

# College of Medicine & Life Sciences

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## 2021-22 Catalog: 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 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.

### 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)
- 11 credits Physician Assistant Program (PA)
- 12 credits MSBS clinical track programs including MS Medical 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

Bioinformatics	(Prog. in Bioinformatics; Dept. of Neurosciences)
Cancer Biology	(Department of Cancer Biology)
Molecular Medicine	(Department of Physiology & Pharmacology)
Medical Microbiology and Immunology	(Department of Med. Micro. & Immun.)
Neurosciences and Neurological Disorders	(Department of Neurosciences)

### Master of Science in Biomedical Sciences

Bioinformatics and Proteomics/Genomics
Biomarkers and Diagnostics (Professional Science Masters)
Cancer Biology
Molecular Medicine
Medical Microbiology and Immunology

## Dual Degrees\*

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

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 Science\*

\*Students must be accepted into the MD program first to be eligible for the dual degree

## Graduate Certificates

Certificate in Biomarkers and Bioinformatics

## 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, 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 at 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, an appropriate test of English language proficiency is required. Scores from The Test of English as a Foreign Language (TOEFL) are accepted and a minimum iBT score of 80, or pBT score of 550 is required. Scores from The International English Language Testing Service (IELTS) are also accepted and a minimum score of 6.5 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 Science 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 also a limited number of tuition scholarships and stipends available for students in the Masters in Biomedical Science programs.

## Bioinformatics and Proteomics/Genomics

*Robert Blumenthal, Ph.D., program director*

The Bioinformatics and Proteomics/Genomics (BIPG) 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 BIPG studies are for an independent degree or for one of the several dual-degree programs. In addition, students in other programs may take BIPG courses as electives.

## Doctor of Philosophy in Biomedical Sciences: Bioinformatics Track

### Program in Bioinformatics, and Department of Neurosciences

*Robert Mccullumsmith M.D., Ph.D., chair*  
*Robert Blumenthal, Ph.D., Track Director*  
*Alexei Fedorov, Ph.D., Associate Track Director*

BIPG PhD students enroll in a 1<sup>st</sup> year core curriculum that provides a comprehensive overview of biochemistry/protein biology, molecular and cellular biology, molecular basis of diseases, research methodology, ethics, and bioinformatic/biostatistical analyses. PhD students complete three laboratory rotations during their 1<sup>st</sup> year and join a BIPG-affiliated laboratory during the spring semester of their 1<sup>st</sup> year. In the 2<sup>nd</sup> year and beyond, BIPG PhD students take advanced and elective courses, including advanced programming in bioinformatics, algorithms for bioinformatics, current topics (journal article discussions), and dissertation research. Other training activities include formal research presentations, Council for Biomedical Graduate Student research fora, and presentations at regional, national, and international conferences. BIPG PhD students are expected to participate in annual meetings of the Great Lakes Bioinformatics Consortium (GLBio, an affiliate of the International Society for Computational Biology). All PhD students in good academic standing (GPA > 3.0) may be supported 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 concentrate on his/her graduate research. Teaching experiences can be arranged if a student desires this training as well. All PhD students are required to complete a written dissertation and defend his/her research project at a final oral defense before the degree will be conferred.

BIPG students may, with Program approval, join laboratories of faculty from any department in the College of Medicine and Life Sciences. The graduate advisory committees must include at least one member of the core Bioinformatics faculty. After joining a laboratory, a graduate advisory committee is jointly chosen by the student and advisor to promote academic progress toward completion of the PhD degree.

#### **Year 1: PhD Students**

(Note: “Current Problems and Research Approaches” abbreviated as ‘CPRA’ below)

##### **Fall Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
n/a	Introduction to Biomedical Research	0
BIPG5200	Statistical Methods in Bioinformatics	3
BMSP6340	CPRA in Genes and Genomes	2
BIPG5100	Funds of Bioinformatics and Proteomics/Genomics	3
BMSP6390	Mentored Research (two 5-week lab rotations)	1
<i>Fall Total</i>	.....	9

##### **Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG6100	Bioinformatic Computation	3
BMSP6350	CPRA in Cell Biology and Signaling	3
BMSP6390	Mentored Research (one or two 5-week lab rotation)	1
[BIPG6400	Applications of Bioinformatics (odd years) – <b>OR</b> –	3
BRIM6200	Biomarker Disc, Validn, and Implementn (even years)	3]
<i>Spring Total</i>	.....	10

All students must pass BIPG ‘100 Question Preliminary Exam’ by May 30<sup>th</sup> of their 1<sup>st</sup> year

##### **Summer Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG5400	Biodatabases	1
INDI6020	"On Being a Scientist"	1
BIPG6890	Independent Study in Bioinfo (Pre-Qualifying Exam)	1
BIPG7300	Transcriptomic Data Science	3
<i>Summer Total</i>	.....	6

