

THE UNIVERSITY OF ARIZONA

Cancer Biology

Graduate Interdisciplinary Program

CANCER BIOLOGY GRADUATE
INTERDISCIPLINARY PROGRAM STUDENT HANDBOOK

UNIVERSITY OF ARIZONA CANCER CENTER
COLLEGE OF MEDICINE

GRADUATE COLLEGE

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA

Acknowledgment:

We are grateful to the graduate programs in Pharmacology/Toxicology, Molecular and Cellular Biology and Biochemistry since the present handbook was modeled in part after those programs. The handbook was prepared by the Student Progress Committee (Drs. Cress, Dalton and Liebler, 1993). Updated 2021

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To the Student:

This handbook outlines the philosophy and requirements of the Graduate Degree offered in the discipline of Cancer Biology at the University of Arizona. It is intended to be used to understand and fulfill the requirements for your graduate degree, in conjunction with the current Graduate College requirements. The requirements of the Interdisciplinary Program in Cancer Biology outlined herein are under the authority of and consistent with the rules and guidelines set forth by the Graduate Council of the U of A. Certain general University regulations and specific Cancer Biology program degree requirements are only outlined in this document; you are urged to consult the current Graduate Catalog at <http://grad.arizona.edu/> for complete details.

Attainment of the degree of Doctor of Philosophy with a major in Cancer Biology requires outstanding scholarship, a demonstration of a depth and breadth of knowledge, and demonstration of the design and execution of original research leading to a dissertation that contributes significantly to the general fund of knowledge in the discipline. The degree is never granted solely as certification of faithful performance of a prescribed program of studies. All degree requirements must be fulfilled.

It is the responsibility of students to familiarize themselves with the general campus-wide requirements and information on transfer of graduate credit from other institutions, off-campus graduate study, scholastic standards, forms that the student must submit to the Graduate College, and the time limit for the completion of requirements for graduate degrees.

The Graduate College <https://grad.arizona.edu/> is your main source for academic policies, and academic integrity.

Resources for parents, for professional development, for health and wellness, parental leave, etc., may be found here: <http://grad.arizona.edu/new-and-current-students>.

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INTRODUCTION

The University of Arizona offers an interdisciplinary graduate program in Cancer Biology leading to the PhD degree with a major in Cancer Biology. Students in this program may choose areas of special concentration such as biochemistry, molecular and cellular biology, pharmacology, or immunobiology. Students may also choose from disciplines such as biochemistry, molecular biology, pathology, and toxicology as areas of study toward the minor.

BACKGROUND

Cancer Biology is a scientific discipline concerned with investigating the regulation of normal and neoplastic cell growth. These studies range in scope from understanding the regulation of DNA transcription, replication and repair to molecular events and the tumor microenvironment in regulating tumor progression and metastasis. The ability of cancer biologists to elucidate basic mechanisms of cellular transformation and molecular events in tumor progression has been applied toward the improved diagnosis, treatment and prevention of cancer. In addition, cancer biologists have contributed toward the understanding of basic mechanisms of growth control which can be universally applied to other disciplines such as developmental biology, virology, immunology and genetics.

The need for specialized training in the area of Cancer Biology is evidenced by the increased need for highly trained professional personnel (PhD, MD-PhD degrees). This need is reflected in the number of positions available in research/teaching/service areas of health professional schools (human and veterinary medicine, pharmacy, dentistry), university graduate and undergraduate programs, pharmaceutical and chemical industries, hospitals, and state and federal government research and regulatory agencies.

The Graduate Program in Cancer Biology at the University of Arizona is oriented towards modern molecular and cellular biology and biochemistry, especially in those areas dealing with mechanisms of cellular growth control, neoplastic transformation, and the role of the tumor microenvironment. Emphasis is placed on the physiological, biochemical and molecular mechanisms of action. Current research by the participating faculty members in the Program include but are not limited to investigations in the fields of DNA replication and transcription, molecular genetics, membrane-cytoskeletal interactions, tumor microenvironment, cancer imaging, and chemical carcinogenesis.

STUDENT RESPONSIBILITIES

The program in Cancer Biology stresses to the student the following issues:

1. Students earn a degree based upon the depth and breadth of their knowledge in the field of cancer biology and their ability to generate and defend an original research proposal. It is **expected** that research findings will be published as peer-reviewed manuscripts.
2. Students are to conduct their experiments in an ethical manner. Experimental fraud related to the creation of false data or the unethical theft of others' work will not be tolerated.

Students should keep their data in a format acceptable to the research advisor and be prepared to turn over their records to the Graduate Program at any time.

3. The student is expected to complete the required and elective coursework in a timely manner.

Via GradPath, you will certify that you are aware of Responsible Conduct of Research Compliance regulations and Academic integrity requirements and will adhere to them in your research.

Responsible Conduct of Research: <http://www.orcr.arizona.edu/>

Academic integrity: <http://deanofstudents.arizona.edu/codeofacademicintegrity>

ORGANIZATION

Philosophy and Goals

The major objective of the Cancer Biology Graduate Interdisciplinary Program is to admit and train doctoral candidates who have the potential to become independent research scientists in various areas of cancer biology. It is also expected that graduates of the program will have an opportunity to acquire effective teaching skills.

Graduate students in the Cancer Biology program will:

1. Be able to think critically and independently.
2. Be able to define key questions in cancer biology that require investigation.
3. Learn to communicate effectively in both the written and oral forms.
4. Develop an awareness of and skill in current and modern technologies.
5. Develop a comprehensive awareness of treatment and management modalities for cancer.
6. Acquire the professional skills necessary for a career in academia or industry.

Administration

The Cancer Biology Graduate Interdisciplinary Program has participating faculty from several departments including the departments of Basic Medical Sciences (Phoenix), Biomedical Engineering, Cellular and Molecular Medicine, Chemistry and Biochemistry, Medicine, Immunobiology, Molecular and Cellular Biology, Nutritional Sciences, Pathology, Pharmacology, Pharmacology and Toxicology, Pediatrics, and Surgery. All graduates of the PhD program receive a PhD in Cancer Biology. Several committees participate in the administration of the graduate program.

Executive Committee

The Executive Committee consists of eight faculty members, and a graduate student representative. Faculty members of the Executive Committee may serve a four-year term and the terms are staggered so two members of the Executive Committee are replaced every year. New members of the Executive Committee are appointed by the Faculty Director of Graduate Interdisciplinary Programs based on recommendations from the Executive Committee. Faculty members of the Executive Committee may serve a maximum of three consecutive terms. The student member, who must have passed the comprehensive exam, serves a one-year term and is elected by the students in the graduate program.

