

University of California Intercampus Research Program on
Experimental Evolution

Irvine  Riverside  Santa Barbara



Approved Proposal:

Summary

We propose to form an *Intercampus Research Program on Experimental Evolution* (IRPEE). This Program would seek participation from all UC Campuses. It would initially have its home at the University of California, Irvine, with major branches at the Santa Barbara and Riverside campuses.

Experimental evolution studies evolutionary processes in the same way that chemistry studies chemical reactions: either forcing evolution to occur in controlled settings or studying naturally occurring evolution close-up. This allows experimental evolutionists to study the explicit mechanisms by which evolution proceeds, rather than the pattern of evolution, which is more commonly studied. Experimental evolution is also used to produce populations with modifications to such biological features as aging, stress resistance, growth, and so on. Such evolutionarily modified populations are valuable material for biologists interested in discovering the specific genetic mechanisms that underlie function.

Three of the southern UC campuses have a remarkable concentration of expertise in experimental evolution. But to this point, these UC campuses have not pursued a joint institutional framework, and our research collaborations have been fairly limited. The creation of a system of local campus branches of an IRP would support the greatest possible exploitation of UC resources. In the future, as other UC campuses develop their own interests in the study of experimental evolution and kindred topics, they can join with the founding campuses in the proposed IRP. Colleagues at UCSD have already indicated an interest in joining the IRP at a later date.

This is a low-cost initiative that builds upon existing strengths among UC campuses. Resources for IRPEE will initially come from the School of Biological Sciences at UCI, the UCI Department of Ecology and Evolutionary Biology, the Santa Barbara and Riverside campuses, and funds raised by the Program itself. At first, these resources will support a very limited administrative structure, seminars, and travel costs between the founding campuses. The initial need for new space and campus resources is minimal. As IRPEE attracts extramural funding, space will be required for funded research and graduate training, and will be negotiated with the host School and Department.

The Intercampus Research Program on Experimental Evolution (IRPEE)

While there are many institutions where evolution is studied as an historical pattern, the number of institutions where experimental evolution is studied remains limited. UC is one of the strongest educational institutions in the world where the study of experimental evolution is concerned, stronger than the institutions of all other countries, England supplying the only possible exception. The IRP would strengthen this type of research within the UC system.

Evolution is important to the solution of many practical problems, not least those of medicine, conservation, and agriculture. It can indicate limits to work on these practical concerns. But it can also supply new experimental techniques that can provide solutions in these areas.

The study of experimental evolution endeavors to make the study of evolution as analytical and penetrating as experimental chemistry. In experimental evolution, evolution occurs right in front of the scientist, not 50 million years ago. In experimental evolution, evolution is not a unique historical event, but a reproducible process that can be studied over and over again. Experimental evolution uses such tools as quantitative genetics, comparative physiology, and above all selection to study the immediate evolution of important biological functions: resisting disease, slowing aging, coping with toxic environments, and so on. When it creates populations with enhanced adaptations, a common by-product of experimental evolution, it helps biologists find the physiological functions that underlie these adaptations.

As such, the study of experimental evolution is a powerful tool of “integrative biology,” one of the new themes of biological research across a wide range of life science disciplines. We will not argue that the study of experimental evolution is the only tool of this kind, as systems biology and related fields also offer other such tools. But study of experimental evolution is a useful tool for accomplishing goals that have been identified as central to 21st Century biology.

The IRPEE will strive to foster the techniques and applications of experimental evolution across a wide frontier. UC already has faculty who have had success using selection, particularly with microbes, insects, rodents, and fish. These individual faculty have also collaborated with faculty from other disciplines in order to identify the crucial biological mechanisms that underlie particular cases of experimental evolution. This range of faculty supplies a spectrum of interdisciplinary approaches to the study of experimental evolution. Among these approaches are organismal physiology, quantitative genetics, molecular sequence analysis, and molecular studies of gene expression.

