

In this course we will discover how, why, and when plants became vital to people and their societies. We will explore the characteristics of particular species that enabled their exploitation, and study several economically important plant groups, including those that provide food and beverages, medicines and narcotics, spices, perfumes, fuels, and fiber. How and when were plants domesticated and what are the consequences of large-scale agriculture? We will also explore the role of technology in efforts to both improve and synthesize plant products, and discuss methods for sustainable agriculture.

Professor Rachel A. Levin McGuire Life Sciences Building 139, x8333, rlevin@amherst.edu
Office hours: Thursdays 3:00-5:00pm & by appointment

Course meeting times: Tuesdays and Thursdays, 10-11:20am, Merrill 315
Two required off-campus field trips (March 7 or 8; April 4 or 5)

Required books (or selected chapters):

- Pollan, M. 2002. *The Botany of Desire: A plant's-eye view of the world*. Random House
- Foster, N and LS Cordel, editors. 1992. *Chilies to Chocolate: Food the Americas Gave the World*. University of Arizona Press
- Standage, T. 2006. *A History of the World in 6 Glasses*. Walker Publishing Company
- Pollan, M. 2007. *The Omnivore's Dilemma: A Natural History of Four Meals*. Penguin
- Hobhouse, H. 2005. *Seeds of Change: Six Plants That Transformed Mankind*. Counterpoint
- Hobhouse, H. 2005. *Seeds of Wealth: Five Plants That Made Men Rich*. Counterpoint

Journal & magazine articles: We will read articles from the primary scientific literature as well as more popular sources. All readings can be freely accessed on-line through the Bio4 E-reserves webpage.

Useful reference texts:

- Levetin, E and K McMahon. 2008. *Plants & Society*, 5th edition. McGraw-Hill
- Simpson, B and M Ogorzaly. 2000. *Economic Botany*. 3rd edition. McGraw-Hill

Expectations: You are expected to attend class, complete reading assignments, and actively engage in the course. Students are required to submit via the course website two questions (or comments) regarding the reading materials (by 10pm the evening before class). At least one of these should be thoughtful with the potential to provoke discussion, whereas the other can have a factual answer that you were not able to resolve with a bit of research. Bring a hard copy of your questions to class. You will also have the opportunity to critique a scientific paper regarding the origins of domestication, work with a partner to prepare and present a food dish of your choice, and research a plant of economic value to humans.

Evaluation: Your final grade for the course will be comprised of the following assignments: Class participation and weekly questions/comments (20%); Summary of plant domestication article (due: Monday March 2 by 5pm, 15%); Four brief (~10 min) quizzes (4 @ 5% each); Culinary creation & presentation (due: Tuesday May 5 in class, 10%); Final project in-class presentation (April 21-30 in class, 10%); Final project paper (due Friday May 8 by 5pm, 25%).

Intellectual Responsibility: Plagiarism and other forms of academic dishonesty are a violation of the Amherst College Honor Code (<https://www.amherst.edu/65945>) and will not be tolerated. Plagiarism includes copying text directly from an article or book, as well as borrowing ideas from another source without appropriate acknowledgement (i.e., citation). If you are unsure, ask me or consult the following web page: <https://www.amherst.edu/campuslife/deanstudents/acadhonesty>

Date	Topic	Readings
Jan 27	Introduction to course, plant basics	
Jan 29	What is a fruit?	BOD, pages xiii-58
Feb 3	History of Agriculture	ER1-3
Feb 5	No class	<i>Get a head start on domestication readings</i>
Feb 10	Crop Domestication	ER4-6
Feb 12	Darwin Day! Selection (Prof. JS Miller)	<i>TBA</i>
Feb 17	Riches of the New World: potatoes, chilies, chocolate, beans	BOD, pages 183-245; C2C, pages 1-14, 61-121, 143-167; ER7-8
Feb 19	Corn and capitalism	C2C, pages 47-60; OMD, pages 15-119; ER9-10
Feb 24	Cereals and other grains	C2C, pages 15-33, 123-141; ER11-13
Feb 26	Plant breeding: bananas; QUIZ 1	ER14-15; Critique due (Mon March 2 by 5pm)
Mar 3	Genetic engineering, J Cavatorta '04 (Department of Plant Breeding & Genetics, Cornell University)	ER16-20
Mar 5	How sweet it is...	SC pp. 53-113; ER21 (will hand out in class)
Mar 7/8	Field trip to local maple sugar shack	
Mar 10	Stimulating brews: coffee, tea, coca-cola	HW6G, pages 1-6, 133-284
Mar 12	Relaxing brews: the benefits of fermentation	HW6G, pages 9-129; ER22-23
Spring Break		
Mar 24	Spices, herbs, and volatiles	C2C, pages 35-45; ER24-30
Mar 26	Psychoactive Drugs and Poisons; QUIZ 2	BOD, pages 113-179; ER31-32
Mar 31	What's in the medicine cabinet?	ER33-37
Apr 2	Fiber and wood	SC, pages 175-233; ER38-40
Apr 4/5	Field trip to Smith College Plant House	
Apr 7	Dyes, rubber and chewing gum	SW, pages 125-185; ER41-43
Apr 9	Algae are plants too...and tasty!	ER44-47
Apr 14	Biofuels	ER48-53
Apr 16	Sustainable agriculture; QUIZ 3	ER54-57
Apr 21	Project presentations	
Apr 23	Project presentations	Draft of final papers due in class (3 copies)
Apr 28	Project presentations	Draft reviews due in class
Apr 30	Project presentations	
May 5	Let's eat! Course evaluations	Culinary creation due in class
May 7	Course wrap up; QUIZ 4	Final paper due (Fri May 8 by 5pm)

