

# College of Medicine & Life Sciences

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## *Graduate Programs*

The College of Medicine & Life Sciences at the University of Toledo offers several graduate-level degree and certificate programs. PhD and MS degrees in biomedical sciences and academic certificates are offered in several basic science and clinical tracks.

## **Admission to Graduate Programs**

Admission requirements for College of Graduate Studies are discussed in the general College of Graduate Studies section of the University of Toledo Catalog; other admission procedures are described under the individual graduate programs. Admission to graduate study in the College of Medicine & Life Sciences is open to graduates of accredited colleges and universities meeting the minimum admission requirements of the College of Graduate Studies as well as specific admission requirements of the department and/or program. Previously admitted students wishing to transfer to a different program must apply for admission to the new program. Admission to one graduate program does not guarantee admission to another graduate program. Please refer to the degree or program descriptions for specific information.

## **Administration of Programs**

All graduate programs in the College of Medicine & Life Sciences are administered jointly by the College of Medicine & Life Sciences and the College of Graduate Studies of the University of Toledo. Students may contact specific departments or programs, the college's graduate advisor, or the College of Graduate Studies for further information on programs or admission requirements. Student should be aware that course names/credit hours may be revised over the course of the program per the department or program requirements. Please consult with your department or program regarding course/credit hour changes.

## **Advising**

Students must meet with their faculty advisor for the purpose of developing a Plan of Study. It is the student's responsibility to meet all requirements for the degree as specified by the graduate program, the department, the College of Graduate Studies and the University of Toledo. Students are encouraged to complete the Plan of Study no later than the first academic year and submit the completed, signed form to the College of Graduate Studies Office located in Mulford Library first floor student services center on the Health Science Campus.

## **Academic Standards**

In addition to the general academic standards outlined in the general section of the College of Graduate Studies Catalog, for the following programs, a maximum number of credits of C will be allowed on a candidate's Plan of Study as listed below:

- 10 credits PhD degree (biomedical sciences - all tracks)
- 8 credits MSBS research tracks (including CAB, MOME, MMIM, NND, and BIPG); and MSN degree
- 11 credits Physician Assistant Program (PA)
- 12 credits MSBS clinical track programs including MSMedical Sciences (unless stated otherwise)
- 3 credits Certificate programs

In addition, students in all graduate programs at UT must earn a cumulative GPA of 3.0 to graduate.

## Graduate Degrees Offered

### Doctor of Philosophy in Biomedical Science

Cancer Biology	(Department of Biochemistry & Cancer Biology)
Molecular Medicine*	(Department of Physiology & Pharmacology)
	(*previously Cardiovascular and Metabolic Disease)
Medical Microbiology and Immunology**	(Department of Medical Microbiology & Immunology)
	(**previously Infection, Immunity, and Transplantation)
Neurosciences and Neurological Disorders	(Department of Neurosciences)

### Doctor of Philosophy in Biomedical Engineering (see College of Engineering catalog)

### Master of Science in Biomedical Sciences

Assistant in Pathology  
Bioinformatics and Proteomics/Genomics  
Biomarkers and Diagnostics (Professional Science Master)  
Molecular Medicine  
Medical Microbiology and Immunology  
Human Donation Sciences (Professional Masters)  
Medical Physics  
Medical Sciences  
Oral Biology  
Orthopedic Sciences  
Physician Assistant Studies

## Dual Degrees

Doctor of Medicine and Doctor of Philosophy in Biomedical Sciences\*

Please go to this link for more information

<http://www.utoledo.edu/med/mdphd/pdf/2016%20UT%20MDPhD%20Handbook.pdf>

Doctor of Medicine and Master of Science in Biomedical Sciences\*

Doctor of Medicine and Master of Public Health\*

\*Students must be accepted into the MD program first to be eligible for the dual degree (contact the College of Health Sciences for additional information about Master of Public Health requirements)

\*\*Additional Dual Degrees available in MD/JD (contact Medical School Admissions) and MD/MBA (Refer to the College of Business and Innovation catalog for additional information).

## Graduate Certificates

Certificate in Biomarkers and Bioinformatics

Certificate in Pathology for Post Second Year Medical Students

## Biomedical Sciences: PhD and Masters Programs

### Accreditation

Graduate programs are accredited either by discipline-specific accrediting agencies or by the Higher Learning Commission of the North Central Association.

### General Admission Standards

To be admitted to the Ph.D. or Master of Science in Biomedical Sciences (MSBS) Program with Regular status, applicants must hold an earned baccalaureate (or equivalent) from an accredited college or university, and have a minimum overall GPA of 3.0 on a 4.0 scale. Typically, applicants will have an undergraduate major in Biology or a related discipline. In addition, Graduate Record Examination (GRE) scores are required in most programs of study (see individual degree programs for specific requirements). Minimum scores of the 50<sup>th</sup> percentile or above for both Verbal and Quantitative scores and 4.0 (Analytical Writing Test) are recommended to be competitive for most degree programs. For international applicants, the Test of English as a Foreign Language (TOEFL) is required and a minimum iBT score of 80, or pBT score of 550 is required. A prior Masters degree is not required to enter the PhD program. At this time, all students accepted without provisions into the PhD in Biomedical Sciences program, and maintaining good academic standing, will receive a full tuition scholarship and a research stipend funded in whole or in part by the College of Graduate Studies and funding from a student's advisor through a grant(s). There are a limited number of tuition scholarships and stipends available for students in the Masters in Biomedical Sciences programs.

## Master of Science Biomedical Sciences: Assistant in Pathology

*Amira Gohara, M.D., Program Director*

### Admission Requirements

1. 3.0 GPA (Exceptions can be made if the applicant has a terminal Ph.D., M.D., or M.B.B.C.H degree)
2. No GRE requirement
3. \$45 application fee
4. 3 letters of recommendation
5. Passing TOEFL (only international students)
6. Prerequisites Courses:

The applicant should be successfully completed the following courses: general chemistry, organic chemistry or biochemistry, biology, microbiology, mathematics and English composition.

### Core Courses

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
ANAT5000	Anatomy for Physician Assistant	5
PHYS5050	Human Physiology	3
PATH6060	Intro Surgical Pathology and Cytology	2
PATH6080	Intro Post Mortem Pathology (Hospital + Forensics)	2

### Fall

### Spring

PATH6890*	Independent Study in Pathology (LIS, medical terminology, lab management)	4
PATH6080	Intro Post Mortem Pathology (Hospital + Forensics)	2
PATH7130	Pathology Case Studies	6

### Summer

PATH7130	Pathology Case Studies	6
PATH6060	Intro Surgical Pathology and Cytology	2
PATH6080	Intro Post Mortem Pathology (Hospital + Forensics)	2

### Fall

ANAT6790	Human Structure and Development	4
INDI6980	Scholarly Project	6
PATH6070	Intro Clinical Lab Medicine	2

\*This course is an independent study in microanatomy to reemphasize what the students learned in the fall semester to allow them to recognize on their own the microscopic feature of various tissues.

### Student Learning Objectives

At the end of the program, the students will be able to:

#### Autopsy Service

- perform a complete autopsy including evisceration, dissection and examination of the various organs including brain
- describe grossly all organs from a given autopsy

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#### Surgical Pathology

- perform gross examinations on surgical specimens
- cut and stain frozen sections

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#### Clinical Pathology

- interpret peripheral blood smears
- provide clinicopathologic correlations for chemistry, microbiology, immunology tests
- perform phlebotomies on in- and out-patients

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#### Electives and Scholarly Activities

- analyze scientific articles
- prepare and present scientific papers at annual scientific day

## **Bioinformatics and Proteomics/Genomics**

*Robert Blumenthal, Ph.D., director*

The Bioinformatics and Proteomics/Genomics (BPG) Programs are designed to provide training in the rapidly -developing interface between computer science and life sciences. Graduates with such training are in high demand, (in part due to the explosion in genome sequence analysis), whether the BPG studies are for an independent degree or for one of the several dual-degree programs. In addition, students in other programs may take BPG courses as electives.

### **Masters, Certificate and Dual Degree Programs**

The program in Bioinformatics and Proteomics/Genomics, along with the Ohio Center of Excellence for Biomarker Research and Individualized Medicine at the University of Toledo, offers a Certificate that can be earned either alone or in association with the

degrees of Doctor of Philosophy (PhD) or Doctor of Medicine (MD). The Certificate program is designed to fit smoothly into the doctoral programs with minimal extra time required. BPG also offers a Master of Science in Biomedical Sciences (MSBS) degree. MSBS students follow a well-defined curriculum that includes core courses, journal club, seminars, independent research, and electives in their area of interest. Both Certificate and MSBS students are trained in the theory, methods and applications of bioinformatics, proteomics, genomics, and biomarker research.

Bioinformatics programs generally place more emphasis on either the computer science or the biomedical aspects of the field. The University of Toledo's program falls into the latter category. However, there are courses in PERL, Java, and SQL programming (for example), and the Program provides biomedical researchers with a solid introduction to the computational aspects, or computer science experts with a rigorous introduction to the biomedical aspects of bioinformatics.

### Master of Science in Biomedical Sciences: Bioinformatics and Proteomics/Genomics

To be admitted to the Masters in Biomedical Sciences Program with Regular status, applicants must hold an earned baccalaureate (or equivalent) from an accredited college or university. Students with a GPA below 3.0, but at or above 2.5, may apply for provisional acceptance that would change to regular (non-probationary) status if their first term graduate coursework has a GPA of 3.0 or above. Typically, applicants will have an undergraduate major in Biology or a related discipline such as Biochemistry or Biophysics. Students with other majors are encouraged to apply; however, their coursework should include several semesters in biology. The GRE is not required for US students with GPA above 3.0, UT or Findlay students entering the bachelors-masters pipeline program, or students with a recent MCAT score of 25 or higher. The GRE is required for all other applicants. For international applicants, the Test of English as a Foreign Language (TOEFL) is also required. Scores must be 550 or higher for paper-administered version, 213 or higher for computer-administered version, and 80 or higher for internet-administered version. For all applicants, laboratory research or computer programming experience is favored, but not required.

\*(CPRA = Current Problems & Research Approaches)

(BIPG = Bioinformatics & Proteomics/Genomics)

#### Fall Year 1

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>	<i># Weeks</i>
BMSP6340	*CPRA Genes & Genomes	2.5	8
BIPG5200	Statistical Methods in BPG	3	16
BIPG5100	Fundamentals in BPG	3	16
BMSP6400	Introduction to Methods in Biomedical Sciences	1	8 (special section for BIPG students)
INDI6020	“On Being A Scientist”	1	12
BMSP6390	**Mentored Research (2x4 wk lab rotations)	2	8
Total		12.5	

\*\*Students must register for a specific 8wk/2cr section of BMSP6390 Mentored Research. As a prerequisite, students must attend an introductory series of short research presentations. These presentations are associated with another course for which BIPG students do not register, but are expected to attend for the first 8 weeks.

