

Annenberg/CPB Course Guide

Rediscovering Biology:

Molecular to Global Perspectives

A 13-part multi-media course for in-service high school biology teachers

Produced by Oregon Public Broadcasting

Rediscovering Biology: Molecular to Global Perspectives

is produced by
Oregon Public Broadcasting

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ISBN: 1-57680-748-7

Funding for
Rediscovering Biology: Molecular to Global Perspectives
is provided by Annenberg/CPB.

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About the Course

Overview

Designed as a professional development content series for in-service high school biology teachers, **Rediscovering Biology** is a set of graduate-level course materials covering new developments in the field of research biology.

The goal of *Rediscovering Biology* is to provide the biology content that teachers need to put emerging biological discoveries in context. This 13-part integrated media learning resource uses video, Web, and print to deliver content and activities sufficient to support a three-credit graduate-level course. The materials may also be used in in-service workshops or study groups.

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, go to http://www.learner.org/channel/workshops/graduate_credit.html. See Course Components for more information about using the materials.

Learning Objectives

With *Rediscovering Biology*, teachers will attain the in-depth knowledge required to put concepts of high school biology—particularly new advances in the field—into context for themselves and their students.

Teachers will:

1. deepen their understanding of current advances in life science in a way that emulates how new knowledge is actually gained by researchers: through inquiry, questioning, investigating, analysis, and exposure to new ideas;
2. experience rich, interactive learning about the latest technological advances in the life sciences; and
3. enrich their understanding of the bioethical issues arising from advances in technology and research areas.

Unit Descriptions

Unit 1. Genomics

Having determined the complete DNA nucleotide sequence of humans and several other organisms, today's research has shifted to identifying genes and determining their function. This unit reviews the techniques used in BLAST searches, microarray experiments, and other genomics tools.

Unit 2. Proteins and Proteomics

Researchers know it is the proteins made by a cell that determine what that cell does. In this unit we explore the varying complements of proteins, their effects, structures, and interactions within the mechanism of cell function and introduce the larger picture of proteomics and systems biology.

Unit 3. Evolution and Phylogenetics

The ability to compare DNA sequences from different organisms is refining our perspective on evolution. This unit illustrates how molecular techniques are now combined with fossil evidence to explore relationships in organisms from whales to anthrax.

About the Course, cont'd.

Unit 4. Microbial Diversity

Microbial diversity far surpasses all other diversity on the planet. This unit examines recent studies of microbes including extremophiles, the comparisons of Bacteria and Archaea, and the formation and life cycle of biofilms.

Unit 5. Emerging Infectious Diseases

New diseases arise and old diseases, such as malaria and influenza, are returning with renewed vigor. In this unit we study the complex causes and far-reaching impacts of emerging infectious diseases around the globe.

Unit 6. HIV and AIDS

Studying natural resistance to HIV has led to insights into the infection process and may produce new treatments or a vaccine. This unit explores recent developments in the study of HIV and AIDS, the future global impact of the current infection levels, and the ethical issues surrounding current research and treatments.

Unit 7. Genetics of Development

Organisms as different as flies, fish, and humans share a set of genes, known as a genetic toolkit, which guides development. This unit explores new understanding of the remarkable similarity in these molecules and processes, and the ethical questions involved in this research.

Unit 8. Cell Biology and Cancer

Cancers result when genes required for normal cell function are mutated and the resulting cells undergo other changes ultimately leading to uncontrolled division. This program reveals new information on normal cell function, proto-oncogenes and tumor suppressor genes and their role in the cell cycle, and current research in drug design for specific cancers.

Unit 9. Human Evolution

Homo sapiens is now the only living representative of what was once a multi-branched bush of hominid species. In this unit we examine mitochondrial Eve and other fossil clues that increasingly point to Africa as the point of origin of our species. How did humans replace their hominid cousins, including Neanderthal, leaving the chimpanzee as our closest living relative?

Unit 10. Neurobiology

Neurons' electrical activity results in the release of neurotransmitters that account for everything from survival, to addiction, to learning and memory. This unit explains how neurons communicate to achieve all these functions.

Unit 11. Biology of Sex and Gender

Several genes help determine what makes a human embryo develop female or male sexual anatomies. This unit examines recent findings that have challenged previous beliefs about the roles of anatomy, environment, and genetics in the determination of gender, and the evolution of sexual determination.

Unit 12. Biodiversity

With current extinction rates exceeding those of previous mass extinctions, many biodiversity studies focus on efforts to count the Earth's species before they are lost. We explore in this unit current field experiments studying complex ecosystems, and how environmental and biodiversity changes might affect their functions.