The chairperson of the Executive Committee is appointed by the Director of Graduate Interdisciplinary Programs based on a candidate selected by a vote of the entire faculty of the Cancer Biology Graduate Interdisciplinary Program. Nominations for the chair position will be accepted from any member of the committee.

Graduate Student Representation

Each year one graduate student representative from the PhD program is elected by the graduate students in the Cancer Biology program for a term beginning in August and ending the following July. The graduate representative must have passed their comprehensive exam to serve. This position serves as an official liaison between the students and faculty of the program. The representative is responsible for organizing graduate student participation in graduate program endeavors (such as the practice comprehensive exams), as well as serving on Program committees in an advisory capacity. Each student should seriously consider his/her choice for the graduate student representative in order to maintain an effective student voice in graduate program issues.

Financial Support

Financial assistance in the form of research assistantships is available to all students admitted into the program. Support in the first year in the program, after completing the initial year in the Arizona Biological and Biomedical Sciences Program, may be provided through a fellowship or research assistant appointment. Later, support will be in the form of research assistantships, a trainee fellowship, or donated funds. Outstanding students are also encouraged to apply for individual predoctoral fellowships from sources outside the University. Graduate research assistant appointments provide a waiver of tuition and student-only health insurance.

Participating Faculty Research

For the most up-to-date list of faculty participating in the Program, visit <http://www.cancerbiology.arizona.edu>

RESOURCES AND FACILITIES

Laboratory Space

Laboratory space is available within the separate departments represented by the participating faculty. The laboratory resources available are listed in literature available from those departments. There are affiliated laboratories at the Main campus of the University of Arizona, Arizona Cancer Center, Arizona Health Sciences Center, University of Arizona Medical Center, the College of Pharmacy and the UA College of Medicine Phoenix campus.

Equipment Resources

Availability of modern scientific instruments is crucially important to research and graduate education programs. Sufficient instrumentation is available to conduct research with a molecular biology, biochemistry and/or cell biology emphasis.

For example, the laboratories in the University of Arizona Cancer Center contain instruments necessary for biological analysis, including spectrophotometers, high performance liquid chromatographs, and FPLC machines and equipment necessary for protein and DNA analysis. All laboratories have access to modern computers and data processing systems. Each laboratory is equipped with specialized instrumentation required for research in its particular field. In addition to individual research laboratories, shared laboratory space includes a tissue culture facility, an experimental irradiator, an equipment room containing centrifuges, spectrophotometers, electroporators and thermocyclers. A shared resources directory of the Arizona Cancer Center is available at <http://www.uacc.arizona.edu/> and describes in detail core facilities which include analytical chemistry, flow cytometry, behavioral measurements, bioinformatics, biostatistics, experimental mouse, and tissue analysis and biorepository.

Library Resources

The University of Arizona takes pride in the outstanding quality of its libraries. The General Library and the Science Library, both on the main campus, hold extensive collections of general and scientific periodicals and books. The Arizona Health Sciences Library, located in the College of Medicine, is readily available to graduate students in Cancer Biology 24 hours a day. In addition to its holdings of pertinent periodicals and books, the library provides access to most science-related journals through the internet.

Research involving human subjects or live vertebrate animals

Research involving human subjects or live vertebrate animals requires permission from the relevant University committee. Consult your research director and the [Office for the Responsible Conduct of Research](#) for details.

Research activities involving the use of human subjects requires the review and approval of the University Human Subjects Committee. A copy of the Human Subjects approval letter along with the Human Subjects Research Statement must be in the student's file in the office of the Cancer Biology Program. The student's advisor confirms to the Graduate College in GradPath that the student is following the Responsible Conduct of Research regulations.

Research involving any live vertebrate animals must be approved by the Institutional Animal Care and Use Committee (IACUC). The Animal Research Protocol Review form must be completed by the student/instructor and submitted to the protocol office for review and approval. Contact [University Animal Care](#) for instructions, forms and protocol.

Laboratory Safety and Environmental Health

It is the responsibility of all personnel involved in scientific study to be aware of the safety precautions and the proper disposal of hazardous wastes specific to the research effort. The student has an obligation to not only be familiar with but also follow the specifics of laboratory safety associated with the desired area of research. The office of Research Laboratory and Safety Services (RLSS) offers training covering basic laboratory safety, fire prevention, hazardous waste disposal, compressed gas safety, basic radiation protection, and industrial hygiene, etc. **Students are required to undergo the laboratory safety and radiation control (if necessary) training early in their graduate career.** <http://rlss.arizona.edu/train/>. Laboratory directors and technicians are the best source for day-to-day laboratory safety techniques and advice on safety seminars required for laboratory personnel.

Requirements for the training in the Responsible Conduct of Research in the Cancer Biology GDP are met through required courses such as Science, Society and Ethics. This training is documented through GradPath.

CBIO DOCTORAL PROGRAM

Admission

Students interested in enrolling as Doctoral students in the Cancer Biology (CBIO) GIDP must apply through the Arizona Biological and Biomedical Sciences (ABBS) Graduate Program first. Details on the application process: <https://abbs.arizona.edu/content/how-apply>. Once accepted into the ABBS program, students will take the courses and lab rotations required in ABBS. By March 15th of the first year, students will select their thesis labs and specific graduate program. At this time, they must submit a signed Change of Program Form indicating they are enrolling in the CBIO GIDP and have it signed by the Program Chair.

Orientation

Once admitted into the program and before the end of the student's first full year, the Chair of the program will conduct an informational meeting to discuss the students' responsibilities and requirements of the CBIO GIDP.

Curriculum and Supervision

A. Program Course Info

The student's **Major Advisor and Advisory Committee** will tailor the coursework to fit specific needs and objectives. The faculty encourages the student to take advanced courses in cancer biology, biochemistry, chemistry, molecular and cell biology and to diversify his/her program with courses in genetics, microbiology, anatomy, pathology, philosophy of science, or mathematics.

1. Full-Time Enrollment of Graduate Students

Full-time status depends on the number of credits a student is enrolled in, and the minimum number depends on the student's funding status.

- Graduate Assistants (GAs) must enroll in a minimum of 6 credits to maintain full-time status.
- Students who are not hired as GAs must enroll in a minimum of 9 credits to maintain full-time status.
- Students working on their dissertations AND not hired as GAs must be enrolled in a minimum of 3 credits.
- International students on student visas should ensure they are enrolled in the minimum number of credits required by their visa regulations, regardless of funding status.

