From:	Smith, Randy
To:	Olesik, Susan; Sabel, Jaime; Andrews, Adam
Cc:	Sutherland, Sue; Herrmann, Samantha; Smith, Randy; Griffiths, Rob; Reed, Katie; Duffy, Lisa; Hunt, Ryan; Horn, David; Martin, Andrew; Vankeerbergen, Bernadette; Talbot, Ann; Warren, Adam; Eveland, Jessica; Brown, Trevor
Subject:	Proposal to establish a Biotech Science Major leading to the Bachelor of Science
Date:	Friday, July 24, 2026 11:27:00 AM
Attachments:	image001.png

Jaime, Susan and Adam,

The proposal from the Center for Life Science Education to establish a Biotech Science major leading to the Bachelor of Science degree was approved by the Council on Academic Affairs at its meeting on July 23, 2026. Thank you for attending the meeting to respond to questions/comments.

The proposal will now be sent to the Board of Trustees for action at its meeting on **August 20, 2026**. If approved by the Board, my office will work with you on the approval process with the Ohio Department of Higher Education.

Once fully approved, the Office of the University Registrar will work with you on any implementation issues.

Please keep a copy of this message for your file on the proposal and I will do the same for the file in the Office of Academic Affairs.

If you have any questions please contact the Chair of the Council, Professor Sue Sutherland (.43), or me.

I wish you success with this important program development.

Randy

THE OHIO STATE UNIVERSITY

W. Randy Smith, Ph.D.
Vice Provost for Academic Programs
Office of Academic Affairs
University Square South, 15 E. 15th Avenue, Columbus, OH 43201
614-292-5881 Office
smith.70@osu.edu
Assisted by:
Katie Reed
Executive Assistant
(614) 292-5672

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

Center for Life Sciences Education

260 Jennings Hall
1735 Neil Avenue
Columbus, OH 43210

614-292-9861 Phone
614-292-4390 Fax

clse.osu.edu

22 July 2026

Dr. Herrmann and Members of the CAA Subcommittee:

On behalf of the Center for Life Sciences Education, we would like to that the Subcommittee for their thoughtful review of our proposal to create the Biotech Science Major. Regarding the questions and feedback posed, we offer the Subcommittee our responses below.

1. We appreciate the letters of concurrence from related programs and recognize that preparation for students' futures extends beyond training for a single career pathway. That said, given the broader goal of ensuring career readiness, the Subcommittee would appreciate further clarification on how this program differentiates itself from existing offerings across the university.
    a. Can you clarify how this Biotechnology major will uniquely prepare students for careers that the other programs will not?

        The field of biotechnology encompasses a wide array of subdisciplines with diverse positions available for potential graduates with a range of skills. The Biotech Science major combines biological sciences, genetics, molecular biology, and biochemistry with the goal of developing the skill set to solve real world challenges.

        In comparing the proposed Major to other existing life science majors (i.e., Biology, Biochemistry, Molecular Genetics, etc.), the Biotech Science specific instruction will involve more advanced laboratory work with greater emphasis on requisite internship or research experiences to build practical skills.

        Topic examples include gene identification, phylogenetics and comparative genomics, bioinorganic chemistry, immunoassaying, DNA sequencing, genetic engineering, industrial microbiology, applicable regulations, and biotechnology ethics.

b. Can the unit provide information on anticipated career outcomes or job placement expectations for graduates, including specific fields or roles for which students will be well prepared?

A biotechnology graduate is prepared to apply biological systems and living organisms to develop new products across multiple industries. With this degree, graduates will be prepared for careers as research scientists, medical diagnostics specialists, clinical research associates, gene therapists, bioinformaticians, biotechnology regulatory affairs specialists, and more.

The growth in Ohio in biotechnology is substantial. In 2023, the Coldwell Banker Richard Ellis, CBRE, listed Columbus and Cincinnati as two top emerging hubs for research in life sciences. Ohio was the only state with two cities in that ranking. There are 280 biotechnology companies that are members of Ohio Life Sciences. Biotechnology includes drug and gene therapy research and development, as well as pharmaceutical and medical devices and development

Pharmavite, a supplement maker, a $1B investment in a new facility for Hikma Pharmaceuticals in Cleveland and a major expansion of the Amgen manufacturing facility in New Albany that expects to produce 400 new well-paying jobs. Other biotechnology companies in Ohio that continue to prosper and expand include Andelyn Biosciences, Forge Biologics, American Regents, Diasome Pharmaceutical, Sarepta Therapeutics, Basking Biosciences, Clarametyx Biosciences, Kurome Therapeutics, 3Bar Biologics, Abbvie, Abeona Therapeutics, Adare Pharma Solutions, Advanced Virology, Alkermes, and Alphyn Biologics. As noted by the Ohio Life Science Industry Assessment and Economic Impact Document of January 2025, Ohio's rate of growth in research, testing and medical device labs is outpacing national trends with 24% increase in jobs since 2019 and growth in the biotechnology companies of 29% since 2019 and the biopharmaceutical seeing an increase of 7.9% in growth since 2019.

As the first Biotech Science major in the State of Ohio, OSU will be the place where organizations will look for graduates for employment.

Throughout the development of this proposed Major, we have been in communication directly with Ohio Life Science, our partner with wide-ranging connections to the Biotechnology Industry in Ohio and beyond. Additionally, both the College of Arts & Sciences' Office of Industry Relations and Career Services have built many already existing relationships with local companies and we are in conversations with them to leverage those relationships to

continue to build opportunities for Biotech Science majors while they are in the program, and after graduation.

2. We had a couple of questions about internship opportunities for the students.
   a. We are pleased to see the opportunity to earn credit for internships and research credits, but are wondering why internships weren't more integrated into the major and are limited to the specific 4999 courses listed. Opportunities for meaningful biotechnology-related research and experiential learning exist across other colleges, such as CFAES. Could you speak to why the requirement is restricted to this list? It seems somewhat at odds with the rationale emphasizing the breadth and interdisciplinary nature of biotechnology and may limit student-tailored pathways aligned with individual professional goals.

      Every Biotech Science major must engage in either an internship or biotechnology-related research. Also mentoring of the majors will occur through collaborations in the capstone course. This is the first major in ASC that has a capstone course with the deliberate plans to collaborate with industry within that course which is a major step for the College of Arts and Sciences.

      Owing to concerns about the potential eventual size of the major, we wanted to maximize opportunities for students by allowing the 4998 and 4999 experiences to count toward the Major. Our intention is to flesh out guidelines for activities within these courses such that they are limited to appropriate biotech experiences.

   b. We are excited about the partnerships described in the proposal and would welcome additional detail. To what extent have industry or external partners committed to supporting internship or experiential learning opportunities for students in this major, and what might those opportunities look like in practice?

      ASC had a biotechnology summit that initially provoked the discussion of the need for this major. We will work with OAA's Workforce Development program to initiate a second summit meeting and invite all of those who attended the previous meeting as well as other new biotechnology companies that have landed in Ohio.

      While we do not have any firm commitments from industry partners currently, we have already actively engaged with the Ohio Life Sciences through their President, Eddie Pauline, and directly with several local biotech companies through the Office of Industry Relations. It is our intention to continue

discussions with these, and other partners to further develop specific opportunities for our students.

c. Given the importance of these partnerships to the stated goals of career preparation and workforce alignment, any additional information on how partners will be engaged (e.g., internships, mentorship, research collaboration, funding, or other programmatic support) will be helpful in highlighting how these partnerships will support the program.

We will provide internships or research opportunities for all students in the Biotech Science major. Students will also receive mentoring from industry connections as part of the capstone course.

3. We had some concerns about the provided budget and resources plan in the proposal that I'm hoping you can address:
   a. Given that advanced laboratory electives are highly resource-intensive, how will the participating departments (Microbiology, Molecular Genetics, etc.) handle the physical space and equipment demands when enrollment scales toward the 500-student target?

      We do not expect a massive influx of new majors when the major is first offered. Instead, we expect to see existing OSU students who will want to change their major. Because they will be existing students, they are already considered in our conversations about capacity. We do expect to see more capacity issues as the major grows beyond the first few years, and the college has committed to monitoring and providing resources as needed.

      From NMS Dean: Microbiology has built out the new courses and laboratories for this major well in advance of the launch of the major. The college has already provided the funds to purchase instruments for those laboratories.

      From NMS Dean: For Molecular Genetics, the courses listed are already on the books. If the demand increases, the college commits to working with the department in hiring additional staff (lecturers, GTAs, and equipment).

      From NMS Dean: There is more capacity in terms of use of laboratory space. Within NMS, the department of Chemistry and Biochemistry offers laboratories in the evenings. If there is demand, more labs will be offered, which will require more staffing.

   b. To support the targeted influx of students, the program's success is heavily contingent on funding and hiring a new dedicated academic advisor

immediately, with a second needed within 3–5 years, as well as at least one additional staff member for assessment. Has the college committed to providing funding for the additional staffing? If university budget constraints delay these hires, student retention and satisfaction could suffer.

From NMS Dean: An additional advisor has already been hired. Our college advising organization monitors the number of majors/advisors and will add more advisors as the demand necessitates.

c. Similar to question 2, have any of the partnerships committed to providing resources to maintain the program?

Not yet, but we are working toward this. Commitments are challenging to garner when the major does not yet exist. We are working with both the Office of Industry Relations and the Office of Advancement to explore opportunities for additional funding sources.

d. The proposal mentions the college will "monitor capacity" to prevent bottlenecks. If existing lab sections are already near capacity, a massive influx of new majors could delay graduation timelines for students who cannot get into required lab courses. Can you speak to how the college will respond to this or what types of contingency plans will be in place?

From NMS Dean: The college monitors enrollments continuously during the student enrollment windows. When waitlists occur, we work with departments/ centers to find mechanisms, such as hiring more instructors and teaching assistants to make sure students have paths to completion of their majors is assured. With this new major, particular attention to its needs will be a high priority.

4. Given that a significant portion of this major's student enrollment is anticipated to be major changers:
   a. What type of recruitment efforts will be made to attract these students?

Academic advising for the new Biotech Science Major will be integrated with the existing advising in the CLSE, which services students in the Biology Major. While separate, the CLSE advisors have a close-knit relationship with advising in the other life science majors and so collectively will be one of our strongest resources for advertising to students who are interested in changing majors.

Additionally, we partner with the Biology Club which has an ongoing Career Series of speakers which can be utilized to promote opportunities both in the

Biotech Science Major and future biotechnology careers. We have regular communication with the life science students through a periodic newsletter and will have opportunities to advertise through the CLSE website.

Finally, the college of Arts and Sciences has an outstanding recruitment team. Recruitment information for the new major will be provided to this team. They will supply this information to high school advisors across the state.

b. When are the Major Core Courses that need to be developed expected to be ready for enrollment for students who may already have credit for a significant portion of the curriculum already?

Of the required courses, Biology 3501.04 has already been successfully offered while the Microbiology 4800 (Advanced Biotechnology) and 4891 (Seminar) courses are approved and being offered in the upcoming academic year. EEOB 4840 has been approved and can be offered as soon as enrollment dictates. MolGen 4810 is in the contingent approval stage.

c. The Biology major can be completed in entirety on a few of the regional campuses already, has consideration been given to offer this major for degree completion on the regional campuses as well?

The Marion campus has already developed a proposal to offer the Major, which will enter the curricular approval process this autumn. Both the faculty and administration of the Lima Campus have expressed significant interest in offering the Major, especially given the proximity of Charles River, a local biotech firm, to campus which would allow for both internship opportunities and potential direct partnerships and resources. We anticipate that a proposal will be forthcoming. Discussions are also ongoing at the Mansfield Campus, where there is interest in offering the Major.

5. Columbus State Community College offers an associate degree in Biotechnology, and many other community and technical colleges across Ohio either have or are developing similar programs. Could you speak to how the proposed major will support students seeking to transition from these institutions into the Biotech Science program? In particular, has consideration been given to how prior coursework and experiential learning from these programs might be recognized or articulated to ensure students can efficiently apply relevant credits and build on existing skills?

Conversations with the Chair of the Department of Biological and Physical Sciences at CSCC have been initiated and have been positive. Their Associate of Arts in Biotechnology is a very technical program and so has a different focus than our

proposed BS. A clear pathway does not yet exist; however, we are committed to finding a path forward.

6. Under the rationale, "limited opportunities" seems like an interesting choice of words. Could you elaborate on what specific limitations the program foresees for inclusion of relevant elective courses?

"Limited opportunities" was perhaps not the best description of the situation. We mean that we have a focus on courses within the CLSE and its four core partner departments (EEOB, Microbiology, Molecular Genetics, and Chem & Biochem) which provides less space for courses in other departments. Owing to the partnership between the CLSE and the four departments, we have a better-established relationship to collect or be provided assessment data for courses associated with the Major. In addition, we do not intend the current list of electives to be permanently exhaustive. Once the Major is established, we intend to add additional elective options as appropriate. Initially, however, we opted for courses where we would have more influence over enrollments, offerings, and assessment data. We did include the business and communication course requirement which will require students to take one course from outside of the life sciences.

7. Was there any overlap with philosophy, public policy, or related disciplines in the design of the ethics curriculum or other components of the academic program? Ethics appeared to be a recurring and important theme throughout the proposal.

We are open to including ethics courses as part of the major. Our list of potential business and communications courses was initially considerably longer and included courses suggested by units from across campus, including the areas you suggest. While we are open and intend to eventually add additional elective courses to this required element of the Major, we wanted to limit options for the initial offerings to better understand enrollment trends and facilitate assessment.

8. What about technological, computational, or bioinformatics competencies? How are those integrated into the curriculum? These areas seem increasingly central to biotechnology and molecular biology, yet they do not appear to be prominently represented within the proposed program structure. Most biology folks spend a lot of time coding/ in R/ performing statistics/ or on supercomputers.

Bioinformatics and the use of R are both taught as part of Biology 3501 – *Integrative Skills in Biology:* Biotechnology, a required core course for students in the Major. Biotechnology is a wide-ranging field, and while some computations skills referenced are useful for particular biotech foci, they might not be universal. Beyond 3501, many of the elective offerings include computational literacies allowing students to gain

appropriate skills in the chosen focus. We are also open to adding a required ELO to the Advanced Biotech course offerings (48xx) once we have reviewed the initial assessment data, should there be additional need to bolster this area of the Major.

We welcome the Subcommittee's further review of the Proposal and any questions you may have.

Sincerely,

Adam Andrews
Assistant Director for Curriculum & Instruction, CLSE

Jaime Sabel, PhD
Director, Center for Life Sciences Education

Susan Olesik, PhD
Divisional Dean, Natural and Mathematical Sciences
College of Arts and Sciences

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

186 University Hall
230 North Oval Mall
Columbus, OH 43210
614-292-1667 Phone
614-292-8666 Fax

artsandsciences.osu.edu

April 06, 2026

W. Randy Smith, Vice Provost,

Council on Academic Affairs

University Square South, Campus

Dear Randy,

I am writing to provide staunch support for the new Biotech Science Major program. I am aware of how much care the initial committee and the CLSE curriculum committee have taken to position this degree so that it fits the needs of the biotechnology industry. Graduates in this major will have a skill set that is highly competitive nationwide compared to those from other biotechnology science majors. I strongly believe this major will position the graduates well for outstanding initial jobs in industry and opportunities in graduate programs.

Biotechnology involves the use of life processes to develop products that improve human health. Approximately 5,000 life science establishments are currently located within Ohio. In 2023, Columbus and Cincinnati were listed among the top emerging U.S. life science hubs. The graduates of this major will contribute strongly to expanding biotechnology industries in central Ohio and across the state of Ohio.

This new major involves collaboration among Molecular Genetics, Microbiology, Evolution, Ecology and Organismal Biology and Biochemistry. Accordingly, the Center for Life Sciences Education, CLSE is the natural home for this major.

In support of this major, ASC will provide a new advisor for this new undergraduate major. I also understand that some faculty on the respective committees were concerned about potentially overwhelming our laboratory courses with the major. The college commits to monitoring this issue and addressing the challenge if more lab courses are needed, which will require more personnel.

The College of Arts and Sciences is looking forward to this new opportunity for our undergraduate students.

Sincerely,

Susan V. Olesik

Dean, Natural and Mathematical Sciences

College of Arts and Sciences

THE OHIO STATE UNIVERSITY

Department of Chemistry and Biochemistry
1118 Newman and Wolfrom Laboratory
100 West 18th Avenue
Columbus, OH 43210-1106

Christopher M. Hadad
hadad.1@osu.edu
614-688-3141

614-292-2251 Phone
614-292-1685 Fax
http://chemistry.osu.edu

April 17, 2026

Chair, Arts and Sciences Curriculum Committee
Ohio State University
CAMPUS

Dear Chair and Members of the Arts and Sciences Curriculum Committee:

On March 24, 2026, the Natural and Mathematical Sciences Subcommittee reviewed a program request for a new Bachelor of Science major in Biotech Science. This was a revised version of a previously submitted program from late 2025.

The program was well received by the NMS curriculum committee, and the proposal was approved with only some minor contingencies. These contingencies were addressed in a slightly updated and revised program which was subsequently submitted by Dr. Adam Andrews in the Center for Life Sciences Education on April 8, 2026. As Chair, I then approved the revised version on behalf of the NMS Curriculum Committee. Thus, this new Biotech Science major can now make its next steps in the review process at the University.

Thus, the new BS major in Biotech Science is now advanced to the ASCC with a motion to approve.

