

14th Biennial Conference on Chemical Education

Paper R-AM-SY-K-2: An Ethics Course for Science Majors

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ETHICS IN THE PHYSICAL SCIENCES COURSE OUTLINE AND REFERENCE BOOKS

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The reference list for this course was developed during my reading over the last 30 years (beginning in graduate school) and in consultation with a large number of generous people, most of whom I met through the AAAS Scientific Freedom and Responsibility office. I am glad to share this in the hope that others will also develop ethics courses or integrate ethics into their chemistry and science curriculum in other ways. **I ask only one thing in payment: that if you find any additional useful references, you send them to me, so that I can also benefit from *your* experience.** I have not read all of these books, so some of the comments are based on reviews; please let me know about duds too. Thanks and good luck.

COURSE OUTLINE

The letters (a - h) coding the parts of the course are also used in the references.

Introduction

Approaches to identifying moral and ethical standards and dilemmas by **philosophy** / religion
How **scientific research** and development is done and disseminated.
The ethical dilemmas in **student**, personal and everyday life - are they different or do only the stakes change?
General issues of **ethics in science** .

Scientists and their Experiments

The **scientific method** : myth and reality
Funding of scientific **research** and **development** , internally and externally
Design, execution and reporting of experiments: opportunities for

error and fraud

- Research questions and intent
- Anticipation and prevention of systematic errors
- Data collection and records
- Data analysis
- Software reliability

The **scientific literature**

Expected content of publications: experiments, analysis, connections and conclusions

Peer review, publication and ownership

The role of **error** in science and technology

Self-deception and wishful thinking and the special allure of data which confirm the hypothesis

Good science, sloppy science, generally accepted procedures

Deliberate **misrepresentation** of data and analysis.

Examples of that clearly represent fraudulent science.

Why do scientists commit fraud?

Can you **distinguish** fraud, wishful thinking and error?

Is the process of selecting and analyzing data intrinsically a **misrepresentation** ?

Standards for scientific information

Federal (NIH, NSF) and NAS definition of fraud and misconduct

Procedures for dealing with scientific misconduct.

Statements of good practice for publication of research results

Publication pressure: the minimum publishable unit, quantity vs quality, evaluation standards.

Scientists and their **Peers**

The **role** of colleagues

Collaborators : authorship and **credit** : coauthors, acknowledgements and references

Reviewers of manuscripts and proposals: privilege and responsibility with prepublication information, ensuring the integrity of the literature, fair evaluations, protection of the ownership of the ideas.

Sources of information: **Copyrights** and plagiarism. Fair use of copyrighted materials, paper and magnetic.

Organizers of symposia and editors of books: ideological bias and gender or race **discrimination** .

Evaluators of careers: jealousy, personality, sex and race

Ensuring the integrity of the research **literature**:

Detecting and reporting fraud and error - does peer review do this?

Conflict of interest : unavoidable. Disclosure or disqualification from some activities.

Scientists and their **Protegees / Employees**

What are the roles of teachers, mentors and bosses?

Responsible **mentoring**

Responsible **evaluation** - to the subject and the recipient

Gender and race , sexual harassment, misc. personality conflicts.
Credit, Appropriate authorship, and references
Responsibility for **safety** and security

Scientists, their **Bosses and their Funding**

Career choice factors

Power

Academia: Administration and **Funding**

Industry: **Management** , Funding, External regulation, e.g. by law

Consulting as a career. **Divided loyalties** .

Government: Supervisors. The real boss is the taxpayer?

Proprietary and classified research.

Disagreements over scientific **facts, interpretation,** and **uses** of discoveries.

Disagreements over **methods,** and **people,** e.g. intellectual property, sexual **harassment** .

Whistle-blowing inside and outside the corporation.

Scientists and the **Public**

Occasions when scientists interact with the public

Responsibility of scientists

Research **relevance** , outcomes, accuracy

The letter of the law: RCRA, OSHA, etc.

Beyond the letter of the law: **public responsibility** .

Anticipating **consequences** of science and technology (e.g. pollution, drug side effects), contributing to constructive use of inventions.

Public education regarding facts, certainty and uncertainty, **risk assessment.**

Demands on scientists

Scientists and war, esp. physics and chemistry.

Responsibilities of all citizens, society

Science and **democracy**

Civil liberties and **national security**

Proprietary rights and public safety.

Major Issues in **Biology and Medicine** which differ from the other sciences

Research

Use of animal subjects

Use of human subjects

Effect on human life expectancy and quality, privacy (e.g. genome project)

Development and Applied Activities

Is medicine science?

Who should have the power to make decisions?

Codes of Ethics for Scientists

NAS/NAM/NAE

American Chemical Society

American Physical Society

The Royal Society of Chemistry
American Institute of Chemists
Others

REFERENCES I: BOOKS AND ARTICLES

Introductory and General Books

Philosophy

Robert L. Holmes, *Basic Moral Philosophy*, Wadsworth, Belmont, CA, 1993. Models that have been and are now used by philosophers to understand and codify the moral sense. The historical information included in the chapters on each approach to a fundamental model is helpful. ABCDEF¹

C. E. Harris, Jr., *Applying Moral Theories*, Wadsworth, Belmont, CA, 1992. Basic philosophical approaches to resolving ethical dilemmas.

Organized by fundamental models and illustrated with modern case studies illustrating complex ethical dilemmas. ABCDEF

Sissela Bok, *Lying: Moral Choice in Public and Private Life*, Pantheon Books, New York, 1978. A profound and engaging analysis of a subject neglected by the philosophers, who are busy arguing about truth. The reasons for lying are unmasked and the consequences examined. You will never accept expert opinion so easily again, nor will you lie easily to others. ABCDEF

John Rajchman, *Truth and Eros: Foucault, Lacan and the Question of Ethics*, Routledge, 1991. Recommended by another ethics in science instructor.

