

# Internet resources in biology

By Martin P. Courtois and Alan H. Goslen

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## *From the Interactive Frog Dissection to Molecules R Us*

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**S**cientists in all areas of biology have embraced the Internet. As a result, thousands of sources are available including newsgroups and listservs, comprehensive and specialized databases, extensive guides to resources, and significant full-text works.

While we can't list all major biology Internet resources in this short article, we will point out the best starting points and essential sources. As in other scientific disciplines, many significant sites are developed by government agencies and learned societies, although many sources are efforts of commercial or university-based research labs.

Biology encompasses many divisions and specializations and we had to be restrictive in scope. Environmental studies are not included, although many sites listed here will be of interest to environmental scientists. Similarly, agriculture, veterinary medicine, and plant and soil sciences are not covered, but are included in the WWW Virtual Library: Biosciences.

### **Gateway systems**

Standard Web search services (Lycos, Infoseek, Open Text, Yahoo!, etc.) yield many resources in the biological sciences. Sites listed below, however, are produced by biologists and focus on scholarly and research-oriented information.

- **Pedro's BioMolecular Research Tools.**

An extensive list of sources including molecular biology search and analysis tools, bibliographic and text searches, guides and tutorials,

journals, and other biological resources. *Access:* [http://www.public.iastate.edu/~pedro/research\\_tools.html](http://www.public.iastate.edu/~pedro/research_tools.html).

- **WWW Virtual Library: Biosciences.**

Comprehensive list of biology resources, arranged by specific subject area, e.g., biochemistry, ecology, immunology, plant biology, etc. *Access:* <http://golgi.harvard.edu/biopages.html>.

- **CSU BIOWEB.** Extensive, annotated list of resources, arranged by specific field. The best starting point for students and others new to the field. *Access:* <http://arnica.csustan.edu/>.

### **Biology listservs and newsgroups**

UseNet newsgroups play a major role in fostering scholarly communication among biologists. There are two major newsgroup categories: bionet and the sci.bio. All bionet newsgroups and many sci.bio newsgroups are available through companion listservs.

- **Biology Network News.** An excellent overview and annotated list with links to major newsgroups. *Access:* <http://nimsn41.nimr.mrc.ac.uk/links/news.html>.

- **BIOSCI/bionet NewsGroups.** Links to newsgroup archives and an FAQ section that includes a list of current newsgroups and companion listservs. *Access:* <http://www.bio.net/>.

### **Listservs**

More than 50 listservs were assessed by subscribing and evaluating the frequency and content of postings. The following lists contain active discourse on scholarly biology issues.

- **APPLIED-ETHOLOGY.** Maintained by the International Society for Applied Ethologists for discussion of animal behavior. *Access:* [applied-ethology-request@sask.usask.ca](mailto:applied-ethology-request@sask.usask.ca).

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- **BIOPI-L.** List for high school biology teachers provides useful ideas about instruction techniques and materials for instructors at all levels. *Access:* [LISTSERV@KSUVM.KSU.EDU](mailto:LISTSERV@KSUVM.KSU.EDU).

- **BIOSAFETY.** Discussion on laboratory safety and other issues of concern to safety personnel. *Access:* [LISTSERV@MITVMA.MIT.EDU](mailto:LISTSERV@MITVMA.MIT.EDU).

- **BIOTECH.** Biotechnology discussion list covers techniques and requests for information about chemicals, biomaterials, and equipment. *Access:* [LISTSERV@UMDD.UMD.EDU](mailto:LISTSERV@UMDD.UMD.EDU).

- **CONSBIO.** Communication about conservation and ecology provides information about research and endangered site alerts. *Access:* [LISTPROC@U.WASHINGTON.EDU](mailto:LISTPROC@U.WASHINGTON.EDU).

- **ECOLOG-L.** Discussion list of the Ecological Society of America. Postings include information about grants, jobs, conferences, and a full range of ecological topics. *Access:* [LISTSERV@UMDD.UMD.EDU](mailto:LISTSERV@UMDD.UMD.EDU).

- **ENTOMO-L.** Information exchange among entomology researchers, instructors, and students. *Access:* [LISTSERV@LISTSERV.UOGUELPH.CA](mailto:LISTSERV@LISTSERV.UOGUELPH.CA).

- **ETHOLOGY.** Discussion about animal behavior and behavioral ecology. *Access:* [LISTSERV@SEARN.SUNET.SE](mailto:LISTSERV@SEARN.SUNET.SE).

