LOYOLA UNIVERSITY MARYLAND

— 1852 —

Provost and Vice President for Academic Affairs

February 14, 2019

James D. Fielder, Jr., Ph.D.
Secretary of Higher Education
Maryland Higher Education Commission
6 Liberty Street
Baltimore, MD 21201

RE: Biochemistry B.S. CIP 26.0202 & HEGIS 041401

Dear Secretary Fielder:

Loyola University Maryland is proposing a new Bachelor of Science degree in Biochemistry. A biochemistry curriculum has been in existence for over 20 years as a part of the institution's interdisciplinary program. The institution's proposal for a stand-alone program will simply allow students to better understand their academic options and permit the awarding of their degree to be noted accordingly.

The current biochemistry curriculum has served students well in preparation for graduate education, particularly providing students with a rigorous pre-health foundation for graduate programs and medical schools. The program falls within the institution's mission as a Jesuit university committed to liberal education and development of the whole person. Additionally, the program prepares students for meaningful vocations and service to the community. Furthermore, as the curriculum is not new, it does not pose an unreasonable program duplication, nor will it require new resources.

Payment in the amount of $850.00 has been included for the proposal review fee arriving via U.S. mail. A copy of the payment is included in this electronic correspondence. Please contact David Mack at dsmack@loyola.edu or 410-617-2317 with any questions.

Sincerely,

Amanda M. Thomas

Amanda M. Thomas, PhD.
Provost and Vice President for Academic Affairs

CC: Stephen E. Fowl, Ph.D., Dean, Loyola College
Bahram Roughani, Ph. D., Associate Dean for Natural and Applied Sciences
Jennifer Frank, Vice President of Academic Affairs, MICUA

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Cover Sheet for In-State Institutions
New Program or Substantial Modification to Existing Program

Institution Submitting Proposal	Loyola University Maryland

Each action below requires a separate proposal and cover sheet.

- (●) New Academic Program
- ( ) New Area of Concentration
- ( ) New Degree Level Approval
- ( ) New Stand-Alone Certificate
- ( ) Off Campus Program
- ( ) Substantial Change to a Degree Program
- ( ) Substantial Change to an Area of Concentration
- ( ) Substantial Change to a Certificate Program
- ( ) Cooperative Degree Program
- ( ) Offer Program at Regional Higher Education Center

Payment Submitted: (●) Yes ( ) No
Payment Type: ( ) R*STARS (●) Check
Payment Amount: 850.00
Date Submitted: 2/28/19

Department Proposing Program	Chemistry	
Degree Level and Degree Type	Bachelor's of Science	
Title of Proposed Program	Biochemistry	
Total Number of Credits	137	
Suggested Codes	HEGIS: 41401.00	CIP: 26.0202
Program Modality	(●) On-campus ( ) Distance Education (*fully online*) ( ) Both	
Program Resources	(●) Using Existing Resources ( ) Requiring New Resources	
Projected Implementation Date	(●) Fall ( ) Spring ( ) Summer Year:	
Provide Link to Most Recent Academic Catalog	URL: https://catalogue.loyola.edu/content.php?catoid=14&navoid=515	
Preferred Contact for this Proposal	Name: David Mack	
	Title: Academic Assessment and Compliance Specialist	
	Phone: (410) 617-2317	
	Email: dsmack@loyola.edu	
President/Chief Executive	Type Name: Rev. Brian F. Linnane, S.J.	
	Signature: Brian F. Linnane, SJ Date: 2/25/19	
	Date of Approval/Endorsement by Governing Board: 2/14/19	

Revised 12/2018

Loyola University Maryland
New Program Proposal for B.S. in Biochemistry

Loyola University Maryland wishes to formalize a popular version of its Interdisciplinary Studies major (CIP 30.9999) by proposing a major in Biochemistry leading to a B.S. degree. Students have been sequencing an interdisciplinary path of Chemistry/Biology courses through the Interdisciplinary Studies major for 20 years. There are several salient reasons for the establishment of the major.

- To formalize the curriculum adopted by many of our students and thereby enable more efficient advising of students and assessment of student learning.

- To better represent the strengths and interests of most of the Chemistry department's majors.

- To position our students for future careers which will rely more on interdisciplinary training.

- The formalizing of the major will better inform prospective students, as there is some confusion as to whether our current Interdisciplinary Studies major allows for a Biochemistry program of study.

A. Centrality to Institutional Mission and Planning Priorities:

1. *Provide a description of the program, including each area of concentration (if applicable), and how it relates to the institution's approved mission.*

As a liberal arts college with a strong STEM presence, Loyola University Maryland has a tradition of cultivating scientists who are curious and creative thinkers, ethical and compassionate stewards, and expressive and collaborative leaders. Our graduates are trained to connect and deepen their skills across a breadth of courses, highlighting the interdisciplinary nature of science. As a result, many science departments offer interdisciplinary (ID) programs, such as the Chemistry/Biology ID major. Since its inception, the Chemistry/Biology ID major has allowed students to explore the structure and function of molecules (chemistry) within biological contexts and has met their needs for a rigorous pre-health foundation. But there has been a momentous shift and motivation in the pre-health track for competitive institutions to have a distinct Biochemistry major. Medical schools recommend/require a semester of undergraduate biochemistry, and since 2015, nearly one in every four questions in the updated Medical College Assessment Test (MCAT) is related to biochemistry. Creating a formal Biochemistry major will enhance the name recognition of our well-established interdisciplinary program, will reflect the Jesuit tradition of preparing students for meaningful vocations and service to the community and will fulfill and direct interests of incoming

students for recruitment and retention. We hope to use the talents of the Chemistry Department to address the trends in the field and needs of our students and serve as a bridge for our students to the future.

2. *Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is an institutional priority.*

A Loyola University Maryland education prepares students not just for the world of today, but the world of tomorrow. Embracing the Jesuit concept of the constant challenge to improve, Loyola University Maryland continues to strive to elevate the exceptional education and experience we offer our students. One of the four cornerstones of our current strategic plan (https://www.loyola.edu/about/strategic-plan) is Ignatian Educational Innovation: Jesuit education must be adaptable to students' individual needs and to the time in which it is delivered—with an eye toward preparation for the future. The needs of today's students and local, national, and global job forecasts show that Loyola must require undergraduates to plan carefully in order to link liberal arts education with their career goals.

Looking at trends in job markets, the majority of the 'future-proof' fields are in biomedical and medical related areas which are typically accessed through college degrees at the interface of chemistry and biology. Offering a biochemistry program would enable Loyola to provide our students better access to these fields.

Furthermore, the state of Maryland is home to one of the largest life science industry and research clusters in the nation, with more than 500 biotech firms, more than 2000 life sciences companies, the NIH, and the FDA. The state has made a commitment to become the leading location for biosciences, and a degree in biochemistry will prepare our students for the future.

3. *Provide a brief narrative of how the proposed program will be adequately funded for at least the first five years of program implementation. (Additional related information is required in section L.*

The Biochemistry major will simply be replacing the current Chemistry/Biology ID major and all courses making up the program are already part of our well-established chemistry and biology programs. There should be no change in faculty workload, type and number of classes offered, laboratory equipment or research funding. Therefore, we do not anticipate any additional program expenses.

4. *Provide a description of the institution's commitment to:*
   a) *ongoing administrative, financial, and technical support of the proposed program*

The Biochemistry major will simply be replacing the current Chemistry/Biology ID major, so there should be no change in administrative, financial or technical support. The program has been taught for over 20 years. This program already has administrative, financial and technical support. It will require no additional resources because at this time we are not creating new courses, and we do not need to hire new faculty. Students will be satisfying the requirements of this program by completing courses that are already offered.

b) *continuation of the program for a period of time sufficient to allow enrolled students to complete the program.*

If, by chance, we decided to discontinue the program we would allow sufficient time for enrolled students to complete the program with no issues. In this instance it would be easy to satisfy the requirement since there are no courses specific only to the proposed program, all courses required are courses that are also part of the Chemistry or Biology major. Therefore, the courses necessary to complete the biochemistry program would continue to be offered through both the Biology and Chemistry Departments, causing no problems.

B. Critical and Compelling Regional or Statewide Need as Identified in the State Plan:

1. *Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State in general based on one or more of the following:*

a) The need for the advancement and evolution of knowledge

Biochemistry is an interdisciplinary field combining foundational courses in biology and chemistry with concepts in physics and mathematics. Traditionally, the field steering biochemistry highlights the biology of organic molecules under the lens of applied chemistry and molecular biology. The proposed program at Loyola builds on current strengths within the Biology and Chemistry Departments and allows students to gain a broad foundation in concepts and techniques essential for success at the interface between these two disciplines. Students begin by developing their skills in fundamental prerequisite courses that combine what is expected for the standalone Chemistry or Biology majors. With this foundation, students are then challenged to build their biochemistry specialization in intensive lecture and lab courses. Many of these courses require students to design new research questions, troubleshoot experiments, present data and take ownership of independent projects. The opportunity to engage in research is embedded into the lab curriculum, allowing each student in the program to develop technical hands-on and data analyses skills. Students completing the biochemistry program will be prepared for a variety of career opportunities, including biomedical research, a range of health professions, and post-graduate education.

b) Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education

Fostering diversity, equity, and inclusion is one of the seven pillars of Loyola's most recent strategic plan and has been identified as one of the main goals of the academic affairs office for the next several years. This initiative has begun to percolate to all levels of the academic structure at Loyola and has been facilitated by the establishment of a faculty fellows' program which has as its main goal the adoption of high impact teaching practices to enhance the learning outcomes of all students, and especially students of color. Our program in Biochemistry will reflect these institution-wide goals and hopefully expand educational opportunities for students of color. Specifically, undergraduate research has been identified by the AAC&U as a high impact practice, and this is one of the features of our departmental curriculum of which we are most proud.

2. *Provide evidence that the perceived need is consistent with the **Maryland State Plan for Postsecondary Education**.*

Although this proposal is essentially just an official naming of the existing ID major in Chemistry/Biology, several aspects of the program dovetail nicely with the Maryland State Plan. In terms of *Access,* Loyola University Maryland in general, and the Chemistry department specifically, is dedicated to inclusive excellence and access to a quality education for all students. We have in place an office of faculty affairs and diversity, led by an associate vice president, and we have in place several faculty development opportunities which are meant to foster high impact practices and inclusive teaching techniques in our courses. In terms of *Success,* the movement of the existing Chemistry/Biology ID major into a single department will enable more focused advising of the Biochemistry majors. Faculty will be able to check in with students on a more regular basis to ensure success and on-time graduation. Finally, in terms of *Innovation,* our department has been and will continue to be largely engaged in undergraduate research, a documented high impact teaching practice, which truly teaches students that risk-taking is a valuable exercise. Experimental biochemistry is by nature a risk-taking enterprise and one that is rewarding in terms of student development, no matter the eventual outcome.

C. Quantifiable and Reliable Evidence and Documentation of Market Supply and Demand in the Region and State:

1. *Describe potential industry or industries, employment opportunities, and expected level of entry (ex: mid-level management) for graduates of the proposed program.*

Graduates with a Biochemistry degree from Loyola will be ready for immediate entry-level employment at the B.S. level in industry and with government agencies and will be prepared to pursue postgraduate education (Masters, PhD, Medical School, Dental School, etc) that will lead to

higher-level employment.

While we do not have official data from the students that have completed the previous Biology/Chemistry ID major, we estimate that approximately 40% of the students who have completed the ID major over the last ten years continue on to medical or dental school, 25% pursue other graduate professional schools (PT, Pharmacy, Nursing, etc.), 20% attend graduate school in biochemistry or related fields (Masters and PhD programs), 15% seek employment in biochemistry/biotechnology in industry or government agency.

