LOYOLA UNIVERSITY MARYLAND

— 1852 —

Office of Academic Affairs

February 15, 2023

Secretary of Higher Education
Maryland Higher Education Commission
6 N. Liberty Street
Baltimore, MD 21201
Sent via email: acadprop.mhec@maryland.gov

RE: New Academic Program Proposal - Bachelor of Science in Biohealth with an AOC in Digital Health and Data Analytics

Dear Secretary:

Loyola University Maryland is pleased to submit a proposal for a new Bachelor of Science in Biohealth with a concentration in Digital Health and Data Analytics. This exciting concentration aims to meet student interest and to support Maryland's position in the BioHealth Capital Region by developing talent for the field. The curricular goals derive from the university mission, a strong foundation in biology, and local employer needs. The concentration's design incorporates multiple disciplines, experiential learning, and flexibility. Depending on a student's educational goals, this program can prepare them for direct entry to the workforce or to advance to graduate education.

The proposal was approved by Loyola's Academic Senate and the Board of Trustees. The President approved this concentration, as made evident by his signature on the MHEC Cover Sheet. I approve the proposed concentration and submit it concomitantly with the proposal for the new Biohealth program for your recommendation for implementation. Should the Commission have any questions about the proposal, please contact Mr. David Mack, Academic Program Development Specialist, at 410-617-2317 or dsmack@loyola.edu.

Sincerely,

Cheryl Moore-Thomas

Cheryl Moore-Thomas, Ph.D., NCC
Interim Provost and Vice President for Academic Affairs

tdf

cc: Dr. Stephen Fowl, Dean, Loyola College of Arts and Sciences
Mr. Matthew Power, President, Maryland Independent College and University Association
Dr. Angela Sherman, Vice President for Academic Affairs, Maryland Independent College and University Association

Office Use Only: PP#

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 # 44770 | Payment Amount: 250.00 | Date Submitted: 2/15/23

Department Proposing Program	Biology Department	
Degree Level and Degree Type	Bachelor of Science with three Areas of Concentration	
Title of Proposed Program	Biohealth - Digital Health and Data Analytics (AOC)	
Total Number of Credits	120-121	
Suggested Codes	HEGIS: 40499.00	CIP: 26.9999
Program Modality	◉ On-campus ○ Distance Education (fully online) ○ Both	
Program Resources	◉ Using Existing Resources ○ Requiring New Resources	
Projected Implementation Date (must be 60 days from proposal submisison as per COMAR 13B.02.03.03)	◉ Fall ○ Spring ○ Summer	Year: 2023
Provide Link to Most Recent Academic Catalog	URL: https://catalogue.loyola.edu/	
Preferred Contact for this Proposal	Name: David Mack Title: Academic Program Development Specialist Phone: (410) 617-2317 Email: dsmack@loyola.edu	
President/Chief Executive	Type Name: Terrence M. Sawyer, J.D. Signature: [signature] Date: 02/15/2023 Date of Approval/Endorsement by Governing Board: 02/15/2023	

Revised 1/2021

LOYOLA UNIVERSITY MARYLAND,
A DEGREE-GRANTING INSTITUTION AUTHORIZED TO OPERATE IN MARYLAND,
PROPOSAL FOR A NEW AREA OF CONCENTRATION WITHIN THE BIOHEALTH
BACHELOR OF SCIENCE DEGREE PROGRAM:

DIGITAL HEALTH AND DATA ANALYTICS AREA OF CONCENTRATION

Submitted in accordance with state regulations found in COMAR 13b.02.03.

on

February 15, 2023

Executive Summary

The proposed program will have the following concentration:

- Digital Health and Data Analytics

In 2020, the Maryland Department of Commerce awarded a Maryland E-Nnovation Initiative Fund grant to Loyola University Maryland to establish an endowed professorship in innovation to help expand scientific research in biohealth and to promote economic and entrepreneurial success in the State of Maryland. The faculty member in the new endowed professorship in innovation has worked within Loyola's biology department to grow undergraduate biomedical research, provide students with professional skills to work in bioscience industries, create new biotechnology research opportunities that extend undergraduate students' exposure to scientific careers, and develop community partnerships with private and public health research organizations. Loyola's proposal is tied directly to the state's investment through this grant to advance biohealth innovation at Loyola and in Maryland.

Unprecedented growth has occurred since 2001 in the BioHealth Capital Region's (BHCR) bioscience industries in Maryland, Virginia, and Washington D.C., with more than 1300 biotechnology-related companies now located in the region. Surprisingly, growth has been limited by the inability to attract and retain a sufficient workforce. Talent seekers consistently reported that jobs remain vacant for extended periods of time, positions go unfilled, and competent employees are recruited away to larger markets. The proposed new program, Biohealth Bachelor of Science with a concentration in Digital Health and Data Analytics, aims to help address this ongoing need, as one potential vocational path for students who may choose to pursue direct entry into the workforce of the BHCR, supplying regional companies with a much-needed talent pipeline.

The proposed new Biohealth program and concentration in Digital Health and Data Analytics complements Loyola University Maryland's existing interdisciplinary biology programs and aligns with Loyola's Jesuit tradition and its mission to "inspire students to learn, lead, and serve in a diverse and changing world" and goals to "prepare students … for lives of meaningful professional service and leadership." The Digital Health and Data Analytics concentration, one of three areas of concentration within the Biohealth program, was designed to support students interested in pursuing direct entry into the workforce or into research-based graduate programs. Students graduating from this program will be poised to be leaders and trailblazers in biological innovations, scientific communication, and data analysis.

Designed for a well-rounded educational experience, the program requirements comprise successful completion of liberal arts, theology, and ethics courses in the Loyola Core Curriculum; a mix of courses in STEM, business, and technical writing in the Biohealth core; and a choice of one of three areas of concentration. With the Digital Health and Data Analytics area of concentration, students will synthesize the many intersections among biology, business, and data science. Each student will also complete at least two internship or research courses to gain real-world experience in their chosen field. The University views the development of internships and relationships with local businesses and researchers as important for Loyola

students and tangibly demonstrative of the synergy between students' liberal arts training in the Jesuit tradition and their vocational planning.

The concentration dovetails with recent department and university grants and goals for STEM education, modern equipment, and an endowed professorship with a focus on innovation and entrepreneurship. The Digital Health and Data Analytics concentration aligns with Loyola's mission and strategic goals, capitalizes on existing university expertise and resources, and supports the state's and the BioHealth Capital Region's needs to attract talent in the biohealth fields.

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.

Loyola's mission is to "inspire students to learn, lead, and serve in a diverse and changing world," and the University "seeks to prepare students … for lives of meaningful professional service and leadership." By preparing students to enter rapidly growing biohealth fields and to understand, utilize, and innovate cutting-edge technologies, this concentration will enable Loyola students to be at the forefront of these rapidly advancing fields. As a rigorous and technical program, the Digital Health and Data Analytics concentration within the Biohealth major will capitalize on Loyola's tradition of academic excellence while also building strong skills in critical thinking, written and oral communication, and ethical reasoning. With a core of courses that span the intersection among the natural sciences, humanities, and business, the Digital Health and Data Analytics concentration will produce the creative and flexible thinkers that are characteristic of a Jesuit education with the ability to "examine their own values, attitudes, and beliefs."[1] The Biohealth program with Digital Health and Data Analytics concentration also requires two experiential learning experiences that prepare students for direct entry into the field and position them to take leadership roles. In addition, these internship or research experiences require students to work with diverse teams and become accustomed to the standards of professionalism that are central to success in the industry.

While Loyola has a strong history of preparing students for medical, dental, and veterinary careers (and the quality of our students' preparation is evident in a medical school acceptance rate that is twice the national average), in recent years, our students' career goals have diversified; we have a growing number of students who are interested in non-clinical careers. The Digital Health and Data Analytics concentration within the Biohealth program seeks to support these students by opening new career and educational paths for them, build unique collaborations between the Biology Department and other Loyola departments, and support the state's needs for a consistent and strong talent pipeline in this area.

The biohealth industry spans a broad array of disciplines including therapeutics, diagnostics, medical devices, digital health, biomedical research and innovation, biomarkers and tools, health informatics, clinical trials and research, and precision medicine. The proposed **area of concentration** will focus on **Digital Health and Data Analytics**.

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

Loyola's current strategic plan, *The Ignatian Compass*, prioritizes several initiatives to enhance

[1] https://www.loyola.edu/about/mission

students' preparation to lead in both the workplace and society. The Biohealth program and Digital Health and Data Analytics concentration prepare students for specific career and post-secondary educational paths while providing them with the skills and intellectual flexibility to grow professionally and pursue new opportunities. The strategic plan specifically calls for career planning to be integral to undergraduate education at Loyola, for increased experiential learning opportunities, and for synergy between students' liberal arts training and their vocational planning. By incorporating courses from the humanities into the core of the Biohealth program, students can more clearly see how these disciplines develop the durable and transferable skills that are highly desired and necessary for success in graduate education and STEM careers. As such, the Biohealth program exemplifies Loyola's hope that students will integrate information across disciplines as the major requires students to take courses from at least three different academic divisions.

