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FOREWORD

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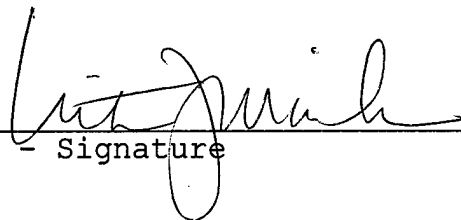
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## Annual Report for DAMD 17-94-J-4116

September 1997

### Biology of Breast Cancer: A Predoctoral Training Program

#### Table of Contents

<u>Item</u>	<u>page</u>
Front Cover	1
Standard Form (SF) 298	2
Foreword	3
Table of Contents	4
Introduction	5
Body and Response to Previous Critique	6-26
Conclusions	
References	27
Appendices	28-48
A. Selected Course Syllabus Outlines	29-33
B. Journal Club Titles	34-37
C. Table I Academic Credentials of Trainees	38
D. Table II Trainees, Their Mentors, and Thesis Titles	39
E. Publications of Trainees	40-43
F. List of Training Faculty and Their Research Interests	44-46
G. Internet Home Page for the Biology of Breast Cancer/ Tumor Biology Program	47
H. Mayo Clinic Graduate School Bulletin (1997-1998)	

## INTRODUCTION

This annual report covers activities for **DAMD17-94-J-4116**, entitled the "Biology of Breast Cancer: A Predoctoral Training Program". In this report we present documentation for the successful completion of the past academic year (1996-1997), and the initiation of the 1997-1998 academic year for this predoctoral training program at the Mayo Clinic. In addition, we specifically address all of the specific issues and concerns raised in the critique of our last annual report.

The Biology of Breast Cancer Predoctoral Training Program is a multidisciplinary predoctoral training program in tumor biology. The focus of this training program is to provide an educational environment that stimulates excellence in scientific thought and training while simultaneously providing exposure to all of the major fields of study relevant to breast cancer. Our goal is to provide students in the the training program with a solid and uniquely multidisciplinary knowledge base in the current study of breast cancer. A second goal of this program is to stimulate new working alliances between students and staff participating in breast cancer related research, education, and clinical endeavors within the Mayo Cancer Center. Research and training in the program is broadly focused on gene regulation, cell cycle control, cancer genetics, oncogene and tumor suppressor action, tumor immunology, signal transduction, antitumor pharmacology, and the application of this information primarily to the biology of breast, but also to ovarian, uterine and prostate cancers. Students participate in laboratory-based research, as well as in a formal tumor biology curriculum that integrates current concepts in cell growth control with the natural history of breast cancer and other human tumors.

The six tasks that were presented in the original application are listed, below:

- **Task 1:** Organize Biology of Breast Cancer Predoctoral Training Program Faculty and Curriculum.
- **Task 2:** Establish New Courses in Specialized Aspects of Tumor Biology, Emphasizing the cell and Molecular Biology of Breast Cancer.
- **Task 3:** Establish Appropriate Mechanisms for Student Recruitment Into this New Training Program.
- **Task 4:** Implement the New Biology of Breast Cancer Predoctoral Training Program Curriculum.
- **Task 5:** Assess Student Progress.
- **Task 6:** Assess Biology of Breast Cancer Predoctoral Training Program Effectiveness and Formalize Assessment in a Written Report.

## BODY

### Response to Specific Issues and Concerns Identified in the Critique of Our 1996 Annual Report:

We appreciate the careful review and constructive criticisms provided by the reviewers of the 1996 Annual Report for DAMD17-94-J-4116. The reviewers' comments and criticisms have been helpful in the preparation of this report. Nearly all of these concerns were due to our failure to effectively communicate the overwhelming success of this new program, both locally within the Mayo Clinic, and nationally as a developing paradigm for other breast cancer research training programs. In this progress report we have made a concerted effort to more fully communicate the past year's activities, and the ramifications of these activities within the Mayo cancer research community. We begin this year's progress report by addressing the specific criticisms and comments outlined in the two review summaries communicated to us by Ms. Judy Pawlus, Chief, Research Management (July 5, 1997), as outlined point-by-point, below:

- What is the distinction between the designations "Mayo Tumor Biology Program" and "Biology of Breast Cancer Program?"

There is no distinction between these two designations. **The Mayo "Tumor Biology Program" and the Mayo "Biology of Breast Cancer Program" are, in fact, one and the same program.** "Tumor Biology" is a more general designation that allows us to include students (not supported by DAMD17-94-J-4116) and faculty who have specific cancer research interests that lie outside of the area of breast cancer. The DAMD17-94-J-4116 award supports only a portion of the students in this new graduate training program. Institutional and Mayo Cancer Center Funds cover a substantial portion of the total costs of this program including: a portion of student stipends and benefits, faculty salaries, research expenses. While a defining feature of this new program is its research focus and integral link with clinical aspects of breast cancer patient care, a general foundation in tumor biology is, nonetheless, both important and essential in achieving this goal. The curriculum for this program is outlined in the course syllabus material (Appendix A and B), are also appended and the thesis research topics and publications of the students matriculating in this program (Appendix C and D). This information clearly details and substantiates the major breast cancer research focus of this new training program.

**In practice, the biology of breast cancer is emphasized throughout the program curriculum.** The reality of any modern multidisciplinary academic

program in biology is that while one can provide direction and guidance in a particular area of study (i.e., the biology of breast cancer), in general, given the complexity of the subject, most specific topics do not stand alone. Issues of fundamental importance to understanding breast cancer are also relevant to other cancers, and the converse is also true. Likewise, there are many instances where the illustrating example of a relevant point may involve biological systems as diverse as yeast and frogs (**not** breast cancer research, but **directly relevant to improving our understanding** breast cancer). Thereby, the tumor biology curriculum is grounded in basic cancer biology with the aim of ultimately leading students to a thorough understanding of all aspects at the forefront of breast cancer research. In order to accomplish this, our curriculum has been strategically developed to provide a strong foundation in the study of cancer *using breast cancer as the model wherever possible*. For example, to illustrate the significant emphasis on and integration of breast cancer in the overall curriculum, topics in breast cancer are featured in three 3 credit hour courses in the curriculum (see below), as well as in approximately one out of every three journal club presentations (see Appendix Exhibit A). Moreover, *all* trainees are required to register for a didactic course in “The Biology of Breast Cancer” (TBIO 8305, Appendix Exhibit A and page 134 in the Mayo Graduate School Bulletin). The three major courses: “Introduction to Tumor Biology” (Tumor Biology I, TBIO 5000) and “Origins of Human Cancer” (Tumor Biology II, TBIO 8000) and “Growth Factors, Oncogenes and Tumor Suppressors” (Tumor Biology III, TBIO 8005) were organized and taught using breast cancer as the principal paradigm for instruction and content. Details on these courses are given in the Appendix (Exhibit A) and are also presented in the following section.

- Was a *new* program established at the Mayo Graduate School in the Biology of Breast Cancer or Tumor Biology?

Yes, a *new* program was established at the Mayo Clinic with financial support, in part, from DAMD17-94-J-4116. Prior to the establishment of this training program there was no curriculum in place leading to the Ph.D. in Biomedical Sciences with a specialization in Tumor Biology. As outlined above (and detailed in the Appendix), the Tumor Biology Program places a major emphasis on breast cancer research: the curriculum is largely focused on breast cancer, and also the majority of Tumor Biology Program trainee thesis projects have direct breast cancer relevance. The formalization and approval of this new Ph.D. training program by the Mayo Graduate School took approximately one year to complete following receipt of the USAMRMC notification of award. This Mayo review process was rigorous. Mayo administration considered the long-term fiscal

implications of approval of a new graduate training program at Mayo. Funds provided by the USAMRMC, while generous, cover only a modest portion of the actual expenses incurred by this new program. Nonetheless, support by the USAMRMC was absolutely vital to the establishment of this new training program. We were not only able to persuade the Mayo Graduate School that our newly proposed program was of sufficient academic merit to warrant approval and implementation, but the highest level of administration of the Mayo Foundation recognized the timeliness and importance of this new multidisciplinary training program in breast cancer biology to the overall goals of the institution. Based on these merits, the Mayo Foundation agreed to sustain financial support for this new program beyond the period of initial support provided by the USAMRMC. Given the effort and resources required to implement a new multidisciplinary training program, the prospect of sustained support was critical to the final approval of this new program. Therefore, support from the USAMRMC was key to the initiation of this new program, and also effectively mandated the breast cancer focus which distinguishes our new curriculum. In addition, Mayo has committed resources to sustain the development of this new program until it is sufficiently mature to compete for longer term extramural support. This supplemental support from the Mayo Foundation has obviously amplified this new program's long-term potential to significantly impact on our understanding of the biology of breast cancer, and concomitantly the potential of this program to impact on the prevention, diagnosis, and treatment of breast cancer.

- Have new courses emphasizing the biology of breast cancer been established and implemented?

Implementation of several new courses was paced throughout the eight academic quarters of the first two years of this program and new courses continue to be added as faculty and student interests dictate. One or two new courses (or a major re-organization of pre-existing courses) were offered each quarter until the foundation for the program curriculum was established. This was not a trivial matter, and involved the recruitment and coordinated participation of numerous staff from diverse backgrounds and departments. Once a course prospectus has been designed it must be presented to the Mayo Graduate School Education Committee for consideration and sanction. In several instances, a new course was approved and implemented after the printing of the *Mayo Graduate School Bulletin* for that year. For this reason, several new courses were actually taught prior to their appearance in the Bulletin. While this is not the preferred order of events, it is nonetheless common in academia where, because of the pace of modern science, the half-

life of a "current" topic is short. One case in point was "The Biology of Breast Cancer" which was first offered in the Spring of 1997. The syllabus for this course is included in the Appendix (Exhibit A) and it is currently listed in the *Mayo Graduate School Bulletin* (attached, Appendix). It is important to note that while the first offering of this course did not take place until the Spring of 1997, all trainees enrolled in this course for credit.

- Why is there no indication of support for the biology of breast cancer training program by the USAMRMC on the Web Page and *Mayo Graduate School Program Bulletin*?

"Advertisement" of specific sources of support for activities within the Mayo Clinic is, by policy, generally not stated in most public forums. This is particularly important with regard to support of academic pursuits, as issues of academic freedom may be compromised. Nonetheless, the 1997 *Mayo Graduate School Bulletin*, which is distributed to all applicants, faculty, and matriculating students *does* acknowledge the USAMRMC "Biology of Breast Cancer" training grant on page 39 (Appendix, Exhibit H).

The world wide web page featuring the "Biology of Breast Cancer" training program also has been updated to include a citation of the training grant support received from the USAMRMC (Appendix Exhibit G).

- The issue of a complementary program in Experimental Pathology:

Yes, we agree that a complementary program in experimental pathology would be a welcome addition. Unfortunately, sufficient resources are currently not available at Mayo to support such a program. Our solution to this deficiency has been to require all of our trainees to attend the annual AACR sponsored workshop on the "Histopathology of Neoplasia" (see below).

- The issue of "slow" recruitment of graduate students and scientific output in breast cancer-related research by trainees.

There are presently a total of twelve students enrolled in this training program (see Appendix, Exhibit C). The original proposal application stated that the program would strive for a "steady state" of 12 to 16 students. Because experience at the Mayo Graduate School indicates that students require on the average 5.4 years to complete Ph.D. training and research, and because implicit in the concept of "steady state" is a balance between entry into the program and graduation, the rate of recruitment into the program is, if

anything, too *rapid*, rather than too “slow” as suggested in the critique. We have experienced no difficulty in recruiting truly outstanding applicants into this new training program (see Table I, Appendix, Exhibit C). All of the applicants accepted into the program have a strong research background in cancer biology, and most have prior research experience in the biology of breast cancer. It is important to note that we do not seek to recruit *large numbers* of students into this program. Rather, the goal of this training program is to give each student a unique opportunity to develop a solid academic foundation in tumor biology, to provide a strong research foundation in breast cancer, and to provide significant mentorship during each trainee’s tenure such that each student is likely to succeed, and that they are likely to distinguish themselves, individually, as leaders in the field of breast cancer research. This philosophy is consistent with the overall goal of this training program: we wish to *prepare outstanding leaders in breast cancer research for the 21st century.*

Our first student has graduated with a Ph.D. and is currently undertaking postdoctoral training in breast cancer research; four students have completed their qualifying examinations and all of the required course work and are in the research phase of their studies. Three of these students have thesis projects that focus on the biology of breast cancer, and the fourth student is working in a molecular virology laboratory on a project related to gene therapy with the clear future intent of pursuing novel therapies for breast cancer (her mother is currently battling this disease). Three students have completed most of their course work and will take their qualifying examinations before the end of this academic year; and five students have just begun their academic studies.

With regard to the “output” of our trainees, we offer two independent measures of their scientific productivity and potential. The first is a list of publications of the students in the program (Appendix, Exhibit E). The students in this program have published 21 papers in peer-reviewed journals and book chapters, as well as numerous abstracts presented at local and national scientific meetings. Many of these publications are in the specific area of breast cancer research, including studies on BRCA1, CLP in breast cancer, ErbB mediated carcinogenesis (both v-erbB and ErbB2), and the molecular cytology of breast cancer, to name just a few. Secondly, two students in this program have recently been awarded independent research support from the NIH (National Research Service Awards) for their thesis research projects. In addition, a third student has received a major grant from a pharmaceutical firm to support a portion of his thesis work. Not obvious from these measures of success, however, is the extended impact that this new training

program has had on Mayo's postdoctoral and clinical research fellows, and on the general laboratory vigor of the faculty who are actively participating in this program. Many postdoctoral and clinical fellows, research and clinical faculty, visiting scientists, and research paramedical staff (research technicians) regularly participate in the activities of this new program. The program, therefore, serves as an academic focus for the many research laboratories interested in breast cancer at the Mayo Clinic. The realized value of this program to the goals of the USAMRMC breast cancer research program has, therefore, been multiplied many times over the Army's initial investment. Finally, while we appreciate the complexities of overseeing a major breast cancer research effort such as the USAMRMC Breast Cancer Research Program, we would also appreciate equal consideration from the USAMRMC for the complexity of a modern academic program in the biology of breast cancer. It is unrealistic for the reviewers to suggest that after only two years of activity an output of "only one student" to receive her doctorate is a deficiency! Again, we appreciate the support from the USAMRMC, and we hope we have provided a sufficient level of detail in this progress report for the reviewers to fully appreciate the phenomenal success of this new program, both locally (by Mayo standards), and nationally with respect to achieving the stated training goals of the USAMRMC Breast Cancer Research Program.

- What is the level of institutional support for activities of the tumor biology training program?

Institutional resources in support of this new training program have been substantial. Combined institutional support for basic research and education was over \$100 million dollars in 1996. The Mayo Clinic provides major support for faculty salaries, research resource core facilities, direct supplementation of research budgets, administration of the Graduate School, and support for students in the program who are not directly supported by either the USAMRMC award or other extramural sources. The Biology of Breast Cancer Program directly benefits from these expenditures. The Mayo Foundation also supports students in the program for travel and registration to at least one national scientific meeting each year, as well as travel to additional meetings if the student makes a research presentation. In addition, the institution has supported five senior students in the program to attend the mandated "Histopathology of Neoplasia" course (an annual AACR sponsored workshop held in Keystone CO). Two students attended this workshop during the summer of 1997, two students attended in 1996, and one student attended in 1995. In addition, the Mayo Clinic supported the Director and Co-Director (Drs. Maihle and Salisbury) of the program, as well as additional faculty (Drs. Lingle, and Reiter) to attend

this workshop in 1996 and 1997. All students are required to attend this workshop at some point during their matriculation in the program. However, because the workshop has a limited enrollment (approximately 100 students each summer) students apply each year until they are accepted (submission of a research abstract aids in this competitive selection process). At this time, all of our students who have applied to attend the workshop have been accepted during the first application cycle.

- Why has this new training program failed to “shift a portion of the faculty into breast cancer related research” ... and to ... “recruit clinicians with basic research training and experience to serve as further bridges between scientists and pure clinicians?”

While it is beyond the scope and authority of a graduate training program to effect these changes, we believe we have significantly impacted upon these goals. Participation in this new program has lead a number of faculty (including Drs. Abraham, Getz, Federspiel, Fitzpatrick, and Salisbury) to move their research programs in the direction of breast cancer research. Both Drs. Getz and Salisbury have new NCI RO1 funding to support breast cancer research projects, and Dr. Federspiel (a new Mayo Staff member) has received a small grant from the Komen Foundation to support a pilot project in breast cancer research. In addition, Drs. Erlichman, Gendler, Grande, Perez, Podratz, Ingle, Jelinek, Jenkins, Lennon, Maihle, O’Fallon, Spelsberg, Sommers (now at City of Hope), and Wold each have either established RO1 funding for breast cancer research, or clinical research protocols in breast cancer, or both. Moreover, the program director (Dr. Maihle) is Co-PI on an NCI funded R21 award that has the sole purpose of developing a breast cancer research program at the Mayo Clinic. Finally, several established and newly appointed Mayo staff whose primary interest is in breast cancer research and/or treatment are awaiting approval by the Mayo Graduate School for faculty privileges in our training program. These individuals include: Dr. Ruth Johnson (Director, Mayo Breast Cancer Clinic), Dr. Deborah Rhodes (Clinical Staff, Mayo Breast Clinic), Dr. Edith Perez (Medical Oncologist, Jacksonville Campus), Dr. Margot Cleary (Adjunct Scientist; Hormel Research Institute), and Dr. Fergus Couch (new Mayo staff member whose primary interest is the study of BRCA1). While the Biology of Breast Cancer Program cannot take credit for these breast cancer-related research activities and staff recruits, the program does serve as the academic home for all of these investigators (and activities), and the program has influenced both the direction and spirit of their laboratories.

### **New Information on Current Trainees:**

Presently there are twelve predoctoral trainees participating in this program, including two trainees (17%) from under-represented minorities. One student has graduated with the Ph.D. degree and is currently a postdoctoral fellow working on strategies for immune therapy in breast cancer. Table I (Appendix Exhibit C) lists the academic credentials of all students in this program. Four of these students are pursuing Ph.D. thesis projects that *directly* involve breast cancer research. The remaining students have either not yet begun the research phase of their graduate studies, or their projects are breast cancer relevant (e.g., the study of HPV's role in the etiology of women's cancers, including breast and cervical carcinoma). Table II lists proposed thesis titles for those students who have passed their qualifying examinations and are currently engaged in thesis research. It is important to note that the curriculum in the Biology of Breast Cancer and Tumor Biology is *not* restricted to only students who are formally accepted into the program. Graduate students from other academic disciplines and clinical fellows, residents, and postdoctoral students also are allowed to formally enroll for credit in all of the courses offered in this new curriculum. Typically, the enrollment in our journal clubs and courses has been between 15 and 20 students each academic quarter.

### **Integration of the Biology of Breast Cancer Throughout the Training Curriculum:**

The curriculum for the Biology of Breast Cancer Program is presented in detail in later sections of this report (under the heading: **Task 2**) and in Appendix Exhibits A and B. This section of the report presents a snapshot of several specific examples of how the biology of breast cancer is integrated throughout our current curriculum, including in didactic lectures, journal clubs, and problem sets where the term "breast cancer" may not appear in the title of the unit. In this section of the report we will 'walk through' the notebook assembled for the introductory course "Tumor Biology I" (TBIO 5000) and I will relate specific examples of the integration of the biology of breast cancer, as appropriate:

In the "Introduction to Tumor Biology" (TBIO 5000) a foundation in general concepts in cancer biology is established for the students using key discoveries, observations, and papers of particular historical importance to cancer biology. For example, the first paper that was reviewed by the class during the fall academic quarter of 1996 (see Appendix, Exhibit B; Journal Club on 10/2/96, Dr. W.L. Lingle presenting) was a treatment of the classic treatise by Theodor Boveri entitled "The Origin of Malignant Tumors" published in 1914 (1). In this remarkable paper,

Boveri defines or outlines the concepts for -- tumor suppressors, oncogenes, growth factors and growth factor receptors, the monoclonal nature of most tumors, the nature and origin of aneuploidy in tumors, cell cycle checkpoints, linked genes, loss of heterozygosity, gene regulation, as well as a description and nature of anaplasia seen in many high grade tumors. While specific modern terminology was not used in this paper, the concepts and their relationship to malignant tumors were presented in this work for the first time ever (yes, Boveri was a genius!). Each of these concepts is directly relevant to our current understanding of breast cancer. In fact, these concepts represent the subject of a large portion of the current literature in the area of basic research in breast cancer and in the titles of many of the basic breast cancer research proposals reviewed and funded by the USAMRMC in the three study sections that both Drs. Maihle and Salisbury served on from 1995-1997 (i.e., Cell Biology and Pathophysiology).

During the second lecture in "Introduction to Tumor Biology" (TBio. 500) ("Properties of Transformed Cells), Dr. Maihle included a discussion of X chromosome inactivation to demonstrate the clonal origin of most tumors. In this lecture, two separate papers using analysis of X-inactivation patterns to demonstrate the clonal nature of breast tumors were used to illustrate the topic (2-3). Likewise in the third lecture of this course ("Causes of Cancer"), Dr. Pittelkow presented a discussion based on a paper which investigated the spontaneous *in vitro* immortalization of breast epithelial cells from a patient with Li-Fraumeni syndrome (4). In the following lecture ("Animal Models in DNA and RNA Tumor Virology") the mouse mammary tumor virus (MMTV), which has been implicated as the causative agent in mouse mammary tumors, was a featured topic in the discussion. During this week students reviewed and discussed two current papers that dealt specifically with viral etiologies in breast cancer in the mouse model (5,6) in addition to a number of other current papers and reviews. The following week in the course concentrated on the nude and SCID mouse models in cancer research and their use in xenograph experiments. Specifically, breast tumor xenographs were discussed in each of the following contexts:

- Do breast tumor xenographs accurately reflect the treatment responsiveness of the original tumors?
- The use of breast tumor xenographs in drug screening.
- Metastatic behavior of human breast tumor xenographs implanted into the subcutaneous tissue of Nude and SCID mice.
- Orthotopic versus ectopic implantation of breast tumor cells and the metastatic behavior of various breast carcinoma derived cell lines in nude mice.

In addition, one of the Problem Set discussion points for this week specifically focused on the issue of growth stimulation by steroids of breast and prostate tumor cell xenographs in mice: For example, students developed a round table discussion based on the following questions and discussion points:

- What are the *in vitro* properties of steroid responsive cell lines?
- Outline an experimental design for the use of such lines in a xenograph model.
- Predict the experimental results of such a study.
- Is the use of an animal model necessary for these studies?

During the following week, Dr. Chella David presented a thorough discussion of transgenic and knockout mouse technologies. An in-depth discussion of the early days of mouse genetics focused on the rediscovery of Mendelism in animals and the establishment of the first inbred mouse strains by Little at the Jackson Laboratories. Little's experiments in the early part of this century lead to the first mouse strains that developed breast cancer with high frequency and that have served as valuable models to this day. An illuminating discussion focused on the MMTV/*c-myc* and MMTV/*v-Ha-ras* mouse models for breast tumorigenesis. A related journal club presentation given earlier (see Appendix, Exhibit B; Journal Club on 1/15/96, Dr. J.L. Salisbury presenting) dealt with the consequences for breast development and oncogenesis in cyclin D knockout mice (7, 8).

The following lecture entitled "Introduction to Analysis of Human Tumors" was given by a guest speaker, Dr. Ann Thor (Northwestern University, Department of Pathology). Dr. Thor was invited because of her expertise and background in breast cancer research. Dr. Thor specifically used breast cancer as the model to illustrate most of her major points throughout the lecture. In addition, during this week, all trainees visited the Mayo Surgical Pathology Suite at Rochester Methodist Hospital where they observed gross inspection and dissection of a variety of breast cancer specimens retrieved from neighboring operating rooms, microscopic preparations made by rapid frozen sectioning, and pathological determinations made by resident and staff pathologists. The journal club presentation during this week was focused on BRCA1 in breast cancer (see Appendix, Exhibit B; Journal Club on 11/20/96, Mr. M. Rogers presenting).

The week of November 26 focused on a discussion of IRB policies and protocols relevant to studies of human tumors. Dr. H. Long, a medical oncologist with an extensive history of clinical research in the study of women's cancers presented this discussion, and while breast

cancer was not specifically the topic, the relevance (and importance) of these discussions to new investigations in the field of breast cancer research is clear.

The final week of the course continued on the theme of surgical pathology. Dr. J. Grande presented an extended review of the histopathology of cancer and used a variety of tumors including breast specimens in his discussion. Again, the journal club presentation during this final week featured BRCA1 and breast cancer (see Appendix, Exhibit B; Journal Club on 12/8/96, Mr. M. Rogers presenting).

This short summary of the degree to which we have integrated the biology of breast cancer into our Fall quarter Tumor Biology I course is illustrative of the manner in which our academic program focuses specifically on breast cancer. These examples demonstrate not only our commitment to meeting the specific goals of the USAMRMC Breast Cancer Research Program, but also demonstrate the defining feature of this new program which is its research focus and integral link with clinical aspects of breast cancer patient care.

**NOTE: Because the overall goals and objectives of our training program have not changed since the submission of our original application, the following sections reflect substantially the same information that we presented in the 1996 Annual Report.**

**Task 1: "Organize Biology of Breast Cancer Predoctoral Training Program Faculty and Curriculum," is addressed in the following section:**

#### **Qualifications of the Program Directors**

Dr. Nita J. Maihle, Associate Professor in Biochemistry and Molecular Biology and Tumor Biology, is Director of the Biology of Breast Cancer Predoctoral Training Program. Dr. Maihle has participated in the recent organization of the tumor biology curriculum and is a well qualified tumor biologist with extensive experience in the training of pre- and postdoctoral fellows. She has an ongoing and productive breast cancer-related research program, and is the Principal Investigator of two NCI-funded RO1 grants ("sErbB in Ovarian Cancer" and sIL-6 in Breast Cancer"). She is also Co-PI on an NCI R21 Award to support the development of a Breast Cancer Research Program within Mayo's Cancer Center. As past Associate Director for Basic Research in the Mayo Cancer Center, Dr. Maihle has played a key role in facilitating the coordination, implementation, and funding of a substantial portion of the basic cancer research at the Mayo Clinic. Dr. Maihle also recently completed charter membership in the NIH Cell Biology and Physiology Study Section (Subcommittee 2) which has its primary responsibility in the review of RO1, R29, R23 and RCDA applications. Thus, Dr. Maihle brings significant administrative experience and a broad perspective to this predoctoral training program. She devotes 10% of her effort to the administration of this training program. Her primary responsibilities are to: 1) oversee recruitment and selection of Ph.D. candidates, 2) to monitor the overall direction of the program and to ensure the equitable selection of trainees, 3) to monitor and ensure the progress of all trainees through

periodic review with both trainees and their mentors, 4) to coordinate all courses, journal clubs, research seminars, and other activities of the Biology of Breast Cancer Predoctoral Training Program, 5) to provide trainees with advice on potential problems or conflicts, and 6) to prepare progress reports for institutional and DAMD review, and to participate in the institutional assessment of the success of this training program. In addition, Dr. Maihle serves as the principal liaison to the Mayo Cancer Center, to coordinate and fully integrate the activities of the Biology of Breast Cancer Predoctoral Training Program with those of the Mayo Cancer Center. Dr. Maihle also is responsible for coordinating several of the course offerings in the Biology of Breast Cancer Predoctoral Training Program, including the "Origins of Human Cancer", "Growth Factors, Oncogenes and Tumor Suppressors", and "Current Topics in Tumor Biology" (with Dr. Salisbury).

Dr. Jeffrey L. Salisbury, Professor of Biochemistry and Molecular Biology and Tumor Biology, is the Education Coordinator of the Mayo Biology of Breast Cancer Predoctoral Training Program. As Co-Director of the Biology of Breast Cancer Predoctoral Training Program, Dr. Salisbury devotes 10% of his effort to administration of the Biology of Breast Cancer Predoctoral Training Program and participation in its activities. Dr. Salisbury is PI on an NCI funded RO1 entitled "Centrosome Hypertrophy in Human Breast Tumors". He was appointed to the Mayo Consulting Staff and to the Mayo Graduate School of Medicine in 1989. Prior to his appointment at Mayo he was an Associate Professor in the departments of Neuroscience, Anatomy, and Oncology in the School of Medicine at Case Western Reserve University (Cleveland OH), and prior to that he was an Assistant Professor of Anatomy and Structural Biology at Albert Einstein College of Medicine (Bronx, NY.) Dr. Salisbury is a well-qualified Molecular/Cell Biologist with extensive experience in the training of pre- and postdoctoral students. He has served on the National Education Committee of the American Society for Cell Biology (two consecutive 3 year terms), and is currently a member of the Mayo Graduate School Education Committee. He conducts an established, cancer-related research program with long-standing emphasis on centrosome dynamics during the cell cycle, and more recently on hypertrophic centrosomes in breast tumor cells. Dr. Salisbury brings a broad perspective on graduate training to the Biology of Breast Cancer Predoctoral Training Program. His primary responsibilities include oversight of student recruitment, student progress, and coordination within the Biology of Breast Cancer Predoctoral Training Program curriculum. He works closely with Dr. Maihle in these efforts. In addition, Dr. Salisbury is responsible for coordinating several of the course offerings in the Biology of Breast Cancer Predoctoral Training Program, including "Principles of Cell and Tissue Design", the "Cell Biology of Cancer", the "Biology of Breast Cancer", and "Current Topics in Tumor Biology" (with Dr. Maihle).

### **Program Faculty**

#### **Qualifications of the Program Faculty**

The Biology of Breast Cancer Predoctoral Training Program faculty consists of a training faculty of 50 full and associate members drawn from seven different departments (see Table III. While individual faculty are associated with traditional discipline-based departments (such as Biochemistry, Molecular Biology, Experimental Pathology, Oncology, Pharmacology, etc.) the administrative structure of the Biology of Breast Cancer Predoctoral Training Program is that of an interdisciplinary programmatic unit. This programmatic structure reflects the interdisciplinary nature of the major research and academic efforts of the associated faculty.

Stringent criteria for participation of faculty as full or associate members in this training program have been established to ensure both a research training focus in the area of cancer biology, as well as academic excellence. Criteria used to identify full faculty members in the Biology of Breast Cancer Predoctoral Training Program include:

- Members of the training faculty with “**Full**” status will have an established track record of accomplishment in biomedical research as demonstrated by significant publications of high scientific merit, excellence, and innovation. These investigators also have consistent records of extramural funding in support of their research programs.
- The collective interests of this training faculty are quite broad, but show direct cancer relevance. These interests include: cell signalling, cancer genetics, gene regulation, tumor immunology, oncogene and tumor suppressor action, cell cycle regulation, tumor virology, gene therapy, hormone responsiveness, and molecular cytology. All training faculty must be members of the NCI-designated Mayo Cancer Center.
- In addition to having an established track record of scientific excellence, the minimum requirement for all investigators to be included as full members of this training program is that they must have mentored at least one Ph.D. candidate, serving in the capacity as thesis advisor, and that student must have left his/her laboratory to continue biomedical research training in a postdoctoral fellowship position with unequivocal training potential in a high quality academic environment.
- Finally, “**affiliated**” faculty, drawn from both clinical and basic science departments, also contribute to the Biology of Breast Cancer Predoctoral Training Program through participation in a variety of relevant educational activities and as clinical instructors. These affiliated faculty may serve as advisory members of qualifying exam and thesis committees, however, they may not serve as research mentors for students who matriculate into the Biology of Breast Cancer Predoctoral Training Program.

### **Administrative Structure**

The Biology of Breast Cancer Predoctoral Training Program is administrated overall through the Mayo Graduate School, and is closely allied with the Mayo Cancer Center. Day-to-day program administration operates largely through the Director (Maihle) and Co-director (Salisbury), and the Tumor Biology Education Committee (Drs. Salisbury, Maihle, Jelinek, and Tindall, and a trainee, Mr. J. Baines). The Tumor Biology Education Committee meets regularly (every two months) to discuss student recruitment, student progress, and coordination within the Biology of Breast Cancer Predoctoral Training Program curriculum. In addition, the Directors of the three cancer-related training grants (Drs. Salisbury, Maihle, Getz, and David) and the Director of the Mayo Cancer Center (Dr. Prendergast) meet regularly (every 6-8 weeks) to discuss ongoing programs and activities related to cancer research and education. The entire Tumor Biology Training faculty interact frequently through courses, journal clubs, and research workshops, and meets twice a year to discuss administration and ongoing activities of the Biology of Breast Cancer Predoctoral Training Program.

**Task 2: “Establish new courses in specialized aspects of tumor biology, emphasizing the cell and molecular biology of Breast cancer and Task 4, “Implement the new Biology of Breast Cancer Predoctoral Training Program curriculum,” are addressed in the following section:**

### **Biology of Breast Cancer Predoctoral Training Program Curriculum**

We have established and implemented a broadly based curriculum in Tumor Biology at the Mayo Clinic. The Biology of Breast Cancer Predoctoral Training Program curriculum includes didactic course work, journal clubs, research seminars and clinical activities. Students who matriculate into the Biology of Breast Cancer Predoctoral Training Program must meet the general course requirements of the Mayo Graduate School in which a minimum of 13 credits are required from the Graduate School Core Curriculum. Students must also complete at least 20 credits from

the didactic Tumor Biology required and elective course curriculum. The Mayo Graduate School core curriculum courses are selected from at least two areas with a minimum of three credits from each area. A student's program of core courses is individually developed in consultation with his/her advisor. Credits derived from seminars and journal clubs are not permitted as core course requirements. Tumor Biology students generally select core courses from the following list of core offerings:

**Mayo Graduate School Core Course Offerings (credits)**

Principles of Cell & Tissue Design (3)  
General Biochemistry (series of 3 x 3 credit courses; total 9)  
Introduction to Molecular Biology (3)  
Molecular Biology Theory and Application (3)  
General Pharmacology (series of 3 x 3 credit courses; total 9)  
Basic Graduate Immunology (3)  
Maintenance of Scientific Integrity and Ethical Conduct in Biomedical Research (1)  
(This course is required for all Mayo graduate students and postdoctoral fellows.)

The academic curriculum of the Biology of Breast Cancer Predoctoral Training Program also includes track requirements(\*) and elective courses, as outlined below:

**Tumor Biology Track Course Offerings (Credits)**

\*Tumor Biology I: Introduction to Tumor Biology (3)  
\*Tumor Biology II: Origins of Human Cancer (3)  
\*Tumor Biology III: Growth Factors, Oncogenes, and Tumor Suppressors (3)  
\*§Current Topics in Tumor Biology (1) (see listing, Appendix exhibit C)  
\*Research Seminars in Tumor Biology (1)  
\*Cell Biology of Cancer (3)  
\*The Business of Science and the Science of Business (1)  
Biology of Pancreatic Cancer (1)  
\*Biology of Breast Cancer (1)  
¶Biology of Gastrointestinal Tumors (1)  
¶Biology of Haematopoietic Cancers (1)  
¶Biology of Prostate Cancer  
Gene Therapy and Cancer (1)  
Cytogenetics (2)  
Cytology Laboratory  
Introduction to Statistical Models (1)  
Introduction to Clinical Epidemiology (1)  
Design of Clinical Studies (1)  
AACR Course in Histopathology of Cancer (1)  
Laboratory Rotations in Tumor Biology (3 required rotations, 2 credits each = 6 total)  
Research in Tumor Biology (Thesis Research (0))

\* Course outlines for required courses are included in the Appendix exhibit A).

§ Students must register in this journal club one quarter each year, but they are expected to attend all quarters.

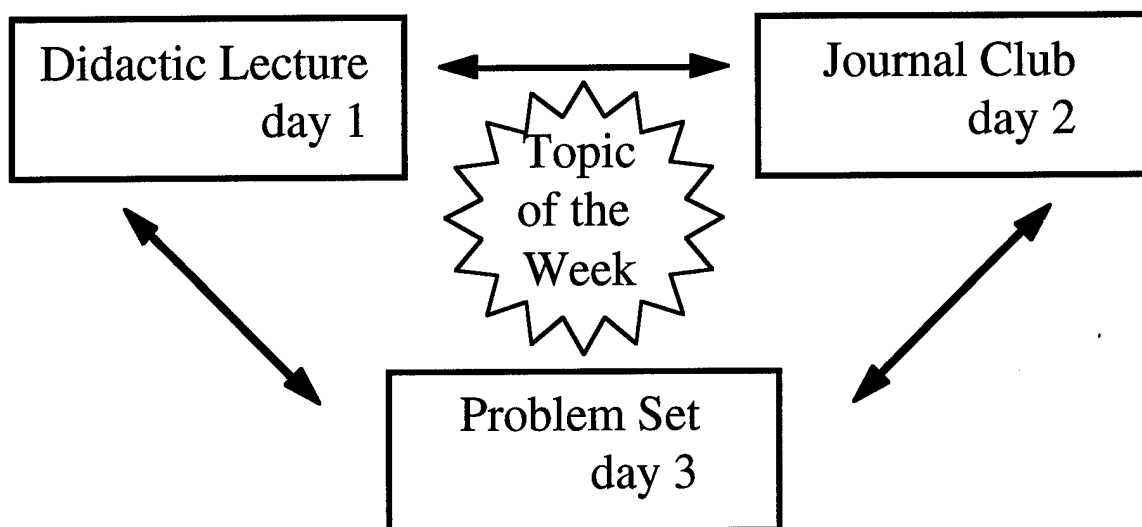
¶ New courses to be added to the curriculum in 1997-1998 academic years.

Additional advanced elective courses may be chosen in any area from the Mayo Graduate School Bulletin (see Appendix Exhibit H) to fulfill the overall degree requirement of 42 credits. In addition, all students in the Biology of Breast Cancer Predoctoral Training Program are required to

take formal classes in Radiation Safety, Animal Care and Use, and also participate in an NIH Grant Writing Workshop. These required courses are organized by various divisions and departments within the Mayo Clinic, and, therefore, are not offered for Graduate School credit (not administrated by the Mayo Graduate School).

### **Innovative Strategies for Teaching**

The required Biology of Breast Cancer Predoctoral Training Program track courses (designated with an asterisk \* above) establish a solid foundation in the first-year students' understanding of the biology of cancer and share several distinguishing and innovative strategies for teaching which enhance learning and student/faculty participation. For example, Tumor Biology I, II, III, and the Cell Biology of Cancer are given as a series during the first four consecutive quarters following matriculation. Individually, these courses meet three times per week with an overview and historical review of a selected topic(s) for the current week presented in a didactic lecture format during the first class session. This is followed by a student presentation of a current or historically relevant research paper(s) in the area of the week's topic during the second class session using the journal club format. Finally, a round table problem set discussion focuses on questions and problems relevant to the week's topic during the third class session. The research paper presentation and round table problem set discussions enhance the effectiveness of these courses through the direct involvement of students in learning, information processing, and application of information to problems within the framework of the week's topic(s). These sessions allow students to organize and categorize information into meaningful units and to 'discover' novel relationships and extract and assimilate important points in an interactive and participatory manner. In this way, students are accountable for the assimilation of new information on an ongoing basis, they are intellectually challenged, and they are required to apply newly gained knowledge to relevant problem-solving exercises.



### **Instruction in the Responsible Conduct of Research**

All graduate students and postdoctoral fellows are required to formally register for and participate in a one credit hour series of presentations and discussions on the responsible conduct of research, scientific integrity, and ethical principles in research (ETHIC 5000: Maintenance of Scientific Integrity and Ethical Conduct in Biomedical Research). This course meets one hour per week during the summer quarter (10-12 sessions) and is taught by faculty of the Mayo Graduate

and Medical Schools, including Tumor Biology Faculty. A course outline for the most recent year is presented in the Appendix (Exhibit A). Specific topics covered in this course include:

- Perspective on Ethical Conduct of Biomedical Research
- Scientific Fraud and its Consequences
- Authorship
- Data Storage and Ownership
- Emerging Issues in Electronic Data Acquisition, Storage and Publishing
- Collection and Interpretation of Data
- Conflict of Interest
- Use of Animals in Research
- The Thermodynamics of Money
- Use of Humans in Research
- Recombinant DNA Research

In addition, a second one credit hour Tumor Biology course (TBio. 5300: Business of Science and Science of Business, see Appendix Exhibit A) addresses selected ethical issues in biomedical research. This course is required for all Tumor Biology Trainees. Of special interest in regard to ethical issues covered this past year in TBio. 5300 was a unit on Integrity and Misconduct in Research and a case study on industry funding of drug development and inappropriate pricing of essential drugs (i.e., the Mortel/Levamisole controversy).

Both of these courses include 10-12 weekly didactic lectures followed by round table discussions of the the relevant topic of the day. Class sessions are well attended by faculty, and senior graduate students and fellows, in addition to the graduate students and postdoctoral fellows who are formally registered for the course.

### **Continuing Education**

Senior students who have already completed the formal course requirements, and postdoctoral fellows who are supported by other cancer-related training grants register for graduate credit and attend the journal club sessions which are integral to the required Biology of Breast Cancer Predoctoral Training Program courses. In this way, these trainees contribute to the critical mass of the class, they also enhance the multidisciplinary nature of the discussions, and through this mechanism these trainees revisit current topics in cancer biology during their advanced training years. In this manner, advanced trainees have the opportunity to reinforce key concepts as well as to remain current with regard to advances in the rapidly developing areas of cancer biology. Likewise, the Biology of Breast Cancer Predoctoral Training Program faculty and their key laboratory personnel actively participate in these regular weekly journal club sessions. Interactions among training faculty and stimulating scientific discussions are further encouraged through a monthly Tumor Biology Tea (tea, coffee, pop, and cookies) immediately following selected journal club sessions.

### **Integration of the Clinical Perspective**

The Biology of Breast Cancer Predoctoral Training Program is designed to give the trainee a broad and well-rounded understanding of cancer from both the basic science and clinical perspectives. Integration of the clinical activities of the Mayo Cancer Center into the training program of Tumor Biology trainees is achieved in at least six different ways.

- First, clinical fellows and residents from a broad spectrum of cancer relevant programs (e.g., oncology hematology/oncology, orthopedic research, gynecologic oncology, pediatric oncology, etc.) formally enroll and participate in Biology of Breast Cancer Predoctoral Training Program courses and journal clubs (for example during this past academic quarter three clinical fellows were formally enrolled in Tumor Biology I, and a total of six fellows and residents regularly attended and actively participated throughout the academic quarter). Active participation by clinical residents and fellows adds considerably to the multidisciplinary perspective of the student body, and to class discussions.
- Second, clinical staff present didactic lectures in their areas of specialty in Biology of Breast Cancer Predoctoral Training Program courses (see selected course outlines in Appendix exhibit C). For example in the Biology of Breast Cancer course, individual lectures were given by clinical staff practicing in Surgery, Medical Oncology, and Surgical Pathology. Likewise, in the Tumor Biology I course, clinical staff presented lectures in epidemiology, chemical carcinogenesis, and tumor pathology.
- Third, Biology of Breast Cancer Predoctoral Training Program trainees are required to attend Mayo Cancer Center Research Workshops ("Works in Progress," see 1996 program; Appendix, exhibit E), Mayo Cancer Center Grant Rounds (see 1996 Program, Appendix, exhibit E), and Oncology Society and Hematology Society lectures, and receive course credit for participating in these activities (TBio 5101: "Research Seminars in Tumor Biology").
- The Biology of Breast Cancer Predoctoral Training Program curriculum also is integrated with clinical practice wherever possible through special course related activities. For example, during a week this past quarter where tumor pathology and the use of clinical specimens in cancer research were the Tumor Biology I course topics, class members were taken as small groups on tours of the Surgical Pathology Suite. During these tours students observed the gross dissection of surgical specimens (including breast carcinomas), rapid freezing and cryomicrotomy, microscopic examination (via video monitors) and diagnosis by staff pathologists, and report to the OR surgeons. All surgical procedures in which cancer is suspect are subject to immediate pathological examination in this manner, while the patient is still undergoing surgery. Some samples are turned around from the OR to the Pathology Suite for diagnosis and results are communicated back to the OR in under four minutes. Needless to say, the activities in this unit are dynamic and intense, and each student group was able to observe these activities over a two-hour period, with ongoing commentary from pathology residents and staff pathologists who were performing the procedures. Similarly, all Biology of Breast Cancer Predoctoral Training Program trainees are required to attend clinical rounds (at least once) with a Mayo staff member (any division or department) during their training. Direct exposure to clinical activities such as these are tremendously useful for students to understand, based on first-hand observation, the intensity, dedication, and skill involved in the clinical care and treatment of breast cancer patients. These activities also promote the involvement of our clinical faculty in Biology of Breast Cancer Predoctoral Training Program activities.
- During their senior year in the Biology of Breast Cancer Predoctoral Training Program, trainees participate in the first year Mayo Medical School curriculum by proctoring a problem set during the two weeks when cancer biology is introduced to the medical students. This activity gives Tumor Biology trainees an opportunity to interact with medical students and to gain practical experience at the instructor level.
- Finally, all Tumor Biology trainees have one or more clinical staff advisors participate as members of their Thesis Advisory Committee. Sometimes this involvement is fairly technical, e.g., participation by a Mayo Cancer Center biostatistician in study design and analysis. In other instances, however, clinical advisors may be directly involved in helping the trainee define a clinically relevant question in their system, and/or assist them with tumor specimen acquisition or data analysis. For example, as one component of Mr. Roger's thesis, he is examining the differential expression of the calmodulin-like protein (CLP) in various histologic subtypes of human breast cancer.

### **Additional Academic Activities**

**Seminars by Students, Faculty and Invited Speakers:** Extensive institutional resources support invitation of nationally and internationally recognized scientists and clinicians to Mayo. Approximately 350-400 speakers come to the Mayo Clinic campus each year. Trainees are, therefore, exposed to diverse biomedical research opportunities, and institutional and departmentally-based research seminars throughout the year. In addition, students attend monthly Mayo supported dinner/research seminars given by the Research, Laboratory Medicine, Oncology, Hematology and Genetics Societies of the Mayo Clinic. These events are especially suited to interactions between students, postdoctoral fellows, and faculty in an informal yet scholarly atmosphere dedicated to scientific discussion. During each of their research years, Biology of Breast Cancer Program Trainees also present research seminars and research posters in the Mayo Cancer Center Research Retreat.

**Attendance at National Research Meetings:** All students are supported to attend at least one national scientific meeting each year even if they are not presenting an abstract. If they are presenting their work, attendance at additional meetings is encouraged and supported by the Mayo Foundation. Mentors take an active role in introducing their students to the professional identity and 'networking' critical to success in a biomedical research career through this mechanism. In recent years Biology of Breast Cancer trainees have attended and/or presented at the following national meetings: AACR, ASCB, FASEB, Annual Oncogene Meetings, Annual Human Cancer Meeting, Cold Spring Harbor Cancer Genetics Meetings, Salk Tyrosine Phosphorylation Meetings, and various Gordon Conferences and Keystone Meetings.

### **Research Training**

#### **Task 5: "Assess Student Progress".**

**Selection of Thesis Laboratory, Mentor, and Thesis Committee:** Biology of Breast Cancer trainees typically matriculate in August and are required to complete three laboratory-based (minimum 8 weeks each) rotations during their first year. All of the full and associate faculty may serve as potential mentors for these research rotations. Selection of the thesis mentor follows completion of successful laboratory-based rotations by mutual consent of the student and mentor with the sanction of the Tumor Biology Education Committee and Mayo Graduate School Education Committee. The selection of a research laboratory coincides with the qualifying examination which consists of a written thesis proposal and its defense before a thesis committee consisting of a minimum of 4 tumor biology faculty (including the thesis advisor), a clinician (where appropriate), and an extramural committee member (optional). Typically the clinical and extramural committee members' research specialties are related to the general area of the student's thesis topic. Following successful completion of the qualifying exam, research progress is assessed through regular Thesis Advisory Committee meetings (minimum of one Thesis Advisory Committee meeting per year). While Thesis Advisory Committee members are available for advice, technical assistance, and consultation throughout the year, these meetings provide a formal opportunity for input by the Thesis Advisory Committee on progress and experimental aspects of the thesis project. The chair of the Thesis Advisory Committee formally reports the outcome of each committee meeting in writing to the Tumor Biology Education Committee and to the Mayo Graduate School. In addition, students present their research progress in quarterly research workshops (one oral presentation per year) and in a yearly, institution wide, Mayo Graduate School Research Symposium (poster format). In addition, all Biology of Breast Cancer Predoctoral Training Program participants participate in the Annual Mayo Cancer Center Research Retreat (poster format).

**Thesis Research:** The Biology of Breast Cancer Predoctoral Training Program places strong emphasis on thesis research. All full training program faculty members have demonstrated records of research training at both the predoctoral and postdoctoral levels. The specific details of an individual student's research training plan are developed following the selection of a thesis advisor and a thesis research laboratory in consultation with the Thesis Advisory Committee. The thesis research project must be hypothesis driven and experimental in nature and must, in addition, have a direct application to the biology of cancer.

**Ph.D. Thesis:** The thesis is the most important document that the Tumor Biology Ph.D. candidate prepares during the course of graduate study, and is a record of the scientific accomplishments that justify the awarding of the degree. The thesis is archival. Consequently, the Mayo Graduate School has developed standards for its format and style that are followed closely. The thesis examination consists of a formal thesis research seminar open to all members of the Mayo community followed by a meeting with the Thesis Examining Committee during which the scientific merit and accomplishments of the candidate are evaluated. Successful completion of a research thesis typically also results in two or more research manuscripts submitted for publication in peer-reviewed journals of high scientific standards.

**Task 3: "Establish appropriate mechanisms for student recruitment into this new training program".**

#### **Trainee Candidates**

The curriculum and thesis research is a predoctoral training program leading to the Ph.D. degree in Biomedical Sciences. Each year, 3 to 5 students are accepted into the program for an appointment term of 4 to 5 years. The program strives for a steady state level of 12 to 16 students. Students recruited for matriculation into the Biology of Breast Cancer Predoctoral Training Program will be selected on the basis of outstanding academic credentials, a stated desire to study and conduct research in the area of breast cancer biology or related disciplines, and an assessment of individual potential by the training faculty. Many of the applicants to the Mayo Graduate School have had research experience within the Mayo system through undergraduate research internships (see below). Typically, candidates for admission to Mayo's graduate programs apply directly to the Graduate School where their academic credentials, letters of recommendation, and personal statements are placed on record. Application materials are selected for consideration by individual program educational committees based on the candidate's stated interests. For consideration for admission to the Biology of Breast Cancer Predoctoral Training Program, the applicant should:

- Hold a bachelor's degree from an accredited college or university with a minimum 3.25 grade point average on a 4.0 scale.
- Have received scores on the verbal, analytical, and quantitative aptitude tests of the Graduate Record Examination indicating a strong academic ability (i.e. above the 75th percentile), with subject tests in biology and biochemistry being highly recommended.
- Have a minimum scientific undergraduate course background (with evidence of superior performance) including: one year of physics, two years of chemistry, one year of biochemistry, and two years of upper level biology.
- Supply supporting documents including: official transcripts, official copies of GRE or MCAT scores, and three letters of recommendation.
- Applicants will be invited to visit the institution during the selection process to meet the faculty and to be introduced to the Biology of Breast Cancer Predoctoral Training Program, the Mayo Cancer Center, and the Mayo Graduate School.
- M.D./Ph.D. candidates considered for admission to the Mayo Medical/Graduate Schools will be introduced to the Biology of Breast Cancer Predoctoral Training Program and representative

faculty during their interview and recruitment visits. Where interests overlap and evaluated potential are judged to be exceptional, these students will be targeted for recruitment into the Biology of Breast Cancer Predoctoral Training Program.

Applications are solicited through national mailings directed to appropriate undergraduate departments, through the Mayo home page (<http://www.mayo.edu>), advertisements in journals targeted to the recruitment of minority applicants (e.g. *Winds of Change*, *Black Issues in Higher Education*), the *Peterson's Guide*, and through the Mayo Graduate School Degree Program Booklet (Appendix exhibit H).

### **Biology of Breast Cancer Predoctoral Training Program Minority Representation**

The Biology of Breast Cancer Predoctoral Training Program has placed special emphasis on recruitment and training of underrepresented minorities. Currently the predoctoral class consists of a total of 12 students, 2 of whom are underrepresented minorities (17%, including one Native American, and one Hispanic student). In addition, two of the seventeen training faculty, including the Director of the Mayo Cancer Center, are members of underrepresented minority groups.

### **Minority Student Recruitment Strategy**

Our success in recruiting and training minority applicants is based in large part on a concerted effort by Mayo to move aggressively forward in this area. In 1991 Mayo created an Office of Minority Student Affairs and focused significant human and financial resources on recruiting and supporting minority students. Dr. Richard McGee was recruited as Associate Dean for Student Affairs and he established the Office of Minority Student Affairs as a resource to support recruitment activities of the various departments and programs within the Mayo Graduate School. This office coordinates minority recruitment activities.

Our overall strategy for minority student recruitment is a broad-based effort aimed at both identifying potential minority applicants early in their academic career, and establishing long-term relationships with minority undergraduate schools and minority students in non-minority schools. Mayo faculty representatives (including Dr. McGee and co-PI on this application, Dr. Maihle) attend almost all national meetings which attract minority science students, including:

- MARC/MBRS national meetings
- The Society for the Advancement of Chicano and Native Americans in Science (SACNAS)
- The American Indian Science and Engineering Society (AISES)
- The Association of Minority Health Professions School (AMHPS)

Additionally, a number of individual schools with high minority enrollment are visited each year by Tumor Biology faculty. An extensive mailing list has been created with which information is sent each year to several hundred schools with high minority populations and advisors of minority students at non-minority schools.

### **Minority Undergraduate Summer Research Programs**

Special emphasis is placed on identifying and recruiting students from underrepresented minority groups through the Mayo Minority Scholar Program (MMSP) and the Summer Undergraduate Research Fellowship (SURF) program. These research programs recruit and support students from around the U.S. for a 10-12 week summer laboratory-based research

experience. Interest in this program has grown tremendously; for the summer of 1996, nearly 1000 students applied, including 300 underrepresented minorities. Sixty fellowships were awarded including 27 to minority students. Through these mechanisms Mayo staff often know and culture individual minority students for several years prior to their matriculation into a graduate program or the Medical School. Thereby Tumor Biology staff members are able to establish a relationship with individual minority applicants well in advance of their matriculation and they are able to assist in the transition to Mayo and Rochester.

**Task 6: "Assess Biology of Breast Cancer Predoctoral Training Program Effectiveness and Formalize Assessment in a Written Report."**

This new training program is currently undergoing an internal (Mayo Graduate School) review which will be completed in December of 1997. A draft report outlining the overall philosophy and goals of the program and their relationship to the overall mission of the institution is in process. Specific operational details of the program, and objective measures of it's success in recruitment applicants and education and mentoring of trainees based on their scientific productivity and accomplishments to date will be assessed. In addition, the program will be evaluated by objective measures of success such as its ability to attract extramural support, and written summaries from research scientists, clinical department heads, and from the Director of the Mayo Cancer Center indicating the practical value of this program for individual research programs, clinical trainees in in Oncology-related practice, and to the mission of the Cancer Center. Finally, a complete report will be made to the USAMRMC.

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**DAMD 17-94-J-4116**

## **Appendix**

<b>Exhibit</b>	<b>Contents</b>	<b>page</b>
<b>A. Selected Course Syllabus Outlines:</b>		
	Tumor Biology I:	
	Introduction for Tumor Biology	29
	Tumor Biology II:	
	Origins of Human Cancer	30
	Tumor Biology III:	
	Growth Factors, Oncogenes, and Tumor Suppressors	31
	Biology of Breast Cancer	32
	Business of Science, Science of Business	33
<b>B. Journal Club Titles</b>		34-37
<b>C. Table I: Academic Credentials of Trainees</b>		38
<b>D. Table II: Trainees, Their Mentors, and Thesis Titles</b>		39
<b>E. Publications of Trainees</b>		40-43
<b>F. Training Faculty</b>		44-46
<b>G. Internet Home Page for the Biology of Breast Cancer</b>		47
<b>H. Mayo Clinic Graduate School Bulletin</b>		(appended)

## Appendix Exhibit A

### Tumor Biology I: Introduction for Tumor Biology

(TBio 5000)

2:30 - 3:30 p.m. Tuesdays, Wednesdays, and Thursdays  
1093 Guggenheim

[50% participation/50% term paper]

October 1, 1996	Properties of transformed cells.	Nita Maihle, Ph.D.
October 2, 1996	Tumor Biology Journal Club: Boveri's "On the Origin of Malignant Tumors"	
October 3, 1996	Introduction to Journal Club and Problem Set Formats	
October 8, 1996	Methods Used to Study Cancer Cells <i>In Vitro</i>	Nita Maihle, Ph.D.
October 9, 1996	Tumor Biology Journal Club: Temin's soft agar colony assay, 1970	
October 10, 1996	Student Discussion Problem Set	
October 15, 1996	Methods Used to Study Cancer Cells <i>In Vivo</i>	Mark Pittelkow, M.D.
October 16, 1996	Moertel Lecture (Dr. Donald Coffey, Johns Hopkins University)	
October 17, 1996	Student Discussion Problem Set	
October 22, 1996	Animal models of DNA and RNA tumor virology	Mark Federspiel, Ph.D.
October 23, 1996	Tumor Biology Journal Club: Rous' Sarcoma Virus (1911)	
October 24, 1996	Student Discussion Problem Set	
October 29, 1996	Nude mice/SCID mice/xenografts	Nita Maihle, Ph.D.
October 30, 1996	Tumor Biology Journal Club: Siebens Symposium on Molecular Medicine	
October 31, 1996	Student Discussion Problem Set	
November 5, 1996	Genetically Engineered Models of Mouse Carcinogenesis	Chella David, Ph.D.
November 6, 1996	Tumor Biology Journal Club: p53 Knockout Mice	
November 7, 1996	Student Discussion Problem Set	
November 12, 1996	Antisense and Antigene Agents Targeted to Cancer-related Genes	James Maher, Ph.D.
November 13, 1996:	Tumor Biology Journal Club: C-raf kinase as a Target for Antisense	
November 14, 1996	Student Discussion Problem Set	
November 19, 1996	Introduction to Analysis of Human Tumors	Ann Thor, M.D.
November 20, 1996	Tumor Biology Journal Club: BRCA1	
November 21, 1996	Student Discussion Problem Set	
November 26, 1996	IRB Policies and Protocols Relevant to Studies on Human Tumors	Harry Long, M.D.
December 3, 1996	Introduction to Surgical Pathology	Joe Grande, M.D.
December 4, 1996	Tumor Biology Journal Club: BRCA1-Ring Protein Interactions	
December 5, 1996	Student Discussion Problem Set	
December 10-12,	(INDEPENDENT STUDY)	
(FINAL EXAM)	Due on Monday, December 16 by 5 p.m.	

## Appendix Exhibit A Tumor Biology II: Origins of Human Cancer

(TBio 8000)  
2:30 - 3:30 p.m. Tuesdays, Wednesdays, and Thursdays  
1093 Guggenheim

[50% participation/50% term paper]

January 7	Origins of Human Cancer: An Overview	Nita Maihle, Ph.D.
January 8	Tumor Biology Journal Club:	
January 9	Problem Set (Maihle)	
January 14	Origins of Human Cancer: Etiology and Genetics	David Smith, Ph.D.
January 15	Tumor Biology Journal Club:	
January 16	Problem Set (Smith and Maihle)	
January 21	Origins of Human Cancer: Progression and Metastasis	Sandra Gendler, Ph.D.
January 22	Tumor Biology and Journal Club: Angiogenesis	
January 23	Problem Set (Gendler and Maihle)	
January 28	Origins of Human Cancer: Epidemiology and Prevention	Ping Yang, M.D.
January 29	Tumor Biology Journal Club: Intestinal Polyposis and COX-2	
January 30	Tumor Immunology: An Overview	Malcolm Mitchell, M.D.
February 4	Problem Set (Epidemiology and Prevention; Yang and Maihle)	
February 5	Tumor Biology Journal Club (Tumor Immunology)	Diane Jelinek, Ph.D.
February 6	Problem Set (Tumor Immunology; Jelinek)	
February 11	Paraneoplastic Syndromes	Vanda Lennon, Ph.D.
February 12	Tumor Biology Journal Club: Paraneoplastic Autoimmunity	
February 13	Problem Set (Lennon and Jelinek)	
February 25	Introduction to Clinical Research	Judy O'Fallon, Ph.D.
February 26	Tumor Biology Journal Club: Phase I Trial of Dolastatin-10	
February 27	Problem Set (O'Fallon and Maihle)	
March 4	Introduction to Chemotherapy	Matthew Ames, Ph.D.
March 5	Tumor Biology Journal Club: Inhibitors of Farnesyl Transferase	
March 6	Problem Set (Ames and Maihle)	
March 11	Tumor Imaging: An Overview	Richard Robb, Ph.D.
March 12	Experimental Tumor Imaging	Richard Ehman, M.D.
March 13	Problem Set (Maihle)	
March 18	Introduction to Surgical Oncology	Heidi Nelson, M.D.
March 19	Tumor Biology Journal Club: Surgical Procedures in Colon Cancer	
March 25	Introduction to Radiation Therapy	James Bonner, M.D.
March 26	Breast Cancer: Patient Vignettes (radiation/chemotherapy)	
March 27	Experimental Gene Therapy	Corey Raffel, M.D.

