

**STS 201 (Lecture 1)**  
**Where Science Meets Society: Nanotechnology, Biology and Society**  
**Spring 2005**  
**Christina Matta**

**Class Times:** 8:50 MWF in 6112 Social Sciences Building

**Office:** 3113 Engineering Centers Building

**Office Hours:** Mondays, 3-4 pm in ECB; online office hours Thursdays, 9-10:30pm

**Email:** [cmatta@wisc.edu](mailto:cmatta@wisc.edu)

**iChat/AIM:** christinamatta

**Course email:** [sts201-1-s06@lists.wisc.edu](mailto:sts201-1-s06@lists.wisc.edu)

**Course Description and Goals**

This course is designed to be an introductory-level, discussion-based class for freshmen and sophomores of all majors. It draws upon recent research in science, technology, and medicine, but assumes no specialized knowledge beyond a keen interest in how science and society interact. As the semester progresses, we will consider the emergent field of nanotechnology and its increasing presence in contemporary society, paying special attention to its relevance to different biological and medical sciences. We will identify and discuss nanotechnology in relation to human medicine, pharmacy, ecology, agriculture, and reproductive physiology – just to name a few – and the issues these interfaces raise.

Because nanotechnology – and therefore nanotechnology studies – is still a new and rapidly evolving field, we will use contemporary controversies and debates in science and technology as a means of modeling how we might think about nanotechnology. What can we learn from studying scientific and public arguments about the safety of other technologies that might help us make sense of current debates about the promise and perils of nanotechnology? Do the lessons we have learned from introducing new technologies or scientific advances into society in the past raise any questions we should consider as nanotechnology becomes a greater part of everyday life? How might we use such examples to anticipate unintended – and potentially harmful – consequences of nanotechnology? Will seemingly benign innovations force us to confront our assumptions about gender roles, religion, participatory politics, and other social structures that, at first glance, seem independent from technological development? *Are* these structures truly independent from science and technology?

This course will also emphasize the need to think critically about the media's portrayal of science and technology. How accurately do media outlets – both news media meant to inform and popular media meant to entertain – portray nanotechnology and its risks and benefits? We will ask: are these portrayals accurate? Why have they highlighted certain facets of nanotechnology and ignored others? In what ways do these portrayals shape our thinking about nanotechnology in society, and how can we learn to critically evaluate the media that bombard us every day? Such evaluations are crucial to developing a general scientific literacy, which is, itself, crucial to active, knowledgeable participation in contemporary society. The ultimate goal of this course, therefore, is to help you develop the necessary intellectual skills to form a critical opinion of issues under debate in science and technology and in public policy.

**Required Texts and Readings**

The textbook for this class is Mark Ratner and Daniel Ratner, *Nanotechnology: A Gentle Introduction to the Next Big Idea* (Prentice Hall: 2002), listed as “Ratner and Ratner” on the syllabus. This book is available for purchase at Underground Textbook Exchange (on Lake Street at the corner of University) *only*, and a copy is available on Reserve at College Library (3-hour loan). Please do buy the book; it's

both a good read and a valuable resource for thinking about nanotechnology, and we will refer to it many times during the semester.

The day-to-day reading assignments also include many different articles, essays, and book chapters. These readings are all available online through College Library's e-reserves, which are accessible through the My UW portal at <http://my.wisc.edu> (click on the "Academic" tab and scroll down to "Course Resources").

### **Other Books on Reserve at College Library**

Excerpts from some of these books are on e-reserve as required reading, but as the semester progresses you may wish to browse the other chapters to help you with your projects:

B.C. Crandall, ed. *Nanotechnology: Molecular speculations on global abundance* (MIT Press, 1996).

Kleinman et al, eds. *Controversies in science and technology, Volume 1: From maize to menopause* (Wisconsin: 2005).

Douglas Mulhall, *Our molecular future: How nanotechnology, robotics, genetics, and artificial intelligence will transform our world.* (Prometheus: 2002).

Ed Regis, *Nano: The emerging science of nanotechnology: Remaking the world – molecule by molecule* (Little, Brown and Company: 1995).

Editors of Scientific American, *Understanding nanotechnology* (Warner Books: 2002).