Sincerely,

Christopher M. Hadad
Professor of Chemistry and Biochemistry
Vice Chair for Research and Administration, Department of Chemistry and Biochemistry
Director, Campus Chemical Instrument Center (Nuclear Magnetic Resonance | Mass Spectrometry and Proteomics)
Ohio State University

Fiscal Unit/Academic Org	Introductory Biology - D0326
Administering College/Academic Group	Arts and Sciences
Co-adminstering College/Academic Group	
Semester Conversion Designation	New Program/Plan
Proposed Program/Plan Name	Biotech Science
Type of Program/Plan	Undergraduate bachelors degree program or major
Program/Plan Code Abbreviation	BIOTECH
Proposed Degree Title	Biotech Science Bachelor of Science

Credit Hour Explanation

Program credit hour requirements		A) Number of credit hours in current program (Quarter credit hours)	B) Calculated result for 2/3rds of current (Semester credit hours)	C) Number of credit hours required for proposed program (Semester credit hours)	D) Change in credit hours
Total minimum credit hours required for completion of program				121	
Required credit hours offered by the unit	Minimum			11	
	Maximum			16	
Required credit hours offered outside of the unit	Minimum			39	
	Maximum			76	
Required prerequisite credit hours not included above	Minimum			0	
	Maximum			0	

Program Learning Goals

Note: these are required for all undergraduate degree programs and majors now, and will be required for all graduate and professional degree programs in 2012. Nonetheless, all programs are encouraged to complete these now.

Program Learning Goals

- 1a. Explain the structure and function of molecules essential to life, i.e. DNA, RNA, and proteins, and how these molecules interact to regulate cellular processes.
- 1b. Explain how traits are inherited and expressed through genes, including DNA structure, gene function, mutation, and regulation.
- 1c. Describe how chemical processes and molecules such as enzymes, nucleic acids, carbohydrates, and lipids drive cellular function and metabolism.
- 1d. Describe the key role that microorganisms play as tools for biotechnology.
- 1e. Describe the physiology, genetics, evolution, and ecology of organisms that are the subjects of biotechnological manipulation.
- 2a. Explain the fundamental concepts and techniques of biotechnology relevant to a chosen subdiscipline of the life sciences.
- 2b. Apply laboratory skills and techniques commonly used in biotechnology research and industrial settings, such as DNA/RNA manipulation, protein assays, and use of bioinformatics tools.
- 2c. Demonstrate an understanding of biosafety by employing safe laboratory practices.
- 2d. Demonstrate literacy in data preparation, organization, archiving and use of tools to process data.
- 3a. Retrieve information from the life sciences literature; read, understand, and critically review scientific papers.
- 3b. Apply the scientific process, including designing and conducting experiments and testing hypotheses.
- 3c. Draw valid conclusions based on quantitative and qualitative results.
- 3d. Adapt tools such as laboratory notebooks and spreadsheets to organize and analyze data associated with scientific processes.
- 3e. Communicate scientific information clearly and effectively in written reports, oral presentations, and through visual media to both scientific and non-scientific audiences.
- 4. Exhibit professional and ethical behavior, including understanding of biosafety, ethical dilemmas in genetic engineering and biotechnology, and the implications and impacts of biotechnology on natural ecosystems and populations.
- 5. Work effectively in diverse teams, demonstrating leadership, collaboration, and problem-solving in both laboratory and non-laboratory project environments.
- 6. Demonstrate preparedness for employment or further education, including ability to articulate their skills and knowledge in professional settings such as internships, job interviews, or graduate school applications.

Assessment

Assessment plan includes student learning goals, how those goals are evaluated, and how the information collected is used to improve student learning. An assessment plan is required for undergraduate majors and degrees. Graduate and professional degree programs are encouraged to complete this now, but will not be required to do so until 2012.

Is this a degree program (undergraduate, graduate, or professional) or major proposal? Yes

Does the degree program or major have an assessment plan on file with the university Office of Academic Affairs? No

DIRECT MEASURES (means of assessment that measure performance directly, are authentic and minimize mitigating or intervening factors)

Classroom assignments

- Embedded testing (i.e. specific questions in homework or exams that allow faculty to assess students' attainments of a specific learning goal)
- Other classroom assessment methods (e.g., writing assignments, oral presentations, oral exams)

Evaluation of a body of work produced by the student

- Capstone course reports, papers, or presentations

INDIRECT MEASURES (means of assessment that are related to direct measures but are steps removed from those measures)

Surveys and Interviews

- Student survey

Additional types of indirect evidence

- Job or post-baccalaureate education placement
- Grade review

USE OF DATA (how the program uses or will use the evaluation data to make evidence-based improvements to the program periodically)

- Analyze and discuss trends with the unit's faculty
- Analyze and report to college/school
- Make improvements in curricular requirements (e.g., add, subtract courses)
- Make improvements in course content
- Make improvements in course delivery and learning activities within courses
- Make improvements in learning facilities, laboratories, and/or equipment
- Periodically confirm that current curriculum and courses are facilitating student attainment of program goals
- Benchmark against best programs in the field

Program Specializations/Sub-Plans

If you do not specify a program specialization/sub-plan it will be assumed you are submitting this program for all program specializations/sub-plans.

Pre-Major

Does this Program have a Pre-Major? No

Attachments

- Biotech Science Major Response to NMS Panel 20260406.pdf: Contingent Approval Response to Panel
  (Letter from Program-offering Unit. Owner: Andrews,Adam Lee)
- Proposal to Create a Bachelor of Science Biotech Science Major Program 20260406.pdf
  (Program Proposal. Owner: Andrews,Adam Lee)
- ASC support letter for BIotech Science major April 26.pdf
  (Support/Concurrence Letters. Owner: Andrews,Adam Lee)

Comments

- Please see subcommittee feedback email sent 03/27/2026. *(by Wade,Macy Joy on 03/27/2026 12:42 PM)*
- Please see subcommittee feedback email sent 12-23-25. *(by Neff,Jennifer on 12/23/2025 04:59 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Andrews,Adam Lee	11/06/2025 09:01 AM	Submitted for Approval
Approved	Kulesza,Amy Elizabeth	11/06/2025 09:18 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	11/10/2025 09:45 AM	College Approval
Revision Requested	Neff,Jennifer	12/23/2025 04:59 PM	ASCCAO Approval
Submitted	Andrews,Adam Lee	03/11/2026 03:01 PM	Submitted for Approval
Approved	Kulesza,Amy Elizabeth	03/11/2026 04:04 PM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	03/11/2026 04:33 PM	College Approval
Revision Requested	Wade,Macy Joy	03/27/2026 12:42 PM	ASCCAO Approval
Submitted	Andrews,Adam Lee	04/07/2026 02:39 PM	Submitted for Approval
Approved	Kulesza,Amy Elizabeth	04/07/2026 02:52 PM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	04/08/2026 12:01 PM	College Approval
Pending Approval	Jenkins,Mary Ellen Bigler Neff,Jennifer Vankeerbergen,Bernadette Chantal Wade,Macy Joy Steele,Rachel Lea	04/08/2026 12:01 PM	ASCCAO Approval

THE OHIO STATE UNIVERSITY

College of Arts and Sciences

Center for Life Sciences Education

260 Jennings Hall
1735 Neil Avenue
Columbus, OH 43210

614-292-9861 Phone
614-292-4390 Fax

clse.osu.edu

7 April 2026

Dr. Hadad and Members of the NMS Panel:

On behalf of the CLSE, I write to thank you for the contingent approval of our proposed new Biotech Science Major. We have addressed the Panel's concerns, as noted below, and look forward to your further consideration.

- **Contingency**: The Subcommittee notes that the proposal indicates the unit's intent for students to be able to use Chemistry 2310 to fulfill the program's organic chemistry requirement (pp. 21–23); however, Chemistry 2310 is not included on the advising sheet (Appendix A). If the unit intends for students to be able to use Chemistry 2310 to fulfill this requirement, the Subcommittee requests that Chemistry 2310 be added to the advising sheet and that the "Required Supporting Courses" credit hours be revised from 34–43 to 30–43.

  I apologize for the oversight as the first page of the revised advising sheet was not previously included. The proposal has been appropriately updated.

- **Contingency**: As part of the University's AI Fluency Initiative, the College of Arts and Sciences has charged individual units with determining how their students will graduate AI fluent. The Subcommittee requests that the unit specify in the proposal how coursework within the proposed major will support students in fulfilling the AI Fluency requirement. Additional information about the University's AI Fluency Initiative can be found on the Office of Academic Affair's AI Fluency webpage.

  A plan for the Biotech Science Major to meet the AI Fluency Initiative's expected outcomes has been included on page 36 of the proposal.

- **Contingency**: The Subcommittee notes that Section 6c of the proposal (pp. 25–27) states that students will be "required to take a course from each of three content areas below and may choose a course from the fourth area as an open elective" (proposal, p. 25). The Subcommittee requests that the CLSE clarify whether students must select three courses from three specific categories among the four listed (biochemistry, evolution, microbiology, and molecular genetics), or whether students may select three courses from any three of the four categories. Additionally, the Subcommittee requests clarification regarding which

categories may be used for elective coursework. For example, may a student who enrolls in Biochemistry 4511 as a required course also enroll in Biochemistry 5613 as an elective option? The Subcommittee asks that these points be clarified both in the proposal and on the advising sheet in Appendix A to ensure that accurate information is available to students.

Our intent is that students must complete at least one course from three of the four areas and may complete a course from the fourth area as an elective. Additional courses from a particular content area (i.e. Biochem 4511 and 5613) may not be used as electives. Language clarifying this intent has been added to page 25 of the proposal as well as page two of the advising sheet (Appendix A).

- **Contingency**: The Subcommittee notes that both curriculum.osu.edu (under the Proposed Degree title) and the letter of support reference a degree *in* Biotech Science. In this context, the preposition "in" would indicate the creation of a new tagged degree rather than a new major in an existing degree. To ensure alignment with the program type described in the proposal (i.e., a new major under the existing Bachelor of Science degree), the Subcommittee requests that the Proposed Degree title field in curriculum.osu.edu read "Biotech Science Bachelor of Science." Additionally, the letter of support should reference the new Biotech Science major instead of the "Biotechnology Science degree."

  We have changed the title in curriculum.osu.edu and Dean Olesik's letter of support has been appropriately updated.

I appreciate the Panel's careful review and comments, we and look forward to the review by the full Arts & Sciences Curriculum Committee.

Sincerely,

Adam L. Andrews

Adam Andrews
Assistant Director for Curriculum & Instruction

Proposal to Create a Bachelor of Science Biotech Science Major Program

Center for Life Sciences Education

College of Arts & Sciences

THE OHIO STATE UNIVERSITY

CENTER FOR LIFE SCIENCES EDUCATION

Table of Contents

Proposal to create the *Biotech Science Major*

Executive Summary

The Center for Life Sciences Education proposes a new undergraduate interdisciplinary Major Program in *Biotech Science*.

The Life Science Departments in the College of Arts & Sciences possess the expertise to support the curriculum for this Major, and all courses except an advanced biotechnology course and a seminar are already being taught.

The Center for Life Sciences Education has the experience and infrastructure to support an interdisciplinary Major.

The Biotechnology industry in Ohio is booming, positioning The Ohio State University to expand upon existing partnership to provide additional co-curricular opportunities for students in addition to post-baccalaureate job opportunities.

1. General Information

- **Name of proposed major**
  - *Biotech Science*
- **Degree students completing the major will receive**
  - Bachelor of Science
- **Proposed implementation date**
  - Autumn 2026
- **Academic units responsible for administrating the major program**

- Center for Life Sciences Education, College of Arts & Sciences

2. Rationale

Modern molecular biotechnology seeks to harness the power of biological systems as solutions to address major needs and challenges of society. Biotechnology can be categorized based on the systems that are manipulated, including microbes, plants, and animals. Applications of biotechnology span multiple sectors including health, energy, agriculture, environment, and material science.[1]

The Center for Life Sciences Education is proposing a new Biotech Science Major program. The Major would provide undergraduate students foundational education and training to pursue careers in the molecular biosciences, or advanced graduate or professional studies. This is in alignment with federal, state, and regional initiatives and recommendations.

The Center for Life Sciences Education (CLSE) is the long-standing administrative home of the Biology Major at The Ohio State University, the institution's second largest Major. While the CLSE offers only the introductory biology courses and two core courses for this interdisciplinary Major, all other upper-level coursework is taught in other units. As such, the CLSE has the experience and infrastructure to offer an interdisciplinary Biotech Science Major utilizing a similar structure. The CLSE's core partner departments in the College of Arts & Sciences (i.e. Department of Chemistry and Biochemistry; Department of Evolution, Ecology, and Organismal Biology; Department of Microbiology; Department of Molecular Genetics) will offer the majority of the Major coursework, with some limited opportunities for inclusion of additional relevant elective courses taken both within and outside of ASC. These core Departments already offer a large array of classes appropriate for inclusion in the Major with sufficient variety for students to choose electives toward a sub-disciplinary focus.

The growth of the biotechnology field both nationally and especially throughout Ohio gives The Ohio State University an ideal opportunity to train future graduates who can be retained in the state as they enter their careers in this rapidly growing field. The industry association, Ohio Life Sciences (OLS) published a report, *Ohio Life Sciences Industry Assessment and Economic Impact Report*, January 2025, which lists 4,900 biotech and life sciences-related businesses across the state, employing nearly 64,000 Ohioans providing $68.0 billion of total economic impact. The College of Arts & Science's Office of Industry Partnerships and Research Collaborations (OIPRC) has already partnered with Ohio Life

[1] *ASC Biotechnology Major Committee Recommendations* Report, 5 February, 2025.

Sciences (OLS), and many of Central Ohio's biotechnology-oriented firms such as Amgen, Sarepta Therapeutics, and Andelyn Biosciences. These companies and others have expressed a need for well-trained graduates that have the skills and knowledge specific to biotechnology. They cite the need for a broad range of laboratory skills, an understanding of scientific laboratory processes, and the ability to synthesize content from across the life sciences and beyond. These already existing partnerships promise immediate opportunities to expand student placement into internships, externships, and eventual post-graduate careers. Addressing the employment needs of Ohio's biotechnology industry has been one of the driving forces behind the development of this Major.

Students with a Biotech Science baccalaureate degree can expect to find positions in laboratory and research roles, the pharmaceutical and healthcare industry, agricultural and environmental biotechnology, industrial and manufacturing roles, or business and communication roles. Many graduates will also choose to pursue graduate education or professional certification in regulatory affairs, data science, or clinical research.

3. Goals/Objectives and Evaluation of Program

Program Goals & Associated Learning Outcomes

Students earning a *Biotech Science Bachelor of Science* will be able to …

1. Demonstrate a strong foundational knowledge in the Biological Sciences that underpin biotechnology.
    a. Explain the structure and function of molecules essential to life, i.e. DNA, RNA, and proteins, and how these molecules interact to regulate cellular processes.
    b. Explain how traits are inherited and expressed through genes, including DNA structure, gene function, mutation, and regulation.
    c. Describe how chemical processes and molecules such as enzymes, nucleic acids, carbohydrates, and lipids drive cellular function and metabolism.
    d. Describe the key role that microorganisms play as tools for biotechnology.
    e. Describe the physiology, genetics, evolution, and ecology of organisms that are the subjects of biotechnological manipulation.
2. Develop Technical Proficiency in Biotechnology Techniques.
    a. Explain the fundamental concepts and techniques of biotechnology relevant to a chosen subdiscipline of the life sciences.
    b. Apply laboratory skills and techniques commonly used in biotechnology research and industrial settings, such as DNA/RNA manipulation, protein assays, and use of bioinformatics tools.
    c. Demonstrate an understanding of biosafety by employing safe laboratory practices.

    d. Demonstrate literacy in data preparation, organization, archiving and use of tools to process data.
3. Foster Research Competence and Scientific Inquiry.
    a. Retrieve information from the life sciences literature; read, understand, and critically review scientific papers.
    b. Apply the scientific process, including designing and conducting experiments and testing hypotheses.
    c. Draw valid conclusions based on quantitative and qualitative results.
    d. Adapt tools such as laboratory notebooks and spreadsheets to organize and analyze data associated with scientific processes.
    e. Communicate scientific information clearly and effectively in written reports, oral presentations, and through visual media to both scientific and non-scientific audiences.
4. Exhibit professional and ethical behavior, including understanding of biosafety, ethical dilemmas in genetic engineering and biotechnology, and the implications and impacts of biotechnology on natural ecosystems and populations.
5. Work effectively in diverse teams, demonstrating leadership, collaboration, and problem-solving in both laboratory and non-laboratory project environments.
6. Demonstrate preparedness for employment or further education, including ability to articulate their skills and knowledge in professional settings such as internships, job interviews, or graduate school applications.

Assessment Plan

Methods

To assess the *Biotech Science Major*, a range of direct and indirect measures will be used. These include:

Direct Measures

- Assessment of student performance in these content areas is measured directly in Biology 1113, 1114, and 3501.04 through the collection of Exam Data and other assessments collected individually through the use of the Carmen rubrics tool.
- The four core life science departments will each participate in providing assessment data in the 1-2 upper-level courses required from each for this major through exam analysis and evaluation of written assignment using the Carmen rubrics tool. These courses include the three versions of the 48xx *Advanced Biotechnology* course, which will utilize assessment of the final written report and in the 4891 Seminar. The CLSE will be responsible for collating and reporting these data.

- An average mastery of 80% on graded assignments will be used as the threshold for success. These data will be drawn from:
    - Exam question data
    - Embedded rubric items on written assignments
    - Laboratory report and Lab Exam data

Indirect Measures

- *Student Assessment of Learning Gains (SALG)*[2] survey, a validated survey tool administered at the end of the term in all Biology courses
    - SALG questions are based on Likert scales of 1-5. We take an average score of 3 for each individual item to be the threshold for success.
- Participation in the Denman Research Forum and the ASC *Graduation Survey*, including both the general and targeted questions.

Alignment

The following table illustrates the direct and indirect methods that will be used for assessment of each specific Program Outcome and the desired achievement level to determine success.

