UNLV

Program Review Self Study

Program Reviewed:	Biochemistry
Degree(s):	BS
Program Chair or Director:	Gary Kleiger
Dean:	Eric Chronister
Date of Report:	February, 2024

GENERAL INSTRUCTIONS

Please complete the program review self-study using this template.

If this review is covering several degree levels, please be sure to address each level in your responses to the questions.

Send completed self-study electronically to: programreview@unlv.edu

The Senior Vice Provost for Academic Affairs is committed to engaging programs in a clear and useful program review process. To facilitate continuous improvement, we welcome feedback from programs and departments, external or internal reviewers and any other constituents of the process.

I. Program Description

College/Program

- College or School: Sciences
- Unit: Chemistry & Biochemistry
- Web Address: https://www.unlv.edu/chemistry
- Program(s) being reviewed: Biochemistry
- Degrees and their abbreviations: BS (Bachelor of Science)

Primary Individual Completing This Worksheet

- Name: Ronald Gary & Gary Kleiger
- Title: Faculty Member (RG); Department Chair (GK)
- Campus phone number: 702-895-1687 (RG); 702-895-3585 (GK)
- Mail stop: 4003
- E-mail: ronald.gary@unlv.edu; gary.kleiger@unlv.edu
- Fax number: N/A
- Date of self-study: February, 2024

Other Faculty Involved In Writing This Report:

- Names: NA

II. Catalog

1. Please insert the current catalog description for the academic program.

Biochemistry Major (BS)

Please see the UNLV College of Sciences, Chemistry department web page at www.unlv.edu/chemistry/ for information about department programs, faculty and facilities. Degree worksheets and 4/5 year plan for the major are available at https://www.unlv.edu/degree/bs-biochemistry.

Please see advising information at the UNLV College of Science Advising at www.unlv.edu/sciences/advising.

Accreditation

Institution - Northwest Commission on Colleges and Universities www.nwccu.org

Learning Outcomes

Upon completion of all undergraduate programs in Chemistry and Biochemistry, students will have a broad understanding of chemistry's sub-disciplines by satisfactorily completing

- Introductory and foundational course work in chemistry, and in-depth course work in chemistry; all with laboratory emphasis. Additionally;
    - Students completing the B.S. program in Chemistry will complete intensive and comprehensive courses as identified by the American Chemical Society Guidelines for Bachelor Degree Programs including a research experience that provides for the development of the skills needed to be an effective professional chemist. The B.S. program in Chemistry is recognized by the ACS-CPT, and has enjoyed this status for over 40 years. Only about 30% of B.S. Chemistry programs in the United States have achieved this recognition.
    - Students completing the B.S. program in Biochemistry will complete most of the same intensive and comprehensive courses in Chemistry with laboratory emphasis as students in the B.S. ACS program above. Additionally, students in this program will complete four intensive and comprehensive courses in Biochemistry along with an advanced Biochemistry Lab. This program also provides for flexibility in the selection of in-depth Biology course electives to complement the rigorous chemistry foundation of the program.
    - Students completing the B.A. program in Chemistry will complete much of the in-depth course work in chemistry along with elective courses offered by departments from within the College of Sciences as well as other colleges within the university. There is greater flexibility in program design for customization of the program to individual student's career interests.
- Build and develop communication skills through writing laboratory reports, term papers, and presentation of seminars and poster seminars.
- Develop critical thinking. Critical thinking skills, development of problem solving abilities are implemented in the very first introductory courses common to all undergraduate

programs offered. These skills are developed as students progress through the sequence of courses (meeting each course prerequisite in a well thought out and logical pattern) required for graduation in all of our programs.

- Develop intellectual growth by integrating into all of our courses concepts of ethics, laboratory safety and environmental stewardship applicable to the profession as well as to local, state, regional, national and international communities and society. Emphasis will be placed on the development of UULOs regarding Global/Multicultural Knowledge and Awareness, and Citizenship and Ethics.
- Graduates shall be able to demonstrate technical competency in the performance of basic laboratory operations, including solution preparation and standardization, common synthetic procedures, standard qualitative and quantitative analysis procedures, and operation of standard laboratory equipment.
- Graduates shall have an in-depth understanding of the theoretical basis of biochemistry, as well as areas of application of chemical principles.
- Graduates must be well versed in the language of biochemistry and should be capable of effectively communicating chemical knowledge in both written and oral forms.
- Graduates shall be able to function as chemical professionals in entry-level jobs or to succeed in graduate studies in biochemistry or related scientific fields.

University Graduation Requirements

Please see Graduation Policies for complete information

Transfer Policy

Biology, chemistry, physics and math transfer courses will be accepted to fill specific degree requirements only with a grade of C or better.

