1. Request to change the requirements for the Bachelor of Science degree in Neuroscience in the College of Natural Science.

   a. Under the heading Requirements for the Bachelor of Science Degree in Neuroscience make the following changes:

      (1) In item 3. j. (2) change the total credits from ‘6’ to ‘6 or 7’ and delete the following course:

         MMG 404 Human Genetics      3

         Add the following course:

         IBIO 341 Fundamental Genetics      4

      (2) In item 3. k. under the Cellular and Developmental Neuroscience concentration delete the following courses:

         ZOL 341 Fundamental Genetics      4
         ZOL 343 Genetics Laboratory      3
         ZOL 425 Cells and Development (W)      4

         Add the following courses:

         IBIO 341 Fundamental Genetics      4
         IBIO 343 Genetics Laboratory      3
         IBIO 425 Cells and Development (W)      4
         NEU 416 Development of the Nervous System Through the Lifespan      3
         NEU 425 Computational Modeling in Neuroscience      3
         NEU 440 Synaptic Transmission      3
         PHM 422 Fundamentals of Neuropharmacology      3
         PHM 431 Pharmacology of Drug Addiction      3
         PHM 480 Special Problems      1 to 3

      (3) In item 3. k. under the Cellular and Developmental Neuroscience concentration replace the note with the following:

         Microbiology and Molecular Genetics 409, Integrative Biology 341, or Pharmacology and Toxicology 431 may not be used for requirement 3. j. (2) and this concentration. No more than 3 credits each of NEU 490 and NEU 492 may count toward this requirement. Students must have approval from the Neuroscience academic advisor to earn credit in NEU 490, NEU 492, or PHM 480 for this concentration.

      (4) In item 3. k. under the Behavioral and Systems Neuroscience concentration delete the following courses:

         ZOL 313 Animal Behavior      3
         ZOL 403 Integrative Neurobiology      3

         Add the following courses:

         IBIO 313 Animal Behavior      3
         IBIO 403 Integrative Neurobiology      3
         NEU 416 Development of the Nervous System Through the Lifespan      3
         NEU 425 Computational Modeling in Neuroscience      3
(5) In item 3. k. under the **Behavioral and Systems Neuroscience** concentration replace the note with the following:

Pharmacology and Toxicology 431 may not be used for requirement 3. j. (1) and this concentration. No more than 3 credits each of NEU 490 and NEU 492 may count toward this requirement. Students must have approval from the Neuroscience academic advisor to earn credit in NEU 490, NEU 492, PHM 480 or PSY 493 for this concentration.

(6) In item 3. k. change the name of the **Cognitive Neuroscience** concentration to the **Cognitive and Computational Neuroscience** concentration and delete the following course:

ENG 492H Honors Seminar in English     3

Add the following course:

NEU 425 Computational Modeling in Neuroscience     3

(7) In item 3. k. under the **Cognitive and Computational Neuroscience** concentration replace the note with the following:

No more than 3 credits each of NEU 490 and NEU 492 may count toward this requirement. Students must have approval from the Neuroscience academic advisor to earn credit in NEU 490, NEU 492, or PSY 493 for this concentration.

Effective Fall 2016.

2. Request to establish a **Master of Science** degree in **Computational Mathematics, Science, and Engineering** in the Department of Computational Mathematics, Science, and Engineering. The University Committee on Graduate Studies (UCGS) recommended approval of this request at its November 9, 2015 meeting.

a. **Background Information:**

Computational Science is the use of computational methods to solve scientific problems – a rapidly growing and evolving field. Modern research problems are often complex and require extensive computation, either to manipulate and explore vast quantities of data or to create sophisticated theoretical models, or both. At present, training in the methods of computational science is ad hoc and varies widely, and many faculty members, particularly in disciplines where computational techniques are not traditionally used, do not have the expertise to educate their students in necessary topics. Faculty discussion of this critical need at both the undergraduate and graduate levels – and the lack of a curriculum to address this need – precipitated extensive faculty discussion and the creation of this proposed master's degree.

MSU is in the midst of a Provost-led initiative focusing on computational and data science, which involves the creation of a new Department of Computational Mathematics, Science and Engineering, the hiring of a substantial number of faculty to staff this department and lead interdisciplinary initiatives in computation-enabled science, and the creation of both undergraduate and graduate curricula that support the need to educate MSU students across the university in computational techniques and provide them a skillset that can be immediately applied to their course work and/or research, making them more desirable to employers.

The master’s degree will give students broad and deep knowledge of the fundamental techniques used in computational modeling and data science, as well as significant exposure to at least one application domain. Students who complete the master’s program will be able to: (1) analyze problems in terms of the algorithms and pre-existing computational tools required to solve a range of problems in computational and data science, and write programs to efficiently solve the problem using cutting-edge computational hardware; (2) construct and implement models and simulations of physical, biological, and social situations, and use these models/simulations to understand experimental or observational data; and (3) apply discipline-focused or methodology-focused topics in computational and data science to solve problems in the student’s application domain of choice.
b. **Academic Programs Catalog Text:**

The Master of Science degree in Computational Mathematics, Science, and Engineering provides students broad and deep knowledge of the fundamental techniques used in computational modeling and data science, as well as significant exposure to at least one application domain.

**Admission**

Admission to graduate study in computational mathematics, science, and engineering is primarily to the doctoral program. Under certain circumstances, the program may consider application for admission to the master's degree program for students who wish to earn the master's degree in preparation for the doctoral program in computational mathematics, science, and engineering, or another doctoral program, or in pursuit of other professional goals.

In addition to meeting the requirements of the university and of the College of Natural Science, students must meet the requirements specified below.

**Requirements for the Master of Science Degree in Computational Mathematics, Science, and Engineering**

A total of 30 credits is required for the degree under either Plan A (with thesis) or Plan B (without thesis). The student’s program of study must be approved by the student’s guidance committee and must meet the requirements specified below.

**Requirements for Both Plan A and Plan B**

1. Complete three of the following courses (9 credits):
   - CMSE 820 Mathematical Foundations of Data Science 3
   - CMSE 821 Numerical Methods for Differential Equations 3
   - CMSE 822 Parallel Computing 3
   - CMSE 823 Numerical Linear Algebra, I 3

   Additional details on applicable course work can be found in the CMSE graduate handbook at www.cmse.msu.edu.

2. Complete additional course work in one or more cognate areas chosen in consultation with the student’s guidance committee as specified in the CMSE graduate handbook at www.cmse.msu.edu.

3. All students must complete Responsible Conduct of Research Training.

**Additional Requirements for Plan A:**

1. The following course:
   - CMSE 899 Master's Thesis Research 4 to 8

2. Successful completion and defense of a thesis based on original research on a problem in computational and/or data science. The thesis research will culminate in a written thesis to be submitted to, and accepted by, a guidance committee. An oral examination of the student’s work may be required.

**Additional Requirements for Plan B:**

1. Completion of additional course work determined in consultation with the student’s guidance committee.

2. Completion of a final examination or evaluation.

Effective Fall 2016
3. Request to establish a **Doctor of Philosophy** degree in **Computational Mathematics, Science, and Engineering** in the Department of Computational Mathematics, Science, and Engineering. The University Committee on Graduate Studies (UCGS) recommended approval of this request at its November 9, 2015 meeting.

   a. **Background Information:**

   Computational Science is the use of computational methods to solve scientific problems – a rapidly growing and evolving field. Modern research problems are often complex and require extensive computation, either to manipulate and explore vast quantities of data or to create sophisticated theoretical models, or both. At present, training in the methods of computational science is ad hoc and varies widely, and many faculty members, particularly in disciplines where computational techniques are not traditionally used, do not have the expertise to educate their students in necessary topics. Faculty discussion of this critical need at both the undergraduate and graduate levels – and the lack of a curriculum to address this need – precipitated extensive faculty discussion and the creation of this proposed doctoral degree.

   MSU is in the midst of a Provost-led initiative focusing on computational and data science, which involves the creation of a new Department of Computational Mathematics, Science and Engineering, the hiring of a substantial number of faculty to staff this department and lead interdisciplinary initiatives in computation-enabled science, and the creation of both undergraduate and graduate curricula that support the need to educate MSU students across the university in computational techniques and provide them a skillset that can be immediately applied to their course work and/or research, making them more desirable to employers.

   The doctoral degree will give students broad and deep knowledge of the fundamental techniques used in computational modeling and data science, as well as significant exposure to at least one application domain, and to conduct significant original research in algorithms and/or applications relating to computational and data science. Students who complete the doctoral program will be able to: (1) analyze problems in terms of the algorithms and pre-existing computational tools required to solve a range of problems in computational and data science, and write programs to efficiently solve the problem using cutting-edge computational hardware; (2) construct and implement models and simulations of physical, biological, and social situations, and use these models/simulations to understand experimental or observational data; (3) apply discipline-focused or methodology-focused topics in computational and data science to solve problems in the student’s application domain of choice; and (4) conduct significant original research and present it in peer-reviewed articles, a written dissertation, and orally in a variety of venues.

   b. **Academic Programs Catalog Text:**

   The Doctor of Philosophy degree in Computational Mathematics, Science, and Engineering provides students broad and deep knowledge of the fundamental techniques used in computational modeling and data science, as well as significant exposure to at least one application domain, and to conduct significant original research in algorithms and/or applications relating to computational and data science.

   **Admission**

   Admission to graduate study in computational mathematics, science, and engineering is primarily to the doctoral program.

   In addition to meeting the requirements of the university and of the College of Natural Science, students must meet the requirements specified below.

   **Requirements for the Doctor of Philosophy Degree in Computational Mathematics, Science, and Engineering**

   The student’s program of study must be approved by the student’s guidance committee and must meet the requirements specified below.
1. Complete the following courses (12 credits):
   CMSE 820 Mathematical Foundations of Data Science  3
   CMSE 821 Numerical Methods for Differential Equations  3
   CMSE 822 Parallel Computing  3
   CMSE 823 Numerical Linear Algebra, I  3
   Additional details on applicable course work can be found in the CMSE graduate handbook at www.cmse.msu.edu.

2. Complete additional course work to total a minimum of 30 credits beyond the bachelor’s degree in one or more cognate areas chosen in consultation with the student’s guidance committee as specified in the CMSE graduate handbook at www.cmse.msu.edu.

3. Complete at least 24 credits and no more than 36 credits of CMSE 999 Doctoral Dissertation Research.

4. Pass a written or practical qualifying examination.

5. Pass an oral or written comprehensive examination no less than six months before the defense of the student’s dissertation.

6. Successfully defend the doctoral dissertation based on original research in algorithms pertaining to, or applications of computational and data science.

7. All students must complete Responsible Conduct of Research Training.

Effective Fall 2016

4. Request to establish a **Graduate Certificate in Computational Modeling** in the Department of Computational Mathematics, Science, and Engineering. The University Committee on Graduate Studies (UCGS) recommended approval of this request at its November 9, 2015 meeting.

   a. **Background Information:**

   Computational Science is the use of computational methods to solve scientific problems – a rapidly growing and evolving field. Modern research problems are often complex and require extensive computation, either to manipulate and explore vast quantities of data or to create sophisticated theoretical models, or both. At present, training in the methods of computational science is ad hoc and varies widely, and many faculty members, particularly in disciplines where computational techniques are not traditionally used, do not have the expertise to educate their students in necessary topics. Faculty discussion of this critical need at both the undergraduate and graduate levels – and the lack of a curriculum to address this need – precipitated extensive faculty discussion and the creation of this proposed graduate certificate.

   MSU is in the midst of a Provost-led initiative focusing on computational and data science, which involves the creation of a new Department of Computational Mathematics, Science and Engineering, the hiring of a substantial number of faculty to staff this department and lead interdisciplinary initiatives in computation-enabled science, and the creation of both undergraduate and graduate curricula that support the need to educate MSU students across the university in computational techniques and provide them a skillset that can be immediately applied to their course work and/or research, making them more desirable to employers.

   This certificate will complement graduate students’ degree programs with a set of courses that achieve several outcomes. Students that have achieved the goals of the Graduate Certificate in Computational Modeling will be able to: (1) demonstrate a basic understanding of functional computer programming as applied to a range of problems in computational and data science; (2) analyze problems in terms of the algorithms and pre-existing computational tools required to solve a range of problems in computational and data science, and write a program to efficiently solve the problem; (3) construct and implement models and simulations of physical, biological, and social situations, and use these models/simulations to understand experimental or observational data; and (4) apply some subset of discipline-focused or methodology-focused topics in computational and data science to solve problems in the student’s primary discipline.

   b. **Academic Programs Catalog Text:**

   The Graduate Certificate in Computational Modeling is intended for students with interest in applying computational and data science approaches to their research problems, or who generally desire broad training in computational modeling and methodology.
## Requirements for the Graduate Certificate in Computational Modeling

Students must complete a minimum of 9 credits from the following:

1. Two of the following core courses (6 credits):
   - CMSE 801 Introduction to Computational Modeling 3
   - CMSE 802 Methods in Computational Modeling 3
   - CMSE 820 Mathematical Foundations of Data Science 3
   - CMSE 821 Numerical Methods for Differential Equations 3
   - CMSE 822 Parallel Computing 3
   - CMSE 823 Numerical Linear Algebra I 3

2. One or more additional courses selected from the following:
   - AST 911 Numerical Techniques in Astronomy 2
   - CEM 883 Computational Quantum Chemistry 3
   - CEM 888 Computational Chemistry 3
   - CMSE 801 Introduction to Computational Modeling 3
   - CMSE 802 Methods in Computational Modeling 3
   - CMSE 820 Mathematical Foundations of Data Science 3
   - CMSE 821 Numerical Methods for Differential Equations 3
   - CMSE 822 Parallel Computing 3
   - CMSE 823 Numerical Linear Algebra I 3
   - CSE 836 Probabilistic Models and Algorithms in Computational Biology 3
   - CSE 845 Multi-disciplinary Research Methods for the Study of Evolution 3
   - CSE 881 Data Mining 3
   - ECE 837 Computational Methods in Electromagnetics 3
   - ME 835 Turbulence Modeling and Simulation 3
   - ME 840 Computational Fluid Dynamics and Heat Transfer 3
   - ME 872 Finite Element Method 3
   - MTH 451 Numerical Analysis I 3
   - MTH 452 Numerical Analysis II 3
   - MTH 850 Numerical Analysis I 3
   - MTH 851 Numerical Analysis II 3
   - MTH 852 Numerical Methods for Ordinary Differential Equations 3
   - MTH 950 Numerical Methods for Partial Differential Equations I 3
   - MTH 951 Numerical Methods for Partial Differential Equations II 3
   - MTH 995 Special Topics in Numerical Analysis and Operations Research 3 to 6
   - PHY 480 Computational Physics 3
   - PHY 915 Computational Condensed Matter Physics 2
   - PHY 919 Modern Electronic Structure Theory 2
   - PHY 950 Data Analysis Methods for High-Energy and Nuclear Physics 2
   - PHY 998 High Performance Computing and Computational Tools for Nuclear Physics 2
   - PLB 810 Theories and Practices in Bioinformatics 3
   - QB 826 Introduction to Quantitative Biology Techniques 1
   - STT 461 Computations in Probability and Statistics 3
   - STT 465 Bayesian Statistical Methods 3
   - STT 802 Statistical Computation 3
   - STT 874 Introduction to Bayesian Analysis 3

Courses used to fulfill requirement 1. may not be used to fulfill this requirement. Additional courses at the 400-level or above may be used to fulfill this requirement if approved by the CMSE graduate advisor. Students must have a minimum 3.0 grade-point average in courses applied to the certificate in order for it to be awarded.

