Resource List for Research-Teaching Linkages

The Centre for Bioscience has composed a select list of resources which is designed to complement the *Research-Teaching Linkages* event. By no means is it intended to be a comprehensive list. For **cases studies and additional information**, please visit the Centre's website **www.bioscience.heacademy.ac.uk/resources/ltr/**

For details of related work across the Higher Education Academy see **www.heacademy.ac.uk/ourwork/research/teaching**

For details of the Enhancement theme on Research-Teaching Linkages see **www.enhancementthemes.ac.uk/themes/ResearchTeaching/default.asp**

Case studies and ideas for linking research and teaching in biosciences

The Centre continues to compile case studies of practice in linking teaching and research in bioscience departments. There are currently **21 case studies** available at **www.bioscience.heacademy.ac.uk/resources/ltr/linkteachresearchcasestudies.aspx**

For details of how to submit a case study please see
www.bioscience.heacademy.ac.uk/resources/ltr/linkteachresearchsubmit.aspx

Barnes CL, Sierra M and Delay ER (2003) Integrated undergraduate research experience for the study of brain injury. Journal of Undergraduate Neuroscience Education (JUNE) 1(2): A47-A52. **www.funjournal.org/downloads/barnesA47.pdf**

Boomer SM, Lodge DP and Dutton BE (2002) Bacterial diversity studies using the 16S rRNA gene provide a powerful research-based curriculum for molecular biology laboratory. Microbiology Education 3 (1): 18-25.
Description and evaluation of a ten-week curriculum for molecular biology that uses 16S ribosomal RNA genes to characterise and compare novel bacteria from hot spring communities in Yellowstone National Park.
www.microbelibrary.org/ (subscribers only)

Brown G and Atkins M (1988) Effective research and project supervision. In Effective Teaching in Higher Education. pp 115 - 149. RoutledgeFalmer, London.

Burgess AB (2002) Cooperative learning: moving from theory to practice in a class of 80 students. Bioscene 28(3): 3-8.
A large lecture course was changed to one focused on small group learning. Students work in structured teams to understand papers from the current biological literature and demonstrate their understanding by completing a worksheet in class each week. A great improvement in students' ability to apply their knowledge to new situations and propose appropriate experiments and answer questions or test hypotheses was observed.
acube.org/volume_28/v28-3p3-8.pdf

Calandra B (2002) Teaching to learn. The Scientist 16 (17): 51.
This article looks at the pleasures as well as practical career benefits that come from making time for both teaching and research. The examples are from the biological sciences, yet they clearly have application to all disciplines.
www.the-scientist.com/

Davis TA (2002) Student designed labs in physiology - what really happens? Bioscene 28 (4): 3-8.
An example of a course using student designed laboratory experiments. The first week is a design week in which student groups ask a question, pose a hypothesis and design an experiment. Week 2 is used to implement the design and collect data. Week 3 is used for group presentations where results, statistical analyses, and literature comparisons are combined to accept or reject the original hypothesis.
acube.org/volume_28/v28-4p3-8.pdf

Dwyer C (2001) Linking research and teaching: a staff-student interview project. Journal of Geography in Higher Education 25 (3): 357-366.
This paper describes the evaluation of a project used in the first year curriculum that requires students to interview a member of staff about their research.

Feltham M (unknown) Integrating key skills with scientific research: Level 2 Scientific Project Management module. Learning Development Unit, Liverpool John Moores University.
Case study describing a novel key skills-based module, Scientific Project Management, that uses the theme of scientific research to provide large numbers of students (250+) the opportunity to develop a diverse range of transferable skills whilst maintaining strong links to the rest of the curriculum.
www.ljmu.ac.uk/lid/ltweb/86328.htm

Gale C (2002) The Stanford Research Communication Programme: a case study of better integrating research in the teaching environment. LTSN Bioscience Bulletin 7:5.
A common tension with university faculty is balancing a teaching load with a research agenda. What if these responsibilities were better integrated, or the tensions between them reduced?
www.bioscience.heacademy.ac.uk/ftp/newsletters/ltsn7p5.pdf

Garett CJ and Overton TL (1996) Using Scientific papers as a Teaching Aid. Education in Chemistry, 33: 137-139.

