

MASSACHUSETTS INSTITUTE OF TECHNOLOGY



**15.363 STRATEGIC DECISION MAKING IN THE LIFE SCIENCES AND DIGITAL HEALTH INDUSTRIES
SPRING SEMESTER 2021**

COURSE SYLLABUS

(Meets Entrepreneurship Elective Requirements)

Professors:

Jonathan J. Fleming - jonathan.j.fleming55@gmail.com

Andrey J. Zarur Ph.D - azarur@greenlightbio.com

Professor Zarur's Assistant: Jackie Mason - jmason@greenlightbio.com

Teaching Assistants:

Juhyun Kim: juhyunk@mit.edu

Rachel Estelle Halperin: r_halp@mit.edu

Sara Elizabeth Gabriel: sgabriel@mit.edu

Class Times and Location:

Wednesdays 5:40pm – 8:20pm
at E62-276 or remote via Zoom link
for 9 units (3-0-6)

Professor Fleming's Background

Mr. Fleming has been a co-founder of many life science companies, run a large institutional venture capital firm for 30 years, and been the CEO of an early-stage biotech company. Currently he is the Chairman of the Board of 5 private companies including: Co-founder and Chairman of the Board of QurAlis – an ALS precision medicine company, and Enclear – developing a CSF dialysis therapy for neurodegenerative diseases. Mr. Fleming is the Chairman of Onc.ai where both the CEO and CBO are 15.363 alumni. Mr. Fleming is the Chairman of the Board of MobileODT a digital health company for women's health applications based in Tel Aviv Israel. He is also the Chairman of the Board of a Cape Cod based commercial shellfish business, Aquaculture Research Corporation. In addition, Mr. Fleming is currently a director of MIT spin-out Continuus Pharmaceuticals.

From 1996 to 2006, Mr. Fleming was the Managing Partner of Oxford Bioscience Partners, an international venture capital firm specializing in life science investments, which raised over \$1 billion in early-stage capital resulting in 22 IPOs and over 40 M&A transactions. During his career Mr. Fleming co-founded the first early-stage health care venture capital funds in the states of Israel and Korea. In addition, he has co-founded several neuroscience companies that were later acquired including: Synaptic Pharmaceuticals (acquired by Lundbeck); Memory Pharmaceuticals (acquired by Roche); and Hynpion Pharmaceuticals

(acquired by Lilly). Since 2005 he has been on the executive board of a health care policy think tank based in Cambridge called NEHI. Mr. Fleming has been a Senior Lecturer at the MIT Sloan School of Management since 2002. He holds a MPA from Princeton University's Woodrow Wilson School of Public and International Affairs, and a BA from the University of California, Berkeley.

Professor Zarur's Background

Dr. Zarur is the Founder and CEO of GreenLight Biosciences, a biotechnology company focused on the development of RNA-based products for human, animal and plant health. GreenLight has over 20 RNA products in various stages of development, including animal and human vaccines and therapeutics, as well as agricultural products such as insecticides, fungicides and viricides. Dr. Zarur is also a co-founder and Chairman of the Board of Solid Biosciences (NASDAQ:SLDB), Allegro/Veracyte (NASDAQ: VCYT) and Lumicell Surgical. Dr. Zarur has been active in early-stage life sciences companies for 30 years, and has actively participated in the creation, operation and exit of over a dozen companies in the healthcare and clean energy sectors.

Prior to GreenLight, he was the Managing Partner at Kodiak Venture Partners, a venture capital firm specializing in the formation of early-stage information and life technology investments. Dr. Zarur was named a Young Global Leader of the World Economic Forum in 2005 and he served as the Chairman of the Precision Medicine Initiative at Davos. He co-founded and served on the Board of Infantia, a foundation dedicated to the construction and operation of elementary schools and pediatric clinics in marginalized communities in Latin America and Southeast Asia. He serves as an advisor to My Life My Choice, a foundation dedicated to stopping human trafficking and sexual exploitation. Dr. Zarur holds Master of Science degrees and a Ph.D. in Chemical Engineering from the Massachusetts Institute of Technology, and undergraduate degrees in Engineering and Medicine from the National University of Mexico (UNAM). Dr. Zarur is the author of several peer-reviewed articles and holds close to 100 provisional and issued patents.

Objective: "Strategic Decision Making in Life Sciences" examines the key strategic decisions faced by entrepreneurs, managers and investors at each stage in the value chain of life science technology-based industries. The course aims to develop your ability to understand and effectively use analytical tools and industry knowledge to make good strategic decisions. Successful careers are based on good strategic decision making. The course will teach value creation in the life sciences industry for companies at various stages; from inception of a new company, through clinical development; from commercialization and reimbursement, through exit and value capture. The course will apply to strategic decision making in 4 different sectors within the life sciences: Drugs/biologics, next generation therapies, digital health, medical device/companion diagnostics. This course is intended for anyone interested in building a life science company or working in the life sciences industry as a founder/entrepreneur, senior industry executive, analyst/consultant or professional investor. It will also provide an analytical background to the industry for biological and biomedical scientists, engineers and physicians with an interest in understanding the commercial dynamics of the life sciences or the commercial potential of their research.