BOD, Botany of Desire; ER, E-reserves literature; C2C, Chilies to Chocolate; OMD, The Omnivore's Dilemma; SC, Seeds of Change; HW6G, History of the World in 6 Glasses; SW, Seeds of Wealth

Food, Fiber, and Pharmaceuticals, Reading list**Spring 2009****I. Required books** (refer to the course schedule for dates/pages)

*I recommend purchasing copies of Foster & Cordel (1992) and Standage (2006); both are available in paperback and can be purchased on-line for a reasonable price. At least one copy of each of the required books is on reserve in the **Science library**. Pollan (2002) is freely available as an e-book (link to it from the E-reserves website for Biology 4).*

Pollan, M. 2002. *The Botany of Desire: A plant's-eye view of the world*. Random House.

Foster, N and LS Cordel, editors. 1992. *Chilies to Chocolate: Food the Americas Gave the World*. University of Arizona Press.

Standage, T. 2006. *A History of the World in 6 Glasses*. Walker Publishing Company.

Pollan, M. 2007. *The Omnivore's Dilemma: A Natural History of Four Meals*. Penguin.

Hobhouse, H. 2005. *Seeds of Change: Six Plants That Transformed Mankind*. Counterpoint.

Hobhouse, H. 2005. *Seeds of Wealth: Five Plants That Made Men Rich*. Counterpoint.

II. Optional books

Koeppel, D. 2008. *Banana: The fate of the fruit that changed the world*. Plume.

Diamond, J. 2005. *Guns, Germs and Steel*. W W Norton & Company Inc.

Carney, J. 2002. *Black Rice: The African Origins of Rice Cultivation in the Americas*. Harvard University Press.

Warman, A. 2007. *Corn and Capitalism: How a Botanical Bastard Grew to Global Dominance*. University of North Carolina Press. *Freely available as an e-book (link to it from the E-reserves website)*

III. E-reserves literature (organized by date & topic)**February 3 - History of Agriculture**

(1) Balter, 2007. Seeking agriculture's ancient roots. *Science* 316:1830-35

(2) Brown et al., 2009. The complex origins of domesticated crops in the Fertile Crescent. *Trends in Ecology and Evolution* 24:103-9

(3) Neumann, 2003. New Guinea: A cradle of agriculture. *Science* 301:180-1

Optional:

Denham et al., 2003. Origins of agriculture at Kuk swamp in the highlands of New Guinea. *Science* 301:189-93

Diamond, J 2005. *Guns, Germs and Steel*, pages 85-191

February 10 - Crop domestication

(4) Diamond, 2002. Evolution, consequences and future of plant and animal domestication. *Nature* 418:700-707

(5) Tanno and Willcox, 2006. How fast was wild wheat domesticated? *Science* 311:1886

(6) Zeder, 2006. Documenting domestication: the intersection of genetics and archaeology. *Trends in Genetics* 22:139-155

Optional:

Sonnante et al., 2007. The domestication of artichoke and cardoon: from Roman Times to the Genomic Age. *Annals of Botany* 100:1095-1100

Zerega, 2004. The breadfruit trail. *Natural History* 112:46-51

February 17 - Riches of the New World: potatoes, chilies, chocolate, beans

- (7) Nabhan, 1997. Why chilies are hot. *Natural History* 106:24-8
- (8) Spooner et al., 2005. A single domestication for potato based on multilocus amplified fragment length polymorphism genotyping. *PNAS* 102:14694-99

Optional:

- Galindo-Tovar et al., 2008. Some aspects of avocado (*Persea americana* Mill.) diversity and domestication in Mesoamerica. *Genet. Resour. Crop Evol.* 55:441-50
- Lentz et al., 2008. Sunflower (*Helianthus annuus* L.) as a pre-Columbian domesticate in Mexico. *PNAS* 105:6232-37
- Pickersgill, 2007. Domestication of plants in the Americas: Insights from Mendelian and molecular genetics. *Annals of Botany* 100:925-940
- Tewksbury et al. 2008. Evolutionary ecology of pungency in wild chilies. *PNAS* 105:11808-11

February 19 - Corn and capitalism

- (9) Movie, *King Corn* (available streaming from course website)
- (10) Jahren and Kraft, 2008. Carbon and nitrogen stable isotopes in fast food: signatures of corn and confinement. *PNAS* 105:17855-17860

Optional:

- Royte, 2006. Corn plastic to the rescue? *Smithsonian* 37(5):84-88
- Warman, A 2003. *Corn & Capitalism: How a Botanical Bastard Grew to Global Dominance*. Chapel Hill: University of North Carolina Press.