Sounds forbidding. A

Mary F. Belenky, Blythe M. Clinchy, Nancy R. Goldberger and Jill M. Tarule, *Women's Ways of Knowing*, Basic Books, New York, 1986. ACD

Nell Noddings, *Caring: A Feminine Approach to Ethics and Moral Education*, University of California, Berkeley, 1984. AD

The life of a scientist

On Being a Scientist, National Academy of Sciences, Washington, DC, 1989.

A pamphlet covering many of the basic issues of scientific life. ABC

Jacob Bronowski, *Science and Human Values*, Messner, NY, 1956. A

philosophical yet practical discussion of the origins of values in science and their impact on society. See exp. 75ff, 85. A

Peter B. Medawar, *The Limits of Science*, Harper and Row, NY, 1984. AB

#Peter B. Medawar, *The Art of the Soluble*, Methuen, London, 1967. A series of lectures, essays and book reviews; see "Two Conceptions of Science" and "Hypothesis and Imagination". A

Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed., Chicago U. Press, Chicago, 1962, 1970. This famous book distinguishes normal science (data collection, adding to the evidence) from revolutionary science, in which a complete change in fundamental outlook, or paradigm, occurs. The

¹Letters refer to parts of the course a, b, c, d, e, f, g, h, (caps or not) as labelled in the Course Outline. Most references provide information on several parts of the course.

classical examples of paradigm shift are Newtonian to quantum mechanics, and the origins of the concepts of continental drift and evolution. Chemistry could perhaps claim a paradigm shift in the concept that structure determines reactivity. A

Donald Braben, *To Be a Scientist*, Oxford Univ. Press, Oxford, UK, 1994.

The author was responsible for funding highly exploratory research and presents an interesting discussion of strategies of success in research (including choosing a problem) and an analysis of the effect of science on the economy and vice-versa. He tries to show what turns people on about doing science, but his contacts are hardly typical. AB EF

Max Perutz, *Is Science Necessary?*, Oxford Univ. Press, 1991. A collection of essays from a thoughtful and famous pioneer in molecular biology.

W. I. B. Beveridge, *Seeds of Discovery: The Logic, Illogic, Serendipity, and Sheer Chance of Scientific Discovery*, Beveridge, 1980?

Ethics for scientists

C. Ian Jackson and John Prados, *Honor in Science*, Sigma Xi, Research Triangle Park, NC 1986. A serious short discussion of basic scientific ethics aimed at junior scientists but a reminder to all. AB

C. I. Jackson and J. W. Prados, *Honor in Science*, *Amer. Sci.*, **1983**, *71*, 462 - 464. Precursor to the book(let). ABC

Mike Muller, *Why Scientists Don't Cheat*, *New Scientist*, **1977** (June 2), *74*, 522 - 523. AB

Richard S. Nicholson, *On Being a Scientist*, *Science*, **1989**, *242*, 305. A

Kristin Shrader-Frechette, *Ethics of Scientific Research*, Rowman and Littlefield, Lanham, MD 1994. A foundation for consideration of ethical issues specific to science. Scientists have a duty to do research; it ought not to be biased, to endanger unnecessarily people or the environment, to use public funds for profit or to fail to receive informed consent. Research ought to be objective, promote the public good and serve the values of a liberal society. ABDFG

Stanley G. Korenman and Allan C. Shipp, *Teaching the Responsible Conduct of Research through a Case Study Approach: A Handbook for Instructors*, American Assoc of Medical Colleges, Washington DC 1994. The book covers all aspects of misconduct in science from a medical perspective, including animal and human subjects and genetic information. ABG

Rosemary Chalk, ed., *Science Technology and Society: Emerging Relationships*, AAAS, Washington, DC 1988. An out-of-print collection of articles on science and freedom, responsibility, ethics, citizens, national security, and the importance of human character on science and science on the world. ABF

D. Callahan and S. Bok, eds., *Ethics Teaching in Higher Education*, Plenum, NY, 1980. What kinds of goals and courses exist elsewhere? A series of articles by a variety of experts. A

Scientists and their Experiments

Doing and Publishing Science

W. I. B. Beveridge, *The Art of Scientific Investigation*, 3rd Ed., Vintage

Books, NY, 1957. B

E. Emmet Reid, Invitation to Chemical Research, Franklin Pub., Palisade, NJ 1961. AB

Howard M. Kanare, Writing the Laboratory Notebook, American Chemical Society Washington, DC, 1985. An excellent practical guide for how to record and certify your data to ensure that your experiments can be reported accurately. B

Henry H. Bauer, Scientific Literacy and the Myth of the Scientific Method, Univ. of Illinois Press, Urbana, 1992. The author attempts to debunk the conventional wisdom about what science is and what the public needs to know about it. A

E. Bright Wilson, An Introduction to Scientific Research, McGraw-Hill, NY, 1952. Ethics is not discussed explicitly, but standards for experimental design, execution, analysis, credit and publication are presented in detail - completely relevant to today. ABCD

Peter B. Medawar, Advice to a Young Scientist, Harper and Row, NY, 1979. How to choose a research topic and collaborators; good manners, good science and their rewards; philosophical foundations and implications. Very British and very old-boy. ABCDE

Stephen S. Carey, A Beginner Guide to the Scientific Method, Wadsworth, Belmont, CA, 1994. For the non-scientist. Much that is predictable, but some good examples and questions that test your critical skills and estimating ability. ABF

Frederick Grinnell, The Scientific Attitude, 2nd ed., Guilford Press, London/New York, 1992. How to do science and be a professional scientist, from a cell biologist's point of view. The scientific method is influenced by thought style, scientific social interactions, and the everyday world. Examples of method, ethics and misconduct from biomedical research. Thorough but dry. ABG

Ethical Guidelines to Publication of Chemical Research, Acc. Chem. Res. 1994, 27, 179 - 181. Also published in The ACS Style Guide (see Books F) CDF

Error

Lewis Branscomb, Integrity in Science, Amer. Sci. 1985, 73, 421 - 423. Self-deception is a bigger problem than fraud. BC

Joseph Jastrow, The Story of Human Error, Appleton-Century-Croft, New York, 1936. B

Daniel W. Hering, Foibles and Fallacies of Science; an account of scientific vagaries, Van Nostrand, New York, 1924. The incidents discussed are "ancient history", including astrology, divination, transmutation of metals. B

Herbert L. Nichols, Science Blundering: an outsider's view, North Castle, Greenwich, CT, 1984

Error or Fraud?