\*\*\* In this and other terms, with permission of advisory committee, student may take Scholarly Project in BPG (BIPG5900) in place of Thesis in Bioinformatics

#### Spring Year 1

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>	<i># Weeks</i>
BIPG6100	Bioinformatic Computation	3	16
BIPG6400	Applications of BPG	3	16
OR			
BRIM6200	Biomarker Discovery, Validation and Implementation	3	16
BMSP6350	Cell Biology & Signaling	3	16
Elective 1	(see approved list)	3	16

BIPG6990	***Thesis in Bioinformatics	1	16
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Total		13	
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Summer Year 1

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>	<i># Weeks</i>
BIPG5400	Biodatabases	1.	4
BIPG5500	Microarray Analysis	1.	4
BIPG6900	Thesis in Bioinformatics	7.	16

Total		9	
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\* Journal paper review and presentation

**Fall Year 2**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>	<i># Weeks</i>
Elective 2	(see approved list).....	3	16
BIPG5300	*Current Topics in BPG .....	1	16
BIPG6900	Thesis in Bioinformatics .....	5	16

Total	.....	9	
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The minimum number of credits required for MSBS is 46.5, with a minimum of 20.5 credits of didactic coursework (letter grade), and a minimum of 10 credits of thesis research. The rest of the credits are approved electives and research in the Cancer Biology track.

## Master of Science in Biomedical Sciences: Professional Science Master in Biomarkers and Diagnostics

The Professional Science Master in Biomarkers and Diagnostics (MSBS-PBD) is designed to be a terminal degree with the graduate having strong prospects for immediate employment in industry. The MSBS-PBD degree is a “job ready” degree. This is achieved by a three-pronged approach:

- To prepare master’s students with a strong foundation in the fundamentals of biomarker discovery and development through focused course work.
- To complement their science education through course work in management, orienting them to realities of the business aspects of the pharmaceutical/ diagnostics industry.
- To place them as interns in a pharmaceutical- or diagnostic-oriented company for four months to enhance their practical training and employability.

The MSBS-PSMBD program is targeted to students completing a bachelors in computer science, chemistry or a biological or pharmaceutical science.

\*(CPRA = Current Problems & Research Approaches)

Fall

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG5200	Statistical Methods in BPG.....	3
BMSP6340	CPRA in Genes and Genomes .....	2.5
BIPG5100	Fundamentals of Bioinformatics .....	3
INDI6020	“On Being a Scientist” .....	1

Either:

MGMT6150	Leading and Developing Yourself .....	3
Or		
MGMT6160	Leading with Power and Influence.....	3
Either:		
HURM6720	Adv Negotiations/Conflict Resol.....	3
Or		
HURM6700	Human Resources Management.....	3

**Spring**

Course	Course Name.....	Credit Hours
BIPG6100	Bioinformatic Computations .....	3
BMSP6350	Cell biology & signaling.....	3
BRIM6200	Biomarker Discovery, Validation, and Implementation.....	3
HURM6730	Performance Management.....	3

**Summer**

Course	Course Name.....	Credit Hours
BIDI5100	Biomarkers and Diagnostics Internship .....	6-8
BIDI5200	Readings in Biomarkers/Diagnostics (Online) .....	1
BIPG6890	Independent Study in BPG .....	2

The minimum number of credit hours for completion of the MSBS, PSM in Biomarkers and Diagnostics degree is 36.5 credits.

## CERTIFICATE IN BIOINFORMATICS AND BIOMARKERS

The Biomarkers and Bioinformatics (BRIM) Certificate Program introduces students to the rapidly growing fields of bioinformatics, proteomics and genomics, and provides a core knowledge of analytical approaches used in these fields. It is particularly valuable for PhD students whose research would be strengthened by expertise in bioinformatics.

Students enrolled in the BRIM Certificate Program take four courses covering the following subject areas:

1. Introduction to the scope of bioinformatics, proteomics and genomics: “Fundamentals of BPG”
2. Training in statistical methods used in biomarker research and bioinformatics: “Statistical Methods in Bioinformatics”
3. Handling and manipulation of databases and introduction to computer programming skills needed to analyze large quantities of nucleic acid and protein sequence data: “Introduction to Bioinformatic Computation”
4. EITHER “Applications of BPG”, in which faculty members using these methods will discuss and demonstrate how these techniques are utilized to solve research problems, OR “Biomarker Discovery, Validation and Implementation”, in which faculty will provide an overview of biomedical discovery and validation techniques followed by application in selected aspects of individualized medicine.

Upon completion of the Program, students will be prepared to utilize biomarker research and bioinformatics techniques, and be able to interact with specialists in a range of biomedical sub-disciplines.

### Curriculum

The curriculum consists of four, 3-credit courses, for a total of 12 credits (listed below) that can be taken over 1-4 years: (BPG – Bioinformatics and Proteomics/Genomics). The following shows the one-year completion schedule.

(BPG – Bioinformatics and Proteomics/Genomics)

#### Fall Year 1

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG5100/7100	Fundamentals of BPG	3
BIPG5200/7200	Statistical Methods in BPG	3

#### Spring Year 1

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG6100/8100	Bioinformatic Computation	3
BIPG6400/8400	Applications of Bioinformatics	3
OR		
BRIM6200/8200	Biomarker Discovery, Validation and Implementation	3

\*BMSP6340 Current Problems & Research Approaches in Genes and Genomes, or equivalent course approved by the BRIM/BPG Program, is required for admission into the Bioinformatics & Biomarkers Certificate Program.

NOTE: The University of Toledo PhD or MSBS students may also take individual BPG or BRIM courses as electives, with permission of the instructor. To receive a Certificate in Biomarkers and Bioinformatics, however, an online application to the program must be submitted and accepted. All applications will be reviewed by the BRIM/BPG Program Admissions Committee. The online application must be filed **ONLY** for those seeking a certificate and is not required for those taking these courses as electives.

#### Applying to the BRIM/BPG Certificate Program:

UT students who are currently in a PhD program:

1. Complete the Request to Add a Graduate Certificate form at the following link, and return to the Graduate School for processing: [https://www.utoledo.edu/graduate/files/Request\\_to\\_add\\_a\\_grad\\_certific.pdf](https://www.utoledo.edu/graduate/files/Request_to_add_a_grad_certific.pdf)
2. Submit a letter of support from major advisor.

Applicants who are NOT UT graduate students:

1. Complete online application. <https://apply.utoledo.edu>
2. Submit Official transcripts
3. Earned bachelors or graduate degree and GRE score
4. Statement of Purpose
5. Two letters of recommendation are required, three letters are optional. In the event that a student decides to pursue the BIPG MSBS degree, it will save time to have the letters of recommendation already on file.

#### **MD/MSBS Bioinformatics Degree**

This is designed for students already in our MD program, who want preparation for clinical research in gene therapy, biomarker discovery, or other aspects of cutting-edge medicine. It involves one year of coursework and research between the 2nd and 3rd years of the standard medical curriculum.

#### **BS/MSBS "Pipeline" Program**

This is an integrated program that can be completed in as little as 5.5 years, yielding both a University of Toledo bachelors of sciences in Biological Sciences and an MSBS in Bioinformatics. This reduced time is made possible in part by 9 University of Toledo credit hours being allowed to count towards both degrees. Students (University of Toledo biology majors) typically apply at the end of their sophomore year. For more information, go to the Pipeline Program website:

<http://www.utoledo.edu/med/depts/bioinfo/pages/pipeline%20ut.html>



# Doctor of Philosophy in Biomedical Sciences: Cancer Biology Track

## Department of Biochemistry & Cancer Biology

*William A. Maltese, Ph.D., chair*

*Kandace Williams, Ph.D., track director*

The Cancer Biology track within the PhD and MSBS\* in Biomedical Sciences program at the University of Toledo fosters young scientists to become cutting-edge researchers who understand the molecular genetic basis of cancer and to develop better therapies for the many forms of cancer. Students in the Cancer Biology track develop scientific thinking and laboratory skills to approach cancer research questions in ways that will best lead to success. Graduates of the Cancer Biology program move on to become successful scientists and leaders in academic, government, and industrial settings.

Cancer Biology PhD and MSBS\* students enroll in a first-year core curriculum that is designed to provide a foundation of knowledge for cutting-edge research. The first-year curriculum provides students with a comprehensive overview of molecular and cellular biology, systems pathophysiology, modern research methodology, and statistical analysis. In addition, students complete laboratory rotations during the first two semesters to identify a Cancer Biology major advisor and laboratory for their thesis or dissertation research project. PhD students complete three rotations and then may join a Cancer Biology laboratory after the spring semester of their first year. MSBS\* students complete one rotation and may join a lab the beginning of spring semester of the first year. In year two and beyond, students take advanced courses, journal clubs, and seminars in Cancer Biology, but primarily focus on their thesis or dissertation research. Doctoral students in good academic standing may be supported financially by a tuition scholarship and stipend during their academic training. This financial assistance does not require the student to be a Teaching Assistant for undergraduates, thus enabling the student to more fully concentrate on his/her graduate program. However, teaching experiences can be arranged if a student desires this training as well. Cancer Biology PhD students generally complete the degree in approximately five years, whereas MSBS students average about 2.5 years.

\* MSBS in Cancer Biology is not currently offered.

Most faculty members in the Cancer Biology track are the Department of Biochemistry and Cancer Biology in the College of Medicine & Life Sciences at the University of Toledo. Other faculty have primary faculty appointments in other departments within the College of Medicine & Life Sciences or other colleges of the University. The laboratory facilities and shared equipment utilized by Cancer Biology faculty are state of the art.