If you are unsure of how many credits you should enroll in, please contact the Program Coordinator.

- Students who have not completed their comprehensive examination should enroll in CBIO900 (Research, 1-9 units).
- After completion of the comprehensive examination, students enroll in CBIO 920 (Dissertation). Although a maximum of 18 units of 920 may be *claimed* for credit on a student's Doctoral Plan of Study, the student may *enroll* for as many units as needed to complete his/her dissertation.

2. Courses

Cancer Biology Required Core Courses				
Semester Offered	Course number/name	Units per offering	Grading	Instructor
Fall, Spring	BIOS576A Biostatistics (Email mtearne@arizona.edu to have him register you for this course)	3	Y	Roe
Fall only	CBIO552 Cancer Biology	4	Y	CBIO Faculty
Spring only	CBIO553 Advanced Topics in Cancer Biology	4	Y	CBIO Faculty
Spring only	CBIO 561 Clinical Experience	2	Y	Scott
Required each semester	CBIO 596H Seminar Series	1	Y	Miranti & Warfel
Required each Fall semester	CBIO 595C Colloquium	1	Y	Caulin
Required Responsible Conduct of Research course - Spring only	MCB 695E Science, Society and Ethics OR	1	Y	CBIO Faculty
	CBIO 595B Scientific Writing, Presentation and Bioethics	2	Y	
Spring only	IMB 521 Scientific Grantsmanship	2	Y	CBIO Faculty
Fall and Spring semesters as part of ABBS first year requirement	Lab Rotations	8	P/F	
Offered each semester, separate section for each faculty member	CBIO695A Research Conference (lab meeting)	1	P/F	
Offered each semester, separate section for each faculty member	CBIO 900 Research CBIO 920 Dissertation	1-9	P/F	
Selection of Possible Electives – not inclusive				
Course number/name		Units/Sem – graded		Instructor(s)
CBIO 515 Mechanisms of Human Disease		4/Spring		Briehl
CBIO 524 Contrast Agents, Molecular Imaging and Kinetics		3/Spring		Matsunaga
CBIO 531 Nutrition and Cancer		2/Spring		Limesand
CBIO 550 Drug Disposition and Metabolism		2/Spring		Zhang
CBIO 555 Cancer Therapeutics		3/Fall		Lee, Pu
CBIO 595A Oncogenes and Signal Transduction journal club		1/Fall		Heimark
CBIO 602A General and Systems Toxicology		3/Fall		Cherrington
CBIO 630A Cell Communication and Signal Transduction		3/Spring		Smith
CBIO 630B Cell Communication and Signal Transduction		3/Fall		Zhang
CMM 579 Art of Scientific Discovery		3/Fall		Gordon
CMM 577 Principles of Cell Biology		4/Fall		CMM faculty
PCOL 601A Epigenetics in Development and Disease		1/Fall		Futscher
PHSC 670 Principles in Drug Discovery, Design, Development		3/Fall		Hulme
PLS 539 Methods in Cell Biology and Genomics		3/Fall		Galbraith

Credit Requirements

Per the Graduate College requirements, <http://cancerbiology.arizona.edu/training/phd-major>, all CBIO GIDP students are required to complete 63 units of course work. Of these, 36 units are in the major, 22 of which must be graded. In addition, a minimum of 18 units of dissertation is required. All students must declare a Minor. A Minor in Cancer Biology requires an additional 9 units of electives, 5 of which must be graded. Electives do not need to be CBIO courses and can be taken from several different programs including, but not limited to, Biochemistry, Genetics (GEN), Pharmacology, Molecular and Cellular Biology, Immunobiology, Cellular and Molecular Medicine, etc. Students seeking minors in other areas need to check with and meet that program's Minor requirements.

Waiver of Core Courses

Waiver of a core course will be handled on a case-by-case basis.

Transfer of Courses

Transfer of a maximum of 30 credits of graduate level coursework is permitted by the Program and the Graduate College contingent upon a copy of an official transcript on file in the Graduate College from an accredited college.

The Research Advisor and Advisory Committee will help the student plan an educational program in which coursework is completed as quickly as possible. Because of individual interests or conflicts in scheduling, some formal coursework may extend into the third year of graduate study.

Incomplete Policy

Students earning a grade of Incomplete "I" for a course should submit a completed Report of Incomplete Grade form to the Cancer Biology GIDP office for inclusion in their academic record. Incomplete grades should be completed in a timely manner and are submitted at the discretion of the course Instructor.

Link to incomplete form: <https://registrar.arizona.edu/grades/incomplete-i-grade>

3. Seminars

Seminars are an important component of the Graduate Program. A weekly seminar series is sponsored by the Graduate Program. All students are required to attend.

Cancer Biology Seminar Series CBIO596h. (Mondays, 9-10 AM, Room 2951, Arizona Cancer Center). These seminars are presented by faculty from within the University or those who come from outside the University as guests of participating faculty or students. These seminars are presented by experienced scientists and consist of an update of recent research in the speaker's laboratory. Registration is required each semester.

Student presentations. Students in the Graduate Program practice presentation skills to the faculty, fellow students, and laboratory personnel through the required Cancer Biology Student/Postdoc Research Colloquium (CBIO 595c). Registration is required each Fall semester.

Volunteer Cancer Biology Student Presentations. On a regular basis, students have the opportunity to practice their presentation skills, prepare for their comprehensive exam and share advances in their research before the Cancer Biology students. Practice comprehensive exams are a part of this student-led meeting. The Graduate Representative coordinates this presentation.

4. Laboratory Rotations

Each first-year student must participate in at least three research laboratory rotations. The objective of the required laboratory research rotations is the introduction of the graduate student to research and familiarization with the scope and nature of the faculty's research endeavors. The research laboratory rotation constitutes a major part of the first-year graduate curriculum. Performance criteria to be used by the laboratory director will include assessment of the student's understanding of the project, effort, technical ability, record keeping of experiments and research presentation(s). Students are expected to devote a minimum of 20 hours per week to the laboratory project.

Occasionally a student is admitted and has already selected a laboratory to pursue their research interests. The student is still required to complete two lab rotations and should discuss options with the Director of the Program. These rotations can be used to learn a technique for use in their dissertation project or to teach a technique in the selected laboratory.

B. Research Advisor and Advisory Committee

Prior to the selection of a Research Advisor, the student must become familiar with the research interests of the faculty. This may be initiated early in the fall semester as the student meets individually with the participating faculty whose research is of particular or potential interest. A general student advisor is available to counsel the student. Additional familiarity is gained through the laboratory research rotations which occur during the first two semesters.