Effective Fall 2016
5. Request to establish a **Graduate Certificate in High-Performance Computing** in the Department of Computational Mathematics, Science, and Engineering. The University Committee on Graduate Studies (UCGS) recommended approval of this request at its November 9, 2015 meeting.

   a. **Background Information:**

   Computational Science is the use of computational methods to solve scientific problems – a rapidly growing and evolving field. Modern research problems are often complex and require extensive computation, either to manipulate and explore vast quantities of data or to create sophisticated theoretical models, or both. At present, training in the methods of computational science is ad hoc and varies widely, and many faculty members, particularly in disciplines where computational techniques are not traditionally used, do not have the expertise to educate their students in necessary topics. Faculty discussion of this critical need at both the undergraduate and graduate levels – and the lack of a curriculum to address this need – precipitated extensive faculty discussion and the creation of this proposed graduate certificate.

   MSU is in the midst of a Provost-led initiative focusing on computational and data science, which involves the creation of a new Department of Computational Mathematics, Science and Engineering, the hiring of a substantial number of faculty to staff this department and lead interdisciplinary initiatives in computation-enabled science, and the creation of both undergraduate and graduate curricula that support the need to educate MSU students across the university in computational techniques and provide them a skillset that can be immediately applied to their course work and/or research, making them more desirable to employers.

   This certificate will complement graduate students’ degree programs with a set of courses that achieve several outcomes. Students that have achieved the goals of the Graduate Certificate in Computational Modeling will be able to: (1) demonstrate a high-level understanding of functional and object-oriented computer programming as applied to a range of problems in computational and data science; (2) analyze problems in terms of the algorithms and pre-existing computational tools required to solve a range of problems in computational and data science, and write a program to efficiently solve the problem on modern parallel computers and specialized hardware; (3) construct and implement models of a variety of systems using modern parallel programming techniques and software development techniques, and use these models/simulations to gain understanding of these systems; and (4) apply some subset of discipline-focused or methodology-focused topics in computational and data science to solve problems in the student’s primary discipline.

   b. **Academic Programs Catalog Text:**

   The Graduate Certificate in High-Performance Computing is intended for students with interest in applying computational and data science approaches that require parallel and/or high-performance computing to their research problems, or who generally desire broad training in parallel computational methodology.

   **Requirements for the Graduate Certificate in High-Performance Computing**

   Students must complete a minimum of 9 credits from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMSE 822</td>
<td>Parallel Computing</td>
<td>3</td>
</tr>
<tr>
<td>AST 911</td>
<td>Numerical Techniques in Astronomy</td>
<td>2</td>
</tr>
<tr>
<td>CEM 883</td>
<td>Computational Quantum Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CEM 888</td>
<td>Computational Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CSE 836</td>
<td>Probabilistic Models and Algorithms in Computational Biology</td>
<td>3</td>
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<tr>
<td>CSE 845</td>
<td>Multi-disciplinary Research Methods for the Study of Evolution</td>
<td>3</td>
</tr>
<tr>
<td>CSE 881</td>
<td>Data Mining</td>
<td>3</td>
</tr>
<tr>
<td>ECE 837</td>
<td>Computational Methods in Electromagnetics</td>
<td>3</td>
</tr>
<tr>
<td>ME 835</td>
<td>Turbulence Modeling and Simulation</td>
<td>3</td>
</tr>
<tr>
<td>ME 840</td>
<td>Computational Fluid Dynamics and Heat Transfer</td>
<td>3</td>
</tr>
<tr>
<td>ME 872</td>
<td>Finite Element Method</td>
<td>3</td>
</tr>
<tr>
<td>MTH 850</td>
<td>Numerical Analysis I</td>
<td>3</td>
</tr>
<tr>
<td>MTH 851</td>
<td>Numerical Analysis II</td>
<td>3</td>
</tr>
<tr>
<td>MTH 852</td>
<td>Numerical Methods for Ordinary Differential Equations</td>
<td>3</td>
</tr>
</tbody>
</table>
Effective Fall 2016

6. Request to change the administrative responsibility for the Bachelor of Science degree in Environmental Biology/Zoology in the Department of Zoology to the Department of Integrative Biology. This department name change was effective July 1, 2015.

Effective Fall 2016.

7. Request to change the requirements for the Bachelor of Science degree in Environmental Biology/Zoology in the Department of Zoology.

   a. Under the heading **Requirements for the Bachelor of Science Degree in Environmental Biology/Zoology** replace the entire entry with the following:

   The University requirements for bachelor's degrees as described in the Undergraduate Education section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Environmental Biology/Zoology.

   The University's Tier II writing requirement for the Environmental Biology/Zoology major is met by completing two of the following courses: Integrative Biology 328, 353, 355L, 384, 415, 425, 445, 450, 483; 485. Those courses are referenced in requirement 3. below.

   Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading Graduation Requirements in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.

   The requirements of the College of Natural Science for the Bachelor of Science degree.

   The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

   The following requirements for the major:

   a. One of the following groups of courses (9 or 10 credits):

   (a)    BS  161  Cell and Molecular Biology     3
          BS  162  Organismal and Population Biology   3
          BS  171  Cell and Molecular Biology Laboratory   2
          BS  172  Organismal and Population Biology Laboratory   2

   (b)    BS  181H Honors Cell and Molecular Biology  3
          BS  182H Honors Organismal and Population Biology  3
          BS  191H Honors Cell and Molecular Biology Laboratory  2
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS 192H</td>
<td>Honors Organismal and Population Biology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>(c) LB 144</td>
<td>Biology I: Organismal Biology</td>
<td>4</td>
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<tr>
<td>LB 145</td>
<td>Biology II: Cellular and Molecular Biology</td>
<td>5</td>
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<tr>
<td>b.</td>
<td>One of the following groups of courses (5 or 6 credits):</td>
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<tr>
<td></td>
<td>(a) CEM 141 General Chemistry</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>CEM 161 Chemistry Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(b) CEM 181H Honors Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>CEM 185H Honors Chemistry Laboratory I</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(c) LB 171 Principles of Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>LB 171L Introductory Chemistry I Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>c.</td>
<td>One course from each of the following groups of courses (6 credits):</td>
<td></td>
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<tr>
<td></td>
<td>(a) CEM 251 Organic Chemistry I</td>
<td>3</td>
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<td></td>
<td>CEM 351 Organic Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(b) CEM 252 Organic Chemistry II</td>
<td>3</td>
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<tr>
<td></td>
<td>CEM 352 Organic Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(c) CEM 255 Organic Chemistry Laboratory</td>
<td>2</td>
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<tr>
<td></td>
<td>CEM 355 Organic Laboratory I</td>
<td>2</td>
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<tr>
<td>d.</td>
<td>One of the following groups of courses (8 to 10 credits):</td>
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<tr>
<td></td>
<td>(a) PHY 231 Introductory Physics I</td>
<td>3</td>
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<td></td>
<td>PHY 232 Introductory Physics II</td>
<td>3</td>
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<tr>
<td></td>
<td>PHY 251 Introductory Physics Laboratory I</td>
<td>1</td>
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<tr>
<td></td>
<td>PHY 252 Introductory Physics Laboratory II</td>
<td>1</td>
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<tr>
<td></td>
<td>(b) PHY 183 Physics for Scientists and Engineers I</td>
<td>4</td>
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<tr>
<td></td>
<td>PHY 184 Physics for Scientists &amp; Engineers II</td>
<td>4</td>
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<tr>
<td></td>
<td>(c) LB 273 Physics I</td>
<td>4</td>
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<tr>
<td></td>
<td>LB 274 Physics II</td>
<td>4</td>
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<td>e.</td>
<td>One of the following courses (3 or 4 credits):</td>
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<tr>
<td></td>
<td>MTH 124 Survey of Calculus I</td>
<td>3</td>
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<tr>
<td></td>
<td>MTH 132 Calculus I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MTH 152H Honors Calculus I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>LB 118 Calculus I</td>
<td>4</td>
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<tr>
<td>f.</td>
<td>One of the following courses (3 or 4 credits):</td>
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<tr>
<td></td>
<td>MTH 126 Survey of Calculus II</td>
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<tr>
<td></td>
<td>MTH 133 Calculus II</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>MTH 153H Honors Calculus II</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>LB 119 Calculus II</td>
<td>4</td>
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<tr>
<td></td>
<td>STT 201 Statistical Methods</td>
<td>4</td>
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<tr>
<td></td>
<td>STT 224 Introduction to Probability and Statistics for Ecologists</td>
<td>3</td>
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<tr>
<td></td>
<td>STT 231 Statistics for Scientists</td>
<td>3</td>
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<tr>
<td></td>
<td>STT 421 Statistics I</td>
<td>3</td>
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<td>g.</td>
<td>All of the following courses (25 credits):</td>
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<tr>
<td></td>
<td>CSS 210 Fundamentals of Soil Science</td>
<td>3</td>
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<td></td>
<td>IBIO 306 Invertebrate Biology</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>IBIO 341 Fundamental Genetics</td>
<td>4</td>
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<tr>
<td></td>
<td>IBIO 355 Ecology</td>
<td>3</td>
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<tr>
<td></td>
<td>IBIO 355L Ecology Laboratory (W)</td>
<td>1</td>
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<td></td>
<td>IBIO 445 Evolution (W)</td>
<td>3</td>
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<td></td>
<td>IBIO 483 Environmental Physiology (W)</td>
<td>4</td>
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<td></td>
<td>PLB 441 Plant Ecology</td>
<td>3</td>
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<tr>
<td></td>
<td>Entomology 404 may be substituted for Integrative Biology 306. Forestry 404 may be substituted for Plant Biology 441.</td>
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<td>h.</td>
<td>One course or pair of courses from each of the following four groups of courses (13 to 15 credits):</td>
<td></td>
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<tr>
<td></td>
<td>(1) FW 471 Ichthyology</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>IBIO 360 Biology of Birds</td>
<td>4</td>
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<td>IBIO 365 Biology of Mammals</td>
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<td></td>
<td>IBIO 384 Biology of Amphibians and Reptiles (W)</td>
<td>4</td>
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<td></td>
<td>(2) PLB 218 Plants of Michigan</td>
<td>3</td>
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<tr>
<td></td>
<td>PLB 418 Plant Systematics</td>
<td>3</td>
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<tr>
<td></td>
<td>(3) FW 420 Stream Ecology</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>GEO 221 Introduction to Geographic Information and</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>GEO 221L Introduction to Geographic Information Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>
GEO 324  Remote Sensing of the Environment  4  
IBIO 353  Marine Biology (W)     4  
IBIO 485  Tropical Biology (W)     3  
PLB 424  Algal Biology      4  
Both Geography 221 and 221L must be completed to satisfy this requirement.  
FW 416  Marine Ecosystem Management    3  
FW 472  Limnology      3  
GLG 421  Environmental Geochemistry    4  
IBIO 357  Global Change Biology (W)   3  
IBIO 446  Environmental Issues and Public Policy  3  

Effective Fall 2016.

8. Request to change the administrative responsibility for the Bachelor of Arts degree in Zoology in the Department of Zoology to the Department of Integrative Biology. This department name change was effective July 1, 2015.

Effective Fall 2016.

9. Request to change the requirements for the Bachelor of Arts degree in Zoology in the Department of Integrative Biology.

a. Under the heading Requirements for the Bachelor of Arts Degree in Zoology replace the entire entry with the following:

1. The University requirements for bachelor's degrees as described in the Undergraduate Education section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Arts degree in Zoology.

The University's Tier II writing requirement for the Zoology major is met by completing two of the following courses: Integrative Biology 328, 353, 355L, 384, 415, 425, 445, 450, 483, and 485. Those courses are referenced in item 3. below.

Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Science that is described in item 1. under the heading Graduation Requirements in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.

2. The requirements of the College of Natural Science for the Bachelor of Arts degree.

The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

3. The following requirements for the major:

a. One of the following groups of courses (9 or 10 credits):

(1)  BS 161  Cell and Molecular Biology  3  
BS 162  Organismal and Population Biology  3  
BS 171  Cell and Molecular Biology Laboratory  2  
BS 172  Organismal and Population Biology Laboratory  2  
(2)  BS 181H  Honors Cell and Molecular Biology  3  
BS 182H  Honors Organismal and Population Biology  3  
BS 191H  Honors Cell and Molecular Biology Laboratory  2  
BS 192H  Honors Organismal and Population Biology Laboratory  2  
(3)  LB 144  Biology I: Organismal Biology  4  
LB 145  Biology II: Cellular and Molecular Biology  5  

b. One of the following groups of courses (5 or 6 credits):

(a)  CEM 141  General Chemistry  4  
CEM 161  Chemistry Laboratory I  1
(b)  CEM  181H  Honors Chemistry I    4  
CEM  185H  Honors Chemistry Laboratory I   2  
(c)  LB  171  Principles of Chemistry I    4  
     LB  171L  Introductory Chemistry Laboratory I  1  
c.  Complete the following course (4 credits):  
     CEM  143  Survey of Organic Chemistry     4  
d.  One of the following courses (3 or 4 credits):  
     PHY  183  Physics for Scientists and Engineers I   4  
     PHY  231  Introductory Physics I         3  
     LB  273  Physics I                        4  
     PHY  193H  Honors Physics I-Mechanics       4  
e.  One of the following courses (3 or 4 credits):  
     LB  118  Calculus I                  4  
     MTH  124  Survey of Calculus I       3  
     MTH  132  Calculus I               3  
     MTH  152H  Honors Calculus I       3  
f.  One of the following courses (3 or 4 credits):  
     LB  119  Calculus II               4  
     MTH  126  Survey of Calculus II     3  
     MTH  133  Calculus II           4  
     MTH  153H  Honors Calculus II   4  
     STT  201  Statistical Methods      4  
     STT  224  Introduction to Probability and Statistics for Ecologists 3  
     STT  231  Statistics for Scientists   3  
     STT  421  Statistics I       3  
g.  All of the following courses (11 credits):  
     IBIO  341  Fundamental Genetics   4  
     IBIO  355  Ecology                 3  
     IBIO  355L  Ecology Laboratory (W)  1  
     IBIO  445  Evolution (W)         3  
h.  Three additional courses in 300-400 level Integrative Biology courses.  
Students are encouraged to consult with their academic advisor to  
identify courses which match their career goals. Courses from other  
departments may be applied to this requirement with the approval of the  
student's academic advisor.  
i.  Complete one course from each of the following three groups of courses  
(9 to 11 credits):  
(a)  Writing (3 credits):  
     CSUS  433  Grant Writing and Fund Development (W)  3  
     WRA  320  Technical Writing (W)       3  
     WRA  331  Writing in the Public Interest (W)  3  
     WRA  341  Nature, Environmental, and Travel Writing  3  
     WRA  453  Grant and Proposal Writing  3  
(b)  Communications (3 or 4 credits):  
     COM  100  Human Communication      3  
     COM  225  An Introduction to Interpersonal  
     Communication                         3  
     COM  240  Introduction to Organizational  
     Communication                         4  
     COM  275  Effects of Mass Communication  3  
     COM  300  Methods of Communication Inquiry  4  
     CSUS  325  Study and Practice of Communication for  
     Sustainability (W)  3  
     FW  435  Integrated Communications for the Fisheries  
     and Wildlife Professional  3  
(c)  Computer Systems (3 or 4 credits):  
     CSE  101  Computing Concepts and Competencies  3  
     CSE  201  Fundamentals of Information Technology  3  
     CSE  231  Introduction to Programming I  3  
     FW  419  Applications of Geographic Information  
     Systems to Natural Resource Management  4  

PART I - NEW ACADEMIC PROGRAMS AND PROGRAM CHANGES – continued - 12
January 21, 2016

GEO 221 Introduction to Geographic Information 3
and
GEO 221L Introduction to Geographic Information Laboratory 1
GEO 324 Remote Sensing of the Environment 4
GEO 325 Geographic Information Systems 3
NSC 204 Introduction to Computational Modeling 4
Both Geography 221 and 221L must be completed to satisfy this requirement.

j. Six credits in 300–400 level courses offered by the Colleges of Arts and Letters or College of Social Science beyond the credits that are counted toward the University's Integrative Studies requirement. Credits from relevant courses completed from item 3. i. may be counted toward this requirement. Courses used to fulfill this requirement must be approved by the student's academic advisor.

k. Additional credits in 300-400 level Integrative Biology courses as needed to meet the requirement of at least 33 credits. Students also may complete more than one course, or pair of courses, from item 3. i. Additional courses completed from item 3. i. may be counted as Integrative Biology electives toward the 33 credits. Courses beyond those taken to satisfy item 3. may come from other departments with the approval of the student's academic advisor.