Course Description: The course is structured around the life sciences industry value chain from early-stage scientific ideas, through licensing, financing and valuation, to discovery, clinical trials, production and sales. The foundations of the course provide a thorough understanding of the economics, risks and competitive dynamics at each of these distinctive stages of the value chain. It also highlights the critical

problems and current issues at each stage. The two instructors combine to have over 50 years of experience in strategic decision-making in the life sciences industry. All of the case studies and examples are based on companies and transactions in which the professors were directly participating in some way. This series of structured, real-world problem-solving exercises will show the application of analytical tools for strategic decision making to a wide range of problems confronting the life sciences industry. Some of the tools used in the course include value chain decision trees, pipeline valuation, alliance valuation, drug adoption and lifecycle predictions, market assessments etc.

Course Organization: The course is held once a week on Wednesday evening from 5:30pm – 8:30pm in E62 – 276 or via a Zoom link. Each week is organized into two periods. There will be 14 sessions in total.

Course Requirements: The course will center on analytical homework assignments, to be done in teams of 4, that will provide you with a chance to gain hands-on experience in using strategic decision-making methods. The homework and group projects are based on real life problems taken from life science firms. There will be four homework assignments over the term to be completed in teams with a grade assigned to each team. Grades will also depend on class participation. There will be no midterm or final exam.

15.363 COURSE DETAILS

Course Requirements & Grading

The course is intended to be a seminar with a lot of interaction as is reflected in the grading schema. Grades will be strongly determined by your class participation, which will depend upon thorough preparation, including relevant homework assignments. The grading schema is as follows:

a) Attendance & Class Participation (20%)

This class follows a seminar format with the discussion often built around case study material. It will therefore be impossible to understand the material if you do not come to class or if you do not participate. Skipping class will affect your grade - and, more importantly, - your own and your classmates' experience in the class. If you miss more than two sessions during the semester it will severely impact your class participation grade.

b) Homework Assignments (80%)

A significant portion of the grade is awarded to a series of homework assignments which will include a mix of both qualitative and quantitative analysis. Homework should be completed in groups of 3-4 people, and one copy of the homework should be submitted for each group. Groups must include at least one non-Sloan person (numbers permitting). The written analysis and spreadsheets are due in the Homework section of Canvas by 5:30pm on the designated due date.

Course Material: There will be some assigned readings posted on Canvas. These readings are intended to bring students with limited experience in the life sciences industry up to speed in order to allow for more advanced discussions during class sessions.

Course Norms and Expectations: Professional conduct is built upon the idea of mutual respect. Such conduct entails (but is not necessarily limited to the following):

Name cards: Please obtain a name card for yourself that contains your first and last name. We will eventually get to know all of your names, but it will take us some time.

Arriving on time: Class starts at 5:35 PM. Because of the layout of our classroom, late arrivals are disruptive. Please try hard to be on time. If you know you are going to be late or will need to leave class early, please let us know in advance, if possible.

Minimizing disruptions: All cell phones and computers should be turned off during class. Please try to avoid engaging in side conversations after the class has begun.

15.363 COURSE READINGS

Required Readings:

The course is built around a series of analytical case studies and related homework assignments. In addition, there will be readings that include relevant articles and commentary from a combination of academic journals, the press and industry publications. These are intended to provide more in-depth analysis as well as relevant commentary or debate. Due to increasing concern about the environment and economy, we will not be creating a course reader this semester and will instead post all required readings and cases on Canvas.

Software:

One of the main goals of the class is to encourage the use of analytical and financial tools to enable solid decision making in life sciences. Decision trees are an invaluable resource for understanding and evaluating potential scenarios leading to desirable outcomes. Although conventional spreadsheet software tools, such as Microsoft Excel, can be used to construct decision trees, there are several dedicated software packages that facilitate their creation and understanding, and provide additional functionality in terms of statistical and sensitivity analysis. We have negotiated a special academic price (\$40 for a 6 month license) with one of the leading distributors of decision-making software called TreeAge Pro. Students are encouraged to obtain the software prior to the first lecture by logging into www.treeage.com/shop/ - under TreeAge Pro Suite, choose "Academic" and then "Student Course License."

15.363 Course Outline

Module 1 – The Tools – Feb 17 through Feb 24 – 2 classes

The objectives of the class, grading, and logistics will be discussed. Teams of 4 will be assigned by the TAs mixing students with business and scientific backgrounds. This section of the class will teach the basic tools and concepts to be used in the case studies and the homework assignments. No homework assignments in this module.

