisms all serve the critical function of aligning individuals with others: Empathy and other-regarding concerns align individuals with one another, and norms align individuals with their group. Such alignment allows us to engage in the kind of large-scale cooperation seen uniquely in humans.