Effective Fall 2016.

10. Request to change the administrative responsibility for the Bachelor of Science degree in Zoology in the Department of Zoology to the Department of Integrative Biology. This department name change was effective July 1, 2015.

Effective Fall 2016.

11. Request to change the requirements for the Bachelor of Science degree in Zoology.

The concentrations in the Bachelor of Science degree in Zoology are noted on the student’s academic record when the requirements for the degree have been completed.

a. Under the heading Requirements for the Bachelor of Science Degree in Zoology replace the entire entry with the following:

1. The University requirements for bachelor's degrees as described in the Undergraduate Education section of this catalog; 120 credits, including general elective credits, are required for the Bachelor of Science degree in Zoology.

The University's Tier II writing requirement for the Zoology major is met by completing Integrative Biology 355L and 445. Those courses are referenced in item 3. below.

Students who are enrolled in the College of Natural Science may complete the alternative track to Integrative Studies in Biological and Physical Sciences that is described in item 1. under the heading Graduation Requirements in the College statement. Certain courses referenced in requirement 3. below may be used to satisfy the alternative track.

2. The requirements of the College of Natural Science for the Bachelor of Science degree.

The credits earned in certain courses referenced in requirement 3. below may be counted toward College requirements as appropriate.

3. The following requirements for the major:

a. One of the following groups of courses (9 or 10 credits):
   (1) BS 161 Cell and Molecular Biology 3
   BS 162 Organismal and Population Biology 3
   BS 171 Cell and Molecular Biology Laboratory 2
BS 172 Organismal and Population Biology Laboratory 2
(2) BS 181H Honors Cell and Molecular Biology 3
BS 182H Honors Organismal and Population Biology 3
BS 191H Honors Cell and Molecular Biology Laboratory 2
BS 192H Honors Organismal and Population Biology Laboratory 2
(3) LB 144 Biology I: Organismal Biology 4
LB 145 Biology II: Cellular and Molecular Biology 5
b. One of the following groups of courses (5 or 6 credits):
   (a) CEM 141 General Chemistry 4
   CEM 161 Chemistry Laboratory I 1
   (b) CEM 181H Honors Chemistry I 4
   CEM 185H Honors Chemistry Laboratory I 2
   (c) LB 171 Principles of Chemistry I 4
   LB 171L Introductory Chemistry Laboratory I 1
c. One course from each of the following groups of courses (8 credits):
   (a) CEM 251 Organic Chemistry I 3
   CEM 351 Organic Chemistry I 3
   (b) CEM 252 Organic Chemistry II 3
   CEM 352 Organic Chemistry II 3
   (c) CEM 255 Organic Chemistry Laboratory 2
   CEM 355 Organic Laboratory I 2
d. One of the following groups of courses (8 credits):
   (a) PHY 231 Introductory Physics I 3
   PHY 232 Introductory Physics II 3
   PHY 251 Introductory Physics Laboratory I 1
   PHY 252 Introductory Physics Laboratory II 1
   (b) PHY 183 Physics for Scientists and Engineers I 4
   PHY 184 Physics for Scientists and Engineers II 4
   (c) LB 273 Physics I 4
   LB 274 Physics II 4
   (d) PHY 193H Honors Physics I-Mechanics 4
   PHY 294H Honors Physics II-Electromagnetism 4
e. One of the following courses (3 or 4 credits):
   LB 118 Calculus I 4
   MTH 124 Survey of Calculus I 3
   MTH 132 Calculus I 3
   MTH 152H Honors Calculus I 3
f. One of the following courses (3 or 4 credits):
   LB 119 Calculus II 4
   MTH 126 Survey of Calculus II 3
   MTH 133 Calculus II 4
   MTH 153H Honors Calculus II 4
   STT 201 Statistical Methods 4
   STT 224 Introduction to Probability and Statistics for Ecologists 3
   STT 231 Statistics for Scientists 3
   STT 421 Statistics I 3
g. One of the following concentrations:
   Animal Behavior and Neurobiology
   (1) All of the following courses (17 credits):
       IBIO 313 Animal Behavior 3
       IBIO 341 Fundamental Genetics 4
       IBIO 355 Ecology 3
       IBIO 355L Ecology Laboratory (W) 1
       IBIO 415 Ecological Aspects of Animal Behavior (W) 3
       IBIO 445 Evolution (W) 3
   (2) One of the following courses (3 credits):
       IBIO 402 Neurobiology 3
       IBIO 405 Neural Basis of Animal Behavior 3
   (3) One of the following courses (4 credits):
       IBIO 306 Invertebrate Biology 4
       IBIO 328 Comparative Anatomy and Biology of Vertebrates (W) 4
(4) One of the following courses (3 or 4 credits):
- ANS 305 Applied Animal Behavior 3
- ANS 405 Endocrinology of Reproduction 4
- ANS 455 Avian Physiology 4
- FW 364 Ecological Problem Solving 3
- FW 419 Applications of Geographic Information Systems to Natural Resources Management 4
- GEO 221 Introduction to Geographic Information 3
- GEO 221L Introduction to Geographic Information Laboratory 1
- GEO 324 Remote Sensing of the Environment 4
- GEO 325 Geographic Information Systems 3
- IBIO 320 Developmental Biology 4
- IBIO 483 Environmental Physiology (W) 4
- LIN 463 Introduction to Cognitive Science 3
- PSY 301 Cognitive Neuroscience 3
- PSY 402 Sensation and Perception (W) 3
- PSY 409 Psychobiology of Behavioral Development (W) 3
- PSY 411 Hormones and Behavior (W) 3
- PSY 413 Laboratory in Behavioral Neuroscience (W) 4
- SOC 412 Animals, People and Nature 3

Both GEO 221 and 221L must be completed to satisfy this requirement.

(5) Additional credits in 300-400 level Integrative Biology courses as needed to meet the requirement of at least 33 credits.

Students may complete more than one course, or pair of courses, from items (2), (3) or (4). Additional courses completed from items (2), (3) or (4) may be counted as Zoology electives toward the 33 credits. Courses beyond those taken to satisfy items (1), (2), (3) or (4) may come from other departments with the approval of the student's academic advisor.

Cell and Developmental Biology
(1) All of the following courses (11 credits):
- IBIO 341 Fundamental Genetics 4
- IBIO 355 Ecology 3
- IBIO 355L Ecology Laboratory (W) 1
- IBIO 445 Evolution (W) 3

(2) One of the following courses (4 credits):
- IBIO 320 Developmental Biology 4
- IBIO 425 Cells and Development (W) 4

(3) Eighteen credits from the following courses:
- BMB 401 Comprehensive Biochemistry 4
- MMG 301 Introductory Microbiology 3
- MMG 302 Introductory Laboratory for General and Allied Health Microbiology 1
- MMG 404 Human Genetics 3
- MMG 409 Eukaryotic Cell Biology 3
- IBIO 328 Comparative Anatomy and Biology of Vertebrates (W) 4
- IBIO 343 Genetics Laboratory 3
- IBIO 402 Neurobiology 3
- IBIO 408 Histology 4
- IBIO 450 Cancer Biology (W) 3

Biochemistry and Molecular Biology 461 and 462 combined, may be substituted for Biochemistry and Molecular Biology 401.

If Integrative Biology 320 and 425 are both completed in item (2), students only need to complete 14 credits in course work to fulfill this requirement.

Ecology, Evolution, and Organismal Biology
(1) All of the following courses (11 credits):
- IBIO 341 Fundamental Genetics 4
- IBIO 355 Ecology 3
IBIO 355L Ecology Laboratory (W)  1
IBIO 445 Evolution (W)    3
(2) One of the following courses (4 credits):
IBIO 306 Invertebrate Biology    4
IBIO 328 Comparative Anatomy and Biology of Vertebrates (W)    4
(3) One of the following courses (3 or 4 credits):
IBIO 313 Animal Behavior    3
IBIO 316 General Parasitology    3
IBIO 357 Global Change Biology (W)    3
IBIO 483 Environmental Physiology (W)    4
IBIO 485 Tropical Biology (W)    3
(4) One of the following courses, or pair of courses (3 or 4 credits):
FW 419 Applications of Geographic Information Systems to Natural Resources Management  4
GEO 221 Introduction to Geographic Information  3
And
GEO 221L Introduction to Geographic Information Laboratory  1
GEO 324 Remote Sensing of the Environment  4
GEO 325 Geographic Information Systems  3
GLG 434 Evolutionary Paleobiology  4
IBIO 446 Environmental Issues and Public Policy  3
PLB 418 Plant Systematics  3
Both Geography 221 and 221L must be completed to satisfy this requirement.
(5) Additional credits in 300-400 level Integrative Biology courses as needed to meet the requirement of at least 33 credits. Students may complete more than one course, or pair of courses, from items (2), (3), or (4). Additional courses completed from items (2), (3), or (4) may be counted as Integrative Biology electives toward the 33 credits. Courses beyond those taken to satisfy items (1), (2), (3), or (4) may come from other departments with the approval of the student’s academic advisor.

**Genetics (33 credits):**
(1) All of the following courses (23 credits):
BMB 461 Advanced Biochemistry I  3
BMB 462 Advanced Biochemistry II  3
MMG 431 Microbial Genetics  3
IBIO 341 Fundamental Genetics  4
IBIO 343 Genetics Laboratory  3
IBIO 355 Ecology  3
IBIO 355L Ecology Laboratory (W)    1
IBIO 445 Evolution (W)  3
(2) One of the following courses (3 or 4 credits):
BMB 472 Advanced Molecular Biology Laboratory  3
IBIO 425 Cells and Development (W)  4
(3) A minimum of 4 credits completed in a genetics laboratory or field experience arranged in consultation with the student’s academic advisor.
(4) Additional credits in 300-400 level Integrative Biology courses as needed to meet the requirement of at least 33 credits. Students may complete more than one course, or pair of courses, from items (2) and (3). Additional courses completed from items (2) and (3) may be counted as Integrative Biology electives toward the 33 credits. Courses beyond those taken to satisfy items (1), (2), and (3) may come from other departments with the approval of the student’s academic advisor.

**General Zoology**
(1) All of the following courses (11 credits):
IBIO 341 Fundamental Genetics    4
IBIO 355 Ecology    3
IBIO 355L Ecology Laboratory (W)    1
IBIO 445 Evolution (W)    3
(2) One of the following courses (4 credits)
  IBIO  306  Invertebrate Biology    4
  IBIO  328  Comparative Anatomy and Biology of Vertebrates (W)    4

(3) One of the following courses (3 or 4 credits)
  IBIO  313  Animal Behavior     3
  IBIO  483  Environmental Physiology (W)    4

(4) One of the following courses (3 or 4 credits)
  MMG  409  Eukaryotic Cell Biology    3
  IBIO  320  Developmental Biology    4
  IBIO  408  Histology     4
  IBIO  425  Cells and Development (W)    4

(5) A minimum of 4 laboratory courses at the 300-400 level selected from the following:
  ANS  313  Principles of Animal Feeding and Nutrition  4
  MMG  302  Introductory Laboratory for General and Allied Health Microbiology   1
  IBIO  306  Invertebrate Biology    4
  IBIO  320  Developmental Biology    4
  IBIO  328  Comparative Anatomy and Biology of Vertebrates (W)    4
  IBIO  343  Genetics Laboratory     3
  IBIO  355L  Ecology Laboratory (W)    1
  IBIO  360  Biology of Birds     4
  IBIO  365  Biology of Mammals     4
  IBIO  384  Biology of Amphibians and Reptiles (W)  4
  IBIO  408  Histology     4
  IBIO  425  Cells and Development (W)    4

Laboratory courses taken to satisfy items (1), (2), (4) may also be applied to this requirement.

(6) Additional credits in 300-400 level Integrative Biology courses as needed to meet the requirement of at least 33 credits. Students may complete more than one course, or pair of courses, from items (2), (3), and (4). Additional courses completed from items (2), (3) or (4) may be counted as Integrative Biology electives toward the 33 credits. Courses beyond those taken to satisfy items (1), (2), (3), (4) or (5) may come from other departments with the approval of the student's academic advisor.

Marine Biology

(1) All of the following courses (23 credits):
  IBIO  303  Oceanography     4
  IBIO  341  Fundamental Genetics     4
  IBIO  353  Marine Biology (W)     4
  IBIO  355  Ecology     3
  IBIO  355L  Ecology Laboratory (W)    1
  IBIO  445  Evolution (W)     3
  IBIO  483  Environmental Physiology (W)    4

(2) One course from each of the following groups of courses (7 or 8 credits):
(a) FW  471  Ichthyology     4
    IBIO  306  Invertebrate Biology    4
(b) BMB  401  Comprehensive Biochemistry     4
    CEM  383  Introductory Physical Chemistry I   3
    FW  416  Marine Ecosystem Management     3
    FW  424  Population Analysis and Management     4
    GEO  221  Introduction to Geographic Information     3
    GEO  221L  Introduction to Geographic Information Laboratory   1
    GEO  324  Remote Sensing of the Environment     4
    IBIO  357  Global Change Biology (W)     3
    MMG  425  Microbial Ecology     3
Both Geography 221 and 221L must be completed to satisfy this requirement.