Biochemistry Degree Requirements - Total: 120 Credits

General Education Requirements - Subtotal: 33-36 Credits

- First-Year Seminar - Credits: 2-3 (See note 1 below)
- English Composition - Credits: 6
  - ENG 101 - Composition I
  - ENG 102 - Composition II
- Second-Year Seminar - Credits: 3
- Constitutions - Credits: 4-6
- Mathematics - Fulfilled by the major requirements
- Distribution Requirements - Credits: 18
  Please see Distribution Requirements for more information.
  - Humanities and Fine Arts: 9 Credits
    - Two courses 3 credits each from two different humanities areas - 6 credits
    - One course in fine arts- 3 credits
  - Social Science: 9 Credits
    - One course each from three different fields
  - Life and Physical Sciences and Analytical Thinking:
    - Automatically satisfied by Major requirements
- Multicultural and International
  - Multicultural, one 3 credit course required
  - International, one 3 credit course required

  These courses may overlap with general education and major requirements. A single course may not meet the multicultural and international requirements simultaneously. For the list of approved multicultural and international courses, go to: https://www.unlv.edu/provost/multicultural-requirements#international

Major Requirements - BS in Biochemistry - Subtotal: 86 Credits

- Mathematics - Credits: 8
  - MATH 181 - Calculus I
  - MATH 182 - Calculus II
- Physics - Credits: 8
  See Note 2 below
  - PHYS 151A - General Physics I
  - PHYS 151L - General Physics I Lab
  - PHYS 152A - General Physics II
  - PHYS 152L - General Physics II Lab
- Biology - Credits: 22
  - BIOL 190A - Introduction to Cell and Molecular Biology
  - BIOL 190L - Introduction to Cell and Molecular Biology Laboratory
  - BIOL 191A - Introduction to Organismal Biology
  - BIOL 191L - Introduction to Organismal Biology Laboratory
  - BIOL 300 - Principles of Genetics

- and at least ten credits from the following list of courses:
  Note: Make certain the prerequisites for each course selected are met before registration, some prerequisites may not be among those courses listed.
    - BIOL 304 - Molecular Genetics
    - BIOL 351 - Microbiology
    - BIOL 405 - Molecular Biology
    - BIOL 409 - Virology
    - BIOL 412 - Molecular Evolution
    - BIOL 415 - Evolution
    - BIOL 417 - Biochemical Adaptations
    - BIOL 425 - Genomics
    - BIOL 440 - Mammalian Physiology
    - BIOL 442 - Principles of Plant Physiology with Laboratory
    - BIOL 445 - Cell Physiology
    - BIOL 447 - Advanced Comparative Animal Physiology
    - BIOL 448 - Mammalian Physiology Laboratory
    - BIOL 453 - Immunology
    - BIOL 460 - Microbial Physiology
    - BIOL 466 - Developmental Biology
    - BIOL 468 - Histology
    - BIOL 470 - Topics in Applied Microbiology
    - BIOL 473 - Advanced Topics in Cell and Molecular Biology
    - BIOL 475 - Neurobiology
    - BIOL 480 - Introduction to Biological Modeling
    - BIOL 481 - Advanced Cell Biology
    - BIOL 485 - Microbial Genetics
    - CHEM 478 - Endocrinology

Chemistry Major Requirements Credits: 48

- CHEM 121A - General Chemistry I
- CHEM 121L - General Chemistry Laboratory I
- CHEM 122A - General Chemistry II
- CHEM 122L - General Chemistry Laboratory II
- CHEM 241 - Organic Chemistry I
- CHEM 241L - Organic Chemistry for Life Sciences Lab I
- CHEM 242 - Organic Chemistry II
- CHEM 242L - Organic Chemistry for Life Sciences Laboratory II
- CHEM 355 - Quantitative Analysis
- CHEM 355L - Quantitative Analysis Laboratory
- CHEM 421 - Physical Chemistry I
- CHEM 422 - Physical Chemistry II
- CHEM 455 - Instrumental Analysis
- CHEM 455L - Instrumental Analysis Laboratory
- CHEM 472 - Biochemistry Laboratory

- CHEM 474 - Biochemistry I
- CHEM 475 - Biochemistry II
- CHEM 476 - Advanced Topics in Biochemistry
- and four additional credits of upper-division chemistry or biology.

General Electives: 0-2 Credits

The number of general electives necessary for each student varies based on how many credits a student uses to satisfy the requirements identified above. The minimum credits required to earn a degree from College of Sciences is 120.

Total Credits: 120

Notes

1. It is strongly recommended that students take SCI 101 to satisfy the First-Year Seminar requirement.
2. The sequence PHYS 180 - PHYS 181 -PHYS 182 (including labs) is an acceptable replacement for PHYS 151A -PHYS 152A (including labs) sequence; however, any two course combination from PHYS 180, 181, and 182 is not an acceptable replacement.
3. At least 40 credits must be earned at the upper-division level (300 and above).