- **GENTALK.** Forum for teachers and students on genetics and biotechnology. *Access:* [LISTSERV@USA.NET](mailto:LISTSERV@USA.NET).

- **HERP-L.** Addresses scientific study of herpetology including ecology, behavior, systematics, and biogeography. *Access:* [LISTPROC@XTAL.HARVARD.EDU](mailto:LISTPROC@XTAL.HARVARD.EDU).

- **MAMMAL-L.** Communication about mammalian biology research. *Access:* [LISTSERV@SIVM.SI.EDU](mailto:LISTSERV@SIVM.SI.EDU).

- **MORPHMET.** Focuses on morphology, the study of the size and shape of organisms. *Access:* [LISTSERV@CUNYVM.CUNY.EDU](mailto:LISTSERV@CUNYVM.CUNY.EDU).

- **PRIMATE-L.** The Wisconsin Primate Research Center's list for researchers. Includes announcements, requests for assistance, and discussion of research. *Access:* [MAJORDOMO@PRIMATE.WISC.EDU](mailto:MAJORDOMO@PRIMATE.WISC.EDU).

- **TAXACOM.** Biological Systematics Discussion List covers classification of plants and animals with an emphasis on current procedures and issues. *Access:* [LISTSERV@CMSA.BERKELEY.EDU](mailto:LISTSERV@CMSA.BERKELEY.EDU).

## Electronic journals

With the rapid growth of online journal publishing, it is impossible to provide an up-to-date list of online journals. These sites, how-

ever, are well maintained and are good sources to check for the latest electronic journals.

- **BetaCyte List of Chemistry Journals.** Although its focus is chemistry and biochemistry journals, this site is a model journals page. Journals are categorized by the extent of information provided online, e.g., full-text/no fee, full-text/fee-based, some full-text articles, tables of contents/abstracts, etc. *Access:* <http://www.betacyte.pair.com/journals.html>.

- **WWW Virtual Library: Journals, Conferences, and Current Awareness.** An extensive, up-to-date list of journals arranged by publisher and title. *Access:* <http://golgi.harvard.edu/journals.html>.

- **Pedro's Biomolecular Research Tools—Bio/Chemical Journals and Newsletters.** Comprehensive guide to more than 200 journal tables of contents/abstracts. Indicates journals with full-text articles online. *Access:* [http://www.public.iastate.edu/~pedro/rt\\_journals.html](http://www.public.iastate.edu/~pedro/rt_journals.html).

## Biology resources

The following resources, arranged by subject area, are prominent sites of interest to many biologists.

- **National Biological Service (NBS).** Information about NBS programs with links to NBS research stations and databases. The National Biological Information Infrastructure initiative to provide access to national, state, local, and private biological databases is of particular interest. *Access:* <http://www.nbs.gov>.

- **The Smithsonian Natural History Web.** Provides information about research programs at the National Museum of Natural History and links to data and graphics files from the Smithsonian's specimen collections. *Access:* <http://www.nmnh.si.edu/>.

- **University of California Paleontology Museum.** Includes outstanding guides to the museum's collections and offers an extensive set of links to other specimen collections. *Access:* <http://ucmp1.berkeley.edu/>.

- **Biodiversity and Biological Collections Webserver.** A guide to sources in systematics and organism-based biology. Focuses on specimen collections, taxonomic authority files, and reports of standards bodies. *Access:* <http://muse.bio.cornell.edu/>.

## Botany

- **The Internet Directory for Botany.** Searchable and browsable index of botany re-

sources; a product of international collaboration among Canadian, Finnish, and U.S. botanists. Includes alphabetical and subject indexes. *Access:* <http://meena.cc.uregina.ca/~liushus/boio/idb.html>.

- **American Association of Botanical Gardens and Arboreta.** Links to member institutions which include most major U.S. and some foreign botanical gardens. Includes links to other sites of botanical interest. *Access:* <http://www.mobot.org/AABGA/welcome.html>.

- **Flora of North America.** A collaborative project to compile comprehensive descriptions of plants growing in the U.S., Canada, and Greenland. The first two volumes of a proposed 14-volume set are available online. *Access:* <http://straylight.tamu.edu/fna/fna.html>.