(3) A minimum of at least 1 credit must be completed in an aquatic biology field experience. Through consultation with their academic advisor, students may determine an appropriate aquatic biology field experience or choose one of the following courses (3 or 4 credits):

- ENT 469 Biomonitoring of Streams and Rivers 3
- FW 474 Field and Laboratory Techniques for Aquatic Studies 3
- IBIO 440 Field Ecology and Evolution 4
- PLB 424 Algal Biology 4

Courses not listed above must have the approval of the student’s academic advisor.

(4) Additional credits in 300-400 level Integrative Biology courses as needed to meet the requirement of at least 33 credits. Students may complete more than one course, or pair of courses, from item (2). Additional courses completed from item (2) may be counted as Zoology electives toward the 33 credits. Courses beyond those taken to satisfy items (1), (2), or (3) may come from other departments with the approval of the student’s academic advisor.

Zoo and Aquarium Science

(1) All of the following courses (31 credits):

- IBIO 313 Animal Behavior 3
- IBIO 320 Developmental Biology 4
- IBIO 328 Comparative Anatomy and Biology of Vertebrates (W) 4
- IBIO 341 Fundamental Genetics 4
- IBIO 355 Ecology 3
- IBIO 355L Ecology Laboratory (W) 1
- IBIO 369 Introduction to Zoo and Aquarium Science 3
- IBIO 445 Evolution (W) 3
- IBIO 489 Seminar in Zoo and Aquarium Science 2
- IBIO 498 Internship in Zoo and Aquarium Science 4

(2) One of the following courses (3 or 4 credits):

- ENT 404 Fundamentals of Entomology 3
- FW 471 Ichthyology 4
- IBIO 360 Biology of Birds 4
- IBIO 365 Biology of Mammals 4
- IBIO 384 Biology of Amphibians and Reptiles (W) 4

(3) One of the following courses (3 or 4 credits):

- ANS 313 Principles of Animal Feeding and Nutrition 4
- ANS 314 Genetic Improvement of Domestic Animals 4
- ANS 315 Anatomy and Physiology of Farm Animals 4
- FW 444 Conservation Biology 3
- FW 472 Limnology 3
- IBIO 353 Marine Biology (W) 4

(4) Two of the following courses (6 to 8 credits):

- ANS 405 Endocrinology of Reproduction 4
- ANS 455 Avian Physiology 4
- FW 424 Population Analysis and Management 4
- GEO 221 Introduction to Geographic Information and Laboratory 3
- GEO 221L Introduction to Geographic Information Laboratory 1
- GEO 324 Remote Sensing of the Environment 4
- IBIO 303 Oceanography 4
- IBIO 306 Invertebrate Biology 4
- IBIO 483 Environmental Physiology (W) 4
- IBIO 485 Tropical Biology (W) 3
- SOC 412 Animals, People and Nature 3

Both Geography 221 and 221L must be completed to satisfy this requirement.
(5) One additional course of at least 3 credits selected from a list of approved courses that is available from the Department of Integrative Biology.

(6) Integrative Biology courses that are not listed above must be approved in advance by the student’s academic advisor. Courses offered by other departments may be substituted if approved in advance by the student’s academic advisor.

Effective Fall 2016.

12. Request to change the administrative responsibility for the Master of Science degree in Zoology in the Department of Zoology to the Department of Integrative Biology. This department name change was effective July 1, 2016.

Effective Fall 2016.

13. Request to change the name of the Master of Science degree in Zoology to the Master of Science degree in Integrative Biology in the Department of Integrative Biology. The University Committee on Graduate Studies (UCGS) will consider this request at its November 9, 2015 meeting.

Students admitted to the major prior to Fall 2016 will be awarded a Master of Science degree in Zoology. Students admitted to the major Fall 2016 and forward will be awarded a Master of Science degree in Integrative Biology.

Effective Fall 2016.

14. Request to change the administrative responsibility for the Doctor of Philosophy degree in Zoology in the Department of Zoology to the Department of Integrative Biology. This department name change was effective July 1, 2016.

Effective Fall 2016.

15. Request to change the name of the Doctor of Philosophy degree in Zoology to the Doctor of Philosophy degree in Integrative Biology in the Department of Integrative Biology. The University Committee on Graduate Studies (UCGS) will consider this request at its November 9, 2015 meeting.

Students admitted to the major prior to Fall 2016 will be awarded a Doctor of Philosophy degree in Zoology. Students admitted to the major Fall 2016 and forward will be awarded a Doctor of Philosophy degree in Integrative Biology.

Effective Fall 2016.

16. Request to change the administrative responsibility for the Doctor of Philosophy degree in Zoology-Environmental Toxicology in the Department of Zoology to the Department of Integrative Biology. This department name change was effective July 1, 2016.

Effective Fall 2016.

17. Request to change the name of the Doctor of Philosophy degree in Zoology-Environmental Toxicology to the Doctor of Philosophy degree in Integrative Biology-Environmental Toxicology in the Department of Integrative Biology. The University Committee on Graduate Studies (UCGS) will consider this request at its November 9, 2015 meeting.

Students admitted to the major prior to Fall 2016 will be awarded a Doctor of Philosophy degree in Zoology-Environmental Toxicology. Students admitted to the major Fall 2016 and forward will be awarded a Doctor of Philosophy degree in Integrative Biology-Environmental Toxicology.

Effective Fall 2016.
PART II - NEW COURSES AND CHANGES

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

ANS 805  Animal Welfare Assessment  
Fall of every year. 3(3-0)  
Interdepartmental with Zoology. Interdepartmental with Integrative Biology  
RB: (ANS 305 or ZOL 313) or background in animal science or zoology including exposure to  
topics such as animal behavior, physiology, management, and husbandry. RB: (ANS 305 or IBIO  
313) or Background in animal science or zoology including exposure to topics such as animal  
behavior, physiology, management, and husbandry.  
Multidisciplinary online computer-based instruction in animal welfare science and related  
issues including physiology, behavior, human-animal interactions, suffering and pain,  
ethics, health, assessment and standards, and economics.  
**Effective Fall 2013  Effective Fall 2016**

ANS 815  Advanced Topics in Reproduction and Development  
Fall of every year. Spring of every year. 3(3-0)  
RB: Animal Science, Biology and Biomedical Sciences  
NEW  Core concepts in animal reproduction and development. Recent advances relevant to  
animal and human fertility, development, and diseases.  
**Effective Summer 2015**

ANS 823  Grant Writing for Biomedical Research  
Spring of every year. 2(2-0)  
RB: Minimum 2 years completed in a graduate (doctoral) program.  
NEW  Best practices for development, preparation and submission of competitive grant  
proposals for biomedical research. Students should identify a faculty member to serve as  
proposal mentor before class begins.  
**Effective Spring 2017**

BE 849  Quantitative Human Health Risk Modeling and Analysis for Microbial Stressors  
Fall of even years. 3(2-2)  
P: STT 421 or STT 464 or (STT 814 or concurrently) or approval of  
department RB: Previous coursework in statistics, and probability theory, mathematical modeling  
covered in the engineering and quantitative sciences. Existing knowledge or current research  
interests in toxicology, microbiology, food safety, and/or public health.  
NEW  Characterization of human health risk from exposures to environmental stressors.  
Development of empirical and statistical models for health effects and exposure analysis.  
Probabilistic risk characterization, uncertainty and sensitivity analysis. Problem-based  
critical evaluation of risk-based environmental decisions.  
**Effective Spring 2016**

BE 869  Life Cycle Assessment for Bioenergy and Bioproduct Systems  
Spring of every year. 3(3-0)  
Interdepartmental with Chemical Engineering. R: Open to graduate  
students in the College of Engineering or in the Department of Biosystems and Agricultural  
Engineering or approval of department. Not open to students with credit in BE 469.  
NEW  Life cycle assessment to evaluate the environmental impacts of biological and chemical  
conversion processes. Biomass supply chain economics and technoeconomics for  
bioenergy and bioproduct systems.  
**Effective Spring 2016**

ENT 319  Introduction to Earth System Science  
Fall of every year. 3(3-0)  
Interdepartmental with Geological Sciences and Plant Biology and  
Sociology and Zoology. Interdepartmental with Geological Sciences and Integrative Biology and  
Plant Biology and Sociology RB: Completion of one course in biological or physical science.  
Systems approach to Earth as an integration of geochemical, geophysical, biological and  
social components. Global dynamics at a variety of spatio-temporal scales. Sustainability  
of the Earth system.  
**Effective Fall 2013  Effective Fall 2016**
PART II - NEW COURSES AND CHANGES – continued - 20
January 21, 2016

ENT 422  Aquatic Entomology
Fall of odd years. 3(2-3) Interdepartmental with Fisheries and Wildlife and Zoology.
Interdepartmental with Fisheries and Wildlife and Integrative Biology P: BS 162
Biology, ecology and systematics of aquatic insects in streams, rivers and lakes. Field
trips and aquatic insect collection required.
SA: ENT 420
Effective Fall 2013 Effective Fall 2016

ENT 461  Field Ecology of Disease Vectors
Summer of every year. W. K. Kellogg Biological Station 3(1-4) Interdepartmental with Fisheries and
Wildlife. RB: (ENT 460 or FW 463) or Courses in Epidemiology or Public Health. R: Not open to
freshmen.
NEW
Collection and identification of arthropod vectors of human and animal diseases in
Michigan. Assays for associated pathogens. Integration of disease ecology and public
health responses to vector-borne disease
Effective Summer 2016

FW 410  Upland Ecosystem Management
Spring of every year. 3(2-3) P: (ZOL 355 or FOR 404) and completion of Tier I writing requirement.
P: (IBIO 355 or FOR 404) or completion of Tier I writing requirement
Analysis and management of upland ecosystems to meet wildlife management and
biodiversity objectives. Mitigation of human impact. Field trips required.
Effective Fall 2014 Effective Fall 2016

FW 416  Marine Ecosystem Management
Fall of every year. 3(3-0) P: (ZOL 355) and completion of Tier I writing requirement P: (IBIO 355)
and completion of Tier I writing requirement RB: FW 110 or ZOL 303 or ZOL 353 RB: FW 110 or
IBIO 303 or IBIO 353
Management of marine ecosystems and populations for ecological and socio-economic
objectives. Anthropogenic impacts, mitigation, and marine resource conservation
strategies. Field trips required.
Effective Fall 2014 Effective Fall 2016

FW 417  Wetland Ecology and Management
Fall of every year. 3(2-3) P: (ZOL 355) and completion of Tier I Writing requirement P: (IBIO 355)
and completion of Tier I writing requirement
Biological, physical, and chemical processes controlling wetland structure and function.
Utilization, mitigation, and conservation of wetlands on a sustainable basis.
SA: FW 412
Effective Fall 2014 Effective Fall 2016

FW 420  Stream Ecology
Fall of every year. 3(3-0) Interdepartmental with Zoology. Interdepartmental with Integrative Biology
P: ZOL 355 or approval of department P: IBIO 355 or approval of department RB: CEM 141
Biological and environmental factors determining structure and function of stream
ecosystems.
Effective Fall 2014 Effective Fall 2016

FW 424  Population Analysis and Management
Fall of every year. 4(3-2) P: ZOL 355 and (STT 224 or STT 231 or STT 421) and (MTH 124 or MTH
132 or LB 118) P: (IBIO 355) and (STT 224 or STT 231 or STT 421) and (MTH 124 or MTH 132 or
LB 118)
Statistical, ecological and management concepts and methods needed to analyze and
interpret demographic data and manage fish and wildlife populations.
Effective Fall 2014 Effective Fall 2016
FW 444  Conservation Biology
Spring of every year. 3(3-0) Interdepartmental with Zoology, Interdepartmental with Integrative Biology P: (ZOL 355 or FOR 404 or PLB 441) and completion of Tier I writing requirement P: (IBIO 355 or FOR 404 or PLB 441) and completion of Tier I writing requirement
Ecological theories and methodologies to manage species, communities and genetic diversity on a local and global scale.
Effective Fall 2014  Effective Fall 2016

FW 449  Wildlife Policy
Spring of odd years. 3(2-2) RB: IBIO 355 and FW 364 R: Not open to freshmen or sophomores or approval of department.
NEW  Controversial issues in wildlife policy. Science and political analysis drawing on ecology, economics, sociology. Argument analysis.
Effective Fall 2015

FW 449L  Wildlife Policy – Study Away
Spring of odd years. 1(0-3) P: FW 449 or concurrently or approval of department; application required R: Not open to freshmen or sophomores.
NEW  Onsite examination of controversial issues of in wildlife policy. Study Away. Field trip required.
Effective Fall 2015

FW 454  Environmental Hydrology for Watershed Management
Spring of odd years. 3(3-0) P: (MTH 124 or MTH 132 or LB 118) and ((PHY 183 or concurrently) or (PHY 231 or concurrently)) RB: ZOL 355 or concurrently RB: IBIO 355 or concurrently
Effect of climate, topography, geology, soil, vegetation, and anthropogenic land uses on the amount, timing, and quality of water yield. Implications for fish and wildlife resource management. Field trips required.
Effective Fall 2014  Effective Fall 2016

FW 471  Ichthyology
Spring of every year. 4(3-3) Interdepartmental with Zoology, Interdepartmental with Integrative Biology P: (BS 162 and BS 172) or (BS 182H and BS 192H) or LB 144) and Completion of Tier I Writing Requirement
Effective Fall 2014  Effective Fall 2016

FW 472  Limnology
Spring of every year. 3(3-0) Interdepartmental with Zoology, Interdepartmental with Integrative Biology P: (CEM 141 or LB 171) and ZOL 355 P: (CEM 141 or LB 171) and IBIO 355
Ecology of lakes with emphasis on interacting physical, chemical, and biological factors affecting their structure and function.
Effective Fall 2014  Effective Fall 2016

FW 474  Field and Laboratory Techniques for Aquatic Studies
Fall of every year. 3(2-3) Interdepartmental with Zoology, Interdepartmental with Integrative Biology P: (FW 101L or FW 238) and completion of Tier I writing requirement
Field and laboratory techniques for the investigation and analysis of lake and stream ecosystems and their biota. Field trips required.
SA: FW 470
Effective Fall 2014  Effective Fall 2016

FW 480  International Studies in Fisheries and Wildlife
Fall of every year. Spring of every year. Summer of every year. 1 to 6 credits. A student may earn a maximum of 12 credits in all enrollments for this course. RB: ZOL 355 RB: IBIO 355 R: Approval of department; application required.
Fisheries and wildlife ecology and management study in regions beyond the United States. Ecological, economic, social, and cultural influences on fisheries and wildlife resources.
Effective Fall 2014  Effective Fall 2016
FW 828 Conservation and Genetics
Molecular Ecology and Conservation Genetics
Fall of even years. 3(2-2) Interdepartmental with Plant Biology and Zoology. Interdepartmental with Integrative Biology and Plant Biology. RB: ZOL 341 or CSS 350 or ANS 314. RB: IBIO 341 or CSS 350 or ANS 314.
Population and evolutionary genetic principles applied to ecology, conservation, and management of fish and wildlife at the individual, population, and species level.
Effective Fall 2002 Effective Fall 2016