2. Has the catalog description/program undergone substantial change(s) since the last program review? If yes, please describe the substantive changes.

No.

III. Relationships

3. What relationship does this program have to other programs or institutions in the NSHE system (e.g. articulation, transfers, partnerships)?

Regarding curriculum articulation, NSHE (Nevada System of Higher Education) provides undergraduate education at 7 member institutions: 3 universities (UNLV, UNR, NSU) and 4 community colleges (CSN, GBC, TMCC, WNC). Board of Regents policy states the following: COURSE NUMBERING (B/R 9/09): 1. All undergraduate courses in the NSHE must be common-course numbered with equivalent courses offered throughout the System. To be assigned a new and unique course number at least 20 percent of the proposed course content must be unique and not found in a current or pending course within the NSHE" (Handbook – Title 4, Chapter 14, Section 16). Within the UNLV Biochemistry BS degree program, transfer with credit for analogous courses taken at other NSHE institutions is routine.

The federally-funded NIH-INBRE program provides funds that are shared amongst NSHE institutions to support research and educational activities. This includes competitively-awarded support for undergraduate research in fields that include Biochemistry. In addition, the UNLV Department of Chemistry & Biochemistry engages in informal cordial relationships and partnerships with colleagues at other NSHE institutions whenever possible.

4. Describe the relationship between this program and other UNLV programs. How does this program serve or interact with other areas of the institution (e.g. collaborations, partnerships, affiliated faculty, general education)?

The UNLV Biochemistry BS degree program requires the completion of MATH, PHYSICS, and BIOLOGY courses in addition to CHEM classes. Conversely, undergraduate Biology BS degree programs require the completion of CHEM classes, including biochemistry classes such as CHEM 474 (Biochemistry I).

IV. Faculty Information and Productivity

5. Evaluate trends in the following areas

a. Composition of full-time faculty

i. Number of Faculty = 7 (biochem), out of 21 TT in the department
ii. Rank = 4 Prof., 1 Assoc. Prof., 2 Asst. Prof.
iii. Percent of faculty with terminal degree = 100%

Faculty Summary:

At present, the Department of Chemistry & Biochemistry has 21 tenured or tenure-track faculty, covering areas such as Organic Chemistry, Analytical Chemistry, Biochemistry, Radiochemistry, Physical Chemistry, and others. Of these, 7 comprise the Biochemistry Group within the department.

Biochemistry Faculty (2013–2024):
Bryan Spangelo (hired 1994, retired 2020)
Ronald Gary (hired 1999)
Ernesto Abel-Santos (hired 2006)
Gary Kleiger (hired 2011)
Hui Zhang (hired 2012)
Hong Sun (hired 2012)
Chandrabali Bhattacharya (hired 2023)
Łukasz Sznajder (hired 2023)

Notes: Dr. Bhattacharya was hired as a Medicinal Chemist, with teaching responsibilities in both biochemistry and organic chemistry. Dr. Gary will be retiring in Summer 2024; a replacement search has been approved and initiated.

b. Scholarship (Gathered by Department)

i. Publications/Creative Activities

Peer-Reviewed Publications Are Listed Alphabetically, by Faculty Name:

- *Abel-Santos, Ernesto – papers 2013 -2024 with UNLV affiliation:*

Alvarado I, Phui A, Elekonich MM, **Abel-Santos E**. Requirements for in vitro germination of Paenibacillus larvae spores. J Bacteriol. 2013 Mar;195(5):1005-11. doi: 10.1128/JB.01958-12. Epub 2012 Dec 21. PMID: 23264573; PMCID: PMC3571325.

Howerton A, Patra M, **Abel-Santos E**. A new strategy for the prevention of Clostridium difficile infection. J Infect Dis. 2013 May 15;207(10):1498-504. doi: 10.1093/infdis/jit068. Epub 2013 Feb 18. PMID: 23420906.

Howerton A, Patra M, **Abel-Santos E**. Fate of ingested Clostridium difficile spores in mice. PLoS One. 2013 Aug 30;8(8):e72620. doi: 10.1371/journal.pone.0072620. PMID: 24023628; PMCID: PMC3758320.

Alvarado I, **Abel-Santos E**. How enteric pathogens know they hit the sweet spot. Future Microbiol. 2014;9(1):13-6. doi: 10.2217/fmb.13.141. PMID: 24328376; PMCID: PMC9536218.

Alvarado I, Elekonich MM, **Abel-Santos E**, Wing HJ. Comparison of in vitro methods for the production of Paenibacillus larvae endospores. J Microbiol Methods. 2015 Sep;116:30-2. doi: 10.1016/j.mimet.2015.06.011. Epub 2015 Jun 27. PMID: 26130193.

