Cancer Biology

The Undergraduate Program in Cancer Biology was established in 2020 as a joint program between the Department of Chemistry in the College of Arts and Sciences and the Department of Cell, Developmental and Integrative Biology (CDIB) in the Heersink School of Medicine. This program is the only one of its kind in the US to specifically train students in cancer biology.

The central mission of the new Cancer Biology undergraduate major is to provide students with a strong educational and research background that maximizes their chances to achieve career goals in cancer biology in particular and life sciences in general. This program is unique in that students will gain a broad background in the biomedical sciences by exposure to courses that support the current requirements of the biomedical enterprise and are applicable to academic, private and government settings. Furthermore, by requiring a research component, all students within this major will have early exposure to a cutting-edge research environment through participation in current investigator-led programs in multiple research-intensive departments at UAB and in collaboration with the O'Neal Comprehensive Cancer Center.

UAB's mission includes the promotion of discovery, knowledge dissemination and education. The Cancer Biology major helps to fulfill these goals by training students to take up positions in research and clinical laboratories, by providing a solid foundation for future graduate study, and by providing informed individuals appropriate for employment in multiple health-related settings. Disciplines covered will include not only cell biology and chemistry, but also microbiology, immunology, genetics, pathology, pharmacology and medicine. This interdisciplinary curriculum reflects the diverse nature of the disease itself.

Because of these features, students will be exposed to a robust and flexible educational experience. Undergraduates will have the opportunity to undertake high quality research in laboratory settings across campus. They will receive research training from world-class investigators at an earlier stage than their peers and have exposure to state-of-the-art technologies, which will increase the desirability of these students for both professional careers or post-graduate programs with an exceptional background in cancer biology and laboratory research.

Admissions

The Undergraduate Cancer Biology Program is designed for graduating high school seniors and college freshmen and sophomores with an outstanding academic record and the desire to pursue a career in biomedical research, medicine or the health professions. Successful applicants to the program should meet the admissions criteria below.

First-time freshmen applicants must have a high school cumulative GPA of 3.5 or higher (on a 4.0 scale) and an ACT composite score of 28 or higher (or the SAT combined V+Q score at 1300 or higher). High school students who do not meet these requirements may be accepted into the program as pre-Cancer Biology majors. Any student who is admitted as a pre-Cancer Biology major must have an overall GPA #3.0 after ~20-30 credits of work at UAB, a GPA #3.0 in their Biology, Chemistry, Physics and Mathematics (preferably BY 123/123L, BY 124/124L, CH115/116, CH117/118, PH 201/202, and MA 105, MA 106, MA 107, MA 125, or MA 168) coursework, and have taken a freshman year curriculum that is compatible with the Program. Admission as CNBY following pre-CNB can be discussed during advising and with the program directors.

Current UAB students and transfer students from other institutions who are freshmen or sophomores (non-direct admits) may select Cancer Biology for their major, but must have an overall GPA #3.0 and must have demonstrated excellent academic performance in science/mathematics courses (as described above) and have a GPA #3.0 in those courses.

GPA and graduation requirements

Students must maintain an overall GPA of at least 3.0 in order to remain in good academic standing in the program. Students will not meet graduation requirements if the overall GPA is below 3.0. If a student's overall GPA falls below 3.0, they will have one semester to bring their overall grade to 3.0 or better or must switch majors. Students must work to be admitted as CNBY by 60 credit hours, which is a degree seeking major (Pre-CNB is not a degree seeking major). If they have not met admission requirements for CNBY, then they will need to switch majors. Courses taken on a pass/fail basis do not count toward the CNBY major.

Those who wish to apply to the Program should contact the Program Directors for additional information. The Co-Directors of the Program, Dr. Braden McFarland and Dr. Sadanandan Velu, are available to meet with high school students and their parents, or with current UAB students to discuss the program.

