

# College of Medicine & Life Sciences

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## 2019-20 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

Cancer Biology

(Department of Cancer Biology)

Molecular Medicine

(Department of Physiology & Pharmacology)

Medical Microbiology and Immunology\*\*

(Department of Medical Microbiology & Immunology)

Neurosciences and Neurological Disorders

(Department of Neurosciences)

### Master of Science in Biomedical Sciences

Bioinformatics and Proteomics/Genomics

Biomarkers and Diagnostics (Professional Science Masters)

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 Sciences programs.

## 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> |
|---------------|---|---------------------|
|               | Introduction to Biomedical Research           | 0                   |
| BMSP6340      | *CPRA Genes & Genomes                         | 2                   |
| BIPG5200      | Statistical Methods in BPG                    | 3                   |
| BIPG5100      | Fundamentals in BPG                           | 3                   |
| INDI6020      | “On Being A Scientist”                        | 1                   |
| BMSP6390      | **Mentored Research<br>(2x4 wk lab rotations) | 1                   |
| Total         |   | 10                  |

\*\*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 “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**

| <i>Course</i> | <i>Course Name</i>                                    | <i>Credit Hours</i> |
|---------------|---|---------------------|
| BIPG6100      | Bioinformatic Computation                             | 3                   |
| BIPG6400      | Applications of BPG                                   | 3                   |
| OR            |   |                     |
| BRIM6200      | Biomarker Discovery,<br>Validation and Implementation | 3                   |

|          |  |    |
|----------|--|----|
| BMSP6350 | Cell Biology & Signaling               | 3  |
| BIPG6890 | ***Independent Study in Bioinformatics | 1  |
| Total    |  | 10 |

\*\*\* 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            |
| BIPG5500 | Microarray Analysis      | 1            |
| BIPG6900 | Thesis in Bioinformatics | 4            |
| 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 |
|----------|--------------------------------|---|

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 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-PSMBD 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,<br>and Implementation ..... | 3                   |
| HURM6730      | Performance Management.....                                  | 3                   |

**Summer**

| <i>Course</i> | <i>Course Name.....</i>                             | <i>Credit Hours</i> |
|---------------|---|---------------------|
| BIDI5100      | Biomarkers and Diagnostics<br>Internship .....      | 6-8                 |
| BIDI5200      | Readings in Biomarkers/Diagnostics<br>(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 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,<br>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 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 Cancer Biology

*JianTing Zhang, Ph.D., chair*  
*Kandace Williams, Ph.D., co-track director*  
*Dayanidhi Raman, Ph.D., co-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                             | 2.5                 |
| BMSP6340  | CPRA in Genes and Genomes                    | 2                   |
| BMSP6360  | CPRA in Cell Membranes                       | 2.5                 |
| BMSP6380  | Methods in Biomedical Sciences               | 2.5                 |
| INDI6020  | "On Being a Scientist"                       | 1                   |
| BMSP6390  | Mentored Research (two 5 week lab rotations) | 1                   |
| Total   |  | 11.5                |

##### **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                   |
| CABP6560      | Readings in Cancer Biology                      | 1                   |
| Total         |   | 9                   |

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

| <i>Course</i> | <i>Course Name</i>   | <i>Credit Hours</i> |
|---------------|--|---------------------|
| BMSP7320      | Statistical Methods I*   | 3                   |
| CABP6730      | Research in CABP or  | 0-3                 |
| CABP6890      | Independent Study in Cancer Biology<br>Or other Electives (optional) | 0-3                 |
| 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*<br>(or take in third year)                  | 0-3                 |
| BIPG7100      | Fundamentals of BPG*   | 3                   |
| CABP9990      | Dissertation Research** or   | 0-6                 |
| CABP6730      | Research in CABP*  | 0-6                 |
| CABP8890      | Independent Study in Cancer Biology<br>Or other Electives (optional) | 0-6                 |
| Total         |  | 9                   |