### **Year 2: PhD Students**

#### **Fall Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG6300	Clinical Proteomics	2
BIPG5300	Current Topics in BPG	1
BIPG6890	Indep Study in BPG (Pre-Qualifying Exam)	3
BIPG6200	Advanced Programming in Bioinformatics	3
<i>Fall Total</i>	.....	9

All students must pass Qualifying Exam by the end of fall semester (December) of their 2<sup>nd</sup> year

#### **Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG6500	Applied Statistics for Bioinformatics	3
BIPG7350	Algorithms for Bioinformatics	3
BIPG9990	Dissertation Research in BPG	2
BIPG5300	Current Topics in BPG	1
<i>Spring Total</i>	.....	9

#### **Summer Semester** (required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG9990	Dissertation Research in BPG	6
<i>Summer Total</i>	.....	6

### **Year 3 and 4: PhD Students**

#### **Fall Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG5300	Current Topics in BPG	1
BIPG9990	Dissertation Research in BPG	8
<i>Fall Total</i>	.....	9

#### **Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG5300	Current Topics in BPG	1
BIPG9990	Dissertation Research in BPG	8
<i>Spring Total</i>	.....	9

#### **Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG9990	Dissertation Research in BPG	6
<i>Summer Total</i>	.....	6

### **Year 5 and beyond: PhD Students**

#### **Fall and Spring Semesters**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
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BIPG5300      Current Topics in BPG      1 credit each in fall and spring

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG9990	Dissertation Research in BPG	1

**Notes about BIPG PhD Program:**

The PhD Qualifying Exam is taken in the Fall semester of the second year. Prior to completing the exam, students should carry out their dissertation research under the course BIPG6890 Independent Study in Bioinformatics. After passing the Qualifying Exam, students conduct their research under the course Dissertation Research (BIPG9990). 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 remaining credits are approved electives and independent study in the Bioinformatics track. Approved electives are taken when needed to supplement the student’s knowledge in areas that the advisor and advisory committee agree are appropriate, and when sufficient progress on thesis research is being made. The Dissertation Research credits are reduced to make space for the elective credits.

The minimum number of credits required to obtain a Ph.D. is 90, with a minimum of 25 credits of didactic coursework (letter grade), and a minimum of 30 credits of dissertation research. The remainder of the credits are approved electives and research in the Bioinformatics track.

**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 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 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>
	Introduction to Biomedical Research	0
BMSP6340	*CPRA Genes & Genomes	2
BIPG5200	Statistical Methods in BPG	3
BIPG5100	Fundamentals in BPG	3
BMSP6390	**Mentored Research	1

(2x5 wk lab rotations)

Total 9

\*\*Students must register for a specific 10 wk/1cr section of BMSP6390 Mentored Research. As a prerequisite, students must attend an introductory series of short research presentations “Introduction to Biomedical Research”. These presentations do not require register, but are BIPG students are expected to attend for the first 3-4 weeks of the Fall semester.

### Spring Year 1

Course	Course Name	Credit Hours
BIPG6100	Bioinformatic Computation	3
BIPG6400	Applications of BPG	3
OR		
BRIM6200	Biomarker Discovery, Validation and Implementation	3
BMSP6350	Cell Biology & Signaling	3
Total		9

\*\*\* Students must pass Qualifying Exam before registering for BIPG 6990 Thesis research. In this and other terms, with permission of advisory committee, student may take Scholarly Project in BPG (BIPG5900) in place of Thesis in Bioinformatics

### Summer Year 1

Course	Course Name	Credit Hours
BIPG5400	Bioinformatics Databases	1
INDI6020	“On Being A Scientist”	1
BIPG5500	Microarray Analysis	1
BIPG6990	Thesis in Bioinformatics	3
Total		6

### Fall Year 2

Course	Course Name	Credit Hours
Elective 2	(see approved list) .....	3
BIPG5300	*Current Topics in BPG.....	1
BIPG6990	Thesis in Bioinformatics .....	5
Total	.....	9

\* Journal paper review and presentation

### Spring Year 2

Course	Course Name	Credit Hours
Elective 2	(see approved list) .....	3
BIPG6990	Thesis in Bioinformatics .....	6
Total	.....	9

### Summer Year 2 (if required)

BIPG6990	Thesis in Bioinformatics .....	6
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The minimum number of credits required for MSBS is 42, with a minimum of 20 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 BIPG track.

## Master of Science in Biomedical Sciences: Professional Science Masters 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-PBD program is targeted to students completing a bachelor 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
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

<i>Course</i>	<i>Course Name</i> .....	<i>Credit Hours</i>
BIPG6100	Bioinformatic Computations .....	3
BMSP6350	Cell Biology & Signaling.....	3
BRIM6200	Biomarker Discovery, Validation, and Implementation.....	3
HURM6730	Performance Management.....	3

