

# REDISCOVERING BIOLOGY

Molecular to Global  
Perspectives

## Overview and Credits

### Introduction to Project

#### Goal and intended audience

*Rediscovering Biology* was designed for high school biology teachers who have substantial knowledge of basic biology but who want to learn about important new discoveries of the last two decades. It was also designed so teachers could familiarize themselves with research methods and tools that will lead to new discoveries in the coming decade. In designing the project we asked: What do teachers already know? What information would help them better understand recent and future developments?

This is not a curriculum development project and does not attempt to provide materials for use in the high school classroom. In most cases, the level of presentation is too advanced for those who are beginning the study of biology. But through exposure to the research methods and techniques used by today's scientists, and with an understanding of some important new concepts, we hope that teachers will gain a heightened appreciation of ideas they already teach, as well as an increased ability to incorporate new topics into their curriculum.

Other users — such as college students, advanced high school students, professional scientists, graduate students from other fields, or well-educated laypersons — may also find this project useful. We welcome their use of these materials.

The materials were designed to be used in various ways. Some individuals may want to learn about a single topic and study parts of one unit on their own. Some may join in small facilitator-led groups, such as professional development in-service sessions, to go over one or a group of related units. Others may choose to complete the entire course. For the latter group, graduate credit may be earned through Colorado State University. For information on earning credit or obtaining materials go to:

[http://www.learner.org/channel/workshops/graduate\\_credit.html](http://www.learner.org/channel/workshops/graduate_credit.html).

#### How topics were chosen

The teachers and researchers on our advisory board each proposed ten to twenty areas of biology that they thought had undergone significant change in the preceding decade. The cumulative list was then combined and narrowed down to thirteen major unit topics that the group agreed would provide a good foundation for those wanting to learn about new developments in biology.



This is not a comprehensive treatment of the field of biology. It includes areas of study that may be entirely new to some, such as genomics and proteomics. It also includes more traditional topics, such as human evolution and neurobiology, which have changed substantially because of the application of new techniques. Indeed, a common theme throughout the project is the application of processes and techniques at the molecular level to enlighten studies of organisms, populations, or ecosystems.

### Assumptions about user knowledge

We assume that users of this material have knowledge equivalent to that of someone with a bachelor's degree in a biological science. Most terms and concepts that are used in a high school biology text are not defined or explained. We also recognize that biology is a rapidly advancing field, and someone who graduated from college a decade ago could not have been exposed to some of what is taught today. Biology is also a huge field of study, and many students who graduate from college this year, even, will not have been exposed to all of the material collected here. Many of the concepts we explore can be found in a recent introductory college biology textbook such as Freeman's *Biological Science*, or Campbell and Reece's *Biology*. Users might find it useful to have access to such a text as an additional reference.

### Project Components

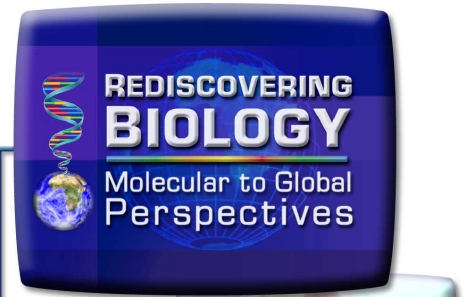
*Rediscovering Biology* is a multimedia project. Each of the thirteen units comprises a half-hour video, an online text chapter, and a set of learning activities. The Web site provides access to all of these, as well as additional resources, including:

- a glossary that serves as a navigational tool to other parts of the project
- interactive case studies
- transcripts from expert scientist interviews
- animations from the videos and case studies
- still images from the videos and text book

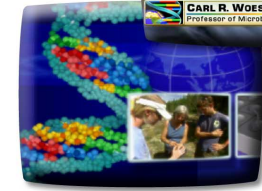
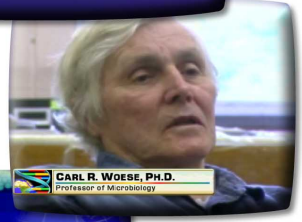
The videos and the text chapters can be used independently; if both are used, it is possible to start with either one. We imagine that most users will watch the video first, then read the chapter, and then perhaps watch the video again.