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

| <i>Course</i> | <i>Course Name</i>   | <i>Credit Hours</i> |
|---------------|--|---------------------|
| CABP8560      | Readings in Cancer Biology*  | 1                   |
| CABP9990      | Dissertation Research*   | 0-8                 |
| CABP8890      | Independent Study in Cancer Biology<br>Or other Electives (optional) | 0-8                 |
| Total         |  | 9                   |

**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<br>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*<br>(if not taken in second year)            | 0-3                 |
| CABP8890      | Independent Study in Cancer Biology<br>Or other Electives (optional) | 0-6                 |
| Total         |  | 9                   |

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

| <i>Course</i> | <i>Course Name</i>   | <i>Credit Hours</i> |
|---------------|--|---------------------|
| CABP9990      | Dissertation Research*   | 8                   |
| CABP8560      | Readings in Cancer Biology*  | 1                   |
| CABP8890      | Independent Study in Cancer Biology<br>Or other Electives (optional) | 0-6                 |
| Total         |  | 9                   |



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

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

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

Dissertation Research (CABP9990) Total of 9 credits Fall and Spring; 6 credits Summer

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

Dissertation Research (CABP9990) Total 1 credit all semesters

\*\*\*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 in the Fall semester of the second year. Prior to completing the exam, students should carry out their dissertation research under the course Research in CABP (6730). 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 remaining credits are approved electives and research in the Cancer Biology track.

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

\* MSBS in Cancer Biology is not currently offered

**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                                    | 2.5                 |
| BMSP6340      | CPRA in Genes and Genomes                           | 2                   |
| BMSP6360      | CPRA in Cell Membranes                              | 2.5                 |
| BMSP6380      | Methods in Biomedical Sciences                      | 2.5                 |
| INDI6020      | "On Being a Scientist"                              | 1                   |
| BMSP6390      | Mentored Research (two 5 week lab rotations)        | 1                   |
| Total         |   | 11.5                |

**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                   |
| CABP6560      | Readings in Cancer Biology                      | 1                   |
| Total         |   | 9                   |

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

| <i>Course</i> | <i>Course Name</i>   | <i>Credit Hours</i> |
|---------------|--|---------------------|
| BMSP5320      | Statistical Methods I*   | 3                   |
| CABP6730      | Research in CABP or  | 0-3                 |
| CABP6890      | Independent Study in Cancer Biology<br>Or other Electives (optional) | 0-3                 |
| Total         |  | 6                   |

Qualifying Examination must be successfully completed by end of summer semester

Masters Program Students: Year 2

Fall Semester (\* = required)

| <i>Course</i> | <i>Course Name</i>  | <i>Credit Hours</i> |
|---------------|---|---------------------|
| CABP6270      | Advanced Cancer Biology*<br>(or take this course in third year) | 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*            | 0-8                 |
|               | Electives                   | 0-8                 |
| Total         |                             | 9                   |

Summer Semester (\* = required)

| <i>Course</i> | <i>Course Name</i> | <i>Credit Hours</i> |
|---------------|--------------------|---------------------|
| CABP6990      | Thesis Research*   | 1-6                 |
|               | Electives          | 0-6                 |
| Total         |                    | 6                   |

Masters Program Students: Year 3 (if necessary)

Fall Semester (\* = required)

| <i>Course</i> | <i>Course Name</i>   | <i>Credit Hours</i> |
|---------------|--|---------------------|
| CABP6270      | Advanced Cancer Biology *<br>(if not taken in second year) | 0-3                 |
| CABP6990      | Thesis Research*   | 1-9                 |
|               | Electives  | 0-9                 |
| Total         |  | 9                   |

Spring Semester (\* = required)

|          |                  |     |
|----------|------------------|-----|
| CABP6990 | Thesis Research* | 1-9 |
|          | Electives        | 0-9 |
| Total    |                  | 9   |