Richard J. Herrnstein and Charles Murray, The Bell Curve: Intelligence and Class Structure in American Life, Free Press, NY 1994. This controversial book claims that certain identifiable groups appear more commonly at the

bottom of the socio-economic spectrum because they are, on average, less intelligent, less able to cope, etc. and quotes a variety of studies of IQ to support their contention. Anyone reading this book should also read reviews by statisticians and black journalists, or read Gould, The Mismeasure of Man, for an alternate interpretation of the data. BC

G. Taubes, Bad Science: The Short Life and Weird Times of Cold Fusion, Random House, NY, 1993. The rush to publicity/publication, the tendency to fall in love with your own theories (but probably not fraud), and university and funding politics are all part of this story, which is not over yet (see articles for updates). BCE

John R. Huizenga, Cold fusion, the scientific fiasco of the century, Oxford U. Press, Oxford & New York, 1994. The author was a strong critic of the possibility of cold fusion from the beginning and has actively campaigned against the fusion interpretation of the unexplained heat in electrochemistry. Peer review was also a big issue here. BC

Judy Sarasohn, Science on Trial: the whistle blower, the accused and the Nobel laureate, St. Martin's Press, New York, 1993. Probably more than you wanted to know about Baltimore, Imanishi-Kari, O'Toole, etc. and whether the data was correctly reported. BCDE

Donald Hollis, Abusing Cancer Science, Strawberry Fields Press, Chelahis, WA, 1987. Hollis is the fly on the wall observing the struggle over priority in the development of NMR imaging, especially to detect cancer. C

Fraud and Misconduct

W. Broad & N. Wade, Betrayers of the Truth, Simon & Schuster, NY 1982. Some famous scientists of the past were less than candid about their observations. BC

Stephen J. Gould, The Mismeasure of Man, W. Norton, NY, 1981. Preconceived results and carelessness continues to distort the study of human intelligence as a function of genetics and environment. BG

Alexander Kohn, False Prophets: fraud, error and misdemeanor in science, Blackwell, NY, 1986. A large number of examples of fraud, theft, slander, and misrepresentation in science are discussed thoroughly from the scientist's point of view. He suggests other interpretations for some famous cases than outright fraud. BCDEF

Robert Bell, Impure Science: fraud, compromise and political influence in scientific research, Wiley, New York, 1992. Science can hurt the public and vice-versa. But the main point of the book is the influence of money (and fame) on the conduct of science. It's not clear the author correctly identifies the villains - he certainly makes it look as if scientists are a greedy, unscrupulous bunch. BF

Marcel LaFollette, Stealing into Print: Fraud, Plagiarism and Misconduct in Scientific Publishing, Univ of California Press, Berkeley, 1992. The book discusses all the ways the scientist can get credit in the scientific literature that might be deceitful, including mistakes, frauds, misappropriation of data and credit, etc. Provides an excellent discussion of the process by which scientific information becomes public. BCDE

Arthur Koestler, The Case of the Midwife Toad, Hutchinson, London, 1971. This classic case of biological fraud attempts to prove that learned behavior

can be inherited. BG

Joseph Hixson, The Patchwork Mouse, Anchor Press, Garden City, NJ, 1976. This tale of blatant fabrication in genetics research reminds me of some of the things students have done. BCDG

Standards for data publication

Daniel Andersen, Lis Attrup, Nils Axelsen & Povl Riis, Scientific Dishonesty and Good Scientific Practice, Danish Medical Council, Copenhagen, 1992.

How science is done, how misconduct is defined, investigated and punished, with mostly medical examples. BG

Responsible Science: Ensuring the Integrity of the Research Process, National Academy Press, Washington, DC 1992. A report prepared by a broadly based committee of scientists identifying areas of threat to scientific integrity and possible solutions. Good bibliography. BCD

Albert H. Teich and Mark S. Frankel, Good Science and Responsible Scientists, AAAS, Washington, DC 1992. A booklet summarizing the conclusions of a National Conference of Lawyers and Scientists with recommendations as to who should take what action. BF

James S. Dodd, ed., The ACS Style Guide: A Manual for Authors and Editors, Amer. Chem. Soc., Washington, DC, 1986. Includes copyright information and the Ethical Guidelines for Authors. BCD

Mark S. Frankel, Science, Engineering and Ethics, AAAS, Washington, DC 1988. A collection of symposium papers and discussions. BCF

John T. Edsall, Scientific Freedom and Responsibility, AAAS, Washington, DC, 1975. BF. A booklet summarizing discussions of the AAAS Committee on Scientific Freedom and Responsibility. It includes science and values, data integrity, theft of ideas, informed consent, potential forbidden research areas, secrecy, responsibility to the public. BCF

Research Ethics, Alan R. Liss, Inc., NY, 1983. A series of interesting readings. B

Project on Scientific Fraud and Misconduct, Reports on Workshops 1,2, and 3, AAAS, Washington DC, 1989. Invited papers from the AAAS/ABA National Conference of Lawyers and Scientists. B

Responsible Science: Ensuring the Integrity of the Research Process, National Academy Press, Washington, DC 1992. A report prepared by a broadly based committee of scientists identifying areas of threat to scientific integrity and possible solutions. Good bibliography. BCD

Albert H. Teich and Mark S. Frankel, Good Science and Responsible Scientists, AAAS, Washington, DC 1992. A booklet summarizing the conclusions of a National Conference of Lawyers and Scientists with recommendations as to who should take what action. BF

Mark S. Frankel, Science, Engineering and Ethics, AAAS, Washington, DC 1988. A collection of symposium papers and discussions. BCF