Castillo QA, Triana J, Eiroa JL, Calcul L, Rivera E, Wojtas L, Padrón JM, Boberieth L, Keramane M, **Abel-Santos E**, Báez LA, Germosén EA. ent-Labdane Diterpenoids from the Aerial Parts of Eupatorium obtusissmum. J Nat Prod. 2016 Apr 22;79(4):907-13. doi: 10.1021/acs.jnatprod.5b00954. Epub 2016 Mar 29. PMID: 27023255.

Alvarado I, Margotta JW, Aoki MM, Flores F, Agudelo F, Michel G, Elekonich MM, **Abel-Santos E**. Inhibitory effect of indole analogs against Paenibacillus larvae, the causal agent of American foulbrood disease. J Insect Sci. 2017 Sep 1;17(5):104. doi: 10.1093/jisesa/iex080. PMID: 29117379; PMCID: PMC7206643.

Sharma SK, Yip C, Esposito EX, Sharma PV, Simon MP, **Abel-Santos E**, Firestine SM. The Design, Synthesis, and Characterizations of Spore Germination Inhibitors Effective against an Epidemic Strain of Clostridium difficile. J Med Chem. 2018 Aug 9;61(15):6759-6778. doi: 10.1021/acs.jmedchem.8b00632. Epub 2018 Jul 30. PMID: 30004695; PMCID: PMC6192251.

Howerton A, Seymour CO, Murugapiran SK, Liao Z, Phan JR, Estrada A, Wagner AJ, Mefferd CC, Hedlund BP, **Abel-Santos E**. Effect of the Synthetic Bile Salt Analog CamSA on the Hamster Model of Clostridium difficile Infection. Antimicrob Agents Chemother. 2018 Sep 24;62(10):e02251-17. doi: 10.1128/AAC.02251-17. PMID: 30012758; PMCID: PMC6153836.

Mefferd CC, Bhute SS, Phan JR, Villarama JV, Do DM, Alarcia S, **Abel-Santos E**, Hedlund BP. A High-Fat/High-Protein, Atkins-Type Diet Exacerbates *Clostridioides* (*Clostridium*) *difficile* Infection in Mice, whereas a High-Carbohydrate Diet Protects. mSystems. 2020 Feb 11;5(1):e00765-19. doi: 10.1128/mSystems.00765-19. PMID: 32047064; PMCID: PMC7018531.

Yip C, Okada NC, Howerton A, Amei A, **Abel-Santos E**. Pharmacokinetics of CamSA, a potential prophylactic compound against Clostridioides difficile infections. Biochem Pharmacol. 2021 Jan;183:114314. doi: 10.1016/j.bcp.2020.114314. Epub 2020 Nov 3. PMID: 33152344; PMCID: PMC7770080.

Phan JR, Do DM, Truong MC, Ngo C, Phan JH, Sharma SK, Schilke A, Mefferd CC, Villarama JV, Lai D, Consul A, Hedlund BP, Firestine SM, **Abel-Santos E**. An Aniline-Substituted Bile Salt Analog Protects both Mice and Hamsters from Multiple Clostridioides difficile Strains. Antimicrob Agents Chemother. 2022 Jan 18;66(1):e0143521. doi: 10.1128/AAC.01435-21. Epub 2021 Nov 15. PMID: 34780262; PMCID: PMC8765400.

Sharma SK, Yip C, Simon MP, Phan J, **Abel-Santos E**, Firestine SM. Studies on the Importance of the 7α-, and 12α- hydroxyl groups of N-Aryl-3α,7α,12α-trihydroxy-5β-cholan-24-amides on their Antigermination Activity Against a Hypervirulent Strain of Clostridioides (Clostridium) difficile. Bioorg Med Chem. 2021 Dec 15;52:116503. doi: 10.1016/j.bmc.2021.116503. Epub 2021 Nov 10. PMID: 34837818; PMCID: PMC9236192.

Bhute SS, Mefferd CC, Phan JR, Ahmed M, Fox-King AE, Alarcia S, Villarama JV, **Abel-Santos E**, Hedlund BP. A High-Carbohydrate Diet Prolongs Dysbiosis and Clostridioides difficile Carriage and Increases Delayed Mortality in a Hamster Model of Infection. Microbiol Spectr. 2022 Aug 31;10(4):e0180421. doi: 10.1128/spectrum.01804-21. Epub 2022 Jun 16. PMID: 35708337; PMCID: PMC9431659.

Yip C, Phan JR, **Abel-Santos E**. Mechanism of germination inhibition of Clostridioides difficile spores by an aniline substituted cholate derivative (CaPA). J Antibiot (Tokyo). 2023 Jun;76(6):335-345. doi: 10.1038/s41429-023-00612-3. Epub 2023 Apr 4. PMID: 37016015; PMCID: PMC10406169.

Liggins M, Ramírez Ramírez N, **Abel-Santos E**. Comparison of sporulation and germination conditions for *Clostridium perfringens* type A and G strains. Front Microbiol. 2023 May 9;14:1143399. doi: 10.3389/fmicb.2023.1143399. PMID: 37228374; PMCID: PMC10203408.

