

**FES 819a**

# **BIOTECHNOLOGY**

## **SOCIAL, ENVIRONMENTAL, AND INTERNATIONAL DIMENSIONS**

**FALL 2002 Tuesdays 2:30 – 5:20** Instructor: **Kathleen McAfee** kathleen.mcafee@yale.edu

OFFICE HOURS: Wed. 11:00– 2:00 or by appointment 301 Prospect St. Room 202 432 3736

Biotechnology promises to break the vicious cycles of hunger, loss of wilderness for farming, and damage by agricultural toxics and wastes — or does it? This course addresses the controversial economic, environmental, legal, and social-justice dimensions of new biotechnologies in the context of globalization. In 2002, it will focus on whether genetic engineering and genomics may or may not be key to reducing hunger and to mitigating the negative environmental, health, and cultural effects of industrial agriculture, and on why this issue is so hotly disputed.

The course is also a practical example in Critical Science Studies, which is pertinent to environmental science and policy more generally. It begins with a look at multiple perspectives on a current, highly contentious case of applied biotechnology, followed by a guest lecture by a working biotech scientist. We then take a brief survey of genetic engineering and its applications and consider different points of view about the benefits and risks of genetically altered organisms for people, ecosystems, and biological diversity.

We look at the political economy of biotech research and development in the private and public sectors, the changing structure of the “life industry”, and the controversial role of patents on living things and scientific knowledge. We consider how the increasing roles of the private sector and of intellectual property affect agriculture and biotech research and policy options.

We examine why biodiversity prospecting and rights to genetic resources are at the center of disputes among developing and industrialized countries. We explore the promise and problems of new global governance institutions and treaties that address biotechnology, genetic resources, and the scientific precautionary principle. We consider the alternatives to high-chemical-input agriculture in theoretical and practical terms, and look at some of the new, rural movements for agroecology and food sovereignty that are putting these alternatives into practice.

We also consider the effects of ideas about biotechnology: how are the concepts and practices of biotech shaped by the socio-economic contexts in which science is carried out? Why do some scientists say the concept of “gene” is obsolete? What is known, and what remains unknown, now that human, animal, and plant genomes are being mapped? How does biotechnology discourse—for example, the metaphor of the “genetic code”—affect public opinion and policy?

Readings, lectures, student presentations, guest lectures, and class discussions will address difficult choices faced by scientists, public officials, farmers, consumers, NGOs, and global governance agencies, e.g., World Trade Organization and Convention on Biological Diversity.

Three 6-8 page papers on course themes, with specific topics selected by each student, will serve as take-home examinations. Some background ecology in basic biology/genetics and ecology, as well as economics and/or social science, will be helpful but are not essential.

## **Biotechnology: Environmental, Social, and International Dimensions**

### REQUIRED TEXTS:

Reading packet – Available for purchase on or before Sept. 6 at Audubon Copy on Whitney Ave.

Lewontin, Richard 2000 *The Triple Helix* Cambridge: Harvard University Press. paperback

Tokar, Brian (ed) 2000 *Redesigning Life? The Worldwide Challenge to Genetic Engineering* Johannesburg: Witwatersrand University Press.

Fox Keller, Evelyn 2000 *The Century of the Gene* Cambridge: Harvard University Press. paperback

deVries, Joseph and Gary Toenniessen 2001 *Securing the Harvest: Biotechnology, Breeding and Seed Systems for African Crops 2001* Rockefeller Foundation, New York; CABI publishers.

CAN BE READ ON-LINE: <http://www.cabi-publishing.org/Bookshop/ReadingRoom/0851995640.asp>

### RECOMMENDED BUT NOT REQUIRED:

Magdoff, Fred, J.B. Foster and Frederick Buttel (eds) 2000 *Hungry for Profit: the Agribusiness Threat to Farmers, Food, and the Environment* New York: Monthly Review Press. paperback

Bourgaize, David. Thomas R. Jewell, Rodolfo G. Buiser 2000 *Biotechnology: Demystifying the Concepts*. San Francisco: Benjamin/Cummings.

