Biology-Chemistry B.S. (BCHM)
Program Learning Outcomes, F2023-S2024

Learning Outcome: PLO#1
Demonstrate an understanding of the process of science and of the concepts and theories of biology across a broad range of organizational levels, as defined by the Vision and Change nationally-validated set of core biology concepts (AAAS, 2011).

Outcome Measure: Bio-MAPS Assessment (https://cperl.lassp.cornell.edu/bio-maps)

Criteria for Success: The overall group mean on the exam will be ≥ 70% correct, and at least 50% of our students will have an overall score ≥ 60% correct. Additionally, the same criteria established for the overall ETS score will be applied to each of the 8 sub-disciplines, which are 1) Evolution, 2) Information Flow, 3) Structure/Function, 4) Energy & Matter, 5) Systems, 6) Cellular & Molecular Biology, 7) Physiology, and 8) Ecology and Evolution.

Aligned with DQP Learning Area:
1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:

	2024, n=6	
	Mean % correct	**% of students scoring above 60%**
Overall group mean	82%	100%
Evolution mean	81%	100%
Information Flow mean	84%	100%
Structure/Function mean	82%	100%
Energy & Matter mean	82%	100%
Systems mean	84%	83%
Cell. & Molec. Mean	85%	100%
Physiology mean	84%	100%
Ecology & Evolution mean	81%	100%

Conclusions Drawn from Data:
This year we changed our assessment from the ETS major field test in Biology to the Bio-MAPS assessment. We wanted an assessment that is aligned with nationally-validated concepts in Biology, and that also measures overarching concepts instead of extremely specialized knowledge. All assessment goals were met.

Changes to be Made Based on Data: No changes are planned currently. However, we also tested our incoming freshmen with this assessment. The plan is to compare the scores of individuals from freshman year to senior year in order to assess the change in each sub-discipline. This information will allow us to specifically target sub-disciplines in which the pedagogy/content may need to be modified.

Learning Outcome: PLO2
Apply key concepts and principles in quantitative analysis, biochemistry, organic chemistry, and physical chemistry (thermodynamics and kinetics).

Outcome Measure: ETS Major Field Test in Chemistry and Senior Exit Survey

Criteria for Success: The overall group mean on each subsection of the ETS exam (Analytical, Biochemistry, Inorganic, Organic, Physical) will be at or above the 50th percentile. At least 80% of students surveyed will feel prepared or better in meeting this PLO.

Aligned with DQP Learning Areas (circle one or more but not all five):
1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:

ETS – MFT Chemistry	2024 n= 5	2023 n= 12	2022 n = 13	2021, n= 8	2019, n=12	2018, n=17	2017, n=20
Overall group mean	40th %ile	50th %ile	25th %ile	70th %ile	47th %ile	59th %ile	65th %ile
Analytical mean	26th %ile	71st %ile	33rd %ile	58th %ile	49th %ile	54th %ile	56th %ile
Biochemistry mean	38th %ile	55th %ile	55th %ile	53th %ile	52nd %ile	52nd %ile	64th %ile
Inorganic mean	34th %ile	56th %ile	37th %ile	68th %ile	40th %ile	55th %ile	52nd %ile
Organic mean	50th %ile	34th %ile	18th %ile	72nd %ile	44th %ile	64th %ile	60th %ile
Physical mean	32nd %ile	45th %ile	25th %ile	67th %ile	52nd %ile	58th %ile	70th %ile

*ETS-MFT not administered in spring 2020 due to COVID-19.

Senior Exit Survey*	2024 n= 5	2023 n= 5	2022 n= 11	2021 n=5	2019 n=8	2017 n=11
% feel prepared or better in quantitative analysis	100%	100%	90.9%	100%	100%	100%
% feel prepared or better in biochemistry	100%	100%	81.8%	100%	100%	100%
% feel prepared or better in bioinorganic chemistry *(not required for Bio-chem major anymore)*	N/A	100%	63.6%	100%	100%	100%
% feel prepared or better in organic chemistry	80%	100%	63.6%	100%	100%	100%
% feel prepared or better in physical chemistry (thermodynamics and kinetics)	80%	60%	36.4%	80%	100%	100%

*Senior exit survey not administered in Chemistry Senior Seminar during spring 2018 and spring 2020 (COVID-19).