The preeminence of UC campuses in the study of study of experimental evolution has been building for some time, primarily by recruitment of faculty in this area. Just in the last few years, six leading faculty in this area were recruited to UC campuses: W. Rice

by UCSB, L. Chao and R. Lande by UCSD, while T. Garland was recruited by UCR. A large fraction of the published studies in this area have come from the faculty of the UC campuses proposed to start the IRP. Indeed, much of the other research in this field has been produced by faculty or doctoral graduates from these UC campuses. [For example, R.E. Lenski moved from UCI to Michigan State University, and continues to collaborate with A.F. Bennett of UCI on experimental evolution.]

The last remaining step on the road to the full exploitation of this accumulation of talent is the creation of a structure to support collaboration and mutual assistance among the faculty, research workers, and graduate students at the University of California. Among the possibilities for collaboration are (one) NIH Program Project Grants in the area of genomic analysis of complex biological problems, (two) IGERT grants from NSF for the training of graduate students in this area, (three) collaborative research grants between campuses, and (four) organization of meetings and publications for the benefit of the field as a whole. But this is only a first listing. Additional opportunities will come with the formation of a supportive institutional structure, including private-sector eleemosynary contributions.

The Need for A Program

We have multiple reasons for proposing a Intercampus Research Program on Experimental Evolution among UC campuses.

First, the Program will strengthen an area in which UC has been a world-leader for the last 15 years by **increasing the visibility** of research in the area of experimental evolution. To our knowledge, there is no institute or Program for the study of study of experimental evolution anywhere in the world. Starting one at UC would make our leadership position visible.

Second, IRPEE will **foster research collaborations** between faculty at UC campuses. An Intercampus Research Program would provide a mechanism to foster interactions between campuses without the need for formal appointments as adjunct faculty. It would strengthen the credibility of collaborations among faculty in their applications for regular research grants and their applications for larger joint grants, such as NIH Program Projects. It is normally difficult to overcome the bureaucratic and other obstacles to creating shared research grant applications among campuses. The IRP would supply a framework within which such grants could be developed expeditiously. More importantly, it would make the intellectual motivation for developing such collaborations completely straightforward. This is not trivial. The potential for synergy among UC campuses in evolutionary research has long been neglected, despite the similar interests of faculty among the campuses.

Third, the IRPEE will enhance the **training of postdoctoral and graduate students**, because they will have access to a wider range of faculty working on experimental evolution. While the IRPEE structure would make a multicampus training grant easier to

develop, even without such a grant, faculty could easily contribute to research-level training over several campuses through the IRPEE structure.

Fourth, the IRP will foster **fund-raising** for the study of experimental evolution, both from governmental sources and from private sources, who may seek eponymous affiliation or designation. Since the IRPEE will be a much less expensive operation than a UC Department or School, it would be less expensive for generous donors to fund their operation. Such funding would then raise the possibility of naming the program after the donor(s).

IRPEE Program Plan

Overall Goals

IRPEE will have three goals: (1) Development of the study of experimental evolution as a tool for solving problems in integrative or systems biology; (2) Application of knowledge of experimental evolution to problems in medicine, agriculture, conservation, and other areas of practical concern; (3) Training of post-doctoral and graduate students in the use and interpretation of evolutionary experiments.

Short Vitae are attached for each researcher.

UCI:

Francisco Ayala
Albert Bennett
Timothy Bradley
Adriana Briscoe
Robin Bush
Walter Fitch
Steven Frank
Anthony Long
Laurence Mueller
Michael Rose
Ann Sakai
Arthur Weis

UCR:

Norman Ellstrand
Theodore Garland
Cheryl Hayashi
Robert Luck
Leonard Nunney
David Reznick
Richard Stouthamer

Nick Waser
Marlene Zuk

UCSB:

John Endler
Susan Mazer
Todd Oakley
William Rice
Robert Warner

Research Areas

- (1) Study of experimental evolution is a topic of central importance for evolutionary biology. There is a need to develop and test the methods of study of experimental evolution, including (a) efficient methods of selection, (b) replication, (c) analysis of the molecular genetics of the response to selection, (d) analysis of the quantitative genetics of the response to selection and (e) tools for analyzing the organismal response to selection.
- (2) Study of experimental evolution allows biologists to learn the functional significance of different kinds of interspecific and genetic variation. Knowledge of experimental evolution can be applied to the functional problems of medicine, conservation, agriculture, and other areas.