After these preliminary interviews and research laboratory experiences, the student decides with whom he/she would like to do his/her dissertation research. The student must communicate their **selection of a research advisor** to the Cancer Biology GIDP office **for approval**.

At the time of research advisor selection, or shortly thereafter, the Advisory Committee is formed. The Advisory Committee consists of three members from the program faculty and two from the minor field, and is chaired by the research advisor. The research advisor discusses membership of the Advisory Committee with the student and recommends the composition of the committee to the Program Chair. The Student Progress Committee may modify the Advisory Committee membership. Faculty members of the Advisory Committee are selected on the basis of their ability to provide useful advice about the research problem, to assist in selection of appropriate coursework, and to help guide the student to successful completion of degree requirements. In addition, the student may choose one additional outside faculty member with expertise in the field in which they are writing their thesis to gain specific insight and assistance with their project.

The Advisory Committee will meet with the student at least once each calendar year to review progress in coursework and research. A report of the Advisory Committee meeting recommendation will be completed by the research advisor (see attached form). The student will be responsible for giving a private dissertation proposal which will consist of a private seminar to the Advisory Committee which will outline the background, preliminary data, and goals of the proposed dissertation topic. The Advisory Committee will focus on the objectives of the proposed dissertation as well as limiting the scope.

C. Student Evaluation

1. Criteria

On behalf of the program faculty, the Student Progress Committee evaluates each student on the basis of accomplishments in formal courses and performance in other areas of the program. For example, for first year students the emphasis is placed upon performance in research laboratory rotations. In subsequent years, the student's development as a research scientist becomes of major importance. It is therefore necessary for each student to perform well in formal courses, in seminars, and in the research laboratory. Failure to meet performance criteria in any of these areas is grounds for dismissal from the Program.

2. Grades in Core Courses

All students must receive a grade of "B" or better in all core courses. A student who receives a grade of "C" or less in a **core course must** repeat that course. A student may petition to have this repeat requirement waived; a waiver can be granted only with the written approval of the

course instructor and the Student Progress Committee. **A grade of "C" or less in a core course constitutes grounds for dismissal from the Graduate Program.**

3. Annual Reports and Individual Development Plans

Each student is required to submit an Annual Report to the Student Progress Committee before the end of the Spring Semester. The Annual Report consists of an update of the year's progress including coursework, presentations (both oral and poster), travel to scientific meetings, publications, etc. Completion of an Individual Development Plan is part of the progress review.

D. Comprehensive Exam and Advancement to Candidacy

Advancement to candidacy requires satisfactory completion of the **Comprehensive Examination** and the required coursework for the degree. As required courses are completed, at the end of the second academic year, the comprehensive examination may be scheduled. The completion of required courses is recommended but is not required to take the comprehensive exam. Students are required to have a committee meeting in the spring semester of their second year, during which they present a draft of specific aims for the written research proposal (see section 1b below). It is the expectation of the program that the **Comprehensive Examination is to be completed no later than September 15th of the third academic year (see timeline section below)**. The student may be dismissed from the program if this requirement is not met and the program's graduate committee determines dismissal is warranted. The student will be officially notified of this via mail and e-mail and copied to the Graduate College. It is the student's responsibility to submit the required on-line forms through GradPath. The comprehensive examination is considered the single major test of whether or not the student is suitable doctorate material.

1. Written Research Proposal

Students will develop a grant proposal closely aligned to their dissertation research, written in the format of a NIH F31 fellowship proposal. This format has been selected with the hope that each student will be able to submit his/her written exam as a fellowship application (F31 for PhD trainees and F30 for MD/PhD trainees). IMB521, the second-year course requirement for CBIO students on scientific grantsmanship will prepare and greatly aid students in preparation and completion of the written research proposal. Guidelines for fellowship proposals can be found at: <http://grants.nih.gov/grants/funding/416/phs416-1.pdf>.

For the Written Exam you will only provide the sections listed below. Students are encouraged to prepare a near final draft for the purpose of getting input once from the dissertation committee before completing the final version. Students may request feedback on this near-final draft from committee members one time prior to their comprehensive exam; to receive feedback, the near-final draft should be submitted to committee members one to two weeks prior to the August 1 deadline. The length of the proposal is not to exceed 7 pages of text (single-spaced, at least one-half inch margins on all sides), excluding the abstract and

references. Tables and figures are included within the 7-page limit; be sure to make them large enough to be legible. Use Arial font 11 point or larger for the text. A symbol font may be used for Greek letter or other special characters. Pages should be numbered. Include your name in a header on each page. The proposal should include the following sections:

a. Abstract: A concise description of the content of the proposal, including long term objectives. One-half page is the recommended length. The abstract does not count against the overall page limits. The abstract should serve as a free-standing description of the entire proposal, not as an introduction to it. Thus, after a few sentences in which you describe the topic, significance, and key background information that provides the basis for your hypothesis, you should give the overall hypothesis. The hypothesis should be followed by a sentence or two about each of the Aims, describing the Aim and the general experimental approach that you will use to pursue each Aim.

b. Specific Aims: Students are required to present this section at a dissertation committee meeting held in the spring semester of the second year. Committee members will provide feedback and give approval for the student to complete the full written proposal. The Specific Aims section includes the experimental design and methods for attaining the goals. What are you going to do? Begin the section with an introduction to the topic and its significance, and then define the broad, long-term objectives of the project and state the major hypothesis that you have formulated. Then, state the Specific Aims, which may be presented as goals to be reached or as questions to be answered. Provide a brief description of the planned approaches for each Aim. This section has a strict one-page limit.

c. Background and Significance: Explain the importance of the topic addressed by your proposed project. Explain how the proposed project will improve scientific knowledge, technical capability, and/or clinical practice. How will the proposed work “fill a gap” and further advance the field? Describe how the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field will be changed if the proposed Specific Aims are achieved. (Paraphrased from NIH instructions) Be sure to critically evaluate existing knowledge and evaluate the conclusions that have been made in previous studies. Explain how your proposal challenges and seeks to shift current research or clinical practice paradigms. Describe any novel or innovative theoretical concepts, approaches, methodologies, instrumentation, or interventions to be developed or used, and any advantages over existing strategies. Explain any improvements or new applications of existing theoretical concepts, approaches, methodologies, instrumentation, or interventions. (Paraphrased from NIH instructions)

d. Preliminary Studies: Describe the studies performed to date and explain your interpretation of the data that are pertinent to the hypotheses proposed. This will help evaluators assess your competence and the basis for the questions you propose to test in your aims. For the purpose of the exam, you may include key data provided from the literature or others in your lab to fill in gaps where you do not have data.