2. *Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program.*

The U.S. Bureau of Labor Statistics website https://www.bls.gov/ooh/home.htm routinely estimates employment projections for a wide variety of careers. According to the BLS the average growth rate of all occupations in the years 2016-2026 is projected to be 7%. As presented in the table below, the growth rate for biochemists/biophysicists (11.5%) is well above the national average; as are the growth rates shown for many other occupations that graduates of the Loyola Biochemistry program might pursue.

Occupation	**Number of jobs 2016**	**Est. 10-year growth**	**Typical entry-level education**	**2017 Median annual wage**
Biochemists and Biophysicists	31,500	11.5%	Doctoral or professional degree	$91,190
Biological Technicians	82,100	10.2%	Bachelor's degree	$43,800
Biological Science Teachers	62,300	15.2%	Bachelor's degree	$78,240
Medical & Clinical Technologists	171,400	11.5%	Bachelor's degree	$51,770
Medical Scientists	120,000	13.4%	Doctoral or professional degree	$82,090

Occupation	Number of jobs 2016	Est. 10-year growth	Typical entry-level education	2017 Median annual wage
Pharmacists	312,500	6.0%	Doctoral or professional degree	$124,170
Physicians & Surgeons	713,800	13.0%	Doctoral or professional degree	$208,000

In addition to data in the table provided above, the Bureau of Labor Statistics projects two of the top twenty occupations with the highest percent change of employment between 2016-2026 are physician assistants (37%) and nurse practitioners (36%): https://www.bls.gov/ooh/fastest-growing.htm. Entry into both occupations is well-suited to the graduates of this Biochemistry program.

3. *Discuss and provide evidence of market surveys that clearly provide quantifiable and reliable data on the educational and training needs and the anticipated number of vacancies expected over the next 5 years.*

As has been discussed above, students majoring in Biochemistry will be well-positioned for entry into a variety of scientific and health-related careers that have been projected by the Bureau of Labor Statistics to have above-average demand levels in the years 2016-2026. In part this is because Biochemistry degrees, like this one, include more numerical/quantitative coursework (such as Physical Chemistry and Calculus-based Physics) than other degrees in the biological sciences. This provides a means for Biochemistry graduates to distinguish themselves in a competitive job market.

Training in biochemistry through the current Loyola Biology/Chemistry ID major has proven to be an excellent preparation for entry into health-related careers requiring postgraduate education. In recent years the Loyola Pre-Health Program has undergone rapid growth and become increasingly diverse in terms of student career goals. Over the last four years (through November 2018) the Loyola Pre-Health Program has nearly doubled, growing from 320 to 600 students across all four class years. Over this same period Loyola Biology/Chemistry ID graduates have stood out amongst those applying to medical school: they have been 22% of Loyola's M.D. applicants but comprise 30% of those accepted. Currently the number of Loyola Pre-Health students seeking careers in medical sciences other than as physicians or dentists is increasing. The ability of Loyola to offer a formal Biochemistry major to these students will improve our ability to prepare and support them

in achieving their career goals.

In other market data, Georgetown University's Center on Education and the Workforce (CEW) https://cew.georgetown.edu/ has published several studies on the connection between education and available jobs. In particular, the employment needs presented in the three CEW reports listed below are all well-suited to being filled by Loyola Biochemistry graduates:

In the report "*Help Wanted: Projecting Jobs and Education Requirements Through 2018"* published in 2010, two of the key findings were that ~90 percent of the jobs in four of the five fastest growing occupational clusters require postsecondary education: Healthcare Professional and Technical Occupations, STEM Occupations, Community Services and Arts Occupations and Education Occupations. By 2018, the United States will need 22 million new workers with college degrees—but will fall short of that number by at least 3 million postsecondary degrees.

In their study 'Healthcare,' CEW finds that "by 2020, 1 out of every 5 dollars will be spent on healthcare in the United States. In our *Healthcare* report, we project 5.6 million jobs in the healthcare sector by 2020, 82 percent of which will require postsecondary education." For Maryland they report an increase of 23% in Healthcare related jobs (compared to 17% for all other jobs).

In the CEW report 'Nursing' they project that the U.S. economy will create 1.6 million job openings for nurses through 2020. Yet there will not be enough nurses to fill those openings, with a projected shortfall of roughly 200,000 nursing professionals by 2020.

4. *Provide data showing the current and projected supply of prospective graduates.*

The chart below shows five years of degrees conferred in Biology and Chemistry programs, the ID Chemistry/Biology major, and the number of majors in either biology or chemistry which choose a minor in the other (biology or chemistry). Over the past five years, students have demonstrated far more interest in combining their knowledge of chemistry with knowledge of biology than solely studying chemistry; over time, there are nearly 2.5 interdisciplinary majors for every one chemistry major.

Loyola Degrees Conferred	**2014**	**2015**	**2016**	**2017**	**2018**
Biology	52	44	47	46	56
Biology with Chemistry minor	2	5	5	8	2
Chemistry	5	2	6	7	7

Loyola Degrees Conferred	2014	2015	2016	2017	2018
Chemistry with Biology minor	1	0	0	0	1
Interdisciplinary (Biology/Chemistry)	13	10	17	14	13

Furthermore, the table below gives the number of graduates of Biochemistry (and Biochemistry with Molecular Biology: Goucher, Univ. of MD Baltimore County) programs in the state over the past five years. These numbers confirm our belief that students who are interested in both chemistry and biology will be attracted to this new Biochemistry major.

Number of Graduates	2014	2015	2016	2017	average
Goucher College	3	2	3	7	4
Stevenson University	1	10	17	12	10
Hood College	7	10	7	5	7
St Mary's College of Maryland	9	14	9	8	10
Mount St. Mary's University	4	8	13	12	9
Univ. of MD College Park	51	55	55	58	56
Univ. of MD Baltimore County	67	73	87	73	75

All but one of Loyola Benchmark institutions offer programs in biochemistry: American University, Bucknell University, College of the Holy Cross, Elon University, Fairfield University, Loyola Marymount University, Providence college, Santa Clara University, University of Scranton, and Villanova. Saint Joseph University does not have a biochemistry program per se, but has a similar program in Chemical Biology,

D. Reasonableness of Program Duplication:

1. *Identify similar programs in the State and/or same geographical area. Discuss similarities and differences between the proposed program and others in the same degree to be awarded.*

In addition to the Maryland schools listed in the chart for section C.4., the following colleges have a biochemistry or biochemistry with molecular biology program: University of Maryland Eastern Shore, and Washington Adventist. Salisbury State University has a minor in Biochemistry but does not have a standalone program. In addition, we are aware of the proposal for a degree being developed at Washington College. Maryland's long-term occupational projections listed by the Maryland Department of Labor, Licensing & Regulation predicts an increase in over 2800 jobs in Maryland alone for Biochemistry related occupations over a ten-year period. Based on the average graduation rates in Maryland in this field over 1,000 jobs would still be available if no increase in graduations occurred. Listing in LinkedIn Jobs current indicates 273 biochemistry job openings near Maryland and 84 jobs near Baltimore.

Additionally, while there are other similar programs in the state, we do not anticipate our program affecting their programs or enrollment. Loyola's program is going to accommodate the students already choosing Loyola University and typically pursuing an Interdisciplinary Studies major.

2. *Provide justification for the proposed program.*

As mentioned above, there is already in place at Loyola an interdisciplinary major in Chemistry and Biology, and this program will simply formalize the major. Biochemistry as a stand-alone major will additionally provide better clarity of program offerings and provide a clear pathway for student advising.

The Biochemistry major offers students a unique interdisciplinary curriculum and exposure to a wide range of faculty members and topics, including undergraduate research. With a curriculum drawing from both disciplines as well as specific biochemistry courses and courses in physics and mathematics, the program provides a broad background in the physical and life sciences. It is suitable for students planning careers in laboratory research or further training in graduate, medical, or other biomedical professional programs, such as medicine, dentistry, and medical technology. According to the MHEC Trends in degrees awarded by program published in January 2018, the number of biochemistry degrees awarded to students has more than doubled since 2004.

E. Relevance to High-demand Programs at Historically Black Institutions (HBIs)

1. *Discuss the program's potential impact on the implementation or maintenance of high-demand programs at HBI's.*

The addition of this new Biochemistry major will have minimal impact on Historically Black Institutions. The closest HBI to Loyola is Morgan State University, which does not currently offer

a major in Biochemistry. Also, as stated before, we don't see the formalization of the program resulting in substantive enrollment growth.

F. Relevance to the identity of Historically Black Institutions (HBIs)

1. *Discuss the program's potential impact on the uniqueness and institutional identities and missions of HBIs.*

The Biochemistry major, as proposed, is a fairly common program and does not impact the uniqueness and institutional identities and missions of HBIs or primarily white institutions.

G. Adequacy of Curriculum Design, Program Modality, and Related Learning Outcomes (as outlined in COMAR 13B.02.03.10):

1. *Describe how the proposed program was established, and also describe the faculty who will oversee the program.*

Our department has offered, for well over 20 years, an interdisciplinary major in Chemistry and Biology. Interdisciplinary Studies (ID) majors who pursued a program of study in chemistry and biology, up to now, were advised by a faculty member in each of the departments of Chemistry and Biology. Loyola would like to create a clearer advising structure and more formally assess student learning in the Biochemistry major. The Chemistry/Biology ID major has gained in popularity over the last several years; since 2014 we have averaged over 13 ID majors graduating per year, far surpassing the Chemistry major.

The shift to a Biochemistry major would not make any significant changes to the curriculum of the Chemistry/Biology ID major. A steering committee composed of faculty from both the departments of Chemistry and Biology will be established to make decisions about any future curricular changes. The exact composition of the steering committee can be decided at a later date, but an initial proposal would be two Faculty from Chemistry and one from Biology, as well as the chairs from each department serving as *ex officio members*. As Biochemistry majors would be "housed" solely in the Department of Chemistry, this would mean advising responsibility would be located in the Department of Chemistry. As mentioned above, these students would still take the same Biology courses, so there would be no decrease in enrollments in any Biology courses. The faculty in chemistry, described in more detail below, includes six full-time tenured or tenure track faculty, two full-time non-tenure track faculty, and two part time faculty. All have terminal degrees (Ph.D.) in chemistry, biochemistry, or a closely related field.

2. *Describe educational objectives and learning outcomes appropriate to the rigor, breadth, and (modality) of the program.*

Students who graduate with a degree in Biochemistry will be able to think like a scientist, will have extensive biochemical knowledge, will be well versed in biochemical techniques and technologies, and will be able to communicate to a diverse audience in both written and oral forms. Further discussion of these core areas of assessment and how they fit with the overall institutional learning aims is in the table below.