Scientists and their Peers

Colleagues in Science

Peter J. Feibelman, A Ph.D. is NOT Enough!, Addison-Wesley, New York, 1993. A useful guide to becoming a successful research scientist; ethics not

mentioned per se but implicit is the interpersonal contracts. CDE
Carl J. Sindermann, The Joy of Science: Excellence and its Rewards, Plenum, NY, 1985. A witty look at how elite scientists spend their time and energy. C

Carl J. Sindermann, Winning the Games Scientists Play, Plenum, NY, 1982. A gently humorous and nontechnical look at how ethical and unethical social interactions between scientists affect their satisfaction and success. CDE

C. J. Sindermann, Survival Strategies for New Scientists, Plenum, NY, 1987. The book is focussed exclusively on success strategies in the research university environment. CDE

Credit and Publication

Jenny McFarland & MIT Association for Postdoctoral Women, Authorship on Publications, in Handbook for Entering Postdoctoral Associates and Fellows, MIT, pp 8-9. C

Discrimination among equals

Pool, Robert, Eve's Rib: Searching for the Biological Roots of Sex Differences, Crown Publishers, NY, 1994. An examination of the observed differences in physiology, biochemistry, mathematics ability, etc. between the sexes and an evaluation of whether they are inherent or learned, and whether the statistical differences are meaningful. BCDG

Clarice M. Yentsch & Carl J. Sindermann, The Woman Scientist: Meeting the Challenges for a Successful Career, Plenum, NY, 1992. Discussion of the hindrances to success for women academic research scientists and ways to overcome them, based on 200 interviews and even more questionnaires. CDE

Scientists and their Protegees / Employees

Responsible Mentors

John I. Goodlad, Roger Soder and Kenneth A. Sirotnik, eds, *The Moral Dimensions of Education*, Jossey-Bass, San Francisco, 1990. Includes the legal and moral responsibility of teachers. D

Discrimination and Misconduct - Protegees

Steven M. Cahn, Saints and Scamps: Ethics in Academia, Rowman and Littlefield, New Jersey, 1986. Responsibilities of teachers, scholars, colleagues and mentors are addressed with examples both good and bad from the author's experience. CD

Science, Annual specials on Women in Science and Minorities in Science. D
Londa Schiebinger, The Mind Has No Sex? Women in the Origins of Modern Science, Harvard U. Press, Cambridge, MA 1989. A scholarly analysis of the philosophical and cultural origins of women's participation and exclusion. Enlightening and very readable. BCDE

Ruth Bleier, Science and Gender: A Critique of Biology and Its Theories on Women, Pergamon, NY, 1984. BD

Jan Harding, Perspectives on Gender and Science, Falmer Press, Phila., 1986, esp. chapters 4, 8 to 10. BCD

Judith A. Ramaley, Covert Discrimination and Women in the Sciences, AAAS,

Washington, DC 1978. Thorough and thoughtful symposium. CDE

Employee Safety and Health

Lynne Olson, The Silkwoods of Silicon Valley, Working Woman, July 1984, 71-2, 106, 108, 110-111. D

Scientists, their Bosses and their Funding

Career Choices

Dorothy Rodman, Donald D. Bly, Ferd Owens, Ann-Claire Anderson, Career Transitions for Chemists, Amer. Chem. Soc., Washington, DC 1995. A clear-eyed look at how to find the right employer for you. Adaptable to other fields. E

Edwin M. Hartmann, *Organizational Ethics and the Good Life*, Oxford U. Press, Oxford and New York, 1996. Argues that a good corporate culture serves the interests of the participants and a sense of the good life appropriate to a moral person. Philosophical and sociological and not science-oriented. E

Richard P. Nielsen, *The Politics of Ethics*, Oxford U. Press, Oxford and New York, 1996. Examines the obstacles to behaving ethically in organizations and corporate mechanisms which could help overcome these obstacles. Not science-oriented. E

*Roger M. Boisjoly, Employment Search with a Conscience, unpublished. How to find an employer who treats employees and products with high ethical standards. DEF

Robert Jackall, Moral Mazes: Bureaucracy and Managerial Work, Harv. Bus. Rev., Spet 1983, 61(5), 118 - 130. Study includes a chemical company and illustrates the pattern of credit up, blame down. E

Power

Dorothy Nelkin, Science as Intellectual Property: Who Controls Scientific Research?, AAAS, Washington, DC, 1984. A short book on the ownership rights of scientific information: granting agency, employer, scientist, public. CDE

Disagreements and Whistleblowing

Deborah G. Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, NJ 1991. A selection of readings about ethical codes, whistleblowers, and what it all means. BEF

Alan F. Westin, Whistleblowing: Loyalty & Dissent in the Corporation, McGraw-Hill, NY, 1981. Case studies of attempts by scientists, engineers, etc. to correct errors from inside and outside their corporations. E

M. P. Glazer and P. M. Glazer, The Whistleblowers: Exposing Corruption in Government and Industry, Basic Books, NY, 1990. BEF

J. S. Bowman, F. A. Elliston and P. Lockhart, Professional Dissent, an annotated bibliography and resource guide, Garland Pub., Inc., NY, 1989. One section on scientists and engineers. EF

Trudy E. Bell and Karl Esch, The Fatal Flaw in Flight 51-L, IEEE Spectrum, 1987, 24(2), 36 - 51. Flight 51-L was the last of the Challenger. EF

Scientists and the Public

Roles in a public forum

Joel Primack and Frank von Hippel, *Advice and Dissent*, Basic Books, NY, 1974. An account of the rewards and frustrations of providing scientific advice to government. F

Peter Block, *Stewardship -- Choosing Service over Self-Interest*, Berrett-Koehler Publishers, San Francisco, 1993. EF

Sissela Bok, Secrets. On the Ethics of Concealment and Revelation, Pantheon, New York, 1982. Includes self-deception, gossip, professional confidentiality, corporate, state and military secrets, whistleblowing, police investigations and privacy issues. BCF

Funding by the public

Paul DeForest, Mark S. Frankel, Jeanne S. Poindexter, Vivian Weil, Eds, Biotechnology: Professional Issues and Social Concerns, AAAS, Washington, DC, 1988. The problems of doing proprietary research in a university. EF