Guilford WH (2001) Teaching Peer Review and the Process of Scientific Writing. Advances in Physiology Education 25 (3): 167- 175.
Describes and evaluates a method for teaching the full scientific publishing process, including anonymous peer review. The result is a review article for submission to a major scientific journal.
advan.physiology.org/cgi/reprint/25/3/167.pdf

Hess G and Brooks E (1998) The class poster conference as a teaching tool. Journal of Natural Resources and Life Sciences Education 27: 155-158.
Describes a biomathematical modelling project culminating in a professional style class poster conference. Students experienced the whole range of activities required to prepare for and attend a conference including writing an abstract, preparing and presenting a poster and answering questions from fellow scientists at the conference.
www.jnrlse.org/

LaPorte RE, Sekikawa A, Sa ER, Linkov F, Lovalekar M (2002) Whisking research into the classroom {Infopoints}. Brit Med J 324: 99.
This article introduces 'Supercourse' an innovative idea to speed up the transfer of current research into the classroom. Scientists put web lectures in a library on the website, and when the article was written 4700 faculty members from 141 countries had contributed 473 lectures.
bmj.com/cgi/content/full/324/7329/99

Lee AT, Hairston RV, Thames R, Lawrence T, Herron SS (2002) Using a computer simulation to teach science process skills to college biology and elementary education majors. Bioscene 28 (4): 35-42.
A computer simulation (Lateblight) was implemented to reinforce the processes of science. The students develop testable hypotheses and then use the program to run experiments and collect data. In addition, they research relevant background information and present their results in a poster.
acube.org/volume_28/v28-4p35-42.pdf

Luciano CS, Young MW and Patterson RP (2002) Bacteriophage: a model system for active learning. Microbiology Education 3 (1): 1-6.
Description and evaluation of a student centred laboratory course in which student teams selected a phage from sewage samples and characterized the phage in a semester-long project that modeled real-life scientific research. Cooperative student teams had primary responsibility for organising the content of the course, writing to learn using a journal article format, involving the entire group in shared laboratory responsibilities, and applying knowledge to the choice of new experiments.
www.microbelibrary.org/

Rangachari PK (2000) Exploring the context of biomedical research through a problem-based course for undergraduate students. Advances in Physiology Education 23 (1): 40-51.
advan.physiology.org/cgi/reprint/23/1/S40.pdf

Reavey D (2001) A new approach to the teaching of experimental design to undergraduates. Good Ideas in Environmental Sciences Learning and Teaching Swapshop, University of Kingston, Surrey.
A mini case study outlining classroom activities based on a published paper designed to allow students to develop the skills of planning and interpreting experimental investigations. See Reavey D (unknown) below for further details.

Reavey D (unknown) A new approach to the teaching of experimental design to undergraduates. Escalate Resources, Escalate Subject Centre for Education.
www.escalate.ac.uk/resources/experimentaldesign/

Rutledge ML (2001) An activity to demonstrate the concept of sampling error for the introductory biology classroom. Bioscene 27 (1): 3-6.
This activity makes students a part of an investigation that determines the frequency of a particular plant variety in a simulated population. It also provides an opportunity for students to observe the inherent variability of estimates, observe the relationship between sample size and sampling error, and consider aspects of research design.
acube.org/volume_27/v27-1p3-6.pdf

Saunders DK and Sievert L (2002) Providing students with the opportunity to think critically and creatively through student designed laboratory exercises. Bioscene 28(3): 9-15.
Students were challenged to design, write up, and carry out their own physiology laboratory experiments. Each group designed an experiment, wrote it up as a laboratory exercise, and then allowed another group to carry out the laboratory exercise. Each group also provided a critique of the other's laboratory exercise.
acube.org/volume_28/v28-3p9-15.pdf

Schailles M and Lembens A (2002) Student learning by research. Journal of Biological Education 37(1): 13-17.
A research and development project involving 10 schools in Southern Germany. Its aim was to help develop secondary students' abilities for understanding biotechnology/genetic engineering.

Stefani LAJ and Tariq VN (1996) Running group practical projects for first year undergraduate students. Journal of Biological Education 30 (1): 36-40.
This article describes some of the problems and the many rewards associated with introducing group project work to a large class of first year undergraduates.

The TELRI Project (2001) Case Study: Bioinformatics on the web. TELRI project, Centre for Academic Practice, University of Warwick. Describes a new course on Bioinformatics integrating a problem solving approach with critical discussion of appropriate approaches and choice of techniques. The focus of the course is on solving a real research problem in the area of genomics.
www.telri.ac.uk/Evaluation/cs-bioinformatics.pdf

Turner ME, Paradise NF, Johnson ML (1998) Simulating a research environment in an undergraduate genetics laboratory. Journal of Biological Education 32 (2): 92-96.
Creating the excitement of scientific discovery in an undergraduate genetics laboratory.