The strategic plan also calls for an emphasis on career discernment and for a curriculum that is adaptable to students' individual needs. Biology faculty serve as advisors to all students in the department beginning in their sophomore year and meet with students each semester to select courses and to guide students in these career discernment processes; students will therefore have the resources of Loyola's Career Center and the Biohealth program directors (the academic advisors to the students) to guide them through this selection process. However, the Biohealth program was designed to allow students to move between concentrations easily, and for students to enter a STEM major later than they are typically able to do so. Since the Biohealth program contains fewer sequenced courses (ones that require multiple prerequisites and must be taken in a specific order), students will be able to move from a non-STEM major to a STEM (Biohealth) major, between Biohealth concentrations, and between the BS in Biology and the BS in Biohealth programs more easily, thereby increasing curricular flexibility for students. This designed flexibility will also allow transfer students from community colleges to complete the Biohealth program at Loyola.

Loyola's strategic plan also calls for greater civic engagement and encourages university members to think of themselves "as responsible for the betterment of our shared world." The fields that the program will prepare students to enter (therapeutics, clinical trials, medical devices, digital health, technical writing, and precision medicine, as examples) directly impact people's health and well-being. As such, many of the courses that students will take as part of their major engage students in considering how biological research, data analysis, and business can be used to make a positive impact on society. Given that the practical applications of what students will be studying will be foregrounded in the major, we anticipate the major to be of strong interest to students who want to make social impacts, who are interested in direct entry to the workforce after graduation, and who are interested in research-based graduate school programs.

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.)

Implementation of the proposed program will not require new resources in terms of faculty, space, and budget given the projected student enrollment and associated revenue. The dean of the Loyola College of Arts and Sciences (LCAS) will commit modest advertising start-up funds for the implementation of the new program and stipends for the directors. The courses included in the proposed program will use existing Loyola faculty resources and existing instructional space. Based upon projected enrollments (informed by surveys of incoming students) and the limited additional needs, the Biohealth program will be unique in that it will be revenue-positive in its first year and is anticipated to grow in both size and revenue each year thereafter.

4. Provide a description of the institution's a commitment to:

a) ongoing administrative, financial, and technical support of the proposed program

The proposed program will be housed within the Biology Department. The department chair will provide overall supervision of the program in terms of financial and personnel decisions. Drs. Christopher Thompson (Professor) and Michael Tangrea (Endowed Professor supported through a Maryland E-Nnovation grant) will serve as the program directors; they will be provided with a stipend to advise students, network with BHCR companies, and provide day-to-day administration of the program. Academic advising will be provided by the directors and, if necessary, other members of the Biology Department. Upon approval, a Biohealth Steering Committee will be formed, composed of faculty, alumni, and local biotech leaders to provide oversight of programmatic and curricular decisions and to offer insight into the needs of the industry.

Technical support for laboratory courses will be provided by the three-person technical staff of the Biology Department under the supervision of the department's Laboratory Manager. Financial support of instructional initiatives for the program will be made by the LCAS and Academic Affairs, via demonstrated need-based increases to the Biology Department's budget.

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

The program will be given at least five years to establish consistent and sustainable enrollments. After that time, if the program fails to meet anticipated student demand, its continuation will be reassessed. However, there are few new expenses associated with the program because all courses in the program already exist at Loyola, giving the program a strong probability of success and viability. If the University chooses to sunset the program in the future, course instruction will continue, and students will be provided the necessary courses to complete their degree.

B. Critical and compelling regional or statewide need 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

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

c) the need to strengthen and expand the capacity of historically black institutions to provide high quality and unique educational programs

The bioscience industries in Maryland, Virginia, and Washington D.C. (referred to as the BioHealth Capital Region or BHCR) have a workforce crisis. Unprecedented growth in the region's bioscience industries has occurred since 2001, with more than 1,300 biotechnology-related companies now located in the region.[2] The BHCR is now the third-largest area in dedicated lab space, the fourth largest in both jobs and NIH funding, and receives the seventh highest amount of venture capital funds in the entire country. The burgeoning industry has led to the creation of nearly 100,000 jobs in the region from 2008-2018, with forecasts for even more rapid growth in the next several years.[3] Surprisingly, the true limiting factor during this time has been the inability to attract and retain a sufficient workforce. Talent seekers consistently reported that jobs remain vacant for extended periods of time, positions go unfilled, and competent employees are recruited away to larger markets.[4] The biggest pool of potential talent resides within the region's colleges and universities. Nearly 100,000 undergraduate students are enrolled in STEM programs throughout the BHCR that, in turn, should serve as a direct talent pipeline for the bioscience workforce. However, this impressive output of students trained in STEM disciplines has not translated into a sustainable bioscience workforce. The proposed concentration will help students develop the knowledge and transferrable skills necessary for successful employment and/or matriculation into graduate programs while also bringing awareness of the rich opportunities for employment in the BHCR, thus supporting the state's need to develop a healthy, robust workforce pipeline.

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

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[2] 8th Annual BIOHEALTH Capital Region Forum, October 4, 2022, https://www.biohealthinnovation.org/biohealthnews/biohealth-regional-news/13972-8th-annual-biohealth-capital-region-forum-recap

[3] Thompson, C., Sanchez, J., Smith, M., Costello, J., Madabushi, A., Schuh-Nuhfer, N., . . . Rivers, D. (2018). Improving Undergraduate Life Science Education for the Biosciences Workforce: Overcoming the Disconnect Between Educators and Industry. CBE Life Sciences Education, 17(3), es12. DOI 10.1187/cbe.18-03-0047

[4] Dubetz, Alissa, Kesteven, Charlotte, and Melaas, Aaron "New Opportunities for Job Creation in Maryland's Life Sciences Industry," Milken Institute, Maryland Life Sciences, 2001: https://milkeninstitute.org/sites/default/files/2021-10/MI_MD_Life%20Sciences.pdf

The proposed program aligns well with the Innovation Strategies outlined in the 2022 Maryland State Plan for Higher Education. The program will help to foster unique collaborations between Loyola and regional businesses with student internships, new co-ops, and the formation of an advisory board to help shape opportunities within the major. Furthermore, by providing students with significant experiential learning and collaborative opportunities, they will be much better prepared to join the workforce, and will, hopefully, stay in the region.

While we believe the Biohealth program and Digital Health and Data Analytics concentration will support many aspects of the 2022 Maryland State Plan for Higher Education, we are most excited to contribute to Priorities 5, 7, and 8. With the hiring of Dr. Tangrea and previous work by Dr. Thompson, Loyola is well poised to build strong relationships with regional companies, to generate high-quality interns and job candidates, and to provide insights into how companies can recruit and retain bachelor's-level students more effectively. This may lead to co-op opportunities, continuing education programs, paid graduate programs, or a host of other collaborative models for encouraging student success and employee recruitment/retention in the field. Furthermore, by having students actively engaged in research, development, quality assurance/quality control (QA/QC), etc. in the region, they will experience first-hand the culture of innovation and will see how risk-taking and experimentation can be both challenging and rewarding for a company.

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.

Based on research conducted and published by Drs. Tangrea and Thompson,[5] 87% of biohealth companies in the region are actively trying to hire students at the bachelor's degree level. Combining this need with improved student preparation (experiential learning through research, internships, and co-ops, etc.), Loyola is hopeful to begin providing a steady stream of well-qualified, experienced, and talented students into Maryland's workforce. Students will be ready to commercialize products (marketing, economic analyses, start new companies, etc.), or to work with data (data analytics, health IT, wearables, etc.). Careers for which students will be prepared offer excellent starting salaries and significant potential for personal and professional growth.

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

[5] Thompson, C., Sanchez, J., Smith, M., Costello, J., Madabushi, A., Schuh-Nuhfer, N., . . . Rivers, D. (2018). Improving Undergraduate Life Science Education for the Biosciences Workforce: Overcoming the Disconnect Between Educators and Industry. *CBE Life Sciences Education, 17*(3), es12. DOI 10.1187/cbe.18-03-0047

The Biohealth program and Digital Health and Data Analytics concentration provide a wide breadth of skills. Many of the jobs associated with these areas of interest include therapeutics, diagnostics, medical devices, biomarkers, health informatics, medical supply sales, marketing, management, biohealth cybersecurity, and digital health. Although many of these jobs are not listed specifically within the U.S. Bureau of Labor Statistics, employment websites, such as Indeed, list numerous jobs in these areas. For example, Indeed lists over 28,000 job openings in therapeutics alone in the last week, of which nearly 300 are within the Baltimore area. Diagnostics lists over 42,000 jobs in the U.S. and over 2800 job opportunities in the Baltimore area in the past week. The medical supply sales, marketing, and management category has listed 23,000 job openings nationwide and 1,200 in the Baltimore area in the past week.

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.