Program ELO	Direct Measures	Indirect Measures
1a. Explain the structure and function of molecules essential to life, i.e. DNA, RNA, and proteins, and how these molecules interact to regulate cellular processes.	Direct measurement in Biology 1113, Biochem 4511/5613, Micro 4100, and MolGen 4500/4606 through the collection of Exam Data and other assessments collected individually through the use of the Carmen rubrics tool.	*Student Assessment of Learning Gains (SALG)* survey, a validated survey tool administered at the end of the term in all Biology courses.
1b. Explain how traits are inherited and expressed through genes, including DNA structure, gene function, mutation, and regulation.	Direct measurement in Biology 1113, Micro 4100, and MolGen 4500/4606 through the collection of Exam Data and other assessments collected individually through the use of the Carmen rubrics tool.	

[2] Seymour, Elaine & Wiese, Douglas & Hunter, Anne-Barrie & Daffinrud, Sue. (1997). Student Assessment of Learning Gains (SALG) CAT. https://www.researchgate.net/publication/252112013_Student_Assessment_of_Learning_Gains_SALG_CAT

1c. Describe how chemical processes and molecules such as enzymes, nucleic acids, carbohydrates, and lipids drive cellular function and metabolism.	Direct measurement in Biology 1113 and 1114, Biochem 4511/5613, and Micro 4100 through the collection of Exam Data and other assessments collected individually through the use of the Carmen rubrics tool.	
1d. Describe the key role that microorganisms play as tools for biotechnology.	Direct measurement in Biology 1113, 3501.04, and Micro 4000/4100 through the collection of Exam Data and other assessments collected individually through the use of the Carmen rubrics tool.	
1e. Describe the physiology, genetics, evolution, and ecology of organisms that are the subjects of biotechnological manipulation.	Direct measurement in Biology 1113, 1114, 3501.04, EEOB 3310x, Micro 4100, and MolGen 4500/4606 through the collection of Exam Data and other assessments collected individually through the use of the Carmen rubrics tool.	
2a. Explain the fundamental concepts and techniques of biotechnology relevant to a chosen subdiscipline of the life sciences.	Direct measurement in Biology 1113 & 3501.04, Biochem 4511/5613, EEOB 3310x, Micro 4000/4100, MolGen 4500/4606, and the 4xxx Advanced Biotech courses through the collection of Exam Data and other assessments collected individually using the Carmen rubrics tool.	*Student Assessment of Learning Gains (SALG)* survey, a validated survey tool administered at the end of the term in all Biology courses.
2b. Apply laboratory skills and techniques commonly used in biotechnology research and industrial settings, such as DNA/RNA manipulation, protein	Direct measurement in Biology 1113 and Micro 4000/4100 through collection of laboratory report data through the use of the Carmen rubrics tool.	

assays, and use of bioinformatics tools.		
2c. Demonstrate an understanding of biosafety by employing safe laboratory practices.	Direct measurement in Biology 1113 and Micro 4000/4100 through collection of laboratory report data through the use of the Carmen rubrics tool.	
2d. Demonstrate literacy in data preparation, organization, archiving and use of tools to process data.	Direct measurement in Biology 1113, 1114, 3501.04, Biochem 4511/5613, EEOB 3310x, Micro 4000/4100, MolGen 4500/4606, and the 48xx *Advanced Biotech* courses through the assessment collected individually using the Carmen rubrics tool in both laboratory reports and other written assignments.	
3a. Retrieve information from the life sciences literature; read, understand, and critically review scientific papers.	Directly measurement in Biology 1113, 1114, 3501.04, Biochem 4511/5613, EEOB 3310x, Micro 4000/4100, MolGen 4500/4606, and the 48xx *Advanced Biotech* courses through the assessment collected individually using the Carmen rubrics tool in both laboratory reports and other written assignments.	Student performance is measured through the *Student Assessment of Learning Gains (SALG)*, a validated survey tool administered at the end of the term in all Biology courses, through participation in the Denman Research Forum participation, and using the ASC *Graduation Survey*.
3b. Apply the scientific process, including designing and conducting experiments and testing hypotheses.	Direct measurement in Biology 1113 and 1114, and Micro 4000/4100 through collection of laboratory report data through the use of the Carmen rubrics tool.	
3c. Draw valid conclusions based on quantitative and qualitative results.	Direct measurement in Biology 1113, 1114, 3501.04, Micro 4000/4100, and the 48xx *Advanced Biotech* courses through	

	the assessment collected individually using the Carmen rubrics tool in both laboratory reports and other written assignments.	
3d. Adapt tools such as laboratory notebooks and spreadsheets to organize and analyze data associated with scientific processes.	Direct measurement in Biology 1113, 1114, and Micro 4000/4100 through the assessment data collected individually with the use of the Carmen rubrics tool in laboratory reports.	
3e. Communicate scientific information clearly and effectively in written reports, oral presentations, and through visual media to both scientific and non-scientific audiences.	Direct measurement in Biology 1113, 1114, 3501.04, and the 48xx *Advanced Biotech* courses through the assessment collected individually using the Carmen rubrics tool in both laboratory reports and other written assignments such as the Oral and Poster Presentations.	
4**.** Exhibit professional and ethical behavior, including understanding of biosafety, ethical dilemmas in genetic engineering and biotechnology, and the implications and impacts of biotechnology on natural ecosystems and populations.	Direct measurement in Biology 1113, 1114, Biochem 4511/5613, EEOB 3310x, Micro 4000/4100, MolGen 4500/4606, and the 48xx *Advanced Biotech* courses through the assessment collected individually using the Carmen rubrics tool in both laboratory reports and other written assignments.	Student performance is measured through the *Student Assessment of Learning Gains (SALG)*, a validated survey tool administered at the end of the term in all Biology courses.
5. Work effectively in diverse teams, demonstrating leadership, collaboration, and problem-solving in both laboratory and non-laboratory project environment.	Direct measurement in Biology 3501.04 through collection of laboratory report data through the use of the Carmen rubrics tool.	Student performance is measured through the *Student Assessment of Learning Gains (SALG)*, a validated survey tool administered at the end of the term in all Biology courses, and using targeted

		questions on the ASC *Graduation Survey*.
6. Demonstrate preparedness for employment or further education, including ability to articulate their skills and knowledge in professional settings such as internships, job interviews, or graduate school applications.	Direct measurement in Biology 3501.04, the 48xx *Advanced Biotech* courses, and 4891 seminar through the assessment collected individually using the Carmen rubrics tool written assignments.	Student performance is measured through the *Student Assessment of Learning Gains (SALG)*, a validated survey tool administered at the end of the term in all Biology courses, and using targeted questions on the ASC *Graduation Survey*.

Timeline

Biology 1113, 1114, and 3501.04 are courses central not only to the *Biotech Science Major*, but also the existing *Biology Major*. As such, data are already being collected from these courses for the purpose of assessment. While most of the program outcomes between the two Majors are different, there will be opportunities to streamline the assessment reporting across the two Majors.

Over the first two years, data will be collected from Biology 1113 and 1114, which will focus on those outcomes associated with Goals 1 and 3. As students move through the program, year three will focus on data collection from 3501.04 and the required core courses from each department, while year four will focus on the data collected from the upper-level courses. The four cycle will then repeat, though we anticipate more overlap as the cohorts of students begin to move through the program.

Program Review

Assessment data collected, collated, and reported by the CLSE Assistant Director and staff will be shared with the CLSE Curriculum Committee and the CLSE Executive Committee, which will have oversight of the Major. Among the Committee members are faculty representatives from each of the four ASC Life Science Departments, providing a regular mechanism for curricular communication across the units. The Committee has the authority to make adjustments to required and elective courses based on the data collected and communal discussion of shared goals.

4. Relationship to Other Programs / Benchmarking[3]

The core structure of proposed Biotech Science Major was initially developed by a committee consisting of faculty from the four life science departments in the College of Arts & Sciences: Kou-San Ju, Associate Professor, Department of Microbiology, Medicinal Chemistry & Pharmacognosy (chair); Paul Herman, Professor, Department of Molecular Genetics; James Pease, Associate Professor, Department of Evolution, Ecology, and Organismal Biology; Vladislav Belyy, Assistant Professor, Department of Chemistry and Biochemistry; Justin North, Assistant Professor, Department of Microbiology, Associate Dean Andrew Martin, Assistant Dean Bernadette Vankeerbergen, and Director of Industry Research Collaborations Elizabeth Drotleff. The Committee was tasked with development of a novel structure for this Major that reflected the strengths of the Life Science Departments and paired those with the needs of the local biotech industry based on continued consultation with biotech representatives. This is the first such proposal developed within the College of Arts & Sciences.

In their exploration, the Committee found that biotechnology majors at institutions around the country are numerous and highly variable. In thinking about the appropriate structure for a program at OSU, they evaluated 12 different biotechnology programs at R1 peer institutions across the country. This included Indiana University, Kent State, University of Houston, James Madison University, Penn State, Rutgers, Syracuse University, Tufts University, University of Georgia, University of Central Florida, UC San Diego, and UC Davis. The majority of Biotechnology Majors were housed in a college of Letters & Sciences, with others in colleges of Agriculture & Environmental Sciences (2), Engineering (2), or Medicine (1). Programs fell into three general categories: (A) those with dedicated biotechnology curriculum including introduction and capstone classes; (B) those that were an amalgam of existing courses without cohesive unity (“biotechnology in name”); or (C) heavily quantity programs akin to chemical engineering or computer science majors (these were all within Engineering).

Considering this landscape, the Committee proposed the best approach for the Biotech Science Major would be the creation of a program that includes dedicated biotechnology classes (model A) and focused in molecular biotechnology. This provides programmatic identity that distinguishes it from other general majors, such as Biology. The foundational overlap between the proposed Biotech Science Major and other Majors in the life sciences will allow for student mobility across majors with little to no loss of credit, while offering a curriculum that is more applied than would be found in more broad, interdisciplinary

[3] *ASC Biotechnology Major Committee Recommendations* Report, 5 February, 2025.

Majors such as Biology, which has a higher load of supporting coursework and more requirements for interdisciplinary coursework.

The proposed Biotech Science Major differs from other programs at Ohio State, such as those offered by the College of Engineering's Department of Food, Agriculture, and Biological Engineering which places heavy emphasis on the Physics and advanced Mathematics necessary for the Engineering of biotechnology. In contrast the proposed Biotech Science Major housed in the College of Arts & Sciences will focus on core molecular techniques, both theoretical and applied, which form the foundation of biotechnology applications with little emphasis on math or physics.

5. Student Enrollment

We anticipate that we could see as many as of 500 majors by the end of the first five years, with student interest in the Biotech Science Major coming from two primary sources:

- Direct entry into the Major
- Major-changing, especially from other Life Science Majors

Based on a comparison of the size of benchmark biotechnology majors, we anticipate interest in an applied career pathway will attract students toward a direct entry to the Major. We anticipate around 25-50 students per year initially declaring the Major with a target of 50-100 students ultimately declaring annually. This population of students is unlikely to be drawn from other OSU majors, with the majority of NFYS students recruited to come to OSU who might have otherwise matriculated elsewhere for a competing biotechnology program.

We anticipate that a significant proportion of the overall interest in the Biotech Science Major will be generated from Major-changing students. Given the extensive overlap in the supporting courses between the proposed Biotech Science and existing Biology Majors, we anticipate the Biotech Science Major will be popular for the *very significant* number of the approximately 45% of pre-health intentioned students who depart the Biology and other Life-Science Majors within the first two years after matriculation. These students often seek career-oriented majors after deciding that a pre-health professions track is not in their best or realistic long-term future. Many of these students will still retain interest in the life sciences broadly and can be guided toward a biotech science pathway as a career-oriented goal with little to no course 'waste' from the first two years. We often hear anecdotally from our academic advisors that students aren't clear on alternative career paths after leaving a pre-health professions track. The structure of the proposed Major will allow for a smooth transition for most students interested in staying within a life science

major, and we anticipate retention of 10-20% of students who would otherwise depart the life sciences.

Given that the supporting and core courses for the Major have large capacities and are offered every term, students will be able to declare the Major to begin any semester. With the exception of *Advanced Biotechnology* and the Seminar, which will inherently be taken toward the end of a student's pathway, there is no set order required for students to complete the core courses.

6. Curricular Requirements

In designing the curriculum, we elected for a bedrock of biology, chemistry, mathematics, and statistics universal to majors in the life sciences. An introductory course will cover essential topics such as the biotechnology origins, principles, and ethics, emphasizing intersections between science and society. This course should have broad appeal among students interested in applied molecular biosciences and serve as a gateway into the major. Biol 3501.04 (*Integrative Skills in Biology: Biotechnology*) will fulfill this role. The course was designed around the University's General Education Embedded Literacies requirements and will utilize biotechnology as a mechanism to teach fundamental skills.

Upper-division classes in general microbiology, biochemistry, evolution, and genetics will establish foundational knowledge in core scientific principles that anchor modern biotechnology. As meaningful laboratory research experience is favored among employers in the chemical and life sciences, this was integrated in multiple required components of the major. Students will be required to complete one course in technical or communication skills from a list of electives. Finally, students can select from a list of diverse electives that cover a wide range of topics related to applied molecular sciences to round out the curriculum. The major is anchored by two courses: an Advanced Biotechnology course and a Seminar. Three versions of the Advanced Biotechnology course, Micro 4800 (approved), as well as MolGen 4810 and EEOB 4840, both in curricular review, will be taught independently by each department with a shared set of common learning outcomes covering both skills and recent or significant developments in biotechnology. Students will have the flexibility to choose which course they would like depending on their chosen biotechnical focus while still meeting program outcomes. A literature-review and seminar course – Micro 4891, will provide real-world exposure to the state of the field with biweekly seminars by industry professionals.

The Biotech Science Major will require 30-43 hours of Prerequisite Supporting Courses and a minimum 37 hours of Major coursework. The Major courses will be subdivided as:

- 10 hours of required *Core Courses*
- 9-13 hours of *Foundational Content Courses*
- 3 hours of (1) *Business and Communication Content Course*
- 6-8 hours of (2) Advanced Laboratory Courses
- 3-9 hours of elective coursework

Given the wide range of elective options at variable credit hours, most students will be able to complete the Major with exactly 37 credit hours should they choose to do so. Students who begin with a Math Placement score L (Calculus) and utilize 37 hours to complete the Major will ultimately require 19 hours of open elective credit hours to reach the 121-hour degree requirement, assuming 10 credit hours overlapping between the GE and Supporting Courses. Students will therefore have ample flexibility to take elective coursework or additional math courses as necessary to reach the Calculus requirement before exceeding the minimum hour to degree.

Following below are the details for each course that may be taken to fulfill either a Supporting or Major course requirement for the proposed Biotech Science Major. Additionally,

- The Major Advising Sheet can be found in Appendix A.
- A summary of the course detail including prerequisites for each course listed can be found in Appendix B.
- The Curriculum Map for the Biotech Science Major can be found in Appendix C.
- A sample four-year plan can be found as Appendix D.

A. Prerequisite Supporting Courses (30-43 credit hours)

*All courses are currently offered.

Introductory Biology Courses

Students will fulfill the Biology course requirements by completing one option from Introductory Biology 1 and one option from Introductory Biology 2. Biology 1 and Biology 2 are not sequential courses, but rather two parts of a whole.

Introductory Biology Course 1

- Biology 1111 and 1112:

  Biology 1111 – *Biological Foundations 1: Cells and Chemistry of Life*; 3 credit hours

  1111 Course description: An introductory exploration of life's chemical and cellular foundations, including macromolecular and cellular structure and function, energetics, pathways, the nature of scientific endeavors, and metacognitive

strategies. Includes a required weekly Peer Led Team Learning Workshop. Intended for student Majoring in STEM fields. Combined with Bio 1112, these courses will address content at similar depth and breadth as Bio 1113x.

Prereq or concurrent: Math 1075 or 1120. Not open to students with credit for 1113x

AND

Biology 1112 – *Biological Foundations 2: Molecular Machinery & Genetics*; 4 credit hours

1112 Course description. An introductory exploration of life's cellular and genetic mechanisms, molecular biology, and metacognitive strategies. Includes a required weekly Peer Led Team Learning Workshop. Intended for student Majoring in STEM fields. Combined with Bio 1111, these courses will address content at similar depth and breadth as Bio 1113x.

Prereq: 1111; Prereq or concurrent: Math 1121 or 1148. Not open to students with credit for 1113x.

OR

- Biology 1113.01: *Biological Sciences: Energy Transfer and Development*; 4 credit hours

  Course description. Exploration of biology and biological principles; evolution and the origin of life, cellular structure and function, bioenergetics, and genetics. A broad introduction to biology comprises both Biology 1113 and 1114. Lecture, Lab.

  Prereq: Math 1120, 1130, 1148, 1150, or above, or Math Placement Level L or M. Prereq or concur: Chem 1110, 1210, 1610, or 1910H, or permission of course coordinator. Not open to students with credit for 1113 or 1113.02.

OR

- Biology 1113.02 – *Biological Sciences: Energy Transfer and Development PLTL*; 5 credit hours

  Course Description. Exploration of biology and biological principles; evolution and the origin of life, cellular structure and function, bioenergetics, and genetics. This course includes a required Peer-Led Team Learning (PLTL) component. Peer-led team learning (PLTL) provides a structure within which students will actively work together in groups to complete a series of activities and deepen their understanding of concepts associated with Biology 1113. A peer leader will work with the group on

challenging and relevant activities to prepare biology students to apply scientific reasoning to authentic problems.

Prereq: Math 1120, 1130, 1148, 1150, or above, or Math Placement Level L or M. Prereq or concur: Chem 1110, 1210, 1610, or 1910H, or permission of course coordinator. Not open to students with credit for 1113 or 1113.01.