Politics, Secrecy and War

Phantom Risk: Scientific Inference and the Law, MIT Press, Cambridge, MA, 1993. A discussion of current and appropriate standards for acceptability of scientific evidence in court using specific examples; as the title suggests, the theme is that risks are overrated. Bendectin, asbestos, PCBs, dioxin, etc. F
Carl F. Cranor, Regulating Toxic Substances: A Philosophy of Science and Law, Oxford U. Press, NY, 1993. The author believes that standards are currently too low, and the 1994 ruling is in accord with his approach to scientific proof. A reviewer pointed out significant legal and scientific errors in the book. F

Daniel Ford, Meltdown: the Secret Papers of the Atomic Energy Commission, Touchstone (Simon and Schuster), NY, 1986. A startling history of the failure of government and industry to ensure safety and quality in reactor design, construction and operation. BEF

Grigori Medvedev, The Truth about Chernobyl, trans. by Evelyn Rossiter, Basic Books, 1991. This is a frightening book. Could it happen here? For a reality check, see old PBS videos "The Brown's Ferry Incident" and "We Almost Lost Detroit". EF

Monika Rennenberg and Mark Walker, Science, Technology and National Socialism, Cambridge U. Press, New York 1993. History buffs might want to examine how science survived the third Reich. BCDEF

Mike Edwards and Gerd Ludwig, Soviet Pollution, Nat. Geog. Aug. 1994, 70 - 99; Chornobyl, Nat. Geog. Aug. 1994. 100 - 115. A reminder of how much worse it could have been in North America, and nearly was. F

Responsibility to the Public, e.g. Safety

M. J. Fraser and A. Kornhauser, eds., Ethics and Social Responsibility of Science, ICSU Press, NY, 1986. F

James H. Jones, *Bad Blood: The Tuskegee Syphilis Experiment*, Free Press (Maxwell Macmillan Intl), NY 1993. An account of the study in which poor

black men were used to study the progress of the disease long after a cure was available, and some other stories about racism in medicine. CDFG

Henry Petroski, To Engineer is Human, St. Martin's Press, New York, 1985. Dramatic examples show convincingly that we all learn more by mistakes than successes. BF

Albert Flores, ed., Ethics and Risk Management in Engineering, University Press of America, Lanham, MD, 1989. A philosophical, economic, legal and technical analysis of risk and benefit. F

Charles Perrow, Normal Accidents: Living with High Risk Technologies, Basic Books, New York, 1984. Examples include nuclear power plants such as Three Mile Island, marine disasters, dams, petrochemical plants, and early NASA near-disasters. DEF

Michael B. Gerard, Whose Backyard, Whose Risk: Fear and Fairness in Toxic and Nuclear Waste Siting, MIT Press, Cambridge, MA 1994. He actually suggests a solution: develop a needs statement, assigned by source state, and provide for a bid process for location within the state, with priority given to already contaminated sites.

Deborah G. Johnson, Computer Ethics, Prentice-Hall, Englewood Cliffs, NJ, 1985. BF

T. Forester & P. Morrison, Computer Ethics: Cautionary Tales and Ethical Dilemmas in Computing, MIT Press, Cambridge, MA, 1990. Theft, hackers, unreliability, privacy, etc. BF

K. R. Foster, D. E. Bernstein, and P. W. Huber, eds., Phantom Risk: Scientific Inference and the Law, MIT Press, Cambridge, MA, 1993. Critical reviews of real and perceived risks of chemicals and a discussion of current and appropriate standards for acceptability of scientific evidence in court using specific examples; as the title suggests, the theme is that risks are overrated. Bendectin, asbestos, PCBs, dioxin, etc. F

Carl F. Cranor, Regulating Toxic Substances: A Philosophy of Science and Law, Oxford U. Press, NY, 1993. The author believes that standards are currently too low, and the 1994 ruling is in accord with his approach to scientific proof. A reviewer pointed out significant legal and scientific errors in the book. F

Paul Brodeur, Outrageous Misconduct: The Asbestos Industry on Trial, Pantheon, New York, 1985. How lobbying by the asbestos producers prevented workers from being protected for many years after the hazard was known and understood. F

Paul Brodeur, The Great Powerline Coverup: how the utilities and the government are trying to hide the cancer hazard posed by electromagnetic fields, Little, Brown & Co., New York, 1993. How statistically significant are the cancers found in the Denver neighborhood laced with high-voltage lines?? This reporter thinks dangerously so, but the scientific evidence is weak - search for recent articles for the other side of this controversy. F

Paul Brodeur, The Zapping of America: Microwaves, their Deadly Risk and the Coverup, Norton, New York, 1977. Is your microwave oven shortening your life? This reporter thinks so, but not all scientists agree. Check the literature for further information. F

Paul Brodeur, Expendable Americans, Viking Press, New York, 1974. An expose of the occupational hazards to workers knowingly perpetrated and

perpetuated by their employers. DF

M. Fumento, Science under Siege: Balancing Technology and the Environment, Morrow, NY, 1993. Discussions of Alar, Agent Orange, gasohol, electric and magnetic fields, VDT's, food irradiation, etc., with an emphasis on epidemiology and risk evaluation. Might be a good companion to Brodeur's books. BFG

L. Caglioti, The Two Faces of Chemistry, MIT Press, Cambridge, MA, 1983. Risk and reward in technology. F

J. L. Casti, Searching for Certainty, Morrow, NY, 1990.

H. W. Lewis, Technological Risk, Norton, NY, 1990.

David L. Parnas, A. John van Schouwen, Shu Po Kwan, Evaluation of Safety-Critical Software, Commun. ACM, 1990, 33, 636 - 648. These authors pointed out the folly of expecting perfect code in such projects as "Star Wars"; many examples given here. BF

Robert D. Bullard, ed., Unequal Protection: Environmental Justice and Communities of Color, Sierra Club Books, San Francisco, 1994

Responsibility of the Public

Issues in Peer Review of the Scientific Basis for Regulatory Decisions, American Chemical Society brochure, 1985. CF