About the Course, cont'd.

Unit 13. Genetically Modified Organisms

While genetic modification of organisms has occurred for millennia, we now have the tools to insert specific genes from one organism into cells of unrelated species. This unit illustrates the processes used, and how such genetically transformed organisms are increasingly common in agriculture, industry, and medicine, and introduces the ethical considerations of GMO research.

Course Components

Rediscovering Biology is a multi-media project. Each of the 13 units comprises a half-hour video, an online text chapter, and a chapter of this course guide that includes a set of learning activities.

For study of any of the content areas, you may view the videos or read the online text chapters independently, or you may choose to use both. For facilitated workshops or graduate-level courses for credit, you should use the videos, online text, and this course guide. The videos and online text cover content, and the course guide provides learning activities and a suggested structure for putting it all together.

The Videos

View videos of *Rediscovering Biology* on the Annenberg/CPB Channel or on-demand at our Web site. You can also order videocassettes from our Web site or by calling 1-800-LEARNER. For a broadcast schedule, video on-demand, or to order videocassettes online, go to www.learner.org.

Each video includes interviews with two or more expert scientists. Through these interviews, you 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 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. Go to the course Web site at www.learner.org/channel/courses/biology for access to the online text and other course resources.

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 and from differences among writers.

Course Components, cont'd.

Course Guide With Learning Activities

Several learning activities have been tailored to the information in each 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. This course guide includes a menu of the unit activities, helpful hints for the facilitator, the approximate length of time needed for each activity, and materials needed to complete the activities.

The Web Site

Go to the course Web site at www.learner.org/channel/courses/biology for access to the online text, a pdf version of this guide and all the activity materials, and 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 online text

Channel-Talk

Channel-Talkbio is the email discussion list for *Rediscovering Biology: Molecular to Global Perspectives*. Share information and pose questions about the course and get to know your colleagues.

To subscribe to Channel-Talkbio, visit:

<http://www.learner.org/mailman/listinfo/channel-talkbio>

Helpful Hints for Facilitators

Successful Course Sessions

These guidelines will help you conduct successful course sessions.

Designate Responsibilities

Each week, someone should be responsible for facilitating the course sessions. This may be a professional facilitator or a volunteer from among the participants, or you may choose to divide and rotate duties among several participants.

Prepare for the Session and Bring the Necessary Materials

For each unit, the facilitator should review the menu of activities in this guide and select which activities to conduct. The facilitator is responsible for preparing and bringing enough materials for the participants to conduct the activities. The facilitator should also tell participants about any assignments that should be completed prior to arriving (for example, reading the appropriate online text chapter; send participants to the course Web site to download the online text chapters). If you will be viewing the video programs on videocassette, you may want to preview the programs.

Keep an Eye on the Time

We have suggested the amount of time you should spend on each question or activity. While these times are merely guidelines, you should keep an eye on the clock, particularly if you are watching a live broadcast. You may want to set a timer to ensure that you won't miss the beginning of the video. If you are watching the programs on videotape, you will have more flexibility if your discussions run longer.

Record Your Discussions

We recommend that someone take notes during each discussion, or even better, that you tape-record the discussions. The notes or audiotapes can serve as make-up materials in case anyone misses a session.

Share Your Discussions on the Web

The course sessions serve as a starting point to share and think about ideas. Encourage participants to continue their discussions with participants from other sites on Channel-Talk at the course Web site at www.learner.org/channel/courses/biology.

Materials Needed

Activity Materials

Each unit in this course guide contains a list of the materials needed for each activity. Consult the list prior to each session, and gather enough materials for the participants. Most of the written materials are provided in the Appendix of this guide.

About the Contributors

Advisors

In addition to determining the content of the units, our advisors and consultants have been actively involved in reviewing the material for all 13 units throughout the development of the course. 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 at the university and secondary levels.

Mark Bloom, Ph.D., 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 co-authored 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, Ph.D., 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, Sc.D., 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 co-author 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, Ph.D., 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, Ph.D., 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.

About the Contributors, cont'd.

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.

Online Text Authors

Amy Does, Ph.D., 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 after-school 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, Ph.D., 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, Ph.D., 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.

Activity Writers

Chris Tachibana, Ph.D., 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 13 units, and gave the learning activities for all units a common voice.

Andrea (Andi) White, Ph.D., 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, Ph.D., (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.

About the Contributors, cont'd.

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 lead 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 educational 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 co-author for the Neurobiology chapter of the online text.