e. Research Design and Methods: Describe the overall research strategy and the procedures you will use to accomplish the Specific Aims of the project. Include the means by which you will

collect, analyze, and interpret data. Describe any new methodology and its advantage over existing methodologies, again emphasizing innovation in either technique or approach. Discuss the potential difficulties and limitations of the proposed procedures and alternative approaches to achieve the Aims. For each set of experiments, include a consideration of possible outcomes and how you will interpret those different possibilities. Indicate how you will establish priorities. Point out particular hazards or shortcomings in experimental design and/or interpretation (beyond routine laboratory activities) associated with the planned research and the appropriate precautions to be taken. The scope of the investigation should be appropriate for a three-year project for one investigator and one technician. The Approach section (parts c through e) should constitute most of the proposal (this section contains the bulk of the 7-page limit for sections b through e).

f. Bibliography and References Cited: Provide complete references, including all authors and titles. If you get information from Web sites, include the URL in this section. Use of bibliographic software such as EndNote is strongly encouraged. Also, if you refer to DNA sequences or protein structures, you should include the GenBank accession numbers or the PDB file numbers respectively in the text. The reference list does not count against the 6-page limit. **Input from others:** The proposal allows the committee to assess the ability of the student to engage in critical thinking and assess the student's knowledge of experimental techniques. Therefore, though the research proposal will of necessity draw from the basic ideas and research environment in the advisor's lab, the student is expected to extend the lab's research with original ideas. For this reason, the student is responsible for generating the proposal – from the hypotheses to experimental design and writing – without direct scientific oversight or involvement from the advisor. However, scientists do not function in a vacuum, and Principal Investigators often seek advice from their peers when writing grant applications. The student is therefore encouraged to consult others (including fellow students, post-docs, faculty, etc.) with regard to preliminary data, hypothesis formation, experimental details, presentation/articulation of ideas, and English usage. Again, IMB521- Scientific Grantsmanship, will prepare students for the written comprehensive exam.

Avoid plagiarism: The proposal must be written in your own words; use of sentences (even with a word or two changed) or ideas from another's work, without attribution, is unacceptable. If it is necessary to use someone else's words, they must be indicated as such by quotation marks, with the appropriate source cited. Violations of acceptable citation practices will not be tolerated and will be pursued through the Honor System of the University.

Cautionary Tale: Avoid computer problems if at all possible. Additionally, make sure to keep a backup copy of all your relevant files (text, figures, references, etc.) on a separate memory device or on the Cloud at least once a day. Loss or damage to your files for any reason (hardware or software problems, virus, theft) will not be accepted as a reason to extend the deadline for exam completion.

Timeline for your exam: *The due date to submit the final written portion of the exam is August 1st, just prior to the start of the third year.* However, students are encouraged to submit earlier should they choose. The near-final draft should be provided to your Advisory Committee

members with sufficient time to give them 1-2 weeks to read it and send feedback, and for you to then complete the final version by August 1st.

To submit your final written comprehensive exam, please provide an electronic PDF file to your Advisory Committee members and copy the Program Coordinators. The due date set above is a firm deadline; late proposals will NOT be accepted, and you will receive a grade of Fail for the exam. If there is some valid reason why you cannot make the deadline due to exceptional circumstances, contact the Graduate Program Director and your Advisory Committee as soon as you know there is a problem. The Graduate Program Director and Advisory Committee will then decide on the validity/necessity of the situation and work with the student to find a solution.

Scheduling your committee for the comprehensive exam can be challenging. Students should plan to discuss scheduling availability with their committee at their first committee meeting.

Written Exam Evaluation: The final version of the written examinations will be reviewed by the student's Advisory Committee and given a grade of Pass, Fail, or Conditional Pass within 2 weeks of the submission. Students should take the written portion of the exam very seriously. It is to the student's advantage that they submit a well-written and thoughtful proposal. A note on scheduling meetings- Given the busy schedules of all involved, students are encouraged to work towards scheduling their oral exam (using a Doodle poll or When Is Good) upon submission of the written portion, even if the outcome of the written is not yet determined. The planned meeting can always be cancelled or postponed depending on the outcome of the written.

- **PASS:** *Students who pass the written examination will proceed to the oral examination, which must be completed by September 15.* It is the student's responsibility to schedule their oral exam with their Dissertation Committee once they have passed their written qualifying exam.
- **FAIL:** Students who fail the written exam must submit a substantially revised proposal to their Dissertation Committee. The timeframe for resubmission will be established by the Dissertation Committee, but should not exceed 6 months. The written exam can only be retaken once; students failing the second written exam will be dismissed from the program. After resubmission, the students should schedule their oral exam within 3 weeks.
- **CONDITIONAL PASS:** Written examinations that are flawed in a manner that could be remediated in a short period of time will receive a grade of Conditional Pass. The written exam must be resubmitted to the Dissertation Committee (and the Graduate Program Coordinator) **within three weeks** for reevaluation. Students who pass the re-write will proceed to the oral examination to be completed by September 15 (***note: no extra time is allowed for the re-write*** – it is expected that students give their best effort on their first submission).

2. Oral Examination

An oral examination is conducted by the Advisory Committee serving as an examining committee. The first hour is devoted to a defense of the **Research Proposal**. The remaining time consists of a broad examination covering any aspect of Cancer Biology and/or the chosen minor field of study.

The exam must last a minimum of 1 hour but cannot exceed 3 hours. It is common for the student to give a 5 to 10-minute overview of the research proposal using audio-visual materials. Previous students have had at least one practice oral exam with other graduate students and postdocs about two weeks before the scheduled exam. This can be helpful in identifying your strengths and weaknesses. Students often need practice using the board to effectively illustrate answers to the questions posed.

The Oral Exam is meant to assess the ability of the student to discuss ideas, think through scientific pitfalls, and defend experimental design and rationale. Students are encouraged to seek input from other students, postdocs, and faculty in preparing for the oral exam through practices, lab meetings, journal clubs, etc. Oral Exams will be conducted by the student's Advisory Committee. ***It is the responsibility of each student to schedule the Comprehensive Exam with their Advisory Committee prior to September 15th of the start of the third year.*** During the oral exam, students will defend their written proposal and answer questions on general knowledge posed by the Committee.

