

## Cancer Biology and Biotechnology (Biol 4015 & 7015) Fall, 2015

**Course description:** The purpose of this course is to introduce the major concepts of cancer biology and many of the state-of-the-art technologies that are being used to learn more about the properties of cancer cells and how to estimate cancer risk, detect cancer early, and treat cancer patients more effectively. Although these topics will be covered in lectures, a major goal of the course is to enable students from any discipline at Georgia Tech be more adept in learning about cancer from primary literature and how they might use their own skills for cancer research.

**Instructor(s):** Al Merrill, Biology ([al.merrill@biology.gatech.edu](mailto:al.merrill@biology.gatech.edu))

Eva Lee, Industrial and Systems Engineering, Director, Center for Operations Research in Medicine and HealthCare ([evakylee@isye.gatech.edu](mailto:evakylee@isye.gatech.edu)) with faculty from the Colleges of Sciences and Engineering at Georgia Tech as well as special invited lecturers from Emory and elsewhere.

Teaching assistant: Po-Yi Ho ([bio4015ta@gmx.com](mailto:bio4015ta@gmx.com))

**Time and location:** Thursdays, Classroom: 5:05 to 7:55 pm; Howey (Physics) L3 (7:05 to 7:55 pm will sometimes be dedicated to small group meetings and student presentations)

**Optional textbook:** No textbook covers all the information in this course, but if you want a general overview of cancer biology, two *relatively* recent (and, thus, maybe you can get used copies cheaply) and good books on cancer biology are: *Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics, 3<sup>rd</sup> Edition* by Lauren Pecorino (Oxford University Press, 2012) and *The Biology of Cancer, 2<sup>nd</sup> Edition* by Robert A. Weinberg (Garland Science, 2013). The Pecorino book is a general (and relatively inexpensive) overview, whereas, the Weinberg book is more in-depth (the tables of contents for these books are given at the end of this syllabus). The Tech library has been requested to put a copy of each on reserve. No textbook is required, however, because all of the information that you will be required to know will be presented in class or you can find in published research papers.

It might help you to look at the cancer research summaries that are posted on the web site for the Integrated Cancer Research Center (<http://www.icrc.gatech.edu>), and the web site:

<http://gtrresearchnews.gatech.edu/wp-content/uploads/2011/06/Georgia-Tech-CancerPublication-2011.pdf>

<b><u>Grading:</u></b>	Exams (Mid-term exam, 25%; Final exam, 30%)	55%
	In-class participation	5%
	Team research project (Festival presentation and final poster, 25%; Individual written report and level of team contribution, 15%)	40%

Final grades will be assigned by the scale: 90% and greater (A); 80-89% (B); 70-79% (C); 60-69% (D); Less than 60% (F)

