California State University, Channel Islands
COURSE SYLLABUS

Faculty: **Maria Silva Elipe (MSE), PhD, Department of Chemistry;**
Zhong John Lu (JL), PhD, Department of Economics

Location: California State University Channel Islands (CSUCI)/Camarillo Campus
Bell Tower 2515

Time: Mondays: 4:30 – 7:20 pm

Office Hours : [Lu] Sage Hall 2151
Monday 3:00 – 4:00 pm and by appointment
[Silva Elipe] Solano Hall 1115
M 7:30-8:30 pm (Days of MSE lectures only, but available upon request other Mondays)

Phone : [Lu] 1-(805)-437-2058 (work); [MSE] 1-(805)-437-8896 (work)
E-mail: john.lu@csuci.edu; maria.silvaelipe@csuci.edu

Exams: **MID-TERM EXAM:**
Monday, October 16, 2017 (1st half of lecture)

FINAL EXAM:
Monday, December 11, 2017 (4:00 - 6:00PM)

Term Paper: **Monday, November 13, 2017, in class**

1. Course Description

The modern pharmaceutical industry has been one of the most innovative and dynamic sectors in the developed world. In the US, this industry has been praised by many for the science focused culture, the highly effective medicines against many previously untreatable diseases and conditions, the substantial and well compensated employment opportunities, and for being a global leader in net exports. On the other hand, the industry has no lack of critics, both in the US and globally. It has often been criticized for monopolist like pricing behavior, for engaging in unethical or illegal promotional activities for off-label usage of its products, and for under-reporting and misreprensenting important safety information. In this course, we will examine a number of aspects of this fascinating industry, including historical development, research methods and processes, regulatory hurdles, intellectual property issues, pricing and reimbursement, marketing, business ethics, generic and biosimilar drugs, and health outcomes research. Selected topics from these areas will be analyzed in depth.

It is hoped that the course will provide students with a better understanding of the industry: basic structures, common business strategies, and critical issues. It is also hoped that lessons from this industry may be applied to other sectors which rely on continuous innovations for survival. In addition, this course may also be useful for students who are interested in employment opportunities in the pharmaceutical industry.

2. Learning Objectives

- Understand the basic health science fundamentals and the industrial organization of pharmaceutical and biotechnology firms;
- Understand the R&D process and regulatory approval process in drug discovery and development, and appreciate the role of innovations in the longterm success of pharmaceutical firms including the patent system and its significance;
- Understand the commercialization of new pharmaceutical products, including the role of health insurance, basic marketing process, pricing and promotional strategy, and the economic evaluation of new medicines;
- Develop ability to learn, collaborate, and interact in a cross-disciplinary learning environment including working in multi-disciplinary teams;
- Understand industry best-practices in selected company and drug case studies and "the science of business & the business of science"

3. Value Proposition

Key value proposition of BUS ECON CHEM 341 is to demonstrate the value of the science-based, strongly R&D-driven pharmaceutical industry, and how deeply science (chemistry, biology, basic pharmacology), business, economics, and management are interconnected & integrated in this sector. The entire pharmaceutical value chain from basic research to product commercialization of both small molecules (chemistry) and large molecule biotherapeutics/biologics (biology) will be instructed, including high-level content, overall process, key milestones & decision points, best-practices and selected case studies.

4. Course Credit

Credit in BUS ECON CHEM 341 could be applied either as an elective course within the BS Business program (as BUS 341) or as an elective outside of the business program (as ECON 341 or CHEM 341). This course provides credit towards the Chemistry minor. Class target audience : Junior and Senior-level students, including, but not limited to, BUS ECON CHEM and STEM students. Underclassmen students with strong, college level academic records may be considered on a case-by-case basis.

5. Course Topics

The following broad topics will be covered in this course:

- **Overview of the Global Pharmaceutical Industry**
  - The BioPharma Industry (Big Pharma and Biotech)
  - Stages and phases of drug research and development (R&D)
  - Cost, risk, and timelines in BioPharma R&D
  - Mergers, acquisitions, and strategic alliances

- **Introduction to US Healthcare System**
  - The organization of the US healthcare market
  - Health insurance and healthcare financing: Private
  - Health insurance and healthcare financing: Public
  - Health insurance and demand for pharmaceuticals

- **Discovery of Drug Targets and Drug Leads**
  - Historical sources of drug leads – natural products
  - New strategies for discovery – genomics and new technologies
  - Methods for drug discovery – from *in silico* to *in vivo*
  - Work processes and decision making in pharmaceutical R&D
  - Biologics drug discovery