Conclusions Drawn from Data: Similar to what we observed in 2022, the criteria for success was met only for organic chemistry even though students feel prepared in all the disciplines as assessed by the senior exit survey. This is a little concerning and we plan on discussing these

results in our Fall kick off department meeting as every other year, students in bio-chem do not meet the criteria for success.

Changes to be Made Based on Data: There are no substantial changes that need to be made at this point even though this year students obtained particularly low scores.

Rubric Used: ETS Comparative Data Guides – MFT for Chemistry

Learning Outcome: PLO3
Use standard instrumentation and laboratory equipment to conduct scientific experiments and perform chemical characterization and analyses.

Outcome Measure: Faculty laboratory instructors' observation of students' use of various standard instruments in different courses (see below) and Senior Exit Survey.

GC: Chemistry 2096 (Organic Chemistry II, formerly CHE 304)
IR: Chemistry 2096 (Organic Chemistry II, formerly CHE 304)
UV-vis: CHE4050 (Advanced Biochemistry)

Criteria for Success: At least 80% of students will be able to use each of the various instruments with little or no guidance. At least 80% of students surveyed will feel prepared or better in meeting this PLO.

Aligned with DQP Learning Areas (circle one or more but not all five):
1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:

% students able to use instrument with little or no guidance	2023-2024	2022-2023	2021-2022	2020-2021	2019-2020	2018-2019	2017-2018
GC	Not assessed	89% (n=15)	Not assessed	COVID-19	COVID-19	100% (n=18)	96.6% (n=29)
IR	Not assessed	89% (n=15)	Not assessed	COVID-19	COVID-19	57.9% (n=19)	96.6% (n=29)
UV-vis	100% (n=19)	87% (n=15)	100% (n=13)	100% (n=16)	COVID-19	91.7% (n=12)	100% (n=22)

Senior Exit Survey*	2024 n= 5	2023, n= 5	2022 n= 11	2021 n=5	2019 n=8	2017 n=11
% feel prepared or better	100%	100%	81.8%	100%	100%	100%

*Senior exit survey not administered in Chemistry Senior Seminar during spring 2018 and spring 2020 (COVID-19).

Conclusions Drawn from Data: Our Biology-chemistry students met the criteria for success in 2023-2024 but we forgot to assess IR and GC in Organic Chemistry II.

Changes to be Made Based on Data: No changes needed at this point but we are still actively considering better ways to assess instrument use to make sure we collect data and it is accurate.

Rubric Used: The following scale will be used.

Instrument	4	3	2	1
GC	Able to use instrument independently.	Able to use instrument with little guidance.	Able to use instrument with guidance.	Unable to use instrument even with guidance.
IR	Able to use instrument independently.	Able to use instrument with little guidance.	Able to use instrument with guidance.	Unable to use instrument even with guidance.
UV-vis	Able to use instrument independently.	Able to use instrument with little guidance.	Able to use instrument with guidance.	Unable to use instrument even with guidance.

Learning Outcome: PLO4
Participate in the life of the Biology and/or Chemistry Department by involvement in one or more of the following areas: research, biology and/or chemistry clubs, and/or various positions of responsibility serving as graders, tutors, stockroom workers and/or teaching assistants.

Outcome Measure: Self-reported data of participation and Senior Exit Survey

Criteria for Success: At least 80% of our students will participate in one or more department related activities (research, science clubs, positions of responsibility) during their time at PLNU. At least 80% of students surveyed will feel prepared or better in meeting this PLO.

Aligned with DQP Learning Areas (circle one or more but not all five):
1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:

	Number of students responding of total	% participated in life of dept	Criteria met?	Notes
Sp 2024	5 of 6	100%	Yes	
Sp 2023	2 of 2	100%	Yes	Small sample size
Sp 2022	7 of 8	100%	Yes	
Sp 2021	7 of 7	85%	Yes	
Sp 2020	NA	NA	NA	Survey not given (Covid)
Sp 2019	8 of 9	89%	Yes	
Sp 2018	NA	NA	NA	Survey not given
Sp 2017	20 of 20	100%	Yes	

Senior Exit Survey*	2024 n=5	2023 n=5	2022, n=11	2021, n=5	2019, n=8	2017, n=11
% feel prepared or better	100%	100%	81.8%	100%	100%	100%

*Senior exit survey not administered in Chemistry Senior Seminar during spring 2018 and spring 2020 (COVID-19).