### Summer

<i>Course</i>	<i>Course Name</i> .....	<i>Credit Hours</i>
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-PBD, 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 have the choice of taking three of the five 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. “Applications of BPG” in which faculty members using these methods will discuss and demonstrate how these techniques are utilized to solve research problems
5. “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 three, 3-credit courses, for a total of 9 credits (listed below) that can be taken over 1-4 years: (BPG – Bioinformatics and Proteomics/Genomics). The following shows the available courses. The choice of which three courses to take should be made in consultation with the Program Director.  
(BIPG – 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 (odd yrs)	3
OR		
BRIM6200/8200	Biomarker Discovery, Validation and Implementation (even yrs)	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 BIPG 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/BIPG 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: <https://www.utoledo.edu/med/depts/bioinfo/pages/Pipeline.html>

### **BIPG Pipeline: Year 1**

#### **Fall Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIOL 2150	Fundamental of Life Science	4
BIOL 2160	Fundamental of Life Science Lab	1
CHEM 1230	General Chemistry I	4
CHEM 1280	General Chemistry I lab	1
ENGL 1110	Composition I	3
NSM 1000	Orientation	2
Total		15

#### **Spring Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIOL 2170	Fundamental of Life Science II	4
BIOL 2180	Fundamental of Life Sciences II Lab	1
CHEM 1240	General Chemistry II	4
CHEM 1290	General Chemistry II Lab	1
ENGL 1130-50	Composition	3
	Electives	3
Total		16

### **BIPG Pipeline: Year 2**

#### **Fall Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIOL 3010	Molecular Genetics	3
BIOL 3020	Molecular Genetics Lab	2
CHEM 2410	Organic Chemistry I	3
CHEM 2460	Organic Chemistry I Lab	1
MATH 1750	Calculus	4
Or MATH 1850		
	Electives	3
Total		16

**Spring Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIOL 3030	Cell Biology .....	3
BIOL 3040	Cell Biology Lab .....	2
CHEM 2420	Organic Chemistry II.....	3
MATH 1760	Calculus II .....	3
Or MATH 1860	.....	
	Elective.....	3
	Elective.....	3
Total	.....	17

**BIPG Pipeline: Year 3****Fall Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIOL 3090	Developmental Biology .....	3
PHYS 2070	General Physics I.....	5
Or PHYS 2130	.....	
CHEM 3510	Biochemistry I.....	3
MATH 2600	Introduction to Statistics.....	3
	Elective.....	3
Total	.....	17

**Spring Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIOL 3070	Human Physiology .....	3
PHYS 2080	General Physics II .....	5
Or PHYS 2140	.....	
CHEM 3520	Biochemistry II.....	3
BIOL 4100	Human Genetics .....	3
Or	.....	
BIOL 4210	Molec Basis of Human Disease .....	3
	Elective.....	3
Total	.....	17

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
	Elective.....	3
	Elective.....	3

**BIPG Pipeline: Year 4****Fall Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit hours</i>
	Elective.....	3
BIOL 4700	Biological Lit & Commun .....	3
BIPG 5200	Statistical Methods Bioinformatics* .....	3
BIPG 5100	Fundamentals of Bioinformatics* .....	3
Total	.....	12

**Spring Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BIPG 6100	Bioinformatic Computation* .....	3
BMSP 6390	Mentored Research.....	1
BIPG 6400	Applications of Bioinformatics .....	3
Or	.....	
BRIM 6200	Biomarker Discovery, Validation, & Impl... 3	

BMSP 6350	Cell Biology & Signaling.....	3
BIOL 4010	Molecular Biology .....	3
Total	.....	13

*Qualifying Exam*

**Summer Semester**

BIPG 5400	Bioinfo Database.....	1
BIPG 5500	MicroArray Analysis.....	1
BIPG 6990	Thesis Research in BPG*.....	3
INDI 6020	On Being a Scientist.....	1
Total	.....	6

**BIPG Pipeline Year 5:**

**Fall Semester**

BIPG 5300	Journal Club Grad.....	1
BIPG 6990	Thesis Research in BPG**.....	5
	GRAD Elective .....	3
Total	.....	9

Spring Semester

BIPG 6990	Thesis Research in BPG**.....	6
	GRAD Elective .....	3
Total	.....	9

\*Count towards both undergrad and graduate degree

\*\*Can be taken only after Qualifying Exam

## Doctor of Philosophy in Biomedical Sciences: Cancer Biology Track

### Department of Cancer Biology

*JianTing Zhang, Ph.D., chair*

*Xiaohong Li, Ph.D., Track Director*

The Cancer Biology track within the Biomedical Science Program at the University of Toledo fosters young scientists to become cutting-edge researchers who understand the molecular and genetic basis of cancer and the knowledge to develop improved therapies for human 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. CAB students may pursue the Doctor of Philosophy (PhD) degree or, after acceptance into the medical school, a combined MD/PhD degree. The Masters' degree in Cancer Biology is not currently offered.

The CAB program faculty research interests and areas of expertise are: 1) Control of tumor cell growth and death, 2) Signal transduction, 3) Mechanisms of cancer cell motility and chemotaxis, 4) Invasion and metastasis, 5) Molecular genetics of cancer risk, 6) Influence of tumor microenvironment on cancer progression and metastasis, 7) Protein trafficking, 8) Epigenetic regulation of oncogenes and tumor suppressor genes. 9) Chromatin remodeling and mechanisms of DNA repair, 10) Nitric oxide signaling alterations in cancer cells and 11) Adipogenesis and pre-adipocyte/adipocyte functions; Role of adipokines in cancer.