Institutional learning aim	*Biochemistry Major learning outcome/aim*	*Courses*
Intellectual excellence	Students will be able to tackle biological and chemical problems in a scientific manner using observations, well-thought hypotheses, predictions, and sound experimental design. Students will be able to communicate and demonstrate an understanding of foundational principles of chemistry and biology.	CH101, CH102, CH301, CH302
Intellectual excellence	Students will have knowledge of the core concepts that pertain to the field of Biochemistry which can be applied to their careers and/or graduate studies. They will be able to ● Demonstrate an in-depth knowledge of the major disciplines at the interface of chemistry and biology and the chemistry of biological systems. ● Recall, relate, synthesize, deploy knowledge, and solve problems in all areas of biochemistry	CH311, CH315, CH431 432, CH433, CH434, all BL200+ courses
Intellectual excellence	Students will critically analyze and evaluate experimental data. They are able to interpret and evaluate results critically. Identify and quantify uncertainties in measurements and limitations in methodologies. They use computational methods to model chemical systems and use computers for data acquisition and processing including graphing and basic statistics.	CH307, CH308, CH311, CH315, CH431, CH432, CH433, CH434

Critical Understanding: Thinking, Reading, Analyzing	Students will be able to identify and analyze problems, breaking them down into constituent parts and applying appropriate tools of conceptual understanding, experimentation, and theory.	CH301, CH302, CH307, CH308, CH311, CH315, CH431, CH432, CH433, CH434
Critical Understanding: Thinking, Reading, Analyzing	Biochemistry Majors will gain proficiency in basic laboratory techniques in both chemistry and biology and be able to apply scientific methodology to the processes of investigation, experimentation and hypothesis testing.	CH307, CH308, CH311, CH315, CH431, CH432, CH433, CH434
Eloquentia perfecta	Students will demonstrate proficiency in the oral presentation of scientific concepts and findings. This includes through dialogue, participation in class, or speaking in front of an audience.	All classes
Eloquentia perfecta	Students will demonstrate proficiency in the written presentation of scientific concepts and findings. This includes through written reports, solutions to problems, and short sentence responses.	CH307, CH308, CH311, CH315, CH431, CH432, CH433, CH434

3. *Explain how the institution will:*
   a) *provide for assessment of student achievement of learning outcomes in the program*

Student learning outcomes will be assessed through two processes. Chemistry Student Learning Outcomes Assessment process is conducted annually for every course by the Chemistry Department. In addition, we are planning on a cumulative assessment of the Biochemistry program for students in their senior year. A similar process has already been established for the chemistry major. The reports are shared with the Dean's office and other relevant stakeholders and could be used for future accreditation requirements.

   b) *document student achievement of learning outcomes in the program*

Program faculty will review aggregated data with the objective of continuous program improvement. We are also developing a portfolio project in which our faculty assessment coordinators will collect examples of work from each Chemistry course throughout a student's career, so as to effectively document that student's progression through the curriculum and to

provide examples of student work that demonstrate attainment of learning aims.

4. Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements

Please see listing below

Biochemistry Program Course Requirements and Suggested Course Sequence							
Course Code	**Course Title**	**Credits**	**Requirement**	**Course Code**	**Course Title**	**Credits**	**Requirement**
First Semester				**Second Semester**			
BL 118	Introduction to Cellular and Molecular Biology *	3	Major Req / Core 12	BL 121	Organismal Biology *	3	Major Req
BL 119	Introduction to Cellular and Molecular Biology Lab *	1	Major Req / Core 12	BL 126	Organismal Biology Lab *	1	Major Req
CH 101	General Chemistry I *	3	Major Req / Core 11	CH 102	General Chemistry II *	3	Major Req
CH 105	General Chemistry Lab I *	1	Major Req / Core 11	CH 106	General Chemistry Lab II *	1	Major Req
WR100	Effective Writing **	3	Core 1	HS 1xx	HS 100-Level Core Course**	3	Core 2
	Language Core	3	Core 6		Fine Arts Core	3	Core 9
	Social Science Core	3	Core 7		Language Core *or* Elective	3	
Third Semester				**Fourth Semester**			
BL 341	Molecular Genetics with Lab */**	5	Major Req	CH 302	Organic Chemistry II *	3	Major Req
CH 301	Organic Chemistry I *	3	Major Req	CH 308	Organic Chemistry Lab II *	1	Major Req
CH 307	Organic Chemistry Lab I *	1	Major Req	MA 252	Calculus II *	4	Major Req
EN 101	Understanding Literature	3	Core 4	PL 200	Level Philosophical Perspectives Course	3	Core 14
MA 251	Calculus I *	4	Core 10	EN 2xx	English 200 Level Writers	3	Core 5
PL 201	Foundations of Philosophy *or*	3	Core 13	BL	Biology Elective*/**	3	Major Req
Fifth Semester				**Sixth Semester**			
CH 431 or BL 431	Biochemistry I * *or* Biochemistry I	3	Major Req	CH 432 or BL 432	Biochemistry II * or Biochemistry II	3	Major Req
CH 433 or BL 433	Biochemistry Lab I * *or* Biochemistry Lab I	1	Major Req	CH 434 or BL 434	Biochemistry Lab II * *or* Biochemistry Lab II	1	Major Req
PH 201	General Physics I *	4	Major Req	PH 202	General Physics II *	4	Major Req
PH 291	General Physics Lab I *	1	Major Req	PH 292	General Physics Lab II *	1	Major Req
TH 201	Introduction to Theology	3	Core 15	TH	Theology Core	3	Core 16
BL or CH	Biology/Chemistry Elective*†	3	Major Req	BL	Biology Elective*/**	3	Major Req
	Nondepartmental Elective	3	Institutional		Nondepartmental Elective	3	Institutional
Seventh Semester				**Eighth Semester**			
CH 311	Physical Chemistry I *	3	Major Req		Social Science Core	3	Core 8
CH 315	Physical Chemistry Lab I *	1	Major Req		Nondepartmental Elective	3	Institutional
	Ethics Core	3	Core 17		Elective†	3	
HS 3xx	History Core	3	Core 3		Elective†	3	
BL or CH	Biology/Chemistry Elective*†	3	Major Req		Elective†	3	
	Elective†	3					

* Required for major.

** Terms may be interchanged.

† Students are strongly encouraged to gain laboratory research experience and should consider enrolling in research courses (BL 481/BL 482 or BL 491/BL 492 or CH 420). CH 420 may be used to fulfill one course for the interdisciplinary major if it is completed as a 3-credit course. Further research credits will count as free electives. Students should consult with their advisor when selecting these electives.

Notes:

1. Biology Electives: For the two biology-only electives, choose from BL 322, BL 332/BL 334, BL 361, BL 410 or BL 411, BL 424, BL 426/BL 427, BL 436, BL 444, and BL 461.

2. Biology/Chemistry Electives: For the two biology/chemistry electives, choose from CH200-level or higher for chemistry electives, including CH 420 and BL200-level or higher for biology electives (see restrictions on research courses).

3. Students must complete the diversity core requirement through a designated diversity core, major, or elective course (see Diversity Core Requirement under Curriculum and Policies).

A listing of discipline required courses and course descriptions can be found in Appendix A.

A listing of all Undergraduate Courses including courses toward the Loyola Core can be found at the following link https://catalogue.loyola.edu/content.php?catoid=14&navoid=510

4. *Discuss how general education requirements will be met, if applicable.*

At Loyola, all students are required to complete the core curriculum, regardless of their major. The core curriculum is comprised of a minimum of 17 courses and represents the foundations of a liberal arts education in the Jesuit tradition. Courses span over areas in humanities, social sciences and natural sciences/mathematics. They include disciplines such as writing, English, history, fine arts, theology, philosophy, and ethics. Core courses in Mathematics and Natural sciences are often dependent on the specific major of the student, and biochemistry majors would have specific requirements as shown in section G4. In addition, one of the required Core courses (in any discipline) must be from the diversity focus list. The diversity core course will focus on domestic diversity, global diversity, or justice awareness.

This core curriculum applies to all students, and students of the previous Chemistry/Biology ID major have all completed these general education requirements.

5. *Identify any specialized accreditation or graduate certification requirements for this program and its students.*

Does not apply.

6. *If contracting with another institution or non-collegiate organization, provide a copy of the written contract.*

Does not apply.

7. *Provide assurance and any appropriate evidence that the proposed program will provide students with clear complete, and timely information on the curriculum, course and degree requirements, nature of the faculty/student interaction, assumptions about technology. competence and skills, technical equipment requirements, learning management system, availability of academic support services and financial aid resources, and costs and payment policies.*

All information about the Biochemistry major and its requirements will be available in the University Academic Catalogue on the University website. The catalogue gives students clear and complete details about major requirements. Course descriptions include prerequisites and corequisites. Additionally, all information is also available on loyola.webadvisor.edu at the time of registration. When students register for a class, they can click on the course number and name and will be given a full description of the course that includes any pre- and co-requisite courses. Student can also use the webadvisor software to perform a degree evaluation at any time that will show all courses required for the degree program, as well as the status of these courses.

Students enrolled in an academic program are given an email account. Students can call 410-617-5555 to determine their user name and password. Students can access e-mail accounts either through on-campus computers or home computers with internet access by going to the main internal Loyola web site (www.loyola.edu). Email accounts can also be accessed through the inside Loyola page (inside.loyola.edu).

Faculty regularly provide students information about the learning management system (Moodle) and academic support services in their syllabi. In addition, the student technology help center is designed to provide support to students for all technology questions. Staff in our academic support areas regularly communicate with students to inform them of the services their offices provide. Financial aid and cost resources are made available to students on the financial aid section of our website. In addition, students are able to be in touch directly with these offices in person, by phone, or by email whenever they have questions.

Computer Facilities

Loyola has extensive computer facilities for student use. Computer labs are found at all locations where courses are taught. These facilities are available for use at both graduate campuses even when the building is not open. Students can use their identification cards to get into the building and the computer labs. There is a charge for printing at the computer labs. Each semester, students

are given $25 toward printing through their identification cards. This equates to 500 copies. Additional funds can be added to the swipe card by calling technology services and following their directions (410-617-5555)

Technology
Our mission is to support, enrich and inspire the academic, social, and administrative experience of the Loyola community through dynamic partnerships and a focus on effective technologies in alignment with the University's mission and dedication to lifelong learning and caring for the whole person. Loyola has extensive services and support in the area of Technology. For information or help call 410-617-5555 or visit http://www.loyola.edu/department/technology-services/student-technology-center

Career Development and Placement Center
The services of the Career Development and Placement Center are available to all Loyola students, graduates, and alumni/ae. Students are welcome to meet by appointment with a career adviser to explore the resources of the Placement Center located in the DeChiaro College Center, West Wing, First Floor, 410-617- 2232; e-mail: cdpc@loyola.edu; website: http://www.loyola.edu/thecareercenter Evening hours are available.

Counseling Center
The staff at the Loyola College Counseling Center offers confidential, goal-oriented group and individual counseling to help students address academic, personal-social and career exploration and decision-making concerns. Further information can be located at http://www.loyola.edu/department/counseling-center

Disability Support Services
The Office of Disability Support Services (DSS) provides services for students with disabilities, which ensure access to all university programs and activities.

Official documentation of disability may be required to determine whether and what kind of special aids or adaptations may be helpful. For additional information call 410-617-2062. Faculty members are not able to make accommodations for disability if a student is not registered with DSS. In addition, it is the policy of the university to not allow retroactive accommodations.

8. *Provide assurance and any appropriate evidence that advertising, recruiting, and admissions materials will clearly and accurately represent the proposed program and the services available.*

Loyola University has a dedicated Office of Marketing and Communications. Loyola endorses and adheres to ethical principles and codes of conduct published by various national organizations.

These include the Public Relations Society of America (PRSA) Code of Ethics, the National Association for College Admission Counseling (NACAC) Statement of Principles of Good Practice, the National Association of Student Financial Aid Administrators (NASFAA) Statement of Ethical Principles and Code of Conduct for Institutional Financial Aid Professionals, American Association of Collegiate Registrars and Admissions Officers (AACRAO) Professional Practices and Ethical Standards, the NAFSA: Association of International Educators Statement of Ethical Principles, and the Association for Institutional Research (AIR) Code of Ethics, which are followed by the Office of Public Relations, Admission Office, the Office of Financial Aid, the Records and Admissions Offices, the Office of International Programs, and the Office of Institutional Research, respectively. Furthermore, the institution provides clear and accurate program information on the University's website.

Our Enrollment Management team will be sent all the relevant information for the program and works closely with academic departments and the Academic Advising and Support Center to ensure that advertised information is clear and accurate. The academic department's website will be a major resource for students. At Loyola, all websites are maintained by the individual departments. This helps to ensure that content is accurate and relevant for anyone who visits a department website.

H. Adequacy of Articulation

1. *If applicable, discuss how the program supports articulation with programs at partner institutions. Provide all relevant articulation agreements.*

Does not apply.