Advising and Information

Program Leadership

Dr. Braden McFarland
Co-Director, Undergraduate Cancer Biology Program
Assistant Professor of Cell, Developmental and Integrative Biology (CDIB)
(205) 934-3599
bdcox@uab.edu

Dr. Sadanandan Velu
Co-Director, Undergraduate Cancer Biology Program
Professor of Chemistry
(205) 975-2478
svelu@uab.edu

Academic Advising

Jamie Grimes
Chemistry Building 212
cnbyadvise@uab.edu (chemadvise@uab.edu)

Bachelor of Science in Cancer Biology

Requirements		Hours
Blazer Core Curriculum Requirements		
Local Beginnings		3
Academic Foundations		9
Thinking Broadly [1]		12
City as a Classroom		3
Biology Courses		**15**
BY 123 & 123L	Introductory Biology I and Introductory Biology I Laboratory	
BY 124 & 124L	Introductory Biology II and Introductory Biology II Laboratory	
BY 210	Genetics	
BY 330	Cell Biology	

Chemistry Courses		**19**
CH 115 & CH 116	General Chemistry I and General Chemistry I Laboratory	
CH 117 & CH 118	General Chemistry II and General Chemistry II Laboratory	
CH 235 & CH 236	Organic Chemistry I and Organic Chemistry I Laboratory	
CH 237 & CH 238	Organic Chemistry II and Organic Chemistry II Laboratory	
CH 460	Fundamentals of Biochemistry	
Cancer Biology Courses		**22**
CNBY 210	Colloquium in Cancer Biology [2]	
CNBY 320	Introduction to Cancer Biology	
CNBY 410	Proliferation and Carcinogenesis	
CNBY 420	Genetic Basis of Cancer	
CNBY 480	Journal Club in Cancer Biology [2]	
CNBY 495	Undergraduate Research in Cancer Biology [3]	
CNBY 499	Senior Undergraduate Research Capstone Course [3]	
Other Required Courses		**20**
PHL 116	Bioethics	
CAS 112	Success in College	
PSDO 200	Introduction to Research	
MA 125	Calculus I	
or MA 168	Mathematics of Biological Systems I	
MA 180	Introduction to Statistics	
or PUH 250	Biostatistics	
PH 201	College Physics I	
or PH 221	General Physics I	
PH 202	College Physics II [4]	
or PH 222	General Physics II	
Major Electives (must take 2)		**6**
CH 461	Advanced Biochemistry	
CH 463	Biochemistry Laboratory	
or CH 464	Physical Biochemistry Laboratory	
CH 471	Medicinal Chemistry and Drug Discovery	
CH 472	Chemistry of Natural Products	
CH 477	Radiochemistry for the Life Sciences	
CNBY 430	Tumor Survival and the Microenvironment	
CNBY 440	Cell Signaling and Cancer	
CNBY 460	Tumor Pathobiology and Immunology	
CNBY 470	Cancer Treatment	
General Electives [5]		**11**
Total Hours		**120**

1. Reasoning, Quantitative Reasoning and Scientific Inquiry with Laboratory credit requirements are included with major courses.
2. 1 credit hour per term, must be taken twice.
3. Undergraduate Research: Cancer Biology Majors are required to complete a minimum of 9 semester credit hours [CNBY 495 (6h) + CNBY 499 (3h)] of research under the direction of a faculty member beginning no later than their junior year. However, qualified students may identify a mentor and begin conducting research as early as their sophomore year if prerequisites are met (PSDO 200; pass) and approval by the faculty mentor and the program co-directors.
4. PH 222 requires Calculus II (MA 126). MA 126 is not required for CNBY majors; only Calculus I (MA 125) is required for CNBY majors.
5. Recommended but not required courses include: BY 115/BY 115L, BY 116/BY 116L, BY 245, BY 311, BY 327/BY 327L, BY 409/BY 409L, BY 416, BY 433, BY 437, BY 440, GGSC 310, GGSC 410, GGSC 420, GGSC 491, and MIC 275.