### PhD Program Students: Year 1

#### Fall Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Introduction to Biomedical Research	0
	Current Problems and Research Approaches (CPRA) in;	
BMSP6330/8330	CPRA in Proteins	2.5
BMSP6340/8340	CPRA in Genes and Genomes	2.5
BMSP6360/8360	CPRA in Cell Membranes	3
BMSP6380/8380	Methods in Biomedical Sciences	3
INDI6020/8020	"On Being a Scientist"	1
BMSP6390/8390	Mentored Research (one 8 week lab rotation)	2
Total		14

#### Spring Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6310/8310	Systems Pathophysiology I	2.5
BMSP6320/8320	Systems Pathophysiology II	2.5
BMSP6350/8350	CPRA in Cell Biology and Signaling	3
BMSP6390/8390	Mentored Research (two 8 week lab rotations)	4
CABP6560/8560	Readings in Cancer Biology	1

Total		13
Summer Term (* = required)		
<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320/7320	Statistical Methods I *	3
BIPG5110/7110	Practical Bioinformatics*	1
CABP6730/8730	Research in CABP *	0-5
CABP6890/8890	Independent Study in Cancer Biology Or other Electives (optional)	0-5
BM.SP6390/8390	Mentored Research (if additional 8 week rotation necessary)	0-2
Total		9

PhD Program Students: Year 2

Fall Term (* = required)		
<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP6270/8270	Advanced Cancer Biology * (or take this course in third year)	0-3
CABP6730/8730	Research in CABP* and/or	1-9
CABP6890/8890	Independent Study in Cancer Biology Or other Electives (optional)	0-9
Total		9

Spring Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP8560	Readings in Cancer Biology *	1
CABP6730/8730	Research in CABP*	1-8
CABP8890	Independent Study in Cancer Biology Or other Electives (optional)	0-8
Total		9

Summer Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP6730/8730	Research in CABP*	1-9
CABP8890	Independent Study in Cancer Biology Or other Electives (optional)	0-9
Total		9

Second Year PhD Qualifying Examination (successful completion required in spring or summer semester of second year)

PhD Program Students: Year 3

Fall Term (* = required)		
<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP9990	Dissertation Research*	6-9
CABP8270	Advanced Cancer Biology * (if not taken in second year)	0-3
Total		9

Spring Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP9990	Dissertation Research*	8
CABP8560	Readings in Cancer Biology *	1
Total		9

Summer Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP9990	Dissertation Research*	9

Third Year Student Seminar (required in fall or spring semester)

PhD Program Students: Year 4 and beyond

Fall, Spring and Summer Terms                      All Dissertation Research (CABP9990)

The PhD Qualifying Exam is taken in the spring semester or summer term of the second year. Prior to completing the exam, students should carry out their dissertation research under the course Research in CABP (6730/8730) or in some cases, Independent Study in CABP (6890/8890). After passing the Qualifying Exam, students conduct their research under the course Dissertation Research (CABP9990). The minimum number of credits required for PhD is 90, with a minimum of 25 credits of didactic coursework (letter grade), and a minimum of 30 credits of dissertation research. The rest of the credits are approved electives and research in the Cancer Biology track.

All PhD students are also required to present a seminar on their research in the third year. They are also required to present posters in the annual UTHSC Graduate Student Research Forums and oral presentations in the annual Larry Gentry Research Symposia beginning in their second year.

## **Master of Science in Biomedical Sciences\*: Cancer Biology Track**

**\* MSBS in Cancer Biology is not currently offered**

Masters Program Students: Year 1

Fall Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Introduction to Biomedical Research	0
Current Problems and Research Approaches (CPRA) in...		
BMSP6330	CPRA in Protein Structure and Catalysis	2.5
BMSP6340	CPRA in Genes and Genomes	2.5
BMSP6360	CPRA in Cell Membranes	3
BMSP6380	Methods in Biomedical Sciences	3
INDI6020	"On Being a Scientist"	1
BMSP6390	Mentored Research (one 8 week lab rotation)	2
Total		14

Spring Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6350	CPRA in Cell Biology and Signaling *	3
CABP6560	Readings in Cancer Biology *	1

BMSP6390	Mentored Research (2 additional rotations possible)	0-4
BMSP6310	Systems Pathophysiology I (optional) and/or	2.5
BMSP6320	Systems Pathophysiology II (optional) and/or	2.5
CABP6730	Research in CABP	0-9
CABP6890	Independent Study in Cancer Biology Or other Electives (optional)	0-9
Total		13

Summer Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320	Statistical Methods I *	3
BIPG5110	Practical Bioinformatics*	1
CABP6730	Research in CABP*	1-5
CABP6890	Independent Study in Cancer Biology Or other Electives (optional)	0-4
Total		9

First Year Qualifying Examination (successful completion required in summer term)

Masters Program Students: Year 2

Fall Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP6270	Advanced Cancer Biology * (or take this course in third year)	0-3
CABP6990	Thesis Research*	0-9
	Electives	0-9
Total		9

Spring Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP6560	Readings in Cancer Biology *	1
CABP6990	Thesis Research*	0-8
	Electives	0-8
Total		9

Summer Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP6990	Thesis Research*	1-9
	Electives	0-9
Total		9

Masters Program Students: Year 3 (if necessary)

Fall Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP6270	Advanced Cancer Biology *	

	(if not taken in second year)	0-3
CABP6990	Thesis Research*	1-9
	Electives	0-9
Total		9
Spring Term (* = required)		
CABP6990	Thesis Research*	1-9
	Electives	0-9
Total		9
Summer Term (* = required)		
CABP6990	Thesis Research*	9

The MSBS Qualifying Exam is taken in the summer term of the first year. Prior to completing the exam, students should carry out their thesis research under the course Research in CABP (6730). After passing the Qualifying Exam, students conduct their research under the course Thesis Research (CABP6990). The minimum number of credits required for MSBS is 40, with a minimum of 25 credits of didactic coursework (letter grade), and a minimum of 10 credits of thesis research. The rest of the credits are approved electives and research in the Cancer Biology track.

All Masters students are also required to present posters in the annual UTHSC Graduate Student Research Forum and oral presentations in the annual Larry Gentry Research Symposia beginning in their second year.

#### Advanced Courses in the Cancer Biology Track

##### Advanced Cancer Biology

A comprehensive examination of the cellular and molecular foundation of cancer. Topics to be covered include: neoplasia; epidemiology and etiology; the role of causative agents such as chemicals, radiation, and viruses; cell proliferation, injury, and death; oncogenes; tumor suppressor genes; cancer therapies, and overviews of several major types of cancer.

##### Readings in Cancer Biology

A readings and discussion course that will examine classic and current research publications from within the broad realm of cancer biology.

##### Independent Study in Cancer Biology

In-depth study of research areas chosen by individual faculty. Examples of such topics may be: drug therapy and resistance, hormonal carcinogenesis, and epigenetic mechanisms of oncogenesis.

## **Doctor of Philosophy in Biomedical Sciences: Molecular Medicine Track**

### **Department of Physiology and Pharmacology**

*Bina Joe, Ph.D., chair*

*Andrew Beavis, Ph.D., track director*

The Molecular Medicine (MOME) track (formerly Cardiovascular and Metabolic Diseases) track in the Biomedical Sciences Graduate program at The University of Toledo College of Medicine & Life Sciences on the Health Science Campus nurtures students and provides them with the necessary tools to pursue an independent career in biomedical sciences. The program

encompasses a unique interdisciplinary approach to train students to conduct research in the underlying molecular mechanisms of diseases that have profound impact on human health.

The program draws on faculty research strengths in signal transduction, genetics, molecular and cellular biology, gene microarrays, genomics, proteomics, gene knockout and transgenics, tissue culture, and protein and carbohydrate biochemistry. The MOME faculty members are not only drawn from its associated department, the Department of Physiology and Pharmacology, and from the Center for Diabetes and Endocrine Research (CeDER), but also from other departments including the Departments of Medicine, and , Orthopedic Surgery. Modern, well-equipped research facilities are available through the participating departments. The MOME program offers degrees of Doctor of Philosophy (PhD) and Masters in biomedical sciences (MSBS). The program also offers these graduate degrees in combination with the Medical Degree (MD) that is offered by the medical school. Students from the four programs, PhD, MSBS, MD/PhD and MD/MSBS, follow a well-defined program that includes core courses, journal clubs, seminars, laboratory rotations, independent research, and electives in the area of interest. Students select faculty advisors and begin their independent dissertation research following the laboratory rotations in the biomedical science core curriculum. The curriculum is designed to enable students, guided by their advisors, to develop the expertise that prepares them for a successful career in research and education

#### PhD Program Students: Year 1

##### Fall Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Introduction to Biomedical Research	0
	Current Problems and Research Approaches (CPRA) in...	
BMSP6330	CPRA in Protein Structure and Catalysis	2.5
BMSP6340	CPRA in Genes and Genomes	2.5
BMSP6360	CPRA in Cell Membranes	3
BMSP6380	Methods in Biomedical Sciences	3
INDI6020	On Being a Scientist	1
BMSP6390	Mentored Research (one 8 week lab rotation)	2
Total		14

##### Spring Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6310	Systems Pathophysiology I	2.5
BMSP6320	Systems Pathophysiology II	2.5
BMSP6350	CPRA in Cell Biology and Signaling	3
BMSP6390	Mentored Research (two 8 week lab rotations)	4
CVMD6600	Journal Paper Review in CVMD	1
Total		13

##### Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320/7320	Statistical Methods I, (required BMS core course)	3
CVMD6730	Research in CVMD	0-6
BMSP6390	Mentored Research (if additional 8 week rotation is necessary)	0-2
Total		9

#### PhD Program Students: Year 2 And Beyond

In addition to the BMS core requirements, PhD students in the Molecular Medicine track will be required to take the following courses to graduate:

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6300/8300	Seminars in CVMD (fall and spring) (required in fall and spring semesters of the 2nd, 3rd and 4th years)	1
CVMD6500/8500	Advanced Topics in CVMD (fall)	3
CVMD6600/8600	Journal Paper Review in CVMD (fall and spring) (required in fall and spring semesters of the 2nd and 3rd years)	1
BMSP6250/8250	Grant Writing Workshop (spring)	2

Curriculum to include advanced electives in Molecular Medicine or other areas to make up the required number of didactic credit hours.

The PhD Qualifying Exam is taken at the end of the second year.

Prior to passing this exam, the student carries out their research under the course Research in Molecular Medicine (CVMD 6730/8730, 1-12 credit hours) or in some cases Independent Study in Molecular Medicine (CVMD 6890/8890). After passing the PhD Qualifying Exam, the student carries out their research under the course Dissertation Research (CVMD 9990).

Students will also be expected to present a poster or oral presentation in the annual UT Health Science Campus Research Forum and the Pharmacology Research Colloquium. The Pharmacology Research Colloquium is held on a rotating basis at UTHSC, Michigan State University, the University of Michigan and Wayne State University. It is an annual event in which the students of "pharmacology" departments at the respective Medical Schools have participated in since 1973. These events provide students with excellent opportunities for developing skills in organizing, presenting and discussing their work.

Typical course schedules for years 2-4  
PhD Program Students: Year 2

#### Fall Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6500/8500	Advanced Topics in CVMD (fall)	3
CVMD6300/8300	Seminars in CVMD (fall and spring)	1
CVMD6600/8600	Journal Paper Review in CVMD (fall and spring)	1
CVMD6730/8730	Research in CVMD and/or	0-4
CVMD6890/8890	Independent Study in CVMD and/or	0-4
	Electives	0-4
Total		9

#### Spring Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6300/8300	Seminars in CVMD (fall and spring)	1
CVMD6600/8600	Journal Paper Review in CVMD (fall and spring)	1
BMSP6250/8250	Grant Writing Workshop (spring)	2
CVMD6730/8730	Research in CVMD and/or	0-5
CVMD6890/8890	Independent Study in CVMD and/or	0-5
	Electives	0-5
Total		9

#### Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6730/8730	Research in CVMD and/or	0-9
CVMD6890/8890	Independent Study in CVMD and/or	0-9
	Electives	0-9
Total		9

Second Year Qualifying Examination (successful completion required in spring or summer semester)

PhD Program Students: Year 3

Fall Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6300/8300	Seminars in CVMD (fall and spring)	1
CVMD6600/8600	Journal Paper Review in CVMD (fall and spring)	1
CVMD9990	Dissertation Research	7
Total		9

Spring Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6300/8300	Seminars in CVMD (fall and spring)	1
CVMD6600/8600	Journal Paper Review in CVMD (fall and spring)	1
CVMD9990	Dissertation Research	7
Total		9

Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD9990	Dissertation Research	9

PhD Program Students: Year 4 and beyond

Fall, Spring and Summer

CVMD6300/8300	Seminars in CVMD (fall and spring)	1
CVMD9990	Dissertation Research	8
Total		9

The minimum number of credits required for PhD is 90, with a minimum of 25 credits of didactic coursework (letter grade), and a minimum of 30 credits of dissertation research. The rest of the credits are approved electives and research in the Molecular Medicine track.

