THE CATHOLIC UNIVERSITY of AMERICA

CELLULAR AND MICROBIAL GRADUATE STUDENT GUIDE

Department of Biology
Clinical Laboratory Science Program
Catholic University of America
Washington DC 20064

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GENERAL INFORMATION

The University

The Catholic University of America is located in the northeast quadrant of Washington D.C., approximately three miles from the Capital. Founded in 1889 as a research-oriented institution, The Catholic University is comprised of ten schools and currently has an enrollment of about seven thousand students, more than half of which are graduate students. The Catholic University is among the founding schools of the Association of American Universities and is one of the original sponsors of Oak Ridge Associated Universities, a nonprofit research management corporation of forty-nine universities fostering research in energy, health, and the environment.

The Department of Biology

Biology is one of seventeen departments in the School of Arts and Sciences. The Department offers the degrees of Master of Science and Doctor of Philosophy in Cell and Microbial Biology and Master of Science and Doctor of Science in Clinical Laboratory Science. In addition, the Department of Biology offers a joint master's program with the School of Library and Information Science in which students complete a total of sixty semester hours and receive both a master's degree in Cellular and Microbial Biology and a master's degree in Information Science. The programs in biology are described in detail in the following pages of this guide. Affiliated with the Department are the Center for Advanced Training in Cell and Molecular Biology and the Institute for Biomolecular Studies. These components, by their unique missions, broaden the opportunities for graduate students in the Department.

The Chairman of the Department of Biology

Dr. Pamela Tuma is the chair of the Department. As chairman, She is responsible for the administration of the Department. The chairman also represents the interests of biology faculty, students, and staff to the University's administration. Student business requiring the approval of the entire faculty such as consideration for candidacy for a degree, selection of a comprehensive examination committee, selection of a thesis review committee, approval to take certain courses outside of the department, approval to transfer credits, etc., must be originated by either the student or the student's advisor and must be processed through the office of the chairman. Prior to originating a request for faculty action the student should first consult his/her advisor. If a new graduate student has not selected a faculty advisor (see *below)* prior to course registration, he/she should seek the advice of the Chairman or the Program Director.

The Assistant to the Chairman

Ms. Marion B. Ficke is a member of the faculty of biology and also serves as assistant to the chairman. In this capacity, she coordinates the premedical program for undergraduates and the scheduling of courses and teaching assistants. Moreover, together with the chairman, she oversees the general progress of graduate students. Ms. Ficke can also be consulted when students need to register for courses but have not yet selected a faculty advisor.

The Office Manager for Biology

Mr. Wavell Pereira assists in many ways to ensure the smooth functioning of the Department. In particular, he maintains the department budget, registration information, department Graduate Student records, as well as department personnel files. He also purchases lab equipment and supplies originating from the department and some individual faculty members.

Clinical Laboratory Science (CLS) Program Director

Dr. Wadad AlSalmi is the CLS director and serves as the on campus advisor for students in regards to course registration, rules and procedures of the Department and University, and the conduct of the thesis research (if the student is a candidate for a degree requiring a thesis). Any questions regarding the Department or University should first be directed to the director. If the question cannot be answered or a problem cannot be resolved satisfactorily, then the student should see the department chairman.

Research Faculty Advisor

The faculty advisor serves as the research thesis advisor. The relationship between advisor and student must be mutually desirable. If, at any time, the student or the advisor feels that this relationship should be discontinued, then one simply informs the other of this decision. The graduate student is free to change advisors at any time and as often as necessary. However, since a change of faculty advisors can significantly slow the progress of thesis research, students should place great care in selection of the advisor.

Selection of the Research Faculty Advisor

Unlike undergraduate students who have faculty advisors assigned to them, graduate students select their own advisors from among the biology faculty. Selection is normally based on the compatibility of the student's research interests and personality with that of the faculty member's. Another consideration that may have a bearing in deciding on a faculty advisor is the number of advisees to whom a prospective advisor is already committed. A faculty member with a large number of students may not be able to provide as much individual guidance as one with a fewer number of students. The selection process is facilitated by becoming familiar with the faculty as soon a possible after the start of the first semester. The description of each faculty member's research and professional interests on the following pages should aid the student in determining whether he/she shares similar interests with a faculty member. After narrowing the field to one or several faculty members, meet with each of them. A faculty member is not obliged to accept a student as an advisee even if the student requests it. Consequently, be sure it is understood that the prospective advisor is willing to be your advisor. When a decision has been reached, inform the prospective advisor of the decision and request that faculty member to be your advisor. No other notification is necessary.

Obtaining Desk space and Establishing a "Home" in the Department

Desk space is normally obtained from the faculty advisor and would normally be in that faculty member's office or laboratory area. If your advisor has not offered you desk space, you should request it. Discuss with your advisor if there are any special procedures and policies that he/she wishes to be followed regarding use of the laboratory, office, telephone, etc. Students who are in the part-time program or are in the cooperative extramural program with other institutions, may be able to obtain desk space in a "community" office or lab if your departmental advisor does not have space for you. This can be arranged through the Department chairman or the assistant to the chairman. The same would apply for new graduate students who have not selected a faculty advisor.

Policy Governing Off -Campus Graduate Student Research

Research for the graduate dissertation is carried out under the direction of the student's research faculty advisor. Faculty advisors must be regular or adjunct faculty of the CUA Department of Biology. It is, thus expected that the graduate research project will be carried out in the laboratory of the faculty advisor.

Also, A student may conduct the research for the graduate dissertation at a local institution, or agency, off campus, as an employee or as a guest scientist. In such circumstances the off-campus supervisor may serve on the dissertation committee, but may not serve as research faculty advisor. The following policy must be followed for such off-campus research.

(1) Permission for a student to undertake his/her research at another institution with the intent of completing his/her research requirements there is subject to the approval of the Department of Biology, and of the student's off campus supervisor.

(2) A regular or adjunct faculty member must agree to serve as the advisor for the project. It must be recognized that many proposed projects will fall outside the research interests, or the expertise of existing faculty, or that faculty appropriate to advise a given project may not be in a position to take on new students. Failure to secure a faculty advisor for a project, regardless of its attractiveness in terms of convenience and facilities available off campus, will mean that the project cannot be used for the dissertation research.

(3) Since a major University requirement for an advanced degree is execution of original research, it is appropriate that the student and the University receive credit if the results of this research are published in a scholarly journal. For these reasons, publishable material arising under the above circumstances will generally be credited as follows: (a) First **author --** the particular student; (b) **Second author --** either the student's major professor or his on-site supervisor *(which one so designated will depend on relative contributions in individual cases and will be a matter of consultative agreement between both parties);* (c) **Third author --** either the major professor or supervisor, depending upon which is designated second author. (d) **Additional author(s) --** any person(s) that the agency feels is appropriate to add; and, (e) The **First author** will be shown as a member of The Catholic University of America and may also be identified as an employee of the institution to which the work is done. In the case where another order is considered preferable, by all those parties involved, it may be adopted. This might be the case, for instance, where multiple publications arise from the student's dissertation research. If

there is disagreement about authorship (order or inclusion), the Chairman of the CUA Biology Department will call a meeting to adjudicate the dispute.

(4) The research performed for the thesis or dissertation should be a project that is discrete from the student's salaried work for the agency and should be performed primarily with the expectations that it will fulfill the thesis or dissertation requirement of the University.

(5) A Letter of Agreement, accepting the above policy and conditions for the degree, must be approved by the departmental chair, the institutional supervisor, and the student. A copy of this letter of agreement is provided in Appendix B.

Policy Governing Taking the Course Research Problems in Biology (Biol 771, 772) Off –Campus

As indicated in the Academic Requirements below, students may take the course Research Problems Biology 771 and/or Biology 772 as part of their course of study. Normally, the research fulfilling the requirements of these courses is conducted on campus in faculty members' laboratories. However, students may fulfill the requirements of the Research Problems courses off-campus. <u>If the student intends to do this, the student's faculty advisor must first grant permission.</u>

IMPORTANT TELEPHONE NUMBERS AND ROOM ASSIGNMENTS

FACULTY

Name	Office		CUA Extension
Dr. Wadad AlSalmi	111	MCW	5270
Dr. John Choy	105	MCW	5278
Dr. Justin Chung	356	NB	5279
Dr. Ann Corsi	206	MCW	5274
Ms. Marion B. Ficke	212	MCW	5870
Dr. John E. Golin	260B	NB	5722
Dr. James J. Greene	261	NB	5273
Dr. Ekaterina M. Nestorovich	G5	MCW	6723
Dr. Franklin Portugal	G1	MCW	5253
Dr. Venigalla B. Rao	306	MCW	5271
Dr. Pamela Tuma	260A	NB	6681

DEPARTMENT OFFICES

Name	Office		CUA Extension
Mr. Wavell Pereira	104	MCW	5267
Dr. Thuan Trinh	110	MCW	5269

FACULTY RESEARCH AND PROFESSIONAL INTERESTS

Wadad T AlSalmi
Clinical Assistant Professor
Director, M.S. and Ph.D. in Clinical Laboratory Science
Ph.D. - The Catholic University of America

The HIV-1 envelope glycoprotein (ENV) is the only viral protein expressed on the surface of the virion. Binding to the Env and blocking membrane fusion remains the sole vaccine target in preventing early infection. However, after three decades of HIV vaccine research, only modest success has been reported. Unfortunately, this region has proven to be a difficult target.

Most previous vaccine trials have been performed with monomeric gp120. It is now believed that gp120 immunogens do not present the Neutralizing Antibody (NAb) epitopes in their proper structural context. In addition, gp120 monomers tend to induce non-NAbs that are only effective against Tier-1 viruses. Viruses classified as Tier-1 are the most sensitive, while Tier-2 and Tier-3 are increasingly resistant to neutralization by antibodies (Abs). Tier-1 NAbs do not confer protection since most transmitted viruses are Tier-2 or Tier-3 variants. Therefore, a new approach to design Env immunogens is essential in developing effective HIV-1 vaccines.

Envelope gp140 trimers that lack the transmembrane and cytoplasmic domains might be better candidates since they mimic the native structure of the glycoprotein as presented on the surface of the virus. However, these gp140 trimers are unstable without the membrane-anchoring domains, and they are often difficult to purify. A more recent approach involves adding “SOSIP” mutations, which introduces a disulfide bond (SOS) to covalently link gp120 to the ectodomain of gp41, while allowing flexibility in the movement of the subunits, and an Ile to Pro (IP) change in one of the core helices of gp41 (HR1 helix) to further strengthen the interactions between gp41 subunits. So far, this approach, which retains the cleavage site between gp120 and gp41, has been the most successful in generating trimers in a native-like conformation.

Our Laboratory uses the accumulated knowledge of the structure and function of the HIV-1 envelope glycoprotein to design an immunogen that leads to the production of Abs, which can inhibit the early stages of viral infection. Viral replication is initiated with the attachment of the envelope glycoprotein to the host cell receptor CD4. This attachment causes the envelope glycoprotein to undergo several conformational changes leading to the fusion of the host cell membrane with the viral membrane. We have designed several different immunogens to prevent this initial interaction, which can then be used as a vaccine.

John S. Choy
Associate Professor
Ph.D. – University of Chicago

Using the budding yeast, *S. cerevisiae*, as a model system, my laboratory studies several areas of research related to genome stability and plasticity: (1) Elucidating the mechanism(s) responsible for integrating nutrient signals with chromosome segregation and the DNA damage response (DDR), (2) Mapping complex haploinsufficient interactions that lead to chromosome instability, (3) Investigating how genome instability is linked to the mechanism of neurodegeneration in Huntington's disease, and (4) Developing single cell technologies to study the aging process. We apply and develop genome-scale and single cell resolution tools with the aim of building a comprehensive understanding of metabolic signaling and its

connection to chromosome structure and function, particularly within the context of genome maintenance and the etiology of disease.