Examples of possible occupations graduates of the proposed program could enter that are listed within the Bureau of Labor Statistics data include:

Occupation Title	SOC Code	Employment, 2021	Projected Employment, 2031	Change, 2021-31	
				Percent	Numeric
Advertising, promotions, and marketing managers	—	347,000	380,700	10	33,700
Agricultural and food scientists	19-1010	37,300	40,200	8	3,000
Food scientists and technologists	19-1012	14,400	15,300	6	800
Biological technicians	19-4021	84,300	92,000	9	7,700
Biomedical engineer	17-2031	17,900	19,700	10	1,700
Microbiologists	19-1022	20,800	22,600	9	1,900
Natural science managers	11-9121	78,800	83,400	6	4,600
Sales representatives, wholesale and manufacturing, technical and scientific products	41-4011	280,700	295,100	5	14,400

Source: U.S. Bureau of Labor Statistics, Employment Program, Occupational Outlook Handbook, https://www.bls.gov/ooh/home.htm

	Maryland Employment Projections		United States Employment Projections		Projected Employment Growth		Projected Job Openings	
Occupations	2018	2028	2020	2030	MD	U.S.	MD 2018-2028	U.S. 2020-2030
Clinical Data Managers	3,900	4,870	63,200	83,000	25%	31%	720	7,100
Clinical Research Coordinators	4,580	4,810	79,000	83,500	5%	6%	580	6,000
Compliance Managers	17,540	18,940	573,000	615,300	8%	7%	4,700	47,100
Molecular and Cellular Biologists	5,280	5,500	46,200	47,900	4%	4%	810	4,200
Soil and Plant Scientists	520	590	18,800	20,700	14%	10%	90	2,300
Bioinformatics Technician	230	260	63,200	83,000	13%	31%	40	7,100
Medical & Clinical Laboratory Technologists	8,060	9,710	335,500	372,000	21%	11%	730	25,900
Technical Writers	2,780	3,190	52,300	58,300	15%	12%	380	5,500

Source: O*NET OnLine is sponsored by the U.S. Department of Labor, https://www.onetonline.org/

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

To Loyola's knowledge, there are no Maryland colleges or universities that offer a Digital Health and Data Analytics concentration within a bachelor's degree; therefore, there is no past data to present.

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.

To Loyola's knowledge, there are no Maryland colleges or universities that offer a bachelor's level area of concentration in Digital Health and Data Analytics. The concomitant program proposal for the B.S. in Biohealth addresses degree level program similarities and differences.

Towson University offers a concentration in Bioinformatics. The curriculum of the two concentrations are not similar. Towson's Bioinformatics concentration requires significantly more mathematics, chemistry, and technical skills than the proposed concentration which serves a different purpose. (See Appendix H.)

2. Provide justification for the proposed program.

To Loyola's knowledge, there are no Maryland colleges or universities that offer a bachelor's level area of concentration in Digital Health and Data Analytics. The concomitant program proposal for the B.S. in Biohealth degree program addresses degree level program similarities and differences.

This proposal is focused on helping students explore a burgeoning field and has been created to assist in meeting the demand for jobs within the state and the country while also preparing them for further education (e.g., graduate programs).

Unprecedented growth in the BioHealth Capital Region's (BHCR) bioscience industries has occurred since 2001, with more than 1300 biotechnology-related companies now located in the region. The burgeoning industry has led to the creation of nearly 100,000 jobs in the BHCR during the last decade, with forecasts for the workforce to double by 2023.[6] Surprisingly, growth has been limited by the inability to attract and retain a sufficient workforce. Talent seekers consistently reported that jobs remain vacant for extended periods of time, positions go unfilled, and competent employees are recruited away to larger markets. The biggest pool of potential talent resides within the region's colleges and universities. Nearly 100,000 undergraduate students are enrolled in STEM programs throughout the BHCR that, in turn, should serve as a direct talent pipeline for the bioscience workforce.[7] Likewise, the Greater Baltimore and metropolitan DC regions represent two of the most highly educated markets in the United States and educate tens of thousands of students in bioscience-related fields annually. However, this impressive output of students trained in STEM disciplines has not translated into a sustainable bioscience workforce.

In 2020, the Maryland Department of Commerce awarded a Maryland E-Nnovation Initiative Fund grant to Loyola University Maryland to establish an endowed professorship in innovation to help expand scientific research in biohealth and to promote economic and entrepreneurial success in the State of Maryland. The faculty member in the new endowed professorship in innovation has worked within Loyola's biology department to grow undergraduate biomedical research, provide students with professional skills to work in bioscience industries, create new biotechnology research opportunities that extend undergraduate students' exposure to scientific careers, and develop community partnerships with private and public health research organizations. Loyola's proposal is tied directly to the state's investment through this grant to advance biohealth innovation at Loyola and in Maryland.

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[6] 8th Annual BIOHEALTH Capital Region Forum, October 4, 2022, https://www.biohealthinnovation.org/biohealthnews/biohealth-regional-news/13972-8th-annual-biohealth-capital-region-forum-recap

[7] Zheng, X., Stapleton, L.M., Henneberger, A.K., & Woolley, M.E. (2016). Assessing the Workforce Outcomes of Maryland Science, Technology, Engineering, and Math (STEMP) Postsecondary Graduates. Baltimore, MD: Maryland Longitudinal Data System Center.

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 HBIs.

To Loyola's knowledge, there are no Maryland colleges or universities that offer a bachelor's level area of concentration in Digital Health and Data Analytics. Thus, there should be no impact on HBIs.

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.

To Loyola's knowledge, there are no Maryland colleges or universities that offer a bachelor's level area of concentration in Digital Health and Data Analytics. Thus, this proposal should have no impact on the uniqueness and institutional identities and missions of HBIs.

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.

The Biohealth B.S., an in-person program, was established through Loyola University Maryland's internal governance, including review by faculty on the Undergraduate Curriculum Committee and the Academic Senate, review by faculty and administrators on the Loyola Conference, which attends to strategic matters of the University, review by the Board of Trustees, and endorsement by the Interim Provost and Vice President for Academic Affairs and the President of the University.

Drs. Christopher Thompson (Professor) and Michael Tangrea (Endowed Professor supported through a Maryland E-Nnovation grant) will serve as the program directors and developed the program proposal with chair of the Biology Department Dr. Lisa Scheifele. (Faculty are described more fully in Appendix D.) The curricular goals derive from the university mission, a strong foundation in biology, and local employer needs. The program design incorporates multiple disciplines, experiential learning, and the flexibility of three different areas of concentration; this proposal focuses on the Digital Health and Data Analytics area of

concentration. Depending on a student's educational goals, this program can prepare them for direct entry to the workforce or to advance to research-based graduate education.

Undergraduate biology programs prepare students almost exclusively for "traditional" career paths (e.g., medicine, dentistry, etc.), thereby providing insufficient skill development for alternative careers or the changing workforce environment. A clear disconnect exists between academic institutions and the modern workplace, jeopardizing the nation's ability to prepare future generations of scientists and engineers equipped with the necessary skills to meet workforce demands. Innovative and integrative approaches are needed, involving all stakeholders in remolding of STEM educational and training paradigms. This means direct integration of workforce technical and professional skills into undergraduate science and engineering curricula with the inclusion of more diverse populations of students. The proposed program is designed to address some of these challenges by building a curriculum that requires significant, real-world experiences beyond the classroom – a relatively rare requirement within biology programs nationwide. Data clearly indicate that if these authentic opportunities are introduced earlier in students' curricular experiences and last longer than a typical 10-week summer program,[8] there will be a significant and positive benefit to the students, partner companies, and the institution, broadly. Loyola's liberal arts education rooted in the Jesuit tradition is uniquely positioned to lead in this area, as many publications have underscored the need for STEM training to also include social justice and altruistic value components to help alleviate disconnection and marginalization that underrepresented groups feel in current academic paradigms.

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

The program will provide novel pathways for students to develop the skills and networks necessary for success in this diverse and changing workforce. Students in this area of concentration will experience and receive training in key aspects of digital health and data analytics, including critical and professional writing, presentation of results, data analysis, and ethical components of the profession. The core courses of the curriculum will develop and promote skills needed for multiple career paths, including excellent oral and written communication skills, intellectual curiosity, use of interdisciplinary approaches, critical and analytical thinking skills, and commitment to life-long learning.

The required and elective courses for the concentration were specifically chosen to help students broaden and deepen their understanding of themes in biohealth. The digital health and data analytics AOC will allow students to deeply explore the intersection of computer programming

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[8] Hansen, Alexandria K, Connors, Patrice, Donnelly-Hermosillo, Dermot, Full, Robert, Lanier, Hayley, Lent, David, Nation, Jasmine, Tucker, Kimberly Pause, Ward, Jennifer, Whitenack, Lisa, Zavaleta, Erika, "Biology Beyond the Classroom: Experiential Learning Through Authentic Research, Design, and Community Engagement" Integrative & Comparative Biology, September 2021: https://academic.oup.com/icb/article/61/3/926/6313284

(CS151, IS352 plus ST310), data analysis (IS251, IS353 plus IS358, IS460, and DS303), and business (for example BA210 and EG491/CS491/ PH491).

The concentration will be augmented with authentic research/internship experiences that allow students to put into practice the skills they learned in the classroom and laboratory. The courses included in the requirements and AOC have been vetted through traditional mechanisms at the departmental level, and each aligns with departmental and university learning objectives. The courses are rigorous but also scaffold student learning to develop a deeper understanding of the material and to foster growth of transferable/durable skills.

Biohealth Program Learning Outcomes

By completing this program, students will be able to:

- Demonstrate a basic knowledge of biological systems and associated laboratory/field skills
- Demonstrate proficiency in communicating information in a variety of formats, including verbal, written, and symbolic (mathematical) channels
- Articulate the ethical issues and Jesuit values surrounding the practice and direction of biological research, marketing, and/or acquisition, storage, and transfer of patient/user data
- Synthesize the interaction among business, communication, marketing, and biology in the context of biohealth product development

3. Explain how the institution will:

a) provide for assessment of student achievement of learning outcomes in the program

Assessment of student learning outcomes will be conducted according to the schedule as indicated in Appendix A.

b) document student achievement of learning outcomes in the program

The Biology Department assessment subcommittee will be responsible for collecting direct evidence of student work, developing assessment rubrics, defining metrics of success, scoring student work against the rubrics, and compiling the data annually for the department, program directors, steering committee and deans. A complete assessment report is submitted to and evaluated by the dean's office annually, and the dean meets with the chair each year to discuss departmental progress. The results of the assessment will be used for continual improvement of the program.