Each video includes interviews with two or more expert scientists. Through these interviews viewers will get a sense of how and why these scientists do their research, and will have a look at some of the equipment and techniques they use. In choosing experts to interview, we looked for those who are nationally and internationally recognized, regardless of their gender or ethnicity. Should you wish to know more about the work of a particular researcher featured in the videos, the full transcripts from the interviews with these experts are available on the Web site.

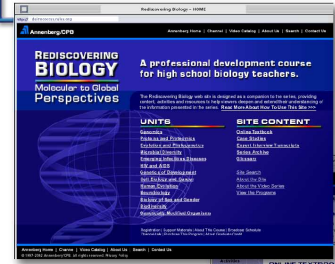
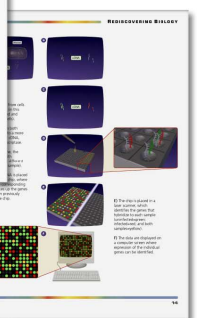
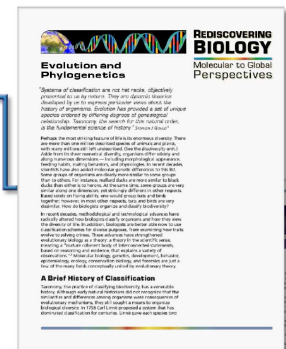
The Web site is both to organize the different components of the project and a place to go for additional information. On the Web, a comprehensive glossary defines important terms used throughout the series, and provides links to text and animations where these concepts are explained or used. Animations from the videos are available on the Web site so that users may study them in more detail, playing them



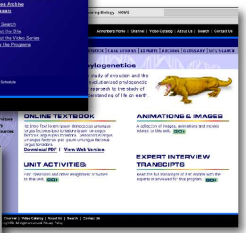
Video



Text



Web



Computer Graphics — Bergmann Graphics

repeatedly or pausing in the middle to study them. Transcripts of interviews of scientists provide a rare opportunity to get to know scientists who are associated with many of the leading discoveries in biology today and understand their research.

## Order of units

Users may decide to study all thirteen units or they may be interested in a single one. Each unit is meant to stand alone, but we often refer to ideas and techniques presented in other units. We have organized the units so that techniques such as microarray analysis or BLAST searches, which are used in several units, are explained early in the series. An html form of the text is available on the Web; from it users may navigate through the various units and the different components.

## Online text

The online text chapters are not simply a repeat of what is in the video. Rather, they show how information from the video fits into the larger field. In other words, they provide context for the focused examples presented in the video. One central theme present in nearly all of the chapters of the online text is the role that genetics and genomic studies have had in increasing our understanding of the various fields of biology.

Each chapter was written by one of three authors, selected for his or her knowledge of biology and ability to write clearly about that knowledge. All of these authors have taught at the college level. The chapters vary somewhat in style and level of difficulty; these differences result both from the nature of the material itself, as well as from differences among writers.

## Authors

**Amy Does, PhD**, is a microbiology instructor at Portland Community College in Portland, Oregon. In addition to teaching prenursing students, she provides professional development for elementary school teachers who conduct afterschool science clubs. She has developed exhibits for a science museum, designed science software for middle school students, and taught college-level biology online. Amy is the author of the Microbial Diversity, Emerging Infectious Diseases, HIV and AIDS, and Genetically Modified Organisms chapters.

**Norman A. Johnson, PhD**, is an adjunct research assistant professor at the University of Massachusetts at Amherst. His research has focused on speciation and several other areas of evolutionary genetics. In addition to the University of Massachusetts, Norman has also taught at the University of Chicago and the University of Texas at Arlington. Norman served as the style editor for all thirteen chapters, and is the author of the Evolution and Phylogenetics, Genetics of Development, Human Evolution, Neurobiology, and Biodiversity chapters.