Carl Djerassi, The Politics of Contraception, Norton, NY, 1980. F

Frans C. Verhagen Energy and Equity: a Selected Research and Action Bibliography, Vance Bibliographies, Monticello, IL, 1984. This should lead you to other books - you don't just read a bibliography. F

P. Huber, Galileo's Revenge, Junk Science in the Courtroom, Basic Books / Harper Collins, NY 1991. A critical analysis of the legal histories of thalidomide, bendectin, the Audi 5000 and "chemical AIDS". This reporter believes that anecdotes, prejudice and fraud have been used to try and convict science in the court. BFG

Francisco J. Ayala and Bert Black, Science and the Courts, American Scientist, 1993, 81, 230 - 239. Expert testimony, the scientific methods and the law. BCF

Virginia Morell, Who Owns the Past, Science, **1995**, 268, 1424 - 1426. Usually, archaeological finds are studied and returned to the group who claims to be decendants. Further information is lost because they are moved. In some cases, permission to study remains is refused. Who does own the past? F

Dorothy Nelkin and M. Susan Lindee, The DNA Mystique: The Gene as Cultural Icon, W. H. Freeman & CO., New York, 1995. Popular culture claims that heredity is all - "my genes made me do it" - an approach which provides an reason/excuse for success and failure, for criminals and geniuses. What happened to hard work? FG

Major Issues in Biology and Medicine

Darwin Cheney, ed, Ethical Issues in Research, University Publishing Group, Frederick, MD, 1993. Heavy emphasis on medical research. BG

Ruth E. Berger, Elizabeth Heitman and Stanley J. Reiser, eds., The Ethical Dimensions of the Biological Sciences, Cambridge U. Press, New York, 1993.

The ethical basis of science, self-deception, guidelines for authorship, fraud and some specific examples. BCDEFG

Z. A. Medvedev, The Rise and Fall of T. D. Lysenko, Columbia Univ. Press, NY, 1969. The chilling story of political coercion of scientific thought, keeping the USSR out of genetic research for generations. Could it happen here, for example in not teaching evolution? EFG

Allen Chase, The Legacy of Malthus: the Social Costs of the New Scientific Racism, Knopf, NY, 1977. BFG

Daniel J. Kevles, In the Name of Eugenics: Genetics and the Uses and Human Heredity, Knopf, NY, 1985. BFG

Jean Rostand, Error and Deception in Science: Essays on the Biological Aspects of Life, tr. A. J. Pomerantz, Hutchison, London, 1960 BG

Christine Pierce and Donald VanDeVeer, Aids, Ethics and Public Policy, Wadsworth, Belmont, CA, 1988. A series of essays, including many on the rights of citizens in a democracy. BFG

Harold J. Morowitz and James Trefil, The Facts of Life: Science and the Abortion Controversy, Oxford University Press, NY. Written by a scientist and a science writer - accessible and provocative. FG

Randy Shilts, And the Band Played On, . The "band" was and is politicians and scientists struggling for power while people die of AIDS. BCDEFG

Christopher D. Stone, Should Trees Have Standing?. Wm Kaufmann, 1995, Avon Books, NY, 1975. Legal rights for animals and plants? FG

Tom L. Beauchamp and LeRoy Walters, Contemporary Issues in Bioethics, 4th ed., Wadsworth (International Thomson Publishing), Belmont, CA, 1994. An introduction to ethical theory, plus introductions to collections of readings about medical ethics in policy, treatment and research and law. AG
Edward Erwin, Sidney Gendin and Lowell Kleiman, eds., Ethical Issues in Scientific Research, Garland Publishing, NY, 1993. An anthology of articles mostly about biomedical and sociological research: values, fraud, human subjects, and animal, genetic and military research. BFG

T. L. Beauchamp and J. F. Childress, Principles of Biomedical Ethics, Oxford U. Press, New York and Oxford, 1989. G

Rene von Schomberg, ed., Contested Technology. Ethics, Risk and Public Debate, Intl Centre for Human and Public Affairs, Tilburg, Netherlands, 1995. Biotechnology and genetic engineering. FG

Basil Blackwell, Bioethics, 1988. A textbook for a different course. G

Codes of Ethics

A. Cournand, The Code of the Scientist and its Relation to Ethics, Science, 1977, 198, 699 - 705.

A. Cournand and M. Meyer, The Scientist's Code, Minerva, 1976 (Spring), 79 - 96.

L. Golberg, A Code of Ethics for Scientists Reporting and Reviewing Information on Chemicals, Fund. Appl. Toxic., 1982, 2(11-12), 289 - 292. BH

Ward Pigman and Emmett B. Carmichael, An Ethical Code for Scientists, Science, 1950 (June 16), 643 - 647.

AAAS: Rosemary Chalk, Mark S. Frankel, and Sallie B. Chafer, AAAS Professional Ethics Project, AAAS, Washington, DC 1980. Summary of activities by professional societies. BCDEFH

ACS:

The Chemists Creed, 1965; The Chemists Code of Conduct, 1994
Professional Employment Guidelines, American Chemical Society, brochure, 1993

Handbook for Teaching Assistants, American Chemical Society, brochure, 1983

Janet S. Dodd, Ed., The ACS Style Guide: A Manual for Authors and Editors, American Chemical Society, Washington, DC 1986, and the updated Ethical Guidelines to Publication of Chemical Research, Acc. Chem. Res. 1994, 27, 179 - 181. CDFH

Academic Professional Guidelines, ACS.

Are you up to date on copyright issues?

AIC: Code of Ethics of the American Institute of Chemists, The Chemist, September 1986, 6 - 13, 18, 20 - 22. Reference includes discussions of ethics, not just a list of rules.

APS: Guidelines for Professional Conduct, 1991.

ACM: ACM Code of Ethics and Professional Conduct, Communications of the ACM, 1992, 35(5), 94 - 99

IEEE: Code of Ethics, Institute of Electrical and Electronics Engineers, August 1990.