## **Master of Science in Biomedical Sciences: Molecular Medicine Track**

Masters Program Students: Year 1

Fall Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Introduction to Biomedical Research	0
	Current Problems and Research Approaches (CPRA) in...	
BMSP6330	CPRA in Protein Structure and Catalysis	2.5
BMSP6340	CPRA in Genes and Genomes	2.5



BMSP6360	CPRA in Cell Membranes	3
BMSP6380	Methods in Biomedical Sciences	3
INDI6020	On Being a Scientist	1
BMSP6390	Mentored Research (one 8 week lab rotation)	2

Total 14

Spring Term (\*=required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6600	Journal Paper Review in CVMD*	1
BMSP6310	Systems Pathophysiology I*	2.5
	or	
BMSP6350	CPRA in Cell Biology and Signaling*	3
	Electives	0-8
CVMD6730	Research in CVMD	0-8
BMSP6390	Mentored Research	2-4
	(1 or 2 8 week rotations if needed)	

Total 12

Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320	Statistical Methods I, (required BMS core course)	3
CVMD6730	Research in CVMD	0-6

Total 9

The MSBS First Year Qualifying Examination (successful completion required in summer term) is taken at the end of the first year.

Masters Program Students: Year 2

Fall Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6300	Seminars in CVMD	1
CVMD6600	Journal Paper Review in CVMD	1
CVMD6990	Thesis Research and/or Electives	0-7

Total 9

Spring Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6310	Systems Pathophysiology I (if not taken in year 1) or	0 or 2.5
BMSP6350	CPRA in Cell Biology and Signaling (if not taken in year 1)	0 or 3
CVMD6300	Seminars in CVMD (required for students in their 2nd year)	1
CVMD6600	Journal Paper Review in CVMD (required by students in their 2nd year)	1
CVMD6990	Thesis Research and/or Electives	0-7

Total 9

Summer Term		
<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6990	Thesis Research and/or Electives	0-9  0-9
Total		9

Masters Program Students: Year 3 (if necessary)

Fall/Spring Terms (12 credits each), Summer (9 credits)		
<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CVMD6990	Thesis Research and/or Electives	1-9  0-8
Total		9

The minimum number of credits required for MSBS is 40, with a minimum of 25 credits of didactic coursework (letter grade).

The MSBS curriculum includes advanced electives in Molecular Medicine or other areas to make up the 25 required didactic credit hours.

A minimum of 10 credits of Thesis Research (CVMD 6990) is required for graduation.

## **Doctor of Philosophy in Biomedical Sciences: Medical Microbiology and Immunology Track**

### **Department of Medical Microbiology and Immunology**

*Akira Takashima, Ph.D., M.D., chair*

*Z. Kevin Pan, Ph.D., Track Director*

The Medical Microbiology and Immunology (MMIM) (formerly Infection, Immunity and Transplantation) training program at the University of Toledo on the Health Science Campus offers the PhD, MD/PhD, and MSBS degrees through the interdisciplinary degree programs in Biomedical Sciences. The primary goal of the doctoral program in Medical Microbiology and Immunology is to train students for independent, creative careers in research and/or teaching. The curriculum for the PhD degree consists of a core of concentrated course work in the first year, followed by specialized elective courses and an emphasis on laboratory research. Elective courses are offered in advanced immunity, microbiology of human infections, advanced virology and cellular and molecular biology of pathogenic bacteria. Other training activities include an annual combined journal club and seminar course (current topics in IIT), participation in annual Medical Microbiology and Immunology student research forums and graduate school student poster forums, presentation of formal third-year seminars and above to track faculty and students, and the completion of a written dissertation or thesis and its oral defense. Students also are encouraged to present their findings at local, national and international meetings in their fields.

During the first two semesters, each student rotates through three research laboratories, conducting short-term projects, gaining exposure to techniques and identifying potential areas for further investigation. At the end of the second semester, each student selects a major advisor who directs the student's doctoral or masters research. A faculty advisory committee is also jointly chosen by the student and advisor to supervise academic progress toward completion of the PhD or MSBS degree.

PhD Program Students: Year 1

Fall Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Introduction to Biomedical Research	0
	Current Problems and Research Approaches (CPRA) in...	
BMSP6330	CPRA in Protein Structure and Catalysis	2.5
BMSP6340	CPRA in Genes and Genomes	2.5
BMSP6360	CPRA in Cell Membranes	3
BMSP6380	Methods in Biomedical Sciences	3
INDI6020	"On Being a Scientist"	1
BMSP6390	Mentored Research	3
	(one 8 week lab rotation)	2
Total		14

Spring Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6310	Systems Pathophysiology I	2.5
BMSP6320	Systems Pathophysiology II	2.5
BMSP6350	CPRA in Cell Biology and Signaling	3
BMSP6390	Mentored Research	4
	(two 8 week lab rotations)	
IITP6030	Current Topics IIT	1
Total		13

Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320/7320	Statistical Methods I, (required BMS core course)	3
IITP6890	Independent Study in IIT	0-6
BMSP6390	Mentored Research	0-2
	(additional 8 week rotation if necessary)	
Total		9

PhD Program Students: Year 2

Fall Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
IITP6020/8020	Advanced Immunology (required)	0-1
MICB6890/8890	Independent Study in Microbiology and/or	0-9
IITP6890/8890	Independent Study in IIT and/or	0-9
	Electives	0-9
Total		9

Spring Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
IITP8030	Current Topics in IIT	1
IITP6040/8040	Advanced Microbiology (required)	1
MICB8890	Independent Study in Microbiology and/or	0-8

IITP8890	Independent Study in IIT and/or Electives	0-8  0-8
Total		9

Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MICB8890	Independent Study in Microbiology and/or	0-9

IITP8890	Independent Study in IIT and/or Electives	0-9  0-9
Total		9

Second Year Qualifying Examination (successful completion required in spring or summer semester)

PhD Program Students: Year 3

Fall Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
IITP8030	Current Topics in IIT	1
IITP9990	Dissertation Research	8
Total		9

Spring Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
IITP9990	Dissertation Research	8
IITP8030	Current Topics in IIT	1
Total		9

Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
IITP9990	Dissertation Research	9

Third Year and Above: (Student Seminar/Current Topics in IIT required in fall and spring semesters)

PhD Program Students: Year 4 and above

Fall, Spring and Summer

IITP8030	Current Topics in IIT	1
Dissertation Research (IITP9990)		8
Total		9

The PhD Qualifying Exam is taken in the spring semester or summer term of the second year. Prior to completing the exam, students should carry out their dissertation research under the course Independent Study in Medical Microbiology and Immunology MICB (6890/8890) or Research in IIT (6890/8890). After passing the Qualifying Exam, students conduct their research under the course Dissertation Research (IITP9990). The minimum number of credits required for PhD is 90, with a minimum of 25 credits of didactic coursework (letter grade), and a minimum of 30 credits of dissertation research. The rest of the credits are approved electives and research in the Medical Microbiology and Immunology track.

## Master of Science in Biomedical Sciences: Medical Microbiology and Immunology Track

The Medical Microbiology and Immunology (MMIM) (formerly Infection, Immunity and Transplantation) track participates in the masters in Biomedical Sciences training program. Students are expected to complete a core curriculum similar to that of doctoral students but with some of the courses as elective offerings, to experience one or more rotations before selecting a major advisor and thesis laboratory. In addition to 40 credit hours in didactic and other courses, including a minimum of 10 credit hours of thesis research is required for degree. Students are required to successfully pass a qualifying exam and to write and defend a research thesis. Students usually complete the degree requirements in 2-3 years.

### Masters Program Students: Year 1

#### Fall Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Introduction to Biomedical Research	0
	Current Problems and Research Approaches (CPRA) in...	
BMSP6330	CPRA in Protein Structure and Catalysis	2.5
BMSP6340	CPRA in Genes and Genomes	2.5
BMSP6360	CPRA in Cell Membranes	3
BMSP6380	Methods in Biomedical Sciences	3
INDI6020	"On Being a Scientist"	1
BMSP6390	Mentored Research (one 8 week lab rotation)	2
Total		14

#### Spring Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6310	Systems Pathophysiology I *	2.5
BMSP6320	Systems Pathophysiology II *	2.5
BMSP6350	CPRA in Cell Biology and Signaling *	3
BMSP6390	Mentored Research (two additional rotations possible)	0-4
IITP6890	Independent Study in IIT	0-4
IITP6030	Current Topics IIT	1
Total		13

#### Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320	Statistical Methods I, (required BMSP core course)	3
IITP6890	Independent Study in IIT	0-6
Total		9

First Year Qualifying Examination (successful completion required in summer term)

### Masters Program Students: Year 2

#### Fall Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
IITP 6020	Advanced Immunology (required)	1
IITP6990	Thesis Research and/or	0-8

	Electives	0-8
Total		9

#### Spring Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
IITP 6030	Current Topics in IIT	1
IITP6040/8040	Advanced Microbiology	1
IITP6990	Thesis Research and/or Electives	0--8  0-8
Total		9

#### Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
IITP6990	Thesis Research and/or Electives	0-9  0-9
Total		9

Masters Program Students: Year 3 (if necessary)

Fall/Spring Terms (15 credits each), Summer (9 credits)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
IITP6990	Thesis Research and/or Electives	0-9  0-19
Total		9

The minimum number of credits required for MSBS is 40, with a minimum of 25 credits of didactic coursework (letter grade), and a minimum of 10 credits of thesis research. The rest of the credits are approved electives and research in the Medical Microbiology and Immunology track.

## Doctor of Philosophy in Biomedical Sciences: Neuroscience and Neurological Disorders Track

### Department of Neurosciences

*Nicolas Chiaia, Ph.D., interim chair*

*Nicolas Chiaia, Ph.D., track director*

The combination of molecular biology and genetics with modern neuroanatomical techniques is transforming both our ability to examine and to understand the nervous system. Ongoing research by the faculty in the Neurosciences and Neurological Disorders graduate program is providing insights into neurotransmission, sensory system function, development and plasticity of the nervous system, regeneration and repair following neural damage, the basis of neural disease, and behavior. As one of four biomedical science degree programs in the University of Toledo, College of Medicine & Life Sciences, the Neurosciences and Neurological Disorders program is an interdisciplinary course of studies whose primary goal is to train students for independent, creative careers in biomedical research and/or teaching. The program awards both PhD and MSBS in biomedical sciences degrees and participates in the MD/PhD and MD/MSBS combined degree programs.