- **Pharmaceutical Research and Development (R&D)**
  - Scientific methods in drug research and development
  - Lead optimization – chemical and biological approaches
  - Preclinical studies – efficacy, toxicity, ADME, and other factors
  - Pharmaceutical formulations and drug delivery systems
  - Biologics drug development

- **Clinical Trials**
  - The regulatory process – what is done in Phase I, II, and III trials
  - The role of the FDA – permissions, review, and oversight
  - Drug Safety and Pharmacovigilance (Phase IV or post-marketing trials)

- **Pharmaceutical Manufacturing and Production**
  - Scale-up from lab to pilot plant to full-scale manufacturing
  - The FDA and Good Manufacturing Practices (GMP) production
  - Work processes and decision making in scale-up and commercialization
  - The role of outsourcing in pharmaceutical development and manufacturing
  - Biologics manufacturing and production
  - Medical devices

- **Intellectual Property (IP) and Patent Protection**
  - The U.S. Patent System – requirements, process, and benefits
  - Patent life and market exclusivity for pharmaceutical products
  - The value and use of IP and patents - products, partnering, licensing
  - Landmark BioPharma patent cases at the US Supreme Court

- **Pricing of Pharmaceutical Products**
  - Basic Principles of Pricing
  - Value-based Pricing of Pharmaceutical Products
  - Price Regulations and Cost-Containment Efforts
  - Economic Evaluation of New Drugs

- **Sales and Marketing of Pharmaceutical Products**
  - The Marketing Process: What is it?
  - Channels of Pharmaceutical Promotions
  - Regulations of Pharmaceutical Promotions

- **The Rise of Generics and Biosimilars**
  - Historical development and growth in the U.S. and abroad
  - The regulatory pathway to generic pharmaceutical products
  - Regulatory policy and pathway for biosimilar products (Biosimilars)

- **Business Ethics**
  - Importance of Doing the Right Thing in Drug Development and Commercialization: what is legal vs. what is right
  - Company Vision, Mission, and Business Reality
  - Case studies in the pharmaceutical industry

- **A Look Ahead**
  - Affordable Care Act (Obamacare) and Future of Pharmaceuticals
  - Rise of Chinese and Indian Pharmaceutical Industries
  - Personalized Medicine (Pharmacogenomics): science and economics

6. <u>Required</u> Course Materials

You are required to purchase 3 books written by former pharmaceutical executives. They are inexpensive and all can be purchased online.

[1] "Science Lessons: What the Business of Biotech taught me about Management"; Gordon Binder (former CEO, Amgen) and Philip Bashe; (Harvard Business Press, 2008); Boston, MA.

[2] "The Moral Corporation : Merck Experiences" by Roy Vagelos (former CEO, Merck), Louis Galambo (Cambridge University Press, 2006); New York, NY.

[3] "Devalued and Distrusted : Can the Pharmaceutical Industry Restore its Broken Image?" by John LaMattina (John Wiley & Sons 2012)

[4] Cases (to be provided by instructors, posted on BlackBoard) : All class materials including PowerPoint Presentations (PPTs), additional reading assignments, cases, final project, instructions for cases and projects etc., will be posted on Bb http://csuci.blackboard.com in due time.

7. <u>Recommended</u> Course Materials

[1] "Modern Pharmaceutical Industry: A Primer"; Thomas M. Jacobsen, Albert I. Wertheimer (Jones and Bartlett, 2010); Sudbary, MA. This book may be useful for students who want to have a handbook for references about the major divisions and functions in most major pharmaceutical firms, such as research, manufacturing, regulatory affairs, marketing, etc.

[2] "Pharmaceutical Economics and Policy, 2nd edition" by Stuart Schweitzer (Oxford University Press). This book is written for upper division undergraduate and master level students in health economics, health management, pharmaceutical administration and public policy. Provides a good overview of key economic, scientific, regulatory, and policy issues facing this industry. The 3rd edition, co-written by Prof. Schweitzer and Prof. John Lu, will be in press at end of 2017.

[3] "2015 Profile of the Biopharmaceutical Research Industry"; Pharmaceutical Research and Manufacturing Association; Washington, DC. This annual report contains lots of useful and current statistics and information for the industry. Posted on BlackBoard.

[4] "Innovation in the Pharmaceutical Industry: New Estimates of R&D Costs"; Joseph DiMasi (Tufts Centerfor the Study of Drug Development, 2014) This briefing provides an overview of the costs, timelines, and risks involved in developing a new drug product. Posted on BlackBoard.