February 24 - Cereals and other grains

- (11) Uga et al. 2003. Variations of Floral Traits in Asian Cultivated Rice (*Oryza sativa* L.) and its Wild Relatives (*O. rufipogon* Griff.). *Breeding Science* 53:345-52.
- (12) Sweeney and McCouch. 2007. The Complex History of the Domestication of Rice. *Annals of Botany* 100:951-57.
- (13) Goff and Salmeron, 2004. Back to the future of cereals. *Scientific American* 291(2):42-9

Optional:

- Carney, J 2002. *Black Rice: The African Origins of Rice Cultivation in the Americas*. Harvard University Press, pages 31-106
- Londo et al., 2006. Phylogeography of Asian wild rice, *Oryza rufipogon*, reveals multiple independent domestications of cultivated rice, *Oryza sativa*. *PNAS* 103:9578-83

February 26 - Plant breeding: bananas

- (14) Canine, 2005. Building a better banana. *Smithsonian* 36: 96-104
- (15) Grimm, 2008. A bunch of trouble. *Science* 322:1046-47

Optional:

- Koeppel, D 2008. *Banana: The fate of the fruit that changed the world*. Plume.

March 3 - Plant breeding: genetic engineering

- (16) Borlaug, 2000. Ending world hunger. The promise of biotechnology and the threat of antiscience zealotry. *Plant Physiology* 124:487-90
- (17) Kaniewski & Thomas, 2004. The potato story. *AgBioForum* 7:41-6
- (18) Langridge, 2000. Edible vaccines. *Scientific American* 283(3):66-71
- (19) Peters, 2000. Genetic engineering in agriculture: who stands to benefit? *Journal of Agricultural and Environmental Ethics* 13:313-27 (**Focus on conclusions**)
- (20) Powledge, 2001. Tobacco Pharming. *Scientific American* 285(4):25-6

Optional:

- Hails, 2000. Genetically modified plants—the debate continues. *Trends in Ecology and Evolution* 15:14-18
- Marvier, 2001. Ecology of transgenic crops. *American Scientist* 89:160-167

March 5 - How sweet it is...

- (21) McGee pp. 648-655, 667-679 (RAL will hand out copies)

March 12 - Relaxing brews: the benefits of fermentation

- (22) Bahre and Bradbury, 1980. Manufacture of mescal in Sonora, Mexico. *Economic Botany* 34:391-400
(23) Legras et al., 2007. Bread, beer and wine: *Saccharomyces cerevisiae* diversity reflects human history. *Molecular Ecology* 16:2091-2102

March 24 - Spices, herbs, and volatiles

- (24) Goff and Klee, 2006. Plant volatile compounds: sensory cues for health and nutritional value? *Science* 311:815-819
(25) Harris, 2000. For the love of mustard. *Smithsonian* 31:102-10
(26) Lubinsky et al., 2008. Neotropical roots of a Polynesian spice: the hybrid origin of Tahitian vanilla, *Vanilla tahitensis* (Orchidaceae). *American Journal of Botany* 95:1040-47
(27) Raloff, 2004. Coffee, Spices, Wine. *Science News* 165:282-84
(28) Rodriguez et al., 2008. New cinnamon-based active paper packaging against *Rhizopus stolonifer* food spoilage. *Journal of Agricultural and Food Chemistry* 56:6364-69
(29) Sherman & Billing, 1999. Darwinian gastronomy: why we use spices. *Bioscience* 49:453-63
(30) Wolkamir, 1995. Without garlic, life would be just plain tasteless. *Smithsonian* 26:71-9

March 26 - Psychoactive Drugs and Poisons

- (31) Boucher, 1991. Cocaine and the coca plant. *Bioscience* 41:72-6
(32) Schultes, 1969. Hallucinogens of plant origin. *Science* 163:245-54

March 31 - What's in the medicine cabinet?