I. Adequacy of Faculty Resources (as outlined in COMAR 13B.02.03.11).

1. *Provide a brief narrative demonstrating the quality of program faculty. Include a summary list of faculty with appointment type, terminal degree title and field, academic title/rank, status (full-time, part-time, adjunct) and the course(s) each faculty member will teach (in this program).*

The faculty teaching courses in the Biochemistry and Molecular Biology program are primarily tenured and tenure track faculty from the Biology and Chemistry departments. The proposed program will not require us to make any changes to the makeup in the staffing of either the Biology or Chemistry departments. The faculty members bring diverse and expert training to these courses to provide our students with different perspectives. All faculty have terminal degrees (Ph.D. in chemistry or closely related field) and significant teaching experience.

Jesse D. More, Ph.D.

Associate Professor of Chemistry and Chair

Ph.D. Organic Chemistry, University of California, San Diego.

Area of Specialty: Organic Chemistry

Courses taught: CH 301, 302, 307, 308, 406

Full-Time

Birgit Albrecht, Ph.D.

Associate Professor of Chemistry

Ph.D. Chemistry, University of Oxford

Areas of Specialty: Biophysical and Theoretical Chemistry

Courses taught: CH 101, 102, 105, 106, 311, 315, 312, 316

Full-Time

Brian K. Barr, Ph.D.

Associate Professor of Chemistry

Ph.D. Biochemistry, Cornell University

Area of Specialty: Protein Biochemistry / Enzymology

Courses taught: CH 105, 106, 308, 431, 432, 433, 434

Full-Time

Elizabeth E. Dahl, Ph.D.

Associate Professor of Chemistry

Ph.D. Earth Systems Science, University of California Irvine

Areas of Specialty: Analytical Chemistry and Marine and Atmospheric Chemistry

Courses taught: CH 105, 106, 201, 410, 411

Full-Time

Courtney J. Hastings, Ph.D.

Assistant Professor of Chemistry

Ph.D. Chemistry, University of California Berkeley

Areas of Specialty: Bioorganic Chemistry; Computational Biomolecular Engineering

Courses taught: CH 101, 102, 301, 302, 307, 308, 310

Full-Time

Nicky McDougal, Ph.D.

Lecturer

Ph.D. Chemistry, Cambridge University

Areas of Specialty: Physical Chemistry

Courses taught: CH 101, 102, 201, 301, 302, 307, 308, 433, 434

Full-Time

Kyle Mino, Ph.D.

Visiting Affiliate Assistant Professor of Chemistry

Ph.D. Chemistry, University of Florida

Areas of Specialty: Analytical Chemistry

Courses taught: CH 101, 102, 105, 106

Part-Time

Timothy J. McNeese, Ph.D.

Professor of Chemistry

Ph.D. Chemistry, Harvard University

Area of Specialty: Inorganic Chemistry

Courses taught: CH 101, 102, 105, 106, 412

Full-Time

Theresa P.T. Nguyen, Ph.D.

Assistant Professor of Chemistry

Ph.D. Chemistry, University of California Los Angeles

Area of Specialty: Biochemistry

Courses taught: CH 101, 102, 431, 432, 433, 434

Full-Time

Heather Schmidt, Ph.D.

Affiliate Faculty and Lab Manager

Ph.D. Chemistry, University of Delaware

Area of Specialty: Physical Chemistry

Courses taught: CH 101, 102, 105, 106, 311, 312, 315, 316

Full-Time

2. *Demonstrate how the institution will provide ongoing pedagogy training for faculty in evidenced-based best practices, including training in:*
   a) Pedagogy that meets the needs of the students

Currently, faculty members have access to a variety of professional development and pedagogical training opportunities at Loyola University. All faculty members are eligible for annual conference travel funds. Faculty also have access to a wide variety of chemical and biochemical journals supplied through the American Chemical Society and faculty can also acquire needed journal articles through interlibrary loan.

Loyola strongly supports faculty development and every semester offers workshops on teaching enhancement. In addition, a faculty fellows' program has been developed, with the goal of increasing awareness and use of evidence based, high impact teaching techniques across all departments and disciplines.

b) The learning management system

Loyola uses the Moodle learning management system and has a fully staffed technology center. Support includes a help line for faculty, several Moodle specialists, and Moodle training workshops to help faculty use Moodle effectively. The institution also provides an Office of

Digital Teaching & Learning that provides additional support and training for face-to-face courses that supplement learning with digitally enhanced supports.

c) *Evidenced-based best practices for distance education, if distance education is offered.*

Distance education does not apply to this in-person program. Although the Biochemistry program is not to be offered as an online program, the institution does provide an Office of Digital Teaching & Learning with a mission to:

• maximize student learning by partnering with faculty to employ best practices in Ignatian digital pedagogy

• design high quality, innovative face to face, hybrid, and online courses

• provide training, instructional design support, and multimedia assistance

• introduce innovative methodologies, research, and pilot appropriate methods.

• support a community of practice in teaching and learning

• fulfill the strategic plan and mission of the university by adopting new learning methodologies

Digital pedagogy workshops are offered through the Office of Digital Teaching and Learning. Instructional Designers are available to develop on-line classes and LUM as a whole follows Quality Assurance Standards for Online Education Programs.

J. Adequacy of Library Resources (as outlined in COMAR 13B.02.03.12)**.**

1. *Describe the library resources available and/or the measures to be taken to ensure resources are adequate to support the proposed program.* ***If the program is to be implemented within existing institutional resources****, include a supportive statement by the President for library resources to meet the program's needs.*

The Loyola-Notre Dame Library (LNDL) hosts well in excess of 400,000 volumes. In 2000, LNDL acquired its 400,000th volume, bringing the library to near its total holding capacity. In 2002, the library implemented the first ENCompass Digital Library System - a federated search engine 'encompassing' most of the library's database contents - in the United States. During the next ten years, the library's digital capabilities expanded exponentially, resulting in the addition of over 250,000 digital book titles and over 56,000 online journals. By 2007, the Maryland Interlibrary Consortium (MIC) consortium of libraries had grown to include four libraries in addition to LNDL, bringing total consortium holdings to over one million volumes.

An extensive building renovation and expansion project commenced in the summer of 2006 after several years of planning to bring the library into the digital age physically. Hillier/RMJM 46 designed the new addition and renovation to the original building; the renovations would bring the size of the library to 125,000 square feet. By July 2008, Whiting-Turner had completed the construction at a cost of $20,000,000.

The library has embarked on two strategic plans during the period from 2005-2012 that have guided the priorities and budget allocations to keep the library a vital organization for students and faculty of Loyola and Notre Dame during the early 21st century. Through all these changes, the library services and resources to the communities of Loyola University and Notre Dame of Maryland University.

On June 10, 2016 the university announced that the Loyola-Notre Dame Library will become an affiliate member of the University System of Maryland Affiliated Institutions Library Consortium (USMAI). The consortium includes sixteen member libraries at Maryland public universities and colleges LNDL was chosen for membership largely because of the uniqueness of its collections, and it is the first private academic library in Maryland to join USMAI.

We do not anticipate that the library will need to change its offerings or services in any way to support this program. The library currently supports students enrolled in the existing Chemistry/Biology ID major and no new classes are being created for the new Biochemistry major. Furthermore, no new library resources will be needed to support faculty research, which will not be affected by this program.

K. Adequacy of Physical Facilities, Infrastructure and Instructional Equipment (as outlined in COMAR 13B.02.03.13)

1. *Provide an assurance that physical facilities, infrastructure and instruction equipment are adequate to initiate the program, particularly as related to spaces for classrooms, staff and faculty offices, and laboratories for studies in the technologies and sciences. If the program is to be implemented within existing institutional resources, include a supportive statement by the President for adequate equipment and facilities to meet the program's needs.*

We do not anticipate any changes or additional requirements of facilities, infrastructure or instructional equipment to support this program. The chemistry department at Loyola University Maryland is housed in Donnelly Science Center and all of the courses that will be part of this program are currently taught in existing Loyola classrooms, and laboratory facilities already exist in our department for teaching General Chemistry, Organic Chemistry, Quantitative Analysis, Physical Chemistry, Biochemistry, Analytical Chemistry and Inorganic Chemistry. Our department

also houses an instrument lab, a prep lab, faculty research labs, and offices for all chemistry faculty/staff. We already support students enrolled in the existing Chemistry/Biology ID major and no new classes are being created for the new Biochemistry major. No new hires will be required and no new resources will be needed to support faculty research.

Instrumentation in the department, available for teaching and undergraduate research purposes includes modern instrumentation such as gas chromatography, high performance liquid chromatography, and nuclear magnetic resonance spectroscopy, among others.

2. Provide assurance and any appropriate evidence that the institution will ensure students enrolled in and faculty teaching in distance education will have adequate access to:
a) An institutional electronic mailing system, and
b) A learning management system that provides the necessary technological support for distance education

Although this program does not include any distance education courses, students are provided with an electronic mailing system and other technologies listed previously in this proposal including section I. above.

L. Adequacy of Financial Resources with Documentation (as outlined in COMAR 13B.02.03.14)

*1. Complete **Table 1: Resources and Narrative Rationale**. Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year. Also provide a narrative rationale for each resource category. If resources have been or will be reallocated to support the proposed program, briefly discuss the sources of those funds.*

Please see table below.

TABLE 1: PROGRAM RESOURCES					
Resource Categories	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1. Reallocated Funds	0	0	0	0	0
2. Tuition/Fee Revenue (c + g below)	791,600	861,730	934,920	1,011,180	1,036,070
a. Number of F/T Students	16	17	18	19	19
b. Annual Tuition/Fee Rate	49,475	50,690	51,940	53,220	54,530
c. Total F/T Revenue (a x b)	791,600	861,730	934,920	1,011,180	1,036,070
d. Number of P/T Students	0	0	0	0	0
e. Credit Hour Rate	785	805	825	845	866
f. Annual Credit Hour Rate	0	0	0	0	0
g. Total P/T Revenue (d x e x f)	0	0	0	0	0
3. Grants, Contracts & Other External Sources	269,948	276,696	283,614	290,704	297,972
4. Other Sources	-366,299	-407,388	-451,364	-488,356	-500,552
TOTAL (Add 1 – 4)	$695,249	$731,038	$767,170	$813,528	$833,490

Notes:

- Average enrollment in interdisciplinary major over last three years is 15 students
- Modest enrollment growth anticipated (see narrative)
- UG tuition in AY18-19 was $47,520/yr
- UG tuition in AY18-19 was $765/credit
- Tuition increases estimated at ~2.5%/year
- UG fees in AY18-19 totaled $700; no increase expected
- 2.b. UG tuition + UF fees (see values mentioned above)
- No P/T students expected in major
- Grants and Contribution calculated using Loyola's APP Model data (FY18 most recent run) adjusted for the proportion of biology majors (12.0%) and chemistry majors (51.15%) that will be biochemistry majors (biochemistry majors distributed equally to both departments).
- Scholarship amount calculated using overall discount rate projections and expected leveling off at 49% (.47, .48, .49, .49, .49 of anticipated tuition amount used in the five years, respectively).

Enrollment assumptions for the proposed biochemistry are based on average enrollment of the chemistry/biology interdisciplinary program over the past five years. Slight growth projections are based labor statistics data projections and the ability (if approved) to market as a stand-alone program.