BECAUSE OF THE COST (\$77) KEY CHAPTERS WILL BE IN READING PACKET

Kloppenborg, Jack Jr. 1988 *First the Seed: the Political Economy of Plant Biotechnology* Cambridge Univ. Press. OUT OF PRINT – SOME CHAPTERS WILL BE IN READING PACKET

### Format and Assessment:

Classes will include lectures by the instructor, but the emphasis will be on critical interpretation of the readings by class members and on student-led discussions. To facilitate this, each student will write and post a 1-page summary of critical issues raised by the readings by the end of Monday in advance of each class session. Each class member will also lead at least one discussion session.

This is a mainly social science course, but it engages with the biological sciences. Participants with some background in biology and ecology will be able to make especially useful contributions, as will students with some social science background, but all FES and other graduate students will be able to manage the materials. Those who have not studied cellular biology or genetics at all may find it useful to purchase Bourgaize et al. *Biotechnology* and read chapters 1 – 7 in addition to the assigned excerpts in the reading packet.

Modern biotechnology has different implications for different countries and is perceived very differently from place to place; students from outside the USA are particularly welcome. Auditors and Yale college students will be admitted only with instructor's permission.

Instructor's assessment will give approximate proportional emphasis to: Class presentations, 1-2 -page weekly papers on the readings, and participation in discussions: 50%. Three take-home exams (1,000-1,600- word papers): 50%. Extra credit: one 600-800- word book(s) review: 5%.

## WEEKLY TOPICS, READINGS and CRITICAL DATES

### **Sept. 10 What is at issue and what is at stake in biotechnology disputes?**

Lecture: Overview of the course and the issues; Class discussion

Borlaug, Norman 2000 "Ending world hunger. The promise of biotechnology and the threat of anti-science zealotry," in *Plant Physiology*, V 124 (October), pp 487-90.

TEXT: Tokar, Brian 2000 "Introduction" in *Redesigning Life? The Worldwide Challenge to Genetic Engineering* Johannesburg: Witwatersrand University Press.

Serageldin, Ismail 2000 "The challenge of poverty in the 21<sup>st</sup> century: the role of science" in Persley, G.J. and M.M. Lantin (eds) *Agricultural Biotechnology and the Poor* Consultative Group on International Agricultural Research/The World Bank; US National Academies of Science.

### **Sept. 17 Anatomy of a controversy: Transgenic corn, suspect science, the US economy and "genetic contamination" in Mexico**

Elias, Paul 2002 "Corn study spurs debate over corporate meddling in academia" Associated Press, April 18.

ETC Group 2002 "Genetic pollution in Mexico's center of maize diversity" Food First *Backgrounder*, Institute for Food and Development Policy, Oakland, CA.

Quist, David and Ignacio Chapela 2002 "Transgenic DNA introgressed into traditional maize landraces in Oaxaca, Mexico" *Nature* 414 6863 Nov 29: 541-543

"Conflicts around a study of Mexican crops" 2002 [letters to the editors of *Nature*] *Nature* 416 & 417., including responses by *Nature* editor.

Jonathan Matthews "A-maizing disgrace: A dirty tricks campaign leads straight to the door of a Monsanto PR company" *The Ecologist*, June 2002

Weiner, Tim 2002 "In corn's cradle, U.S. imports bury family farms" *New York Times*, February 26.

Economic Research Service, US Department of Agriculture 2002 "Mexico: policy" <http://www.ers.usda.gov/briefing/mexico/policy.htm> Jan. 10. ON-LINE

CIMMYT (Centro Internacional de Mejoramiento de Maíz y Trigo) 2002 "Transgenic maize in Mexico: facts and future research needs" 8 May [http://www.cimmyt.cgiar.org/whatisimmyt/Transgenic/FactsandFuture\\_08May02.htm](http://www.cimmyt.cgiar.org/whatisimmyt/Transgenic/FactsandFuture_08May02.htm) ON-LINE

Raghavan, Chakravarthi (2002) "Mexico: NAFTA corn liberalization fails farmers, environment" *SUNS/ North-South Development Monitor* Oct. 25.

Press release "Mexican groups appeal to NAFTA environmental commission to force action against genetic contamination" 23 April 2002.

Statement of Via Campesina (translated from the Spanish) 2000 "*Biodiversity, Biosafety, and Genetic Resources*" Bangalore, India Oct.