Sharma SK, Schilke AR, Phan JR, Yip C, Sharma PV, **Abel-Santos E**, Firestine SM. The design, synthesis, and inhibition of Clostridioides difficile spore germination by acyclic and bicyclic tertiary amide analogs of cholate. Eur J Med Chem. 2023 Dec 5;261:115788. doi: 10.1016/j.ejmech.2023.115788. Epub 2023 Sep 4. PMID: 37703709; PMCID: PMC10680100.

- *Bhattacharya, Chandrabali – papers 2013 -2024 with UNLV affiliation:*

- *Gary, Ronald – papers 2013 -2024 with UNLV affiliation:*

Cummings JL, Banks SJ, **Gary RK**, Kinney JW, Lombardo JM, Walsh RR, Zhong K. Alzheimer's disease drug development: translational neuroscience strategies. CNS Spectr. 2013 Jun;18(3):128-38. doi: 10.1017/S1092852913000023. Epub 2013 Mar 11. PMID: 23472637.

Mudireddy SR, Abdul AR, Gorjala P, **Gary RK**. Beryllium is an inhibitor of cellular GSK-3β that is 1,000-fold more potent than lithium. Biometals. 2014 Dec;27(6):1203-16. doi: 10.1007/s10534-014-9783-y. Epub 2014 Aug 8. PMID: 25104312.

Sami F, Lu X, Parvathaneni S, Roy R, **Gary RK**, Sharma S. RECQ1 interacts with FEN-1 and promotes binding of FEN-1 to telomeric chromatin. Biochem J. 2015 Jun 1;468(2):227-44. doi: 10.1042/BJ20141021. PMID: 25774876; PMCID: PMC4441847.

Jensen DA, **Gary RK**. Estimation of alkane-water logP for neutral, acidic, and basic compounds using an alkylated polystyrene-divinylbenzene high-performance liquid chromatography column. J Chromatogr A. 2015 Oct 23;1417:21-9. doi: 10.1016/j.chroma.2015.09.020. Epub 2015 Sep 9. PMID: 26372447.

Sami F, **Gary RK**, Fang Y, Sharma S. Site-directed mutants of human RECQ1 reveal functional importance of the zinc binding domain. Mutat Res. 2016 Aug;790:8-18. doi: 10.1016/j.mrfmmm.2016.05.005. Epub 2016 May 17. PMID: 27248010; PMCID: PMC4967042.

Gorjala P, Cairncross JG, **Gary RK**. p53-dependent up-regulation of CDKN1A and down-regulation of CCNE2 in response to beryllium. Cell Prolif. 2016 Dec;49(6):698-709. doi: 10.1111/cpr.12291. Epub 2016 Sep 9. PMID: 27611480; PMCID: PMC5096984.

Abdul AURM, De Silva B, **Gary RK**. The GSK3 kinase inhibitor lithium produces unexpected hyperphosphorylation of β-catenin, a GSK3 substrate, in human glioblastoma cells. Biol Open. 2018 Jan 26;7(1):bio030874. doi: 10.1242/bio.030874. PMID: 29212798; PMCID: PMC5829510.

Lim RC, De Silva B, Park JH, Hodge VF, **Gary RK**. Aqueous solubility of beryllium(II) at physiological pH: effects of buffer composition and counterions. Prep Biochem Biotechnol. 2020;50(6):585-591. doi: 10.1080/10826068.2020.1719514. Epub 2020 Jan 28. PMID: 31990243.

Gerson TM, Ott AM, Karney MMA, Socea JN, Ginete DR, Iyer LM, Aravind L, **Gary RK**, Wing HJ. VirB, a key transcriptional regulator of *Shigella* virulence, requires a CTP ligand for its regulatory activities. mBio. 2023 Oct 31;14(5):e0151923. doi: 10.1128/mbio.01519-23. Epub 2023 Sep 20. PMID: 37728345; PMCID: PMC10653881.

Lim RC, **Gary RK**. Kinetic analysis of T4 polynucleotide kinase via isothermal titration calorimetry. {submitted and under revision at Archives of Biochemistry and Biophysics, as of Feb. 2024}

- *Kleiger, Gary – papers 2013 -2024 with UNLV affiliation:*

Ziemba A, Hill S, Sandoval D, Webb K, Bennett EJ, **Kleiger G**. Multimodal mechanism of action for the Cdc34 acidic loop: a case study for why ubiquitin-conjugating enzymes have loops and tails. J Biol Chem. 2013 Nov 29;288(48):34882-96. doi: 10.1074/jbc.M113.509190. Epub 2013 Oct 15. PMID: 24129577; PMCID: PMC3843100.