2. *Complete **Table 2: Program Expenditures and Narrative Rationale**. Provide finance data for the first five years of program implementation. Enter figures into each cell and provide a total for each year. Also provide a narrative rationale for each expenditure category.*

TABLE 2: PROGRAM EXPENDITURES:					
Expenditure Categories	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1. Faculty (b + c below)	0	0	0	0	0
a. Number of FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
2. Admin. Staff (b + c below)	0	0	0	0	0
a. Number of FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
3. Support Staff (b + c below)	0	0	0	0	0
a. Number of FTE	0	0	0	0	0
b. Total Salary	0	0	0	0	0
c. Total Benefits	0	0	0	0	0
4. Technical Support and Equipment	0	0	0	0	0
5. Library	0	0	0	0	0
6. New or Renovated Space	0	0	0	0	0
7. Other Expenses	500	500	500	500	500
TOTAL (Add 1 – 7)	500	500	500	500	500

The proposed Biochemistry program does not require any new resources as all courses and equipment are already being taught as part of the either the Chemistry or Biology programs or as part of the Chemistry/Biology ID major.

No new faculty will be required as all necessary faculty already teach as part of the Chemistry or Biology programs or as part of the Chemistry/Biology ID major.

$500.00 has been built into the program for incidentals such as typical updating of marketing and other promotional materials.

M. Adequacy of Provisions for Evaluation of Program (as outlined in COMAR 13B.02.03.15).

1. Discuss procedures for evaluating courses, faculty and student learning outcomes.

The Biochemistry program will be subject to the same requirements for assessment and evaluation as existing Loyola degree programs. This will be managed by the Loyola Chemistry Department, which currently manages this process for the Bachelor of Science (B.S.) Degree in Chemistry.

All Loyola University students complete course evaluations at the end of each of their courses. The results of these evaluations are delivered to the relevant faculty and submitted to their department chairs and the Dean for use in annual faculty evaluations, tenure and promotion decision making.

Loyola ensures that the assessment activities we pursue are not only sufficient for accreditation purposes, but are also meaningful and help us improve teaching practice and student learning priorities. We have established a yearly assessment of our current chemistry degree program that is manageable and sustainable, and we will implement a complementary process for this new biochemistry degree program. As part of this process for each degree program at Loyola, academic departments submit yearly reports that 1) describe how assessment data are captured, 2) present student learning outcomes data, and 3) outline a plan to address issues that have been identified. This annual report also summarizes changes that Departments have made in response to previous assessment data, thus “closing the assessment loop.”

All faculty are evaluated on every course as to teaching effectiveness, preparedness for class, etc. in the student evaluation forms. The chair of our department regularly examines these evaluations and discusses with individuals positive and negative student feedback. When students have legitimate concerns about an affiliate (per course) faculty member, steps are taken to ensure that those concerns are addressed. In addition, we have an extensive and regular peer evaluation of teaching program in which faculty perform classroom observation and evaluation of a portfolio of student work and instructor generated content.

3. *Explain how the institution will evaluate the proposed program's educational effectiveness, including assessments of student learning outcomes, student retention, student and faculty satisfaction, and cost-effectiveness*

Each department at Loyola is required to submit an annual report, which includes progress towards previous year's goals and a complete assessment report. The reports are evaluated by the Dean's office annually, and the Dean meets with the chair each year to discuss departmental progress. Programs also engage in Academic Program Review on a six-seven year cycle at Loyola.

N. Consistency with the State's Minority Student Achievement Goals (as outlined in COMAR 13B.02.03.05).

1. *Discuss how the proposed program addresses minority student access & success, and the institution's cultural diversity goals and initiatives.*

The recruitment and retention of minority students is a priority for Loyola University. In fall 2017, 23% of Loyola's undergraduates were minority students of which 5% were African American. Data indicates an increasing number of Students of Color selecting STEM fields including the Chemistry/Biology ID major. 2012 – 2017 data for the retention of first to second year students at Loyola indicates White student retention at 87% and Students of Color at 86% with African American students listed at 84% retention. Loyola's four-year graduation rates of Whites is 79% Students of Color 76% of which African American student's graduation rate is 73%. Loyola strives for all students to achieve and with increasing number of students of color selecting STEM fields including the Chemistry/Biology ID major. The biochemistry program is just one more option for the increasing number of students of color interested in this field.

Although Loyola's attainment gap is not as large as some institutions, any gap in attainment is taken seriously at Loyola. Overcoming these gaps is of high importance as can be seen by Loyola's strategic plan. Loyola's new strategic plan includes a priority for the enhancement of Ignatian Citizenship, a goal of which is to "seek, embrace, and promote diversity, equity, and inclusiveness." The university pursues this goal with the help of the President's Advisory Council for Diversity, Equity, and Inclusion and through divisional goals across the university that tie to the strategic plan. The Council's aim is to foster a both diverse and welcoming atmosphere at Loyola by spearheading initiatives such as:

- Assessment and programming to address campus climate
- Training for all members of the community on engaging
- Recruitment, hiring and retention practices that enhance diversity
- Review recruitment and retention practices to enhance diversity
- Enrollment practices that enhance diversity
- Spaces on campus for affinity groups
- Related educational opportunities for the University community
- Engagement with the city of Baltimore
- How to create a culture of accountability on diversity issues

- External engagement on diversity and equity – boards, alumni, etc.
- Serve as an advisory board to the president and to the senior officer for equity and inclusion
- Make recommendations for the job description for the senior officer for equity and inclusion

O. Relationship to Low Productivity Programs Identified by the Commission:

1. *If the proposed program is directly related to an identified low productivity program, discuss how the fiscal resources (including faculty, administration, library resources and general operating expenses) may be redistributed to this program.*

Does not apply

P. Adequacy of Distance Education Programs (as outlined in COMAR 13B.02.03.22)

1. *Provide affirmation and any appropriate evidence that the institution is eligible to provide Distance Education.*

Does not apply.

2. *Provide assurance and any appropriate evidence that the institution complies with the C-RAC guidelines, particularly as it relates to the proposed program.*

Does not apply.

Appendix A

Biochemistry Program Discipline Course Descriptions
(in alphabetical order)

BL 118 - Introduction to Cellular and Molecular Biology

(3.00 cr.)

Corequisite: BL 119. An examination of the cellular basis of life, specifically how cell structure determines cell function, thereby enabling cells to adapt to their environment. Topics include metabolism, energy conservation, central dogma, gene regulation, cell reproduction, and the cell in its social context. Required for biology majors. Fulfills the natural science core requirement. FO

BL 119 - Introduction to Cellular and Molecular Biology Lab

(1.00 cr.)

Corequisite: BL 118. Laboratory work supports and enhances material from the lecture. In addition, students are introduced to techniques used in the laboratory, as well as in the field of cellular and molecular biology. These techniques include microscopy, enzyme kinetic studies, DNA isolation, and gel electrophoresis. FO

BL 121 - Organismal Biology

(3.00 cr.)

Prerequisite: BL 118, BL 119. Corequisite: BL 126. Students are provided a brief introduction into the diversity of organisms, followed by a more in-depth examination of the relationship between the structure and function of cells, tissues, and organ systems in plants and animals. A comparative approach is used to examine how organisms solve various issues pertaining to life. These problems include nutrition, exchange of gasses, reproduction and development, transport of materials, and control via hormonal and neural communication. Students are introduced to the process of scientific thinking, as well as the principles of organismal biology. Required for biology majors. Fulfills the natural science core requirement. FO

BL 126 - Organismal Biology Lab

(1.00 cr.)

Corequisite: BL 121. Laboratory work supports and enhances material from the lecture. The course focuses on observational skills and covers topics that include diversity of organisms,

introductory comparative anatomy, and vertebrate anatomy. Technical skill development includes microscopy and invertebrate and vertebrate dissections.
FO

BL 201 - Ecology, Evolution, and Biodiversity

(3.00 cr.)

Corequisite: BL 202. Restricted to majors, interdisciplinary majors, and biology, environmental and sustainability, or natural sciences minors, or students with written permission of the department chair. An examination of the processes which produce the diversity of organisms on our planet. Topics include the biotic and abiotic factors which determine the distribution and abundance of species and evolutionary processes which lead to adaptation, speciation, and extinction. Also examines conservation of the diversity of life by studying the interaction between humans and other organisms. Addresses quantitative aspects of biology, modeling, and graphical representations of empirical and theoretical concepts. Required for biology majors.
Fulfills the natural science core requirement for nonscience majors. IES

BL 202 - Process of Science and Ecology, Evolution, and Biodiversity Lab

(2.00 cr.)

Corequisite: BL 201. Students explore the biodiversity of life on earth through field trips, lab experiences, and computer simulations. Basic biostatistics is introduced and used throughout this course. Student-designed investigative projects allow students working in small groups to practice skills in experimental design, data collection, computer-aided analyses, and communication skills.

BL 206 - Human Anatomy and Physiology I

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126 or equivalent. Corequisite: BL 207. The first in a sequence of courses in human anatomy and physiology designed to meet the requirements for students pursuing careers in nursing or allied health. The course covers basic body organization; functional biochemistry; cytology; histology; study of integumentary, skeletal, muscular, circulatory, and respiratory systems; and emphasis on the study of normal anatomy and physiology with clinical applications. Written or electronic permission of the department chair or director of curriculum and advising. Closed to students who have taken BL 260 or BL 452.

BL 207 - Human Anatomy and Physiology Lab I

(1.00 cr.)

Corequisite: BL 206. A laboratory course designed to provide exercises and other activities that supplement and reinforce topics covered in BL 206.

BL 208 - Human Anatomy and Physiology II

(3.00 cr.)

Prerequisite: BL 206, BL 207. Corequisite: BL 209. A continuation of BL 206. A comprehensive study of the digestive, excretory, endocrine, reproductive, and nervous systems. Written or electronic permission of the department chair or director of curriculum and advising. Closed to students who have taken BL 260 or BL 452.

BL 209 - Human Anatomy and Physiology Lab II

(1.00 cr.)

Corequisite: BL 208. A laboratory course designed to provide exercises and other activities that supplement and reinforce topics covered in BL 208.

BL 210 - Introduction to Human Nutrition

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126 or equivalent. An introduction to nutrition principles including the digestive system; the six nutrients and their roles in the body; food sources with an emphasis on the anatomy, physiology, and biochemical processes; nutrient recommendations; nutritional needs during the life cycle; nutritional factors in food selection and preparation of foods with an emphasis on the nutritional and chemical properties of foods; nutrition in health and disease: weight control, diabetes, cardiovascular disease, dental health, cancer and nutrition; conducting a diet history; development of healthful recipes and menus; and evaluation of nutrition information for the public. Exercises include evaluation of the diet and recipes using computerized analysis; evaluation of body composition; and sampling of foods with healthful properties such as vegetarian items, low fat foods, and foods with particular phytochemicals.

BL 220 - Natural History of Maryland Species

(4.00 cr.)

Prerequisite: BL 121, BL 126, BL 201, BL 202; or written permission of the department chair for nonmajors. Studies the natural history of Maryland's native plants and animals. Their ranges, habitats, adaptations, conservation status, and interactions with other species are studied using ecological and evolutionary principles. Through lectures, laboratory exercises and field trips, Maryland's many habitats-from the Chesapeake Bay

to the Appalachian Plateau-are explored. IES

BL 222 - Aquatic Biology

(3.00 cr.)

Prerequisite: BL 121, BL 126, BL 201, BL 202. Corequisite: BL 223 . A study of physical, chemical, and biological interrelationships in aquatic environments including freshwater, estuarine, and marine systems.

BL 223 - Aquatic Biology Lab

(2.00 cr.)

Corequisite: BL 222. Field trips reinforcing the concepts of BL 222. Trips may include visits to local streams, reservoirs, and Chesapeake Bay sites. Trips may be supplemented by laboratory analysis of collections. Weekend field trips may also be required.

BL 230 - Avian Biology with Lab

(5.00 cr.)

Prerequisite: BL 121, BL 126, BL 201, BL 202. An introduction to the study of birds, their evolutionary origins, diversity, special adaptations, life histories, social behavior, and ecology. The laboratory includes bird watching, identification, dissections, and behavior. Two or three weekend day trips are included.