(1) Nutrient availability is an important factor in tumorigenesis and in maintenance of healthy tissue. Notably, cancer cells are known to harbor mutations in genes that serve important roles in nutrient signaling and as early as the 1930's Otto Warburg provided evidence that cancers have a unique metabolic program that differs profoundly from normal cells. Key nutrients such as glucose, amino acids, phosphate, and ammonium can activate signaling cascades resulting in significant changes in the transcriptome that modulate cellular physiology and the decision to enter or exit the cell division cycle. The Ras/Protein kinase A (PKA) signaling pathway is a key regulator that senses intra- and extracellular glucose and transduces signals to activate or inhibit cell growth in both yeast and human cells. We previously discovered that cells with deregulated PKA activity has greater than a 20-fold increase in the rate of chromosome loss compared to wild-type cells. We are currently using targeted and genome-scale genetics and molecular approaches to elucidate the mechanism by which PKA signaling can modulate chromosome segregation fidelity. We also have a very limited understanding of how metabolic signaling impacts the DDR, which ultimately can lead to changes in the integrity of the genome. In particular, glucose deprivation can occur when blood supply to cells become restricted as is the case in tissue ischemia and in solid tumors, where rapidly proliferating cells compete for limited glucose and oxygen. Toward investigating how metabolic signaling is integrated with the DDR we are (1) using genome-scale genetics in the model system, *S. cerevisiae*, to explore if different nutrient conditions lead to "rewiring" of the network of pathways required for a proper DDR and (2) dissecting the changes in protein-protein interactions essential for the DDR under specific nutrient conditions.

(2) Copy number variation (CNV) and aneuploidy are common features of cancer. In particular, recurrent hemizygous focal deletions are observed in several cancer types and the vast majority does not harbor tumor suppressor genes. This raises the possibility that these regions carry haploinsufficient genes that contribute to tumorigenesis. In addition, many of the same cancers are also aneuploid, yet the mechanism of aneuploid formation is unclear. This motivates the following question: Might there be haploinsufficient genes that predispose cells to chromosome missegregation leading to aneuploidy? Toward this end, we developed a method to perform genome-wide screens to identify haploinsufficient mutations that cause chromosome instability in *S. cerevisiae*. The genes revealed from this work point to a variety of biological processes that impact genome stability. Notably, this work uncovered a new link between metabolic signaling and chromosome stability and a novel function for gamma-tubulin in controlling spindle assembly during chromosome segregation. Based on this work, we are now (1) investigating mechanisms of how altered gene dosage of metabolic signaling genes can cause chromosome instability and (2) constructing a comprehensive haploinsufficiency genetic map of metabolic pathways used to maintain genome stability by studying epistasis of haploinsufficient mutants.

(3) Huntington's disease is the most frequently inherited neurodegenerative disease that is associated with the loss of cortical and striatal neurons that are found in the brain. Typically individuals show symptoms such as a loss in motor coordination, and higher order cognitive abilities such as reasoining and thinking, which begin between the ages of 30-50, and progressively worsen over the course of 10-25 years. Presently there is no cure, however, it is well established that an expanded glutamine repeat in the huntingtin (HTT) gene is known to cause the disease. The mutant HTT protein is known to form aggregates in human neurons and it is thought that the aggregates lead to neuronal cell death, yet we still lack a clear mechanism of how these aggregates function. Expression of the first exon of HTT with the expanded glutamine repeats are also known to form aggregates in yeast and also

causes a loss in viability. The mutant HTT aggregates are thought to cause protein stress and several groups have mapped out a large number of genetic interactions suggesting that HTT aggregates affect numerous processes, including the formation of reactive oxygen species. We have found that mutant HTT modulates genome stability and working to understand the mechanism of action. We are also investigating similar possibilities with other neurodegenerative diseases that are associated with proteinopathies.

(4) Aging has been described as the greatest carcinogen. It is well established that as cells age, the frequency of mutation increases. In yeast, it is known that nearing the last quarter of their life span there is a significant increase in loss of heterozygosity, demonstrating that as part of the aging process the genome becomes less stable. The mechanisms are not yet fully established and we still do not have a clear understanding of all the physiological changes that occur as a result of aging. My laboratory in collaboration with Dr. Xiaolong Luo in the Department of Mechanical Engineering at Catholic University are developing microfluidic platforms coupled with fluorescence microscopy to allow us to (1) investigate the changes in cell cycle kinetics and (2) monitor changes in the DDR, all as a function of age and at single cell resolution.

Byung Min (Justin) Chung
Assistant Professor
Ph.D. – Northwetsern University, Illinios

The major focus of my laboratory is to elucidate novel functions of keratins in cancer cells. Intermediate filament proteins are the most diverse cytoskeleton proteins, and keratin family of intermediate filament proteins are abundantly expressed in all epithelial cells. Keratins, like all intermediate filament proteins, form ~10 nm wide filaments and provide crucial structural support upon mechanical and non-mechanical stresses. Interestingly, recent studies have revealed several non-mechanical support functions for keratins including cell migration and proliferation.

In cancer, an aberrant expression of keratins is frequently observed, and keratin expression has diagnostic and even prognostic value. We previously demonstrated that keratins contribute towards cancer cell proliferation and invasion by regulating gene expression through an interaction with an RNA-binding protein. My laboratory investigates the cellular roles, regulation and mechanisms of actions of keratins in the context of various metastatic cancers.

Ann Corsi
Associate Professor
Ph.D. – University of California, Berkeley

Our research is aimed at understanding the basic question in developmental biology: "During development, how does a cell's fate become specified?" Or, more simply, how does a cell know to become a muscle cell and not a nerve cell or some other type of cell? Specific proteins contribute to a cell's fate, and regulators called transcription factors control the presence of these proteins. A careful examination of how transcription factors perform their function, therefore, will be critical for understanding cell-fate specification. We are studying cell-fate specification in the context of transcriptional regulation in the mesoderm. The mesoderm is the middle embryonic germ layer from which muscle, connective, and heart tissues are derived. The model organism that we use is the nonparasitic soil nematode, *Caenorhabditis elegans*. *C. elegans* have a number of advantages for studying development such as transparent cells, complete genome information, and powerful genetics. The animals also have a short generation time of 3 days allowing rapid experimentation. In addition, the nematodes have several tissue types that are mesodermal in origin and yet a

small total number of mesodermal cells so that we can focus on events at a single cell level.

A number of transcription factors play a role in cell-fate specification. We are focusing on a basic helix-loop-helix (bHLH) transcription factor CeTwist, which plays a role in patterning and specification of the mesoderm in *C. elegans.* Our aim is to understand the mechanism by which this factor controls the expression of target genes in a diverse set of mesodermal cells. CeTwist forms heterodimers with another bHLH factor, CeE/DA. As first step towards our aim, we have identified target genes of the heterodimers using microarrays representing all of the transcripts in the *C. elegans* genome (Wang et al., 2006). We have also explored the mechanism of regulation of one of the target genes, *arg-1* (Zhao et al., 2007). In the promoter region of *arg-1*, we have found three elements that are uniquely required for the expression pattern of *arg-1*. Currently, we are pursuing various lines of investigation to understand how these elements are uniquely used by the bHLH factors for regulating transcription in individual cells. Furthermore, we have identified a role for CeTwist containing homodimers (manuscript in preparation) and are using a microarray approach to identify target genes of the homodimers. Finally, in order to understand the temporal and spatial regulation of the CeTwist and CeE/DA genes, we are using a reporter gene approach to identify elements important for their expression. Collectively, we expect our multifaceted approaches will provide a mechanistic understanding of target gene control by bHLH factors in mesoderm development.

Our work has important human health consequences. Mutations in the human Twist gene are associated with a developmental disorder called Saethre-Chotzen syndrome in which patients have craniofacial and digit defects. Mutations in human homologs of several CeTwist target genes, including *arg-1,* are associated with other human syndromes causing defects similar to those seen in Saethre-Chotzen patients, and similar diseases exist whose underlying genetic basis is not yet known. Thus, *C. elegans* genes identified by the genetic and molecular approaches in our laboratory will reveal candidates for defective human genes in individuals suffering from related developmental syndromes. We have already found several candidate genes and expect that a careful understanding of their regulation will help us to understand more about craniofacial diseases in humans.

Marion B. Ficke
Assistant to the Chairman and Pre-Medical Coordinator
M.S. - The Catholic University of America

Clinical microbiology, particularly diagnostic *bacteriology, is my area of professional interest. I maintain a position as a clinical microbiologist at Holy Cross Hospital.
In the Department of Biology, I teach courses in general and pathogenic microbiology. Academic advising, premedical advising, and coordinating teaching assistants' assignments are among the administrative responsibilities of the Assistant to the Chairman.

John Golin
Professor
Ph.D. - University of Chicago

Research in our laboratory is centered on two different problems in molecular genetics: the molecular mechanism of general recombination in eukaryotes and the phenomenon of multiple drug resistance.
During both the vegetative (mitotic) or the meiotic cell cycle, pairs of chromosomes align and exchange genetic information. As a result of these events between paired chromosomes, new combinations of alleles arise with each generation. Meiotic recombination which occurs more frequently, is responsible for the genetic diversity underlying natural selection and

evolution. Vegetative recombination plays several roles in the cell including that of tumor promotion. Although genetic recombination occurs with astonishing fidelity, it is a complicated process involving several molecular intermediates. in order to learn more about the size and structure of these, we use recombinant DNA technology to initiate recombination events at a known chromosomal location. We then follow the intermediates from the point of their formation to their ultimate molecular resolution using the techniques of DNA hybridization and classical genetics.

The phenomenon of multiple drug resistance was first described in mammalian cells. Amplification of specific genes results in resistance to a wide range of mechanistically and structurally unrelated drugs. We have described a similar phenomenon in yeast. Recently, we have cloned and characterized a gene pdr2, which when present in high copy number confers cross resistance to many compounds. We are in the process of determining whether this gene is essential for viability. DNA sequencing of pdr2 is being carried out. This may help us to identify the protein product and/or infer some basic biochemical features of the peptide.

James J. Greene
Professor
Ph.D. - The Johns Hopkins University

Regulation of cell proliferation is likely to be a complex process involving the coordinate expression of discrete genes. In the prospects of identifying the genetic elements involved in controlling cell proliferation, this laboratory is focusing on the regulatory events that arrest the proliferation of dividing cells and restore them to the quiescent state. The approach being taken in our research is to apply recombinant DNA technology to examine changes in gene expression associated with the arrest of proliferation induced by the growth antagonist interferon. This effort has resulted in the identification of several potential "antiproliferative" genes that have now been characterized.

Recent evidence from our laboratory suggests that the antiproliferative genes work in concert with changes in the cellular redox potentials to profoundly influence signaling pathways that activate or deactivate genes. Consequently, a major emphasis of our current research is the molecular characterization of the nature of these alterations in the cellular signaling pathways and relating them to changes in cell growth.

Ekaterina M. Nestorovich
Associate Professor
Ph.D.- St. Petersburg State University, St. Petersburg, Russia

Biological nanosensors: ion-channel engineering to solve medical problems.

Ekaterina M. Nestorovich earned her Ph.D. in electrochemistry from St. Petersburg State University, Russia under supervision of Prof. Valery Malev. She performed a postdoctoral research in biophysics with Dr. Sergey Bezrukov at the National Institutes of Health. While at the NIH, she mastered the art of ion channel reconstitution into planar lipid bilayers (the models of biological membranes) and modern methods of statistical analysis of ionic currents – powerful tools which allowed her to study kinetic and transport properties of channel-forming proteins at the single-molecule level.

From the biomedical science perspective, she searches for novel effective approaches to make good use of ion-conducting nanostructures in a variety of medical, chemical, and biotechnological applications. From the biophysical perspective, she pursues a new level of understanding of biological structures through the physical forces that animate them. By learning the physics and chemistry of biological structures' functioning, Dr. Nestorovich

strives to determine how to design new agents that effectively correct the deviant interactions associated with diseases.

Franklin Portugal
Clinical Associate Professor
Director, M.S. in Biotechnology
Ph.D. – University of Illinois, Chicago

Our laboratory has two main areas of interest. The first is the investigation of factors secreted by certain pathogenic bacteria that can self-inhibit the pathogen's own growth. These factors appear distinct from quorum sensors, which do not inhibit growth but switch on the expression of virulence genes when pathogens enter the stationary phase of growth in culture. Quorum sensors for Gram negative bacteria are derivatives of homoserine lactones, whereas quorum sensors for Gram positive bacteria are small peptides. Furthermore, these unknown factors also appear to be different from bacteriocins, which bacteria secrete and which prevent growth of competing organisms but not the bacterial species that secreted the factor. Our investigations center on the exact chemical structure for the self-inhibitory factors from both Gram negative and Gram positive organisms. Once the structures are known, we will investigate what regulates expression of these factors during growth, and how these factors might be used to treat patients with serious infections who are not responding well to antibiotics.