Introductory Biology Course 2

- Biology 1114.01 – *Biological Sciences: Form, Function, Diversity, and Ecology*; 4 credit hours

  Course description.; Exploration of biology and biological principles; evolution and speciation, diversity in structure, function, behavior, and ecology among prokaryotes and eukaryotes. A broad introduction to biology comprises both Biology 1113 and 1114.; Lecture, Lab.

  Prereq: Math 1120, 1130, 1148, or 1150 or above, or Math Placement Level L or M. Prereq or concur: Chem 1110, 1210, 1610, or 1910H, or permission of course coordinator. Not open to students with credit for 1114 or 1114.02.

OR

- Biology 1114.02 – *Biological Sciences: Form, Function, Diversity, and Ecology PLTL*; 5 credit hours

  Exploration of biology and biological principles; evolution and speciation, diversity in structure, function, behavior, and ecology among prokaryotes and eukaryotes. This course includes a required Peer-Led Team Learning (PLTL) component. Peer-led team learning (PLTL) provides a structure within which students will actively work together in groups to complete a series of activities and deepen their understanding of concepts associated with Biology 1114. A peer leader will work with the group on challenging and relevant activities to prepare biology students to apply scientific reasoning to authentic problems.

  Prereq: Math 1120, 1130, 1148, or 1150 or above, or Math Placement Level L or M. Prereq or concur: Chem 1110, 1210, 1610, or 1910H, or permission of course coordinator. Not open to students with credit for 1114 or 1114.01.

Mathematics Course

Students will fulfill this requirement by completing Mathematics through Calculus 1. This can be achieved with the two-semester version (Math 1140 and 1141) or a single semester version (Math 1151 or 1156).

- Math 1140 and 1141

  Math 1140 – *Calculus with Review I*; 4 credit hours

  This is the first of a two semester course sequence. The topics covered in Math 1140 will include differential calculus of one real variable, with review of important algebra and pre-calculus concepts. Calculus with Review I is a course designed with an emphasis on reviewing these fundamental pre-calculus skills as they apply to calculus.

  Prereq: A grade of C- or above in 1148 and 1149, or in 1144, 1150, or 150, or Math Placement Level L

  AND

  Math 1141 – *Calculus with Review II*; 4 credit hours

  This is the second of a two semester course sequence. The topics covered in Math 1141 will include differential calculus of one real variable, with review of important algebra and pre-calculus concepts. Math 1141 is a course designed with an emphasis on reviewing these fundamental pre-calculus skills as they apply to calculus.

  Prereq: A grade of C- or above in 1140.

OR

- Math 1151 – *Calculus I*; 5 credit hours

  Differential and integral calculus of one real variable.

  Prereq: A grade of C- or above in 1148 and 1149, or in 1144, 1150, or 150, or Math Placement Level L

OR

- Math 1156 – *Calculus for the Biological Sciences*

  Differential calculus and mathematical modeling in the life sciences.

  Prereq: A grade of C- or above in 1148 and 1149, or a grade of C- or above in 1150, or credit for 150, or Math Placement Level L

Statistics Course

Students will fulfill this requirement by completing one statistics course from the list below.

- Stat 1450x – *Introduction to the Practice of Statistics*; 3 credit hours

Algebra-based introduction to data analysis, experimental design, sampling, probability, inference, and linear regression. Emphasis on applications, statistical reasoning, and data analysis using statistical software.
Prereq: Math 1116 or 1130 or above, or Math Placement Level L or M, or permission of instructor

OR

- Stat 2450x – *Introduction to Statistical Analysis I*; 3 credit hours
  Calculus-based introduction to statistical data analysis. Includes sampling, experimental design, probability, binomial and normal distributions, sampling distributions, inference, regression, ANOVA, two-way tables.
  Prereq: Math 1131, 1141, 1151, 1156, 1161.xx, or 1181H, or equiv, or permission of instructor

OR

- Stat 2480x – *Statistics for the Life Sciences*; 3 credit hours
  Calculus-based introduction to the statistical analysis of biological data, including probability, common discrete and continuous distributions, experimental design, hypothesis testing, linear regression and correlation.
  Prereq: Math 1131, 1141, 1151, 1156, 1161.xx, or 1181H, or equiv, or permission of instructor

General Chemistry Courses

Students will fulfill the General Chemistry course requirement by completing one option from General Chemistry Course 1 and one option from General Chemistry Course 2. The chemistry courses have specific sequences for students and are not interchangeable.

- Chem (1206 and 1208) or 1210 => Chem 1220
- Chem 1610 => 1620
- Chem 1910H => 1920H

General Chemistry Course 1

- Chem 1206 and 1208

  Chem 1206 – *Foundations 1 of General Chemistry*; 3 credit hours

  Chem 1206 is the first course in a two-course series, for science majors, covering units & measurement, atomic structure, electron configuration, periodic trends, bonding, and molecular structure. The chemistry content is covered in the same depth and rigor as in Chem 1210, and is about 1/2 of the Chem 1210 content. Additionally, metacognitive learning strategies are taught in the course.

Prereq or concur: Math Placement Level L or M, Math 1120, 1130, 1131, 1140, 1148, 1150, or above

AND

Chem 1208 – *Foundations 2 of General Chemistry*; 4 credit hours

CHEM 1208 is second course in a two-course series, for science majors, covering the mole, stoichiometry, chemical reactions, thermochemistry, gases, liquids, and solids, paired with metacognitive learning strategies. CHEM 1208 also includes a laboratory experience, that covers labs from both CHEM 1206 and CHEM 1208 content. Credit for CHEM 1206 and CHEM 1208 is equivalent to CHEM 1210.

Prereq: Chem 1206, and a grade of C- or above in Math 1120, 1130, 1131, 1140, 1148, 1150, or above

OR

- Chem 1210 – *General Chemistry 1*; 5 credit hours
  First course for science majors, covering dimensional analysis, atomic structure, the mole, stoichiometry, chemical reactions, thermochemistry, electron configuration, bonding, molecular structure, gases, liquids, and solids.
  Prereq: One unit of high school chemistry, and Math Placement Level L or M; or a grade of C- or above in Math 1120, 1130, 1131, 1148, 1150, or above

OR

- Chem 1610 – *General Chemistry for Majors 1*; 5 credit hours
  First course for chemistry and biochemistry majors, covering dimensional analysis, atomic structure, the mole, stoichiometry, chemical reactions, thermochemistry, electron configuration, bonding, molecular structure, gases, liquids, and solids.
  Prereq: One unit of high school chemistry, and Math Placement Level L or M; or a grade of C- or above in Math 1120, 1130, 1131, 1148, or 1150, or above, and enrolled in Chemistry or Biochemistry major; or permission of department

OR

- Chem 1910H – *Honors General Chemistry 1*; 5 credit hours
  Fundamental chemical principles and the chemistry of nonmetals for selected students.
  Prereq: ACT composite score of 30 or above, and ACT mathematics score of 30 or above, and ACT science reasoning score of 28 or above. Prereq or concur: Math 1141 or 1151 or above, or permission of instructor

General Chemistry Course 2

- Chem 1220 – *General Chemistry 2*; 5 credit hours

  Continuation of 1210 for science majors, covering solutions, kinetics, chemical equilibrium, solubility and ionic equilibria, qualitative analysis, thermodynamics, electrochemistry, descriptive chemistry, coordination compounds, and nuclear chemistry.
  Prereq: 1210, 1215, 1250, 1610, or 1910H, and Math Placement Level L or M, or a grade of C- or above in Math 1120, 1130, 1131, 1148, or 1150, or above; or credit for both Chem 1206 and 1208.

OR

- Chem 1620 – *General Chemistry for Majors 2*; 5 credit hours
  Continuation of 1610 for science majors, covering solutions, kinetics, chemical equilibrium, solubility and ionic equilibria, qualitative analysis, thermodynamics, electrochemistry, descriptive chemistry, coordination compounds, and nuclear chemistry.
  Prereq: 1210, 1215, 1250, 1610, or 1910H; and a grade of C- or above in Math 1120, 1130, 1131, 1148, or 1150, or above, or Math Placement Level L or M; and enrollment in Chemistry or Biochemistry major; or permission of department

OR

- Chem 1920H – *Honors General Chemistry 2*; 5 credit hours
  Continuation of Chem 1910H for selected students covering fundamental principles and the chemistry of metals.
  Prereq: 1910H (202H). Not open to students with credit for 203H, 1220 or 1620

Organic Chemistry Courses

Students will fulfill the Organic Chemistry course requirement by completing either the standalone option of Chem 2310 or the combination of one option from Organic Chemistry Course 1 and one option from Organic Chemistry Course 2. The chemistry courses have specific sequences for students and are not interchangeable.

- Chem 2310
- Chem 2510 => Chem 2520
- Chem 2610 => 2620
- Chem 2910H => 2920H

Standalone Organic Chemistry Course Option

- Chem 2310 – *Introductory Organic Chemistry*; 4 credit hours
  A condensed presentation of organic chemistry organized by functional groups with an emphasis on practical applications.
  Prereq: 1110, 1220 (122), 1250 (125), 1620, or 1920H. Not open to students with credit for 2510 (251), 2610, or 2910H.

OR

Organic Chemistry Course 1

- Chem 2510 – *Organic Chemistry 1*; 4 credit hours
  Introduction to structure, nomenclature, physical properties, preparation and reactions of alkanes, alkenes, conjugated dienes, alkynes, alcohols, ethers, epoxides, aldehydes, and ketones. Other topics include stereochemistry, conformations of molecules, acids, bases, and reaction mechanisms.
  Prereq: Chem 1208, or 1210, or 1250, or 1610 or 1910H; and Chem 1220, or 1620 or 1920H; and Math Placement Level L or M, or a grade of C- or above in Math 1120, 1130, 1131, 1148, 1150, or above

OR

- Chem 2610 – *Organic Chemistry for Majors 1*; 4 credit hours
  Introduction to structure, nomenclature, physical properties, preparation and reactions of alkanes, alkenes, alkynes, alcohols, ethers, epoxides, aldehydes and ketones. Other topics include stereochemistry, acids, bases, and reaction mechanisms.
  Prereq: 1220 (123), 1620 (163), or 1920H (203H); and Chemistry or Biochemistry major, or permission of Department

OR

- Chem 2910H – *Honors Organic Chemistry 1*; 4 credit hours
  Honors introduction to structure, nomenclature, physical properties, preparation and reactions of alkanes, alkenes, alkynes, alcohols, ethers, epoxides, aldehydes and ketones, including stereochemistry, acids, bases, and reaction mechanisms.
  Prereq: 1220 (123), 1620 (163), or 1920H (203H); Honors program or permission of department or instructor

AND

Organic Chemistry Course 2

- Chem 2520 – *Organic Chemistry 2*; 4 credit hours
  Continuation from 2510, including aromatic systems, carboxylic acids, carboxylic acid derivatives, amines, carbon-carbon bond-forming reactions, polymers, carbohydrates, and amino acids.
  Prereq: Chem 1208, 1210, 1250, 1610, or 1910H, and Chem 1220, 1620, or 1920H, and Chem 2510, 2610, or 2910H, and Math Placement Level L or M, or a grade of C- or above in Math 1120, 1130, 1131, 1148, 1150, or above

OR

- Chem 2620 – *Organic Chemistry for Majors 2*; 4 credit hours

Continuation from 2610, including aromatic systems, carboxylic acids, carboxylic acid derivatives, amines, carbon-carbon bond-forming reactions, polymers, carbohydrates and amino acids.
Prereq: 2510 (252), 2610, or 2910H; and Chemistry or Biochemistry major, or permission of Department

OR

- Chem 2920H – *Honors Organic Chemistry 2*; 4 credit hours
  Continuation from 2910H, including aromatic systems, carboxylic acids, carboxylic acid derivatives, amines, carbon-carbon bond-forming reactions, polymers, carbohydrates and amino acids.
  Prereq: Honors standing, and 2910H (252H) or 252; or permission of department or instructor

B. Required Major Core Courses (10 credit hours)

*All courses are approved.

Foundational Course with Embedded Literacies

- Bio 3501.04 – *Integrative Skills in Biology: Biotechnology*; 3 credit hours
  A biotechnology themed integrative approach to fundamental skills enhancement in the life sciences. *Note that this course is designed around and satisfies the Advanced Writing, Data Analysis, and Technology Embedded Literacies*.
  Prereq: 1113, 1114, and Chem 1220; or permission of instructor

Students who complete an alternate decimalized version of Biology 3501.xx *prior to declaring* the Biotech Science Major will be allowed to substitute that version of the course for the 3501.04 requirement and thus fulfill the Embedded Literacy requirement for the Major.

Advanced Biotechnology Course

- EEOB 4840 – *Biodiversity Biotechnology*; 3 credit hours hours (in curricular review)
  Study of the properties and use of organisms that are relevant to biotechnology from an ecological and evolutionary perspective, including structural and chemical properties of organisms, communities and microbiomes, biomaterials and bio-inspired design, bioprospecting, GMOs, and conservation implications.

OR

- Micro 4800 – *Advances in Microbial Biotechnology*; 3 credit hours
  Lecture course covering topics in applied microbial biotechnology, biocatalysis, and chemical biology. The origins of modern biotechnology, impact of microbial chemicals, and significant developments in biotechnology will be discussed.
  Prereq: MICRBIO 4100; or BIOCHEM 4511 or 5613; or PHR 3200

OR

- MolGen 4810 – *Advances in Genetic Biotechnology*; 3 credit hours
  This upper-level course explores recent breakthroughs and emerging technologies in the field of biotechnology, with a focus on biotechnology in the genetic sector. Topics will include regulation of gene expression, genome editing technologies (CRISPR and beyond), synthetic biology, use of microbial and cellular systems in the discovery of natural compounds and the production of commodity chemicals, and applications in medicine and agriculture. Students will engage with primary literature and learn to critically evaluate cutting-edge research, providing foundational knowledge and skills for careers in biotechnology and beyond.
  Prereq: Completion of MolGen4500 or MolGen4606 with a grade of C- or higher, or permission of instructor

Common Advanced Biotechnology Course ELOs

While each of the four sub-disciplinary courses will approach the topic from individual perspectives by adding content specific to their area, all versions of the Advanced Biotechnology course will commonly share the following course learning outcomes (with Program Outcome Alignment):

1. Describe the historical origins of various modern biotechnologies. (2a)
2. Explain commonly employed methods in biotechnology. (2a)
3. Demonstrate ability to interpret raw and processed data sets. (3b)
4. Describe and debate ethical dilemmas in genetic engineering and biotechnology. (4)
5. Critically evaluate peer-reviewed papers. (3a)
6. Demonstrate effective leadership and collaboration within group work. (5)

Students will choose one Advanced Biotechnology offering to fulfill the Major requirement. As the scientific content of the three Advanced Biotech courses will vary by discipline, students may elect to take *up to one additional version* to fulfill open elective hours toward the Major. While students may benefit from some breadth by taking up to two versions, the limit ensures the opportunity for depth of content with other electives.

Seminar Course

- Micro 4891 – *Progress in Biotechnology*; 1 credit hour
  Students will gain insight into real-world applied molecular sciences and biotechnology research through seminars presented by industry scientists; bi-weekly discussions will facilitate understanding of core research principles presented in seminars through shared reflection and discussion of research articles relevant to seminars.

Prereq: Microbiology 4100; or Biochemistry 4511 or 5613; or Pharmacy 3200

4891Course Expected Learning Outcomes

1. Gain insight into real-world applied molecular sciences and biotechnology research being conducted at companies
2. Be exposed to career paths and opportunities in the applied molecular sciences and biotechnology
3. Understand how fundamental biological discoveries can be commercialized
4. Understand how to learn from scientific research seminars
5. Critically evaluate research papers, accurately interpret raw and processed data sets
6. Identify key findings of research papers and explain them clearly to an audience of peers
7. Identify strong arguments supported by conclusive data; identify weak arguments supported by inconclusive data
8. Argue the merits and/or weaknesses of published work from a knowledgeable perspective

Internship or Research Credit Hours

Students will be required to have a minimum of 3 credit hours of either 4191, 4998/H, or 4999/H from one or a combination of Biochemistry, Biology, EEOB, Microbiology, or Molecular Genetics. While discouraged, an additional course from the Advanced Laboratory electives list may be substituted for this requirement in the event a student struggles to find a laboratory or internship opportunity.

C. Major Foundational Content Courses (9-13 credit hours)

*All courses are currently offered. Students will be required to take a course from each of three content areas below and may choose a course from the fourth area as an open elective. Additional courses from a completed content area may not be used as electives.

Biochemistry Course

- Biochem 4511 – *Introduction to Biological Chemistry*; 4 credit hours
  An introductory course in biochemistry dealing with the molecular basis of structure, metabolism, genetic replication, transcription, and translation in plants, animals, and microorganisms.
  Prereq: Chem 1220, 1250, 1620, or 1920H, and 2510, 2310, 2610, or 2910H and one semester of Biological Sciences

OR

- Biochem 5613 – *Biochemistry and Molecular Biology 1*; 3 credit hours
  An introductory course in biochemistry and molecular biology developing in three semesters the molecular basis of structure and function of living cells.

Prereq: Chem 2510 (252), 2610, or 2910H. Prereq or concur: Chem 2520 (253), 2620, or 2920H, and one semester in Biological Sciences

Evolution Course

- EEOB 3310.01 – *Evolution*; 4 credit hours
  Basic conceptual issues and processes in evolution with an emphasis on the ecological basis of adaptation and consequences of natural selection. Also available summer term at Stone Lab.
  Prereq: Biology 1114 or 1114H, or permission of instructor.

OR

- EEOB 3310.02 – *Evolution (Hybrid Online)*; 4 credit hours
  This course surveys the many processes that underlie biological evolution and illustrates the patterns they generate, with a focus on adaptation, types of selection, population genetics, species interactions and biodiversity. This course is presented in a hybrid online format.
  Prereq: Biology 1114 or 1114H, or permission of instructor.