FW 849 Applied Bayesian Inference using Monte Carlo Methods for Quantitative Biologists
Fall of even years. 3(2-2) Interdepartmental with Animal Science and Statistics and Probability. RB: (STT 814 and ZOL 851) or equivalent courses. RB: (STT 814 and IBIO 851) or equivalent courses.
R: Not open to undergraduate students.
Effective Spring 2013 Effective Fall 2016

FW 863 Wildlife Disease Ecology
Spring of even years. 3(3-0) Interdepartmental with Large Animal Clinical Sciences and Zoology. Interdepartmental with Integrative Biology and Large Animal Clinical Sciences.
Role of wildlife disease in ecological interactions, factors underlying pathogen emergence, mathematical modeling of infectious diseases, conservation medicine.
Effective Spring 2014 Effective Fall 2016

FW 876 Advanced Fish Ecology
Fall of odd years. 3(2-2) RB: (IBIO 355, FW 471 and FW 479) or Ecology, Biology of Fish (Ichthyology), and Fish Management. R: Open to graduate students or approval of department.
Advanced ecology of fishes in freshwater and marine ecosystems.
Effective Fall 2015

FW 877 Fish Population Dynamics
Fall of even years. Spring of even years. 3(2-2) 4(3-2) RB: Course in Ecology and Statistics. R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Natural Science.
Quantitative analysis of fish populations. Evaluation, causes, and impacts of the rates of change in survival, growth, reproduction, and recruitment for fish populations and their yield.
Effective Fall 1998 Effective Fall 2015

FSC 813 Food Laws and Regulations in Latin America
Fall of every year. Summer of every year. 3(3-0) RB: (FSC 810) or food science, law, food safety, international development or related disciplines. RB: (FSC 810) or food law background. Not open to students with credit in LAW 810G.
Current issues that have shaped Latin American food regulation. Overview of regional characteristics. Basic food laws, agency responsibilities, product registration requirements, basic standards, food labeling, food safety, food additives, and food importation. Trade issues, international organizations, and commercial agreements.
Effective Fall 2013 Effective Spring 2015

HRT 460 Green Roofs and Walls
Fall of every year. 4(4-0) 2(2-0) Interdepartmental with Fisheries and Wildlife and Geography and Planning, Design and Construction. P: HRT 203 or FW 101 or GEO 206 or PDC 120 or EGR 100 R: Open to juniors or seniors or graduate students.
Green roof and wall design and installation practices including plant species and substrates. Environmental impact, ecosystem services, integration with other environmental practices. Influence of economics, public policy, and industry organizations on the implementation of green roofs on a wide scale. Multidisciplinary nature of planning and implementation of successful green roof and wall projects.
Effective Fall 2014 Effective Fall 2016
COLLEGE OF ENGINEERING

BE 482 Diffuse-Source Pollution Engineering  
Spring of every year. 3(2-2) P: (BE 350 or CE 483) and (BE 360 or CE 487) R: Open to juniors or seniors in the College of Engineering.  
Identification, estimation, and control of diffuse source pollution from agricultural and urban sources. Analysis of diffuse source pollutants in biological systems. Engineering design of practices and structures to prevent, mitigate, and treat diffuse source pollution, including low impact development (LID) strategies.  
Effective Fall 2013 Effective Spring 2016

CSE 482 Big Data Analysis  
Spring of every year. 3(3-0) P: CSE 331 and CSE 335 and STT 351 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.  
NEW  
Data collection, storage, and preprocessing. Data analysis technique. Programming for Large-Scale Data Analysis. Case studies and applications.  
Effective Spring 2017

ECE 280 Electrical Engineering Analysis  
Fall of every year. Spring of every year. 3(3-0) P: (MTH 234 or MTH 254H) and (ECE 201 or concurrently)  
Application of linear algebra, complex numbers, vectors, probability, and random processes to elementary problems in electrical and computer engineering. Application to signals, systems, noise, electromagnetics, and reliability. Modeling using standard software packages.  
Effective Fall 2013 Effective Fall 2016

ECE 477 Microelectronic Fabrication  
Fall of every year. 3(2-3) P: (ECE 474 or concurrently) and ECE 303 R: Open to juniors or seniors in the College of Engineering.  
Microelectronic processing fundamentals and simulations. Comparison of current microfabrication technologies and their limitations.  
SA: ECE 483  
Effective Fall 2013 Effective Fall 2016

COLLEGE OF HUMAN MEDICINE

HM 612 Pain Medicine  
Fall of every year. Spring of every year. Summer of every year. 6(6-0) A student may earn a maximum of 18 credits in all enrollments for this course. P: SUR 608 and MED 608 R: Open to students in the College of Human Medicine.  
Request the use of the Pass-No Grade (P-N) system.  
Request the use of ET-Extension to postpone grading.  
The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.  
Effective Spring 2014 Effective Summer 2015
MED 492  Basics and Methods in Biomedical Research
Fall of every year. Spring of every year. 2(2-0) 2 to 4 credits. P: (BS 161 or BS 181H) and (BS 171 or BS 191H) or LB 145) and ((MTH 103 or MTH 110 or MTH 116) or designated score on Mathematics Placement test) and (CEM 252 or CEM 352) R: Open to sophomores or juniors or seniors or approval of department. R: Approval of department. Introduction to research concepts, strategies, methods and laboratory techniques in biomedical research. Laboratory safety, regulations, quality control and quality assurance. Online presentations and hands-on experience. Request the use of the Pass-No Grade (P-N) system. Effective Fall 2013 Effective Spring 2015

LYMAN BRIGGS COLLEGE

LB 133 Introduction to History, Philosophy, and Sociology of Science
Fall of every year. Spring of every year. 4(4-0) P: Designated score on English Placement test R: Open to students in the Lyman Briggs College or in the Science, Technology, Environment and Public Policy Specialization. Not open to students with credit in AL 192 or AL 192H or RCAH 112 or WRA 110 or WRA 115 or WRA 125 or WRA 130 or WRA 135 or WRA 140 or WRA 145 or WRA 150 or WRA 195H. Not open to students with credit in RCAH 111 or RCAH 112 or WRA 101 or WRA 195H. Introduction to the history, philosophy, and sociology of science, technology, the environment, and medicine. Instruction and practice in formal writing. SA: LBS 133 Effective Spring 2014 Effective Fall 2016

COLLEGE OF NATURAL SCIENCE

BS 162 Organismal and Population Biology
Fall of every year. Spring of every year. Summer of every year. 3(3-0) Interdepartmental with Plant Biology and Zoology. Interdepartmental with Integrative Biology and Plant Biology. P: BS 161 or BS 181H or LB 145 Not open to students with credit in BS 182H or LB 144. Biological diversity and organismal biology. Principles of evolution, transmission genetics, population biology, community structure, ecology. SA: BS 110, BS 148H Effective Fall 2013 Effective Fall 2016

BS 172 Organismal and Population Biology Laboratory
Fall of every year. Spring of every year. Summer of every year. 2(1-3) Interdepartmental with Plant Biology and Zoology. Interdepartmental with Integrative Biology and Plant Biology. P: (BS 162 or concurrently) or (BS 182H or concurrently) Not open to students with credit in BS 192H or LB 144. Nature and process of organismal biology including experimental design, statistical methods, hypothesis testing in genetics, ecology, and evolution. SA: BS 110, BS 158H Effective Fall 2013 Effective Fall 2016

BS 182H Honors Organismal and Population Biology
Fall of every year. 3(3-0) Interdepartmental with Lyman Briggs and Plant Biology and Zoology. Interdepartmental with Integrative Biology and Lyman Briggs and Plant Biology. Not open to students with credit in BS 162 or LB 144. Diversity and basic properties of organisms, with emphasis on genetic principles, ecological interactions, and the evolutionary process. Historical approach to knowledge discovery. SA: BS 148H, BS 110 Effective Fall 2013 Effective Fall 2016
BS 192H  Honors Organismal and Population Biology Laboratory
Fall of every year. 2(1-3) Interdepartmental with Lyman Briggs and Plant Biology and Zoology. Interdepartmental with Integrative Biology and Lyman Briggs and Plant Biology. P: BS 182H or concurrently. Not open to students with credit in BS 172 or LB 144.
Nature and process of organismal biology, including experimental design and statistical methods, hypothesis testing, genetics, ecology, and evolution.
SA: BS 158H, BS 110
Effective Fall 2013

CEM 484  Molecular Thermodynamics
Spring of every year. 3(4-0) P: (MTH 235 or MTH 255H or MTH 340 or MTH 347H) and (CEM 142 or CEM 152 or CEM 182H or LB 172) P: (MTH 235 or MTH 340 or MTH 347H) and (CEM 142 or CEM 152 or CEM 182H or LB 172) RB: CEM 483
Microscopic properties of atoms and molecules revealed by spectroscopic measurements; connection between thermodynamic properties of macroscopic chemical systems and microscopic properties established using statistical thermodynamics.
SA: CEM 361, CEM 391
Effective Spring 2013

CEM 495  Molecular Spectroscopy
Fall of every year. 2(1-4) P: (CEM 483 or CEM 484) and (CEM 395 or CEM 499) and ((CEM 262 or CEM 186H) and completion of Tier I writing requirement) P: (CEM 483 or CEM 484) and (CEM 395 or CEM 499) and (CEM 262 and completion of Tier I writing requirement)
Experiments in magnetic resonance, optical, and vibrational spectroscopies.
SA: CEM 472
Effective Fall 2013

CEM 499  Chemical Physics Seminar
Spring of every year. 1(1-0) A student may earn a maximum of 2 credits in all enrollments for this course. P: ((PHY 215) and completion of Tier I writing requirement) and (MTH 235 or MTH 255H or MTH 340 or MTH 347H) P: ((PHY 215) and completion of Tier I writing requirement) and (MTH 235 or MTH 340 or MTH 347H)
Written and oral reports on selected journal articles in chemical physics.
Effective Spring 2013

NSC 801  CMSE 801 Introduction to Computational Science
Introduction to Computational Modeling
Fall of every year. 3(3-0) RB: One semester of introductory calculus
Basics of computational science using a wide variety of application examples. Algorithmic thinking and model building, programming fundamentals, data visualization, numerical methods. Introduction to computational modeling using a wide variety of application examples. Algorithmic thinking and model building, data visualization, numerical methods, all implemented as programs. Command line interfaces. Scientific software development techniques including modular programming, testing, and version control.
Effective Spring 2016

NSC 802  CMSE 802 Methods in Computational Science
Methods in Computational Modeling
Spring of every year. 3(3-0) RB: (NSC 801) or equivalent programming experience RB: (CMSE 801) or equivalent experience
Effective Fall 2016
CMSE 820  Mathematical Foundations of Data Science  
Spring of every year. 3(3-0) RB: CMSE 802 or equivalent experience in programming and numerical methods. Differential equations at the level of (MTH 235 OR MTH 255H OR (MTH 340 AND MTH 442) OR (MTH 347H AND MTH 442)). Linear algebra at the level of (MTH 309 OR MTH 317H). Probability and statistics at the level of STT 231  
NEW  Introduces students to the fundamental mathematical principles of data science that underlie the algorithms, processes, methods, and data-centric thinking. Introduces students to algorithms and tools based on these principles  
Effective Fall 2016

CMSE 821  Numerical Methods for Differential Equations  
Spring of every year. 3(3-0) RB: CMSE 802 or equivalent experience in programming and numerical methods. Differential equations at the level of (MTH 235 OR MTH 255H OR (MTH 340 AND MTH 442) OR (MTH 347H AND MTH 442)). Linear algebra at the level of (MTH 309 OR MTH 317H)  
Effective Fall 2016

CMSE 822  Parallel Computing  
Fall of every year. 3(3-0) Interdepartmental with Computer Science and Engineering. RB: Calculus at the level of MTH 133. Ability to program proficiently in C/C++, basic understanding of data structures and algorithms (both at the level of CSE 232). Basic linear algebra and differential equations.  
Effective Fall 2016

CMSE 823  Numerical Linear Algebra, I  
Fall of every year. 3(3-0) RB: (CMSE 802) or equivalent experience in programming and numerical methods. Linear algebra at the level of MTH 309 or MTH 317H.  
Effective Fall 2016

CMSE 890  Selected Topics in Computational Mathematics, Science, and Engineering  
Fall of every year. Spring of every year. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Approval of department.  
NEW  Topics selected to supplement and enrich existing courses and lead to the development of new courses.  
Effective Fall 2016

CMSE 891  Independent Study in Computational Mathematics, Science, and Engineering  
Fall of every year. Spring of every year. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department.  
NEW  Topics selected to supplement and enrich existing courses.  
Effective Fall 2016

CMSE 899  Master's Thesis Research  
Fall of every year. Spring of every year. Summer of every year. 1 to 6 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open to master’s students in the Department of Computational Mathematics, Science, and Engineering.  
NEW  Master's thesis research  
Effective Fall 2016
CMSE 999  Doctoral Dissertation Research  
Fall of every year. Spring of every year. Summer of every year. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course. R: Open to doctoral students in the Department of Computational Mathematics, Science, and Engineering.

NEW  Doctoral Dissertation Research  
Effective Fall 2016

GLG 433  Vertebrate Paleontology  
Fall of even years. 4(3-2) Interdepartmental with Zoology. Interdepartmental with Integrative Biology P: ZOL 328 or GLG 304 or ZOL 360 or ZOL 365 or ZOL 384 or ZOL 445 or GLG 434 or FW 471  
Fossil vertebrates with emphasis on evolution and interrelationships of major groups. Modern techniques of identification and interpretation of fossils.  
Effective Fall 2014 Effective Fall 2016

GLG 434  Evolutionary Paleobiology  
Fall of odd years. 4(3-2) Interdepartmental with Zoology. Interdepartmental with Integrative Biology  
RB: BS 162 or GLG 304 or LB 144 or BS 182H  
Patterns and processes of evolution known from the fossil record  
Effective Fall 2014 Effective Fall 2016

GLG 435  Geomicrobiology  
Fall of every year. 4(3-2) Interdepartmental with Microbiology and Molecular Genetics. RB: GLG 201 or MMG 201 or BS 161 or LB 145 R: Open to juniors or seniors or graduate students in the College of Natural Science or in the Lyman Briggs College.  
NEW  
Geological and microbiological perspectives on microbial activities in diverse environmental settings, including geological change mediated by microorganisms, microbial evolution driven by geologically diverse habitats, including the evolution of life on Earth, the search for life on other planets, the study of life in extreme environments, and industrial applications of geomicrobiology.  
Effective Fall 2016

GLG 493  Field Studies in Geological Sciences  
On Demand. 1 to 6 credits. A student may earn a maximum of 8 credits in all enrollments for this course. P: GLG 201 and GLG 304 RB: Specific programs may have additional prerequisites. R: Open to juniors or seniors or graduate students in the Department of Geological Sciences or in the Lyman Briggs Environmental Geosciences Coordinate Major or in the Lyman Briggs Geological Sciences Coordinate Major. Approval of department.  
NEW  
One to six week field experiences in solid earth and environmental geosciences within the US and abroad. Field trips required. Request the use of ET-Extension to postpone grading. The work for the course must be completed and the final grade reported within 1 semester after the end of the semester of enrollment.  
Effective Summer 2016

GLG 498  Topics in Geological Sciences  
On Demand. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. P: GLG 201 and GLG 304 or approval of department RB: Recommended background may vary with topic R: Open to juniors or seniors or graduate students in the Department of Geological Sciences or in the Lyman Briggs Environmental Geosciences Coordinate Major or in the Lyman Briggs Geological Sciences Coordinate Major.  
NEW  
Selected topics in geological and geoenvironmental sciences supplementing or expanding specific topics, or examining topics not covered in regular courses.  
Effective Spring 2016

GLG 813  Hillslope Hydrology  
Spring of every year. (3-1) R: Open to graduate students.  
NEW  
Advanced course on Hillslope Hydrology covering the physical, chemical, and isotopic characteristics of river runoff generation from the pore to the catchment scale.  
Effective Spring 2017
GLG 889  Special Problems in Geocognition
Fall of every year. Spring of every year. Summer of every year. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.