Royal Society: Guidance on Professional Conduct, incorporating A Code of Professional Practice, Royal Society of Chemistry, brochure, 1992. Oriented toward consulting.

US GOVT.

Principles of Ethical Conduct for Government Officers and Employees, Exec. Order 12674, 12731, Apr. 12, 1989

REFERENCES II: FICTION AND (AUTO)BIOGRAPHY

Each student completes two papers, one of which may be a review of a novel or biography about science; the review must examine ethical issues for professional scientists raised in the books.

Novels

Carl J. Djerassi, Cantor's Dilemma, Doubleday, NY, 1989. (see also The Hudson Review, 1986, 39(3), 405 - 418). A study of academic research and the lives of graduate students that asks: could Nobel Prize-winning research have been fraudulent? BCDEF

K. Vonnegut, The Cat's Cradle, Delacorte press, NY, 1963. A psychedelic tale which raises questions about scientists' responsibilities for their discoveries and presages a scientific controversy of the late 1960's. F

Margaret Atwood, The Handmaid's Tale, Houghton Mifflin, Boston, 1986. Sex discrimination in science carried to extremes. BCDEFG

Walter M. Miller, Jr. A Canticle for Leibowitz, Lippincott, NY, 1959. Importance of the written record and freedom in science. BFG

P. D. James, The Children of Men, Knopf, NY, 1992. How would humankind react if it faced the prospect of its own end? FG

Nevil Shute, On the Beach, Morrow, NY 1957. The world after a nuclear war - not much science in it but lots on the effects of science and technology. F

Farley Mowat, Never Cry Wolf, Dell, NY, 1963. A semifictional (?) account of biological preconceptions. BFG

Michael Crichton, Jurassic Park, Ballantine, NY 1990. Thoughtless commercial exploitation of genetic technology has frightening consequences. BFG

Michael Crichton, Congo, 1980. Ethics in biology dominate this book. FG

Michael Crichton, The Andromeda Strain, Knopf, NY, 1969. Some of the issues of bioethics raised were actively considered in the 1960's. FG

Nevil Shute, No Highway, Morrow & Co, NY 1948. An aircraft failure is predicted by a scientist whose personal life suggests his judgement might be impaired; is response warranted? Stereotypes of scientists, and a 1948 view of the role of women. The author designed aircraft, including one that turned out to be flawed. Finding a copy may be difficult. EF

Robert Byrne, Skyscraper, Atheneum, NY, 1985. Lots of sex and intrigue along with the technical detail. Finding a copy may be difficult. BF

Patricia D. Cornwell, Cruel and Unusual, Avon Books, NY, 1993. A murder mystery involving careless handling of forensic evidence raises questions of boss-employee interactions. DEF

Dorothy Sayers, Gaudy Night, Harper, NY 1960 (1936). Not about science, but provides some interesting insight into the difficulties of dealing with internal problems in an organization, in this case a school. CDE

C. P. Snow, The Affair, Charles Scribner's Sons, NY 1960. The aftermath of a case of fraud; for more about the British educational system, see the appendix in C. P. Snow's The Masters, Scribner's, NY 1951. BCD

C. P. Snow, The Corridors of Power, This book is considers the role of scientists in public policy and political power struggles. F

Robin Cook, Mutation, G. Putnam and Sons, NY 1989. Genetic engineering of your own offspring to produce a superbright child seems like a good idea, but... FG

Robin Cook, Outbreak, Berkley Books, NY 1987. Could the Ebola virus be spread by malice rather than accident? FG

Sinclair Lewis, Arrowsmith, Grosset and Dunlap, NY, 1945.

Robert Martin, A Stampede of Zebras. A play (by an NIH biologist) in which a well-known scientist defends his co-author against an accusation of fraud; mysteriously neat notebooks appear in support of the case during a congressional hearing. BC

R. T. Campbell, Unholy Dying: A Detective Story, 1945. A thesis advisor who steals from his students is murdered. Finding a copy may be difficult. CDE

Angus Wilson, Anglo-Saxon Attitudes, 1956. A novel about an important but possibly fake, archaeological find. B

Kinglsey Amis, Lucky Jim,. How can you publish your research when your

enemies are friends with the editors? A social science tale with much relevance. CDE

Carl Djerassi, The Bourbaki Gambit, U of Georgia Press, Athens, GA, 1994. This book about a group of unwillingly retired scientists explores the role of ego in science. Is what they did unethical? CDE

Joseph Wambaugh, The Blooding, A murder mystery which delves into the controversy about DNA fingerprinting to establish guilt or innocence. FG
Mary Wollstonecraft Shelley, Frankenstein, An interesting question to explore is whether the book reflects an antiscientific bias in her society or an attempt to sound a warning in a society which believed science would cure all ills. FG

Aldous Huxley, Brave New World, This book examines the issue of intelligence testing and prejudice from a different point of view, and makes eugenics seem reasonable. FG

Alan Lightman, The Good Benito, Pantheon Books, NY, 1995? A novel about the life of a young physicist, recommended as summer reading for scientists.

Marshall Jevons, The Fatal Equilibrium, Ballantine Books, NY. A novel about a logical economics professor and a murder; it reveals some of the potential temptations of academia. CDEF

Robin Cook, Coma, Signet, NY 1977. A medical ethics thriller with not much discussion of the ethics - what might we do to obtain organs? FG

Stephen White, Privileged Information, Zebra Book, Kensington Pub., NY 1991. A clinical psychologist struggles with the ethics of protecting client confidentiality when his career and even his life may be at stake. FG

Autobiographies

Primo Levi, The Periodic Table, Schocken Books, NY, 1984. A Jewish chemist in a concentration camp laboratory; he survived, but committed suicide in 1987. His other books and his poetry provide further insight. BEF
Christopher Stoll, The Cuckoo's Egg, The author's free-wheeling search for the "wily hacker" who obtained US military secrets by illegal access to computers and sold them to East Germany. CF