Cancer Biology PhD 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 dissertation research project. PhD students complete three rotations and then may join a Cancer Biology laboratory in the spring semester of their first year. 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.

**PhD Program Students: Year 1\*\*\***

**Fall Semester** (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 Proteins	2
BMSP6340	CPRA in Genes and Genomes	2
BMSP6360	CPRA in Cell Membranes	2
BMSP6380	Methods in Biomedical Sciences	2
BMSP6390	Mentored Research (two 5 week lab rotations)	1
Total		9

**Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6470	Systems Pathophysiology	4
BMSP6350	CPRA in Cell Biology and Signaling	3
BMSP6390	Mentored Research (one-two 5 week lab rotation)	1
CABP8560	Readings in Cancer Biology-JC*	0.5
Total		8.5

**Summer Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
INDI6020	On Being a Scientist .....	1
BMSP7320	Statistical Methods I*	3
CABP6730	Research in CABP or	0-2
CABP6890	Independent Study in Cancer Biology Or other Electives (optional)	0-2
Total		6

**PhD Program Students: Year 2\*\*\***

PhD Qualifying Examination - successful completion required by end of Fall semester of Year 2

**Fall Semester** (\* = required) (\*\* = only if Qualifying Exam has been passed)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP8270	Advanced Cancer Biology* (or take in third year)	0 or 3
BIPG7100	Fundamentals of BPG*	3
CABP9990	Dissertation Research** or	0-6
CABP6730	Research in CABP*	
CABP8560	Readings in Cancer Biology*-RPR	0.5
CABP8890	Independent Study in Cancer Biology Or other Electives (optional)	0-6
Total		8.5

**Spring Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP8560	Readings in Cancer Biology-JC*	0.5
CABP9990	Dissertation Research*	0-8
CABP8890	Independent student in Cancer Biology Or other Electives (optional)	0-8
Total		8.5

**Summer Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP9990	Dissertation Research*	1-6
CABP8890	Independent Study in Cancer Biology	

	Or other Electives (optional)	0-6
Total		6

**PhD Program Students: Year 3\*\*\***

**Fall Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP9990	Dissertation Research*	3-9
CABP8270	Advanced Cancer Biology*	
	(if not taken in second year)	0 or 3
CABP8560	Readings in Cancer biology-RPR*	0.5
CABP8890	Independent Study in Cancer Biology	
	Or other Electives (optional)	0-6
Total		8.5

**Spring Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP9990	Dissertation Research*	0- 8
CABP8560	Readings in Cancer Biology-JC*	0.5
CABP8890	Independent Study in Cancer Biology	
	Or other Electives (optional)	0-6
Total		8.5

**Summer Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP9990	Dissertation Research*	6

**PhD Program Students: Year 4\*\*\***

**Fall**

CABP8560	Readings in Cancer Biology-RCR*	0.5
CABP 9990	Dissertation Research	0-8
Total		8.5

**Spring**

CABP9990	Dissertation Research	9
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**Summer**

CABP9990	Dissertation Research	6
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**PhD Program Students: Year 5 and beyond\*\*\***

**Fall, Spring and Summer Terms**

Dissertation Research (CABP9990)	Total 1 credit all semesters
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\*\*\*All CAB students are expected to give a CAB student seminar every year, except when the student's graduate advisory committee approves that s/he may begin writing their dissertation, that student may be exempt from giving a seminar but is still required to attend all CAB seminars during this time. CAB students are also required to present posters in the annual COMLS Graduate Student Research Forums and oral presentations in the annual Larry Gentry Research Symposia beginning in their second year.

The PhD Qualifying Exam is taken by the end of Fall semester of the second year. Prior to completing the exam, students should carry out their dissertation research under the course Research in CABP (CABP6730). 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 24 credits of didactic coursework (letter grade), and a

minimum of 30 credits of dissertation research. The remaining credits are approved electives and research in the Cancer Biology track.

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

The Cancer Biology (CAB) track participates in the Masters in Biomedical Sciences training program. MSBS students are expected to complete a 1<sup>st</sup> year core curriculum similar to that of doctoral students, but CAB MSBS students join a laboratory after two rotations and elective courses are not required during the 2<sup>nd</sup> year. The primary goal of the MSBS program in CAB is to train students in the basic techniques required to perform molecular and cellular research on cancer topics and/or teaching. MSBS students are required to obtain a minimum of 40 credit hours total, with a minimum of 20 credit hours in didactic courses, and a minimum of 10 credit hours of thesis research for the MSBS degree. The rest of the credits are approved electives and research in the Cancer Biology track. MSBS students also are required to successfully pass a qualifying exam by the end of summer of their 1<sup>st</sup> year and to write and defend a research thesis before the degree will be conferred. MSBS students typically complete the degree requirements in 2-3 years.

