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| **CSM****Biology/BS Program** |
| **Student Outcomes Assessment Plan (SOAP)** |
| 1. **Mission Statement**
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| The mission of the Department of Biology is to provide a diverse undergraduate program that matches the breadth of modern biology, develops students’ knowledge of core concepts and core competencies (as identified by AAAS’s *Vision and Change*) to prepare students for career opportunities that use biology as a foundation. The Bachelor of Science (BS) curriculum provides the depth of coverage required to promote students’ conceptual understanding of biological principles, core competencies, and practices.To accomplish this mission, the department offers a learning environment for students planning careers as professional life scientists, as medical professionals, teachers, and for those requiring a basic life science background for other majors including students fulfilling their general education science requirements. |

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| 1. **Goals and Student Learning Outcomes**
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| The goals of the Biology BS program are designed to prepare undergraduate students for careers in the life sciences. To contribute effectively to their discipline, life science professionals need to engage with information, including managing large, complex data sets, understanding and evaluating evidence; and drawing from knowledge of related disciplines (e.g., chemistry, physics, engineering, social sciences) to address societal challenges.The Biology Department’s expectations for student learning are based on the core concepts and core competencies of *Vision and Change*, as developed by the *American Association for the Advancement of Science* for undergraduate biology education.**Goal A:** Students will develop a basic understanding of the core concepts of biology.**Outcome A1:** Students will demonstrate an understanding of biology in the context of the five core concepts of biology (evolution; structure and function; information flow, exchange, and storage; pathways and transformations of energy and matter; living systems are interconnected and interacting).**Outcome A2:** Students will apply the five core concepts of biology to solve relevant problems.**Goal B:** Students will apply the process of science.Students will understand that biology is evidence-based and grounded in the formal practices of observation, experimentation, and hypothesis testing. **Outcome B1:** Students will identify and apply the scientific methods of observation, experimentation, hypothesis formulation, and hypothesis testing.**Outcome B2:** Students will obtain and evaluate information and information resources.**Goal C:** Students will use quantitative reasoning.Students should understand that biology often relies on applications of quantitative analysis and mathematical reasoning. Developing the ability to apply quantitative skills to biological problems should be required of all undergraduates, as they interpret and act on quantitative data from a variety of sources.**Outcome C1:** Students will interpret quantitative data to address biological problems.**Outcome C2:** Students will use mathematical approaches to discover emergent properties in biological systems.**Goal D:** Students will use modeling and simulation.Students should understand how mathematical and computational tools describe living systems. In this way, students will experience how biological systems are dynamic, interactive, and complex, whether at the molecular, cellular, organismal, or ecosystem level.**Outcome D1:** Students will explain the basic components of models and explain the advantages and limitations of modeling and systems approaches to study biological systems.**Outcome D2:** Students will use modeling and simulation tools to examine a dynamic biological system.**Goal E:** Students will understand the interdisciplinary nature of science.Students should have experience applying concepts and sub-disciplinary knowledge from within and outside of biology to interpret biological phenomena.**Outcome E1:** Students will analyze concepts by combining examples, facts, and theories from more than one scientific field of study (e.g. understanding structural features or processes from a molecular point of view using chemistry).**Outcome E2:** Students will demonstrate their advanced understanding of concepts by serving as a sub-discipline knowledge expert on a multi-disciplinary team.**Goal F:** Students will communicate and collaborate with other disciplines. Students should have experience communicating biological concepts and interpretations through a variety of formal and informal written, visual, and oral methods.**Outcome F1:** Students will communicate science in multiple forms to diverse audiences, including written, oral, and electronic formats.**Outcome F2:** Students will demonstrate effective collaboration by working with each to discuss scientific concepts (e.g. through active learning practices such as think-pair-share).**Goal G:** Students will understand the relationship between science and society. Students will explore science in a social context through real-life examples to explore the effect of science and technology on human society.**Outcome G1:** Students will communicate and apply biological principles and global perspectives in an ethical manner to current issues in human society.**Outcome G2:** Students will evaluate the impact of scientific discoveries on society and the ethical implications of that research. |

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| 1. **Curriculum Map (Matrix of Courses X Learning Outcomes)**
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| The following curriculum map matrix connects Biology core courses and student learning outcomes. **I = Introduced E=Emphasized or Reinforced M=Mastered**