Outcomes: Students will be given the grade of “pass” or “fail” at the time of the Exam. According to Graduate College policy, “More than one negative or abstaining vote will result in failure of the exam.” A minimum of four committee members must be present for the exam. It is expected that the student's Advisor should have minimal input during the questioning of the student. Failure of the oral examination may be grounds for dismissal from the graduate program. However, the student's Dissertation Committee may allow the student to retake the exam. According to Graduate College policy, a student may take the oral Comprehensive Exam only twice. The timing of the retake will be within six months following the first oral examination and must be conducted by the same committee that administered the first oral exam. Failure in both attempts results in automatic dismissal from the PhD program.

Upon successful completion of the comprehensive examination, presuming the required coursework has been completed, the student will be notified by the Graduate College of their advancement to doctoral candidacy (and the fees assessed at that point for candidacy). A copy of the final Prelim proposal, after any corrections, should be sent to the Program Coordinator for program records. After completion of formal courses and during the pursuit of the dissertation research, the candidate is expected to continue to participate actively in CBIO programmatic activities.

E. Dissertation

At the time of advancement to candidacy, planning of the research program begins in meetings with the Advisory Committee and submission of the Dissertation Committee Appointment form. The Committee reviews the goals and experimental approaches as summarized by the candidate, particularly in relation to the objectives set out in the dissertation proposal, and helps formulate and approve any changes or new plans deemed appropriate. At this time, it may become necessary to increase the frequency of Advisory Committee meetings. The candidate is expected to fulfill specific goals recommended by the Committee. A report of the suggested goals is recorded by the research advisor at the time of the advisory committee meetings (form in back of handbook).

An outline (Prospectus/Proposal GradPath form) of the dissertation content and style must be approved by the Advisor before it is written. The details of the mechanics of the writing must follow the Graduate College requirements: <https://grad.arizona.edu/gsas/dissertations-theses>. There is also relevant information that you will need in order to submit your Dissertation upon its final approval. Please follow these instructions closely so that you will not be asked to reformat once it has been submitted.

When the dissertation is written, the candidate submits a copy to each member of the Advisory Committee **at least three weeks prior** to the final oral examination. After the Committee members have reviewed the dissertation and they approve with minor revisions, the student will submit through GradPath the “Announcement of Final Oral Defense.” The Graduate College must receive the Announcement (following faculty approvals) at least one week before the defense date in order to announce the defense to the public, who may attend the candidate’s presentation. Upon receipt of the Announcement of Final Examination by the Graduate College, the announcements of the upcoming final examination will be sent to the entire Cancer Biology GIDP faculty and students.

F. Final Examination

Formal defense of the dissertation research constitutes the final examination. This consists of a public seminar by the candidate immediately followed by discussion of the material by the audience, including members of the Advisory Committee. The Advisory Committee will examine the candidate further in a closed-door session. A copy of the final approved dissertation will be available for review by the dissertation committee for context and style.

The deadline a candidate faces for graduation in a given term is for online submission of the final approved dissertation. If the committee requires revisions following the student’s final examination, all revisions must be completed to the committee’s satisfaction before the dissertation can be submitted for archiving. Graduation deadlines can be found on the Graduate College site: <http://grad.arizona.edu/academics/degree-certification/deadlines-for-graduation>.

G. Limitation on Time to Fulfill Degree Requirements

The PhD degree with a major in Cancer Biology requires approximately five years of education beyond the baccalaureate degree. As the success of laboratory experiments or the time required for their completion cannot be predicted accurately, up to six years may be required for completion of degree requirements, which include an original and significant scientific contribution. The dissertation must be completed within 5 years of completion of the comprehensive exam

H. Requirements for Minor

The Graduate College requires all PhD students to complete a "minor" program of study. PhD candidates in other disciplines may select a minor in Cancer Biology. The program invites graduate students in other departments and programs of the University to minor in Cancer Biology. One faculty member of the Cancer Biology GDP must serve on the students Advisory Committee and a minimum of 9 units, 5 of which must be graded, of Cancer Biology coursework are required.

Minor programs for Cancer Biology majors may include Cancer Biology of any of the following disciplines: Biochemistry, Microbiology, Immunobiology, Molecular Biology, Physiology, Pharmacology, Genetics, Cellular and Molecular Medicine. Other options must be approved individually by the Advisory Committee and Chairperson of the Program.

I. Scientific Meetings

As part of the educational process, students in training are encouraged to attend national scientific meetings as travel support permits. Priority for travel support will be given to students presenting at the American Association for Cancer Research. Students should discuss participation in meetings and travel support with their Research Advisors and contact the Program office for possible travel funding opportunities.

J. Master's Degree Option for PhD Students

At times students enrolled in the doctoral program are not able to continue their doctoral degree. Students who wish to obtain the MS degree in Cancer Biology are expected to complete the following requirements:

1. Contact Program Chair (copy Program Coordinator) in writing of intention/circumstances to obtain a terminal Master's degree.
2. Pass required Cancer Biology coursework with B grade or above.
3. Form a committee comprised of three faculty members, two must be Cancer Biology. Send a notice to the Program Chair with the list of your committee members.
4. Complete Graduate College Master's Plan of Study form and Master's/Specialist Committee Appointment Form.

5. Demonstrate scientific insight/integrative thinking (three options)
 - A. Write a critical literature review
 - B. Write a research proposal, following CBIO GIDP comprehensive exam guidelines
 - C. Write a first author manuscript

Student must orally defend one of options in #5 if student has not passed comprehensive exams.

Specific content of written portion of MS requirement for students enrolled in PhD program are established on a case-by-case basis by the student's committee.

K. Timelines and Documentation

A significant portion of the process for obtaining a graduate degree involves the proper handling of University-mandated paperwork and requirements. The departmental requirements and the graduate college requirements are not necessarily one and the same. Both entities must be satisfied to obtain a graduate degree. Graduate College requirements, such as the timely submission of accurate forms and adherence to deadlines, are rigid and generally not subject to appeal. The Graduate College changes its requirements occasionally so be advised that the requirements presented here are current as of Spring 2021. Therefore, if the student has any doubts or questions concerning the material in this section, the wisest course is to contact the Graduate College Graduate Student Academic Services office directly.

Submission of on-line forms by candidates is required through GradPath. This includes in order of submission: Responsible Conduct of Research Statement; Plan of Study; Advisory Committee Appointment (Comprehensive Exam Committee); Announcement of Doctoral Comprehensive Exam; Results of Comprehensive Exam (posted by Advisory Committee); Doctoral Dissertation Committee Appointment (usually same as the Advisory Committee); Prospectus/Proposal Confirmation (posted by the Program Coordinator); Announcement of Final Oral Defense; and Results of Final Oral Defense (posted by Advisory Committee).