Huang H, Ceccarelli DF, Orlicky S, St-Cyr DJ, Ziemba A, Garg P, Plamondon S, Auer M, Sidhu S, Marinier A, **Kleiger G**, Tyers M, Sicheri F. E2 enzyme inhibition by stabilization of a low-affinity interface with ubiquitin. Nat Chem Biol. 2014 Feb;10(2):156-163. doi: 10.1038/nchembio.1412. Epub 2013 Dec 15. PMID: 24316736; PMCID: PMC3905752.

Kleiger G, Mayor T. Perilous journey: a tour of the ubiquitin-proteasome system. Trends Cell Biol. 2014 Jun;24(6):352-9. doi: 10.1016/j.tcb.2013.12.003. Epub 2014 Jan 20. PMID: 24457024; PMCID: PMC4037451.

Sandoval D, Hill S, Ziemba A, Lewis S, Kuhlman B, **Kleiger G**. Ubiquitin-conjugating enzyme Cdc34 and ubiquitin ligase Skp1-cullin-F-box ligase (SCF) interact through multiple conformations. J Biol Chem. 2015 Jan 9;290(2):1106-18. doi: 10.1074/jbc.M114.615559. Epub 2014 Nov 25. PMID: 25425648; PMCID: PMC4294478.

Hill S, Harrison JS, Lewis SM, Kuhlman B, **Kleiger G**. Mechanism of Lysine 48 Selectivity during Polyubiquitin Chain Formation by the Ube2R1/2 Ubiquitin-Conjugating Enzyme. Mol Cell Biol. 2016 May 16;36(11):1720-32. doi: 10.1128/MCB.00097-16. PMID: 27044868; PMCID: PMC4959314.

Ibarra R, Sandoval D, Fredrickson EK, Gardner RG, **Kleiger G**. The San1 Ubiquitin Ligase Functions Preferentially with Ubiquitin-conjugating Enzyme Ubc1 during Protein Quality Control. J Biol Chem. 2016 Sep 2;291(36):18778-90. doi: 10.1074/jbc.M116.737619. Epub 2016 Jul 12. PMID: 27405755; PMCID: PMC5009252.

Kleiger G, Deshaies R. Tag Team Ubiquitin Ligases. Cell. 2016 Aug 25;166(5):1080-1081. doi: 10.1016/j.cell.2016.08.014. PMID: 27565338.

Hill S, **Kleiger G**. Self-regulating ubiquitin ligases. EMBO J. 2017 Feb 15;36(4):392-393. doi: 10.15252/embj.201696154. Epub 2017 Jan 13. PMID: 28087580; PMCID: PMC5694948.

Hill S, Hill C, **Kleiger G**. Using In Vitro Ubiquitylation Assays to Estimate the Affinities of Ubiquitin-Conjugating Enzymes for Their Ubiquitin Ligase Partners. Methods Mol Biol. 2018;1844:39-58. doi: 10.1007/978-1-4939-8706-1_4. PMID: 30242702.

Jones RD, Enam C, Ibarra R, Borror HR, Mostoller KE, Fredrickson EK, Lin J, Chuang E, March Z, Shorter J, Ravid T, **Kleiger G**, Gardner RG. The extent of Ssa1/Ssa2 Hsp70 chaperone involvement in nuclear protein quality control degradation varies with the substrate. Mol Biol Cell. 2020 Feb 1;31(3):221-233. doi: 10.1091/mbc.E18-02-0121. Epub 2019 Dec 11. PMID: 31825716; PMCID: PMC7001477.

Hill S, Reichermeier K, Scott DC, Samentar L, Coulombe-Huntington J, Izzi L, Tang X, Ibarra R, Bertomeu T, Moradian A, Sweredoski MJ, Caberoy N, Schulman BA, Sicheri F, Tyers M, **Kleiger G**. Robust cullin-RING ligase function is established by a multiplicity of poly-ubiquitylation pathways. Elife. 2019 Dec 23;8:e51163. doi: 10.7554/eLife.51163. PMID: 31868589; PMCID: PMC6975927.

Baek K, Krist DT, Prabu JR, Hill S, Klügel M, Neumaier LM, von Gronau S, **Kleiger G**, Schulman BA. NEDD8 nucleates a multivalent cullin-RING-UBE2D ubiquitin ligation assembly. Nature. 2020 Feb;578(7795):461-466. doi: 10.1038/s41586-020-2000-y. Epub 2020 Feb 12. PMID: 32051583; PMCID: PMC7050210.

Scott DC, **Kleiger G**. Regulation of Cullin-RING E3 ligase dynamics by Inositol hexakisphosphate. Proc Natl Acad Sci U S A. 2020 Mar 24;117(12):6292-6294. doi: 10.1073/pnas.2001683117. Epub 2020 Mar 10. PMID: 32156730; PMCID: PMC7104172.

