EMTM 670
MEDICAL DEVICES
(Room 337 Towne Bldg)

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Course description and Objectives

This course will provide a basic understanding of some of the scientific principles at the foundation of medical devices. In addition, some of the unique business aspects of medical device companies will be highlighted and discussed such as FDA regulation, bioterrorism, safety of medical devices, and medical ethics.

Medicine has been forever changed by advances in biotechnology and medical devices. Advances in molecular biology and the completion of the human genome project will forever change the practice of medicine. A few designer drugs have targeted and cured specific diseases that only a decade ago were considered incurable. Further advances will proceed at a logarithmic pace, and the pharmaceutical companies of the future will produce drugs that target very specific diseases through genetic engineering. A thorough understanding of the basic principles underlying medical diagnosis and treatment in the context of biotechnology is essential for future business leaders. Medical devices have evolved recently at a feverish pace, with advances in engineering including nanotechnology paving the way for these advances. These advances in technology come at a price, and price pressures have impacted hospitals in America today, possibly forcing tough choices for future leaders.

Specifically, the course uses a mixture of case discussions and lectures from leaders in the field of medical technologies to help students/participants:

1. gain an introductory understanding of some of the basic scientific and medical concepts that form a foundation for understanding biotechnology and medical devices.
2. develop a systematic approach for evaluating the technology and business structure of biotechnology and medical device companies
3. understand some of the essentials and pitfalls common to medical device start-ups
4. form an understanding of medical device companies by interacting with scientists and business leaders making key decisions for major companies or Universities
5. understand some of the unique ethical issues surrounding the field of medicine
6. develop a passion for the field of biotechnology and medical devices
7. See laser surgery in action: Field Trip to a Dermatologic Laser Center (to be scheduled)
Biographical Summary: Eric F. Bernstein

Eric F. Bernstein earned a bachelor of science degree from Duke University in 1981 graduating Phi Beta Kappa, *summa cum laude* with distinction in his major. He then earned his degree in medicine from Yale University School of Medicine in 1986 where he served as Banner Bearer at commencement exercises and class president. Following his internship he completed a fellowship at the National Cancer Institute at the National Institutes of Health, working in the area of photodynamic therapy and cytokines for wound healing. Following completion of his dermatology residency at Hahnemann University, he accepted a position as Associate Professor in the Department of Dermatology and Cutaneous Biology at Jefferson Medical College. There Dr. Bernstein directed a photobiology laboratory and was the first director of the newly established Laser Surgery Center. Dr. Bernstein’s research focused on the molecular and cellular effects of various lasers on human skin, and on the molecular causes of skin photoaging. This research resulted in the development of a rapid high-throughput screening molecular model of skin photoaging.

Dr. Bernstein then received a Small Business Innovation Research Award from the National Institutes of Health to further develop his company, DakDak Photoaging Technologies, based on a molecular model of skin photoaging. Following completion of this grant, Dr. Bernstein sold the company to Charles River Laboratories, but recently re-acquired it as DakDak, LLC. DakDak performs in vitro phototoxicology testing for large pharmaceutical companies, and pursues discovery of novel anti-aging and pharmaceutical compounds. Dr. Bernstein is also director of the Laser Surgery and Cosmetic Dermatology Centers Ardmore, Pennsylvania, performing laser skin surgery.

Dr. Bernstein has served on the scientific advisory board of numerous laser companies, and was a member of the Board of Directors of Candela Corporation, a leading manufacturer of medical laser systems, and now heads their Scientific Advisory Board. He has also been a consultant to a number of cosmetic and biotechnology companies, including Estee Lauder, Sirna, Candela Corporation, Freedom-2 and others. Dr. Bernstein has served on the laser special study section of the National Institutes of Health, and is serving on the data safety monitoring board for a gene therapy trial. He is past president of the Philadelphia Dermatologic Society, past vice president of the International Society of Cosmetic Laser Surgeons, and has served as program chair for the annual meeting of the American Society for Lasers in Medicine and Surgery.