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

Students are considered to have met their graduation requirements when they have completed all degree requirements. Degree requirements include successful completion of the requirements of their major and area of concentration, a minimum of 38 courses (3-, 4-, or 5-credit courses), the diversity course graduation requirement, satisfaction of Loyola's Core Curriculum, all totaling a minimum of 120 credits, while maintaining a minimum cumulative average of 2.000 in all Loyola courses. The residency requirement is satisfactory completion of at least 60 credits at Loyola University Maryland.

The proposed Bachelor of Science in Biohealth is a 120-122-credit program with three Areas of Concentration. All students complete Loyola's liberal arts core curriculum, which includes 47 credits. The major includes 20 credits of required biohealth core courses plus an area of concentration, ranging from 24 to 30 credits. Each concentration includes two internship or research courses. The Digital Health and Data Analytics concentration is composed of nine courses and ranges from 29-30 credits, based on student choice. Students majoring in Biohealth would have eight to ten 3-credit non-major ("free") electives, amounting to another 24 to 30 credits of non-major electives. See program advising sheets in Appendix B for the full requirements of the concentration.

A list of courses and descriptions is included in Appendix C.

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

Loyola undergraduate students are required to satisfy the requirements of the Loyola Core Curriculum. The Loyola Core Curriculum comprises the foundations of a liberal arts education in the Jesuit tradition. Courses span areas in the humanities, social sciences, and natural sciences/mathematics. They include disciplines such as fine arts, writing, English, history, theology, philosophy, and ethics. The diversity course requirement focuses on domestic diversity, global diversity, or justice.

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

No specialized accreditation is required for the program.

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

The proposal does not include contracting with another institution or non-collegiate organization.

8. 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 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 program requirements, including pre-requisites, curriculum, administration, financial aid, and any other relevant information will be maintained on the program's website and in the undergraduate catalogue. The program directors will be responsible for ensuring that the webpage remains current and that students are informed of any changes. Individual course requirements will be clearly delineated on syllabi and in catalogue descriptions prior to registration. The program directors will also be available to discuss program/course requirements and university services during office hours or by appointment.

Loyola provides support services that include an Office of Technology Services, Counseling Center, Disability Support Services, Financial Aid Office, the Loyola-Notre Dame Library, a National Fellowships Office, The Study, the Writing Center, and many other support services to assist students for success. As mentioned above, Loyola's website provides the appropriate program costs and student support resources, including required consumer information disclosures.

9. 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 Maryland 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 Marketing and Communications, the 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.

Loyola's 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 key resource for students. At Loyola, all websites are maintained by 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.

No formal articulation agreements for this program have been developed with partner institutions. However, Loyola offers a seamless transfer program to students who complete an associate degree at a Maryland community college. Most students who complete their associate degree at any Maryland community college will be considered as having fulfilled all Loyola core requirements (with the exception of two courses that would fulfill the theology and philosophy requirements) that serve as the foundation of our Jesuit liberal arts curriculum. Additionally, if students have taken at least two semesters of a college-level foreign language (e.g., Spanish 101 and 102), they will have completed Loyola's language requirement.

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 the proposed program.

See Appendix D, for a list of the faculty who will teach in the proposed program AOC. The program's faculty are distinguished and meet or exceed the requirements set in COMAR as well as Loyola University Maryland faculty requirements.

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

Loyola currently offers two formal university-wide teaching enhancement workshops each year for all faculty, as well as numerous less formal pedagogical opportunities throughout the year. Several workshop sessions are dedicated to pedagogical training for faculty and instructors, including discussions of best practices for promoting student learning. In 2018, Loyola established Teaching Fellows who act as learning communities to research, incorporate, and disseminate best practices. Cohorts of teaching fellows have been formed for high-impact teaching practices, equity and inclusion, and digital teaching and learning.

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, including support and training for face-to-face courses that supplement learning with digitally enhanced support.

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

The program is not a distance education program. However, the Office of Digital Teaching and Learning instructional designers are available to develop on-line classes. Loyola as a whole follows quality assurance standards for online education programs including adhering to C-RAC guidelines.

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.

The Loyola-Notre Dame Library (LNDL) staff reviewed the proposed program and affirmed the library has adequate resources to support the proposed program, providing a large collection of resources for students. The staff provided a list of existing and recommended resources for the Biohealth bachelor's program to help students gain greater understanding within their chosen concentration. The list can be found in Appendix E, and the expenses for the recommended resources have been incorporated in the program expenditures budget table in Appendix G.

Existing costs will be supported by Loyola College of Arts and Sciences and the Office of Academic Affairs. The president's signature on the Commission's Proposal Cover Sheet indicates his support for the library resource to meet the program's needs.

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.

Because the proposed program relies only on already-existing courses and resources, there should be no change in needs for existing facilities, equipment, staff or laboratories, so the program can be implemented with the current resources in place at our institution. The Loyola College of Arts and Sciences and the Office of Academic Affairs have committed to the resources required for the library and marketing of the program. If the program is successful, an affiliate faculty member could be added to the program, and the expenditure would be offset by tuition revenues.

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

The proposed program is not a distance education program. Regardless of program delivery mode, students are provided with an electronic mailing system and other technologies listed above in section G8, upon matriculation. The institution has several computer labs and utilizes Moodle as the learning management system. The Office of Technology Services provides technical support for all student email accounts and for those using the learning management system.

b) a learning management system that provides the necessary technological support for distance education

The program is not a distance education program. All students enrolled in the program are provided access to the university's learning management system. The Office of Technology Services provides technical support for all student email accounts and for those using the learning management system. The Office of Digital Teaching and Learning provides additional support to students and faculty specifically for distance education courses.

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.

See the Resources Table in Appendix F.

Loyola University Maryland will provide the resources required to support the proposed program. Revenue from the program is expected to exceed expenses within the first year of the program's start.

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.

See the Program Expenditures Table in Appendix G.

Expenditures are limited and no new faculty are projected until the fourth year of program implementation. This faculty line is projected for an assistant teaching professor and will be required only in the event the program is successful and meets or exceeds projected growth.

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.

Loyola University Maryland utilizes several mechanisms for evaluating courses, including student course evaluation, faculty peer evaluations, and faculty annual updates. The latter require faculty to perform self-evaluation of courses and teaching effectiveness, and to provide evidence of achieving student learner outcomes. In turn, all these assessment vehicles are evaluated by the department chair and dean. In the case of Loyola's proposed Biohealth program, a review will be performed annually by the Chair of the Biology Department and the Associate Dean for the Natural and Applied Sciences.

See Appendix A.

2. 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.

The results of the assessment will be used for continual improvement of the program. Reports will be completed regularly and will include measures of student achievement of the program learning outcomes. The reports, an assessment cycle, and the curricular map will be recorded in a centralized software system used university-wide. Institutional evaluation will occur in accordance with the University's and Middle State's accreditation timelines. The cost-effectiveness of the program will be reviewed annually by the Dean.

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 seven-year cycle at Loyola, and assessment of the Biohealth program will be included in the next Biology Department program review in 2027.

See Appendix A.

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.

Loyola University Maryland has a strategic focus on enhancing equity and inclusion for the university community. The university is committed, through its mission and core values, to

creating a community that embraces and celebrates the inherent value and dignity of each person. The strategic plan goal to enhance equity and inclusion guides faculty and administrators' work toward promoting inclusive academic excellence. Specifically, teaching practices identified by AAC&U as highly impactful for the success of all students are being incorporated more fully in academic and cocurricular programs across the university. The provost has invested in related professional development by funding cohorts of faculty fellows to explore, employ, disseminate, and support high-impact teaching strategies. Faculty Fellows for High-Impact Practices (HIPs) are represented in all three schools, including the Loyola College of Arts and Sciences. Following a similar model, a cohort for Equity & Inclusion Fellows and a cohort for Digital Teaching and Learning has been established.

Furthermore, a variety of studies have indicated that internships are key to improving a college student's return on investment and minimizing underemployment. This is especially true for students of color.[9,10] By requiring internships or other authentic experiences, this proposed major will provide students from diverse backgrounds with the tools, mentors, and skills to discern their path and to embark upon a successful career.

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.

This program is not a low productivity program.

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.

Loyola University Maryland is approved to offer distance education, but this program is not a distance education program.

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

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[9] https://www.naceweb.org/diversity-equity-and-inclusion/trends-and-predictions/racial-disproportionalities-exist-interms-of-intern-representation/

[10] https://forms.workday.com/content/dam/web/en-us/documents/whitepapers/Dynamos%20for%20Diversity.FINAL.pdf

Loyola University Maryland is approved to offer distance education and abides by C-RAC Guidelines, but this program is not a distance education program.

Appendix A: Assessment

The following 4-year cycle will be used to assess the learning aims of the biohealth program and has been chosen to bring the biohealth program into alignment with the BS in Biology major for shared learning objectives. Gray boxes show the year in which assessment will occur.