ADDITIONAL MATERIAL FROM A RANGE OF PERSPECTIVES CAN BE FOUND AT: [http://www.BIOTECH-INFO.NET/mexican\\_bt\\_flow.html](http://www.BIOTECH-INFO.NET/mexican_bt_flow.html)

## **Sept. 24 From molecular biology to genetic engineering and genomics**

### ***Guest lecture by an agricultural biotechnology scientist***

Bourgaize et al. 1999 *Biotechnology: Demystifying the Concepts* Benjamin/Cummings  
pp 1- 11, 23 – 46, 128 – 134, Chapter 8 “Genetic Engineering: Tools and Techniques”  
pp 138 – 169; Chapter 9 “Analysis of DNA and applications” pp 196 – 207

OPTIONAL Walter E. Hill 2000 *Genetic Engineering: A Primer* Amsterdam: Harwood Academic.  
Chapter 4 “Making and altering proteins.” pp 59 – 81

OPTIONAL: Grace, Eric 1997 *Biotechnology Unzipped: Promises and Realities* Washington: National Academies Press. pp 1 – 132 (Yale bookstore, or 1 copy on reserve)

Chapter 1 "How biotechnology came about"; Chapter 2 "Tools in the genetic engineering workshop"; Chapter 3 "Biotechnology and the body"; Chapter 4 "Biotechnology on the farm"

## **Oct 1 The birth of molecular biology, the concept of the gene, and the agendas of genetics**

TEXT: Evelyn Fox Keller *The Century of the Gene*: pp 1 – 148 TEXT

Lily E. Kay “Problematizing basic research in molecular biology” in Thackray, Arnold (ed) 1998  
*Private Science*. Philadelphia: University of Pennsylvania Press. pp 20 – 38

## **Oct 8 Reductionism and determinism in biology and biotechnology**

Gould, Stephen Jay 2001 “Humbled by the genome’s mysteries,” *N.Y. Times* Feb. 19

TEXT: Lewontin *The Triple Helix* pp 3 – 129 TEXT

OPTIONAL Steven Rose 1998 *Lifelines: Biology Beyond Determinism* Oxford University Press  
Ch. 5 “Genes and organisms” pp 98 - 133  
Ch. 10 “The poverty of reductionism pp 272 – 299

### ***First short paper / exam due 5 PM October 11***

## **Oct 15 Agricultural genetic engineering: food crops and pharming**

Biotechnology www sites: <http://www.whybiotech.com> (Council for Biotechnology Information); others.

McCalla, Alexander and Lynn R Brown 2000 “Feeding the developing world in the next millennium: A question of science?” in G.J. Persley and M.M. Lantin (eds) *Agricultural Biotechnology and the Poor* Washington: the World Bank/ Consultative Group on International Agricultural Research.

Magdoff, Fred, John Bellamy Foster, and Frederick Buttel (eds.), *Hungry for Profit*, Monthly Review Press.  
pp 7 – 21 Introduction “An overview” TEXT

Crouch, Martha *Redesigning Life* Chapter 1 “From golden rice to terminator technology: Why agricultural biotechnology will not feed the world or save the environment.” TEXT

Kloppenborg, Jack *First the Seed* Chapter 1: “Introduction” and Chapter 2: “Science, Agriculture, and Social Change.”

OPTIONAL: *Hungry for Profit* pp 107 – 123

Chapter 6 “New agricultural biotechnologies and the struggle for democratic choice.” TEXT

## **Oct 22 Risks of transgenic crops; agro-ecosystems and the natural environment**

Horsch, Robert and Fraley, Robert (Monsanto) 1998 "Biotechnology can help reduce the loss of biodiversity" in Guruswamy, Lakshman D. and Jeffrey McNeely (eds) *Protection of Global Biodiversity: Diverging Strategies* Duke University Press, pp 49 – 65.

Altieri, Miguel *Hungry for Profit* Chapter 4 pp 77 – 92 "Ecological impacts of industrial agriculture and the possibilities for truly sustainable farming." TEXT

Steinbrecher, Ricarda 2000 "Ecological consequences of genetic engineering," in Tokar *Redesigning Life*.

Regal, Philip (1994) "Scientific principles for ecologically based risk assessment of transgenic organisms" in *Molecular ecology* 3: pp. 5-13.