**Teresa Thiel, PhD**, is a professor of biology at the University of Missouri-St. Louis. Her main interests are molecular biology, microbiology, and bioinformatics. She directs a program for high school teachers and students called "Science in the Real World: Microbes in Action" that includes a Web site of the same name. She teaches microbiology and microbial genetics to undergraduate and graduate students, and offers summer workshops in microbiology for teachers.

Teresa is the author of the Genomics, Proteins and Proteomics, Cell Biology and Cancer, and Biology of Sex and Gender chapters.

## Learning activities

Each unit contains several learning activities tailored to the information in the unit. These activities include simple review and discussion questions; exercises that demonstrate how data are generated, interpreted, and applied; explorations of ethical issues; and consideration of how the information relates to other fields. Most of the activities assume the participants are familiar with the unit's video and online text.

## Case studies

Four interactive Web-based case studies showcase a specific area of applied or basic research in cancer, comparative evolution, HIV, or genetically modified organisms. Each case study takes the participant through a series of steps in a research project. After viewing explanatory and background material on the project, the participant chooses an experiment to perform or a hypothesis to test. The case studies provide an interactive experience that complements the video and text chapters; and provide a window into the choices, challenges, compromises, and rewards associated with one area of biological inquiry. Each case study is an independent activity but may incorporate information from more than one unit.

Because the case studies go into greater depth than the videos and texts, and rely on information from them, it is best to do them after completing the other components. The first Web page of each case study provides links to the videos and online texts that are relevant to the study.

## Writers

**Chris Tachibana, PhD**, has taught undergraduate biology since 1992 at Salt Lake Community College, Penn State University, and the University of Washington. She is a research scientist at the University of Washington Biochemistry Department and the Carlsberg Research Labs in Denmark. Chris developed two case studies: The Genetics of Resistance to HIV and Designing an Anti-Cancer Drug. She also authored the learning activities for the Genomics, Proteins and Proteomics, Emerging Infectious Diseases, HIV and AIDS, Cell Biology and Cancer, Biology of Sex and Gender, and Genetically Modified Organisms units. In addition, she produced the learning activity course guides for all thirteen units, and gave the learning activities for all units a common voice.

**Andrea (Andi) White, PhD**, is a postdoctoral research associate at the University of California, Berkeley. As a graduate student at the University of New Hampshire she was a teaching assistant for marine ecology, honors biology, economic botany, and a lab coordinator for plant biology. Her current research interests focus on algal stress physiology and biochemistry, and the generation of environmentally friendly, alternative fuel sources from green algae. Andi developed two case studies: Evolution of Tungara Frog Mating Calls and Plant Genetic Modification. She also authored learning activities for the Evolution and Phylogenetics, Microbial Diversity, Genetics of Development, Human Evolution, Neurobiology, and Biodiversity units.

**Norman A. Johnson, PhD**, (see biography under online author) also contributed to the learning activities for the Evolution and Phylogenetics, Microbial Diversity, Genetics of Development, Human Evolution, Neurobiology, and Biodiversity units.

## Project Team

### Advisors

In addition to determining the content of the units, our advisors and consultants have been actively involved in reviewing the material for all thirteen units throughout its development. Videos, animations, case studies, and text chapters have all been reviewed several times during their production for accuracy and to ensure that these materials are as useful as possible to the intended audience.

Our primary advisors and consultants consisted of a team of eight scientists involved in teaching, curriculum development, and research.

**Mark Bloom, PhD**, is a science educator at Biological Sciences Curriculum Study (BSCS). He has developed print and Web-based curriculum materials for students in middle school, high school, and college. Previously, he was the assistant director of the Dolan DNA Learning Center, where he ran workshop programs for high school and college teachers. He developed the first educational kits using the polymerase chain reaction and coauthored the college lab manual *Laboratory DNA Science*. Mark was lead advisor for the Genomics, Proteins and Proteomics, Cell Biology and Cancer, and Biology of Sex and Gender units.