Dr. Bernstein is currently volunteer faculty at the University of Pennsylvania in the Department of Dermatology as a Clinical Associate Professor. He has authored over 60 peer-reviewed articles and over 20 review articles or book chapters, and given more than 200 presentations at scientific meetings. He has been issued 10 U.S. and international patents. Dr. Bernstein has served as a reviewer for 16 peer-reviewed journals. In addition, Dr. Bernstein has been cited in the popular press appearing on CNN, 20/20, local NBC, CBS and Fox news, and in the Philadelphia Inquirer, the Philadelphia Daily news, Allure and other venues. Dr. Bernstein also earned an MSE in Management of Technology from the School of Engineering and Applied Science at the University of Pennsylvania.
Course Prerequisites

There are no course prerequisites. No scientific background is assumed, although help will be expected and accepted regarding use of computers during presentations.

Course Materials

1. Bulk Pack of reprinted case reports.

Course Administration

Participants will read all the case reports for each session. Cases will be discussed in class. The textbooks should supplement any technical information needed to help with the readings. The class atmosphere is mellow, and I encourage everyone to voice carefully considered facts or opinions. You must have fun in this class; I have found it is the best way to learn.

Each student will write an analysis of two of the assigned Harvard Case Studies to be handed in before the 3rd and 6th classes. In addition, groups of 3-4 students will prepare a synopsis of a modern biotechnology or medical company assigned by me. The report will focus heavily on the core technology, with emphasis on R and D. A financial analysis of the company should be included. Would you buy this stock? Would you work for this company? A written presentation will be handed in on the last day of class. Grades will depend heavily on effort put forth, everybody can get an A; there will be no curve.

Class participation: 25% of grade.
Written reports: case reports (1) 25%, business analysis 50%.
OUTLINE OF COURSE

CLASS 1. INTRO. TO MEDICINE/BIOTECHNOLOGY/MEDICAL DEVICES
March 12th 8:30-11:30am

A. READING
1. The Life Sciences Revolution: A Technical Primer
For more than two decades, scientific advances have been driving profound changes in drug discovery and the drug industry itself. This case provides an overview and description of these technical and scientific advances. Written for the nonscientific reader, it may be used as companion reading for other case materials that require basic knowledge of the tools, techniques, and approaches used in the pharmaceutical and biotechnology industries. Teaching Purpose: To provide technical background on the science behind the "life sciences revolution."

2. Transforming Life, Transforming Business: The Life-Science Revolution
If you think the Internet has changed the shape of business, just imagine what genetic engineering is going to do. In this groundbreaking article, Juan Enriquez and Ray Goldberg explain how advances in genetics will not only have dramatic implications for people and society, they will reshape vast sectors of the world economy. The boundaries between many once-distinct businesses, from agribusiness and chemicals to pharmaceuticals and health care to energy and computing, will blur, and out of that convergence will emerge what promises to be the largest industry in the world: life science. And as scientific advances continue to accelerate, more and more businesses will be drawn, by choice or by necessity, into the life-science industry. Companies have realized that unlocking life's code opens up virtually unlimited commercial possibilities, but operating within this new industry presents a raft of wrenchingly difficult challenges as well. Companies must rethink their business, financial, and M&A strategies. They must make vast R&D investments with distant and uncertain payoffs. They must enter into complex partnerships and affiliations, sometimes with direct competitors. And perhaps most difficult, they must contend with a public that is uncomfortable with even the thought of genetic engineering. The optimal structure of the life-science industry--and of the companies that compose it--is as yet unknown. But the actions that executives take now will go a long way toward determining the ultimate role their companies play in the world's largest and most important industry.

3. Novartis: Betting on Life Sciences
The merger of Ciba-Geigy and Sandoz produced genomic-based synergies for health care, agribusiness, and nutritional supplements. How to build on the strength of the individual divisions and provide synergies that would continue Novartis' leadership role is the question facing the company. Teaching Purpose: How to position a firm in a life science industry?

4. ATH Technologies, Inc. (A): Making the Numbers
An exercise that takes students through five stages of growth in an entrepreneurial start-up in the medical devices industry: 1) founding, 2) growth, 3) push to profitability, 4) refocus on process, and 5) takeover by new management. At each stage, students must confront tensions in balancing
profit, growth, and control. Difficulties encountered in the business are due to management's attempts to design and use formal control systems to achieve profit and performance goals.

B. CLASS STRUCTURE

PART 1. **Gerard Puorro**, CEO, Candela Corporation, “You Read the Case: Now find out what REALLY happened!”