In addition, K. Eric Drexler's *Engines of creation: The coming era of nanotechnology* (Anchor: 1987) is on e-reserve in its entirety (though the file lacks both index and table of contents).

### **Class List**

The list address for this course is [sts201-1-s06@lists.wisc.edu](mailto:sts201-1-s06@lists.wisc.edu). Please make sure that you have activated your UW NetID and that you have forwarded your email accordingly if you do not use your @wisc.edu address as your primary email. Likewise, if you are using another email service as your primary address, please make sure your inbox has ample space to receive course messages. *You are responsible for the information contained in messages that bounce back to me as undeliverable.*

### **Course Requirements and Policies Grading**

Your grade for this class is based upon the following requirements and percentages:

Discussion/class participation: 20%

Four reading responses (300-500 words): 20% (5% each)

Four research assignments (400-600 words): 20% (5% each, due January 27, February 10, February 24, and February 17)

In-class quizzes and writing (to be announced): 10%

In-class presentation (week of April 24): 10%

Final paper: 20%

## Attendance and Participation

Attendance and participation are required, not optional, and count for 20% of your final grade in general and 10% through the in-class presentation at the end of the semester. Therefore, I am fairly strict. I will allow you three absences; each absence after the third will count against your final grade.

In accordance with the university's policy on religious holidays, please let me know *in writing within the first two weeks of class* if you will be absent to observe a holiday or attend services. Athletes likely to be traveling with their team should also inform me within the first two weeks of the course of any potential absences.

I also expect that once you are here, you will be prepared to discuss the assigned readings and to ask any questions you may have. Your class participation grade is based upon my assessment of your active involvement in class; this means you *must* be willing to speak up in class (though it is more important to offer thoughtful comments than it is to be generally talkative).

I know that speaking in class can sometimes seem daunting, but we'll do our best to help each other out and work through our ideas about the (sometimes confusing) concepts we'll be discussing over the course of the semester. If you feel shy or unsteady at first, please come talk to me early in the semester so I can help set you at ease.

## Written Assignments

This course includes a fair amount of writing in lieu of midterm and final exams. These assignments are short (no more than 600 words, or about two pages), and include four reading response papers and a series of research exercises in preparation for the final paper. This may seem overwhelming, but giving a smattering of smaller assignments gives me the opportunity to assess how well you're synthesizing the course readings without the pressure of in-class exams. It also allows me to distribute your grade across as many assignments as possible so that your final grade does not rest on any one assignment.

Reading responses (5% each; 20% of your final grade): The four reading responses are to be drawn from the readings marked as "optional" on the course schedule, and should not be more than 300-500 words in length. These mini-essays do not need to be strenuously analytical – instead, they're a chance for you to comment on a facet of nanotechnology in society beyond what we'll be discussing in lecture. What interested you most about a certain reading? Was there anything that frustrated you about a particular reading, or that you found particularly engaging? How do its conclusions and arguments compare to the other readings assigned that week? Or, in general, what did you think?

**The reading responses are due by Friday of the week in which the reading you've chosen is assigned.** There are optional readings scattered throughout the semester and therefore ample opportunity to turn in a reading response. I won't accept them late, so *don't* wait until the last four weeks of the course to turn them in, as not every week has an optional reading.

Formal writing assignments (5% each; 20% of your final grade): There are four formal research/writing assignments due in the first half of the semester. These assignments are preparation for the final paper, and are described in more detail on the reading schedule.

Final paper (20%): In the final paper, you will locate an example of popular representation of nanotechnology – either an article in a newspaper or magazine, a novel or short story, a film, music, etc. – and discuss its accuracy (or, in the case of science fiction, its relationship to reality) by tracing the

concepts or technologies depicted back to an original scientific research paper or other scholarly publication. This paper should be no fewer than 2000 words (roughly 6 pages) and should not exceed 3200 words (10 pages). Again, we'll walk through the steps of the final paper in workshops conducted in class, and I'll distribute the assignment in full and a list of suggested media and sources on March 31.