Pre reads:	None	
In class discussions:	Types of Strategic Decisions	W1A
	Uncertainty in the Life Sciences	W1A
	The Decision Tree	W1B
	The Perspective of the Analyst	W1B

The Value Chain	W2A
The Financial Tools	W2B

Module 2 – Value creation and strategic financing decisions - March 3 through March 17 - 3 classes

The goal of this module is for students to begin using the tools to analyze strategic decisions. In this module the choices will involve different alternatives to finance the company and the impact these choices have on the cap table. Students will acquire some understanding of immune oncology and the strategic decision making required to be successful in this field.

Pre-reads:	Case – VC backed IO company with multiple financing alternatives through clinical trials. Primer on immune oncology Primer on size market size and pricing of IO agents	
In class lectures/discussions:	Introduction to the case Background on immune oncology/mabs Building the value chain for solid tumor I/O products Identifying the value inflection points in this value chain How to construct a decision tree for this case Changes to the cap table through a series of financings How the changes in the cap table impact the different participant non symmetrically why the perspective of the analyst is important Pros and cons of various financing alternatives In class team meetings lead by TAs and profs In class presentation by teams of their decision tree New information leads to first homework assignment	W 1A W 1A W 1A W 1B W 1B W 2A W 2A W 2B W 3A W 3B W 3B
In class assignment:	Teams must choose which player in the case they choose to play (founder/CEO/VC) to solve the in-class assignments.	
Homework #1:	Teams must make a new decision tree based on new information. Assigned week 3 of class, due week 4, in class review week 5	

Module 3 - March 24 to March 31 – Covid – Strategic decisions for vaccines and diagnostics - 2 classes

In this module the objectives are to teach a basic familiarity with the product development process and the specific challenges of SARS Cov 2. What is new and special about mRNA vaccines? What are the challenges in manufacturing and distribution? What are the strategic questions for players in this area, including the government? Students will use the tools in the class to set up a decision tree for large players in the life sciences, such as big pharma and the government.

Pre-read case study:	The development of the COVID diagnostic kits and vaccines	
In-class discussions:	Use of sequencing, variants of the virus, challenges of Dx Vaccines, what is different with mRNA? Challenges in manufacturing and distribution Where do we go from here? Panel Discussion	W 1A W 1B W 2A W 2B

Homework #2: Second homework assignment will be a problem to determine the best design of COVID vaccine clinical trials: Pfizer vs. Moderna vs. AstraZeneca vs JNJ
Homework assigned week 5, due week 6, in class discussion week 7

Module 3 – April 7 through April 21 - Gene modification - the next big disruption - 3 classes

In this module we have three objectives: to teach the importance of strategic decisions in clinical trial design highlighting new trial designs acceptable to the FDA; to teach the benefits and challenges of the new therapeutic modalities such as gene therapy, ASOs, RNAi etc. and how they compare; and to teach the background for understanding how cost of product development is determined and how prices get set in the drug industry.

Pre-reads	Case study: SMA – Spinraza vs. Zolgensma Primers on SMA and how the therapies work (ICER)	
In-class discussion/Lectures:	Introduction to the case/review of timelines	W 1A
	Clinical trial design tradeoffs and strategic decisions	W 1B
	Discussion of costs and price setting for old and new therapies	W 2A
	Create the value chain for SMA and identify VIPs	W 2B
	Strategic decision discussion in class is Avexis trial design	W 3A
	Alternative Pricing Structures	W 3B

Commented [RH1]: Do you want this to stay in the official syllabus?

Homework #3: Third Homework assignment: Zolgensma: Novartis vs. Avexis.
Homework assigned week 8, due week 9, class discussion week 10

Module 5 – April 28 to May 12 – Strategic Decisions in Digital Health - 3 weeks

The objective of this module is to provide an overview of the breadth of digital health applications, market segments and value chains. Key strategic decisions in different market segments will be explored via case study and company presentations.

Pre read:	Background paper on AI/ML Digital Health Market Report	
In class discussions:	Overview of the digital medicine landscape	W 1A
	Strategic Decisions in Digital Health	W 1A
	AI/ML in drug discovery – challenges and opportunities	W 1A
	Case Study and Presentation (ReviveMed - Leila Pirhaji)	W 1B
	AI/ML in clinical decision support for oncology	W 2A
	Case Study and Presentation (Onc.ai – Zeenat Patrawala)	W 2B
	Digital Therapeutics – What are they/what are the challenges?	W 3A
	Case Study and Presentation (Pear - Corey)	W 3B

Homework #4: Fourth Homework: Case Study – Best strategy for Ai/ML based classifier to predict cervical cancer.
Assigned week 11, due week 12, class discussion week 13.

Module 6 – May 19 – Strategic Decision Making for IPO and M&A - 1 week

Pre-read: IPO vs M&A Considerations

In class discussion: Panel with IPO'd CEOs vs M&A CEOs: Armon Sharei (IPO SQZ), Ilan Ganot (IPO Solid), Sean Nolan (Avexis – M&A Novartis)

Wrap up.