NEW  Individual study on current problems in geocognition and geoscience education research
Effective Summer 2016

ZOL 101
IBIO 101  Preview of Zoology Exploring Biology
Fall of every year. Spring of every year. 1(1-0) R: Open to freshmen in the Zoology Major. R: Open to freshmen or sophomores in the Department of Integrative Biology or in the Environmental Biology/Zoology Major or in the Bachelor of Science in Zoology or in the Bachelor of Arts in Zoology.

Zoology as a discipline, Availability of diverse career options, Integration of human and technical skills in scientific problem solving. Biology as a discipline, Investigation of diverse careers options and of skills and background knowledge required to be a modern biologist, Integration of human and technical skills in scientific scholarship and inquiry.
Effective Spring 2014 Effective Fall 2016

ZOL 303
IBIO 303  Oceanography
Fall of every year. 4(4-0) Interdepartmental with Geological Sciences. P: (CEM 141 or CEM 181H or LB 171 or CEM 151) and (PHY 231 or PHY 183 or PHY 193H or LB 273 or PHY 183B or PHY 231C)
Physical, chemical, biological, and geological aspects of oceanography: ocean circulation, waves, tides, air-sea interactions, chemical properties of ocean water, ocean productivity, shoreline processes, and sediments.
Effective Spring 2014 Effective Fall 2016

ZOL 306
IBIO 306  Invertebrate Biology
Fall of every year. 4(3-3) P: BS 162 or LB 144 or BS 182H
Systematics, morphology, and natural history of invertebrate animals. Identification of live and preserved specimens. Recognition of selected groups.
Effective Spring 2014 Effective Fall 2016

ZOL 313
IBIO 313  Animal Behavior
Fall of every year. Spring of every year. Summer of every year. 3(3-0) P: BS 162 or LB 144 or BS 182H R: Not open to freshmen.
Development, physiological mediation, adaptive significance and evolution of behavior. SA: ZOL 213
Effective Spring 2014 Effective Fall 2016

ZOL 316
IBIO 316  General Parasitology
Spring of every year. 3(3-0) P: LB 144 or BS 162 or BS 182H
Identification, life history, host-parasite relationships, and epidemiology of protozoan, helminth, acanthocephalan, copepod, and arthropod parasites of animals and humans.
Effective Spring 2014 Effective Fall 2016

ZOL 320
IBIO 320  Developmental Biology
Fall of every year. 4(3-3) P: (BS 161 or LB 145 or BS 181H) and (BS 162 or LB 144 or BS 182H)
Principles of development, emphasizing vertebrates. Illustrations from morphological and experimental investigations.
SA: ZOL 220
Effective Spring 2014 Effective Fall 2016
**ZOL 328**
**IBIO 328**  
Comparative Anatomy and Biology of Vertebrates (W)  
Spring of every year. 4(3-3) P: (BS 162 or LB 144 or BS 182H) and completion of Tier I writing requirement  
Comparative morphology and natural history of vertebrates. Dissection of representatives of most vertebrate classes.  
SA: ZOL 228  
**Effective Spring 2014 Effective Fall 2016**

**ZOL 341**  
**IBIO 341**  
Fundamental Genetics  
Fall of every year. Spring of every year. Summer of every year. 4(4-0) Interdepartmental with Plant Biology. P: BS 161 or LB 145 or BS 181H  
Principles of heredity in animals, plants and microorganisms. Classical and molecular methods in the study of gene structure, transmission, expression and evolution.  
**Effective Fall 2012 Effective Fall 2016**

**ZOL 343**  
**IBIO 343**  
Genetics Laboratory  
Spring of every year. 3(0-6) P: (ZOL 341 or concurrently) and completion of Tier I writing requirement  
Experiments involving genetics of Drosophila and other eucaryotic organisms.  
**Effective Spring 2014 Effective Fall 2016**

**ZOL 353**  
**IBIO 353**  
Marine Biology (W)  
Fall of every year. 4(4-0) P: (BS 162 or LB 144 or BS 182H) and completion of Tier I writing requirement  
**Effective Spring 2014 Effective Fall 2016**

**ZOL 355**  
**IBIO 355**  
Ecology  
Fall of every year. Spring of every year. Summer of every year. 3(3-0) Interdepartmental with Plant Biology. P: BS 162 or LB 144 or BS 182H  
Interrelationships of plants and animals with each other and the environment. Principles of individual, population, community, and ecosystem ecology. Application of ecological principles to global change and other anthropogenic stressors.  
SA: ZOL 250  
**Effective Spring 2014 Effective Fall 2016**

**ZOL 355L**  
**IBIO 355L**  
Ecology Laboratory (W)  
Fall of every year. Spring of every year. Summer of every year. 1(0-3) Interdepartmental with Plant Biology. P: (ZOL 355 or concurrently) and completion of Tier I writing requirement  
Population, community, and ecosystem ecology, utilizing plant and animal examples to demonstrate general field principles.  
**Effective Spring 2014 Effective Fall 2016**

**ZOL 357**  
**IBIO 357**  
Global Change Biology (W)  
Spring of every year. 3(3-0) P: (ZOL 355) and completion of Tier I writing requirement RB: Intended for science or engineering majors R: Not open to freshmen.  
Causes and consequences of modes of contemporary global change that are caused by biological systems or impact biological systems. Theories, evidence, and predictions in global warming, ocean acidification, desertification, eutrophication, food security, and mass extinction.  
**Effective Spring 2016 Effective Fall 2016**
ZOL 360  
IBIO 360  Biology of Birds  
Fall of every year. 4(3-3) P: BS 162 or LB 144 or BS 182H  
Behavior, ecology, evolution, and systematics of birds; biodiversity. Laboratories emphasize diversity of form and function, life history patterns, and identification.  
**Effective Spring 2014**  
**Effective Fall 2016**

ZOL 365  
IBIO 365  Biology of Mammals  
Spring of every year. 4(3-3) P: BS 162 or LB 144 or BS 182H  
Analysis of the behavior, ecology, evolution, and systematics of mammals. Laboratories emphasize diversity of form and function, life history patterns, and identification.  
**Effective Spring 2014**  
**Effective Fall 2016**

ZOL 369  
IBIO 369  Introduction to Zoo and Aquarium Science  
Spring of every year. 3(3-0) Interdepartmental with Fisheries and Wildlife and Landscape Architecture and Veterinary Medicine. P: BS 162 or LB 144 or BS 182H  
Fundamentals of zoo and aquarium operations including research, interpretation, design, nutrition, captive breeding, conservation, ethics and management.  
**Effective Fall 2014**  
**Effective Fall 2016**

ZOL 370  
IBIO 370  Introduction to Zoogeography  
Fall of every year. 3(3-0) Interdepartmental with Fisheries and Wildlife and Geography. P: ZOL 355  
Patterns of geographical distribution of animals and the ecological and historical processes leading to these patterns.  
**Effective Fall 2014**  
**Effective Fall 2016**

ZOL 384  
IBIO 384  Biology of Amphibians and Reptiles (W)  
Fall of every year. 4(3-3) P: (BS 162 or LB 144 or BS 182H) and completion of Tier I writing requirement  
The evolution, systematics, ecology, and behavior of amphibians and reptiles. Laboratory emphasizes diversity and identification of families and Great Lakes species. Field trips may be required.  
**Effective Spring 2014**  
**Effective Fall 2016**

ZOL 390  
IBIO 390  Practicum in Zoo/Aquarium Careers  
Summer of every year. 4 credits.  
Practical application of science, business and education methods through typical workdays with zoo professionals.  
**Effective Spring 2014**  
**Effective Fall 2016**

ZOL 400H  
IBIO 400H  Honors Work  
Fall of every year. Spring of every year. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course. R: Not open to freshmen or sophomores.  
Honors work on a topic in zoology.  
Request the use of ET-Extension to postpone grading.  
The work for the course must be completed and the final grade reported within 1 semester after the end of the semester of enrollment.  
**Effective Spring 2014**  
**Effective Fall 2016**

ZOL 402  
IBIO 402  Neurobiology  
Fall of every year. Spring of every year. 3(3-0) P: (BS 162 or LB 144 or BS 182H) and (BS 161 or LB 145 or BS 181H) R: Not open to freshmen or sophomores and not open to students in the Program in Neuroscience and not open to students in the Lyman Briggs Neuroscience Major.  
Structure and function of nerve cells and nervous systems.  
**Effective Spring 2014**  
**Effective Fall 2016**
ZOL 403  
**IBIO 403  Integrative Neurobiology**  
Spring of odd years. 3(3-0)  
P: ZOL 402 or PSY 209  
RB: Junior or Senior level  
How the nervous system has evolved mechanisms to determine the location and significance of physical and social sensory information. Epigenetic factors that guide nervous system development.  
**Effective Spring 2014 Effective Fall 2016**

ZOL 405  
**IBIO 405  Neural Basis of Animal Behavior**  
Spring of every year. 3(3-0)  
P: (BS 161 or LB 145 or BS 181H) and (BS 162 or LB 144 or BS 182H)  
Structure and function of neurons and neural circuits underlying naturally-occurring animal behaviors.  
**Effective Spring 2016 Effective Fall 2016**

ZOL 408  
**IBIO 408  Histology**  
Fall of every year. 4(3-3)  
P: BS 161 or LB 145 or BS 181H  
Structure of cells and their interactions to form tissues.  
SA: ZOL 350  
**Effective Spring 2014 Effective Fall 2016**

ZOL 415  
**IBIO 415  Ecological Aspects of Animal Behavior (W)**  
Fall of every year. 3(3-0)  
P: (ZOL 313) and completion of Tier I writing requirement  
Advanced topics in the ecology and evolution of animal behavior.  
**Effective Spring 2014 Effective Fall 2016**

ZOL 425  
**IBIO 425  Cells and Development (W)**  
Spring of every year. 4(3-3)  
P: (BS 161 and BS 171) or LB 145 or ((BS 181H and BS 191H) and completion of Tier I writing requirement)  
The role of cells in growth, differentiation and development of animals from protozoa to mammals.  
SA: ZOL 221  
**Effective Spring 2014 Effective Fall 2016**

ZOL 440  
**IBIO 440  Field Ecology and Evolution**  
Summer of every year. 4 credits. Interdepartmental with Plant Biology.  
P: ZOL 355  
Solving conceptual and practical research problems in ecology and evolution under field conditions.  
**Effective Spring 2014 Effective Fall 2016**

ZOL 445  
**IBIO 445  Evolution (W)**  
Fall of every year. Spring of every year. Summer of every year. 3(3-0)  
Interdepartmental with Crop and Soil Sciences and Plant Biology.  
P: (ZOL 341 or CSS 350) and completion of Tier I writing requirement  
R: Not open to freshmen.  
SA: ZOL 345  
**Effective Spring 2014 Effective Fall 2016**
ZOL 446  IBIO 446  Environmental Issues and Public Policy  
Fall of every year.  3(3-0) Interdepartmental with Environmental Studies and Applications.  
Interdepartmental with Community Sustainability.  R: Not open to freshmen or sophomores.  
Interrelationship of science and public policy in resolving environmental issues.  Technical,  
social, economic, and legal influences.  Case study approach.  
Effective Spring 2014 Effective Fall 2016

ZOL 450  IBIO 450  Cancer Biology (W)  
Spring of every year.  3(3-0) P: (BMB 200 or BMB 401 or ZOL 425) or (BMB 461 and BMB 462) and  
completion of Tier I writing requirement.  
Cancer biology: cellular and molecular aspects.  Applications of modern biotechnology to  
cancer research.  Causes, treatment, and prevention of cancer.  World distribution and risk  
factors of cancer.  
Effective Spring 2014 Effective Fall 2016

ZOL 483  IBIO 483  Environmental Physiology (W)  
Spring of every year.  4(4-0) P: ((BS 161 or LB 145 or BS 181H) and completion of Tier I writing  
requirement) and (BS 162 or LB 144 or BS 182H) and (CEM 141 or CEM 151 or CEM 181H or LB  
171)  
Aspects of physiology important to the environmental relations of vertebrates and  
invertebrates: energetics, thermal relations, osmotic-ionic relations, and exercise  
physiology.  
Effective Spring 2014 Effective Fall 2016

ZOL 485  IBIO 485  Tropical Biology  
Fall of every year.  3(3-0) Interdepartmental with Plant Biology.  P: ZOL 355 P: (IBIO 355) and  
completion of Tier I writing requirement.  R: Open to juniors or seniors.  
Tropical biota emphasizing evolutionary and ecological principles compared across  
tropical ecosystems.  
SA: ZOL 485  
Effective Summer 2015 Effective Fall 2016

ZOL 489  IBIO 489  Seminar in Zoo and Aquarium Science  
Fall of every year.  1(1-0) Interdepartmental with Fisheries and Wildlife and Landscape Architecture.  
Interdepartmental with Community Sustainability and Fisheries and  
Wildlife and Landscape Architecture.  A student may earn a maximum of 3 credits in all enrollments  
for this course.  R: Approval of department.  
Scientific writing and oral presentations related to zoo and aquarium studies.  
Effective Spring 2014 Effective Fall 2016

ZOL 490  IBIO 490  Overseas Study in Zoology  
Fall of every year.  3 to 6 credits.  A student may earn a maximum of 6 credits in all enrollments for this course.  P: (BS 162 or LB 144 or BS 182H) and (BS 161 or LB 145 or BS 181H) R: Open to seniors or graduate students.  
Topical problems course in Zoology or coordinated by Zoology faculty in foreign countries.  
Effective Spring 2014 Effective Fall 2016