The second area of interest is the application of a novel and highly sensitive biosensor that uses molecular interactions to identify pathogens and/or biological materials. This patented biosensor was developed in collaboration with faculty at the University of Maryland, College Park. The biosensor combines biotechnological principles with a fiber optic-based operating system that employs a near-infrared laser to create a positive fluorescent signal. After passage through a photoelectric tube that converts light impulses into electric ones, the pulses are then amplified by many magnitudes-of order. The electric signals are then detected and displayed on an oscilloscope. Current applications of this system include uses in medicine, agriculture, and biological warfare.

Venigalla B. Rao
Professor
Ph.D. - Indian Institute of Science

DNA packaging in Viruses

Organized packing of nucleic acids in biological systems is a fascinating phenomenon. We use bacteriophage T4 as a model system to elucidate the mechanism of DNA packaging in double stranded DNA containing icosahedral viruses. DNA packaging occurs by translocation of DNA into a preformed capsid shell and its organization into a condensed structure.

Phage DNA packaging is also an excellent model system to understand the mechanisms of DNA condensation in biological systems and a paradigm for molecular analysis of the fascinating molecular motors.

We employ a combination of molecular genetic, recombinant DNA, and biochemical approaches to elucidate the mechanisms of DNA packaging. It is believed that a complex packaging machine assembled at the unique portal vertex of the coat structure drives DNA translocation utilizing ATP hydrolysis as the energy source. The principal components of the pump, the gene products 16 and 17, have been cloned, overexpressed, and purified. We have developed a powerful combinatorial mutagenesis paradigm and mapped a DNA translocating ATPase site in gp17. Biochemical characterization of the gp16-gp17 complex

and molecular understanding of the linkage between ATP hydrolysis and DNA movement are the principal projects in the lab. Extensive biochemical and molecular genetic analyses of the translocating ATPase are underway with the intent to generate a 3D-molecular structure for the phage T4 packaging machine.

Bacteriophage T4 for multicomponent display and vaccine development

We have developed novel strategies to use phage T4 for display of multiple vaccine epitopes on T4 capsid surface. The DNA fragments corresponding to the vaccine epitopes are fused in-frame to the two non-essential outer capsid proteins Hoc (highly antigenic outer capsid protein) and Soc (small outer capsid protein). The fusion proteins, under appropriate genetic backgrounds, are assembled onto the Hoc- Soc- capsids. These recombinant phage displaying foreign epitopes are used as potential vaccines for elicitation of protective immune responses. This system is currently being developed to construct efficacious multicomponent vaccines HIV and Anthrax

Structural analysis of phage T4 assembly pathway

In collaboration with Dr. Alasdair Steven's group, Lab of Structural Biology, NIAMS, NIH, we have performed Cryo-electron microscopy and generated 3D-image reconstructions of a number of intermediates in the phage T4 assembly pathway. One of the goals of this project is to analyze the profound structural transitions that occur during the morphogenesis of a complex icosahedral capsid. Ultimately, we would like to perform structural analysis of the DNA packaging pump associated with the prohead shell.

Pamela L. Tuma, Chair
Professor
PhD: Northwestern University Medical School

My lab investigates membrane dynamics in polarized epithelial cells. Epithelial cells are vital for the success of multicellular organisms. They line all organs of the body and provide a selective barrier between the external and internal worlds. Intercellular junctions establish this barrier by cementing the cells together, thus restricting distinct cellular activities to either the apical or basolateral plasma membrane (PM) domain. Such functional asymmetry (or polarity) reflects the differential distribution of PM proteins in the two domains. How is polarity established and maintained? How does polarity vary in response to physiological changes, during development or among different cell types? We believe that answers to these fundamental questions come, in part, from understanding membrane trafficking in polarized epithelial cells. Our long-term goal is to understand the mechanisms regulating apical membrane dynamics in polarized hepatocytes. The hepatic apical PM faces the bile and is specialized to communicate with the external world, yet protect the cell from this harsh environment. How are the apical proteins required for these and other specialized tasks specifically targeted to the apical surface? How are they retained? Are unique molecules required? How are these processes perturbed in cancerous cells that are characterized by a loss of cell polarity?

Our studies in understanding apical vesicle targeting are focused on investigating the function of Munc 18-2. The Munc18 proteins have been identified as key players in vesicle targeting and fusion. Munc18-2 is an epithelial-specific isoform and is peripherally associated with the hepatic apical PM. This subcellular location and restricted expression pattern suggest a unique function for Munc18-2 in regulation of apical vesicle delivery. We are examining this possibility using morphological, biochemical and molecular approaches. We have also initiated studies to examine the retention of apical resident proteins at the apical PM. An emerging hypothesis proposes that domain-specific proteins maintain their

polarized distributions by actin-based scaffolds that actively exclude them from endocytosis. We are examining this hypothesis in polarized hepatocytes using similar approaches.

ACADEMIC PROGRAMS

MASTER OF SCIENCE
in
CELLULAR AND MICROBIAL BIOLOGY

The Catholic University of America offers the degree Master of Science in Clinical Laboratory Science with thesis and non-thesis options. The courses in the thesis and non-thesis tracks are identical except for Thesis Guidance (6 credits) which is required in the thesis option but not in the non-thesis option. Students in the non-thesis option must satisfy this 6 credit requirement by completing Research Problems in Biology (3 credits) and additional electives. Students in both programs must pass a written comprehensive examination. Students in the thesis option must also complete a research project and write an acceptable thesis. The non-thesis option is considered a terminal degree and is not normally applicable towards the Ph.D. degree.

I. COURSE REQUIREMENTS

A total of 30 credit hours are required for the completion of the degree.

	Core Courses:	Credit
1.	Methods in Biological Research, Biol. 727, 725: Techniques for research including chromatography, centrifugation, electrophoresis and cell sorting. *(Fall)*	4
2.	Cell Structure and Function, Biol. 559: Prokaryotic and eukaryotic cell structure and function. *(Spring)*	3
3.	Gene Organization and Expression, Biol. 538: Organization of prokaryotic and eukaryotic genomes; transcription and translation processes; nucleic acid biochemistry. *(Spring)*	3
4.	Comparative Metabolism, Biol. 774: Primary metabolic pathways of organisms will be studied in depth. *(Spring)*	3
5.	Specialty seminars, Biol. 781 or Biol. 781A: These seminars, which are offered every semester, must be completed twice for credit. All graduate students however will be expected to participate in the seminars even in those semesters when they are not enrolled for credit. *(Spring and Fall)*	2

Additional Program Requirements:		
1.	Thesis Guidance or Research Problems plus electives (non-thesis) Some on campus research is required of those students who plan to do their thesis research off campus; these students must register one time for Research Problems under the direction of a faculty member before requesting permission to do thesis research off campus.	6
	Elective Courses	
2.	A minimum of 9 additional credits will be selected in conjunction with the major professor from the elective courses listed below.	9
	Total Credits	**30**

Elective Courses:

The following are examples of elective courses offered by the Department. Other electives may also be available.

	Elective Courses	Credit
BIOL 550	Molecular Diagnosis of Infectious Disease	3
BIOL 551	Clinical Laboratory Education	2
BIOL 571	Immunopathology	3
BIOL 596	Computational Genomics	3
BIOL 721	Case Studies in Clinical Microbiology	2
BIOL 734	Special Topics in Clinical Laboratory Science	3
BIOL 744	Red & White Blood Cell Disorders	2
BIOL 747	Advanced Hematology	2
BIOL 748	Quality Assurance and Regulations in the Clinical Lab	1
BIOL 750	Hematopathology	2
BIOL 751	Laboratory Management	3
BIOL 780	Advanced Clinical Microbiology	3
BIOL 790	Current Topics in Clinical Laboratory Science	1
BIOL 774	Comparative Metabolism	3
BIOL 540	Mechanisms of Gene Mutation and Transmission	3
BIOL 563	Developmental Biology	3
BIOL 565	Model Organisms and Human Disease	3
BIOL 574	Virology	3
BIOL 584	Mechanisms of Bacterial Pathogenesis	3
BIOL 586	Molecular Genetics and Recombinant DNA Methodology	3
BIOL 598	Membrane Trafficking and Disease	3
BIOL 599	Signal Transduction and Biomembranes	3
BIOL 765	Research Topics in Biology I	2

BIOL 766	Research Topics in Biology II	2
BIOL 771	Research Problems in Biology I	3
BIOL 772	Research Problems in Biology II	3

Additional courses at the NIH or consortium may be applicable contingent upon faculty approval.

II. LIMITATION ON COURSE REQUIREMENTS

A. Courses Outside the University

No more than 6 credits obtained outside The Catholic University of America may be applied toward the M.S. degree. This includes courses taken at the NIH but does not apply to consortium courses.

B. Currency of Course Work

In order to assure currency of information only courses taken within the year period immediately preceding the awarding of the M.S. degree may normally be applied toward fulfillment of the requirements for that degree.

C. Course Credits Beyond the M.S. Degree

Students in the M.S. program cannot take more than 6 course credits beyond the requirements of the M.S. degree without the permission of the faculty.

III. GRADE REQUIREMENTS

In order to receive the M.S. degree the student must have a minimum of a 3.0 average and no more than 6 credit hours of C grades. When a total of 3 credit hours of C grades are received or when the GPA in any given semester falls below the 3.0 the student will be considered marginal. If the GPA is below 3.0 for two consecutive semesters or more than 6 credit hours of C grades are received, the student is subject to dismissal. Students who receive one grade of F will also be subject to dismissal.

IV. RESEARCH ROTATIONS

It is expected that all graduate students be involved in research whether they are enrolled in the M.S. program with thesis or without. We are a small department but one that is actively involved in research. We want each of you to become acquainted with the entire faculty and become familiar with the faculty's research. The mechanism for accomplishing this is by your participation in short research rotations in faculty members' laboratories. These rotations are a part of a formal course, Biology 725. We feel that this is an important experience to all new students. For those who are in a thesis program, this experience will help you to select a thesis advisor. For all students, whether or not you are in a thesis program, this experience will expose you to the diversity of biological research, the different techniques and experimental approaches used to pursue this research. It is necessary to complete rotations with ALL participating faculty members before a student is allowed to enroll for a Research Problems course. Completion of this requirement is also necessary before a student selects

his /her thesis advisor. Students that do not fully participate in these rotations cannot receive a grade higher than a “B”.

V. RESIDENCE REQUIREMENTS

The minimum period of residence for the master's degree is one year of full-time residence (or the equivalent) beyond the bachelor's degree. A full-time student may not complete this requirement in less than two semesters or in less than one semester and two summer sessions. A part-time student may not complete this requirement in less than four semesters.

Every graduate student is required to maintain continuous enrollment from the date of first registration until a degree program is completed, unless he or she is granted a leave of absence. Following is a summary of the current rules as they apply to graduate students:

Continuous Enrollment Options:

1. *Course requirements not completed*
   Must register for at lease 3 credits of graduate course work per semester (or approved undergraduate remedial work), unless granted a leave of absence (see definition below).

2. *Course requirements completed but comprehensive not passed*
   Must register for at least 3 credits of graduate course work, or "In Absentia" status unless granted a leave of absence.

3. *Comprehensive passed but thesis topic not approved*
   Must register for at least 3 credits unless granted a leave of absence. Two consecutive semesters of unsatisfactory performance constitute grounds for dismissal. Students in this category are not eligible for registration in absentia (see definition below).

4. *Thesis topic approved, but degree not completed*
   Must register for 3 credits unless granted a leave of absence or allowed to register in absentia (only 2 in absentia semesters are allowed).

Consequences

Any student who fails to maintain continuous enrollment under one of the options available is presumed to have withdrawn from the University and must therefore petition for readmission. An applicant for readmission must pay the application fee. In addition, the official catalog specifies that a student who is readmitted after completing all degree requirements except the dissertation must pay, at the current rates, any fees owed for the period of lapsed enrollment.

Definitions of Leave of Absence and In Absentia

Leave of Absence:

Normally requires documentation of sustained ill health, required military service, or equally serious circumstances resulting in *involuntary* interruption of graduate studies. In exceptional cases, the Dean may also approve a leave of absence *for one semester only* to prepare for the comprehensive examination. The cumulative total period may not exceed one year. All requests for leave of absence must be approved in advance of the effective date by the department chairperson and dean.