## Appendix Exhibit A

# Tumor Biology III: Growth Factors, Oncogenes, and Tumor Suppressors

(TBio 8005)  
2:30 - 3:30 p.m. Tuesdays, Wednesdays, and Thursdays  
1093 Guggenheim

[50% participation/50% term paper]

April 8	Introduction to Cell Growth Control	Jeffrey Salisbury, Ph.D.
April 9	Tumor Biology Journal Club	
April 10	Problem Set	
	(AACR Meeting, April 12-16)	
April 15	Tumor Virology - DNA	Nita J. Maihle, Ph.D.
April 16	Tumor Biology Journal Club	
April 17	Problem Set	
April 22	Infectious Disease and Cancer Etiology	David Persing, M.D.
April 23	Tumor Biology Journal Club	
April 24	Problem Set	
April 29	Growth Factors/Receptors	Nita Maihle, Ph.D.
April 30	Tumor Biology Journal Club	
May 1	Problem Set	
May 6	Cytokines/Receptors	Diane Jelinek, Ph.D.
May 7	Tumor Biology Journal Club	
May 8	Problem Set	
May 13-15	Independent Study	
May 20	MCC-LAB Medicine Research Retreat (8 a.m.-4 p.m.)	
May 21	Transcriptional Regulation by Growth Factors	Mike Getz, Ph.D.
May 22	Problem Set	
May 27	Intracellular Mediators: Kinases and Phosphatases	Frank Rusnak, Ph.D.
May 28	Tumor Biology Journal Club	
May 29	Problem Set	
June 3	Intracellular Mediators: G Proteins	Robert Abraham, Ph.D.
June 4	Tumor Biology Journal Club	
June 5	Problem Set	
June 10	Tumor Suppressors I: An Overview	David Smith, Ph.D.
June 11	Tumor Biology Journal Club	
June 12	Problem Set	
June 17	Tumor Suppressors II: p53, Rb, and Others	David James, Ph.D.
June 18	Tumor Biology Journal Club	
June 19	Problem Set	

## Appendix Exhibit A Biology of Breast Cancer

Lecture Guggenheim 1093  
1:30-2:30 p.m. Fridays

(50% participation/50% final exam)

- This course is aimed at integrating basic concepts in developmental, cellular and molecular biology of the breast together with current information on the etiology, diagnosis and treatment of breast cancer.
- The faculty include members from diverse basic science and medical disciplines including cell and molecular biology, pathology, oncology and surgery.

April 11	Breast Cancer: The Magnitude of the Problem	James Ingle, M.D.
April 18	Development, Anatomy and Histology, and Cell Biology of the Breast	Jeffrey L. Salisbury, Ph.D.
April 25	Histopathology of the Breast	Lester Wold, M.D.
May 2	Experimental Models of Breast Cancer	Sandra Gendler, Ph.D.
May 9	Oncogenes, Growth Factors, and Breast Cancer	Edward Leof, Ph.D.
May 16	Tumor Suppressors and Breast Cancer	Steve Ritland
May 23	Radiation Therapy for Breast Cancer	Ivy Peterson, M.D.
May 30	Surgical Treatment of Breast Cancer	John Donohue, M.D.
June 6	Breast Cancer Diagnosis and Imaging	Ruth Johnson, M.D.
June 13	Systemic Therapy for Breast Cancer	James Ingle, M.D.
June 20	Experimental Therapies for Breast Cancer	Nita Maihle, Ph.D.
June 27	Final Examination Due (by 5:30 p.m.)	

## Appendix Exhibit A Business of Science, Science of Business

TBio 5300  
K. E. Bennet, M.B.A. and N. J. Maihle, Ph.D.  
Mayo Graduate School  
Summer Quarter (even years)

- 1) Introduction (August 2) Orientation and Objectives [KEB/NJM]
- 2) Administrative Structures in Support of Research (August 5) [KEB]  
Not-for-Profit & For Profit
- 3) Overview of Research Accounting (August 7) [KEB]  
Research Budgets  
Direct versus Indirect costs
- 4) Sources of Financial Support for Research (August 9) [NJM]  
Intramural & Extramural Support  
Federal & Private
- 5) Sources of Financial Support for Research (August 12) [KEB]  
Corporate  
Strategic Alliance, Joint Development  
Licensing/Venture Capital
- 6) Introduction to Intellectual Property (August 14) [KEB]  
Definition of Intellectual Property  
Protection of Intellectual Property  
Patents & Trade Secrets  
Ownership of Intellectual Property
- 7) Introduction of Cases (August 16) [KEB]
- 8) Commercialization of Research Discoveries (August 21) [KEB]  
Licensing  
Market Value of Invention
- 9) Independent Study on Cases (August 19)
- 10) Laws and Policies Governing Conduct of Research (August 23)  
Institutional [NJM]  
State, Federal and International [KEB]
- 11) Case Presentations "Levamisole" (August 26) [KEB/NJM]
- 12) Case Presentations - "University of Florida" (August 28) [KEB/NJM]
- 13) Course Wrap-Up (August 30) [KEB/NJM]

## Appendix Exhibit B

# Journal Club and Special Seminar Titles

<u>Date</u>	<u>Title</u>	<u>Presenter</u>
1/15	Mice lacking cyclin D1 are small and show defects in eye and mammary gland development. Fantl et al., (1995). <i>Genes and Devel.</i> 9:2364-2372. Cyclin D1 provides a link between development and oncogenesis in the retina and breast. Sicinski et al., (1995). <i>Cell</i> 82:621-630.	Dr. J.L. Salisbury
1/29	A p53-dependent mouse spindle checkpoint. Cross et al., (1995). <i>Science</i> 267:1353-1356.	Dr. R. White
2/5	BRCA1 and BRCA2 breast cancer susceptibility genes (1995). <i>Nature</i> 378: 789-792; (1994). <i>Science</i> 266: 66-71.	Mr. S. Ritland
2/12	Aberrant subcellular localization of BRCA1 in breast cancer (1995). <i>Science</i> 270:789-791.	Ms. T. Arora
2/26	Organization of heterologous DNA inserts on the mouse meiotic chromosome. <i>Chromosoma</i> 103:401-407	Mr R. Muthupillai
3/4	Magnetic resonance elastography by direct visualization of propagating acoustic strain waves. (1995) <i>Science</i> 269:1854-1857.	Mr. J. Parvizi
3/11	Early p53 alterations in mouse skin carcinogenesis by UVB radiation. Berg et al., (1996). <i>Proc. Natl. Acad. Sci.</i> 93:274-278.	Mr. Mike Rogers
4/23	Anti-angiogenic therapy of transgenic mice impairs <i>de novo</i> tumor growth. Parangi, et al., (1996). <i>Proc. Natl. Acad. Sci.</i> 93:2002-2007.	Dr. A. Baron
4/30	Role of the INK4a locus in tumor suppression and cell mortality. Serrano, et al., (1996) <i>Cell</i> 85:27-37.	Dr. Jill Reiter
5/7	Potential role of the inactivated X chromosome in ovarian epithelial tumor development. Cheng, et al., (1996) <i>J. Natl. Cancer Institute</i> 88:510-518.	Dr. J.B. Villeneuve
10/2	The Origin of Malignant Tumors. Theodor Boveri (1914). reprinted in English in 1929 as a monograph published by Williams and Wilkins Company.	Dr. Wilma Lingle
10/9	Characteristics of an assay for Rous Sarcoma Virus and Rous Sarcoma cells in tissue culture. Temin and Rubin (1958). <i>Virology</i> 6:669-688.	Ms. Nicole Becker
10/16	<b>Second Annual Charles G. Moertel, M.D. Lecture</b> New and Future Directions in Predicting Prostate Tumor Behavior	Dr. Donald Coffey

## Appendix Exhibit B

# Journal Club and Special Seminar Titles

<u>Date</u>	<u>Title</u>	<u>Presenter</u>
10/23	Metastasis and tumor immunity. Peyton Rous (1910). <i>JAMA</i> 55:1805. Transmission of a malignant new growth by means of a cell-free filtrate Peyton Rous (1911). <i>JAMA</i> 56:198. RNA-dependent DNA polymerase in virions of Rous Sarcoma virus. Temin and Mizutani (1970). <i>Nature</i> 226:1211-1213.	Mr. Jon Baines
10/30	<b>Harold W. Siebens Symposium on Molecular Medicine</b> Human Gene Therapy: Lessons from Viruses and Clinical Applications. Regulation of the Delivery of Therapeutic Proteins from Genetically Engineered Tissues. Gene Transfer and Cardiovascular Disease. Cell and Gene Therapy of Blood Diseases.	Dr. G. Nabel Dr J. Heard Dr. M. E. Nabel Dr. M. Brenner
11/6	High incidence of lung, bone, and lymphoid tumors in transgenic mice overexpressing mutant alleles of the p53 oncogene Lavigueur et al., (1989). <i>Mol. Cell. Biol.</i> 9:3982-3991. Mice deficient for p53 are developmentally normal but susceptible to spontaneous tumors. Donehower et al., (1992). <i>Nature</i> 356: 215-221. p53 loss of function: implications for the processes of immortalization and tumorigenesis. Finlay, (1992). <i>BioEssays</i> 14:557-560.	Dr. B. Silverman
11/13	Antitumor activity of a phosphorothioate antisense oligodeoxynucleotide targeted against <i>C-raf</i> kinase. Monia, et.al., <i>Nature Medicine</i> 2:668-675.	Ms. Julie Johnson
11/20	Aberrant subcellular localization of BRCA1 in breast cancer. Chen et al., (1995). <i>Science</i> 270:789-791. BRCA1 is secreted and exhibits properties of a granin. Jensen et al., (1996). <i>Nature Genetics</i> 12:303-308. Location of BRCA1 in human breast and ovarian cells. Scully et al., (1996). <i>Science</i> 272:123-125.	Mr. Michael Rogers
11/26	Mechanisms of HIV-1 reverse transcriptase resistance to nucleoside and nonnucleoside inhibitors.	Dr. S. H. Hughes
12/8	Identification of a RING protein that can interact <i>in vivo</i> with the BRCA1 gene product. Wu, et al., <i>Nature Genetics</i> 14:430-440.	Mr. Michael Rogers
1/22	Angiostatin induces and sustains dormancy of human primary tumors in mice. O'Reilly et al., (1996). <i>Nature Medicine</i> 2:689-692. Angiostatin: A novel angiogenesis inhibitor that mediates the suppression of metastases by a Lewis lung carcinoma. O'Reilly et al., (1994). <i>Cell</i> 79:315-328.	Dr. Richard White

## Appendix Exhibit B

# Journal Club and Special Seminar Titles

<u>Date</u>	<u>Title</u>	<u>Presenter</u>
1/29	Suppression of intestinal polyposis in Apc $\Delta$ 716 knockout mice by inhibition of cyclooxygenase 2 (COX-2). Oshima, et al., (1996). <i>Cell</i> 87:803-809.	Mr. Steve Ritland
2/5	Transfer of myeloma idiotype-specific immunity from an actively immunized marrow donor. Kwak, et.al., (1995). <i>The Lancet</i> 345:1016-1019. Tumor infarction in mice by antibody-directed targeting of tissue factor to tumor vasculature. Huang, et.al. (1997) <i>Science</i> 275:547-550	Mr. Jonathan Baines
2/12	$\alpha$ -Conotoxin Imperialis I inhibits nicotine-evoked hormone release and cell proliferation in human neuroendocrine carcinoma cells. Codignola, et. al.,(1996). <i>NeuroScience Letters</i> 206:53-56. Regulation of E-cadherin-mediated adhesion by muscarinic acetylcholine receptors in small cell lung carcinoma. Williams, et al., (1993). <i>J. Cell Biol.</i> 121:642-654.	Mr. Michael Gustafson
2/26	Analysis of a Phase I Clinical Protocol: Phase I Trial of Dolastatin-10 in Patients with Advanced Cancer." Pitot, et al., A Clinical Protocol.	Ms. Julie Johnson
3/5	Novel tricyclic inhibitors of farnesyl protein transferase. Bishop, et al., (1995). <i>J. Biol. Chem.</i> 270:30611-30618.	Mr. Greg Eley
3/12	Experimental Tumor Imaging: a Special Lecture.	Dr. Richard Ehman
3/19	Curative resection for left colonic carcinoma: hemicolectomy vs. segmental colectomy. Rouffet et al., (1994). <i>Diseases Colon and Rectum</i> , 37:651-659.	Ms. Sheri Holmen
3/26	Chemotherapy and Radiation Therapy: Breast Cancer Patient Vignettes.	Dr. N. Maihle
4/9	Ras signalling linked to the cell-cycle machinery by the retinoblastoma protein. Peeper, et al., (1997) <i>Nature</i> 386: 177-181.	Dr. André Baron
4/16	Kaposi's Sarcoma-associated Herpesvirus contains G protein-coupled receptor and cyclin D homologs which are expressed in Kaposi's Sarcoma and malignant lymphoma. Cesarman,et al., (1996). <i>J.Virology</i> 70:8218-8223.	Ms.Linda Frederick

## Appendix Exhibit B

# Journal Club and Special Seminar Titles

<u>Date</u>	<u>Title</u>	<u>Presenter</u>
4/23	The association of an HPV16 oncogene variant with HLA-B7 has implications for vaccine design in cervical cancer. Ellis, et al.,(1995). <i>Nature Medicine</i> 1(5):464-470.	Ms. Taruna Arora
4/30	Activation of <i>RET</i> as a dominant transforming gene by germline mutations of MEN2A and MEN2B. Santoro, et al., (1995). <i>Science</i> 267:381-383.	Mr. Jonathan Baines

## Appendix Exhibit C

### Table I: Academic Credentials of Trainees

<u>Name</u>	<u>Undergraduate School</u>	<u>GPA</u>	<u>GRE</u>
Baines, J. E.*¶	University of Arizona, Tucson, AZ	3.39/4.0	(MCAT 64)
Calhoun, E. S.*	Truman State University, Kirksville, MO	3.65/4.0	1920
Canales, N. D.	Mount St. Mary's, Los Angeles, CA	3.34/4.0	1690
Eley, G. D.	University of Georgia, Athens, GA	3.01/4.0	2070
French, J. D.	University of Sioux Falls, SD	3.94/4.0	1850
Holmen, S. L.¶	Western Michigan University, Kalamazoo, MI	3.68/4.0	1630
Johnson, J. L.	University of Wisconsin, Madison, WI	3.38/4.0	1880
Lomberk, G.	Boston College, Chestnut, MA	3.3/4.0	2100
Ritland, S. R.¶	University of Wisconsin, Eau Claire, WI	3.54/4.0	2010
Rogers, M. S.¶	Brigham Young University, Provo, UT	3.66/4.0	2390
Schehl, C. M.	University of Dayton, OH	3.3/4.0	1980
Xu, K.	Beijing Medical University, P.R. China	3.6/4.0	2160
Adelsman, M. A.	Mayo Clinic Graduate School	(Graduated with Ph.D. 6/96)	

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\*Members of under-represented minority groups.

¶ Passed Qualifying Exam.

## Appendix Exhibit D

### Table II: Trainees, Mentors, Thesis Titles

<u>Student</u>	<u>Mentor</u>	<u>Proposed Thesis Title</u>
Adelsman, M. A.	Dr. N. J. Maihle	"Ligand-Independent Dimerization of Oncogenic v- <i>erbB</i> Products"
Baines, J. E.	Dr. D. H. Persing	"Novel Immunotherapeutic Approaches to HPV-Induced Malignancies"
Calhoun, E. S.	Dr. D. F. Jelinek	Thesis project not determined
Canales, N. D.	Dr. S. J. Gendler	"The Role of Muc-1 in Mouse Mammary Tumor Metastasis"
Eley, G. D.	Dr. C. D. James	"Characterization of the Human Epidermal Growth Factor Receptor Amplicon"
French, J. D.	Dr. L. M. Karnitz	Thesis project not determined
Holmen, S. L.	Dr. M. J. Federspiel	"Viral Receptors Engineered to Inhibit Viral Entry"
Johnson, J. L.	Dr. N. J. Maihle	"Mechanisms of c- <i>erbB1</i> Oncogenic Signaling"
Lomberk, G.	Dr. D. I. Smith	Thesis project not determined
Ritland, S. R.	Dr. S. J. Gendler	"Genetic Linkage for Tumor Modifier Loci in the MMTV-neu Transgenic Mouse Mammary Tumor Model"
Rogers, M. S.	Dr. E. E. Strehler	"Studies on the Structure and Function of Human CLP in Breast Cancer"
Schehl, C. M.	Dr. N. J. Maihle	Thesis project not determined
Xu, K.	Dr. J. L. Salisbury	Thesis project not determined

## Appendix Exhibit E

# Publications of Trainees

### Adelsman, Margaret A.

#### **Papers**

**Adelsman MA**, Huntley BK, Maihle NJ: Ligand-independent dimerization of oncogenic *v-erbB* products involves covalent interactions. *J Virol* 70:2533-2544, 1996.

### Canales, Nohelia

#### **Abstracts**

Bower A, Serdoncillo C, **Canales N**: The specificity of atrial natriuretic peptide on the release control of melanocyte stimulating hormone from the pituitary.

**Canales N**, Radice G: Histological analysis of mammary glands in P-cadherin deficient mice.

Bower A, **Canales N**, Becker K, Ocampo M: Atrial natriuretic peptide release inhibition by dopamine and melanocyte stimulating hormone.

### Holmen, Sheri L.

#### **Papers**

**Holmen SL**, Ginsberg LC: Luciferase as a reporter gene for the expression of glucose 6-phosphate dehydrogenase in mammalian cells. *Proceedings*, Eighth National Conference on Undergraduate Research, Vol. III, pp 923-927, 1994.

**Holmen SL**, VanBrocklin MW, Eversole RR, Stapleton SR, Ginsberg LC: Efficient lipid-mediated transfection of DNA into primary rat hepatocytes. *In Vitro Cell Dev Biol* 30:347-351, 1995.

#### **Abstracts**

Effect of insulin on glucose-6-phosphate dehydrogenase activity. Fourth Annual Undergraduate Research Symposium, Argonne National Laboratories, Argonne, Illinois, 1993.

**Holmen SL**, Ginsberg LC, Stapleton SR, Rank KB: Luciferase as a reporter gene for the expression of glucose-6-phosphate dehydrogenase in mammalian cells. National Undergraduate Research Conference, Western Michigan University, Kalamazoo, Michigan, 1994.

Soluble forms of the avian leukosis virus receptor Tv-a significantly inhibit virus infection in vitro and in vivo. Retrovirus Meeting, Cold Spring Harbor, New York, 1997.

### Johnson, Julie L.

#### **Papers**

**Johnson JL**, Fenton S, Sheffield LG: Prolactin inhibits epidermal growth factor-induced Ras-MAPK signaling in mammary epithelial cells. *J Biol Chem* 271:21574-21578, 1996.

#### **Abstracts**

**Johnson JL**, Fenton SE, Sheffield LG: The effect of prolactin on EGF-induced Ras activity in mammary epithelium. Experimental Biology Meeting, 1995.

**Johnson JL**, Jelinek D: Analysis of insulin-like growth factor expression on normal vs. transformed B cells: Mayo Graduate School Poster Session, 1996.

**Johnson JL**, Maihle NJ: Receptor-mediated endocytosis and *v-erbB*-mediated transformation. Experimental Pathology and Laboratory Medicine Symposia, 1997.

Ritland, Steve R.

**Papers**

- Herrmann M, Hay I, Bartelt D, **Ritland S**, Dahl R, Grant C, Jenkins R: Cytogenetic and molecular genetic studies of follicular and papillary thyroid cancers. *J Clin Invest* 88:1596-1604, 1991.
- Ransom D, **Ritland S**, Kimmel D, Moertel C, Dahl R, Scheithauer B, Kelly P, Jenkins R: Cytogenetic and loss of heterozygosity studies in ependymomas, pilocytic astrocytomas, and oligodendrogliomas. *Genes Chromosom Cancer* 5:348-356, 1992.
- Ransom D, **Ritland S**, Moertel C, Dahl R, O'Fallon J, Scheithauer B, Kimmel D, Kelly P, Olopade O, Diaz M, Jenkins R: Correlation of cytogenetic analysis and loss of heterozygosity studies in human diffuse astrocytomas and mixed oligo-astrocytomas. *Genes Chromosom Cancer* 5:357-374, 1992.
- Cliby W, **Ritland S**, Hartmann L, Dodson M, Halling K, Keeney G, Podratz K, Jenkins R: Human epithelial ovarian cancer allelotype. *Cancer Res* 53:2393-2398, 1993.
- Cliby W, Sarkar G, **Ritland S**, Hartmann L, Podratz K, Jenkins R: Absence of prohibitin gene mutations in human epithelial ovarian tumors. *Gynecol Oncol* 50:34-37, 1993.
- Dodson M, Hartmann L, Cliby W, DeLacey K, Keeney G, **Ritland S**, Su J, Podratz K, Jenkins R: Comparison of loss of heterozygosity patterns in invasive low grade and high grade epithelial ovarian carcinomas. *Cancer Res* 53:4456-60, 1993.
- Tomlinson F, Keelan P, Scheithauer B, **Ritland S**, Jenkins R, Parisi J, Cunningham J, Olsen K: Aggressive medulloblastoma with high level n-myc amplification and p53 point mutation. *Mayo Clin Proc* 69:359-365, 1994.
- Cheng T, Ganju V, **Ritland S**, Sarkar G, Jenkins R: Analysis of p53 mutations in human gliomas by RNA single-strand conformational polymorphism. IN PCR in Neuroscience (G Sarkar, ed), pp 210-227, 1995.
- Dalrymple SJ, Herath JF, **Ritland SR**, Moertel CA, Jenkins RB: Use of fluorescence *in situ* hybridization (FISH) to detect loss of chromosome 10 in astrocytomas. *J Neurosurg* 83:316-323, 1995.
- Ritland SR**, Ganju V, Jenkins RB: Region-specific loss of heterozygosity on chromosome 19 is related to morphologic type of glioma. *Genes Chromosom Cancer* 12:277-282, 1995.
- Takahashi S, Shan AL, **Ritland SR**, Delacey KA, Bostwick DG, Lieber MM, Thibodeau SN, Jenkins RB: Frequent loss of heterozygosity at 7q31.1 in primary prostate cancer is associated with tumor aggressiveness and progression. *Cancer Res* 55:4114-4119, 1995.
- Ritland SR**, Rowse GJ, Chang Y, Gendler SJ: Loss of heterozygosity analysis in primary mammary tumors and lung metastases of MMTV-MTAg and MMTV-neu transgenic mice. *Cancer Res* 57:3520-3525, 1997.

**Abstracts**

- Ritland S**, Cheng C: Selection of pumpkin genomic DNA clones by zinc finger gene homology screening. Wisconsin Academy of Sciences, Green Bay, Wisconsin, May 1988.
- Ransom D, Jenkins R, Olopade F, Diaz M, **Ritland S**, Bren G: Loss of chromosome 10 alleles and loss of  $\alpha$ -interferon genes in human gliomas. (AACR, 1990) *Cancer Res Proc* 31:38, 1990.
- Ransom D, **Ritland S**, Jenkins R, Scheithauer B, Kelly P, Kimmel D: Loss of heterozygosity studies in human gliomas. (AACR, 1991) *Cancer Res Proc* 32:302, 1991.
- Jenkins R, Kimmel D, Moertel C, Stalboerger P, **Ritland S**, Ransom D. Cytogenetic and molecular genetic loss-of-heterozygosity studies in human ependymomas and pilocytic astrocytomas. (HGM11, 1991) *Cytogenet Cell Genet* 58:2029, 1991.
- Jenkins R, Ransom D, **Ritland S**, Moertel C, Dahl R, O'Fallon J, Scheithauer B, Kelly P, Kimmel D: Correlation of cytogenetics and loss of heterozygosity studies of chromosome 10 in gliomas. (4th International Workshop on Chromosomes in Solid Tumors, 1991) *Cancer Genet Cytogenet* 59:107, 1992.

- Herrmann M, **Ritland S**, Hay I, Jenkins R: Loss of heterozygosity studies in thyroid neoplasia. (4th International Workshop on Chromosomes in Solid Tumors, 1991) *Cancer Genet Cytogenet* 59:107, 1992.
- Cliby W, **Ritland S**, Hartmann L, Persons D, Podratz K, Jenkins R: Frequent allelic loss in epithelial ovarian cancers mapped to chromosome arms 6p, 6q, 11p, 13q, 17p, and 17q. (AACR, 1992) *Cancer Res Proc* 33:379, 1992.
- Wu P, **Ritland S**, Goellner J, Grant C, Jenkins R, Hay I: Allelic loss in differentiated non-medullary thyroid neoplasm. European Thyroid Association, 1992.
- Cliby W, **Ritland S**, Hartmann L, Dodson M, Podratz K, Jenkins R: Allelotype for epithelial ovarian cancer. Society of Gynecologic Oncologists, Palm Desert, California, February 1993.
- Dodson M, **Ritland S**, Cliby W, Podratz K, Hartmann L, Jenkins R: Loss of heterozygosity in low grade epithelial ovarian tumors. (AACR, 1993) *Cancer Res Proc* 34:511, 1993.
- Jenkins R, **Ritland S**, Halling K, Thibodeau S: An evaluation of microsatellite repeat expansion in human gliomas. Tenth International Conference on Brain Tumor Research and Therapy, Stalheim, Norway, May 1993.
- Jenkins R, Dodson M, Delacey K, **Ritland S**, Bartelt D, Cliby W, Podratz K, Hartmann L: Genetic studies of low and high grade epithelial ovarian tumors. 4th International Gynecologic Cancer Society, Stockholm, Sweden, August 1993.
- Dodson M, Hartmann L, Cliby W, DeLacey K, Keeney G, **Ritland S**, Su J, Podratz K, Jenkins R: Comparison of loss of heterozygosity patterns in invasive low grade and high grade epithelial ovarian carcinomas. Society of Gynecologic Oncologists, Orlando, Florida, February 1994.
- Dalrymple S, Herath J, **Ritland S**, Borell T, Jenkins R: Use of fluorescent in situ hybridization (FISH) to detect chromosome 10 loss in glial neoplasms. (Am Assoc Neurol Surgeons, 1993) *J Neurosurg* 80:413A, 1994.
- Ritland S**, Jenkins R: Deletion mapping of chromosome 19 in human oligodendroglioma, astrocytoma, and mixed oligoastrocytoma. (Keystone Tumor Suppressor Gene Symposia, Taos, New Mexico, February 1994) *J Cell Biochem* 18C:197, 1994.
- Ritland S**, Jenkins R: Quantitative image processing techniques in molecular genetic analysis. Keystone Histopathobiology of Neoplasia Workshop, Keystone, Colorado, July 1994.
- Ritland S**, Gendler S: Genetic analysis of tumorigenesis in transgenic mice. Mayo Dept. BMB Retreat, Winona, Minnesota, September 1995.
- Ritland S**, Rowse G, Gendler S: Loss of heterozygosity analysis in primary mammary tumors and lung metastases of mice transgenic for the polyoma middle T antigen. Genetic Mechanisms of Cancer, M.D. Anderson Cancer Center, Houston, Texas, October 1995.
- Ritland S**, Rowse G, Gendler S: Genetic analysis of APC<sup>Min</sup> and MMTV-MTAg transgenic mice. Tumor Susceptibility Genes, Keystone Conference, February 1996.
- Rowse G, **Ritland S**, Gendler S: Genetic modulation of mammary tumor development in mice transgenic for the *neu* protooncogene. American Association for Cancer Research, San Diego, California, May 1997.
- Ritland S**, Gendler S: Chemoprevention trials using 5-ASA in the Apc-Min mouse. Mayo Comprehensive Cancer Center, June 1997.
- Rowse G, **Ritland S**, Gendler S: Genetic modulation of mammary tumor development in mice transgenic for the *neu* protooncogene. American Association for Cancer Research, San Diego, California, May 1997.
- Rowse G, **Ritland S**, Gendler S: Role of genetic modulation in mammary tumorigenesis induced by overexpression of the *neu* proto-oncogene in transgenic mice. The Mouse in Mammary Carcinogenesis Research Meeting, Bar Harbor, Maine, September 1997.
- Ritland S**, Gendler S: Cancer chemoprevention studies using piroxicam in the Apc<sup>Min</sup> mouse. 5th International Conference on Eicosanoids and Other Bioactive Lipids in Cancer, Inflammation, and Related Diseases, La Jolla, California, September 1997.

- Ritland S, Gendler S:** Evaluation of 5-aminosalicylic acid for intestinal tumor chemoprevention in the *Apc<sup>Min</sup>* mouse. 5th International Conference on Eicosanoids and Other Bioactive Lipids in Cancer, Inflammation, and Related Diseases, La Jolla, California, September 1997.
- Ritland S, Rowse G, Chang Y, Gendler S:** Genetic mapping of a tumor suppressor gene locus in MMTV-*neu* transgenic mice. AACR Tumor Suppressor Genes Special Conference, Victoria B.C., September 1997.
- Ritland S, Rowse G, Chang Y, Gendler S:** Genetic analysis of mammary tumor susceptibility in MMTV-*neu* transgenic mice. DOD Era of Hope Conference, Washington, D.C., November 1997.

Rogers, Michael S.

*Papers*

- Rogers MS:** The overexpression of human cytosolic thymidine kinase in *E. coli*. Honors Thesis, Brigham Young University, Provo, UT, 1993.
- Borrowman A, **Rogers MS**, O'Neill KL: An improved washing apparatus for nucleoside phosphorylation assays. *BioTechniques* 15:402-406, 1993.
- Rogers MS, Strehler EE:** Calmodulin. IN Guidebook to the Calcium-Binding Proteins (Celio MR, Pauls T, Schwaller B, eds), Oxford University Press, Oxford, UK, pp 34-40, 1996.
- Rogers MS, Strehler EE:** Calmodulin-like proteins. IN Guidebook to the Calcium-Binding Proteins (Celio MR, Pauls T, Schwaller B, eds), Oxford University Press, Oxford, UK, pp 41-43, 1996.
- Garamszegi N, Garamszegi ZP, **Rogers MS**, DeMarco SJ, Strehler EE: Application of a chimeric green fluorescent protein to study protein-protein interactions. *BioTechniques* (in press).

*Abstracts*

- Rogers MS, Leavitt RW, O'Neill KL:** The overexpression of human cytosolic thymidine kinase in *E. coli*. Intermountain Branch Meeting of the American Society for Microbiology, May 1, 1993.
- Rogers MS, Rhyner JA, Strehler EE:** Identification and partial purification of a potential calmodulin-like protein specific target. Histopathobiology of Neoplasia Workshop of the American Association for Cancer Research, July 11, 1995.
- Rogers MS, Rhyner JA, Strehler EE:** Identification and partial purification of a potential calmodulin-like protein specific target. Annual Retreat of the Department of Biochemistry and Molecular Biology, Mayo Graduate School, July 22-23, 1995.
- Rogers MS, Foley MA, Ziesmer SC, Roche PC, Hartmann LC, Strehler EE:** Distribution of human calmodulin-like protein (CLP) in normal and breast tumor tissues. The Department of Laboratory Medicine/Pathology and the Mayo Cancer Center Research Symposium, May 20, 1997.

Schehl, Colleen M.

*Papers*

- Schehl CM, Ostrander GK:** Identification of the *BRCA1* germline mutation, 797delAA, in a Japanese breast-ovarian cancer patient. *J Natl Cancer Inst* (in press).
- Schehl CM, Ostrander GK:** Lack of germline mutations indicates the retinoblastoma (*Rb*) gene is not involved in hereditary predisposition to ovarian cancer in Japanese women (under revision).

*Abstracts*

- Schehl CM, Suzuki Y, Ostrander GK:** Retinoblastoma (*Rb*) gene sequence mutations and predisposition to ovarian cancer in Japanese women. 88th Annual Meeting of the American Association for Cancer Research, San Diego, California, April 12-16, 1997.

## Appendix Exhibit F

### THE FACULTY AND THEIR RESEARCH

- Robert T. Abraham, Associate Professor; Ph.D., Pittsburgh, 1981. Signal transduction; cell-cycle regulation; leukemogenesis; BRCA1 as a target of ATM.
- Matthew M. Ames, Professor; Ph.D., California, San Francisco, 1976. Development and characterization of novel antitumor agents.
- Amy G. Andrews, Assistant Professor; D.V.M., Michigan State, 1987. Animal models in cancer studies.
- James A. Bonner, Assistant Professor; M.D., Wayne State, 1985. Radiobiology.
- Chella S. David, Professor; Ph.D., Iowa State, 1966. Immunogenetic aspects of immune response, with emphasis on the major histocompatibility complex class II Ia genes and T-cell receptor gene.
- Gordon W. Dewald, Professor; Ph.D., North Dakota, 1972. Cytogenetics and molecular cytogenetics of congenital disorders and hematologic malignancies
- Richard L. Ehman, Professor; M.D., Saskatchewan, 1979. Magnetic resonance imaging.
- Charles Erlichman, Professor; M.D., Toronto (Canada), 1974. Pharmacology of drugs used in cancer therapy.
- Mark J. Federspiel, Assistant Professor; Ph.D., Michigan State, 1987. Retroviral vectors; antiviral strategies; molecular medicine.
- Lorraine A. Fitzpatrick, Professor; M.D., Chicago, 1980. Prostate cancer metastatic to bone; skeletal calcification; steroid regulation of metastatic disease.
- \*Sandra J. Gendler, Associate Professor; Ph.D., USC, 1984. Tumor cell biology; mucins in breast cancer and cystic fibrosis.
- Michael J. Getz, Professor; Ph.D., Texas at Houston, 1972. Molecular biology of peptide growth factors; biology of tissue factor in tumorigenesis, TGF and breast stromal response.
- Joseph P. Grande, Associate Professor; Ph.D., 1983, M.D., 1985, Chicago. Extracellular matrix and breast cancer; tumor pathology.
- Lynn C. Hartmann, Associate Professor; M.D., Northwestern, 1983. Mechanisms of carcinogenesis in epithelial ovarian cancer; drug/hormone resistance; familial cancers.
- James N. Ingle, Professor; M.D., Johns Hopkins, 1971. Clinical trials, hormonal therapy, and prognostic/predictive factors in breast cancer.
- C. David James, Associate Professor; Ph.D., Wright State, 1986. Cancer genetics; cell cycle regulation.
- Diane F. Jelinek, Assistant Professor; Ph.D., Texas Southwestern Medical Center, 1985. Cytokine-mediated signaling and gene expression in normal and malignant human B lymphocytes; IL-6 and breast cancer.
- Robert B. Jenkins, Associate Professor; Ph.D., 1981, M.D., 1983, Chicago. Genetics of brain, prostate and women's cancer.
- Scott H. Kaufmann, Associate Professor; M.D./Ph.D., Johns Hopkins, 1981. Pharmacology of topoisomerase-directed antineoplastic agents; apoptosis; resistance to anticancer drugs.
- Paul J. Leibson, Associate Professor; Ph.D., 1981, M.D., 1979, Chicago. Tumor immunology; lymphocyte activation; antiviral immunity.
- Vanda A. Lennon, Professor; M.B.B.S., Sydney (Australia), 1966; Ph.D., Melbourne (Australia), 1973. Immunobiology of autoimmunity and cancer; ionic channel protein antigens in human neoplasms of lung, ovary, and breast (carcinomas), and thymic epithelium (thymoma).
- Edward B. Leof, Associate Professor; Ph.D., North Carolina, 1982. TGF- $\beta$  regulation of cellular proliferation and breast cancer; genetics of pneumocystis carinii.

- Ricardo V. Lloyd, Professor; M.D./Ph.D., Wisconsin, Madison, 1975. Endocrine tumor biology, especially pituitary and thyroid.
- John A. Lust, Assistant Professor; M.D./Ph.D., Boston University, 1983. Role of IL-6 and IL-6R in pathogenesis of multiple myeloma; detection of minimal residual disease in myeloma transplant patients by PCR.
- L. James Maher, Associate Professor; Ph.D., Wisconsin, 1988. Nucleic acid biochemistry; triple helix DNA.
- Nita J. Maihle, Associate Professor; Ph.D., Yeshiva (Einstein), 1983. Molecular basis of cancer; human breast, ovarian, and prostate carcinomas; gliomas.
- David J. McKean, Professor; Ph.D., Johns Hopkins, 1972. Signaling and gene transcription events in T helper lymphocytes; MHC class II protein transport.
- Mark A. McNiven, Associate Professor; Ph.D., Maryland, 1987. Cytoskeletal dynamics in mammalian cells; molecular basis of cellular migration during metastasis; vesicle-based transport in epithelial cells.
- L. Joseph Melton, III, Professor; M.D., LSU, 1969. Chronic disease epidemiology.
- Heidi Nelson, Associate Professor; M.D., Washington (Seattle), 1981. Colorectal cancer; immunotherapy.
- Judith R. O'Fallon, Professor; Ph.D., North Carolina, 1973. Cancer clinical trials design, conduct, and analysis.
- Dennis J. O'Kane, Assistant Professor; Ph.D., SUNY at Stony Brook, 1979. Telomerase activity as a diagnostic marker for cancer; translational research on new tumor markers.
- David H. Persing, Associate Professor; M.D./Ph.D., California, San Francisco, 1988. Precore promoter mutations in hepatic tumors; immunogenetic determinants of chronic papillomavirus infections and cervical cancer; association of chronic infections with lymphoproliferation.
- Mark R. Pittelkow, Professor; M.D., Mayo, 1979. EGF-related growth factor/receptor function: epidermal keratinocyte and melanocyte regulation of growth and differentiation.
- Karl C. Podratz, Professor; M.D./Ph.D., St. Louis, 1974. Molecular prognostic determinants in gynecologic malignancies.
- Franklyn G. Prendergast, Professor; M.B.B.S., West Indies, 1968; Ph.D., Minnesota, 1977. Fluorescence spectroscopy; protein structure and dynamics; biochemistry and bioluminescence.
- Corey Raffel, Associate Professor; M.D./Ph.D., California, San Diego, 1980. Pediatric neuro-oncology; gene therapy and cancer.
- Jeffrey L. Salisbury, Professor; Ph.D., Ohio State, 1978. Cell cycle control; centrosomes; mitotic spindle poles; breast cancer.
- David I. Smith, Professor; Ph.D., Wisconsin, 1978. Chromosomal fragile sites; molecular genetics of cancer development.
- Thomas C. Spelsberg, Professor; Ph.D., West Virginia, 1967. Steroid action on early (*c-myc*) gene transcription, steroids and TGF- $\beta$  action on bone cell functions, and early gene expression.
- Emanuel E. Strehler, Associate Professor; Ph.D., ETH Zurich (Switzerland), 1981. Intracellular  $Ca^{2+}$  homeostasis and signaling; molecular mechanisms of disease, CLP in breast cancer.
- Stephen N. Thibodeau, Professor; Ph.D., Washington (Seattle), 1979. Cancer genetics; colon and prostate cancer.
- Donald J. Tindall, Professor; Ph.D., North Carolina, 1973. Mechanism of androgen action in prostate cancer.
- David O. Toft, Professor; Ph.D., Illinois, 1967. Mechanisms of action of steroid receptors and heat shock proteins.
- Raul Urrutia, Assistant Professor; M.D., Cordoba (Argentina), 1987. Cell differentiation.
- Richard M. Weinshilboum, Professor; M.D., Kansas, 1967. Molecular pharmacogenetics of drug metabolism - including antineoplastic agents.
- Peter J. Wettstein, Professor; Ph.D., North Carolina at Chapel Hill, 1977. Role of minor histocompatibility antigens in allograft rejection.

Anthony J. Windebank, Professor; B.M. B.Ch., Oxford, 1974. Molecular mechanisms of neurotoxic cell injury; growth factors and regeneration.  
Lester E. Wold, Professor; M.D., Chicago, 1977. Immunocytochemistry; bone tumors and tumor-like conditions; breast diseases.  
Charles Y-F. Young, Assistant Professor; Ph.D., Brigham Young, 1984. Calpain inhibitor-induced apoptosis in human prostate adenocarcinoma cells.

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\*Scottsdale campus.



## *MGS: Areas of Specialization and Faculty Research Interests*

Advanced courses, tutorials, seminars and journal clubs provide the depth of knowledge you will require to become an expert in your chosen field of study. Because our student-to-faculty ratio is low, classes frequently use small-group, interactive tutorial settings.

Listed below are brief descriptions of each of the areas of specialization offered by Mayo Graduate School.



### The Biology of Breast Cancer and Tumor Biology

This integrated, multi-disciplinary program offers specialized training in the biology of cancer, especially women's cancers. The 32-member faculty have research and clinical appointments in a broad range of medical and research specialties. The program's research strengths include gene regulation, cell cycle control, oncogene and tumor suppressor action, tumor immunology, signal transduction, anti-tumor pharmacology, and the biology of breast, ovarian, uterine, lung, gastrointestinal and prostate cancers.

Supported in part by a grant from the USAMRMC Breast Cancer Research Program: DAMD 17-94-J-4116.

The faculty contact person is:

Jeffrey L. Salisbury, Ph.D.  
Department of Biochemistry and Molecular Biology  
507-284-4070  
[salisbury@mayo.edu](mailto:salisbury@mayo.edu)



**Return to: Mayo Graduate School**

**Home  
Page**

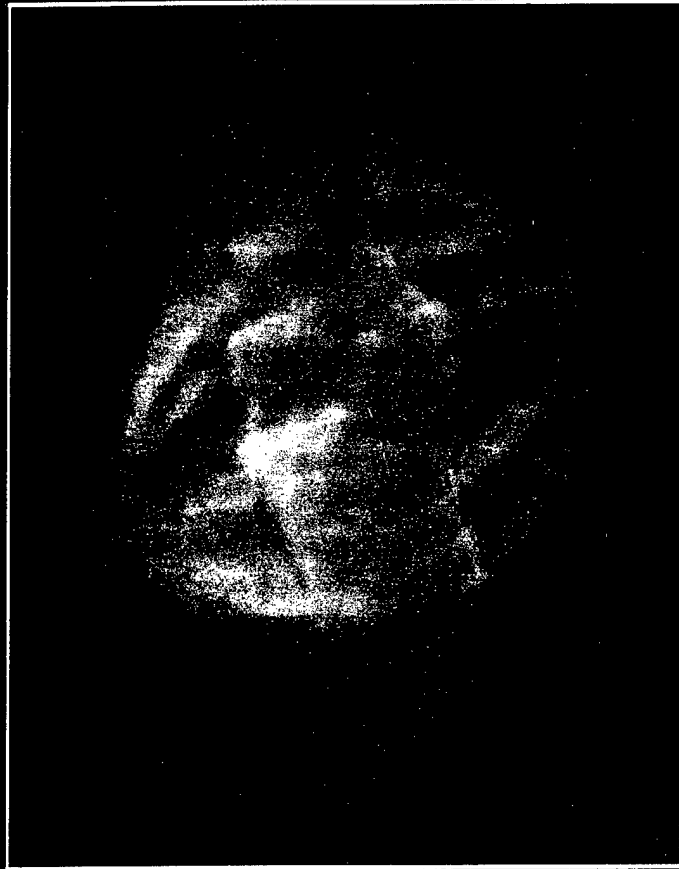
**Locations**

**Table of  
Contents**

**Search**

**Other  
Resources**

**How to  
Contact Us**



M A Y O

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GRADUATE SCHOOL  
DEGREE PROGRAMS  
1997 - 1998



Cover: HeLa mitotic spindle stained for microtubules (green) and DNA (blue). Provided by Jeffrey L. Salisbury, Ph.D.

## **The Mayo Vision**

Mayo aspires to provide the highest quality, compassionate care at a reasonable cost through a physician-led team of diverse people working together in clinical practice, education and research in a unified multi-campus system.

## **The Mayo Pledge**

Mayo pledges to conduct its interdependent programs of medical care, research and education in keeping with the highest standards of ethics and quality. Fundamental to this pledge is the absolute need to combine the science and art of medicine and technology with personalized care. Excellence in all endeavors with respect for the individual—both patient and employee—is the primary goal. Mayo will achieve this pledge through:

Comprehensive and compassionate patient care delivered through an integrated, multispecialty group practice.

Superior biomedical research.

Scholarly educational programs to teach and train medical and scientific professionals for national and Mayo needs and to be a health information resource for the public.

## **Institutional Principles**

To realize the vision, and in keeping with the pledge, Mayo has as its principles:

1. To honor the commitment that "the needs of the patient come first."
2. To be local, regional, national and international in service.
3. To emphasize access for patients who may most benefit from Mayo's practice characteristics.
4. To be a unified, integrated medical system in multiple locations offering the Mayo style of group practice.
5. To recruit and retain outstanding people to work as a team in an interdisciplinary setting.
6. To respect the individual contributions of each member of the Mayo family and to reaffirm the importance of "continuing interest by every member of the staff in the professional progress of every other member."
7. To promote cultural diversity and equality of opportunity within the Mayo family.
8. To serve appropriately those patients whose financial circumstances indicate that payment of normal charges would be a difficult burden.
9. To be a leader in conducting our activities in a manner which protects, conserves and reuses natural resources.
10. To consider resource allocation at Mayo within the perspective of a system rather than its individual entities.
11. To conduct our activities in a manner that permits a financial return sufficient to meet present and future requirements, both operational and capital, for its programs in practice, education and research.
12. To measure success in terms of quality and not quantity; service and not self-serving; financial security and not accumulated wealth; system in contrast to individual entity.

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## 1997-98 ACADEMIC CALENDAR

### Fall Quarter

Registration for fall quarter courses due - September 5, 1997.\*  
Fall quarter begins - September 29, 1997.  
Last date to withdraw - November 7, 1997.  
Thanksgiving Holiday - November 27, 1997.  
Last day of quarter - December 19, 1997.  
Break - December 20, 1997 - January 4, 1998.

### Winter Quarter

Registration for winter quarter courses due - December 12, 1997.\*  
Winter quarter begins - January 5, 1998.  
Last date to withdraw - February 13, 1998.  
Last day of quarter - March 27, 1998.  
Break - March 28 - April 5, 1998.

### Spring Quarter

Registration for spring quarter courses due - March 13, 1998.\*  
Spring quarter begins - April 6, 1998.  
Last date to withdraw - May 15, 1998.  
Memorial Day Holiday - May 25, 1998.  
Last day of quarter - June 26, 1998.

### Summer Quarter

Registration for summer quarter courses due - June 5, 1998.\*  
Summer quarter begins - June 29, 1998.  
Independence Day Holiday - July 3, 1998.  
Last date to withdraw - August 7, 1998.  
Labor Day Holiday - September 7, 1998.  
Last day of quarter - September 18, 1998.  
Break - September 19 - 27, 1998.

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\*Later registration allowed, with permission of instructor, if course less than 15% completed.

## 1998-99 ACADEMIC CALENDAR

### Fall Quarter

Registration for fall quarter courses due - September 4, 1998\*  
Fall quarter begins - September 28, 1998  
Last date to withdraw - November 6, 1998  
Thanksgiving Holiday - November 26, 1998  
Last day of quarter - December 18, 1998  
Break - December 19, 1998 - January 3, 1999

### Winter Quarter

Registration for winter quarter courses due - December 11, 1998\*  
Winter quarter begins - January 4, 1999  
Last date to withdraw - February 12, 1999  
Last day of quarter - March 26, 1999  
Break - March 27 - April 4, 1999

### Spring Quarter

Registration for spring quarter courses due - March 12, 1999  
Spring quarter begins - April 5, 1999  
Last date to withdraw - May 14, 1999  
Memorial Day Holiday - May 24, 1999  
Last day of quarter - June 25, 1999

### Summer Quarter

Registration for summer quarter courses due - June 4, 1999\*  
Summer quarter begins - June 28, 1999  
Independence Day Holiday - July 5, 1999  
Last date to withdraw - August 6, 1999  
Labor Day Holiday - September 6, 1999  
Last day of quarter - September 17, 1999  
Break - September 18 - 26, 1999

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\*Later registration allowed, with permission of instructor, if course less than 15% completed.

**MAYO FOUNDATION**  
**DEPARTMENT OF EDUCATION SERVICES**

Richard M. Weinsilboum, M.D.  
*Director for Education*

M. Marsha Hall  
*Chair, Department of Education Services*

Richard McGee, Ph.D., Director  
Office of Minority Affairs

Jackie L. Johnson, M.S.W.  
*Minority Student Adviser*

***Mayo Graduate School***

Anthony J. Windebank, M.D.  
*Dean*

Richard McGee, Ph.D.  
*Associate Dean for Student Affairs*

Catharine J. Chellgren  
*Registrar/Administrator*

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## TABLE OF CONTENTS

	Page
Introduction .....	7
Policies .....	13
Description of Ph.D. Degree Program and Basic Science Track Requirements .....	19
Description of Master's Degree Program and Basic Science Track Requirements .....	41
Description of Employee Master's Degree and Track Requirements .....	53
Description of Master's Degree Program and Clinical Track Requirements .....	67
Course Listing .....	85
Graduate Faculty Listing .....	137
Index .....	169



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## INTRODUCTION



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## HISTORY

The Mayo Foundation, of which the Mayo Clinic is a part, developed gradually from the family medical practice of Dr. William Worrall Mayo and his sons, Dr. William James Mayo and Dr. Charles Horace Mayo. The elder Dr. Mayo came to Rochester in 1863 to practice medicine. His sons assisted him during their boyhood and later joined him in the practice of medicine. As the demand for their services increased, the Mayos invited other physicians to work with them.

This pioneering venture in the private group practice of medicine became known in the early 1900s as Mayo Clinic. This name today describes an organization of over 1700 scientists and medical and surgical specialists working together as a team for the advancement of medical and biomedical education, research in medicine and related sciences and medical care.

The Mayo Graduate School originally was organized under the auspices of Mayo Graduate School of Medicine. In January 1989, Mayo Graduate School became a separate unit that administers Mayo Ph.D. and Master's degree programs in the basic sciences and Master's degree programs in the clinical sciences. Enrollment currently includes approximately 120 Ph.D. or M.D.-Ph.D. candidates in basic science fields and 15 master's candidates in clinical fields. Other educational components of Mayo Foundation include:

- Mayo Graduate School of Medicine, organized in 1915 to offer programs of graduate medical education. Enrollment currently includes more than 1000 residents and fellows in clinical fields and 230 research fellows involved in postdoctoral basic science research training.
- Mayo Medical School, an undergraduate medical school offering the M.D. degree, opened in 1972, with a current enrollment of 160 students.
- Mayo School of Health-Related Sciences, organized in 1972 to provide training and certification in the health professions allied to medicine. Twenty-one programs are offered with a total enrollment of over 300. Two of the 21 programs include a Masters in Physical Therapy and and Masters in Nurse Anesthesia.
- Mayo School of Continuing Medical Education, organized in 1977 to provide continuing education for physicians, through the staff of Mayo Clinic.

Mayo Foundation is accredited by the Commission on Institutions of Higher Education of the North Central Association of Colleges and Schools.

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## RESEARCH OPPORTUNITIES

Outstanding research opportunities are open to those accepted into the educational programs of the Mayo Graduate School and Mayo Graduate School of Medicine. Two modern buildings with a total of more than 965,000 square feet of space are largely devoted to research programs and related services. Other research space and facilities are scattered throughout the institution. State of the art facilities are available in each of the basic science departments.

Mayo research programs offer a spectrum of diverse opportunities for individuals

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in nearly all aspects of biomedical sciences. Mayo has a long history of internationally recognized research in areas as diverse as: the biochemistry of endocrine hormones; the physiology of respiratory, cardiovascular and gastrointestinal systems; the molecular mechanisms that regulate the immune response; analysis of the genes encoding blood clotting factors; and three dimensional computer-based magnetic resonance imaging.

The research programs have been open from their inception to graduate students, medical students, research fellows, and residents.

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## **FACULTY**

All staff appointments are made to Mayo Clinic/Mayo Foundation and this staff constitutes the faculty for the educational programs of Mayo Foundation. The 1700-plus faculty members include full-time investigators in the sciences related to medicine, clinician-investigators and clinicians. Each member of the staff is full-time salaried, and individual staff members have ample opportunity to teach. Members of the staff have the overall responsibility for undergraduate and graduate education in medicine and the medical sciences, for continuing education and research as well as for the care of patients. Graduate faculty privileges are awarded to qualified faculty members with interest in delivering graduate level courses and in supervising candidates for graduate degrees (see listing of graduate faculty, last section of the catalog).

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## **FACILITIES**

The majority of the educational programs, clinical practice and research are conducted in Rochester within the facilities of Mayo Foundation. Mayo facilities in Jacksonville, Florida and Scottsdale, Arizona, which were opened in 1986 and 1987, also participate in Mayo's clinical practice, education and research programs.

### **Rochester**

Mayo Foundation's Rochester facilities are located in a seven-block area in downtown Rochester. The 22-story Murry and Leonie Guggenheim Building houses a large proportion of the research laboratories and lecture halls. The Medical Sciences Building is devoted largely to research and educational activities in anatomic pathology, biophysics and surgery, among others. The Plummer Building is home for the Medical Library and many support services as well as some research and diagnostic laboratories. Rochester Methodist Hospital is within the same area and Saint Marys Hospital, which includes additional research facilities, is about a mile away.

The 20-story Mayo Building is the heart of the Mayo complex. It houses most of the medical and surgical departments and is the center for outpatient diagnosis. The administrative offices of Mayo Graduate School, Mayo Graduate School of Medicine and Mayo School of Health-Related Sciences are located in the Siebens Building. Most of Mayo's clinical laboratories are in the Conrad N. Hilton Building. The Harwick Building contains medical and x-ray records, the computer

center and full-service cafeteria. Mayo Medical School's administrative offices, learning resource center and student lounge are contained in the Mitchell Student Center. The Baldwin Building for Community Medicine is the center of care for Rochester area patients.

## **Jacksonville**

Mayo Clinic Jacksonville is a comprehensive outpatient medical facility located on 240 acres near the Intracoastal Waterway in eastern Jacksonville. It includes a full-service laboratory, an on-site pharmacy, an ambulatory surgical center and a radiation-oncology center. A state-of-the-art medical research building houses researchers conducting a large-scale study of Alzheimer's disease.

St. Luke's Hospital, located nine miles inland from the clinic, is a modern 289-bed facility with 16 operating rooms, two ICUs, a bone marrow transplant unit, an epilepsy unit, two cardiac catheterization laboratories and a stereotactic neurosurgery suite.

## **Scottsdale**

Mayo Clinic Scottsdale is a comprehensive outpatient clinical facility located on 149 acres in northern Scottsdale. It includes an ambulatory surgical center, a pain clinic, a full-service laboratory, an on-site pharmacy, a patient library, and an 188-seat auditorium used for physician and patient education programs. The 75,000-square-foot Johnson Medical Research Center houses researchers focusing on molecular genetics, molecular immunology, molecular and cell biology, and molecular chemistry.

## **Telecommunications System**

Mayo's clinics in Rochester, Scottsdale and Jacksonville are linked via a sophisticated video telecommunications system, which provides video teleconferencing and data transmission. Staff in Rochester, Scottsdale and Jacksonville can have live, interactive consultations at the other sites via TV monitors. Clinical and research test results can be transmitted between sites. In addition, Mayo has a five-digit telephone dialing and pager system that ties together all three practice sites.

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## **OFFICE OF MINORITY STUDENT AFFAIRS**

The Office of Minority Student Affairs assists and supports minority students in all of the educational programs at Mayo. Located on the fifth floor of the Siebens Building, it is staffed by Dr. Richard McGee, Director of the Office and Associate Dean for Student Affairs in the Graduate School and Ms. Jackie Johnson, Minority Student Adviser. Both are available to answer questions and provide assistance with any issue related to the needs of minority students in Mayo and the Rochester community.

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## **EMERGENCY LOANS**

Limited short-term financial help for graduate students is available to help alleviate financial hardship resulting from an emergency. Details are available in the Graduate School Office, telephone 284-3163.

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## **ROCHESTER**

Rochester provides many cultural, educational and other activities not usually found in cities of similar size. Local people provide the talent and support for a symphony orchestra and chorale, a civic theater, an independent repertory theater, a community art center and a historical society. The Minnesota Orchestra, the Saint Paul Chamber Orchestra, and other nationally known entertainers perform regularly at Mayo Civic Auditorium. Eight colleges or universities offer classes in Rochester or at campuses within an hour's drive of the city.

The four seasons enjoyed by Rochester provide opportunities for ice skating, skiing, biking, hiking, and hunting. The local lakes and rivers are utilized for a variety of water sports. Attractions in the Twin Cities, Minneapolis and St. Paul (80 miles to the north of Rochester), include the Tyrone Guthrie Repertory Theater, Minnesota Orchestra, Mall of America, professional baseball, basketball, and football.

Rochester offers a variety of apartments at rates comparable to those in other cities of similar size.

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## **GRADUATE STUDENT ASSOCIATION**

The Mayo Graduate Student Association is composed of all students pursuing graduate degrees at the Mayo Graduate School. Its purpose is to facilitate interaction among graduate students, and between students, faculty and administration. It provides a means for students to give input to departments concerning coursework and curriculum. A graduate student is chosen each year by the Graduate Student Association to serve on the Mayo Graduate School Education Committee.

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## POLICIES



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## STIPENDS

Students with baccalaureate or Master's degrees who are accepted into the Ph.D. program receive a regular bi-weekly stipend beginning at commencement of the program. The stipend continues for an expected duration of four years contingent upon satisfactory performance. Extensions for additional years may be requested from the Mayo Graduate School Education Committee and are granted if performance is satisfactory and funding is available from the program, laboratory or extramurally. The stipend for all graduate students is set at a uniform level (\$15,500 for 1997-98) and is reviewed at regular intervals.

Students who are accepted into a combined M.D.-Ph.D. program are provided a stipend (\$15,500 for 1997-98). The stipend continues throughout the student's M.D.-Ph.D. program. Medical School and Graduate School tuition and fees are provided by a full scholarship for students accepted into this combined M.D.-Ph.D. program, with satisfactory performance.

Clinical residents accepted into the Master's program receive the usual stipend for clinical fellows at their level of training.

Employees pursuing master's degrees on a part-time basis receive their usual employee salary.

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## TUITION

Annual tuition for Ph.D. graduate students is \$17,900. Tuition for non-degree candidates is \$200 per quarter credit. Tuition is provided by a full scholarship for students who are enrolled in a degree program of Mayo Graduate School. Extramural sources of funds are used to defray tuition when appropriate.

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## REGISTRATION

Registration for Mayo Graduate School courses is accomplished through the Graduate School Office and must be made in writing before the applicable deadline (see Academic Calendar). Mayo courses are primarily intended for individuals appointed to the educational programs of Mayo Graduate School. Others can enroll if they show appropriate prerequisites and secure the course chair's approval. Openings in some courses are severely limited; degree candidates are given preference for these courses.

*Registration for credit* - Unless waived, payment of tuition is required at the time of registration. Tuition is refunded if a course is cancelled.

### *Changes in registration*

- If a student withdraws within the first one-half of a course, tuition is refunded and a grade of "W" is recorded on the transcript. Later withdrawals result in a grade of "F", and tuition is not refunded. Withdrawal forms are available in the Graduate School office.
- **Retroactive registration after a course is completed is not permitted.**
- Students who wish to register for a course after the deadline date must get written permission from the instructor of the course. Late registration forms are available in the Graduate School office.

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## GRADING SYSTEM

Mayo Graduate School uses two grading systems:

A	Outstanding	S	Satisfactory
A-	Excellent	N	No credit
B+	Very Good		
B	Acceptable		
B-	Marginal/below standards expected		
C+	Below standards		
C	Poor/lowest performance to receive credit		
F	Unsatisfactory		

The Grade Point (GPA) average is based on:

A	=	4.0	B-	=	2.7
A-	=	3.7	C+	=	2.3
B+	=	3.3	C	=	2.0
B	=	3.0	F	=	0.0

The grading system to be used is determined at the time the course is established. A grade of S or N is not considered in determination of GPA. The GPA, which is recorded on the official transcript, is calculated by dividing the sum of all grade points earned by the sum of all credits assigned grade points.

In addition to the grades the transcripts show the following, if applicable:

W – Withdraw

I – Incomplete. Students have, at the option of the faculty, a maximum of one year to make up any deficiency. If the deficiency is not corrected within the year, the transcript will show an "F" for the course.

X – The course is continued over more than one quarter and the grade assigned at the end of the final quarter.

Students may retake courses to improve their grades with the permission of their adviser and the course chair. Both grades will appear on the transcript and the higher grade will be used in computation of the GPA.

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## TRANSCRIPT REQUEST

Official transcripts will be issued by the Graduate School office only upon receipt of a written request.

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## DEFINITION OF CREDIT HOUR

Credit is determined by the number of contact hours per week. A one-hour lecture per week equals one credit per quarter. A quarter is usually 12 weeks. Credit is also given for laboratory time in some courses.