Freshman

First Term	Hours	Second Term	Hours
CAS 112	3	BY 123 & 123L	4
CH 115 & CH 116	4	CH 117 & CH 118	4
EH 101	3	EH 102	3
MA 168 or 125	4	PHL 116	3
Blazer Core Course[1]	3	PSDO 200	1
	17		**15**

Sophomore

First Term	Hours	Second Term	Hours
BY 124 & 124L	4	BY 210 & 210L	4
CH 235 & CH 236	4	CH 237 & CH 238	4
CNBY 210[2]	1	CNBY 210[2]	1
Blazer Core Course[1]	3	CNBY 320	3
Blazer Core Course[1]	3	Blazer Core Course[1]	3
	15		**15**

Junior

First Term	Hours	Second Term	Hours
BY 330	3	CNBY 410	3
CH 460	3	CNBY 495	3
CNBY 420	3	PH 202 & 202L	4
PH 201 & 201L	4	Blazer Core Course[1]	3
PUH 250 or MA 180	3	Blazer Core Course[1]	3
	16		**16**

Senior

First Term	Hours	Second Term	Hours
CNBY 480[3]	1	CNBY 480[3]	1
CNBY 495	3	CNBY 499	3
Elective CH or CNBY 400 level course[4]	3	Elective CH or CNBY 400 level class[4]	3
General Elective[5]	3	General Elective[5]	3
General Elective[5]	3	General Elective[5]	3
	13		**13**

Total credit hours: 120

1. See GPS for list of courses that can satisfy core and/or major requirements.
2. CNBY 210 must be taken twice.
3. CNBY 480 must be taken twice.
4. List of elective CH or CNBY 400 courses (students must pick two - all 3 credit hours): CH 461, CH 463 (or CH 464), CH 471, CH 472, CH 477, CNBY 430, CNBY 440, CNBY 460, CNBY 470.
5. Recommended (but not required) courses for the general electives include: BY 115/BY 115L, BY 116/BY 116L, BY 245, BY 327/BY 327L,

BY 311, BY 409/BY 409L, BY 416, BY 433, BY 437, BY 440, GGSC 310, GGSC 410, GGSC 420, GGSC 491, and MIC 275.

Courses

CNBY 210. Colloquium in Cancer Biology. 1 Hour.
This course will introduce students to current topics in cancer biology. The goal is to cover a wide range of subjects, with speakers from UAB and if appropriate from outside institutions. Topics covered will be very broad and will range from basic science to clinical and translational medicine, and if appropriate will also address some of the ethical issues surrounding cancer treatment and the sociological impact of chronic disease. The goal will be to build interest in the topic and for students to gain a broad appreciation of the many facets of the disease.

CNBY 320. Introduction to Cancer Biology. 3 Hours.
This course will introduce students to cancer biology. Topics will include the history of cancer, hallmarks of cancer biology on a cellular level, common cancers in the body, cancer treatment, and prevention and risk factors. This course will serve as a foundation and prerequisite to the more advanced upper level CNBY courses.
Prerequisites: (BY 123 [Min Grade: C] or BY 123 [Min Grade: P]) and (BY 124 [Min Grade: C] or BY 124 [Min Grade: P])

CNBY 410. Proliferation and Carcinogenesis. 3 Hours.
This course will cover the basic tenets of cell biology as they apply to cancer. Topics to be covered will include the cell cycle, how cells normally grow and divide, how they stop growing and how that process is disrupted in cancer; the normal processes associated with cell death such as autophagy, apoptosis and necrosis; the concepts of “stemness” and immortalization in relation to cancer cells and the role of telomerase, mutagens, environmental toxins and DNA repair.
Prerequisites: CNBY 320 [Min Grade: C]

CNBY 420. Genetic Basis of Cancer. 3 Hours.
This course will provide an overview of genomic organization transcription and translation, prior to commencing an in-depth study of cancer genetics and the roles of oncogenes, tumor suppressors, RNA, DNA methylation, gene amplification and the control of gene expression and the viral causes of cancer. Students will also be introduced to basic concepts in bioinformatics and database mining using The Cancer Genome Atlas (TCGA) as a model.
Prerequisites: CNBY 320 [Min Grade: C]

CNBY 425. Sex Differences in Cancer. 3 Hours.
This course will provide an overview of the sex differences in cancer with regards to incidence, prevalence, and mortality of various cancers as well as the role of the X and Y chromosomes in tumor cell survival. The course will also discuss hormone dependent cancers and the importance of cancer screenings and awareness for all persons, including all sexes and genders.
Prerequisites: CNBY 320 [Min Grade: C]

CNBY 430. Tumor Survival and the Microenvironment. 3 Hours.
This course will examine cancer cell physiology in terms of the tumor microenvironment, nutrients and angiogenesis and will explore how these influence cancer cell survival, invasion and metastasis.
Prerequisites: CNBY 320 [Min Grade: C]

