



# KGI Researchers Publish Key Paper on Evolution of Cooperation

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CLAREMONT, Calif., Nov. 9, 2010 /PRNewswire/ — In the world of Darwinian evolution, Keck Graduate Institute (KGI) researchers have discovered that the level of cooperation (or defection) among genes, cells, tissues and individuals depends on communication and the predictability of the environment.

The path-breaking research, “Critical Dynamics in the Evolution of Stochastic Strategies for the Iterated Prisoner’s Dilemma,” was published recently in *PLoS Computational Biology*, the premier journal in the field. Rooted in evolutionary game theory, the results have wide-ranging implications for understanding the nature of cooperation, from coaxing cancerous cells to join the non-cancerous bandwagon, to exploring the conditions under which a stock market bubble expands or unravels.

“We showed that cooperation does not sit outside of Darwinian evolution, but is a direct consequence of it as long as the environmental conditions are right,” said KGI Professor Christoph Adami, PhD, one of three researchers involved in the two-year project. Adami was joined by Research Assistant Professor Arend Hintze, PhD, and Dimitris Iliopoulos (PhD ’10), who received his doctorate in computational and systems biology.

For three decades, researchers have tested the evolution of cooperation using different player strategies and environments, said Adami. A recognized leader in the field, Martin Nowak, director of the Program for Evolutionary Dynamics at Harvard University, observed that cooperation flourishes in certain scenarios, such as when players are spatial neighbors or share a kin network. Still, Nowak concluded that the phenomenon could be outside of standard Darwinian evolution, because of its apparent contradiction to the selfish goal of survival.

Using a series of extensive computer simulations of evolving populations, Adami and his team found that players will adopt cooperation strategies if the environment is sufficiently predictable, where players can use information from previous moves to plan future ones. Cooperation is inherently more risky than defection, since a player is forgoing a short-term benefit for a long-term goal. Limiting environmental “noise” inspires confidence among players that they can eventually reap the rewards of cooperation.

On the flip side, players will defect in uncertain and inconsistent environments, characterized by higher mutation or replacement rates. In sum, changing environmental parameters can determine the incidence of cooperation or defection when players communicate.

“An unpredictable environment affects the reliability of the communication channel,” explained Adami, who is on sabbatical this year at Michigan State University’s BEACON Center for the Study of Evolution in Action. “Players communicate information about previous moves to other players. They are more likely to cooperate with another player who has cooperated in the past.”

The research is not limited to biological settings. Under KGI's REU program for undergraduate research in biotechnology and bioengineering, the researchers are working with students to apply the same principles of cooperation and defection to study the rise and fall of stock market bubbles.

In the future, Adami hopes to collaborate with cancer biologists to examine the environmental factors that influence a cancerous cell's ability to escape the "punishment" for non-cooperative behavior (cell death), and replicate uncontrollably. "To study cancer using the principles of evolutionary game theory, we need more direct contact with clinical researchers to make meaningful contributions," he said.

## **KGI BACKGROUND**

Educating the future leaders of the bioscience industry, Keck Graduate Institute (KGI) offers an interdisciplinary graduate education through its Master of Bioscience (MBS), Postdoctoral Professional Masters in Bioscience Management (PPM), Postbaccalaureate Premedical Certificate (PPC), PhD and other academic programs. Using team-based learning and real-world projects, KGI's innovative curriculum seamlessly combines applied life sciences, bioengineering, bioethics and business management. KGI also has a robust research program concentrating on the translation of basic discoveries in the life sciences into applications that can benefit society. KGI is a member of The Claremont Colleges, located in Claremont, California.

*Keck Graduate Institute of Applied Life Sciences is dedicated to education and research aimed at translating into practice, for the benefit of society, the power and potential of the life sciences.*

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