**Steve Boyarsky** is the coordinator of curriculum improvement at Staff Development at Southern Oregon Education Service District. Steve coordinates professional development in a three-county region in southern Oregon. He taught high school biology and human anatomy/physiology for 18 years. Steve has been involved with state and national level biology education through the National Science Teachers Association, a congressional fellowship, grants, and curriculum projects. Steve commented on appropriateness of content, level, and style of all project components.

**Alan Dickman, PhD**, is the biology curriculum director and an associate professor of biology at the University of Oregon. He has organized summer outreach programs in science for middle school, high school, and community college teachers, and has been involved in nationally funded programs to improve college-level biology education. Alan teaches introductory biology courses and an upper-division forest biology course. As lead scholar, Alan was responsible for final scholarly quality of all content of all project components.

**Marion Field Fass, ScD**, is an associate professor of biology at Beloit College. She has been involved in curriculum reform efforts in biology through the BioQUEST Curriculum Consortium and the SENCER (Science Education for New Civic Engagements and Responsibilities) project of AAC&U. In 2002 she traveled to Kenya and Tanzania to work with professors who were developing undergraduate courses about the epidemic of HIV/AIDS and about its impact in their communities. Marion was lead advisor for the Microbial Diversity, Emerging Infectious Diseases, HIV and AIDS, and Genetically Modified Organisms units.

**Paula Henderson** has taught biology at Newark High School in Newark, Delaware since 1980, and received the Outstanding Biology Teacher award for Delaware in 1993. She has taught a course in human heredity and development at the University of Delaware, and is a coauthor of the NIH/BSCS module “The Brain: Understanding Neurobiology Through the Study of Addiction.” Paula commented on appropriateness of content, level, and style of all project components.

**Patrick Phillips, PhD**, is an associate professor of biology and a member of the Center for Ecology and Evolutionary Biology at the University of Oregon. His research focuses on theoretical and empirical studies of evolutionary genetics. He teaches foundations of biology, evolution, population genetics, and experimental design; and is the creator of the evolutionary biology Web site, EvoNet.org. Patrick was lead advisor for the Evolution and Phylogenetics, Genetics of Development, Human Evolution, Neurobiology, and Biodiversity units.

**John Postlethwait, PhD**, is a professor of biology in the Institute of Neuroscience at the University of Oregon. His research interest is in developmental genetics; he and his group have discovered a genome duplication event that occurred before the vast radiation of teleost fish, which account for half of all species of vertebrates. His lab is currently investigating the genetic mechanisms that may help account for that explosion of biodiversity. The author of two non-majors textbooks for college students, John is committed to undergraduate education and has taught introductory biology to mostly non-biology majors since 1964. John provided critical assistance for the Genetics of Development unit and parts of several other units.

**Carol Wheeler** is a biology teacher and department chair at Pine Creek High School in Colorado Springs, Colorado. She worked in medical research and was a certified histocompatibility technologist prior to teaching. She received a Christa McAuliffe grant to develop a molecular biology course, and an Intel grant designed to help get students eligible to compete in science fairs at the international level. Carol commented on appropriateness of content, level, and style of all project components.

## Evaluation

In addition to the guidance from our team of advisors and consultants, an independent formative evaluation of three of the thirteen units was conducted by **RMC Research Corporation**. RMC Research staff selected ten biology teachers and ten professional development providers, who varied with respect to geographic location, race and ethnicity, and background knowledge in biology. These reviewers provided helpful input on these three units while they were being developed; suggestions made on these units were generalized, where appropriate, to the other ten units.

## Funder

*Rediscovering Biology* is funded by Annenberg/CPB, a partnership between the Annenberg Foundation and the Corporation for Public Broadcasting (CPB), which uses media and telecommunications to advance excellent teaching in American schools. Annenberg/CPB videos help teachers increase their expertise in their fields and improve their teaching methods. For information on obtaining Annenberg/CPB materials, go to [www.learner.org](http://www.learner.org) or call 1-800-LEARNER.

## Producer

Oregon Public Broadcasting (OPB) is a highly experienced producer of educational content with expertise in both traditional and new media approaches to formal education, community outreach, and television production.