[5] There will be a number of handouts from the instructors as the course progresses, and the materials will be posted online. You will be notified as to the best time and for which lecture you should read them (see Course Schedule at end of this document).

It is also recommended that you periodocally check on the following sources for up-to-date news and research materials for your book report and the class project: **FierceBiotech** (www.fiercebiotech.com), and **FiercePharma** (http://www.fiercepharma.com), both of which have a free daily subscription newsletter/blog. Also, ***The Economist, Business Week, Forbes***, and ***The Wall Street Journal***. The Broome Library carries these periodicals in both hardcopy and electronically.

8. Assignments & Projects

8.1. BOOK REPORT (20%):
Each student will write a minimum 1,500-1,800 word book report (5-6 pages, double-space typed), on the two required biographies (#1 and #2 on the required list): "Science Lessons: What the Business of Biotech taught me about Management" by Gordon Binder (former CEO, Amgen) and Philip Bashe (Harvard Business Press, 2008), and "The Moral Corporation: Merck Experiences" by Roy Vagelos (former CEO, Merck) and Louis Galambo (Cambridge University Press, 2006).

Note that Mr. Binder has a MBA in finance and Mr. Vagelos is a MD. Although both were former CEOs of a premier biopharmaceutical company in the world, their perspectives on running an innovative healthcare company may be different. One can think of Mr. Binder as a business man running a science company, while Mr. Vagelos as a scientist running a complex business. The book report should focus on key lessons learnt and to compare/contrast of the ways these executives managed their respective companies. Tie in what you learn in this course to the books in your critique. Main topics which must be covered in the paper include:

- Pharmaceutical R&D: innovation and risk
- Pricing
- Ethics
- Strategic partnership with another firm
- Clinical trials/regulatory process

Book report must be written and submitted individually, but you may discuss and share ideas. Paper is due on Monday, November 13, in class. Late paper will not be accepted.

There are some book reviews on these books already, as well as papers written by former students, and the instructors have read them. You may use as many references as you want, BUT plageriasm will NOT be allowed (and your grade will be severely impacted). We want

to see what you have learned from reading the books AND taking this course, NOT repeating what others have learned. We can tell a book report written by a student vs. a business professor or business journalist.

Note: You must reference all the books and sources you used for the paper. Any paper without references will be deducted at least 5% from the total.

8.2 TEAM PROJECT (20%):
This team-based project is a key deliverable for this course, as it reflects the typical modus operandi of most pharmaceutical companies.

Students will form multi-disciplinary projects teams, consisting of 4-5 students from different disciplines. Every team must have at least one student with a biology/chemistry/STEM major, and one student with a business/econ/social science major. Project Teams will organize (and possibly elect a project manager who serves as the captain of the team), select a topic, decide how to communicate amongst themselves, plan/allocate work, and jointly present selected case studies as posted on BlackBoard. The last three lectures of the semester will be reserved solely for student project teams to make PowerPoint presentations (18-20 minute presentation, 3-5 minute QA, ~15-18 slides) to the entire class.

Project teams should determine their case study topic ASAP, so as to have sufficient time to get organized, conduct research, and prepare the PPT presentations and executive summary reports. More detailed instructions and the project list for you to select from will be provided later in this document.

Please note that the instructors MUST approve the team roster. In some cases, we will have to modify the team roster. For example, if we run out of STEM majors, we may reject teams that have more than 3 or more STEM majors.

Students who do not belong to a team by the 6th week will be matched by the instructors, as a last resort. Of course, we strongly encourage you to form the teams on your own first, as the experience from past classes indicates that is the best way to complete this project.

All students on each Project Team **must** make contribution to the research, the preparation of presentation, the PPT slides, and the (~250 words) Executive Summary Report (in Word).

We are confident you will be able to work together effectively across different disciplines, personalities, and styles. It is not necessarily easy, but the process and experience will be beneficial not only for you in this class, but also in future employment settings.

9. Course conduct, rules & attendance

BUS ECON CHEM 341 meets once a week for a total of 14 times (including midterm and student team presentations). The class will be largely held in lecture/discussion/summary mode. Students are expected to a) be prepared for each lecture topic: relevant readings in book chapters or materials will be provided by the instructor (posted on BlackBoard); b) be engaged in understanding the fundamentals of each topic; and c) use lecture time for Q/A. Your questions, engagement, participation and contributions will be the difference between a dull class and a fun class. Cell phones are off limited during lectures for ANY PURPOSE.

In order to be successful in this course, all students are expected to be in >90% attendance. Attendance will be taken in every lecture. Each unexcused absence will cost you 1% of the course grade during regular lectures, and each unexcused absence during student presentations (last three lectures) will cost you 2%.

