Workshop on Molecular Evolution
July 27-August 8, 2003
(Extended Special Topics Session
August 8-August 15, 2003)

Course Director: Michael P. Cummings, University of Maryland and Marine Biological Laboratory

Molecular evolution has become the nexus of many areas of biological research. It both brings together and enriches such areas as biochemistry, molecular biology, microbiology, population genetics, systematics, developmental biology, genomics, bioinformatics, in vitro evolution, and molecular ecology. The Workshop provides an important contribution to these fields in that it promotes interdisciplinary research and interaction, and thus provides a glue that sticks together disparate fields. Due to the wide range of fields addressed by the study of molecular evolution, it is difficult to offer a comprehensive course in a university setting. It is rare for a single institution to maintain expertise in all necessary areas. In contrast, the Workshop is uniquely able to provide necessary breadth and depth by utilizing a large number of faculty with appropriate expertise. Furthermore, the flexible nature of the Workshop allows for rapid adaptation to changes in the dynamic field of molecular evolution. For example, the 2003 Workshop included recently emergent research areas of molecular evolution of development and genomics.

The interest in the Workshop remains very strong and is increasing. The number of applications for the 2003 course was 143, continuing the trend of increased applications since 2000. In 2003 there were 60 students participating in the Workshop, which was taught by 19 faculty and 4 teaching assistants. The students came from all over the world (17 countries), and represented several career stages: graduate students (57%), postdoctoral researchers (13%), faculty/principal investigators (27%), and other (3%). For the years 2000 – 2003, the students came from more than 164 different institutions.

The subjects covered in the Workshop included the following -

1. Databases and sequence matching: database searching; protein sequence versus protein structure; homology; mathematical, statistical, and theoretical aspects of sequence database searches.

2. Phylogenetic analysis: theoretical, mathematical and statistical bases; sampling properties of sequence data; Bayesian analysis; hypothesis testing.


4. Molecular evolution integrated at organism and higher levels: population biology; biogeography; ecology; systematics and conservation.
5. Molecular evolution and development: gene duplication and divergence; gene family organization; coordinated expression in evolution.


7. Comparative genomics: genome content; genome structure; genome evolution.

8. Transposable elements: types; history; evolutionary dynamics; as a major component of genomes.

9. Molecular evolution integrated at different levels II: biochemistry; cell biology; physiology; relationship of genotype to phenotype.

Formal instruction consisting of lectures, software demonstrations and computer work was scheduled over a 13 hour period each day during the two week period. The extended topics session provided essentially unlimited access to Workshop resources over a one week period. Twelve students participated in the extended topics session.

For 2003 the Workshop Web site was rebuilt from scratch and implemented a simpler design and some expanded content. The web site serves four primary purposes -

1. Prepare students in advance of their participation in the Workshop. All Workshop participants are strongly encouraged to make use of the web site as part of their preparations for attending the course. In this way each participant is made aware of the details of the Workshop schedule, expectations, and provided with resources to help prepare them in the best ways possible at their convenience. There is a web page with detailed information on preparing prior to the start of the Workshop.

2. Assist students while in attendance at the Workshop. Students have opportunities to review lecture notes and graphics, and follow-up on lecture and lab presentations through rapid access to relevant materials. The web site provides an extensive reference list, glossary and pages devoted to software used in the Workshop.

3. Provide a means to maintain and increase learning after participating in the Workshop. Although the attendance at the Workshop is only two or three weeks in length, the ability for a participant to refresh their knowledge by review of course materials continues well after they depart Woods Hole. In this way the students can use the Workshop as a continuing source of learning about molecular evolution.

4. Provide a resource for those who do not attend the Workshop. For a variety of reasons not everyone who is interested in doing so can attend the Workshop. The web site serves these people by providing an integrated resource through which they can learn more about molecular evolution. Many participants in past Workshops share their notes, handouts, and recollections from their experience with their colleagues. One motivation
for the web site is to increase the value and reach of the Workshop by leveraging its assets by providing a definitive source of material. The Workshop web site has been quite successful, having received over 2.4 million requests for pages in the first 36 months of operation. The web site has been accessed from over 90,000 different computers from all over the United States and many other countries (primarily Europe and Japan). The web site will continue to be updated and expanded in future years.

Partial funding support for the Workshop comes from the National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA). Some software was generously provided by Accelrys.

Table 1 – Diversity of Students Participating in the Workshop on Molecular Evolution

<table>
<thead>
<tr>
<th>Year</th>
<th># of Students</th>
<th>Female Students</th>
<th>Minority Students</th>
<th>Foreign Students*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>60</td>
<td>29</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>2002</td>
<td>63</td>
<td>24</td>
<td>1</td>
<td>29</td>
</tr>
<tr>
<td>2001</td>
<td>60</td>
<td>29</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>2000</td>
<td>61</td>
<td>23</td>
<td>1</td>
<td>31</td>
</tr>
</tbody>
</table>

*These students for the years 2000 – 2003 represented 38 different countries.

