

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 undergraduate GPA #3.0 after ~20-30 credits of work at UAB, an undergraduate 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 undergraduate GPA #3.0 and must have demonstrated excellent academic performance in science/mathematics courses (as described above) and have an undergraduate GPA #3.0 in those courses.

GPA and graduation requirements

Students must maintain an overall undergraduate 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 undergraduate GPA is below 3.0. If a student's overall undergraduate GPA falls below 3.0, they will have one semester to bring their overall undergraduate GPA 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
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Academic Advising

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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 | |
| BY 123 & 123L | Introductory Biology I and Introductory Biology I Laboratory |
| BY 124 & 124L | Introductory Biology II and Introductory Biology II Laboratory |
| BY 210 & 210L | Genetics and Genetics Laboratory |

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|--------------------------------------|----------------------------------------------------------------------------------------------------|------------|
| BY 330 | Cell Biology | |
| Chemistry Courses | | 19 |
| CH 115 & 115R & CH 116 | General Chemistry I and General Chemistry I Recitation and General Chemistry I Laboratory | |
| CH 117 & 117R & CH 118 | General Chemistry II and General Chemistry II Recitation and General Chemistry II Laboratory | |
| CH 235 & 235R & CH 236 | Organic Chemistry I and Organic Chemistry I Recitation and Organic Chemistry I Laboratory | |
| CH 237 & 237R & CH 238 | Organic Chemistry II and Organic Chemistry II Recitation 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 ⁵ | |
| CNBY 420 | Genetic Basis of Cancer ⁵ | |
| 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 | |
| PSDO 200 | Introduction to Research | |
| PSDO 300 | Introduction to the Health Professions | |
| MA 125 & 125L or MA 168 | Calculus I and Calculus I Lab Mathematics of Biological Systems I | |
| MA 180 or PUH 250 | Introduction to Statistics Biostatistics | |
| PH 201 & 201R & 201L | College Physics I and College Physics I Recitation and College Physics Laboratory I | |
| PH 202 & 202R & 202L | College Physics II and College Physics II - Recitation and College Physics Laboratory II | |
| Major Electives (must take 2) | | 6 |
| CH 461 | Advanced Biochemistry | |
| CH 463 or CH 464 | Biochemistry Laboratory Physical Biochemistry Laboratory | |
| CH 471 | Medicinal Chemistry and Drug Discovery | |
| CH 472 | Chemistry of Natural Products | |
| CH 477 | Fundamentals of Radiochemistry | |
| CNBY 425 | Sex Differences in Cancer ⁵ | |
| CNBY 430 | Tumor Survival and the Microenvironment ⁵ | |
| CNBY 435 | Pediatric Cancers | |
| CNBY 440 | Cell Signaling and Cancer ⁵ | |
| CNBY 445 | Cancer Neuroscience ⁵ | |
| CNBY 450 | Microbiome in Cancer ⁵ | |
| CNBY 455 | Cancer Bioinformatics ⁵ | |
| CNBY 460 | Tumor Pathobiology and Immunology ⁵ | |
| CNBY 470 | Cancer Treatment ⁵ | |
| General Electives⁴ | | 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 freshman year if prerequisites are met (PSDO 200; pass) and approval by the faculty mentor and the program co-directors.

⁴ Recommended but not required courses include: BY 115 Human Anatomy/BY 115L Human Anatomy Laboratory, BY 116 Introductory Human Physiology/BY 116L Introductory Human Physiology Laboratory, BY 261 Introduction to Microbiology/BY 261L Introduction to Microbiology Laboratory, BY 271 Biology of Microorganisms/BY 271L Biology of Microorganisms Laboratory BY 245 Biological Data Interpretation and Analysis, BY 311 Molecular Genetics, BY 327 Histology/BY 327L Histology Laboratory, BY 409 Principles of Human Physiology/BY 409L Principles of Human Physiology Laboratory, BY 416 Cellular Physiology, BY 433 Advanced Molecular Genetics and Medicine, BY 437 Epigenetics, BY 440 Immunology, GGSC 310 Genome Structure and Organization, GGSC 410 Genetic Basis of Human Disease, GGSC 420 Applications of Bioinformatics, GGSC 491, and MIC 275 Introduction to the Immune System.

⁵ Course can be used as shared credit for students enrolled in the Multidisciplinary Biomedical Sciences (MBS) Accelerated Bachelors/Master's Program (ABM). Distinct advantages of MBS-ABM include the use of up to 12 hours of shared credit that is applied to both your BS and MS degrees, taking graduate courses at the undergraduate tuition rate, and additional opportunities for academic advising and mentoring.

Grade Requirement

A grade of C or better is required in all courses applied to the major.

Proposed Program of Study for a Major in Cancer Biology

Freshman

| First Term | Hours | Second Term | Hours |
|---------------------------------|-------|--------------------------------|-----------|
| CH 115 & 115R & CH 116 | | 4 BY 123 & 123L | 4 |
| EH 101 | | 3 CH 117 & 117R & CH 118 | 4 |
| MA 168 or 125 | | 4 EH 102 | 3 |
| Blazer Core Course ¹ | | 3 PHL 116 | 3 |
| Bazer Core Course ¹ | | 3 PSDO 200 | 1 |
| | | 17 | 15 |