OR

- EEOB 3310.20 – *Evolution (Hybrid Lecture)*; 3 credit hours
  This course surveys the many processes that underlie biological evolution and illustrates the
  patterns they generate, with a focus on adaptation, types of selection, population genetics, species interactions and biodiversity. This course is presented in a hybrid online format.
  Prereq: Biology 1114.01 or 1114H; or permission of instructor.

Microbiology Course

- Micro 4000x – *Basic and Practical Microbiology*; 4 credit hours
  Provides an understanding of microorganisms and their interaction with the human experience.
  Prereq: 3 cr hrs in Biology.

OR

- Micro 4100 – *General Microbiology*
  Fundamental principles of microbiology and the characteristics of microorganisms with emphasis on their structure, molecular biology, growth, classification, physiology, ecology, biotechnology, ecology, and applied microbiology.
  Prereq: Biology 1113, or 1113H, and Chem 1220.

Molecular Genetics Course

- MolGen 4500.x – *General Genetics*; 3 credit hours
  The principles of genetics, including molecular genetics, transmission genetics of prokaryotes and eukaryotes, developmental and non-chromosomal genetics, recombinant DNA and genomics, and the genetics and evolution of populations.
  Prereq: Biology 1101, 1113, or 1113H, and 3 additional sem cr hrs in Biological Sciences

OR

- MolGen 4606 – *Molecular Genetics*; 4 credit hours
  A comprehensive genetics course for majors covering transmission and molecular genetics; DNA replication, repair and mutation; transcription and translation; analysis and manipulation of genes at the molecular level.
  Prereq: Biology 1113 (113), 1113H (115H), 1114 (114), 1114H (116H), or Chem 1210 (121) or equiv, or permission of instructor

D. Business and Communications Content Courses (3 credit hours)

Student will select one course from this list which will support development of skills for the biotechnology business environment.

*All courses are currently offered.

- AEDECON 3101 – *Principles of Agribusiness Management*
  Introduction to agribusiness management principles and skills in the context of the four functions of management: planning, organizing, directing, and controlling.
  Prereq: 2001 (200) or 2001H (201H) or Econ 2001 (200) or 2001H (200H). Not open to students with credit for 401.
- AEDECON 4340 - *Project Management for Sustainability and Applied Economics*
  An introduction to project management concepts and techniques focusing on how to initiate, plan, manage, control, and close projects related to sustainability and applied economics.
  Prereq: none
- BUSMHR 4244 – *Negotiations*
  This course will explore the major concepts and theories of negotiation and the dynamics of interpersonal and inter-group negotiation and problem-solving strategies.
  Prereq: English 1110.01 or equiv. Not open to students with credit for 4220.
- BUSOBA 3130 - *Foundations of Operations Management*
  Introduction to operations & supply chain management to improve organizations; specifically analyzing, controlling & improving resources & processes to increase productivity, generate value-added output & meet business strategic & tactical goals.

Prereq: Math 1116, 1130, 1148, or equiv, and Econ 2001.01, or equiv. Not open to students with credit for 3230. Not open to students enrolled in the BSBA degree program.

- COMM 3330 - *Communication and Conflict Management*
  An overview of the communication and conflict literature with emphasis on effective conflict management.
  Prereq: Not open to students with credit for 3330H (531H) or 531.
- COMM 3331 - *Communication and Decision Making*
  Decision-making as a process; comparisons between interpersonal, bargaining-negotiation contexts, and group organizations; descriptive and prescriptive models of decision-making in small groups and organizations.
  Prereq: Not open to students with credit for 631.
- COMM 4635 - *Communication Dynamics in Groups*
  This class examines how communication dynamics affect group performance in organizations through topics such as: communication roles and norms, effective communication in teamwork and decision-making, leadership, group cohesion, managing conflict and using communication technologies.
  Prereq: none
- English 3305 - *Technical Writing*
  Study of principles and practices of technical writing. Emphasis on the style, organization, and conventions of technical and research reports, proposals, memoranda, professional correspondence, etc..
  Prereq: English 1110.xx; or GE foundation writing and info literacy course.

E. Advanced Laboratory Course Electives (6-8 credit hours)

Students will choose two courses from this list of electives to support laboratory skill development.

*All courses are currently approved.

- Biochem 5621 – *Biochemistry and Molecular Biology Laboratory*; 4 credit hours
  Laboratory course covering the principles and application of basic lab techniques, protein purification, enzyme assays, and recombinant DNA technologies.
  Prereq: A grade of C- or above in 4511 or 5613, or equiv.
- Micro 4140 – *Molecular Microbiology Laboratory*; 3 credit hours
  Advanced laboratory covering structure, maintenance, expression and exchange of genetic materials in microbial cells and methods in immunobiology.
  Prereq or concur: Micrbio 4130
- Micro 4145 – *Introduction to Industrial Microbiology and Bioprocessing Laboratory*; 3 credit hours
  Discovery-based lab course to introduce students to industrial microbiology. Students will use fermentation processes and biological engineering of

microorganisms for the production of value-added molecules. Students will gain operational knowledge of bioreactors and of molecular biology and microbiology techniques relevant to industrial microbiology.
Prereq: 4100, or 4000.01, 4000.02; or permission of instructor

- Micro 4150 – *Immunobiology Laboratory*; 3 credit hours
  This course will provide an introduction to the experimental approaches and laboratory methods commonly used in Immunology research. Topic areas include the purification, characterization and applications of antibodies, the characterization and responses of cells and organs of the immune system, and cell culture techniques for the use of eukaryotic cells in immunology research.
  Prereq: 4110, or 5122, or permission of the Instructor.
- MolGen 5601 – *Eukaryotic Molecular Genetics Lab*; 3-4 credit hours
  Current laboratory techniques used in the genetic, cellular, and molecular analyses of yeast, Drosophila, and other model systems.
  Prereq: 4500 or 4606, or permission of instructor.
- MolGen 5602 – *Eukaryotic Cell and Developmental Biology Laboratory*; 3-4 credit hours
  Laboratory course emphasizing techniques and methods central to cell and developmental biology of eukaryotes.
  Prereq: 4500 or 4606; or permission of instructor.
- PHR 4600 – *Pharmaceutical Sciences Laboratory*; 3 credit hours
  Lab exercises to teach the theory and practice of basic techniques in pharmaceutics, medicinal chemistry and pharmacology: including spectroscopy, hydrolysis, drug synthesis, pKa determination, IC50 determination, enzyme kinetics, and drug action.
  Prereq: Chem 2540, and enrollment in the BSPS program or Pharmaceutical Sciences minor; or permission of instructor. Prereq or concur: PHR 3200 or 4100, or Biochem 4511 or 5613.
- PHR 4610 – *Experimental Techniques in Drug Discovery*; 4 credit hours
  Examination of the laboratory instrumentation and methods used in the drug discovery process.
  Prereq: 3200, or equiv. Biochem course, or permission of instructor.

F. Major Elective Courses (3-9 credit hours)

*All courses are currently approved.

- Biochem 5614 – *Biochemistry and Molecular Biology II*; 3 credit hours
  Continuation of Biochem 5613.

Prereq: A grade of C- or above in 5613.

- Biochem 5615 – *Biochemistry and Molecular Biology III*; 3 credit hours
  Continuation of Biochem 5614.
  Prereq: A grade of C- or above in 5614.
- Biochem 5721 – *Physical Biochemistry 1*; 3 credit hours
  Introduction to physical chemistry with emphasis on biological applications; designed for students in the life sciences.
  Prereq: Biology 1113; Math 1152 (153), 1172, 1181H, or 2162 (162); and Physics 1201 (113) or 1251 (133). Prereq or concur: Chem 2520 (253), 2620, or 2920H.
- Biochem 5722 – *Physical Biochemistry 2*; 3 credit hours
  Continuation of Biochem 5721.
  Prereq: 5721, or Chem 4200 or 4300.
- CBE 5730 – *Industrial Biopharmaceuticals*; 3 credit hours
  Key technologies of industrial biopharmaceuticals (protein, cellular and gene therapies) will be introduced: therapy development, unit operations, bioprocessing, biomanufacturing, GLP, cGMP, quality control, clinical trials, and FDA regulations.
  Prereq: 2200; or BiomedE 2000; or Biochem 2210; or Biology 3401; or MolGen 2690; or Grad standing in Engineering; or permission of instructor. Not open to students with credit for BiomedE 5830. Cross-listed BiomedE 5830.
- Chem 5230 – *Neurotransmitter Chemistry*; 3 credit hours
  Come and explore the natural and unnatural organic molecules involved in neurotransmission. Through the study of synthetic strategies, mechanistic principles, and the structural requirements for biological activity, students will investigate the chemical world of endogenous molecules, pharmaceuticals, and drugs of abuse. Recommended prereqs: Chem 2550, and Biochem 4511 or 5613.
  Prereq: 2520, 2620, or 2920H, and 2540; or Grad standing; or permission of instructor.
- Chem 5240 – *Introduction to Protein Modeling*; 3 credit hours
  This course provides a practical introduction to the theory and methods of molecular modeling and computational chemistry as it pertains to modeling large biological molecules such as proteins. Hands-on experience will be obtained by all attendees in doing molecular mechanics and modeling dynamic systems (molecular dynamics). Recommended prereq: Biochem 4511.
  Prereq: 2310, 2510, 2610, or 2910H; or Grad standing; or permission of instructor.

- Chem 5430 – *Carbohydrate Chemistry*; 3 credit hours
  Introduction to synthesis, conformation, and biological importance of carbohydrates and oligosaccharides, including nomenclature, protecting groups, glycoside synthesis, biosynthesis and biology, and NMR methods.
  Prereq: 2520 (253), 2620, or 2920H (253H), or equiv.
- EEOB 2511 – *Human Anatomy*; 4 credit hours
  This introductory course in human anatomy introduces students to the principles of vertebrate anatomy with emphasis on human systems. Weekly laboratory meetings provide students with experience dissecting a small mammal as a model for human organ systems.
  Prereq: 3 sem cr hrs in Biological Sciences.
- EEOB 3310.22 – *Evolution (Laboratory)*;1 credit hour
  This course surveys the many processes that underlie biological evolution and illustrates the patterns they generate, with a focus on adaptation, types of selection, population genetics, species interactions and biodiversity. This course is a laboratory course intended to be taken concurrently with EEOB 3310.20 or by students with credit in EEOB 3310.20.
  Prereq or concur: 3310.01 or 3310.20
- EEOB 3320 – *Organismal Diversity*; 3 credit hours
  A survey of organismal diversity and the evolutionary relationships between and within major groups of organisms. Class is laboratory based.
  Prereq: 3310.
- EEOB 3410 – *Ecology*; 4 credit hours
  Distribution and abundance of species, population dynamics, community ecology, ecosystem dynamics, and applied perspectives. Also available summer term at Stone Lab.
  Prereq: Biology 1114 or 1114H, or permission of instructor.
- EEOB 3510 – *Cellular and Developmental Biology*; 3 credit hours
  Introduction to the structure and function of animal cells, and to patterns of early development in vertebrates and invertebrates.
  Prereq: 3310, and Biology 1113 or 1113H
- EEOB 3610 – *Evolutionary Genomics*; 3 credit hours (in curricular review)
  An introduction to core principles of the modeling and investigation of biological data using quantitative models applied to genomic and other data. The course focuses on applications of quantitative modeling methods to study of the evolution and ecology to natural populations of animals, plants, and fungi.

Prereq: Recommend a working knowledge of molecular genetics, inheritance genetics, and basic statistics. No specific course is required as a formal prerequisite.

- EEOB 4520 – *Comparative Physiology*; 4 credit hours
  Functional systems in invertebrates and vertebrates: respiration, circulation, water, ion, and energy balance; communication; locomotion; and reproduction.
  Prereq: Biology 1114 or 1114H, and 1 course in Biological Sciences.
- EEOB 4560 – *Comparative Endocrinology*; 2 credit hours
  Introduction to hormones and hormone action; comparison between vertebrates and invertebrates with emphasis on special situations such as metamorphosis.
  Prereq: 4520 and Biochem 4511, or equiv, or permission of instructor.
- EEOB 5360 – *Biodiversity Informatics*; 3 credit hours
  This course will provide students with the knowledge and practical skills to access, manage, analyze, and utilize biodiversity data for scientific research and conservation efforts. The course covers a comprehensive understanding of diverse biodiversity data sources and introduces a range of analytical, statistical, and computational tools essential for biodiversity data analysis.
  Prereq: 3410, or 3310.01, or 3310.02; or permission of instructor.
- HCS 5325 – *Plant Genetics*; 3 credit hours
  This course will serve as a general introduction to the basic principles of plant genetics. Specifically, this course focuses on concepts in molecular genetics, transmission genetics, quantitative genetics, and population genetics which can be used to understand the biological processes of plants, our use and improvement of crop plants, and the process of evolution.
  Prereq: 2202 or MolGen 3300, and Chem 1110 or 1210, and Biology 1101 or 1113 or MolGen 1101; or Grad standing
- HCS 5625 – *Applied Plant Biotechnology*; 2 credit hours
  An introduction to the principles of plant biotechnology. Examining concepts relevant to biotechnology, plant breeding and genetics. The course content will present a broad range of applicable information pertaining to modification and improvement of a wide range of crops, including both agronomic and horticultural crop species important in temperate and tropical areas.
  Prereq: 4325 or 5325.
- Micro 2100 – *Wild Yeast: Isolation to Fermentation*; 3 credit hours
  An introduction to yeast biology and microbiological techniques used in fermentation. Students will isolate an unknown yeast from the environment and characterize the growth behavior of the wild strains; use molecular biology and

bioinformatics to determine the yeast species they have isolated; use the wild yeast to prepare a fermentation and characterize the finished 'wild' ferment.
Prereq: Biology 1110 or 1113, and Chem 1110, 1210, or 1610; or permission of instructor.

- Micro 4110 – *Microbial Pathogenesis and Immunobiology*; 3 credit hours
  Provides an overview of microbe-host interactions with an emphasis on virulence mechanisms of bacterial pathogens, host infection routes, immune recognition of microbes, and the cellular and molecular effectors of the host immune system.
  Prereq: 4000 (509) or 4100 (520)
- Micro 4120 – *Microbial Physiology and Diversity*; 3 credit hours
  Principles of microbial growth, metabolism, microbial structure and function, and regulation of microbial metabolism.
  Prereq: 4100. Prereq or concur: Biochem 4511.
- Micro 4130 – *Microbial Genetics*; 3 credit hours
  Structure, maintenance, expression, and exchange of genetic materials in microbial cells.
  Prereq: 4100, MolGen 4500, or 4606.
- Micro 5161 – *Introduction to Computational Genomics*; 3 credit hours
  Application of computational tools to the analysis of microbial genomes and their gene products. Recommended background in basic molecular biology, genetics or biochemistry.
- MolGen 3436 – *Introductory Plant Physiology*; 3 credit hours
  Topics in plant physiology at the introductory level: diffusion, transpiration, water stress, translocation, photosynthesis, plant growth hormones, tropisms, flowering, and fruit development.
  Prereq: Biology 1113, 1113H, 1114, 1114H, and 6 cr hrs in Chem.
- MolGen 4700 – *Molecular Cell and Developmental Biology*; 3 credit hours
  A genetics-based introduction to the structure and function of cells and the early development of invertebrates and vertebrates, with a special focus on the molecular mechanisms underpinning cellular biology and development.
  Prereq: 4500 or 4606, or permission of instructor.
- MolGen 4703 – *Human Genetics*; 3 credit hours
  This course covers principles of human genetics, including mapping and identification of disease genes, animal models, genetic testing and gene therapy, with a focus on reading the primary scientific literature.
  Prereq: A grade of C- or above in 4500 or 4606, or permission of instructor.

- MolGen 5300 – *Cancer Genetics*; 3 credit hours
  Students will learn about the genetic evolution of human cancer. Specifically, the hallmarks of cellular transformation and tumor progression will be discussed. Students will be introduced to modern approaches aimed at targeting genetic aberrations in cancer cells. Includes hands-on training in the use of online databases of cancer genetics.
  Prereq: A grade of C- or above in 4606 or 4500; or Grad standing.
- MolGen 5607 – *Cell Biology*; 3 credit hours
  Analysis of the structure and function of animal and plant cells and their components, stressing molecular genetic and biochemical approaches.
  Prereq: 4500 or 4606. Not open to students with credit for 607, 607H, 5607E.
- MolGen 5607E – *Cell Biology with Embedded Honors*; 4 credit hours
  Analysis of the structure and function of animal and plant cells and their components, stressing molecular genetic and biochemical approaches.
  Prereq: 4500 or 4606. Not open to students with credit for 607, 607H, 5607E.
- MolGen 5623 – *Genetics and Genomics*; 3 credit hours
  Advanced study of plant physiology; regulation of plant growth and development, hormones, and stress physiology.
  Prereq: 3300, 4500, 4606, Biology 1114, 1114H, or permission of instructor.
- MolGen 5650 – *Analysis and Interpretation of Biological Data*; 3 credit hours
  Methods of analyzing biological data including: sampling, descriptive statistics, distributions, analysis of variance, inference, regression, and correlation. Emphasizes practical applications of statistics in the biological sciences.
  Prereq: Math 1149 or 1150 (150) or equiv, and 10 semester cr hrs at the 3000-level (or 300 level in the quarter system) or above in Agricultural or Biological Sciences.
- MolGen 5701 – *DNA Transactions and Gene Regulation*; 3 credit hours
  Understanding mechanisms of DNA replication, DNA repair and recombination, transcription, translation, regulation of gene expression, and the experimental approaches to these topics.
  Prereq: 4500, 4606, Biochem 4511, or equiv., and Sr standing; or Grad standing; or permission of instructor. Not open to students with credit for Biochem 5701. Cross-listed in Biochem.
- MolGen 5720 – *Genomic Data Analysis*; 3 credit hours
  This course will introduce students to genome nomenclature, annotations, and genome databases. Students will use command line tools and R language to engage in genomic data archival, analysis, and visualization. They will perform genome annotation, interrogate genomic data to interpret gene function and

regulation, and use AI-based approaches to facilitate their learning and genome analysis.
Prereq: MolGen 4500 or MolGen 4606 or instructors' permission

- MolGen 5800 – *Organelle Biology*; 2 credit hours
  Structure and function of plastids and mitochondria, apicoplasts and hydrogenosomes.
  Prereq: 4500, 4500E, or 4606, or permission of instructor.
- PHR 2500 – *Drug Discovery, Development and Delivery*; 3 credit hours
  Provides a comprehensive overview of the drug discovery, development, and delivery process within the U.S. healthcare system, exploring the roles of vested stakeholders (e.g., patients, pharmaceutical industry, providers, insurers, society, etc.) during a drug's "bench to bedside" development including its post-development place in therapy.
  Prereq: none
- PHR 4420 – *Biologics: Transforming Medicine*; 2 credit hours
  Overview of biopharmaceutical products and their production methods.
  Concur: 3200, or permission of instructor.