A. READING
1. Monsanto's Genetically Modified Organisms: The Battle for Hearts and Shopping Aisles
Monsanto, an American company founded in 1901, originally specialized in chemicals. In 1995, the firm reoriented its strategy around more lucrative, but unproven, fields such as agricultural biotechnology. Describes how, in the space of a few years, Monsanto became market leader of bioengineered cereal crops--commonly known as genetically modified organisms--but is accused of applying an unsafe gene technology and trying to dominate world food supplies. The firm is caught up in a worldwide controversy. Documents how Monsanto was implicated in a trade dispute and reacted poorly to public criticism, particularly in its lack of dialogue with stakeholders. Illustrates how public pressure obliged Monsanto to stop following a promising strategy.

2. Genzyme Corp.: Strategic Challenges with Ceredase
Genzyme Corp., one of the largest biotechnology companies, has succeeded in developing, manufacturing, and commercializing its first therapeutic, a treatment for a rare genetic disease. Analysis of the case requires students to identify and understand how Genzyme has designed its strategy to effectively manage, mitigate, or exploit the uncertainties it had faced in the past. In 1993, the company faces challenges in managing future uncertainties involving the product's market, manufacturing, and pricing.

B. CLASS STRUCTURE


PART 2. Brian Zelickson, M.D., President, Zel Dermatology, Inventor and Founder, Vibraderm, Inc., Founder and Principal, BARRX Medical, Inc., Using RF to treat Barrett’s esophagus a previously untreatable condition—This could be curing cancer!
A. READING

1. Abgenix and the XenoMouse
Abgenix has a unique method for generating antibodies useful in treating a number of diseases, including cancer. In early 2000, the company's cancer drug has performed very well in animal testing and is moving to early stage human testing. Abgenix must decide whether to sell the product development program to a large pharmaceutical company or to enter into a joint venture to push the product ahead. Teaching Purpose: To introduce the issue of deciding whether to define your product as access to a technology, a developing program for defining a product based on the technology, or a finished program and marketable product. Exposes students to product line planning in largely uncertain environments.

2. Guidant: Radiation Therapy
Guidant is a device company that developed coated stents that prevent re-stenosis of coronary vessels following insertion of the stent. This technology has revolutionized the field of cardiology. In addition, Guidant has been in the news concerning controversy over its implantable defibrillators, illustrating issues concerning device regulation and approval.

3. Drug Eluting Stents: A Paradigm Shift in the Medical Device Industry
By the mid-2000s, no segment of the $180 billion global medical device industry was as dynamic as the market for drug eluting stents (DESs). In the United States, which accounted for nearly three-quarters of the total DES market, only two companies had regulatory approval to sell the small devices: Johnson & Johnson and Boston Scientific. In combination, these two organizations expected 2005 DES sales of approximately $5.5 billion—an increase of 36% from 2004. Forecasts called for the segment to exceed $7 billion by 2008. Driven in part by its size, the DES market was among the most competitive and challenging sectors in the medical device industry. The competitive landscape was marked by intense rivalries and plagued by fierce litigation over intellectual property. Yet, it was also characterized by complex intercompany partnerships, collaboration, and licensing deals. Although DESs had been shown to significantly reduce restenosis rates, new safety concerns were emerging related to the development of life threatening blood clots linked to DESs.

Some controversy also existed regarding the cost/benefit of DESs. And product recalls and program failures were common as companies sought to bring new DES technologies to market. Against this backdrop, the segment was characterized by dramatic swings in market share. Despite all of this, the future for DESs looked promising.

An overview of Medtronic, an innovative medical device company. Medtronic has been in the news recently regarding device approvals and FDA regulation.

B. CLASS STRUCTURE
PART 1. **Eric F. Bernstein, M.D.**, Starting a small biotechnology company, Soup to Nuts, and how it boomeranged back!

PART 2. **Gene Walton, III, M.B.A. (Wharton)**, US Department of Housing and Urban Development, Discounted Cash Flow Determination—What’s that company worth without all the hype?
A. READING

1. **BioTransplant, Inc.: Initial Public Offering, January 1996**
Examines the decision to go public. BioTransplant is an early stage biotechnology company that must decide how to finance its research and development. The pros and cons of public offerings are analyzed versus alternative financing sources.

2. **Genzyme: Engineering the Market for Orphan Drugs**
Genzyme has made money with external technology in orphan drug markets generally considered to be too small to be attractive to other drug companies. Now competition is entering these same markets, placing Genzyme's business model under new pressures. Teaching Purpose: Illustrates novel approach to targeting drug markets and creative ways to use external technology.