Summer Semester (\* = required)

|          |                  |   |
|----------|------------------|---|
| CABP6990 | Thesis Research* | 6 |
|----------|------------------|---|

The MSBS Qualifying Exam is taken in the summer semester 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 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                             | 2.5                 |
| BMSP6340          | CPRA in Genes and Genomes                    | 2                   |
| BMSP6360          | CPRA in Cell Membranes                       | 2.5                 |
| BMSP6380          | Methods in Biomedical Sciences               | 2.5                 |
| INDI6020          | "On Being a Scientist"                       | 1                   |
| BMSP6390          | Mentored Research (two 5-week lab rotations) | 1                   |
| <i>Fall Total</i> | .....  | <i>11.5</i>         |

### **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> | .....  | <i>9</i>            |

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                   |
| MMIM6890            | Research in MMI (Pre-Qualifying Exam) | 3                   |
| <i>Summer Total</i> | .....                                 | <i>6</i>            |

## 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> | .....                                 | <i>9</i>            |

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> | .....                        | <i>9</i>            |

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

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

### **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                             | 2.5                 |
| BMSP6340          | CPRA in Genes and Genomes                    | 2                   |
| BMSP6360          | CPRA in Cell Membranes                       | 2.5                 |
| BMSP6380          | Methods in Biomedical Sciences               | 2.5                 |
| INDI6020          | "On Being a Scientist"                       | 1                   |
| BMSP6390          | Mentored Research (two 5-week lab rotations) | 1                   |
| <i>Fall Total</i> | .....  | <i>11.5</i>         |

#### **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> | .....                              | <i>9</i>            |

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                   |
| MMIM6890            | Research in MMI       | 3                   |
| <i>Summer Total</i> | .....                 | <i>6</i>            |

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> | .....                          | <i>9</i>            |

#### **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> | .....                            | <i>9</i>            |

**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                                    | 2.5                 |
| BMSP6340      | CPRA in Genes and Genomes                           | 2                   |
| BMSP6360      | CPRA in Cell Membranes                              | 2.5                 |
| BMSP6380      | Methods in Biomedical Sciences                      | 2.5                 |
| INDI6020      | "On Being a Scientist"                              | 1                   |
| BMSP6390      | Mentored Research (two 5 week lab rotations)        | 1                   |

Total 11.5

**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                   |
| 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,<br>(required BMS core course) | 3                   |
| 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> |
|---------------|--|---------------------|
| MOME8300      | Seminars in MOME (fall and spring)<br>(required in fall and spring semesters of the 2nd, 3rd and 4th years)        | 1                   |
| MOME8500      | Advanced Topics in MOME (fall)   | 3                   |
| MOME/8600     | Journal Paper Review in MOME (fall and spring)<br>(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> |
|---------------|--|---------------------|
| MOME/8500     | Advanced Topics in MOME (fall)                 | 3                   |
| MOME8300      | Seminars in MOME (fall and spring)             | 1                   |
| MOME8600      | Journal Paper Review in MOME (fall and spring) | 1                   |
| MOME8730      | Research in MOME<br>and/or                     | 0-4                 |
| MOME8890      | Independent Study in MOME<br>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 6890/8890). 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> |
|---------------|--|---------------------|
| MOME8300      | Seminars in MOME (fall and spring)             | 1                   |
| MOME8600      | Journal Paper Review in MOME (fall and spring) | 1                   |
| BMSP8250      | Grant Writing Workshop (spring)                | 2                   |
| MOME9990      | Dissertation Research                          | 0-6                 |
|               | and/or   |                     |
|               | Electives                                      | 0-6                 |
| Total         |  | 9                   |