In-class presentation (10%): During the week of April 24, all class sessions will be devoted to in-class presentations on your research for the final paper. These are not formal presentations – you won't have to make posters or PowerPoint slides and lecture in front of the class – but are more like a group-led discussion. You will present with other students who are working on the same type of popular media to identify the main themes that appear in that medium, using your own research to illustrate your points. For example, the film group might choose to focus on images of nanotechnology as destructive, and the news media group might discuss why CNN never seems to get the technical details quite right. This is a chance for you to share your interests with the rest of the class, and to ask for their ideas and suggestions as well. These are group presentations, but I'll grade them on an individual basis, so don't rely on your classmates to do your talking for you.

Quizzes and other in-class writing: From time to time, I may give in-class quizzes or short writings. These assignments, total, will count for 10% of your final grade.

### **Writing Format and Grading**

All take-home written assignments must be typed with either 1-1/2 or double spacing and one-inch margins on all sides. Print your work in 11- or 12-point Times New Roman (or comparable font), and number your pages and staple them together. I will not accept handwritten assignments, nor will I accept assignments that are not stapled. Generally, 1000 words of text is roughly 3 pages, if you are using 11-point Times New Roman with 1-1/2 spacing.

You must turn in all written work on the day it is due to receive full credit. I will consider requests for extensions on a case-by-case basis with adequate prior notice (e.g. *not* the morning an assignment is due).

I will grade all writing *except* the final paper as +, ✓, or – (if necessary). For late papers, I will grade down one full step for the first day (from + to ✓ or from ✓ to –).

The final project will be graded on a letter scale. I will penalize late submissions (those without an approved extension) by one-half grade per day late, starting from the grade I assign it for its quality. This means that if you write a B paper and turn it in the day after it is due without talking to me first, you will receive a BC. My grading criteria are explained at the end of this syllabus.

### **Plagiarism**

This is the definition of plagiarism that is in effect for this class: “plagiarism is the use, citation, or paraphrase of someone else’s words or ideas without attribution. Plagiarism is covered under the university’s policy on academic dishonesty, and may result in failure of the class, a disciplinary hearing before the Dean of Students, expulsion, or some combination thereof. Generally speaking, if you have used three or more words from a source, a phrase that is not in common usage, or if you have referred to an idea or concept that is not common knowledge for your audience, you *must* attribute it...if you are

uncertain what constitutes plagiarism or academic dishonesty, come talk to me.”<sup>1</sup> In other words, don’t copy from other people’s work and submit it as your own. Plagiarism is grounds for at least an automatic F on the assignment, and possibly worse.

### Special Accommodations

If you need accommodations – such as an interpreter, a note-taker, or course materials in a different format – for a learning or other disability, please contact the McBurney Resource Center as soon as possible. Their office is at 1305 Linden Drive in the Middleton Office Building (it’s a short little building just past and across the street from VanHise Hall) and their phone number is 263-2741. They will evaluate your request and give you a form (VISA) to bring to me. The sooner you consult with the McBurney Center, the sooner I will be able to help meet your needs.

### Course Schedule

Readings are listed under the day upon which they are due (so, for Friday, January 20, read Ratner and Ratner, Drexler, etc). Readings listed as “optional” can be used for the required reading responses as described above.

#### Week 1: Beginnings

(W) January 18: Administrivia; course policies and goals; pre-assessment

(F) January 20: What is nanotechnology?

**Reading:** Ratner and Ratner, Chapters 1-3; The Scale of Things; K. Eric Drexler, “Machines of inner space,” reprinted in M. Krummenacker and J. Lewis, eds. *Prospects in nanotechnology: Toward molecular manufacturing* (Wiley, 1995; originally published 1990); Sections 1-3 (pages 1-17) in Mihail C. Roco and William Sims Bainbridge, eds. *Societal implications of nanoscience and nanotechnology* (Kluwer, 2001)

*Optional (Response 1):* Christine Peterson, “Nanotechnology: Evolution of the concept,” in B.C. Crandall and J. Lewis, eds. *Nanotechnology: Research and perspectives* (MIT Press, 1992)