Benbrook, Charles 2000 "Who controls and who will benefit from plant genomics?"

\_\_\_ 1999 "Impacts on soil microbial communities needs further studies"  
[http:// www.biotech-info.net/microbial\\_communities.html](http://www.biotech-info.net/microbial_communities.html) .

Ellstrand Norman C. 2002 "Gene flow from transgenic crops to wild relatives: What have we learned, what do we know, what do we need to know?" Univ. of CA Riverside, *Proceedings: Scientific Methods Workshop: Ecological and Agronomic Consequences of Gene Flow from Transgenic Crops to Wild Relatives*, Ohio State University March 5th and 6<sup>th</sup>.

PROCEEDINGS CAN BE READ AT: [http://www.biosci.ohio-state.edu/~lspencer/gene\\_flow.htm](http://www.biosci.ohio-state.edu/~lspencer/gene_flow.htm)

Yoon, Carol Kaesuk 1999 "Reassessing ecological risks of transgenic crops", *New York Times* Sept. 3.

National Academy of Sciences 2002 "Regulation of transgenic plants should be reinforced; field monitoring for environmental effects is needed". Press release Feb. 21., OR full report at [http://www.nap.edu/catalog/10258.html?onpi\\_newsdoc0221022](http://www.nap.edu/catalog/10258.html?onpi_newsdoc0221022)

OPTIONAL: Hansen, Michael Jan. 2000 "Genetic engineering is not an extension of conventional plant breeding: How genetic engineering differs from conventional breeding, hybridization, wide crosses and horizontal gene transfer" Consumer Policy Institute/Consumers Union.

ADDITIONAL MATERIAL CAN BE FOUND AT <http://www.BIOTECH-INFO.NET/risks.html>

## **Oct 29 Political economy of biotechnology industries**

Bourgaize et al. 1999 *Biotechnology* Chapter 15

Kenney, Martin 1998 pp 131 – 143 in Thackray (ed) *Private Science*, "Biotechnology and the creation of a new economic space."

Shand, Hope 2001 pp 222 – 237 Chapter 16 in *Redesigning Life* "Gene giants: Understanding the 'life industry'." TEXT

Pollack, Andrew 2001 "The green revolution yields to the bottom line" *NY Times* 15 May.

Kloppenburg, Jack 1988 *First the Seed* Chapter 5: "Heterosis and the social division of labor".

OPTIONAL Wright, Susan 1998 pp 80 – 104 in *Private Science* "Molecular politics in a global economy"

## **Nov 12      Biotechnology and intellectual property**

Kloppenborg, Jack 1988 *First the Seed* Chapter 6 “Plant Breeders Rights.”

Kevles, Daniel 1998 pp 65 – 79 in *Private Science* “Diamond v Chakrabarty and beyond.”

Mossinghoff, Gerald 1998 “The Biodiversity Convention and intellectual property rights: conflict or harmony? *Patent World*, #106, October.

Thompson, Nicholas 2001 “Gene Blues: Is the Patent Office prepared to deal with the genomic revolution?” *Washington Monthly*, April.

Press, Eyal and Jennifer Washburn 2000 "The kept university," *Atlantic Monthly* March.

Barton John H., and Peter Berger 2001 “Patenting agriculture: An intense drive to patent agricultural biotechnologies may hurt those who would benefit most: people in developing countries *Issues in Science and Technology On-line* 7: 4, pp 43-50.

OPTIONAL BACKGROUND: Heffer, Laurence R. and Robert D. Litowitz “What is intellectual property?” US Dept. of State International Information Programs: <http://usinfo.state.gov/products/pubs/intelprp/>

## ***Second short paper / exam due 5 PM November 15***

## **Nov 5      International disputes about biotechnology and genetic resources**

Kloppenborg, Jack 1988 *First the Seed*: Chapter 7 “Seeds of Struggle”

McAfee, Kathleen *mss.* “International regimes and the commoditization of genetic resources,” forthcoming in Schurman and Kelso (eds) *Remaking the World*.

Purdue, Derrick 2000 “Global governance: hegemonic TRIPs, biotech, and the WTO,” pp 41 – 58 in Purdue, *Anti-GenetiX: the Emergence of the anti-GM Movement* London: Ashgate.