### Masters Program Students: Year 1

#### Fall Semester (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 Proteins	2
BMSP6340	CPRA in Genes and Genomes	2
BMSP6360	CPRA in Cell Membranes	2
BMSP6380	Methods in Biomedical Sciences	2
BMSP6390	Mentored Research (two 5 week lab rotations)	1
Total		9

#### Spring Semester (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6470	Systems Pathophysiology	4
BMSP6350	CPRA in Cell Biology and Signaling	3
CABP6560	Readings in Cancer Biology	1
CABP6730	Research in CABP	1
Total		9

#### Summer Semester (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320	Statistical Methods I*	3
INDI6020	"On Being a Scientist"	1
CABP6730	Research in CABP	2
Total		6

Qualifying Examination must be successfully completed by end of summer semester, which consists of 20 questions taken from a '100 question cancer biology bank' that was given to you at the start of your 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).

### Masters Program Students: Year 2

#### Fall Semester (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP6270	Advanced Cancer Biology (elective)	0-3
CABP6990	Thesis Research*	1-9

	Electives	0-9
Total		9

Spring Semester (\* = required)

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

Summer Semester (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP6990	Thesis Research*	1-6
Total		6

Masters Program Students: Year 3 (if necessary)

Fall Semester (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
CABP6990	Thesis Research*	9
Total		9

Spring Semester (\* = required)

CABP6990	Thesis Research*	9
Total		9

Summer Semester (\* = required)

CABP6990	Thesis Research*	6
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All Masters students are also required to present posters in the annual COMLS 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 carcinogenesis.

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

### Department of Medical Microbiology and Immunology

Z. Kevin Pan, Ph.D., Chair

Z. Kevin Pan, Ph.D., Co-Track Director  
 Jason Huntley, Ph.D., Co-Track Director

The Medical Microbiology and Immunology (MMIM) (formerly Infection, Immunity and Transplantation) training program at the University of Toledo College of Medicine and Life Sciences on the Health Science Campus offers PhD, MD/PhD, and MSBS degrees through the Biomedical Science interdisciplinary degree program. The primary goal of the doctoral program in Medical Microbiology and Immunology is to train students for independent careers in bacteriology, virology, and immunology research and/or teaching.

MMIM PhD students enroll in a 1<sup>st</sup> year core curriculum that provides a comprehensive overview of biochemistry/protein biology, molecular and cellular biology, molecular basis of diseases, research methodology, ethics, and statistical analyses. PhD students complete three laboratory rotations during their 1<sup>st</sup> year and join a MMIM laboratory during the spring semester of their 1<sup>st</sup> year. In the 2<sup>nd</sup> year and beyond, MMIM PhD students take advanced and elective courses, including advanced immunology, advanced microbiology, current topics in MMIM (journal club and departmental seminar series), and dissertation research. Other training activities include formal research presentations at annual Medical Microbiology and Immunology Departmental retreats, Council for Biomedical Graduate Student research forums, and presentations at regional, national, and international conferences. All PhD students in good academic standing (GPA > 3.0) may be supported 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 concentrate on his/her graduate research. Teaching experiences can be arranged if a student desires this training as well. All PhD students are required to complete a written dissertation and defend his/her research project at a final oral defense before the degree will be conferred.

MMIM students are strongly encouraged to join laboratories of MMIM primary faculty. Other faculty in the College of Medicine and Life Sciences may have joint appointments in MMIM or may serve on graduate advisory committees. After joining a laboratory, a graduate advisory committee is jointly chosen by the student and advisor to promote academic progress toward completion of the PhD degree. The MMIM Department occupies recently-renovated space and maintains state-of-the-art equipment to answer complex microbiology and immunology questions, including studies on host-pathogen interactions and immune-mediated diseases.

**Year 1: PhD Students**

(Note: “Current Problems and Research Approaches” abbreviated as ‘CPRA’ below)

**Fall Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
n/a	Introduction to Biomedical Research	0
BMSP6330	CPRA in Proteins	2
BMSP6340	CPRA in Genes and Genomes	2
BMSP6360	CPRA in Cell Membranes	2
BMSP6380	Methods in Biomedical Sciences	2
BMSP6390	Mentored Research (two 5-week lab rotations)	1
<i>Fall Total</i>	.....	9

**Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6470	Systems Pathophysiology	4
BMSP6350	CPRA in Cell Biology and Signaling	3
BMSP6390	Mentored Research (one or two 5-week lab rotation)	1
MMIM6030	Current Topics in MMIM	1
<i>Spring Total</i>	.....	9

All students must pass MMIM ‘100 Question Exam’ by May 30<sup>th</sup> of their 1<sup>st</sup> year

**Summer Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP7320	Statistical Methods I	3



INDI6020	"On Being a Scientist"	1
MMIM6890	Research in MMI (Pre-Qualifying Exam)	2
<i>Summer Total</i>	.....	6

