CANCER BIOLOGY

Lecture course by Alex Lyakhovich, Office: FENS 1043, Tel. 9506
email: alex.lyakhovich@sabanciuniv.edu

Name: **Cancer Biology 2023/24 (other name Molecular Oncology)**

Codes: **BIO436/636**

#When/Where: **Class 8:40 am - 10:30 am Monday FENS L061**
Class 11:40 am - 12:30 pm Friday FENS L045

Instructor: **Alex Lyakhovich**

#Subject to change, please see final schedule

Aim: The course aims to provide a comprehensive overview of the molecular oncology

Course Description: The course is divided into four parts: basic theory of cancer biology (Lectures 1-6), molecular mechanisms of cancer development and progression (Lectures 7-13), molecular mechanisms of tumor suppressors (Lectures 14-20) and hot topics of cancer research (Lectures 21-24). This course is designed for both graduate and undergraduate students* and provides them with a basic understanding of the molecular and cellular mechanisms of cancer initiation, development and progression. In the part describing molecular mechanisms of tumor suppression, the fundamental principles of cancer diagnosis, prevention, and therapeutic interventions are also discussed.

Kanser Biyolojisi Bu ders, kanserin moleküler mekanizmalarını incelemeyi amaçlamaktadır. Derste, kanserin genetik ve çevresel nedenleri, kanser türleri, kansere eden olan moleküler değişiklikler, anjiogenez, metastaz, hücresel stress mekanizması olan otofajisinin kanserdeki rolü ve kanserin tedavisi işlenecektir. Ders, temel bilgiler yanında en son gelişmelerin makaleler ışığında tartışılması şeklinde yürütülecektir. Öğrencilerin derse aktif katılımı beklenmektedir.

Sustainable Development: the course is related to sustainable development goal 3 as part of health-related global issues and the trends in public health

Levels: Undeclared, Doctorate, Masters, Exchange - Erasmus Mundus DR, MA, UG, Special Student, Scientific Preparatory, Undergraduate, Exchange - Socrates Erasmus DR, MA, UG
Course Attributes: Lang. of Instruction: English, 3.000 Credit hours, 10 ECTS, Course Offered by FENS

Prerequisites: A basic level understanding of biology, molecular and cell biology, chemistry, biochemistry and statistics is a highly prerequisite.

Attendance and participation: Required in at least 80% of the lectures

Evaluation criteria: T1- 15%, T2-15%, Midterm-20%, Final – 30%, quizzes – 20%

LEARNING OUTCOME: Knowledge on how Cancer is formed, develops, progresses, cured

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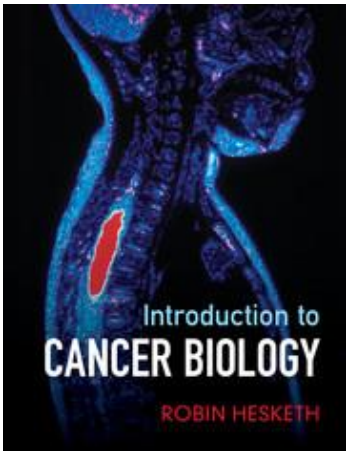
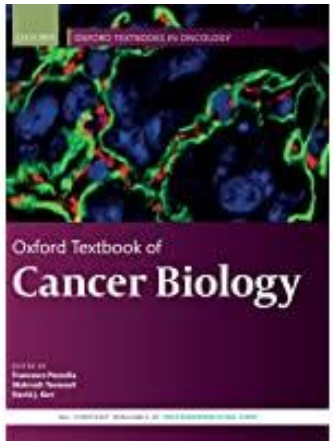
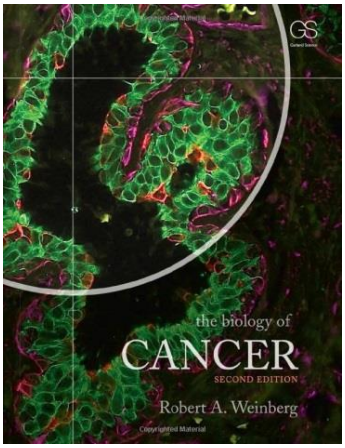
Any of the following books can be used as supportive materials:







PECORINO, Lauren. Molecular biology of cancer : mechanisms, targets, and therapeutics. 3rd ed. New York: Oxford University Press, 2012. xviii, 342. ISBN 9780199577170.