Wood EW (1990) RGD-Tutorials teaching on fibronectin. Biochemical Education 18 (2): 87-89.
Describes a 'Review, Get, Do' approach to turn lecture time into an interactive experience. The students undertake activities giving an insight into how biochemists use primary literature in their daily lives.

Wilkinson, D.M. (2007) Involving students in a live research project; predator students in a web based computer game.
www.ljmu.ac.uk/lid/lid_docs/Davecase_study.doc

Willmott CJR, Clark RP and Harrison TM (2003) Introducing undergraduate students to scientific reports. Bioscience Education E-journal 1 (1): 1-10.
Description and evaluation of a series of exercises undertaken with Level 1 students as introductory training towards the reading and presentation of scientific papers at Level Three and the writing up of student research projects.
www.bioscience.heacademy.ac.uk/journal/vol1/beej-1-10.htm

Resources to use with students

Barnard C, Gilbert F, McGregor, P (1993) Asking Questions in Biology - Design, Analysis and Presentation in Practical Work. Longman, Harlow. This book explores how to: formulate hypotheses and predictions, design critical observations and experiments to test them, choose appropriate statistical analyses, present results and write reports.

Benos DJ, Kirk KL and Hall JE (2003) How to Review a Paper. Advances in Physiology Education 27(2): 47-52. An excellent introduction to how and why papers are reviewed.
advan.physiology.org/cgi/reprint/27/2/47

Beynon RJ (1993) Postgraduate Study in the Biological Sciences: A Researcher's Companion. Portland Press Ltd, London.
A guide aimed at both student and supervisor. The emphasis is on the importance of planning and the need to develop independence of thought and action.

Bioscience Horizons (coming soon)
A new national undergraduate journal featuring undergraduate research.
oxfordjournals.org/our_journals/biohorizons/

Engage in Research: The interactive resource for bioscience students
A website aimed primarily at undergraduates, covering a range of questions about research and the scientific method.
www.engageinresearch.ac.uk

ed. Greenfield T (2002) Research Methods for Postgraduates. Arnold, London.
Presents an interdisciplinary perspective and includes guidance on writing a proposal and securing funds; the design of trials and surveys; data analysis; presentation; intellectual property; and career opportunities.

Hay I and Thomas SM (1999) Making sense with posters in biological science education. J. Biol. Edu. 33 (4): 209-214.
Briefly reviews the purposes of posters in teaching biology before going on to provide some detailed instruction for students on how to prepare a good, effective poster.

Luck M (1999) Your Student Research Project. Gower Publishing Ltd, Aldershot.
Considers a final year research project in the context of a student lifestyle. Includes advice, ideas and examples whilst giving thought to how to manage workload in a crowded and exciting life.

Phillips EM and Pugh DS (1994) How to get a PhD; a handbook for students and their supervisors. Open University Press. 'A handbook and survival manual for PhD students'. Issues that are often neglected such as time management, and overcoming the difficulties of communicating with supervisors.

Quinn GP and Keough MJ (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press, Cambridge.
An essential book for any student or researcher in biology needing to design experiments, sampling programs or analyse the resulting data. Data sets, chapter questions and links to software are provided by an associate website.

Seel DC (1989) Getting started on a research project in field biology: practical guidance for students. Journal of Biological Education 23 (3): 222-238.
A research project in field biology is an organised piece of study involving an appreciable amount of planning. Certain stages need to be anticipated very early on in order that the work can be completed satisfactorily and pleasurably.

Spangler BD (2002) Methods in Molecular Biology and Protein Chemistry: Cloning and Characterization of an Enterotoxin Subunit. John Wiley and Sons Ltd, Chichester.
A structured series of experiments developing molecular biology and biochemistry skills as an integrated part of a research project. A major goal of the course is to teach students how to troubleshoot, re-do experiments as necessary and make progress towards a research goal.

Wedgwood M (1987) Tackling Biology Projects. MacMillan Education Ltd, Houndmills.
This book offers straightforward help and guidance in a style which is uncomplicated and authoritative while taking a sympathetic and realistic view of the kinds of problems, difficulties and challenges faced by students when doing a practical project in biology.