BL 241 - Invertebrate Zoology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Recommended Prerequisite: BL 201, BL 202. An introduction to the exciting and amazing world of animals without backbones. The course focuses on the life histories, behavior, structure, physiology, and ecology of common invertebrate groups. Consideration is given to adaptations for interacting with plants and animals. Emphasis is also placed on those creatures that have a significant impact on the human condition, including those invertebrates of medical and agricultural importance. Students explore live and preserved specimens in lab to gain a greater understanding of structure-function relationships.

BL 250 - General Entomology with Lab

(5.00 cr.)

Prerequisite: BL 121, BL 126. Recommended Prerequisite: BL 201. An introduction to the insect world emphasizing insect life histories, structure, behavior, physiology, and ecology. Consideration is given to adaptations for interacting with plants, animals, and man.

Laboratories are designed to introduce all aspects of insect biology and implement methods for studying insect pollination, carrion ecology, morphology, apiculture, and cell culture. Field trips to various habitats emphasize insect diversity and collection techniques.

BL 255 - Introduction to Biomedical Research

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Restricted to sophomores or juniors. A laboratory course aimed at developing essential skills utilized in various areas of biomedical science research such as developmental biology, cancer biology, neurobiology, physiology, stem cell biology, biotechnology, and regenerative medicine. The course introduces students to laboratory techniques, process of experimental design, laboratory record keeping, scientific ethics, troubleshooting experimental challenges, and scientific research communication. Closed to students who have taken BL481 or BL482.

BL 260 - Vertebrate Morphology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. An integrated approach to the development, microscopic and macroscopic anatomy of vertebrates. The course examines the evidence of how major vertebrate organ systems have evolved from basal deuterostome ancestors. It also examines how transition from aquatic to terrestrial habitat paralleled transformations of the respiratory, skeletal, and circulatory systems. The laboratory component explores the early embryology of frog and chick and the gross anatomy of the cat. Closed to students who have taken BL 206 or BL 208.

BL 270 - Ecology with Lab

(5.00 cr.)

Prerequisite: BL 201, BL 202. An introduction to the principles of ecology stressing interaction between organisms and their environment at the levels of the individual, population, community, and the ecosystem. These principles are then applied to current environmental and conservation problems and issues. Laboratory experiments, computer simulations, and field experiences designed to demonstrate basic ecological principles. One weekend field trip may be required.

BL 276 - Human Health and the Environment

(3.00 cr.)

Prerequisite: BL 111 or BL 201 or CH 114; and SC 106 (may be taken concurrently); or written permission of the environmental and sustainability studies minor director. What

does Lyme disease have to do with climate change? Why did children lose millions of IQ points to leaded gasoline and paint? Why do so many children in Baltimore have asthma? Answers may be found in this exploration of the bidirectional relationship between our health and the health of our homes, communities, food, air, waterways and climate. Study of toxicology, risk assessment, prevention, environmental justice, history, and policy will provide framework for understanding effects of environmental exposures. Examples of how major exposures such as air toxins are managed in Baltimore and Maryland lend context and relevance to class discussions. Finally, examples of environmental impacts on children, the most vulnerable population group will emphasize a major course theme: a multidisciplinary approach is necessary to guarantee the health of future generations and the planet. Same course as SC 276. IES

BL 280 - General Genetics with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Recommended Prerequisite: Recommended BL201. An introductory course in genetics with lab exercises using plants, drosophila, and humans to reinforce the principles of classical, molecular, and population genetics.

BL 281 - General Genetics

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Recommended Prerequisite: BL 201. An introduction to genetics focused on principles of classical, molecular, and population genetics.

BL 305 - Plant Ecology with Lab

(5.00 cr.)

Prerequisite: BL 121, BL 126, BL 201, BL 202. General principles of ecology are used to study the relationship of plants to physical and biological factors. Through a synthetic approach using lecture, lab, and discussion, students learn about the pivotal role of plants in the ecosystem.

Topics include urban ecology, plant community ecology, restoration ecology, and global climate change. Field and laboratory experiments emphasize ecological research techniques and allow students to gain experience in designing studies, making field observations, and learning standard methods of data collection and analyses. A weekend field trip may be required.
IES

BL 310 - Botany with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. The cell biology, anatomy, physiology, diversity, and economic importance of plants with emphasis on practical applications in pharmacology, horticulture, and the environment. Laboratory activities acquaint students with practical applications of botany while maintaining a strong emphasis on the basic facts and principles necessary for a sound foundation in the plant sciences. IES

BL 316 - Comparative Physiology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. A comprehensive introduction to the similarities and differences in the functional processes of animals at selected levels in phylogeny. Emphasis is placed on the adaptive significance of life processes that have evolved as a consequence of an ever-changing environment. Laboratory experiences include comparative examination of the structure and function of select vertebrate and invertebrate organ systems. Techniques rely on modern and classic research methods used to study physiological processes, including protein electrophoresis, cell structure, electrocardiography, and electroencephalography.

BL 317 - Comparative Physiology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. A comprehensive introduction to the similarities and differences in the functional processes of animals at selected levels in phylogeny. Emphasis is placed on the adaptive significance of life processes that have evolved as a consequence of an ever-changing environment.

BL 320 - Natural History of Maryland Species

(4.00 cr.)

Prerequisite: BL 121, BL 126, BL 201, BL 202; or written permission of the department chair for nonmajors. Studies the natural history of Maryland's native plants and animals. Their ranges, habitats, adaptations, conservation status, and interactions with other species are studied using ecological and evolutionary principles. Through lectures, laboratory exercises and field trips, Maryland's many habitats-from the Chesapeake Bay to the Appalachian Plateau-are explored.

BL 321 - Synthetic Biology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Introduces students to the field of synthetic biology, focusing on the design and engineering of biological devices and synthetic genomes. Topics include genome structure and organization in prokaryotes and eukaryotes; gene synthesis technology; methods for the synthesis of whole genomes; design of genetic circuits; and the practical applications of synthetic biology in the creation of biofuels, production of pharmaceuticals, and development of vaccines. Closed to students who have taken BL 322.

BL 322 - Synthetic Biology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Examines the emerging field of synthetic biology, focusing on the design of biological devices and organisms. Topics include gene structure and regulation; genome organization; synthesis of whole genomes; genetic circuits; and the practical applications of synthetic biology in the creation of biofuels, production of pharmaceuticals, and development of vaccines. The laboratory employs bioinformatic tools to analyze DNA sequences and design genes, as well as bioengineering techniques to construct a portion of a genome.
Closed to students who have taken BL 321. FO/IFS

BL 332 - Microbiology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Corequisite: BL 334. An introduction to the fascinating world of microorganisms. Topics for discussion include the structure and function of microbes; microbial metabolism, nutrition, and growth; the control of microorganisms in the environment and in the body; the classification of microorganisms and viruses; infection and immunity; and applied microbiology. An overview of microbial diseases by body system is also provided.

BL 334 - Microbiology Lab

(2.00 cr.)

Corequisite: BL 332. Laboratory work focuses on microbiological technical skill development, including sterile techniques used in the cultivation of microorganisms and multiple staining procedures used in the identification of microorganisms. It also teaches students about the theory and use of differential selective media and tests to identify microbes, as well as antibiotic sensitivity testing. Students apply knowledge gained through the course to identify unknown cultures of microorganisms.

BL 341 - Molecular Genetics with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Students are introduced to the basic principles of molecular genetics and how studies in molecular genetics have advanced fields such as genetic engineering. Topics include structure and function of nucleic acids and proteins; gene expression and regulation in prokaryotic and eukaryotic organisms; and the nature of mutations and cancer. Examines some of the genetic tools used to analyze genes. The laboratory emphasizes basic and advanced techniques of DNA, RNA, and protein manipulation. Students also learn to use computer software to access gene databases and analyze gene sequences. FO/IFS

BL 343 - Molecular Genetics with Seminar

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Students are introduced to the basic principles of molecular genetics and how molecular genetics is used for basic research and applied field such as genetic engineering. Topics include the structure and function of nucleic acids; DNA replication, transcription, translation; gene regulation; and various molecular genetic technologies. In the seminar, students present and discuss papers dealing with current applications of molecular genetics and the associated ethical dilemmas. Students are also introduced to basic laboratory procedures.

BL 346 - Plant-Animal Interactions

(3.00 cr.)

Prerequisite: BL 121, BL 126, BL 201, BL 202. Corequisite: BL 347. Interactions between plants and animals may strongly influence their evolution and ecology. These interactions are arguably the most important forces structuring ecological communities. Students explore the predominant interactions between plants and animals (e.g., pollination, herbivory, seed dispersal) using evolutionary and ecological approaches. The ecological conditions that favor certain types of interactions and the (co)evolution of interactions are emphasized. IES

BL 347 - Plant-Animal Interactions Seminar

(2.00 cr.)

Corequisite: BL 346. Students explore the expansive plant-animal interactions literature, with human impacts on the dynamics of plant-animal interactions as the main theme of the seminar. The class is conducted in the style of a journal club, where individual students take the responsibility for leading discussions on current articles from the

literature. Students learn to critically analyze experimental designs, ecological and evolutionary theory, and key conclusions of the articles, while working toward research proposals to study the potential effects of continued anthropogenic influences.

BL 350 - Biology of Mammals with Lab

(5.00 cr.)

Prerequisite: BL 121, BL 126, BL 201, BL 202. The diversity found within the class Mammalia is examined to gain an understanding of the evolution, physiology, and ecology of these animals. An examination of the conservation problems of this group is included. Students examine the distinctive characteristics of mammals, both in the lab and through field study of natural populations. IES

BL 351 - Forensic Entomology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Recommended Prerequisite: BL 201, BL 202, BL
250. Forensic entomology is the application of basic and applied principles of insect biology and the collection of entomological data in such a manner that it can be used as evidence in criminal investigations to aid in resolving legal issues that are either criminal or civil in nature. Lectures explore the use of insects in the science of forensic entomology and its impact on death scene investigation, neglect, or abuse; contamination of food products and other marketable goods; and subsequent litigation. Laboratories focus on techniques associated with death scene investigation, particularly in the collection and identification of arthropods found on a corpse. Some field trips may be associated with the laboratory portion of the course. FO/IFS

BL 355 - Forensic Biology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126; or written permission of the department chair for nonmajors. An introduction to the role of biology in forensic sciences. Topics include biological evidence, influences of invertebrates, vertebrates and microorganisms on legal matters, and
in-depth discussion of body fluid analyses. Labs examine techniques associated with biological evidence analyses. FO/IFS

BL 361 - Plant Physiology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. A study of the basic processes of plant life including photophysiology, nutrition, water relations, transport phenomena, growth and development, and stress physiology. The laboratory portion examines techniques and instruments physiologists use to study plant function. Activities include comparative photosynthesis, nutrient analysis using atomic absorption spectroscopy, and tissue culture.

BL 370 - Pharmacology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Introduces students to the study of how drugs affect the human body (pharmacodynamics) and how the human body alters drugs
(pharmacokinetics). This course examines the fundamental concepts and terminology required to understand the differences among drug effects, as well as the mechanisms of actions of various drug classes used to treat common diseases in society. The class also explores questions such as why many drugs have so many side effects. Does not fulfill the natural sciences core requirement. (Spring only)

BL 390 - Conservation Biology

(3.00 cr.)

Prerequisite: BL 121, BL 126, BL 201, BL 202. Corequisite: BL 392 or BL 393. A comprehensive survey of current practices and theoretical background in conservation biology. Students examine local and global threats to biological diversity; the value of biological diversity; conservation strategies including the design and management of protected areas, captive breeding of endangered species, and reintroduction programs; and ethical and moral responsibilities of our society as it interacts with nature and other nations. IES

BL 392 - Conservation Biology Seminar

(2.00 cr.)