In Absentia:

Student is required to be away from campus while preparing the thesis, but is not eligible for a leave of absence. One credit of tuition is charged. Available only to students with thesis topic approved and all course requirements completed. This option is not available for the semester in which the dissertation topic is submitted, or for the semester in which the final oral is scheduled. Total eligibility is limited to two semesters. All requests for registration in absentia must be approved in advance of the effective date and require significant justification.

VI. SELECTION OF TOPIC APPROVAL AND THESIS COMMITTEES

A. Topic Approval Committee

According to University regulations the student must submit a thesis proposal to the school of arts and sciences at least one semester prior to the awarding of the degree. Prior to submission of the School of Arts and Sciences, the proposal must be approved first by the Topic Approval Committee and next by the entire Biology Faculty. The Topic Approval Committee will be selected based on the research interests of the student and may be established at the same time as or subsequent to the comprehensive examination committee. This committee will consist of three members with a minimum of two Biology Faculty members. The student will meet with the topic Approval Committee for the purposes of evaluating general knowledge of methodology and aptitude for scientific research. Additionally, this evaluation will provide a forum for discussion of the research plan and alternative approaches, and will establish an informal support network, which may be of benefit throughout the research experience. Although students may begin their research prior to taking their comprehensive examination, this research will not be formally applicable toward the degree until the comprehensive examination is passed and the research proposal is accepted.

B. Thesis Committee

Based on the topic approval examination and the research focus of the student, the student's major professor will propose a Thesis Committee to the Biology Faculty for approval. This committee must consist of a minimum of two members, one of which must be a CUA biology Faculty member. The Thesis Committee is responsible for reading and critically evaluating the thesis, insuring that the approved research plan is adhered to, and providing a source of guidance.

VII. TOPIC APPROVAL EXAMINATION

Topic approval must be obtained at least one semester before the completion of the M.S. degree.

A. Preparation for Examination

A preliminary oral topic approval examination must be conducted by the Topic Approval Committee prior to presentation of the topic to the Biology Faculty. The student will submit a detailed research proposal to each member of the committee no later than one week prior to the scheduled evaluation. The composition of this proposal is left to the discretion of the student and the major professor, but should include a two-page summary which addresses information regarding significance, rationale, background, brief description of methods, and general plan of attack. The student and the evaluation committee will discuss an awareness of background research and relevant literature, methodology, alternative approaches, means of analyzing data, significance, and general rationale of the aims of the research.

B. Topic Approval Examination

The committee and the student will decide upon any modification or alternative approaches to the topic research plan. Additionally, this evaluation process will clarify grammar and wording of the written document.

Following such evaluation the committee can:

a) recommend approval of the proposed research, as is, to the Biology Faculty at the next regular scheduled faculty meeting;

b) recommend approval of the proposed research topic with appropriate modifications in approach and/or grammar to the Biology Faculty at the next regular meeting; or

c) request that the student correct weaknesses in the proposal as determined by both the student and the committee, and reschedule another evaluation process.

The final, revised thesis topic should be submitted to the entire faculty at least 3 days prior to the faculty meeting at which the topic will be considered. A summary statement of the approved topic, with modifications, will be presented to the Biology Faculty by the student's major professor. Committee members may present summaries of the evaluation at this time. Upon faculty approval, the major professor will discuss any necessary changes with the student who will then submit the two-page document to the departmental administrative assistant for submission to the Dean's Office.

It should be noted that as research progresses, records and data should be recorded in a manner determined by the student and major professor. Furthermore,

for safety reasons, the records and data should be recorded in duplicate and the duplicate should be stored separate from the original.

VIII. GUIDELINES ON PREPARATION AND TIMING OF THESIS

Master's degree candidates must complete all degree requirements within three years (or six summer session) after the date of completion of course work. An extension of up to one year may be granted upon petition to the Dean. An approved Leave of Absence period is not counted in determining the calendar deadlines.

The date for submission of the master's thesis is established by the University and indicated in the class schedule for the spring semester. By this date a copy of your thesis should be given to your major professor. This will give your committee adequate time to read it and make suggestions, and give you time to make any revisions. If the submission deadline is not met, the Thesis Committee is not obligated to evaluate the thesis that semester. The student should realize that several drafts of the thesis will probably be necessary and thus allow sufficient time for writing. The document must be written in a lucid, concise manner. The completed draft, which you first give to your major professor should be proofread and corrected for misspelling, grammatical errors and inconsistencies. The major professor is not responsible for editing the document.

See Appendix A for University regulations regarding unethical and unacademic practices with reference to graduate research.

IX. REQUIREMENTS FOR CONVERSION TO THE DIRECT Ph.D. PROGRAM

A student currently enrolled in the M.S. program can request consideration for pursuing the Ph.D. degree without first obtaining the Master's degree. The request consists of the student submitting the following:

1. A letter to the departmental chairperson requesting permission to be admitted into the Ph.D. degree program.

2. A comprehensive description of the proposed doctoral research.

This request will be considered by the faculty as a whole taking into consideration the student's academic performance to date and the student's potential to conduct independent research. The academic qualifications for the conversion to the direct Ph.D. program require superior grades with no grade of "C".

Moreover, the student is expected to have demonstrated ability to conduct research in a faculty member's laboratory by taking a Research Problems course at least once prior to the request. If the student has had additional research experience outside of the department, documentation of this experience could be optionally submitted in addition to the two documents described above. The student's research potential will be evaluated not only on his or her technical and organization skills but also on initiative, creativity, and conceptual contribution to the research.

M.S. DEGREE REQUIREMENTS CHECKLIST

Check		Item	Date Completed
☐	1.	Core courses or equivalent	___/___/_____
☐	2.	Specialty seminars	___/___/_____
☐	3.	Research guidance/problems	___/___/_____
☐	4.	Biology graduate seminars	___/___/_____
☐	5.	Elective courses	___/___/_____
☐	6.	Application for candidacy	___/___/_____
☐	7.	(Submission of approved Candidacy form to Dean)*	___/___/_____
☐	8.	Selection of topic approval committee**	___/___/_____
☐	9.	Preliminary topic approval exam**	___/___/_____
☐	10.	Topic approval examination**	___/___/_____
☐	11.	Topic approval by Biology Faculty**	___/___/_____
☐	12.	(Submission of approved thesis form to Dean)*	___/___/_____
☐	13.	Selection of thesis committee**	___/___/_____
☐	14.	Thesis completed**, ****	___/___/_____
☐	15.	Residency requirement***	___/___/_____

NOTES:

* Items in parenthesis are items that are done on behalf of the student by departmental personnel. However, it is the ultimate responsibility of the student to insure that all items and forms are completed. It is also advised that the student review their file for accuracy at least one semester prior to the anticipated graduation

** For M.S. with Thesis program only.

*** In view of the nature of the residency requirement, students are encouraged early in their graduate programs to plan to meet this requirement by the prudent and timely selection of courses, credits, and registration status (full time or part time, etc.).

**** It is traditional that the student provides his/her major advisor with a bound copy of the final thesis.

ACADEMIC PROGRAMS

DOCTOR OF PHILOSOPHY
in
CELLULAR AND MICROBIAL BIOLOGY

The Catholic University of America offers the degree Doctor of Philosophy in Cellular and Microbial Biology. There are two options for completion of the degree. In the first option (M.S./Ph.D.) the student first completes the M.S. degree before proceeding for the Ph.D. degree. The M.S. degree may be completed at CUA or at some other institution. In the second option (the direct Ph.D.) the student may proceed directly for the Ph.D. degree without obtaining the M.S. degree. The second option, which must be completed on a full-time basis until the written comprehensive examination is passed, is primarily intended for scientifically mature students who have had undergraduate research experience. The curriculum for these two options is identical with two exceptions: 1) student in the direct Ph.D. option complete their written comprehensive examination during the fifth semester of studies; 2) students in the direct Ph.D. option must also complete one Research Problems course within the first three semesters of study in order for the faculty to evaluate their research potential. It is possible, however, for a student originally accepted into the M.S./Ph.D. option to request conversion to the direct Ph.D. program (see M.S. degree, section VIII).

Students who have completed their M.S. at CUA and wish to enter the Ph.D. program should submit a letter stating their request to the Biology Graduate Admissions Committee for approval.

I. COURSE REQUIREMENTS

A total of 53 credit hours are required for the completion of the degree.

	Core Courses:	Credit
1.	Methods in Biological Research, Biol. 727, 725: Techniques for research including chromatography, centrifugation, electrophoresis and cell sorting. *(Fall)*	4
2.	Cell Structure and Function, Biol. 559: Prokaryotic and eukaryotic cell structure and function. *(Spring)*	3
3.	Gene Organization and Expression, Biol. 538: Organization of prokaryotic and eukaryotic genomes; transcription and translation processes; nucleic acid biochemistry. *(Spring)*	3
4.	Comparative Metabolism, Biol. 774: Primary metabolic pathways of organisms will be studied in depth. *(Spring)*	3

5.	Molecular Genetics and Recombinant DNA, Biol. 586: Experimental approaches for the cloning, Identification, and analysis of genes and gene expression. *(Fall)*	3
6.	Specialty Seminars, Biol 713, 714, 777, 778 These seminars, which are offered every semester, must be completed twice for credit for the M.S.;and four times for the Ph.D. All graduate students will be expected to participate in the seminars even in those semesters when they are not enrolled for credit. However, students may not register exclusively for 713, 714 (Microbiology Seminar) or 777, 778 (Cell Biology Seminar). An exemption to present a Friday (cell or microbiology) seminar is granted during the semester that a student will be depending a Ph.D. dissertation. Such students are nevertheless expected to attend and to participate in the general discussions. *(Spring and Fall)*	4

Additional Program Requirements:

	Thesis Guidance or Research Problems plus electives (non-thesis)	
1.	Some on campus research is required of those students who plan to do their thesis research off campus; these students must register one time for Research Problems under the direction of a faculty member before requesting permission to do thesis research off campus.	6
	Subtotal for Required Courses	**26**

Elective Courses **27**

A minimum of 27 hours of elective courses specified below, are to be selected in conjunction with the major professor. These courses will delineate an area of expertise for the student. Research Topics and Research Problems credits are not to exceed a total of 12 credit hours. Six of these credits may be related to the dissertation research.

It is assumed that entering graduate students will have taken a basic Microbiology (equivalent to BIOL 549/4 credits) and Biochemistry (equivalent to BIOL 554/3 credits) as undergraduates. Deficiencies should normally be made up during the first year. Students may use only one but not both of these courses for a graduate elective.

Elective Courses		Credit
BIOL 550	Molecular Diagnosis of Infectious Disease	3
BIOL 551	Clinical Laboratory Education	2
BIOL 571	Immunopathology	3
BIOL 596	Computational Genomics	3
BIOL 721	Case Studies in Clinical Microbiology	2
BIOL 734	Special Topics in Clinical Laboratory Science	3
BIOL 744	Red Blood Cell Disorders	2
BIOL 747	Advanced Hematology	2
BIOL 748	Quality Assurance and Regulations in the Clinical Lab	1
BIOL 750	Hematopathology	2
BIOL 751	Laboratory Management	3
BIOL 780	Advanced Clinical Microbiology	3
BIOL 790	Current Topics in Clinical Laboratory Science	1
BIOL 774	Comparative Metabolism	3
BIOL 540	Mechanisms of Gene Mutation and Transmission	3
BIOL 563	Developmental Biology	3
BIOL 565	Model Organisms and Human Disease	3
BIOL 574	Virology	3
BIOL 584	Mechanisms of Bacterial Pathogenesis	3
BIOL 598	Membrane Trafficking and Disease	3
BIOL 599	Signal Transduction and Biomembranes	3
BIOL 765	Research Topics in Biology I	2
BIOL 766	Research Topics in Biology II	2
BIOL 771	Research Problems in Biology I	3
BIOL 772	Research Problems in Biology II	3

II. LIMITATIONS ON COURSE REQUIREMENTS

A. Courses Outside the University

1. Students who transfer more than 6 credits toward the Ph.D. degree can complete no more than 5 additional credits outside the University.

2. Students who transfer 6 or fewer credits toward the Ph.D. degree can complete no more than a total of 12 credits outside the University.

3. No more than 24 transfer credits of grade B or better may be applied toward the Ph.D. degree.

B. Currency of Course Work

In order to assure currency of information, only courses taken within the 7-year period immediately preceding the awarding of a graduate degree may normally be applied toward fulfillment of the requirements for that degree.