## Syllabus: Cancer Biology and Biotechnology (Biol 4015 & 7015)

<i>Date (class #)</i>	<i>Topic(s)</i>	<i>Faculty</i>
Aug. 20 (1)	5 pm An overview of cancer and tools to study cancer 7:00 pm Time available for organization of small groups	A. Merrill, PhD (GT Biol)
Aug. 27 (2)	5 pm Overview of cancer and tools to study cancer (cont) 6:30 pm Small group meetings to discuss papers/select topic	A. Merrill, PhD (GT Biol)
Sept. 3 (3)	5 pm Small group meetings to finalize project choice 6 pm Computational methods in cancer informatics, early intervention, diagnosis, and treatment 7 pm: Small group meetings to finalize paper/topic	Po-Yi Ho (GT Biol)  Eva Lee, PhD (GT ISyE)
Sept. 7	Teams send CBT team & topic form to TA	
Sept. 10 (4)	5 pm Special topic discussions: Harnessing the Power of the Immune System for Cancer Control 6 pm Special topic discussions Measuring changes in gene regulation during tumorigenesis 7 pm: Resolve any issues regarding selection of paper/topic	Margaret K Offermann (MD, PhD; <a href="http://www.Salutramed.com">www.Salutramed.com</a> ) Philip Santangelo (GT/Emory BME)
Sept. 17 (5)	5 pm Special topic discussion: Mechanics and Malignancy: Biophysics of Cancer 6 pm Special topic discussion: Cancer detection & treatment in the era of systems biology 7 pm Flash talks #1 by project teams (3 teams)	Michelle Dawson (GT ChBE)  May Wang (GT/Emory BME)
Sept. 24 (6)	5 pm Basic and clinical aspects of ovarian cancer  6:00 pm Flash talks #1 by project teams (8-9 teams)	John McDonald, PhD (GT Biol; Ovarian Cancer Institute) Po-Yi Ho (GT Biology)
Oct. 1 (7)	5 pm Special topic discussion: Proteases and tumor migration/metastasis 6:00 Special topic discussion: Nanomedicine 7:00 pm Flash talks #1 by project teams (3 teams)	Manu O. Platt (GT BME)  Mostafa El-Sayed (GT Chem/Biochem)
Oct. 8 (8)	5 pm Special topic discussion: Botanicals in cancer prevention, treatment and survivorship 6:30 pm Flash talks #1 by project teams (3-5 teams)	Omer Kucuk (Emory Winship Cancer Inst)
<b>Oct. 15 (9)</b>	<b>5 pm Mid-term exam</b> 6:30 pm Factors to consider in preparation of Festival posters	Po-Yi Ho (GT Biol)
Oct. 22 (10)	5 pm Special topic discussions: Engineering effector proteins as modulators of cell signaling pathways for breast cancer therapy 6 pm* Flash talks #2 by project teams (up to 7-9 teams)	Julie Champion (GT ChBE)  *on one of these evenings, we might insert another special topic discussion
Oct. 29 (11)	5 pm Special topic discussions: Targeted Epigenetic Inhibition 6 pm* Flash talks #2 by project teams (up to 7-9 teams)	Adegboyega Oyelere (GT Chem/Biochem)  *on one of these evenings, we might insert another special topic discussion
Nov. 5 (12)	5 pm Special topic discussion: Engineering immunotherapy 6 pm* Flash talks #2 by project teams (up to 7-9 teams)	Susan N. Thomas (GT ME)  *on one of these evenings, we might insert another special topic discussion
Nov. 10	Nearly final drafts of the posters due (e-mail to TA )	
Nov. 12 (13)	5 to 7 pm Final preparation and review of posters for Festival	Po-Yi Ho (GT Biol) Al Merrill, PhD (GT Biol)
Nov. 19 (14)	5 to 7 pm <b>Georgia Tech Festival of Research Ideas in Cancer Biology and Technology, IBB Atrium</b>	Entire class
<b>Nov. 26</b>	No class Thanksgiving holiday	
Dec. 2 3	Revised posters due by e-mail to TA Individual written reports due in class	
Dec. 3 (15)	5 pm Review of principles and approaches covered 6:30 pm Discuss format of the final exam	A. Merrill (GT Biol)
Dec. 10	<b>5 pm Final exam</b> (all lectures & information presented on student posters)	

**Course format**

The first classes will be introductory lecture(s) that survey the major concepts of cancer biology and begin to introduce some of the technologies applied to cancer. The goal of these lectures is to ensure that everyone has a fundamental understanding of cancer.

The majority of the next classes will be short presentations on special topics by researchers who are developing and using state-of-the-art technologies. These are not intended to be “lectures” but illustrations of how research active scientists, engineers and clinicians are applying their skills to this disease. Ample time will be allocated for students to discuss the ideas raised by these presentations, and you are encouraged to think about questions such as: What is the underlying principle of cancer cell biology that is being addressed? What challenge is the new technology trying to solve? How does the new technology work? How might it be improved? Etc.

Students will also work in teams to select a research paper that addresses an important facet of cancer and involves an interesting, and often novel, technology. The team will become expert in the subject by exploring the published research literature and then prepare an oral presentation that will explain it to the class and a poster that will be shown in the “Festival of Research Ideas in Cancer Biology and Technology” that is open to the entire campus. The poster will also include a concrete plan developed by the team for studies that would follow-up on those described in the paper.

**Exams (55% of final grade)**

The mid-term exam (25% of final grade) will cover the information in all the lectures and special topic discussions through Oct. 8.

The final exam (30% of final grade) will be on the information related to the team posters, but students should appreciate not only just what is shown on the posters but also how it is related to concepts presented elsewhere in the course.

**In-class participation (5% of final grade)**

As explained above, the special topics presentations and the team presentations are not intended to be traditional “lectures” but to stimulate thinking, and discussion, about cancer and how technologies can be used to obtain a better understanding of cancer and to be clinically useful for cancer detection and treatment. Everyone is encouraged to participate in the discussion. The “in-class participation” grade will be earned by filling in an “I participated” form that records each time that you have asked a thoughtful question or made a comment in class related to the material. You should download the form so you will have it available to fill in when you have done this in class (it needs to be turned in to the TA during the same class); if you forget to bring a form, the TA will sometimes have copies you can use. Each form that you turn in will be worth 1% (i.e., if you turn in 5 during the semester, you will qualify for full credit).

**NOTE: Graduate students are required to perform one additional duty for full participation credit.** For one of the questions/comments you raise in class, you should look

up two research papers on the topic and write a brief statement (several sentences will suffice) about what the paper contains that relates to your question/comment. If you have already done this in formulating the point you raised in class (for example, perhaps you have done a Pub Med search on your laptop as you formulated the question, or soon afterwards), then you can write the references on the form before you give it to the TA that evening. Otherwise, send it to the TA via e-mail before the next class.