**Year 2: PhD Students**

**Fall Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM8020	Advanced Immunology	1
MMIM8030	Current Topics in MMIM	1
MMIM6890	Research in MMI (Pre-Qualifying Exam)	7
<i>Fall Total</i>	.....	9

All students must pass Qualifying Exam by the end of fall semester (December) of their 2<sup>nd</sup> year

**Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM8040	Advanced Microbiology	1
MMIM8030	Current Topics in MMIM	1
MMIM9990	Dissertation Research in MMI	7
<i>Spring Total</i>	.....	9

**Summer Semester** (required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM9990	Dissertation Research in MMI	6
<i>Summer Total</i>	.....	6

**Year 3 and 4: PhD Students**

**Fall Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM8030	Current Topics in MMIM	1
MMIM9990	Dissertation Research in MMI	8
<i>Fall Total</i>	.....	9

**Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM9990	Dissertation Research in MMI	8
MMIM8030	Current Topics in MMIM	1
<i>Spring Total</i>	.....	9

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM9990	Dissertation Research in MMI	6
<i>Summer Total</i>	.....	6

**Year 5 and beyond: PhD Students**

**Fall and Spring Semesters**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM8030	Current Topics in MMIM	1 credit each in fall and spring

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM9990	Dissertation Research in MMI	1

**Notes about MMIM PhD Program:**

All PhD students must pass their Qualifying Exam by the end of the Fall semester (December) of the 2nd year. Before passing the Qualifying Exam, Ph.D. students should conduct research by registering for 'Research in MMI' (Satisfactory/Unsatisfactory; MMIM6890). After passing the Qualifying Exam, Ph.D. students should conduct their research by registering for Dissertation Research in MMI (MMIM9990).

The minimum number of credits required to obtain a Ph.D. is 90, with a minimum of 25 credits of didactic coursework (letter grade), and a minimum of 30 credits of dissertation research. The remainder of the credits are approved electives and research in the Medical Microbiology and Immunology track.

All Ph.D. students are required to register for Current Topics in MMIM (MMIM8030) during all fall and spring semesters while they are enrolled as a student. When a student's graduate advisory committee approves that he/she may begin writing their dissertation, that student then may be exempt from registering for Current Topics in MMIM.

## 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. MSBS students are expected to complete a 1<sup>st</sup> year core curriculum similar to that of doctoral students, but MMIM MSBS students join a laboratory after one or two rotations and fewer elective courses are required during the 2<sup>nd</sup> year. The primary goal of the MSBS program in Medical Microbiology and Immunology is to train students in the basic techniques required to perform bacteriology, virology, and immunology research and/or teaching. MSBS students are required to obtain a minimum of 40 credit hours in didactic and other courses, including a minimum of 10 credit hours of thesis research for the MSBS degree. MSBS students also are required to successfully pass a qualifying exam by the end of summer of their 1<sup>st</sup> year and to write and defend a research thesis before the degree will be conferred. MSBS students typically complete the degree requirements in 2-3 years.

**Year 1: Masters Students:**

(Note: "Current Problems and Research Approaches" abbreviated as 'CPRA' below)

**Fall Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
n/a	Introduction to Biomedical Research	0
BMSP6330	CPRA in Proteins	2
BMSP6340	CPRA in Genes and Genomes	2
BMSP6360	CPRA in Cell Membranes	2
BMSP6380	Methods in Biomedical Sciences	2
BMSP6390	Mentored Research (two 5-week lab rotations)	1
<i>Fall Total</i>	.....	9

**Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6470	Systems Pathophysiology	4
BMSP6350	CPRA in Cell Biology and Signaling	3
MMIM6890	Research in MMI	1
MMIM6030	Current Topics in MMIM	1
<i>Spring Total</i>	.....	9

All students must pass MMIM '100 Question Exam' by June 30<sup>th</sup> of their 1<sup>st</sup> year

**Summer Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP7320	Statistical Methods I	3
INDI6020	"On Being a Scientist"	1
MMIM6890	Research in MMI	3
<i>Summer Total</i>	.....	6

All MSBS students must pass the Qualifying Exam by the end of the summer semester (August) of their 1<sup>st</sup> year

**Year 2: Masters Students**

**Fall Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM6030	Current Topics in MMIM	1
MMIM6990	Thesis Research in MMI	7-8
MMIM6020	Advanced Immunology (optional)	0-1
<i>Fall Total</i>	.....	9

**Spring Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM6030	Current Topics in MMIM	1
MMIM6990	Thesis Research in MMI	7-8
MMIM6040	Advanced Microbiology (optional)	0-1
<i>Spring Total</i>	.....	9

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM6990	Thesis Research in MMI	6
<i>Summer Total</i>	.....	6

**Year 3 (if necessary): Masters Students**

**Fall/Spring Semesters** (9 credits each), **Summer Semester** (6 credits)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MMIM6990	Thesis Research in MMI	9 Fall and Spring; 6 Summer
<i>Total</i>	.....	9 Fall and Spring; 6 Summer