III. RESEARCH ROTATIONS

It is required that all graduate students enrolled in the Ph.D. program be involved in the research rotations, even if they have already selected or have otherwise committed to a research advisor. We are a small department but one that is actively involved in research. We want each of you to become acquainted with the entire faculty and become familiar with the faculty's research. The mechanism for accomplishing this is by your participation in short research rotations in faculty members' laboratories. These rotations are a part of a formal course, Biology 725. We feel that this is an important experience to all new students. For those who are in a thesis program, this experience will help you to select a thesis advisor. For all students, whether or not you are in a thesis program, this experience will expose you to the diversity of biological research, the different techniques and experimental approaches used to pursue this research. It is necessary to complete rotations with ALL participating faculty members before a student is allowed to enroll for a Research Problems course. Completion of this requirement is also necessary before a student selects his /her thesis advisor. (Certain exceptions are made to allow for students to select an advisor in advance when their financial support is contingent upon funding from that faculty member). Students that do not fully participate in these rotations cannot receive a grade higher than a “B”.

IV. GRADE REQUIREMENTS FOR PH.D. DEGREE

In order to receive the Ph.D. degree the student must have a 3.0 average and no more than 6 credit hours of C grades. All C grades are reviewed by the faculty at the end of each semester. When a total of 3 credit hours of C grades are received or when the GPA in any given semester falls below a 3.0 the student will be considered marginal. If the GPA is below 3.0 for two consecutive semesters or more than 6 credit hours of C grades are received, the student is subject to dismissal. Students who receive one grade of F will also be subject to dismissal.

V. RESIDENCE REQUIREMENTS

The minimum period of residence for the doctoral degree is three years or the equivalent beyond the bachelor's degree. A full-time student may not complete this requirement in less than six semesters. A part-time student may not complete this

requirement in less than twelve semesters. At the discretion of the department and with the approval of the dean, work completed at another university may be accepted as fulfilling a maximum of two semesters of the minimum period of residence. Continuous

enrollment is required from the date of first registration until a degree program is completed, unless he or she is granted a leave of absence. Following is a summary of the current rules as they apply to graduate students:

Continuous Enrollment Options

1. *Course requirements not completed*
   Must register for at least 3 credits of graduate course work per semester (or approved undergraduate remedial work), unless granted a leave of absence (see definition below).

2. *Course requirements completed but comprehensive not passed*
   Must register for at least 3 credits of graduate course work or in absentia status, unless granted a leave of absence.

3. *Comprehensive passed but thesis topic not approved*
   Must register for at least 1 credit graded graduate course work, unless granted a leave of absence. Students in this category are not eligible for registration in absentia. (see definition below).

4. *Thesis topic approved, but degree not completed*
   Must register for 3 credits unless granted a leave of absence or allowed to register in absentia (only 2 in absentia semesters are allowed).

Consequences

Any student who fails to maintain continuous enrollment under one of the options available is presumed to have withdrawn from the University and must therefore petition for readmission. An applicant for readmission must pay the application fee. In addition, the official catalog specifies that a student who is readmitted after completing all degree requirements except the dissertation must pay, at the current rates, any fees owed for the period of lapsed enrollment.

Definitions of Leave of Absence and In Absentia

Leave of Absence:

Normally requires documentation of sustained ill health, required military service, or equally serious circumstances resulting in *involuntary* interruption of graduate studies. In exceptional cases, the Dean may also approve a leave of absence *for one semester only* to prepare for the comprehensive examination. The cumulative total period may not exceed one year. All requests for leave of absence must be approved in advance of the effective date by the department chairperson and dean.

In Absentia:

Student is required to be away from campus while preparing the thesis, but is not eligible for a leave of absence. One credit of tuition is charged. Available only to students with thesis topic approved and all course requirements completed. This option is not available for the semester in which the dissertation topic is submitted, nor for the semester in which the final oral is scheduled. Total eligibility is limited to two semesters. All requests for

registration in absentia must be approved in advance of the effective date and require significant justification.

VI. COMPREHENSIVE EXAMINATION

A. Eligibility and Committee Selection

Students are eligible to take the written comprehensive examination after completing 35 credit hours in the major field (or during the semester in which the last of the 35 credits are being completed). The qualifying oral examination is to be taken at least 3 weeks before the written part. Both exams will be prepared and administered by the same faculty committee whose composition will be recommended by the faculty advisor (after consultation with the student) at a faculty meeting. The faculty can approve the recommended committee or can make changes in it. The committee will consist of a minimum of 3 biology faculty members who will be selected based on the completed courses and research interests of the student. A curriculum vitae for any external committee member not known to the faculty must be made available to the faculty to aid their assessment of the person's potential to serve on the committee. The student is advised to initiate selection of a committee well in advance of the qualifying oral examination in order that the committee can be consulted regarding preparation for the exam. The student must present to the department chairman a list of completed courses and grades in sufficient time for the chairman to review the materials before the faculty meeting at which committee selection occurs. The student must register for the written comprehensive examination with the Registrar at the beginning of the semester in which the exam will be taken, or at least three weeks prior to the examination.

B. Qualifying Oral Examination

The comprehensive examination committee will administer an oral examination to determine the candidate's readiness to sit for the written examination. The candidate must arrange a time for the qualifying oral examination in consultation with his major professor and the other faculty members who will administer the exam (normally three or four in all). The qualifying oral is usually taken the semester before the scheduled written comprehensive examination period or a minimum of 21 days before the first day of the published written comprehensive period.

C. Format and Administration of the Written Examination

Candidates for the Ph.D. degree must write a comprehensive examination testing their knowledge of cellular and microbial biology and their area of research concentration. Students should not expect the subject matter of the examination to be confined to material covered in the specific courses that the student has taken. However, in structuring the examination the Department takes into account the specific orientation of the candidate's program. Graduate comprehensive examinations will be administered on Thursday and Friday of the

designated comprehensive period during two morning and two afternoon sessions of three hours each. Ph.D. students must write during all 4 sessions. A minimum of one question will be given in each period. A student who twice fails the written comprehensive examination may not be considered for admission to candidacy for the doctoral degree. Exams will be graded and results forwarded to the student within two weeks according to the grading policy described in Appendix C.

The doctoral candidate is expected to have an extensive knowledge of his/her general area of concentration and, in addition, may be tested on his/her specific area of research concentration or specialization. The doctoral candidate should have a breadth and depth of knowledge in these areas greater than that of the master's student.

The oral and written examinations will be constructed so as to determine the following: (1) awareness of current literature as well as significant historical developments in the major field; (2) theoretical (reasoning) competence; and, (3) factual, practical and methodological competence.

D. Application for Candidacy

After the comprehensive examination is passed, students must complete the application for candidacy form that is available in the Biology office. This application along with a list of completed courses and course grades must be submitted to the department chairman one week prior to the faculty meeting at which candidacy will be proposed. Students must check with the Biology Office as to the exact dates for faculty meetings.

VII. SELECTION OF TOPIC APPROVAL AND DISSERTATION COMMITTEES

A. Topic Approval Procedure

1. After students have passed written comps, if they have not yet chosen the dissertation topic and propose a Thesis Topic Committee, they will have three months to do so. The student, in consultation with his/her advisor, should write a preliminary proposal that will form the basis for a committee meeting to be held within 6 months of passing written comps. The student should plan to introduce his/her research proposal by giving a 20-30 minute presentation.

2. The student will then meet with his/her committee at least once a year to present a progress report. The presentation should be about 30-45 minutes. If the committee and student agree and the timing is acceptable, the student may present the progress seminar as part of the spring microbiology or cell seminars. If this option is elected, the student and committee will meet privately following the seminar to evaluate progress and make further modifications / suggestions. The committee may stipulate additional meetings if necessary. For instance, as the final topic proposal is written, the student may need to meet with the committee or at least have the committee review the draft. We recommend that all current students who have passed

comps have their topic committee approved as soon as it is feasible and schedule yearly committee meetings.

3. Based on discussion with his/her committee, the student will write a final topic proposal. The student and committee should meet and review the draft before submitting it to the faculty. The topic proposal must be approved by the faculty no less than two semesters prior to graduation.

4. A step by step guide for students:

a. During the third semester: have a topics proposal committee approved by the faculty.
- See graduate student guide for directions about committee makeup and approval.
- Be that all members agree to serve on your committee before proposing it to the faculty.

b. Within 6 months of the third semester: write a preliminary proposal and use it as the basis for the first committee meeting.
- The initial meeting should include a 20-30 minute student presentation.
- Directions for format, length, and content of the proposal are found below.
- The same format is used for the final draft of the proposal (section d)

c. Meet at least once yearly with the committee.
- The meeting should include a 30-45 minute student presentation.
- The presentation may be done in conjunction with Friday seminar.
- Additional meetings will be scheduled if needed to monitor progress.

d. After successful completion of comps but at least two semesters before graduation: have topic proposal approved by the faculty and submitted to the Associate Dean of Graduate Studies (Arts and Sciences) (see Appendix E - Doctoral Dissertation Topic and Committee Request for Approval From).
- Register for Dissertation guidance during the semester your topic is approved.

B. Dissertation Committee

Based on the topic approval examination and the research focus of the student, the student's major advisor will propose a Dissertation Committee to the Biology Faculty for approval. This committee, normally comprised of the members of the Topic Approval Committee, must consist of at least three members, at least two of which must be CUA Biology Faculty members. This committee is normally proposed at the time the dissertation topic is presented to the Biology Faculty. The Dissertation Committee is responsible for reading and critically evaluating the dissertation, insuring that the approved research plan is adhered to, and providing a source of guidance.

VIII. TOPIC APPROVAL EXAMINATION

A. Preparation for Examination

A preliminary topic approval examination must be conducted by the Topic Approval Committee prior to presentation of the topic to the Biology Faculty. The student will submit a concise research proposal to each member of the committee no later than one week prior to the scheduled evaluation. The proposal, which should be no longer than two pages, should be presented in the following format (see Appendix F - Directions for Preparing the Proposal).

1. Background:

   A brief statement of the problem to be studied and the background or antecedents of the problem, which led the student to propose a study of this particular area

2. Purpose:

   A specific statement of the purpose or purposes of the proposed study

3. Methodology:

   A description of the methodology to be used: if the study involves the testing of a hypothesis, the hypothesis should be clearly spelled out. Techniques, statistical measures, method of sampling, and any other essential features of the methodology should be clearly indicated where these are applicable.

4. Contribution:

   The specific or unique contribution which this study should bring to the field of knowledge under consideration

5. References:

   References should be limited to those major works of relevance. A detailed bibliography need not be supplied.

Notice of the date, time and place of the topic proposal examination will be provided to all faculty of the Department of Biology in the form of a copy of the proposed text, which is provided to members of the examination committee. This notice shall be given at least one week prior to the examination. The examination will be open to any and all faculty who wish to participate but responsibility for the adequate examination of the topic and the proposal rests with the examination committee.

B. Topic Approval Examination

During this examination the student and the committee will discuss an awareness of background research and relevant literature, methodology, alternative approaches, means of analyzing data, significance, clarity of the written document and general rationale of the aims of the research.

Following the evaluation the committee can:

a) recommend approval of the proposed research, as is, to the Biology Faculty at the next regular scheduled faculty meeting.

b) recommend approval of the proposed research topic with appropriate modifications in approach and/or grammar to the Biology Faculty at the next regular meeting; or

c) request that the student correct weaknesses in the proposal as determined by both the student and the committee, and reschedule another evaluation process.

The summary statement of the approved topic, with modifications, will be presented to the Biology Faculty by the student's major professor. Committee members may present summaries of the evaluation at this time.

It should be noted that as research progresses, records and data should be recorded in a manner determined by the student and major professor. Furthermore, for safety reasons, the records and data should be recorded in duplicate and the duplicate should be stored separate from the original.

IX. GUIDELINES ON PREPARATION AND TIMING OF DISSERTATION

Doctoral candidates must have dissertation topics approved within two years following the date of admission to candidacy.

If a doctoral candidate for whom a dissertation topic has been approved does not complete the dissertation and take the final oral examination within five years after admission to candidacy, the dean and/or department chairman will inform the candidate that, unless a request is made and granted for a reasonable extension of time, the topic will be withdrawn and may be submitted for approval by another student. In this case the candidate will be subject to dismissal. An extension, which must be approved by the dean will normally not exceed one year.