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|  | Learning outcomes | BIOL 1A | BIOL 1B | BIOL 101 | BIOL 102 | BIOL 103 | BIOL 104 | BIOL 105 |
| Goal A | A1 | I | I | E | E | E | E | M |
| A2 | I | I | I | E | E | E |  |
| Goal B | B1 | I | I | E | E | E | E/M |  |
| B2 | I | I | I | I | E | E/M | M |
| Goal C | C1 | I | I | E | E |  | E | M |
| C2 |  |  | I | I |  | E | E |
| Goal D | D1 |  | I | I | I | E |  | M |
| D2 |  | I | I | I |  | I | E |
| Goal E | E1 | I |  | E | E | E | E/M | M |
| E2 |  | I | I |  |  |  |  |
| Goal F | F1 |  |  | I | I | E |  |  |
| F2 | I | I | E | E | E | E | M |
| Goal G | G1 |  |  |  | I | E | I | M |
| G2 | I |  |  | I | E |  |  |

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| 1. **Assessment Methods**
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| * 1. **Direct Measures**
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| **Pre/Post Instruction Survey**Valid and reliable pre- and post-instruction surveys can assess how well students understand the core concepts addressed in the Biology core courses (SLO A1 & A2). The pre-instruction survey will be given at the beginning of course instruction (in approximately week 2 of the course) and the post-instruction survey will be given at the end of instruction (approximately week 15). Target courses are BIOL 1A, BIOL 1B, BIOL 102 and BIOL 105. The instruments selected to measure student outcomes in these courses are published instruments with documented validity and reliability that consistently measure their intended content for their intended population (Appendix A1). The data will be analyzed using descriptive and inferential statistics per their published procedures. The instruments selected are aligned to assess core concepts:BIOL 1A: The Energy and Matter in Dynamic Systems Survey (Wilson et al., 2006) is a 5-item multiple-choice instrument that measures students’ knowledge of energy and matter as related to photosynthesis and cellular respiration.BIOL 1B: The Conceptual Inventory of Natural Selection (CINS; Anderson et al., 2002) is a 20-item multiple-choice instrument that measures students’ knowledge of natural selection.BIOL 102: The Genetics Concept Assessment (Smith et al., 2008) is a 25-item multiple-choice instrument that measures students’ understanding of genetics.BIOL 105: The Measure of Understanding of Macroevolution (MUM; Nadelson & Southerland, 2010) is a 22-item multiple-choice instrument that measures students’ understanding of macroevolutionary principles, including phylogenetics, deep time, and speciation mechanisms. **Student Writing – Term Paper Pair**BIOL 1A and BIOL 105 term papers will be evaluated to assess SLO B1 & B2. BIOL 1A is the first biology core course and each student in the course will write a term paper on a topic in biological disease. Evolution (BIOL 105) is the Department’s culminating core course. Each student in the course will write a term paper on a topic in evolutionary biology. In each term paper, each student selects a topic that is researched through the primary scientific literature, and discussed. When used for program assessment, a minimum of 20 term papers per each course will be independently scored by at least two faculty according to the rubric published by Timmerman et al 2011 (see appendix 2A). **Student Writing – Lab Report**BIOL 104 provides students with opportunities in wet laboratory techniques of data collection, graphing, data analysis, interpretation of results, and scientific writing. BIOL 104 lab report will be evaluated to assess SLO C1 & D1. When used for program assessment, a minimum of 30 lab reports will be independently scored by at least two faculty according to the rubric published by Timmerman et al 2011 (see appendix A2). **Exam Questions**SLO E1 & SLO G1 will be assessed through exam questions in BIOL 103 and BIOL 102, respectively. Descriptive statistics for relevant exam questions will be reported.**Class Observation**SLO F1 will be assessed in BIOL 101 through the methodological observation of Smith et al., 2013 (see appendix A3). The Classroom Observation Protocol for Undergraduate STEM (COPUS) uses 25 codes to document classroom activity, including actions of both the students and the instructor. Data are collected in two-minute intervals using an online interface. |
| * 1. **Indirect Measures**
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| **Student Research Tabulation**Each year, as part of the Department’s annual report, faculty will tabulate the number of student engaged in faculty-directed research including publications, poster and oral presentations at scientific meetings, funding awards and honors. These findings provide direct evidence of student mastery of the process of scientific inquiry and communication. Our target is to maintain high quality student involvement in research and the communication of their findings in the form of publications and presentations.**BIOL 190 Survey**Pre/post-research experience survey will be performed by each student enrolled in BIOL 190. Not every student takes BIOL 190, however this survey is expected to provide insights into student experiences in the departmental BIOL 190 course. The Survey of Undergraduate Research Experiences (SURE) survey will be administered online and analyzed according to the procedures outlined by Lopatto (2004; Appendix A4).**Pipeline Analysis**Pipeline analysis (conducted at the end of the review period) will follow the progress of students through the biology curriculum as Biology majors. The completion of this assessment relies on assistance from the office of Institutional Research, Assessment and Planning, and their ability to supply appropriate data that includes student record data to address questions on:· Are students taking core courses in sequence? ·At what points do we lose students from the major? ·Do they leave the university or transfer to other majors? ·Do we disproportionately lose minority students? ·Does the success of transfer students differ from that of continuing students? ·Can we identify predictors of success (or failure) for at-risk students? |