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## COURSE NUMBERING

Courses at the 5— and 8— levels are graduate level courses that may be used in fulfillment of degree program requirements. Courses at the 8— level are considered to be at the boundary of what is known or done in a particular field. They can be expected to be exceptionally rigorous.

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## STUDENT RESPONSIBILITY

Each graduate student must complete all requirements established for his or her degree by the Graduate School and the Program. **It is the student's personal responsibility to be aware of and understand these requirements.** A student's adviser may not assume these responsibilities, nor may substitute, waive, or exempt the student from any established requirement or academic standard. Such exemptions may, however, be proposed for consideration by the Graduate School, which reserves the right to modify requirements at any time.

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## TRANSFER CREDITS

Students who wish to transfer credits to substitute for a Mayo course must contact the Mayo course director. If the course director determines that a student has the knowledge equivalent to satisfactory performance in the Mayo course, the student will receive the transfer credits.

Students who wish to transfer credits for courses not offered at Mayo may request credit for graduate courses taken at other institutions if they received a grade of A or B. The request must have the approval of the student's education coordinator and the Graduate School. A description of the course from the course catalog or a course outline must accompany the request. The time interval since the credits were earned is a consideration in such decisions. Credits must normally have been earned within the previous ten years (more recently in the case of rapidly advancing subjects).

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## RESIDENCE REQUIREMENT

Regardless of how many transfer credits are awarded, candidates for graduate degrees from Mayo Graduate School must complete a minimum period in residence after admission to their degree program. For Ph.D. degree candidates, the minimum period of residence will be two years, and for Master's degree candidates the period is one year.

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## EXTENSIONS

Graduate student appointments are for four years and M.D.-Ph.D. appointments

are for three years in the graduate program. Extensions beyond the fourth year for Ph.D. students and beyond three years for M.D.-Ph.D. students, with stipend support, are permitted with evidence of satisfactory performance and a recommendation signed by at least four of the five members of the student's advisory committee. Each extension is for a maximum of one year.

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## CONFIDENTIALITY OF STUDENT RECORDS

The Family Educational Rights and Privacy Act (FERPA) affords students certain rights with respect to their education records. They are:

1. The right to inspect and review their education record.
2. The right to request the amendment of the education record to ensure that it is not inaccurate, misleading, or otherwise in violation of the student's privacy or other rights.
3. The right to consent to disclosure of personally identifiable information contained in the education records, except to the extent FERPA authorizes disclosure without consent.
4. The right to file with the U.S. Department of Education a complaint concerning alleged failures by Mayo Graduate School to comply with the requirements of FERPA.
5. The right to obtain a copy of Mayo Graduate School's student records policy.

The complete FERPA policy is available in the Student/Faculty Handbook.

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## EQUAL OPPORTUNITY/AFFIRMATIVE ACTION


Mayo Graduate School is committed to equal opportunity and affirmative action in the appointment process. This policy is in accord with the policy of Mayo Clinic and Mayo Foundation, which is to seek and select persons for appointment, employment or admission, and to train, advance, promote, transfer and compensate such persons on the basis of individual capability, potential or contribution to the programs and goals of the institution. In making these selections and subsequent personnel decisions, Mayo actively encourages the recognition, development and optimal use of the capabilities of women, racial minorities, persons with disabilities and veterans of the Vietnam era.

Additionally, Mayo observes, respects and supports stated policies of the State and Federal governments that preclude discrimination. Each department chair, administrator, supervisor and employee of Mayo Clinic and Mayo Foundation is responsible for conducting appointment and employment activities in compliance with this policy.

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A Student/Faculty Handbook with Mayo Graduate School policies and procedures is available in the Mayo Graduate School office.

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**DESCRIPTION OF  
PH.D. DEGREE PROGRAM  
AND BASIC SCIENCE  
TRACK REQUIREMENTS**



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## THE DOCTOR OF PHILOSOPHY PROGRAM IN BIOMEDICAL SCIENCES

### Purpose and Philosophy

The Biomedical Sciences Ph.D. Program is intended to train students in the most modern approaches to biomedical research, and to assist with development of analytical, technical, oral and written communication skills which allow students to become independent investigators of the most important and challenging problems in biomedical research.

Students are provided with a supportive atmosphere where they can find role models and mentors to emulate in the development of their research skills and begin acculturation into the biomedical research community. Courses introduce students to the body of information most important to their subsequent research endeavors, and other educational activities facilitate the development of independent learning skills. Students are assisted with formulation of career goals and pathways which best utilize their individual talents and skills.

Mayo's Ph.D. program places heavier emphasis on research training than it does on course work. This philosophy is a natural outgrowth of the institution's long history as a center for investigation in the life sciences. Courses are nevertheless an integral part of the Ph.D. program, providing the intellectual foundation necessary for a well-rounded scientist. A minimum of forty-two credits are required of all Ph.D. students. Mayo's graduate level courses in specific disciplines of the basic sciences will be adequate preparation for most students. Degree candidates who need to obtain additional specialized course work not available at Mayo will be provided with an opportunity for up to three academic quarters of off-campus study at a cooperating institution of higher learning. In such cases, the normal graduate student stipend will continue, and full tuition will be reimbursed. All Ph.D. candidates must complete at least two years of full-time registration at Mayo to be eligible for their degree.

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### ADMISSIONS REQUIREMENTS

To be considered for admission to the Ph.D. program, applicants should:

1. Hold a bachelor's degree from an accredited college or university with a minimum 3.0 Grade Point Average based on the 4.0 scale.
2. Have received scores on the verbal, analytical, and quantitative aptitude tests of the Graduate Record Examination indicating strong academic ability (i.e., above the 75th percentile). Subject Tests (e.g. biology, chemistry, biochemistry) are strongly encouraged.
3. Have a minimum undergraduate background with evidence of superior performance, including:

Two years of college chemistry (includes organic)	One year of biology
One year of calculus	One year of physics

A course in biochemistry or molecular biology is highly recommended.

See track requirements for additional course prerequisites.

4. Supply supporting documents, including:

- Official transcripts
- Official copies of GRE or MCAT scores
- Three letters of recommendation

Foreign applicants must take the Test of English as a Foreign Language (TOEFL) to be considered for an appointment.

Each area of specialization may establish additional requirements.

Inquiries regarding admission to the Ph.D. Program in the Biomedical Sciences should be directed to:

Mayo Graduate School  
200 First Street Southwest  
Rochester, MN 55905  
(507) 266-0122  
phd.training@mayo.edu

Completed applications must be submitted by December 31.

Authority to make appointments rests with the Graduate School Education Committee on the recommendation of the individual department or program education committee.

Falsifying or omitting information on or accompanying the application may disqualify an applicant from admission or subject a student to dismissal.

The application and supporting documents become the property of Mayo Graduate School upon receipt.

The average number of years to degree is 4.95.

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## CORE COURSES (MINIMUM 13 CREDITS)

Students must complete a minimum of 13 credits of didactic course work which will provide a broad-based foundation in the biomedical sciences. The 13 credits must include the required one-credit course entitled, "Responsible Conduct of Research." The courses should normally be outside the area of specialization, but exceptions may be approved on an individual basis. A student's program of courses is individually developed in consultation with his or her adviser. A series of basic graduate level courses are available to students so they may obtain a comprehensive background in the fundamental disciplines of biochemistry, cell biology and molecular biology. Seminars and journal clubs are not permitted as core courses.

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## AREA OF SPECIALIZATION (MINIMUM OF 18 CREDITS)

The core courses are followed by course work in the area of specialization (minimum of 18 credits). These courses are chosen with the aid and approval of the student's adviser. Courses appropriate to the different areas of specialization are outlined in the next section. The remaining 11 credits can be selected from any area that the student and adviser deem appropriate and necessary.

The typical program structure is as follows:

Year I - Core, area of specialization coursework, and laboratory rotations

Year II - Advanced courses and commencement of thesis research

Year III & IV - Primarily thesis research with some additional advanced courses

All students enrolled in the Ph.D. program are full-time students. Full-time enrollment each quarter may include any combination of coursework, lab rotations or research. Students who have completed all coursework and are engaged in full-time thesis research must register for research each quarter. These students retain full-time enrollment status and will be graded on the S-N scale. No credit hours will be assigned, and research is not calculated in the GPA. **Students in their research phase must register for research each quarter.** Research will be graded on the S-N scale, no credit will be given and, therefore, research is not calculated in the GPA.

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## LABORATORY ROTATIONS

Each student must complete at least three laboratory rotations and a minimum of six credits. Two rotations must be within the area of specialization.

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## M.D.-PH.D. PROGRAM

The M.D.-Ph.D. program is a highly competitive program for students with exceptional academic records and previous research experience. Both the M.D. and Ph.D. degrees may be obtained in an integrated seven to eight-year program.

The elements of the Ph.D. program for students enrolled in the M.D.-Ph.D. program are generally the same as those for non-M.D. candidates, except for laboratory rotations. The laboratory rotation requirement for M.D.-Ph.D. students is satisfied by completing three one-month rotations. It is recommended that two rotations be completed before entering medical school and one between the first and second year of medical school. After the first two laboratory rotations, students follow the Mayo Medical School curriculum for two years. After taking the United States Medical Licensing Examination Step I in June of the second year, students begin their graduate school training. The advanced course work in the area of specialization and the thesis research are undertaken and usually completed in the next three to four years. During the final two years students complete years three and four of the medical school curriculum.

The appointment to the M.D.-Ph.D. program includes a full tuition scholarship for both medical school and graduate school and stipend (\$15,500 for 1997-98) for the seven to eight years of training.

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## OFFICIAL DEGREE PROGRAM FORM

Students are expected to file their Official Degree Program form describing all course work completed and proposed, that will be used in fulfillment of degree

requirements, including transfer credits, during their second academic year. The members of the student's qualifying oral examining committee will be appointed on the basis of the recommendations on the Ph.D. Oral Qualifying Exam Committee form.

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## CHANGES IN APPROVED PROGRAM

Once approved, the Degree Program must be fulfilled in every detail to meet graduation requirements unless alterations are requested in writing and approved by the graduate education coordinator and the Graduate School Education Committee.

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## MINIMUM GRADE REQUIREMENTS

Students are expected to maintain a grade point average of 3.0 in didactic course work. Students whose performance falls below this standard in a given quarter may be placed on academic probation, as provided for in the Guidelines for Probation and Dismissal (outlined in the Student/Faculty Handbook).

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## QUALIFYING EXAMINATIONS

The qualifying examinations are intended to test the student's fund of information in the sciences related to the chosen field of study and to evaluate the student's ability to reason critically.

**Written examination** - The qualifying written examination for Ph.D. and M.D.-Ph.D. graduate students must be completed before the end of the second year. The content and format of the examination is determined by each program. The written examination can be taken no more than twice. It must be retaken by the end of the quarter following the quarter in which the exam was first taken. The written examination will test knowledge and critical reasoning in the area of specialization. Material from supporting disciplines may be included.

The Graduate School must be informed of the date of the examination **in advance** so that the written examination report can be sent to the adviser.

**Oral examination** - When the Graduate School is notified that the written examination has been passed, the oral qualifying examination can be taken. The Graduate School must be informed of the date of the examination in advance so that the Report of Examination form can be sent to the chair. The oral qualifying examination for the Ph.D. and M.D.-Ph.D. students must be completed before the end of the second year. The oral qualifying examination committee will consist of a minimum of four faculty members. Two members must have full graduate faculty privileges. All four members must be present at the exam. Only one dissenting vote will be allowed for a "Pass" or "Conditional Pass." In the event of a Conditional Pass, the specific requirements that must be satisfied by the student will be listed on the Ph.D. Oral Qualifying Examination Report Form. The oral qualifying examination may be taken no more than twice and it must be retaken within six months.

**Registration for the ninth quarter is contingent on completion of the qualifying exams.**

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## **THESIS**

Thesis Advisory Committee - Ph.D. candidates are expected to submit to the Graduate School Office the composition of their thesis advisory committee no later than the end of the first quarter of the student's third year. The Thesis Advisory Committee form is available from the Graduate School Office. The Thesis Advisory Committee must consist of five faculty members. Three must have full graduate faculty privileges.

The Mayo Institutional Review Board must review all protocols for research involving the use of human subjects. It is the candidate's responsibility to secure approval of any such protocols before the research is undertaken.

Thesis Proposal - A written thesis proposal, presentation and thesis committee discussion of the proposal must be completed by the middle of the student's third graduate year. This requirement may be accomplished during the qualifying oral examination. The thesis advisory committee must be approved prior to this committee discussion.

Preparation of thesis - The thesis is the most important document that the Ph.D. candidate will prepare during the course of graduate study and is a record of the scientific accomplishments that justify the awarding of the degree. The thesis is archival. Consequently, the Graduate School has developed standards for its format and style, which should be closely followed. Copies of the guide to preparation of the thesis are available on request from the Graduate School Office. The thesis must be submitted to the final oral examining committee at least three weeks prior to the examination.

Students enrolled in the M.D.-Ph.D. program must submit their final thesis to their advisory committee and the Thesis Readers Report must be signed and submitted to the Graduate School Office before they can resume studies in the Medical School.

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## **STUDENT PROGRESS**

Students must have annual meetings with their Thesis Advisory Committee. The first of these meetings, the presentation of the thesis proposal, must be held before the end of the tenth quarter in the program. Registration for the 11th quarter will be contingent upon satisfactory completion of this requirement.

Annual meetings must be held before the end of the 14th and 18th quarters. Registration for subsequent quarters will be contingent upon satisfactory completion of this requirement. Registration forms will include a line for recording the date of these meetings.

**If students do not meet deadlines, they will not remain in good standing. Continuation of stipend depends upon remaining in good standing.**

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## **FINAL ORAL EXAMINATION**

The final oral examination will be scheduled after 1) the qualifying written and oral examinations have been taken and passed, 2) all course work shown on the Degree Program form has been completed and 3) a copy of the title page of the thesis is filed in the Graduate School Office. The exam will be open to the Mayo public. The final oral examining committee should receive copies of the thesis at least three weeks prior to the final oral examination. The examining committee will have at least five members, counting the student's research adviser. The Graduate School strongly encourages the inclusion of an external examiner, i.e., a recognized authority on the thesis topic from another institution. At least three members of the committee, one being the adviser, must have full graduate faculty privileges. One dissenting vote will be allowed for a "pass." If more than one committee member feels the candidate did not pass, a determination of either "fail" or "conditional pass" must be made. If the pass is with conditions, the conditions must be outlined in writing on the back of the Ph.D. Final Oral Examination Report Form. The final oral can be taken no more than twice.

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## **FINAL THESIS CORRECTIONS**

After a student has passed the final oral examination, members of the thesis advisory committee must sign a form indicating that they are satisfied that the final corrections to the thesis have been made. Four of the five committee members must have signed before the student will be cleared for graduation.

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## **GRADUATION DEADLINE**

Students are graduated four times a year, the third Friday in February, August and November and mid-May. The latter involves a formal ceremony as part of the Mayo Foundation graduation exercises in conjunction with the Mayo Medical School. No ceremony is held in February, August and November, but students who do graduate at one of these times are encouraged to participate in the May ceremony.

To graduate in February, August or November students must have all requirements completed by the first working day of the month prior to the graduation month. To graduate in May, students must have a draft of the thesis to their adviser by March 15 and their thesis defense scheduled. All other requirements must be completed by April 20, except submission of the thesis. The final copy of the thesis, ready for binding, must be submitted before graduation day.

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## BIOCHEMISTRY

E.B. Leof, Ph.D., *Graduate Education Coordinator*

Z. Bajzer, Ph.D.	C. T. McMurray, Ph.D.
M. E. Bolander, M.D.	M. A. McNiven, Ph.D.
R. E. Brown, Ph.D.	L. J. Miller, M.D.
T. P. Burghardt, Ph.D.	S. Naylor, Ph.D.
G. W. Dewald, Ph.D.	W. G. Owen IV, Ph.D.
N. L. Eberhardt, Ph.D.	R. E. Pagano, Ph.D.
D. N. Fass, Ph.D.	L. R. Pease, Ph.D.
M. R. Federspiel, Ph.D.	J. T. Penniston, Ph.D.
T. A. Felmlee, Ph.D.	D. R. Pfeifer, Ph.D.
L. A. Fitzpatrick, M.D.	J. F. Poduslo, Ph.D.
S. J. Gendler, Ph.D.	F. G. Prendergast, M.D., Ph.D.
M. J. Getz, Ph.D.	J. R. Riordan, Ph.D.
J. P. Grande, M.D. Ph.D.	P. C. Roche, Ph.D.
S. M. Jalal, Ph.D.	F. M. Rusnak, Ph.D.
R. B. Jenkins, M.D.	J. L. Salisbury, Ph.D.
J. D. Jones, Ph.D.	H.H.O. Schmid, Ph.D.
C. Kappen, Dr.rer.nat.	T. C. Spelsberg, Ph.D.
B. C. Kline, Ph.D.	E. E. Strehler, Ph.D.
R. Kumar, M.D.	S. N. Thibodeau, Ph.D.
V. M. Kumar, Ph.D.	D. J. Tindall, Ph.D.
J. J. Lee, Ph.D.	D. O. Toft, Ph.D.
N. A. Lee, Ph.D.	R. T. Turner, Ph.D.
A. H. Limper, M.D.	R. Urrutia, M.D.
S. I. Macura, Ph.D.	G. Vockley, M.D., Ph.D.
L. J. Maher, III, Ph. D.	S. Vuk-Pavlovic, Ph.D.
N. J. Maihle, Ph.D.	Z. Vuk-Pavlovic, Ph.D.
D. J. McCormick, Ph.D.	E. D. Wieben, Ph.D.
J. A. McDonald, M.D., Ph.D.	C.Y.F. Young, Ph.D.

### Ph.D. Degree

The requirements for the Biochemistry track conform to the general requirements of the Mayo Graduate School in which a minimum of 24 credits are required in Biochemistry, 13 credits of biomedical core courses, and 5 other credits as deemed appropriate for an individual student's program. **Prerequisites to the track are one year of organic chemistry with laboratory and physical chemistry.** Students lacking the prerequisites will be admitted with the provision that the prerequisites will be rectified during the first year.

The track requirements are:

Bioc	5858	Laboratory Rotations in Biochemistry (2 cr./rotation - 3 rotations req.)	6 cr.
Bioc	8000	General Biochemistry: Structure	3 cr.
Bioc	8001	General Biochemistry: Kinetics, Catalysis and Mechanisms	3 cr.
Bioc	8002	General Biochemistry: Energy Transduction and Signalling	3 cr.
Bioc	8005	Physical Biochemistry	1 cr.

Bioc	8010	Physical Biochemistry	1 cr.
Bioc	8015	Physical Biochemistry	1 cr.
*Bioc	8050	Principles of Cell and Tissue Design	3 cr.
Bioc	8500	Biochemistry and Molecular Biology Journal Club (1 cr./yr. - 3 yrs. required)	3 cr.
*MBio	8101	Replication and Transcription Regulation	3 cr.
*MBio	8102	Regulation of Protein Synthesis	3 cr.

\*These courses may be used to satisfy core requirements.

All of these courses, except the Journal Club, must be completed before the student takes the written qualifying examination in year two. At the discretion of the student's committee, one or more advanced topics may be taken during the second year.

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## BIOPHYSICAL SCIENCES BIOMEDICAL IMAGING TRACK

R. A. Robb, Ph.D., *Graduate Education Coordinator*

M. Belohlavek, M.D., Ph.D.	A. Manduca, Ph.D.
U. Bite, M.D.	C.H. McCollough, Ph.D.
J. A. Bonner, M.D.	E.C. McCullough, Ph.D.
R.L. Ehman, M.D.	R.L. Morin, Ph.D.
J.P. Felmlee, Ph.D.	H.H. Ottesen, Ph.D.
J. M. Fernandez, Ph.D.	W. Pavlicek, Ph.D.
B.K. Gilbert, Ph.D.	J. L. Rae, Ph.D.
J.E. Gray, Ph.D.	S.J. Riederer, Ph.D.
J.F. Greenleaf, Ph.D.	E.L. Ritman, M.D., Ph.D.
N. J. Hangiandreou, Ph.D.	G.C. Sieck, Ph.D.
C.R. Jack, M.D.	S.M. Sine, Ph.D.
M. J. Joyner, M.D.	J.H. Szurszewski, Ph.D.
B. F. King, M.D.	S.R. Taylor, Ph.D.
R.W. Kline, Ph.D.	R.J. Vetter, Ph.D.
J. Lu, Ph.D.	

### Ph.D. Degree

#### I. Minimum Requirements

A minimum of 42 credits of course work are required for a Ph.D. in the Biophysical Sciences Biomedical Imaging Track. Thirteen core credits are taken outside the student's major area of concentration, as required by the Graduate School. Twenty-nine *technical* credits are required in the subjects related to the major area, which includes six credits in advanced laboratory methods (lab rotations) and a minimum of six credits in advanced seminars and/or tutorials.

#### II. Elective Course Work

A program of course work for both the core and technical components of the Ph.D. program in the Biomedical Imaging Track may be selected from the following typical curriculum:

**Core (13 credit minimum)**

MGS	5000	Fundamentals of Cell Structure and Function	5 cr.
+MGS	5400	Responsible Conduct of Research	1 cr.
HSR	5823	Introductory Statistics I	3 cr.
HSR	5827	Introduction to Regression	1 cr.
Imm	5806	Basic Graduate Immunology	3 cr.
MBio	5000	Introduction to Molecular Biology	3 cr.
Nsci	8300	Concepts in Neurophysiology	2 cr.
Phys	5801	Principles of Biomechanics	3 cr.

**Technical (29 credit minimum)**

*BPhy	5001	Laboratory Rotations in Biophysical Sciences (4 wks.)	1 cr.
*BPhy	5002	Laboratory Rotations in Biophysical Sciences (8 wks.)	2 cr.
*BPhy	5003	Laboratory Rotations in Biophysical Sciences (12 wks.)	3 cr.
BPhy	5150	Introductory Radiation Biology	2 cr.
BPhy	5225	Introduction to Neural Networks	3 cr.
BPhy	5250	Anatomy for Biomedical Imaging	2 cr.
BPhy	5350	Critical Review of Biomedical Imaging Literature	1 cr.
BPhy	5400	Molecular Electronics	3 cr.
BPhy	5450	Biomedical Image Processing I - Fundamental Concepts	4 cr.
BPhy	5500	Tutorial in Organization and Computer Programming	3 cr.
BPhy	5520	Algorithms and Problem Solving	2 cr.
BPhy	5550	Virtual Reality Methods and Applications in Biomedical Research	4 cr.
BPhy	5610	Imaging and Computers	3 cr.
BPhy	5740	Magnetic Resonance Imaging Systems	3 cr.
BPhy	5800	Physics and Technical Principles of Medical Imaging	3 cr.
BPhy	8100	Medical Health Physics	2 cr.
BPhy	8150	Radiation Therapy Physics	4 cr.
BPhy	8300	Tutorial in Visual Perception and Psychophysics	2 cr.
BPhy	8301	Tutorial in High-Speed Signal Processing	2 cr.
BPhy	8302	Tutorial in Ultrasonic Imaging	2 cr.
BPhy	8304	Tutorial in Physiological Imaging	2 cr.
BPhy	8420	Wave Propagations and their Medical Applications	2 cr.
BPhy	8450	Biomedical Image Processing II - Intermediate Analysis	3 cr.
BPhy	8470	Two-Dimensional Digital Signal Processing	3 cr.
BPhy	8490	Biomedical Image Processing III - Advanced Topics	3 cr.
BPhy	8500	Tutorial in Imaging Science	2 cr.
BPhy	8704	Digital Signal Processing I	3 cr.
BPhy	8705	Digital Signal Processing II	3 cr.
BPhy	8740	Magnetic Resonance Imaging Systems - Advanced Topics	3 cr.
BPhy	8770	Fuzzy Logic Theory and Applications	3 cr.
BPhy	8853	Readings in Biophysical Sciences	2 cr.
CSci	5107	Computer Graphics I	3 cr.
CSci	5117	Computer Graphics II	3 cr.
CSci	5301	Numerical Analysis	4 cr.
CSci	5511	Artificial Intelligence I	4 cr.
CSci	8511	Concepts in Computer Vision	4 cr.

Phy	5551	Topics in Physics for Biology and Medicine	5 cr.
Phy	5552	Topics in Physics for Biology and Medicine	5 cr.
Phy	5553	Topics in Physics for Biology and Medicine	5 cr.
Phys	8300	Concepts in Neurophysiology	3 cr.

+Required course

\*At least three different rotations and a minimum of 6 cr. are required.

### III. Advanced Studies

Students in the Biomedical Imaging Track are required to take a minimum number of credits in two specific areas of advanced study. These areas are laboratory methods and special tutorials and seminars.

*Laboratory Methods (BPhy 5001-3, 6 credits)*

Students rotate through the laboratories of senior faculty and become familiar with the techniques, procedures, and projects in the area of research of each laboratory. Laboratory rotations are one, two, or three months (1 cr/mo) and a minimum of six credits and three different laboratories is required.

*Tutorials and Seminars (6 credits)*

The student is required to take a minimum of six credits in advanced tutorials and/or seminars related to the selected area of dissertation research. Tutorials are arranged with senior faculty. Credit for this requirement can be granted for special off-campus courses. A typical curriculum from which to select the tutorials and seminars follows:

BPhy	8300	Tutorial in Visual Perception and Psychophysics	2 cr.
BPhy	8301	Tutorial in High-Speed Signal Processing	2 cr.
BPhy	8302	Tutorial in Ultrasonic Imaging	2 cr.
BPhy	8304	Tutorial in Physiological Imaging	2 cr.
BPhy	8500	Tutorial in Imaging Science	2 cr.
BPhy	8600	Biophysics/Bioengineering Seminars	1 cr.
BPhy	8750	Magnetic Resonance Technical Seminar	1 cr.
Phys	8851	Physiology Seminars	1 cr.

### IV. Dissertation Research (BPhy 8890)

All students must take and satisfactorily pass a comprehensive qualifying exam, consisting of both written and oral components, before formally beginning their dissertation research. This exam is taken before the end of the second year of the program. As arranged by the adviser, the student may spend several weeks in a laboratory at another institution to learn new or advanced techniques related to the research topic selected. During the third year of the program it is expected that all students will have decided on a dissertation project. By the middle of the third year of study, students must prepare a written prospectus and give a seminar on the background of their proposed dissertation research and present any results they have obtained. By this time, a Thesis Committee chaired by the student's adviser is appointed. Each student meets at least once a year with his/her Committee to discuss their progress. The Committee decides when the research has progressed sufficiently so that a dissertation can be written, and is responsible for coordinating the final thesis defense. The Committee will usually include an outside reviewer from an academic institution other than the Mayo Graduate School. All members of the Department are encouraged to attend any thesis defense, which will include a seminar on the dissertation results by the candidate.

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## IMMUNOLOGY

L. R. Pease, Ph.D., *Graduate Education Coordinator*

R. T. Abraham, Ph.D.	V. A. Lennon, M.D., Ph.D.
C. S. David, Ph.D.	D. J. McKean, Ph.D.
G. J. Gleich, M.D.	C. V. Paya, M.D.
J. J. Goronzy, M.D., Ph.D.	D. H. Persing, M.D.
D. F. Jelinek, Ph.D.	M. Rodriguez, M.D.
L.M. Karnitz, Ph.D.	P. J. Wettstein, Ph.D.
H. Kita, M.D.	C. M. Weyand, M.D., Ph.D.
P. J. Leibson, M.D., Ph.D.	

### Ph.D. Degree

#### Core (Distribution) Credits

Responsible Conduct of Research	1 cr.
3 credits in each of any two areas other than Immunology	6 cr.
Additional elective (non-seminar) courses in any area other than Immunology	6 cr.

In addition to the core requirement, students are required to take the following combination of courses:

*Imm 5858	Laboratory Methods in Immunology (2 cr./rotation - 3 rotations req.)	6 cr.
Imm 5806	Basic Graduate Immunology	3 cr.

During each of the first and second years, students must elect two different courses from the following. Courses may be repeated in subsequent terms, but at least two different courses must be elected in each of the first two years.

Imm 8862	Current Topics in Cellular Regulation	1 cr.
Imm 8863	Current Topics in Immunology	1 cr.
Imm 8867	Current Topics in Hypersensitivity	1 cr.

Students are required to take the following tutorial courses:

Imm 8876	Tutorial in T Cell Derived Lymphokines	2 cr.
Imm 8877	Tutorial in Molecular Basis of Immune Recognition	2 cr.
Imm 8878	Tutorial in Effector Mechanisms	2 cr.
Imm 8879	Tutorial in Cellular Activation	2 cr.
Imm 8880	Tutorial in Immunopathology	2 cr.
Imm 8882	Tutorial in Cellular Recognition and Development of the Immune Response	2 cr.

Six elective credits from any courses approved for graduate credit.

In addition, before completion of the program, all students are encouraged to attend the one-week-long summer course in Advanced Immunology sponsored by the American Association of Immunologists.

\*Not required of M.D.-Ph.D. students.

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## MOLECULAR BIOLOGY

E.B. Leof, Ph.D., *Graduate Education Coordinator*

Z. Bajzer, Ph.D.	C. T. McMurray, Ph.D.
M. E. Bolander, M.D.	M. A. McNiven, Ph.D.
R. E. Brown, Ph.D.	L. J. Miller, M.D.
T. P. Burghardt, Ph.D.	S. Naylor, Ph.D.
G. W. Dewald, Ph.D.	W. G. Owen, IV, Ph.D.
N. L. Eberhardt, Ph.D.	R. E. Pagano, Ph.D.
D. N. Fass, Ph.D.	L. R. Pease, Ph.D.
M. R. Federspiel, Ph.D.	J. T. Penniston, Ph.D.
T. A. Felmlee, Ph. D.	D. R. Pfeifer, Ph.D.
L. A. Fitzpatrick, MD	J. F. Poduslo, Ph.D.
S. J. Gendler, Ph.D.	F. G. Prendergast, M.D., Ph.D.
M. J. Getz, Ph.D.	J. R. Riordan, Ph.D.
J. P. Grande, M.D., Ph. D.	P. C. Roche, Ph.D.
S. M. Jalal, Ph.D.	F. M. Rusnak, Ph.D.
R. B. Jenkins, M.D.	J. L. Salisbury, Ph.D.
J. D. Jones, Ph.D.	H.H.O. Schmid, Ph.D.
C. Kappen, Dr.rer.nat.	T. C. Spelsberg, Ph.D.
B. C. Kline, Ph.D.	E. E. Strehler, Ph.D.
R. Kumar, M.D.	S. N. Thibodeau, Ph.D.
V.M. Kumar, Ph.D.	D. J. Tindall, Ph.D.
J. J. Lee, Ph.D.	D. O. Toft, Ph.D.
N. A. Lee, Ph.D.	R. T. Turner, Ph.D.
A. H. Limper, M.D.	R. Urrutia, M.D.
S. I. Macura, Ph.D.	G. Vockley, M.D., Ph.D.
L. J. Maher, III, Ph.D.	S. Vuk-Pavlovic, Ph.D.
N. J. Maihle, Ph.D.	Z. Vuk-Pavlovic, Ph.D.
D. J. McCormick, Ph.D.	E. D. Wieben, Ph.D.
J. A. McDonald, M.D., Ph.D.	C.Y.F. Young, Ph.D.

### Ph.D. Degree

The requirements for the Molecular Biology track conform to the general requirements of the Mayo Graduate School in which a minimum of 18 credits are required in Molecular Biology, 13 credits of Biomedical core courses, and 11 credits as deemed appropriate for individual student's programs.

The track requirements are:

*BIOC	8000	General Biochemistry: Structure	3 cr.
*BIOC	8001	General Biochemistry: Kinetics, Catalysis and Mechanisms	3 cr.
*BIOC	8002	General Biochemistry: Energy Transduction and Signalling	3 cr.
MBio	5858	Laboratory Rotations in Molecular Biology (2 cr./rotation - 3 rotations req.)	6 cr.
MBio	8050	Principles of Cell and Tissue Design	3 cr.
MBio	8101	Replication and Transcription Regulation	3 cr.
MBio	8102	Regulation of Protein Synthesis	3 cr.

MBio 8500 Biochemistry and Molecular Biology Journal Club 3 cr.  
(1 cr/yr - 3 yrs required)

\*These courses may be used to satisfy core requirements.

## MOLECULAR NEUROSCIENCE

A. J. Windebank, M.D., *Graduate Education Coordinator*

M. M. Ames, Ph.D.	K. M. McEvoy, M.D.
A. J. Aksamit, M.D.	R. McGee, Ph.D.
E. E. Bennaroch, M.D.	M. McKinney, Ph.D.
W. S. Brimijoin, Ph.D.	J. W. McLaren, Ph.D.
T. P. Burghardt, Ph.D.	C. J. McMurray, Ph.D.
S. W. Carmichael, Ph.D.	M. A. McNiven, Ph.D.
J. L. Carter, M.D.	F. B. Meyer, M.D.
R. J. Caselli, M.D.	P. C. O'Brien, M.D.
J.R. Daube, M.D.	R. E. Pagano, Ph.D.
P. J. Dyck, M.D.	R. C. Petersen, M.D., Ph.D.
A. G. Engel, M.D.	J. F. Poduslo, Ph.D.
J. M. Fernandez, Ph.D.	C. Raffel, M.D., Ph.D.
J. S. Gill, Ph.D.	E. Richelson, M.D.
N.R. Graff-Radford, M.D.	R. A. Robb, Ph.D.
J. A. Hardy, Ph.D.	M. Rodriguez, M.D.
C. R. Jack, M.D.	C. Shin, M.D.
R. B. Jenkins, M.D., Ph.D.	G. C. Sieck, Ph.D.
C. Kappen, Dr.rer.nat.	S. M. Sine, Ph.D.
D. W. Kimmel, M.D.	E. E. Strehler, Ph.D.
L. T. Kurland, M.D.	J. H. Szurszewski, Ph.D.
T. D. Lagerlund, M.D.	R. Urrutia, M.D.
J. J. Lee, Ph.D.	R. M. Weinsilboum, M.D.
V. A. Lennon, M.D., Ph.D.	B. J. Westmoreland, M.D.
P. A. Low, M.D.	J. P. Whisnant, M.D.
N. J. Mailhe, Ph.D.	S. G. Younkin, M.D., Ph.D.

### Ph.D. Degree

The requirements for the Molecular Neuroscience Ph.D. Track conform to the general requirements of the Mayo Graduate School in which a minimum of 13 credits are required from the core curriculum. Courses must be selected from at least two areas with a minimum of three credits from each area. None of these courses may be in the area of specialization. We recommend that students select courses after discussion with their adviser.

The track requirements are:

NSci 8400	Neuroanatomy	3 cr.
NSci 8854	Basic Neuroscience	5 cr.
NSci 8300	Concepts in Neurophysiology	3 cr.
*NSci 5001	Laboratory Rotations in Neuroscience (4 wks.)	1 cr.
*NSci 5002	Laboratory Rotations in Neuroscience (8 wks.)	2 cr.
*NSci 5003	Laboratory Rotations in Neuroscience (12 wks.)	3 cr.
NSci 8500	Neuroscience Seminars	1 cr.
NSci 8600	Neuroscience Journal Club	1 cr./yr.

\*At least three different rotations and a minimum of 6 cr. are required.

Forty-two credits are required to complete the degree program. In addition to the core and track requirements, additional courses should be selected after consultation between the student and his/her Advisory Committee.

The Qualifying Examination for the Molecular Neuroscience Track has both a written and oral examination. In order to make requirements uniform within each of the tracks of the Graduate School, the Preliminary Qualifying Examination for Molecular Neuroscience is being changed. The new type of comprehensive qualifying examination is being "phased in" over the next two years.

**For students matriculating on or before September 1994**, the written examination takes the form of a thesis proposal. This proposal must be submitted to the Examining Committee between the beginning of the summer quarter of the first year and the end of the winter quarter of the second year. The proposal should summarize goals, methods and rationale for a research project. This does not have to be the students' thesis research proposal. The specific guidelines for the form of this proposal are available from the Molecular Neuroscience Secretary.

The oral examination will be conducted no more than six weeks after satisfactory review by the Examining Committee of the written proposal. The oral examination will be composed of three parts. The first part will be an oral presentation by the student of their proposal. The second part will be a discussion between the student and the examiners about this proposal. The third part will be a wide ranging discussion of any course work material covered by the student during their first 1 1/2 years that may be broadly relevant to the proposal.

**The Qualifying Examination must be completed before the end of the second year in the program. Students should note that continuation of stipend depends on timely completion of the Qualifying Examination.**

**For students matriculating after September 1994**, the students will complete a written qualifying examination which will cover the breadth of material in the core courses and track courses which most students will have completed during their first year. This qualifying examination will offer the opportunity to consolidate a broad base of knowledge in biomedical science and insure that students have the necessary foundation to embark on their thesis research. This written examination may contain a mixture of essay-type and multiple choice questions. It will be set and graded by the faculty responsible for teaching the courses.

This examination, the written qualifying examination, will be offered once each year in the summer. Students are strongly encouraged to take the examination after the first year while course work is still fresh. The exam must be completed successfully before the end of the second year in the program.

Before the end of 2 1/2 years in the program, the degree candidate must complete a thesis proposal. This proposal must be submitted to the Thesis Advisory Committee before the student has completed 10 quarters in the program. The proposal should summarize the goals, methods, and rationale for a research project. The specific guidelines for the form of this proposal are available from the Molecular Neuroscience Secretary. It is a "mini grant" proposal.

This will be followed by an oral defense which will be conducted no more than 6 weeks after satisfactory review by the Thesis Advisory Committee of the written

proposal. The oral defense will be composed of two or three parts. The first part will be an oral presentation by the student of their proposal; the second part will be a discussion between the student and the Committee about this proposal. If there were any conditional elements or weaknesses identified at the time of the written qualifying examination, the Committee may then have a third part to the defense which will include a wide-ranging discussion of either the area of deficiency or course work material covered by the student during the first 2 years. **Students will be notified after their Qualifying Examination whether this third component should be expected during the thesis proposal defense.**

## PHARMACOLOGY

C. T. McMurray, Ph.D., *Graduate Education Coordinator*

R. T. Abraham, Ph.D.	S. Naylor, Ph.D.
M. M. Ames, Ph.D.	F. G. Prendergast, M.D., Ph.D.
W. S. Brimijoin, Ph.D.	E. Richelson, M.D.
J. A. Hardy, Ph.D.	C. Shin, M.D.
Z. Katusic, M.D.	J. H. Szurszewski, Ph.D.
S. H. Kaufmann, M.D., Ph.D.	S. R. Taylor, Ph.D.
J. J. Lipsky, M.D.	A. Terzic, Ph.D.
R. McGee, Ph. D.	R. M. Weinshilboun, M.D.
M. McKinney, Ph.D.	S. G. Younkin, M.D., Ph.D.
T. P. Moyer, Ph.D.	

### Ph.D. Degree

#### Core Courses (13 credits minimum)

Bioc	8000	General Biochemistry: Structure	3 cr.
Bioc	8001	General Biochemistry: Kinetics, Catalysis and Mechanisms	3 cr.
Bioc	8002	General Biochemistry: Energy Transduction and Signalling	3 cr.
*MGS	5400	Responsible Conduct of Research	1 cr.
Imm	5806	Basic Graduate Immunology	3 cr.
MBio	5000	Introduction to Molecular Biology	3 cr.
MBio	8050	Principles of Cell and Tissue Design	3 cr.
Nsci	8854	Basic Neurosciences	5 cr.
Phar	8863	Molecular Biology: Theory and Application	4 cr.

#### Track (19 credits)

+Phar	5001	Laboratory Rotations in Pharmacology (4 wks.)	1 cr.
+Phar	5002	Laboratory Rotations in Pharmacology (8 wks.)	2 cr.
+Phar	5003	Laboratory Rotations in Pharmacology (12 wks.)	3 cr.
Phar	5100	Pharmacology Seminar Series (4 yrs. req.)	1 cr./yr.
Phar	5800	General Pharmacology	9 cr.
Phar	8800	Research Seminars in Pharmacology	1 cr.
Phar	8805	Drug Metabolism	3 cr.
Phar	8806	Pharmacology of Receptors	3 cr.

\*Required

+At least three different rotations and a minimum of 6 cr. are required.

### Electives (11 credits)

Students shall complete a total of 11 credits of elective courses. These courses should provide some diversity of exposure to physiological, biochemical, molecular and quantitative approaches. The elective courses may be chosen from listed course offerings, with the approval of the student's adviser and the Graduate Education Coordinator.

### Research

Phar 8801 Research in Pharmacology

Directed research projects under the supervision of a faculty adviser.

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## PHYSIOLOGY

R. A. Robb, Ph.D. *Graduate Education Coordinator*

K. An, M.D.	V. M. Miller, Ph.D.
A. G. Andrews, D.M.V.	T. O'Brien, M.D.
J. C. Burnett, M.D.	J. N. Pemberton, M.D.
E. P. DiMagno, M.D.	S. F. Phillips, M.D.
T. P. Dousa, M.D.	J. L. Rae, Ph.D.
J. M. Fernandez, Ph.D.	E. L. Ritman, M.D., Ph.D.
L. A. Fitzpatrick, M.D.	M. G. Rock, M.D.
C. S. Frisk, D.V.M.	J. C. Romero, M.D.
P. Gloviczki, M.D.	M.G. Sarr, M.D.
J. F. Greenleaf, Ph.D.	H. V. Schaff, Ph.D.
M. J. Joyner, M.D.	G. C. Sieck, Ph.D.
A. A. Khraibi, Ph.D.	S. M. Sine, Ph.D.
S. Khosla, M.D.	J. H. Szurszewski, Ph.D.
D. W. Klass, M.D.	S. R. Taylor, Ph.D.
F. G. Knox, M.D., Ph.D.	R. T. Turner, Ph.D.

## Ph.D. Degree

### I. Minimum Requirements

A minimum of 42 credits of course work are required for a Ph.D. in the Physiology Track. Thirteen core credits are taken outside the student's major area of concentration, as specified by the Graduate School. Twenty-nine technical credits are required in subjects related to the major area, which includes a three-credit course in **Concepts in Neurophysiology**, a three-credit course in **Research Animal Experimental Surgery and Methods**, 6 credits in **Laboratory Methods in Physiology**, and a minimum of six credits in advanced seminars and readings.

### II. Elective Course Work

A program of course work for both the core and technical components of the Ph.D. program in the Physiology track may be selected from the following typical curriculum:

#### Core (13 credit minimum)

*MGS	5400	Responsible Conduct of Research	1 cr.
BPhy	5450	Biomedical Image Processing I - Fundamental Concepts	4 cr.
BPhy	5500	Tutorial in Computer Organization and Programming	3 cr.

HSR	5823	Introductory Statistics I	3 cr.
HSR	5827	Introduction to Regression	1 cr.
Imm	5806	Basic Immunology	3 cr.
MBio	5000	Introduction to Molecular Biology	3 cr.

\*Required

**Technical (29 credit minimum)**

*Phys	5001	Laboratory Rotations in Physiology (4 wks.)	1 cr.
*Phys	5002	Laboratory Rotations in Physiology (8 wks.)	2 cr.
*Phys	5003	Laboratory Rotations in Physiology (12 wks.)	3 cr.
BPhy	5150	Introductory Radiation Biology	2 cr.
BPhy	5400	Molecular Electronics	2 cr.
BPhy	8450	Biomedical Image Processing II - Intermediate Analysis	3 cr.
BPhy	8600	Biodynamics Research Seminars	1 cr.
+Phys	5500	Research Animal Experimentation Surgery and Methodology	3 cr.
Phys	5801	Principles of Biomechanics I	3 cr.
Phys	5802	Principles of Biomechanics II	3 cr.
Phys	8300	Concepts in Neurophysiology	3 cr.
Phys	8851	Physiology Seminars	1 cr.
Phys	8854	Readings in Physiology	2 cr.
Phys	8855	Cardiovascular Physiology	3 cr.
Phys	8856	Respiratory Physiology	2 cr.
Phys	8857	Neurophysiology	2 cr.
Phys	8858	Physiology of Smooth Muscle and its Innervation	2 cr.
Phys	8859	Renal Physiology	2 cr.
Phys	8860	Endocrine Physiology	2 cr.
Phys	8862	Excitation-Contraction Coupling in Skeletal Muscle	3 cr.
Phys	8878	Physiology of Bone I	3 cr.
Phys	8879	Physiology of Bone II	2 cr.
Phys	8880	Principles of Solid Mechanics	3 cr.
Phys	8881	Mechanics of Deformable Materials	3 cr.

\*At least three different rotations and a minimum of 6 cr. are required.

+Required

**III. Advanced Studies**

Students in the Physiology Track rotate through the laboratories of senior faculty and become familiar with the techniques, procedures, and projects in each laboratory. Laboratory rotations may be one, two or three weeks (1 cr/1 mo) and a minimum of six credits and three different laboratories is required.

Students in the Physiology Track are required to take a minimum of three quarters of advanced study in at least two different ongoing seminars, journal clubs, and/or readings courses. Each student must give at least two different seminar presentations. A typical curriculum from which to select such ongoing courses follows:

BPhy	8600	Biophysics/Bioengineering Seminars	1 cr.
Phys	8851	Physiology Seminars	1 cr.
Phys	8854	Readings in Physiology	2 cr.

#### IV. Dissertation Research

All students must take and satisfactorily pass a comprehensive qualifying exam, consisting of both written and oral parts, before formally beginning their dissertation research. This exam must be taken before the end of the second year of the program. Before the middle of the third year of the program, it is expected that all students will have decided on a dissertation project. As arranged by the adviser, the student may spend several weeks in a laboratory of another institution to learn new or advanced techniques related to the research topic selected. During their third year of study, students give a seminar on the background of their proposed dissertation problem and present any results they have obtained. At this time, a Thesis Committee chaired by the dissertation supervisor is appointed. Each student meets at least once a year with his/her Committee to discuss their progress. The Committee decides when the research has progressed sufficiently so that a dissertation can be written, and is responsible for coordinating the final thesis defense. The Committee will usually include an outside reviewer from an academic institution other than the Mayo Graduate School. All members of the Department are encouraged to attend any thesis defense, which will include a seminar on the dissertation results by the candidate.

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## TUMOR BIOLOGY

Jeffrey L. Salisbury, Ph.D. *Graduate Education Coordinator*

R. T. Abraham, Ph.D.	L. J. Maher, III, Ph.D.
M. M. Ames, Ph.D.	N. J. Maihle, Ph.D.
A. G. Andrews, D.M.V.	R. McGee, Ph.D.
A. T. Baron, Ph.D.	D. J. McKean, Ph.D.
K. E. Bennet, M.S.	M. J. McManus, M.D.
J. A. Bonner, M.D.	M. A. McNiven, Ph.D.
M. P. Cleary, Ph.D.	L. J. Melton, M.D.
C. S. David, Ph.D.	H. Nelson, M.D.
G. W. Dewald, Ph.D.	J. R. O'Fallon, Ph.D.
R. L. Ehman, M.D.	D. J. O'Kane, Ph.D.
C. Erlichman, M.D.	D. H. Persing, M.D., Ph.D.
M. J. Federspiel, Ph.D.	M. R. Pittelkow, M.D.
L. A. Fitzpatrick, M.D.	K. C. Podratz, M.D., Ph.D.
S. J. Gendler, Ph.D.	F. G. Prendergast, M.D., Ph.D.
M. J. Getz, Ph.D.	C. Raffel, M.D., Ph.D.
J. P. Grande, M.D., Ph.D.	J. L. Reiter, Ph.D.
L. C. Hartmann, M.D.	D. I. Smith, Ph.D.
J. N. Ingle, M.D.	T. C. Spelsberg, Ph.D.
C. D. James, Ph.D.	E. E. Strehler, Ph.D.
D. F. Jelinek, Ph.D.	S. N. Thibodeau, Ph.D.
R. B. Jenkins, M.D., Ph.D.	D. J. Tindall, Ph.D.
S. H. Kaufmann, M.D., Ph.D.	D. O. Toft, Ph.D.
H. Lee, Ph.D.	R. A. Urrutia, M.D.
P. J. Leibson, M.D., Ph.D.	R. M. Weinsilboum, M.D.
V. A. Lennon, M.D.	P. J. Wettstein, Ph.D.
E. B. Leof, Ph.D.	R. A. White, Ph.D.
W. L. Lingle, Ph.D.	A. J. Windebank, M.D.
R. V. Lloyd, M.D., Ph.D.	L. E. Wold, M.D.
J. A. Lust, M.D., Ph.D.	C.Y. F. Young, Ph.D.

## Ph.D. Degree

Students in the Tumor Biology Track must complete the following, in addition to the 13 core credit requirement.


TBio	5000	Tumor Biology I: Introduction to Tumor Biology	3 cr.
TBio	5100	Research Seminars in Tumor Biology	1 cr.
TBio	5150	Current Topics in Tumor Biology	1 cr.
TBio	5300	The Business of Science and the Science of Business	1 cr.
TBio	5858	Laboratory Rotations in Tumor Biology (2 cr./rotation - 3 rotations req.)	6 cr.
TBio	8000	Tumor Biology II: Origins of Human Cancer	2 cr.
TBio	8005	Tumor Biology III: Growth Factors, Oncogenes, and Tumor Suppressors	3 cr.
TBio	8200	Cell Biology of Cancer	3 cr.

In addition, all students in the Tumor Biology Program shall register for the Animal Care and Use Training Sessions and the American Association of Cancer Research (AACR) course in Histopathology of Cancer. Additional advanced elective courses in any area may be taken to fulfill the overall degree requirements of 42 credits.

The Tumor Biology program is supported in part by a predoctoral training award from the USAMRDC entitled "Biology of Breast Cancer."



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**DESCRIPTION OF  
MASTER'S DEGREE PROGRAM  
AND BASIC SCIENCE  
TRACK REQUIREMENTS**



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## MASTER OF SCIENCE PROGRAM IN BIOMEDICAL SCIENCES

The Master of Science (M.S.) Program in Biomedical Sciences is available only to: 1) M.D.s, D.D.S.s and D.M.D.s enrolled in clinical residency programs and/or research fellowships of the Mayo Graduate School of Medicine (basic science specialty requirements described below-clinical science specialty requirements described in a later section); 2) candidates for the Ph.D. in good academic standing but unable to complete all the requirements for the doctorate - requirements available from the Graduate School office; 3) Employees (requirements described in a later section).

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## MASTER OF SCIENCE PROGRAM IN BIOMEDICAL SCIENCES

(Basic Science Specialties)

The degree requirements include a minimum of 12 credits in biomedical sciences and 12 credits in the area of specialization. Full-time registration for a minimum of one year is required. Fifty percent of the didactic credits must be completed in Mayo Graduate School. General program requirements and specialty track descriptions are outlined later. The equivalent of one year of full-time effort must be devoted to research.

Courses in basic biomedical sciences are required to provide the student with the knowledge to address a research problem, conduct the research and evaluate the results. Courses in the area of specialization are required in addition to provide special skills, techniques or knowledge related to the specialty track.

The primary purpose of the degree program is to enhance the scholarly dimension of the education of physicians and M.D. research fellows who have an interest in academic medicine. Training in research is emphasized. The degree program provides a structure for development of a plan to address a research problem, an orderly approach to the project, assurance of the credentials of the adviser, appropriate supervision and a suitable approach to the analysis and presentation of the results.

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## GENERAL PROGRAM REQUIREMENTS

**Eligibility:** The program described below is designed chiefly for Mayo residents and research fellows who hold appointments to the programs of Mayo Graduate School of Medicine. Potential candidates for the degree must hold appointments of sufficient duration to complete degree program requirements.

**Application:** Candidate must complete a Masters Program Biomedical Sciences Application form. This form, which requires departmental approval of the degree program and research project, is available in the Graduate School Office.

**Time Requirement:** All requirements must be satisfied within one year after completion of the Graduate School of Medicine fellowship.

**Thesis Protocol:** No later than two months after entering the laboratory, the candidate must submit a protocol to the Mayo Graduate School Education Committee. This protocol must clearly define the candidate's role in his/her project and must have sufficient detail to permit review by an advisory committee

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(guidelines are available in the Graduate School Office). If the protocol is not submitted during the first quarter in the laboratory, registration for research credits will not be allowed for the second quarter.

**Degree Program:** Students are encouraged to submit their Degree Program form and thesis titles to the Graduate School before the end of the second year of registration. Students and advisers should include on the program forms: a) the minimum number of courses/credits necessary to fulfill degree requirements (credits may vary depending on the chosen area of specialization), b) the thesis title and c) the recommended thesis readers and final oral examining committee. The examining committee consists of a minimum of three individuals, one of whom is the student's adviser, who serves as chair of the committee. One member must be from outside the department and no member other than the chair can be from among a student's research advisers. The recommended committee must be approved by the Graduate School.

**Changes in Approved Program:** Once approved, the program must be fulfilled in every detail to meet graduation requirements. Alterations in the program should be requested in writing and are subject to approval of the Mayo Graduate School Education Committee.

**Minimum Grade Requirements:** The minimum grade point average required by the Graduate School for courses included on the official program for the degree is 3.0 (on a 4.0 scale). Grades of A through C, and S are acceptable, but grades of S are not calculated in the grade point average. At least two-thirds of the credits taken and included on any degree program must be graded under the A through F system.

**Minimum Credit Requirements:** Students must complete a minimum of 12 credits in biomedical sciences and 12 additional credits in the area of specialization (see individual specialty track descriptions for specific course requirements). A minimum of one year in time and effort must be devoted to research. Students are not admitted to a specialty track unless there is reasonable assurance that course work required for completion of degree requirements is available.

**Transfer Credits:** A total of 12 didactic credits can be transferred into this program. Students who wish to transfer credits to substitute for a Mayo course must contact the Mayo course director. If the course director determines that a student has the knowledge equivalent to satisfactory performance in the Mayo course, the student will receive the transfer credits.

Students who wish to transfer credits for courses not offered at Mayo may request credit for graduate courses taken at other institutions if they received a grade of A or B. The request must have the approval of the student's education coordinator and the Graduate School. A description of the course from the course catalog or a course outline must accompany the request. The time interval since the credits were earned is a consideration in such decisions. Credits must normally have been earned within the previous ten years (more recently in the case of rapidly advancing subjects).

**Thesis:** The thesis must be submitted to the final oral examining committee at least three weeks before the oral examination.

**Written Examination:** Must be taken no later than six months before completion of the training program.

**Final Examination:** Candidates for the M.S. degree must pass a final oral examination, which can be taken only after the written examination has been passed, courses on the Degree Program form are completed, and the thesis reviewed. Successful completion of the final oral examination requires a unanimous decision by all of the members of the committee.

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## BIOCHEMISTRY

E. B. Leof, Ph.D., *Graduate Education Coordinator*

Z. Bajzer, Ph.D.	M. A. McNiven, Ph.D.
M. E. Bolander, M.D.	L. J. Miller, M.D.
R. E. Brown, Ph.D.	S. Naylor, Ph.D.
T. P. Burghardt, Ph.D.	W. G. Owen, IV, Ph.D.
G. W. Dewald, Ph.D.	R. E. Pagano, Ph.D.
N. L. Eberhardt, Ph.D.	L. R. Pease, Ph.D.
D. N. Fass, Ph.D.	J. T. Penniston, Ph.D.
T. A. Felmler, Ph.D.	D. R. Pfeifer, Ph.D.
L. A. Fitzpatrick, MD	J. F. Poduslo, Ph.D.
S. J. Gendler, Ph.D.	F. G. Prendergast, M.D., Ph.D.
M. J. Getz, Ph.D.	J. R. Riordan, Ph.D.
J. P. Grande, M.D., Ph.D.	P. C. Roche, Ph.D.
S. M. Jalal, Ph.D.	F. M. Rusnak, Ph.D.
R. B. Jenkins, M.D.	J. L. Salisbury, Ph.D.
J. D. Jones, Ph.D.	H.H.O. Schmid, Ph.D.
C. Kappen, Dr.rer.nat.	T. C. Spelsberg, Ph.D.
B. C. Kline, Ph.D.	E. E. Strehler, Ph.D.
R. Kumar, M.D.	S. N. Thibodeau, Ph.D.
M. J. Kumar, Ph.D.	D. J. Tindall, Ph.D.
J. J. Lee, Ph.D.	D. O. Toft, Ph.D.
N. A. Lee, Ph.D.	R. T. Turner, Ph.D.
A.H. Limper, M.D.	R. Urrutia, M.D.
S. I. Macura, Ph.D.	G. Vockley, M.D., Ph.D.
L. J. Maher, III, Ph.D.	S. Vuk-Pavlovic, Ph.D.
N. J. Maible, Ph.D.	Z. Vuk-Pavlovic, Ph.D.
D. J. McCormick, Ph.D.	E. D. Wieben, Ph.D.
J. A. McDonald, M.D., Ph.D.	C.Y.F. Young, Ph.D.
C. T. McMurray, Ph.D.	

## Master's Degree

The Master's degree track in Biochemistry is open only to residents and research fellows in the Mayo Graduate School of Medicine.

### Course Requirements

#### A. Course Work in Biomedical Sciences

Students will be expected to complete 12 credits of course work from the Biomedical Sciences core curriculum including the following three courses:

MBio	8050	Principles of Cell and Tissue Design	3 cr.
MBio	8101	Replication and Transcription Regulation	3 cr.
MBio	8102	Regulation of Protein Synthesis	3 cr.

The remaining three credits can be selected from approved Mayo Graduate School courses, or students with extensive background in particular areas may request to test out of these requirements.

#### B. Advanced Courses in Biochemistry

Bioc	8000	General Biochemistry: Structure	3 cr.
Bioc	8001	General Biochemistry: Kinetics, Catalysis and Mechanisms	3 cr.
Bioc	8002	General Biochemistry: Energy Transduction and Signaling	3 cr.
Bioc	8005	Physical Biochemistry	1 cr.
Bioc	8010	Physical Biochemistry	1 cr.
Bioc	8015	Physical Biochemistry	1 cr.

C. Students will be required to register for Bioc 8840 Research in Biochemistry (6 credits per quarter) for a total of 4 quarters or 24 credits.

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## IMMUNOLOGY

L. R. Pease, Ph.D., *Graduate Education Coordinator*

R. T. Abraham, Ph.D.	V. A. Lennon, M.D., Ph.D.
C. S. David, Ph.D.	D. J. McKean, Ph.D.
G. J. Gleich, M.D.	C. V. Paya, M.D.
J. J. Goronzy, M.D., Ph.D.	D. H. Persing, M.D.
D. F. Jelinek, Ph.D.	M. Rodriguez, M.D.
L. M. Kainitz, Ph.D.	P. J. Wettstein, Ph.D.
H. Kita, M.D.	C. M. Weyand, M.D., Ph.D.
P. J. Leibson, M.D., Ph.D.	

## Master's Degree

The Master's degree track in Immunology is open only to residents and research fellows in the Mayo Graduate School of Medicine.

### Course Requirements

#### A. Course Work in Biomedical Sciences

Students will be expected to complete 12 credits of course work (or their equivalent) selected from the Biomedical Sciences core curriculum. Students with extensive background in particular areas of the core curriculum will have the opportunity to test out of the core courses.

#### B. Advanced Courses in Immunology

Each student will be expected to take Imm 5806 Basic Graduate Immunology and a minimum of three tutorials offered by the Immunology faculty in areas specific to the student's research interest. Each student is expected to participate in a minimum of three different Current Topics courses before the degree requirements are completed.

Imm	8862	Current Topics in Cellular Regulation
Imm	8863	Current Topics in Immunology
Imm	8867	Current Topics in Hypersensitivity Reactions

C. Students will register for Imm 8840 Experimental Immunology (6 credits per quarter) for a total of 4 quarters or 24 credits.

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## MOLECULAR BIOLOGY

E. B. Leof, Ph.D., *Graduate Education Coordinator*

Z. Bajzer, Ph.D.	M. A. McNiven, Ph.D.
M. E. Bolander, M.D.	L. J. Miller, M.D.
R. E. Brown, Ph.D.	S. Naylor, Ph.D.
T. P. Burghardt, Ph.D.	W. G. Owen, IV, Ph.D.
G. W. Dewald, Ph.D.	R. E. Pagano, Ph.D.
N. L. Eberhardt, Ph.D.	L. R. Pease, Ph.D.
D. N. Fass, Ph.D.	J. T. Penniston, Ph.D.
T. A. Felmlee, Ph.D.	D. R. Pfeifer, Ph.D.
L. A. Fitzpatrick, MD	J. F. Poduslo, Ph.D.
S. J. Gendler, Ph.D.	F. G. Prendergast, M.D., Ph.D.
M. J. Getz, Ph.D.	J. R. Riordan, Ph.D.
J. P. Grande, M.D., Ph.D.	P. C. Roche, Ph.D.
S. M. Jalal, Ph.D.	F. M. Rusnak, Ph.D.
R. B. Jenkins, M.D.	J. L. Salisbury, Ph.D.
J. D. Jones, Ph.D.	H.H.O. Schmid, Ph.D.
C. Kappen, Dr.rer.nat.	T. C. Spelsberg, Ph.D.
B. C. Kline, Ph.D.	E. E. Strehler, Ph.D.
R. Kumar, M.D.	S. N. Thibodeau, Ph.D.
M. J. Kumar, Ph.D.	D. J. Tindall, Ph.D.
J. J. Lee, Ph.D.	D. O. Toft, Ph.D.
N. A. Lee, Ph.D.	R. T. Turner, Ph.D.
A.H. Limper, M.D.	R. Urrutia, M.D.
S. I. Macura, Ph.D.	G. Vockley, M.D., Ph.D.
L. J. Maher, III, Ph.D.	S. Vuk-Pavlovic, Ph.D.
N. J. Maihle, Ph.D.	Z. Vuk-Pavlovic, Ph.D.
D. J. McCormick, Ph.D.	E. D. Wieben, Ph.D.
J. A. McDonald, M.D., Ph.D.	C.Y.F. Young, Ph.D.
C. T. McMurray, Ph.D.	