Nationally-recognized, NIH-funded Neuroscience faculty who serve as research mentors are drawn from a number of departments including: Neurosciences, Neurology, Physiology and Pharmacology, Otolaryngology, Psychiatry and Radiation Therapy. Modern, state-of-the-art research laboratory and core facilities are available through the program and these participating departments.

The Neurosciences and Neurological Disorders training program at the University of Toledo on the Health Science Campus offers the PhD, or MD/PhD degrees through the interdisciplinary degree programs in Biomedical Sciences. The primary goal of the doctoral program in Neurosciences and Neurological Disorders is to train students for independent, creative careers in research and/or teaching. The curriculum for the PhD degree consists of a core of concentrated course work in the first year, followed by specialized elective courses and an emphasis on laboratory research. Elective courses are offered in developmental and systems neuroscience, as well as ion channel function, sensory physiology, and neuropharmacology. During the first two semesters, each student rotates through four research laboratories, conducting short-term projects, gaining exposure to techniques and identifying potential areas for further investigation. At the end of the second semester, each student selects a major advisor who directs the student's doctoral or thesis research. A faculty committee is also jointly chosen by the student and advisor to supervise academic progress toward completion of the PhD or MSBS degree. In addition to 90 credit hours in didactic and other courses, PhD students are required to successfully pass a qualifying exam and to write and defend a research dissertation. \*Masters students complete a minimum of 40 credit hours and write and defend a research thesis.

**\* MSBS in Neuroscience and Neurological Disorders is not currently offered**

#### PhD Program Students: Year 1

##### Fall Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Introduction to Biomedical Research	0
	Current Problems and Research Approaches (CPRA) in...	
BMSP6330	CPRA in Protein Structure and Catalysis	2.5
BMSP6340	CPRA in Genes and Genomes	2.5
BMSP6360	CPRA in Cell Membranes	3
BMSP6380	Methods in Biomedical Sciences	3
INDI6020	"On Being a Scientist"	1
BMSP6390	Mentored Research (one 8 week lab rotation)	2
Total		14

##### Spring Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6310	Systems Pathophysiology I	2.5
BMSP6320	Systems Pathophysiology II	2.5
BMSP6350	CPRA in Cell Biology and Signaling	3
BMSP6390	Mentored Research (two 8 week lab rotations)	4
NNDP6500	Seminar in Neuroscience	1
Total		13

Summer Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320/7320	Statistical Methods I (required BMS core course)	3
NNDP6730	Research in NNDP	0-6
BMSP6390	Mentored Research (if additional 8 week rotation is necessary)	0-2
Total		9

Ph.D Program Students: Year 2

Fall Term (\*= required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6560/8560	Readings In Neuroscience	1-4
NNDP6720/8720	Current Topics in Neuroscience	1-4
BIOE4720/5620	Cellular Electrophysiology	3
NNDP6730	Research in Neuroscience	0-4
Total		9

Spring Term (\*= required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP7810	Neuroscience	6
BMSP8250	Grant Writing Workshop (elective)	0-2
NNDP8500	Seminar in Neuroscience	1
NNDP8540	Journal Paper Review in Neuroscience * (if offered)	0-2
NNDP8720	Current Topics in Neuroscience	1-4
INDI8790	Basic & Advanced Light Microscopy: (elective)	0-4
INDI8860	Electron Microscopy: (elective)	0-4
NNDP6730	Research in Neuroscience	0-5
Total		9

Summer Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6730	Research in Neuroscience	0-8
NNDP8990	Research in Neuroscience	0-9
NNDP9990	Dissertation Research in Neuroscience	0-9
Total		9

PhD Program Students: Year 3

Fall Term (\*= required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6730	Research in Neuroscience	0-9
NNDP9990	Dissertation Research in Neuroscience	0-9
Total		9



Spring Term (\*=required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP8500	Seminar in Neuroscience	1
NNDP6730	Research in Neuroscience	0-8
NNDP9990	Dissertation Research in Neuroscience	0-8

Total 9

Summer Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6730	Research in Neuroscience	0-9
NNDP9990	Dissertation Research in Neuroscience	0-9

Total 9

PhD Program Students: Year 4 and above

Fall/Spring Terms (12 credits each), Summer (9 credits)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP9990	Dissertation Research in Neuroscience	0-9

The minimum number of credits required for PhD is 90, with a minimum of 25 credits of didactic coursework (letter grade), and a minimum of 30 credits of dissertation research. The rest of the credits are approved electives and research in the NND track.

## **\*Master of Science in Biomedical Sciences: Neurosciences and Neurological Disorders Track**

\* MSBS in Neuroscience and Neurological Disorders is not currently offered

## **Department of Neurosciences**

*Nicolas Chiaia, Ph.D., interim chair*

*Nicolas Chiaia, Ph.D., track director*

The NND track participates in the masters in biomedical sciences training program. Students are expected to complete a core curriculum similar to that of doctoral students but with some of the courses as elective offerings, to experience one or more rotations before selecting a major advisor and thesis laboratory. In addition to 40 credit hours in didactic and other courses, including a minimum of 10 credit hours of thesis research, students are required to successfully pass a qualifying exam and to write and defend a research thesis. Students usually complete the degree requirements in 2-3 years.

Masters Program Students: Year 1

Fall Term (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Introduction to Biomedical Research	0
Current Problems and Research Approaches (CPRA) in...		
BMSP6330	CPRA in Protein Structure and Catalysis	2.5
BMSP6340	CPRA in Genes and Genomes	2.5
BMSP6360	CPRA in Cell Membranes	3
BMSP6380	Methods in Biomedical Sciences	3
INDI6020	"On Being a Scientist"	1
BMSP6390	Mentored Research (one 8 week lab rotation)	2

Total 14

Spring Term (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6310	Systems Pathophysiology I *	2.5
BMSP6320	Systems Pathophysiology II *	2.5
BMSP6350	CPRA in Cell Biology and Signaling*	3
BMSP6390	Mentored Research (two additional rotations possible)	0-4
NNDP6730	Research in Neuroscience	0-6
NNDP6500	Seminar in Neuroscience	1

Total 13

Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320	Statistical Methods I (required BMS core course)	3
NNDP6730	Research in Neuroscience	0-6

Total 9

First Year Qualifying Examination (successful completion required in spring or summer term)

Masters Program Students: Year 2

Fall Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6730	Research in Neuroscience	0-8
NNDP6990	Thesis Research in Neuroscience and/or Electives	0-9

Total 9

Spring Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6730	Research in Neuroscience	0-8
NNDP6990	Thesis Research in Neuroscience and/or Electives	0-9

Total 9

Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6990	Thesis Research in Neuroscience	0-9

Total 9

Masters Program Students: Year 3 (if necessary)

Fall/Spring Terms (12 credits each), Summer (9 credits)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6990	Thesis Research in Neuroscience	0-9
Total		9

The minimum number of credits required for MSBS is 40, with a minimum of 25 credits of didactic coursework (letter grade), and a minimum of 10 credits of thesis research. The rest of the credits are approved electives and research in the NND track.

## **Master of Science in Biomedical Sciences: Human Donation Science**

### Professional Science Masters Degree

The Human Donation Science Master Degree (MSBS-HDS, PSM) program is designed to provide entry-level professional preparation for individuals who wish to become an organ procurement transplant coordinator. Organ procurement coordinators facilitate the organ donation process from beginning to end. They are the liaisons between the donor's family, the coroner, the medical and nursing staff, the organ procurement organization and ultimately the transplant surgeon. As a result, coordinators must skillfully and diplomatically deal with a number of issues, agendas and personalities in order to achieve a successful organ transplant. Combining science coursework with business and management coursework further enables the HDS-MSBS, PSM graduate to step into the professional world of organ and tissue donation and transplantation.

Entrance requirements/prerequisites:

- Baccalaureate degree from a school that is accredited by a nationally recognized body for accreditation of postsecondary education.
- Overall grade point average of 3.0 in undergraduate work.
- Submission of online University of Toledo Graduate School Application.
- Three letters of recommendation (using the University of Toledo forms).
- A minimum of two semesters of coursework in the biological sciences, a minimum of two semesters of coursework in chemistry, and one semester of college algebra or higher.
- Satisfactory completion of a course in medical terminology or pass a medical terminology proficiency examination. Candidates who are unable to pass the medical terminology proficiency examination will be required to participate in a self-study program and pass a re-test.
- The Graduate Record Examination (GRE) and TOEFL are only required for international students.
- Interview, if requested.
- Graduate School application fee.

Although not required, shadowing an organ procurement coordinator is highly recommended.

#### Fall Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
HDSC5010	Organ Transplant Procurement	3
HDSC5210	Clinical Foundations Organ Donation	6
HDSC5110	Fundamental Concepts and Clinical Practicum I	3
Elective		3
Total		15

#### Spring Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
HDSC5310	Clinical Aspects Procurement	4
HDSC5120	Clinical Practicum II	2
HDSC5020	Human Donation Science Scholarly Project	3
Elective		3
Elective		3
Total		15

#### Summer Term

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
HDSC5130	Human Donation Science Internship	8
HDSC5410	Human Donation Science Capstone Seminar	2

Total

10

Elective Coursework (choose three)

PUBH6000 Biostatistics (fall / spring) 3CR

HURM 6730 Performance Management (fall / spring) 3CR

MGMT 6160 Leading with Power and Influence (fall) 3CR

MGMT6150 Leading and Developing Yourself (fall / spring) 3CR

LAWM5000 Law and the Legal System (fall) 3CR

Total Program Credit Hours (minimum) for MSBS, PSM degree in Human Donation Science is 40 credits.

## Medical Physics Programs

### Degree Programs

MSBS Medical Physics (Diagnostic Imaging Track)

MSBS Medical Physics (Radiation Oncology Track)

(also PhD in Physics and Astronomy with specialization in medical physics in both tracks is offered through the College of Natural Sciences & Mathematics.)

### Accreditations

The MSBS program in Medical Physics and the PhD in Physics and Astronomy with specialization in Medical Physics are accredited by the Commission on Accreditation of Medical Physics Educational Programs ([www.campep.org](http://www.campep.org)).

## Master of Science in Biomedical Sciences: Medical Physics

Programs of study leading to the MSBS degree in Medical Physics are offered by the graduate faculty of the Department of Radiation Oncology and the Department of Radiology. In addition to the basic medical science and radiological physics coursework, a specific course of study is offered in radiation oncology physics or in diagnostic imaging. This course of study includes didactic courses, independent study, and hands-on clinical covering the selected discipline, along with specific technical research culminating in a research project or thesis. The graduate program is committed to excellence in scientific education, clinical experience, and research leading to the professional development of highly motivated and dedicated students. In addition to the capability of creative scientific research, the coursework and clinical experience is intended to provide students with the fundamental knowledge and educational requirement for eventually becoming board certified in their area of study by The American Board of Radiology, The American Board of Medical Physics, or other credentialing body.

### Curriculum:

The didactic course curriculum includes the following courses in addition to additional special topic courses and clinical training.