PhD Timetable

Year I	
Complete required core coursework	Maintain 3.0 GPA and no less than a "B" grade in core courses
Participate in laboratory rotations and identify a dissertation advisor	
Year II	
Complete required core coursework	Maintain 3.0 GPA and no less than a "B" grade in core courses
Doctoral Course Program	In the third semester (after completing at least 12 units) the student should submit the doctoral plan of study via GradPath
Choose Research Advisory Committee	In consultation with the Research Advisor, choose the Advisory Committee in third semester
Meet with Advisory Committee	Submit forms via GradPath
Meet with student Progress Committee each year	Complete an Individual Development Plan (IDP); submit a progress report from Advisory Committee
Original Research Proposal	In the 4th semester of course work, the student should begin planning and reading for the original research proposal
Written Research Proposal	Must be approved in advance by the Advisory Committee
Schedule and pass Comprehensive Oral Examination	By September 15 th of third year. Submit forms via GradPath
Year III	Concentrate on research. Publish results
Year IV-V	Publish results
Doctoral Application to Candidacy	Submit via GradPath
Deadlines	Available on-line
Student Manual for Theses and Dissertations	Available on-line
Announcement of Final Examination	Submit form via GradPath no later than 3 weeks before proposed exam date
Final Dissertation Draft	Submit on-line to Graduate College

CBIO MD/PhD DUAL DEGREE PROGRAM

The MD/PhD Dual Degree Program in Cancer Biology GIDP prepares students for academic careers involving research and teaching, as well as other careers where biotechnology training is required.

The Association of American Medical College summarizes the objective of an advanced dual degree: “The MD/PhD training organizes the experimental and clinical thinking of the physician-scientist. This synergy enables a physician-scientist to recognize new ways that clinical care or the understanding of disease mechanisms will benefit from research and to mount the appropriate effort. Likewise, the synergy achieved in dual-degree training enables the physician-scientist to see how the results of research discoveries and insights can be converted into clinically significant outcomes.”

The goal of the University of Arizona MD and Cancer Biology GIDP PhD Dual Degree Program is to provide outstanding aspiring physician scientists with biomedical training so that they emerge as leaders in both academic medicine and research. Students accomplish this by spending the first two academic years exclusively in the College of Medicine, followed by 3-5 years of interdisciplinary doctoral training in cancer biology. Upon successful completion of a PhD thesis, students then return to the College of Medicine and complete their final two years of clinical training.

Admission

Candidates are admitted independently to the College of Medicine and the Cancer Biology Graduate Interdisciplinary Program. Prior to the end of their second Fall semester in Medical School, the student will have to apply to the Graduate College. Before they can do so, they must contact the CBIO GIDP Program Coordinator, who will open the Admissions application website for CBIO GIDP: <https://apply.grad.arizona.edu/users/login>. They must pay the application fee, provide three letters of reference, request and submit official transcripts, and complete the application. Once the application is complete, the CBIO GIDP Chair will review the application and make the final decision about admittance.

Curriculum and Supervision

Although the time to completion of both programs, combined is usually NINE years, the Cancer Biology GIDP PhD/MD Dual Degree Program makes it possible to complete both degree objectives in 8-9 years. This is accomplished by counting certain units of College of Medicine coursework in the Cancer Biology GIDP.

Dual Degree Requirements

Dual degree applicants must meet the application deadlines and testing requirements to each program independently. Students pursuing the dual degree will spend the first three academic

semesters exclusively in the medical school, followed by 4 years to complete the graduate course work and dissertation research, and then completing the clinical medical school requirements.

Fees

Students will be charged the fee/tuition of that program in which they are taking the most number of units. For example, COM fees would be charged in years 1 and 2. The Graduate Program Coordinator for the student's first program/year will be responsible for letting the bursar's office know the enrollment status of the student.

Doctor of Philosophy in Cancer Biology PhD Requirements

Per Graduate College policy, doctoral students must complete a minimum of 36 units of graduate-level coursework. 36 total units must be in the major subject area (22 units in the major must be taken as letter-grade and must be courses at the 500-level or greater) and 9 units in the minor. 18 units of dissertation credit are also required.

Students accepted into the Cancer Biology GDP as part of their dual degree will follow CBIO GDP program policies of participating in program events, conducting cancer biology research in a laboratory, presenting their findings and publishing the results in a peer-reviewed journal.

Course Listings

PhD/MED Courses	Credits
CBIO553 Advanced Topics in Cancer Biology	4 - graded
CBIO596h Cancer Biology Seminar Series (1 unit each semester x 4 years)	8 - graded
CBIO595c Cancer Biology Colloquium (1 unit each Fall x 4 years)	4 - graded
EPID576a Biostatistics for Public Health or an approved substitute	3 - graded
CBIO695a Research Conference (1 unit each semester x 4 years)	8 – P/F
Scientific Writing and Ethics (1-2 units, choice of two courses) MCB 695E Science, Society and Ethics OR CBIO 595B Scientific Writing, Presentation and Bioethics	2 - graded
IMB 521 Scientific Grantsmanship	2 - graded
CBIO900 Research (1-9 units each semester)	9 – P/F
MED 802 will be applied to replace CBIO552 Cancer Biology and CBIO561 Clinical Experience	8 – P/F
Subtotal Credits	48, 22 graded
CBIO920 Dissertation	18
MED 807 units to be used for the minor	9
TOTAL	75