### Master's Degree

The Master's degree track in Molecular Biology is open only to residents and research fellows in the Mayo Graduate School of Medicine.

#### Course Requirements

A. Course work in Biomedical Sciences

Students will be expected to complete 12 credits of course work from the Biomedical Sciences core curriculum including the following 3 courses:

Bioc	8000	General Biochemistry: Structure	3 cr.
Bioc	8001	General Biochemistry: Kinetics, Catalysis and Mechanisms	3 cr.
Bioc	8002	General Biochemistry: Energy Transduction and Signaling	3 cr.

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The remaining three credits can be selected from approved Mayo Graduate School courses, or students with extensive background in particular areas may request to test out of these requirements.

#### B. Advanced Courses in Molecular Biology

MBio	8050	Principles of Cell and Tissue Design	3 cr.
MBio	8101	Replication and Transcription Regulation	3 cr.
MBio	8102	Regulation of Protein Synthesis	3 cr.

plus 3 additional credits in Molecular Biology.

C. Students will be required to register for MBio 8840 Research in Molecular Biology (6 credits per quarter) for a total of 4 quarters or 24 credits.

In addition, the Master of Science degree requires passing the biochemistry and molecular biology written qualifying exam and the defense of a thesis.

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## MOLECULAR NEUROSCIENCE

### A. J. Windebank, M.D., *Graduate Education Coordinator*

A. J. Aksamit, M.D.	R. McGee, Ph.D.
E. E. Bennaroch, M.D.	M. McKinney, Ph.D.
W. S. Brimijoin, Ph.D.	J. W. McLaren, Ph.D.
T. P. Burghardt, Ph.D.	C. J. McMurray, Ph.D.
S. W. Carmichael, Ph.D.	M. A. McNiven, Ph.D.
J. L. Carter, M.D.	F. B. Meyer, M.D.
R. J. Caselli, M.D.	P. C. O'Brien, M.D.
J.R. Daube, M.D.	R. E. Pagano, Ph.D.
P. J. Dyck, M.D.	R. C. Petersen, M.D., Ph.D.
A. G. Engel, M.D.	J.F. Poduslo, Ph.D.
J. M. Fernandez, Ph.D.	C. Raffel, M.D., Ph.D.
J. S. Gill, Ph.D.	E. Richelson, M.D.
N. R. Graff-Radford, M.D.	R. A. Robb, Ph.D.
J. A. Hardy, Ph.D.	M. Rodriguez, M.D.
C. R. Jack, M.D.	C. Shin, M.D.
R. B. Jenkins, M.D., Ph.D.	G. C. Sieck, Ph.D.
C. Kappen, Dr.rer.nat.	S. M. Sine, Ph.D.
D. W. Kimmel, M.D.	E. E. Strehler, Ph.D.
L. T. Kurland, M.D.	J. H. Szurszewski, Ph.D.
T. D. Lagerlund, M.D.	R. Urrutia, M.D.
J. J. Lee, Ph.D.	R. M. Weinshilboum, M.D.
V. A. Lennon, M.D., Ph.D.	B. J. Westmoreland, M.D.
P. A. Low, M.D.	J. P. Whisnant, M.D.
N. J. Maihle, Ph.D.	S. G. Younkin, M.D., Ph.D.
K. M. McEvoy, M.D.	

## Master's Degree

The Master's degree track in Molecular Neuroscience is open only to residents and research fellows in the Mayo Graduate School of Medicine.

## Course Requirements

### A. Course work in Biomedical Sciences

Students will be expected to complete 12 credits in biomedical sciences outside the area of specialization.

### B. Molecular Neuroscience course requirements

Students will complete 12 credits within molecular neuroscience in addition to a minimum of one year in full-time laboratory research.

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## PHARMACOLOGY

C. T. McMurray, Ph.D., *Graduate Education Coordinator*

R. T. Abraham, Ph.D.	F. G. Prendergast, M.D., Ph.D.
M. M. Ames, Ph.D.	E. Richelson, M.D.
W. S. Brimijoin, Ph.D.	C. Shin, M.D.
J. A. Hardy, Ph.D.	J. H. Szurszewski, Ph.D.
Z. Katusic, M.D.	S. R. Taylor, Ph.D.
S. H. Kaufmann, M.D., Ph.D.	A. Terzic, Ph.D.
J. J. Lipsky, M.D.	R. M. Weinsilboum, M.D.
M. McKinney, Ph.D.	S. G. Younkin, M.D., Ph.D.
T. P. Moyer, Ph.D.	

## Master's Degree

### General

The Department of Pharmacology offers an M.S. degree track within the Biomedical Sciences Program. This track is open to residents and research fellows in the Mayo Graduate School of Medicine. Students holding only a baccalaureate will not be admitted to pursue the M.S. as a terminal degree. Students will be assigned to a research adviser on entry into the degree program. It is assumed that the equivalent of twelve months will be spent in full-time academic work, which will consist primarily of research, but will also involve advanced course work.

### Course Requirements

#### A. Introductory Biomedical Sciences Courses

Students are expected to complete 12 credits of introductory Biomedical Sciences courses. The required introductory courses are as follows:

Phar	5801	General Pharmacology	2 cr.
Phar	5802-5	General Pharmacology	7 cr.
Bios	5823	Introductory Statistics I	3 cr.

plus 9 credits to be chosen from the courses given below:

BPhy	5500	Tutorial in Computer Organization and Planning	3 cr.
Imm	5806	Basic Graduate Immunology	3 cr.

#### B. Advanced Courses in Pharmacology

Students will register for Phar 8840 Research in Pharmacology (6 credits) for a total of 4 quarters or 24 credits. During three of these quarters, they will also

register for Phar 8800 Research Seminars in Pharmacology (1 credit). In addition, students must complete a minimum of 6 credits of course work from the following list:

Phar	8802	Pharmacology of Heart Muscle	3 cr.
Phar	8803	Biochemical Basis of Neuropharmacology	3 cr.
Phar	8804	Clinical Pharmacology	1 cr.
Phar	8805	Drug Metabolism	3 cr.
Phar	8806	Pharmacology of Receptors	3 cr.
Phar	8810	Toxicology	3 cr.

### C. Course Work in Supporting Fields

Students are encouraged to undertake advanced didactic course work in other fields of basic Biomedical Science such as biostatistics, electronics and computer science, physiology, biochemistry, and immunology.

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## PHYSIOLOGY

R. A. Robb, Ph.D., *Graduate Education Coordinator*

K. An, M.D.	V. M. Miller, Ph.D.
A. G. Andrews, D.M.V.	T. O'Brien, M.D.
J. C. Burnett, M.D.	J. H. Penberton, M.D.
E. P. DiMagno, M.D.	S. F. Phillips, M.D.
T. P. Dousa, M.D.	J. L. Rae, Ph.D.
J. M. Fernandez, Ph.D.	E. L. Ritman, M.D., Ph.D.
L. A. Fitzpatrick, M.D.	M. G. Rock, M.D.
C. S. Frisk, D.V.M.	J. C. Romero, M.D.
P. Glowiczki, M.D.	M. G. Sarr, M.D.
J. F. Greenleaf, Ph.D.	H. V. Schaff, Ph.D.
M. J. Joyner, M.D.	G. C. Sieck, Ph.D.
S. Khosla, M.D.	S. M. Sine, Ph.D.
A. A. Khraibi, Ph.D.	J. H. Szurszewski, Ph.D.
D. W. Klass, M.D.	S. R. Taylor, Ph.D.
F. G. Knox, M.D., Ph.D.	R. T. Turner, Ph.D.

## Master's Degree

### General

The M.S. program is available only to Mayo fellows with an M.D. and/or Ph.D. degree who hold appointments in the clinical or research programs of the Mayo Graduate School of Medicine. The program will generally consist of two years of academic and research work. During one of the years, students are expected to spend most of their efforts in the research laboratory while at the same time taking didactic course work. The other year of the program, which in the case of a resident, may coincide with the residency program, will consist of course work and/or preparation of the thesis. Defense of thesis will be held at the end of the program. To be admitted candidates must have achieved high academic standards as evidenced by performance on the GRE or MCAT or have two highly positive letters of recommendation from Mayo investigators who are in a position to evaluate the candidate's academic and research potential.

### Course Requirements

Phys	8840	Research in Physiology (each quarter during research year)	24 cr.
Phys	8854	Readings in Physiology (each quarter during research year)	4 cr.


At least eight additional credits are required from the following advanced courses in Physiology.

Phys	5500	Research Animal Experimental Surgery and Methodology	3 cr.
Phys	5801	Principles of Biomechanics I	3 cr.
Phys	5802	Principles of Biomechanics II	3 cr.
Phys	8855	Cardiovascular Physiology	3 cr.
Phys	8856	Respiratory Physiology	2 cr.
Phys	8858	Physiology of Smooth Muscle and of its Innervation	2 cr.
Phys	8859	Renal Physiology	2 cr.
Phys	8860	Endocrine Physiology	2 cr.
Phys	8862	Excitation-Contraction Coupling in Skeletal Muscle	3 cr.
Phys	8878	Physiology of Bone I	3 cr.
Phys	8879	Physiology of Bone II	2 cr.

Students will be expected to complete an additional minimum of 12 credits of course work in supporting fields in Biomedical Sciences. Courses in supporting fields are available in various departments at Mayo, such as Biochemistry, Biophysical Sciences, Immunology, Molecular Biology, Molecular Neuroscience, Pharmacology and Tumor Biology, or through other mechanisms such as the UNITE program which is affiliated with the University of Minnesota.



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**DESCRIPTION OF EMPLOYEE  
MASTER'S DEGREE PROGRAM AND  
TRACK REQUIREMENTS**

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## **MASTER OF SCIENCES PROGRAM IN BIOMEDICAL SCIENCES FOR MAYO EMPLOYEES**

The Master's Degree in Biomedical Sciences is designed to develop the individual's information base in a basic science field and enable the individual to become competent in acquiring knowledge independently. This Master's program emphasizes course work and does not include a research thesis. A limited number of positions are available annually in each of the basic science tracks.

The Master's program provides the Mayo employee with an organized plan of study to enhance their professional development. The Master's degree is the culmination of this educational program and documents the acquisition of a high level of knowledge in a particular area of science. Although employees currently do not receive direct salary benefit from attaining a Master's degree, receipt of the degree may make the employee qualified for a job of a higher classification, should one become available.

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## **ADMISSIONS REQUIREMENTS AND PROCEDURES**

Enrollment is restricted to permanent Mayo employees. Applicants must have received a bachelor's degree from an accredited college or university, must have taken appropriate undergraduate science courses to adequately prepare for the Master's program and must have an undergraduate grade point average that demonstrates a record of academic excellence. Scores on the verbal, analytical and quantitative aptitude tests of the Graduate Record Examination should be above the 70th percentile. The employee's supervisor must endorse in writing the application of the employee.

Applicants must fill out an application form, supplying transcripts from previous colleges, GRE scores, supervisor's endorsement and three letters of recommendation.

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## **TUITION EXPENSES**

Tuition for Mayo employees accepted into the Master's program will be provided by scholarship for courses taken to meet Master's degree requirements. Mayo will not provide a stipend or reimburse other costs that may be associated with the degree program.

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## **REGISTRATION REQUIREMENT**

At least 60% of the coursework for the Master's degree must be completed in Mayo Graduate School. Acceptance of transfer credits will follow the guidelines currently in place for the Ph.D. program.

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## **TIME REQUIREMENT**

All requirements for the Master's degree must be completed within seven years. The seven year period begins on the date the letter of acceptance is sent.

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## **MINIMUM CREDIT REQUIREMENTS**

Students must complete a minimum of 44 quarter credits. Twenty of the credits must be in the area of specialization and a minimum of 8 quarter credits in one or more related fields outside the area of specialization, including the course entitled, "Responsible Conduct of Research." The selection of the courses to be used to meet these requirements will be determined by the student and the student's graduate faculty committee. Individual basic science departments may have additional degree requirements for specific degree tracks. The student's graduate faculty committee will consist of at least three faculty members from the student's area of specialization and one member from outside the area of specialization. The composition of this committee will be determined by the Graduate School upon recommendation of the student and the student's departmental educational coordinator.

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## **OFFICIAL DEGREE PROGRAM**

Students must submit their degree program form on or before completing 15 credits of coursework.

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## **MINIMUM GRADE REQUIREMENT**

Students must maintain a grade point average of 3.0. Guidelines for probationary status resulting from academic or nonacademic deficiency will follow the guidelines established for the Mayo Ph.D. students.

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## **PROJECT**

Master's degree tracks will specify the requirements for a nonresearch project to be completed as a required/optional component of the degree program.

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## **COMPREHENSIVE EXAMINATION**

At the completion of the required course work, students must take a comprehensive written examination. Departments will have the option of also requiring an oral examination. The examination(s) are designed to evaluate the student's depth and breadth of knowledge in the student's area of specialization

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and related fields of study. A committee of at least three examiners from inside and one examiner from outside the student's area of study will be appointed by the Graduate School upon recommendation of the student and the student's department educational coordinator at the time of approval of the official degree program. A majority vote of the committee, all members present and voting, is required to pass the examination. In the case where the student fails the examination, the committee will recommend to the Graduate School remedial studies that should be undertaken by the student before the student retakes the examination. Students will be allowed to retake the examination only once.

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## GRADUATION

Students are graduated four times a year, the third Friday in February, August and November and mid-May. The latter involves a formal ceremony as part of the Mayo Foundation graduation exercises in conjunction with the Mayo Medical School. No ceremony is held in February, August and November, but students who do graduate at one of these times are encouraged to participate in the May ceremony.

To graduate in February, August or November students must have all requirements completed by the first working day of the month prior to the graduation month. To graduate in May, students must have all requirements completed by March 15.

## BIOCHEMISTRY

E. B. Leof, Ph.D., *Graduate Education Coordinator*

Z. Bajzer, Ph.D.	C. T. McMurray, Ph.D.
M. E. Bolander, M.D.	M. A. McNiven, Ph.D.
R. E. Brown, Ph.D.	L. J. Miller, M.D.
T. P. Burghardt, Ph.D.	S. Naylor, Ph.D.
G. W. Dewald, Ph.D.	W. G. Owen IV, Ph.D.
N. L. Eberhardt, Ph.D.	R. E. Pagano, Ph.D.
D. N. Fass, Ph.D.	L. R. Pease, Ph.D.
T. A. Felmler, Ph.D.	J. T. Penniston, Ph.D.
L. A. Fitzpatrick, MD	D. R. Pfeifer, Ph.D.
S. J. Gendler, Ph.D.	J. F. Poduslo, Ph.D.
M. J. Getz, Ph.D.	F. G. Prendergast, M.D., Ph.D.
J. P. Grande, M.D., Ph.D.	J. R. Riordan, Ph.D.
S. M. Jalal, Ph.D.	P. C. Roche, Ph.D.
R. B. Jenkins, M.D.	F. M. Rusnak, Ph.D.
J. D. Jones, Ph.D.	J. L. Salisbury, Ph.D.
C. Kappen, Dr.rer.nat.	H.H.O. Schmid, Ph.D.
B. C. Kline, Ph.D.	T. C. Spelsberg, Ph.D.
M. J. Kumar, Ph.D.	E. E. Strehler, Ph.D.
R. Kumar, M.D.	S. N. Thibodeau, Ph.D.
J. J. Lee, Ph.D.	D. J. Tindall, Ph.D.
N. A. Lee, Ph.D.	D. O. Toft, Ph.D.
A. H. Limper, M.D.	R. T. Turner, Ph.D.
S. I. Macura, Ph.D.	R. Urrutia, M.D.
L. J. Maher, III, Ph.D.	G. Vockley, M.D., Ph.D.
N. J. Maihle, Ph.D.	S. Vuk-Pavlovic, Ph.D.
D. J. McCormick, Ph.D.	Z. Vuk-Pavlovic, Ph.D.
J. A. McDonald, M.D., Ph.D.	E. D. Wieben, Ph.D.
	C.Y.F. Young, Ph.D.

## Employee Master's Degree

Area of Specialization (25 credit minimum)

Bioc	8000	General Biochemistry: Structure	3 cr.
Bioc	8001	General Biochemistry: Kinetics, Catalysis and Mechanisms	3 cr.
Bioc	8002	General Biochemistry: Energy Transduction and Signalling	3 cr.
Bioc	8005	Physical Biochemistry	1 cr.
Bioc	8010	Physical Biochemistry	1 cr.
Bioc	8015	Physical Biochemistry	1 cr.
Bioc	8050	Principles of Cell and Tissue Design	3 cr.
Bioc	8500	Biochemistry and Molecular Biology Journal Club (1 cr./yr. 3 yrs. total)	1 cr.
Bioc	8300	Master's Project	3 cr.
*MBio	8050	Principles of Cell and Tissue Design	3 cr.
*MBio	8101	Replication and Transcription Regulation	3 cr.
*MBio	8102	Regulation of Protein Synthesis	3 cr.

**Outside Area of Specialization (8 credit minimum)**

MGS 5400 Responsible Conduct of Research

1 cr.

Plus a minimum of 7 additional credits required in two areas not including biochemistry. Courses noted with the asterisk (\*) may be used to fulfill this requirement.

**Elective Courses (15 credit minimum)**

The balance of the 44 credits required for the degree may be distributed among biochemistry courses and courses in related fields, at the discretion of the student in consultation with the advisory committee.

**Master's Project**

The Master's Project in Biochemistry shall consist of an independent consideration of an important topic in Biochemistry, Cell Biology, or Molecular Biology written as a scholarly review. This document shall present a fundamental question(s) in the field, address the current state of understanding, and detail practical experimental approaches to its solution. The final document and oral defense shall be thorough and of sufficient merit to satisfy the examining (advisory) committee.

**Advisory Committee**

Each student shall have an advisory committee consisting of three members of the graduate faculty. In addition to overseeing the student's educational program, this committee will be responsible for evaluating the scope and content of the Master's project. Selection of members of this committee should be discussed with the education coordinator. One of these committee members should have graduate privileges outside the area of specialization. The student's employer may **not** sit on the advisory committee.

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**BIOPHYSICAL SCIENCES BIOMEDICAL IMAGING**Richard A. Robb, Ph.D., *Graduate Education Coordinator*

M. Belohlavek, M.D., Ph.D.	A. Manduca, Ph.D.
U. Bite, M.D.	C. H. McCollough, Ph.D.
J. A. Bonner, M.D.	E. C. McCullough, Ph.D.
R. L. Ehman, M.D.	R. L. Morin, Ph.D.
J. P. Felmlee, Ph.D.	H. H. Ottesen, Ph.D.
J. M. Fernandez, Ph.D.	W. Pavlicek, Ph.D.
B. K. Gilbert, Ph.D.	S. J. Riederer, Ph.D.
J. E. Gray, Ph.D.	E. L. Ritman, M.D., Ph.D.
J. F. Greenleaf, Ph.D.	G. C. Sieck, Ph.D.
N. J. Hangiandreou, Ph.D.	S. M. Sine, Ph.D.
C. R. Jack, M.D.	J. H. Szurszewski, Ph.D.
M. J. Joyner, M.D.	S. R. Taylor, Ph.D.
R. W. Kline, Ph.D.	R. J. Vetter, Ph.D.
J. Lu, Ph.D.	

**Employee Master's Degree****I. Minimum Requirements**

A minimum of 44 credits of course work are required for the Employee Master's

Degree in Biophysical Sciences Biomedical Imaging Track. A minimum of 8 credits are taken outside the student's major area of concentration, as required by the Graduate School. A minimum of 20 credits are required in subjects within the major area, which includes a 3 credit course in advanced biomedical imaging. An additional 16 credits may be selected from the curriculum for a total of 44 credits.

## II. Course Work

A program of course work for the Master's Degree program in the Biomedical Imaging Track may be selected from the following typical curriculum.

### Outside Major Area (8 credit minimum)

MGS	5000	Fundamentals of Cell Structure and Function	5 cr.
MGS	5400	Responsible Conduct of Research	1 cr.
HSR	5823	Introductory Statistics	3 cr.
HSR	5827	Introduction to Regression	1 cr.
Imm	5806	Basic Graduate Immunology	3 cr.
MBio	5000	Introduction to Molecular Biology	3 cr.
NSci	8300	Concepts in Neurophysiology	3 cr.
Phys	5801	Principles of Biomechanics	3 cr.

### Within Major Area (20 credit minimum)

BPhy	5150	Introductory Radiation Biology	2 cr.
BPhy	5150	Introductory Radiation Biology	2 cr.
BPhy	5225	Introduction to Neural Networks	3 cr.
BPhy	5400	Molecular Electronics	3 cr.
BPhy	5450	Biomedical Image Processing I - Fundamental Concepts	4 cr.
BPhy	5500	Tutorial in Computer Organization and Programming	3 cr.
BPhy	5520	Algorithms and Problem Solving	2 cr.
BPhy	5550	Virtual Reality Methods and Applications in Biomedical Research	4 cr.
BPhy	5610	Imaging and Computers	3 cr.
BPhy	5800	Physics and Technical Principles of Medical Imaging	3 cr.
BPhy	5850	Virtual Reality Methods and Application in Biomedical Research	4 cr.
Bphy	5900	Masters Project in Biomedical Imaging	5 cr.
BPhy	8450	Biomedical Image Processing II - Intermediate Analysis	3 cr.
BPhy	8490	Biomedical Imaging Processing III - Advanced Topics	3 cr.
BPhy	8740	Magnetic Resonance Imaging Systems	3 cr.

### UNITE courses

CSci	5107	Computer Graphics I	3 cr.
CSci	5117	Computer Graphics II	3 cr.
CSci	5511	Artificial Intelligence I	4 cr.
CSci	8511	Computer Image Processing	4 cr.
Phy	5551, 5552, 5553	Topics in Physics for Biology and Medicine	15 cr.

## III. Project (BPhy 5900)

The student must complete a special project for five credits toward the Master's Degree in the Biomedical Imaging Track. Projects should not entail investigative research, but rather comprise written reports on established, state-of-the-art methods and procedures in the field of study, including literature review.

#### IV. Examination

At the completion of the required coursework, each student must take a comprehensive written examination, followed by an oral examination. The examinations evaluate the student's depth and breadth of knowledge in the area of specialization and related fields of study. A committee of three examiners from the student's area of study and an examiner from outside the student's area of study conduct the examination.

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### IMMUNOLOGY

L. R. Pease, Ph.D., *Graduate Education Coordinator*

R. T. Abraham, Ph.D.	V. A. Lennon, M.D., Ph.D.
C. S. David, Ph.D.	D. J. McKean, Ph.D.
G. J. Gleich, M.D.	C. V. Paya, M.D.
J. J. Goronzy, M.D., Ph.D.	D. H. Persing, M.D.
D. F. Jelinek, Ph.D.	M. Rodriguez, M.D.
L. M. Karintz, Ph.D.	P. J. Wettstein, Ph.D.
H. Kita, M.D.	C. M. Weyand, M.D., Ph.D.
P. J. Leibson, M.D., Ph.D.	

### Employee Master's Degree

#### Courses in Area of Specialization (21 credit minimum)

A total of 9 credits from the following (Topics courses can be taken more than once):

*Imm	5806	Basic Graduate Immunology	3 cr.
Imm	8863	Current Topics in Immunology	1 cr.
Imm	8865	Current Topics in Tumor Immunology	1 cr.
Imm	8867	Current Topics in Hypersensitivity	1 cr.

#### \* Required

Students are required to take the following tutorial courses:

Imm	8876	Tutorial in T Cell Derived Lymphokines	2 cr.
Imm	8877	Tutorial in Molecular Basis of Immune Recognition	2 cr.
Imm	8878	Tutorial in Effector Mechanisms	2 cr.
Imm	8879	Tutorial in Cellular Activation	2 cr.
Imm	8880	Tutorial in Immunopathology	2 cr.
Imm	8882	Tutorial in Cellular Recognition and Development of the Immune Response	2 cr.

#### Outside Major Area of Specialization

MGS	5400	Responsible Conduct of Research	1 cr.
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An additional 7 credits in two different areas outside the Immunology track.

#### Electives (15 credits)

The remainder of the 44 credits can be selected from any field, with no more than 9 credits in seminar or journal club style courses.

### Written Examination

The master's candidate must pass the written Immunology Qualifying Exam to complete the degree requirements.

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## MOLECULAR BIOLOGY

E. B. Leof, Ph.D., *Graduate Education Coordinator*

Z. Bajzer, Ph.D.	M. A. McNiven, Ph.D.
M. E. Bolander, M.D.	L. J. Miller, M.D.
R. E. Brown, Ph.D.	S. Naylor, Ph.D.
T. P. Burghardt, Ph.D.	W. G. Owen, IV, Ph.D.
G. W. Dewald, Ph.D.	R. E. Pagano, Ph.D.
N. L. Eberhardt, Ph.D.	L. R. Pease, Ph.D.
D. N. Fass, Ph.D.	J. T. Penniston, Ph.D.
T. A. Felmlee, Ph.D.	D. R. Pfeifer, Ph.D.
L. A. Fitzpatrick, M.D.	J. F. Poduslo, Ph.D.
S. J. Gendler, Ph.D.	F. G. Prendergast, M.D., Ph.D.
M. J. Getz, Ph.D.	J. R. Riordan, Ph.D.
J. P. Grande, M.D., Ph.D.	P. C. Roche, Ph.D.
S. M. Jalal, Ph.D.	F. M. Rusnak, Ph.D.
R. B. Jenkins, M.D.	J. L. Salisbury, Ph.D.
J. D. Jones, Ph.D.	H.H.O. Schmid, Ph.D.
C. Kappen, Dr.rer.nat.	T. C. Spelsberg, Ph.D.
B. C. Kline, Ph.D.	E. E. Strehler, Ph.D.
R. Kumar, M.D.	S. N. Thibodeau, Ph.D.
M. J. Kumar, Ph.D.	D. J. Tindall, Ph.D.
J. J. Lee, Ph.D.	D. O. Toft, Ph.D.
N. A. Lee, Ph.D.	R. T. Turner, Ph.D.
A. H. Limper, M.D.	R. Urrutia, M.D.
S. I. Macura, Ph.D.	G. Vockley, M.D., Ph.D.
L. J. Maher, III, Ph.D.	S. Vuk-Pavlovic, Ph.D.
N. J. Maihle, Ph.D.	Z. Vuk-Pavlovic, Ph.D.
D. J. McCormick, Ph.D.	E. D. Wieben, Ph.D.
J. A. McDonald, M.D., Ph.D.	C.Y.F. Young, Ph.D.
C. T. McMurray, Ph.D.	

### Employee Master's Degree

#### Area of Specialization (20 credit minimum)

*Bioc	8000	General Biochemistry: Structure	3 cr.
*Bioc	8001	General Biochemistry: Kinetics, Catabolism and Mechanisms	3 cr.
*Bioc	8002	General Biochemistry: Energy Transduction and Signalling	3 cr.
MBio	5500	Introduction to Cytogenetics (or any 8000 level Molecular Biology course except Journal Club)	2 cr.
MBio	8050	Principles of Cell and Tissue Design	3 cr.
MBio	8101	Replication and Transcription Regulation	3 cr.
MBio	8102	Regulation of Protein Synthesis	3 cr.
MBio	8500	Biochemistry and Molecular Biology Journal Club (1 cr/yr. - 3 yrs. total)	1 cr.
MBio	8400	Master's Project	3 cr.

Three additional credits in Molecular Biology not including journal club credits.

**Outside Area of Specialization (8 credit minimum)**

MGS 5400 Responsible Conduct of Research 1 cr.

An additional seven credits are required in two areas other than Molecular Biology. Courses with the asterisk (\*) can be used to fulfill this requirement.

**Elective Courses (16 credit minimum)**

The balance of the 44 credits required for the degree may be distributed between Molecular Biology courses and courses in related fields, at the discretion of the student in consultation with the advisory committee.

**Master's Project**

The Master's Project in Biochemistry shall consist of an independent consideration of an important topic in Biochemistry, Cell Biology, or Molecular Biology written as a scholarly review. This document shall present a fundamental question(s) in the field, address the current state of understanding, and detail practical experimental approaches to its solution. The final document and oral defense shall be thorough and of sufficient merit to satisfy the examining (advisory) committee.

**Advisory Committee**

Each student shall have an advisory committee consisting of three members of the graduate faculty. In addition to overseeing the student's educational program, this committee will be responsible for evaluating the scope and content of the Master's project. Selection of members of this committee should be discussed with the education coordinator. One of these committee members should have graduate privileges outside the area of specialization. The student's employer may **not** sit on the advisory committee.

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**PHARMACOLOGY**

C. T. McMurray, Ph.D., *Graduate Education Coordinator*

- |                             |                                |
|-----------------------------|--------------------------------|
| R. T. Abraham, Ph.D.        | S. Naylor, Ph.D.               |
| M. M. Ames, Ph.D.           | F. G. Prendergast, M.D., Ph.D. |
| W. S. Brimijoin, Ph.D.      | E. Richelson, M.D.             |
| J. A. Hardy, Ph.D.          | C. Shin, M.D.                  |
| Z. Katusic, M.D.            | J. H. Szurszewski, Ph.D.       |
| S. H. Kaufmann, M.D., Ph.D. | S. R. Taylor, Ph.D.            |
| J. J. Lipsky, M.D.          | A. Terzic, Ph.D.               |
| M. McKinney, Ph.D.          | R. M. Weinsilboum, M.D.        |
| T. P. Moyer, Ph.D.          | S. G. Younkin, M.D., Ph.D.     |

**Employee Master's Degree**

**Core Courses (12 credits minimum)**

Bioc	8000	General Biochemistry: Structure	3 cr.
Bioc	8001	General Biochemistry: Kinetics, Catalysis and Mechanisms	3 cr.
Bioc	8002	General Biochemistry: Energy Transduction and Signalling	3 cr.

MGS	5400	Responsible Conduct of Research	1 cr.
Imm	5806	Basic Graduate Immunology	3 cr.
MBio	5000	Introduction to Molecular Biology	3 cr.

**Track (19 credits)**

Phar	5100	Pharmacology Seminar Series (1 cr./yr. - 4 yrs. req.)	4 cr.
Phar	5800	General Pharmacology	9 cr.
Phar	8800	Research Seminars in Pharmacology	1 cr.
Phar	8805	Drug Metabolism	3 cr.
Phar	8806	Pharmacology of Receptors	3 cr.

**Electives (11 credits)**

Three credits each must be taken from at least 3 different categories A to D.

**Category A**

Phar	8803	Biochemical Basis of Neuropharmacology	3 cr.
N	8854	Basic Neurosciences	5 cr.

**Category B**

Phar	8802	Pharmacology of Heart Muscle	3 cr.
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**Category C**

Phar	8804	Clinical Pharmacology	1 cr.
Phar	8810	Toxicology	3 cr.
Phar	8879	Tutorial in Cellular Activation	2 cr.

**Category D**

HSR	5823	Introductory Statistics I	3 cr.
BPhy	5500	Tutorial in Computer Organization and Programming	3 cr.

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## PHYSIOLOGY

R. A. Robb, Ph.D. *Graduate Education Coordinator*

K. An, M.D.	T. O'Brien, M.D.
A. G. Andrews, D.M.V.	J. H. Pemberton, M.D.
J. C. Burnett, M.D.	S. F. Phillips, M.D.
E. P. DiMagno, M.D.	J. L. Rae, Ph.D.
T. P. Dousa, M.D.	E. L. Ritman, M.D., Ph.D.
J. M. Fernandez, Ph.D.	M. G. Rock, M.D.
L. A. Fitzpatrick, M.D.	J. C. Romero, M.D.
C. S. Frisk, D.V.M.	M. G. Sarr, M.D.
P. Gloviczki, M.D.	H. V. Schaff, Ph.D.
J. F. Greenleaf, Ph.D.	G. C. Sieck, Ph.D.
M. J. Joyner, M.D.	S. M. Sine, Ph.D.
S. Khosla, M.D.	J. H. Szurszewski, Ph.D.
D. W. Klass, M.D.	S. R. Taylor, Ph.D.
F. G. Knox, M.D., Ph.D.	R. T. Turner, Ph.D.
V. M. Miller, Ph.D.	

## Employee Master's Degree

### I. Minimum Requirements

A minimum of 44 credits of coursework is required for a Master's Degree in the Physiology Track. A minimum of eight credits are taken outside the student's major area of concentration, as required by the Graduate School. A minimum of 20 credits are required in subjects within the major area, which includes a three-credit course in physiology. An additional 16 credits may be selected from the curriculum for a total of 44 credits.

### II. Course Work

A program of coursework for the Master's Degree program in the Physiology Track may be selected from the following typical curriculum.

#### Outside Major Area (8 credit minimum)

BPhy	5450	Biomedical Image Processing I - Fundamental Concepts	4 cr.
BPhy	5500	Tutorial in Computer Organization and Programming	3 cr.
HSR	5823	Introductory Statistics I	3 cr.
HSR	5827	Introduction to Regression	1 cr.
Imm	5806	Basic Graduate Immunology	3 cr.
MBio	5000	Introduction to Molecular Biology	3 cr.
NSci	8300	Concepts in Neurophysiology	3 cr.

#### Within Major Area (20 credit minimum)

BPhy	5150	Introductory Radiation Biology	2 cr.
BPhy	5150	Introductory Radiation Biology	2 cr.
BPhy	5400	Molecular Electronics	2 cr.
Phys	5500	Research Animal Experimental Surgery and Methodology	3 cr.
Phys	5801	Principles of Biomechanics I	3 cr.
Phys	5802	Principles of Biomechanics II	3 cr.
Phys	5900	Masters Project in Physiology	5 cr.
NSci	8300	Concepts in Neurophysiology	3 cr.
Phys	8855	Cardiovascular Physiology	3 cr.
Phys	8856	Respiratory Physiology	2 cr.
Phys	8858	Physiology of Smooth Muscle and of its Innervation	2 cr.
Phys	8859	Renal Physiology	2 cr.
Phys	8860	Endocrine Physiology	2 cr.
Phys	8862	Excitation-Contraction Coupling in Skeletal Muscle	3 cr.
Phys	8878	Physiology of Bone I	3 cr.
Phys	8879	Physiology of Bone II	2 cr.

### III. Project

The student must complete a special project for five credits toward the Master's Degree in the Physiology Track. Projects should not entail investigative research, but rather comprise written reports on established, state-of-the-art methods and procedures in the field of study.

### IV. Examination

At the completion of the required coursework, each student must take a comprehensive written examination, followed by an oral examination. The examinations evaluate the student's depth and breadth of knowledge in the area of

specialization and related fields of study. A committee of three examiners from the student's area of study and an examiner from outside the student's area of study conduct the examination.

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## TUMOR BIOLOGY

Jeffrey L. Salisbury, Ph.D. *Graduate Education Coordinator*

R. T. Abraham, Ph.D.	L. J. Maher, III, Ph.D.
M. M. Ames, Ph.D.	N. J. Maihle, Ph.D.
A. G. Andrews, D.M.V.	R. McGee, Ph.D.
A. T. Baron, Ph.D.	D. J. McKean, Ph.D.
K. E. Bennet, M.S.	M. J. McManus, M.D.
J. A. Bonner, M.D.	M. A. McNiven, Ph.D.
M. P. Cleary, Ph.D.	L. J. Melton, M.D.
C. S. David, Ph.D.	H. Nelson, M.D.
G. W. Dewald, Ph.D.	J. R. O'Fallon, Ph.D.
R. L. Ehman, M.D.	D. J. O'Kane, Ph.D.
C. Erlichman, M.D.	D. H. Persing, M.D., Ph.D.
M. J. Federspiel, Ph.D.	M. R. Pittelkow, M.D.
L. A. Fitzpatrick, M.D.	K. C. Podratz, M.D., Ph.D.
S. J. Gendler, Ph.D.	F. G. Prendergast, M.D., Ph.D.
M. J. Getz, Ph.D.	C. Raffel, M.D., Ph.D.
J. P. Grande, M.D., Ph.D.	J. L. Reiter, Ph.D.
L. C. Hartmann, M.D.	D. I. Smith, Ph.D.
J. N. Ingle, M.D.	T. C. Spelsberg, Ph.D.
C. D. James, Ph.D.	E. E. Strehler, Ph.D.
D. F. Jelinek, Ph.D.	S. N. Thibodeau, Ph.D.
R. B. Jenkins, M.D., Ph.D.	D. J. Tindall, Ph.D.
S. H. Kaufmann, M.D., Ph.D.	D. O. Toft, Ph.D.
H. Lee, Ph.D.	R. A. Urrutia, M.D.
P. J. Leibson, M.D., Ph.D.	R. M. Weinshilboum, M.D.
V. A. Lennon, M.D.	P. J. Wettstein, Ph.D.
E. B. Leof, Ph.D.	R. A. White, Ph.D.
W. L. Lingle, Ph.D.	A. J. Windebank, M.D.
R. V. Lloyd, M.D., Ph.D.	L. E. Wold, M.D.
J. A. Lust, M.D., Ph.D.	C. Y. F. Young, Ph.D.

## Employee Master's Degree

### General

The Master's Degree candidate in Tumor Biology will satisfy all of the requirements set forth by the Mayo Graduate School for the Master's Degree. In addition, the candidate will complete the didactic course work and attend the journal clubs/workshops indicated below, for a total of 44 credit hours. The Master's project in Tumor Biology shall consist of an independent consideration of an important topic in Tumor Biology written as a scholarly review. This document shall present a fundamental question(s) in the field, address the current state of understanding, and detail practical experimental approaches to its solution. The final document and oral defense by the student shall be thorough and of sufficient merit to satisfy the examining (advisory) committee.

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**Area of Specialization:**

TBio	5000	Tumor Biology I: Introduction to Tumor Biology	3 cr.
TBio	8000	Tumor Biology II: Origins of Human Cancer	3 cr.
TBio	8005	Tumor Biology III: Growth Factors, Oncogenes and Tumor Suppoessors	3 cr.
TBio	8200	Cell Biology of Cancer	2.5 cr.
TBio	5150	Current Topics in Tumor Biology: Journal Club	1 cr. X 3
Imm	5806	Basic Graduate Immunology	3 cr.
TBio	5300	Business of Science and the Science of Business	1 cr.
TBio	5100	Research Seminars in Tumor Biology	1 cr. X 3
TBio	8400	Master's Project	3 cr.

Track courses = 23.5 cr.

**Outside Area of Specialization:**


MBio	5000	Introduction to Molecular Biology	3 cr.
MBio	5300	Principles of Cell and Tissue Design	3 cr.
MBio	5500	Human Cytogenetics	2 cr.
MBio	8100	Advances in Cell and Molecular Biology	3 cr.
MBio	8101	Replication and Transcription	3 cr.
MBio	8102	Regulation of Protein Synthesis	3 cr.
MBio	8910	Molecular Control of Cell Differentiation	1 cr.
Phar	5801	General Pharmacology I	2 cr.
TBio	5200	Principles of Pancreatic Cancer	1 cr.
TBio	5250	Gene Therapy and Cancer	1 cr.

A balance of the 44 credits required for the degree may be distributed among those offered by the Graduate School

**Advisory Committee:**

Each student shall have an advisory committee consisting of three members of the graduate faculty. In addition to overseeing the student's educational program, this committee will be responsible for evaluating the scope and content of the Master's project.

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**DESCRIPTION OF  
MASTER'S DEGREE PROGRAM  
AND CLINICAL  
TRACK REQUIREMENTS**

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## MASTER OF SCIENCE PROGRAM IN BIOMEDICAL SCIENCES

(Clinical Specialties)

The degree program requirements for a master's in a clinical field include a minimum of 20 credits in biomedical sciences and 15 credits in the area of specialization. Full-time registration for a minimum of one year is required. General program requirements and specialty track descriptions are outlined on the following pages. The equivalent of a minimum of six months of full-time effort must be devoted to research.

Courses in basic biomedical sciences are required to provide the student with the knowledge to address a research problem, conduct the research and evaluate the results. Courses in the area of specialization are required in addition to provide special skills, techniques or knowledge related to the specialty track.

The primary purpose of the degree program is to enhance the scholarly dimension of the education of physicians who have an interest in academic medicine. Training in research is emphasized. The degree program provides a structure for development of a plan to address a research problem, an orderly approach to the project, assurance of the credentials of the adviser, appropriate supervision, and a suitable approach to the analysis and presentation of the results.

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## GENERAL PROGRAM REQUIREMENTS

**Eligibility:** The program described below is designed chiefly for Mayo residents who hold appointments to the clinical programs of Mayo Graduate School of Medicine. Potential candidates for the degree must hold appointments of sufficient duration to complete degree program requirements.

**Application:** The candidate must complete a Statement of Intent to Pursue a Degree. This form, which requires departmental approval of the degree program and research project, is available in the Graduate School Office.

**Time Requirement:** All requirements must be satisfied within one year after completion of the residency or fellowship.

**Thesis Protocol:** No later than two months after entering the laboratory, the candidate must submit a protocol to the Mayo Graduate School Education Committee. This protocol must clearly define the candidate's role in his/her project and must have sufficient detail to permit review by an advisory committee (guidelines are available in the Graduate School Office). If the protocol is not submitted during the first quarter in the laboratory, registration for research credits will not be allowed for the second quarter.

**Official Program:** Students are encouraged to submit their programs and thesis titles to the Graduate School before the end of the second year of registration. Students and advisers should include on the program forms: a) the minimum number of courses/credits necessary to fulfill degree requirements (credits may vary depending on the chosen area of specialization), b) the thesis title and c) the recommended thesis readers and final oral examining committee. The examining committee consists of a minimum of three individuals, one of whom is the student's adviser, who serves as chair of the committee. One member must be

from outside the department and no member other than the chair can be from among a student's research advisers. If the student has a clinical and research adviser, both will be put on the committee along with another examiner from the area of specialization and another from a basic science field. The recommended committee must be approved by the Graduate School.

**Changes in Approved Program:** Once approved, the program must be fulfilled in every detail to meet graduation requirements. Alterations in the program should be requested in writing and are subject to approval of the Mayo Graduate School Education Committee.

**Minimum Grade Requirements:** The minimum grade point average required by the Graduate School for courses included on the official program for the degree is 3.0 (on a 4.0 scale). Grades of A through C, and S are acceptable, but grades of S are not calculated in the grade point average. At least two-thirds of the credits taken and included on any degree program must be graded under the A through F system.

**Minimum Credit Requirements:** Students must complete a minimum of 20 credits in biomedical sciences and 15 additional credits in the area of specialization (see individual specialty track descriptions for specific course requirements). A maximum of 12 research credits can be applied towards the 20 biomedical science credits. One clinical rotation, to a maximum of 6 credits, can be used towards the 15 in the area of specialization. The remaining 9 must be didactic credits in the area of specialization. A minimum of six months or its equivalent in time and effort must be devoted to research. Students are not admitted to a specialty track unless there is reasonable assurance that course work required for completion of degree requirements is available.

**Thesis:** The thesis must be submitted to the final oral examining committee at least three weeks prior to the oral examination.

**Written Examination:** Must be taken no later than six months before completion of the training program.

**Final Examination:** Candidates for the M.S. degree must pass a final oral examination, which can be taken only after the written examination has been passed, courses on the official program completed, and the thesis reviewed. Successful completion of the final oral examination requires a unanimous decision by all of the members of the committee.

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## DENTISTRY - ORTHODONTICS

B. E. Larson, D.D.S., *Graduate Education Coordinator*

T. A. Guenther, D.D.S.

A. H. Sather, D.D.S.

A. J. Hill, Jr., D.D.S.

### Master's Degree

#### Biomedical Sciences Courses

*Anat	8852	Surgical Anatomy of the Head and Neck	3 cr.
*HSR	5400	Introduction to Statistical Models	1 cr.
*HSR	5410	Design of Clinical Studies	1 cr.
*Odon	8857	Research in Selected Problems (1 cr./qtr. - 10 qtrs. required)	10 cr.
*Phys	5801	Principles of Biomechanics	3 cr.

#### \*Required Courses

Three credits from the following courses required:

(Substitution permitted with prior approval)

HSR	5823	Introductory Statistics I	3 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Logistic Regression and Related Topics	1 cr.
Path	8873	Oral Pathology (2 cr./yr. - 3 yrs. required)	6 cr.
Phys	8878	Physiology of Bone I (must audit if not taken for credit)	3 cr.
Pdon	8884	Pathology of Periodontal Disease	1 cr.

#### Orthodontic Didactic Courses (all required)

Odon	8806	Orthodontic Seminar: Technique (1 cr./qtr. - 11 qtrs. required)	11 cr.
Odon	8807	Orthodontic Seminar: Literature Review (1 cr./qtr. - 11 qtrs. required)	11 cr.
Odon	8808	Orthodontic Seminar: Case Presentation (1 cr./qtr. - 11 qtrs. required)	11 cr.
Odon	8809	Surgical Orthodontic Seminar (1 cr./qtr. - 9 qtrs. required)	9 cr.
Odon	8810	Clinical Oro-Facial Pathology and Developmental Disorders	1 cr.
Odon	8811	Facial Growth and Development	1 cr.

#### Orthodontic Clinical Courses (all required)

Odon	8800	Advanced Orthodontic Techniques	3 cr.
Odon	8802	Orthodontic Case Analysis	6 cr.
Odon	8803	Orthodontic Treatment Planning	6 cr.
Odon	8804	Clinical Orthodontics (6 cr./qtr. - 4 qtrs. required)	24 cr.
Odon	8805	Advanced Clinical Orthodontics (6 cr./qtr. - 4 qtrs. required)	24 cr.
Odon	8851	Dental Roentgenology	1 cr.
Odon	8852	Oral Diagnosis	5 cr.
OS	8850	Oral and Maxillofacial Surgery	3 cr.

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## DENTISTRY - PERIODONTICS

C. M. Reeve, D.D.S., *Graduate Education Coordinator*

P. J. Sheridan, D.D.S.

### Master's Degree

#### Biomedical Sciences Courses

*Anat	8852	Surgical Anatomy of Head and Neck	3 cr.
Derm	8841	Diagnostic Dermatology	2 cr.
HSR	5400	Introduction to Statistical Models	1 cr.
HSR	5410	Design of Clinical Studies	1 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Logistic Regression and Related Topics	1 cr.
*Pdon	8857	Research in Selected Problems (2 cr./qtr. - 6 qtrs. required)	12 cr.
*Path	8873	Oral Pathology (2 cr./yr. - 3 yrs. required).	6 cr.

#### \*Required Courses

#### Periodontics Didactic Courses (all required)

Pdon	8883	Periodontal Seminar (1 cr./qtr. - 9 qtrs. required)	9 cr.
Pdon	8884	Pathology of Periodontal Disease	1 cr.

#### Periodontics Clinical Courses (all required)

Pdon	8880	Clinical Periodontics (6 cr./qtr. - 2 qtrs. required)	12 cr.
Pdon	8881	Advanced Clinical Periodontics (6 cr./qtr. - 2 qtrs. required)	12 cr.

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## DENTISTRY - PROSTHODONTICS

S. E. Eckert, D.D.S., *Graduate Education Coordinator*

R. P. Desjardins, D.M.D.

### Master's Degree

#### Biomedical Sciences Courses

*Anat	8852	Surgical Anatomy of Head and Neck	3 cr.
*HSR	5400	Introduction to Statistical Models	1 cr.
*HSR	5410	Design of Clinical Studies	1 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Logistic Regression and Related Topics Epidemiologic Studies	1 cr.
*Path	8873	Oral Pathology (2 cr./yr. 3 yrs. required)	6 cr.
*Pros	8857	Research in Selected Problems (2 cr./qtr. 6 qtrs. required)	12 cr.

*Phys	5801	Principles of Biomechanics I	3 cr.
Phys	8878	Physiology of Bone I	3 cr.

\*Required Courses

**Prosthodontic Didactic Courses (all required)**

Pros	8841	Prosthodontic Seminar (Complete Dentures) (1 cr./qtr. -2 qtrs. required)	2 cr.
Pros	8843	Prosthodontic Seminar (Partial Dentures)	1 cr.
Pros	8845	Prosthodontic Seminar (Fixed)	1 cr.
Pros	8847	Seminar: Maxillofacial Prosthetics Advanced Prosthodontics (1 cr./qtr.-1 qtr. required)	2 cr.
Pros	8848	Seminar: Current Literature (1 cr./qtr. -9 qtrs. required)	9 cr.
Pros	8849	Seminar: Maxillofacial Prosthetics (Extraoral) and Advanced Prosthodontics	1 cr.
Pros	8850	Seminar: Implant Prosthodontics	1 cr.
Pros	8862	Dental Materials	1 cr.
Pros	8870	Occlusion	1 cr.
Pros	8871	Physiology, Pharmacology and Pre-Prosthetic Surgery	1 cr.
Pros	8872	Prosthodontic Practice Management	1 cr.
Pros	8873	Cranio-mandibular Disorders and Facial Pain	1 cr.
Pros	8874	Prosthodontic Management of the Geriatric Patient	1 cr.

**Prosthodontic Clinical Courses (all required)**

Pros	8840	Clinical Prosthodontics: Complete Dentures (6 cr./qtr. - 2 qtrs. required)	12 cr.
Pros	8842	Clinical Prosthodontics: Partial Dentures (6 cr./qtr. - 4 qtrs. required)	24 cr.
Pros	8844	Maxillofacial Prosthetics (Intraoral) Implant Prosthodontics - Advanced Prosthodontics (6 cr./qtr. - 3 1/2 qtrs. required)	21 cr.
Pros	8846	Maxillofacial Prosthetics (Extraoral) Advanced Prosthodontics	3 cr.
Pros	8851	Dental Roentgenology	1 cr.
Pros	8852	Oral Diagnosis and Treatment of Cranio-mandibular Disorders	2 cr.
Pros	8854	Implant Prosthodontics (6 cr./qtr. - 3 qtrs. required)	18 cr.
Pros	8876	Clinical Prosthodontics: Fixed Partial Dentures	6 cr.
Pros	8880	Dental Laboratory Technology	6 cr.
I	8866	Oncology (Special Clinical and Laboratory Techniques)	1 cr.
SpPa	8861	Speech Pathology	2 cr.
ENT	8851	Clinical Otolaryngology	6 cr.
R	8853	Radiation Oncology	2 cr.

## OBSTETRICS AND GYNECOLOGY

T. O. Wilson, M.D., *Graduate Education Coordinator*

L. D. Erickson, M.D.	K. C. Podratz, M.D., Ph.D.
R. H. Heise, M.D.	K. D. Ramin, M.D.
R. A. Lee, M.D.	C. R. Stanhope, M.D.
J. Magrina, M.D.	M. J. Webb, M.D.
P. L. Ogburn, Jr., M.D.	

### Master's Degree

#### Biomedical Sciences Courses

##### Didactic\*

HSR 5823	Introductory Statistics	3 cr.
HSR 5827	Introduction to Regression	1 cr.
HSR 5831	Introduction to Clinical Epidemiology	1 cr.
HSR 5835	Logistic Regression and Related Topics	1 cr.
HSR 5840	Survival Analysis	1 cr.

\*Six credits are required.

##### Research

**Bioc 8840	Master's Research in Biochemistry	6 cr.
**MBio 8840	Master's Research in Molecular Biology	6 cr.
**Imm 8840	Research in Immunology	6 cr.
**Phar 8840	Research in Pharmacology	6 cr.
**Phys 8840	Master's Research in Physiology	6 cr.

\*\*A minimum of two quarters of one of these is required.

A minimum of two additional credits of didactic course work is required in the area of research, with the approval of the adviser.

#### Obstetrics and Gynecology Didactic Courses (all required)

Anat 8000	Anatomy of the Pelvis-Perineum	2 cr.
ObG 5000	Basic Colposcopy	2 cr.
ObG 5801	Introduction to Obstetrics	3 cr.
ObG 5803	Introduction to Surgical Gynecology	3 cr.
ObG 8856	Reproductive Endocrinology	1 cr.

#### Obstetrics and Gynecology Clinical Courses

Satisfactory completion of a minimum of 3 years of clinical experience in Obstetrics and Gynecology.

ObG 8852	Clinical Obstetrics and Gynecology (6 cr./qtr. - 6 qtrs. required)	36 cr.
ObG 8853	Operative Surgery (6 cr./qtr. - 6 qtrs. required)	36 cr.

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## OBSTETRICS & GYNECOLOGY - GYNECOLOGIC ONCOLOGY

### Master's Degree

#### Biomedical Sciences Didactic Courses

##### Didactic\*

HSR	5823	Introductory Statistics	3 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Logistic Regression and Related Topics	1 cr.
HSR	5840	Survival Analysis	1 cr.

\*Six credits are required.

##### Research

**Bioc	8895	Research in Biochemistry	6 cr.
**MBio	8900	Research in Molecular Biology	6 cr.
**Imm	8840	Research in Immunology	6 cr.
**Phar	8840	Research in Pharmacology	6 cr.
**Phys	8840	Research in Physiology	6 cr.

\*\*Four quarters of one of these is required.

A minimum of two additional credits of didactic course work is required in the area of research, with the approval of the adviser.

#### Gynecologic Oncology Didactic Courses

Anat	8000	Anatomy of the Pelvis-Perineum	2 cr.
ObG	5803	Introduction to Surgical Gynecology (1 cr./qtr. 8 qtrs. required)	8 cr.

#### Gynecologic Oncology Clinical Courses

ObG	8857	Gynecologic Oncology (6 cr./qtr. - 8 qtrs. required)	48 cr.
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## OBSTETRICS & GYNECOLOGY - REPRODUCTIVE ENDOCRINOLOGY

### Master's Degree

#### Biomedical Sciences Didactic Courses

##### Didactic\*

HSR	5823	Introductory Statistics	3 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Logistic Regression and Related Topics	1 cr.
HSR	5840	Survival Analysis	1 cr.

\*Six credits are required.

##### Research

**Bioc	8895	Research in Biochemistry	6 cr.
**MBio	8900	Research in Molecular Biology	6 cr.

**Imm	8840	Research in Immunology	6 cr.
**Phar	8840	Research in Pharmacology	6 cr.
**Phys	8840	Research in Physiology	6 cr.

\*\*Four quarters of one of these is required.

A minimum of two additional credits of didactic course work is required in the area of research, with the approval of the adviser.

#### Reproductive Endocrinology Didactic Courses

ObG	5803	Introduction to Surgical Gynecology	1 cr.
ObG	8854	Seminars in Gynecologic Endocrinology (1 cr./qtr. - 8 qtrs. required)	8 cr.
ObG	8856	Clinical Reproductive Endocrinology	1 cr.

#### Reproductive Endocrinology Clinical Courses

ObG	8858	Reproductive Endocrinology I	3 cr.
ObG	8859	Reproductive Endocrinology II	3 cr.
ObG	8860	Reproductive Endocrinology III	3 cr.

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## OBSTETRICS & GYNECOLOGY - UROGYNECOLOGY/ RECONSTRUCTIVE PELVIC SURGERY FELLOWSHIP

### Master's Degree

#### Biomedical Sciences Didactic Courses

Didactic*			
HSR	5823	Introductory Statistics I	3 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Statistical Methods for Epidemiologic Studies	2 cr.

\*Six credits are required.

#### Research

**Bioc	8895	Research in Biochemistry	6 cr.
**MBio	8900	Research in Molecular Biology	6 cr.
**Imm	8840	Research in Immunology	6 cr.
**Phar	8840	Research in Pharmacology	6 cr.
**Phys	8840	Research in Physiology	6 cr.

\*\*Four quarters of basic science research is required.

A minimum of two additional credits of didactic course work is required in the area of research, with the approval of the adviser.

#### Urogynecology/Reconstructive Pelvic Surgery Fellowship Didactic Courses

Anat	8860	Special Topics in Anatomy	3-4 cr.
ObG	5803	Introduction to Surgical Gynecology (1 cr./qtr. - 4 qtrs. required)	4 cr.

#### Urogynecology/Reconstructive Pelvic Surgery Fellowship Clinical Courses

ObG	8870	Advanced Gynecologic Operative Surgery (6 cr./qtr. - 4 qtrs. required)	24 cr.
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## OPHTHALMOLOGY

J. M. Pach, M.D., *Graduate Education Coordinator*

K. N. Baratz, M.D.	D. H. Johnson, M.D.
G. B. Bartley, M.D.	J. A. Leavitt, M.D.
W. M. Bourne, M.D.	T. J. Liesegang, M.D.
R. F. Brubaker, M.D.	L. J. Maguire, M.D.
H. Buettner, M.D.	T. J. McPhee, M.D.
R. J. Campbell, M.D.	J. M. Pach, M.D.
J. C. Erie, M.D.	D. M. Robertson, M.D.
J. A. Garrity, M.D.	R. R. Waller, M.D.
G. G. Hohberger, M.D.	B. R. Younge, M.D.

### Master's Degree

#### Biomedical Sciences Courses

The candidate must complete a minimum of 20 quarter credits from the following biomedical sciences courses:

HSR	5823	Introductory Statistics I	3 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Logistic Regression and Related Topics	1 cr.
Imm	5806	Basic Graduate Immunology	3 cr.
Phar	5801-5805	General Pharmacology	9 cr.
Phar	8803	Biochemical Basis of Neuropharmacology	3 cr.
Phar	8806	Pharmacology of Receptors	3 cr.
Phys	8300	Concepts in Neurophysiology	3 cr.
Phys	8855	Cardiovascular Physiology	3 cr.
Phys	8858	Physiology of Smooth Muscle and of its Innervation	2 cr.
Phys	8859	Renal Physiology	2 cr.
Phys	8860	Endocrine Physiology	2 cr.
Oph	8900	Research in Ophthalmology (6 cr./qtr. - 2 qtrs. required)	12 cr.

#### Ophthalmology Didactic Courses (all required)

Oph	8100	Fundamentals and Principles of Ophthalmology	4 cr.
Oph	8101	Optics, Refraction and Contact Lenses	4 cr.
Oph	8102	Ophthalmic Pathology, Ocular Tumors, Intraocular Inflammation, and Uveitis	4 cr.
Oph	8103	Retinal and Vitreous Diseases	4 cr.
Oph	8104	Neuro-ophthalmology and General Medical Ophthalmology	4 cr.
Oph	8015	Binocular Vision and Ocular Motility	4 cr.
Oph	8106	External and Corneal Diseases	4 cr.
Oph	8107	Glaucoma, Disorders of the Lens and Anterior Segment Trauma	4 cr.
Oph	8108	Orbital Diseases and Plastic and Reconstructive Surgery	4 cr.

#### Ophthalmology Clinical Courses

Oph	8851	Refraction and Strabismus	6 cr.
Oph	8852	Ocular Therapy	6 cr.

Oph	8853	Medical and Neurologic Ophthalmology	6 cr.
Oph	8854	Ophthalmic Surgery	6 cr.
Oph	8855	Ophthalmic Pathology, Anatomy, and Surgical Technique	6 cr.

## ORTHOPEDICS

A. D. Hanssen, M.D., *Graduate Education Coordinator*

P. C. Amadio, M.D.	D. G. Lewallen, M.D.
H. B. Kitaoka, M.D.	B. F. Morrey, M.D.
K. An, Ph.D.	S. W. O'Driscoll, M.D., Ph.D.
R. D. Beckenbaugh, M.D.	H. A. Peterson, M.D.
R. A. Berger, M.D., Ph.D.	D. J. Pritchard, M.D.
A. T. Bishop, M.D.	M. G. Rock, M.D.
M. E. Bolander, M.D.	A. R. Schroeder
M. E. Cabanela, M.D.	T. C. Shives, M.D.
D. C. Campbell, II, M.D.	F. H. Sim, M.D.
R. H. Cofield, M.D.	M. J. Stuart M.D.
W. P. Cooney, M.D.	R. T. Turner, Ph.D.
B. L. Currier, M.D.	M. B. Wood, M.D.

## Master's Degree

### Biomedical Sciences Courses

*Phys	8878	Physiology of Bone I	3 cr.
*Phys	8879	Physiology of Bone II	2 cr.
*Phys	5801	Principles of Biomechanics I	3 cr.
*Phys	5802	Principles of Biomechanics II	3 cr.
*M	5805	Microbiology of Musculoskeletal System	1 cr.
*Anat	8855	Orthopedic Anatomy (1 cr./qtr. - 2 qtrs. required)	2 cr.
*Path	8872	Bone and Soft Tissue Pathology	3 cr.
*Phys	8840	Research in Physiology (6 cr./qtr. - 2 qtrs. required) or	12 cr.
*Bioc	8895	Research in Biochemistry (6 cr./qtr. - 2 qtrs. required)	12 cr.
Phys	8880	Principles of Solid Mechanics	3 cr.
Phys	8881	Mechanics of Deformable Materials	3 cr.