- **Plants National Database.** Produced by the National Plant Data Center of the U.S. Department of Agriculture, this database includes common and scientific names, economic importance, growth habits, links to a distribution map, and references to the literature. *Access:* <http://trident.ftc.nrcs.usda.gov/plants>.

## Ecology

- **Ecology WWW page.** Includes a broad view of ecology and resources from many life science areas. Sites are listed by title and are searchable by keyword (title and URL). *Access:* <http://biomserv.univ-lyon1.fr/Ecology-WWW.html>. North American mirror at <http://meena.cc.uregina.ca/~liushus/bio/ecology.html>.

- **Biodiversity, Ecology, and the Environment.** Good starting point for Web resources. Includes a comprehensive list of biological journals available online. *Access:* <http://golgi.harvard.edu/biopages/biodiversity.html>.

- **Long-Term Ecological Research (LTER) Program.** Established by the National Science Foundation to support research on long-term ecological phenomena in the U.S. Includes links to 18 LTER sites as well as a searchable bibliography of research at LTER sites. *Access:* <http://lternet.washington.edu/>.

## Genetics and molecular biology

The Human Genome Project and other genetics research is computer-intensive and led to the development of comprehensive and sophisticated Web resources. While the basic science behind these sources can be intimidating, the "Primer on Molecular Genetics" and the help screens at Entrez provide excellent introductions for the nonbiologist.

- **The NCBI WWW Entrez Browser.** Integrates many protein and DNA sequence databases (GenBank, EMBL, DDBJ) into one easy-to-use format. Includes more than one million Medline records as well as BLAST (Basic Local Alignment Search Tool) searches and 3-D views of structures. *Access:* <http://www3.ncbi.nlm.nih.gov/Entrez/>.

- **NIH Molecular Modeling Home Page.** Provides links to and short descriptions of services that give 3-D views of molecules. *Access:* [http://cmm.info.nih.gov/modeling/net\\_services.html](http://cmm.info.nih.gov/modeling/net_services.html).

- **Molecules R US.** This site provides a forms interface to search and retrieve molecular structure data from the Brookhaven Protein Data Bank. Using viewer programs such as RasMol, Mage, and Raster3d, protein structures can be viewed and manipulated in a variety of formats. Links to retrieve viewer software are provided. *Access:* <http://molbio.info.nih.gov/cgi-bin/pdb>.

- **Jackson Laboratory WWW Server.** Jackson Lab maintains the Mouse Genome Database and the Encyclopedia of the Mouse Genome, sources of comprehensive current information on mouse genetics including data on mouse loci, experimental genetic mapping data, probes and PCR primers, polymorphisms, nomenclature, and associated bibliographic references. *Access:* <http://www.jax.org/>.

- **Online Mendelian Inheritance in Man (OMIM).** OMIM is the continuously updated, full-text, searchable version of Victor A. McKusick's *Mendelian Inheritance in Man*, a comprehensive encyclopedia of human genes and genetic disorders. *Access:* <http://www3.ncbi.nlm.nih.gov/omim/>.

- **Computational Molecular Biology at NIH.** Major sequence- and text-based databases, analytical tools, lab protocols, and important reference sources in molecular biology. *Access:* <http://molbio.info.nih.gov/molbio/>.

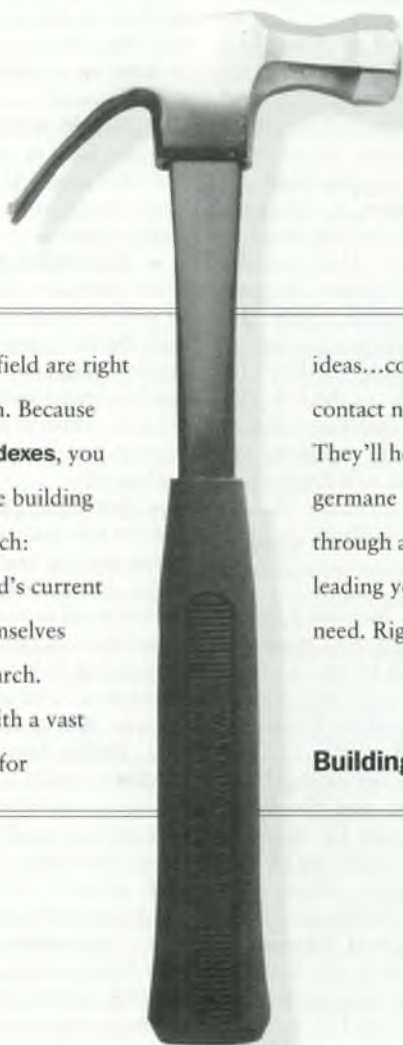
- **Primer on Molecular Genetics.** A good introduction to basic genetics and biocomputing for the nonspecialist. Includes an extensive glossary. *Access:* <http://www.gdb.org/Dan/DOE/intro.html>.