Views of the United States on the relationship Between the Convention on Biological Diversity and the TRIPs Agreement CAN BE READ ON-LINE; ENTER IP/C/W/257 FOR “DOCUMENT SYMBOL” AT:  
[http://docsonline.wto.org/gen\\_search.asp](http://docsonline.wto.org/gen_search.asp)

Third World Network 2000 “Joint NGO Statement on the Review of Article 27.3(b) of the TRIPs Agreement  
Third World Network 27 November URL: <http://www.twinside.org.sg/>

Mazhar, Farhad “Destructive consequences of ‘controlling plant gene expression’ of ‘Terminator’ technology for food security and biodiversity,” from Third World Network <http://www.twinside.org.sg/title/express-cn.htm>

## Nov 19      **Can biotechnology feed the world? The case of Africa**

Pearce, Fred 2000 “Feeding Africa” *New Scientist* 05-27 Interview with Florence Wambugu.

Rosset, Peter 2000 “Genetic engineering of food crops for the third world: an appropriate response to poverty, hunger and lagging productivity?” *Reading packet* or [www.foodfirst.org/progs/global/biotech/belgium-gmo.html](http://www.foodfirst.org/progs/global/biotech/belgium-gmo.html)

Toenniessen, Gary and Joseph DeVries *Securing the Harvest: Biotechnology, Breeding and Seed Systems for African Crops*. CABI/. Oxford Univ Press.

Chapter 1 “Introduction & summary”; Chapter 3 “The roots of hunger”

OPTIONAL: other chapters can be read on-line at:

<http://www.cabi-publishing.org/Bookshop/ReadingRoom/0851995640.asp>

Kuyek, Devlin, "Genetically Modified Crops in African Agriculture Implications for Small Farmers", GRAIN, Barcelona, August 2002, 24 pp.

Kuyek, Devlin, "Intellectual Property Rights in African Agriculture: Implications for Small Farmers", GRAIN, Barcelona, August 2002, 24 pp.

Berhan Gebre Egziabher, Tewolde 2001 “Why poor nations would lose in a biotech war on hunger,” interview in *Sierra* by Snell, Marilyn B. <http://www.sierraclub.org/sierra/200107/profile.asp>

OPTIONAL: Thompson, Jennifer 2002 *Genes for Africa: Genetically Modified Crops in the Developing World* UCT Press South Africa. ON RESERVE.

## Dec 2      **Bioprospecting, biopiracy; new social movements for resource rights and food sovereignty**

Tauli-Corpus, Victoria “Biotechnology and Indigenous People” in Tokar (ed) *Redesigning Life?* TEXT

Laird, Sarah A. and Kerry ten kate 2002 “Biodiversity prospecting: the commercial use of genetic resources and best practice in benefit-sharing” Ch. 8 in *Biodiversity and Traditional Knowledge: Equitable Partnerships in Practice* London: Earthscan. pp 241 – 285.

Shiva, Vandana “Biopiracy: The Theft of Knowledge & Resources” in Tokar (ed) *Redesigning Life?* TEXT

Parry, Bronwyn 2000 “The fate of the collections: social justice and the annexation of plant genetic resources” Ch. 15 in Charles Zerner (ed) *People, Plants and Justice: The Politics of Nature Conservation* pp 374 – 402. New York: Columbia Univ. Press.

Intermediate Technology Development Group 2002 *Sustaining Agricultural Biodiversity*. <http://www.itdg.org/html/advocacy/sab.htm> 5 July

Uphoff, Norman (ed) 2002 *Agroecological Innovations: Increasing Food Production with Participatory Development* London: Earthscan. Chapters 1 and 2.

***Third and final short paper / exam due 5 PM December 18***

***Extra-credit literature reviews accepted up to 5 PM December 21***

### Recommended supplementary sources:

Also see the list of biotechnology-related internet sites to be handed out in class.