The minimum number of credits required for a 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: 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 Semester** (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 Proteins	2
BMSP6340	CPRA in Genes and Genomes	2
BMSP6360	CPRA in Cell Membranes	2
BMSP6380	Methods in Biomedical Sciences	2
BMSP6390	Mentored Research (two 5 week lab rotations)	1
Total		9

#### **Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6470	Systems Pathophysiology	4
BMSP6350	CPRA in Cell Biology and Signaling	3
BMSP6390	Mentored Research (one 5 week lab rotation)	1
MOME6600	Journal Paper Review in MOME	1
Total		9

#### **Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320	Statistical Methods I, (required BMS core course)	3
INDI6020	"On Being a Scientist"	1
MOME6730	Research in MOME	3-6
Total		6

### **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>
MOME6300	Seminars in MOME (fall and spring) (required in fall and spring semesters of the 2nd, 3rd and 4th years)	1
MOME6500	Advanced Topics in MOME (fall)	3
MOME6600	Journal Paper Review in MOME (fall and spring) (required in fall and spring semesters of the 2nd and 3rd years)	1

BMSP8250 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. Students will also be expected to present a poster or oral presentation in the annual COMLS Graduate Research Forum in the spring of each year 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 Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME8500	Advanced Topics in MOME (fall)	3
MOME6300	Seminars in MOME (fall and spring)	1
MOME6600	Journal Paper Review in MOME (fall and spring)	1
MOME6730	Research in MOME and/or	0-4
MOME8890	Independent Study in MOME and/or	0-4
	Electives	0-4
Total		9

The PhD Qualifying Exam is taken at the end of the Fall semester of the second year. Prior to passing the PhD Qualifying Exam, the student carries out their research under the course Research in Molecular Medicine (MOME 6730, 1-9 credit hours) or in some cases Independent Study in Molecular Medicine (MOME 6890). After passing the PhD Qualifying Exam, the student carries out their research under the course Dissertation Research (MOME 9990).

**Spring Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME6300	Seminars in MOME (fall and spring)	1
MOME6600	Journal Paper Review in MOME (fall and spring)	1
BMSP6250	Grant Writing Workshop (spring)	2
MOME9990	Dissertation Research and/or	0-6
	Electives	0-6
Total		9

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME9990	Dissertation Research and/or	0-6
	Electives	0-6
Total		6

**PhD Program Students: Year 3**

**Fall Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME6300	Seminars in MOME (fall and spring)	1
MOME6600	Journal Paper Review in MOME (fall and spring)	1
MOME9990	Dissertation Research	7
Total		9

**Spring Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME6300	Seminars in MOME (fall and spring)	1
MOME6600	Journal Paper Review in MOME (fall and spring)	1
MOME9990	Dissertation Research	7
Total		9

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME9990	Dissertation Research	6

**PhD Program Students: Year 4****Fall, Spring and Summer**

MOME8300	Seminars in MOME (fall and spring)	1
MOME9990	Dissertation Research	8 (fall and spring) ; 5 (summer)
Total		9 (fall and spring) ; 6 (summer)

**PhD Program Students: Year 5 and beyond****Fall, Spring and Summer Semesters**

All Dissertation Research (MOME9990)      Total 1 credit all semesters

The minimum number of credits required for PhD is 90, with a minimum of 20 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 Semester** (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 Proteins	2
BMSP6340	CPRA in Genes and Genomes	2
BMSP6360	CPRA in Cell Membranes	2
BMSP6380	Methods in Biomedical Sciences	2
BMSP6390	Mentored Research (two 5 week lab rotations)	1
Total		9

**Spring Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME6600	Journal Paper Review in MOME*	1
BMSP6470	Systems Pathophysiology*	0 or 4
	or	
BMSP6350	CPRA in Cell Biology and Signaling*	0 or 3
MOME6730	Research in MOME	0-8
	or	
BMSP6390	Mentored Research (5 week rotation if needed)	0-1
	Electives	0-7
Total		9

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320	Statistical Methods I, (required BMSP core course)	3
INDI6020	"On Being a Scientist"	1
MOME6730	Research in MOME	3
Total		6

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

**Masters Program Students: Year 2****Fall Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME6300	Seminars in MOME	1
MOME6600	Journal Paper Review in MOME	1
MOME6990	Thesis Research and/or Electives	0-7  0-7
Total		9

**Spring Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6470	Systems Pathophysiology (if not taken in year 1) or	0 or 4
BMSP6350	CPRA in Cell Biology and Signaling (if not taken in year 1)	0 or 3
MOME6300	Seminars in MOME (required for students in their 2nd year)	1
MOME6600	Journal Paper Review in MOME (required by students in their 2nd year)	1
MOME6990	Thesis Research and/or Electives	0-7 0-7
Total		9

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME6990	Thesis Research and/or Electives	0-6  0-6
Total		6

**Masters Program Students: Year 3** (if necessary)**Fall/Spring Semester** (9 credits each), **Summer** (6 credits)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
MOME6990	Thesis Research and/or Electives	1-9  0-8
Total		9 (fall and spring) ; 6 (summer)

The minimum number of credits required for MSBS is 40, with a minimum of 18 credits of didactic coursework (letter grade). A minimum of 10 credits of Thesis Research (MOME 6990) is required for graduation.