ZOL 494  IBIO 494  Independent Study  
Fall of every year.  1 to 6 credits.  A student may earn a maximum of 8 credits in all enrollments for this course.  R: Approval of department.  
Supervised research on a topic not normally covered in the classroom.  
Request the use of ET-Extension to postpone grading.  
The work for the course must be completed and the final grade reported within 1 semester  
after the end of the semester of enrollment.  
Effective Spring 2014 Effective Fall 2016
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
<th>Enrollment</th>
<th>Credits</th>
<th>Restrictions</th>
<th>Approval</th>
<th>Effective Dates</th>
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<tbody>
<tr>
<td>ZOL 495</td>
<td>IBIO 495 Undergraduate Seminar</td>
<td>Fall of every year. Spring of every year. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course. R: Open to seniors in the Zoology Major. Economic, social and environmental impact of current developments in Zoology.</td>
<td>Fall</td>
<td>1</td>
<td>1</td>
<td>Open</td>
<td>Spring 2014 - Fall 2016</td>
</tr>
<tr>
<td>ZOL 496</td>
<td>IBIO 496 Internship in Zoology</td>
<td>Fall of every year. Spring of every year. Summer of every year. 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open to seniors. Approval of department. Practical experience applying zoology training in a setting outside the University. Request the use of ET-Extension to postpone grading. The work for the course must be completed and the final grade reported within 1 semester after the end of the semester of enrollment.</td>
<td>Fall</td>
<td>4</td>
<td>8</td>
<td>Open</td>
<td>Spring 2014 - Fall 2016</td>
</tr>
<tr>
<td>ZOL 497</td>
<td>IBIO 497 International Internship in Zoo and Aquarium Science</td>
<td>Fall of every year. Spring of every year. Summer of every year. 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. RB: Biological Sciences R: Open to juniors or seniors or graduate students. Approval of department; application required. A student may earn a maximum of 8 credits ZOL 496, ZOL 497, ZOL 498 Application of zoological experience in a zoo or aquarium setting outside the United States.</td>
<td>Fall</td>
<td>4</td>
<td>8</td>
<td>Open</td>
<td>Spring 2014 - Fall 2016</td>
</tr>
<tr>
<td>ZOL 498</td>
<td>IBIO 498 Internship in Zoo and Aquarium Science</td>
<td>Fall of every year. Spring of every year. Summer of every year. 4 credits. Interdepartmental with Fisheries and Wildlife and Landscape Architecture. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open to juniors or seniors. Approval of department. Application of zoological experience in a zoo or aquarium setting outside the university. Request the use of ET-Extension to postpone grading. The work for the course must be completed and the final grade reported within 1 semester after the end of the semester of enrollment.</td>
<td>Fall</td>
<td>4</td>
<td>8</td>
<td>Open</td>
<td>Spring 2014 - Fall 2016</td>
</tr>
<tr>
<td>ZOL 801</td>
<td>IBIO 801 Professional Development</td>
<td>Fall of every year. 1(2-0) R: Open only to graduate students in the Department of Zoology. R: Open to graduate students in the Department of Integrative Biology. Ethical conduct in research. Selecting research topics and approaches. Scientific writing, grantsmanship, and publication. Career paths inside and outside academia.</td>
<td>Fall</td>
<td>1(2-0)</td>
<td>2</td>
<td>Open</td>
<td>Spring 2005 - Fall 2016</td>
</tr>
<tr>
<td>ZOL 822</td>
<td>IBIO 822 Topics in Ethology and Behavioral Ecology</td>
<td>Spring of odd years. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course. RB: ZOL 415 R: Open only to graduate students. R: Open to graduate students. Critical analysis through seminar-discussions of the primary research literature.</td>
<td>Fall</td>
<td>3(3-0)</td>
<td>6</td>
<td>Open</td>
<td>Spring 2005 - Fall 2016</td>
</tr>
</tbody>
</table>
ZOL 824  IBIO 824  Stable Isotope Biogeochemistry  
Spring of every years. 2(1-2) Interdepartmental with Geological Sciences. RB: CEM 142 or CEM 152 or CEM 182H or LB 171  
Principles of stable isotope chemistry applied to biogeochemical problems: climate change, ecology, contaminants, oceanography, limnology, and paleobiology.  
**Effective Fall 2009 Effective Fall 2016**

ZOL 832  IBIO 832  Evolution of Nervous Systems  
Spring of odd years. 3(3-0) Interdepartmental with Neuroscience. RB: Background in neurobiology or evolutionary biology recommended. R: Open to graduate students in the Department of Computer Science and Engineering or in the Program in Neuroscience or in the Department of Psychology or in the Department of Zoology or approval of department.  
Evolutionary origins, mechanisms, and consequences of evolutionary change in nervous systems.  
**Effective Spring 2013 Effective Fall 2016**

ZOL 848  IBIO 848  Current Topics in Evolutionary Development Biology  
Spring of every year. 3(3-0) RB: (ZOL 445 or ZOL 320 or ZOL 425 or ZOL 341) or background in evolutionary biology or developmental biology.  
Genetic and developmental basis for evolutionary change. Synthesis of molecular and developmental genetics with evolutionary biology. Discussion of primary literature in evolutionary development.  
**Effective Spring 2008 Effective Fall 2016**

ZOL 851  IBIO 851  Statistical Methods for Ecology and Evolution  
Fall of every year. 3(2-2) Interdepartmental with Plant Biology. RB: (STT 814) or or an equivalent course.  
Statistical modeling and interpretation of biological data using computationally intensive methods for estimation and inference. General linear models, mixed and process models, and estimation strategies applied to students using their own data using the R language.  
**Effective Fall 2010 Effective Fall 2016**

ZOL 855  IBIO 855  Molecular Evolution: Principles and Techniques  
Fall of odd years. 3(2-2) Interdepartmental with Microbiology and Molecular Genetics and Plant Biology. RB: ZOL 341 or ZOL 445 RB: (IBIO 341 or IBIO 445) or ZOL 341 or ZOL 445  
Current techniques used to characterize and compare genes and genomes. Genetic variation, assays of variation. Data analysis and computer use to conduct a phylogenetic analysis to compare organisms and infer relationships.  
SA: ZOL 855  
**Effective Fall 2005 Effective Fall 2016**

ZOL 867  IBIO 867  Nature and Practice of Cognitive Science  
Spring of every year. 3(3-0) Interdepartmental with Computer Science and Engineering and Linguistics and Philosophy and Psychology. RB: Undergraduate course work in behavioral biology, cognitive psychology, philosophy, linguistics, or artificial intelligence.  
Survey of how different disciplines explore the cognitive processes underlying intelligent behavior.  
**Effective Spring 2003 Effective Fall 2016**

ZOL 890  IBIO 890  Special Problems  
Fall of every year. Spring of every year. Summer of every year. 1 to 3 credits. A student may earn a maximum of 10 credits in all enrollments for this course. R: Approval of department.  
Current problems in Zoology.  
**Effective Fall 1990 Effective Fall 2016**
ZOL 891  
IBIO 891  
Current Topics in Ecology and Evolution  
Summer of every year. 1 to 2 credits. Interdepartmental with Crop and Soil Sciences and Plant Biology. A student may earn a maximum of 10 credits in all enrollments for this course.  
Presentation and critical evaluation of theoretical and empirical developments in ecology and evolutionary biology by visiting scientists.  
Request the use of the Pass-No Grade (P-N) system.  
**Effective Summer 2005 Effective Fall 2016**

ZOL 895  
IBIO 895  
Seminar  
Fall of every year. Spring of every year. 1(1-0) A student may earn a maximum of 6 credits in all enrollments for this course.  
Graduate seminar on current research topics in Zoology.  
**Effective Fall 1992 Effective Fall 2016**

ZOL 896  
IBIO 896  
Population and Community Ecology  
Fall of every year. 4(4-0) Interdepartmental with Plant Biology.  
Population dynamics of animals and plants utilizing life tables and projection matrices.  
**Effective Fall 2003 Effective Fall 2016**

ZOL 897  
IBIO 897  
Ecosystem Ecology and Global Change  
Spring of odd years. 4(4-0) Interdepartmental with Fisheries and Wildlife and Plant Biology.  
Structure and function of natural ecosystems and their responses to global environmental change. Biogeochemical cycles, food webs, energy flow, nutrient cycling, and ecosystem management and restoration.  
**Effective Spring 2011 Effective Fall 2016**

ZOL 899  
IBIO 899  
Master's Thesis Research  
Fall of every year. Spring of every year. Summer of every year. 1 to 6 credits. A student may earn a maximum of 36 credits in all enrollments for this course.  
Master's thesis research.  
Request the use of ET-Extension to postpone grading.  
The work for the course must be completed and the final grade reported within 30 semesters after the end of the semester of enrollment.  
**Effective Summer 2002 Effective Fall 2016**

ZOL 999  
IBIO 999  
Doctoral Dissertation Research  
Fall of every year. Spring of every year. Summer of every year. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course.  
Doctoral dissertation research.  
Request the use of the Pass-No Grade (P-N) system.  
**Effective Summer 2014 Effective Fall 2016**

MTH 291  
Mathematics Snapshots  
Spring of every year. 1(2-0) A student may earn a maximum of 2 credits in all enrollments for this course. P: MTH 132 or MTH 152H or LB 118 or approval of department RB: MTH 309 or MTH 314 or MTH 317H  
Selected topics in mathematics and its applications. Emphasis will be on important and intriguing ideas in mathematics without indulging in technical details.  
**DELETE COURSE**  
**Effective Summer 2015**
MMG 141  Introductory Human Genetics
Fall of every year. Spring of every year. 3(3-0) R: Not open to students in the Biochemistry and Molecular Biology major or in the Biological Science Major or in the Clinical Laboratory Sciences Major or in the Human Biology Major or in the Microbiology Major or in the Physiology Major or in the Plant Biology Major or in the Zoology Major or in the Biomedical Laboratory Science Major or in the Environmental Biology/Microbiology Major or in the Environmental Biology/Zoology Major or in the Genomics and Molecular Genetics Major or in the Neuroscience Major and not open to students in the Lyman Briggs Biochemistry and Molecular Biology Coordinate Major or in the Lyman Briggs Biological Science-Interdepartmental Coordinate Major or in the Lyman Briggs Biomedical Laboratory Science Coordinate Major or in the Lyman Briggs Environmental Biology/Plant Biology Coordinate Major or in the Lyman Briggs Environmental Biology/Microbiology Coordinate Major or in the Lyman Briggs Environmental Biology/Zoology Coordinate Major or in the Lyman Briggs Genomics and Molecular Genetics Coordinate Major or in the Lyman Briggs Human Biology Coordinate Major or in the Lyman Briggs Microbiology Coordinate Major. R: Not open to students in the Biochemistry and Molecular Biology major or in the Biological Science Major or in the Biomedical Laboratory Science Major or in the Clinical Laboratory Sciences Major or in the Environmental Biology/Microbiology Major or in the Environmental Biology/Zoology Major or in the Genomics and Molecular Genetics Major or in the Human Biology Major or in the Microbiology Major or in the Neuroscience Major or in the Physiology Major or in the Plant Biology Major or in the Zoology Major and not open to students in the Lyman Briggs Biochemistry and Molecular Biology Coordinate Major or in the Lyman Briggs Biological Science-Interdepartmental Coordinate Major or in the Lyman Briggs Biomedical Laboratory Science Coordinate Major or in the Lyman Briggs Environmental Biology/Plant Biology Coordinate Major or in the Lyman Briggs Environmental Biology/Microbiology Coordinate Major or in the Lyman Briggs Environmental Biology/Zoology Coordinate Major or in the Lyman Briggs Genomics and Molecular Genetics Coordinate Major or in the Lyman Briggs Human Biology Coordinate Major or in the Lyman Briggs Microbiology Coordinate Major. Not open to students with credit in ZOL 341. Not open to students with credit in IBIO 341.

SA: ZOL 141
Effective Summer 2016 Effective Fall 2016

NEU 301  Introduction to Neuroscience I
Fall of every year. 3(3-0) P: (BS 161 or BS 181H or LB 145) and (BS 162 or BS 191H or LB 145) P: (BS 161 or BS 181H or LB 145) and (BS 162 or BS 191H or LB 144) R: PSY 101 R: Open to undergraduate students in the Program in Neuroscience.
Survey of the field of neuroscience, including molecular, cellular, and autonomic, sensory and motor systems.
Effective Fall 2014 Effective Fall 2016

NEU 310  Psychology and Biology of Human Sexuality
Spring of even years. 3(3-0) Interdepartmental with Psychology and Zoology. Interdepartmental with Integrative Biology and Psychology P: (PSY 101 or concurrently) and ((BS 161 or concurrently) or (BS 162 or concurrently) or (BS 162 or concurrently) or (BS 181H or concurrently) or (BS 182H or concurrently)) Not open to students with credit in HDFS 445.

Effective Fall 2014 Effective Fall 2016
NEU 417  Instrumental Methods of Analysis in Neuroscience
Spring of every year. 3(3-0) Interdepartmental with Chemistry. P: (((CEM 251 and CEM 252) or (CEM 351 and CEM 352)) and (PHY 231 and PHY 232)) or (PHY 183 and PHY 184) or (PHY 193H and PHY 294H) or (LB 273 and LB 274) RB: NEU 301 or CEM 262
NEW Design, operational principles and practical application of modern instrumental methods used for the separation, identification and quantification of neurochemical species in neuroscience. How modern methods of chemical analysis are used to study neurosignaling and the chemical composition in single secretory cells, and the chemical structure of cells and tissues. Uses a combination of problem-based learning approaches, case studies and traditional lectures, to develop critical thinking skills in the areas of instrument selection, method development and data interpretation.
Effective Spring 2016

NEU 425  Computational Modeling in Neuroscience
Spring of every year. 3(3-0) P: NEU 302 RB: (MTH 124 and MTH 126) or (MTH 132 and MTH 133) R: Open to undergraduate students in the Neuroscience Major or in the Lyman Briggs Neuroscience Major.
NEW Introduction to neuroscience modeling techniques; review of successful models; student will create their own model of a dynamic neural process or behavior
Effective Spring 2016

NEU 430  Genomics of Brain Development, Learning, and Behavior
Summer of every year. 3(3-0) P: (ZOL 341) and (NEU 302 or ZOL 402) P: (ZOL 341) and (NEU 302 or concurrently) RB: PSY 209
Role of genes in brain development and function. Issues in behavioral and psychiatric genetics.
Effective Summer 2015 Effective Spring 2016

NEU 435  Ion Channels of Excitable Membranes
Fall of every year. 3(3-0) Interdepartmental with Zoology. P: (NEU 302 and NEU 311L) or ZOL 402 RB: (PHM 350 or PSL 431) and ZOL 341 R: Open to undergraduate students in the Neuroscience Major or in the Bachelor of Science in Zoology or in the Lyman Briggs Neuroscience Major or in the Lyman Briggs Zoology Coordinate Major.
NEW Introduction to ion channels and their critical role in normal physiological functioning, sensory and neuromuscular diseases and disorders, as well as targets of toxins and poisons.
Effective Fall 2015

NEU 440  Synaptic Transmission
Spring of even years. 3(3-0) P: NEU 301 R: Open to undergraduate students in the Neuroscience Major or in the Lyman Briggs Neuroscience Major.
NEW Chemical and electrical aspects of nerve impulse transmission at synaptic and neuroeffector junctions. Influence of drugs.
Effective Spring 2016