Introduction to Cancer Biology textbook by Robin Hesketh, University of Cambridge ISBN: 9781107601482 LENGTH: 352 pages

Oxford Textbook of Cancer Biology (Oxford Textbooks in Oncology) Illustrated Edition by Francesco Pezzella (Editor), Mahvash Tavassoli (Editor), David Kerr (Editor)

The Biology of Cancer, 2nd Edition and up by Robert A. Weinberg (Author)

- **EARNING GRADES**
- 2 tests 15x2= 30 points
- 1 midterm 20 points
- 1 final 30 points
- quizzes and article questions 20 points

A	100 – 90 %
A -	89 – 85 %
B +	84 – 80 %
B	79 – 75 %
B -	74 – 70 %
C +	69 – 65 %
C	64 - 60 %
C -	59 – 55 %
D +	54 - 50 %
F	Less than 49

- A few bonus points will be awarded for class participation and will be added to each upcoming test.

Grading: If the first decimal place is 5 and larger, then the number will be rounded up to the next integer (e.g., 67.5 → 68). Failing to take one of the exams without a medical excuse will result in failing the course. The letter grade ranges are provided in the table below.

Attendance: all tests get points; all bonus questions get points; no attendance, no points. If you score less than 70% on any of the tests, you must physically attend class

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Academic Integrity Policy -- YOU MUST READ AND FOLLOW

Each student will be evaluated only for her/his own work. Students are encouraged to work and study together; however, what you put down on your problem sets, lab reports, and exam papers should be your own work in your own words. Be aware that you will not be helping your friends by allowing them to copy.

Do not allow your friends to make use of your problem sets or, lab reports and exams, allowing them to copy *will not help them* in the long run. Such behavior, as all forms of cheating, is unfair and disrespectful to yourself, to all the students in the class, to your instructors and teaching assistants, and to the University.

A student involved in cheating has misused the trust extended to him or her. If discovered, such behavior will have DISCIPLINARY consequences for all parties involved. Violations of academic integrity will result in zero grades for that worksheet or exam, both for those who cheat and those who allow and help them cheat. In all such situations we will ask you to have a face-to-face meeting with the instructor. We have mutual trust and respect for each other as individuals while sharing a collaborative learning experience. This is very valuable for all of us, and having to lose this trust and respect would be very regrettable.

Class Participation: Participation will be based on the quality of your comments during discussions and the questions you ask during lecture. To get a C in participation you should be asking a question or speaking once every few weeks. Of course, asking questions every class does not insure a high participation grade, rather, an A is earned by asking thoughtful questions about material that may be confusing and making comments that move discussions forward.

You can ask me to evaluate your participation at any point in the semester.

NA Policy: If you miss one of the exams, you will automatically receive NA for the course. If you otherwise fail the course, you will receive NA

Cell/Mobile phone policy: Cellular phones that ring during lecture are extremely disruptive to a productive learning environment—distracting both the professor and the other students. Individuals that allow their phones to ring during class may be asked to leave. This also covers constant texting and vibrating phones. Please do not text during my lectures. I don't text with anyone during any part of the class but the break and I ask you to also refrain for the 160 minutes of class, even during group work or discussions. Honestly, I find it insulting and rude. Any communication via an electronic device during an exam or quiz will be considered cheating. There is no problem if you would like to use them during the breaks in class. However, if your phone becomes a distraction then I reserve the right to confiscate your phone and return it back at the end of the lecture ☺

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Week 1

Lecture 1. Introduction. A small survey about cancer. The course structure. Grading. DOs and DON'Ts. How to get ''A'' for this course.

Week 2

Lecture 2 A brief history of cancer biology. The nature of malignant tumor. Normal and cancerous cells vs normal tissues and tumors. Molecular hallmarks. Theories of cancer. **Lecture 3** Models of tumors and cells in cancer biology. Pros and Cons.

Week 3

Lecture 4 Oncogenesis and tumor genome. Types of DNA mutations. Consequences of these mutations. Types of malignancies. The theory of two-hit and multi-hit tumorigenesis. Oncogenes, protooncogenes and tumor suppressor genes. Original research papers. Discussion. **Lecture 5.** How to transform normal cells into cancer cell? Molecular mechanisms of cancer development and progression: mutations, growth factors, receptors, signal transduction. Analysis of clinical data. Lollyplot and Oncoplot, how to read them.