#### Week 2: Beginnings, Continued

(M) January 23: What can nano do? The promise and the reality

**Reading:** Wolfgang Porod, “Nanotechnology: The possibilities of a new science.” *Resource* 12:7 (September 2005), 15-16; H. Keith Henson, “Trivial (uses of) nanotechnology” and Tom McKendree, “Nanotech hobbies,” both in B.C. Crandall, ed. *Nanotechnology: Molecular speculations on global abundance* (MIT Press, 1996)

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<sup>1</sup> This paragraph has been taken verbatim from the syllabus of History of Science 333, as taught by Professor Lynn K. Nyhart in the History of Science Department. (That’s why it’s in quotation marks.) This footnote is an example of how to cite other people’s work in your own paper; see Lynn K. Nyhart, “History of Science 333 Course Syllabus,” Spring 2001. Other formats (such as parenthetical citations with a full bibliography) are likewise acceptable.

**Assignment for Friday, January 27:** Bring in a newspaper or magazine article from the past six months that discusses some aspect of nanotechnology you find interesting. It can be a report of a new invention, a review of a movie or book in which nano is a theme, a description of a new use for nano, etc – be creative and pick something you think would generate good discussion. Write 1-2 paragraphs summarizing the article and explaining what about this technology interested you.

(W) January 25: Technology shaping every-day life

**Reading:** Langdon Winner, “Do artifacts have politics?” In Winner, *The whale and the reactor: A search for limits in an age of high technology* (Chicago, 1986); Ruth Schwartz Cowan, “An introduction: Housework and its tools” and “*The invention of housework: The early stages of industrialization,*” in Cowan, *More work for mother: The ironies of household technology from the open hearth to the microwave* (Basic: 1983)

(F) January 27: Discussion of articles and search methods

### **Week 3: Introduction to Nanotechnology in the Biomedical Sciences**

(M) January 30: Nanotechnology as a research tool: what can it bring to the biological sciences and medicine?

**Reading:** Ratner and Ratner, Chapters 7 and 8 (skip first paragraphs on Paracelsus, which are problematic); Mihail C. Roco, “Nanotechnology: Convergence with modern biology and medicine.” *Current Opinion in Biotechnology* 14 (2005): 337-346 (skip section on “research priorities and investments”); S.E. McNeil, “Nanotechnology for the biologist.” *Journal of Leukocyte Biology* 78 (2005) 585-594.

(W) February 1: Clinical and Practical Potential

**Reading:** A. Paul Alivisatos, “Less is more in medicine,” in *Understanding nanotechnology* (Warner Books: 2002); Richard Coombs et al, “Clinical implications for nanotechnology,” in Coombs, ed. *Nanotechnology in medicine and the biosciences* (Gordon and Breach, 1996);

*Optional (Response 2):* Browse the Summer 2005 special issue of *Newsweek*, “Your Health in the 21<sup>st</sup> Century” (Volume 145: Issue 26A; also available online through Reader’s Guide Full Text). Pick one of the articles therein and describe the technology or innovation in question, the author’s position on its potential (if the author has one), and the issues you think this technology raises for medical practice. If you choose an article detailing a new means of treatment, be sure to note whether you would choose this treatment for yourself and why (or why not).

(F) February 3: Workshop – Locating scientific papers

**Assignment for Friday, February 10:** Pick one example from the three remaining articles and locate the original publication (usually either a research paper or a press release) that describes the technology. Bring in a copy of the original publication along with a short (two pages, maximum) description of why you chose this example, what search engines or databases you used and why, and what you found. If your search revealed more than one paper as the original source, explain why you chose the one you did over the other(s).

### **Week 4: Evaluating Nanotechnologies I – The Case of Cancer**

(M) February 6: Understanding cancer biology and treatments. **Guest Lecture by Dr. Kyle Holen, M.D.**

**Reading:** D. Mooney, 2005. "Cancer: One step at a time." *Nature* 436:7050 (28 July 2005) 468-9; National Cancer Institute Alliance for Nanotechnology in Cancer, "Nanotechnology heads to the clinic," October 2005; Joan Raymond and Barbara Kantrowitz, "Making chemo easier to take," *Newsweek* 145:26A (Summer 2005) 16-20