An approved Leave of Absence period is not counted in determining the calendar deadlines. The date for submission of the Masters thesis is indicated in the schedule for the spring semester. A copy of your Ph.D. dissertation should be given to your major professor by this date. This will give your committee adequate time to read it and make suggestions and you time to make any revisions. If the submission deadline is not met, the Dissertation Committee is not obligated to evaluate the dissertation that semester.

The student should realize that several drafts of the dissertation will probably be necessary and thus allow sufficient time for writing. The document must be written in a lucid, concise manner. The completed draft, which you give to your major professor should be proofread and corrected for misspelling, grammatical errors and inconsistencies. Additionally, there are specific standards for the writing of the thesis including pagination, margins, and so forth. The student is ultimately responsible for making sure that his/her thesis meets these standards. Further information can be obtained from the Office of the Dean for Graduate Studies.

See Appendix A for university regulations regarding unethical and unacademic practices with reference to graduate research.

X. FINAL ORAL EXAMINATION (THESIS DEFENSE)

Administrative Considerations

Upon completion of the dissertation, but before it has been finally approved, the candidate must defend it in an oral examination in the presence of an examination board. This board will be appointed by the academic dean of the school with approval of the assistant academic vice president for graduate programs and research centers.

Before you can schedule your final examination, your major professor and the readers must go to the Dean's Office to sign a form indicating that they have read the dissertation and that they believe you are ready for the defense. In the case of an off-campus reader, a memo will suffice for scheduling purposes and the form can be signed just prior to the examination.

As soon as the readers have signed, you should go schedule the examination with the office of the Dean, Room 109 McMahon Hall (319-5253) or (319-5254). Check in advance for pertinent deadlines.

At least three weeks prior to the date of the examination, you must submit your information for the examination leaflet to the Dean's Office. Detailed instructions and a sample leaflet can be obtained from Ms. Nathan.

Format of the Thesis Defense

The oral examination board shall include two faculty members outside the major department or school and the members, ordinarily three in number, of the candidate's Dissertation Committee. The examination will consist of two parts: a public seminar and a closed session. The first part is a formal presentation of the thesis in a seminar format. The seminar should last for 40 to 60 minutes and is given in a manner that is consistent with research seminars in the Candidate’s field. This portion of the examination will be open to the public. Immediately after the seminar portion is the closed session with the Oral Examination Committee. No one else may be admitted into is portion of the examination without permission of the dean of the school. The duration of the oral examination (both public and closed sessions) will not ordinarily extend beyond two hours. Oral examinations will not be scheduled during the summer session. Each member of the examining board has one vote, and the candidate must receive a Pass vote from

all but one examiner in order to pass the examination. No examining board is permitted to pass a candidate conditionally. After successful completion of the final oral examination, the candidate may proceed with arrangements for deposition of two approved copies of the dissertation. This should be done no more than 4 weeks after the oral examination. A bound copy should also be given to the advisor.

If the candidate fails in the final oral examination, he or she must obtain permission from the school to retake the examination. A candidate will not be permitted to retake the final oral examination until at least one semester, or an equivalent period of time, has elapsed from the date of failure. If the candidate fails a second time in the oral examination, he or she ceases to be a candidate for the doctoral degree.

XI. COMPLETION OF REQUIREMENTS

A student who fails to complete all the requirements for the doctoral degree within five years from the date of admission to candidacy must petition for an extension of time. Unless a leave of absence has been granted, extension of time will normally be for only one year.

Ph.D. DEGREE REQUIREMENTS CHECKLIST

Check		Item	Date Completed
☐	1.	Core courses or equivalent	___/___/_____
☐	2.	Specialty seminars	___/___/_____
☐	3.	Biology graduate seminars	___/___/_____
☐	4.	Elective courses	___/___/_____
☐	5.	Selection of comprehensive exam committee	___/___/_____
☐	6.	Qualifying oral examination	___/___/_____
☐	7.	Written comprehensive examination	___/___/_____
☐	8.	(Submission comp. exam results to Dean)*	___/___/_____
☐	9.	Application for candidacy	___/___/_____
☐	10.	(Submission of approved Candidacy form to Dean)*	___/___/_____
☐	11.	Selection of topic approval committee	___/___/_____
☐	12.	Preliminary topic approval exam	___/___/_____
☐	13.	Topic approval examination	___/___/_____
☐	14.	Topic approval by Biology Faculty	___/___/_____
☐	15.	(Submission of approved thesis form to Dean)*	___/___/_____
☐	16.	Selection of thesis committee	___/___/_____
☐	17.	Topic approval by Academic Vice President	___/___/_____
☐	18.	Thesis completed***, ****	___/___/_____
☐	19.	Final oral examination (Thesis defense)	___/___/_____
☐	20.	Residency requirement**	___/___/_____

NOTES:

* Items in parenthesis are items that are done on behalf of the student by departmental personnel. However, it is the ultimate responsibility of the student to insure that all items and forms are completed. It is also advised that the student review their file for accuracy at least one semester prior to the anticipated graduation

** In view of the nature of the residency requirement, students are encouraged early in their graduate programs to plan to meet this requirement by the prudent and timely selection of courses, credits, and registration status (full time or part time, etc.).

*** The thesis must be completed in accordance with strict formatting guidelines. A guide for the writing and production of the thesis can be obtained from the Vice Provost and the Dean of Graduate Studies.

**** It is traditional that the student provide his/her major advisor with a bound copy of the final thesis.

APPENDICES

APPENDIX A

Policy On
ACADEMIC HONEST AND UNETHICAL PRACTICES

A student who is involved in unethical practices in connection with any work required for a course will receive a grade of **F** (Failure) for the course. The same rule is applicable to comprehensive examinations. Further penalties may be imposed in accordance with specific circumstances.

It is strictly prohibited, as an unethical practice, to submit as one's own work term papers, research, professional papers or dissertations in which material is provided by a professional research agency or by other persons is utilized. A graduate student who employs such assistance or other unethical practice in the research or writing of a dissertation shall be liable to expulsion from the university upon proper hearing by the department or school and dean.

Note: The operative words in the preceding regulation are "as one's own work." Whether the material comes from a professional research agency or a ghost writer or is simply plagiarized, its submission as one's own work is unethical. On the other hand, if due acknowledgement is given, for example, to statistical or printed sources, the practical is ethical. It will then be for the faculty to judge, by way of existing process, whether there is sufficient original work to justify accepting the paper or dissertation.

Department of Biology's Definition of Plagiarism

The presenting of the writing of others as that of your own hand, is an extremely serious academic offense, and will not be tolerated. The actual writing of term papers or other assignments must be your own creation. Any use of the actual words of other authors must be minimal (*i.e.*, a few lines at most), surrounded by quotation marks, and clearly acknowledged with an appropriate reference to the original source of the material. Even the use of a single sentence from someone else's writing, without quotations and proper referencing, will constitute plagiarism. University policy now stipulates that any plagiarism on a piece of assigned work will result in the in the guilty party receiving an F grade for the course. If you have any doubts about what constitutes plagiarism, see your instructor for clarification

Unethical and Unacademic Practices in Graduate Research

At its meeting of February 17, 1981, the Graduate board approved for distribution to School and departments the following amplification and clarification of the University regulations concerning unethical and unacademic practices, with reference to graduate research.

It is understood that the guidelines below refer to assistance to graduate students from persons other than their faculty advisors or, in the case of candidates for the doctorate, their major professors and other Dissertation Committee members. It is important, moreover, that the approval given for legitimate assistance in the "gray" area referred to below should be in writing so that it will be available, for example, to the

members of an oral examination board or to other members of the faculty who may review the work of the student.

I. Prohibited utilization of professional assistance in the preparation of term papers and dissertations refers not only to the writing of such papers and dissertations, but also to the design and execution of the work on which the writing is based.

II. The regulation clearly is *not* intended to exclude any routine assistance that is strictly technical, mechanical or clerical, i.e., that is *subsidiary* in level and scope to the work itself. Examples of such legitimate assistance include: typing, coding, rating, proofreading, keypunching, search for specific bibliographical materials, computer programming, computer operation.

III. The regulation clearly *excludes*:

A. The writing of any portion of the text, whether of the paper or dissertation itself, or of the summary, abstract, proposal, and the like.

B. Relegation to any other party of (1) any part of the design of the research, or (2) any *substantive* part of the execution of the research. Examples include: development of tests or questionnaires; general search and review of the literature; organization and collection of data; statistical analysis and interpretation.

IV. The relegation *may or may not exclude*:

A. Relegation of specific and circumscribed tasks in the execution of the project e.g., interviewing subjects; organization or preprocessing of data for the application of a particular statistical procedure).

B. Limited editorial help in the writing of the dissertation.

C. Consultation with an outside expert for the improvement of analysis and interpretation of the results.

V. In determining the legitimacy of assistance within this "gray" area, two governing principles should be observed:

A. In all instances, specific approval of the major professor or of the faculty advisor is to be secured in advance both as to the nature and source of such assistance. When passing on the legitimacy of such assistance, the major professor or advisor may consult with other faculty members or non-faculty individuals of his or her own choice, if the nature of assistance lies outside his or her own expertise.

B. If called upon, the student must demonstrate his or her complete and full command, in substance and in reasonable detail, or any aspect of the paper or dissertation. Request for such demonstration may be made by the faculty at any time and is not limited to formal examinations. This means that the student, in his or her work, ordinarily should not use

instruments, procedures, or methods beyond the scope or level at which he or she is formally trained in course work or which, to the satisfaction of cognizant faculty, he or she has acquired through self-study.

VI. It should be noted that within the "gray" area described in this section, specific instances of assistance on papers or dissertations may be legitimate *severally** (e.g., minor text editing **or** some help with data processing **or** relegation of some phase of data collection) but may not be legitimate in the *aggregate** (e.g., minor text editing **and** help in data processing and help in data collection).

VII. These guidelines are applicable whether assistance is secured gratis or for payment. For their own protection, however, whenever students engage technical or other legitimate assistance for payment, they should seek competent guidance as to the quality and reasonable cost of such services.

*Severally is being used in this sense to mean individually.

APPENDIX B

LETTER OF AGREEMENT REGARDING

OFF-CAMPUS GRADUATE STUDENT RESEARCH

The following letter describes the department policy governing off-campus research. It must be signed by both the student and off-campus research supervisor as well as the Chairperson of the Department of Biology before the thesis topic can be approved.

Occasionally it is mutually advantageous to both a graduate student and a local institution, or agency, for the student to do his degree research off-campus either as an employee or as a guest scientist. Also, a person already employed may desire, with his agency's permission, to work towards an advanced degree.

Degree requirements at the University may include among other things, the execution of original research appropriate to the degree sought. On occasion the research interest of the student, the faculty of the Department of Biology, and the outside agency may coincide. On such occasion it may be both acceptable and appropriate that the research be carried out at such an agency.

It is expected that the results of the student's research will be of sufficient value to warrant its submission to an appropriate journal for publication. In such instances, the sponsoring institutions are necessarily concerned since credit for the institution and individuals involved in the research must be equitably recognized.

To avoid possible misunderstanding, the Department of Biology has formulated the following policy:

1. Permission for a student to undertake his/her research at another institution with the intent of completing his/her research requirements, it is subject to the approval of the Department of Biology and the student's off-campus supervisor.

2. The student's major advisor will be a member of the faculty of the Department of Biology.

3. Since a major University requirement for an advanced degree is execution of original research, it is appropriate that the student and the University receive credit if the results of this research are published in a scholarly journal. For these reasons, publishable material arising under the above circumstances will be credited as follows:

    (a) Primary author -- the particular student;

(b) Second author -- either the student's major professor or his on-site supervisor (which one so designated will depend on relative contributions in individual cases and will be a matter of consultative agreement between both parties);

(c) Third author -- either the major professor or supervisor, depending upon which is designated second author;

(d) Additional author(s) -- any person(s) that the agency feels it appropriate to add;

(e) The primary author will be shown as a member of The Catholic University of America and may also be identified as an employee of the institution in which the work is done, and,

4. The research performed for the thesis or dissertation should be a project that is discrete from the student's salaried work for the agency and should be performed primarily with the expectation that it will fulfill the thesis or dissertation requirement of the University.