### \*Required Courses

#### Orthopedics Didactic Courses (all required)

Or	5803	Prosthetics for Orthopedics	1 cr.
Or	8500	Technique of Microvascular Anastomosis	2 cr.
Or	8860	Basic Knowledge and Motor Skills of Orthopedic Subspecialties	3 cr.
R	8854	Radiology of the Musculoskeletal System	1 cr.

#### Orthopedics Clinical Courses (all required)

Or	8851	Orthopedic Diagnosis	6 cr.
Or	8852	Adult Reconstruction	6 cr.
Or	8853	Surgery of the Hand	6 cr.
Or	8854	Pediatric Orthopedics	6 cr.
Or	8855	Orthopedic Oncology	6 cr.
Or	8856	Fractures	2 cr.

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## OTORHINOLARYNGOLOGY

C. W. Beatty, M.D., *Graduate Education Coordinator*

C. D. Bauch, Ph.D.	T. V. McCaffrey, M.D., Ph.D.
D. A. Fabry, Ph.D.	T. J. McDonald, M.D.
G. W. Facer, M.D.	H. B. Neel III, M.D., Ph.D.
R. O. Gustafson, M. D.	K. D. Olsen, M.D.
S. G. Harner, M.D.	B. W. Pearson, M.D.
J. L. Kasperbauer, M.D.	M. S. Robinette, Ph.D.
E. B. Kern, M.D.	J. R. Salassa, M.D.
N.E. Maragos, M.D.	D. A. Sherris, M.D.
M. S. Marion, M.D.	

### Master's Degree

#### Biomedical Sciences Courses

*Anat	8852	Surgical Anatomy of Head and Neck	3 cr.
Anat	8860	Special Topics in Anatomy	1-4 cr.
*HSR	5823	Introductory Statistics I	3 cr.
HSR	5400	Introduction to Statistical Models	1 cr.
HSR	5410	Design of Clinical Studies	1 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Logistic Regression and Related Topics	1 cr.
Phar	5801	General Pharmacology	2 cr.
Phar	5802-5	General Pharmacology	7 cr.
Phar	8803	Biochemical Basis of Neuropharmacology	3 cr.
Phar	8806	Pharmacology of Receptors	3 cr.
Phys	8859	Renal Physiology	2 cr.
Imm	5806	Basic Graduate Immunology	3 cr.
*ENT	8890	Graduate Research (6 cr./qtr. - 2 qtrs. required)	12 cr.

\*Required courses, an additional six credits to be chosen from courses listed, for a total of at least 25 credits in the Biomedical Sciences area. Other biomedical sciences courses may be included as electives at the discretion of the staff adviser.

#### Otorhinolaryngology Didactic Courses (all required)

ENT	5150	Core Curriculum	2 cr.
ENT	5300	Core Colloquium	1 cr.
ENT	8800	Seminar: Otorhinolaryngology	1 cr./yr.
ENT	8100	Problems in Clinical Diagnosis	4 cr.
ENT	8200	Clinical Testing Practicum	1 cr.
ENT	8300	Soft Tissue and Plastic Reconstruction	1 cr.
ENT	8500	Rhinology and Rhinologic Surgery Dissection	3 cr.
ENT	8857	Temporal Bone Anatomy and Surgery of the Temporal Bone	3 cr.

#### Otorhinolaryngology Clinical Courses (all required)

ENT	8851	Clinical Otorhinolaryngology	6 cr.
ENT	8852	Preoperative and Postoperative Care of Patients	6 cr.
ENT	8853	Operative Otorhinolaryngology	6 cr.
ENT	8854	Operative Otorhinolaryngology	6 cr.

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## PHYSICAL MEDICINE AND REHABILITATION

S. F. Noll, M.D., *Graduate Education Coordinator*

R. W. DePompolo, M.D.

### Master's Degree

The basic residency program is designed to train residents to be competent in the field of physical medicine and rehabilitation and to meet the requirements of the American Board of Physical Medicine and Rehabilitation. Candidates for a Master's degree will require an additional year of training (authorized by the Graduate Education Committee for Medical and Laboratory Specialties of the Mayo Graduate School of Medicine).

**\*Biomedical Sciences Courses** (9 credits required in addition to 12 credits of research)

Anat	8855	Orthopedic Anatomy	2 cr.
HSR	5823	Introductory Statistics I	3 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Logistic Regression and Related Topics	1 cr.
Phar	8803	Biochemical Basis of Neuropharmacology	3 cr.
Phys	5801	Principles of Biomechanics	3 cr.
**Phar	8862	Excitation-Contraction Coupling in Skeletal Muscle	3 cr.
PhM	8900	Research Work on Selected Problems (6 cr./qtr. - 2 qtrs. required)	12 cr.

### \*Electives

Derm	8847	Cutaneous Photobiology	1 cr.
I	8861	Rheumatology (Special Clinical and Laboratory Techniques)	6 cr.
N	8859	Neurological Diseases in Children	6 cr.
R	8854	Radiology of the Musculoskeletal System	1 cr.

\*The foregoing list includes courses relevant to the field of PM&R but is not intended to be all-inclusive.

\*\*Requires permission of instructor

### Physical Medicine & Rehabilitation Clinical Courses (*all required*)

PhM	8851	Outpatient Clinical Physical Medicine and Rehabilitation (6 cr./qtr. - 1-2 qtrs. required)	6 cr.
PhM	8852	Physical Medicine and Rehabilitation Hospital Consulting Service (6 cr./qtr. - 2 qtrs. required)	12 cr.
PhM	8853	Hospital Rehabilitation Service (6 cr./qtr. - 3 qtrs. required)	18 cr.
N	8852	Neurologic Diseases in Adults	6 cr.
N	8860	Electromyography (6 cr./qtr. - 2 qtrs. required)	12 cr.
I	8853	Medical Diagnosis and Hospital Service	4 cr.
I	8858	Cardiovascular Diseases (Special Clinical and Laboratory Techniques) (6 cr./qtr. - .5 qtr. required)	3 cr.
Or	8852	Adult Reconstruction (6 cr./qtr. - .5 qtr. required)	3 cr.

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**Physical Medicine & Rehabilitation Didactic Courses (all required)**

Anat	5500	Functional Anatomy of Back and Extremities	1.5cr.
PhM	8854	Basic and Applied Physiatriy (2 cr./qtr. - 12 qtrs. required)	24 cr.
PhM	8855	Amputations and Prosthetics	3 cr.
PhM	8856	Seminars in Physical Medicine and Rehabilitation (1 cr./qtr. - 12 qtrs. required)	12 cr.
PhM	8857	Readings in Physical Medicine and Rehabilitation (1 cr./qtr. - 12 qtrs. required)	12 cr.

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**PSYCHIATRY**

D. E. McAlpine, M.D., *Graduate Education Coordinator*

*Psychiatry*

A. J. Cunnien, M.D.  
R. E. Finlayson, M.D.  
M. R. Hansen, M.D.  
N. P. Hanson, M.D.  
K. M. Logan, M.D.  
A. R. Lucas, M.D.  
M. J. Martin, M.D.  
T. Maruta, M.D.  
G. L. Moore, M.D.  
R. M. Morse, M.D.  
D. C. Newman, M.D.  
M. A. Palmen, M.D.  
J. W. Richardson, M.D.  
E. Richelson, M.D.  
J. D. Rome, M.D.  
L. A. Wells, M.D., Ph.D.

*Psychology*

R. C. Colligan, Ph.D.  
L. J. Davis, Jr., Ph.D.  
R. J. Ivnik, Ph.D.  
D. Osborne, Ph.D.  
M. S. Schwartz, Ph.D.

**Master's Degree****Biomedical Science Courses**

A minimum of 20 credits must be earned from the list below or equivalent course work approved by candidate's program adviser.

HSR	5823	Introductory Statistics I	3 cr.
HSR	5827	Introduction to Regression	1 cr.
HSR	5831	Introduction to Clinical Epidemiology	1 cr.
HSR	5835	Logistic Regression and Related Topics	1 cr.
N	5801	Introduction to Neuroscience	6 cr.
Phar	8803	Biochemical Basis of Neuropharmacology	3 cr.
Phar	8806	Pharmacology of Receptors	3 cr.
P	8900	Research in Psychiatry (6 cr./qtr. - 2 qtrs. req.)	12 cr.

**Psychiatry Didactic Courses** - A minimum of 12 credits must be earned from those listed below.

*P	8501	Psychiatry Didactic Lecture Series I	2 cr.
*P	8502	Psychiatry Didactic Lecture Series II	2 cr.

*P	8503	Psychiatry Didactic Lecture Series III	2 cr.
*P	8504	Psychiatry Didactic Lecture Series IV	2 cr.

**\*Required Courses**

P	8350	Individual Study in Psychiatry	2 cr.
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Individual Study consists of directed readings in a specific area of the Behavioral Sciences, under the supervision of a consultant faculty member. At the end of this course, each candidate must present his or her chosen topic to the department in a one-hour lecture. Re-registration for the course is permitted, up to a maximum of 6 credits (a different topic must be studied each time).

P	8400	Behavioral Science Seminar	2 cr.
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Specific quarter-long seminars in the Behavioral Sciences will be offered, depending on student interest and staff availability. These are intended to provide intensive, guided education in areas of interest and relevance to the students in the program at any given time. Topics may include Psychopharmacology, Neuropsychology, Specific Therapeutic Modalities, General Psychopathology, among others. Unlimited re-registration for this course is permitted (a different topic must be studied each time).

**Psychiatry Clinical Courses**

A minimum of 36 credits must be earned in this category.

P	8100	Hospital Psychiatry I: Second Assistant	4 cr.
P	8101	Hospital Psychiatry II: Second Assistant	4 cr.
P	8102	Hospital Psychiatry III: First Assistant	4 cr.
P	8103	Hospital Psychiatry IV: First Assistant	4 cr.
P	8150	ADDU: Adult Chemical Dependency	4 cr.
P	8160	ACDU: Adolescent Chemical Dependency	4 cr.
P	8170	IPC: Interpersonal Process	4 cr.
P	8180	Child Psychiatry	4 cr.
P	8200	OPS: Outpatient Psychiatry I	4 cr.
P	8201	OPS: Outpatient Psychiatry II	4 cr.
P	8250	Consultation/Liaison Psychiatry	4 cr.
P	8300	Theory and Practice of Psychology	4 cr.
P	8500	Zumbro Valley Mental Health Center	4 cr.
P	8550	Federal Medical Center: Prison Psychiatry	4 cr.

To earn degree credits, the following two criteria must be satisfied for each course attempted:

- Completion of the clinical rotation, with a passing grade being assigned by the clinical consultant supervisor.
- Passing a one-hour oral examination which will be administered by the "Examiner" indicated for each course, or another consultant in Psychiatry/Psychology so designated by the listed "Examiner." The person giving the oral examination may not have also functioned as a clinical consultant to the examinee during the clinical rotation.

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## DIAGNOSTIC RADIOLOGY

S. J. Swensen, M.D., *Graduate Education Coordinator*

J. W. Beabout, M.D.	E. C. McCullough, Ph.D.
B. J. Erickson, M.D., Ph.D.	W. E. Miller, M.D.
J. J. Gisvold, M.D.	J. R. Muhm, M.D.
J. E. Gray, M.D.	C. C. Reading, M.D.
R. R. Hattery, M.D.	P. F. Sheedy, M.D.
M. A. Holbrook, M.D.	A. W. Stanson, M.D.
C. D. Johnson, M.D.	D. H. Stephens, M.D.
R. L. MacCarty, M.D.	

## Master's Degree

### Biomedical Sciences Courses

Select a minimum of 9 credits from the list below to meet the biomedical science requirement. Other courses may be approved with consultation and approval of the adviser.

BPhy	5601	Fundamental Concepts in Biomedical Imaging	3 cr.
BPhy	5225	Introduction to Neural Networks	3 cr.
BPhy	5400	Molecular Electronics	3 cr.
BPhy	5450	Biomedical Imaging Processing I - Fundamental Concepts	4 cr.
BPhy	5500	Tutorial in Computer Organization and Programming	3 cr.
BPhy	5800	Physics and Technical Principles of Medical Imaging	3 cr.
BPhy	8450	Biomedical Image Processing II - Intermediate Analysis	3 cr.
BPhy	8470	Two-Dimensional Digital Signal Processing	3 cr.
BPhy	8704	Digital Signal Processing I	3 cr.
BPhy	8705	Digital Signal Processing II	3 cr.
BPhy	8740	Magnetic Resonance Imaging Systems - Advanced Topics	3 cr.
CSci	5107	Computer Graphics I	3 cr.
CSci	5117	Computer Graphics II	3 cr.
CSci	5301	Numerical Analysis	4 cr.
CSci	5511	Artificial Intelligence I	4 cr.
CSci	8511	Concepts in Computer Vision	4 cr.
HSR	5823	Introductory Statistics I	3 cr.
R	8900	Research in Radiology (6 cr./qtr. - 2 qtrs. required)	12 cr.

### Radiology Didactic Courses

A minimum of 9 credits must be selected from the following.

R	8833	Gastrointestinal Radiology	1 cr.
R	8834	Genitourinary Radiology	1 cr.
R	8835	Introduction to Diagnostic Radiology	3 cr.
R	8836	Musculoskeletal Radiology	1 cr.
R	8831	Chest Radiology	1 cr.
R	8830	Cardiac/Vascular Radiology	1 cr.
R	8832	Cross-sectional Imaging	1 cr.
R	8838	Nuclear Medicine	1 cr.
R	8839	Pediatric Radiology	1 cr.
R	8837	Neuroradiology	1 cr.

**Radiology Clinical Courses**

A minimum of 6 credits must be selected from the following:

R	8884	Pediatric Radiology	1 cr.
R	8887	Uroradiology	1 cr.
R	8885	Skeletal Radiology	1 cr.
R	8886	Ultrasound	1 cr.
R	8882	Hospital Radiology	1 cr.
R	8881	Gastrointestinal Radiology	1 cr.
R	8883	Neuroradiology	1 cr.
R	8880	Chest Radiology	1 cr.



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## COURSE LISTINGS



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## SYMBOLS AND EXPLANATIONS

The following symbols are used throughout the course descriptions in lieu of page footnotes:

- \* Mayo Medical School course, limited enrollment. Permission of course instructor required. Courses do not follow typical quarter schedule. Contact Graduate School Office to register and for the schedule.
- # Consent of the instructor is required prior to registration.
- + Consent of the department or division offering the course is required prior to registration.

f,w,s,su Following course number indicates fall, winter, spring, or summer quarters.

A hyphen between course numbers (e.g., 5803-5804) indicates a sequence of courses that must be taken in the order listed.

A comma between course numbers (e.g., 8857,8858,8859) indicates a series of courses that may be entered any quarter.

Courses designated as "clinical" or "research" are open only to selected categories of students (usually residents or degree candidates enrolled in the training programs of the appropriate department).

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## ANATOMY

- \*Anat 5001f. *HUMAN GROSS ANATOMY*. (8 cr; #) Cahill, Carmichael  
A study of the entire human body by sequential dissection of body regions.
- \*Anat 5200s. *MICROSCOPIC ANATOMY*. (2 cr) Carmichael, Salisbury  
A lecture and laboratory course on the cell and tissue types.
- Anat 5500su. *FUNCTIONAL ANATOMY OF BACK AND EXTREMITIES*.  
(1.5 cr) Carmichael, Christopherson  
Dissection, demonstration, and discussion of the back and limbs with emphasis on applied anatomy of importance to physical medicine and rehabilitation.
- Anat 8000s. *ANATOMY OF THE PELVIS-PERINEUM*. (2 cr) Cahill, Podratz  
Six two hour dissection and demonstration periods on the female pelvis and perineum. Primarily intended for residents in ObGyn.
- Anat 8851. *ANATOMY FOR GENERAL SURGEONS*. (3 cr) Cahill  
Surgical anatomy of the thorax, abdomen, pelvis and neck, by dissection, demonstration and discussion. Also listed under S.
- Anat 8852s. *SURGICAL ANATOMY OF HEAD AND NECK*. (3 cr; offered even yrs) Carmichael, Kasperbauer  
Cadaver dissection and lecture demonstration. Laboratory participation required for credits. Also listed under ENT.

- Anat 8855f,w,s,su. *ORTHOPEDIC ANATOMY*. (2 cr) Carmichael and staff  
Lectures, prosections and demonstrations of gross anatomy of the musculoskeletal system with special emphasis on relationships and surgical approaches. Also listed under Or.
- Anat 8860f,w,s. *SPECIAL TOPICS IN ANATOMY*. (1-4 cr) Cahill  
Dissection of cross-sections and/or regions of special interest.

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## BIOCHEMISTRY

- Bioc 5200f,w,s. *MOLECULAR AND CELL BIOLOGY WORKSHOP*. (1 cr/yr)  
Strehler, Maher  
Work-in-progress presentations on experimental research projects, given by graduate students and postdoctoral research fellows.
- Bioc 5858f,w,s,su. *LABORATORY ROTATIONS IN BIOCHEMISTRY*.  
(2 cr/8 wks) Staff  
Tutorial course involving methods of isolation, characterization, and assay of subcellular particles, proteins, nucleic acids, lipids, steroids, and carbohydrates. General techniques, instrumental analyses, and special procedures emphasized. A minimum of three rotations are required.
- Bioc 8000f. *GENERAL BIOCHEMISTRY: STRUCTURE*. (3 cr; prereq calculus, organic chemistry, quantitative analytical chemistry or #) Strehler  
Structure in biological materials; structure in membranes, proteins and nucleic acids with emphasis on methods used to study macromolecular structure.
- Bioc 8001w. *GENERAL BIOCHEMISTRY: KINETICS, CATALYSIS AND MECHANISMS*. (3 cr; prereq Bioc 8000) Rusnak  
Enzyme mechanisms and kinetics, with emphasis on bioorganic chemistry and interpretation of rate data.
- Bioc 8002s. *GENERAL BIOCHEMISTRY: ENERGY TRANSDUCTION AND SIGNALLING*. (3 cr; prereq Bioc 8001) Penniston  
Mechanisms of energy transduction and signalling within cells.
- Bioc 8005w. *PHYSICAL BIOCHEMISTRY*. (1 cr; prereq Bioc 8000 or equiv)  
Macura  
Physical principles and measurement including spectroscopy, hydronamics, energetics.
- Bioc 8010s. *PHYSICAL BIOCHEMISTRY*. (1 cr; prereq Bioc 8000 or equiv) Bajzer  
Physical principles and measurement including spectroscopy, hydronamics, energetics.
- Bioc 8015su. *PHYSICAL BIOCHEMISTRY*. (1 cr; prereq Bioc 8000 or eqiv) Owen  
Physical principles and measurement including spectroscopy, hydronamics, energetics.
- Bioc 8030s. *DATA FITTING AND MODEL PARAMETER ESTIMATION*. (3 cr; prereq Linear Algebra, Calculus) Bajzer  
An introduction to modeling and methods for data fitting with applications to biomedical sciences. Theoretical knowledge along with emphasis on data reduction practice are offered to provide sufficient skills in using data fitting procedures. Also listed under Molecular Biology.

- Bioc 8050f. *PRINCIPLES OF CELL AND TISSUE DESIGN*. (3 cr; prereq MBio 5000 concurrent or equivalent) Salisbury, McNiven  
This course covers general aspects of cell structure with particular emphasis on nuclear organization (exclusive of DNA!), membrane structure and dynamics, protein targeting and processing as they relate to cell structure, protein phosphorylation, calcium-binding proteins, the cytoskeleton (interphase and mitotic) and vesicular transport. Also listed under Molecular Biology. emphasis on data reduction practice are offered to provide sufficient skills in using data fitting procedures. Also listed under Molecular Biology.
- Bioc 8101w. *REPLICATION AND TRANSCRIPTION REGULATION*. (3 cr; prereq undergraduate biochemistry) McMurray, Getz  
This course will discuss the structure and function of replication and transcription complexes. Emphasis will be placed on control mechanisms and energetics of transcription/replication in prokaryotes and eukaryotes. Also listed under Molecular Biology.
- Bioc 8102s. *REGULATION OF PROTEIN SYNTHESIS*. (3 cr; prereq general background in biochemistry or molecular biology) Toft  
General and specialized aspects of protein synthesis and processing will be covered. Regulation of protein synthesis at several posttranscriptional levels will be included. Also listed under Molecular Biology.
- Bioc 8290. *INDEPENDENT STUDY IN BIOCHEMISTRY*. (1-2 cr) Staff  
Tutorials arranged on an individual basis in selected advanced topics in Biochemistry. Students will be expected to define a topic and specific reading list in consultation with a member of the faculty. Mastery of the subject matter will be assessed by examination or by submission of a formal review of the subject area.
- Bioc 8300. *MASTER'S PROJECT IN BIOCHEMISTRY*. (3 cr) Staff  
Readings in Biochemistry culminating in the submission of the Master's Thesis. Topics will be chosen by student in consultation with the adviser and the student's advisory committee. May be taken only once for credit.
- Bioc 8500f,w,s. *BIOCHEMISTRY AND MOLECULAR BIOLOGY JOURNAL CLUB*. (1 cr per year) Rusnak, Wieben  
Students of the Molecular Biology program will present current readings in the general areas of Cell and Molecular Biology.
- Bioc 8501w. *FOCAL TOPICS IN GROWTH REGULATION*. (2 cr; prereq MBio 8005, Imm 8862 or #) Leaf  
Three areas of current study in growth regulation will be examined. This will permit an in-depth four week study of each. Potential topics will include ERKs/MAP kinases, tyrosine kinases, T cell antigen receptor signalling, cell cycle control, cyto-architecture, and tumor suppressors.
- Bioc 8550f. *BIOORGANIC CHEMISTRY*. (3 cr; offered even yrs) Rusnak  
A chemical approach to understanding enzyme catalysis. This course will cover extensively both theoretical and experimental methods aimed at elucidating the chemical details of enzyme action. Topics include radical reactions in biology, biometric catalysis, catalytic antibodies, catalytic RNA, enzyme mechanisms, and metalloprotein biochemistry.

- Bioc 8705f. *CELLULAR MECHANISMS IN PULMONARY HOST-DEFENSE FUNCTION*. (2 cr; offered even yrs) Limper  
This course will focus on defining the biochemical reactions that make up the signal transduction processes in stimulated lung cells. Alveolar macrophages will be the principle cells studied.
- Bioc 8710w. *CELL BIOLOGY OF MEMBRANE LIPIDS*. (2 cr; offered odd yrs; prereq Bioc 8000 or #) Pagano  
The following will be covered: Lipid structures and properties; Liposomes: Sphingolipid metabolism and biology; Lipid asymmetry and transbilayer movement; Lipid traffic in eukaryotic cells; and Lipid metabolic diseases.
- Bioc 8715f,w,s. *MOLECULAR MECHANISMS OF SECRETION*. (1 cr) McNiven  
This course will review the rapidly expanding field of protein and lipid trafficking through the secretory pathway of eukaryotic cells. Papers reviewed will focus on the molecular mechanisms of membrane budding, transport, targeting, and fusion between endoplasmic reticulum, Golgi apparatus, and the plasma membrane. Special attention will be placed on the contributions of the small and trimeric GTP-binding proteins, molecular motor enzymes, COP proteins, and SNARE/SNAP complexes to secretory vesicle biogenesis and subsequent exocytic release. Also listed under Molecular Biology.
- Bioc 8801f,w,s. *TUTORIAL: CONCEPTS OF VESICULAR TRAFFICKING*. (1 cr; prereq Bioc 8050) McNiven  
Study of the basic mechanisms by which cells package, process, and transport synthesized and/or endocytosed proteins.
- Bioc 8806s. *PHARMACOLOGY OF RECEPTORS*. (3 cr; offered odd yrs) Brimijoin and staff  
Origin of concept of drug receptor interaction; molecular basis for drug macromolecule interactions; mathematical theories; isolation and physicochemical characterization useful in pharmacology. Also listed under Pharmacology.
- Bioc 8863w. *MOLECULAR BIOLOGY: THEORY AND APPLICATION*. (3 cr; prereq MBio 5000; offered odd yrs) McMurray  
Students will gain a thorough working knowledge of molecular biology. The course will deal with theoretical aspects of the techniques as a basis for their practical application. The course will use computer technology to aid in the design and application of all techniques.
- Bioc 8905w. *PCR: THEORY, METHODS, AND APPLICATIONS*. (1 cr; offered even yrs) Urrutia  
This course is designed to analyze the basic principles of the most advanced PCR-based laboratory techniques. Emphasis will be given to the description of up-to-date PCR strategies. Protocols will be offered as a compilation of proven methods that can be easily repeated in the attendant's laboratory. Also listed under Molecular Biology and Molecular Neurosciences.
- Bioc 8910f,s. *MOLECULAR CONTROL OF CELL DIFFERENTIATION*. (1 cr) Urrutia  
Discussion of classic, as well as current, articles on the mechanisms underlying cell commitment, pattern formation, and phenotype

acquisition. Emphasis will be given to articles on transcription factors and their target genes during embryogenesis, teratogenesis, and carcinogenesis. Also listed under Molecular Biology and Molecular Neurosciences.

## Research

- Bioc 8840. *RESEARCH IN BIOCHEMISTRY*. (6 cr/ qtr) Staff  
Graduate thesis research for Master's students under supervision of staff.
- Bioc 8890. *RESEARCH IN BIOCHEMISTRY*. Staff  
Graduate thesis research for Ph.D. students under supervision of staff.

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## BIOPHYSICAL SCIENCES

- BPhy 5001f,w,s,su. *LABORATORY ROTATIONS IN BIOPHYSICAL SCIENCES*.  
(1 cr) Staff  
Laboratory rotation lasting four weeks. Familiarizes students with the techniques and procedures in the areas of expertise and research specialization of the investigators in the area of Biophysical Sciences. Specific laboratory methods of ultrasonic imaging, x-ray imaging, and radioisotope imaging will be studied as they are practiced in the laboratories of the investigators of Mayo Clinic.
- BPhy 5002f,w,s,su. *LABORATORY ROTATIONS IN BIOPHYSICAL SCIENCES*.  
(2 cr) Staff  
Laboratory rotation lasting eight weeks. Familiarizes students with the techniques and procedures in the areas of expertise and research specialization of the investigators in the area of Biophysical Sciences. Specific laboratory methods of ultrasonic imaging, x-ray imaging, and radioisotope imaging will be studied as they are practiced in the laboratories of the investigators of Mayo Clinic.
- BPhy 5003f,w,s,su. *LABORATORY ROTATIONS IN BIOPHYSICAL SCIENCES*.  
(3 cr) Staff  
Laboratory rotation lasting twelve weeks. Familiarizes students with the techniques and procedures in the areas of expertise and research specialization of the investigators in the area of Biophysical Sciences. Specific laboratory methods of ultrasonic imaging, x-ray imaging, and radioisotope imaging will be studied as they are practiced in the laboratories of the investigators of Mayo Clinic.
- BPhy 5100f. *RADIOLOGICAL HEALTH*. (2 cr; #) Vetter  
Introduction to concepts of radiological health, philosophy and principles of radiation protection, interpretation of standards and regulations, and planning of facilities and activities.
- BPhy 5150w. *INTRODUCTORY RADIATION BIOLOGY*. (2 cr; offered even yrs)  
Bonner  
Emphasis is on understanding the actions of radiation on living systems including physico-chemical interactions, effects at the molecular, cellular, tissue, and organismal levels, carcinogenesis, genetic effects, and embryo-fetus effects; mechanisms providing basis of radiation therapy are stressed.

- BPhy 5160w. *INTRODUCTION TO RADIOLOGIC PHYSICS AND RADIATION DOSIMETRY*. (3 cr; offered odd yrs; prereq calculus, atomic or modern physics; offered even yrs) Felmlee  
This is an introductory graduate course designed for those interested in the radiation sciences. It will rigorously cover ionizing radiation, interactions, cavity theory, and dosimetry fundamentals.
- BPhy 5225f. *INTRODUCTION TO NEURAL NETWORKS*. (3 cr; offered even yrs; prereq background of computer science, engineering or #) Manduca  
This course will provide a theoretical and practical understanding of the most important artificial neural network models. The focus will be on practical applications of the technology.
- BPhy 5250w. *ANATOMY FOR BIOMEDICAL IMAGERS*. (2 cr; offered odd yrs) Carmichael  
This is a tutorial style course wherein each student dissects a region of interest and prepares a demonstration on that region for the other students. An overview of human anatomy will also be presented.
- BPhy 5350s. *CRITICAL REVIEW OF BIOMEDICAL IMAGING LITERATURE*. (1 cr; offered odd yrs) Manduca  
Evaluation and review of biomedical imaging literature, with emphasis on using professional peer-review models. Includes review of literature, oral and written presentations of articles, and critical assessment of paper quality.
- BPhy 5400w. *MOLECULAR ELECTRONICS*. (3 cr; offered odd yrs) Fernandez  
This course will cover the theory of operation of the patch-clamp amplifier as it is used to study single ion channels and fusion pores. Students will be required to build a complete patch-clamp amplifier, demonstrate their performance and show a good understanding of the theory of operation. Prior knowledge of electronics is not required.
- BPhy 5450f. *BIOMEDICAL IMAGE PROCESSING I - FUNDAMENTAL CONCEPTS*. (4 cr) Robb and staff  
Provides an introduction to important concepts in applied biomedical imaging, including discussion of image composition, interactive display, image processing and segmentation, and quantitative analysis. Practical applications in basic science and medicine are discussed. Students will use ANALYZE biomedical imaging software developed at Mayo to investigate these topics.
- BPhy 5500w,s. *TUTORIAL IN COMPUTER ORGANIZATION AND PROGRAMMING*. (3 cr) Robb and staff  
Provides an introduction to the architecture and functional organization of computers, and familiarity with the fundamental concepts and techniques for programming a computer, including learning the C programming language.
- BPhy 5520s,su. *ALGORITHMS AND PROBLEM SOLVING*. (2 cr) Robb  
A hands-on introduction to common software tools used in data analysis; matrix mathematics, statistical processing, image processing and analysis; project orientation.

- BPhy 5550su. *VIRTUAL REALITY METHODS AND APPLICATIONS IN BIOMEDICAL RESEARCH*. (4 cr; prereq BPhy 5450 or equivalent) Robb and staff  
 A hands-on introduction to the concepts, methods and applications of virtual reality simulations in biomedical research.
- BPhy 5610s. *IMAGING AND COMPUTERS*. (3 cr; prereq BPhy 5450 or 5500 desirable) Robb and staff  
 This course will expose students to modern workstation computers and a variety of image processing computational techniques. Topics include serial and parallel processing, shared memory, kernel threading, remote procedure calls, vector and MPP systems. Theory will be coupled with working examples.
- BPhy 5740f. *MAGNETIC RESONANCE IMAGING SYSTEMS*. (3 cr; prereq advanced calculus, Fourier analysis, and a course in modern physics) Riederer  
 Introduction to physics and engineering aspects of modern diagnostic magnetic resonance imaging (MRI).
- BPhy 5800w. *PHYSICS AND TECHNICAL PRINCIPLES OF MEDICAL IMAGING*. (3 cr; prereq General and Modern Physics, Calculus, and Fourier analysis or #) McCollough  
 An in-depth study of the fundamental principles of medical image formation. Diagnostic imaging modalities to be covered include: Radiographic X-ray Imaging, X-ray Computed Tomography, Digital Radiography, Nuclear Medicine, Ultrasound, and Magnetic Resonance Imaging.
- BPhy 5850f. *ULTRASONOGRAPHY - PHYSICS, INSTRUMENTATION AND QUANTITATION*. (2 cr) Belohlavek  
 Introductory topics will include fundamental principles of ultrasound signal propagation and image formation in conventional and Doppler ultrasonography. Special topics will cover quantitative analysis and enhancement of ultrasound images including tissue characterization, noise reduction, boundary recovery, and advanced imaging techniques such as multidimensional echocardiography.
- BPhy 5900f,w,s,su. *MASTER'S PROJECT IN BIOMEDICAL IMAGING*. (5 cr) Staff  
 This course is comprised of a special laboratory project in image acquisition, processing, and/or analysis in which the student uses tools and skills learned in coursework on solving a practical problem in biomedical imaging applications. Extensive literature review is included. The course is required for Employee Master's Degree candidates. The student must write a report on the project.
- BPhy 8100f. *MEDICAL HEALTH PHYSICS*. (2 cr; prereq BPhy 5100 or equiv; #) Vetter  
 Radiation protection philosophy and principles as applied to the medical environment: protection of patients, public, and employees; procedures for obtaining Nuclear Regulatory Commission license.
- BPhy 8301su. *TUTORIAL IN HIGH--SPEED SIGNAL PROCESSING*. (2 cr; prereq Bioengineering) Gilbert  
 Very high-speed computer architecture and circuits.

- BPhy 8302. *TUTORIAL IN ULTRASONIC IMAGING*. (2 cr; #) Greenleaf  
Principles and methods of imaging tissue and related parameters.
- BPhy 8304f,w,s. *TUTORIAL IN PHYSIOLOGICAL IMAGING*. (2 cr; prereq  
Physiology series) Ritman  
X-ray imaging of physiological systems and analysis of resulting data.
- BPhy 8420s. *WAVE PROPAGATIONS AND THEIR MEDICAL APPLICATIONS*.  
(2 cr; prereq college physics) Lu  
Wave propagation is a fundamental phenomenon of acoustics,  
electromagnetics, and optics. This course will emphasize the wave  
propagation of ultrasound and their applications to medical imaging and  
tissue property identification. New beams such as limited diffraction  
beams and localized waves and their potential medical applications will be  
studied.
- BPhy 8450w. *BIOMEDICAL IMAGE PROCESSING II - INTERMEDIATE  
ANALYSIS*. (3 cr; prereq BPhy 5450 or equivalent) Robb and staff  
Digital processing of images, image signal characteristics, histogram  
analysis, domain processing, digital filters, image compression,  
reconstruction from projections.
- BPhy 8470s. *TWO-DIMENSIONAL DIGITAL SIGNAL PROCESSING*. (3 cr;  
offered even yrs; prereq BPhy 8700 or working knowledge of linear system  
theory and one-dimensional digital signal processing) Ottesen  
Fundamentals of 2-D digital signal processing, including Fourier and V-  
transforms, discrete cosine transforms, and finite impulse responses;  
foundation for image processing.
- BPhy 8490s. *BIOMEDICAL IMAGE PROCESSING III - ADVANCED TOPICS*.  
(3 cr; prereq BPhy 5450, BPhy 8450 or equivalent experience/courswork)  
Manduca  
An in-depth study of difficult problems in imaging science as they relate to  
biomedical images. Areas of study include image segmentation, image  
registration, texture analysis, shape description and matching,  
deconvolution, multispectral analysis, 3-D and 4-D image reconstruction  
and display (volume rendering).
- BPhy 8500w,s. *TUTORIAL IN IMAGING SCIENCE*. (2 cr; prereq BPhy 8450,  
8470 and 8490 or equivalent experience) Robb  
Special topics in the imaging sciences; including 3-D imaging, volume  
rendering, image segmentation, image registration and correlations, shape  
description and analysis, multi-spectral imaging, virtual reality  
visualization, image modeling.
- BPhy 8600f,w,s,su. *BIOPHYSICS/BIOENGINEERING SEMINARS*. (1 cr) Lu  
Presentations of research topics, activities, and results from the  
Biodynamics Research Unit. Students are required to give a presentation,  
of a published article review or of their research project, during the course.
- BPhy 8704f. *DIGITAL SIGNAL PROCESSING I*. (3 cr; prereq an introduction to  
complex variables and an exposure to linear systems theory for continuous  
time signals, including Laplace and Fourier transforms. No previous  
knowledge is required of discrete time signals, Z-transforms, or discrete

Fourier transforms) Ottesen

First of a two-part series starts with discrete time signals and systems, and the effects of sampling. It moves into the areas of Discrete Fourier Transforms (DFT), Z-transforms, convolutions, signal flow-graphs, and various methods for design of common digital filters of the Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) types.

BPhy 8705w. *DIGITAL SIGNAL PROCESSING II*. (3 cr; prereq BPhy 8704 or #) Ottesen

Advanced designs of digital filters will be covered, followed by the effects of noise and introductions of the discrete Wiener and the steady-state Kalman filters. An introduction to adaptive digital signal processing and a discussion of the Fast Fourier Transform (FFT) will be given. The course concludes with two-dimensional Digital Signal Processing, its theory and approach for designing digital filters to be used in image processing.

BPhy 8740w. *MAGNETIC RESONANCE IMAGING SYSTEMS - ADVANCED TOPICS*. (3 cr; prereq BPhy 5740; offered even yrs) Riederer

A technical study of advanced topics in contemporary magnetic resonance imaging (MRI). Topics to be discussed include vascular imaging and flow assessment, motion effects and compensation, echo-planar imaging, cardiac imaging, and neuro-functional MRI.

BPhy 8750f,w,s. *MAGNETIC RESONANCE TECHNICAL SEMINAR*. (1 cr; #) Riederer

Seminar held weekly consisting of a presentation of some contemporary technical research topic in magnetic resonance.

BPhy 8770s. *FUZZY LOGIC THEORY AND APPLICATIONS*. (3 cr, prereq BPhy 8704 and an interest in intelligent systems and decision and control; offered odd yrs) Ottesen

Fuzzy logic theory and applications is intended for students and practicing scientists and engineers. It covers the applied concepts of fuzzy logic to several application areas. There will be homework, case studies, and class projects.

BPhy 8853f,w,s,su. *READINGS IN BIOPHYSICAL SCIENCES*. (2 cr) Staff

## Research

BPhy 8890. *RESEARCH IN BIOPHYSICAL SCIENCES*. Staff  
Opportunities in research to be arranged with individual staff members.

## UNITE courses from University of Minnesota

CSci 5107. *COMPUTER GRAPHICS I*. (4 cr; prereq CLA CSci major or IT CSci major upper div. or Grad; 3107 or 5101 and 5121 or #)  
Introduction. Definition of interactive computer graphics, its goals and its problems. A model system. Data structures for computer graphics, picture structure and transformations. Structures of graphical programming languages. Interaction handling. Raster graphics.

- CSci 5117. *COMPUTER GRAPHICS II*. (4 cr; prereq CLA CSci major or IT CSci major upper division or Grad; 3107 or 5101 and 5107 and 5121 or #)  
Introduction to vector geometry. Three-dimensional modeling and viewing transformations. Perspective viewing generation and 3-D clipping. Introduction to curves and surfaces. Hidden line and hidden surface removal. Realistic image generation. Advanced display system architectures. Modeling of 3-D graphics programming.
- CSci 5301. *NUMERICAL ANALYSIS*. (4 cr; prereq Math 3142 or equivalent or #...a knowledge of FORTRAN or PASCAL is assumed)  
Floating point arithmetic and rounding errors. Iterative methods. Numerical solution of nonlinear equations. Newton's method. Direct methods for linear systems of equations. Gaussian elimination. Factorization methods. Interpolation and approximation. Numerical integration and differentiation. Introduction to numerical solution of ordinary differential equations.
- CSci 5511. *ARTIFICIAL INTELLIGENCE I*. (4 cr; prereq CLA CSci major or IT CSci major upper div. or Grad, 5121 or #)  
Introduction to the ideas and issues of Artificial Intelligence. Knowledge representation, problem solving, search, inference techniques, theorem proving. Expert systems. Introduction to applications of Artificial Intelligence. Artificial Intelligence programming languages.
- CSci 8511. *ADVANCED CONCEPTS IN ARTIFICIAL INTELLIGENCE*. (4 cr; prereq #)  
In-depth coverage of selected areas of active research in artificial intelligence. Possible topics include machine perception, expert systems, robotics, natural language processing.
- Phy 5551. *TOPICS IN PHYSICS FOR BIOLOGY AND MEDICINE - Mechanics in Molecular Physics*. (5 cr; prereq general physics and calculus; offered alt yrs)  
Statics (forces in bones and joints). Graphical analysis. Statistical physics (entropy, reversibility, Boltzmann factor and Nernst equation, Brownian movement, free energy). Diffusion, bulk flow, and osmosis.
- Phy 5552. *TOPICS IN PHYSICS FOR BIOLOGY AND MEDICINE - Electricity and Signals*. (5 cr; prereq general physics and calculus; offered alt yrs)  
Electricity and circuits (electrocardiogram, networks, nerve conduction); transducers, amplifiers, feedback and control; oscillators; signal analysis (Fourier analysis, correlation functions, power spectra).
- Phy 5553. *TOPICS IN PHYSICS FOR BIOLOGY AND MEDICINE - Lights Atoms and Nuclei*. (5 cr; prereq general physics and calculus; offered alt yrs)  
Atoms (dispersion, absorption, spectra, polarized light). X-rays (production, absorption, dosimetry). Nuclei (nuclear size, mass, decay).

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## DENTISTRY

### Orthodontics

#### Didactic

- Odon 8806f,w,s,su. *ORTHODONTIC SEMINAR: TECHNIQUE*. (1 cr) Staff  
Seminar on technical orthodontic procedures.
- Odon 8807f,w,s,su. *ORTHODONTIC SEMINAR: LITERATURE REVIEW*.  
(1 cr) Staff  
Classical orthodontic literature as well as current literature review.
- Odon 8808f,w,s,su. *ORTHODONTIC SEMINAR: CASE PRESENTATION*.  
(1 cr) Staff  
Cases with complete records reviewed and new patient treatment plans discussed.
- Odon 8809f,w,s. *SURGICAL ORTHODONTIC SEMINAR*. (1 cr) Lund, Sather  
Case presentation, illustration, diagnostic and treatment procedures that encompass the various dental specialties.
- Odon 8810 w. *CLINICAL ORO-FACIAL PATHOLOGY AND DEVELOPMENTAL DISORDERS*. (1 cr; offered every 3rd yr; prereq D.D.S., D.M.D., M.D. or equivalent required) Larson  
A review of the clinical presentations of many congenital and acquired pathological disorders, developmental deficiencies, and malformations important to the dental specialist.
- Odon 8811 w. *FACIAL GROWTH AND DEVELOPMENT*. (1 cr; offered every 3rd yr; prereq basic background in the anatomy and physiology of human facial growth and development) Guenther  
The one-quarter course will primarily consist of reviewing current knowledge of the growth and development of the human face from conception to adulthood. A course textbook will be utilized as well as classical and current literature which will be used to evaluate current state-of-the-art knowledge and discuss issues related to current clinical procedures and their effect on facial growth.

#### Research

- Odon 8857f,w,s,su. *RESEARCH IN SELECTED PROBLEMS*. (2 cr) Staff  
Arrangements for research in selected areas related to minor.

#### Clinical

- Odon 8800f,w,s,su. *ADVANCED ORTHODONTIC TECHNIQUES*. (3 cr) Staff  
Initial technical procedures in preparation for clinical patient care.  
Technical procedures on the typodont, model preparation, photography, metallurgy, and cephalometrics.
- Odon 8802f,w,s,su. *ORTHODONTIC CASE ANALYSIS*. (6 cr) Staff  
First phase involves complete review of previously treated cases. Second phase is application of basic analytic principles to clinical patients.

- Odon 8803f,w,s,su. *ORTHODONTIC TREATMENT PLANNING*. (6 cr) Staff  
Mechanical principles coordinated with case analyses to provide the treatment plan. Force analysis and biomechanics of tooth movement.
- Odon 8804f,w,s,su. *CLINICAL ORTHODONTICS*. (6 cr) Staff  
Individual treatment care and clinical observation. Treatment care coordinated with other services in selected instances in the hospital.
- Odon 8805f,w,s,su. *ADVANCED CLINICAL ORTHODONTICS*. (6 cr) Staff  
Final treatment care of individual patients.
- Odon 8851f,w,s,su. *DENTAL ROENTGENOLOGY*. (1 cr) Staff  
Includes x-ray diagnosis and techniques.
- Odon 8852f,w,s,su. *ORAL DIAGNOSIS*. (5 cr) Staff  
Clinical course in diagnosis related to dental problems.

## **Periodontics**

### **Didactic**

- Pdon 8883f,w,s,su. *PERIODONTIC SEMINAR*. (1 cr) Reeve, Sheridan  
Literature review and discussion.
- Pdon 8884f,w,s,su. *PATHOLOGY OF PERIODONTAL DISEASE*. (1 cr) Reeve, Sheridan  
Histopathology of periodontal disease. Oral mucous membrane; calcified tissues. .

### **Research**

- Pdon 8857f,w,s,su. *RESEARCH IN SELECTED PROBLEMS*. (2 cr) Reeve, Sheridan and staff

### **Clinical**

- Pdon 8851f,w,s,su. *DENTAL ROENTGENOLOGY*. (1 cr) Reeve, Sheridan  
X-ray diagnosis and technique.
- Pdon 8852f,w,s,su. *ORAL DIAGNOSIS*. (5 cr) Reeve, Sheridan  
Clinical diagnosis related to dental problems.
- Pdon 8859f,w,s,su. *PERIODONTAL AND PROSTHODONTIC CONSIDERATIONS IN DENTISTRY*. (1 cr) Eckert, Reeve
- Pdon 8880f,w,s,su. *CLINICAL PERIODONTICS*. (6 cr) Reeve, Sheridan  
Etiology, diagnosis, and treatment of periodontal disease.
- Pdon 8881f,w,s,su. *ADVANCED CLINICAL PERIODONTICS*. (6 cr) Reeve, Sheridan  
Case presentation and treatment of difficult periodontal problems.

## Prosthodontics

### Didactic

- Pros 8841. *PROSTHODONTIC SEMINAR*. (1 cr; offered f 1992, w 1993, every 3rd year) Desjardins, Eckert  
Literature review and discussion of past and current concepts and practices of complete denture prosthesis.
- Pros 8843w. *PROSTHODONTIC SEMINAR*. (1 cr; offered w 1994, every 3rd yr) Desjardins, Eckert  
Literature review and discussion of past and current concepts and practices of removable partial denture prosthesis.
- Pros 8845s. *FIXED PROSTHODONTIC SEMINAR*. (1 cr; offered s 1993, every 3rd yr) Eckert  
Clinical and laboratory phases of prosthodontics; principles, practices, and concepts related to fixed prosthodontics.
- Pros 8847w. *SEMINAR: MAXILLOFACIAL PROSTHETICS (INTRAORAL) ADVANCED PROSTHODONTICS*. (1 cr; offered w 1995, every 3rd yr) Desjardins, Eckert  
Literature review and discussion of past and current concepts and practices of implant prosthodontics and maxillofacial prosthetics.
- Pros 8848f,w,s. *SEMINAR: CURRENT LITERATURE*. (1 cr) Desjardins, Eckert  
Review and discussion of practical, clinical, or laboratory applications of current literature in prosthodontics and related fields.
- Pros 8849s. *SEMINAR: MAXILLOFACIAL PROSTHETICS (EXTRAORAL) ADVANCED PROSTHODONTICS* (1 cr; offered s 1992, every 3rd yr) Desjardins, Eckert  
Lectures and discussions on clinical and laboratory procedures involved in fabrication of extraoral prostheses.
- Pros 8850f. *IMPLANT PROSTHODONTICS*. (1 cr; offered f 1994, every 3rd yr) Desjardins, Eckert  
Literature review and discussion of past and present concepts and practices of implant prosthodontics.
- Pros 8859f,w,s. *PERIODONTAL AND PROSTHODONTIC CONSIDERATIONS IN DENTISTRY*. (1 cr) Eckert, Reeve  
This course is designed to promote serious discussions of subjects of interest in the areas of periodontology and prosthodontics. The interrelationship of the two fields is stressed.
- Pros 8862s. *DENTAL MATERIALS*. (1 cr; offered s 1994, every 3rd yr) Desjardins, Eckert  
Discussion of physical properties, mechanical properties, and technical procedures related to dental materials most commonly used in prosthodontics.
- Pros 8870f. *OCCLUSION*. (1 cr; offered f 1993, every 3rd yr) Eckert  
A series of detailed discussions of the principles, practices, and concepts of occlusion.

- Pros 8871f,w,s. *PHYSIOLOGY, PHARMACOLOGY AND PRE-PROSTHETIC SURGERY*. (1 cr; offered f 1996, and every 4th yr) Eckert, Desjardins  
Discussion of physiology of major organ systems in conjunction with pharmacologic management of disorders of these systems. Pre-prosthetic surgery is discussed and reviewed through an evaluation of the literature.
- Pros 8872su. *PROSTHODONTIC PRACTICE MANAGEMENT*. (1 cr/yr) Eckert, Desjardins  
Discussion of topics related to the management of a prosthodontic practice.
- Pros 8873f,w,s. *CARDIO-MANDIBULAR DISORDERS AND FACIAL PAIN*. (1 cr; prereq Pros 8870; offered f 1996 and every 4th yr) Eckert, Desjardins, Lund, Reeve  
Literature review and discussion of past and current concepts and practices in the management of patients with cardio-mandibular disorders including myofascial pain dysfunction, temporomandibular disorders and atypical face pain.
- Pros 8874f,w,s. *PROSTHODONTIC MANAGEMENT OF THE GERIATRIC PATIENT*. (1 cr; offered f 1996 and every 4th yr) Eckert, Desjardins  
Literature review and discussion of medical complications found in the geriatric patient with emphasis placed on special considerations made during prosthodontic treatment.

## Research

- Pros 8857f,w,s,su. *RESEARCH IN SELECTED PROBLEMS*. (2 cr; offered 4 quarters of final year) Desjardins, Eckert

## Clinical

- Pros 8840f,w,s,su. *CLINICAL PROSTHODONTICS: COMPLETE DENTURES*. (6 cr) Desjardins, Eckert  
Orientation and introduction to clinical and laboratory phases of prosthodontics in the medical center with emphasis on principles, concepts, and practices related to complete denture prosthesis.
- Pros 8842f,w,s,su. *CLINICAL PROSTHODONTICS: PARTIAL DENTURES*. (6 cr) Desjardins, Eckert  
Orientation and introduction to clinical and laboratory phases of prosthodontics in the medical center with emphasis on principles, concepts, and practices related to removable and fixed partial denture prosthesis.
- Pros 8844f,w,s,su. *MAXILLOFACIAL PROSTHETICS (INTRAORAL)/IMPLANT PROSTHODONTICS ADVANCED PROSTHODONTICS*. (6 cr) Desjardins, Eckert  
Clinical and laboratory procedures involved in management of patients with acquired, congenital, and developmental intraoral defects.
- Pros 8846f,w,s,su. *MAXILLOFACIAL PROSTHETICS (EXTRAORAL) ADVANCED PROSTHODONTICS*. (6 cr) Desjardins, Eckert  
Clinical and laboratory procedures involved in management of patients with acquired and congenital extraoral defects.

- Pros 8851f,w,s,su. *DENTAL ROENTGENOLOGY*. (1 cr) Lund  
Xray diagnosis and technique.
- Pros 8852f,w,s,su. *ORAL DIAGNOSIS AND TREATMENT OF CRANIO-MANDIBULAR DISORDERS*. (2 cr) Lund  
Clinical diagnosis related to dental problems.
- Pros 8854f,w,s,su. *IMPLANT PROSTHODONTICS*. (6 cr) Eckert, Desjardins  
Clinical and laboratory procedures involved in the management of patients who receive prostheses supported and retained by endosseous implants.
- Pros 8876f,w,s,su. *CLINICAL PROSTHODONTICS: FIXED PARTIAL DENTURES*. (6 cr) Eckert  
Presentation and introduction to clinical and laboratory phases of prosthodontics in the medical center with emphasis on principles, concepts and practices related to fixed partial denture prostheses.
- Pros 8880f. *DENTAL LABORATORY TECHNOLOGY*. (6 cr) Desjardins, Eckert  
A full-time clinical assignment to familiarize the resident with all aspects of laboratory technology used in the fabrication of fixed, removable and maxillofacial prostheses.

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## HEALTH SCIENCES RESEARCH

- HSR 5000s. *INTRODUCTION TO HEALTH SERVICES RESEARCH*. (1 cr)  
Evans  
This course will present basic concepts, theory, and methods associated with health services research. This multidisciplinary field will be critically appraised from both a sociological and an economic perspective. The limitations of a clinical perspective will be delineated. The following topics will be covered during the course: health care economics, technology assessment, health care financing, outcome measurement and analysis, evidence-based medicine, risk adjustment, severity measurement, economic determination analysis (including cost-effectiveness analysis), quality of care measurement, disease management, managed care, and continuous quality improvement. This course will focus on the foregoing topics as they relate to the organization and delivery of health care services. An essential distinction will be made between the goals of research and the dogma sometimes associated with continuous quality improvement. Finally, the relationship between health services research and the coverage and reimbursement policies of third party payers will be explored. This course will be presented in the form of lectures by several instructors.
- HSR 5200su. *DESIGN OF CLINICAL RESEARCH*. (1 cr) Gray  
This course will present the principles and methodologic concepts relevant to the design of prospective and retrospective clinical research, i.e. research on human patients. The focus of this course will be on translating research questions into study designs that allow hypotheses to be tested. Topics to be addressed include: identifying appropriate research questions, generating testable hypotheses, specifying research design, developing measurement instruments, considering sample size and power, conducting the study, planning the data analysis, and identifying possible funding

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sources. This course will consist of lectures by the instructor and guest speakers. The students participating in the course will develop their own abbreviated clinical research proposals for constructive review by the instructors and peers.

- HSR 5300s. *BAYESIAN STATISTICAL INFERENCE*. (1 cr; prereq HSR 5823)  
Bailey  
The Bayesian school of inference will be introduced, and compared and contrasted with the frequentist school. The role of Bayesian inference in the analysis of actual data sets will be explored, including applications in nuisance parameter problems, multiple inference, and sequential inference. The relationship between confidence intervals and posterior probability intervals, and between P-values and posterior probabilities, will be discussed. The empirical Bayes approach will also be developed and discussed.
- HSR 5400su. *INTRODUCTION TO STATISTICAL MODELS*. (1 cr) Wollan  
A survey of families of statistical models most often used in clinical research, emphasizing consequences of the choice of model, interpretation of the model, and interpretation of statistical conclusions about the model. Choice of model based on type of data, choice based on goodness-of-fit, and choice based on tradition. Interpretation of coefficients and confidence intervals for coefficients. Interpretation of hypothesis tests for individual coefficients and hypothesis tests for groups of coefficients. Checking assumptions of a model, and alternatives if they are violated, such as transformations and non-parametric methods. Sample sizes and power. Examples chosen from recent medical research.
- HSR 5410su. *STATISTICAL DESIGN OF CLINICAL STUDIES*. (1 cr; prereq HSR 5400 or equiv) Wollan  
Introduction to types of designs frequently used in clinical studies. Discussion of structure of clinical studies, factorial studies, matched observations and surveys. Examples will be chosen from recent medical research, with discussion of the reasons for choosing the design, sample sizes needed, difficulties, and alternatives.
- HSR 5823f. *INTRODUCTORY STATISTICS I*. (3 cr) Sloan, Li, Sargent  
This course describes the role of statistics in evaluating data based on experimental designs and random sampling. Starting with elementary probability theory, basic techniques of summarizing and analyzing data are discussed including: measures of central tendency and variability, tabulating and graphing, point and interval estimation, and hypothesis testing (including chi-square and t-tests). Parametric and non-parametric methods for continuous and discrete data will be presented. Applications to medical research will be emphasized using illustrations from actual research studies.
- HSR 5827w. *INTRODUCTION TO REGRESSION*. (1 cr; prereq HRS 5823)  
Therneau  
This course considers the evaluation of the relationship between a continuous dependent variable (e.g. serum cholesterol) and a continuous or discrete independent variable (e.g. age or gender). Topics include the method of least squares, prediction, correlation, analysis-of-variance approach to regression, analysis of residuals, design considerations, and an introduction to basic multiple regression.

HSR 5831su. *INTRODUCTION TO CLINICAL EPIDEMIOLOGY* (1 cr) Melton  
This course will present basic terminology and methodologic concepts in epidemiology from a clinical perspective. Topics which will be covered will include clinical measurement (reliability, validity, abnormality), diagnosis (sensitivity, specificity, predictive value, receiver operator curves, screening vs. case finding), measures of disease frequency (prevalence, incidence, cumulative incidence), prognosis (cohort studies, selection bias, follow-up bias), etiology (causation, relative risk, case-control studies, odds ratios), and therapy (randomized clinical trials, generalizability). This course will be presented in the form of lectures by the instructor, which will emphasize the application of these epidemiologic concepts to interpretation of the clinical literature.

HSR 5832su. *CRITICAL APPRAISAL OF EPIDEMIOLOGIC METHODS IN THE MEDICAL LITERATURE*. (1 cr; prereq HSR 5831) Rocca  
This course will increase the ability of students to interpret and criticize research articles in the medical literature. One article for each of the following major types of epidemiologic study will be discussed: 1) a prevalence study; 2) an incidence study; 3) a case-control study; 4) a cohort study; and 5) a clinical trial. The articles used as examples will be derived from the neurologic literature. Two lectures will be allocated to each of the five study designs listed above. The instructor will explain the general terminology and give guidelines on how to read the article in a first lecture. The students will then be assigned to read the article and write a summary report following a standardized format prior to the second lecture. The instructor and the students will jointly interpret and discuss the example in the second lecture. The two additional lectures will be an introduction and a summary.

HSR 5835w. *LOGISTIC REGRESSION AND RELATED TOPICS*. (1 cr; prereq HRS 5823, HRS 5827) Schaid  
Logistic regression is often used as an analytic tool for medical studies with binary outcomes, such as case-control studies. The goals of this course are: 1) to demonstrate how logistic regression may be used to estimate the magnitude of association between a risk variable and disease, in terms of an odds ratio (OR), to estimate a confidence interval for this OR, and to test hypotheses regarding the OR; 2) to demonstrate how the OR may be influenced by confounding variables and/or interactions among variables, and how logistic regression may be used to adjust for the presence of confounders and to test for the presence of interactions; 3) to illustrate how stepwise logistic regression may be used to select a model when several risk variables are of interest; 4) to demonstrate the analysis of matched case-control studies by logistic regression. Additional topics which are similar to logistic regression and which will be covered are Poisson regression for analysis of rates and discriminant analysis (i.e. classification of subjects into groups based on patient characteristics). Since the theme of this course is appropriate analysis and interpretation of clinical data, computer printouts of analyses of medical research data are reviewed. An understanding of basic statistics and linear regression is required.

HSR 5837s. *CLINICAL TRIALS DESIGN AND CONDUCT*. (1 cr; prereq HRS 5823 or equivalent) O'Fallon, J.  
This course will focus on the theoretical considerations and practical

implementation issues involved in designing and conducting clinical trials. There are four major units: study design, protocol development, protocol implementation and study conduct. The study design unit includes designs for all types of clinical trials together with consideration of the rationale for randomization, stratification, blinding of treatment arms, early stopping rules, and surrogate endpoints. The protocol development unit addresses protocol content issues, including consideration of procedures needed to implement protocol requirements in the areas of patient entry, patient management, and data collection, along with efficient methods to present them. The protocol implementation unit addresses the practical aspects of developing quality controlled systems and procedures at the local center, operations office, and statistical center for carrying out protocol requirements and generating routine reports. The study conduct unit focuses on issues involved in the proper analysis of clinical trials data, namely, evaluability of problem cases, characteristics of a thorough analysis, and consideration of the effects of multiple tests, interim analyses, stopping rules, and use of biased statistics.

- HSR 5839s. *QUESTIONNAIRE AND SURVEY DESIGN - PRACTICAL ASPECTS OF SURVEY RESEARCH*. (1 cr; offered even yrs) Offord  
Presented will be techniques useful in conducting mailed self-administered surveys, telephone interviews, and personal interviews. Components of a survey, including writing of goals, objectives, sample design, question construction, logistics, and analysis will be discussed. In addition, there will be a brief section on validity of questionnaires.
- HSR 5840w. *SURVIVAL ANALYSIS*. (1 cr; prereq HRS 5823, HRS 5827) Suman  
Topics will include estimation of the survival distribution, methods of comparing survival distributions, methods of identifying important prognostic factors and multivariate modeling techniques. Specific methods to be discussed include the Kaplan-Meier estimator, the actuarial life-table estimator, the log-rank (Mantel-Haenszel) statistic, the Wilcoxon-Gehan statistic, and the Cox proportional hazards model.

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## IMMUNOLOGY

- \*Imm 5806f. *BASIC GRADUATE IMMUNOLOGY*. (3 cr) McKean and staff  
Structure, genetics, and function of immunoglobulins; biosynthesis of antibody; cellular regulation of immune response; tumor and transplantation immunology; immune response to infectious agents; autoimmunity and immune deficiencies.
- Imm 5858f,w,s,su. *LABORATORY METHODS IN IMMUNOLOGY*. (2 cr/8 wks; open only to Immunology Ph.D. Track Students) Staff  
A minimum of three rotations are required. Immunology graduate students must take all three in immunology laboratories.
- Imm 8862f,w,s. *CURRENT TOPICS IN CELLULAR REGULATION*. (1 cr) Abraham  
Weekly discussions of recent scientific literature on topics related to receptors, transmembrane signalling mechanisms, and gene expression.