The MSBS curriculum includes advanced electives in Molecular Medicine or other areas to make up the 18 required didactic credit hours.

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

### Department of Neurosciences

*Robert Mccullumsmith M.D., Ph.D., chair*

*David Giovannucci, 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 five 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 currently awards PhD in biomedical sciences degree and participates in the MD/PhD 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 three research laboratories, conducting short-term projects, gaining exposure to techniques and identifying potential areas for further investigation. During the second semester, each student selects a major advisor who directs the student's doctoral research. A faculty committee is also jointly chosen by the student and advisor to supervise academic progress toward completion of the PhD degree. In addition to 90 credit hours in didactic and other courses, PhD students are required to successfully pass a qualifying exam that consists of independently writing and defending a research dissertation.

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

#### **PhD Program Students: Year 1**

##### **Fall Semester** (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 Proteins	2
BMSP6340	CPRA in Genes and Genomes	2
BMSP6360	CPRA in Cell Membranes	2
BMSP6380	Methods in Biomedical Sciences	2
BMSP6390	Mentored Research (two 5 week lab rotations)	1
Total		9

##### **Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6470	Systems Pathophysiology	4
BMSP6350	CPRA in Cell Biology and Signaling	3
BMSP6390	Mentored Research (one 5-week lab rotation)	1



NNDP6500	Seminar in Neuroscience	1
<i>Spring Total</i> .....		9

**Summer Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP5320	Statistical Methods I*	3
INDI6020	"On Being a Scientist"*	1
NNDP6730	Research in NNDP	0-3
Total		6

**Ph.D Program Students: Year 2**

**Fall Semester** (\*= required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6560	Readings In Neuroscience	1-4
NNDP6720	Current Topics in Neuroscience	1-4
BIOE5620	Cellular Electrophysiology	3
NNDP6730	Research in NNDP	0-4
Total		9

The PhD Qualifying Exam is taken by the end of the Fall semester of the second year.

**Spring Semester** (\*= required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP8500	Seminar in Neuroscience	1
NNDP8540	Journal Paper Review in Neuroscience * (if offered)	0 or 2
NNDP8720	Current Topics in Neuroscience	1-4
INDI8790	Basic & Advanced Light Microscopy (elective)	0 or 4
INDI8860	Electron Microscopy (elective)	0 or 4
BMSP6250	Grant Writing Workshop (elective)	0 or 2
NNDP9990	Dissertation Research in Neuroscience	0-5
Total		9

**Summer Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP9990	Dissertation Research in Neuroscience	6
Total		6

**PhD Program Students: Year 3**

**Fall Semester** (\*= required)

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

**Spring Semester** (\*= required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP8500	Seminar in Neuroscience	1
NNDP9990	Dissertation Research in Neuroscience	8
Total		9

**Summer Semester** (\* = required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP9990	Dissertation Research in Neuroscience	6

Total 6

**PhD Program Students: Year 4**

**Fall/Spring Terms** (9 credits each); Summer (6 credits)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP9990	Dissertation Research in Neuroscience	0-9 Fall and Spring, 6 Summer

**PhD Program Students: Year 5 and beyond**

**Fall, Spring and Summer Semesters**

All Dissertation Research (NNDP9990) Total 1 credit all semesters

The minimum number of credits required for PhD is 90, with a minimum of 20 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**

*Robert Mccullumsmith, M.D., Ph.D., chair*  
*David Giovannucci, 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. The minimum number of credits for MSBS is 40, wit a minimum of 20 credit hours in didactic courses, and a minimum of 10 credit hours of thesis research. Students are also 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 Semester** (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 Proteins	2
BMSP6340	CPRA in Genes and Genomes	2
BMSP6360	CPRA in Cell Membranes	2
BMSP6380	Methods in Biomedical Sciences	2
BMSP6390	Mentored Research (two 5 week lab rotations)	1
Total		9

**Spring Semester** (all are required)

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
BMSP6470	Systems Pathophysiology	4
BMSP6350	CPRA in Cell Biology and Signaling	3
BMSP6390	Mentored Research (one or two 5-week lab rotation)	1
NNDP6500	Seminar in Neuroscience	1
<i>Spring Total</i>	.....	9

Summer Semester

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
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BMSP5320	Statistical Methods I (required BMS core course)	3
INDI6020	"On Being a Scientist"	1
NNDP6730	Research in Neuroscience	0-3
Total		6

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

**Masters Program Students: Year 2**

**Fall Semester**

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

**Spring Semester**

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

**Summer Semester**

<i>Course</i>	<i>Course Name</i>	<i>Credit Hours</i>
NNDP6990	Thesis Research in Neuroscience	0-6
Total		6

**Masters Program Students: Year 3 (if necessary)**

**Fall/Spring Semesters (9 credits each); Summer (6 credits)**

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