(W) February 8: Biomedical research and its potential

**Reading:** University of Michigan, "U-M gets \$2.5 million grant to use nanotechnology to fight cancer," 10/18/2005; Tom Bethell, "A map to nowhere: The genome isn't a code and we can't read it," *The American Spectator* 34:3 (April 2001) 51-56; Daniel Voss, "Nanomedicine nears the clinic," *Technology Review* 103:1 (Jan/Feb 2000) 60-65

*Optional (Response 3):* Read Sato et al, 2005. "Non-cross-linking gold nanoparticle aggregation as a detection method of single-base substitutions." *Nucleic Acids Research* 33:1, 1-5. Write 250-500 words explaining what "discovery" this paper is announcing and how it could be relevant to cancer research and therapies.

(F) February 10: Workshop – understanding scientific papers; bring original paper to class

**Assignment for Friday, February 24:** Using the questions and concepts we discussed in class, write a 300-400 word analysis of the paper you selected as representing your technology. Include what the technology is, what prompted its development and what purpose it serves. If you see questions or potential uses that aren't addressed in the article, include those in your essay as well.

### **Week 5: Evaluating Nanotechnologies II – The Case of *In Vitro* Fertilization**

(M) February 13: New directions in fertility research

**Reading:** University of Michigan, "New microfluidic devices found to be effective method of in-vitro fertilization in mice," 10/12/2005 and "New technique for sorting sperm could improve fertility treatment," 7/8/2005; Suh et al, 2005. "IVF within microfluidic channels requires lower total numbers and concentrations of sperm." *Human Reproduction* (e-print) 1-7.

(W) February 15: Groupwork – preparation for in-class debate and discussion

**Reading:** Dick Teresi and Kathleen McAuliffe, "Male pregnancy." In Daniel Hopkins, ed. *Sex/machine: Readings in culture, gender, and technology* (Indiana: 1998)

**Assignment for Friday:** Write a 500-600 word essay explaining the decision your group reached and the reasons behind your stance.

(F) February 17: In-class debate: implementation and implications of *in vitro* fertilization

### **Week 6: Nanotechnology and the Brain**

(M) February 20: The brain-computer interface and rehabilitation therapies

**Reading:** G. Wolbring, "Science and technology and the triple D (disease, disability, defect)." In M.C. Roco and W.S. Bainbridge, eds. *Converging technologies for improving human performance: nanotechnology, biotechnology, information technology and cognitive science* (Kluwer: 2003) Susan

A. Greenfield, "Biotechnology, the brain and the future." *Trends in Biotechnology* 23:1 (January 2006) 34-41; Friehs et al, "Brain-Machine and Brain-Computer Interfaces," *Stroke* 34:Supplement I (November 2004) 2702-2705

(W) February 22: Augmenting human performance and cognition

**Reading:** Wrye Sententia, "Neuroethical considerations: Cognitive liberty and converging technologies for improving human cognition," pages 221-228, and Zack Lynch, "Neurotechnology and society (2010-2060)." In M.C. Roco and C.D. Montemango, eds. *The coevolution of human potential and converging technologies* (New York Academy of Sciences: 2004); M.C. Roco and W.S. Bainbridge, "Overview: Converging technologies for improving human performance," **pages 1-7 only.** In M.C. Roco and W.S. Bainbridge, eds. *Converging technologies for improving human performance: nanotechnology, biotechnology, information technology and cognitive science* (Kluwer:2003)

(F) February 24: In-class workshop: comparing scientific and popular media  
**Analysis of scientific paper due.**

### **Week 7: Cyborgs: From the Six-Million-Dollar Man to the Borg**

(M) February 27: What is a cyborg? Is it alive?

**Reading:** Kevin Warwick, "Cyborg 1.0," *Wired* 8:02 (February 2000); Hari Kunzru, "You are cyborg," *Wired* 5:02 (February 1997); **third reading TBA.**

*Optional (Response 4):* Browse <http://www.kevinwarwick.com/>. Why did Prof. Warwick choose to have these implants? Is this something you would ever do? Why or why not? What circumstances might make such implants seem appealing? What factors might make them seem unappealing?