**Summer Semester**

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

**PhD Program Students: Year 3**

**Fall Semester**

| <i>Course</i> | <i>Course Name</i>                             | <i>Credit Hours</i> |
|---------------|--|---------------------|
| MOME8300      | Seminars in MOME (fall and spring)             | 1                   |
| MOME8600      | 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> |
|---------------|--|---------------------|
| MOME6300/8300 | Seminars in MOME (fall and spring)             | 1                   |
| MOME6600/8600 | 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 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 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                                    | 2.5                 |
| BMSP6340      | CPRA in Genes and Genomes                           | 2                   |
| BMSP6360      | CPRA in Cell Membranes                              | 2.5                 |
| BMSP6380      | Methods in Biomedical Sciences                      | 2.5                 |
| INDI6020      | "On Being a Scientist"                              | 1                   |
| BMSP6390      | Mentored Research (two 5 week lab rotations)        | 1                   |
| Total         |   | 11.5                |

#### 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 (1 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,<br>(required BMSP core course) | 3                   |
| 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              | 0-7                 |
|               | and/or                       |                     |
|               | Electives                    | 0-7                 |
| Total         |                              | 9                   |

#### Spring Semester

| <i>Course</i> | <i>Course Name</i>   | <i>Credit Hours</i> |
|---------------|--|---------------------|
| BMSP6470      | Systems Pathophysiology<br>(if not taken in year 1) or         | 0 or 4              |
| BMSP6350      | CPRA in Cell Biology and Signaling<br>(if not taken in year 1) | 0 or 3              |
| MOME8300      | Seminars in MOME   | 1                   |

|          |   |     |
|----------|---|-----|
|          | (required for students in their 2nd year) |     |
| MOME8600 | Journal Paper Review in MOME              | 1   |
|          | (required by students in their 2nd year)  |     |
| MOME6990 | Thesis Research                           | 0-7 |
|          | and/or Electives                          | 0-7 |
| Total    |   | 9   |

#### Summer Semester

| Course   | Course Name     | Credit Hours |
|----------|-----------------|--------------|
| MOME6990 | Thesis Research | 0-6          |
|          | and/or          |              |
|          | Electives       | 0-6          |
| Total    |                 | 6            |

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

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

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

The minimum number of credits required for MSBS is 40, with a minimum of 25 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 25 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                                      | 2.5                 |
| BMSP6340      | CPRA in Genes and Genomes                             | 2                   |
| BMSP6360      | CPRA in Cell Membranes                                | 2.5                 |
| BMSP6380      | Methods in Biomedical Sciences                        | 2.5                 |
| INDI6020      | "On Being a Scientist"                                | 1                   |
| BMSP6390      | Mentored Research (two 5 week lab rotations)          | 1                   |
| Total         |   | 11.5                |

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

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

| <i>Course</i> | <i>Course Name</i>                                   | <i>Credit Hours</i> |
|---------------|--|---------------------|
| BMSP5320/7320 | Statistical Methods I<br>(required BMSP core course) | 3                   |
| 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                 |
| BIOE4720/5620 | 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<br>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 |
| BMSP8250 | 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 | 0-6                 |
| 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 | 0-9                 |
| 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 | 0-8                 |
| Total         |                                       | 9                   |

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

| <i>Course</i> | <i>Course Name</i>                    | <i>Credit Hours</i> |
|---------------|---------------------------------------|---------------------|
| NNDP9990      | Dissertation Research in Neuroscience | 0-6                 |
| 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 (MMIM9990) Total 1 credit all semesters

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**

*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. 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 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                                      | 2.5                 |
| BMSP6340      | CPRA in Genes and Genomes                             | 2                   |
| BMSP6360      | CPRA in Cell Membranes                                | 2.5                 |
| BMSP6380      | Methods in Biomedical Sciences                        | 2.5                 |
| INDI6020      | "On Being a Scientist"                                | 1                   |
| BMSP6390      | Mentored Research (two 5 week lab rotations)          | 1                   |
| Total         |   | 11.5                |

**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> |
|---------------|---|---------------------|
| BMSP5320      | Statistical Methods I<br>(required BMS core course) | 3                   |
| 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<br>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<br>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                   |

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.