OPB has produced many series for Annenberg/CPB, including *THE UNSEEN UNIVERSE: An Introduction to Microbiology*; *A WORLD OF ART: Works in Progress*, a series on contemporary artists; *AMERICAN PASSAGES: A Literary Survey*, a multimedia series for college students; and *ARTIFACTS & FICTION*, a professional development workshop series for teachers on interdisciplinary approaches to American literature. OPB has also been the co-producer for video series and digital materials to accompany several McGraw-Hill textbook publications.

OPB has a long history of producing Web sites, teachers' guides, and other curriculum materials to accompany educational and PBS broadcast series. Working in close concert with national advisory boards, OPB's staff has produced curriculum materials in the humanities and sciences for a variety of grade levels and teacher professional development.

OPB is also a major producer of PBS Primetime documentary series, and has created programming for NOVA, FRONTLINE, and other programs as well as numerous specials and limited series.

## Research Staff

*Rediscovering Biology* would not be possible without the hard work of the research and production staff at Oregon Public Broadcasting. The research staff provided critical support for video producers, authors, and activity developers.

**Cindy Lefton** has a bachelor's degree in zoology and a master's degree in mass communication with an emphasis on science writing and editing. She has served as the editor of a medical news magazine, and has edited several medical textbooks and journal articles. Her interests in science and nature have led to volunteer service as an education coordinator for a wildlife rehabilitation facility, a zoo guide, and a science fair coordinator.

**Liza Nicoll** earned a bachelor's degree in biology and a bachelor's degree in health science at the University of Massachusetts at Amherst in the spring of 2001. Since completing work on *Rediscovering Biology* she has continued to work in television production, researching for a world history documentary series.

**Stephani Sutherland** earned a doctorate in neuroscience from the Vollum Institute at Oregon Health & Science University, where she coordinated an outreach program in public junior high and high schools called Kids Interested in Discovering Science (KIDS). Since leaving the research laboratory in 2001, she has worked as a science news reporter for the Los Angeles Times and traveled around the world. She now works for the Journal of Neuroscience and writes freelance science news for various journals. Stephani was also a coauthor for the Neurobiology chapter of the online text.

## Interviewees

We are grateful to so many of these people who were willing to find time for this project. The following people provided valuable information to the project through interviews.

### **Genetically Modified Organisms**

Leon Corzine; David L. Dornbos, Jr., PhD; Rebecca J. Goldberg, PhD; Marion Nestle, PhD, MPH; Thomas E. Newberry; and Gary H. Toenniessen, PhD.

### **Emerging Infectious Diseases**

Capt. Daniel Carucci, MD, PhD; Rita Colwell, PhD; Laurie Garrett; Stuart B. Levy, MD; Judith M. Martin, MD; and Lukas K. Tamm, PhD.

### **Cell Biology Cancer**

Elizabeth Blackburn, PhD; Brian Druker, MD; Leland Hartwell, PhD; Mary-Claire King, PhD; and Robert Weinberg, PhD.

### **Biology of Sex and Gender**

Holly Ingraham, PhD; David Page, MD; and Eric Vilain, MD, PhD.

### **Genomics**

David Altshuler, MD, PhD; James Carrington, PhD; Jonathan Eisen, PhD; and Eric Lander, PhD.

### **Proteins and Proteomics**

Hamid Bolouri, PhD; Ned David, PhD; Stanley Fields, PhD; Hunter Fraser; Aaron Hirsh; and Leroy Hood, PhD.

### **Microbial Diversity**

Anne Camper, PhD; Bill Costerton, PhD; Dan Kotansky, PhD; Anna-Louise Reysenbach, PhD; Frank F. Roberto, PhD; Phil Stewart, PhD; and Paul Sturman.

### **HIV and AIDS**

Edward Berger, PhD; Laurie Garrett; Jay Levy, MD; Rob Roy MacGregor, MD; Erik Vonmuller; and David Weiner, PhD.

### **Evolution and Phylogenetics**

Phillip Gingerich, PhD; Timothy Read, PhD; and Carl Woese, PhD.