James Watson, The Double Helix, Atheneum, NY 1968. Perhaps a questionable example of ethics in science - who else should have received credit? One is discussed by Ann Sayre in Rosalind Franklin and DNA, Norton, NY, 1975 and by Francis Crick. C

Francis Crick, What Mad Pursuit: A Personal View of Scientific Discovery, Basic Books, New York, 1988. His view is very different from James Watson's of their joint discovery. AC

Richard Feynmann, Surely You're Joking Mr. Feynmann, Adventures of a Curious Character, and/or What Do You Care What Other People Think? All of these books are fairly light with little philosophical comment. Feynman's driving curiosity is interesting, even exemplary, but comes across as somewhat selfish. The third book includes his tenure on the committee examining the Challenger explosion. F

June Goodfield, An Imagined Life: A Story of Scientific Discovery, Univ. of Michigan Press, . A partially fictionalized biographical account of a few

years in the life of a research scientist. AG

Jeremy Bernstein, The Life it Brings: One Physicist's Beginnings, Ticknor and Fields, 1987. Child of rabbi becomes theoretical physicist becomes writer. His biographies of Einstein and Rabi in the New Yorker make terrific reading.

Salvador E. Luria, A Slot Machine, A Broken Test Tube, Harper and Row, 1985. Examples of "chance favoring the prepared mind" in microbiology research.

Rita Levi-Montalcini, In Praise of Imperfection, Basic Books? She received the Nobel Prize for her work on the development of the nervous system. An abbreviated biography is found in McGrayne's book to complement this autobiography.

Francois Jacob, The Statue Within, Basic Books, New York, 1988. A science student becomes guerrilla, then returns to science to win a Nobel Prize. Reflections on his life reveal many situations where he had to make decisions which were ethically difficult - sometimes he regretted his choices. B

Luis Alvarez, Alvarez: Adventures of a Physicist, Basic Books, New York, 1987. From World War II radar and atomic bomb projects to the puzzle of dinosaur extinction.

Herbert F. York, Making Weapons, Talking Peace, Basic Books, New York, 1987. The cold war involved scientists in different ethical dilemmas than the war itself. EF

Freeman Dyson, Disturbing the Universe, Harper and Row, NY, 1979. A superior writer and well-known physicist. EF

Andrew Dequassie, The Green Flame: Surviving Government Secrecy, American Chemical Society, Washington, DC, 1991. A personal account of a secret boron fuel project that was ultimately cancelled. EF

Carl Djerassi, The Pill, Pygmy Chimps, and Degas' Horse: the Autobiography of Carl Djerassi, Basic Books, NY 1992. More personal comments and reflections than in "Steroids".

Carl Djerassi, Steroids Made it Possible, ACS, Washington, DC 1990. A straightforward account of the life of a chemist whose work often had immediate applications. A few reflections toward the end.

Barbara McClintock, A Feeling for the Organism, A woman doing science in a different way and with great patience and persistence, in spite of few accolades, finally wins the Nobel Prize. BC

Nevil Shute Norway, Slide Rule: The Autobiography of an Engineer, Morrow, NY, 1954. The author's early years in aircraft design provide interesting examples of the temptations of engineers to cut corners to meet deadlines and costs. EF

Biographies (most have less focus on ethics than fiction and autobiographies)

S. B. McGrayne, Noble Prize Women in Science: Their Lives, Struggles and Momentous Discoveries, Carol Pub., NY, 1993. 9 winners and 4 others are profiled in some detail - what ethical issues arise in addition to the institutional discrimination? BCDE

Ann Sayre, Rosalind Franklin and DNA, Norton, NY, 1975. The story of a brilliant woman who was una ppreciated in sexist British science, whose

data and interpretation was used without her knowledge by Watson, Crick and Wilkins to unravel the structure of DNA. BCE

Peter Goodchild, J. Robert Oppenheimer: Shatterer of Worlds, Houghton Mifflin, Boston, 1980. BF

James Gleick, Genius: The Life and Science of Richard Feynmann, Pantheon, NY, 1992. Biographies of Feynmann provide a different perspective from his own accounts. BCDEF

Jagdish Mehra, The Beat of a Different Drum: The Life and Science of Richard Feynmann, Oxford U. Press, 1994. Biographies of Feynmann provide a different perspective from his own accounts. BCDEF

Abraham Pais, Niels Bohr's Times, in Physics, Philosophy and Polity, Oxford University Press, NY. Niels Bohr was more than a brilliant scientist and Danish patriot - he used his considerable reputation to influence western policy. CDF

Robert Kanigel, Apprentice to Genius: the Making of a Scientific Dynasty, Macmillan, New York, 1986. A kind of family tree in biochemistry - successes and squabbles in pharmacology. CDF

biographies of I. I. Rabi, e.g. by Jeremy Bernstein. F

James G. Herschberg, James B. Conant: Harvard to Hiroshima and the Making of the Nuclear Age, Alfred A. Knopf, New York, 1993. A pragmatic chemist dealing with important moral and ethical questions as he influences the direction of an university and of public policy. Be forewarned - 948 pp! CDE

Gerald L. Geison, The Private Science of Louis Pasteur, Princeton U. Press, Princeton, NJ 1995. One hundred years ago, ethical issues regarding testing of vaccines were not yet developed; was Pasteur's rabies vaccine tested in too risky a way? And how much did he steal or borrow from colleagues and competitors? A new look at an otherwise careful and influential scientist. It would be worthwhile to compare this account with a more positive one. BCEFG

BCEFG

Robert M. Hazen, The New Alchemists: Breaking Through the Barriers of High Pressure, Times Books, NY, 1994. Competition in industrial research. CDEF

LINDA M. SWEETING 1995

Electron Magnetic Resonance: Applications in Physical Sciences and Biology, Volume 50, describes the principles and recent trends in different experimental methods of Electron Magnetic Resonance (EMR) spectroscopy. In addition to principles, experimental methods and applications, each chapter contains a complete list of references that guide the reader to relevant literature. The book is intended for both skilled and novice researchers in academia, professional fields, scientists and students without any geographical limitations. It is useful for both beginners and experts in the field of Elec