Course Title: Cancer Biology
Instructor: Pablo Sánchez Vela, MD; sanchezp@mskcc.org
Grading policy: This class is a not for grade class, but scholars will be evaluated with a grade to get a sense of how they performed in this class
Duration: 5 in-person sessions plus at least 3 recorded lectures
Audience: 15 Bridge post-bac scholars

Course Topics and Learning Objectives
The Cancer Biology course will teach scholars how to think about cancer as a disease and as a biological problem. This course leverages the world-class research and clinical expertise at Memorial Sloan Kettering Cancer Center (MSK). This course will feature five in-person sessions as well as several recorded lectures that Bridge scholars are required to view on their own time and ahead of the first lecture.

This course will:

- Provide a review of advanced concepts in cancer biology
- Expose scholars to techniques and experimental design applied to basic-translational cancer research
- Potentiate the ability to perform critic analysis of basic-translational research
- Strengthen capacities to develop a research project

Scientific topics covered in the recorded lectures will include:

- Cancer as a disease
- Genetic and epigenetic mechanisms
- Computational biology and oncology
- Cancer signaling
- Cancer metabolism
- Metastasis
- Tumor modeling and heterogeneity
- Cancer types and microenvironments

The structure of the program will be:

- Session 1: Intro to Cancer Biology
- Session 2: Guided Paper Discussion
- Session 3: Guided Paper Discussion
- Session 4: Guided Paper Discussion
- Session 5: Group activity
- Recoded GSK Lectures
- Take home activity (1st Submission)
- Take home activity (Feedback)
- Take home (2nd Submission)

Recorded Lectures

Scholars will be required to watched 3 recorded basic and translational science lectures. Scholars will have available up to 20 recorded basic and translational science lectures from scientists in SKI and HOPP. These lectures will be viewed on their own time and will help prime discussions at the in-person sessions. These sessions will be posted on Moodle every week.

A list of lecture topics include:

- Introduction to Cancer Biology
- Oncogenes
- p53 and Tumor suppression
- Cancer Evolution
- Genomic Analysis of Cancer
- Single-cell functional genomics
- Mechanisms of Metastasis
- Metastasis to CNS
- Genetic Drivers of Hematopoietic Malignancies
- Lymphoma/IDH Inhibitors
- Tumor Microbiome
- Cancer Metabolism
- Leveraging and Engineering Cancer Metabolism
- Pancreatic cancer
- Epigenetic control of oncogene signaling in sarcoma
- Lung Cancer
- Prostate Cancer
- Breast Cancer

In-Person Sessions

Session 1: Introduction to course and basic techniques applied in basic cancer research.
Wednesday, August 7, 2024; 3:30 PM to 5:00 PM

In this session, the structure, aims and evaluation system for the course will be presented. Additionally, an overview of techniques used in basic cancer research will be provided, and general principles of experimental design will be discussed.

Sessions 2 – 4: Guided paper discussions
Session 2: Wednesday, August 14, 2024; 3:30 PM to 5:00 PM
Session 3: Wednesday, August 21, 2024; 3:30 PM to 5:00 PM
Session 4: Wednesday, August 28, 2024; 3:30 PM to 5:00 PM
In each of these three sessions, a basic/translational paper will be discussed. Selected papers will include both preclinical (*in vitro* mechanistic data, *in vivo* treatment, patient-derived xenografts, etc) and clinical data.

Paper discussions will include description of figure panels included in the article by the students, who will be called by the class lead to provide context, describe the results in each figure, discuss the interpretation and implications of the results, suggest additional experiments or controls that would expand the implications of the results, and criticize the methodology, presentation, and description of the results in the paper. The main goal of this activity is to “act as peer-reviewers” and train critical thinking.

The papers to be discussed are:

- **Session 2**: Razavi P, Chang MT et al. The Genomic Landscape of Endocrine-Resistant Advanced Breast Cancers. Cancer Cell. 2018 Sep 10;34(3):427-438.e6. doi: 10.1016/j.ccell.2018.08.008. PMID: 30205045; PMCID: PMC6327853.

- **Session 3**: Hill W, Lim EL, Weeden CE et al. Lung adenocarcinoma promotion by air pollutants. Nature. 2023 Apr;616(7955):159-167. doi: 10.1038/s41586-023-05874-3. Epub 2023 Apr 5. PMID: 37020004; PMCID: PMC7614604.
- **Session 4**: Dunbar AJ, Bowman RL et al. Jak2V617F Reversible Activation Shows Its Essential Requirement in Myeloproliferative Neoplasms. Cancer Discov. 2024 May 1;14(5):737-751. doi: 10.1158/2159-8290.CD-22-0952. PMID: 38230747; PMCID: PMC11061606.

Session 5: Guided live research activity
Wednesday, September 4, 2024; 3:30 PM to 5:00 PM

In this activity, students will be divided into two groups. A translational research project with preliminary data, common for both teams, will be shared with the students at the beginning of the session. As an example, the project could be "Study of the role of X gene in Y cancer type, and therapeutic implications".