Table 2: 2000 – 2003 Molecular Evolution Course Faculty

2003

Course Director
Michael Cummings  University of Maryland

Faculty
Peter Beerli  University of Washington
Scott Edwards  University of Washington
Jonathan Eisen  TIGR
Joseph Felsenstein  University of Washington
Mary Kuhner  University of Washington
Axel Meyer  University of Konstanz
Michael Miyamoto  University of Florida
Daniel Myers  Pomona College
William Pearson  University of Virginia
<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>David Rand</td>
<td>Brown University</td>
</tr>
<tr>
<td>David Swofford</td>
<td>Florida State University</td>
</tr>
<tr>
<td>Steve Thompson</td>
<td>Florida State University</td>
</tr>
<tr>
<td>Paul Turner</td>
<td>Yale University</td>
</tr>
<tr>
<td>Ziheng Yang</td>
<td>University College London</td>
</tr>
<tr>
<td>Anne Yoder</td>
<td>Yale University</td>
</tr>
<tr>
<td>Mark Holder</td>
<td>University of Connecticut</td>
</tr>
<tr>
<td>William Pearson</td>
<td>University of Virginia</td>
</tr>
<tr>
<td>Margaret Riley</td>
<td>Yale University</td>
</tr>
<tr>
<td>Daniel Voytas</td>
<td>Iowa State University</td>
</tr>
<tr>
<td>Matthew Dean</td>
<td>University of Iowa</td>
</tr>
<tr>
<td>Johanna Fehling</td>
<td>Scottish Assoc for Marine Sci</td>
</tr>
<tr>
<td>Scott Handley</td>
<td>Washington University</td>
</tr>
<tr>
<td>David Kysela</td>
<td>Yale University</td>
</tr>
<tr>
<td>Claire Fraser</td>
<td>The Inst. for Genomic Research</td>
</tr>
<tr>
<td>William Pearson</td>
<td>U. of Virginia</td>
</tr>
<tr>
<td>Michael Sanderson</td>
<td>UC Davis</td>
</tr>
<tr>
<td>Daniel Voytas</td>
<td>Iowa State University</td>
</tr>
<tr>
<td>Shozo Yokoyama</td>
<td>Syracuse University</td>
</tr>
<tr>
<td>Antonis Rokas</td>
<td>University of Wisconsin-Madison</td>
</tr>
</tbody>
</table>

**Lecturers**

**Teaching Assistants**

**2002**

**Course Director**

Michael Cummings  
*Marine Biological Laboratory*

**Faculty**

**Lecturers**

**Teaching Assistants**

Antonis Rokas  
*University of Wisconsin-Madison*
Rauri C.K. Bowie  
Louise Mead  
Katarina Winka  
University of Cape Town  
Oregon State University  
Umeå University

2001  
**Director**  
Michael Cummings  
*Marine Biological Laboratory*

**Faculty**  
Peter Beerli  
Scott Edwards  
Jonathan Eisen  
Joseph Felsenstein  
Claire M. Fraser  
Mary Kuhner  
Paul O. Lewis  
Emilia Martins  
Axel Meyer  
William Pearson  
David Rand  
Ken Rice  
David Swofford  
Steven Thompson  
Daniel F. Voytas  
Ziheng Yang  
Anne D. Yoder  
Shozo Yokoyama  
University of Washington  
University of Washington  
Institute for Genomic Research  
University of Washington  
Institute for Genomic Research  
University of Washington  
University of Connecticut  
University of Oregon  
University of Konstanz, Germany  
University of Virginia Health Sciences Center  
Brown University  
GlaxoSmithKline Pharmaceuticals  
Smithsonian Institution  
BioInfo 4U  
Iowa State University  
University College London  
Northwestern University Medical School  
Syracuse University

**Teaching Assistants**  
Josephine Babin  
Sheri A. Church  
Scott Handley  
Andrew McArthur  
Ellen Pritham  
David Reed  
Antonis Rokas  
Julie Thompson-Maaloum  
Katarina Winka  
Louisiana State University  
University of Virginia  
Washington University  
Marine Biological Laboratory  
University of Massachusetts  
University of Utah  
University of Edinburgh  
Inst. de Genetique et de Biol. Moleculaire et Cellulaire  
Umea University

2000  
**Course Director**  
Michael Cummings  
*Marine Biological Laboratory*

**Faculty**  
Peter Beerli  
Scott Edwards  
University of Washington  
University of Washington
Jonathan Eisen  
Joseph Felsenstein  
Claire M. Fraser  
John P. Huelsenbeck  
Mary Kuhner  
Paul O. Lewis  
Wayne P. Maddison  
Axel Meyer  
Nipam Patel  
William Pearson  
David Rand  
Ken Rice  
Margaret A. Riley  
David Swofford  
Steven Thompson  
Daniel F. Voytas  
Anne D. Yoder  
Shozo Yokoyama

Institute for Genomic Research
University of Washington
Institute for Genomic Research
University of Rochester
University of Washington
University of Connecticut
University of Arizona
University of Konstanz, Germany
University of Chicago
University of Virginia Health Sciences Center
Brown University
Bioinformatics
Yale University
Smithsonian Institution
BioInfo 4U
Iowa State University
Northwestern University Medical School
Syracuse University

Teaching Assistants
Linda Amaral-Zettler  
Josephine Babin  
Sheri A. Church  
Paige M. Dennis  
Ben FrantzDale  
Andrew McArthur  
Monica Medina  
Ellen Pritham  
David Reed  
Molly E. Waring

Marine Biological Laboratory
Louisiana State University
University of Virginia
University of Massachusetts
Marine Biological Laboratory
Marine Biological Laboratory
University of Massachusetts
Louisiana State University
Marine Biological Laboratory