Conclusions Drawn from Data: The BCHM majors are participating in the life of the department. Our criteria for success has been met.

Changes to be Made Based on Data: No changes to the program.

Rubric Used: Not applicable to self-reported data.

Learning Outcome: PLO5
Develop a rationally defensible integration of science and faith.

Outcome Measure: During their senior year, students will defend the integration of their faith with various scientific topics via a written essay.

Criteria for Success: At least 80% of our students will score at a level of 3 or higher on the science/faith integration essay rubric, which considers both science/faith integration and critical thinking.

Aligned with DQP Learning Areas (circle one or more but not all five):
1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:

	Number of students	% scoring 3 or above	Criteria met?	Notes
Sp 2024	6	100%	Yes	
SP 2023	2	100%	Yes	Small sample size
SP 2022	8	100%	Yes	
SP 2021	4	100%	Yes	Small sample size
Sp 2020	9	100%	Yes	
Sp 2019	8	100%	Yes	
Sp 2018	9	100%	Yes	
Sp 2017	8	75%	Almost	criteria met within statistical bounds

Conclusions Drawn from Data: The BCHM majors are able to develop a rationally defensible integration of science and faith.

Changes to be Made Based on Data: No changes to the program.

Rubric Used: See attached.

BIO 4097 Grading Rubric for *Integration of Science & Faith* Essay (100 points)

Grading aspect	Capstone 4	Milestone 3	Milestone 2	Benchmark 1
Integration of science and faith (evolution or creation care) **0 -20 points**	☐ Deep personal reflection is evident ☐ Question for this assignment was clearly answered ☐ Clear statement of position. ☐ Well-defended position that merges faith and scientific reasoning (note: the exact position is not important, but rather the evidence of reflection, understanding, and ability to defend that position)	Meets 3 of the criteria for a Capstone 4. Comments:	Meets 2 of the criteria for a Capstone 4. Comments:	Meets 1 or none of the criteria for Capstone 4 Comments:
Critical Thinking **0 – 20 points**	☐ Issue is stated clearly & position is well-supported with evidence & sources. ☐ Alternate position(s) is/are clearly addressed in a manner that flows well with the author's argument ☐ Clear arguments against these alternate positions using personal reflection and scientific information ☐ Evaluation of altering position(s) demonstrate(s) grace and understanding	Meets 3 of the criteria for a Capstone 4. Comments:	Meets 2 of the criteria for a Capstone 4. Comments:	Meets 1 or none of the criteria for Capstone 4 Comments:
Incorporation of concepts discussed in PLNU classes **0 – 20 points**	☐ Specific concepts from specific PLNU classes, including science and/or religion classes, are included as part of reflection and defense of position. ☐ Includes a clear reflection of how the position has changed while at PLNU. If his/her position has not changed, essay still includes a clear explanation of why it did not change, that demonstrates personal reflection.	Meets 1 of the criteria for a Capstone 4. Comments:		Meets none of the criteria for a Capstone 4. Comments:
Written Communication **0 – 20 points**	☐ No, or very few, grammatical and spelling errors. ☐ Essay flow is excellent with a clear introduction, argumentative reasoning, and a strong conclusion. ☐ Writing effectively communicates with a coll. sci. audience. ☐ Sufficient length to make a good, complete defense (1200 – 1600 words)	Meets 3 of the criteria for a Capstone 4. Comments:	Meets 2 of the criteria for a Capstone 4. Comments:	Meets 1 or none of the criteria for Capstone 4 Comments:
Information Literacy **0 – 20 points**	☐ Sources are current, authoritative, and relevant to the topic ☐ Communicates, organizes and synthesizes information from sources to achieve a specific purpose, with clarity and depth ☐ Use of in-text citations as well as the annotated bibliography ☐ Excellent choice of paraphrasing, summarizing, or quoting to enhance the essay and support the author's argument ☐ Distinguishes between common knowledge and ideas requiring attribution ☐ Source for the alternate view actually holds that viewpoint	Meets 3 of the criteria for a Capstone 4. Comments:	Meets 2 of the criteria for a Capstone 4. Comments:	Meets 1 or none of the criteria for Capstone 4 Comments:

Learning Outcome: PLO6
Be prepared for post graduate studies or a science-related career.

Outcome Measure: Tracking of alumni data regarding their postgraduate education and profession along with Senior Exit Survey.