Learning Outcome	**2023-24**	**2024-25**	**2025-26**	**2026-27**
1. Students will demonstrate a basic knowledge of biological systems and associated laboratory/field skills.				
2. Students will demonstrate proficiency in communicating information in a variety of formats, including verbal, written, and symbolic (mathematical) channels.				
3. Students will articulate the ethical issues and Jesuit values surrounding the practice and direction of biological research, marketing, and/or acquisition, storage, and transfer of patient/user data.				
4. Students will synthesize the interaction among business, communication, marketing, and biology in the context of biohealth product development.				

Assessment of student learning outcomes will be conducted according to the schedule below. The results of the assessment will be used for continual improvement of the program. Programs engage in Academic Program Review on a seven-year cycle at Loyola, and assessment of the Biohealth program will be included in the next Biology department program review in 2027. Institutional evaluation will occur in accordance with the University's and Middle State's Accreditation timelines.

Curriculum Map for BS in Biohealth

Required Courses	LO1	LO2	LO3	LO4
BL118/BL119	x			
BL121/BL126	x			
BL201/BL202	x	x		
BL315	x	x	x	x
ST210 or ST265		x		
CS105 or CS106 or CS107				
MK240		x		
AC201 or MG201				x
WR326		x		
BL399 or other internship courses	x	x	x	x

Program Learning Outcomes:

By completing this program, students will be able to:

1. Demonstrate a basic knowledge of biological systems and associated laboratory/field skills.
2. Demonstrate proficiency in communicating information in a variety of formats, including verbal, written, and symbolic (mathematical) channels.
3. Articulate the ethical issues and Jesuit values surrounding the practice and direction of biological research, marketing, and/or acquisition, storage, and transfer of patient/user data.
4. Synthesize the interaction among business, communication, marketing, and biology in the context of biohealth product development

Appendix B: Advising Sheet

LOYOLA
UNIVERSITY MARYLAND

Biohealth Bachelor of Science:

Area of Concentration in Digital Health and Data Analytics

Liberal Arts Core Curriculum	***Credits***
1. WR 100 Effective Writing	3
2. History 100 Encountering the Past	3
3. EN 101 The Art of Reading	3
4. History 200 Level ***OR*** English 200 Level	3
5. World Language Intermediate II Level (104 level)*	3
6. Social Science Core	3
7. Social Science Core	3
8. Fine Arts (AH109, AH110, AH111, DR250, DR251, DR252, MU201, MU202, MU203, MU204, PT270, SA224 or SA227)	3
9. ST 210: Statistics ***OR*** ST 265: Biostatistics	3
10. BL 118 Intro to Cellular and Molecular Biology	3
BL 119 Intro to Cellular and Molecular Biology Lab (1 cr.)	1
11. BL 121 Organismal Biology	3
BL 126 Organismal Biology Lab (1 cr.)	1
12. PL 201 Foundations of Philosophy	3
13. TH 201 Theology Matters	3
14. PL 202 – 299 ***OR*** TH 202 – 299	3
15. Ethics: PL 300 – 319 ***(If student took TH 202 – 299 for #14)*** TH 300 – 319 ***(If student took PL 202 – 299 for #14)***	3
Diversity Course**	
Liberal Arts Core Curriculum – Credit Subtotal	47

Biohealth B.S. Program Core	***Credits***
BL 118 Intro to Cellular and Molecular Biology and BL 119 Intro to Cellular and Molecular Biology Lab (1 cr.) *BL118 meets science course requirement for Liberal Arts Core*	***
BL 121 Organismal Biology and BL 126 Organismal Biology Lab (1 cr.) *BL 121 taken w/ BL 126 meets science lab requirement for Liberal Arts Core*	***
ST 210: Statistics ***OR*** ST 265: Biostatistics *ST 210 or ST 265 meets the Mathematics requirement for Liberal Arts Core*	***
16. BL 201 Ecology, Evolution, and Biodiversity	3
BL 202 Proc. of Sci. and Ecology, Evolution, and Biodiversity Lab (2 cr.)	2
17. BL 315 Bench to Bedside	3
18. CS 105/106/107 Making Sense of Data	3
19. MK 240 Marketing	3
20. AC 201 Financial Accounting ***OR*** MG 201 Management	3
21. WR 326 Technical Writing	3
Biohealth B.S. Program Core – Credit Subtotal	20

Digital Health and Data Analytics Concentration Requirements	***Credits***
22. CS 151 Computer Science through Programming ***OR*** IS 352 Intro to Programming in Python	3-4
23. IS 251 Data Analytics and Info Systems	3
24. IS 353 Data Management and Database Systems	3
25. IS 358 Business Intelligence and Data Mining	3
26. MA 251 Calculus I	4
27. BL 399 or BL 481 Internship or Research Course	3
28. BL 400 or BL 482 Internship or Research Course	3
29. Concentration Elective	3
30. Concentration Elective	4
Digital Health and Data Analytics Area of Concentration – Credit Subtotal	29-30

Electives	***Credits***
31. Free Elective	3
32. Free Elective	3
33. Free Elective	3
34. Free Elective	3
35. Free Elective	3
36. Free Elective	3
37. Free Elective	3
38. Free Elective	3
Free Electives – Credit Subtotal	24
Degree Program – Credit Total	120-121

Summary: Loyola Core Curriculum is 15 courses plus labs, totaling 47 credits; Biohealth B.S. with an area of concentration in Digital Health and Data Analytics is 15 courses plus labs, totaling 49-50 unduplicated credits, and the total degree program is 38 courses plus labs, totaling 120-121 credits.

*Students who place higher than the 104 level on Loyola's world language placement exam may be exempt from the world language core requirement, pending confirmation from Loyola's Modern Language department after a **proctored on-site** placement exam. Those students will need to complete 1 additional free elective in lieu of the world language core.

The Diversity course requirement may simultaneously fulfill a Core, Major, Minor or Elective requirement. The Diversity course may be taught in any discipline and will focus on domestic diversity, global diversity, or justice awareness. **The Diversity course must be taken at Loyola.

***Course meets both a requirement of the Biohealth program requirements and meets Loyola's Liberal Arts Core requirement. Credits for these courses included under Loyola's Liberal Arts Core credit total.

Menu of Electives for the Digital Health and Data Analytics Concentration

Students choose two courses from among these electives:		
Course Number	**Course Title**	**Credits**
BA210	Design Thinking and Innovative Solutions	3
IS460	Data Visualization	3
MA252	Calculus II	4
EG491/CS491/PH491	Technical Innovation and Entrepreneurship	3
DS303	Discovering Information in Data	3
ST310	Statistical Computing	3

Appendix C – Course Descriptions

Course Descriptions - Digital Health and Data Analytics Area of Concentration

AC 201 - Financial Accounting
(3.00 cr.)
Focuses on introducing financial accounting which provides information for decision makers outside the entity primarily by means of general-purpose financial statements. Students acquire a basic knowledge of the language of business. Topics include the application of accounting theory and generally accepted accounting principles to business transactions encountered by corporations during the accounting cycle.

BA 210 - Design Thinking and Innovative Solution
(3.00 cr.)
Innovation and human-centered design are the driving force behind the collaborative mindsets that employers and communities are looking for to create socially focused solutions. By adopting this human-centered approach, successful entrepreneurs not only create new social or commercial ventures, but also reinvent companies to remain competitive in an ever-changing market. Students apply the tools, methods, and self-reflection techniques necessary to thrive in a fast-paced environment that puts a premium on empathy and the exchange of diverse ideas to bring innovative solutions to reality. Ideation techniques are used to develop new human-centered ideas that change or build upon established practices and are applied in collaboration with classmates and community members to create new products or solutions. Students apply creative skills through journaling, storytelling, and extensive out of class time dedicated to collaborative group work.

BL 118 - Introduction to Cellular and Molecular Biology
(3.00 cr.)
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.

BL 119 - Introduction to Cellular and Molecular Biology Lab
(1.00 cr.)
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.

BL 121 - Organismal Biology
(3.00 cr.)
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.

BL 126 - Organismal Biology Lab
(1.00 cr.)
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.

BL 201 - Ecology, Evolution, and Biodiversity
(3.00 cr.)
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.

BL 202 - Process of Science and Ecology, Evolution, and Biodiversity Lab
(2.00 cr.)
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 315 - Bench to Bedside: Translating Science to Patient Care
(3.00 cr.)
How do bioinnovations advance patient care and improve our ability to diagnose and treat disease in the clinical setting? Any new medical device or molecular diagnostic on the market today started originally as an idea in a scientific laboratory. This seminar course follows this exciting “Bench to Bedside” path from idea creation to impacting patient care. Topics may include an introduction to biomedical research and development, intellectual property protection, grant funding, and clinical research. Through this course, students follow the journey of delivering a novel biomedical product to improve the lives of patients. Written assessments, discussions, and oral presentations supplement text and lecture material.

BL 399 - Biology Internship I
(3.00 cr.)
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 400 - Biology Internship II
(3.00 cr.)
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. Does not count towards fulfillment of major requirements for the Biology or Biology interdisciplinary program. May only be taken as a free elective.

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.

BL 482 – Biology Research II
(3.00 cr.)
A continuation of BL481. Written or electronic permission of a sponsoring faculty member. Does not count towards fulfillment of major requirements for the Biology or Biology interdisciplinary program. May only be taken as a free elective.