Reports from previous Centre for Bioscience events

Report from Developing Enquiring Minds: Integrating research, teaching and learning
Napier University, 14 March 2007
www.bioscience.heacademy.ac.uk/events/napier07.aspx

Research Links throughout the Bioscience Curriculum
Higher Education Academy, York, 25 October 2005
www.bioscience.heacademy.ac.uk/events/york05.aspx

CETL links

The Learning Through Enquiry Alliance
A partnership of Enquiry-Based Learning Centres for Excellence in Teaching and Learning (CETLs). **www.ltea.ac.uk/**

Key references

Boyer EL (1990) Scholarship Reconsidered: Priorities of the Professoriate. The Carnegie Foundation for the Advancement of Teaching, Princeton, NJ. A seminal book which argues that the emphasis in US universities on what he calls 'discovery research', has been at the expense of more integrative scholarship and a concern for undergraduate teaching.

Jenkins A (2004) A Guide to the Research Evidence on Teaching-Research Relations. Higher Education Academy, York.
www.heacademy.ac.uk/assets/York/documents/ourwork/research/id383_guide_to_research_evidence_on_teaching_research_relations.pdf

Jenkins A, Healey M, and Zetter R (2007) Linking teaching and research in disciplines and departments. Higher Education Academy, York.
www.heacademy.ac.uk/assets/York/documents/LinkingTeachingAndResearch_April07.pdf

Jenkins A, Breen R, Lindsay R (2003) Reshaping Teaching in Higher Education: Linking Teaching and Research. Kogan Page, London.
Covers the research evidence; academic research and student motivation; designing the curriculum to link teaching and research; organizing the institution and the department to link teaching and research; how national policies can support teaching-research links.

Sears H and Wood EJ (2005) Linking Teaching and Research in the Biosciences. Bioscience Education E-journal, volume 5 available at
www.bioscience.heacademy.ac.uk/journal/vol5/beej-5-4.htm

A longer bibliography of selected references on Generic Teaching/Research Relationships is available at **www.brookes.ac.uk/genericlink/bibliography.htm!**

Educational Research References - Bioscience

Bell RL, Blair LM, Crawford BA and Lederman NG (2003) Just do it? Impact of a science apprenticeship program on high school students understandings of the nature of science and scientific inquiry. Journal of Research in Science Teaching 40 (5): 487-509.

Centre for Academic Practice, University of Warwick. Research based Learning Project. The project is exploring the theme of linking teaching and research and supporting academic departments in clarifying how research informs their teaching. In many cases this involves making explicit existing practice rather than necessarily requiring fundamental change. **www2.warwick.ac.uk/services/ldc/resource/rbl**

Committee on Undergraduate Biology Education to Prepare Research Scientists for the 21st Century (2002) Bio2010 Transforming Undergraduate Education for Future Research Biologists. National Academies Press, Washington, D.C.
books.nap.edu/books/0309085357/html/

Coker JS and Davies E (2002) Involvement of plant biologists in undergraduate and high school student research. Journal of Natural Resources and Life Sciences Education 31: 44-47. Results of a survey by the American Society of Plant Biologists of member participation in support of undergraduate research and high school research.

Hattie J and Marsh HW (1996) The Relationship Between Research and Teaching: A Meta-Analysis. Review of Educational Research 66: 507-542.
A meta-analysis of 58 research studies on teaching /research relationships; analysed through discussion of various models of how teaching and research may be related.

Leach J, Lewis J and Ryder J. (1998) Learning about the actual practice of science: three case studies of undergraduate labwork from the UK. Leeds: Centre for Studies in Science and Mathematics Education, University of Leeds.
www.education.leeds.ac.uk/research/cssme/projects.php?project=62&page=2

Leach J, Millar R, Ryder J, Séré M-G, Hammelev D, Niedderer H and Tselfes V (1998) Survey 2: Students' images of science as they relate to labwork learning. Working Paper 4 of the Labwork in Science Education Project.

Leach J, Ryder J, Driver R. (1997) Undergraduate science research projects and students' images of the nature of science. Undergraduate Learning in Science Project Working Paper 5. ISBN 0 904421 767. This paper addresses students' images of the nature of science and investigates the extent to which these are changed through project work.