10. Evaluation & Grading

Failure to take the Mid-Term exam, or Final Exam, will result in a score of zero on that item. Makeup exams will only be given in rare instances, and on a case-by-case basis, including clearly documented evidence (medical and family emergencies) provided by the student.

Weight for each required activity or deliverable:

- Participation, QA, Engagement 10%
- Book Report 20%
- Midterm Exam 20%
- Team Case Study (content, presentation, teamwork) 20%
- Final Exam 30%

Grading Guidelines

A/A+/A-	90-100%;
B/B+/B-	80-89%;
C/C+/C-	70-79%;
D/D+/D-	55% to 69%;
F	<55%

Final course grade cut-offs may change slightly based on grade distributions at the instructors' discretion.

11. Academic Dishonesty

This course will follow the CSUCI Policy on Academic Dishonesty (SP01-57). Academic dishonesty includes cheating, inventing false information or citations, plagiarism and helping someone else commit an act of academic dishonesty. It usually involves an attempt by a student to show possession of a level of knowledge or skill that he/she does not possess. The course instructors have the initial responsibility for detecting and dealing with academic dishonesty. If the Instructors believe an act of academic dishonesty has occurred, the instructors are obligated to discuss the matter with the student(s) involved. Instructors will ensure that there is reasonable evidence of academic dishonesty. However, if circumstances prevent consultation with student(s), instructors may take whatever action (subject to student appeal) as deemed appropriate.

12. CSUCI Disability Statement

CSU Channel Islands is committed to equal educational opportunities for qualified students with disabilities in compliance with Section 504 of the Federal Rehabilitation Act of 1973 and the Americans with Disabilities Act (ADA) of 1990. The mission of Disability Accommodation Services is to assist students with disabilities to realize their academic and personal potential. Students with physical, learning, or other disabilities are encouraged to contact the Disability Accommodation Services office at (805) 437-8510 for personal

assistance and accommodations. Handouts are available in alternative accessible formats on request.

13. SUBJECT-2-CHANGE Disclaimer Statement

All information contained in this syllabus, other than that mandated by the University, may be subject to change with advance notice, as deemed appropriate by both Instructors.

Tentative Course Schedule (Fall 2017; Monday)

Date	Lecture Topic	Items Due	Instructor (JL, MSE)	Required Course Materials
8/28 Week 1	Class introduction and syllabus; Introduction to the global biopharmaceutical industry	Purchase required books (for book report); Forming groups for class project	MSE, JL	Slides
9/4 Week 2	Labor Day; No Class			
9/11 Week 3	Discovery of Drug Targets & Leads, Pharmaceutical R&D	Forming groups for class project	MSE	Slides + JLL +A +B +C + D
9/18 Week 4	Pharmaceutical R&D, Clinical Trials	Read books for book report	MSE	Slides + JLL + D +E
9/25 Week 5	Introduction to Healthcare System	Read books for book report	JL	Slides
10/2 Week 6	Clinical Trials, Pharmaceutical Manufacturing and Production	Read books for book report	MSE	Slides + JLL +E +F
10/9 Week 7	Case Study: Development of Lipitor at Pfizer	Read books for book report	MSE	Slides + JLL
10/16	Midterm (75 minutes); Intellectual Property: Pharmaceutical Patents	Finalization of groups for class project; Selection of Class Project Topic	JL, MSE for exam; JL for lecture	Slides + JLL
10/23 Week 7	Value and Pricing of Pharmaceutical Products	Read books for book report	JL	Slides + JLL
10/30 Week 10	Pharmaceutical Marketing and Promotion: Case Study	Read books for book report	JL	Slides + JLL
11/6 Week 11	Importance of Generics and Biosimilars	Read books for book report	JL	Slides + JLL
11/13 Week 12	Business Ethics and Future of Drug Industry	**Book Report Due**	JL	Slides + JLL
11/20 Week 13	Course project presentations I (all groups)	Final project PPT slides; Word executive summary	JL, MSE	
11/27 Week 14	Course project presentations II (all groups)	Final project PPT slides; Word executive summary	JL, MSE	
12/4 Week 15	Course project presentations III (all groups); Wrap up and Final Exam prep	Final project PPT slides; Word executive summary	JL, MSE	
12/11 Week 16	**Final Exam 4-6 pm**		JL, MSE	

JLL = "Devalued and Distrusted : Can the Pharmaceutical Industry Restore its Broken Image?" by John LaMattina (John Wiley & Sons 2012)
A-F Handouts from "Drugs : From Discovery to Approval" by Rick Ng (Wiley Blackwell, 2015)