CS 105 - Making Sense of Data with Database Management Systems
(3.00 cr.)
The world is flooded with data, but data by itself is useless. It needs to be gathered, processed, analyzed, visualized, and finally interpreted. This course examines real world data and the tools needed to make sense of it. Students learn what data is, how it is processed, how it can help predict the future, and what ethical dilemmas arise from data analytics. The use of logic in writing data analysis programs is emphasized. Students gain hands-on experience analyzing data with high-level programming, spreadsheets, and database management systems. Recommended for business majors. Fulfills one math/science core requirement.

CS 106 - Making Sense of Data with SPSS
(3.00 cr.)
The world is flooded with data, but data by itself is useless. It needs to be gathered, processed, analyzed, visualized, and finally interpreted. This course examines real world data and the tools needed to make sense of it. Students learn what data is, how it is processed, how it can help predict the future, and what ethical dilemmas arise from data analytics. The use of logic in writing data analysis programs is emphasized. Students gain hands-on experience analyzing data with high-level programming, spreadsheets, and SPSS.

CS 107 - Making Sense of Data with Matlab
(3.00 cr.)
The world is flooded with data, but data by itself is useless. It needs to be gathered, processed, analyzed, visualized, and finally interpreted. This course examines real world data and the tools needed to make sense of it. Students learn what data is, how it is processed, how it can help predict the future, and what ethical dilemmas arise from data analytics. The use of logic in writing data analysis programs is emphasized. Students gain hands-on experience analyzing data with high-level programming, spreadsheets, and Matlab.

CS 151 - Computer Science through Programming
(4.00 cr.)
Introduces students to problem solving with the fundamentals of programming, enabling them to decompose complex problems into elementary steps for effective implementation in a modern programming language. Students work with numeric and textual data, procedural programming with conditionals and loops, basic linear data structures, and on testing their solutions. Problems may draw on topics in computer security, data encoding, graphics, games, financial analysis, physical models, and others. Provides a general survey of some of the major areas of computer science, such as digital logic, software engineering, computer graphics, artificial intelligence, theory of computation, object-oriented programming, and ethical and societal issues in computing.

CS 491 – Technical Innovation and Entrepreneurship
(3.00cr.)
A survey of innovation and entrepreneurship. Introduces theoretical frameworks and examples of issues, skills, and challenges of innovating in the fields of science and engineering. Establishes multidisciplinary skill sets for creating and managing technology-based entrepreneurship. Includes idea generation evaluation, intellectual property, teamwork, business plans, financing through private and public sources, developing and marketing products, and legal issues. Includes a semester-long group project with a faculty and/or industrial mentor. *Written or electronic permission of the instructor. Same course as* EG 491 *and* PH 491.

DS 303 - Discovering Information in Data
(3.00 cr.)
Students use tools for acquiring, cleaning, analyzing, exploring, and visualizing data. This course teaches students how to make data-driven decisions and effectively communicate results. A major component of this course is learning how to use python-based programming tools to apply methods to real-life datasets including those that arise from physics applications.

EG 491 - Technical Innovation and Entrepreneurship
(3.00 cr.)
A survey of innovation and entrepreneurship. Introduces theoretical frameworks and examples of issues, skills, and challenges of innovating in the fields of science and engineering. Establishes multidisciplinary skill sets for creating and managing technology-based entrepreneurship. Includes idea generation evaluation, intellectual property, teamwork, business plans, financing through private and public sources, developing and marketing products, and legal issues. Includes a semester-long group project with a faculty and/or industrial mentor.

IS 251 - Data Analytics and Information Systems
(3.00 cr.)
Students examine the strategic role of information systems in organizations and the integration of data analytics into business activities enabling quality, timeliness, and competitive advantage. They are immersed in the collection, exploration, visualization and application of data to make informed business decisions. Students apply database, spreadsheet, and visualization skills to solve real world business challenges. Students develop a real-world data visualization project relatable to a business application of real world data.

IS 352 - Introduction to Programming in Python
(3.00 cr.)
An introduction to software development with an emphasis on real-world applications. Students are introduced to programming in a modern computer language with Python. Principles of program design, programming structures, data structures, program testing, and debugging are covered. Emphasis is placed on developing an applied analytics project relatable to a business application.

IS 353 - Data Management and Database Systems
(3.00 cr.)
Students analyze, create a logical design, and implement the physical design for a relational database system. The course includes significant exposure to SQL (Structured Query Language) in both Microsoft Access and Oracle. Students are also exposed to the challenges associated with valuing data as a digital asset and with information lifecycle management (ILM).

IS 358 - Business Intelligence and Data Mining
(3.00 cr.)
Students are introduced to data mining as a technology to discover information and knowledge from large datasets for business decisions. Students utilize SAS Enterprise Miner™ to perform data mining using methods such as clustering, regression and decision trees. Students develop a real world project using leading business intelligence technology for data mining. Forms the foundation for customer relationship management in marketing and for forensic accounting.

IS 460 - Data Visualization
(3.00 cr.)
Investigates the processing and cleaning of real-world datasets and their appropriate representation in visual form. Data resides in a multitude of databases and formats and comes in a variety of forms such as structured, semi-structured, and unstructured. Making data understandable to non-technical users requires knowledge of the best techniques for presenting data to aid in its interpretation. This course focuses on the use of data visualization coding techniques in software applications such as Tableau™, Python, and R. Students discover how to create bar charts, line charts, dual axis plots, histograms, trellis charts, pie charts, donut charts, nested pie charts, bump charts, heatmaps, spider plots, maps, and more.

MA 251 - Calculus I
(4.00 cr.)
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.

MA 252 - Calculus II
(4.00 cr.)
A continuation of MA 251. Techniques and applications of integration; improper integrals; parametric equations and polar coordinates; sequences and series.

MG 201 - Management
(3.00 cr.)
Develops knowledge and skills in the management of organizational behavior (OB). A focus is placed on how organizations create value through people by fostering employee performance, commitment, and well-being. Topics include individual characteristics such as personality and ability, motivational characteristics such as job attitudes, stress, motivation, relationships, and learning, organizational characteristics such as power, leadership, teamwork, and organizational culture. The learning method is experiential with a focus on lectures, self and team assessments, cases, class discussions, exercises and simulations, and team projects, cases, team decisions, and discussion. Testing methods may include exams, papers, and team projects.

MK 240 - Marketing
(3.00 cr.)
Students acquire an understanding of marketing’s role in helping an organization create value. Students learn to identify the elements of the marketing mix, recognize how these elements can be integrated to achieve organizational objectives, and describe a product’s marketing plan. Topics include market research, consumer behavior, market segmentation, targeting, positioning, and the marketing mix-product, promotion, pricing, and distribution. This class typically involves working in teams to complete a team project.

PH 491 – Technical Innovation and Entrepreneurship
(3.00 cr.)
A survey of technical innovation and entrepreneurship. Introduces theoretical frameworks and examples of issues, skills, and challenges of innovating in the fields of science and engineering. Establishes multi-disciplinary skill sets for creating and managing technology-based entrepreneurship. Includes idea generation, evaluation, intellectual property, teamwork, business plans, financing through private and public sources, developing and marketing products, and legal issues. Includes a semester-long group project with a faculty and/or industrial mentor. *Written or electronic permission of the instructor. Same course as CS491 and EG491.*

ST 210 - Introduction to Statistics
(3.00 cr.)
A non-calculus-based course covering descriptive statistics; regression model fitting; probability; normal, binomial, and sampling distributions; estimation; and hypothesis testing. Degree credit will not be given for more than one of EG 381 or ST 210 or ST 265 or ST 381. Closed to students who have taken EC 220 or EG 381 or PY 292 or ST 265 or ST 381.

ST 265 - Biostatistics
(3.00 cr.)
A non-calculus-based course covering descriptive statistics, regression model fitting, probability, distributions, estimation, and hypothesis testing. Applications are geared toward research and data analysis in biology and medicine.

ST 310 - Statistical Computing
(3.00 cr.)
Reviews a number of statistics topics as a vehicle for introducing students to statistical computing and programming using SAS and R for graphical and statistical analysis of data. Statistics topics include graphical and numerical descriptive statistics, probability distributions, one and two sample tests and confidence intervals, simple linear regression, and chi-square tests. SAS topics include data management, manipulation, cleaning, macros, and matrix computations. Topics in R include data frames, functions, objects, flow control, input and output, matrix computations, and the use of R packages. Lastly, this course also includes an introduction to the resampling and bootstrap approaches to statistical inference. Required for statistics and data science majors.

WR 326 - Technical Writing
(3.00 cr.)
Helps students interested in business, the humanities, and the STEM fields prepare for jobs that require technical writing. Using industry-standard technology, such as Adobe Creative Suite and social media, students produce standard workplace documents, as well as instructions and technical descriptions. Students learn about project management, workplace ethics, and basic research methods through usability testing and user experience (UX) projects. Students collaborate in teams with clients or community partners to develop high-impact, visually dynamic documents such as grant proposals, websites, and multimedia applications. At the end of the semester, students deliver a presentation to refine public speaking skills.