Week 4

Lecture 6 More on oncoplot. Molecular mechanisms of tumor suppressors: p53 and pRb. Cell cycle of normal and cancerous cells. Data visualization: TCGA and CGH. DNA damage and repair (part 1). Original papers. **Lecture 7 TEST1 (March 8).**

Week 5

Lecture 8 Discussion of Test 1 results – what we learned and what we missed. The transformation of a cancer cell into a malignant tumor. Evolution of tumor cells and tumor phylogeny. DNA/RNA sequencing, clustering. VEGF and vascularization. Molecular mechanisms of cancer development and progression: angiogenesis, metastasis. **Lecture 9** Tumor microenvironment, metastatic niches. EMT vs. MET. Role of Wnt pathway. TGFb, CAF and TAM – who are those guys? Discussion of original papers.

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Week 6

Lecture 10 Cancer stem or tumor initiating cells – do they really exist? Original research papers to discuss. **Lecture 11** Cancer resistance. Modern theories of cancer resistance: microenvironment, EMT, loss of apoptosis, drug efflux, DDR increase, cancer stem cells. Do we really die from primary cancer? Tumor circulating tumor cells and Metastasis.

Week 7

Lecture 12 Cancer metabolism. Glycolysis vs. OXPHOS. Metabolic shift. Molecular pathways contributing to metabolic reprogramming.

Weeks 7-8

Midterms (March 29 - April 1) workshops 1 and 2

Practical exercises. The audience is divided into groups. Each group takes a research article from leading journals (Nature, Science, Cell - not older than 3 years). One group reports the article and answers questions from the other groups. The groups then switch places. Everyone should read all 4 articles and be prepared to participate in the Q&A sessions. Your score will be divided equally between the presentations (10) and the questions (10). The goal is to develop critical thinking and performance skills.

Week 8

Lecture 13 Is cancer contagious? Molecular mechanisms of cancer development and progression: oncogenes, tumor viruses. Oncolytic viruses.

Week 9

Lecture 14 Molecular mechanisms of tumor development and progression: telomere biology and immortalization. Aging vs. cancer, who comes first? Apoptosis (part 2). Discussion of original papers. **Lecture 15** Evolution of tumor cells and tumor epigenetics (part 1). Molecular mechanisms.

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Week 10

Lecture 16 Molecular mechanisms of tumor development and progression: more on tumor epigenetics (part 2) and defects in DNA repair genes. Error-prone and error-free repair (part 2, the first one was in Lecture 6). **Lecture 17** Rare cancers and rare diseases. Cancer predisposition. Discussion of original papers.

Week 11

Lecture 18 Molecular mechanisms of tumor development and progression: growth factors, G-proteins and oncogenic activation and transformation. More on RAS signaling pathway. Discussion of original papers. **Lecture 19** Hormones and carcinogenesis. G-protein coupled receptors (GPCRs) and oncogenic transformation.

Week 12

TEST2 – May 6. Lecture 20 Current anticancer approaches – 1. Basic principles of anticancer therapy. Neoadjuvant vs adjuvant therapy. Survival curves. Pros and cons of surgery, radio-, chemo- and immunotherapy. **Lecture 21** Current anticancer approaches - 2. Targeted therapy. What to target and why? FDA list – do we need that many drugs? Targeted therapy and chemoresistance.

Week 13

Lecture 22 Current anticancer approaches - 3. Targeted therapy and drug design. How mutations help to develop new drugs. What to do if the target is absence or the tumor is not druggable. Precision therapy. Basic principles of cancer and immune response – why our system does not eliminate cancer? **Lecture 23** Current anticancer approaches - 4. Tumor immunoediting and tumor escape. Immunotherapy and CAR-technology. Molecular mechanisms of tumor suppressors: novel molecular targets for anticancer therapy. Discussion of original papers.

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Week 14

Lecture 24 Current anticancer approaches – 4. What we missed and what we gained. Conclusion remarks - the current state of cancer research in the world.

Lecture 25 Final test (15 points max).

Topics for final exam (15 points max) – **final assignments** have to be completed by June 6

Final grades - date to be confirmed.