Criteria for Success (if applicable): Success rates for alumni who apply for graduate or professional schools will be >75% and the percentage of graduates who obtain jobs in science-related occupations will be >70%. At least 80% of students surveyed will feel prepared or better in meeting this PLO.

Aligned with DQP Learning Areas (circle one or more but not all five):

1. Specialized Knowledge
2. Broad Integrative Knowledge
3. Intellectual Skills/Core Competencies
4. Applied and Collaborative Learning
5. Civic and Global Learning

Longitudinal Data:

1) The success rate for alumni who apply to graduate or professional schools has been well over 90% for at least 20 years.

2) In addition, an alumni survey is conducted by the Office of Institutional Research at PLNU every year. This survey is sent to alumni who graduated 5 years previously. These data are not disaggregated by specific degree, but are applicable to all Biology Department majors. The same can be said about Chemistry Department Majors and the data is shown in the table below.

Year of Summary	**2023** (Biology)	**2023** (Chemistry)	**2022** (Biology)	**2022** (Chemistry)
Population Surveyed	264	123	262	122
Response Rate	41%	39.8%	44%	41%
Year of Graduation	2014-2018	2014-2018	2012-2016	2012-2016
Employed Full-Time OR Currently in Graduate School Full-Time	82%	88%	85%	88%
Went to graduate school and graduated (of those who are employed full-time)	59%	63%	55%	67%
Satisfied or Very Satisfied with PLNU Education	92% ± 7%(SD)	93% ± 4.7%(SD)	94% ± 6%(SD)	96% ± 4.8%(SD)

3) Senior exit survey administered in Chemistry Senior Seminar (not administered during spring 2018 and spring 2020 (COVID-19).)

Senior Exit Survey*	2024 n=5	2023 n=5	2022, n=11	2021, n=5	2019, n=8	2017, n=11
% feel prepared or better	100%	100%	100%	100%	100%	100%

Conclusions Drawn from Data:
The Biology Department majors and Chemistry Department majors are successful at obtaining jobs and entering graduate/professional schools. They also seem to be highly satisfied with their PLNU education.

Changes to be Made Based on Data:
No changes to program but we continue to reach out to local biotech companies in order to establish relationships and allow our students to get jobs.

Rubric Used: Not applicable to self-reported data.

Chemistry Seminar Exit Survey 2023 (Biology-Chemistry Major)

1) What is your current career goal?
- a) Professor
- b) Teacher
- c) Health professional – please specify
- d) Biotechnology or pharmaceutical industry
- e) Academic or government lab
- f) Graduate student – please specify field or specialty
- g) Other – please specify

2) Rank how well prepared you were to meet the following program learning outcomes (goals) that were set for your major.

I. Students will demonstrate an understanding of the process of science, and of the concepts and theories of biology across a broad range of organizational levels: molecular, cellular, and organismal.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

II. Students will apply key concepts and principles in quantitative analysis.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

III. Students will apply key concepts and principles in biochemistry.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

IV. Students will apply key concepts and principles in bioinorganic chemistry.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

V. Students will apply key concepts and principles in organic chemistry.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

VI. Students will apply key concepts and principles in physical chemistry (thermodynamics and kinetics).
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

VII. Students will use standard instrumentation and laboratory equipment to conduct scientific experiments and perform chemical characterization and analyses.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

VIII. Students will participate in the life of the Biology and/or Chemistry Department by involvement in one or more of the following areas: research, biology and/or chemistry clubs, and/or various positions of responsibility serving as graders, tutors, stockroom workers and/or teaching assistants.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

IX. Students will develop a rationally defensible integration of science and faith.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

X. Students will be prepared for post graduate studies or a science-related career.
unprepared / somewhat unprepared / prepared / well prepared / extremely well prepared

3) Were you involved in the PLNU chemistry summer research program?

a) Yes – describe what role this experience played in your learning of chemistry
b) No – describe why not

4) Do you have any suggestions related to the summer research program?

5) What were one or two aspects of the chemistry curriculum that might have been improved?

6) Do you feel prepared to take the next step academically?
a) Yes – describe what experiences (classes) helped you to get there
b) No – describe what additional or different experiences would have helped

7) If you were starting over as a freshman next fall, would you make any different decisions about your major, or about elective course choices, etc.?

8) Are there chemistry courses that PLNU does not offer that you would have liked to take?

9) Do you feel like you are a part of the chemistry department community? Why or why not?