## Microbiology

- **EcoCyc: Encyclopedia of E. coli Genes and Metabolism.** Comprehensive encyclopedia describing the genetics and metabolism of the bacterium *E. coli*. Information is provided primarily in a graphical interactive format. Avail-



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able through a Web server, but should be downloaded and run locally for best results. *Access:* <http://www.ai.sri.com/ecocyc/ecocyc.html>.

• **All the Virology on the WWW.** Produced by the Garry Lab at Tulane University, this is an excellent list of virus-related sources on the Web. Includes tutorials, pointers to other virology sites, publications from the lab, etc. *Access:* <http://www.tulane.edu/~dmsander/garryfavweb.html>.

• **Microbial Strain Data Network (MSDN).** A well-organized page that provides links to culture catalogs, collections, and other sources on viruses, bacteria, fungi, yeasts, etc. *Access:* <http://www.bdt.org.br/bdt/msdn/>.

• **American Society for Microbiology.** An extensive, nonannotated list of links to resources in microbiology, as well as information about products, services, and business of the society. *Access:* <http://www.asmta.org/>.

## Zoology

• **Zoology on the Internet (Zoology Record).** Maintained by BIOSIS; organized by topic and by animal group. *Access:* <http://www.york.biosis.org/zrdocs/zoolinfo/zoolinfo.htm>.

• **Entomology Index of Internet Resources.** Collaborative effort among researchers at Colorado State University and Iowa State University. This searchable database can be browsed by subject categories. *Access:* <http://www.ent.iastate.edu/List/defaultN.html>.

• **Herpetology (Biosciences).** World Wide Web Virtual Library index of herpetology. Contains a directory of herpetological sites for classification, meetings, organizations, journals, universities, museums, and other topics of interest. *Access:* <http://xtal200.harvard.edu:8000/herp/>.

## Education resources

• **Project BIO.** Joint project among Iowa State University and community colleges, high schools, and industries to develop and share biology education resources. Major efforts include developing online biology courses and sharing curriculum materials. *Access:* [http://biotech.zool.iastate.edu/Project\\_Bio/Homepage.html](http://biotech.zool.iastate.edu/Project_Bio/Homepage.html).

• **BioEd: Biological Sciences Education Resources.** Comprehensive list of education resources for college-level biology. *Access:* <http://www-hpcc.astro.washington.edu/scied/bio.html>.

• **Access Excellence.** Sponsored by Genentech; designed to provide information for high school biology teachers and enable exchange of lesson plans and techniques. The "Resource" section contains an excellent selection of educational links of benefit to college and university instructors. *Access:* <http://www.gene.com/ae/>.

• **The MIT Biology Hypertextbook.** Hypertextbook designed for the MIT Introductory Biology course contains a syllabus, chapters on basic college biology, a searchable index, self quizzes, and practice problems. *Access:* <http://esg-www.mit.edu:8001/bio/>.

• **The Interactive Frog Dissection.** An online tutorial with step-by-step instructions and pictures of a frog dissection. *Access:* <http://curry.edschool.Virginia.EDU/go/frog/>.

• **Biology Education Software FAQ.** Maintained by the Biology Education Software Taskforce (B.E.S.T.) at the University of Washington, this site contains reviews of selected biology education software. Each review contains a description, short review, and a section on source and pricing. *Access:* <http://www.zoology.washington.edu/biosoft/>.

• **Whole Frog Project.** Uses high-resolution MRI imaging and other techniques to visualize anatomical structures. Includes MPEG and Quicktime movies of a rotating, transparent frog. *Access:* <http://george.lbl.gov/ITG.hm.pg.docs/Whole.Frog/Whole.Frog.html#intro>.

• **UTK Mathematical Life Sciences Archives WWW Server Home Page.** Contains reviews of mathematical and educational software for life sciences. Shareware programs may be downloaded directly. *Access:* <http://archives.math.utk.edu/mathbio/>. ■

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