3. **Genzyme Corp.: A Financing History**
Genzyme Corp.'s financing history is unusual compared to most biotech companies. This case presents the sequence of financings employed by Genzyme, along with the product-market and corporate-development strategies adopted by Henri Termeer, Genzyme's CEO. As such, the case permits students to evaluate the sequence of financings as a "program" rather than a series of unrelated deals, and to consider them in light of the business strategy. Teaching Purpose: May be used as a broad, comprehensive financing case or, alternatively, as a narrower discussion vehicle for the information and agency problems that confront a high-technology firm faced with financing growth options.

4. **Medi-Cult: Pricing a Radical Innovation**
Highlights the issues involved in the launch of an infertility product and procedure that allows women to become pregnant without having to undergo unpleasant hormone stimulation or experience dangerous side effects. In bringing its product to market, Medi-Cult, a small biotechnology company, must deal with regulatory constraints, larger competitors, and the challenges of introducing a new product into the local and global marketplace. Questions raised are: Should the product be priced according to its perceived value? Should Medi-Cult pursue a penetration or market skimming strategy in pricing the new product? How will the contribution margin be affected if a global, regional, or multinational pricing strategy is chosen? What are the ethical issues in pricing pharmaceuticals?

B. CLASS STRUCTURE

PART 1. **Lou Troillo**, Esq., Finnegan, Henderson, Farabow, Garrett and Dunner, LLP, You’ve got a patent, Now the REAL work starts.
PART 2. **Gabriel Karpati**, Senior Scientist, NASA, Systems Engineering at NASA-It’s not science fiction, it just sounds like it.
A. READING

1. **Four Principles of Biomedical Ethics: Definitions and Examples**
   Introduces four principles of biomedical ethics, excerpted from Principles of Biomedical Ethics, Tom L. Beauchamp and James F. Childress (Oxford University Press, 2001). The principles provide a conceptual framework for the analysis and resolution of moral problems encountered in the clinical delivery of health care, medical research, and the distribution of health care resources. The four principles are: respect for autonomy, nonmaleficence ("doing no harm"), beneficence, and justice. Teaching Purpose: 1) To provide contextual background and a framework for analysis of cases featuring moral or ethical problems in health care, pharmaceutical development, or biotechnological advances; and 2) to provide a basis for classroom exploration of the role of principles in moral reasoning.

**DNA: Handle with Care**
Lori Andrews, a professor of science, technology, and law, discusses the legal and ethical issues surrounding genomics. She explains what executives need to know about handling sensitive genetic information and technologies.

B. CLASS STRUCTURE

**PART 1.** Timothy Foster, M.D., Assistant Professor of Orthopaedic Surgery Co-Director, Sports medicine Boston University School of Medicine and Associate Editor and Current Concepts Editor, The American Journal of Sports Medicine, “Medical Devices in Orthopedic Surgery from the end user’s perspective”

**PART 2.** Richard Felten, FDA, Medical Device Branch, The FDA Approval Process for Medical Devices-One Tough, Thankless, and Critical Job (title by EFB)
CLASS 6. IP, FDA, CT, MRI...ALL THESE LETTERS, WHAT DO THEY MEAN?
May 21st  8:30-11:30am

A. READING

1. **Candela Laser V. Cynosure, Inc.**
   Focuses on the intellectual property aspects of a medical device company.

2. **Note on the FDA review process for medical devices.**
   A 2-page review of the FDA process for approving medical devices.

3. **EMI and the CT Scanner (A)**
   Describes the development of the first CT Scanner by EMI, a company new to the medical industry, and EMI's entry into the U.S. market. The company's early success is threatened by the entry of a dozen competitors (some very large and experienced), by government regulation, and by internal organizational problems.

4. **EMI and the CT Scanner (B)**
   Describes the development of the first CT Scanner by EMI, a company new to the medical industry, and EMI's entry into the U.S. market. The company's early success is threatened by the entry of a dozen competitors (some very large and experienced), by government regulation, and by internal organizational problems.

B. CLASS STRUCTURE


CLASS 6a. **VOLUNTARY FIELD TRIP (to be scheduled)**

Visit a dermatologic laser center. See the various devices using different wavelengths and cooling strategies to treat a myriad of skin conditions.