A = Drug Discovery Target Receptors
B = Drug Discovery Small Molecule Drugs
C = Drug Discovery Large Molecule Drugs
D = Drug Development & Preclinical
E = Clinical Trials
F = Manufacturing & Production

14. Topics for Team Project (Each team picks one; maximum two teams per topic; first come, first serve)

Development of a Launch Strategy for Name of Drug

Required readings (on Blackboard):

1) "Forecasting Denosumab"; T. Calkins; Kellogg School of Management, 2011 (Case No: KEL 531)
2) "Why Are Prescription Drugs so Expensive ?" by Amy Nordrum (International Business Times ; May 19, 2015).
3) "A Tale of Two Drugs" by Barry Werth (MIT Technology Review; October 22, 2013)

In the article by Tim Calkins: "Forecasting Denosumab", he describes how Amgen is planning to introduce/launch Denosumab (Prolia®/Xgeva®) in the US, considered (at the time) by many industry experts as the next blockbuster innovative drug therapy for patients with osteoporosis (a bone disorder) and for patients with bone metastasis (experienced in many late stage cancers). The other two articles provide some rationale and case studies on drug pricing (to supplement what you will learn in the lectures).

You (your group) are now asked to create a launch plan for one of the following newly approved drugs (select ONE drug per group – at most 2 groups per drug) in the US, using a similar approach to the one taken Calkins. The first name is the tradename, and one in the parathesis is the generic name.

- **Corlanor (ivabradine)**; by Amgen; indicated for the reduction in the risk of hospitalization for worsening heart failure in patients with stable, symptomatic chronic heart failure; Approved in April 2015
- **Ibrance (palbociclib)**: by Pfizer; to treat advanced (metastatic) breast cancer; approved by FDA in February 2015.
- **Nucala (mepolizumab)**: by GlaxoSmithKline; for treatment of preventing severe asthma attacks in patients with history of those attacks (esacerbations) when conventional treatments cannot control them; Approved in November 2015.
- **Vraylar (cariprazine)**: by Allergan/Gedeon Ritcher; for treatment of manic or mixed episodes associated with bipolar I disorder and for the treatment of schizophrenia; Approved in September 2015.
- **Epclusa (sofosbuvir and velpatasvir)**: by Gilead Sciences; for the treatment of chronic C virus (HCV) for adult patients with or without cirrhosis; Approved in June 2016.
- **Zinbryta (daclizumab)**: by Biogen/AbbVie; for the treatment of relapsing forms of multiple sclerosis for adults patients; Approved in May 2016.

- **Tecentrip (atezolizumab)**: by Roche/Genentech; for the treatment of bladder cancer; Approved in October 2016.
- **Adlyxin (lixisenatide)**: by Sanofi; for the treatment of type 2 diabetes for adults; Approved in July 2016.
- **Taltz (isekizumab)**: by Eli Lilly & Co.; for the treatment of psoriasis; Approved in March 2016.

In this plan, you are expected to analyze/discuss:

- A description of the manufacturer launching the drug
- The disease the drug is indicated for and the existing treatment options prior to the new drug approval. Is the targeted population very small?
- Describe what are the unmet needs with the current existing treatment. Are they clinical or financial in nature, or both?
- Summary of key clinical trial results, efficacy, side effects on the new drug. How the new drug may be better than the existing treatment options?
- How the price for the new drug compares to the existing treatment options. Does the price reflect its value? Why or why not? Does the new drug generate measurable economic value? Use the knowledge on value based pricing to support your conclusion.
- If you are a private insurance company, would you set any barrier to the drug's use (for example, tier status)? Why?
- Briefly discuss the promotional plan for the new drug (which channels of promotion are most effectively)
- Potential challenges facing the new drug in the near future (using the SWOT framework) – including possible negative publicity, patent litigation, competitive landscape, reimbursement hurdle, etc.

You are encouraged to research company annual reports, published literatures on the disease and treatment options, FDA website and announcements, and press coverages on these new drugs. Be sure to properly reference all sources.

The deliverable for this project is 1) a 250 word executive summary in Microsoft WORD (excluding title or references; 2) a 15-18 slide deck in PowerPoint; and 3) group presentation to the whole class at end of the semester (~15-18 minutes + 5 minutes Q&A).

Please note that we are not looking for a perfect launch plan with this exercise. We are looking to see how you can comprehensively apply the knowledge learnt in this class to a real world scenario. An early start of this project is very important, as it will require a significant amount of work. Feel free to check with us along the way.