Approved:

_____	_____
Date	Chairperson, Biology
_____	_____
Date	Institutional Supervisor
_____	_____
Date	Student

APPENDIX C

PROCEDURES FOR COMPREHENSIVE EXAMINATIONS

The following are the procedures for M.S. and Ph.D. comprehensive examinations:

1. Students planning to take the comprehensive exam should inform the Associate Dean for Graduate Programs to audit/check their eligibility (if the student have enough credits to take the comprehensive exam) beginning of the semester. If found eligible, students **MUST** register for comprehensive exam either through Cardinal Station or by using the Add/Drop form (Registrar's Office).

2. Students taking comprehensive examinations should notify the Office Manager three weeks in advance so that arrangements can be made for rooms. After the oral exam Ph.D. students should notify the Office Manager if the written exam will not be taken.

3. One week prior to the scheduled comprehensive exam, the students and faculty will be notified (through e-mail) of their room assignment by the Office Manager.

4. The Office Manager will coordinate the receipt of all questions from the faculty in advance of the written comprehensive exam.

5. The committee chair should be responsible for informing the faculty outside the Department about the format of the exam and the time limits imposed on the students.

6. The use of a computer for the exam will generally not be permissible. Students with physical conditions which make the lengthy handwriting difficult may request use of a Department computer.

7. The times for comprehensives are 9:00 am, to 12:00 noon and 1:00 pm-4:00pm. At the start of the morning and afternoon sessions of the exam, students will report to the Department office to pick up the questions. When a faculty member gives the same question to multiple students, all must answer that question in the same session.

8. Students must be able to contact faculty members during the entire exam period so that questions can be addressed.

9. Students will return completed exams to the Office Manager. These will be distributed to the respective faculty members with the names of the committee chairperson and committee members on the envelope.

10. The committee has two weeks to grade the exam. The examination blue books should be dated and initialed by the faculty member and returned to the chair of the student's comprehensive examination committee. The grade should be indicated on the blue books.

11. If necessary, the committee chair may convene the committee to discuss the student's performance on the exam. The committee will determine whether the student has passed or failed the exam. If all but one section of the exam have been judged to be satisfactory, the student may be retested in the area of deficiency before a final decision is issued. Such retesting and a decision as to pass or fail must be rendered before the A&S deadline for submission of comprehensive examination results. If the grade is unanimous, no committee meeting is necessary.

12. It is the responsibility of the committee chair to inform the student and the Chair of the committee's decision (and comments from the committee, if any), and to return all examination blue books to the Office Manager. Upon receiving the information, the Department's Office Manager and the Department Chair will complete the necessary paperwork and submit it to the office of the Dean of Arts & Sciences.

APPENDIX D

EXAMPLES OF TOPIC PROPOSALS

Example #1

Vps3p Dependent Multidrug Resistance in *Saccharomyces cerevisiae*
Topic Proposal by Robert M. Rutledge

Introduction

Multiple drug resistance (MDR) is a phenomenon found in many organisms including humans, bacteria, and pathogenic and non-pathogenic yeast. As MDR becomes more prevalent, management of cancer, bacterial infections, and mycoses becomes more difficult. *Saccharomyces cerevisiae* is an important model organism for studying multidrug resistance because its cellular components and pathways are very similar to those of mammalian cells. In *S. cerevisiae* and mammalian cells, a well documented means of multidrug resistance is energy-driven efflux by membrane transport proteins. The efflux pumps most frequently responsible for resistance to xenobiotic compounds are the proteins of the ABC superfamily.

While many ABC transporters have a very tight specificity, multidrug efflux pumps recognize a broad range of substrates. Furthermore, although there is significant substrate overlap between different transporters, some drugs show high specificity for certain transporters. Of particular interest is cycloheximide, which shows a high degree of specificity for the yeast Pdr5p transporter. Null mutations in *PDR5* cause striking cycloheximide hypersensitivity. Second-locus revertants were isolated that restore cycloheximide resistance to near wild type levels. One of these, Rev4, was found to have a mutation in the transcription factor, Yrr1p. This allele, *YRR1-2,* is a gain-of-function mutation that suppresses the cycloheximide sensitive phenotype. Deletion of wild type *YRR1* does not alter relative cycloheximide resistance. These observations imply that Yrr1-2p regulates a target that does not normally provide cycloheximide resistance in wild type strains (Keeven, *et al*., 2002).

Transposon mutagenesis of the Rev4 strain (this study) produced several unique cycloheximide sensitive mutants. The most interesting, RR4, was found to have a Tn3 insertion in the *VPS3* gene. Vps3p, a cytoplasmic protein that may associate with intracellular membranes and the cytoskeleton, is involved in vacuolar protein sorting (VPS) and is essential for proper vacuole function and morphology (Raymond, *et. al.* 1990). As such, Vps3p is a major protein of the endocytic system of yeast. The suppression of the cycloheximide resistant revertant phenotype in a Δ*vps3* mutant (RR4) suggests that the endocytic system may play a central role in multidrug resistance. This research is directed to assessing the involvement of the endocytic system and its essential proteins in multidrug resistance as well as the interaction of this system with the Pdr5p transporter, neither of which have been previously studied.

Purpose

Resistance to several xenobiotic compounds, including known Pdr5p substrates, depends on a functioning endocytic system, especially the vacuole; however, critical

endocytic system proteins have not been identified. Moreover, the interdependence of this system and Pdr5p and other transporters has not been examined. The purpose of

my research is to identify specific proteins of the endocytic system required for multidrug resistance, their interrelationships, regulation, and relationship to Pdr5p.

Methodology

To garner insight into the role of Vps3p in multidrug resistance, the *Saccharomyces* Genome Database (SGD) will be searched for all established *VPS3* gene and protein interactions. In addition, data from a microarray analysis of Rev4 will be used to identify upregulated endocytic system genes. Moreover, additional interactions will be identified from published studies of functional genomics and genetics of the yeast protein sorting system. To determine which protein sorting pathways are operative and which genes are essential in drug resistance, priority will be given to genes overexpressed in the Rev4 mutant and those that control the operation of the endosomal and endosome-independent routes to the vacuole. Initial testing of each of these genes will begin with commercially available single deletion mutants. Multidrug sensitivity of these mutants will be assessed through minimal inhibitory concentration (MIC) assays on known Pdr5p substrates, including cycloheximide, rhodamine-6-G, tritylimidazole, clotrimazole, and sulfometuron methyl. Controls will include comparison to deletions grown on medium with and without drug and comparison with isogenic wildtype strains grown on the same media. Initially, all strains will be monitored for growth over a 96 hr. period. For slow growth strains, the optimal period of growth will be determined on medium without drug before completing a MIC assay.

To determine whether there is a single endocytic pathway of multidrug resistance, single deletion strains that exhibit drug sensitivity in MIC assays will be used to construct double mutants. To do this, deletion strains in which the entire orf of interest has been replaced by a geneticin resistance cassette (denoted by *orf*::GEN^R) will be used. The *orf*::GEN^R will then be amplified by PCR and the product used to transform strains containing a deletion marked by the *URA3* or *LEU2* gene. MIC assays of double and single mutants will be compared using the same substrates as the single deletion MIC assays. Double mutants that exhibit the same level of sensitivity will be considered components of the same pathway. In contrast, a double mutant exhibiting greater drug sensitivity than single mutants will indicate that the two genes probably function independently of each other at least to some degree. Additionally, a rhodamine transport assay using FACS analysis will be used to assess whether single and double mutants have an adverse effect on Pdr5p (Hanson, *et. al.,* 2005; Fleckenstein, *et. al.*, 2005). The rhodamine FACS analysis is a very sensitive method of determining Pdr5p activity. Deletion mutants that show drug sensitivity but which do not diminish Pdr5p efflux operate independently of Pdr5p. In such cases, double mutants of the drug sensitive endocytic system gene deletion and a *pdr5* deletion will be more sensitive in MIC assays than either single gene deletion.

Regulation of the putative endocytic system pathway of multidrug resistance will be examined by considering 2 other mutants generated via transposon mutagenesis of the Rev4 (*YRR1-2*) strain. These mutants were selected since they exhibit multidrug sensitivity similar to RR4 and because they possess disruptions of regulatory genes. The genes disrupted in these strains are *sin4* (RR2), and *snf5* (RR3), which are components of the mediator and SWI/SNF complexes respectively. Investigation of regulation will be done by constructing double mutants with pertinent endocytic system deletion mutants such as *vps3*. Genes regulated by Sin4p or Snf5p will show the same

MIC sensitivity in single and double mutants. In addition, real-time RT-PCR will be used to determine expression levels of key endocytic system genes, such as *VPS3*, in *sin4* and *snf5* single and double mutants if the double mutant is more sensitive than the

single mutants. These will be compared with expression levels of *PDR5* in the same strains. A similar experiment will be performed with isogenic *YRR1* and *YRR1-2* strains to determine whether any of the endocytic system genes described above are overexpressed in the presence of this gain-of-function allele.

Contribution

Multidrug resistance is a complex phenomenon that involves more than efflux proteins alone (Keeven, 2002; Fleckenstein, *et al.*, 2005). The finding that *VPS3* is required for resistance to the Pdr5p substrate, cycloheximide, implicates the yeast endocytic system. Identification of key endocytic system proteins and pathways essential for resistance and their relationship to Pdr5p would be a novel contribution to the fields of genetics and cell biology.

References

Fleckenstein, A., Rutledge, R., and Golin, J. 2005. Mutations in the yeast SWI/SNF and SAGA complexes have only modest effects on *PDR5* expression, but inactivate a second major multidrug-resistance pathway that does not involve major drug transporters. *Genetics,* in review.

Hanson, L., May, L., Tuma, P., Keeven, J., Mehl, P., Ferenz, M., Ambudkar, S.V., and Golin, J. 2005. The role of hydrogen bond acceptor groups in the interaction of substrates with Pdr5p, a major yeast drug transporter. *Biochemistry*, submitted for publication.

Keeven, J., Ko, D., Shallom, J., Uccelini, B., and Golin, J. 2002. *PDR2*-mediated resistance to translational inhibitors requires the *UBP6* product. *Current Genetics,* **41(1):**11-19.

Raymond, C.K, O'Hara, P.J., Eichinger, G., Rothman, J.H., Stevens, T.H. 1990. Molecular analysis of the yeast *VPS3* gene and the role of its product in vacuolar protein sorting and vacuolar segregation during the cell cycle. *The Journal of Cell Biology*, **111:** 877-892.

Example #2
HIV-1 Evolution in Recently Infected Patients
Topic Proposal by Mary Kearney

Background and statement of the problem:
Human immunodeficiency virus (HIV) has resulted in more deaths worldwide than any other single infectious agent. Currently, the pandemic has spread to over 40 million individuals and has resulted in a total of 30 million deaths worldwide. Combination antiretroviral therapy (ARV) was developed in 1995 and is highly effective in controlling

HIV disease progression in patients. However, extensive viral genetic diversity and rapid evolution leads to the emergence of drug resistant HIV variants. The vast diversity of HIV populations *in vivo* is the result of a rapid replication cycle, an error-prone reverse-transcriptase enzyme, and a high rate of viral recombination. HIV's rapid evolution is also likely to be a major factor in the host's inability to control infection *in vivo*, ultimately resulting in a loss of CD4+ cells and leading to the onset of acquired immunodeficiency syndrome (AIDS). Consequently, *in vivo* studies aimed at furthering our knowledge of HIV diversity and evolution are important to understanding the emergence of drug resistance and disease pathogenesis.
Previous studies on HIV evolution and viral diversity *in vivo* have shown that genetic diversity is low in recent infection and increases in chronic infection [1]. The primary target of these studies has been the HIV envelope gene (*env*) and has utilized either heteroduplex tracking assays (HTA) or cloning and sequencing methods. These methods have limitations including a lack of nucleotide information from HTA and the possibility of obtaining multiple sequences derived from the same few viral templates during the PCR step of cloning which could lead to an inaccurate measurement of viral diversity, especially from samples with lower viral RNA levels.
Performing multiple PCR reactions in which cDNA from single viral variants (limiting-dilution PCR (LD-PCR) is the only way to ensure accurate measurements of viral diversity and evolution. There are few studies employing LD-PCR techniques to HIV populations and those that exist have primarily been cross-sectional studies of proviral DNA sequencing and/or have few patients, few time points, and analyze only a single gene region. A complete study of HIV diversity and evolution from multiple patients analyzing genetic changes across multiple gene regions has not been performed. Consequently, little is known regarding the origination, maintenance, and evolution of HIV genetic diversity within individuals especially across various gene regions.