- Imm 8863f,w,s. *CURRENT TOPICS IN IMMUNOLOGY*. (1 cr; prereq Imm 5806 or equivalent) Jelinek, Wettstein  
Current literature on important areas of immunology. Critical review of methods, results and findings.
- Imm 8867f,w,s. *CURRENT TOPICS IN HYPERSENSITIVITY REACTIONS*. (1 cr; #) Gleich  
This is a series of seminars on hypersensitivity with particular emphasis on immediate-type reactions, vasoactive amine-containing cells, eosinophils and helminths. Students are evaluated by their performance of a seminar during the course.
- Imm 8876w. *TUTORIAL IN T CELL DERIVED LYMPHOKINES*. (2 cr; prereq basic immunology; offered even yrs) McKean  
The course will use primary literature citations to explore the biological and biochemical basis of T lymphocyte-derived lymphokine responses. fundamental principles of immunology, animal models and clinical observations.
- Imm 8877w. *TUTORIAL IN MOLECULAR BASIS OF IMMUNE RECOGNITION* (2 cr; prereq Imm 5806 or equivalent; offered odd yrs) Pease  
Regulation and structure of genes and proteins that function in specific immune recognition. Genes of the MHC, T cell receptors, and immunoglobulins will be featured.
- Imm 8878s. *TUTORIAL IN EFFECTOR MECHANISMS*. (2 cr; prereq Imm 5806; offered even yrs) Leibson  
Current concepts on effector mechanisms employed during cell-mediated and antibody-mediated immune responses, with major focus on cytotoxic T lymphocytes, natural killer cells, eosinophils, basophils and mast cells.
- Imm 8879w. *TUTORIAL IN CELLULAR ACTIVATION*. (2 cr; prereq Imm 5806 or equivalent, basic knowledge of receptor pharmacology is desirable but not a requisite; offered even yrs) Abraham  
This course focuses on the intracellular signaling pathways which regulate the activation, growth, and differentiation of lymphoid cells. Additional emphasis is placed on molecular mechanism of immunosuppression by cyclosporine, FK506, and related compounds.
- Imm 8880s. *TUTORIAL IN IMMUNOPATHOLOGY*. (2 cr; offered odd yrs) Rodriguez  
Concepts in the immunopathology of virus and bacterial infection, autoimmunity, tumor immunology, and transplantation. Emphasis will be on immune mechanisms that the host uses to respond to against pathologic agents, how dysregulation of these responses lead to autoimmunity, and adaptative strategies infectious agents use to evade immunity.
- Imm 8882w. *TUTORIAL IN CELLULAR RECOGNITION AND DEVELOPMENT OF THE IMMUNE RESPONSE*. (2 cr; prereq Imm 5806; offered odd yrs) Goronzy, Weyand  
The course will review the biology of T cells and B cells as the two major cellular components of the immune system. The current concept of the formation of a functional T and B cell repertoire will be discussed. In particular, positive and negative selection mechanisms and the induction of tolerance will be reviewed. The basic understanding of the molecular and functional structures of MHC molecules, T cell receptors, and

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immunoglobulins is required to understand the different selection mechanisms. Finally, the role of the immune repertoires and the regulatory events in the generation of functional T and B cell immune responses will be discussed. This course will review studies of the mechanisms of graft rejection and the induction of self tolerance. Topics will include transplantation antigens, tumor-specific antigens, relationship between in vivo and in vitro assays of T-cell immunity, and self-tolerance.

## Research

- Imm 8840f,w,s,su. *RESEARCH IN IMMUNOLOGY*. (6 cr/qtr) Staff  
Graduate thesis research for Master's students under supervision of staff.
- Imm 8852f,w,s,su. *RESEARCH IN IMMUNOLOGY*. Staff  
Graduate thesis research for Ph.D. students under supervision of staff.

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## M.D.-PH.D.

- MDPD 5000f,w,s,s. *LABORATORY ROTATIONS FOR M.D.-PH.D. STUDENTS*.  
(1 cr) Staff  
Three one-month rotations required.

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## MAYO GRADUATE SCHOOL

- MGS 5000s. *FUNDAMENTALS OF CELL STRUCTURE AND FUNCTION*. (5 cr)  
McGee, Gill  
This course is for students with backgrounds in quantitative sciences (e.g. - math, physics, computer science, engineering) who want to learn about structural elements common to most mammalian cells, and the intracellular and intercellular biochemical processes which control cellular function. A key goal of the course will be acquisition of the "language" common to many of the biological sciences and a working knowledge of techniques used to study cell structure and function. The goal is to prepare students to read current literature and participate in seminars involving cell and molecular biology with sufficient comprehension to work with biological scientists on questions of mutual interest.
- MGS 5200su. *WRITING SCIENTIFIC PAPERS FOR PUBLICATION*. (1 cr) Staff  
This course will include the following topics: Choosing the Journal; Identifying the Audience; Choosing the Title; Writing the Introduction; Tone and Style; Writing the Methods and Results; Writing the Discussion and Abstract.
- MGS 5400su. *RESPONSIBLE CONDUCT OF RESEARCH*. (1 cr) Staff  
A series of presentations on various aspects of biomedical ethics.

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## MEDICINE

### Didactic

- \*I 5801s. *ENDOCRINE SYSTEM*. (6 cr; prereq 1 yr organic and inorganic chemistry) Abboud  
Lecture and discussion course emphasizing normal and abnormal endocrine physiology and biochemistry. Graduate students required to complete a paper.
- \*I 5804s. *RENAL SYSTEM*. (4 cr) Erickson  
Lectures and discussion regarding basic renal pathophysiology. Examination required for credit.
- \*I 5805s. *DIGESTIVE SYSTEM*. (4 cr; prereq 1 yr general physiology or equiv or #) Wang  
Lecture and discussion emphasizing normal and abnormal gastrointestinal physiology.
- \*I 5806s. *RESPIRATORY SYSTEM*. (6 cr) Peters  
Introduction to the respiratory system structure and function, with emphasis on normal physiology and concepts of pathophysiology.
- \*I 5807w. *HEMATOPOIETIC SYSTEM*. (4 cr) Tefferi  
Designed to give students background in pre-clinical sciences necessary to solve problems presented by patients with disorders of hemostasis and of blood forming and lymphoreticular systems.
- \*I 5809su. *ALLERGY*. (1 cr; prereq I 5806) Maddox  
Discussion of immunologic hypersensitivity, hypersensitivity disorders, pathophysiology of asthma, allergic rhinitis and drug allergy. Included are case discussions and demonstrations of skin testing and spirometry.
- \*I 5810w. *CARDIOVASCULAR SYSTEM*. (5 cr) Bresnahan  
Lectures, seminars, and laboratories on the fundamentals of cardiovascular anatomy, physiology, and biochemistry.
- I 5900f,w,s,su. *PRACTICAL ASPECTS OF PATIENT-ORIENTED RESEARCH SEMINAR*. (1 cr/yr) Poland and staff  
A seminar series designed to allow an initial examination of the practical issues and concerns related to patient-oriented research. The course is designed for those entering research careers or desiring further skills in patient-oriented research.

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## MOLECULAR BIOLOGY

- MBio 5000w. *INTRODUCTION TO MOLECULAR BIOLOGY*. (3 cr; prereq #) Kline  
Basic principles of cell organization and function, with emphasis on the use of molecular biology to increase the understanding of cellular physiology at the molecular level.

- MBio 5200f,w,s. *MOLECULAR AND CELL BIOLOGY WORKSHOP*. (1 cr/yr)  
Strehler, Maher  
Work-in-progress presentations on experimental research projects, given by graduate students and postdoctoral research fellows.
- MBio 5500w. *HUMAN CYTOGENETICS*. (2 cr; offered even yrs) Jalal  
Emphasizes structure and function of chromosomes and how cytogenetics relates to human clinical problems. Topics include karyotype evolution, aneuploidy, polyploidy, structural anomalies, nomenclature, and principles of banding. A review of chromosomal syndromes, chromosome breakage syndromes, cell division, and genomic imprinting will be included. Some clinical areas to be discussed include prenatal diagnosis, malignant hematologic disorders, and pediatric and obstetrical problems with chromosome anomalies. Research topics will include the chromosomal and molecular basis of cancer and molecular cytogenetics.
- MBio 5858f,w,s,su. *LABORATORY ROTATIONS IN MOLECULAR BIOLOGY*. (2 cr/8 wks) Staff  
A minimum of three rotations are required.
- MBio 8250w. *TUMOR BIOLOGY II: ORIGINS OF HUMAN CANCER*. (3 cr; prereq TBio 5000) Maihle, Tindall  
Topics to be covered include: basic tumor biology, oncogenes, tumor viruses, anti-oncogenes (tumor suppressors), tumor immunity, cancer chemotherapy, and biological response modifiers. Also listed under Tumor Biology 8000.
- MBio 8370s. *TUMOR BIOLOGY III: GROWTH FACTORS, ONCOGENES, AND TUMOR SUPPRESSORS* (3 cr; prereq TBio 5000, TBio 8000) Maihle, Tindall  
This course will focus on the mechanisms by which growth factors and oncogenes influence cell growth and division. Topics include: transmembrane signal transduction; cell cycle and regulation of cell division; ontogeny of oncogenes; mechanisms of oncogene activation; the insulin receptor family; PDGF/sis and PDGF receptor; EGF receptor/c-erb B 1 and 2 (neu); introduction to hematopoietic growth factors/receptors; receptors which lack intrinsic kinase activity, ras family of oncogenes; introduction to nuclear signal transduction; chromosome/DNA-binding proteins; development and differentiation; wound-healing and angiogenesis; carcinogenesis in humans; and anti-oncogenes. Also listed under Tumor Biology 8005.
- MBio 8030s. *DATA FITTING AND MODEL PARAMETER ESTIMATION*. (3 cr; prereq Linear Algebra, Calculus) Bajzer  
An introduction to modeling and methods for data fitting with applications to biomedical sciences. Theoretical knowledge along with emphasis on data reduction practice are offered to provide sufficient skills in using data fitting procedures. Also listed under Biochemistry.
- MBio 8050f. *PRINCIPLES OF CELL AND TISSUE DESIGN*. (3 cr; prereq MBio 5000 concurrent or equivalent) Salisbury, McNiven  
This course covers general aspects of cell structure with particular emphasis on nuclear organization (exclusive of DNA!), membrane structure and dynamics, protein targeting and processing as they relate to cell structure, protein phosphorylation, calcium-binding proteins, the cytoskeleton (interphase and mitotic) and vesicular transport. Also listed under Biochemistry.

- MBio 8101w. *REPLICATION AND TRANSCRIPTION REGULATION*. (3 cr; prereq undergraduate biochemistry) McMurray, Getz  
This course will discuss the structure and function of replication and transcription complexes. Emphasis will be placed on control mechanisms and energetics of transcription/replication in prokaryotes and eukaryotes. Also listed under Biochemistry.
- MBio 8102s. *REGULATION OF PROTEIN SYNTHESIS*. (3 cr; prereq general background in biochemistry or molecular biology) Toft  
General and specialized aspects of protein synthesis and processing will be covered. Regulation of protein synthesis at several posttranscriptional levels will be included. Also listed under Biochemistry.
- MBio 8390. *INDEPENDENT STUDY IN MOLECULAR BIOLOGY*. (1-2 cr) Staff  
Tutorials arranged on an individual basis in selected advanced topics in Molecular Biology. Students will be expected to define a topic and specific reading list in consultation with a member of the faculty. Mastery of the subject matter will be assessed by examination or by submission of a formal review of the subject area.
- MBio 8400. *MASTER'S PROJECT IN MOLECULAR BIOLOGY*. (3 cr) Rusnak  
Readings in Molecular Biology culminating in the submission of the Master's Thesis. Topics will be chosen by the student in consultation with the advisor and the student's advisory committee. May be taken only once for credit.
- MBio 8500f,w,s. *BIOCHEMISTRY AND MOLECULAR BIOLOGY JOURNAL CLUB*. (1 cr per year) Rusnak, Wieben  
Students of the Molecular Biology program will present current readings in the general areas of Cell and Molecular Biology.
- MBio 8501w. *FOCAL TOPICS IN GROWTH REGULATION*. (2 cr; prereq MBio 8005, Imm 8862 or #) Leaf  
Three areas of current study in growth regulation will be examined. This will permit an in-depth four week study of each. Potential topics will include ERKs/MAP kinases, tyrosine kinases, T cell antigen receptor signalling, cell cycle control, cyto-architecture, and tumor suppressors.
- MBio 8710w. *TOPICS IN MEMBRANE LIPIDS*. (2 cr; offered odd yrs; prereq Bioc 8000 or #) Pagano  
The following will be covered: Lipid structures and properties; Liposomes: Organization of lipids in membranes; Cholesterol uptake and metabolism; Lipid traffic in eukaryotic cells; Lipid second messengers; and Lipid metabolic diseases. Concepts, approaches and techniques of human genetics are presented by way of detailed discussion of original articles.
- MBio 8715f,w,s. *MOLECULAR MECHANISMS OF SECRETION*. (1 cr) McNiven  
This course will review the rapidly expanding field of protein and lipid trafficking through the secretory pathway of eukaryotic cells. Papers reviewed will focus on the molecular mechanisms of membrane budding, transport, targeting, and fusion between endoplasmic reticulum, Golgi apparatus, and the plasma membrane. Special attention will be placed on the contributions of the small and trimeric GTP-binding proteins, molecular motor enzymes, COP proteins, and SNARE/SNAP complexes to secretory vesicle biogenesis and subsequent exocytic release. Also listed under Biochemistry.

- MBio 8801f,w,s. *CONCEPTS OF VESICULAR TRAFFICKING*. (1 cr; prereq MBio 8050) McNiven  
Study of the basic mechanisms by which cells package, process, and transport synthesized and/or endocytosed proteins.
- MBio 8863w. *MOLECULAR BIOLOGY: THEORY AND APPLICATION*. (3 cr; prereq MBio 5000; offered odd yrs) McMurray  
Students will gain a thorough working knowledge of molecular biology. The course will deal with theoretical aspects of the techniques as a basis for their practical application. The course will use computer technology to aid in the design and application of all techniques.
- MBio 8877w. *TUTORIAL IN MOLECULAR BASIS OF IMMUNE RECOGNITION*. (2 cr; prereq Imm 5806 or equivalent; offered odd yrs) Pease  
Current concepts in immunology addressed at the level of the gene with primary focus on the MHC, immunoglobulin, and T-cell receptor gene complexes. Also listed under Immunology.
- MBio 8905w. *PCR: THEORY, METHODS, AND APPLICATIONS*. (1 cr; offered even years) Urrutia  
This course is designed to analyze the basic principles of the most advanced PCR-based laboratory techniques. Emphasis will be given to the description of up-to-date PCR strategies. Protocols will be offered as a compilation of proven methods that can be easily repeated in the attendant's laboratory. Also listed under Biochemistry and Molecular Neuroscience.
- MBio 8910f,w,s,su. *MOLECULAR CONTROL OF CELL DIFFERENTIATION*. (1 cr) Urrutia  
Discussion of classic, as well as current, articles on the mechanisms underlying cell commitment, pattern formation, and phenotype acquisition. Emphasis will be given to articles on transcription factors and their target genes during embryogenesis, teratogenesis, and carcinogenesis. Also listed under Biochemistry and Molecular Neuroscience.

## Research

- MBio 8840f,w,s,su. *RESEARCH IN MOLECULAR BIOLOGY*. (6cr/qtr) Staff  
Graduate thesis research for Master's students under supervision of staff.
- MBio 8900f,w,s,su. *RESEARCH IN MOLECULAR BIOLOGY*. Staff  
Graduate thesis research under supervision of staff.

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## MOLECULAR NEUROSCIENCE

- NSci 5001f,w,s,su. *LABORATORY ROTATIONS IN MOLECULAR NEUROSCIENCE*. (1 cr) Staff  
Laboratory rotation lasting four weeks.
- NSci 5002f,w,s,su. *LABORATORY ROTATIONS IN MOLECULAR NEUROSCIENCE*. (2 cr) Staff  
Laboratory rotation lasting eight weeks.

- NSci 5003f,w,s,su. *LABORATORY ROTATIONS IN MOLECULAR NEUROSCIENCE*. (3 cr) Staff  
Laboratory rotation lasting twelve weeks.
- NSci 8200w. *NEUROBIOLOGY OF HUMAN DISEASE*. (1 cr/offered odd yrs) Windebank, Gill  
The course will provide an overview of the clinical, cellular, and pathological aspects of a number of human neurodegenerative and neurotoxic disease processes. A brief description of the disease will be provided in regards to the functional compromise observed in patients. The major areas of research in regards to cellular and molecular mechanisms of the disease process will be discussed. Current trends in research will be related to curative or treatment strategies directed toward the disease.
- NSci 8300w. *CONCEPTS IN NEUROPHYSIOLOGY*. (3 cr) Windebank  
Essential physiology of excitable membranes, channels, cell signalling, mechanisms, and electromechanical coupling. Also listed under Physiology.
- NSci 8400f. *NEUROANATOMY*. (3 cr) Caselli  
Structure and functional anatomy of the nervous system. The human system will be used as the most complex model of the nervous system available.
- NSci 8500f,w,s. *NEUROSCIENCE SEMINAR*. (1 cr/yr) Windebank  
Seminar series by Mayo faculty and visiting faculty covering advanced topics in Molecular Neuroscience research.
- NSci 8600f,w,s. *NEUROSCIENCE JOURNAL CLUB*. (1 cr) Windebank  
A journal club for graduate students covering advanced topics in molecular neuroscience.
- NSci 8650su. *MOLECULAR NEUROSCIENCE WORKS IN PROGRESS*. (1 cr) Windebank  
Presentation of ongoing research projects by graduate students in Molecular Neuroscience Ph.D. Program.
- NSci 8854w. *BASIC NEUROSCIENCE*. (5 cr) Benarroch  
Lectures dealing with basic topics in CNS structure function and pharmacology.
- NSci 8905w. *PCR: THEORY, METHODS, AND APPLICATIONS*. (1 cr; offered even yrs) Urrutia  
This course is designed to analyze the basic principles of the most advanced PCR-based laboratory techniques. Emphasis will be given to the description of up-to-date PCR strategies. Protocols will be offered as a compilation of proven methods that can be easily repeated in the attendant's laboratory. Also listed under Biochemistry and Molecular Biology.
- NSci 8910f,s. *MOLECULAR CONTROL OF CELL DIFFERENTIATION*. (1 cr) Urrutia  
Discussion of classic, as well as current, articles on the mechanisms underlying cell commitment, pattern formation, and phenotype acquisition. Emphasis will be given to articles on transcription factors and

their target genes during embryogenesis, teratogenesis, and carcinogenesis. Also listed under Biochemistry and Molecular Biology.

## Research

- NSci 8840 *RESEARCH IN MOLECULAR NEUROSCIENCE*. (6 cr/qtr) Staff  
Graduate thesis research for Master's students under supervision of staff.
- NSci 8900. *RESEARCH IN MOLECULAR NEUROSCIENCE*. Staff  
Graduate thesis research under supervision of staff.

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## OBSTETRICS AND GYNECOLOGY

### Didactic

- ObG 5000su. *BASIC COLPOSCOPY*. (2 cr; offered odd yrs) Kastner and staff  
Introduction to the pathology and clinical features of intraepithelial neoplasia of the low female genital tract through lectures, demonstrations, and historical case material. Algorithms for the appropriate use of the methodology of colposcopy will be present. At the completion of the didactic portion of the course, the student will be prepared to begin utilizing this technique clinically.
- ObG 5801f,w,s,su. *INTRODUCTION TO OBSTETRICS*. (1 cr) Ogburn and staff  
Didactic sessions presented weekly. Student preparation and participation required.
- ObG 5802f,w,s. *INTRODUCTION TO MEDICAL GYNECOLOGY*. (1 cr) Fish and staff  
Selected topics in gynecology presented weekly. Student preparation and participation required.
- ObG 5803f,w,s. *INTRODUCTION TO SURGICAL GYNECOLOGY*. (1 cr) Wilson  
Theoretical and practical basis of gynecologic surgery.
- ObG 8100s. *INTRODUCTORY REPRODUCTIVE ENDOCRINOLOGY*. (1 cr) Staff  
Introduction to management of reproductive endocrinology and infertility patients. During a six-week rotation, residents will perform the initial evaluation for a variety of infertility and reproductive endocrine problems and will participate in subsequent evaluations and care. They will gain expertise in performing all relative infertility tests and participate in the management of patients undergoing ovulation induction therapy with clomiphene, human menopausal gonadotropins, and bromocriptine. They will be involved in the preoperative evaluation, surgical treatment, and postop care of these patients and they will participate in bi-weekly Reproductive Endocrinology conferences. Relevant physiology and pathophysiology will be reviewed.
- ObG 8854f,w,s,su. *SEMINARS IN GYNECOLOGIC ENDOCRINOLOGY*. (1 cr) Staff  
Weekly seminar(s), case presentations and didactic sessions.
- ObG 8856w. *CLINICAL REPRODUCTIVE ENDOCRINOLOGY*. (1 cr; offered

even yrs) Staff  
Clinical aspects of reproductive endocrinology and infertility reviewed in didactic sessions.

## Research

ObG 8890. *RESEARCH IN OBSTETRICS-GYNECOLOGY*. (6 cr; +) Staff  
Graduate thesis research under supervision of staff.

## Clinical

ObG 8852f,w,s,su. *CLINICAL OBSTETRICS AND GYNECOLOGY*. (6 cr)  
Ogburn and staff  
This course consists of two equal emphases: 1) Clinical training in the management of problems and diseases involving the reproductive system of women as well as health maintenance for women overall, and 2) the clinical care of pregnant women and their labor and delivery including diseases affecting pregnant women and their fetuses, management of complications and strategies to optimize the outcome for women and their children.

ObG 8853f,w,s,su. *OPERATIVE SURGERY*. (6 cr) Lee, Podratz, Stanhope, Webb, Wilson

ObG 8857f. *GYNECOLOGIC ONCOLOGY*. (6 cr; prereq satisfactory completion of an obstetrical and gynecologic residency training program at an accredited institution and maintenance of satisfactory status within the Gynecologic Oncology Fellowship Program) Podratz  
Preoperative evaluation, surgical treatment, and postoperative management of benign and malignant gynecologic disease processes and the complications thereof arising within the female genitalia. In addition, the acquisition of theoretical and practical knowledge regarding the natural history, the diagnosis, alternatives to surgical management, prognosis, and the postoperative immediate and long-term disposition for each of the disease processes requiring surgery will be anticipated.

ObG 8858f. *REPRODUCTIVE ENDOCRINOLOGY*. (3 cr; prereq satisfactory completion of a residency in obstetrics and gynecology and maintenance of satisfactory status within the Reproductive Endocrinology Fellowship Program) Staff  
Outpatient and surgical management of patients presenting with reproductive endocrinology disorders and infertility. Also will encompass the relevant physiology and pathophysiology.

ObG 8859w. *REPRODUCTIVE ENDOCRINOLOGY II*. (3 cr; prereq ObG 8858) Staff  
Outpatient and surgical management of patients presenting with reproductive endocrinology disorders and infertility. Also will encompass the relevant physiology and pathophysiology.

ObG 8860s. *REPRODUCTIVE ENDOCRINOLOGY III*. (3 cr; prereq ObG 8859) Staff  
Outpatient and surgical management of patients presenting with reproductive endocrinology disorders and infertility. Also will encompass the relevant physiology and pathophysiology.

- ObG 8861. *REPRODUCTIVE ENDOCRINOLOGY*. (6 cr) Staff  
Experience is obtained in the outpatient setting with regard to reproductive endocrinology including exposure to in vitro fertilization as well as with operating room experience. Experience is also obtained in transvaginal ultrasound.
- ObG 8870f,w,s,su. *ADVANCED GYNECOLOGIC OPERATIVE SURGERY*. (6 cr; prereq completion of Ob-Gyn residency training program) Webb, Magrina and staff  
The preoperative, intra operative and postoperative management of gynecological patients.
- ObG 8880f,w,s,su. *SURGICAL GYNECOLOGY AND REPRODUCTIVE ENDOCRINOLOGY - CHIEF RESIDENT ASSOCIATE*. (6 cr) Webb and staff
- ObG 8885f,w,s,su. *OBSTETRICS AND MEDICAL GYNECOLOGY - CHIEF RESIDENT ASSOCIATE*. (6 cr) Ogburn
- ObG 8891. *ELECTIVE ROTATION*. (6 cr) Wilson and staff  
Typical rotations would include gynecologic surgery, high-risk obstetrics, reproductive endocrinology and infertility, research or off-campus rotations.
- ObG 8900f,w,s,su. *FAMILY MEDICINE RESIDENT OBSTETRICAL ROTATION*. (1 cr; prereq previous obstetrical rotation, no MMS III or obstetrical residents serving OB out-patient rotations) Heise  
The Family Medicine resident will be based on Charlton 4 Obstetrical outpatient care clinic and be exposed to prenatal care as administered by obstetrical staff coordinators, level 1 and level 2 ultrasound, indications for and observations of amniocentesis, cordocentesis, and chorionic villi sampling. He/she will learn indications for and participate with routine antepartum testing. The resident will also attending obstetrical morning high-risk rounds, weekly OB grand rounds, and receive didactic presentations by obstetrical staff coordinators.
- ObG 8905f,w,s,su. *FAMILY MEDICINE GYNECOLOGY ELECTIVE ROTATIONS*. (1-2 cr; prereq second and third year family medicine residents) Heise  
The Family Medicine resident will enhance his/her skills in gynecologic history taking and gynecologic examination performance. The resident will observe colposcopy, office laser surgery, and become familiar with various screening techniques for maintaining gynecologic health. The resident will become familiar with various contraceptive techniques and their specific indications, as well as being introduced to common gynecologic disorders emphasizing menstrual irregularities, vaginitis, pelvic inflammatory disease, fibroids, pelvic pain, urinary incontinence, postmenopausal estrogen replacement therapy, and breast disease. He/she will have daily reading assignments with didactic presentations and clinical rotational exposures with a number of staff medical gynecologists.

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## OPHTHALMOLOGY

### Didactic

- Oph 8100. *FUNDAMENTALS AND PRINCIPLES OF OPHTHALMOLOGY*. (4 cr) Staff  
Anatomy, biochemistry, physiology, and pathology.
- Oph 8101. *OPTICS, REFRACTIONS AND CONTACT LENSES*. (4 cr) Staff
- Oph 8102. *OPHTHALMIC PATHOLOGY, OCULAR TUMORS, INTRAOCULAR INFLAMMATION, AND UVEITIS*. (4 cr) Staff
- Oph 8103. *RETINAL AND VITREOUS DISEASES*. (4 cr) Staff
- Oph 8104. *NEUROOPHTHALMOLOGY AND GENERAL MEDICAL OPHTHALMOLOGY*. (4 cr) Staff
- Oph 8105. *BINOCULAR VISION AND OCULAR MOTILITY*. (4 cr) Staff
- Oph 8106. *EXTERNAL AND CORNEAL DISEASES*. (4 cr) Staff
- Oph 8107. *GLAUCOMA, DISORDERS OF THE LENS AND ANTERIOR SEGMENT TRAUMA*. (4 cr) Staff
- Oph 8108. *EYELID, LACRIMAL, AND ORBITAL DISORDERS*. (4 cr) Staff

### Research

- Oph 8900f,w,s,su. *OPHTHALMOLOGY RESEARCH*. (6 cr) Brubaker, Bourne, Johnson, Holmes  
Thesis research under supervision of staff.

### Clinical

- Oph 8851f,w,s,su. *REFRACTION AND STRABISMUS*. (6 cr) Baratz, Dyer, Erie, Hardwig, Hohberger, Holmes  
Theory of refraction, retinoscopy, diagnosis of refractive errors of the eye, prescribing of lenses, disturbances of motility of the eyes, orthoptics and strabismus surgery. Prescribing and fitting contact lenses.
- Oph 8852f,w,s,su. *OCULAR THERAPY*. (6 cr) Bartley, Bourne, Brubaker, Buettner, Herman, Garrity, Johnson, Maguire, Pach, Robertson  
Diagnosis and treatment of diseases of the eye and its adnexa.
- Oph 8853f,w,s,su. *MEDICAL AND NEUROLOGIC OPHTHALMOLOGY*. (6 cr) Garrity, Leavitt, Younge  
Ophthalmology and ophthalmoscopy as they pertain to the fields of internal medicine and neurology.
- Oph 8854f,w,s,su. *OPHTHALMIC SURGERY*. (6 cr) Baratz, Bartley, Bourne, Brubaker, Buettner, Erie, Garrity, Hardwig, Herman, Hohberger, Johnson, Maguire, Pach, Robertson, Holmes
- Oph 8855f,w,s,su. *OPHTHALMIC PATHOLOGY, ANATOMY, AND SURGICAL TECHNIQUE*. (6 cr; prereq resident in ophthalmology) Bartley, Campbell, Herman

- Oph 8860f,w,s,su. *OPHTHALMOLOGY - CHIEF RESIDENT ASSOCIATE*. (6 cr; prereq must have completed PGY-1, 2, and 3 years and must be in good academic standing as determined by the Education Committee of the Department of Ophthalmology.) Staff

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## ORTHOPEDICS

### Didactic

- Or 5803f,s. *PROSTHETICS FOR ORTHOPEDICS*. (1 cr) Shives  
Lectures and discussions regarding upper and lower extremity prosthetics for amputations at various levels - includes class participation in the application of immediate-type pylons.
- See Anat 8855. *ORTHOPEDIC ANATOMY*. (2 cr) Carmichael and staff  
Lectures, prosections and demonstrations of gross anatomy of the musculoskeletal system with special emphasis on relationships and surgical approaches.
- Or 8500su. *TECHNIQUE OF MICROVASCULAR ANASTOMOSIS*. (2 cr) Wood  
This course offers supervised instruction in the techniques of microvascular anastomosis, care and use of microsurgical instruments, and proper application of the operating microscope. It will familiarize the candidate with the techniques of small vessel repair as well as nerve repair. Techniques of nerve and vascular dissection will also be emphasized. At the completion of the course the student will have repaired lacerations in synthetic material, conducted vascular repairs of blood vessels 1 mm in size, and carried out end-to-end nerve repair in the rat.
- Or 8550f,w,s,su. *NONSTRUCTURED MICROVASCULAR ANASTOMOSIS*. (2 cr; prereq student must be involved in or have completed a training program in an approved surgical specialty or subspecialty or be involved as a research fellow, technician, etc.) Schroeder  
Forty hours of instruction and practice which includes the care and adjustment of the operating microscope, the basic techniques of microsurgical suture placement, and microvascular anastomosis of a rat femoral artery and rat femoral vein. Following successful completion of the above measures, the students will extend their application to end-to-side microvascular anastomosis as well as epineural and fascicular nerve repair using the rat sciatic nerve model.
- Or 8860f,w,s,su. *BASIC KNOWLEDGE AND MOTOR SKILLS OF ORTHOPEDIC SPECIALTIES*. (3 cr; #) Rock  
This course will cover pertinent basic knowledge and motor skills as it applies to the subspecialties of Orthopedics, including adult reconstruction/trauma, hand and upper extremity, pediatrics, spine, and sports medicine.

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## Clinical

- Or 8851f,w,s,su. *ORTHOPEDIC DIAGNOSIS*. (6 cr) Morrey and staff  
Instruction in patient assessment by history, physical examination, imaging modes, laboratory tests and other adjunctive special evaluation techniques in the investigation of the musculoskeletal system and its disease processes. Included are experiences in outpatient, inpatient and operating room settings. The didactic program includes clinical conferences, lectures and journal clubs.
- Or 8852f,w,s,su. *ADULT RECONSTRUCTION*. (6 cr) Cabanela and staff  
This course covers all areas of Adult Reconstructive Surgery, including spine, hip, knee, shoulder, elbow, ankle and foot. Course will include personal teaching on patient assessment, surgical technique, pre and postoperative care, as well as follow-up care.
- Or 8853f,w,s,su. *SURGERY OF THE HAND*. (6 cr) Cooney and staff  
Supervised exposure to clinical hand surgery with weekly teaching conference and monthly journal club.
- Or 8854f,w,s,su. *PEDIATRIC ORTHOPEDICS*. (6 cr) Peterson  
Incidence, etiology, evaluation and treatment of congenital developmental, metabolic, and post-traumatic orthopedic conditions from birth to physiologic maturity.
- Or 8855f,w,s,su. *ORTHOPEDIC ONCOLOGY*. (6 cr) Pritchard and staff  
Orthopedic oncology residents participate in evaluation and management of patients with various musculoskeletal neoplasms. The surgical experience includes modern limb salvage procedures.
- Or 8856f,w,s,su. *FRACTURES AND RELATED INJURIES*. (6 cr) Lewallen and staff  
Instruction in patient assessment by history, physical examination, imaging modes, laboratory tests and other adjunctive special evaluation techniques in the investigation of the musculoskeletal system and its fractures and related injuries. Included are experiences in outpatient, inpatient and operating room settings. The didactic program includes clinical conferences, lectures and journal clubs.
- Or 8858f,w,s,su. *FOOT FELLOWSHIP*. (6 cr) Staff  
One-year experience in diagnosis and treatment of foot and ankle problems.
- Or 8870f,w,s,su. *ORTHOPEDIC - CHIEF RESIDENT ASSOCIATE*. (6 cr; prereq appointment is recommended by the Department of Orthopedics Education Committee and then undergoes institutional review.) Staff

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## OTORHINOLARYNGOLOGY

### Didactic

- ENT 5150f,w,s,su. *CORE CURRICULUM*. (2 cr) Staff  
This series of Saturday morning lectures rotates systematically every two years through basic and advanced discussions of topics in the various

aspects of the field of otorhinolaryngology. The lectures are presented by the staff and are divided into eight-week segments covering otology/audiology, rhinology, head and neck, general ENT, and plastic/reconstructive.

- ENT 5300f,w,s,su. *CORE COLLOQUIUM*. (1 cr) Olsen, McCaffrey Course is designed for open discussion among staff and participants regarding surgical indications and management and prevention of complications in patients with medical and surgical problems in otorhinolaryngology-head and neck surgery.
- ENT 8100f,w,s,su. *PROBLEMS IN CLINICAL DIAGNOSIS*. (4 cr) Beatty and staff  
Presentations by resident and consulting staff of representative diagnostic and management problems in otorhinolaryngology.
- ENT 8200f,w,s,su. *CLINICAL TESTING PRACTICUM*. (1 cr) Beatty and staff  
The purpose of this study is to acquaint the resident with the principles of audiologic testing, electronystagmography and rhinomanometry.
- ENT 8300s. *SOFT TISSUE AND PLASTIC RECONSTRUCTION*. (1 cr; offered even years) Olsen  
The purpose of this course is to acquaint the resident with the basic principles of soft tissue surgery. Local skin flaps including advancement, rotation, transposition and island flaps will be discussed. The techniques of scar revision will be demonstrated.
- ENT 8500f. *RHINOLOGY AND RHINOLOGIC SURGERY DISSECTION*. (3 cr; offered odd yrs) Kern  
This rhinology dissection course is given with fresh frozen cadavers. The basic purpose of this course is to acquaint the resident with the surgical anatomy and basic operative procedures of the nasal septal and external nose, including nasal septal reconstruction, sinus surgery, and rhinoplasty. There are dissections assigned and didactic material presented.
- ENT 8800f,w,s,su. *SEMINAR: OTORHINOLARYNGOLOGY*. (1 cr per year) Neel
- See Anat 8852s. *SURGICAL ANATOMY OF HEAD AND NECK*. (3 cr) Kasperbauer  
Cadaver dissection and lecture demonstration. Laboratory participation required for credits.
- ENT 8857w. *TEMPORAL BONE ANATOMY AND SURGERY OF THE TEMPORAL BONE*. (3 cr) Beatty, Facer, Harner, McDonald  
This course is designed to present the basic anatomy of the temporal bone, surgical landmarks, and to familiarize the resident with the surgical techniques of temporal bone surgery and the appropriate anatomy.

## Research

- ENT 8890f,w,s,su. *GRADUATE RESEARCH*. (6 cr; #) McCaffrey  
Graduate thesis research under staff supervision.

## Clinical

- ENT 8851f,w,s,su. *CLINICAL OTORHINOLARYNGOLOGY*. (6 cr) Staff  
Theory and practice with differential diagnosis and treatment of diseases of the ear, nose, paranasal sinuses, pharynx, larynx, head, and neck; their relation to general diagnosis.
- ENT 8852f,w,s,su. *PREOPERATIVE AND POSTOPERATIVE CARE OF PATIENTS*. (6 cr) Staff  
Junior residency service. Care of the pre- and postoperative in-hospital management of patients with diseases associated with the ears, nose and throat. Initial assessment of trauma involving head and neck as well as emergency room management of those patients.
- ENT 8853f,w,s,su. *OPERATIVE OTORHINOLARYNGOLOGY*. (6 cr) Staff  
Senior residency service. Senior surgical residency with the teaching staff. Management of the patient during entire hospital stay. Surgery performed under direction of faculty by the resident when properly qualified.
- ENT 8854f,w,s,su. *OPERATIVE OTORHINOLARYNGOLOGY - CHIEF RESIDENT ASSOCIATE*. (6 cr) Staff  
The chief resident manages the pre-operative, surgical and postoperative care of the patient. Faculty are available for supervision and consultation.

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## PATHOLOGY

### Didactic

- Path 8854f,w,s,su. *DISEASES OF THE LIVER*. (2 cr) Bjornsson  
Diagnostic exercise on the multiheaded microscope, using current liver biopsy specimens. Intended for morphologists, but also suitable for physicians with special interest in hepatology.
- Path 8872w,su. *BONE AND SOFT TISSUE PATHOLOGY*. (3 cr) Unni  
Discussion of the gross and microscopic appearances of tumors and tumor-like conditions of bone and joints.
- Path 8873f,w,s,su. *ORAL PATHOLOGY*. (2 cr) Unni

### Research

- Path 8890f,w,s,su. *GRADUATE RESEARCH*. (6 cr; #) Staff

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## PHARMACOLOGY

- Phar 5001f,w,s,su. *LABORATORY ROTATIONS IN PHARMACOLOGY*. (1 cr) Staff  
Four-week laboratory rotation to gain experience with a broad spectrum of research techniques useful in pharmacology.

- Phar 5002f,w,s,su. *LABORATORY ROTATIONS IN PHARMACOLOGY*. (2 cr)  
Staff  
Eight-week laboratory rotation to gain experience with a broad spectrum of research techniques useful in pharmacology.
- Phar 5003f,w,s,su. *LABORATORY ROTATIONS IN PHARMACOLOGY*. (3 cr)  
Staff  
Twelve-week laboratory rotation to gain experience with a broad spectrum of research techniques useful in pharmacology.
- Phar 5100f,w,s. *PHARMACOLOGY SEMINAR SERIES*. (1 cr/yr) Brimijoin  
Attendance is required at the weekly pharmacology seminars. Register once per year. Fall quarter only.
- \*Phar 5800f,w,s. *PHARMACOLOGY AND THERAPEUTICS*. (9 cr for series;  
Pharmacology graduate students must use this registration; prereq a good background in vertebrate physiology and general biochemistry at the college or graduate level) Weinshilboum and staff  
  
Survey course for medical and graduate students with no previous training in pharmacology. Covers the basic principles of drug uptake distribution and metabolism, receptor-activation, and pharmacology of specific organ systems.
- \*Phar 5801f. *GENERAL PHARMACOLOGY I*. (1 cr) Weinshilboum
- \*Phar 5802f. *GENERAL PHARMACOLOGY II*. (2 cr; prereq Phar 5801)  
Weinshilboum
- \*Phar 5803w. *GENERAL PHARMACOLOGY III*. (1.5 cr; prereq Phar 5801, Phar 5802) Weinshilboum
- \*Phar 5804w. *GENERAL PHARMACOLOGY IV*. (1.5 cr; prereq Phar 5801, Phar 5802) Weinshilboum
- \*Phar 5805w. *GENERAL PHARMACOLOGY V*. (1.5 cr; prereq Phar 5801, Phar 5802) Weinshilboum
- \*Phar 5806s. *GENERAL PHARMACOLOGY VI*. (1.5 cr; prereq Phar 5801, Phar 5802) Weinshilboum
- Phar 8000w. *TUTORIAL IN PATCH CLAMP TECHNIQUE*. (2 cr) Terzic  
An introduction to patch clamp electronics and ion channel measurements. A limited number of students pursuing research with patch clamp techniques will be accepted.
- Phar 8800f,w,s. *RESEARCH SEMINARS IN PHARMACOLOGY*. (1 cr) Taylor  
The purpose of this course is to provide a forum for development of graduate speaking skills in a seminar setting. Students prepare talks presented to students, faculty, fellows, and research technicians.
- Phar 8802w. *PHARMACOLOGY OF HEART MUSCLE*. (3 cr; #; offered odd yrs)  
Staff  
Lectures, discussions, and demonstrations on the cellular basis of action of drugs on heart muscle. Origin of concept of drug-receptor interaction; molecular basis for ligand-protein binding; classical analysis of dose-response curves; isolation and characterization of receptor; current progress in amine, peptide, and steroid receptors.

- Phar 8803s. *BIOCHEMICAL BASIS OF NEUROPHARMACOLOGY*. (3 cr; offered odd yrs; #) Brimijoin and staff  
Lectures and discussions on the cellular and biochemical basis of drug actions in the nervous system. In-depth review of classical papers on mechanisms of neurotransmission, exocytosis transmitter inactivation, neurotoxicity, and cellular pathophysiology of the nervous system. Regular student presentations are expected.
- Phar 8804f. *CLINICAL PHARMACOLOGY*. (1 cr; prereq Phar 5800; offered 1996 and every 3rd yr) Lipsky and staff  
Rational pharmacologic basis of therapy with major categories of drugs used in clinical practice of medicine. Emphasis on pharmacokinetics, drug metabolism, pharmacogenetics, and mechanism of action of drugs.
- Phar 8805s. *DRUG METABOLISM*. (3 cr; offered odd yrs) Ames, Weinsilboum  
Principles of disposition of drugs in biological systems. Lectures on absorption, distribution, excretion, and metabolic transformation of drugs; descriptions of enzyme systems and factors affecting them.
- Phar 8806s. *PHARMACOLOGY OF RECEPTORS*. (3 cr; offered odd yrs; #) Brimijoin and staff  
Origin of concept of drug-receptor interaction; molecular basis for ligand-protein binding; classical analysis of dose-response curves; isolation and characterization of receptor; current progress in amine, peptide, and steroid receptors.
- Phar 8810s. *TOXICOLOGY*. (3 cr; offered even yrs) Moyer  
Lectures and discussion on the principles of intoxication by drugs and other foreign substances. Includes mechanisms of intoxication, detoxication, and a review of specific organic and inorganic intoxicants.
- Phar 8811s. *CELLULAR PHARMACOLOGY: THE MOLECULAR BASIS OF DRUG ACTION*. (3 cr; offered even yrs) Kaufmann  
Using recent literature articles, this course will examine the mechanisms of action of selected pharmaceutical agents at the cellular and subcellular level. Drug targets to be examined during the quarter include the bacterial cell wall, plasma membrane receptors, ion channels, ras farnesyl transferase, glycosylation pathways, the vesicular flow pathway, microtubules, DNA, DNA topoisomerases, and HIV transcriptase.
- Phar 8862w. *EXCITATION-CONTRACTION COUPLING IN SKELETAL MUSCLE*. (3 cr; offered odd yrs; prereq courses in electronics, computer science and mathematics) Taylor and staff  
Areas covered include cell-specific features of excitation, excitation-contraction coupling, and molecular mechanisms in force generation. Also listed under Physiology.
- Phar 8863w. *MOLECULAR BIOLOGY: THEORY AND APPLICATION*. (3 cr; prereq MBio 5000; offered odd yrs) McMurray  
Students will gain a thorough working knowledge of molecular biology. The course will deal with theoretical aspects of the techniques as a basis for their practical application. The course will use computer technology to aid in the design and application of appropriate techniques.

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- Phar 8879w. *TUTORIAL IN CELLULAR ACTIVATION*. (2 cr; prereq Imm 5806 or equivalent, basic knowledge of receptor pharmacology is desirable but not a requisite; offered even yrs) Abraham  
This course will focus on current topics related to receptors and transmembrane signaling events involved in the activation and growth of hematopoietic cells. Also listed under Immunology.

## Research

- Phar 8801. *RESEARCH IN PHARMACOLOGY*. Staff  
Directed research projects for Ph.D. students under the supervision of a faculty adviser.
- Phar 8840. *RESEARCH IN PHARMACOLOGY*. (6 cr/qtr) Staff  
Directed research projects for Master's students under the supervision of a faculty adviser.

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## PHYSICAL MEDICINE AND REHABILITATION

### Didactic

- PhM 8850su. *INTRODUCTION AND ORIENTATION TO PHYSICAL MEDICINE AND REHABILITATION*. (2 cr) Staff  
Introduction to the functions of the Department of Physical Medicine and Rehabilitation and the roles of physicians and other health professionals in the department.
- PhM 8854f,w,s. *BASIC AND APPLIED PHYSIATRY*. (2 cr) Staff  
Study, presentation, and discussion of selected relevant subjects.
- PhM 8856f,w,s. *SEMINARS IN PHYSICAL MEDICINE AND REHABILITATION*. (1 cr) Staff  
Selected readings, seminars, and research papers presented by staff and residents.
- PhM 8857f,w,s,su. *READINGS IN PHYSICAL MEDICINE AND REHABILITATION*. (1 cr) Staff  
Presentation by students and staff of selected readings devoted to a single subject area at each session.

### Research

- PhM 8900f,w,s,su. *RESEARCH WORK ON SELECTED PROBLEMS*. (6 cr) Staff  
The resident will conduct a research project with prior approval of the Physical Medicine and Rehabilitation Research Committee and faculty adviser.

### Clinical

- PhM 8100f,w,s,su. *PEDIATRIC REHABILITATION*. (6 cr) Schutt and staff  
The resident (2nd or 3rd year) works only with pediatric cases for one quarter. The duties are generally in Saint Marys Hospital in the morning and in the outpatient department in the afternoon.

- PhM 8851f,w,s,su. *OUTPATIENT CLINICAL PHYSICAL MEDICINE AND REHABILITATION*. (6 cr) Staff
- PhM 8852f,w,s,su. *PHYSICAL MEDICINE AND REHABILITATION HOSPITAL CONSULTING SERVICE*. (6 cr) Staff  
Physical medicine and rehabilitation as related to rheumatology, orthopedic surgery, neurology, and various other medical and surgical specialties.
- PhM 8853f,w,s,su. *HOSPITAL REHABILITATION SERVICE*. (6 cr) Staff
- PhM 8855f,w. *AMPUTATIONS AND PROSTHETICS*. (3 cr) Staff  
Surgical, medical, and rehabilitative aspects of amputee management. Lectures, laboratories, experience, and attendance at the Amputee Clinic.
- PhM 8860 w,s,su,f. *FELLOWSHIP IN SPORTS MEDICINE*. (6 cr; prereq Board eligible or Board certified physician in Physical Medicine and Rehabilitation) Rizzo  
The program will consist of a supervised clinical experience in Sports Medicine of not less than six months and an additional 0.2 to 0.5 FTE of research time. The fellow will be directly supervised by a member of the Department of Physical Medicine and Rehabilitation and will work closely with orthopedists and physical therapists as well as counselors with expertise in the area of Sports Medicine.
- PhM 8880f,w,s,su. *PHYSICAL MEDICINE AND REHABILITATION - SENIOR RESIDENT ASSOCIATE*. (6 cr) Staff  
The Physical Medicine and Rehabilitation Senior Resident Associate rotation is offered to PM&R residents during their final year of training who have successfully completed their inpatient PM&R rotations. The SRA rotation is designed to offer an independent clinical practice opportunity in inpatient primary care and consultative rehabilitation. The clinical experience is complemented by Department Grand Rounds, clinical conferences, basic science lecture series, discussion groups, and Journal Club.

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## PHYSIOLOGY

- Phys 5001f,w,s,su. *LABORATORY ROTATIONS IN PHYSIOLOGY*. (1 cr) Staff  
Laboratory rotation lasting four weeks. Students rotate through laboratories of several senior investigators to get exposure to areas of research, state-of-the-art methods, and senior faculty programs. The student will write a summary of laboratory projects and methods at completion of rotation.
- Phys 5002f,w,s,su. *LABORATORY ROTATIONS IN PHYSIOLOGY*. (2 cr) Staff  
Laboratory rotation lasting eight weeks. Students rotate through laboratories of several senior investigators to get exposure to areas of research, state-of-the-art methods, and senior faculty programs. The student will write a summary of laboratory projects and methods at completion of rotation.

- Phys 5003f,w,s,su. *LABORATORY ROTATIONS IN PHYSIOLOGY*. (3 cr) Staff  
Laboratory rotation lasting twelve weeks. Students rotate through laboratories of several senior investigators to get exposure to areas of research, state-of-the-art methods, and senior faculty programs. The student will write a summary of laboratory projects and methods at completion of rotation.
- Phys 5500w. *RESEARCH ANIMAL EXPERIMENTAL SURGERY AND METHODOLOGY*. (3 cr) Frisk, Andrews  
Presentation of information on the humane use of laboratory animals in biomedical research. Material covered will include the biology and experimental techniques of the majority of species used and regulations and ethics involving animal experimentation. Sessions on experimental surgery will include veterinary anesthesia, aseptic technique, post-operative care and experimental surgical techniques. A laboratory will be included.
- Phys 5801w,su. *PRINCIPLES OF BIOMECHANICS I*. (3 cr) An and staff  
Basic concepts of orthopedic biomechanics.
- Phys 5802f,s. *PRINCIPLES OF BIOMECHANICS II*. (3 cr; prereq Phys 5801) An and staff  
Advanced concepts of orthopedic biomechanics.
- Phys 5900f,w,s,su. *MASTER'S DEGREE PROJECT IN PHYSIOLOGY*. (5 cr) Staff  
This course is comprised of a special laboratory project in physiology in which the student uses tools and skills learned in coursework. The course is required for Employee Master's Degree candidates. The student must write a report on the project.
- Phys 8300w. *CONCEPTS IN NEUROPHYSIOLOGY*. (3 cr; offered even yrs) Windebank  
Essential physiology of excitable membranes, channels, cell signalling, mechanisms, and electromechanical coupling. Also listed under Molecular Neuroscience.
- Phys 8851f,w,s. *PHYSIOLOGY SEMINARS*. (1 cr; prereq Phys 8854 or, with other listed courses, +) Staff  
Weekly seminars in which whole department participates. Research papers presented by students, staff or invited lecturers.
- Phys 8854f,w,s,su. *READINGS IN PHYSIOLOGY*. (2 cr) Staff  
Assigned readings and reports on current topics and issues in Physiology.
- Phys 8855f. *CARDIOVASCULAR PHYSIOLOGY HYPERTENSION*. (3 cr; offered odd yrs; prereq human anatomy and principles of biophysics) Romero  
Hemodynamics, neural, and renal regulatory mechanisms: their participation in the development of hypertension.
- Phys 8856w. *RESPIRATORY PHYSIOLOGY*. (3 cr; offered odd yrs) Sieck  
The goal of this course is to provide an in-depth account of the functional components of the respiratory system and their integration in health and disease.

- Phys 8858w. *PHYSIOLOGY OF SMOOTH MUSCLE AND OF ITS INNERVATION* (2 cr; offered even yrs) Szurszewski, Miller and staff  
Lectures and discussions on electrical behavior of smooth muscle, ionic basis of electrical behavior; innervation of various types of smooth muscle and neuromuscular transmission in smooth muscle. Regular student presentations will be expected.
- Phys 8859w. *RENAL PHYSIOLOGY*. (2 cr; offered odd yrs) Know  
Renal hemodynamics, glomerular function, mechanisms and regulation of electrolyte transport. Two laboratory sessions demonstrating basic renal function and the effects of diuretics.
- Phys 8860s. *ENDOCRINE PHYSIOLOGY*. (2 cr; offered odd yrs) O'Brien  
This course focuses on several aspects of endocrine physiology, including mechanisms of hormone action, calcium homeostasis, glucose, and fatty acid metabolism, pituitary, thyroid and adrenal physiology, and immunologic aspects of endocrinology.
- Phys 8862w. *EXCITATION-CONTRACTION COUPLING IN SKELETAL MUSCLE*. (3 cr; offered odd yrs; prereq courses in electronics, computer science and mathematics) Taylor and staff  
Areas covered include cell-specific features of excitation, excitation-contraction coupling, and molecular mechanisms in force generation. Also listed under Pharmacology.
- Phys 8878w,su. *PHYSIOLOGY OF BONE I*. (3 cr; #) Turner and staff  
Lectures in physiology of both normal and abnormal bone; renal, respiratory, and endocrine physiology and function as related to bone.
- Phys 8879f,s. *PHYSIOLOGY OF BONE II*. (2 cr; #) Turner and staff  
Studies include structure and mineralization of bone both normal and abnormal, ion transport, mineral and hormonal metabolism as related to bone.
- Phys 8880. *PRINCIPLES OF SOLID MECHANICS*. (3 cr; prereq physics and calculus; offered on request) An  
Application of vector mechanics to musculoskeletal systems; experimental methodology in obtaining anatomic kinematic data.
- Phys 8881. *MECHANICS OF DEFORMABLE MATERIALS*. (3 cr; prereq Phys 8880; offered on request) An  
Stress and strain concepts and method of calculation for biological and implantable materials. Methodology and instrumentation for measuring stress, strain, fracture, and wear.

## Research

- Phys 8840f,w,s,su. *RESEARCH IN PHYSIOLOGY*. (6 cr/qtr) Staff  
Opportunities in research for master's students to be arranged with individual staff members.
- Phys 8853f,w,s,su. *RESEARCH IN PHYSIOLOGY*. (+) Staff  
Opportunities in research for Ph.D. students to be arranged with individual staff members.

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## PSYCHIATRY

### Didactic

- P 8301w. *ELECTIVE: TEACHING MEDICAL STUDENTS*. (3 cr) Hansen  
This course is an elective for senior residents. It is a half-time course. The resident serves as a teaching assistant for the first-year medical school course in Human Growth and Development from Conception to Death. The resident attends lectures, acts as discussion leader with a group of students approximately once each week, advises students for their special projects, runs the medical student group, and works with the adolescent project. This course provides the resident an opportunity to interact with medical students in a major academic, pre-clinical course, to learn teaching techniques, and to review material.
- P 8350. *INDIVIDUAL STUDY IN PSYCHIATRY*. (2 cr) Staff  
A tutorial/individualized study program intended for fellows in the Department of Psychiatry and Psychology as a one-to-one learning experience under the direction and supervision of an appropriate faculty member. This experience encourages the fellow to intensively examine a specific issue in Psychiatry under the tutelage of a faculty member who is an expert on that issue. Re-registration is permitted, up to a maximum of three completed individual study courses.
- P 8400. *BEHAVIORAL SCIENCE SEMINAR*. (2 cr) Staff  
A group learning experience employing didactic presentations and group discussion of specialized issues in the Behavioral Sciences, intended as an advanced learning experience for fellows in the Department of Psychiatry and Psychology. Content of each seminar will be determined by the interests and needs of the fellows in conjunction with the availability of faculty expertise. Reregistration is permitted with no limit.
- P 8501. *PSYCHIATRY DIDACTIC LECTURE SERIES I*. (2 cr) Staff  
The first of four six-month lecture series in the major theoretical and clinical areas of Psychiatry. Topics include an introduction to the medical and behavioral sciences of Psychiatry and Psychology, the history of Psychiatry and Psychology, theories of personality development, and issues relevant to the initial evaluation, assessment and disposition of the acute psychiatric patient.
- P 8502. *PSYCHIATRY DIDACTIC LECTURE SERIES II*. (2 cr) Staff  
The second of four six-month lecture series in the major theoretical and clinical areas of Psychiatry. Topics include the detailed study of the primary diagnostic entities in Psychiatry (e.g. psychotic illnesses, personality disorders, neurotic disorders, organic brain syndromes) and the study of related neurosciences (e.g. seizure disorders, neurodiagnostic procedures, learning disabilities).
- P 8503. *PSYCHIATRY DIDACTIC LECTURE SERIES III*. (2 cr) Staff  
The third of four six-month lecture series in the major theoretical and clinical areas of Psychiatry. Lectures and readings in this sequence focus upon the primary interventions used in the fields of Psychiatry and Psychology (e.g. pharmacotherapies and psychotherapies) as well as the contribution made to other medical specialties (e.g. coronary care, dialysis,

Physical Medicine and Rehabilitation) through liaison psychiatric consultations.

- P 8504. *PSYCHIATRY DIDACTIC LECTURE SERIES IV*. (2 cr) Staff  
The last of four six-month lecture series in the major theoretical and clinical areas of Psychiatry. Topics include major areas of subspecialty interest in Psychiatry (e.g. Child and Adolescent Psychiatry, Chemical Dependencies, Forensic Psychiatry), the professional interface of Psychiatry with Clinical Psychology, and selected topics of special interest to psychiatrists (e.g. Ethical Issues in Psychiatry).

## Research

- P 900. *RESEARCH IN PSYCHIATRY*. (6 cr) Staff  
Graduate thesis research.

## Clinical

- P 8100. *HOSPITAL PSYCHIATRY I: SECOND ASSISTANT*. (4 cr) Staff  
Entry-level clinical experience in hospital psychiatry emphasizing major forms of psychopathology and standard hospital based psychiatry therapies.
- P 8101. *HOSPITAL PSYCHIATRY II: SECOND ASSISTANT*. (4 cr) Staff  
Intermediate-level clinical experience in inpatient psychiatry.
- P 8102. *HOSPITAL PSYCHIATRY III: FIRST ASSISTANT*. (4 cr) Staff  
Advanced inpatient hospital psychiatry with greater emphasis on independent clinical decision processes and the supervision/teaching of second assistants.
- P 8103. *HOSPITAL PSYCHIATRY IV: FIRST ASSISTANT*. (4 cr) Staff  
Most advanced inpatient hospital psychiatry with greatest emphasis on independent clinical decision processes and the supervision/teaching of second assistants.
- P 8140f,w,s,su. *PAIN MANAGEMENT CENTER*. (2-4 cr) Staff  
Intermediate level clinical experience in outpatient/inpatient pain rehabilitation program.
- P 8150. *ADDU: ADULT CHEMICAL DEPENDENCY*. (4 cr) Staff  
Clinical experience in the adult aspects of chemical dependency diagnosis and treatment emphasizing the medical, psychological, and social parameters of chemical addictions.
- P 8160. *ACDU: ADOLESCENT CHEMICAL DEPENDENCY*. (4 cr) Staff  
Clinical experience in the adolescent aspects of chemical dependency diagnosis and treatment emphasizing the medical, psychological, and social parameters of chemical addictions.
- P 8170. *IPC: INTERPERSONAL PROCESS*. (4 cr) Staff  
Clinical experience with intensive group, milieu and individual psychotherapies provided to nonpsychotic patients in a day-hospital setting with emphasis on interpersonal processes and theories.
- P 8180. *CHILD PSYCHIATRY*. (6 cr) Staff  
Clinical experience in child and adolescent psychopathology and treatment, both inpatient and outpatient.

- P 8200. *OPS: OUTPATIENT PSYCHIATRY I.* (4 cr) Staff  
Elementary-level clinical experience in the outpatient practice of psychiatry.
- P 8201. *OPS: OUTPATIENT PSYCHIATRY II.* (4 cr) Staff  
Advanced-level clinical experience in the outpatient practice of psychiatry.
- P 8250. *CONSULTATION/LIAISON PSYCHIATRY.* (4 cr) Staff  
Advanced clinical experience in psychiatric consultation to other medical subspecialties.
- P 8270f,w,s,su. *FELLOWSHIP IN SUBSTANCE ABUSE.* (6 cr) Morse  
This is a one-year clinical fellowship in addictive disorders designed primarily for graduates of psychiatric residencies. With the institution of subspecialty examination in addiction psychiatry offered by the ABPN beginning in 1993, a basic one-year fellowship in addictions will be a prerequisite for this certification. The fellow will have clinical experience and supervision in both inpatient and outpatient assessment and treatment of addiction in adults and the outpatient assessment and treatment of drug abuse in adolescents. In addition, the fellow will design and carry out a clinical research project and will participate in educational seminars as well as teach psychiatric residents and Mayo medical students.
- P 8271f,w,s,su. *FELLOWSHIP IN CONSULTATION-LIAISON PSYCHIATRY.* (6 cr) O'Connor  
This is a one-year long experience in consultation-liaison psychiatry at the post-graduate year 5 level. The fellowship consists of six months of a core experience and six months of electives. The core experience entails performing inpatient and outpatient consultations under the supervision of a staff psychiatrist and serving as a senior resident on a medical psychiatry unit. A wide range of elective activities is available--the only requirement being the choice be consistent with the fellow's career goals. Ample time is provided for research.
- P 8300. *THEORY AND PRACTICE OF PSYCHOLOGY.* (4 cr) Staff  
Clinical experience and exposure to the interface between Psychiatry and Psychology.
- P 8500. *ZUMBRO VALLEY MENTAL HEALTH CENTER.* (4 cr) Staff  
Clinical experience in the evaluation and treatment of patients at a community mental health center. Coordination of services with community agencies is emphasized.
- P 8550. *FEDERAL MEDICAL CENTER: PRISON PSYCHIATRY.* (4 cr) Staff  
Clinical experience in the evaluation and management of mentally ill inmates at this major correctional treatment facility. Issues in forensic psychiatry will be considered.
- P 8890f,w,s,su. *FELLOWSHIP IN SLEEP DISORDERS.* (6 cr; prereq finished residency in Pulmonology, Neurology or Psychiatry) Hauri  
The main emphasis of this fellowship is on the clinical treatment of all sleep disorders. Fellows rotate through Psychiatry, Pulmonology, and ENT, and they take a two-month course in clinical neurophysiology. Ample time is provided for research.