Liwocha J, Krist DT, van der Heden van Noort GJ, Hansen FM, Truong VH, Karayel O, Purser N, Houston D, Burton N, Bostock MJ, Sattler M, Mann M, Harrison JS, **Kleiger G**, Ovaa H, Schulman BA. Linkage-specific ubiquitin chain formation depends on a lysine hydrocarbon ruler. Nat Chem Biol. 2021 Mar;17(3):272-279. doi: 10.1038/s41589-020-00696-0. Epub 2020 Dec 7. PMID: 33288957; PMCID: PMC7904580.

Horn-Ghetko D, Krist DT, Prabu JR, Baek K, Mulder MPC, Klügel M, Scott DC, Ovaa H, **Kleiger G**, Schulman BA. Ubiquitin ligation to F-box protein targets by SCF-RBR E3-E3 super-assembly. Nature. 2021 Feb;590(7847):671-676. doi: 10.1038/s41586-021-03197-9. Epub 2021 Feb 3. PMID: 33536622; PMCID: PMC7904520.

Ibarra R, Borror HR, Hart B, Gardner RG, **Kleiger G**. The San1 Ubiquitin Ligase Avidly Recognizes Misfolded Proteins through Multiple Substrate Binding Sites. Biomolecules. 2021 Nov 2;11(11):1619. doi: 10.3390/biom11111619. PMID: 34827617; PMCID: PMC8615460.

Scott DC, King MT, Baek K, Gee CT, Kalathur R, Li J, Purser N, Nourse A, Chai SC, Vaithiyalingam S, Chen T, Lee RE, Elledge SJ, **Kleiger G**, Schulman BA. E3 ligase autoinhibition by C-degron mimicry maintains C-degron substrate fidelity. Mol Cell. 2023 Mar 2;83(5):770-786.e9. doi: 10.1016/j.molcel.2023.01.019. Epub 2023 Feb 16. PMID: 36805027; PMCID: PMC10080726.

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millisecond Lys48-linked poly-ubiquitin chain formation by cullin-RING ligases. *Nature Structural and Molecular Biology* 31, 378-389. 10.1038/s41594-023-01206-1.

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- *Spangelo, Bryan – papers 2013 -2024 with UNLV affiliation:*

  Vo V, Tanthmanatham O, Han H, Bhowmik PK, **Spangelo BL**. Synthesis of [PtCl2(4,4'-dialkoxy-2,2'-bipyridine)] complexes and their in vitro anticancer properties. Metallomics. 2013 Aug;5(8):973-87. doi: 10.1039/c3mt00128h. PMID: 23817622; PMCID: PMC3954779.

- *Sun, Hong – papers 2013 -2024 with UNLV affiliation:*

  Lu F, Wu X, Yin F, Chia-Fang Lee C, Yu M, Mihaylov IS, Yu J, **Sun H**, Zhang H. Regulation of DNA replication and chromosomal polyploidy by the MLL-WDR5-RBBP5 methyltransferases. Biol Open. 2016 Oct 15;5(10):1449-1460. doi: 10.1242/bio.019729. PMID: 27744293; PMCID: PMC5087680.

  Zhu L, Xiong X, Kim Y, Okada N, Lu F, Zhang H, **Sun H**. Acid sphingomyelinase is required for cell surface presentation of Met receptor tyrosine kinase in cancer cells. J Cell Sci. 2016 Nov 15;129(22):4238-4251. doi: 10.1242/jcs.191684. Epub 2016 Oct 6. PMID: 27802163; PMCID: PMC5117200.

  Zhang C, Hoang N, Leng F, Saxena L, Lee L, Alejo S, Qi D, Khal A, **Sun H**, Lu F, Zhang H. LSD1 demethylase and the methyl-binding protein PHF20L1 prevent SET7 methyltransferase-dependent proteolysis of the stem-cell protein SOX2. J Biol Chem. 2018 Mar 9;293(10):3663-3674. doi: 10.1074/jbc.RA117.000342. Epub 2018 Jan 22. PMID: 29358331; PMCID: PMC5846134.

  Leng F, Yu J, Zhang C, Alejo S, Hoang N, **Sun H**, Lu F, Zhang H. Methylated DNMT1 and E2F1 are targeted for proteolysis by L3MBTL3 and $CRL4^{DCAF5}$ ubiquitin ligase. Nat Commun. 2018 Apr 24;9(1):1641. doi: 10.1038/s41467-018-04019-9. PMID: 29691401; PMCID: PMC5915600.

  Li W, Xiong X, Abdalla A, Alejo S, Zhu L, Lu F, **Sun H**. HGF-induced formation of the MET-AXL-ELMO2-DOCK180 complex promotes RAC1 activation, receptor clustering, and cancer cell migration and invasion. J Biol Chem. 2018 Oct 5;293(40):15397-15418. doi: 10.1074/jbc.RA118.003063. Epub 2018 Aug 14. PMID: 30108175; PMCID: PMC6177597.