### **Team research paper analysis and presentation at the Festival of Research Ideas in Cancer Biology and Technology (40% of final grade)**

The goal of this portion of the course is to give you a chance to work on a challenging problem in the area of cancer biology and technology. During the first week of class, the instructors will have you divide into teams of approximately 5 members per team, and over the next two weeks you will pick a research paper that addresses some facet of cancer that involves technology.

The team will fill in the “CBT team & topic” form (download template from T-square) and send it to the TA by Sept. 7. We will go over these during part of the Sept. 10 class to try to refine the selections, if necessary, and further refinement will occur when the papers are summarized in the Flash Talk #1, described below.

For the next several weeks, you will analyze the paper and think about how its technology can be improved or applied. You are responsible for exploring the published research literature to broaden your understanding of the technology you have selected, and encouraged to discuss your ideas with the instructors and any persons at Tech, Emory or other institutions who might be of assistance.

The TEAM deliverables are:

a) Two in-class progress reports on the technology and your thoughts about how to improve/apply it. These will be given as “flash talks”—one to give a brief outline of the paper/project selected, the other to explain how the group plans to extend the work. Flash talks are Powerpoint presentations with just the essentials summarized in 5 slides in 5 minutes followed by 5 minutes of discussion with the instructors and class about how it might be improved. Thus, Flash talk #1 will cover (in one slide each): What is the need? What is done now? How does this paper propose to meet the need? What evidence is there that it works? What do the authors (and/or you) suggest should be done next? Flash talk #2 will give only a very abbreviated background on the need and current technology (one slide), one summarizing what this paper has done, then three slides explaining how your group proposes to extend the work. E-mail your slides to TA before noon on the day of your presentation.

Depending on how many teams there are, scheduling these talks in the time allowed might be difficult. If there are too many groups; we might divide into smaller groups that present the information and critique each other rather than present this to the entire class.

b) A poster that describes the technology and your proposal about how to improve or apply it (the format for this will be discussed in class). Drafts of all posters must be ready for review in class on November 12. They do not need to be printed in full size for this class, but can be brought to class on a USB drive or printed a size that can be read easily (such as 11 x 14”).

c) Presentation of the poster at the Festival of Research Ideas in Cancer Biology and Technology on November 19.

d) Revision of the poster in response to suggestions at the Festival

e) Submission of the revised poster (electronically) to the TA on or before Dec. 2 (so we can review them and post them on T-square for everyone to have access to the information).

EACH individual member of the team is also responsible for sending a one-to-two page summary of the technology and its improvement/application (in his/her own words—this must be written by YOU and not cut-

and-paste from the team's report) (this is due to the TA on or before Dec. 3). More details about what must be included in this summary will be posted on T-square. The purpose of this separate summary is to ensure that all team members work closely enough with the project that they can clearly describe its content, and it is also an opportunity for each team member to explain their role in preparing the final poster and any particular ideas that they might want to express that didn't appear in the final version. The grade (20% of the final grade) will be comprised of 15% for the written report, and 5% for being an active participant in the preparation of the poster.

**The Georgia Tech Festival of Research Ideas in Cancer Biology and Technology.** This will be held in the atrium of the Petit Institute of Bioengineering and Biosciences from 4 to 7 PM on November 19. This will be publicized to the cancer research community essentially as follows:

Goal: You are invited to attend the third Festival of Research Ideas in Cancer Biology and Technology at Georgia Tech. The purpose of this event is to provide an open and stimulating forum for exploration of new ideas for basic and translational research in cancer biology and technology. Ideas for how new technologies can be applied to cancer as well as findings from ongoing research at Georgia Tech, the Winship Cancer Center at Emory University, and local institutions will be presented in the Atrium of the Petit Institute for Bioengineering and Biosciences. Contact [al.merrill@biology.gatech.edu](mailto:al.merrill@biology.gatech.edu) for more information, including if you are a cancer researcher and would like to display a poster on your work.

Thus, your posters will be viewed not only by your student colleagues but also by professional cancer researchers (and likewise, you will see posters from some of their work). Any useful suggestions/comments that you receive should be used to revise your poster and its suggestions for improvement/application of the technology before you submit an electronic copy of the revised poster to the TA. The final version should be sent both as a Powerpoint slide and as a pdf file.

**Grading for this portion of the course:** All members of a project group will receive the same grade for the poster (worth 20% of your final grade); **each individual will get a separate grade (worth 20% total) for the independent one-page summary of the project (15% of the total) and a description of your roles in preparing the poster and presenting it at the Festival (this is worth 5% of this total, and under usual circumstances, full credit is awarded for satisfactory sharing of the workload).**

**NOTE:** If a group member feels they do not fit in the original group they joined, or the group thinks a member is not fulfilling their share of the responsibilities for the team project, contact Dr. Merrill as soon as possible so a solution can be found. Since all members of a project group will receive the same grade for the poster, and likewise, each member will need to declare what has been their role in preparing the poster and presenting it at the Festival (so their 5% participation grade will depend on doing a fair share of the work), it is in the best interest of everyone to resolve any conflicts of this sort as soon as possible. In exceptional circumstances, it might be necessary for a student to prepare a project alone.