Corequisite: BL 390. Faculty and small groups of students present seminars on selected topics in conservation biology. Also, groups of students present opposing viewpoints on selected topics in a courtroom-like setting (environmental law). Employs computer simulations to further the understanding of theoretical models presented in lecture. Possible field trips to zoological parks and research centers to see application of principles.

BL 393 - Conservation Biology Lab

(2.00 cr.)

Corequisite: BL 390. Provides students with opportunities to participate firsthand in research and conservation practices on local or campus ecological problems. Through a specific field project that aims to improve the campus or local community, students are trained on real-world methods of biodiversity studies and biological conservation, as well as the applications of ecological concepts and principles covered in BL 390. Weekend field trips may be included.

BL 399 - Biology Internship

(1-3.00 cr.)

Restricted to juniors or seniors. Provides students with practical experiences (knowledge or skills) that ordinarily could not be obtained from courses completed at Loyola or associated programs. Generally the experiences are in a professional setting (allied health, industry, or government agency) and often help with career determination. Students arrange for an on-site supervisor and a faculty sponsor to coordinate activities and evaluate the student's performance. Minimum expectation is 150 hours for a three-credit internship. Written or electronic permission of the department chair.

BL 401 - Endocrinology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Recommended Prerequisite: BL 452. An examination of the mammalian endocrine system with emphasis on humans. General aspects of endocrinology are covered, including pertinent anatomy, receptor dynamics, techniques used to study endocrinology, and how the system is regulated. An in-depth exploration of multiple endocrinological examples follows. In addition, students read historical and primary literature and lead class discussions.

BL 403 - Neurobiology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. An integrated examination of the mammalian nervous system with emphasis on the human brain. A review of basic neuroanatomy and neurophysiology. Students conduct in-depth explorations of specific topics such as neuropathologies, neuropharmacology, neuroanatomical sex differences, aging, and the molecular and cellular bases of memory and learning. The laboratory includes an examination of histological preparations and human brain slices; discussions of primary

literature and review articles; instructor presentation of special topics in neurobiology including visual, auditory, and vestibular systems; and student presentations of selected topics in neurobiology. Closed to students who have taken BL 405, PY 331, or PY 332.

BL 404 - Laboratory Experience in Neurobiology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Introduces modern techniques used to study brain anatomy and neuronal phenotypes. This course includes literature review and discussion of the theoretical background and current practices using various types of microscopy. Students dissect preserved mammalian brains, examine prepared histological sections, and learn how to use an atlas. Additionally, students learn basic histology by collecting samples of various cells and tissues; how to properly and safely section and mount preserved brain samples; and apply state-of-the-art techniques of cell staining and computer-assisted visualization and analysis.

Special emphasis is placed on use of immunohistochemical techniques using fluorescently labeled antibodies for detection of various cellular proteins. Students also have the opportunity to participate in creating images using the confocal microscope. This opportunity requires some time outside of the normally scheduled class time. Closed to students who have taken BL 403 or BL 405. (Fall only)

BL 405 - Neurobiology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. A review of basic neuroanatomy and neurophysiology. Students conduct in-depth explorations of specific topics such as neuropathologies, neuropharmacology, neuroanatomical sex differences, aging, and the molecular and cellular bases of memory and learning. Closed to students who have taken BL 403, PY 331, or PY 332.

BL 406 - Endocrinology Lab

(2.00 cr.)

Corequisite: BL 401. An introduction to modern techniques used in the study of endocrinology. Students learn how to handle and work with rodents and perform simple surgical procedures. In addition, instruction is given on methods of cell culture and hormone measurement. The second half of the course involves individual student research projects, culminating in student research presentations.

BL 408 - Endocrinology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Recommended Prerequisite: BL 452. An examination of the mammalian endocrine system with emphasis on humans. General aspects of endocrinology are covered, including pertinent anatomy, receptor dynamics, techniques used to study endocrinology, and how the system is regulated. An in-depth exploration of multiple endocrinological examples follows. In addition, students read historical and primary literature and lead class discussions. The second half of the course involves individual student research projects, culminating in student research presentations. Laboratory experiences include an introduction to modern techniques used in the study of endocrinology. Students learn how to handle and work with rodents and perform simple surgical procedures. In addition, instruction is given on methods of cell culture and hormone measurement.

BL 410 - Developmental Biology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Patterns of development from fertilization through organ formation are examined. Topics include descriptive embryology, mechanisms of cellular differentiation, cellular interactions, metamorphosis, and sex determination. In the lab, students use experimental and descriptive techniques to explore the mechanisms whereby single-celled zygotes change into more complex animals.

BL 411 - Developmental Biology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Patterns of development, from fertilization through organ formation, are addressed. Topics include embryology, mechanisms of cellular differentiation, cellular interactions, metamorphosis, and sex determination.

BL 420 - Histology

(4.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. The microscopic examination of the anatomy and physiology of mammalian tissues and organs. Lecture/Laboratory.

BL 424 - Cancer Biology with Seminar/Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. An in-depth examination of the molecular and genetic basis of cancer biology. Clinical aspects of cancer are also discussed, including topics related to histopathology, diagnosis, and treatment. The laboratory component of the course introduces students to the study of cancer cells and their characteristics, and to current cancer biology techniques. Lab techniques include cell culture, histopathology, microarray, cell viability assays, invasion assays, molecular biology techniques, and cancer stem cell assays. In the seminar component of the course, students critically analyze primary research literature, learn about different cancer types, and discuss socioeconomic topics related to cancer.

BL 426 - Cell Biology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Corequisite: BL 427. Restricted to juniors or seniors. A survey of biochemical and molecular aspects of cellular function with emphasis cell ultrastructure and communication.

BL 427 - Cell Biology Lab

(2.00 cr.)

Corequisite: BL 426. An introduction to modern techniques used in cell biology. Laboratory work focuses on sterile culture techniques used in the cultivation of cells and tissues. Students also learn common techniques used in cellular/molecular laboratories such as microscopy, staining, cell fractionation, electrophoresis, and ELISAs.

BL 428 - Bioterrorism

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126; or written permission of the instructor. A survey of the history and biology of bioterrorism and biowarfare agents. The course focuses on the cellular and molecular biology of organisms identified by the Centers for Disease Control and Prevention as bioweapons. Emphasis is placed on scientific communication (student-led lectures) and reading/understanding of relevant scientific literature. FO/IFS

BL 431 - Biochemistry I

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126, CH 302, CH 308. Corequisite: BL 433. General principles of biochemistry including studies of the macromolecules

(carbohydrates, lipids, proteins and nucleic acids), enzyme kinetics and reaction mechanisms, and intermediary metabolism. Same course as CH 431. FO/IFS

BL 432 - Biochemistry II

(3.00 cr.)

Prerequisite: BL 431, BL 433. Corequisite: BL 434. An examination of select topics in biochemistry, focusing on how life processes are regulated by the interactions between molecules. Topics vary and may include protein structure and function; protein-DNA interactions; signal transduction cascades; enzyme reaction mechanisms; the cytoskeleton; protein synthesis; and cellular secretion. Students lead discussions and/or make oral presentations. Same course as CH 432. FO/IFS

BL 433 - Biochemistry Lab I

(1.00 cr.)

Corequisite: BL 431. Designed to supplement and reinforce concepts covered in the lecture course. Students are introduced to the techniques of the modern biochemistry laboratory. Experiments include computer visualization of biomolecules, enzyme kinetics, chromatography, and electrophoresis. Same course as CH 433. FO/IFS

BL 434 - Biochemistry Lab II

(1.00 cr.)

Prerequisite: BL 431, BL 433. Corequisite: BL 432. An introduction to modern experimental biochemistry focusing on techniques for the purification, characterization, and analysis of proteins. Same course as CH 434. FO/IFS

BL 435 - Evolution with Seminar

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126, BL 201, BL 202. An examination of the evidence for Darwin's theory of evolution by natural selection. Students study the details of the process of evolution from several perspectives including population genetics, evolutionary ecology and macroevolution. Topics include genome evolution, adaptation, speciation, and extinction.
Lecture. Closed to students who have taken BL 436. Field Trips. IES

BL 436 - Evolution

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126, BL 201, BL 202. An examination of the evidence of Darwin's theory of evolution by natural selection. Students study the details of the process of evolution from several perspectives including population genetics, evolutionary ecology, and macroevolution. Topics include genome evolution, adaptation, speciation, and extinction.
Closed to students who have taken BL 435.

BL 438 - Exploring the Human Genome

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. An introduction to the human genome, including the structure, function, and evolution of the genome. Students explore techniques of genome-wide analysis, applications of genomics findings to questions of human health, and ethical issues surrounding the acquisition and sharing of human genome sequences. Topics include similarities and differences in genetic sequences among individuals; identification of genes that cause inherited human diseases and cancer; use of genome sequences to track human ancestry; and use of genomic sequencing to identify microbes that live on and in the human body in healthy and diseased states.

BL 440 - Special Topics in Biology

(3.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126, BL 201, BL 202. Special topics in biology of interest to the instructor. Topics vary from semester to semester.

May be repeated for credit with different topics.

BL 444 - Stem Cell Biology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. Examines concepts, theories, and techniques in stem cell biology. Focuses on stem cell technology including types of stem cells, ethics of stem cell use, pluripotency, culture methods, characterization, and monitoring tools such as imaging and differentiation strategies. Laboratory component includes development of techniques used in stem cell research, as well as investigations of primary literature.

BL 452 - General and Human Physiology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126. General physiological principles and

studies on selected human and vertebrate organ systems are discussed. Laboratory exercises include vertebrate organ dissections, computer simulations, direct physiological measurements, and microscopy that coordinate with lecture topics. Pathophysiology is also discussed, and human case studies are used to solve physiological problems. Closed to students who have taken BL 206 or BL 208.

BL 454 - Animal Behavior

(3.00 cr.)

Prerequisite: BL 121, BL 126, BL 201, BL 202. Corequisite: BL 455. A comprehensive introduction to the field of animal behavior. Topics include the hormonal and neural mechanisms that control behavior; development and evolution of behavior; and diverse topics in behavioral ecology, animal communication, and sociobiology.

BL 455 - Animal Behavior Lab

(2.00 cr.)

Corequisite: BL 454. Students develop observational skills and the ability to quantify behavior and design behavioral experiments through laboratory exercises, field trips, and an independent group research project.

BL 461 - Immunology with Lab

(5.00 cr.)

Prerequisite: BL 118, BL 119, BL 121, BL 126, BL 201, BL 202, and one additional upper-level biology elective. The biology of the immune system is explored. Structural, functional, and applied aspects of cellular and humoral immune mechanisms in the vertebrates are also studied. Students conduct contemporary experiments to demonstrate aspects of cellular and humoral immunity. Students implement numerous immunological techniques using both in vitro and in vivo systems.

BL 467 - Seminar: Career Choices

(1.00 cr.)

An examination of different careers available to biologists or a related field of study. Experts from several health professions present on careers available to Loyola students. May be repeated for credit with different topics. (Pass/Fail)

BL 470 - Seminar: Special Topics in Organismal Biology

(3.00 cr.)

Prerequisite: Two upper-level biology courses (BL 208 or higher) including at least one Category B biology elective and junior/ senior standing, or written permission of the instructor. An examination of current topics and areas in organismal biology with an emphasis on primary literature. Students lead group discussions and/or make oral presentations. May be repeated for credit with different topics.

BL 471 - Seminar: Special Topics in Ecology, Evolution, and Diversity

(3.00 cr.)

