Course Title: Cancer Engineering
Course Number: E302
Credits: 9
Course Director(s): Daniel A. Heller, PhD, Danwei Huangfu, PhD, Kayvan R. Keshari, PhD, Jason S. Lewis, PhD, Thomas Norman, PhD, and Andrea Ventura, MD, PhD
Course Instructors/TAs: Ross Boltyanskiy, PhD, Inbal Caspi, PhD and Christian Figueroa-Espada PhD
Course Prerequisites: Experimental Biology; Open to first year Cancer Engineering PhD students only
Grading Policy: Letter Grade

Course Description and Learning Objectives:

Foundations
This section teaches basic concepts necessary for success in a cancer engineering-focused research lab. Topics covered include pharmacology, drug development, drug delivery, nanomaterials, instrumentation, and diagnostics. This course will introduce foundational concepts of cancer engineering from the perspective of solving problems in cancer biology and oncology.

By the end of this section students should be able to:

- Understand and recall fundamental concepts of pharmacology
- Calculate basic pharmacokinetic parameters including single and two-compartment models.
- Understand the basic drug development process from bench to bedside, including clinical trials
- Recall basic principles of drug delivery
- Identify material types used for drug delivery and imaging
- Calculate packing parameters for lipid nanoparticle development
- Understand basic principles of nanoengineering instrumentation, including dynamic light scattering, zeta potential, and atomic force microscopy
- Decide which types of instrumentation should be used to investigate given material parameters
- Assess medical device development strategies
- Understand the field of laboratory medicine and the development process of laboratory diagnostics and pathological assessments

Imaging
This section will introduce basic and advanced concepts in molecular imaging in the context of cancer biology. Topics covered include methods for optical, acoustic, nuclear as well as magnetic resonance imaging: starting from basic physics to specific cancer applications. This section will focus on the technical aspects of these approaches that will allow students to be successful in acquiring higher level imaging technique as well as in solving problems relevant to the study of cancer.

By the end of this section students should be able to:

- Understand the basic principles of each imaging techniques including concepts in signal acquisition / processing as well as image quality (such as resolution, image contrast, SNR, quantification etc)
- Appreciate the relevance and differences of in-vivo vs. in-vitro imaging
- Quantify standard parameters for each imaging modality
- Identify and apply appropriate imaging strategies for a target biological mechanism
- Familiarize themselves with a variety of cutting edge imaging techniques in cancer research

Genetic Engineering

Genetic engineering, the deliberate modification of organisms, cells, tissues, or viruses by manipulation of their genomes, has led to groundbreaking discoveries in molecular biology and genetics as well to the development of innovative animal models and therapies for human diseases. This section will provide a foundation in genetic engineering tools and concepts that can be applied to laboratory research. This section will also provide students with a greater awareness of the benefits and risks of genetic engineering and an overview of the latest research and technologies advancing the science of genetic engineering and biotechnology. This section will start with a broad review of the genetic principles explored during the Experimental Biology course that are essential to understanding genetic engineering. Genetic engineering concepts will specifically focus on their relevance to the fields of cancer biology and oncology.

By the end of this section, students should have broad knowledge of the following topics:

- Genetics concepts needed to understand genetic engineering
- Tools for editing genomes
- Techniques to produce different cellular, tissue, and animal models using genetic engineering
- Strengths and limitations of animal models for disease
- Characteristics and classes of therapies that benefit from genetic engineering
- Applications of genetic engineering in cancer therapeutics and diagnostics

Course Structure

The course meets daily from 9:30 am – 12:30 pm for nine weeks. Changes to that schedule are posted on the course grid and communicated to students via email.

This course will include a combination of lectures on each topic as well as well as case studies and group discussions around historical and current journal articles.

Teaching Fellows

Teaching Fellows, drawn from senior GSK students and the postdoctoral community at MSK, are present in the course sessions. Their role is to act as an additional source of information/assistance, to help keep the discussion sessions moving, to conduct a review session, and to observe and grade the students on their participation. Each Teaching Fellow covers about three weeks of the course. At the end of the respective section, they meet with the Section Leader to discuss the student grades for participation.

Assignments and Methods for Assessing Student Achievement

Students' performance will be evaluated based on completion of problem sets, a final take-home project and attendance/participation. Each assignment will be weighted according to the following ratios when determining the final grade:

Assignment	**% of grade**
Problem Sets/ Final Project	67%
Class Participation	33%
Total	**100%**

The problem sets will be sent out via email before 3:00 pm on the date specified in the course schedule; they will be due 7 days later, by 3:00 pm. Late submissions may not be accepted and could impact the final grade for the course.

Class Participation and Attendance

All students are expected to attend the GSK Core Class regularly. A student must notify the Senior Registrar/Curriculum Specialist and teaching fellow prior to class if he or she is going to be absent. This notice should be sent by email to mcdonagd@sloankettering.edu. A student is allowed a total of 3 absences for all sections of the core course over the course of semester. Any absences in excess of 3 will result in 4 percentage points being subtracted from a student's participation grade PER ABSENCE.

Each student will be responsible for presenting at least one journal article. They must highlight the relevant background of the paper and its importance and caveats. All other students are expected to have come to class having thoroughly read the pre-assigned journal articles. They must also engage in the journal discussions by asking and answering relevant science questions.

Basis for Grade Determination

At the end of the class, students will receive a final letter grade based on their performance on the above assignments. The final letter grade will be determined using the following grading scale:

Letter Grade	Range
A	85-100
A-	82-84
B+	78-81
B	75-77
B-	72-74
C+	68-71
C	65-67
C-	62-64
F	<62

Course Evaluation

At the end of the class students will be asked to evaluate the course and lectures by completing an anonymous survey. This feedback will be used to evaluate the effectiveness and relevance of the topics and provide direction for the subsequent iterations of the course.

Academic Dishonesty, Plagiarism and Artificial Intelligence

The Policy can be found in the Student and Faculty Handbook linked on the GSK Website.

Course Schedule

The course schedule can be found on the Moodle site.