(W) March 1: Resistance is futile: cyborgs in science fiction

**Reading:** Wikipedia entry on Borg, <http://en.wikipedia.org/wiki/Borg>; Thomas Richards, "Contact and Conflict," pages 38-52. In Richards, *Star Trek in myth and legend* (Orion Media: 1997); Kevin Warwick, "The Matrix – our future?" In Christopher Grau, ed. *Philosophers explore The Matrix* (Oxford University Press: 2005)

(F) March 3: Fear of a master race

**Reading:** Steve Mizrach, "Should there be a limit placed on the integration of humans and computers and electronic technology?" (1996), also available online at <http://www.koni.ch/cyborg/cyborg-ethics.html>; "Who's afraid of human enhancement?" *Reason* 37:8 (January 2006) 22-32; M. Goldblatt, "DARPA's programs in enhancing human performance." In M.C. Roco and W.S. Bainbridge, eds. *Converging technologies for improving human performance: nanotechnology, biotechnology, information technology and cognitive science* (Kluwer: 2003)

### **Week 8: Ecosystems I: Nanotech, biotech, and agriculture**

(M) March 6: Innovation or hazard? GMOs as model controversy

**Reading:** Allison Snow, "Genetic modification and gene flow: An overview," and Paul Gepts, "Introduction of transgenic crops in centers of origin and domestication," both in Kleinman et al, eds.

*Controversies in Science and Technology, Volume 1: From Maize to Menopause* (Wisconsin: 2005); ETC Group, "Nano-Agriculture: Down on the farm." In *Down on the Farm*, pages 8-14 (stop at section on encapsulation)

(W) March 8: Exploring consequences: The case of agricultural antibiotics

**Reading:** Christine Mlot, "Antibiotic resistance: The agricultural connection," Abigail Salyers, "Agricultural uses of antibiotics: Evaluating possible safety concerns," and Randall Singer, "Antibiotics in animal agriculture: An ecosystem dilemma," all in Kleinman et al, eds. *Controversies in Science and Technology, Volume 1: From Maize to Menopause* (Wisconsin: 2005)

(F) March 10: Assessing risk: What do GMOs and agricultural antibiotics teach us about assessing risk in nanotechnology?

**Reading:** ETC Group, *Down on the Farm*, pages 53-56; Richard Owen and Michael Depledge, "Nanotechnology and the environment: Risks and rewards," *Marine Pollution Bulletin* 50 (2005) 609-612.

*Optional (Response 5):* Skim the remainder of *Down on the Farm*. What is the ETC Group? What is their stance on nanobiotechnology, and how do they explain it in *Down on the Farm*? What motivations might they have for taking such a position?

### Spring Break March 12-19

**Week 9: Ecosystems II: Nanotechnology, ecology, and the environment**

(M) March 20: Nanotechnology in the environment: Threats and benefits

**Reading:** Vicki L. Colvin, "The potential environmental impact of engineered nanomaterials." *Nature Biotechnology* 21:10 (October 2003) 1166-1170 and errata; A. Goho, "Plastic particles pick up pollution," *Science News* 165:8 (February 21, 2004) 116-117; Jill Banfield, "Making sense of the world: convergent technologies for environmental science." In M.C. Roco and W.S. Bainbridge, eds. *Converging technologies for improving human performance: nanotechnology, biotechnology, information technology and cognitive science* (Kluwer: 2003); ETC Group, "Keeping nanoparticles out of the environment." In *Down on the Farm*, page 7.

(W) March 22: Nanotoxicity and biodiversity

**Reading:** Rick Weiss, "Nanoparticles toxic in aquatic habitat, study finds," *The Washington Post* (March 29, 2004) A02; Eva Oberdörster, "Manufactured nanomaterials (Fullerenes, C60) induce oxidative stress in the brain of juvenile largemouth bass," *Environmental Health Perspectives* 112:10 (July 2004) 1058-1062

(F) TBA

**Week 10: Science Fiction and Popular Media**

(M) March 27: Utopia and dystopia

## Readings TBA

(W) March 29: Is science fiction predictive?