Training

It is a major goal of the faculty to use the IRPEE structure to foster the training of visiting faculty, postdoctoral fellows, and UC graduate students in the study of experimental evolution. The faculty of the University of California have already played this role in interactions with faculty at other institutions. The Program would help develop this role overtly. In addition, the IRPEE institutional structure would strengthen UC applications for training grant support in the area of selection, whether those applications come from the Program itself or from the individual campuses.

Initial Three-Year Plan

It is intended that the first three years of the IRP would involve the following principal activities: developing contacts and understanding between the three campuses initially involved; recruiting participants from additional UC campuses; formulating plans for grant proposals; and preparing grant proposals for submission to extramural agencies. Informally, we expect that collaboration in research and teaching will be fostered during this initial period.

Administration

As the funded activities of IRPEE increase, it will be necessary to support the work of an administrative assistant for handling financial affairs. Funds for this purpose will be included in applications for research and training grants. Initially, tasks for which the Director will be responsible include approval of proposals submitted through the Program, submission of proposals to raise Program funds and coordination with related UC fund-raising efforts, organizing review processes, organization of seminar series, coordination among the campus branches, and so on.

Initially, the Director of the Program will be Professor Michael R. Rose of the Department of Ecology and Evolutionary Biology, UC Irvine, who has taken the lead in putting this proposal together.

Professor Rose will be advised by a committee composed of UC faculty, where this committee would have a chair who is not the IRPEE director. The membership of this committee will be open to all UC campuses, but will not include every campus at the beginning. Initial advisory committee membership will include representatives from Irvine, Santa Barbara and Riverside, as well as a member from another campus, probably Los Angeles or San Diego, as faculty at both campuses have expressed interest in becoming involved in the IRPEE. The committee will advise the Director, especially reviewing proposals for research and graduate education projects to be sponsored and administered by IRPEE. The input of this advisory committee will be critical in every major decision affecting the IRP.

Should the IRP become involved in one or more important public issues, an additional Public Advisory Committee will be formed. This committee would include non-faculty representatives of the citizenry, relevant state agencies, and industry. This group would advise the IRP Director and the faculty advisory committee on IRP priorities and areas of concern. Such committees already contribute to the operation of other multi-campus programs. Their methods of operation would be adopted by this second advisory committee, once there is a perceived need.

Funding

Funding is not requested from the University of California Office of the President for the establishment of this IRP and its operations for its first three years. After the initial period, should the budgetary situation of the University of California allow, matching funds may be requested from UCOP to supplement externally-funded grants.

Initially, activities will be kept at a low-level of cost, focusing on meetings and project development with faculty at UCI and the other campuses proposed for the IRP.

In terms of the division of responsibility for expenditures during the first three years, the following terms are proposed.

Each participant Department or group would assume responsibility for its own expenses in grant preparation and other administrative functions.

Each participant Department or group would assume responsibility for its own expenses in travelling to UC Irvine to participate in multicampus meetings.

The University of California, Irvine, School of Biological Sciences would assume responsibility for any hosting expenses: parking, snacks, lunch, audiovisual equipment, etc.

At this time, the UCI School of Biological Sciences has committed \$600 per year for three years toward hosting IRPEE meetings. The Department of Ecology and Evolutionary Biology, UCI, has committed \$2000 per year for three years toward the initial expenses of the IRPEE.

Subsequent Activities

After the initial period, the activities of the IRP will be shaped by its success in attracting funding. At a minimum, we hope that the IRP will play a critical role in attracting at least one intercampus research grant and one intercampus graduate-level teaching grant.