### **Human Evolution**

Kari Stefansson, MD; Ian Tattersall, PhD; Ajit Varki, MD; and Christopher Wills, PhD.

### **Neurobiology**

Wolfhard Almers, PhD; Fred Gage, PhD; Richard Haganir, PhD; and John Williams, PhD.

### **Biodiversity**

James Miller, PhD; Richard Ostfeld, PhD; Peter H. Raven, PhD; Eleanor Sterling, PhD; and G. David Tilman, PhD.

### **Genetics of Development**

Judith Eisen, PhD; Markus Grompe, MD; John Incardona, PhD; Nipam Patel, PhD; and John Postlethwait, PhD.



## Additional Acknowledgements

We would like to thank the following people at Oregon Public Broadcasting in addition to the researchers who made this project possible.

Executive Producer Meighan Maloney; Production Manager Doug Brazil; Production Media Manager Catherine Stimac; Production Assignment Manager Joshua Wolfe; Web Developer John Kin; Web Assistant Ryan Servatius; Assistant Production Manager Mary Hager; Database Administrator Heather Chambers; and Copyeditor Jennifer Ingraham.

The *Rediscovering Biology* video series was produced by Oregon Public Broadcasting's Educational Media Production Department. The creative team consisted of the following: Executives in Charge of Production David Davis and Jack Galmiche; Executive Producer Meighan Maloney; Producer/Writers Melissa Gerr, Nadine Jesling, Amanda Lowthian, and Eric Slade; Writer Andrew Holtz; Series Host Lew Frederick; Academic Director Alan Dickman; Production Assignment Manager Joshua Wolfe; Production Manager Doug Brazil; Production Media Manager Catherine Stimac; Researchers Cindy Lefton, Liza Nicoll, and Stephani Sutherland; Director of Production Services Milt Ritter; Manager of Production Scheduling Bill Dubey; Director of Engineering Information Dave Fulton; Assistant Director Sean Hutchinson; Assistant Production Manager Mary Hager; Pre-Production Coordinator Thea Bergeron; Videographers Art Adams, Karel Bauer, S.O.C., David Dennison, Paul Jacobson, Lisa Suinn Kallem, Jim Langley, Michael McNamara, Corky Miller, Ben Nieves, John Patzer, Todd Sonflieth, Dave Spangler, and Wally Szczubialk; Editors Tom Babich, Bruce Barrow, Sarah Marcus, Chris Nolan, John Patzer, and Kate Schoninger; Field Audio Michael A. Bidese, Chad Birmingham, Darren Brower, Kevin Brown, Chris Callus, Francis X. Coakley, Tony D'Annunzio, Thom Dentler, Jay Farrington, Dave Foreman, Thomas Forliti, Gerry Formicola, G. John Garrett, Joel Groeblichhoff, Cindy Hogan, Chip Lake, Randy Layton, Gordon Masters, Casey Quinlan, C.A.S, Todd Schmidt, Brandt Sennhenn, Mike Tyrey, Ted Ver Valen, Bill Ward, and Matt Yeasley; Creative Director Tim Bergmann; Production Artists Dora Papay, Corrina Reff, and Jefferson P. Vowell; 3-D Animations Hot Pepper Studios, Animation Dynamics, Inc., and Kevin Washington; Rights Assistant Morgan Currie; Theme Music Cal Scott; Production Intern Larry Johnson; Production Art Interns Soumalay Douangmala, Kim Harshberger, and Kevin Jaquette; Production Assistants Michael Aaris, David Banyan, Emily Chapman, Mike Forest, Kenyatta Gomez, Madeleine Pappas, Michelle Pridemore, Anastasia Savko, Alex Selkowitz, and Jonathan Zintel.

The *Rediscovering Biology* Web Site was produced by the following creative team: Oregon Public Broadcasting Web Developer/Producer John Kin; Web Assistant Ryan Servatius; Database Administrator Heather Chambers; Project Coordination, Flash Interactive Development and Project Design AMAZING! Online Marketing, LLC in association with Moshofsky/Plant Creative Services and Bergmann Graphics.