Appendix D: Faculty

Loyola Faculty and Credentials for Proposed Digital Health and Data Analytics Concentration

Name	Highest Degree/Field	Rank	Status	Courses
Athaide, Dr. Gerard	Ph.D., Marketing	Professor	Full-time	MK240
Bender, Mr. Michael	Master of Taxation	Assistant Teaching Professor Executive in Residence	Full-time	AC201
Bishop-Monroe, Dr. Robbie	Ph.D., Business Administration	Assistant Professor	Full-time	AC201
Bui, Dr. Hoang	Ph.D., Computer Science and Engineering	Associate Professor	Full-time	CS151
Clark, Dr. Timothy	Ph.D., Algebra, Algebraic Combinatorics	Associate Professor	Full- time	MA251
Curtis, Dr. Tiffany	Ph.D., English	Assistant Teaching Professor	Full-time	WR326
Deshpande, Ms. Neeta	M.S., Statistics	Assistant Teaching Professor Mathematics and Statistics	Full-time	ST210/ST265
Drummey, Dr. Kevin	Ph.D., Statistics, Bayesian Statistics, Mathematics Education	Assistant Teaching Professor Mathematics and Statistics	Full-time	ST210/ST265
Feild, Dr. Jefferson	Ph.D., Computer Science	Affiliate Instructor Computer Science	Part-time	DS303
Galbraith, Dr. Michael	Ph.D., Mathematics	Affiliate Instructor Mathematics and Statistics	Part-time	MA252
Isaacman, Dr. Sibren	Ph.D., Electrical Engineering	Associate Professor	Full-time	CS151
Jefferson, Dr. Theresa	D.Sc. Information Management	Associate Professor	Full-time	IS358
Kenyon, Dr. Robert	Ph.D., Instructional Technology	Lecturer Director, Undergraduate Data Science Program	Full-time	CS105, CS106, CS107, CS151
Knapp, Dr. Michael	Ph.D., Number Theory	Professor	Full-time	MA251
Krahel, Dr. John Peter	Ph.D., Accounting	Associate Professor	Full-time	AC201
Kshetry, Ms. Pratima	M.S., Information Science	Assistant Teaching Professor	Full-time	IS353, IS352, IS251

Appendix D: Faculty

Name	Highest Degree/Field	Rank	Status	Courses
Lee, Dr. Bu Hyoung	Ph.D., Statistics: Time Series Analysis	Assistant Professor	Full- time	ST210, ST310
Lenzo, Mr. Salvatore	MBA	Director Information Systems for Sellinger School of Business and Management	Full-time	IS251
London, Dr. Jake	Ph.D., Management Information Systems	Assistant Professor of Information Systems	Full-time	IS251, IS352
Luvison, Dr. Dave	DBA, Management	Executive in Residence	Full-time	MG 201
Michel, Dr. John W.	Ph.D. Organizational Behavior	Associate Professor	Full-time	MG 201
Olsen, Dr. Megan	Ph.D., Computer Science	Associate Professor	Full-time	CS151
Oberbroeckling, Dr. Lisa	Ph.D., Mathematics	Associate Professor	Full-time	MA251
Peake, Mr. Adam	MBA	Executive in Residence	Full-time	MK240
Roche, Dr. Bernadette	Ph.D., Biology	Associate Professor	Full-time	BL 201/202
Romani, Dr. William	Ph.D., Education	Entrepreneur in Residence	Full-time	BA210
Roughani, Dr. Bahram	Ph.D., Physics	Associate Dean of the Natural and Applied Science	Full-time	CS491/ EG491/ PH491
Scheifele, Dr. Lisa	Ph.D., Cell/Cellular and Molecular Biology	Associate Professor	Full-time	BL 121/126, BL118/119,
Schoeffield, Dr. Andrew	Ph.D., Microbiology	Associate Professor	Full-time	BL121/126, BL118/119
Soroosh, Dr. Jalal	Ph.D., Accounting	Professor	Full-time	AC201
Tallon, Dr. Paul	Ph.D., Management	Professor	Full-time	IS353, IS460
Tao, Dr. Jiyuan	Ph.D., Applied Analysis, Optimization	Professor	Full-time	MA252
Tangrea, Dr. Michael	Ph.D., Molecular and Cellular Biology	Professor	Full-time	BA401, BL315 BL 118/119, BL121/126,
Thompson, Dr. Christopher	Ph.D., Immunology	Professor	Full-time	BL426/427 BL399, BL400 BL481, BL482
Veatch-Blohm, Dr. Maren	Ph.D., Plant Physiology	Associate Professor	Full-time	BL 201/202,
Zhang, Dr. Jason	Ph.D., Marketing	Professor	Full-time	MK240

Appendix E: Library Resources

Resources that Support the Program:

Books

LNDL and other USMAI libraries provide access to 6,307 categorized as "Biomedical", "Biopharmaceutics", and "Biotechnology", under Library of Congress subject headings. Roughly half of the available titles were published 2010-2022. Library staff recommend adding 30 print and 12 eBook titles to the collection over a three-year period to cover the new courses and program. Books in this subject area average $100 for print and $150 for ebooks, totaling $1,600 in year one and $4,995 with inflation over three years.

Related Library of Congress Subject Headings (broad to narrow)

Broad:
Biomedical
Biopharmaceutics
Biotechnology

Narrow:
Medical technology
Biomaterial
Bioengineering
Biotechnology—Risk assessment
Biomedical engineering
Computer applications to medicine
Medical informatics
Medical physics. Medical radiology. Nuclear medicine
Pharmacology
Pharmacokinetics

Journals

The library provides full-text access to the following key journals in this field:

Through current journal issue

- Biomedical Journal (2002-present)
- Biomedical Research (1980-present)
- BMC Biotechnology (2000-present)
- Health Informatics Journal (1999-present)
- Health Information Management (2006-present)
- Trends in Biotechnology (2000-present)

Select years or publisher embargoed content

- American Journal of Bioethics (2001-present – full text delay: 15 months)
- Nature Biotechnology (01/01/2000-08/31/2021)
- Nature Reviews Drug Discovery (01/01/2002-08/31/2021)

Databases

LNDL subscribes to several databases that would support this program including:

- American Chemical Society (ACS) Publications
- Business Source Complete
- CINAHL Plus with Full-Text
- Clinical Pharmacology
- Cochrane Database of Systematic Reviews
- DynaMed Plus
- Health Source: Nursing/Academic Edition
- MEDLINE
- Mergent Intellect
- Natural Medicines
- Nexis Uni
- PubMed
- ScienceDirect: Elsevier Journals
- SciFinder Scholar
- Springer Nature Biomedical and Life Sciences eBook Collection
- TOXLINE
- Web of Science

The library recommends adding the following database:

- **Journal of Visualized Experiments (JoVE) ($15,000 quote, Oct. 2022):** A peer-reviewed multi-disciplinary scientific video journal indexed in PubMed and Web of Science enables users to quickly and systematically learn new research methods and technologies developed at top science laboratories. Includes access to Science Education video library, JoVe Core video textbooks, and JoVe Lab Manual, whose content spans multiple disciplines including biology, molecular biology, chemistry, and organic chemistry.

When the program is approved, the library will add a link to the following open access database on our website. As open access material, no subscription or payment is required from LNDL for users to access this material:

- **TRIP Database:** Trip is a clinical search engine designed to allow users to quickly and easily find and use high-quality research evidence to support their practice and/or care.

Acquisitions

Resource	**Price Year 1**	**Price Year 2**	**Price Year 3**	**Inflation**
Databases	$15,600	$16,224	$26,873	4%
Journals	$0	0	0	-
Print and eBooks	$1,600	$1,664	$1,731	4%
Total Cost	**$17,200**	**$17,888**	**$18,604**	**4%**

Technology Support

LNDL offers a wide variety of technology that would support the instruction of the program, including virtual reality, 3D printers, a recording studio, visualization wall with touch screen capacity, video editing software, 360 cameras, laser cutter, and a large format printer. This technology has a number of potential uses. Virtual reality can provide students with experiences such as visualizing different anatomical systems, traveling through the body as a human cell, exploring chemical compounds and nanoparticles. Students could also use tools like the 3D printers and laser cutter to create physical representations of molecules or develop prototypes.

Research & Instruction Support

The Research and Instruction unit offers online and face-to-face scheduled consultations and assistance via 24/7 chat, the Help Desk, phone, and e-mail to support the research needs of these students. Because this is a graduate program and students will likely be unfamiliar with the Library, the Health and Natural Sciences Librarian can collaborate with faculty to develop justin-time research instruction. Additionally, existing library tutorials can be embedded into the learning management system to orient students to general Library services and resources.

Appendix F: Program Resources

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)	$199,135	$475,980	$767,201	$1,077,622	$1,234,472
a. Number of F/T Students	5	12	19	26	29
b. Annual Tuition/Fee Rate	$39,827	$39,665	$40,379	$41,447	$42,568
c. Total F/T Revenue (a x b)	$199,135	$475,980	$767,201	$1,077,622	$1,234,472
d. Number of P/T Students	0	0	0	0	0
e. Credit Hour Rate	0	0	0	0	0
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	0	0	0	0	0
4. Other Sources	0	0	0	0	0
TOTAL (Add 1 – 4)	$199,135	$475,980	$767,201	$1,077622	$1,234,472

Notes:
2.a. Plan is for 5 new-to-Loyola students in first year and 8 each following year. Assumes 4 years to graduate. Also assumes one student leaves Loyola between first and second year for each cohort.
2.b. Net revenue from tuition and R&B is shown. Assumes 3% increase in tuition and R&B each year. Tuition discount rate estimated by Enrollment Management models to grow, but at a slower rate.