CNBY 435. Pediatric Cancers. 3 Hours.
This course will provide an overview of the cancers that primarily affect children. We will discuss the biology, genetics, treatments, and risks of each, and students will present reports of recent pediatric clinical trials. We will also discuss the potential long-term consequences following cancer treatment for survivors.
Prerequisites: CNBY 320 [Min Grade: C]

CNBY 440. Cell Signaling and Cancer. 3 Hours.
In this course the major cell signaling pathways involved in cancer cell development will be examined. An initial overview of signaling (cytosolic, nuclear, dual-address), receptors and basic second messenger pathways (PKA/PKC) will be followed by an in-depth study of pathways of particular relevance to cancer such as receptor tyrosine kinases, RAS, PI3 kinase/PTEN, growth factors (e.g. EGF, TGF-#), integrins, Wnt/#-catenin and JAK/STAT pathways. The role of post-translational modifications of proteins, such as glycosylation will also be discussed.
Prerequisites: CNBY 320 [Min Grade: C]

CNBY 445. Cancer Neuroscience. 3 Hours.
This course will provide an overview of the various types of cancers that grow in the brain from a neuroscience perspective. Specifically, we will focus on the connections between neurons and cancer cells, the role of neurotransmitters on tumor growth, functional connectivity within the brain through imaging, and understanding symptoms including epilepsy and edema. Lastly, we will discuss current clinical trials as well as long-term mental and physical side effects for survivors.
Prerequisites: CNBY 320 [Min Grade: C] or NBL 230 [Min Grade: C]

CNBY 455. Cancer Bioinformatics. 3 Hours.
This course introduces the integration of various data types: single-cell sequencing, genomics, metagenomics, flow cytometry, and more into cancer biology research. Students will explore how multi-omics approaches enable novel insights into cancer mechanisms, diagnosis, and treatment. Emphasis is placed on computational tools and methodologies for data analysis and interpretation in cancer research.
Prerequisites: CNBY 320 [Min Grade: C]

CNBY 460. Tumor Pathobiology and Immunology. 3 Hours.
This course will examine the pathological changes that occur in cancer cells and tissues. The course will start with a brief overview of normal histology and will then focus on pathological changes that occur in some select cancers, e.g., colon, lung and breast. This will be followed by exploration of the roles of infection and immunity in cancer that will involve the role of innate and adaptive immunity and cancer cell defenses. The course will conclude by discussing cancer staging and classification of different cancers.
Prerequisites: CNBY 320 [Min Grade: C]

CNBY 470. Cancer Treatment. 3 Hours.
Major advances have been made in the diagnosis and treatment of multiple cancers. This course will review current therapeutic approaches to cancer treatment including radiotherapy, chemotherapy, surgery and gene therapy. This course will also include an introduction to the role of personalized medicine in cancer treatment. The course will conclude by considering other facets of caring for the patient with cancer including maintenance of nutrition, mental health and palliative care.
Prerequisites: CNBY 320 [Min Grade: C]

CNBY 480. Journal Club in Cancer Biology. 1 Hour.
This journal club will be appropriate for senior students. Students, either individually or in small groups will select, read and present articles from the current cancer literature as guided by their instructor.

CNBY 495. Undergraduate Research in Cancer Biology. 0-6 Hours.
In this major, students will be required to undertake a research project and register for 6 credit hours of CNBY 495 Undergraduate Research, as well as this CNBY 499 Senior Research Capstone course during their final semester of research.
Prerequisites: PSDO 200 [Min Grade: P]

CNBY 499. Senior Undergraduate Research Capstone Course. 3 Hours.
In this major, students will be required to undertake a research project and register for 6 credit hours of CNBY 495 Undergraduate Research, as well as this CNBY 499 Senior Research Capstone course during their final semester of research. This latter course will serve as the opportunity for students to write their research into a manuscript for publication, present a poster or give an oral presentation describing their research for presentation at the UAB EXPO or another scientific meeting. Students will work closely with faculty mentors to ensure quality of research and writing.
Prerequisites: CNBY 495 [Min Grade: P]