The students will have time to design which next experiments they would like to conduct, and in 10-minute shifts, the class lead will be visiting each of the teams providing the results for those experiments in real time (i.e., drawing plots, western blots, etc. on the white board). During the 10 minutes the class lead is providing results for one team, the other team will have time to design a new set of experiments for their next shift. After 4-5 shifts, the students will be given time to structure their results into a consistent story, and then each team will present their "paper" to the other team. During that presentation the whole class will be discussing the approaches taken, missing experiments or controls that might be important for their story to be consistent, etc.

The main goal of this session is that the students get a taste of how to design experiments and interpret results to answer a specific scientific question, in a guided environment.

How students will be evaluated

Take Home Assignment (67%)

Similar to the guided live research session, the students will be assigned a translational research project with preliminary data, but this time individually, as an assignment. The students will have to design a small project (2 pages) addressing the scientific question posed (i.e. a light version of the research strategy section of a grant).

The project will have the following structure:

a. **Background**: A brief background (one paragraph, less than half a page) will be provided on the topic related to the research question, elaborating on the clinical and biological context to justify the experimental approaches suggested (i.e. *"Gene X is overexpressed in different tumor types and has been associated to worse overall survival in patients. Even if gene X is overexpressed in a subset of lung tumors, to date the role of gene X has not been studied in the context of lung cancer*").
b. **Hypothesis**: A small paragraph (3-4 sentences) stating the overarching hypothesis defining the project (i.e., *"We hypothesize that gene X may have an oncogenic role in a subset of patients with lung cancer in whose tumors gene X is overexpressed*").
c. **Experimental approach**: State the specific aims of the proposal, with a relatively detailed description of the experimental methodology proposed to approach each of the specific

aims. Imagine any resource you may need (*in vitro* or *in vivo* model, clinical cohort, clinical tissue,…) is available for you to leverage, but make sure to describe the model with detail. Please justify why and how you are going to do what (i.e. "*To study the role of X gene in two lung cancer cell lines, we will leverage CRISPR-Cas9 technology and overexpression viral vectors to generate isogenic cell lines with differential X gene expression, and we will perform tumorigencity surrogate assays (proliferation and soft agar*").

d. **Potential pitfalls and alternative approaches**: One short paragraph describing potential limitations or biases of the methods described, and proposing alternative approaches to perform the specific aims, particularly in the case where the previously described methods may be technically challenging (i.e., "*If gene X knock out by CRISPR-Cas9 is not possible, as gene X might be essential and complete abrogation of its expression might be toxic, we will use siRNA technology as an alternative, to downregulate gene X expression*"). This section can also be integrated in (c).
e. **Impact**: One to two short phrases describing the potential implications (significance) of the study (i.e., "*Understanding the role of gene X in lung cancer will help to inform rational therapeutic strategies with patients in which gene X is overexpressed"*).

This activity will be divided in two parts:

a. Wednesday, September 18th, 2024; 23:59 PM.
1. The project will be submitted, and feedback will be provided on *October 2nd*

b. Wednesday, October 16th, 2024; 23:59 PM.
2. The students will have the chance to resubmit after addressing the comments provided. This will make the activity a learning experience, rather than just an evaluation.

The project will be evaluated as a letter grade with a minimum of a B need to pass the course.

The main goals of this activity are that (1) the students face the blank page and individually perform the creative activity of designing a project on their own, and that (2) they hopefully learn from the feedback provided.

Class Participation and Attendance (33%)

All scholars are expected to attend all sessions. A scholar must notify the Bridge team and instructor prior to class if they will absent. This notice should be sent by email.

Basis of Grade Determination

Students will receive a final letter grade based on their class participation (33%), and performance on the take home problem set (67%). The final letter grade will be determined using the following grading scale:

Letter Grade	Range
A	85-100
A-	82-85
B+	78-82
B	75-78

B-	72-75
C+	68-72
C	65-68
C-	62-65
F	<62

Academic Integrity Policy

Each student in this course is expected to abide by the Gerstner Sloan Kettering Policy of Academic Integrity and Plagiarism.

Students are expected to understand all standard rules associated with plagiarism. Resources available to further inform the student of what constitutes plagiarism can be found in the MSK Code of Conduct, the content of the Responsible Conduct of Research course as well as in many guides offered to explain the seriousness of any breach of not submitting one's own work for credit. A guidebook "Writing with Sources – a Guide for Students", is offered to each student upon matriculation; an additional copy is available in the student library.

Any instance of suspected plagiarism by a student will be brought to the attention of the Dean for further inquiry and action. Proven instances of plagiarism can result in dismissal from GSK.

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Course Evaluation

At the end of the course, students will be asked to complete an anonymized survey that evaluates the course.

Recommended Textbook:

The Biology of Cancer Third Edition.

- Author : Robert A. Weinberg
- Publisher : W. W. Norton & Company
- Edition : Third edition (July 1, 2023)
- Language : English
- Paperback : 984 pages

- ISBN-10 : 0393887650
- ISBN-13 : 978-0393887655