- Altieri, Miguel 1995 (2<sup>ND</sup> EDITION) *Agroecology: The Science of Sustainable Agriculture* Westview Press.
- Barracough, Solon and Krishna Ghimire 2000 *Agricultural Expansion and Tropical Deforestation* London: Earthscan.
- Brookfield, Harold 2001 *Exploring Agrobiodiversity* New York: Columbia Univ. Press.
- Busch, Lawrence 1995 *Making Nature; Shaping Culture: Plant Biodiversity in Global Context* Univ. of Nebraska Press.
- Charles, Daniel 2001 *Lords of the Harvest: Biotech, Big Money and the Future of Food* Cambridge, MA: Perseus.
- Conway, Gordon 1997 *The Doubly Green Revolution*: Ithaca, NY: Comstock / Cornell Univ. Press..
- Crispeels, Martin and David Sadava 2002 (2<sup>nd</sup> ed.) *Plants, Genes and Crop Biotechnology* Sudbury MA Jones & Bartlett.
- Evenson, Robert 2002 (new book coming soon on economics of agricultural biotechnology)
- Gottweis, Herbert 1998 *Governing Molecules: The Discursive Politics of Genetic Engineering in Europe and the United States* Cambridge, MA: MIT Press.
- Grace, Eric 1997 *Biotechnology Unzipped: Promises and Realities* Washington: National Academies Press.  
INTRODUCTORY OVERVIEW OF BIOTECHNOLOGY APPLICATIONS
- Hindmarsh, Richard, Geoffrey Lawrence and Janet Norton, (eds) 1998 *Altered Genes II Reconstructing Nature: the Debate* Scribe Publications.
- Ho, Mae-Wan 1998/99 *Genetic Engineering: Dream or Nightmare?* New York: Continuum.
- Hubbard, Ruth and Elijah Wald 1997 *Exploding the Gene Myth* Boston: Beacon Press.
- Kaplan, Jonathan M. 2000 *The Limits and Lies of Human Genetic Research*: New York: Routledge.
- Kay, Lily E. 2000 *Who Wrote the Book of Life? A History of the Genetic Code* Stanford Univ. Press.
- Laird, Sarah (ed. 2002 *Biodiversity and Traditional Knowledge: Ethical Partnerships in Practice* London: Earthscan
- McHughen, Alan 2000 *Pandora's Picnic Basket: the Potential and Hazards of Genetically Modified Foods* Oxford University Press.
- Nature* special issue: 2002 Insight: *Food and the future* 418:6898 (8 Aug) <http://www.nature.com/nature/insights/6898.htm>
- Nelson, Gerald 2001 (ed) *Genetically Modified Organisms in Agriculture: Economics & Politics* Academic Press
- Pardey, Phillip (ed) 2001 *The Future of Food: Biotechnology, Markets, and Policies in an International Setting* Washington: International Food Policy Research Institute/ John Hopkins Univ. Press.
- Perkins, John H. (1997). *Geopolitics and the Green Revolution: wheat, genes, and the cold war*. Oxford and New York: Oxford University Press.
- Pottier, Johan 1999 *Anthropology of Food: The Social Dynamics of Food Security* Cambridge UK: Polity.
- Purdue, Derrick. 2000 *Anti-GenetiX: Emergence of the Anti-GM Movement* Hampshire UK Ashgate.
- Rose, Steven P.R. 1997 *Lifelines: Biology Beyond Determinism* Oxford: Oxford Univ. Press.
- Shiva, Vandana 199X *Biopiracy* Boston: South End Press; \_\_\_\_ *Monocultures of the Mind* London: Zed.
- Stock, Gregory and John Campbell (eds), 2000 *Engineering the Human Germline* Oxford Univ. Press.
- Thackray, Arnold 1998: *Private Science: Biotechnology and the Rise of the Molecular Sciences* University of Pennsylvania Press.
- Thompson, Jennifer 2002 *Genes for Africa: Genetically Modified Crops in the Developing World* UCT Press South Africa. INTRODUCTION TO CROP GENETIC ENGINEERING FOR LAYPEOPLE, PRO-GE PERSPECTIVE.
- Toenniessen, Gary and Joseph De Vries *Securing the Harvest: Biotechnology, Breeding and Seed Systems for African Crops*. CAB I/ Oxford Univ Press.
- Uphoff, Norman (ed) 2002 *Agroecological Innovations: Increasing Food Production with Participatory Development* London: Earthscan.
- Zerner, Charles (ed.) 2000 *People, Plants, and justice: The Politics of Nature Conservation* New York: Columbia Univ. Press.