Medical physics core courses include:

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MPHY6310	Anatomy/Physiology	4
INDI6020	“On Being a Scientist” Seminar	1
MPHY6010	Survey of Diagnostic Medical Imaging I	3
MPHY6120	Radiation Dosimetry I	3
MPHY6160	Radiation Biology	3
MPHY6300	Radiation Detection and Measurement	3
MPHY6200	Radiation Protection and Regulation	3
MPHY6110	Survey of Clinical Radiation Therapy	2
MPHY6500	Medical Physics Seminar	1

INDI6990 Thesis Research 10

Typical course curriculum in Medical Physics - Radiation Oncology track include:

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
Radiological Physics		
MPHY6130	Radiation Dosimetry II	3
MPHY6180	Physics of Radiation Therapy	3
MPHY6190	Brachytherapy	3
MPHY6320	Practical Measurements in Radiation Oncology	2

Typical course curriculum in Medical Physics - Diagnostic Imaging track include:

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MPHY6020	Survey of Diagnostic Medical Imaging II	3
MPHY6060	Principles of Nuclear Medicine	3
MPHY6860	Independent Study in Radiology (CT and MRI)	2

### **Non-thesis option:**

A non-thesis option is available for students who present advanced degrees from previous graduate work which included a scientific thesis or dissertation.

### **PhD track:**

The PhD in Physics with Concentration in Medical Physics: Please refer to the College of Natural Sciences Catalog for additional information regarding this program, and specifically, the Department of Physics and Astronomy section for admission and degree requirements. Information also may be found at <http://www.utoledo.edu/med/depts/radther/>.

### **Research Facilities**

The Department of Radiation Oncology has access to a variety of computer systems for radiation oncology treatment planning, programming, and image analysis. A wide range of radiation measuring equipment is available, including a full range of dosimetry and quality control test equipment, Wellhoffer computerized beam scanning system, an array of ionization chambers, software and hardware packages for film dosimetry and analysis, oscilloscopes, and test phantoms. Also available are multichannel analyzer scintillation detectors, autogamma, and liquid scintillation counters, diode, thermoluminescent dosimetry systems, nanodot dosimeters, digital scanner for chromic film dosimetry system, RIT densitometry package, etc.

The Medical Physics program is housed on the Health Science Campus and the University of Toledo Medical Center (UTMC) where much of the medical physics training is accomplished at the newly built Dana Cancer Center. This state-of-the-art building houses the radiation oncology department and has a division of radiology, medical oncology, and surgical oncology. All the specialists are under one roof and the concept of a true cancer center is practiced. Besides being a leader in stereotactic radiosurgery (SRS) and stereotactic Body Radiotherapy (SBRT), the University of Toledo Medical Center provides IMRT treatment planning with IGRT capabilities, conventional 3D conformal external beam radiotherapy, and other stereotactic neurologic radiosurgery capabilities such as AVM with inverse planning arc modulation technology. Other treatment modalities that students are exposed to are: Brachytherapy low and high dose rate, Radionuclide therapy using P-32, I-131, Sr-89, Ra-223, etc. There also exists a large Cs-137 irradiator is also available on campus for blood, small animal, or other cellular petri-dish irradiation.

### **Department of Radiation Oncology Equipment:**

- A Varian True Beam Linear Accelerator, capable of producing photon energies of 6MV, 10MV, and 18 MV, and 6X FFF, and a range of electron energies from 6 to 20 MeV in 2-3 MeV increments.
- A Varian Edge Linear Accelerator, capable of producing photon energies of 6MV, 10MV, 6X FFF, and 10X FFF. This is a specialized new Varian product designed for SRS/SBRT cases with 2.5 mm leaves.

- Both accelerators are equipped with latest state of the ART technology including onboard imaging, EPID MV imaging, Rapid ARC (VMAT), and Gating. The Edge unit is also capable of Optical Surface Monitoring System (OSMS) used for patient positioning.
- ARIA patient management system
- A Philips ADAC Pinnacle treatment planning software package for external beam radiotherapy planning,
- Varian Eclipse Treatment Planning system
- MIM software for rigid and deformable image fusion
- A remote afterloading High Dose Rate brachytherapy unit manufactured by Varian for treatment of interstitial, intracavitary and intraluminal tumors and the associated BrachyVision software package for HDR brachytherapy treatment planning
- VariSeed software package used for prostate seed implant program
- A Philips Gemini Large Bore PET/CT unit equipped with Sim package used for radiotherapy treatment simulations
- An array of low dose rate brachytherapy sources of CS-137 for intracavitary treatment
- A fully automated water scanning system manufactured by Welhoffer
- Various film scanning systems such as VIDAR scanners and HOWTEK scanner for normal diagnostics and chromic film dosimetry
- RIT dosimetry software system for dosimetric analysis using films
- BAT ultrasound system
- An array of ionization chambers and electrometers for dosimetry measurements including highly sensitive farmer, and parallel plate chambers, micro chambers, and scintillation chambers.
- Thermoluminescence dosimeter (TLD) system and oven for annealing TLD chips.
- A MicroStar II OSLD system with nanodots for in-vivo dosimetry

#### **Department of Radiology Equipment:**

- Multiple fixed and mobile radiographic and fluoroscopic systems
- Image intensifier and flat panel solid state detector fluoroscopic systems
- Computed radiography and digital radiography systems
- Mammography and stereotactic mammography systems
- Multi-slice (16 and 64) computed tomography systems
- 1.5 and 3.0 Tesla MRI imaging systems
- 4 SPECT imaging systems
- A PET/CT imaging system
- Multiple ultrasound imaging systems
- Hospital-wide GE Centricity PACS system
- Terarecon Aquarius Image Processing workstations and image servers.
- Multiple Windows and Linux PC's for image processing and analysis
- Full complement of diagnostic medical physics test phantoms and dosimetry equipment.

## **Master of Science in Biomedical Sciences: Medical Science**

Program Director: Nitin Puri, M.D., Ph.D.

The primary goal of this program is to educate and train graduate students who have completed all prerequisites required for medical school but wish to enhance their understanding of the biological sciences and improve their academic credentials for applying to medical school. The 2016-2017 academic year represents a complete redesign of the former MSBS-MS program with renewed emphasis on the core-teachings of pathophysiology of disease. The program has been conceived with three primary objectives:

1. Provide clinically relevant, medical and graduate-level education to students who wish to boost their academic standing, towards a long-term goal of pursuing a career in medicine.
2. Create a strong foundation for improved performance in any MD/DO-curriculum, and USMLE step 1 and step 2 exams.
3. Provide basic and clinical research opportunities to broaden student perspective and strengthen their overall portfolio.

This advanced-foundational graduate program provides a unique opportunity for the graduate students to train along-side medical students (11 credits, multiple modules) and gain meaningful clinical and/or basic science research experience. Students will have the opportunity to complete coursework with medical students (and graded using the same scale), participate in other graduate college courses, as well as the opportunity to work with an advisor to design, perform and present a scholarly project. This curriculum will

provide foundational information for continued study in the medical school curriculum. Students completing this program with strong academic performance, as indicated by high GPAs, will have confirmed their ability to perform in the medical school curriculum, and therefore greatly strengthen their overall admission package. Students in good academic standing in the program are guaranteed an interview for medical school at the University of Toledo, College of Medicine & Life Sciences. Students who successfully complete the program will also be awarded the Master of Science in Biomedical Sciences degree (MSBS). Completion of this degree is a requirement, but not a guarantee of admission into the Doctor of Medicine (MD) degree program at the University of Toledo College of Medicine & Life Sciences. If you have previously applied to the MD degree program at the University of Toledo College of Medicine & Life Sciences, and wish to re-apply after completing the MSBS-MS program, you will need to submit a new application to the medical school.

- Applicant must be a U.S. Citizen or Permanent Resident
- Baccalaureate degree from an accredited college or university
- All prerequisites required for medical school must be completed prior to admission into the MSBS-MS program
  - Official MCAT score (28/500 or higher is recommended)
  - Official undergraduate transcripts confirming degree submitted directly to the College of Graduate Studies
- GPA of 3.0 or greater is recommended
- One letters of recommendation
  - Committee recommendation letters are accepted with all signatures
  - Recommendation letters must include your full name
- Personal statement
  - Personal Statements submitted from medical school admission are accepted. A new career goals personal statement is required for MSBS-MS admission.
  - Personal Statements must include your full name
- University of Toledo College of Graduate Studies online application
  - Application Fee submitted at the time of online application
  - Please note: If you have already applied to the University of Toledo Medical School you must submit written authorization to the College of Graduate Studies in order for your medical school file to be accessed. Please do not make this request until you have submitted your application and fee.

Fall Term		
Course	Course Name	Credit Hours
INDI5200	Cellular and Molecular Biology	11
INDI 5550	Concepts in Anatomy & Pathophysiology	3
PUBH 6000	Biostatistics	3
INDI 6980	Scholarly Project	1
Total		18

Spring Term		
Course	Course Name	Credit Hours
INDI 6980	Scholarly Project	1
INDI 5350	Pathophysiology of Organ Systems	10
Total		11

Summer Term		
Course	Course Name	Credit Hours
INDI 6020	“On Being a Scientist”	1
INDI 6920	Readings in Population Health	1
INDI 6980	Scholarly Project	6
Total		8

Program total minimum number of credits for MSBS degree in Medical Science is 37 credits.

# Master of Science in Biomedical Sciences: Oral Biology

## Department of Dentistry

*Michael Nedley, D.D.S., chair*

The oral biology program is restricted to Pediatric Dentistry Residents who are completing their training at the University of Toledo, College of Medicine & Life Sciences and UTM C. The program's curriculum is designed specific to each Dental Resident and students should consult with their advisor to create their specific Plan of Study.