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## RADIOLOGY

### Didactic

- R 8830f,w,s,su. *CARDIAC/VASCULAR RADIOLOGY*. (1 cr; offered 2 quarters per year--quarters vary each year) Reading and staff  
Case-based presentation, didactic lectures, and group discussion about all aspects of cardiac/vascular radiology. Course is intended for Diagnostic Radiology residents.
- R 8831f,w,s,su. *CHEST RADIOLOGY*. (1 cr; offered 2 quarters per year--quarters vary each year) Reading and staff  
Case-based presentation, didactic lectures, and group discussion about all aspects of chest radiology. Course is intended for Diagnostic Radiology residents.
- R 8832f,w,s,su. *CROSS-SECTIONAL IMAGING*. (1 cr; offered 2 quarters per year--quarters vary each year) Reading and staff  
Case-based presentation, didactic lectures, and group discussion about all aspects of cross-sectional imaging radiology. Course is intended for Diagnostic Radiology residents.
- R 8833f,w,s,su. *GASTROINTESTINAL RADIOLOGY*. (1 cr; offered 2 quarters per year--quarters vary each year) Reading and staff  
Case-based presentation, didactic lectures, and group discussion about all aspects of gastrointestinal radiology. Course is intended for Diagnostic Radiology residents.
- R 8834f,w,s,su. *GENITOURINARY RADIOLOGY*. (1 cr; offered 2 quarters per year--quarters vary each year) Reading and staff  
Case-based presentation, didactic lectures, and group discussion about all aspects of genitourinary radiology. Course is intended for Diagnostic Radiology residents.
- R 8835su. *INTRODUCTION TO DIAGNOSTIC RADIOLOGY*. (3 cr) Reading and staff  
Introduction to all aspects of Diagnostic Radiology including bone, chest, GI, GU, neuro, nuclear medicine, ultrasound, MRI, pediatrics, vascular, radiologic physics, and radiation protection.
- R 8836f,w,s,su. *MUSCULOSKELETAL RADIOLOGY*. (1 cr; offered 2 quarters per year--quarters vary each year) Reading and staff  
Case-based presentation, didactic lectures, and group discussion about all aspects of musculoskeletal radiology. Course is intended for Diagnostic Radiology residents.
- R 8837f,w,s,su. *NEURORADIOLOGY*. (1 cr; offered 2 quarters per year--quarters vary each year) Reading and staff  
Case-based presentation, didactic lectures, and group discussion about all aspects of neuroradiology. Course is intended for Diagnostic Radiology residents.
- R 8838f,w,s,su. *NUCLEAR MEDICINE*. (1 cr; offered 2 quarters per year--quarters vary each year) Reading and staff  
Case-based presentation, didactic lectures, and group discussion about all aspects of nuclear medicine. Course is intended for Diagnostic Radiology residents.

- R 8839f,w,s,su. *PEDIATRIC RADIOLOGY*. (1 cr; offered 2 quarters per year--quarters vary each year) Reading and staff  
Case-based presentation, didactic lectures, and group discussion about all aspects of pediatric radiology. Course is intended for Diagnostic Radiology residents.
- R 8854w,su. *RADIOLOGY OF THE MUSCULOSKELETAL SYSTEM*. (1 cr) Staff  
Radiological principles in evaluation of bone pathology and skeletal disorders.

## Research

- R 8900 f,w,s,su. *RESEARCH IN RADIOLOGY*. (1 cr) Reading and staff  
Instruction in research techniques combined with practical research experience. Much of this research experience will occur in the MRI Research Laboratory setting, but other areas of imaging research experience, outside of MRI, may be pursued as well. Course is intended for Diagnostic Radiology residents.

## Clinical

- R 8807f,w,s,su. *NUCLEAR MEDICINE*. (6 cr) Staff  
Twelve months of Nuclear Medicine training as part of a complete residency program to meet the requirements of Diagnostic Radiology with special competence in Nuclear Radiology, or 12 months following an approved Diagnostic Radiology residency program. This training is to prepare candidates for a career in Diagnostic Radiology with special training in Nuclear Medicine, and to prepare them for the oral examinations and special competency of the American Board of Radiology.
- R 8852f,w,s,su. *DIAGNOSTIC RADIOLOGY*. (6 cr) Staff  
Forty-eight months of Diagnostic Radiology as a resident to meet the requirements of the Residency Review Committee in Diagnostic Radiology of the ACGME. This training is to prepare candidates for a career in Diagnostic Radiology and to prepare them to take the written and oral exams of the American Board of Radiology.
- R 8862f,w,s,su. *DIAGNOSTIC RADIOLOGY ELECTIVE*. (13 cr) Staff  
Two-six weeks in diagnostic radiology observing the role of the radiologist in the evaluation and treatment of patients in all areas of radiology including: chest radiology, uro-radiology, skeletal radiology, pediatric radiology, gastrointestinal radiology, computed tomography, ultrasonography, neuroradiology, nuclear medicine, and hospital radiology. For those residents with a particular area of interest, time may be spent in one or more specific areas: pediatric residents in pediatric radiology, neurology or neurosurgical residents in neuroradiology, urology residents in uro-radiology, G.I. residents in gastrointestinal radiology, etc.
- R 8870f,w,s,su. *ABDOMINAL IMAGING FELLOWSHIP*. (6 cr; prereq Board eligible in Diagnostic Radiology) Reading  
GI Core includes gastrointestinal fluoroscopy/double contrast exam-outpatient, inpatient (to include exposure to interventional procedures), body CT, ultrasound, elective. GU Core includes adult urography, GU CT, GU ultrasound, digital/angio, MRI, and elective.

- R 8871f,w,s,su. *ANGIO-INTERVENTIONAL IMAGING FELLOWSHIP*. (6 cr; prereq Board eligible or certified in Diagnostic Radiology) Reading  
The program includes angiography, vascular computed tomography, MRI, ultrasound, interventional, and electives.
- R 8872f,w,s,su. *CARDIAC IMAGING FELLOWSHIP*. (6 cr; prereq Board eligible, having completed a four-year radiology training program or equivalent if foreign applicant) Reading  
The program includes cardiac catheterization laboratory, echocardiology, cardiac CT/ cine CT, cardiac MRI, research, cardiac pathology.
- R 8873f,w,s,su. *CROSS-SECTIONAL IMAGING FELLOWSHIP*. (6 cr; prereq Board eligible in Diagnostic Radiology) Reading  
Program includes ultrasonography, computed tomography, and MRI.
- R 8874f,w,s,su. *MUSCULOSKELETAL IMAGING FELLOWSHIP*. (6 cr; prereq Board eligible in Diagnostic Radiology) Reading  
The program includes musculoskeletal radiography and arthrography, musculoskeletal CT, musculoskeletal MRI, musculoskeletal nuclear medicine, musculoskeletal elective, and bone reading.
- R 8875f,w,s,su. *NEURORADIOLOGY FELLOWSHIP*. (6 cr; prereq Board eligible, having completed a four-year radiology training program) Reading  
The program includes neuropathology, cerebral angiography, myelography, head/spine CT, head/spine MRI.
- R 8876f,w,s,su. *RADIOLOGY RESEARCH FELLOWSHIP*. (6 cr; prereq Board certified or eligible in Diagnostic Radiology) Reading  
This program is designed to provide an opportunity for medical imaging research training at the fellowship level. The fellow will progress from participation in existing research programs within the department to formulation of an original program of investigation. Individual research projects will require advocacy and supervision by a staff member of the Department of Radiology. These projects will be considered for presentation at scientific meetings and for publication in the peer review literature.
- R 8877f,w,s,su. *THORACIC IMAGING FELLOWSHIP*. (6 cr; prereq Board eligible or certified in Diagnostic Radiology) Reading  
The program includes outpatient chest radiology, thoracic computed tomography, hospital/inpatient chest radiography, pulmonary medicine hospital rounds, thoracic surgery, and elective.
- R 8878f,w,s,su. *CLINICAL MEDICAL PHYSICS*. (6 cr) Gray  
This program provides comprehensive training and experience for candidates with doctoral degrees in the relevant physics sciences and who are interested in careers as clinical medical physicists in diagnostic imaging. Medical physics residents will learn the principles and procedures involved in the production of clinical diagnostic images, methods of image evaluation applicable in the clinical environment, techniques for optimization of radiation exposure for diagnostic examinations, radiation protection, methods of calculating specific organ doses and risk estimates, and principles, terminology, and applications of anatomical and physiological imaging techniques.

- R 8880f,w,s,su. *CHEST RADIOLOGY*. (1 cr) Reading and staff  
Instruction in clinical chest radiology film interpretation and procedural  
skills. Course is intended for Diagnostic Radiology residents.
- R 8881f,w,s,su. *GASTROINTESTINAL RADIOLOGY*. (1 cr) Reading and  
staff  
Instruction in clinical gastrointestinal radiology film interpretation and  
procedural skills. Course is intended for Diagnostic Radiology residents.
- R 8882f,w,s,su. *HOSPITAL RADIOLOGY*. (1 cr) Reading and staff  
Instruction in clinical hospital radiology film interpretation and procedural  
skills. Course is intended for Diagnostic Radiology residents.
- R 8883f,w,s,su. *NEURORADIOLOGY*. (1 cr) Reading and staff  
Instruction in clinical neuroradiology film interpretation and procedural  
skills. Course is intended for Diagnostic Radiology residents.
- R 8884f,w,s,su. *PEDIATRIC RADIOLOGY*. (1 cr) Reading and staff  
Instruction in clinical pediatric radiology film interpretation and  
procedural skills. Course is intended for Diagnostic Radiology residents.
- R 8885f,w,s,su. *SKELETAL RADIOLOGY*. (1 cr) Reading and staff  
Instruction in clinical skeletal radiology film interpretation and procedural  
skills. Course is intended for Diagnostic Radiology residents.
- R 8886f,w,s,su. *ULTRASOUND*. (1 cr) Reading and staff  
Instruction in clinical ultrasound radiology film interpretation and  
procedural skills. Course is intended for Diagnostic Radiology residents.
- R 8887f,w,s,su. *URORADIOLOGY*. (1 cr) Reading and staff  
Instruction in clinical uroradiology film interpretation and procedural  
skills. Course is intended for Diagnostic Radiology residents.

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## TUMOR BIOLOGY

- TBio 5000f. *TUMOR BIOLOGY I: INTRODUCTION TO TUMOR BIOLOGY*. (3 cr) Maihle, Tindall  
Material to be covered includes fundamental concepts and methods in tumor biology, as well as normal tissue histology and tumor pathobiology.
- TBio 5100f,w,s,su. *RESEARCH SEMINARS IN TUMOR BIOLOGY*. (1 cr/yr) Maihle, Salisbury  
Informal presentation of intramural research findings from the laboratories involved in relevant research investigations. Discussions will be based on chalk-talk format with the open research notebook. In addition, speakers from outside the institution will present throughout the year. All Tumor Biology trainees will be expected to present their research plans/findings in this forum annually and will be encouraged to actively participate in this highly multidisciplinary exchange of ideas and information.
- TBio 5150f, w,s. *CURRENT TOPICS IN TUMOR BIOLOGY*. (1 cr) Salisbury, Maihle  
This journal club will discuss current primary literature covering all aspects of tumor biology with an emphasis on women's cancers. The journal club will meet once per week and be conducted under the open discussion format with directed student and faculty presentations. During the fall quarter, journal articles of fundamental and historic interest in the area of tumor biology will be read and discussed. Topics to be covered include: cell cycle, oncogenes, tumor suppressors, growth factors, signal transduction, metastasis, DNA tumor viruses, retroviruses.
- TBio 5200f. *PRINCIPLES OF PANCREATIC CANCER*. (1 cr) Urrutia  
Anatomy, fine structure, and embryology of the pancreas. Basic cell biology and regulation of pancreatic gene expression. Cellular and animal models for the study of normal and neoplastic pancreatic cell differentiation. Epidemiology, etiology, diagnosis and management of pancreatic cancer.
- TBio 5250w. *GENE THERAPY AND CANCER*. (1 cr; odd yrs) Federspiel, Salisbury  
Current papers in the area of gene therapy and cancer will be reviewed and discussed in the journal club format. Students in the Tumor Biology program will participate in all sessions and will present a paper during the quarters that they are enrolled in this journal club.
- TBio 5300su. *THE BUSINESS OF SCIENCE AND THE SCIENCE OF BUSINESS*. (1 cr; offered even years) Bennet, Maihle  
This course reviews concepts fundamental to the commercial potential of biotechnology. Topics include current patent issues in biotechnology, regulatory issues in biotechnology and research funding mechanisms, as well as the grant review process.

- TBio 5858f,w,s,su. *LABORATORY ROTATIONS IN TUMOR BIOLOGY* (2 cr)  
Staff  
Tutorial course involving general techniques, instrumental analysis, and special procedures undertaken in the laboratory of choice. In addition, the student will assimilate the general research area of the laboratory through readings, lab meetings, and discussion. Students and faculty shall use these rotations to determine the degree of general mutual interest in research topics for potential thesis projects.
- TBio 8000w. *TUMOR BIOLOGY II: ORIGINS OF HUMAN CANCER*. (3 cr; prereq TBio 5000) Maihle, Tindall  
Topics to be covered include: basic tumor biology, oncogenes, tumor viruses, anti-oncogenes (tumor suppressors), tumor immunity, cancer chemotherapy, and biological response modifiers. Also listed under Molecular Biology 8250.
- TBio 8005s. *TUMOR BIOLOGY III: GROWTH FACTORS, ONCOGENES, AND TUMOR SUPPRESSORS*. (3 cr; prereq TBio 5000, TBio 8000) Maihle, Tindall  
This course will focus on the mechanisms by which growth factors and oncogenes influence cell growth and division. Topics include: transmembrane signal transduction; cell cycle and regulation of cell division; ontogeny of oncogenes; mechanisms of oncogene activation; the insulin receptor family; PDGF/sis and PDGF receptor; EGF receptor/c-erbB 1 and 2 (neu); introduction to hematopoietic growth factors/receptors; receptors which lack intrinsic kinase activity, ras family of oncogenes; introduction to nuclear signal transduction; chromosome/DNA-binding proteins; development and differentiation; wound-healing and angiogenesis; carcinogenesis in humans; and anti-oncogenes. Also listed under Molecular Biology 8370.
- TBio 8200w. *CELL BIOLOGY OF CANCER*. (2 cr; offered even years; prereq TBio 5000) Salisbury, Gendler, Lingle  
This course will cover normal histology and the histopathology of neoplasia and will consist of one lecture and one laboratory session each week. Normal development and microscopic anatomy of the four basic tissue types will be covered, followed by a detailed examination of integument, hemopoietic system, male and female reproductive tracks, respiratory system, and GI track. Specific primary and metastatic tumors of each system will also be covered. The laboratory session will involve study of microscopic slide preparations and problem set discussion sessions.
- TBio 8305s. *BIOLOGY OF BREAST CANCER*. (1 cr; offered odd years) Maihle, Salisbury  
This course will cover the cell and developmental biology of the breast and the histopathobiology of breast tumors. Experimental models for breast cancer, growth factors, oncogenes, and tumor suppressers in breast cancer will be covered. Clinical topics including radiation and chemotherapy, surgical treatments, diagnosis, and experimental therapies in breast cancer will also be presented.

TBio 8400 *MASTER'S PROJECT IN TUMOR BIOLOGY* (3 cr) Staff  
Readings and/or research in Tumor Biology culminating in the submission of the Master's Project. Topics will be chosen by the student in consultation with the adviser and the student's advisory committee.

## **Research**

TBio 8840f,w,s,su. *RESEARCH IN TUMOR BIOLOGY*. Staff  
Graduate thesis research for Master's students under supervision of staff.

TBio 8900f,w,s,su. *RESEARCH IN TUMOR BIOLOGY*. Staff  
Graduate thesis research under supervision of staff.



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## GRADUATE FACULTY LISTING



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## FACULTY OF THE GRADUATE SCHOOL

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The following are Full Members (FM) of the Graduate School faculty and are available as thesis advisers for doctoral candidates in the indicated areas of specialization within the Biomedical Sciences Ph.D. program.

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**Abraham, Robert T., Ph.D.**, University of Pittsburgh, 1981, FM-Immunology, Pharmacology & Tumor Biology. Biochemistry and molecular biology of T-lymphocyte activation and proliferation. Cytokine receptor signal transduction. Molecular mechanisms of action of immunosuppressant drugs.

Representative articles: Interleukin-2 triggers a novel phosphatidylinositol 3-kinase-dependent MEK activation pathway. *Molec. Cell. Biol.* 15:3049-3057, 1995 (with Karnitz, Burns, Sutor and Blenis).

Immunopharmacology of rapamycin. *Annual Review of Immunology*, in press, 1996 (with Wiederrecht).

**Ames, Matthew M., Ph.D.**, California, San Francisco, 1976, FM-Molecular Neuroscience, Pharmacology & Tumor Biology. Design, synthesis and evaluation of novel anticancer agents; mechanism of action of anticancer agents; preclinical and clinical pharmacology (metabolism, disposition, pharmacokinetics) of anticancer agents in adult and pediatric cancer patients.

Representative projects: the role of serine proteases in tumor cell growth and mechanism-based serine protease inhibitors as potential antitumor agents; biology and biochemistry of carcinoid tumors, a neuroendocrine malignancy.

Representative articles: Comparative resistance of idarubicin, doxorubicin and their C-13 alcohol metabolites in human MDR1-transfected NIH-3T3 cells. *Cancer Chemother. Pharmacol.* 36, 223-226, 1995 (with Kuffel).

Kinetic properties of tryptophan hydroxylase and aromatic-L-amino acid decarboxylase in human carcinoid tumors. *Biochem. Pharmacol.*, 50(6), 845-850, 1995 (with Gilbert and Bates).

**Brimijoin, W. Stephen, Ph.D.**, Harvard, 1969, FM-Pharmacology & Molecular Neuroscience. Neurobiology of cholinesterases. Development of cholinergic systems in the brain.

Representative articles: Using antibodies to unwire the sympathetic nervous system. *News in Physiol. Sci.* 10:101-106, 1995.

Transient Expression of Acetylcholinesterase mRNA and Enzyme Activity in Developing Rat Thalamus Studied by Quantitative Histochemistry and In Situ Hybridization. *Neurosci.* 71:555-556, 1996 (with Hammond).

**Burnett, Jr., John C., M.D.**, Loyola University, 1974, FM-Physiology. Regulation of cardiovascular-renal homeostasis, natriuretic peptides, endothelial-derived vasoactive factors, endocrinology of congestive heart failure and hypertension.

Representative articles: Angiotensin converting enzyme inhibition modulates endogenous endothelin in chronic canine thoracic inferior vena caval constriction. *J. Clin. Invest.* 97:1286-1292, 1996 (with Clavell, Mattingly, Stevens, Nir, Wright, Aarhus and Heublein).

A functional role for endogenous atrial natriuretic peptide in a canine model of

early left ventricular dysfunction. *J. Clin. Invest.* 95:1101-1108, 1995 (with Stevens, Kinoshita, Matsuda and Redfield).

**David, Chella S., Ph.D.**, Iowa State University, 1966, FM-Immunology & Tumor Biology. Research centers on immunogenetic aspects of immune response, with emphasis on the major histocompatibility complex (MHC) class II Ia genes and T-cell receptor gene (TCR). This group has generated several transgenic mice expressing human MHC genes, which are used in structure/function analysis, disease correlation, and thymic regulation of T-cell development. Two major ongoing studies on disease models are (1) using collagen-induced arthritis to study the role of MHC, TCR, and other parameters in arthritis and to evaluate different immunotherapeutic protocols; and (2) studying the role of enterobacteria in HLA-B27-linked spondyloarthropathies.

Representative articles: Immune response of HLA-DQ8 transgenic mice to HLA-DRB1 HV3 peptides correlates with predisposition to rheumatoid arthritis. *Proc. Natl. Acad. Sci.* 93:2824-2829, 1996 (with Zanelli, Krco, Baisch, and Cheng).

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**Dewald, Gordon W., Ph.D.**, University of North Dakota, 1972, FM-Biochemistry and Molecular Biology & Tumor Biology. Human Cytogenetics: Structure, function and behavior of chromosome abnormalities in congenital disorders and malignant neoplasms.

Representative articles: The application of fluorescent in situ hybridization to detect Mbc1/abl fusion in variant Ph chromosomes in CML and ALL. *Cancer Genetics and Cytogenetics* 71:7-14, 1993 (with Schad, Christensen, Tiede, Zinsmeister, Spurbeck, Thibodeau and Jalal).

Cytogenetic guidelines for fragile X studies tested in routine practice. *American Journal of Medical Genetics* 44:816-821, 1992 (with Buckley, Sprubeck and Jalal).

**Dousa, Thomas P., M.D.**, Charles University, Prague, 1962, Ph.D., Academy of Sciences, Prague, 1968, FM-Medicine & Physiology. Mechanism of hormone action on kidney; role of cyclic 3',5'-nucleotides and phosphorylations in regulation in normal kidney and in kidney in disease; role of cyclic 3',5'-nucleotide phosphodiesterases in renal cell injury. Regulatory role of cyclic ADP-ribose on Na<sup>+</sup>/Pi cotransporter in the kidney cells.

Representative articles: Formation of reactive oxygen metabolism in glomeruli is suppressed by inhibition of cAMP phosphodiesterase isozyme type IV. *Kidney Int.* 46:28-36, 1994 (with Chini, Chini, Williams and Matousovic).

Nicotinate Adenine Dinucleotide Phosphate (NAADP) triggers a specific calcium release system in sea urchin eggs. *J. Biol. Chem.* 270:3216-3223, 1995 (with Chini and Beers).

**Dyck, Peter J., M.D.**, University of Toronto, 1955, FM-Molecular Neuroscience. Neurobiology of nerve; neuropathological alterations and morphometric changes in experimental and human neuropathies; assessment of vibratory cold and warm sensation thresholds; correlation of neuropathologic and clinical abnormalities.

Representative articles: Ultrastructural morphometric abnormalities of sural nerve endoneurial microvessels in diabetes mellitus. *Ann. Neurol.* 36:408-415, 1994 (with Giannini).

A plasma exchange versus immune globulin infusion trial in chronic inflammatory demyelinating polyradiculoneuropathy. *Ann. Neurol.* 36:838-845, 1994 (with Litchy, Kratz, Suarez, Low, Pineda, Windebank, Karnes and O'Brien).

**Ehman, Richard L., M.D.**, University of Saskatchewan, 1979, FM-Biophysical Sciences & Tumor Biology. Basic development of MR imaging techniques, vascular, cardiac, and flow imaging with MRI, functional imaging with MRI.

Representative articles: Magnetic resonance elastography by direct visualization of propagating acoustic strain waves. *Science* 269:1854-1857, 1995 (with Muthupillai, Lomas, Rossman, Greenleaf and Manduca).

Navigator-echo-based real-time respiratory gating and triggering for reduction of respiration effects in 3D coronary MR angiography. *Radiology* 1996:55-60, 1996 (with Wang, Rossman, Grimm and Riederer).

**Engel, Andrew G., M.D.**, McGill University, 1955, FM-Molecular Neuroscience & Neurology. Disorders of neuromuscular transmission; immunology of muscle diseases.

Representative articles: Congenital myasthenic syndrome caused by prolonged acetylcholine receptor channel openings due to a mutation in the M2 domain of the E subunit. *Proc. Natl. Acad. Sci. USA* 92:758-762, 1995 (with Ohno, Hutchinson, Milone, Brengman, Bouzat and Sine).

Patch-clamp analysis of the properties of acetylcholine receptor channels at the normal human end-plate. *Muscle Nerve* 17:1364-1369, 1994 (with Milone and Hutchinson).

**Fass, David N., Ph.D.**, Florida State University, 1969, FM-Biochemistry and Molecular Biology. Hemostasis and regulation of clotting factor levels and activities; genetics and gene expression in von Willebrand's disease; regulation of cell proliferation.

Representative articles: Molecular cloning of cDNA encoding human antihaemophilic factor. *Nature* 312:342-347, 1984 (with Toole, Knopf, Wozney, Sultzman, Buecker, Pittman, Kaufman, Brown, Shoemaker, Orr, Amphlett, Foster, Coe, Knutson, and Newick).

Molecular genetic analysis of porcine von Willebrand disease: Tight linkage to the von Willebrand factor locus. *Blood* 72:308-318, 1988 (with Bahou, Bowie, and Ginsburg).

**Fernandez, Julio M., Ph.D.**, University of California, Los Angeles, FM-Biophysical Sciences, Physiology & Molecular Neuroscience. Mechanisms of secretion.

Representative articles: The exocytotic fusion pore and neurotransmitter. *Neuron*, in press (with Monck).

Release of secretory products during transient vesicle fusion. *Nature* 363:554-557 (with Alvarez de Toledo and Fernandez-Chacon).

**Fitzpatrick, Lorraine A., M.D.**, University of Chicago, 1980, FM-Tumor Biology & AM-Biochemistry and Molecular Biology & Physiology. Bone disease, metastasis, and cancer.

Representative articles: Antithetic effects of ryanodine and ruthenium red on osteoclast-mediated bone resorption and intracellular calcium concentration. *J. Cell Biochem.* 59:281-289, 1995 (with Ritchie, Strei and Maercklein).

Diffuse calcification in human atherosclerotic coronary arteries: Association of osteopontin with atherosclerosis. *J. Clin. Invest.* 94:1597-1604, 1994 (with Severson, Edwards and Ingram).

**Gendler, Sandra J., Ph.D.**, University of Southern California, 1984, FM-Biochemistry and Molecular Biology & Tumor Biology. Mucins in cancer, cystic fibrosis, and development; transgenic mouse studies of breast and colon cancer; protein targeting.

Representative publications: Delayed Mammary Tumor Progression in Muc-1 Null Mice. *J. Biol. Chem.* 270:30093-30101, 1995 (with Spicer, Rowse and Lidner).

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**Getz, Michael J., Ph.D.**, Texas at Houston, 1972, FM-Biochemistry and Molecular Biology & Tumor Biology. Molecular and cellular biology of peptide growth factors; regulation of specific gene transcription; pathobiology of cancer.

Representative articles: Negative regulation of the vascular smooth muscle  $\alpha$ -actin gene in fibroblasts and myoblasts: Disruption of enhancer function by sequence-specific single-stranded-DNA-binding proteins. *Mol. Cell. Biol.* 15:2429-2436, 1995 (with Sun et al.)

Tissue factor gene transcription in serum-stimulated fibroblasts is mediated by recruitment of c-Fos into specific AP-1 DNA-binding complexes. *Biochemistry* 34:12355-12362, 1995 (with Felts et al.).

**Gilbert, Barry K., Ph.D.**, Mayo Graduate School (University of Minnesota), 1972, FM-Biophysical Sciences. Design of computer hardware; development of computer aided design (CAD) software; development of Gallium Arsenide digital integrated circuit and high performance, compact electronic packaging technologies for high-performance digital signal processors; studies of mathematical algorithms for biomedical signal and image processing and analysis; computation-bound problems in biomedical research.

Representative articles: Frequency-Domain Analysis of Coupled Nonuniform Transmission Lines Using Chebyshev Pseudo-Spatial Techniques. *IEEE Transactions on Microwave Theory and Techniques* 40(11):2025-2033, November 1992.

Design Guidelines for Digital Multichip Modules Operating at High System Clock Rates. *The International Journal of Microcircuits and Electronic Packaging* 15(4):171-182, Fourth Quarter 1992.

**Gleich, Gerald J., M.D.**, University of Michigan, 1956, FM-Immunology & Medicine. Allergic inflammation with particular reference to the role of the eosinophilic leukocyte; analysis of eosinophil granules to define biologic activities associated with the eosinophil; the mechanism of eosinophilia in clinical syndromes and, in particular, the importance of cytokines such as interleukin 5 in the causation of clinical eosinophilia; and the cause of the eosinophilia-myalgia syndrome.

Representative articles: Eosinophil granule proteins increase microvascular macromolecular transport in the hamster cheek pouch. *J Immunol* 153:2664-2670, 1994 (with Minnicozzi, Durán and Egan).

Expression, purification, and characterization of the recombinant proform of eosinophil granule major basic protein. *J Immunol* 155:1472-1480, 1995 (with Popken-Harris, McGrogan, Loegering, Checkel, Kubo, Thomas, Moy, Sottrup-Jensen, Snable, and Kikuchi).

**Goronzy, Jorg J., M.D.**, University of Aachen, West Germany, 1979, **Ph.D.**, Heidelberg University, West Germany, 1988, FM- Immunology. Chronic inflammatory immune responses. Research is focused on elucidating the role of T cells in the initiation and perpetuation of chronic inflammatory response.

Representative articles: Dominant clonotypes in the repertoire of peripheral CD4<sup>+</sup> T cells in rheumatoid arthritis. *J Clin Invest* 94:2068-2076, 1994 (with Bartz-Bazzanella, Hu, Jendro, Walsler-Kuntz, and Weyand).

Mechanisms underlying the formation of the T cell receptor repertoire in rheumatoid arthritis. *Immunity* 2:597-605, 1995.

**Gray, Joel E., Ph.D.**, University of Toronto, 1977, FM-Biophysical Sciences & AM-Radiology. Diagnostic imaging, psychophysics and perception, radiation risk.

Representative articles: Evaluation of resolution and sensitometric characteristics of an asymmetric screen-film imaging system. *Radiology* 188:537-539, 1993 (with Stears, Swensen, and Bunch).

Acceptance and use of the SMPTE medical diagnostic imaging test pattern for television and hard-copy recording cameras. *SMPTE Journal* 99(12):1001-1007, 1990 (with Lisk, Anderson, Harshbarger, Schwenker and Uzenoff).

**Greenleaf, James F., Ph.D.**, Purdue, 1970, FM-Biophysical Sciences & AM-Physiology. Computer methods of biological data acquisition, analysis, and display; algebraic reconstruction; ultrasonic imaging; mathematical signal processing, ultrasonic therapy.

Representative articles: The effect of concave and convex weight adjustments on self-organizing maps. *IEEE Trans. Neural Networks* 7(1):87-96, January, 1996 (with Zheng).

Ultrasound: Physics and instrumentation. *Academic Radiology* 2:S115-S117, 1995.

**Hardy, John A., Ph.D.**, Imperial College, London, 1979, FM-Neuroscience & Pharmacology. Genetics and molecular biology of neurodegenerative disease, especially Alzheimer's disease.

Representative articles: Amyloid, the presenilins and Alzheimer's disease. *Trends in Neuroscience* 20(4):154-159, 1997.

Localization of fronto-temporal dementia with parkinsonism in an Australian kindred to chromosome 17q21-22. *Annals of Neurology*, in press, 1997 (with Hutton, et al.).

**Jelinek, Diane F., Ph.D.**, Southwestern Graduate School in Biomedical Sciences, 1985, FM-Immunology & AM-Tumor Biology. Molecular biology of cytokine regulation of normal and malignant B cell growth and differentiation.

Representative articles: CD40 expression in malignant plasma cells: Role in stimulation of autocrine IL-6 secretion by a human myeloma cell line. *J. Immunol.* 152:117-128, 1994 (with Westendorf, Ahmann, Armitage, Spriggs, Lust, Greipp and Katzmann).

Differentiation activation of a calcium-dependent endonuclease in human B lymphocytes: Role in ionomycin-induced apoptosis. *J. Immunol.* 155:3297-3307, 1995 (with Aagaard-Tillery).

**Kaufman, Kenton R., Ph.D.**, North Dakota State University, 1988, FM-Biomedical Imaging. Dynamics of human movement; mechanics of muscles, bones and joint of the lower extremity; mechanical analysis of sports performance.

Representative articles: Physiological prediction of muscle forces: Part I - Theoretical Formulation. *Neurosci.* 40:(3):781-792, 1991 (with An, Litchy and Chao).

Energy Efficient Knee Ankle Foot Orthosis. *J Prosthetics Orthotics* 8(3):79-85, 1996 (with Irby, Mathewson, Wirta and Sutherland).

**Kaufmann, Scott H., M.D., Ph.D.**, Johns Hopkins University, 1981, FM-Pharmacology & AM-Tumor Biology. Resistance to cancer chemotherapy agents. Mechanisms of drug-induced apoptosis.

Representative articles: Cleavage of Poly (ADP-ribose) Polymerase by a Proteinase with Properties like ICE. *Nature* 371:346-347, 1994 (with Lazebnik, Desnoyers, Poirier, and Earnshaw).

Increased expression of the multidrug resistance-associated protein gene in relapsed acute leukemia. *Blood* 85:186-193, 1995 (with Schneider, Cowan, Bader, Toomey, Schwartz, Karp, and Burke).

**Knox, Franklyn G., M.D., Ph.D.**, SUNY, Buffalo, 1965, FM-Physiology & Medicine. Renal physiology; the study of the intrarenal regulation of electrolyte transport.

Representative articles: Renal Regulation of Phosphate Excretion. IN: *The Kidney*, Seldin and Giebisch, eds., Chapter 71, pp 2511-2532, 1992 (with Berndt).

Control of Sodium Excretion: An Integrative Approach. IN: *Handbook of Physiology*, Section 8, Renal Physiology, E. Windhager, ed., Chapter 21, pp 927-968, 1992 (with Granger).

**Kumar, Rajiv, M.D.**, Delhi University, 1972, FM-Biochemistry and Molecular Biology & AM-Medicine. Calcium and phosphorus metabolism; the mechanism of action of sterol (vitamin D) and steroid hormone, clinical research involving mineral metabolism; mechanism of vasopressin action.

Representative articles: A factor derived from human sclerosing hemangioma cells inhibits sodium-dependent phosphate transport in cultured renal epithelia. *New Engl. J. Med.* 330:1645-1649, 1994 (with Cai, Hodgson, Kao, Lenno, Klee, Zinsmeister, and Kumar)

Identification of metal binding sites in rat brain calcium-binding protein. *J. Biol. Chem.* 270:30353-30358, 1995 (with Veenstra, Gross, Hunziker and Kumar).

**Lee, James J., Ph.D.**, California Institute of Technology, 1986, FM-Biochemistry and Molecular Biology. Transgenic mouse models of immune mediated inflammation: recruitment and activation of eosinophils.

Representative articles: Interleukin 5 expression in the lung epithelium of transgenic mice leads to pulmonary changes pathognomonic of asthma. *Journal of Experimental Medicine*; in press, 1997 (with McGarry, Denzier, Larson, Farmer, Carrigan, Brenneise, Gelfand, Leikauf and Lee).

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The Single MyoD-family gene of *Ciona intestinalis* encodes two differentially expressed proteins: Implications for the evolution of Chordate muscle gene regulation. *Development*; in press, 1997 (with Meedel and Farmer).

Asthma: Does IL-5 have a more provocative role? *American Journal of Respiratory Cell Molecular Biology*, in press, 1997 (with Lee).

**Leibson, Paul J., M.D., Ph.D.**, University of Chicago, 1979, 1981, FM-Immunology & Tumor Biology. Exploring human cell-mediated antiviral and anti-tumor immunity, with a special interest in natural killer (NK) cell activity.

Representative articles: Inhibition of selective signaling events in natural killer cells recognizing major histocompatibility complex class I. *Proc. Natl. Acad. Sci. USA* 92:6484-6488, 1995 (with Kaufman, Schoon, and Robertson).

Interaction between lck and syk family tyrosine kinases in Fcγ receptor-initiated activation of natural killer cells. *J. Biol. Chem.* 270:16415-16421, 1995 (with Ting, Dick, Schoon, Karnitz and Abraham).

**Lennon, Vanda A., M.B., B.S. (M.D.)**, University of Sydney, 1966, **Ph.D.**, University of Melbourne, 1973, FM-Immunology, Molecular Neuroscience & Tumor Biology & T/E-Neurology. Organ-specific autoimmunity directed against the nervous system is often a manifestation of a patient's immune responses against a remote and occult carcinoma of lung, ovary, or breast, or thymic epithelial neoplasm. Our molecular and immunobiological studies of ionic channels, neurotransmitter receptors and other neuron-related molecules expressed in these human tumors are yielding novel and clinically important insights into the nature of tumor molecules that are spontaneously immunogenic in man, and the immunologic mechanisms responsible for by-passing self-tolerance.

Representative articles: Calcium channel antibodies in Lambert-Eaton myasthenic syndrome and other paraneoplastic syndromes. *New Engl. J. Med.* 332:1467-1474, 1995.

β subunit heterogeneity in N-type Ca<sup>2+</sup> channels. *J. Biol. Chem.* 271:3207-3215, 1996.

**Leof, Edward B., Ph.D.**, University of North Carolina, 1982, FM - Biochemistry and Molecular Biology & Tumor Biology. Cellular signalling and the mechanism of action of growth factors.

Representative articles: Conditional binding to and cell cycle-regulated inhibition of cyclin-dependent kinase complexes by p27<sup>Kip1</sup>. *Cell Growth Diff.* 6, 915-925, 1995 (with Eblen, Fautsch and Anders).

Chimeric GM-CSF/TGFβ receptors define a model system for investigating the role of homomeric and heteromeric receptors in TGFβ signaling. Submitted.

**Lipsky, James J. M.D.**, Johns Hopkins, 1972, FM-Pharmacology. Clinical pharmacology, sulfur drug metabolism, metabolic activation, vitamin K metabolism, enzymology.

Representative articles: S-Methyl N,N-Diethylthiocarbamate Sulfone, a Potential Metabolite of Disulfiram and Potent Inhibitor of Low Km Mitochondrial Aldehyde Dehydrogenase. *Biochem. Pharmacol.* 49:693-700, 1995 (with Mays, Nelson, Fauq, Shriver, Veverka, and Naylor).

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**Lloyd, Ricardo V., M.D., Ph.D.**, University of Wisconsin, 1975, FM-Tumor Biology. Endocrine tumor biology, especially pituitary and thyroid.

Representative articles: Aberrant p27/kip1 Expression in Endocrine and Other Tumors. *American Journal of Pathology*:150:401-407, 1997 (with Jin, Quian, and Kulig).

Prolactin Receptor Messenger Ribonucleic Acid in Normal and Neoplastic human pituitary Tissues, *Journal of Clinical Endocrinology and Metabolism* 82:963-968, 1997 (with Jin, Qian, Kulig, Scheithauer, Calle-Rodrigue, Abboud, Davis, and Kovacs).

**Low, Phillip A., MBBS**, University of Sydney, 1966, M.D., (Research), 1977; FM-Molecular Neuroscience. Neurophysiology of peripheral nerve microenvironment. Human autonomic physiology.

Representative articles: Low PA (Ed), *Clinical Autonomic Disorders: Evaluation and Management*. Boston: Little, Brown and Company, 1993.

Hypoxic effect of exogenous insulin on normal and diabetic peripheral nerve. *Am J Physiol* 226:E980-E985, 1994 (with Kihara, Zollman, Smithson, and Lagerlund).

**Macura, Slobodan, Ph.D.**, University of Belgrade, 1978, FM-Biochemistry and Molecular Biology. The solution structure of macromolecules using NMR.

Representative articles: Somatostatin Analogue Octreotide Modulates Metabolism and Effects of 5-Fluorouracil and 5-Fluorouridine in Human Colon Cancer Spheroids. *Cancer Letter* 86:41-51, 1994 (with Chen, Huzak, and Vuk-Pavlovic).

Hydrogen Bonding Networks in Proteins as Revealed by Amide  $^1J_{NC}$  Coupling Constant. *J. Am. Chem. Soc.* 117:405-410, 1995 (with Juranic and Ilich).

**Maher, L. James, III, Ph.D.**, University of Wisconsin, 1988, FM-Biochemistry and Molecular Biology & Tumor Biology. Nucleic acid biochemistry, triple helix DNA.

Representative articles: Inhibition of DNA binding Proteins by Oligonucleotide-Directed Triple Helic Formation. *Science* 245:725-730, 1989 (with Wold and Dervan).

DNA Binding by Asymmetric Phosphate Neutralization. *Science* 266:1829-1834, 1994 (with Strauss).

**Maihle, Nita J., Ph.D.**, Albert Einstein College of Medicine, 1983, FM-Biochemistry and Molecular Biology & Tumor Biology & AM-Molecular Neuroscience.

Molecular basis of carcinogenesis: oncogenes, tumor suppressors, tumor virus. Human cancers: breast, ovarian and prostate carcinomas, gliomas.

Representative articles: A 1.8 kb alternative transcript from the human epidermal growth factor receptor gene encodes a soluble, truncated form of the receptor. *Genomics*, submitted, 1996 (with Reiter).

Ligand-independent dimerization of oncogenic *v-erbB* products involves covalent interactions. *J. Virology* 70:2533-2544, 1996 (with Adelman and Huntley).

**McCullough, Edwin C., Ph.D.**, University of Wisconsin, 1971, FM-Biophysical Sciences & AM-Radiology. Radiation therapy physics including treatment planning, quality assurance of simulators and linear accelerators, and intraoperative electron beam therapy and stereotactic radiotherapy.

Representative articles: Doses to radiation sensitive organs and structures located outside the radiotherapeutic target volume for four treatment situations. *International Journal of Radiation Oncology, Biology and Physics* 26:483-489, 1993.

An analysis of photon beam buildup region dosage with regard to treatment energy preference. *Medical Dosimetry* 19:5-14, 1994.

**McDonald, John A., Ph.D.**, Rice University, 1970, **M.D.**, Duke University, 1973, FM-Biochemistry and Molecular Biology. Cell biology of extracellular matrix, including integrins, fibronectin, and hyaluronan, during embryogenesis, cancer, and tissue repair.

Representative articles: Integrin activation and cytoskeletal interaction are essential for the assembly of fibronectin matrix cell. *Cell* 83:715-724, 1995 (with Wu, Keivens, Otoole, and Ginsberg).

Identification of a new biological function for the integrin  $\alpha 5 \beta 1$ : Initiation of matrix assembly. *Cell Adhesion and Communication*, in press, 1996 (with Wu, Hughes and Ginsberg).

**McKean, David J., Ph.D.**, Johns Hopkins, 1973, FM-Immunology & Tumor Biology. Characterization of molecular intracellular signaling mechanisms regulating lymphokine gene transcription and T lymphocytes activated by antigen, CD28 and IL-1 receptors. Structure-function analysis of murine major histocompatibility complex class II molecules: regulation of class II complex assembly and intracellular transport.

Representative articles: *International Immunology* 7:9-20, 1995. *J. Exper. Med.* 180:1321-1328, 1995.

**McKinney, Michael, Ph.D.**, Johns Hopkins, 1982, FM-Molecular Neuroscience & AM-Pharmacology. Neuropharmacology, central cholinergic neurotransmission, molecular neurobiology of cholinergic neurons, Alzheimer's Disease.

Representative articles: Differential expression of GAP-43 mRNA in central cholinergic neuronal populations. *Mol. Brain Res.* 23:213-220, 1994 (with Kent).

Differential expression of mRNA for the calmodulin-dependent nitric oxide synthase within cholinergic neuronal populations. *Mol. Brain Res.* 23:111-125, 1994 (with Sugaya).

**McMurray, Cynthia T., Ph.D.**, Oregon State University, 1987, FM-Pharmacology, AM-Biochemistry and Molecular Biology & Molecular Neuroscience. Mechanisms of nuclear signaling via membrane receptors: second-messengers, phosphorylation, gene expression, protein/DNA structure function; chromatin packaging; neurodegenerative disease; mutation.

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Representative publications: Trinucleotides associated with expansion in human disease from hairpin structures in vitro. *Cell* (in press), 1995 (with Gacy, Goellner, Juranic, and Macura).

Induction of rat prodynorphin gene through G-coupled receptors may involve phosphorylation-dependent derepression and activation. *Mol. Cell. Biol.* 14(5):2837-2848, 1994 (with Collins-Hicok, Lin, Spiro, Laybourn, Tschumper, and Rapacz).

**McNiven, Mark A., Ph.D.**, University of Maryland, 1987, FM-Molecular Neuroscience & Tumor Biology & AM-Biochemistry and Molecular Biology. Molecular mechanisms of vesicular transport, cytoskeleton, secretion and endocytosis in mammalian cells.

Representative articles: Association of a dynamin-like protein with the Golgi apparatus in mammalian cells. *J. Cell Biol.*, in press (with Henley).

Upregulation of molecular modor-encoding genes during hepatocyte growth factor- and epidermal growth factor-induced cell motility. *J. Cell Physiol.*, in press (with Török, Urrutia and Nakamura).

**Morin, Richard L., Ph.D.**, University of Oklahoma, 1980, FM-Biophysical Sciences. Electronic medical imaging; computed tomography; magnetic resonance imaging; computer networks in imaging.

Representative articles: CT reconstruction algorithm selection in the evaluation of solitary pulmonary modules. *J. Comp. Assist. Tomog.* 19:932-935, 1995 (with Swensen, Aughenbaugh, et al.).

The technical design and performance of ultrafast computed tomography. *Radiol. Clin. No. Amer.* 32:521-536, 1994 (with McCollough).

**Moyer, Thomas P., Ph.D.**, North Dakota State University, 1975, FM-Pharmacology. Toxicology, clinical correlation studies of diagnostic tests.

Representative articles: Testing for arsenic. *Mayo Clin. Proc.* 68:1210-1211, 1993.

Liver biopsy diagnosis of homozygous hemochromatosis: A diagnostic algorithm. *Mayo Clin. Proc.* 68:263-267, 1993 (with Ludwig, et al.).

**Naylor, Stephen, Ph.D.**, University of Cambridge, United Kingdom, 1987, DSc University of East Anglia, United Kingdom, 1991, FM-Pharmacology & AM-Biochemistry and Molecular Biology. Drug and Xerobrotic metabolism using capillary electrophoresis - MS. Protein-drug interactions and immunochemical detection of haloperndol - neuroprotiens.

Representative articles: Identification of a Naturally Occurring Ligands for Thymic Positive Selection. *Immunity* 6:389-399, 1997 (with Hogquist, Tomlinson, Kieper, McGargill and Jameson).

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Utility of Membrane Preconcentration in Capillary Electrophoresis-Mass Spectrometry in Overcomng Limited Sample Loading for Analysis of Biologically Derived Drug Metabolites, Peptides, and Proteins. *J. Am. Soc. Mass Spectrom.* 8:15-24, 1997 (with Tomlinson, Benson, Jameson and Johnson).

**Owen, Whyte, G., Ph.D.**, University of North Carolina, 1975, FM-Biochemistry and Molecular Biology. Regulation of blood coagulation and fibrinolysis, especially protein chemistry of plasma zymogens; thrombin enzymology and physiology; protease inhibitors.

Representative articles: Hirudin as a molecular probe for thrombin in vitro and during systemic coagulation in the pig. *Proc. Nat. Acad. Sci.* 90:1819-1823, 1993 (with Zoldhelyi and Chesebro).

Endogenous antithrombin associated with microvascular endothelium. Quantitative analysis in perfused rat hearts. *Biochemistry* 33:818-822, 1994 (with Felsch).

**Pagano, Richard E., Ph.D.**, University of Virginia, 1968, FM-Biochemistry and Molecular Biology & Molecular Neuroscience. Intracellular transport of lipids; lipid metabolism; liposomes; fluorescence methods.

Representative articles: Ceramide as a modulator of endocytosis. *J. Biol. Chem.* 270:13291-13297, 1995 (with Chen and Rosenwald).

A Chinese hamster ovary cell mutant defective in the non-endocytic uptake of fluorescent analogs of phosphatidylserine: Isolation using a cytosol acidification protocol. *J. Cell Biol.* 128:793-804, 1995 (with Hanada).

**Paya, Carlos V., M.D.**, University of Madrid, 1981, **Ph.D.**, University of Madrid, 1992, FM-Immunology. Viral immunology. Study of the interactions between human pathogenic viruses (HIV, CMV and host cell nuclear transcription factors (NF-kB, CREB) in immune cells (T cells, monocytes).

Representative articles: Protein kinase C-z mediates NF-kB activation in human immunodeficiency virus-infected Monocytes. *J. Virol.* 70:223-231, 1996 (with Figueira, McElhinny, Bren, MacMorran, Diaz Meco and Moscat).

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Macrophage-dependent apoptosis of CD4+ T lymphocytes from HIV-infected individuals is mediated by FasL and TNF. *J. Exp. Med.* 185:55-64, 1997 (with Badley, Dockrell, Simpson, Schut and Leibson).

**Pease, Larry R., Ph.D.**, University of Michigan, 1978, FM-Immunology & Biochemistry and Molecular Biology. Molecular Immunogenetics: Molecular analysis of genetic mechanisms leading to genetic diversity in the major histocompatibility complex. Evolution of class I promoter structure. Structural and functional contributions of sequence diversity among antigen presenting molecules (transplantation antigens) in antigen presentation to T cells and in repertoire selection.

Representative articles: *Immunol.* 150:3375-3381, 1993. *Mol. Cell. Biol.* 13:4374-4381, 1993.

**Penniston, John T., Ph.D.**, Harvard, 1962, FM-Biochemistry and Molecular Biology. Biological membranes; erythrocytes; calmodulin; Ca<sup>2+</sup> transport.

Representative articles: Mutants in the putative nucleotide-binding region of the plasma membrane Ca<sup>2+</sup> pump: A reduction in activity due to slow dephosphorylation. *J. Biol. Chem.* 270:30111-30114, 1995 (with Adamo, Filoteo and Enyedi).

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**Persing, David H., M.D., Ph.D.**, University of California, 1988, FM-Tumor Biology & AM-Immunology. Molecular immunobiology of zoonotic infections, pathogen-pathogen interactions leading to immune suppression, host and pathogen specific determinants of human papillomavirus transformation, intracellular mechanisms of papillomavirus assembly.

Representative articles: Infections with a *Babesia*-like organism in northern California. *N. Engl. J. Med.* 332:298-303, 1995 (with Herwaldt, Glaser, Lane, Thomford, Mathiesen, Krause, Phillip and Conrad).

Perpetuation of the agent of human granulocytic ehrlichiosis in a deer tick-rodent cycle. *PNAS*, in press (with Telford, Dawson, Katavolos, Warner and Kolbert).

**Poduslo, Joseph F., Ph.D.**, University of Pennsylvania, 1973, FM-Biochemistry and Molecular Biology & Molecular Neuroscience & T/E-Neurology. Molecular Neurobiology, Neurochemistry, Membrane Biochemistry. Regulation of myelin gene expression; Role of axon in inducing Schwann cell myelin gene expression; Therapeutic approaches for preventing demyelination; Post-translational protein modifications: glycosylation, sulfation, acylation, and phosphorylation: Quantification of protein permeability at the blood nerve/brain barriers; Delivery of therapeutic proteins into the nervous system.

Representative articles: Polyamine modification increases the permeability of proteins at the blood-nerve and blood-brain barriers. *J. Neurochem.* 66:1599-1609, 1996 (with Curran).

Permeabilities at the blood-brain and blood-nerve barriers of the neurotrophic factors: NGF, CNTF, NT-3, BDNF. *Molecular Brain Res.* 36:280-286, 1996 (with Curran).

**Prendergast, Franklyn G., M.D.**, University of West Indies, 1968, **Ph.D.**, University of Minnesota, 1977, FM-Biochemistry and Molecular Biology, Pharmacology & Tumor Biology. Fluorescence spectroscopy; protein structure and dynamics, microspectrofluorometry. Biochemistry of bioluminescence; membrane biochemistry.

Representative articles: Maximum likelihood method for the analysis of time-resolved fluorescence decay curves. *Eur. Biophys. J.* 20:247-262, 1991 (with Bajzer, Therneau and Sharp).

Fluorescence circular dichroism, attenuated total reflectance (ATR) FT-IR and <sup>13</sup>C NMR characterization of the structure and dynamics of synthetic melittin and melittin analogues in lipid environments. *Biochemistry* 31:1301-1313, 1992 (with Weaver, Kempe, Brauner and Mendelsohn).

Tryptophan-47 rotational isomerization in variant-3 scorpion neurotoxin: A combination thermodynamic perturbation and umbrella sampling study. *Biophys. J.* 57:1269-1279, 1990 (with Haydock and Sharp).

**Rae, James L., Ph.D.**, Michigan State University, 1968, FM-Biophysical Sciences & Physiology. Electrophysiology of ocular epithelia including mechanisms of cataract formation and mechanisms of corneal deturgence.

Representative articles: A cation channel in frog lens epithelia responsive to pressure and calcium. *J. Memb. Biol.* 93:259-269, 1986 (with Cooper, Tang and Eisenberg).

Potassium channels from chick lens epithelium. *Federation Proc.* 45:2718-2722, 1986.

**Richelson, Elliott, M.D.**, Johns Hopkins, 1969, FM-Pharmacology & Molecular Neuroscience & AM-Psychiatry. Basic and clinical neuropsychopharmacology.

Representative articles: Chimeric rat/human neurotensin receptors localize a region of the receptor sensitive to binding of a novel, species specific, picomolar affinity peptide. *Journal of Biological Chemistry*, in press, 1996.

Pharmacological and biochemical profiles of unique neurotensin (8-13) analogs exhibiting species selectivity, stereo-selectivity and super-agonism. *Journal of Biological Chemistry* 270:18359-18366, 1995 (with Cusack, McCormick, Pang, Souder and Garcia).

**Riederer, Stephen J., Ph.D.**, FM-Biophysical Sciences. Technical aspects of medical diagnostic imaging: nuclear magnetic resonance imaging (MRI); digital imaging.

Representative articles: Contrast optimization of fluid-attenuated inversion recovery (FLAIR) imaging. *Magn. Reson. in Med.* 34:868-877, 1995 (with Rydberg, Rydberg and Jack).

Multiple breathhold 3D time-of-flight MR angiography of the renal arteries. *Magn. Reson. in Med.* 35:426-434, 1996 (with Wilman, Grimm, Rossman, Wang, Ehman and King).

**Riordan, John R., Ph.D.**, University of Toronto, 1979, FM-Biochemistry and Molecular Biology. Structure and function of membrane proteins involved in human disease including CFTR, drug transporters and myelin proteolipid protein.

**Ritman, Erik L., MBBS**, Melbourne University Medical School, 1964, **Ph.D.**, University of Minnesota, 1973, FM-Biophysical Sciences, Physiology & AM-Medicine. Cardiovascular physiology; quantitation of cardiac dynamics and coronary circulation by computer assisted analysis of x-ray CT images.

Representative articles: Computed tomography evaluation of regional increases in microvascular permeability after reperfusion of locally ischemic myocardium in intact pigs. *Academic Radiology* 2:952-958, 1995.

Microvascular blood volume-to-flow relationships in porcine heart wall: whole body CT evaluation in vivo. *American Journal of Physiology* 269 (Heart Circ Physiol 38):H1820-H1826, 1995 (with Liu, Bahn, and technical assistance of Beighley).

**Robb, Richard A., Ph.D.**, University of Utah, 1971, FM-Biophysical Sciences, Molecular Neuroscience & Physiology. Computerized analysis of multidimensional biomedical images; scientific visualization; display and analysis of 3-D image data; computer aided surgery and treatment planning; virtual reality; workstations and networks for distributed image processing.

Representative articles: *Three-Dimensional Biomedical Imaging*: R. A. Robb, editor; CRC Press, 1985, Volumes I and II.

*Three-Dimensional Biomedical Imaging - Principles and Practice*: VCH Publishers, New York, NY, 1994.

**Rodriguez, Moses, M.D.**, Northwestern University, 1975, FM-Immunology & AM-Molecular Neuroscience & Neurology. Viral immunopathology. The laboratory is concerned with the role of the immune response and virus persistence in demyelination of the central nervous system in diseases such as multiple sclerosis.

Representative articles: Theiler's virus persistence and demyelination in Major Histocompatibility Complex Class II-Deficient Mice. *J. Virol.* 70:1729-1737, 1996 (with Njenga, Pavelko, Baish, David, and Leibowitz).

Monoclonal antibody SCH94.03, which promotes central nervous system remyelination, recognizes an antigen on the surface of oligodendrocytes. *J. Neurosci. Res.* 43:273-281, 1996 (with Asakura, Miller, Murray, Bansal, and Pfeiffer).

**Romero, Juan C., M.D.**, University of Cuyo, Argentina, 1964, AM-Medicine & FM-Physiology. Renal and cardiovascular physiology; the role of renal humoral factors in the control of blood pressure.

Representative articles: Role of endothelium-dependent relaxing factor nitric oxide on renal function. *J. Am. Soc. Nephrol.* 2:1371-1387, 1992 (with Lahera, Salom and Biondi).

Are renal hemodynamics a key factor in the development and maintenance of arterial hypertension in humans? *Hypertension* 23:3-9, 1994 (with Ruilope, Lahera and Rodicio).

**Salisbury, Jeffrey L., Ph.D.**, Ohio State University, 1978, FM-Biochemistry and Molecular Biology & Tumor Biology. Cell Biology; Cell Cycle Progression; Centrosomes; Mitotic Spindle Poles; Breast Cancer.

Representative articles: Centrin, centrosomes, and mitotic spindle poles. *Current Opinion in Cell Biol.* 7:39-45, 1995.

Identification of a complex between centrin and heat shock proteins in CSF arrested *Xenopus* oocytes and dissociation of the complex following oocyte activation. *Devel. Biol.* 171:51-59, 1995 (with Uzawa, Grams, Madden and Toft).

**Schaff, Hartzell V., M.D.**, University of Oklahoma, 1973, FM-Physiology. Cardiovascular effects of extracorporeal circulation; alterations in endothelial cell function during global ischemia and reperfusion; myocardial function in valvular heart disease.

Representative articles: Detection of intraluminal release of endothelium-derived relaxing factor from human saphenous veins. *Circulation* 88:II-128-132, November 1993 (with Chua, Pearson and Evora).

Oxygen radical-mediated vascular injury selectively inhibits receptor-dependent release of nitric oxide from canine coronary arteries. *The Journal of Thoracic and Cardiovascular Surgery* 107:505-509, February 1994 (with Secombe and Pearson).

**Schmid, Harald H.O., Ph.D.**, University of Graz, Austria, 1964, FM-Biochemistry and Molecular Biology. The structure, metabolism and function of complex lipids in biological membranes.

Representative articles: Peroxidative damage to cardiac mitochondria. II. Immunological analysis of modified adenine nucleotide translocase. *Arch. Biochem. Biophys.* 315:1-7, 1994 (with Giron-Calle and Zwizinski).

Generation and remodeling of phospholipid molecular species in rat hepatocytes. *Arch. Biochem. Biophys.* 319:168-176, 1995 (with Schmid, P.C. and Deli).

**Sieck, Gary C., Ph.D.**, University of Nebraska Medical Center, 1976, AM-Anesthesiology & FM-Molecular Neuroscience & Physiology. Plasticity in neuromotor control including: alterations in motor unit mechanical and metabolic properties; alterations in motoneuron morphometry; alterations at neuromuscular junction. Models include postnatal development; neural inactivation; compensatory loading and steroidal treatment.

Representative articles: Mechanical properties of muscle units in the cat diaphragm. *J. Neurophysiol.* 59: 1055-1066, 1988 (with Fournier).

Oxidative capacity and capillary density of diaphragm motor units. *J. Appl. Physiol.* 67: 620-627, 1989 (with Enad, et al).

**Sine, Steven M., Ph.D.**, University of California, San Diego, 1980, FM Biophysical Sciences, Molecular Neuroscience, Physiology.

Representative articles: Activation of Torpedo acetylcholine receptors expressed in mouse fibroblasts: single channel current kinetics reveal distinct agonist binding affinities. *Journal of General Physiology* 96: 395-437, 1990 (with Claudio and Sigworth).

Molecular dissection of subunit interfaces in the acetylcholine receptor: Identification of residues that determine curare selectivity. *Proc. Natl. Acad. Sci. USA* 90:9436-9440, 1993.

**Smith, David I., Ph.D.**, University of Wisconsin, Madison, 1978, FM-Tumor Biology. Molecular genetics of cancer development; molecular markers for pancreatic cancer and chromosomal fragile sites.

Representative articles: Frequent breakpoints in the region surrounding FRA3B in sporadic renal cell carcinomas. *Oncogene* 1997;14:1269-1277 (with Wang, Paradee, Shridhar, Mullins, Rivard Neboyskey, Sakr, Grignon, Petros, Wilke and Glover).