G. Summary of Departmental Contributions

The Center for Life Sciences Education will be responsible for the administration, advising, and assessment for the interdisciplinary Biotech Science Major as well as offering courses listed under the Biology catalog.

The table below outlines the total credit hours counting toward the degree requirement as offered by each associated unit.

Unit	Required / Core Credits		Open Elective Credits	
	Lower Level	Upper Level	Lower Level	Upper Level (*Students will select 12-20 hours total)
Agricultural, Environmental, and Development Economics				6
Biology (CLSE)	8-10	3-6	0	0
Business Management and Human Resources				3
Business Operations and				3

Business Analytics				
Chemical and Biomolecular Engineering	0	0	0	3
Chemistry and Biochemistry	18-20	3-11	0	19
Communications				9
Evolution, Ecology, and Organismal Biology	0	3-11	0	30
English	0	0	0	3
Horticulture and Crop Science (CFAES)	0	0	0	5
Mathematics	5-8	0	0	0
Microbiology	0	4-12	0	24
Molecular Genetics	0	3-11	0	35-38
Pharmacy	0	0	0	12
Statistics	3	0	0	0

H. AI Fluency

The Biotech Science Major will be well place to fulfill the University's AI Fluency initiative given the natural overlap within STEM fields. The Major will meet the six AI Fluency learning outcomes in the following courses, with others in revision to meet the outcomes at a future date.

Outcome	Courses
Explain foundational concepts such as artificial intelligence, large language models, machine learning	GenEd 1201, EEOB 3310x, Micro 4100
Explore the potential benefits and limitations of common AI applications in the context of a chosen field	Bio 1113x, Bio 3501x, GenEd 1201, EEOB 3310x, Micro 4100, Micro 4120, Micro 4130, Micro 4140
Evaluate the types of inputs and outputs foundational to AI systems — including data, prompts, commands and emerging modalities — and explain how input form and quality influence output quality, performance and reliability	GenEd 1201, EEOB 3310x, Micro 4100, Micro 4130
Use AI tools to accomplish specific goals in the field of study, and critically assess outputs for accuracy and relevance to the task	Bio 3501x, GenEd 1201, EEOB 3310x, Micro 4130, Micro 4140

Design innovative applications of AI within a discipline, supported by a rationale for the potential value and feasibility	EEOB 3310x
Explore the implications (ethical, societal, environmental, legal, practical) of AI use cases and develop reasoned recommendations for responsible implementation within a field of study	Bio 3501x, EEOB 3310x

I. Additional Resources Required

Three Departments (EEOB, Microbiology, and Molecular Genetics) have or will each be developing a new course (48xx – *Advanced Biotechnology*) and a cross-listed seminar course (Micro 4891- *Seminar*) and staffing those courses from within their own faculty. EEOB has plans to develop one additional new course, EEOB 3610 – Evolutionary *Genomics* as an elective offering, while Molecular Genetics has developed MolGen 5720 – *Genomic Data Analysis*. Beyond those courses, no new offerings are currently planned to facilitate the implementation of this Major. Student demand for electives will be monitored and additional sections proposed as appropriate. Given that all other courses are currently offered, no additional course resources beyond appropriate staffing are necessary at this time.

We anticipate the need for one additional academic advisor initially and potentially a second should the anticipated interest in the major manifest within 3-5 years. The CLSE's current team of academic advisors already service approximately 350 students or more each and cannot take on the load of an additional Major's students without additional support, especially should the Major attain the anticipated enrollment. College Leadership has been supportive of the need for additional advising resources should the Major grow as anticipated.

The CLSE will also request an additional staff line to help facilitate the annual Major assessment process, which will involve significant coordination with multiple units to gather data from the range of interdisciplinary courses utilized in the Major.

Appendix A: Biotech Science Major Advising Sheet

Biotech Science Major Checklist
Bachelor of Science

NAME_____ DATE_____
SEMESTER OF GRADUATION _____

General Education Requirements (32-39 credit hours)

- ❒ GE Launch Seminar (1) — GENED 1201
- ❒ Foundations: Writing and Information Literacy (3) — _____
- ❒ Foundations: Mathematics & Quantitative Reasoning / Data Analysis (3-5) — _____
- ❒ Foundations: Literacy, Visual & Performing Arts (3) — _____
- ❒ Foundations: Historical & Cultural Studies (3) — _____
- ❒ Foundations: Natural Sciences (4-5) — _____
- ❒ Foundations: Social & Behavioral Sciences (3) — _____
- ❒ Foundations: Race, Ethnicity and Gender Diversity (3) — _____
- ❒ Theme: Citizenship for a Diverse & Just World (4-6) — _____
- ❒ Theme: Student Choice (4-6) — _____
- ❒ GE Reflection (1) — GENED 4001

Required Arts & Sciences Courses (1-13 Credit Hours)

- ❒ Arts & Sciences Survey (1) — _____
- ❒ World Language (0-12) — _____

Required Supporting Courses (30-43 credit hours)

Biology (Check 2 boxes)

- ❒ Biology 1113.01 (4) or 1113.02 (5)* or Biology 1111 (3) and 1112 (4)*
- ❒ Biology 1114.01 (4) or 1114.02 (5)*
- ❒ _____Substitution

* Can be used to fulfill the GEN Foundation: Natural Sciences requirement

Mathematics/Statistics (Check 2 boxes)

- ❒ Math 1151 or 1156 (5)** OR 1140 (4) AND 1141 (4)
- ❒ Stat 1450 (3) or Stat 2480 (3) or Stat 2450 (3)
- ❒ _____Substitution

** Can be used to fulfill the GEN Foundation; MQR/DA requirement

Chemistry (Check 2 boxes)

- ❒ Chemistry 1206 (3) and 1208 (4) or 1210 or 1610 or 1910H (5)
- ❒ Chemistry 1220 or 1620 or 1920H (5)
- ❒ _____Substitution

Organic Chemistry (Check 1 box)

- ❒ Chemistry 2310 (4)
- ❒ Chemistry 2510 or 2610 or 2910H (4) AND Chemistry 2520 or 2620 or 2920H (4)
- ❒ _____Substitution

Embedded Literacies (no additional credit hours)

- ❒ Advanced Writing 3501.xx
- ❒ Advanced Data Analytics 3501.xx
- ❒ Technology Literacy 3501.xx

Notes:

- † indicates a course within the major with a laboratory component
- *Students are required to take one 48xx *Advanced Biotechnology* course. Up to one additional version from the list of three may be taken to fulfill open elective hours.
- Major Core and Elective courses must total 37 semester units and must include three laboratory courses. At least two laboratory courses must come from the *Advanced Laboratory Electives* category.
- At least 30 of the 37 semester units must be courses in Biochemistry, Biology, EEOB, Microbiology, or Molecular Genetics. Courses from outside these units must be from the pre-approved electives list.
- An additional *Advanced Laboratory Elective Course* may be substituted for the 4191/4998/4999 research hour requirement.
- A minimum grade of C- in every core and elective course is required.
- Transfer credit allowed - no more than one half of the credit hours required on the major.
- Honors versions of courses substitute freely.

Biotech Science Major Checklist
Bachelor of Science

Required Core Courses – Check all 4 boxes (10 credit hours)

- ❒ Biology 3501.04 (3)
- ❒ EEOB 4840 or Micro 4800 or MolGen 4810 (3)*
  (*A second course may be taken as an open elective)
- ❒ Micro 4891 (1)
- ❒ Bio 4191 (3) or
  Biochem/Bio/EEOB/Micro/MolGen 4998 or 4999 (3)

Foundational Content Courses – Check 3 boxes (9-13 credit hours)

**An additional course from the fourth checkbox may be taken as an open elective*

- ❒ Biochem 4511 (4) or 5613 (3)
- ❒ EEOB 3310.01 or 3310.02† or 3310.20 (3-4)
- ❒ MolGen 4500xx (3) or 4606 (4)
- ❒ Micro 4000† (4) or 4100† (5)

Business & Communication Content Courses – Check 1 box (3 credit hours)

**Only one course may count toward Major hours*

- ❒ AEDECON 3101 (3)
- ❒ AEDECON 4340 (3)
- ❒ BUSMHR 4244 (3)
- ❒ BUSOBA 3130 (3)
- ❒ COMM 3330 (3)
- ❒ COMM 3331 (3)
- ❒ COMM 4635 (3)
- ❒ English 3305 (3)

Advanced Laboratory Courses – Check 2 boxes (6-8 credit hours)

**Additional courses may be taken as open electives*

- ❒ Biochem 5621† (4)
- ❒ Micro 4140† (3)
- ❒ Micro 4145† (3)
- ❒ Micro 4150† (3)
- ❒ MolGen 5601† (3-4)
- ❒ MolGen 5602† (3-4)
- ❒ PHR 4600† (3)
- ❒ PHR 4610† (4)

Major Electives (3-9 credit hours)

- ❒ Biochem 5614 (3)
- ❒ Biochem 5615 (3)
- ❒ Biochem 5721 (3)
- ❒ Biochem 5722 (3)
- ❒ CBE 5730 (3)
- ❒ Chem 5230 (3)
- ❒ Chem 5240 (3)
- ❒ Chem 5430 (3)
- ❒ EEOB 2511† (4)
- ❒ EEOB 3310.22† (1)
- ❒ EEOB 3320† (3)
- ❒ EEOB 3410† (4)
- ❒ EEOB 3510 (3)
- ❒ EEOB 3610 (3)
- ❒ EEOB 4520 (4)
- ❒ EEOB 4560 (2)
- ❒ EEOB 5360 (3)
- ❒ HCS 5325 (3)
- ❒ HCS 5625 (2)
- ❒ Micro 2100† (3)
- ❒ Micro 4110 (3)
- ❒ Micro 4120 (3)
- ❒ Micro 4130 (3)
- ❒ Micro 5161 (3)
- ❒ MolGen 3436 (3)
- ❒ MolGen 4700 (3)
- ❒ MolGen 4703 (3)
- ❒ MolGen 5300 (3)
- ❒ MolGen 5607 (3) or 5607E (4)
- ❒ MolGen 5623 (3)
- ❒ MolGen 5650 (3)
- ❒ MolGen 5701 (3)
- ❒ MolGen 5720 (3)
- ❒ MolGen 5800 (2)
- ❒ PHR 2500 (3)
- ❒ PHR 4420 (2)

Core Hours		**TOTAL CREDIT HOURS**	
Elective Hours			
Total BioSci Hours			

Appendix B: Summary of Course Details

Catalog Number	Course Name	Credit Hours	Prerequisites
Prerequisite Supporting Courses			
Biology 1111	*Biological Foundations 1: Cells and Chemistry of Life*	3	Prereq or concurrent: Math 1075 or 1120
Biology 1112	*Biological Foundations 2: Molecular Machinery & Genetics*	4	1111; Prereq or concurrent: Math 1121 or 1148
Biology 1113x	*Biological Sciences: Energy Transfer and Development*	4-5	Math 1120, 1130, 1148, 1150, or above, or Math Placement Level L or M. Prereq or concur: Chem 1110, 1208, 1210, 1610, or 1910H, or permission of course coordinator
Biology 1114x	*Biological Sciences: Form, Function, Diversity, and Ecology*	4-5	Math 1120, 1130, 1148, or 1150 or above, or Math Placement Level L or M. Prereq or concur: Chem 1110, 1208, 1210, 1610, or 1910H, or permission of course coordinator.
Math 1140	*Calculus with Review I*	4	A grade of C- or above in 1148 and 1149, or in 1144, 1150, or 150, or Math Placement Level L
Math 1141	*Calculus with Review II*	4	A grade of C- or above in 1140.
Math 1151	*Calculus 1*	5	A grade of C- or above in 1148 and 1149, or in 1144, 1150, or 150, or Math Placement Level L
Math 1156	*Calculus for the Biological Sciences*	5	A grade of C- or above in 1148 and 1149, or a grade of C- or above in 1150, or credit for 150, or Math Placement Level L
Stat 1450x	*Introduction to the Practice of Statistics*	3	Math 1116 or 1130 or above, or Math Placement Level L or M, or permission of instructor
Stat 2450	*Introduction to Statistical Analysis I*	3	Math 1131, 1141, 1151, 1156, 1161.xx, or 1181H, or equiv, or permission of instructor
Stat 2480	*Statistics for the Life Sciences*	3	Math 1131, 1141, 1151, 1156, 1161.xx, or 1181H, or equiv, or permission of instructor
Chem 1206	*Foundations 1 of General Chemistry*	3	Prereq or concur: Math Placement Level L or M, Math 1120, 1130, 1131, 1140, 1148, 1150, or above
Chem 1208	*Foundations 2 of General Chemistry*	4	Chem 1206, and a grade of C- or above in Math 1120, 1130, 1131, 1140, 1148, 1150, or above

Chem 1210	*General Chemistry 1*	5	One unit of high school chemistry, and Math Placement Level L or M; or a grade of C- or above in Math 1120, 1130, 1131, 1148, 1150, or above
Chem 1610	*General Chemistry for Majors 1*	5	One unit of high school chemistry, and Math Placement Level L or M; or a grade of C- or above in Math 1120, 1130, 1131, 1148, or 1150, or above, and enrolled in Chemistry or Biochemistry major; or permission of department
Chem 1910H	*Honors General Chemistry 1*	5	ACT composite score of 30 or above, and ACT mathematics score of 30 or above, and ACT science reasoning score of 28 or above. Prereq or concur: Math 1141 or 1151 or above, or permission of instructor
Chem 1220	*General Chemistry 2*	5	1210, 1215, 1250, 1610, or 1910H, and Math Placement Level L or M, or a grade of C- or above in Math 1120, 1130, 1131, 1148, or 1150, or above; or credit for both Chem 1206 and 1208.
Chem 1620	*General Chemistry for Majors 2*	5	1210, 1215, 1250, 1610, or 1910H; and a grade of C- or above in Math 1120, 1130, 1131, 1148, or 1150, or above, or Math Placement Level L or M; and enrollment in Chemistry or Biochemistry major; or permission of department
Chem 1920H	*Honors General Chemistry 2*	5	1910H (202H). Not open to students with credit for 203H, 1220 or 1620
Chem 2310	*Introductory Organic Chemistry*	4	1110, 1220 (122), 1250 (125), 1620, or 1920H. Not open to students with credit for 2510 (251), 2610, or 2910H.
Chem 2510	*Organic Chemistry 1*	4	Chem 1208, or 1210, or 1250, or 1610 or 1910H; and Chem 1220, or 1620 or 1920H; and Math Placement Level L or M, or a grade of C- or above in Math 1120, 1130, 1131, 1148, 1150, or above
Chem 2610	*Organic Chemistry for Majors 1*	4	1220 (123), 1620 (163), or 1920H (203H); and Chemistry or

			Biochemistry major, or permission of Department
Chem 2910H	*Honors Organic Chemistry*	4	1220 (123), 1620 (163), or 1920H (203H); Honors program or permission of department or instructor
Chem 2520	*Organic Chemistry 2*	4	Chem 1208, 1210, 1250, 1610, or 1910H, and Chem 1220, 1620, or 1920H, and Chem 2510, 2610, or 2910H, and Math Placement Level L or M, or a grade of C- or above in Math 1120, 1130, 1131, 1148, 1150, or above
Chem 2620	*Organic Chemistry for Majors 2*	4	2510 (252), 2610, or 2910H; and Chemistry or Biochemistry major, or permission of Department
Chem 2920H	*Honors Organic Chemistry 2*	4	Honors standing, and 2910H (252H) or 252; or permission of department or instructor
Required Major Core Courses			
Bio 3501.04	*Integrative Skills in Biology: Biotechnology*	3	1113.xx, 1113E, or 1113H; and 1114.xx, 1114E, or 1114H; and Chem 1220, 1620, or 1920H; or permission of instructor
EEOB 4840	*Biodiversity Biotechnology*	3	4 credit hours of EEOB 3310.xx or permission of instructor
Micro 4800	*Advances in Microbial Biotechnology*	3	MICRBIO 4100; or BIOCHEM 4511 or 5613; or PHR 3200
MolGen 4810	*Advances in Genetic Biotechnology*	3	MolGen4500 or MolGen4606 with a grade of C- or higher, or permission of instructor
Micro 4891	*Progress in Biotechnology Seminar*	1	Microbiology 4100; or Biochemistry 4511 or 5613; or Pharmacy 3200
Biochem 4998	*Undergraduate Research in Biochemistry*	1-3	Permission of instructor under whose supervision the work is to be completed. Repeatable to a maximum of 20 cr hrs or 5 completions.
Bio 4191	*Internship in Biology*	1-3	Permission of instructor. Repeatable to a maximum of 8 cr hrs or 8 completions. This course is graded S/U.
Bio 4998	*Research*	1-3	Permission of advisor. Repeatable to a maximum of 30 cr hrs or 8 completions. This course is graded S/U.