Sample Plan of Study for Dual Degree MD/PhD Cancer Biology GIDP

<p>Year One Medicine</p>	<p>Fall and Spring: MED 802 - Foundations (6 weeks, 8 units) MED 803 - Nervous System (9 weeks, 8 units) MED 804 - Muscular and Skeletal (6 weeks, 5 units) MED 805 - Cardiology, Pulmonary and Renal (11 weeks, 11 units) MED 806 - Digestion, Metabolism, Hormones (9 weeks, 9 units) Courses may be used for graduate credit upon request and approval.</p>
<p>Year Two, third Semester Medicine</p>	<p>Fall: MED 807 - Infection and Immunity (10 weeks, 9 units) MED 808 - Lifecycles (7 weeks, 9 units) MED 809 - Advanced Topics (2 weeks, 8 units – integrated into curriculum) Complete Step 1 United States Medical Licensing Exam (USMLE) Courses may be used for graduate credit upon request and approval.</p>
<p>Year One Cancer Biology GIDP</p>	<p>Spring: MCB 695E Ethics-RCR 1.0 P/F CBIO 595B Sci Writing 1.0 Graded CBIO 596H Seminar 1.0 Graded CBIO 695A Res Conf 1.0 P/F CBIO 900 Research 2.0 P/F</p>
<p>Year Two Cancer Biology GIDP</p>	<p>Fall: BIOS 576A Biostats 3.0 Graded CBIO 595A Onco Sign 1.0 Graded CBIO 596H Seminar 1.0 Graded CBIO 596C Colloq 1.0 Graded CBIO 695A Res Conf 1.0 P/F CBIO 900 Research 5.0 P/F Form Thesis Advisory/Comprehensive Exam Committee. Spring: CBIO 553 Adv Top Canc 4.0 Graded IMB 521 Grant Writing 2.0 Graded CBIO 596H Seminar 1.0 Graded CBIO 695A Res Conf 1.0 P/F CBIO 900 Research 4.0 P/F Complete Comprehensive Exam by end of summer</p>
<p>Year Three + Four (+ Five if needed) Cancer Biology GIDP</p>	<p>Fall: CBIO 595C Cancer Biology Student/Postdoc Research Colloquium (1 Unit) CBIO 596H Cancer Biology GIDP Seminar Series (1 unit) CBIO 695A Research Conference 1 unit CBIO 920 Dissertation 1-9 units Spring: CBIO 596H Cancer Biology GIDP Seminar Series (1 unit) CBIO 695A Research Conference 1 unit CBIO 920 Dissertation 1-9 unit</p>
<p>Year Three Medicine</p>	<p>Clinical Clerkships Transition to Clerkships (1 week) Intersessions (2 weeks) Required Clerkships</p>

	<p>The seven required clerkships are organized into four blocks: Neurology Clerkship (3 weeks) and Psychiatry Clerkship (6 weeks) plus 3 weeks of elective time or a 3-week Surgery Subspecialty Selective Obstetrics and Gynecology Clerkship (6 weeks) and Surgery Clerkship (6 weeks) Medicine Clerkship (12 weeks, with two, 4-week blocks of inpatient medicine and one, 4-week block of ambulatory medicine) Pediatrics Clerkship (6 weeks) and Family and Community Medicine Clerkship (6 weeks) Complete Step 2 United States Medical Licensing Exam (USMLE)</p>
Year Four Medicine	<p>Continue Clinical Clerkships Sub-internship selective (4 weeks) in a core discipline including internal medicine, general surgery, pediatrics, obstetrics and gynecology, emergency medicine or family medicine. Emergency Medicine or Critical Care selective (4 weeks) Surgery Subspecialty Selective (3 weeks) in any subspecialty (if not completed in Year 3) Elective courses (24 weeks) Enter the Residency Match Process Complete Residency Interviews</p>

Guidelines for Comprehensive Exam Proposal Preparation

- The proposition must be distinct from research proposals which are active in the laboratory in which the student proposes to do his/her dissertation. In fact, the faculty encourages the student to explore Cancer Biology areas distant from his/her research interests.
- The proposal should be prepared in the form of the NIH research grant application. NIH grant application packets should be examined for guidance. The following sections should be included: Abstract, Significance, Rationale, Specific Aims, Research Plan. The Research Plan should include experimental methodology, examples of the type(s) of data expected, the statistical tests to be applied, and how the data would be interpreted. Clarity and logic are of utmost importance.
- An extensive bibliography is not required, but references to the most pertinent citations should be included.
- The total written presentation, proposition plus experiments to be defended, should be a maximum of 12 single-spaced typewritten pages. Secondary details should be left to the oral defense.
- Suitable propositions may address a variety of topics. For example, the student may propose a re-interpretation of literature data, a crucial experiment to test a theory or hypothesis, a new theoretical approach to a problem, or the design of a new piece of equipment. The limit to suitability is the student's imagination and approval of the advisory committee. The topic and scope of the research proposal must be approved by the Advisory Committee prior to writing the proposal.
- The faculty strongly emphasizes that the responsibility for the quality of the proposition, be it originality, approach, or significance, rests completely with the student. The student selects the area, prepares the written proposition, submits it to the faculty, and defends it at the oral. The proposal must be approved by the student's advisory committee. At the time of the oral defense, the committee judges the acceptability of the proposition by the extent to which the student demonstrates scientific maturity, originality, and ability to explain and defend his/her position.
- The general format is:
 - I. Title page
 - II. Abstract
 - III. Research Plan (10 pages total)
 - A. Hypothesis/Specific Aims (1 page)
 - B. Background and Significance (2-3 PAGES)
 - C. Experimental Design (6-8 pages)
 - D. Expected outcomes and potential pitfalls
 - IV. References (include complete reference)
 - V. Appendix (Figures, Tables, flow diagrams)

Sample of a Dissertation Outline

The dissertation outline must be approved by your Advisory Committee regarding content and style. In addition to the mechanics of the writing, it must conform to Graduate College guidelines.

This example is taken from a recent dissertation with the specific examples in parentheses. Dissertations are approximately 120 - 200 pages in length, containing 20-30 figures.

Title of Dissertation (DNA replication in *Drosophila* embryos: proteins at the fork.)

Abstract

Chapter 1. Introduction (An overview of DNA replication and its regulation.)

Sections of specific information, for example:

(Replication Fork Enzymes)

(Modulation of DNA polymerase)

(Cell cycle Control)

(Cell cycle regulation during *Drosophila* embryogenesis)

(Specific Aims of this work)

Chapter 2. Experimental Methods and Materials

(Enzyme Purifications)

(Enzyme Assays)

(Other Procedures)

Chapter 3. Purification of Characterization of DNA polymerase

Introduction

Results

Discussion

Chapter 4. DNA polymerase associated proteins in early embryos

Introduction

Results

Discussion

Chapter 5. Characterization of DNA polymerase associated kinase

Introduction

Results

Discussion

Chapter 6. Summary - Regulation of DNA replication at the replication on fork.

References

FORM: Report of Student Advisory Committee Meeting

Cancer Biology Interdisciplinary Graduate Program

STUDENT _____

DATE OF MEETING: _____

Summary and/or Recommendations: (to be filled out by major professor)

We have reviewed the student's annual Summary Progress Report and the summary of academic progress. Signatures of Committee Members:

_____	_____
_____	_____
_____	_____

Dissertation Director/Advisor

Important Instructions: The student is responsible for bringing the appropriate forms to his/her committee meetings.

The major advisor on the student's committee is responsible for the completion of this form and its return to the Cancer Biology Program Coordinator.