A 350 Kb cosmid contig in 3p14.2 that crosses the t(3;8) hereditary renal cell carcinoma translocation breakpoint and 17 aphidicolin-induced FRA3B breakpoints *Genomics* 1996;35:87-93 (with Paradee, Wilke, Wang, Shridhar, Mullins, Hoge and Glover).

Aphidicolin-induced FRA3B breakpoints cluster in two distinct regions. *Genomics* 1997; in press (with Wang, Paradee, Mullins, Shridhar, Rosati, Wilke and Glover).

**Spelsberg, Thomas C., Ph.D.**, West Virginia, 1967, FM-Biochemistry and Molecular Biology & Tumor Biology. One area pertains to the gene regulation of steroid hormones, including 1) the biological functions of a nuclear matrix receptor binding factor and its DNA binding element, 2) the role this complex plays in the nuclear binding of steroid receptors, and in the steroid regulation of "early" gene's (proto-oncogene) expression. A second area pertains to the biological and molecular actions of steroids (estrogens) and growth factors (TGF- $\beta$ ) in bone cells (osteoblasts and osteoclasts). This includes the steroid regulation of growth factor production, the growth factor and steroid regulation of a novel human transcription factor, termed TGF- $\beta$  inducible early gene (TIEG).

Representative articles: Identification of a novel TGF- $\beta$  regulated gene encoding a putative zinc finger protein in human osteoblasts. *Nucleic Acids Res.* 23(23):4907-4912, 1995 (with Subramaniam, Harris, Rasmussen, and Riggs).

Composition and structure of a nuclear matrix acceptor site for the avian progesterone receptor in the c-myc gene promoter. *Recent Progress in Hormone Research* 52:63-96, 1996 (with Lauber, Sandhu and Subramaniam).

**Strehler, E. Emanuel, Ph.D.**, Swiss Fed. Institute of Technology, 1981, FM-Biochemistry and Molecular Biology & Molecular Neuroscience & AM-Tumor Biology. Intracellular calcium regulation; Calcium transport; Gene regulation.

Representative articles: Sodium-calcium exchanges and calcium pumps. In: Principles of Medical Biology, Vol. 6 (Bittar, E.E. and Bittar, N., eds.) JAI Press Inc., pp. 125-150, 1996.

Transcript distribution of plasma membrane  $Ca^{2+}$  pump isoforms and splice variants in the human brain. *Molec. Brain Res.* 28:263-272, 1995 (with Zacharias and Dalrymple).

**Szurszewski, Joseph H., Ph.D.**, University of Illinois, Urbana, 1966, FM-Biophysical Sciences, Molecular Neuroscience & Physiology. Ionic currents underlying excitability and synaptic transmission in gastrointestinal smooth muscle; mechanisms of neuromodulation in peripheral autonomic ganglia; three dimensional morphology of smooth muscle cells and autonomic neurons; central mechanisms regulating satiety and obesity.

Representative articles: Calcium currents in human and canine jejunal circular smooth muscle cells. *Gastroenterology* 109:707-717, 1995 (with Farrugia, Rich, Rae and Sarr).

Facilitating effect of CCK on nicotinic neurotransmission in cat pancreatic ganglion. *American Journal of Physiology* 270:G526-G534, 1996 (with Ma).

**Taylor, Stuart R., Ph.D.**, New York University, 1966, FM-Biophysical Sciences, Pharmacology & Physiology.  $Ca^{2+}$  in excitation-contraction coupling; Electronic imaging microscopy; Signal transduction and  $Ca^{2+}$ -binding proteins in muscle.

Representative articles: Volume changes during contraction of isolated frog muscle fibers. In: Third International Symposium on Excitation-Contraction Coupling in Skeletal, Cardiac, and Smooth Muscle, Plenum Publ. Corp., New York *Adv. Exp. Med. Biol.* 311:91-101, 1992 (with Neering, Quesenberry and Morris).

High-speed video imaging and digital analysis of microscopic features in contracting striated muscle cells. *Optical Engineering* 32:306-313, 1993 (with Roos).

**Tindall, Donald J., Ph.D.**, University of North Carolina, Chapel Hill, 1973, FM-Biochemistry & Molecular Biology & Tumor Biology. Regulation of gene expression by androgenic steroid hormones.

Representative articles: Characterization of an early growth response gene, which encodes a zinc finger transcription factor, potentially involved in cell cycle regulation. *Molecular Endocrinology* 9:1610-1620, 1995 (with Blok, Grossmann and Perry).

The androgen receptor is transcriptionally suppressed by proteins that bind single-stranded DNA. *J. Biol. Chem.* 270:10968-10975, 1995 (with Grossmann).

**Toft, David O., Ph.D.**, University of Illinois, Urbana, 1967, FM-Biochemistry & Molecular Biology & Tumor Biology. Cellular and molecular basis of steroid receptor and heat shock proteins.

Representative articles: A novel chaperone complex for steroid receptors involving heat shock proteins, immunophilins, and p23. *J. Biol. Chem.* 269:24989-24993, 1994 (with Johnson).

ATP-dependent chaperoning activity of reticulocyte lysate. *J. Biol. Chem.* 269:9493-9499, 1994 (with Schumacher, Hurst, Sullivan, McMahon and Matts).

**Turner, Russell T., Ph.D.**, Pennsylvania State University, 1975, FM-Biochemistry and Molecular Biology, Physiology and AM-Orthopedics. Regulation of bone and mineral homeostasis, gravitational physiology, growth factors, vitamin D metabolism, mechanisms of action of estrogens and antiestrogens.

Representative articles: Mechanism of action of estrogen on intramembranous bone formation: Regulation of osteoblast differentiation and activity. *Endocrinology* 131:883-889, 1992 (with Backup, Sherman, Hill, Evans, and Spelsberg).

Disuse osteopenia is accompanied by down regulation of gene expression for bone proteins in growing rats. *Am. J. Physiol.* 263:E1029-E1034, 1992 (with Wakley and Portwood).

**Vetter, Richard J., Ph.D.**, Purdue, 1969, FM-Biophysical Sciences. Biological effects and dosimetry of ionizing and nonionizing radiation from medical sources; environmental fate of radionuclides.

Representative articles: Effect of Pulsed Progressive Fluoroscopy on Reduction of Radiation Dose in the Cardiac Catheterization Laboratory. *J. Am. Coll. Cardiol.* 15:159-162, 1990 (with Holmes, Wondrow, Gray, Fellows and Julsrud).

Dosimetry and Biodistribution of an Iodine-123-Labeled Somatostatin Analog in Patients with Neuroendocrine Tumors. *J. Nucl. Med.* 33:1613-1619, 1992 (with O'Connor, Kvolz, Brown, Hung, Hayostek, and Chuo).

**Vockley, Gerard, M.D., Ph.D.**, University of Pennsylvania, Philadelphia, 1984. FM-Biochemistry and Molecular Biology. Molecular nature of the defects responsible for Acyl CoA Dehydrogenase deficiencies in humans and structure-function relationships in the Acyl CoA Dehydrogenase family.

Representative articles: Identification of the active site catalytic residue in human isovaleryl-CoA dehydrogenase. *Biochemistry* 34:10146-10152, 1995 (with Mohsen).

Cloning of a cDNA for Short/Branched Chain Acyl-Coenzyme A Dehydrogenase from Rat and Characterization of its Tissue Expression and Substrate Specificity. *Archives of Biochemistry & Biophysics* 331:127-33, 1996 (with Willard, Vicaneck, Battaile, Vanveldhoven, Fauq, and Rozen).

Functional role of the active site glutamate-368 in rat short chain acyl-CoA dehydrogenase. *Biochemistry* 35:15356-15363, 1996 (with Battaile and Mohsen).

**Vuk-Pavlovic, Stanimir, Ph.D.**, University of Zagreb, Croatia, 1975, FM-Biochemistry and Molecular Biology. Regulation of tumor growth; biological response modifiers; hematopoietic stem cells.

Representative articles: Expression of somatostatin receptor subtypes in breast carcinoma, carcinoid tumor and renal cell carcinoma. *J. Clin. Endocrinol. Metabolism* 80:2974-2979, 1995 (with Vikić-Topić, Raisch and Kvolz).

Mathematical modeling of cellular interaction dynamics in multicellular tumor spheroids. In: *Proc. 1st World Congress on Nonlinear Analysts* (V. Lakshmikantham,

ed.), Vol. 4, pp. 3645-3654, Walter de Gruyter, Berlin, 1996 (with Bajzer and Marusic).

**Weinshilboum, Richard M., M.D.**, University of Kansas, Lawrence, 1967, FM-Pharmacology, Molecular Neuroscience & Tumor Biology & AM-Medicine. Pharmacogenetics, clinical pharmacology, neuropharmacology, and neurochemistry.

Representative articles: Sulfotransferase enzymes. IN: Conjugation-Deconjugation Reactions in Drug Metabolism and Toxicity, chapter 22, edited by F.C. Kauffman, "Handbook of Experimental Pharmacology" series, volume 112, pp. 45-78, Springer-Verlag, Berlin Heidelberg, 1994.

Human liver nicotinamide N-methyltransferase: cDNA cloning, expression and biochemical characterization. *J. Biol. Chem.* 265:14835-14840, 1994.

**Wettstein, Peter J., Ph.D.**, University of North Carolina, 1976, FM-Immunology & Tumor Biology. Investigation of genetic control of allograft rejection and evolution of immunoregulatory gene families.

Representative articles: Differential binding of a minor histocompatibility antigen peptide to H-2 class I molecules correlates with immune responsiveness. *J. of Immunology* 150:2753-2760, 1993 (with van Bleek and Nathenson).

Murine minor histocompatibility antigens detected by helper T cells: Recognition of an endogenous peptide. *J. of Immunology*. In press.

**Weyand, Cornelia M., M.D.**, University of Aachen, West Germany, 1979, **Ph.D.**, University of Heidelberg, West Germany, 1988, FM-Immunology. Molecular mechanisms of autoimmune diseases. Research interests center on T lymphocytes in autoimmune diseases and on the genetic elements conferring susceptibility toward autoimmunity.

Representative articles: Distinct vascular lesions in giant cell arteritis share identical T cell clonotypes. *J. Exp. Med.* 179:951-960, 1994 (with Schonberger, Oppitz, Hunder, Hicok, and Goronzy).

Correlation between disease phenotype and genetic heterogeneity in rheumatoid arthritis. *J. Clin. Invest.* 95:2120-2126, 1995 (with McCarthy and Goronzy).

**Wieben, Eric D., Ph.D.**, Yale University, 1979, FM-Biochemistry & Molecular Biology. Post-transcriptional regulation of gene expression, RNA processing, molecular analysis of autoimmune antigens, androgen control of cell growth.

Representative articles: The snRNP E protein gene contains four introns and has upstream homology to genes for ribosomal proteins. *J. Biol. Chem.* 263:17772-17779, 1989 (with Stanford, Holicky, and Perry).

Processing of two protein precursors yields four mature guinea pig seminal vesicle secretory proteins. *Biol. Reprod.* 38:1155-1164, 1988 (with Norvitch, Harvey and Moore).

**Windebank, Anthony J., B.M.B.Ch.**, Oxford, 1974, FM-Molecular Neuroscience & AM-Neurology. Cell biology of the nervous system. Mechanisms of neurotoxicity at the cellular and molecular level with particular emphasis on drugs used to treat cancer. Growth factors and mechanisms of regeneration in the peripheral nervous system.

Representative articles: Role of nerve growth factor in Suramin neurotoxicity studied in vitro. *Ann. Neurol.* 36:221-228, 1994 (with Russell and Podratz).

The effect of nerve growth factor, ciliary neurotrophic factor, and ACTH analogs on cisplatin neurotoxicity in vitro. *Neurology* 44:488-494, 1994 (with Smith and Russell)

**Younkin, Steven G., M.D.**, University of Pennsylvania, 1972, **Ph.D.**, University of Pennsylvania 1971, FM-Molecular Neuroscience & Pharmacology. Biochemistry and molecular biology of Alzheimer's disease, role of amyloid proteins.

Representative articles: Amyloid  $\beta$  protein (A $\beta$ ) in Alzheimer's disease brain: Biochemical and immunochemical analysis with antibodies specific for forms ending at A $\beta$ 40 or A $\beta$ 42. *J. Biol. Chem.* 270:7013-7016 (with Gravina, Ho, Eckman, Long, Otvos, Younkin and Suzuki).

Age-related CNS disorder and early death in transgenic FVB/N mice overexpressing Alzheimer amyloid precursor proteins. *Neuron.* 15(5):1203-1218, 1995 (with Hsiao, Borchelt, Olson, Johannsdottir, Kitt, Yunis, Xu, Eckman, Price, et al.).

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The following faculty members may teach, exam, and advise degree candidates as indicated:

T/E - Teaching/Examining member. Privileges include participation as director of graduate courses and as members of examining or advisory committees.

AM - Associate member; FM - Full member (in non-Ph.D.granting field). Privileges include all of the above, in addition to serving as thesis adviser for Master's degree candidates or co-adviser for Ph.D. degree candidates in the relevant program track.

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**Aksamit, Allen J., M.D.,** AM-Molecular Neuroscience & Neurology Molecular pathogenesis of viral infections of the central nervous system.

**Amadio, Peter C., M.D.,** AM-Orthopedics. Tendon healing and biomechanics

**An, Kai-Nan, M.D.,** AM-Orthopedics & T/E-Physiology. Biomechanics of normal and abnormal hand; Artificial ligament replacement; Static force and stability analysis of human elbow; Fluid circulation in bone; Bone fracture fixation; Tendon injury and repair

**Andrews, Amy G., D.M.V.,** 1987, T/E-Physiology & Tumor Biology. Animal models and surgery in biomedical sciences

**Bailey, Kent R., Ph.D.,** T/E-Biostatistics. Design, analysis, interpretation of clinical research protocols, Clinical trials, prospective observational studies; Retrospective studies; Laboratory experiments primarily in cardiovascular diseases

**Bajzer, Zeljko, Ph.D.,** AM-Biochemistry and Molecular Biology. Data reduction and mathematical modeling in biomedical sciences

**Baratz, Keith H., M.D.,** T/E-Ophthalmology

**Baron, Andre T., Ph.D.,** T/E - Tumor Biology. Soluble receptors as prognostic markers in breast and ovarian cancer.

**Bartley, George B., M.D.,** T/E-Ophthalmology. Eyelid disorders and surgery, lacrimal disorders and surgery, orbital disorders and surgery, essential blepharospasm, Graves' ophthalmopathy

**Bauch, Christopher D., Ph.D.,** T/E-Otorhinolaryngology. Comprehensive audiologic assessment, including pure-tone and speech audiometry, hearing aids, and electrophysiologic assessment

**Beabout, John W., M.D.,** AM-Radiology

**Beatty, Charles W., M.D.,** T/E-Otorhinolaryngology

**Beckenbaugh, Robert D., M.D.,** AM-Orthopedics. Studies on the function of hand, upper limb, wrist and finger

**Belohlavek, Marek, M.D., Ph.D.,** T/E-Biomedical Imaging. Biomedical data acquisition, analysis and display; ultrasound imaging of cardiovascular morphology and function

**Benarroch, Eduardo E., M.D.,** T/E-Molecular Neuroscience & Neurology. Neurochemistry and neuropharmacology

**Bennet, Kevin E., M.S.,** T/E-Tumor Biology

**Berger, Richard A., M.D.,** AM-Orthopedics. Gross and histomorphology of capsular ligaments with special emphasis on innervation patterns. Kinematics, kinetics, and material property studies related to the upper extremity

- Bishop, Allen T., M.D.,** T/E-Orthopedics
- Bite, Uldis, M.D.,** AM-Biophysical Sciences. Computer simulation of reconstructive surgery; quantitative analysis of three dimensional CT and MRI data
- Bolander, Mark E., M.D.,** AM-Biochemistry and Molecular Biology & AM-Orthopedics
- Bonner, James A., M.D.,** AM-Biophysical Sciences & T/E-Tumor Biology. Oncology, radiation resistance
- Bourne, William M., M.D.,** AM-Ophthalmology. Corneal disease; Corneal physiology; Corneal preservation; Corneal surgery
- Brown, Rhoderick E., Ph.D.,** T/E-Biochemistry and Molecular Biology. Structure and function of glycolipids and sphingolipids in biological and model membranes; Spontaneous and protein-mediated intermembrane lipid transfer with emphasis on glycolipids and gangliosides
- Brubaker, Richard F., M.D.,** FM-Ophthalmology. Physiology of eye pressure control; Pathophysiology of glaucoma; Computer applications in ophthalmology; Quantitative fluorophotometry of the eye
- Buettner, Helmut, M.D.,** AM-Ophthalmology
- Burghardt, Thomas P., Ph.D.,** AM-Biochemistry and Molecular Biology & Molecular Neuroscience. Biophysical investigation of the molecular mechanism of muscle contraction; Physical research into the mechanism of emission from fluorescent probes
- Cabanela, Miguel E., M.D.,** T/E-Orthopedics
- Cahill, Donald R., Ph.D.,** FM-Anatomy. Cross-sectional anatomy; tooth eruption and exfoliation
- Campbell, Donald C., II, M.D.,** T/E-Orthopedics
- Campbell, R. Jean, M.D.,** AM-Ophthalmology & T/E Pathology. Electron microscopy in relation to corneal transplantation; Tumors of the orbit, lid and extraocular muscle
- Carlson, Harley C., M.D., Ph.D.,** AM-Radiology. Motility of gastrointestinal tract; Clinical research in gastroenterologic roentgenology
- Carmichael, Stephen W., Ph.D.,** FM-Anatomy & T/E-Molecular Neuroscience. Basic mechanisms of neurosecretion; Adrenal medullary cytology
- Caselli, Richard J., M.D.,** T/E-Molecular Neuroscience
- Christopherson, Mark W., M.D.,** T/E-Anatomy
- Chute, Christopher G., Ph.D.,** T/E-Health Sciences Research. Classification and information retrieval research related to clinical events. Experimental evaluation on the practical attributes of medical concepts, devoid of trivial modifiers, with respect to clinical epidemiology and outcomes assessment
- Cleary, Margot P., Ph.D.,** T/E-Tumor Biology. Metabolism and breast cancer
- Cofield, Robert H., M.D.,** T/E-Orthopedics. Prosthetic shoulder arthroplasty; Rotator cuff disease; Shoulder instability; fractures and dislocations of shoulder girdle
- Colligan, Robert C., Ph.D.,** AM-Psychology. Adolescent characteristics associated with personality inventories; Personality functioning in young children undergoing intensive care

**Cooney, William P., M.D., AM-Orthopedics.** Orthopedic biomechanic static hand function; Microvascular surgery; Tendon healing

**Cunniën, Alan J., M.D., T/E-Psychiatry.** Civil and criminal forensic psychiatric evaluations

**Currier, Bradford L., M.D., T/E-Orthopedics.** Surgery of the spine

**Daube, Jasper R., M.D., T/E-Molecular Neuroscience & Neurology.** Amyotrophic lateral sclerosis

**DeSanto, Lawrence W., M.D., AM-Otorhinolaryngology.** Conservation surgery of the larynx; Ophthalmopathy of Graves' disease; Cancer of the base of the tongue; Vocal rehabilitation; Surgery of base of skull; Cancer of external ear

**Desjardins, Ronald P., D.M.D., AM-Dentistry.** Prosthodontics

**Earle, John D., M.D., AM-Radiology.** Research in diagnostic and therapeutic radiology

**Eberhardt, Norman L., Ph.D., AM-Biochemistry and Molecular Biology.** Molecular endocrinology

**Eckert, Steven E., D.D.S., T/E-Prosthodontics.** Dentistry/oral and maxillofacial prosthodontics; Fixed and removable prosthodontics

**Erickson, Bradley J., M.D., Ph.D., T/E-Biophysical Sciences.** Application of image processing techniques to solve clinical problems

**Erickson, Lisa D., M.D., T/E-Obstetrics and Gynecology.** Reproductive endocrinology and infertility, assisted reproductive technologies

**Erie, Jay C., M.D., T/E-Ophthalmology**

**Erlichman, Charles M.D., T/E-Tumor Biology.** Oncology, pharmacology of drugs used in cancer therapy

**Fabry, David A., Ph.D., AM-Otorhinolaryngology.** Hearing aid technology and programming strategies

**Facer, George W., M.D., AM-Otorhinolaryngology.** Nasal physiology and reconstructive surgery of the nose; Chronic ear disease and reconstruction of the hearing mechanism; Cochlear and middle ear implants

**Federspiel, Mark J., Ph.D., AM-Biochemistry and Molecular Biology & Tumor Biology.** Molecular medicine, retroviral vectors, antiviral strategies, gene therapy, molecular virology

**Felmlee, Joel P., Ph.D., AM-Biophysical Sciences.** Correction of motion in magnetic resonance imaging

**Felmlee, Teresa, Ph.D., T/E-Biochemistry and Molecular Biology.** Bacterial systems

**Finlayson, Richard E., M.D., AM-Psychiatry.** Addictions; Geriatrics

**Frisk, Craig, D.V.M., T/E-Physiology**

**Garrity, James A., M.D., T/E-Ophthalmology**

**Gill, Jagjit S., Ph.D., T/E-Molecular Neuroscience.** Mechanism of neurotoxic-induced cell death

**Gisvold, John J., M.D., T/E-Radiology.** Early breast cancer detection

**Gloviczki, Peter, M.D., AM-Physiology.** Ischemia and reperfusion injury to the spinal cord. Injury to the blood vessels, small vessel vascular grafts

**Graff-Radford, Neill R., M.D., T/E-Molecular Neuroscience**

**Grambsch, Patricia M., Ph.D., T/E-Biostatistics**

**Grande, Joseph P., M.D., Ph.D.,** AM-Biochemistry and Molecular Biology & T/E-Tumor Biology. Pathology, transcriptional regulation

**Gray, Darryl T., M.D., Sc.D.,** T/E-Health Sciences Research. Application of methods of clinical epidemiology, cost-effectiveness analysis and decision analysis to evaluations of clinical procedures

**Guenther, Terry A., D.D.S.,** T/E-Orthodontics

**Gustafson, Ray O., M.D.,** T/E-Otorhinolaryngology. Tumor immunology

**Hangiandreou, Nicholas J., Ph.D.,** AM-Biomedical Imaging. Physics of Medical Imaging; Systems for Digital Medical Image Management (PACs and Teleradiology)

**Hansen, Mark R., M.D.,** T/E-Psychiatry. Brain imaging in psychiatric disorders

**Hanson, Norman P., M.D.,** T/E-Psychiatry. Psychiatric epidemiology; Family psychiatry; Diabetes complications and control trial

**Hanssen, Arlen D., M.D.,** AM-Orthopedics

**Harner, Stephen G., M.D.,** AM-Otorhinolaryngology. Brain stem audiometry; Acoustic neuroma; Temporal bone histopathology

**Hartmann, Lynn C., M.D.,** T/E-Tumor Biology. Oncology, breast and ovarian cancer

**Hattery, Robert R., M.D.,** AM-Radiology. Ultrasound; Computer tomography; Uroradiology; Magnetic resonance imaging

**Heise, Robert H., M.D.,** T/E-Obstetrics and Gynecology

**Herman, David C., M.D.,** T/E-Ophthalmology

**Hill, Arnold J., Jr., D.D.S.,** T/E-Orthodontics

**Hohberger, George G., M.D.,** T/E-Ophthalmology

**Holbrook, Margaret A., M.D.,** T/E-Radiology

**Ilstrup, Duane, M.S.,** T/E-Biostatistics

**Ingle, James N., M.D.,** T/E-Tumor Biology. Breast Cancer

**Ivnik, Robert J., Ph.D.,** AM-Psychology. Neuropsychology and neuro-psychodiagnostics; Neuropsychological correlates of medical diseases; Alzheimer's disease; Epilepsy; ALS; Effects of Aspartame (Nutrasweet) on cognition

**Jack, Clifford R., II, M.D.,** AM-Biophysical Sciences & T/E-Molecular Neuroscience

**Jalal, Syed M., Ph.D.,** T/E-Biochemistry and Molecular Biology. Genetics, especially human cytogenetics

**James, C. David, Ph.D.,** AM-Tumor Biology. Molecular biology and genetics of central nervous system tumors; receptor tyrosine kinase signal transduction and cell cycle regulation

**Jenkins, Robert B., M.D.,** AM-Biochemistry and Molecular Biology & Tumor Biology. Molecular genetic studies of congenital and neoplastic disorders with cytogenetic abnormalities

**Johnson, Douglas H., M.D.,** AM-Ophthalmology

**Johnson, Kenneth A., M.D.,** T/E-Orthopedics

- Jones, James D., Ph.D.,** AM-Biochemistry, Laboratory Medicine & FM-Nutrition. Amino acid toxicities and interrelationships; Metabolism of creatinine and guanidine compounds; Adaptive mechanisms for conservation of nitrogen in mammals
- Jorgensen, Edward O., M.D.,** T/E-Obstetrics and Gynecology
- Joyner, Michael J., M.D.,** AM-Physiology. Neural control of circulation in humans. Oxygen-carrying blood substitutes. Gas exchange
- Jung, Sin-Ho, Ph.D.,** T/E-Health Sciences Research. Survival analysis, generalized linear models, nonparametric statistics, Time series
- Kappen, Claudia, Dr.rer.nat.,** AM-Biochemistry and Molecular Biology & Molecular Neuroscience. The regulation of gene expression during embryonic development
- Karnitz, Larry M., Ph.D.,** AM-Immunology. Intracellular signaling pathways regulating cellular responses to ionizing radiation and cytokines
- Kasperbauer, Jan L., M.D.,** T/E-Anatomy & AM-Otorhinolaryngology. Mechanisms of cellular differentiation in human squamous cell carcinoma; head and neck gross anatomy
- Katusic, Zvonimir S., M.D., Ph.D.,** AM-Pharmacology. Nitric oxide and the role of the endothelium in regulating vascular tone
- Kavanagh, Brian F., M.D.,** AM-Orthopedics. Hip reconstruction; Principles of uncemented hip arthroplasty and revision hip arthroplasty
- Keller, Eugene E., D.D.S.,** AM-Dentistry. Radiographic analysis of dental, skeletal and facial development in patients with various endocrine and metabolic diseases
- Kern, Eugene B., M.D.,** FM-Otorhinolaryngology. Nasal physiology; Rhinomanometry
- Khraibi, Ali A., Ph.D.,** T/E-Physiology. The role of interstitial hydrostatic pressure in hypertension
- Khosla, Sundeep, M.D.,** T/E-Physiology. Calcium and bone metabolism; Familial endocrine disorders
- Kimmel, David W., M.D.,** T/E-Molecular Neuroscience
- Kita, Hirohito, M.D.,** T/E-Immunology. Immunobiology of eosinophilic leukocytes. Pathophysiologic mechanisms of allergic diseases and eosinophilic disorders.
- Kitaoka, Harold B., M.D.,** T/E-Orthopedics. Anatomy of the foot and ankle
- Kline, Robert W., Ph.D.,** AM-Biomedical Imaging. Radiation oncology physics. Treatment beam characterization and planning. Brachytherapy and stereotactic treatment techniques
- Kumar, Vijay M., Ph.D.,** T/E-Biochemistry and Molecular Biology. Regulation of gene expression in prostate, isolation and characterization of 5'-flanking region, in vitro expression
- Lagerlund, Terrence D., M.D.,** T/E-Molecular Neuroscience
- Larson, Brent E., D.D.S.,** AM-Orthodontics. Biomechanics, computer image processing
- LaRusso, Nicholas F., M.D.,** AM-Medicine & Biochemistry and Molecular Biology. Cell biology, intracellular transport and digestion
- Leavitt, Jacqueline, M.D.,** T/E-Ophthalmology

- Lee, Nancy A., Ph.D., AM-Biochemistry and Molecular Biology.** The expression and function of cell surface proteins during thymopoiesis. The generation of transgenic mice as models for human disease
- Lee, Hakjoo, Ph.D., T/E-Tumor Biology.** Soluble forms of c-erbB-3 in human breast and ovarian cancer
- Lee, Raymond, A., M.D., AM-Obstetrics and Gynecology**
- Lewallen, David G., M.D., AM-Orthopedics.** Biomechanics; Fracture healing
- Liesegang, Thomas J., M.D., AM-Ophthalmology**
- Limper, Andrew H., M.D., AM-Biochemistry and Molecular Biology.** Molecular mechanisms of macrophage recognition of microorganisms
- Lingle, Wilma L., Ph.D., T/E-Tumor Biology.** Tumor biology, hypertrophic centrosomes in breast and prostate tumors
- Litchy, William J., M.D., T/E-Molecular Neuroscience & Neurology.** Electrophysiology of nerve and muscle
- Logan, Kathleen M., M.D., T/E-Psychiatry.** Child and adolescent
- Lu, Jian-yu, Ph.D., T/E-Biophysical Sciences.** Ultrasound, imaging techniques, and biomedical physics
- Lucas, Alexander R., M.D., AM-Psychiatry.** Psychopathology of childhood; psychopharmacologic treatment of children; Anorexia Nervosa; Biologic aspects of child psychiatry
- Lund, Bruce A., D.D.S., AM-Dentistry.** Hypotension anesthesia in orthognathic surgery; Use of durapatite in augmentation for edentulous ridges; Use of heterologous bone in apicoectomies
- Lust, John A., M.D., Ph.D., AM-Tumor Biology.** Oncology and hematology, cytokines and multiple myeloma
- Maguire, Leo J., M.D., T/E-Ophthalmology.** Corneal topography; Refractive surgery; Ocular allergy
- Manduca, Armando, Ph.D., T/E-Biophysical Sciences.** Image processing and the application of artificial intelligence and artificial neural network techniques to imaging problems
- Maragos, Nicholas E., M.D., T/E-Otorhinolaryngology**
- Marion, Mitchell S., M.D., AM-Otorhinolaryngology.** Temporal bone histopathology
- Martin, Maurice J., M.D., FM-Psychiatry.** Longitudinal studies of psychiatrically normal groups; Muscle contraction headaches
- Martin, William J., M.D., T/E-Pharmacology.** Electrophoretic mobility of leukocyte elastase; Alpha antitrypsin and leukocyte elastase interaction; Models of acute lung injury including oxygen toxicity, paraquat toxicity, drug-induced lung injury and neutrophil mediated lung injury
- Maruta, Toshihiko, M.D., AM-Psychiatry**
- McAlpine, Donald E., T/E-Psychiatry**
- McCaffrey, Thomas V., M.D., Ph.D., AM-Otorhinolaryngology.** Cholinergic control of airway resistance
- McCollough, Cynthia H., Ph.D., AM-Biophysical Sciences.** The physics of diagnostic medical imaging, especially X-ray computed tomography, digital radiology, quantitative and cardiac imaging

- McCormick, Daniel J., Ph.D., AM-Biochemistry and Molecular Biology.** Factors that confer biologic specificity in protein-protein interactions
- McDonald, Thomas J., M.D., AM-Otorhinolaryngology.** Wegener's Granulomatosis; Sarcoidosis
- McEvoy, Kathleen M., M.D., Ph.D., T/E-Molecular Neuroscience**
- McGee, Richard, Ph.D., AM-Molecular Neuroscience, Pharmacology & Tumor Biology**
- McLaren, Jay W., Ph.D., AM-Molecular Neuroscience**
- McLeod, Richard A., M.D., T/E-Radiology**
- McManus, Michael J., M.D., T/E-Tumor Biology.** Molecular biology of pediatric tumors; oncogenes; growth factors and growth factor receptors; cellular mechanisms of signal transduction
- McPhee, Thomas J., M.D., T/E-Ophthalmology**
- Mellenberg, David E., Ph.D., T/E-Biophysical Sciences.** Measurement and calculation of radiation dose as it is applied to radiation oncology as well as the application of X-ray imaging, CT, and MRI to the treatment of tumors with radiation
- Melton, L. Joseph, III, M.D., AM-Epidemiology & T/E-Tumor Biology**
- Meyer, Frederic B., M.D., AM-Molecular Neuroscience**
- Miller, Laurence J., M.D., AM-Biochemistry and Molecular Biology**
- Miller, Virginia, Ph.D., T/E-Physiology**
- Miller, W. Eugene, M.D., AM-Radiology.** Chest radiology; Angiography; Detection of early lung cancer; Lymphangiography
- Moore, Gordon L., II, M.D., AM-Psychiatry**
- Morrey, Bernard F., M.D., AM-Orthopedics.** Biomechanics of the elbow joint and shoulder; Effect of defects in bone; Pre and postop biomechanical assessment of elbow surgery
- Morris, James J., M.D., AM-Physiology.** Biomechanical assessment of cardiac performance, pulmonary and arterial flow mechanics, and ventriculo-arterial hydraulic coupling in the intact circulation, as related to cardiovascular disease and cardiac surgery
- Morse, Robert M., M.D., AM-Psychiatry.** Alcoholism; Drug dependence; Delirium and organic brain syndrome
- Muhm, John R., M.D., T/E-Radiology**
- Murtaugh, Paul A., Ph.D., T/E-Health Sciences Research.** Statistical description of dose-response relationships; Repeated-measures screening tests for cancer recurrence; Ecological statistics
- Neel, H. Bryan, III, M.D., Ph.D., AM-Microbiology & FM- Otorhinolaryngology.** General tumor immunology; Cryosurgery for cancer; Nasopharyngeal carcinoma; Hormone receptors in head and neck cancer; Grafts and implants in head and neck surgery
- Nelson, Heidi M.D., T/E-Tumor Biology.** Tumor biology, oncology, cancers of the GI track
- Newman, Deborah C., M.D., AM-Psychiatry.** Affective disorders, psychoneuroendocrinology, psychopharmacology, chemical dependency

- O'Brien, Peter C., Ph.D.,** AM-Biostatistics & T/E-Molecular Neuroscience. Neurology; Ob-Gyn; Endocrinology; Statistical methods
- O'Brien, Timothy, M.D.,** T/E-Physiology. Clinical management of lipid disorders and Diabetes Mellitus, adenoviral-mediated gene transfer to the vasculature
- O'Driscoll, Shawn W., M.D.,** AM-Orthopedics. Cartilage regeneration, physiology, biochemistry, biomechanics and anatomy of the shoulder and elbow
- O'Fallon, Judith R., Ph.D.,** T/E-Biostatistics & Tumor Biology. Cancer clinical trials and data management
- O'Fallon, William M., Ph.D.,** AM-Biostatistics. Statistical methodology in epidemiology
- Offord, Kenneth P., M.S.,** T/E-Biostatistics. Pulmonary physiology; Statistical computing; Linear models; Categorical data analysis; Psychometrics; Smoking cessation
- Ogburn, Paul L., Jr., M.D.,** AM-Obstetrics and Gynecology
- O'Kane, Dennis J., Ph.D.,** AM-Tumor Biology. Telomerase activity as a diagnostic marker for cancer
- Olsen, Kerry D., M.D.,** AM-Otorhinolaryngology
- Olsen, Wayne O., Ph.D.,** FM-Audiology & Otorhinolaryngology. Development of tests for central auditory nervous system dysfunction
- Osborne, David, Ph.D.,** AM-Psychology. Objective personality assessment; Biofeedback; Sexual dysfunction; Psychophysiology problems
- Ottesen, Hal H., Ph.D.,** T/E-Biophysical Sciences. Random processes and noise; Digital signal processing; Systems identification; Magnetic recording and data communication; Artificial intelligence
- Oursler-Velasquez, Merry Jo, Ph.D.,** AM-Biochemistry and Molecular Biology. Actions of steroids and growth factors and cytokines on bone cells-osteoblast and osteoclasts, cancer metastasis to bone, integrins
- Pach, John M., M.D.,** T/E-Ophthalmology
- Palmen, Michael A., M.D.,** T/E-Psychiatry. Low dose Benzodiazepine dependence; Sleep disturbance related to psychoactive chemical use
- Pavlicek, William, Ph.D.,** AM-Biophysical Sciences. Radiologic imaging technologies including ultrasound, magnetic resonance, biomagnetism, computerized tomography, and diagnostic image management
- Pearson, Bruce W., M.D.,** AM-Otorhinolaryngology. Transseptal hypophysectomy; Surgical restoration of voice; Immunodiagnosis in head and neck cancer; Maxilloethmoidal cancer surgery
- Pemberton, John H., M.D.,** T/E-Physiology. Physiology of the colon and anorectum
- Petersen, Ronald C., M.D., Ph.D.,** AM-Neurology & T/E-Molecular Neuroscience. Cognitive function: memory, learning, language; Neuropsychology; Psychopharmacology
- Peterson, Gerald C., M.D.,** T/E-Psychiatry
- Peterson, Hamlet A., M.D.,** T/E-Orthopedics
- Pfeiffer, Douglas R., Ph.D.,** T/E-Biochemistry and Molecular Biology. Cation transport, mechanism, control and role in the control of metabolism and cell function

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- Pittelkow, Mark R., M.D., AM-Dermatology & Tumor Biology**
- Podratz, Karl C., M.D., Ph.D., AM-Obstetrics and Gynecology & Tumor Biology & T/E-Anatomy**
- Pritchard, Douglas J., M.D., FM-Orthopedics.** Immunosurveillance of melanoma; Orthopedic oncology: Circulating tumor cells; Osteosarcoma treatment protocol; Rehabilitation of cancer amputees; Biomechanics of tumor prostheses
- Raffel, Corey, M.D., Ph.D., AM-Molecular Neuroscience & Tumor Biology.** Tumor biology, pediatric oncology, gene therapy, molecular medicine
- Ramin, Kirk D., M.D., T/E-Obstetrics and Gynecology.** Hypertensive disorders in pregnancy and major hormonal effects at the cellular level in pregnancy
- Rand, James A., T/E-Orthopedics.** Disorders of the knee as well as fracture healing
- Reese, David F., M.D., AM-Radiology**
- Reeve, Charles M., D.D.S., AM-Dentistry.** Oral pathology
- Reiter, Jill L., Ph.D., T/E-Tumor Biology.** Alternate transcripts of c-erbB in breast and ovarian cancer
- Richardson, Jarrett W., M.D., T/E-Psychiatry.** Sleep disorders; chemical dependency; affective disorders; neuropsychiatric issues in brain-injured patients
- Robertson, Dennis M., M.D., AM-Ophthalmology.** Long-Term effects of Iodine-125 on the ocular tissues; HLA antigens in alcoholism; Central serous chorioretinopathy
- Robinette, Martin S., Ph.D., T/E-Otorhinolaryngology.** Audiological assessment of the auditory system: psychoacoustics, hearing aid technology
- Rocca, Walter A., M.D., Ph.D., T/E-Health Sciences Research.** Epidemiology of Parkinson's disease; epidemiology of dementia; epidemiology of epilepsy
- Roche, Patrick C., Ph.D., AM-Biochemistry and Molecular Biology.** Development and evaluation of prognostic, immunohistochemical markers for breast, ovarian, and endometrial cancer. Functional, structural, and molecular analysis of gonadotropin receptors in normal and abnormal reproductive states
- Rock, Michael G., M.D., AM-Orthopedics & Physiology**
- Rome, Jeffrey D., M.D., T/E-Psychiatry**
- Rorie, Duane K., M.D., Ph.D., T/E-Anatomy & Anesthesiology.** Effect of anesthetics on autonomic function; Effect of hypoxia on neuroeffector junctions; Neurotransmitter dynamics in hepatic vasculature
- Rusnak, Frank M., Ph.D., AM-Biochemistry and Molecular Biology.** Enzyme biochemistry, expression vectors
- Salassa, Robert R., M.D., AM-Otorhinolaryngology.** Evaluation and treatment of dysphagia
- Sargent, Daniel Jay, Ph.D., T/E-Health Sciences Research.** Clinical trials, survival analysis and Bayesian statistical methods.
- Sarr, Michael G., M.D., AM-Physiology.** Smooth muscle physiology of gastrointestinal tract, in vivo and in vitro measurements—dogs, man, rats
- Sather, A. Howard, D.D.S., AM-Dentistry.** Orthodontics
- Schaid, Daniel J., Ph.D., T/E-Biostatistics.** Statistical methods for clinical trials; Statistical methods in genetics

- Schroeder, Alton R., T/E-Orthopedics**
- Schutt, Ann H., M.D., AM-Physical Medicine and Rehabilitation.** Postoperative management of total knee arthroplasties; Cerebral Palsy; Rehabilitation in paraplegia and quadriplegia; Scleroderma; Rheumatoid arthritis of the hand
- Schwartz, Mark S., Ph.D., AM-Psychology.** Biofeedback and self-regulation; Neuropsychology of memory; Stress and psychopharmacology; Bruxism, nocturnal
- Sheedy, Patrick F., M.D., AM-Radiology.** Angiography of gastrointestinal bleeding; Pancreatic carcinoma and primary liver tumors; Computerized axial tomography pertaining to acute head injury, musculoskeletal disorders, lymphoma tumors and retroperitoneal tumors; Computerized tomography of orbits, liver, pancreas and adrenal glands
- Sheridan, Phillip J., D.D.S., AM-Dentistry.** Periodontics
- Sherris, David A., M.D., AM-Otorhinolaryngology.** Facial cosmetic and reconstructive surgery, wound healing and cell culture techniques
- Shin, Cheolsu, M.D., AM-Molecular Neuroscience.** Kindling model of epilepsy; Hippocampal neuron cell culture; Role of early genes in epileptogenesis; Ischemic and excitotoxic neuronal injury
- Shives, Thomas C., M.D., T/E-Orthopedics**
- Silverstein, Marc D., M.D., T/E-Health Sciences Research.** Clinical epidemiology and health services research in respiratory diseases; Diagnostic test assessment; Technology assessment
- Silverstein, Murray N., M.D., Ph.D., AM-Medicine & T/E-Health Sciences Research.** Hypoglycemia associated with neoplasia; The role of glycolytic inhibitors in leukemia; Myeloproliferative disease
- Sim, Franklin H., M.D., T/E-Orthopedics**
- Sinaki, Mehrsheed, M.D., AM-Physical Medicine and Rehabilitation.** Rehabilitation of osteoporosis patients; Back pain syndromes; Rehabilitation of post-stroke patients; Post-stroke depression
- Sloan, Jeff A., Ph.D., T/E-Health Sciences Research.** Quality of life measurement in cancer patients
- Stanhope, C. Robert, M.D., AM-Obstetrics and Gynecology**
- Stanson, Anthony W., M.D., T/E-Radiology**
- Steckelberg, James M., M.D., AM-Orthopedics.** Bacterial and fungal infections; musculoskeletal infection; infective endocarditis and pneumonia experimental models; epidemiology of infections
- Stephens, David H., M.D., AM-Radiology.** Computerized tomography of abdominal organs; Radiologic investigation of pancreas
- Stuart, Michael J., M.D., T/E-Orthopedics.** Adult reconstruction, sports medicine, knee anatomy, biomechanics, instrumented testing, arthroplasty and ligament reconstruction
- Su, John, Ph.D., T/E-Health Sciences Research.** Design and analysis of clinical trials, early stopping rules and group sequential methods
- Suman, Vera Jean, Ph.D., T/E-Biostatistics.** Estimation of HIV transmission probabilities
- Swanson, David W., M.D., FM-Psychiatry.** Medical dependency; Psychological aspects of pain

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- Terzic, Andre, Ph.D.**, AM-Pharmacology. Molecular basis of normal and abnormal cardiac function
- Therneau, Terry M., Ph.D.**, T/E-Biostatistics
- Thibodeau, Stephen N., Ph.D.**, AM-Biochemistry and Molecular Biology & Tumor Biology. Application of recombinant DNA techniques to medical genetics; Characterization of disease loci by both genetic (Family linkage studies) and physical techniques
- Thorsteinsson, Gudni, M.D.**, AM-Physical Medicine and Rehabilitation. Management of chronic pain; Rehabilitation of spinal cord injury; Multiple sclerosis; Hand dysfunction
- Trautmann, James C., M.D.**, AM-Ophthalmology
- Urrutia, Raul A., M.D.**, AM-Molecular Neuroscience, Biochemistry and Molecular Biology & Tumor Biology. Role of molecular motor enzymes in vesicular transport and morphogenesis
- Van Roekel, Ned B., D.D.S.**, T/E Dentistry. Prosthodontics
- Velimirovic, Bratislav M., M.D., Ph.D.**, T/E-Physiology. Characterization of G protein modulation of inward rectifying potassium channels in the heart and central nervous systems
- Vuk-Pavlovic, Zvezdana, Ph.D.**, T/E-Biochemistry and Molecular Biology. Cellular defense mechanisms in pathogenesis of pulmonary disease
- Waller, Robert R., M.D.**, AM-Ophthalmology. Blindness in blepharoplasty; Meibomian gland carcinoma of the eyelids
- Webb, Maurice J., M.D.**, AM-Obstetrics and Gynecology. Ploidy in ovarian cancer
- Wells, Lloyd A., M.D., Ph.D.**, AM-Psychiatry. Borderline syndromes; Anorexia Nervosa
- Westmoreland, Barbara F., M.D.**, T/E-Molecular Neuroscience & Neurology. Electroencephalography
- White, Richard A., Ph.D.**, T/E-Tumor Biology. Centrosome defects in cultured breast tumor cells
- Wiebers, David O., M.D.**, AM-Neurology & T/E-Molecular Neuroscience. Cerebrovascular disease
- Williamson, Byrn, Jr., M.D.**, T/E-Radiology. Uroradiology; Computed tomography of the body; Ultrasound
- Wilson, Timothy O., M.D.**, AM-Obstetrics and Gynecology. Endometrial carcinoma; Radioactive colloid chromic phosphate in ovarian carcinoma
- Wollan, Peter C., Ph.D.**, T/E-Health Sciences Research. Constrained estimation and testing; Nonparametric regression; Data visualization; Parallel computing; Design of experiments and quality control
- Wood, Michael B., M.D.**, AM-Orthopedics. Microvascular surgery
- Youdas, James W.**, T/E-Anatomy
- Young, Charles Y.F., Ph.D.**, AM-Biochemistry and Molecular Biology & Tumor Biology. Molecular mechanisms of androgen action; Molecular mechanism of programmed cell death in human prostate
- Younge, Brian R., M.D.**, AM-Ophthalmology. Aerospace medicine
- Zinsmeister, Alan**, T/E-Biostatistics. Applied stochastic processes; Time series analysis; Survival analysis; Statistical computing; Statistical methodology for analysis of multivariate data

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# INDEX

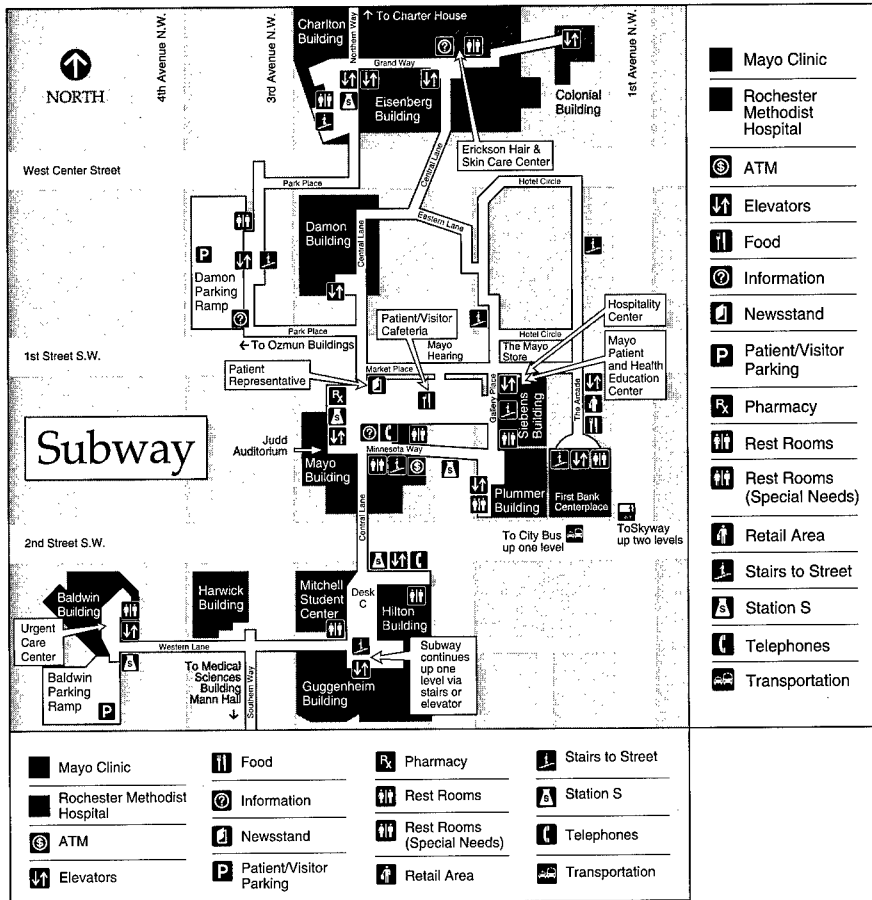


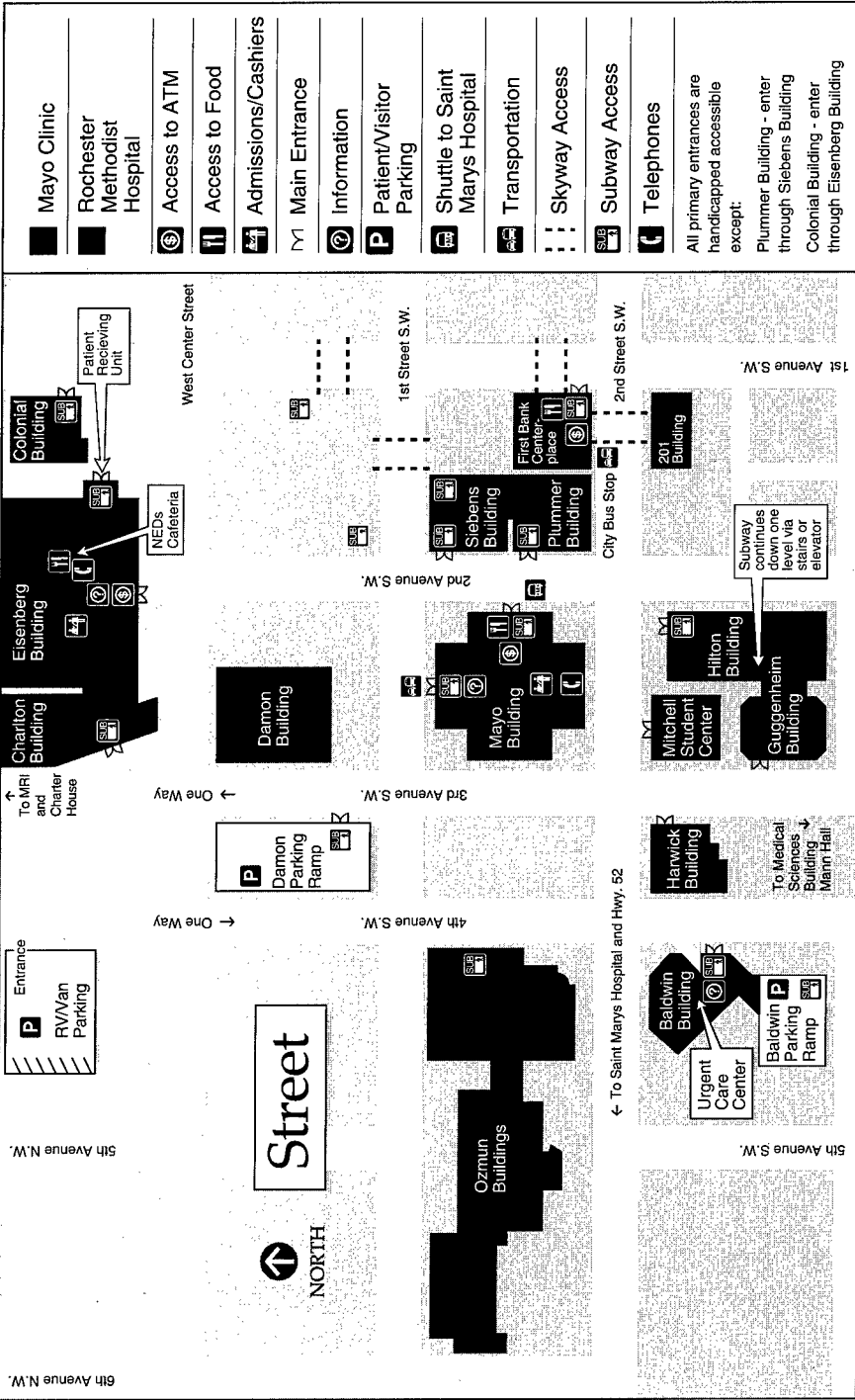
	Page
Academic Calendar .....	2
Admissions Requirements, Employee Master's .....	53
Admissions Requirements, Ph.D. Degree .....	21
Advanced Gynecologic Surgery Master's Track .....	74
Affirmative Action, Equal Opportunity .....	18
Anatomy Courses .....	87
Application, Basic Science Master's Degree .....	43
Application, Clinical Master's Degree .....	68
Biochemistry Basic Science Master's Track .....	45
Biochemistry Courses .....	88
Biochemistry Employee Master's Track .....	57
Biochemistry Ph.D. Track .....	27
Biomedical Imaging Courses .....	91
Biomedical Imaging Employee Master's Track .....	58
Biomedical Imaging Ph.D. Track .....	28
Biophysical Sciences Employee Master's Track .....	58
Biophysical Sciences Ph.D. Track .....	28
Biophysical Sciences Courses .....	91
Biostatistics Courses .....	101
Calendar .....	2
Changes in Approved Program, Basic Science Master's Degree .....	44
Changes in Approved Program, Clinical Master's Degree .....	69
Changes in Approved Program, Ph.D. Degree .....	24
Changes in Registration .....	15
Comprehensive Examination, Employee Master's .....	55
Confidentiality of Student Records .....	18
Computer Courses .....	95
Core Courses, Ph.D. Degree .....	22
Course Listing .....	85
Course Numbering .....	17
Credit Hour, Definition of .....	16
Credit Requirements, Minimum, Employee Master's .....	55
Credit Requirements, Minimum, Clinical Master's Degree .....	69
Defense of Ph.D. Thesis .....	26
Degree Program, Employee Master's .....	53
Degree Program, Ph.D. Degree .....	23
Dentistry Courses and Rotations .....	97
Dentistry Master's Tracks .....	70
Diagnostic Radiology Master's Track .....	82
Doctor of Philosophy Program in Biomedical Sciences .....	21
—Purpose and Philosophy .....	21
—Core Courses .....	22
—Area of Specialization .....	22
—Admissions Requirements .....	21
—M.D.-Ph.D. Program .....	23
—Official Degree Program .....	23
—Changes in Approved Program .....	24
—Minimum Grade Requirements .....	24
—Qualifying Oral and Written Examinations .....	24
—Thesis Advisory Committee .....	25
—Thesis, Preparation of .....	25
—Student Progress .....	25

—Final Oral Examination	.26
—Final Thesis Corrections	.26
—Graduation	.26
—Tracks	.27
Eligibility, Basic Science Master's Degree	.43
Eligibility, Clinical Master's Degree	.68
Epidemiology Courses	.103
Equal Opportunity / Affirmative Action	.18
Emergency Loans	.12
Extensions	.17
Facilities	.10
Faculty	.137
Final Examination, Basic Science Master's Track	.45
Final Oral Examination, Clinical Master's Degree	.68
Final Oral Examination, Ph.D. Degree	.26
Grade Requirements, Minimum, Employee Master's	.55
Grade Requirements, Minimum, Clinical Master's Degree	.68
Grade Requirements, Minimum, Ph.D. Degree	.24
Grading System	.16
Graduate Student Association	.12
Graduation, Ph.D.	.26
Graduation, Employee Master's	.56
Gynecologic Oncology Master's Track	.74
Gynecologic Surgery Master's Track, Advanced	.75
Health Sciences Research Courses	.101
History	.9
Housing	.12
Immunology Courses	.104
Immunology Employee Master's Track	.60
Immunology Basic Science Master's Track	.46
Immunology Ph.D. Track	.31
Inquiries	.22
Internal Medicine Courses	.107
Late Registrations	.15
Loans, Emergency	.12
Master of Science Program in Biomedical Sciences for Mayo Employees	.53
—Admissions Requirements	.54
—Tuition	.54
—Registration Requirement	.54
—Time Requirement	.55
—Minimum Credit Requirements	.55
—Official Degree Program	.55
—Minimum Grade Requirement	.55
—Project	.55
—Comprehensive Examination	.55
—Graduation	.56
Master of Science Program in Biomedical Sciences (Basic Science)	.43
—Eligibility	.43
—Application	.43
—Time Requirement	.43
—Thesis Protocol	.43
—Official Program	.44

—Changes in Approved Program	.44
—Minimum Grade Requirements	.44
—Minimum Credit Requirements	.44
—Transfer Credits	.44
—Thesis	.44
—Written Examination	.44
—Final Examination	.45
Master of Science Program in Biomedical Sciences (Clinical)	.67
—Eligibility	.68
—Application	.68
—Time Requirement	.68
—Thesis Protocol	.68
—Official Program	.68
—Changes in Approved Program	.69
—Minimum Grade Requirements	.69
—Minimum Credit Requirements	.69
—Thesis	.69
—Written Examination	.69
—Final Examination	.69
Mayo Graduate School Courses	.106
M.D.-Ph.D. Laboratory Rotation	.106
M.D.-Ph.D. Program	.23
Medicine Courses	.107
Molecular Biology Basic Science Master's Track	.47
Molecular Biology Courses	.107
Molecular Biology Employee Master's Track	.60
Molecular Biology Ph.D. Track	.32
Molecular Neuroscience Courses	.110
Molecular Neuroscience Ph.D. Track	.33
Obstetrics & Gynecology Courses and Rotations	.112
Obstetrics & Gynecology Master's Track	.73
Off-Campus Coursework	.21
Office of Minority Affairs	.11
Official Degree Program, Employee Master's	.55
Official Program, Basic Science Master's Degree	.43
Official Degree Program, Clinical Master's Degree	.68
Official Degree Program, Ph.D. Degree	.23
Ophthalmology Courses and Rotations	.115
Ophthalmology Master's Track	.76
Oral Examination, Final, Ph.D. Degree	.26
Oral Qualifying Examination, Ph.D. Degree	.24
Orthodontics Courses and Rotations	.97
Orthodontics Master's Track	.70
Orthopedics Courses and Rotations	.116
Orthopedics Master's Track	.77
Otorhinolaryngology Course and Rotations	.117
Otorhinolaryngology Master's Track	.78
Pathology Courses	.119
Periodontics Course and Rotations	.98
Periodontics Master's Track	.71
Pharmacology Courses	.119
Pharmacology Employee Master's Track	.62

Pharmacology Basic Science Master's Track	.49
Pharmacology Ph.D. Track	.35
Physical Medicine & Rehabilitation Courses and Rotations	.122
Physical Medicine & Rehabilitation Master's Track	.79
Physiology Courses	.123
Physiology Employee Master's Track	.63
Physiology Basic Science Master's Track	.50
Physiology Ph.D. Track	.36
Policies	.13
Project, Employee Master's	.55
Prosthodontics Courses and Rotations	.99
Prosthodontics Master's Track	.71
Psychiatry Courses and Rotations	.126
Psychiatry Master's Track	.80
Qualifying Oral and Written Examinations, Ph.D. Degree	.24
Radiology Courses and Rotations	.129
Radiology Master's Track	.82
Registration for Coursework	.15
—Credit	.15
—Changes in	.15
Registration Requirement, Employee Master's	.54
Reproductive Endocrinology Master's Track	.75
Research Opportunities	.9
Residency Programs	.9
Residency Requirement	.17
Retroactive Registration	.15
Stipends	.15
Student Association	.12
Student Records, Confidentiality of	.18
Student Responsibility	.17
Symbols and Explanations	.87
Test of English as a Foreign Language	.22
Thesis Corrections, Ph.D.	.26
Thesis Defense, Ph.D.	.26
Thesis, Clinical Master's Degree	.68
Thesis, Preparation of, Ph.D. Degree	.25
Thesis Protocol, Basic Science Master's Degree	.43
Thesis Protocol, Clinical Master's Degree	.68
Time Requirement, Basic Science Master's Degree	.43
Time Requirement, Employee Master's	.55
Time Requirement, Clinical Master's Degree	.68
Transcript Request	.16
Transfer Credits, Ph.D.	.17
Tuition	.15
Tuition for Employee Master's	.54
Tumor Biology Courses and Rotations	.133
Tumor Biology Ph.D. Track	.38
UNITE Courses	.95
Withdrawal from a Course	.15
Writing Course	.106
Written Examination, Basic Science Master's Track	.44
Written Examination, Clinical Master's Degree	.69
Written Qualifying Examination, Ph.D. Degree	.24





- Mayo Clinic
  - Rochester Methodist Hospital
  - Access to ATM
  - Access to Food
  - Admissions/Cashiers
  - Main Entrance
  - Information
  - Patient/Visitor Parking
  - Shuttle to Saint Marys Hospital
  - Transportation
  - Skyway Access
  - Subway Access
  - Telephones
- All primary entrances are handicapped accessible except:
- Plummer Building - enter through Siebens Building
  - Colonial Building - enter through Eisenberg Building