EEOB 4998	*Undergraduate Research*	1-3	2 courses in Biological Sciences, and permission of instructor. Repeatable to a maximum of 12 cr hrs or 5 completions. This course is graded S/U.
Micro 4998	*Undergraduate Research in Microbiology*	1-3	Permission of instructor. Repeatable to a maximum of 20 cr hrs or 8 completions. This course is graded S/U.
MolGen 4998	*Undergraduate Research in Molecular Genetics*	1-3	Permission of instructor. Repeatable to a maximum of 20 cr hrs or 8 completions. This course is graded S/U.
Biochem 4998H	*Undergraduate Honors Research in Biochemistry*	1-3	Honors standing, and permission of instructor under whose supervision the work is to be completed. Repeatable to a maximum of 20 cr hrs or 5 completions.
Bio 4998H	*Honors Undergraduate Research*	1-3	Honors standing, and permission of advisor. This course is graded S/U.
EEOB 4998H	*Undergraduate Research - Honors*	1-3	Honors standing, and 2 courses in Biological Sciences, and permission of instructor. Repeatable to a maximum of 12 cr hrs or 5 completions. This course is graded S/U.
Micro 4998H	*Honors Research in Microbiology*	1-3	Honors standing, and permission of instructor. Repeatable to a maximum of 20 cr hrs or 8 completions. This course is graded S/U.
MolGen 4998H	*Undergraduate Research in Molecular Genetics*	1-3	Honors standing, and permission of instructor. Repeatable to a maximum of 20 cr hrs or 8 completions. This course is graded S/U.
Biochem 4999H	*Thesis Research in Biochemistry*	1-3	Permission of instructor under whose supervision the work is to be completed. Repeatable to a maximum of 20 cr hrs or 5 completions.
Bio 4999	*Thesis Research*	1-3	1113 (113) or 1113H (115H), and 1114 (114) or 1114H (116H), and permission of advisor. Repeatable to a maximum of 12 cr hrs or 8 completions. This course is graded S/U.

EEOB 4999	*Undergraduate Thesis Research*	1-3	8 cr hrs in Biological Sciences, and permission of instructor. Repeatable to a maximum of 12 cr hrs or 5 completions. This course is graded S/U.
Micro 4999	*Undergraduate Research in Microbiology-Thesis*	1-3	Permission of instructor. Repeatable to a maximum of 10 cr hrs or 2 completions. This course is graded S/U.
MolGen 4999	*Thesis Research in Molecular Genetics*	1-3	Sr standing, and permission of instructor. Repeatable to a maximum of 10 cr hrs or 2 completions. This course is graded S/U.
Biochem 4999H	*Honors Thesis Research in Biochemistry*	1-3	Honors, and Jr or Sr standing, and permission of instructor under whose supervision the work is to be completed. Repeatable to a maximum of 20 cr hrs or 5 completions.
Bio 4999H	*Honors Thesis Research*	1-3	Honors standing, and 1113 (113) or 1114 (114), and permission of advisor. Repeatable to a maximum of 12 cr hrs or 8 completions. This course is graded S/U.
EEOB 4999H	*Undergraduate Thesis Research - Honors*	1-3	Honors standing, and 8 cr hrs in Biological Sciences, and permission of instructor. Repeatable to a maximum of 12 cr hrs or 5 completions. This course is graded S/U.
Micro 4999H	*Honors Research in Microbiology-Thesis*	1-3	Honors standing, and Jr or Sr standing, and permission of instructor. Repeatable to a maximum of 10 cr hrs or 2 completions. This course is graded S/U.
MolGen 4999H	*Thesis Research in Molecular Genetics*	1-3	Honors standing, and Sr standing, and permission of instructor. Repeatable to a maximum of 10 cr hrs or 2 completions. This course is graded S/U.
Major Foundational Content Courses			
Biochem 4511	*Introduction to Biological Chemistry*	4	Chem 1220, 1250, 1620, or 1920H, and 2510, 2310, 2610, or 2910H and one semester of Biological Sciences

Biochem 5613	*Biochemistry and Molecular Biology I*	3	Chem 2510 (252), 2610, or 2910H. Prereq or concur: Chem 2520 (253), 2620, or 2920H, and one semester in Biological Sciences
EEOB 3310.01	*Evolution*	4	Biology 1114 or 1114H, or permission of instructor.
EEOB 3310.02	*Evolution (Hybrid Online)*	4	Biology 1114 or 1114H, or permission of instructor.
EEOB 3310.20	*Evolution (Hybrid Lecture)*	3	Biology 1114.01 or 1114H; or permission of instructor
Micro 4000x	*Basic and Practical Microbiology*	4	3 credit hours in Biology
Micro 4100	*General Microbiology*	5	Biology 1113, or 1113H, and Chem 1220.
MolGen 4500x	*General Genetics*	3	Biology 1101, 1113, or 1113H, and 3 additional sem cr hrs in Biological Sciences
MolGen 4606	*Molecular Genetics*	4	Biology 1113 (113), 1113H (115H), 1114 (114), 1114H (116H), or Chem 1210 (121) or equiv, or permission of instructor
Business and Communication Content Courses			
AEDECON 3105	*Principles of Agribusiness and Global Food Supply Chains*	3	2001 or Econ 2001
AEDECON 4340	*Project Management for Sustainability and Applied Economics*	3	none
BUSMHR 4244	*Negotiations*	3	English 1110.01 or equiv.
BUSOBA 3130	*Foundations of Operations Management*	3	Math 1116, 1130, 1148, or equiv, and Econ 2001.01, or equiv. Not open to students with credit for 3230.
COMM 3330	*Communication and Conflict Management*	3	none
COMM 3331	*Communication and Decision Making*	3	none
COMM 4635	*Communication Dynamics in Groups*	3	none
English 3305	*Technical Writing*	3	English 1110.xx; or GE foundation writing and info literacy course.
Advanced Laboratory Elective Major Courses			
Biochem 5621	*Biochemistry and Molecular Biology Laboratory*	4	A grade of C- or above in 4511 or 5613, or equiv.
Micro 4140	*Molecular Microbiology Laboratory*	3	Prereq or concur: Micrbio 4130

Micro 4145	*Introduction to Industrial Microbiology and Bioprocessing Laboratory*	3	4100, or 4000.01, 4000.02; or permission of instructor
Micro 4150	*Immunobiology Laboratory*	3	4110, or 5122, or permission of the Instructor.
MolGen 5601	*Eukaryotic Molecular Genetics Lab*	3-4	4500 or 4606, or permission of instructor.
MolGen 5602	*Eukaryotic Cell and Developmental Biology Lab*	3-4	4500 or 4606; or permission of instructor.
PHR 4600	*Pharmaceutical Sciences Laboratory*	3	Chem 2540, and enrollment in the BSPS program or Pharmaceutical Sciences minor; or permission of instructor. Prereq or concur: PHR 3200 or 4100, or Biochem 4511 or 5613.
PHR 4610	*Experimental Techniques in Drug Discovery*	4	3200, or equiv. Biochem course, or permission of instructor.
Major Elective Courses			
Biochem 5614	*Biochemistry and Molecular Biology II*	3	A grade of C- or better in 5613
Biochem 5615	*Biochemistry and Molecular Biology III*	3	A grade of C- or better in 5614
Biochem 5721	*Physical Biochemistry I*	3	Biology 1113; Math 1152 (153), 1172, 1181H, or 2162 (162); and Physics 1201 (113) or 1251 (133). Prereq or concur: Chem 2520 (253), 2620, or 2920H.
Biochem 5722	*Physical Biochemistry II*	3	5721, or Chem 4200 or 4300.
CBE 5730	*Industrial Biopharmaceuticals*	3	2200; or BiomedE 2000; or Biochem 2210; or Biology 3401; or MolGen 2690; or Grad standing in Engineering; or permission of instructor.
Chem 5230	*Neurotransmitter Chemistry*	3	2520, 2620, or 2920H, and 2540; or Grad standing; or permission of instructor.
Chem 5240	*Introduction to Protein Modeling*	3	Recommended prereq: Biochem 4511. Prereq: 2310, 2510, 2610, or 2910H; or Grad standing; or permission of instructor.
Chem 5430	*Carbohydrate Chemistry*	3	2520 (253), 2620, or 2920H (253H), or equiv.
EEOB 2511	*Human Anatomy*	4	3 sem cr hrs in Biological Sciences
EEOB 3310.22	*Evolution Laboratory*	1	Prereq or concur: 3310.20
EEOB 3320	*Organismal Diversity*	3	3310

EEOB 3410	*Ecology*	4	Biology 1114 or 1114H, or permission of instructor.
EEOB 3510	*Cellular and Developmental Biology*	3	3310, and Biology 1113 or 1113H
EEOB 3610	*Evolutionary Genomics*	3	none
EEOB 4520	*Comparative Physiology*	4	Biology 1114 or 1114H, and 1 course in Biological Sciences
EEOB 4560	*Comparative Endocrinology*	2	4520 and Biochem 4511, or equiv, or permission of instructor
EEOB 5360	*Biodiversity Informatics*	3	3410, or 3310.01, or 3310.02; or permission of instructor.
HCS 5325	*Plant Genetics*	3	2202 or MolGen 3300, and Chem 1110 or 1210, and Biology 1101 or 1113 or MolGen 1101; or Grad standing
HCS 5625	*Applied Plant Biotechnology*	2	4325 or 5325
Micro 2100	*Wild Yeast: Isolation to Fermentation*	3	Biology 1110 or 1113, and Chem 1110, 1210, or 1610; or permission of instructor.
Micro 4110	*Microbial Pathogenesis and Immunobiology*	3	4000 (509) or 4100 (520)
Micro 4120	*Microbial Physiology and Diversity*	3	4100. Prereq or concur: Biochem 4511.
Micro 4130	*Microbial Genetics*	3	4100, MolGen 4500, or 4606.
Micro 5161	*Introduction to Computational Genomics*	3	none
MolGen 3436	*Introductory Plant Physiology*	3	Biology 1113, 1113H, 1114, 1114H, and 6 cr hrs in Chem.
MolGen 4700	*Molecular, Cell, and Developmental Biology*	3	4500 or 4606, or permission of instructor.
MolGen 4703	*Human Genetics*	3	A grade of C- or above in 4500 or 4606, or permission of instructor.
MolGen 5300	*Cancer Genetics*	3	A grade of C- or above in 4606 or 4500; or Grad standing.
MolGen 5607/5607E	*Cell Biology / Cell Biology with Embedded Honors*	3/4	4500 or 4606.
MolGen 5623	*Genetics and Genomics*	3	4500, 4606, 5607, or 5608, or Grad standing
MolGen 5650	*Analysis and Interpretation of Biological Data*	3	Math 1149 or 1150 (150) or equiv, and 10 semester cr hrs at the 3000-level (or 300 level in the quarter system) or above in Agricultural or Biological Sciences.
MolGen 5701	*DNA Transactions and Gene Regulation*	3	4500, 4606, Biochem 4511, or equiv., and Sr standing; or Grad

			standing; or permission of instructor. Cross-listed in Biochem.
MolGen 5720	*Genomic Data Analysis*	3	MolGen 4500 or MolGen 4606 or instructors' permission
MolGen 5800	*Organelle Biology*	2	4500, 4500E, or 4606, or permission of instructor
PHR 2500	*Drug Discovery, Development and Delivery*	3	None
PHR 4420	*Biologics: Transforming Medicine*	2	Concur: 3200, or permission of instructor.

Appendix C: Biotech Science Major Curriculum Map

Biotech Science Major BS Program Outcomes

Students earning a Bachelor of Science in *Biotech Science* will be able to …

1. Demonstrate a strong foundational knowledge in the Biological Sciences that underpin biotechnology.
    a. Explain the structure and function of molecules essential to life, i.e. DNA, RNA, and proteins, and how these molecules interact to regulate cellular processes.
    b. Explain how traits are inherited and expressed through genes, including DNA structure, gene function, mutation, and regulation.
    c. Describe how chemical processes and molecules such as enzymes, nucleic acids, carbohydrates, and lipids drive cellular function and metabolism.
    d. Describe the key role that microorganisms play as tools for biotechnology.
    e. Describe the physiology, genetics, evolution, and ecology of organisms that are the subjects of biotechnological manipulation.
2. Develop Technical Proficiency in Biotechnology Techniques.
    a. Explain the fundamental concepts and techniques of biotechnology relevant to a chosen subdiscipline of the life sciences.
    b. Apply laboratory skills and techniques commonly used in biotechnology research and industrial settings, such as DNA/RNA manipulation, protein assays, and use of bioinformatics tools.
    c. Demonstrate an understanding of biosafety by employing safe laboratory practices.
    d. Demonstrate literacy in data preparation, organization, archiving and use of tools to process data.
3. Foster Research Competence and Scientific Inquiry.
    a. Retrieve information from the life sciences literature; read, understand, and critically review scientific papers.
    b. Apply the scientific process, including designing and conducting experiments and testing hypotheses.
    c. Draw valid conclusions based on quantitative and qualitative results.
    d. Adapt tools such as laboratory notebooks and spreadsheets to organize and analyze data associated with scientific processes.
    e. Communicate scientific information clearly and effectively in written reports, oral presentations, and through visual media to both scientific and non-scientific audiences.
4. Exhibit professional and ethical behavior, including understanding of biosafety, ethical dilemmas in genetic engineering and biotechnology, and the implications and impacts of biotechnology on natural ecosystems and populations.
5. Work effectively in diverse teams, demonstrating leadership, collaboration, and problem-solving in both laboratory and non-laboratory project environments.

6. Demonstrate preparedness for employment or further education, including ability to articulate their skills and knowledge in professional settings such as internships, job interviews, or graduate school applications.

B = beginning, I = intermediate, A = advanced

Category	Course Options (Choose 1 per Category)	Credit Hours	Biotech Science BS Learning Outcomes																
Required Prerequisite Supporting Courses			1a	1b	1c	1d	1e	2a	2b	2c	2d	3a	3b	3c	3d	3e	4	5	6
Biology 1	Biology 1111 & 1112	7	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	
	Biology 1113x	4-5																	
Biology 2	Biology 1114x	4-5			B		B			B	B	B	B	B	B	B	B	B	
Math	Math 1140 and 1141	8	B		B		B				B								
	Math 1151	5																	
	Math 1156	5																	
Statistics	Stat 1450x	3									B	B		B	B				
	Stat 2450	3																	
	Stat 2480	3																	
Gen Chem 1	Chem 1206 & 1208	7	B	B	B			B	B	B	B	B	B	B	B	B	B		
	Chem 1210	5																	
	Chem 1610	5																	
	Chem 1910H	5																	
Gen Chem 2	Chem 1220	5	B	B	B			B	B	B	B	B	B	B	B	B	B		
	Chem 1620	5																	
	Chem 1920H	5																	
Organic Chem 1	Chem 2310	4	I		I			I	I	I	I						I		
	Chem 2510	4	I		I			I	I	I	I						I		
	Chem 2610	4																	
	Chem 2910H	4																	
Organic Chem 2	Chem 2520	4	I		I			I	I	I	I						I		
	Chem 2620	4																	
	Chem 2920H	4																	
Required Major Core Courses (10 credit hours) *Choose one course from each area			1a	1b	1c	1d	1e	2a	2b	2c	2d	3a	3b	3c	3d	3e	4	5	6
Embedded Literacies / Foundation	Bio 3501.04	3	I	I	I	I	I	I	I		I	I		I		I	I	I	B
Advanced Biotechnology	EEOB 4840	3	A	A	I	I	A	A	I		A	A	A	A	A	A	A	A	A
	Micro 4800	3	A	A	A	A	A	A				A		A		A	B	I	
	MolGen 4810	3						A				A		A		A		A	
Seminar	Micro 4891	1	A	A	A	A	A	A				A		A		A			I
Required Major Content Courses (9-13 credit hours) *Must choose a class from three areas			1a	1b	1c	1d	1e	2a	2b	2c	2d	3a	3b	3c	3d	3e	4	5	6
Biochemistry	Biochem 4511	4	A	I	A	B	B	I					B				B		
	Biochem 5613	3																	
Evolution	EEOB 3310x	3-4		I	I		I	I	I		I	I	I	I		I	I		B