### **Other useful information**

**Table of Contents for optional textbooks:** this might be helpful to you in deciding which textbook to consult if you need supplemental reading.

**Molecular Biology of Cancer. Mechanisms, Targets, and Therapeutics, 3rd Ed. Lauren Pecorino (Oxford Press)**

1. Introduction
2. DNA and Stability: Mutations versus Repair
3. Regulation of Gene Expression
4. Growth Factor Signaling and Oncogenes

5. The Cell Cycle
6. Growth Inhibition and Tumor Suppressor Genes
7. Apoptosis
8. Stem Cells and Differentiation
9. Metastasis
10. Infections and Inflammation
11. Nutrients, Hormones, and Gene Interactions
12. The Cancer Industry: Drug Development and Clinical Trial Design
13. Cancer in the Future: Focus on Diagnostics and Immunotherapy

**The Biology of Cancer, 2nd Ed, Robert A. Weinberg (Garland Science)**

1. The Biology and Genetics of Cells and Organisms
2. The Nature of Cancer
3. Tumor Viruses
4. Cellular Oncogenes
5. Growth Factors, Receptors, and Cancer
6. Cytoplasmic Signaling Circuitry Programs Many of the Traits of Cancer
7. Tumor Suppressor Genes
8. pRb and Control of the Cell Cycle Clock
9. p53 and Apoptosis: Master Guardian and Executioner
10. Eternal Life: Cell Immortalization and Tumorigenesis
11. Multi-step Tumorigenesis
12. Maintenance of Genomic Integrity and the Development of Cancer
13. Dialogue Replaces Monologue: Heterotypic Interactions and the Biology of Angiogenesis
14. Moving Out: Invasion and Metastasis
15. Crowd Control: Tumor Immunology and Immunotherapy
16. The Rational Treatment of Cancer

**Accessing research literature:**

**Pub Med:** <http://www.ncbi.nlm.nih.gov/pubmed/>

**Google Scholar:** <https://scholar.google.com/>

**Georgia Tech online journals:** [http://sfx.galib.uga.edu/sfx\\_git1/cgi/core/citation-linker.cgi](http://sfx.galib.uga.edu/sfx_git1/cgi/core/citation-linker.cgi)

**Additional information (required by Georgia Tech):**

All students are required to adhere to the Georgia Tech Academic Honor Code ([www.honor.gatech.edu](http://www.honor.gatech.edu)). This includes, but is not limited to, the following issues that pertain to the oral and written critiques, quizzes, and exams for this class:

1. Plagiarism is not allowed. Plagiarizing is defined by Webster's as "to steal and pass off (the ideas or words of another) as one's own; use (another's production) without crediting the source."

In simpler terms: When you use any phrases, sentences, etc. verbatim from another source, they must be identified by quotation marks and citation of the source. In scientific writing, it is generally preferable to rephrase information from other sources and cite the source rather than use the same text, even when you offset

the text with quotation marks. When you show diagrams, models and other materials that are not your own, the sources must also be identified.

These rules apply both to published information and information that you might receive from another student, website, previous class report, etc.

Plagiarizing will be dealt with according to the GT Academic Honor Code.

2. Students are encouraged to collaborate in some aspects of the preparation of oral and written critiques, such as the early stages where you are achieving an understanding of the assigned papers; however, the final critiques must be written by each student alone.

For team oral presentations, students may collaborate in all aspects of the work, indeed, it is expected that all will contribute equally to the final product and that they will share the single grade that is awarded for the ppt presentation. Students may use copyrighted figures, etc. from publications in the ppt presentation (if appropriate citations are given) because the ppt will only be posted on the access restricted WebCt website. However, if the team uses multiple copies of any copyrighted items (such as the pdf file of a copyrighted article), each student must download their own copy from the Georgia Tech library website rather than for one student to distribute the pdf.

In the event the assigned paper has been used by a previous class, students are not allowed to use any of the ppt slides in whole or part that were prepared by the other class.

3. Unless specifically identified as group work; quizzes, tests, take-home-tests, homework, etc. are to be completed alone.

4. For Quizzes/Tests: Cheating off of another person's test or quiz is unethical and unacceptable. Cheating off of anyone else's work is a direct violation of the GT Academic Honor Code, and will be dealt with accordingly.

5. Because the exams for this course change every semester, students may use old tests as study tools.

**For any questions involving these or any other Academic Honor Code issues, please consult the professors, teaching assistant, or [www.honor.gatech.edu](http://www.honor.gatech.edu).**