Prerequisite: Two upper-level biology courses (BL 222 or higher) including at least one Category C biology elective and junior/senior standing, or written permission of the instructor. An examination of current topics in ecology, evolution, and diversity with an emphasis on primary literature. Students lead group discussions and/or make oral presentations. May be repeated for credit with different topics. IES

BL 472 - Seminar: Special Topics in Cellular and Molecular Biology

(3.00 cr.)

Prerequisite: Two upper-level biology courses (BL 222 or higher) including at least one Category A biology elective and junior/senior standing, or written permission of the instructor. An examination of current topics in cell and molecular biology with an emphasis on primary literature. Students lead group discussions and/or make oral presentations. May be repeated for credit with different topics.

BL 473 - Special Topics in Forensic Biology

(3.00 cr.)

Prerequisite: Two upper-level biology courses (BL 222 or higher) including at least one biology elective at the 300- level or higher and junior/senior standing, or written permission of the department chair. An examination of current topics in forensic biology with an emphasis on the use of primary literature. Students lead group discussions and/or make oral presentations.
May be repeated for credit with different topics. FO/IFS

BL 481 - Biology Research I

(3.00 cr.)

Requires a preliminary paper outlining the nature and scope of the problem, the experimental procedures, and associated literature. Also requires progress reports and a final research paper.
Students should secure a faculty sponsor the semester prior to enrollment. Written or electronic permission of a sponsoring faculty member. May be repeated for credit.

BL 482 - Biology Research II

(3.00 cr.)

Prerequisite: BL 481. A continuation of BL 481. Written or electronic permission of a sponsoring faculty member.

BL 483 - Biology Research III

(3.00 cr.)

Prerequisite: BL 481, BL 482. A continuation of BL 482. Written or electronic permission of a sponsoring faculty member.

BL 491 - Honors Biology Research I

(3.00 cr.)

Prerequisite: Two upper-level biology courses (BL 222 or higher). Restricted to students with a cumulative GPA of 3.000 or higher. Requires the student to create a faculty committee of at least three members, including the sponsoring biology faculty member and at least one other biology faculty member. Prior to registration, students must write, submit and have an honors thesis proposal approved by the committee. Additional requirements include the submission and defense of a final paper to the committee in a format decided by the sponsoring faculty member, and presentation of research in a departmental seminar. Prior research experience required (BL 481, Hauber Fellowship). Major GPA of 3.500. Written or electronic permission of the department chair.

BL 492 -Honors Biology Research II

(3.00 cr.)

Prerequisite: BL 491. A continuation of BL 491. Students must apply for this course and receive written or electronic permission of a sponsoring faculty member.

BL 496 - Environmental Studies Experience

(3.00 cr.)

A capstone experience in the environmental and sustainability studies minor, in which a student arranges an internship, independent study, or research experience with a faculty sponsor to engage in an in-depth exploration of a topic associated with environmental or sustainability issues. Written or electronic permission of a sponsoring faculty member and the environmental and sustainability studies director. Generally completed during the senior year. IES

BL 498 - Forensic Studies Experience

(3.00 cr.)

A capstone experience in forensic studies in which a student may arrange an internship, independent study, or research experience with a faculty sponsor to engage in an in-depth exploration of a topic associated with forensic or criminal investigation. Generally completed during senior year; students should secure a faculty sponsor and obtain the approval of the forensic studies director by the end of junior year. Written or electronic permission of a sponsoring faculty member. FO/IFS

CH 101 - General Chemistry I

(3.00 cr.)

Prerequisite: MA 004 or a score of 56 or better on Part I of the Math Placement Test or a math SAT score of 560 or better or a math ACT score of 24 or better or one year of high school calculus. Corequisite: CH 105. Basic atomic structure, periodic table, chemical equations, gases, liquids, solids, electrolysis, properties of elements and compounds, rates and mechanisms of reactions.

CH 102 - General Chemistry II

(3.00 cr.)

Prerequisite: CH 101. Corequisite: CH 106. A continuation of CH 101.

CH 105 - General Chemistry Lab I

(1.00 cr.)

Corequisite: CH 101. An introduction to the laboratory study of the physical and chemical properties of matter; the principles and applications of gravimetric, volumetric chemical, and qualitative analysis.

CH 106 - General Chemistry Lab II

(1.00 cr.)

Prerequisite: CH 101, CH 105. Corequisite: CH 102. A continuation of CH 105.

CH 201 - Quantitative Analysis

(4.00 cr.)

Prerequisite: At least a C or better in CH 102. An investigation into techniques used to determine chemical composition. Includes application of statistical analysis to chemical systems and emphasizes chemical equilibrium. Provides a foundation for advanced level courses in physical chemistry, instrumental analysis, and laboratory techniques. Lecture/Laboratory.
FO/IFS

CH 301 - Organic Chemistry I

(3.00 cr.)

Prerequisite: CH 102. Corequisite: CH 307. An introduction to the language, theory, and practice of organic chemistry. Topics include acid-base chemistry, conformational analysis, stereochemistry, reactions of aliphatic compounds, synthesis, and mechanisms. Emphasis is placed on the importance of organic chemistry in biology and medicine.

CH 302 - Organic Chemistry II

(3.00 cr.)

Prerequisite: CH 301. Corequisite: CH 308. A continuation of CH 301, with an expanded discussion of reaction mechanisms and synthesis. Topics include the use of spectroscopy in structure determination, the reactions of aromatic compounds and carbonyl compounds, heterocyclic chemistry, and medicinal chemistry.

CH 307 - Organic Chemistry Lab I

(1.00 cr.)

Prerequisite: CH 102, CH 106. Corequisite: CH 301. Techniques used in the isolation, purification and synthesis of organic compounds.

CH 308 - Organic Chemistry Lab II

(1.00 cr.)

Prerequisite: CH 301, CH 307. Corequisite: CH 302. A continuation of CH 307.

CH 311 - Physical Chemistry I

(3.00 cr.)

Prerequisite: CH 102, MA 251. At least a C or better in CH 102. Corequisite: CH 315. A detailed examination and analysis of kinetics and the laws of classical thermodynamics with applications to the properties of gases, liquids, and solids, as well as to solutions, phase, and chemical equilibria.

CH 312 - Physical Chemistry II

(3.00 cr.)

Prerequisite: CH 311, MA 251. Corequisite: CH 316. An introduction to quantum chemistry and spectroscopy. The theory of quantum mechanics is presented at a fundamental level and applied to the electronic structure of atoms and molecules, atomic and molecular spectroscopy, and statistical mechanics.

CH 315 - Physical Chemistry Lab I

(1.00 cr.)

Corequisite: CH 311. Principles of experimental physical chemistry and introduction of techniques and instruments used in modern chemical research. Emphasis is placed on interpreting results, critical thinking, and writing formal reports.

CH 316 - Physical Chemistry Lab II

(1.00 cr.)

Prerequisite: CH 311, CH 315. Corequisite: CH 312. Principles of experimental physical chemistry are applied to the acquisition and interpretation of basic data on atomic and molecular structure using spectroscopic instrumentation and computational chemistry techniques. Emphasis is placed on interpreting results, critical thinking, and writing formal reports.

CH 406 - Organic Synthesis

(3.00 cr.)

Prerequisite: CH 302, CH 308. At least a C or better in CH 302. A detailed survey of methods used to make molecules using organic chemical synthesis. Students become well-versed in drawing organic reaction mechanisms and in designing and evaluating synthetic strategies and tactics. Syntheses of medicinally important molecules

(antibiotics, antivirals, and other drugs) will be used to introduce new reactions and reinforce understanding of mechanism and strategy. (Spring Only)

CH 410 - Instrumental Methods

(3.00 cr.)

Prerequisite: CH 201, CH 311, CH 315. At least a C or better in CH 311. Corequisite: CH 411. Principles and applications of analytical instrumentation. An introduction to spectroscopic, chromatographic, and electrochemical techniques. FO/IFS

CH 411 - Instrumental Methods Lab

(1.00 cr.)

Prerequisite: CH 201, CH 311, CH 315. Corequisite: CH 410. Covers principles and applications of some spectroscopic and chromatographic techniques. Applications of chemometrics. FO/FS

CH 412 - Inorganic Chemistry

(4.00 cr.)

Prerequisite: CH 312, CH 316. The application of thermodynamic, kinetic, and structural principles to the synthesis and characterization of the chemical elements and main group, transition metal, and organometallic compounds. Lecture/Laboratory.

CH 420 - Chemistry Research

(1-3.00 cr.)

Supervised faculty/student research projects. Written or electronic permission of the department chair. May be repeated for credit.

CH 431 - Biochemistry I

(3.00 cr.)

Prerequisite: CH 302, CH 308. Corequisite: CH 433. General principles of biochemistry including studies of the macromolecules (carbohydrates, lipids, proteins and nucleic acids), enzyme kinetics and reaction mechanisms, and intermediary metabolism. Same course as BL 431. FO/IFS

CH 432 - Biochemistry II

(3.00 cr.)

Prerequisite: CH 431. Corequisite: CH 434. An examination of select topics in biochemistry, focusing on how life processes are regulated by the interactions between molecules. Topics vary and may include energy metabolism (oxidative phosphorylation, photosynthesis, and glycogen metabolism); signal transduction cascades; amino acid and lipid metabolism; enzyme reaction mechanisms; and protein synthesis. Students lead discussions and/or make oral presentations. Same course as BL 432. FO/IFS

CH 433 - Biochemistry Lab I

(1.00 cr.)

Corequisite: CH 431. Designed to supplement and reinforce concepts covered in the lecture course and introduce students to the techniques of the modern biochemistry laboratory. Experiments include computer visualization of biomolecules, enzyme kinetics, chromatography, and electrophoresis. Same course as BL 433. FO/IFS

CH 434 - Biochemistry Lab II

(1.00 cr.)

Prerequisite: CH 431, CH 433. Corequisite: CH 432. Modern experimental biochemistry focusing on techniques for the purification, characterization, and analysis of proteins. Same course as BL434. FO/IFS

MA 251 - Calculus I

(4.00 cr.)

Prerequisite: MA 109 or a score of 56 or better on Part II of the Math Placement Test or one year of high school calculus. A rigorous approach to Calculus for all majors. Topics include limits, definition, interpretation, and applications of the derivative; differentiation rules; antiderivatives; definition of definite and indefinite integrals; and the Fundamental Theorem of Calculus. Degree credit will not be given for both MA 151 and MA 251. DS/FO/IFS

MA 252 - Calculus II

(4.00 cr.)

Prerequisite: At least a C- or better in MA 251. A continuation of MA 251. Techniques and applications of integration; improper integrals; parametric equations and polar coordinates; sequences and series. FO/IFS

PH 201 - General Physics I

(4.00 cr.)

Corequisite: MA 251, PH 291 or written permission of the department chair. Designed for majors in the physical sciences. Topics include vectors, kinematics, Newton's laws and dynamics, conservation laws, rigid body equilibrium, rotational mechanics, oscillatory motion, fluid mechanics and motion in a gravitational field, and wave motion. Fundamental concepts of vector analysis and calculus are developed. Fulfills one math/science core requirement. (Fall only)

PH 202 - General Physics II

(4.00 cr.)

Prerequisite: PH 201. Corequisite: MA 252; PH 292 or written permission of the department chair. A continuation of PH 201 which includes classical electromagnetic theory and geometrical optics. Fulfills one math/science core requirement. (Spring only)

PH 291 - General Physics Lab I

(1.00 cr.)

Corequisite: PH 201. An introduction to experimental physics stressing principles of measurement, treatment and presentation of data and error analysis with experiments taken primarily from mechanics. (Fall only)

PH 292 - General Physics Lab II

(1.00 cr.)

Prerequisite: PH 291 or written permission of the department chair. Corequisite: PH 202. A continuation of PH291 with experiments taken from sound, wave motion, electrostatics, DC and AC circuits, and geometrical optics. Basic electronic instrumentation introduced. (Spring only)