### Summer Session II Year 1

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
DENT6040	Conscious Sedation I	2
DENT6060	Principles of Behavior & Communicative Management	2
DENT6070	Pediatric Dentistry Literature Review	0.5
DENT6050	Clinical Pediatric Dentistry	0.5
Total		5

### Fall Year I

DENT6010	Growth and Development	0.5
DENT6020	Pharmacology I	0.5
DENT6030	Dento-alveolar Trauma I	0.5
DENT6050	Clinical Pediatric Dentistry	1
DENT6070	Pediatric Dentistry Literature Review	0.5
INDI6980	Scholarly Project	1-10
PUBH6000	Biostatistics	3
Total		9

### Spring Year 1

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
DENT6050	Clinical Pediatric Dentistry	1
DENT6070	Pediatric Dentistry Literature Review	0.5
DENT6080	Anatomy and Embryology of the Head and Neck	1
DENT6090	Current Concepts in Dental Microbiology	0.5
DENT6120	Pharmacology II	0.5
DENT6130	Dento-alveolar Trauma II	0.5
DENT6140	Conscious Sedation II	2
INDI6980	Scholarly Project	1-10
Total		9

### Summer Year 2

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
DENT6100	Pediatric Medicine Lecture	1
DENT6110	Oral Health Policies	2



INDI6980	Scholarly Project	1-10
Total		5

Fall Year 2

Course	Course Name	Credit Hours
DENT6100	Pediatric Medicine Lecture	1
DENT6110	Oral Health Policies	2
DENT6150	American Board of Pediatric Dentistry Review	2
DENT6160	Special Care Dentistry	1
INDI6980	Scholarly Project	1-10

Total		9
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Spring Year 2

Course	Course Name	Credit Hours
DENT6100	Pediatric Medicine Lecture	1
DENT6200	Oral Pathology	1
INDI6020	“On Being a Scientist”	1
INDI6980	Scholarly Project	1-10

Total		9
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## Master of Science in Biomedical Sciences: Orthopedic Sciences

### Department of Orthopedic Surgery

*Nabil Ebraheim, M.D., chair*

*Martin Skie, M.D., track director*

Master of Science in Biomedical Sciences (MSBS)

Track Name: Bone Biology and Orthopedic Sciences

The Department of Orthopedic Surgery offers graduate-level courses through the Master of Science in Biomedical Sciences program at the University of Toledo. This is a 2-year program consisting of classes, seminars, and research. The students work with Dr. Martin Skie, Department of Orthopedic Surgery; Beata Lecka-Czemik, Department of Orthopedic Surgery; A. Champa Jayasuriya, Department of Orthopedic Surgery; and Dr. Vijay Goel, Department of Bioengineering. Our unique partnership with the Department of Bioengineering allows our researchers and physicians to have access to not only lab and research facilities, but also to the expertise of scientists in the biomechanics field.

Research in Orthopedic Sciences at the University of Toledo College of Medicine & Life Sciences covers a broad spectrum of topics including:

- Biomechanics
- Biomineralization
- Bone diseases
- Bone tissue engineering and regenerative medicine
- Hand and foot disorders
- Hip and knee replacements
- Spinal injuries and disorders
- Sports medicine
- Stem cell technologies
- Trauma/fixation

Currently offered courses include:

CPRA = Current Problems/Research Applications

**Fall Year 1**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6330	CPRA in Protein Structure and Catalysis	2.5
BMSP6340	CPRA in Genes and Genomes	2.5
BMSP 6360	CPRA in Cell Membranes	3
BMSP6380	Methods of Biomedical Science	3
INDI6020	“On Being a Scientist”	1
ORTH6500	Musculoskeletal Anatomy & Orthopaedic Basic Science Seminar	3
Total		15

**Spring Year 1**

BMSP6350	CPRA in Cell Biology and Signaling	3
ORTH5800	Bone Biology and Physiology	3
ORTH6500	Musculoskeletal Anatomy & Orthopaedic Basic Science Seminar	3
ORTH6990*	Thesis Research	0-10
OR		
INDI6980 *	Scholarly Project	0-10
Total		12

**Summer Year 1**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
ORTH5700	Orthopaedic X-ray Conference	1
BMSP5320	Statistical Methods I	3
ORTH6550	Journal Paper Review	1
ORTH6990*	Thesis Research	0-10
OR		
INDI6980*	Scholarly Project	0-10
Total		9

**Fall Year 2**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIOE5710	Soft and Hard Tissue Biomechanics	3
ORTH5700	Orthopaedic X-ray Conference	1
*ORTH6910	Orthopaedic Trauma	1-3
*ORTH6920	Orthopaedic Spine	1-3
*ORTH6930	Sports Medicine	1-3
*ORTH6940	Adult Reconstruction & Tumor	1-3
*ORTH6950	Foot & Ankle	1-3
*ORTH6960	Upper Extremity and Hand	1-3
ORTH6500	Musculoskeletal Anatomy and Orthopaedic Basic Science Seminar	3
ORTH6550	Journal Paper Review	1
ORTH6990*	Thesis Research	0-10
OR		
INDI6980*	Scholarly Project	0-10
Total		15

## Spring Year 2

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
ORTH5700	Orthopaedic X-ray Conference	1
ORTH6750	Biomaterials in Medicine	3
**ORTH6910	Orthopaedic Trauma	1-3
**ORTH6920	Orthopaedic Spine	1-3
**ORTH6930	Orthopaedic Biomechanics	1-3
**ORTH6940	Orthopaedic Anatomy	1-3
**ORTH6950	Foot & Ankle	1-3
**ORTH6960	Upper Extremity and Hand	1-3
ORTH6500	Musculoskeletal Anatomy and Orthopaedic Basic Science Seminar	3
ORTH6550	Journal Paper Review	1
ORTH6990*	Thesis Research	0-10
OR		
INDI6980*	Scholarly Project	0-10
Total		15

### **Minimum number of credit hours for MSBS in Orthopedic Sciences degree completion is 69 for the 2-year program.**

\* Students who elect to do a basic science project will register for ORTH6990 Thesis Research. Students who elect to do a clinical science project will register for INDI 6980 Scholarly Project. In addition to 59 credit hours in didactic and other courses, students will also take a minimum of 10 credit hours of thesis research or scholarly project. Thesis research will require the student to write and orally defend a thesis, scholarly project will require a written paper and oral presentation of the project.

\*\* In the fall and spring of year 2 the student will choose one of the clinical electives (ORTH 6910, 6920, 6930, 6940, 6950, 6960) to take for each semester. Credit for the clinical elective courses: minimum 1 credit, maximum 3 credits

Additional information may be found at [http://www.utoledo.edu/med/depts/ortho/master\\_program/index.html](http://www.utoledo.edu/med/depts/ortho/master_program/index.html)

## Department of Physician Assistant Studies

### Master of Science in Biomedical Science: Physician Assistant Studies

*Patricia A. Hogue, Ph.D., PA-C., chair*

#### Accreditation

The University of Toledo Physician Assistant Program is fully accredited by the Accreditation Review Commission on Education for the Physician Assistant, Inc. (ARC-PA). Graduates of accredited programs are eligible to take the national certifying examination offered by the National Commission on Certification of Physician Assistants (NCCPA). Most states require certification in order to practice.

#### Masters Programs

Physician Assistants (PAs) are health care professionals, prepared and licensed to practice medicine with physician supervision. Within the physician/PA relationship, PAs exercise autonomy in decision-making and provide a wide range of diagnostic and

therapeutic services. The role of the Physician Assistant includes provision of primary and specialty care in medical and surgical practices located in rural, urban or suburban areas. Physician Assistant practice is patient care centered but may include education, research and administration duties. The American Academy of Physician Assistants (AAPA) is the national organization that represents graduate PAs. The Student Academy of the American Academy of Physician Assistants (SAAAPA) serves the interests of PA students. The University of Toledo PA Program is a member of the Physician Assistant Education Association (PAEA), which is the national organization representing Physician Assistant education.

### **Master of Science in Biomedical Science: Physician Assistant Studies**

The University of Toledo (UT) Physician Assistant Program is a graduate entry-level professional course of study enabling individuals who hold baccalaureate degrees to become PAs. The program is designed to prepare graduates for primary care practice with emphasis placed on both service to medically under-served populations and the team approach to the delivery of health care. The program integrates graduate level critical thinking and analysis, problem solving, scientific inquiry, self-directed learning and the effective use of modern technology for professional practice that includes elements of research, leadership, education and continued professionalization of the physician assistant occupation.

#### Admission Requirements

The Physician Assistant Program admits students each Fall Semester only.

To be considered for the Physician Assistant Program, candidates must comply with all of the following:

The completion of all admission requirements to the central application service or CASPA (<https://portal.caspaonline.org/>) by OCTOBER 1. CASPA will be available once the next cycle of application opens.

CASPA submissions must include:

- Completed and signed application form
- Application fee
- Two letters of recommendation
- Transcripts for all colleges/universities attended
- In addition, candidates must complete the supplementary application online and pay the associated application fee.

Applicants to the University of Toledo PA Program must be citizens or permanent residents of the United States. Applicants who have completed any of their previous undergraduate or graduate training internationally must fulfill the requirements of the University of Toledo, College of Graduate Studies for international students, available on the College of Graduate Studies website at [www.utoledo.edu/graduate](http://www.utoledo.edu/graduate). The University of Toledo PA Program requires applicants to provide foreign transcript evaluation from one of the accepted credential evaluation agencies: ECE or WES. The evaluation will be at the applicant's expense. In addition to the requirement for regular admission, all students from non-English speaking countries must achieve satisfactory scores on the Test of English as a Foreign Language (TOEFL) (unless the international applicant has graduated from a US accredited college or university). All international applicants must also demonstrate that they have adequate financial resources for their graduate education before they can be admitted. The TOEFL score requirements and a copy of the financial statement form are available for viewing at the College of Graduate Studies website at [www.utoledo.edu/graduate](http://www.utoledo.edu/graduate).

Applicants must have earned a Bachelor level degree with a cumulative 3.00 grade point average to be competitive AND to qualify for financial aid. For those applicants who will receive their Bachelor-level degree in the year that they will matriculate, the degree must be completed by June for those applying for entry into the University of Toledo PA class that begins in August.

The following Minimum Prerequisites must be completed with a grade of B- or better:

1. Human Anatomy (Lab recommended)
2. Human Physiology (Lab recommended)
3. Inorganic/General Chemistry with Lab
4. Organic Chemistry with Lab
5. Microbiology with Lab
6. Introductory Psychology, or upper-level Psychology

7. Additional Psychology Course (Lifespan Psychology recommended)
8. College Algebra, or higher mathematics
9. Medical Terminology (minimum 1 credit hour or pass a medical terminology test)

Notes about Admission Requirements:

Each prerequisite course above must consist of at least three (3) SEMESTER credit hours . All coursework identified above must be current within eight (8) years of admission to the program. The deadline for finishing prerequisite coursework for the class entering in August is June 30<sup>th</sup>. These are minimum program requirements. All prerequisites must be completed with a grade of B- or better. For courses where separate grades are assigned for lecture and laboratory sections, the candidate must receive a grade of B- or better for BOTH lecture and lab. For applicants enrolled at institutions that use a QUARTER system, credit hours are converted such that five (5) quarter hours = three (3) semester hours. There are many factors involved in the holistic selection process, including but not limited to: cumulative undergraduate (or completed graduate) grade point average, cumulative science grade point average, personal experiences, writing sample, reference letters, familiarity with the PA profession and the University, problem solving and teamwork.

An applicant must complete the general admission requirements specified above. Circumstances which may result in a provisional admission include: An applicant with a Bachelor's degree in progress (must be completed by June 30<sup>th</sup>). An official transcript with the degree posted must be received prior to matriculation into the program.

An applicant who has any prerequisite courses to complete at the time of application may be admitted with provisional status, with a clear understanding that remaining prerequisites must be satisfactorily (grade of B- or better) completed prior to June 30<sup>th</sup> for matriculation into the Program. Official transcripts or other appropriate documentation will be required.

In addition to the above minimum requirements, preference will be given to applicants that have earned a B- or better in any of the following advanced healthcare and science-related undergraduate or graduate courses, including but not limited to: genetics, biochemistry, immunology, physics, psychology, physiology, pathophysiology, pharmacology or mathematics.