Appendix G: Program Expenditures

TABLE 2: PROGRAM EXPENDITURES:					
Expenditure Categories	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1. Faculty (b + c below)	$4,844.25	$14,532.75	$19,377.00	$73,246.00	$75,632.00
a. Number of FTE	0.125	0.375	0.5	1.0	1.0
b. Total Salary	$4,500.00	$13,500.00	$18,000.00	$56,300.00	$58,000.00
c. Total Benefits	$344.25	$1,032.75	$1,377.00	$16,946.00	$17,632.00
2. Admin. Staff (b + c below)	$4,156.80	$4,281.50	$4,416.74	$4,549.24	$4,696.53
a. Number of FTE	0.05	0.05	0.05	0.05	0.05
b. Total Salary	$3,200.00	$3,296.00	$3,394.88	$3,496.73	$3,601.63
c. Total Benefits	$956.80	$985.50	$1,021.86	$1,052.51	$1,094.90
3. Support Staff (b + c below)	$14,289.00	$14,717.67	$21,255.56	$21,893.23	$22,602.02
a. Number of FTE	0.25	0.25	0.35	0.35	0.35
b. Total Salary	$11,000.00	$11,330.00	$16,337.86	$16,828.00	$17,332.84
c. Total Benefits	$3,289.00	$3,387.67	$4,917.70	5,065.23	$5,269.18
4. Technical Support and Equipment	$500.00	$525.00	$550.00	580.00	10,600.00
5. Library	$17,200.00	$17,888.00	$18,603.52	$19,347.66	$20,121.57
6. New or Renovated Space	0.00	0.00	0.00	0.00	0.00
7. Other Expenses	$16,675.00	$25,985.00	$28,430.00	$38,380.00	$36,280.00
TOTAL (Add 1 – 7)	$37,665.05	$57,929.92	$92,632.82	$157,996.13	$169,932.12

Notes:
1.a. Year 1-3, increasing reliance on per course faculty. Then an Assistant Teaching Professor hired in year 4.
1.b. Per course stipends in years 1-3. Expected starting salary for an Assistant Teaching Professor in year 4 with a subsequent 3% increase for year 5.
1.c. Per course faculty receive (only FICA, 7.65%, paid as benefits. Loyola's benefits for full-time employees averages 29.9%, including the 7.65% FICA rate, A slow anticipated increase entered in years 3 and 5.
2.b. Salary determined by averaging existing administrators' salaries. 3% annual salary increase included.
2.c. Loyola's benefits for full-time employees averages 29.9%, including the 7.65% FICA rate, A slow

anticipated increase entered in years 3 and 5.
3.a. Extra laboratory staff support. FTE increases in years 4 and 5 as enrollment reaches higher level.
3.b. Salary determined by averaging existing staff salaries. 3% annual salary increase included.
3.c. Loyola's benefits for full-time employees averages 29.9%, including the 7.65% FICA rate, A slow anticipated increase entered in years 3 and 5.
4. Supplies increase 5%/year. Anticipated $10,000 in equipment repair/replacement added in year 5.
5. Year-over-year increases have recently average 4% for similar library expenses.
7. Other expenses include travel to internship sites, field trips, research expenses for student research courses, student conference travel, Biotech conference attendance and community engagement, marketing and promotion of the program, and increased costs for biology lab courses. Calculated using the known historical costs per student.

Appendix H.

Towson Bioinformatics Concentration			Loyola Digital Health and Data Analytics Concentration	
CHEM 330 ESSENTIALS OF ORGANIC CHEMISTRY (5) A one-term survey course in organic chemistry for non-chemistry majors taught on a conceptual basis. Not part of a traditional two-term organic chemistry sequence. Emphasis will be on principles, mechanisms, and modern techniques. Laboratory will include synthesis and identification of organic compounds. Three lecture hours, one recitation hour, and one three hour lab. Prerequisites: CHEM 132 and CHEM 132L. Lab/Class fee will be assessed.	*OR*	**CHEM 331 ORGANIC CHEMISTRY I (5) with lab** Structure, stereochemistry, reactions and their mechanisms, preparation and properties of alkanes, alkenes, alkynes, alkyl halides and alcohols. Laboratory techniques include purification, spectroscopic (IR, NMR) and chromatographic (GLPC) methods of identification, and synthesis. Three lecture hours, one hour of laboratory lecture, and one three-hour lab. CHEM 331 and CHEM 332 comprise a traditional two-term organic chemistry sequence. Prerequisites: CHEM 132 and CHEM 132L. Lab/Class fee will be assessed.	No Equivalent Course Requirement or Elective	
COSC 236 INTRODUCTION TO COMPUTER SCIENCE I (4) Introduction to structured problem-solving, algorithm development and computer programming. Three lecture hours and two laboratory hours. Prerequisites: COSC 175 and at least one of [MATH 117, MATH 119, MATH 211, (MATH 231 or ECON 205), MATH 273, MATH 274, MATH 275, or a qualifying score on the Math Placement Exam].			**CS 151 - Computer Science through Programming (4 cr.)** Introduces students to problem solving with the fundamentals of programming, enabling them to decompose complex problems into elementary steps for effective implementation in a modern programming language. Students work with numeric and textual data, procedural programming with conditionals and loops, basic linear data structures, and on testing their solutions. Problems may draw on topics in computer security, data encoding, graphics, games, financial analysis, physical models, and others. Provides a general survey of some of the major areas of computer science, such as digital logic, software engineering, computer graphics, artificial intelligence, theory of computation, object-oriented programming, and ethical and societal issues in computing.	*OR* **IS 352 - Introduction to Programming in Python (3 cr.)** An introduction to software development with an emphasis on real-world applications. Students are introduced to programming in a modern computer language with Python. Principles of program design, programming structures, data structures, program testing, and debugging are covered. Emphasis is placed on developing an applied analytics project relatable to a business application.
COSC 237 INTRODUCTION TO COMPUTER SCIENCE II (4) Development of programming and problem-solving skills, with a focus on object-oriented programming and design. Students will design and develop programs using encapsulation and information hiding, inheritance, polymorphism, and generics. Introduction to data structures and their implementations (lists, stacks, queues, and trees), recursion, and searching and sorting algorithms. Includes two laboratory hours per week. Prerequisites: COSC 236; MATH 211 or MATH 273.			No additional CS course	
COSC 336 DATA STRUCTURES AND ALGORITHM ANALYSIS (4) Fundamental data structures used in programming and the basic techniques used to design and analyze algorithms. Topics include: complexity analysis of elementary algorithms, linear data structures, trees, heaps, graphs, search algorithms (balanced binary trees, B-trees, hashing), sorting algorithms, basic graph algorithms (graph traversal, topological sorting, shortest path, minimum spanning trees), and paradigms in the design of algorithms (divide and conquer, dynamic programming, greedy). Prerequisites: COSC 237 and MATH 274.			No additional CS course	
COSC 457 DATABASE MANAGEMENT SYSTEMS (3) Data models and sublanguages; security and integrity problems; functions of the database administrator; implementation and use of a database management system; a comparison of widely used DBMS packages. Prerequisite: COSC 336.	*OR*	**CIS 458 ORGANIZATIONAL DATABASE MANAGEMENT (3)** The database environment in an organization. Database development, analysis, design, implementation, and administration. Applications of database programs for organizational information processing. Students cannot earn credit for both COSC 457 and CIS 458. Prerequisites: (CIS 334 or COSC 336) and MATH 263.	IS 353 - Data Management and Database Systems (3 cr.) Students analyze, create a logical design, and implement the physical design for a relational database system. The course includes significant exposure to SQL (Structured Query Language) in both Microsoft Access and Oracle. Students are also exposed to the challenges associated with valuing data as a digital asset and with information lifecycle management (ILM).	
MATH 263 DISCRETE MATHEMATICS (3) Sets, logic, induction, functions, relations, sequences, recursion, combinatorics, graphs and trees, matrices with an emphasis on applications in computer science. Prerequisite: COSC 236.	*OR*	**MBBB 315 GENOMICS (3)** The study of genes, their expression within a cell and how they interact with cellular components. An overview that details how genes within living systems operate and affect living populations. Topics include sequencing of genomes, genome organization, evolution and genomic changes, genomic identification and annotation, gene and genome circuits, synthetic biology, proteomics and systems biology. Prerequisite: BIOL 309.	No Equivalent Course Requirement or Elective	
MATH 274 CALCULUS II (4) Differentiation and integration of exponential, logarithmic, and inverse trigonometric functions; techniques of integration and applications; indeterminate forms; improper integrals; sequences and series of numbers; power series. Prerequisite: MATH 273. Core: Mathematics.			*Optional AOC Elective: MA 252 - Calculus II (4 cr.)* A continuation of MA 251. Techniques and applications of integration; improper integrals; parametric equations and polar coordinates; sequences and series.	
MBBB 401 ADVANCED BIOINFORMATICS (3) Advanced topics in bioinformatics, and the use of computational tools in simulation, animation, modeling and visualization of biological data. Techniques such as statistical analysis, data mining, databases, and data warehousing are covered. Prerequisites: MBBB 301 and COSC 237.			No Equivalent Course Requirement or Elective	