NEU 445  Analysis of Neural Activity Data (W)
Fall of every year. 3(3-0) P: ((NEU 301 and (NEU 302 or concurrently)) and completion of Tier I writing requirement) and (MTH 124 or MTH 132 or MTH 152H or LB 118) and (STT 201 or STT 231 or STT 421 or PSY 295)
NEW Conceptual and practical approaches to analyzing large functional datasets. Emphasis on statistical issues, including preprocessing, estimation methods, hypothesis testing, dimension reduction, and correlation with behavior. Data types include electrophysiological recording, EEG, MEG, fMRI and optical imaging.
Effective Fall 2015
PHY 431
Optics I
Fall of every year. 3(2-3) P: (PHY 192 or LB 274) and (PHY 192 or PHY 184B or PHY 204H) and ((MTH 235 or concurrently) or (MTH 355H or concurrently)) and Completion of Tier I Writing Requirement P: (PHY 192 or LB 274) and (PHY 192 or LB 274) and ((MTH 235 or concurrently) or (MTH 347H or concurrently)) and Completion of Tier I Writing Requirement
Lenses, aberrations, apertures, and stops. Diffraction, interferometry, spectroscopy, fiber optics.
Effective Fall 2013 Effective Fall 2015

PLB 424
Algal Biology
Fall of even years. Summer of odd years. 4(2-4) Interdepartmental with Zoology. Interdepartmental with Integrative Biology P: (BS 162 or LB 144 or BS 182H) and (BS 172 and completion of Tier I writing requirement) RB: ZOL 355 and ZOL 355L
Algal taxonomy, systematics, physiology, ecology, and environmental assessment. Lab focus on identification of freshwater algal genera collected from regional habitats.
SA: BOT 424
Effective Fall 2014 Effective Fall 2016

PLB 443
Restoration Ecology
Fall of odd years. Spring of every year. 3(2-2) Interdepartmental with Biosystems Engineering and Plant Biology and Zoology. Interdepartmental with Biosystems Engineering and Fisheries and Wildlife and Integrative Biology P: FOR 404 or PLB 441 or ZOL 355 RB: CSS 210 or BE 230
Principles of ecological restoration of disturbed or damaged ecosystems. Design, implementation, and presentation of restoration plans. Field trips required.
Effective Fall 2014 Effective Fall 2017

PLB 849
Evolutionary Biology
Spring of every year. 3(3-0) Interdepartmental with Zoology. Interdepartmental with Integrative Biology RB: ZOL 341 and (STT 422 or concurrently)
Major conceptual, theoretical and empirical questions in evolutionary biology. Readings and lectures are synthesized in student discussions and papers.
SA: BOT 849
Effective Fall 2002 Effective Fall 2016

PLB 898
Population and Community Ecology Theory Laboratory
Fall of every year. 1(0-3) Interdepartmental with Zoology. Interdepartmental with Integrative Biology RB: 1 semester of calculus
Practical experience designing and analyzing mathematical models in ecology from single species to communities, food webs and ecosystems.
Effective Fall 2012 Effective Fall 2016

STT 465
Bayesian Statistical Methods
Fall of every year. 3(3-0) Interdepartmental with Epidemiology. P: STT 442
Effective Fall 2014 Effective Fall 2015

STT 805
Statistical Modeling for Business Analytics
Summer of every year. 3(3-0) RB: STT 442 R: Open to master's students in the Business Analytics Major.
NEW
Low dimensional data visualization; Simple linear regression; Regression diagnostics; Analysis of variance; Multiple linear regression; Regression model building; Variable selection; Categorical data; Logistic regression; Proportional odds model; Introduction to time series.
Effective Summer 2016
COLLEGE OF NURSING

NUR 422  Nursing in London
Summer of every year. 5(5-0) R: Approval of college; application required.
Historical evolution of nursing in the National Health Service: British nursing education, hospital and community health nursing, standards of care, research, and management. Influence of professional nursing upon British national health policies.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 1 semester after the end of the semester of enrollment.
Effective Fall 2014 Effective Summer 2016

NUR 441  Future of Nursing: Graduate Education
Fall of every year. Spring of every year. 2(2-0) R: NUR 450 or concurrently P: NUR 322 or concurrently R: Open to students in the Nursing Major.
Options for graduate education in nursing. Students will develop post-BSN professional goals. Identify potential clinical focus and population of interest for research/scholarship/practice. Completion of an application to the graduate program of their choice.
Effective Spring 2013 Effective Fall 2016

COLLEGE OF VETERINARY MEDICINE

LCS 562  Care and Management of the Neonatal Foal
Spring of every year. 1(1-0) RB: Completion of year 1 in the graduate professional curriculum. R: Open to graduate-professional students in the College of Veterinary Medicine.
Weekly seminars focusing on common diseases. Case presentations.
Request the use of the Pass-No Grade (P-N) system.
Effective Spring 2009 Effective Spring 2016

LCS 563  Bovine Pregnancy Diagnosis
Fall of every year. 1(1-1) RB: Completion of year 2 in the graduate professional curriculum. R: Open to graduate-professional students in the College of Veterinary Medicine.
Basic reproductive physiology. Farm based laboratories in bovine transrectal palpation and sonography. Field trips required.
Request the use of the Pass-No Grade (P-N) system.
Effective Spring 2008 Effective Fall 2016

LCS 565  Equine Sports Medicine
Fall of odd years. Fall of every year. 1(1-0) RB: Completion of year 2 in the graduate professional curriculum. R: Open to graduate-professional students in the College of Veterinary Medicine.
Physiologic responses to exercise and discipline specific disorders of equine athletes.
Request the use of the Pass-No Grade (P-N) system.
Effective Spring 2009 Effective Fall 2016

LCS 569  Sport Horse Evaluation, Rehabilitation and Therapy
Spring of every year. 1(1-0) RB: Completion of year 1 of the graduate professional program in the College of Veterinary Medicine. R: Open to graduate-professional students in the College of Veterinary Medicine.
NEW
This course will provide students with hands-on skills in the diagnostic evaluation of the equine athlete and experience with diagnostic procedures and treatment modalities. Traditional medical approaches, acupuncture, and chiropractic manipulation of the athlete will be performed by the student and can be used to maintain or enhance performance in the competition horse.
Effective Spring 2016
LCS 621  Equine Practice Clerkship
Practice Based Ambulatory Clerkship
Fall of every year. Spring of every year. Summer of every year. 3 credits. RB: Completion of semester 5 of the graduate-professional program in the College of Veterinary Medicine. R: Open to graduate-professional students in the College of Veterinary Medicine.
Supervised, off-campus experience in an assigned veterinary practice. Regular equine farm calls. After-hours emergencies. Veterinary practice management. Supervised, off-campus experience in an assigned veterinary practice. Regular equine and food animal farm calls. After-hours emergencies. Veterinary practice management. Request the use of the Pass-No Grade (P-N) system. Request the use of ET-Extension to postpone grading. The work for the course must be completed and the final grade reported within 1 semester after the end of the semester of enrollment. Effective Fall 2013 Effective Spring 2016

PDI 560  Introduction to Veterinary Cytology
Fall of every year. 1(0-2) RB: Completion of year 2 of the graduate professional program in the College of Veterinary Medicine. R: Open to graduate-professional students in the College of Veterinary Medicine.
Principles of sample collection, slide preparation, fluid analysis and interpretation using clinical case material. Request the use of the Pass-No Grade (P-N) system. Effective Spring 2009 Effective Fall 2016

PDI 561  International Veterinary Medicine
Fall of every year. 1(1-0) RB: Completion of year 2 of the graduate professional program in the College of Veterinary Medicine. R: Open to graduate-professional students in the College of Veterinary Medicine.
Veterinary sciences and the needs of international countries. Request the use of the Pass-No Grade (P-N) system. Effective Summer 2012 Effective Fall 2016

PDI 564  Topographic and Applied Anatomy of Live Horses and Cattle
Fall of every year. 1(0-2) RB: Completion of year 2 of the graduate professional program in the College of Veterinary Medicine. R: Open to graduate-professional students in the College of Veterinary Medicine.
Identification of structures and landmarks of clinical significance in live horses and cattle in relation to the structures imaged using endoscopy, ultrasonography, radiology, MRI, and CT scans. Request the use of the Pass-No Grade (P-N) system. Effective Fall 2009 Effective Fall 2016

PHM 431  Pharmacology of Drug Addiction
Fall of every year. 3(3-0) Interdepartmental with Neuroscience, RB: Zoology or Human Biology or Psychology or Biochemistry or Physiology.

PHM 461  Tropical Medicine Pharmacology (I)
Fall of every year. Summer of every year. 2(2-0) P: PHM 350 or concurrently R: Open to juniors or seniors or master's students. Approval of department.
Tropical diseases, epidemiologic and clinical features, and pharmacologic treatments. Multidisciplinary and interdisciplinary approaches, especially in poverty settings. Effective Fall 2016
PHM 801  Fundamental Principles of Pharmacology and Toxicology
Fall of every year. 1 to 2 credits. 3(3-0) R: Open to doctoral students or approval of department. R:
Open to graduate students in the College of Natural Science or in the Department of Pharmacology
and Toxicology or approval of department.
Core principles of pharmacology and toxicology including pharmacokinetics, toxicokinetics
(drug/toxicant absorption, distribution, metabolism, elimination, modeling),
pharmacodynamics (drug-receptor and drug-enzyme interactions), and drug discovery.
Effective Fall 2013  Effective Fall 2016

PHM 827  Physiology and Pharmacology of Excitable Cells
Fall of every year. 4(4-0) Interdepartmental with Neuroscience and Physiology and Zoology.
Interdepartmental with Integrative Biology and Neuroscience and Physiology RB: PSL 431 or PSL
432 or BMB 401 or BMB 461 or ZOL 402 RB: (PSL 431 or PSL 432 or BMB 401 or BMB 461 or
IBIO 402) or PSL 431 or PSL 432 or BMB 401 or BMB 461 or IBIO 402
Function of neurons and muscle at the cellular level: membrane biophysics and potentials,
synaptic transmission, sensory nervous system function.
Effective Fall 2001  Effective Fall 2016

SCS 563  Introduction to Exotic Species and Small Mammal Medicine
Spring of every year. 1(1-0) RB: Completion of year 1 of the graduate-professional program in the
College of Veterinary Medicine. R: Open to graduate-professional students in the College of
Veterinary Medicine.
Basic anatomy, physiology, and common disease processes of small mammals, birds,
and reptiles. Species include ferrets, rabbits, guinea pigs, small rodents, pet birds, and
reptiles.
Request the use of the Pass-No Grade (P-N) system.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 1 semester
after the end of the semester of enrollment.
Effective Spring 2009  Effective Spring 2016

SCS 564  Applied Small Animal Nutrition
Fall of every year. 1(1-0) RB: Completion of year 1 of the graduate-professional program in the
College of Veterinary Medicine. R: Open to graduate-professional students in the College of
Veterinary Medicine.
Principles of life stage nutrition and making dietary recommendations for healthy and sick
small animal patients.
Request the use of the Pass-No Grade (P-N) system.
Effective Fall 2014  Effective Fall 2016

SCS 565  Animal Behavior
Spring of every year. 1(1-0) RB: Completion of year 1 of the graduate-professional program in the
College of Veterinary Medicine. R: Open to graduate-professional students in the College of
Veterinary Medicine.
Diagnosis, treatment and prevention of behavioral problems in dogs and cats. Topics
include problem prevention, behavioral intervention, aggression, anxiety related problems,
inappropriate elimination, normal unwanted behavior, client counseling and interaction,
and companion animal welfare.
Request the use of the Pass-No Grade (P-N) system.
Effective Spring 2010  Effective Spring 2016

SCS 566  Emergency and Critical Care Medicine Seminars
Fall of every year. Spring of every year. 1(1-0) RB: Completion of year 1 of the graduate
professional program in the College of Veterinary Medicine. R: Open to graduate-professional
students in the College of Veterinary Medicine.
Case-based discussion of small animal veterinary emergency and critical care medical
issues.
Request the use of the Pass-No Grade (P-N) system.
Effective Summer 2010  Effective Spring 2016
SCS 568  Small Animal Advanced Orthopedics Seminars
Fall of every year. 1(1-0) RB:Completion of year 2 of the graduate-professional program in the College of Veterinary Medicine. R: Open to graduate-professional students in the College of Veterinary Medicine.
   Basic biomechanics and research in orthopedics including novel concepts and techniques in fracture management, arthropathies, corrective osteotomies, implant design, and performance.
   Request the use of the Pass-No Grade (P-N) system.
Effective Fall 2009 Effective Fall 2016

VM 250  Veterinary Comparative Clinical Physiology
Fall of every year. 4(4-0) P: (Completion of Tier I Writing Requirement) and (BS 161 and BS 171) or LB 145 P: (Completion of Tier I Writing Requirement) and (BS 161 and BS 171) or LB 145 R: Approval of college. C: VM 130 concurrently.
Effective Spring 2013 Effective Fall 2016

VM 811  Evolution and Ecology of Foodborne Pathogens
Fall of every year. Spring of every year. Summer of every year. 3 credits. R: Open to master’s students in the Food Safety major or approval of college.
   Evolution of foodborne pathogens. Ecology of microbial organisms found in the food chain from introduction through human consumption.
   Request the use of ET-Extension to postpone grading.
   The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
Effective Fall 2012 Effective Spring 2016

VM 824  Global Food Safety
Fall of every year. Spring of every year. 3(3-0) RB: Professional or graduate status with knowledge of food safety. R: Open to graduate students in the Food Safety major or approval of college.
   Understanding food safety challenges in different geographic regions. Development of interventions for food safety in a global context.
   Request the use of ET-Extension to postpone grading.
   The work for the course must be completed and the final grade reported within 3 semesters after the end of the semester of enrollment.
Effective Spring 2014 Effective Spring 2016

VM 828  Food Safety Seminar Series
Fall of every year. Spring of every year. 1(1-0) Interdepartmental with Agriculture and Natural Resources and Natural Science and Social Science. RB: Enrollment in graduate program in related discipline
   Selected current topics covering the broad areas of food safety as they relate to production, processing, transport, microbiology, toxicology, and social and human dimensions.
DELETE COURSE
Effective Spring 2016

VM 832  Food Safety Disease Control
Summer of every year. 3(3-0) R: Open to graduate students in the Food Safety major or approval of college.
   Applied approaches to food borne disease control using case studies.
   Request the use of ET-Extension to postpone grading.
   The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
DELETE COURSE
Effective Summer 2016
VM 834  Current Issues in Food Safety
Summer of every year. 1 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to graduate students in the College of Veterinary Medicine or in the Food Safety Major or approval of department.

NEW  Course includes several 1 credit condensed topic areas related to Food Safety such as: Allergen Control in the Manufacturing Setting, Microbial Control in the Manufacturing Setting, Good Manufacturing Practices, Seafood/Seafood HACCP, Ingredient Safety, Produce Food Safety and other topics as needed.
Request the use of ET-Extension to postpone grading.
The work for the course must be completed and the final grade reported within 2 semesters after the end of the semester of enrollment.
Effective Summer 2016

VM 835  Food Safety for Produce
Spring of every year, Summer of every year. 3(3-0) R: Open to graduate students in the Food Safety Major or approval of department.
Overview of food safety requirements for the produce sector with a focus on Good Agriculture Practices (GAPS).
Effective Summer 2015 Effective Spring 2016