**Reading:** Tony Miksanek, “Molecular Black Bags: Science Fiction’s Prescription for Nanotechnology and Medicine,” *Literature and Medicine* 20:1 (Spring 2001) 55-70; Heather Green, “Attack of the Killer Dust,” *Business Week* 3810 (December 2, 2002) 103

(F) March 31: Assignment and discussion of final paper: acceptable popular media, strategizing, deadlines.

## Week 11: Runaway Nano

(M) April 3: Fearing the “grey goo”: auto-assemblers, super microbes, and popular fear

**Reading:** Ratner and Ratner, pages 49-51; K. Eric Drexler, “Engines of Construction” and “Engines of Destruction”, pages 3-20 and 171-190, in Drexler, *Engines of Creation* (Anchor Books: 1986); Michael Crichton, “Artificial Evolution in the Twenty-first Century.” In Crichton, *Prey* (HarperCollins, 2002).

(W) April 5: Conduits of fear: Misrepresentation in news and popular media

**Reading:** James M. Pethokoukis, “Devil in the Details?” *U.S. News & World Report* 134:3 (January 27-February 3); **other readings TBA**

(F) April 7: Can it happen? Scientists’ responses

**Reading:** Ralph Merkel, “The risks of nanotechnology,” in M. Krummenacker and J. Lewis, eds. *Prospects in Nanotechnology: Toward Molecular Manufacturing* (Wiley, 1995); “Testimony of Ray Kurzweil on the societal implications of nanotechnology, Committee on Science, U.S. House of Representatives, Hearing. April 9, 2003,” pages 1-7; Chris Phoenix and Eric Drexler, “Safe exponential manufacturing,” *Nanotechnology* 15 (2004) 869-872.

*Optional (Response 6):* What was Drexler’s initial position on grey goo, and what is his position now? Why did his opinion change? Do you find his new position reassuring? Why or why not?

## Week 12: Use and misuse: confronting the “dual-use” dilemma

(M) April 10: Limits on research: External pressures, scientific obstacles, and social consequences

**Reading:** Ellen Thompson, “Terror in the laboratory: Federal rules hamper research that could save potatoes – and lives.” *Isthmus* (May 28, 2004) 7; Joanna Kempner et al, “Forbidden knowledge,” *Science* 307 (11 February 2005) 854; “The question of forbidden knowledge,” *Science* 308 (10 June 2005) 1549-1550

(W) April 12: Limits on use: Being responsible users and consumers

**Reading:** Anonymous, “Handle nano-technology with care,” *African Business* 285 (March 2003) 36; Bill Joy, “The Dark Side of technology: Morality in the dot com era,” *Vital Speeches of the Day* 66:23 (September 15, 2005) 706; Jay Stowsky, “Secrets to shield or share? New dilemmas for military R&D policy in the digital age,” *Research Policy* 33 (2004) 257-269

(F) April 14: Conducting responsible research

**Reading:** “Excerpt from *Foresight Guidelines on Molecular Nanotechnology*.” In Douglas Mulhall, *Our molecular future: How nanotechnology, robotics, genetics, and artificial intelligence will transform our world* (Prometheus: 2002); John Ziman, “Why must scientists become more ethically sensitive than they used to be?” *Science* 282:5395 (4 December 1998) 1813-1814

*Optional (Response 7):* Skim Neil Jacobstein and Glenn Harlan Reynolds, “Foresight Guidelines Version 4.0: Self Assessment Scorecards for Safer Development of Nanotechnology,” also available online at <http://www.foresight.org/guidelines/index.html>, and discuss whether you think the “safer development” guidelines they suggest are adequate for preventing the misuse of nanotechnologies. **Note:** This is a longer version of the guidelines listed above. The PDF was meant to print as a booklet rather than as individual sheets, so follow the page numbers at the bottom of each frame (not each page) as you read.