A candidate with less than a 3.0 undergraduate GPA may be considered for admission with regular student status only if he/she has completed at least 10 semester hours (15 quarter hours) of applicable coursework at the graduate level and has a minimum GPA of 3.0 in these courses.

Formal healthcare experience and/or shadowing of PAs or other healthcare providers is not required. Candidates with formal health care experience must submit copies of any license, registration, or certification related to that field.

Prior to matriculation, candidates must present evidence that they are currently trained in basic cardiopulmonary resuscitation (CPR) according to American Heart Association standards. This training must be maintained throughout the program of study. Candidates must demonstrate proof of prior Medical Terminology Course with a grade of B- or better or pass a proficiency exam administered prior to matriculation.

Preference will be given to current Ohio residents, graduates of The University of Toledo, non-traditional and diverse applicants and those with significant health care experience.

The University of Toledo PA Program does not provide advanced placement or advanced standing for any students.

Selection Process:

Candidates for interviews will be selected from those with completed applications (both CASPA and the University of Toledo PA Supplemental Application Form) who meet the minimum entrance requirements. Interviews typically occur in January and

February. The selection process is highly competitive and merely meeting minimum entrance requirements does not guarantee an interview or admission to the program. Formal patient contact experience is not a requirement for entrance. There are many factors involved in the selection process, including but not limited to: cumulative undergraduate (or completed graduate) grade point average, cumulative science grade point average, personal experiences, writing sample, reference letters, familiarity with the PA profession and the University, problem solving and teamwork.

Based upon a point scoring system with holistic consideration of each candidate, the Admissions Committee may recommend one of the following:

Acceptance: The review of the candidates' scores that are based upon the candidate's completed CASPA application and interviews will be recommended to the University of Toledo, College of Graduate Studies for acceptance. The number of candidates recommended for acceptance will be determined by the PA Program class size of 45 students. Following interviews, candidates are informed of acceptance beginning in March.

Alternate/Waiting List: A limited number of candidates will be listed as alternates and will be notified of this admission status. Candidates not admitted from the alternate list must reapply if they wish to be considered for the following year. Following interviews, candidates are informed of alternate status in March and April.

Non-Acceptance: Candidates not accepted will be notified in writing. Candidates wishing to be considered for the following year must reapply. Candidates not accepted are informed in April and May.

Admission Criteria for "Provisional" Status:

An applicant must complete the general admission requirements specified above. Circumstances which may result in a provisional admission include:

- An applicant with a Bachelor's degree in progress (must be completed by June 30<sup>th</sup>). An official transcript with the degree posted must be received prior to matriculation into the program.
- An applicant with an undergraduate cumulative grade point average (GPA) less than 3.0 may be admitted with provisional status. Students must achieve a 3.0 in graduate study at University of Toledo by the completion of 15 semester hours or may be subject to dismissal. In the past, candidates with undergraduate GPAs less than 3.0 have not been competitive unless they have demonstrated academic achievement through the completion of a relevant graduate level degree program.
- An applicant who has any prerequisite courses to complete at the time of application may be admitted with provisional status, with a clear understanding that remaining prerequisites must be satisfactorily (grade of B- or better) completed prior by June 30<sup>th</sup> for matriculation into the Program. Official transcripts or other appropriate documentation will be required.
- Candidates who are unable to pass the medical terminology proficiency examination will be required to participate in a self-study program and retest or satisfactorily complete a medical terminology course at an accredited college or university prior to matriculation in Fall courses.

Technical Standards for Admission

Our objective is to increase the opportunities for persons with disabilities, while maintaining the expectation that all students achieve the goals of the Program. The technical standards for admission establish the expectations and abilities considered essential for students admitted to the Physician Assistant Program in order to achieve the level of competency required for graduation and ultimately practice as a physician assistant. All students admitted to the PA Program are expected to be able to demonstrate the abilities specified below.

Physician Assistant Program students:

- must have the mental capacity to assimilate and learn a large amount of complex, technical and detailed information, to solve clinical problems, and synthesize and apply concepts and information from various disciplines in order to formulate diagnostic and therapeutic plans;

- must have the ability to maintain composure and emotional stability during periods of high stress;
- must have the ability to communicate effectively and sensitively with patients from different social and cultural backgrounds and develop effective professional rapport with patients and co-workers;
- must have the ability to record examination and diagnostic results clearly, accurately and efficiently;
- must have adequate sensory function to fulfill minimum competency objectives for palpation, percussion and auscultation necessary to perform a physical examination;
- must possess sufficient postural control, neuromuscular control and eye-to-hand coordination to use standard medical/surgical instruments and possess sufficient control of the upper extremities to meet the physical requirements for training and for performing a safe physical examination;
- are expected to learn and perform common diagnostic and therapeutic procedures (e.g., phlebotomy, suturing) and interpret the results;
- are expected to have a degree of coordination of motor skills necessary to respond to emergency situations quickly and appropriately.

Candidates are urged to ask questions about the program's technical standards for clarification and to determine whether they can meet the requirements with or without reasonable accommodations. Questions may be directed to the Program Director or Office of Student Services. Revealing a disability is voluntary; however, such disclosure is necessary before any accommodations may be made in the learning environment or in the Program's procedures. Information about disabilities is handled in a confidential manner. Reasonable accommodations will be made to comply with the Americans with Disabilities Act. These require program and institutional approval. Requests for accommodations must be submitted in writing, allowing sufficient time prior to matriculation for action on these requests pursuant to Policy 01061, Nondiscrimination on the Basis of Disability.

#### Other Requirements

Individuals selected for admission to the program must undergo a general physical examination and provide evidence of up-to-date immunization prior to the start of classes in the first year and again just prior to the beginning of clinical rotations in the second year. In addition, students are required to maintain health insurance and liability insurance coverage. Further information is contained in the College of Graduate Studies Handbook and will be reviewed in detail at orientation.

#### Curriculum

To remain in good academic standing in the Physician Assistant Program, a student must be able to demonstrate the possession of:

- a current cumulative graduate GPA of at least 3.0
- a minimum of "B" grade in all PHYA courses except the following courses which require a minimum grade of "C"
  - PHYA601 - Basic Genetics
  - PHYA613 - Research & Stats
- The maximum number of credit hours of "C" which may apply toward a degree is eleven (11) (this number is the 5 ANAT credits + the 3 PHYS credits + the 1 PHYA601 genetics credit + the 2 PHYA613 stat credits)

#### COURSE SEQUENCE

##### Semester 1 FALL

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
ANAT5000	Anatomy for Physician Assistants	5
PHYS5050	Physiology for Physician Assistants	3
PHYA5010	Introduction to the P.A. Profession	1
PHYA5100	Prin. of Interviewing & Medical History	3
PHYA5140	Health Care Teams & Systems	2

Total 14

##### Semester 2 SPRING

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
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PHYA5400	Pathophysiology I	2
PHYA5210	Diagnostic & Therapeutic Skills I	2
PHYA5310	Clinical Medicine I	4
PHYA5510	Pharmacology I	2
PHYA5130	Patient Evaluation	3
PHYA6050	Medical Ethics	2

Total 15

#### Semester 3 SUMMER

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
PHYA5520	Pharmacology II	2
PHYA5410	Pathophysiology II	2
PHYA5340	Clinical Medicine II	3
PHYA5220	Diagnostic & Therapeutic Skills II	1
PHYA6110	Health Promotion & Disease Prevention	1
PHYA6010	Basic Genetics	1
PHYA6030	Intro to Long Term Care	1

Total 11

#### Semester 4 FALL

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
PHYA5230	Diagnostic & Therapeutic Skills III	2
PHYA5330	Clinical Medicine III	6
PHYA5430	Pathophysiology III	1
PHYA5530	Pharmacology III	2
PHYA6130	Research & Statistics	2
PHYA6150	Behavioral Science	2

Total 15

#### Semester 5 SPRING

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
PHYA6500	Introduction to Clinical Practice	1
PHYA6600	Research Practicum	1
PHYA6610	Scholarly Project I	1
	Clinical Practice (3 rotations)	6

Total 9

#### Semester 6 SUMMER

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Clinical Practice (3 rotations)	6
PHYA6620	Scholarly Project II	1

Total 7

#### Semester 7 FALL

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
PHYA6630	Scholarly Project III	1
PHYA6760	Clinical Preceptorship	4
	Clinical Practice (2 rotations)	4



Total	9
TOTAL PROGRAM HOURS	80

The revised program is pending review.

Clinical Practice consists of a total eight (one-month) rotations, with one in each of the following specialties: emergency medicine, internal medicine, family medicine, long-term care, prenatal/gynecology, surgery, pediatrics, and an elective (which may be any specialty of medicine).

## Certificate in Pathology for Post Second Year Medical Students

*Amira Gohara, Ph.D., chair*

Pathology for Post-Second Year Medical Students Certificate  
 “Pre-Clinical Pathology Fellowship”

### Admission Requirements

- Successful completion of a second year medical school curriculum from an LCME accredited medical school with grades equivalent to a GPA  $\geq 3.0$ .
- GRE exam not required

### Core Courses

Course #	Course Title	Credits
<u>Fall</u>		
PATH6060	Introduction to Surgical Pathology & Cytology	2
PATH6070	Introduction to Clinical Laboratory Medicine	2
PATH6080	Introduction to Postmortem Pathology	2
PATH6890	Independent Study in Pathology	1
<u>Spring</u>		
PATH6060	Introduction to Surgical Pathology & Cytology	2
PATH6070	Introduction to Clinical Laboratory Medicine	2
PATH6080	Introduction to Postmortem Pathology	2
PATH6890	Independent Study in Pathology	1
<u>Summer</u>		
PATH6060	Introduction to Surgical Pathology & Cytology	2
PATH6070	Introduction to Clinical Laboratory Medicine	2
PATH6080	Introduction to Postmortem Pathology	2

Students from LCME accredited medical schools who have completed their second year and are in good academic standing are eligible to apply for this program. While the American Board of Pathology gives up to 1 year credit toward certification for time spent as a Fellow, the Fellowship is not limited to those planning to make pathology a career.

### Student Learning Objectives

At the end of the fellowship, the students will be able to:

#### Autopsy Service

- perform a complete autopsy including evisceration, dissection and examination of the various organs including brain
- describe grossly and microscopically all organs from a given autopsy and provide a clinicopathologic correlation as to the cause of death

#### Surgical Pathology

- Perform gross and microscopic examinations on surgical specimens
- cut, stain and review frozen sections
- interpret frozen sections
- interpret gross and microscopic surgical pathology specimens

#### Clinical Pathology

- interpret peripheral blood smears
- provide clinicopathologic correlations for chemistry, microbiology and immunology tests
- perform phlebotomies on in- and out-patients

#### Electives and Scholarly Activities

- analyze scientific articles
- interpret EM specimens
- prepare and present scientific papers at annual scientific day

#### Teaching

- teach second year medical school labs