Lopatto D (2003) The essential features of undergraduate research. Council on Undergraduate Research Quarterly March 2003: 139-142. The results of an informal inquiry amongst science faculty at three US institutions: What are the essential features of a successful undergraduate research experience? What are the benefits of a successful undergraduate research experience? **www.cur.org/Quarterly/mar03/essentialUR.pdf**

Mabrouk PA and Peters K (2000) Student perspectives on undergraduate research experiences in chemistry and biology. Council on Undergraduate Research Quarterly September 2000: 25- 33. **www.cur.org/Quarterly/sept00/mabrouk.pdf**

Mickley GA, Kenmuir C and Remmer-Roeber D (2003) Mentoring undergraduate students in neuroscience research: a model system at Baldwin-Wallace College. The Journal of Undergraduate Neuroscience Education (JUNE) 1(2): A28-A35.
Describes "the Neuroscience laboratory at Baldwin-Wallace College and identifies a system that has been successful in attracting and mentoring undergraduate neuroscientists and providing meaningful laboratory experiences in the context of a sustained research programme." **www.funjournal.org/downloads/mickleyA28.pdf**

Roach M, Blackmore P and Dempster J (2000) Supporting high level learning through research-based methods: Interim guidelines for course design. TELRI project, Centre for Academic Practice, University of Warwick. **www.telri.ac.uk/guidelines.pdf**

Ryder J and Leach J. (1996) A summary of findings and recommendations arising from the Research Project Study. Undergraduate Learning in Science Project Working Paper 8. ISBN 0 904 42180 5. This paper presents a summary of research findings from the study. Recommendations arising from these findings are intended as suggestions or discussion points for science lecturers who are involved in the implementation of research projects in the undergraduate science curriculum.

Ryder J, Leach J, Driver R. (1996) Final year projects in undergraduate science courses. Undergraduate Learning in Science Project Working Paper 3. ISBN 0 904 42174 0.
This paper addresses science lecturer's views of the aims of final year projects, their views of the supervision of project students, project assessment and the departmental administration of projects.

TLTP 3 Project: Technology Enhanced Learning in Research-led institutions (TELRI).
The TELRI project was set up to assist academic staff to develop research-based approaches to teaching, through the effective use of learning technologies.

Wood W (2003) Inquiry-based undergraduate teaching in the life sciences at large research universities: a perspective on the Boyer report. Cell Biology Education 2: 112-116.
A paper describing the outcomes of a discussion by life scientists of the 1997 Boyer Commission report. The group concluded that whilst "independent research experience for every undergraduate may not be feasible or desirable"...."life science departments should institute transformations towards inquiry based teaching across a broad spectrum of research-related experiences, ranging from student centred, inquiry- based introductory courses to project laboratories to faculty-mentored independent research."

International links

Australia

The Nexus Project
An institutional project at the University of Wollongong that has: "explored the ways in which academics across the disciplines perceive the link between teaching and research."
cedir.uow.edu.au/nexus/

France

Biologos - on-line undergraduate research journal from the University of Rennes
www.biologos.univ-rennes1.fr/ (in French)

USA

The Council on Undergraduate Research (CUR)
Promotes research by faculty and undergraduates in the natural and social sciences, mathematics, and engineering at predominantly undergraduate colleges and universities.
www.cur.org/

Journal of Young Investigators
Online peer-reviewed national journal of undergraduate research
www.jyi.org/

The University of Arizona Undergraduate Biology Research Program (UBRP)
"The Undergraduate Research program is an educational program designed to teach students science by involving them in biologically related research. Students are paid for their time in the lab where they develop an understanding of scientific method and receive a realistic view of biological research".
https://ubrp.arizona.edu/

Caltech's Summer Undergraduate Research Fellowships program (SURF)
SURF is modelled on the grant-seeking process: students collaborate with potential mentors to define and develop a project; applicants write research proposals for their project; faculty committee reviews the proposals and recommends awards; students carry out the work over a 10-week period in the summer. At the conclusion of the program, they submit a technical paper and give an oral presentation at SURF Seminar Day, a symposium modelled on a professional technical meeting.
www.surf.caltech.edu/

University of Michigan Undergraduate Research Opportunity Program (UROP)
The Undergraduate Research Opportunity Program (UROP) creates research partnerships between first and second year students and University of Michigan faculty. A key feature of the program is that it operates during the academic year and peer advisors help undergraduate researchers adjust to unfamiliar expectations and learning opportunities.
www.lsa.umich.edu/urop/