### **Week 13: Nanoterrorism: A weapon for a technological world?**

(M) April 17: Fact or fiction? Real and imagined threats

**Reading:** Joshua Green, “The Myth of Cyberterrorism,” *The Washington Monthly* 34:11 (November 2002) 8-13; Linda Rothstein et al, “Rethinking Doomsday,” *Bulletin of the Atomic Scientists* 60:6 (November/December 2004); **other readings TBA**

(W) April 19: Prevention and control

**Reading:** M.A. Somerville and R.M. Atlas, “Ethics: A weapon to counter bioterrorism.” *Science* 307 (25 March 2005) 1881-2; James Murday, “NBIC for homeland defense: Chemical/biological/radiological/explosive (CBRE) detection/protection,” and Tony Fainberg, “Future roles for science and technology in counterterrorism.” Both in M.C. Roco and W.S. Bainbridge, eds. *Converging technologies for improving human performance: nanotechnology, biotechnology, information technology and cognitive science* (Kluwer: 2003)

(F) April 19: In-class workshop: Preparing for presentations

### **Week 14: Group discussions: Nanotechnology in the media**

April 24-28: No required reading this week; continue working on final project.

### **Week 15: The future and our role in it: Thinking ahead about nanotechnology**

(M) May 1: Where have we been? Where are we going?

**Reading:** Richard Feynman, “There’s plenty of room at the bottom: An invitation to enter a new field of physics,” reprinted in M. Krummenacker and J. Lewis, eds. *Prospects in nanotechnology: Toward molecular manufacturing* (Wiley, 1995) (originally published 1960); Bill Joy, “Why the future doesn’t need us,” *Wired* 8:4 (April 2000); J.S. Brown, “Don’t count society out: A response to Bill Joy,” in Roco and Bainbridge, eds; *Societal implications of nanoscience and nanotechnology*

(W) May 3: Avoiding complacency

**Reading:** Douglas Mulhall, “The right questions” and “Bypassing the road to Hell,” in *Our molecular future: How nanotechnology, robotics, genetics, and artificial intelligence will transform our world*. (Prometheus, 2002); Ratner and Ratner, Chapter 11, “Nanotechnology and You”

(F) May 5: Wrap-up

**Final papers due in 3113 ECB by noon on WEDNESDAY, MAY 10**

### **Grading Policy for the Final Project<sup>2</sup>**

- A: For outstanding essays only. Thesis and argument are clear, thought-provoking, and based on solid research; relationships drawn between facts and ideas are sophisticated, subtle, and/or original. Writing is grammatically correct and succinct. The essay flows well from point to point, without any puffery or wasted words.
- AB: For very good essays that for some reason fall short of the criteria listed above. For example, the argument may be murky in one place; information may be presented that doesn't directly or clearly contribute to the argument; the writing style may be awkward in places or flawed by one or two consistent (if minor) grammatical errors.
- B: Your basic “fine” grade. The essay may pursue a straightforward but not especially deep or sophisticated argument; it is okay as far as it goes, but doesn't penetrate the material very far. It may have good ideas overshadowed by more serious grammatical problems, a weakness in argumentation, and/or a significant misunderstanding of evidence. In other words, the essay is fine, but not outstanding.
- BC: The essay shows some of the basics of the ideal essay, but is weakened by a lack of serious think-work or by writing problems. It may make superficial connections without offering sufficient evidence to make the connections plausible or persuasive, or it may have what is in principle a good argument supported by incorrect facts. Alternatively, it may provide a fairly solid argument with minor flaws, expressed in consistently awkward or ungrammatical prose.
- C: A grade signifying some serious problem in essay-writing. The essay may deliver facts without a recognizable thesis or argument; it may wander away from the point; or it may be a thoughtful attempt so weakened by writing problems (grammar, punctuation, word choice) that it is difficult for the reader to understand its crucial points.
- D: A marginal grade. There may be enough in here to show you have attended a few lectures and/or done some of the reading, but the essay indicates no effort at analysis or thinking on your own, or else shows a serious misunderstanding of the nature of the material and/or the assignment. Also used for essays that are just barely coherent.
- F: For unacceptable essays. An essay may be judged unacceptable if it contains plagiarism (see definition above); if it consists primarily of content inappropriate to the intent of the assignment or the material for this course; if it shows a complete misunderstanding of the course content or the assignment; or if the writing fails to meet standard college-level requirements of basic communication in English.

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<sup>2</sup> This grading policy, with a few minor changes in phrasing, comes verbatim from Prof. Lynn K. Nyhart's History of Science 333 syllabus, as credited above.