- (33) Coley et al., 2003. Using ecological criteria to design plant collection strategies for drug discovery. *Frontiers in Ecology and the Environment* 1:421-28
(34) Cowan, 1990. Medicine on the wild side. *Science News* 138:280-2
(35) Cox and Balick, 1994. The ethnobotanical approach to drug discovery. *Scientific American* 264:82-7
(36) Shanley and Luz, 2003. The impacts of forest degradation on medicinal plant use and implications for health care in eastern Amazonia. *Bioscience* 53:573-84
(37) Swerdlow, 2000. Nature's Rx. *National Geographic* 197:98-117

Optional:

- Gold et al., 2003. The lowdown on Ginkgo biloba. *Scientific American* 288:86-91
Hobhouse, H 2005. Seeds of Change: Six Plants That Transformed Mankind. Counterpoint, pages 3-50
Jackson, 1989. Searching for medicinal wealth in Amazonia. *Smithsonian* 19:94-103
Nicolaou et al. 1996. Taxoids: New weapons against cancer. *Scientific American* 274:94-8
Plotkin, 1990. The healing forest: the search for new jungle medicines. *The Futurist* 24:9-15
Riddle and Estes, 1992. Oral contraceptives in ancient and medieval times. *American Scientist* 80:226-33
Taylor, 2002. Getting to the root of ginseng. *Smithsonian* 33:98-103

April 2 - Fiber and wood

- (38) Clark, 1965. Plant fibers in the paper industry. *Economic Botany* 19:394-405
(39) McLaughlin & Schuck, 1991. Fiber properties of several species of Agavaceae from the southwestern United States and Northern Mexico. *Economic Botany* 45:480-486
(40) Rymer, 2004. Saving the music tree. *Smithsonian* 35(1):52-63

April 7 - Dyes, Rubber and Chewing gum

- (41) Antúnez de Mayolo, 1989. Peruvian natural dye plants. *Economic Botany* 43:181-191
- (42) Balandrin et al., 1985. Natural Plant Chemicals: Sources of Industrial and Medicinal Materials. *Science* 228:1154-1160
- (43) Dogan et al., 2003. Plants used as natural dye sources in Turkey. *Economic Botany* 57:442-453

April 9 - Algae are plants too...and tasty!

- (44) Balter, 2008. Ancient algae suggest sea route for first Americans. *Science* 320:729
- (45) Dillehay et al., 2008. Monte Verde: Seaweed, food, medicine, and the peopling of South America. *Science* 320:784-6
- (46) Plaza et al., 2008. In search of new functional food ingredients from algae. *Trends in Food Science & Technology* 19:31-39
- (47) Radmer, 1996. Algal diversity and commercial algal products. *Bioscience* 46:263-270

Optional:

- Cardozzo et al., 2007. Metabolites from algae with economical impact. *Comparative Biochemistry and Physiology, Part C* 146:60-78
- Raja et al., 2008. A perspective on the biotechnological potential of microalgae. *Critical reviews in microbiology* 34:77-88

April 14 - Biofuels

- (48) Ashley, 2008. Cellulose success. *Scientific American* 298:32-3
- (49) Fitzherbert et al., 2008. How will oil palm expansion affect biodiversity? *Trends in Ecology and Evolution* 23:538-45
- (50) Kintisch, 2008. Minnesota ecologist pushes prairie biofuels. *Science* 322:1044-5
- (51) Koh and Ghazoul, 2008. Biofuels, biodiversity, and people: Understanding the conflicts and finding opportunities. *Biological Conservation* 141:2450-60
- (52) Service, 2008. Eyeing oil, synthetic biologists mine microbes for black gold. *Science* 322:522
- (53) Wald, 2007. Is ethanol for the long haul? *Scientific American* 296:42-9

Optional:

- Groom et al., 2008. Biofuels and biodiversity: principles for creating better policies for biofuel production. *Conservation Biology* 22:602-9
- Hill et al., 2006. Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels. *PNAS* 103:11206-10
- Koh and Wilcove, 2008. Oil palm: disinformation enables deforestation. *Trends in Ecology and Evolution* 24:67-8
- Kondamudi et al., 2008. Spent coffee grounds as a versatile source of green energy. *Journal of Agricultural and Food Chemistry* 56:11757-60
- Renner, 2007. Green gold in a shrub. *Scientific American* 296:20-23
- Wassener, 2008. Airline flies a 747 on fuel from a plant. *New York Times*, December 31, 2008

April 16 - Sustainable agriculture

- (54) Pollan, 2008. Farmer in Chief. *New York Times Magazine*, October 12, 2008
- (55) Raloff, 2007. Herbal herbicides: weed killers manufactured by mother nature. *Science News* 171(11):167-69
- (56) Rozema and Flowers, 2008. Crops for a salinized world. *Science* 322:1478-80
- (57) Tilman et al. 2002. Agricultural sustainability and intensive production practices. *Nature* 418:671-77

Optional:

- Bisht et al., 2007. Traditional crop diversity and its conservation on-farm for sustainable agricultural production in Kumaon Himalaya of Uttaranchal state: a case study. *Genetic Resources and Crop Evolution* 54:345-357