Purpose:
The goal of this project is to characterize the development of HIV-1 genetic diversity and divergence in recently infected patients and to observe the viral changes over time to identify patterns in evolution for HIV-infected individuals. Analyzing the genetic composition of individual viral HIV-1 sequences from recently infected patients may reveal important genetic information about early HIV-1 infection which will aid in understanding the basic mechanisms of HIV evolution as well as in the development of novel therapies and possible vaccines.

Methodologies:
Single Genome Sequencing (SGS): HIV-1 RNA will be extracted from patient plasma samples containing a total of 10,000 copies of viral RNA. The extracted RNA will be

denatured and used as template for cDNA synthesis with random hexamers. To obtain PCR products derived from single cDNA molecules for SGS, the resulting cDNA will be serially diluted in buffer to achieve an endpoint for PCR amplification. Primers for amplification are designed to bind to a conserved region of *pro-pol* or *env*. Each PCR product will subsequently be used as template for nested PCR reactions. According to the Poisson distribution, the cDNA dilution yielding PCR product in 3 out of every 10 PCR reactions is resultant of 1 copy of cDNA template per positive PCR reaction approximately 80% of the time. Sequencing will be done by direct dideoxy terminator sequencing in both directions using overlapping internal primers.

Sequence Analysis**:** Sequences from each plasma sample will be aligned and compared to the HIV-1 subtype B consensus sequence using Clustal W software. The

extent of genetic variation will be measured by average pair wise distance (APD) for each gene. Rates of diversification (APD/month) will be compared among genes for each patient. Genetic divergence (relative to the earliest sample after infection) will be measured by the method of Achaz et al [3]. The nucleotide changes within patient samples will be analyzed to determine nucleotide positions that are under positive and negative selection through measurements of synonymous vs. nonsynonymous changes and insertions and deletions. Phylogenetic analyses will be used to observe intra- and inter-patient genetic relationships and sequence divergence over time.

Experimental design:

Longitudinal plasma samples will be collected from 12 persons with acute/early HIV-1 infection spanning <1 year post-seroconversion to 5 years post-seroconversion. Individual viral sequences of the P6 region of *gag*, protease (*pro*), reverse transcriptase (*pol*) and envelope (*env*) will be obtained using SGS, a LD-PCR method designed for HIV-1 [2]. Analysis of multiple, LD-PCR derived viral sequences from 12 patients with 4 – 15 longitudinal plasma samples will be performed in order to answer the following questions:

i) What is the time course and extent of HIV diversification and divergence in patients following HIV infection and how does it vary among different gene regions? The diversity of HIV viral populations from sequentially collected plasma samples will be measured to determine the rate of diversification for each patient. The rates will be compared among patients and among different gene regions. The rate of divergence from the earliest sample for each gene fragment will also be measured in order to determine the range of time for a viral population at one time point to be distinguishable from that of another time point.

ii) What are the genetic mechanisms involved in HIV diversification in vivo? Nucleotide and protein sequences will be analyzed to determine what extent synonymous changes, nonsynonymous changes, or insertions and deletions contribute to diversification among the different gene fragments. Nucleotide changes will be compared among patient HIV sequences to determine if similar changes drive diversity across patients.

iii) What factors affect HIV diversity *in vivo*? Various factors including viral RNA levels, CD4+ cell counts, and HLA type will be investigated to determine their affect on viral diversity and divergence.

Possible Outcomes:

Genetic similarities and differences of viral sequences among patients with early HIV-1 infection have not been well characterized. For example, conflicting data on diversity and on frequency and length of insertions and deletions in HIV-1 *env* in early

infection may be resolved with these studies. Additionally, one can discover the rates of evolution among different gene regions and more specifically which nucleotide positions are under positive and negative selection *in vivo.* The proposed study should further elucidate the effects of viral RNA levels, CD4+ cell counts, and HLA types on HIV evolution in patients.

Contribution and originality:
This will be the first complete longitudinal study of HIV diversity and evolution using single-genome sequencing to analyze genetic changes across multiple gene regions in recent HIV-1 infection to chronic infection. This study should give insight into specific genetic changes and factors that influence the origination, maintenance, and

mechanisms of evolution of HIV genetic diversity within individuals. A better understanding of HIV diversity and evolution would greatly aid in understanding the pathogenesis and progression of the disease as well as in the development of possible vaccines.

Selected Bibliography:
1. Delwart, E.L., et al., *Human immunodeficiency virus type 1 evolution in vivo tracked by DNA heteroduplex mobility assays.* J Virol, 1994. **68**(10): p. 6672-83.
2. Palmer, S., et al., *Multiple, linked human immunodeficiency virus type 1 drug resistance mutations in treatment-experienced patients are missed by standard genotype analysis.* J Clin Microbiol, 2005. **43**(1): p. 406-13.
3. Achaz, G., et al., *A robust measure of HIV-1 population turnover within chronically infected individuals.* Mol Biol Evol, 2004. **21**(10): p. 1902-12.

APPENDIX E

The Catholic University of America
Washington, D.C. Date:

DOCTORAL DISSERTATION TOPIC AND COMMITTEE: REQUEST FOR APPROVAL
(Please Type)

Candidate's Name:_____ School: _____

Department:_____ Program: _____ Degree Sought: _____

Having been admitted to candidacy for the above doctoral degree on _____ (specify date) the above candidate wishes to submit the following topic for the approval of the University.

Supporting information concerning the topic and the projected research (methodology, purpose, contribution, etc.) is submitted on the attached pages(s).

The topic will be investigated and the dissertation prepared under the direction of the following committee:

Full Name, Highest Degree Held	Faculty Rank, Department and/or School
Major Professor: _____	_____
First Reader: _____	_____
Second Reader: _____	_____
Additional Member (if any): _____	_____

____ The proposed research does not involve human research subjects.
____ The proposed research does involve human research subjects, and requires full committee review.
____ The proposed research does involve human subjects, however is exempt under 45 CFR 46, para. 46.101(b) _____ (note appropriate subparagraph), and requires verification only.

Proposed by: **By signing, the candidate acknowledges that he/she has read and complied with the instructions for preparing a proposal on the reverse side of this page.**

_____
Degree Candidate Date

Endorsed by:

_____
Major Professor of Proposed Committee Date

_____ _____
Chair of Department (if applicable) Date Dean of School Date

Recommended by:

_____ _____
Committee for the Protection of Human Research Subjects (if applicable) Date Doctoral Dissertation Proposal Reviewer Date

Approved by:

_____
Vice Provost and Dean of Graduate Studies Date

APPENDIX F

DIRECTIONS FOR PREPARING THE PROPOSAL

The proposal, attachments and "Request for Approval" form should be ***typed***. The proposal should not exceed ***two pages***, with at least one-half inch margins, and the typeface should be no smaller than a 12 point Times Roman Font or the equivalent. The first page should be headed by the full title of the proposed research and the candidate's name. The proposal should be concise, organized in a coherent manner, and include the following information:

1. A ***Statement of the Problem and Background***, which should identify the current state of relevant research and provide important background information.

2. A clear statement of the ***Purpose*** of the sponsored study, and the rationale or intellectual justification for the research. The research questions to be investigated should be clearly stated. If the study involves the testing of hypotheses, these should also be clearly stated.

3. A description of the proposed ***Methodology***. In the sciences, the following should be clearly described when applicable: the population to be sampled and the proposed sampling procedures; significant variables and how each is to be measured; how the data will be obtained and analyzed; and any other information needed to understand the proposed methodology. When the study is in the arts or in the humanities, the following should be clearly indicated; the nature of the data, information, or themes to be studied; the kinds of interpretive procedures to be employed; and the types of supporting evidence or arguments for the question investigated. A plan of scholarship that outlines the possible chapters of the dissertation may be included or attached. The bibliographic materials should inform the methods used.

4. The ***Contribution and Originality*** of the proposed study. The proposed research must be original and the proposal must indicate that identical research has not previously been conducted. The proposal must also clearly state the contribution that the researcher expects to make to the relevant field of knowledge.

5. If the relevant citations are not included within the body of the proposal, a brief ***Selected Bibliography*** containing the most important primary and secondary sources relevant to the study should be attached.

6. When the study involves human subjects, a short section addressing ***Human Subjects Concerns*** should note how subjects are recruited, how they are to be involved, and how the information on subjects will be protected. Additional detailed information is available from the Office of Sponsored Programs and Research Services for all research projects requiring review by the Committee for the Protection of Human Subjects as defined by the Code of Federal Regulations 45 CFR 46. If the preliminary determination of the candidate and Major Professor is that the proposal falls within an exempt category, please note the appropriate subparagraph under 45 CFR 46, para. 46.101(b), on the proposal form as indicated. Sample informed consent forms and any other appropriate supporting materials should be submitted with the proposal for review.

7. If any proposed committee member is an ***extern***, note that individual's position and organization under "Faculty Rank" and attach a resume or curriculum vitae to the proposal. Externs must have the requisite academic credentials and expertise in the field of study. They will be permitted to serve as the Major Professor only in extraordinary circumstances.

The information may be presented in a continuous paragraph format: however, the use of separate sections, clearly labeled as suggested above, is recommended, since this format facilitates the evaluation of the proposal. Additional requirements concerning the proposed methodology, other details of procedure, bibliographic information, etc., may be made by individual departments or schools. First person plural language ("we" and "our") should be avoided. The researcher, even when investigating as part of a team, completes the dissertation as an individual project. If the dissertation is written in a language other than English, this fact must be noted in the proposal. When completing the proposal form, be sure that ***all*** requested information is provided.

This form with original signatures (Degree Candidate, Major Professor of Proposed Committee, Chair of Department if applicable, and Dean of School) and supporting documents, plus five complete copies, should be submitted to the Coordinator of Graduate Student Services in the Office of the Vice Provost and Dean of Graduate Studies (116 McMahon Hall). Proposals are accepted for review during the period between the opening and closing classes during the Fall and the Spring semesters. Proposals requiring Human Subjects clearance will be forwarded for review to the Office of Sponsored Programs and Research Services. Every proposal is reviewed by an anonymous member of the faculty identified by the Vice Provost and Dean of Graduate Studies. If changes are required, the proposal is returned to the candidate with suggestions for revision. ***Candidates should not proceed beyond the preliminary stage in the investigation of the topic until receiving a copy of the form signed by the Vice Provost and Dean of Graduate Studies.***

APPENDIX G

INSTRUCTIONS IN PREPARING PH.D. LEAFLET

Material for leaflet should be in the Dean's Office 3 weeks before the date of the examination. Use a good bond typing paper 8 ½ x 11 and have a dark typewriter ribbon, or use bold on your computer. It must be in correct typed form as we do not re-type but photoduplicate and reduce.

The first page is prepared in the Dean's Office. On one sheet, type a short Summary of the dissertation. **This must not be longer than one page** and must be Approved by the major professor.

On the second sheet type **Outline of Studies.** List the courses taken toward the Degree also only one page.

On the third sheet type **Biographical Data.** Begin with birth date. List previous Education and degrees already held. List any teaching experience or publications. Be sure to include permanent address. (One page only)

Orals may be scheduled on any day that classes are held at either 10:00 A.M., 1:00 P.M., or 2:00 P.M. Schedule may be set up to suit the student but it is the **responsibility** of the student to check with the professors as to when they are available.

For further information, please see Ms. Jowanna Nathan 109 McMahon Hall or call 319-5254.

******Please note (if there are any changes made in the **TITLE** of the dissertation) no matter how small or large, it is **mandatory** that a "**Change of Title**" form be processed at least two weeks prior to your defense date.

APPENDIX H

POLICY ON USE OF DEPARTMENTAL EQUIPMENT

Many pieces of expensive, scientific equipment are available in the department. Some are intended for general use by faculty and students, and others were acquired for the research projects of particular professors. These pieces of equipment are here to further our research efforts, and so will be made available to graduate students who need to use them. It is expected that use of departmental equipment, or, by permission, of equipment belonging to a particular professor's laboratory, will be done responsibly. This means that equipment will be used properly, and that it will be left in clean and functional condition after use. Before using any piece of equipment for the first time, a student will seek permission from the individual in charge of it, obtain any necessary instructions and protocols, and determine what needs to be done to keep that item functioning properly. Misuse or damage of departmental equipment, whether intentional or due to negligence, will be considered a clear indication that the individual concerned lacks the necessary attitudes and skills to use it. Cases of considerable neglect or irresponsibility may warrant loss of Teaching Assistantship and scholarship support.