Microbiology	Micro 4000x	4	B	B	B	B	B	B	I	A	B	B		B	B	B		B	
	Micro 4100	5	I	I	I	I	I	B	I	A	I		I	I	I	I		I	
Molecular Genetics	MolGen 4500x	3	A	A		I		I					I	I					
	MolGen 4606	4	A	A		I	I	I					I	I					
Major Electives (6-10 credit hours total)			1a	1b	1c	1d	1e	2a	2b	2c	2d	3a	3b	3c	3d	3e	4	5	6
Advanced Laboratory Electives (Choose 2 minimum)	Biochem 5621	4	I	I	I	I	I	A	I	A	A	I	I	A	A	I	A	A	
	Micro 4140	3	A	A		A	A	A	A	A	A		A	A	A	A	A	A	
	Micro 4145	3	I	I	I	A	A	A	A	A	A		A	A	A	A	A	A	B
	Micro 4150	3	I						A	A	A		A	A	A	A	A	A	
	MolGen 5601	3-4	A	A	A	I	A	A	A	A	A	I	A	A	A	A		A	
	MolGen 5602	3-4	A	A	A	I	A	A	A	A	A	I	A	A	A	A		A	
	PHR 4600	3	A		A			A	A	A	A	I	A	A	A	A	A		
	PHR 4610	4	A		A			A	A	A	A	I	A	A	A	A	A		
Business and Communication Content (Choose 1)	AEDECON 3101	3																I	I
	AEDECON 4340	3																I	I
	BUSMHR 4244	3																I	I
	BUSOBA 3130	3																I	I
	COMM 3330	3																I	I
	COMM 3331	3																I	I
	COMM 4635	3																I	I
	English 3305	3														A			I
Major Electives	Biochem 5614	3	A	I	A	B	B	I					B				B		
	Biochem 5615	3	A	I	A	B	B	I					B				B		
	Biochem 5721	3	A	I	A			A				I	I	A					
	Biochem 5722	3	A		I			A			B		I	I				I	I
	CBE 5730	3	A	A	A	A		A			I	I		I		A	A	A	I
	Chem 5230	3	I		A	I		I				A		I	I	A		A	
	Chem 5240	3	A					A	A	I	I		I	I	I	I			
	Chem 5430	3	I		I	I						A				I			
	EEOB 2511	4	B	B	B	B	I	B			B	B	B				B	I	
	EEOB 3310.22	1		I	I		I	I	I		I	I	I	I		I	I		B
	EEOB 3320	3		I	I	B		I				I	I	I			B	B	
	EEOB 3410	4		B	B	I	I	I	I		I	I	I	I	I	I	I	I	I
	EEOB 3510	3	I	I	I	I	I	I	A			I	I	I		I	I	I	I
	EEOB 3610		I	A	A	B	A	A	A		A	I	I	A	I	I	A	I	I
	EEOB 4520	4	I	I	A	I	A	I	I			I	I	I		I	I	I	I
	EEOB 4560	2	A	A	A	I	A	A	I			I	A	A	I	I	I	I	I
	EEOB 5360	3			I	I	I	A	A		A	I	A	A	A	I	I	I	I
	HCS 5325	3	I	I			I					I				I			
	HCS 5625	2	A	A	A		A	A				A				A	A		
	Micro 2100	3	B		B	B	B		B	A	B		B	B	B	B		B	
	Micro 4110	3	A		A														
	Micro 4120	3	A		A	I	A												
	Micro 4130	3	A	A	A	I	A	A				I		A				I	
	Micro 5161	3	A	A			A		A		A			A		A			
	MolGen 3436	3	I		I		I												
	MolGen 4700	3	A		A			A											

	MolGen 4703	3	A	A			A	A			A	A		A					
	MolGen 5300	3	A	A	A		A	A	A		A	A				A			
	MolGen 5607/5607E	3/4	A		A			A											
	MolGen 5623	2	A	A	A			A			A	A		A		A			
	MolGen 5650	3									A	A	A	A	A	A			
	MolGen 5701	3	A	A	A														
	MolGen 5720	3	A	A				A	A		A	A	A	A	A	A			
	MolGen 5800	3	A	A	A		A					A		A		A			
	PHR 2500	3		B	B	B		I			B	B				B	I	I	B
	PHR 4420	2	I	I	I	I	I	A			I	I				I	A	I	I

Appendix D: Sample Four-Year Plan

BIOTECH SCIENCE BS – 4 Year Sample Plan					
SEMESTER	**COURSE**	**CREDIT HOURS**	**CH Sem Total**	**CH per Year**	**Credit Hour Summary**
Autumn I	ASC 1100	1	15	32	**Gen Ed Hours = 39***
	Foreign Lang 1	4			
	Math 1151 (GE: MQR)	5			
	Chem 1210 (GE: Nat Sci)	5			**ASC Hours = 13**
Spring I	Foreign Lang 2	4	17		
	GenEd 1201	1			
	GE Found: SBS	3			**Supporting Course Hours = 34***
	Bio 1113.01	4			
	Chem 1220	5			
Autumn II	Foreign Lang 3	4	15	29	
	GE Found: WIL	3			**Major Core Course Hours = 25**
	Bio 1114.01	4			
	Chem 2510	4			
Spring II	GE Found: HCS	3	14		
	GE Found: LVPA	3			**Major Elective Course Hours = 12**
	Chem 2520	4			
	Bio 3501.04	3			
	Bio 4998	1			
Autumn III	CJDW Theme	3	16	32	**Open Elective Hours = 8**
	Stat 2480	3			
	Biochem 4511	4			
	Micro 4100	5			**TOTAL HOURS = 121**
	Bio 4998	1			
Spring III	CJDW Theme	3	16		
	Choice Theme	3			
	GE Found: REGD	3			***10 CH overlap between Supporting Courses and GE**
	MolGen 4500	3			
	Bio 4998	1			**Plan assumes Math Placement 'L'
	Micro 4145	3			
Autumn IV	Choice Theme	3	14	28	
	Micro 4800	3			
	MolGen 5601	3			
	English 3305	3			
	Open Elective	2			
Spring IV	GenEd 4001	1	14		
	Micro 4981	1			
	MolGen 5602	3			
	Open Major Elective	3			
	Open Elective	3			
	Open Elective	3			

Appendix E: Concurrences

College of Engineering

Wednesday, November 5, 2025 at 1:05:35 PM Eastern Standard Time

Subject: Re: Biotech Science Major and Minor Concurrence Request
Date: Friday, October 10, 2025 at 1:01:49 PM Eastern Daylight Time
From: Matyas, Cory
To: Tomasko, David, Andrews, Adam, Quinzon-Bonello, Rosario
CC: Sabel, Jaime, Vankeerbergen, Bernadette
Attachments: image001.png, image002.png, BME Cocur.pdf, CBE Concur.png

Hi Adam,
Engineering has reviewed the materials and obtained concurrence from both the Department of Biomedical Engineering and the Department of Chemical and Biomolecular Engineering. Neither department raised any concerns with the proposals, and both are supportive of the initiative. Emails confirming from each department are attached.

Please let me know if you need anything further from the College of Engineering.

Cory

THE OHIO STATE UNIVERSITY

Corinne Matyas, M.Ed.
Assistant Dean of Curriculum and Assessment
College of Engineering
Hitchcock Hall | 2070 Neil Ave. | Columbus, OH 43210
614-292-2154 | matyas.3@osu.edu

From: Tomasko, David <tomasko.1@osu.edu>
Date: Friday, October 3, 2025 at 11:28 AM
To: Andrews, Adam <andrews.171@osu.edu>, Matyas, Cory <matyas.3@osu.edu>, Quinzon-Bonello, Rosario <quinzon-bonello.1@osu.edu>
Cc: Sabel, Jaime <sabel.12@osu.edu>, Vankeerbergen, Bernadette <vankeerbergen.1@osu.edu>
Subject: Re: Biotech Science Major and Minor Concurrence Request

Hi Adam,
We'll share this with a couple of relevant departments get some feedback.

Cory/Rosie,
I suggest CBE and BME.

David

Friday, October 10, 2025 at 12:55:30 PM Eastern Daylight Time

Subject: RE: Biotech Science Major and Minor Concurrence Request
Date: Friday, October 10, 2025 at 12:33:03 PM Eastern Daylight Time
From: Childers, Rachel
To: Matyas, Cory, Ghadiali, Samir
Attachments: image003.png, image004.png, image005.png

Hi Cory,

I don't see any issues with concurrence for these proposals. The upper level course choices are pretty different from BME and seem to align more heavily on the microbio side of things.

Rachel Childers, Ph.D.

Professional Practice Associate Professor & Director of Undergraduate Education

Department of Biomedical Engineering

Fontana Labs 4100B, 140 W 19th Ave., Columbus, Ohio 43210

Childers.73@osu.edu | 614.247.6681

(She/Her) | Student Hours Link

THE OHIO STATE UNIVERSITY

From: Matyas, Cory <matyas.3@osu.edu>
Sent: Friday, October 3, 2025 1:55 PM
To: Childers, Rachel <childers.73@osu.edu>; Ghadiali, Samir <ghadiali.1@osu.edu>
Subject: FW: Biotech Science Major and Minor Concurrence Request

Hi Rachel & Samir,
The Center for Life Sciences Education has proposed new Major and Minor programs in Biotech Science and is requesting concurrence from the College of Engineering. Given the potential for content overlap, David suggested BME should review the proposals.

If you can, please review the attached documents and share your feedback with me by October 12, so the College has time to prepare our formal response.

Happy Friday!
Cory

THE OHIO STATE UNIVERSITY

Corinne Matyas, M.Ed.
Assistant Dean of Curriculum and Assessment
College of Engineering

Department of Chemical and Biomolecular Engineering

FW: Biotech Science Major and Minor Concurrence Request

Endres, Brian <endres.10@osu.edu>

Today at 1:30 PM

To: Matyas, Cory

Well, this was quick! CBE grants concurrence for the major and minor.

Thanks!
Brian

THE OHIO STATE UNIVERSITY

Brian Endres, M.Ed
Manager, Academic Advising
William G. Lowrie Department of Chemical and Biomolecular Engineering
616 Koffolt Laboratories (CBEC), 151 W. Woodruff Ave., Columbus, OH 43210
endres.10@osu.edu; cbe.osu.edu
SCHEDULE ADVISING APPT
My ZOOM meeting room

Friday, October 24, 2025 at 7:16:55 AM Eastern Daylight Time

Subject: RE: Biotech Science Major and Minor Concurrence Request
Date: Thursday, October 23, 2025 at 9:21:12 AM Eastern Daylight Time
From: Osborne, Jeanne
To: Andrews, Adam
CC: Sabel, Jaime, Vankeerbergen, Bernadette
Attachments: image001.png, image002.png

Dear Adam,

Thank you for the time to gather feedback from the units within the College of Food, Agricultural, and Environmental Sciences. We are pleased to provide concurrence for the proposed new Major and Minor programs in Biotech Science. There was some feedback from a few units for your consideration:

- Plant Pathology – there are potential mycology courses that might be considered for electives in these programs. I would be happy to organize a discussion.
- Food, Agricultural and Biological Engineering – consider FABENG 3500, Biological Engineering as a possible elective in the major; the extensive minor prerequisites might be limiting in terms of students that could pursue this minor. It is assumed that 'MATH 1150 or higher' would include calculus, and perhaps consider that additional MATH taken by engineers (e.g., MATH 1172) could be counted toward the 23 credits or prerequisites?
- Horticulture and Crop Science – consider HCS 5625, Applied Plant Biotechnology be considered as an option for the minor electives (in addition to the current inclusion in the major electives).

We look forward to these offerings and anticipate that the Biotech Science minor might be of interest to students in our programs.

Please let me know if you need additional information or clarification.

Take care,

Jeanne

THE OHIO STATE UNIVERSITY

Jeanne M. Osborne
Assistant Dean for Academic Affairs
College of Food, Agricultural, and Environmental Sciences
100E Agricultural Administration, 2120 Fyffe Rd.
Columbus, OH 43210
Tel: 614-292-1734
Fax: 614-292-1218
e-mail: Osborne.2@osu.edu

Department of Chemistry and Biochemistry

Friday, October 3, 2025 at 10:34:56 AM Eastern Daylight Time

Subject: Re: Biotech Science Major and Minor Concurrence Request
Date: Friday, October 3, 2025 at 10:34:15 AM Eastern Daylight Time
From: Turro, Claudia
To: Andrews, Adam
CC: Jackman, Jane, Sabel, Jaime
Attachments: image001.png

Hi Adam,

You have the concurrences and support from Chemistry and Biochemistry.

Claudia

Claudia Turro
Dr. Melvin L. Morris Professor and Department Chair

From: "Andrews, Adam" <andrews.171@osu.edu>
Date: Friday, October 3, 2025 at 10:20 AM
To: "Turro, Claudia" <turro.1@osu.edu>
Cc: "Jackman, Jane" <jackman.14@osu.edu>, "Sabel, Jaime" <sabel.12@osu.edu>
Subject: Biotech Science Major and Minor Concurrence Request

Claudia,

Yesterday the CLSE Curriculum Committee approved final versions of the *Biotech Science Major* and *Biotech Science Minor* proposals to move forward. I write to ask formally for CBC's concurrence and support for both proposals.

I am requesting your response within the standard two-week timeframe, by October 17. If you have any questions or concerns, or if this presents a problem, please let me know.

Thank you,
Adam

THE OHIO STATE UNIVERSITY
CENTER FOR LIFE SCIENCES EDUCATION

Adam L. Andrews
Assistant Director for Curriculum & Instruction

College of Arts and Sciences | Center for Life Sciences Education

240D Jennings Hall, 1735 Neil Avenue, Columbus, OH 43210
(614) 247-6345 Office / (614) 292-4390 Fax
andrews.171@osu.edu clse.osu.edu

Friday, October 31, 2025 at 3:28:02 PM Eastern Daylight Time

Subject: Fw: biotech sci
Date: Friday, October 31, 2025 at 2:25:28 PM Eastern Daylight Time
From: Sabel, Jaime
To: Andrews, Adam
Attachments: Outlook-2wiqb3ia.png, Outlook-e0hzlvhd.png

THE OHIO STATE UNIVERSITY
CENTER FOR LIFE SCIENCES EDUCATION

Jaime L. Sabel, Ph.D
Director, Center for Life Sciences Education
Associate Professor, Department of Molecular Genetics

Pronouns: she/her / Honorific: Dr.

The Ohio State University
Center for Life Sciences Education
260P Jennings Hall, 1735 Neil Avenue, Columbus, OH 43210
sabel.12@osu.edu / clse.osu.edu / osu.edu

Phone: (614) 688-0262

From: Kubatko, Laura <lkubatko@stat.osu.edu>
Sent: Friday, October 31, 2025 2:03 PM
To: Sabel, Jaime <sabel.12@osu.edu>
Cc: Kubatko, Laura <lkubatko@stat.osu.edu>
Subject: Re: biotech sci

Hi Jaime,

On behalf of EEOB, I am happy to give concurrence for the Biotech Science major.

Thanks,
Laura

Get Outlook for iOS

Thursday, November 6, 2025 at 8:30:36 AM Eastern Standard Time

Subject: Re: Biotech Sci
Date: Wednesday, November 5, 2025 at 3:09:41 PM Eastern Standard Time
From: Sabel, Jaime
To: Fredrick, Kurt
CC: Andrews, Adam
Attachments: Outlook-xvlutbzc.png, Outlook-xwt03hdj.png

Hi Kurt,
The individual courses will be sent to you separately for concurrence, so yes, we are just asking about the overall framework for the major.

Jaime

THE OHIO STATE UNIVERSITY
CENTER FOR LIFE SCIENCES EDUCATION

Jaime L. Sabel, Ph.D
Director, Center for Life Sciences Education
Associate Professor, Department of Molecular Genetics

Pronouns: she/her / Honorific: Dr.

The Ohio State University
Center for Life Sciences Education
260P Jennings Hall, 1735 Neil Avenue, Columbus, OH 43210
sabel.12@osu.edu / clse.osu.edu / osu.edu

Phone: (614) 688-0262

From: Fredrick, Kurt <fredrick.5@osu.edu>
Sent: Wednesday, November 5, 2025 3:04 PM
To: Sabel, Jaime <sabel.12@osu.edu>
Cc: Andrews, Adam <andrews.171@osu.edu>
Subject: Re: Biotech Sci

Hi Jaime,
I guess I do not understand the question. I know there was a meeting about content overlap between M4800 and the MG course but have not seen a revised syllabus for the MG course. Also, there are other upper-level courses (EEOB, CBC) in the works, but I haven't seen either syllabus. These are all proposed courses at this point, though, and the major doesn't depend on all these offerings. I am okay with the framework in general, as long as the

upper-level courses have non-overlapping science content.
Best,
Kurt

From: Sabel, Jaime <sabel.12@osu.edu>
Date: Wednesday, November 5, 2025 at 1:27 PM
To: Fredrick, Kurt <fredrick.5@osu.edu>
Cc: Andrews, Adam <andrews.171@osu.edu>
Subject: Biotech Sci

Hi Kurt,
I'm checking in to see if you would be able to confirm concurrence on the Biotech Science major. We have everything else in place to submit.

Thanks,
Jaime

THE OHIO STATE UNIVERSITY
CENTER FOR LIFE SCIENCES EDUCATION

Jaime L. Sabel, Ph.D
Director, Center for Life Sciences Education
Associate Professor, Department of Molecular Genetics

Pronouns: she/her / Honorific: Dr.

The Ohio State University
Center for Life Sciences Education
260P Jennings Hall, 1735 Neil Avenue, Columbus, OH 43210
sabel.12@osu.edu / clse.osu.edu / osu.edu
Phone: (614) 688-0262

Department of Molecular Genetics

Tuesday, November 4, 2025 at 11:42:39 AM Eastern Standard Time

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Subject: Re: Biotech Science Major and Minor Concurrence Request
Date: Tuesday, November 4, 2025 at 11:33:07 AM Eastern Standard Time
From: Dobritsa, Anna
To: Andrews, Adam, Cole, Susan
CC: Sabel, Jaime
Attachments: image001.png

Hi Adam,

Molecular Genetics is happy to provide concurrence to the proposals for Biotech Science Major and Minor. Good luck!

Best,
Anna

****

Anna Dobritsa
Associate Professor, Department of Molecular Genetics
and Center for Applied Plant Sciences
The Ohio State University
Aronoff Laboratory, Rm. 570
318 W. 12th Ave, Columbus, OH 43210
(614) 688-2197

From: Andrews, Adam <andrews.171@osu.edu>
Sent: Friday, October 3, 2025 10:22 AM
To: Cole, Susan <cole.354@osu.edu>
Cc: Sabel, Jaime <sabel.12@osu.edu>; Dobritsa, Anna <dobritsa.1@osu.edu>
Subject: Biotech Science Major and Minor Concurrence Request

Susan,

Yesterday the CLSE Curriculum Committee approved final versions of the *Biotech Science Major* and *Biotech Science Minor* proposals to move forward. I write to ask formally for Molecular Genetics' concurrence and support for both proposals.

I am requesting your response within the standard two-week timeframe, by October 17. If you have any questions or concerns, or if this presents a problem, please let me know.

Thank you,
Adam