Sophomore

| First Term | Hours | Second Term | Hours |
|---------------------------------|-------|---------------------------------|-------|
| BY 124 & 124L ² | | 4 BY 210 & 210L ² | 4 |
| CH 235 & 235R & CH 236 | | 4 CH 237 & 237R & CH 238 | 4 |
| CNBY 210 ³ | | 1 CNBY 210 ³ | 1 |
| Blazer Core Course ¹ | | 3 CNBY 320 | 3 |

| | | |
|---------------------------------|---------------------------------|-----------|
| Blazer Core Course ¹ | 3 PSDO 300 | 1 |
| | Blazer Core Course ¹ | 3 |
| <hr/> | | |
| | 15 | 16 |

Junior

| First Term | Hours | Second Term | Hours |
|-----------------------------------|-----------|-------------------------------------|-----------|
| BY 330 | | 3 CNBY 410 | 3 |
| CH 460 | | 3 CNBY 495 | 3 |
| CNBY 420 | | 3 PH 202 & 202R & 202L ² | 4 |
| PH 201 & 201R & 201L ² | | 4 Blazer Core Course ¹ | 3 |
| PUH 250 or MA 180 | | 3 Blazer Core Course ¹ | 3 |
| <hr/> | | | |
| | 16 | | 16 |

Senior

| First Term | Hours | Second Term | Hours |
|---------------------------------------------------|-----------|----------------------------------------------------|-----------|
| CNBY 480 ⁴ | | 1 CNBY 480 ⁴ | 1 |
| CNBY 495 | | 3 CNBY 499 | 3 |
| Elective CH or CNBY 400 level course ⁵ | | 3 Elective CH or CNBY 400 level class ⁵ | 3 |
| General Elective ⁶ | | 3 General Elective ⁶ | 3 |
| General Elective ⁶ | | 3 General Elective ⁶ | 2 |
| <hr/> | | | |
| | 13 | | 12 |

Total credit hours: 120

¹ Blazer Core courses can be taken anytime during the degree. See GPS for list of courses that can satisfy core and/or major requirements. Additionally, honors version of courses will also satisfy requirements (example: CH 125 honors for CH 115).

² Some students take BY 124/124L during the summer before sophomore fall, here or elsewhere, which allows them to move BY 210/210L to sophomore fall if desired, and move PH 201/201R/201L to sophomore spring, and move PH 202/202R/202L to junior fall.

³ CNBY 210 Colloquium in Cancer Biology must be taken twice.

⁴ CNBY 480 Journal Club in Cancer Biology must be taken twice.

⁵ List of elective CH or CNBY 400 courses (students must pick two - all 3 credit hours): 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 Fundamentals of Radiochemistry, CNBY 425 Sex Differences in Cancer, CNBY 430 Tumor Survival and the Microenvironment, CNBY 435 Pediatric Cancers, CNBY 440 Cell Signaling and Cancer, CNBY 445 Cancer Neuroscience, CNBY 450 Microbiome in Cancer, CNBY 455 Cancer Bioinformatics, CNBY 460 Tumor Pathobiology and Immunology, CNBY 470 Cancer Treatment.

⁶ Recommended (but not required) courses for the general electives include: BY 115 Human Anatomy/BY 115L Human Anatomy Laboratory, BY 116 Introductory Human Physiology/BY 116L Introductory Human Physiology Laboratory, BY 245 Biological Data Interpretation and Analysis, BY 261 Introduction to Microbiology/BY 261L Introduction to Microbiology Laboratory, BY 271 Biology of Microorganisms/BY 271L Biology of Microorganisms Laboratory, BY 327 Histology/BY 327L Histology Laboratory, BY 311 Molecular Genetics, BY 409 Principles of Human Physiology/BY 409L Principles of Human Physiology Laboratory, BY 416 Cellular Physiology, BY 433 Advanced Molecular Genetics and Medicine,

BY 437 Epigenetics, BY 440 Immunology, GGSC 310 Genome Structure and Organization, GGSC 410 Genetic Basis of Human Disease, GGSC 420 Applications of Bioinformatics, GGSC 491 Personalized Genomic Medicine, and MIC 275 Introduction to the Immune System.

Minor in Cancer Biology

| Requirements | Hours |
|--------------------------------------------------------------------------|-----------|
| CH 235 Organic Chemistry I & CH 236 and Organic Chemistry I Laboratory | 4 |
| CH 237 Organic Chemistry II & CH 238 and Organic Chemistry II Laboratory | 4 |
| CNBY 320 Introduction to Cancer Biology | 3 |
| Elective Coursework | 9 |
| CH 461 Advanced Biochemistry | |
| CH 471 Medicinal Chemistry and Drug Discovery | |
| CH 472 Chemistry of Natural Products | |
| CH 477 Fundamentals of Radiochemistry | |
| CNBY 410 Proliferation and Carcinogenesis | |
| CNBY 420 Genetic Basis of Cancer | |
| CNBY 430 Tumor Survival and the Microenvironment | |
| CNBY 440 Cell Signaling and Cancer | |
| CNBY 460 Tumor Pathobiology and Immunology | |
| CNBY 470 Cancer Treatment | |
| CNBY 495 Undergraduate Research in Cancer Biology | |
| Total Hours | 20 |

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] and BY 124 [Min Grade: C]

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- β), integrins, Wnt/ β -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 450. Microbiome in Cancer. 3 Hours.

This course explores the complex interactions between cancer biology and the microbiome, focusing on mechanisms, therapeutic strategies, and clinical applications. Students will engage with current research, analyze experimental data, and discuss emerging trends in microbiome-cancer interactions. The course integrates lectures, literature analysis, and critical discussions to develop a deep understanding of this evolving field.

Prerequisites: CNBY 320 [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.

Prerequisites: CNBY 320 [Min Grade: C]

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]