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| Student Learning Outcomes X Assessment Methods Matrix |
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| **Goal** | **SLO** | **Direct Measures** | **Indirect Measures** |
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|  | Student Learning Outcome | Pre/Post Instruction Survey | Student Writing **–** Term Paper Pair | Student Writing **–** Lab report | Exam Questions | Class Observation | Pre/Post Research Experience | Pipeline Analysis |
| GOAL A | A1 | X |  |  |  |  |  | X |
|  | A2 | X |  |  |  |  |  |  |
| GOAL B | B1 |  | X |  |  |  | X |  |
|  | B2 |  | X |  |  |  | X |  |
| GOAL C | C1 |  |  | X |  |  |  |  |
|  | C2 |  |  |  |  |  |  |  |
| GOAL D | D1 |  |  | X |  |  |  |  |
|  | D2 |  |  |  |  |  |  |  |
| GOAL E | E1 |  |  |  | X |  |  |  |
|  | E2 |  |  |  |  |  |  |  |
| GOAL F | F1 |  |  |  |  |  |  |  |
|  | F2 |  |  |  |  | X |  |  |
| GOAL G | G1 |  |  |  | X |  |  |  |
|  | G2 |  |  |  |  |  |  |  |

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| 1. **Timeline for Implementation of Assessment Methods and Summary Evaluations**
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| Assessment Method | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | 2022-23 | 2023-24 |
| 1. Pre/Post Instruction Survey | X | X | X | X | X | X | X |
| 2. Student Writing (Term Paper) |  | X |  |  | X |  |  |
| 3. Student Writing (Experimental Data Analysis) |  |  | X |  |  | X |  |
| 4. Exam questions |  |  |  | X |  |  | X |
| 5. Class Observation |  | X |  |  | X |  |  |
| 6. Student Research Tabulation | X | X | X | X | X | X | X |
| 7. Pre/Post Research Experience | X | X | X | X | X | X | X |
| 8. Pipeline Analysis |  |  |  |  |  | X |  |

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| Process for Closing the Loop |
| In the Department of Biology, the Chair of the Undergraduate Assessment Committee serves as the departmental assessment coordinator aided by 2-3 additional faculty that form the Undergraduate Assessment Committee. The Committee is responsible for designing and carrying out assessment activities with the help of the entire faculty as needed. The Undergraduate Committee also analyzes the resulting data and suggests changes to the program as necessary. Assessment data and suggested program changes are presented to the entire faculty in the monthly faculty meeting, and the entire faculty decides whether to implement any changes (and they are also free to suggest their own changes). |

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| Appendix |
| **Appendix A1 – published methods for pre/post instruction survey**Anderson, D. L., Fisher, K. M., & Norman, G. J. (2002). Development and evaluation of the Conceptual Inventory of Natural Selection. *Journal of Research in Science Teaching, 39,* 952-978. doi: 10.1002/tea.10053Nadelson, L. S., & Southerland, S. A. (2010). Development and preliminary evaluation of the measure of understanding of macroevolution: Introducing the MUM. *The Journal of Experimental Education, 78,* 151-190.Smith, M. K., Wood, W. B., & Knight, J. K. (2008). The genetics concept assessment: a new concept inventory for gauging student understanding of genetics. *CBE-life sciences Education*, *7*(4), 422-430.Wilson, C. D., Anderson, C. W., Heidemann, M., Merrill, J. E., Merritt, B. W., Richmond, G., & Parker, J. M. (2006). Assessing students’ ability to trace matter in dynamic systems in cell biology. *CBE - Life Sciences Education, 5,* 323-331. doi: 10.1187/cbe.06–02–0142**Appendix A2 – published rubric for evaluating student writing**Timmerman, B. E. C., Strickland, D. C., Johnson, R. L., & Payne, J. R. (2011). Development of a ‘universal’ rubric for assessing undergraduates' scientific reasoning skills using scientific writing. *Assessment & Evaluation in Higher Education*, *36*, 509-547.**Appendix A3 – published method for class observation**Smith, M. K., Jones, F. H., Gilbert, S. L., & Wieman, C. E. (2013). The Classroom Observation Protocol for Undergraduate STEM (COPUS): a new instrument to characterize university STEM classroom practices. *CBE-Life Sciences Education*, *12*, 618-627.**Appendix A4 – published method for BIOL 190 survey**Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): First findings. *Cell biology education*, *3*, 270-277. |