  Leng F, Saxena L, Hoang N, Zhang C, Lee L, Li W, Gong X, Lu F, **Sun H**, Zhang H. Proliferating cell nuclear antigen interacts with the CRL4 ubiquitin ligase subunit CDT2 in

DNA synthesis-induced degradation of CDT1. J Biol Chem. 2018 Dec 7;293(49):18879-18889. doi: 10.1074/jbc.RA118.003049. Epub 2018 Oct 9. PMID: 30301766; PMCID: PMC6295734.

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Zhai XH, Xiao J, Yu JK, **Sun H**, Zheng S. Novel sphingomyelin biomarkers for brain glioma and associated regulation research on the PI3K/Akt signaling pathway. Oncol Lett. 2019 Dec;18(6):6207-6213. doi: 10.3892/ol.2019.10946. Epub 2019 Oct 2. PMID: 31788096; PMCID: PMC6865128.

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Guo P, Hoang N, Sanchez J, Zhang EH, Rajawasam K, Trinidad K, **Sun H**, Zhang H. The assembly of mammalian SWI/SNF chromatin remodeling complexes is regulated by lysine-methylation dependent proteolysis. Nat Commun. 2022 Nov 5;13(1):6696. doi: 10.1038/s41467-022-34348-9. PMID: 36335117; PMCID: PMC9637158.

- *Sznajder, Łukasz – papers 2013 -2024 with UNLV affiliation:*

  Taylor K, Piasecka A, Kajdasz A, Brzęk A, Polay Espinoza M, Bourgeois CF, Jankowski A, Borowiak M, Raczyńska KD, **Sznajder ŁJ**, Sobczak K. Modulatory role of RNA helicases in MBNL-dependent alternative splicing regulation. Cell Mol Life Sci. 2023 Oct 26;80(11):335. doi: 10.1007/s00018-023-04927-0. PMID: 37882878; PMCID: PMC10602967.

  Sznajder L, Khan M, Tadross M, Ciesiołka A, Nutter C, Taylor K, Pearson C, Sobczak K, Lewis M, Swanson M, Yuen R. Autistic traits in myotonic dystrophy type 1 due to MBNL inhibition and RNA mis-splicing. Res Sq [Preprint]. 2023 Aug 14:rs.3.rs-3221704. doi: 10.21203/rs.3.rs-3221704/v1. PMID: 37645891; PMCID: PMC10462192. {submitted and under revision at Nature Neuroscience, as of Feb. 2024}

- *Zhang, Hui – papers 2013 -2024 with UNLV affiliation:*

  Lu F, Wu X, Yin F, Chia-Fang Lee C, Yu M, Mihaylov IS, Yu J, Sun H, **Zhang H**. Regulation of DNA replication and chromosomal polyploidy by the MLL-WDR5-RBBP5

methyltransferases. Biol Open. 2016 Oct 15;5(10):1449-1460. doi: 10.1242/bio.019729. PMID: 27744293; PMCID: PMC5087680.

Zhu L, Xiong X, Kim Y, Okada N, Lu F, **Zhang H**, Sun H. Acid sphingomyelinase is required for cell surface presentation of Met receptor tyrosine kinase in cancer cells. J Cell Sci. 2016 Nov 15;129(22):4238-4251. doi: 10.1242/jcs.191684. Epub 2016 Oct 6. PMID: 27802163; PMCID: PMC5117200.

Chen F, Zhang C, Wu H, Ma Y, Luo X, Gong X, Jiang F, Gui Y, **Zhang H**, Lu F. The E3 ubiquitin ligase SCF^{FBXL14} complex stimulates neuronal differentiation by targeting the Notch signaling factor HES1 for proteolysis. J Biol Chem. 2017 Dec 8;292(49):20100-20112. doi: 10.1074/jbc.M117.815001. Epub 2017 Oct 25. PMID: 29070679; PMCID: PMC5723999.

Zhang C, Hoang N, Leng F, Saxena L, Lee L, Alejo S, Qi D, Khal A, Sun H, Lu F, **Zhang H**. LSD1 demethylase and the methyl-binding protein PHF20L1 prevent SET7 methyltransferase-dependent proteolysis of the stem-cell protein SOX2. J Biol Chem. 2018 Mar 9;293(10):3663-3674. doi: 10.1074/jbc.RA117.000342. Epub 2018 Jan 22. PMID: 29358331; PMCID: PMC5846134.

Hoang N, Zhang X, Zhang C, Vo V, Leng F, Saxena L, Yin F, Lu F, Zheng G, Bhowmik P, **Zhang H**. New histone demethylase LSD1 inhibitor selectively targets teratocarcinoma and embryonic carcinoma cells. Bioorg Med Chem. 2018 May 1;26(8):1523-1537. doi: 10.1016/j.bmc.2018.01.031. Epub 2018 Feb 7. PMID: 29439916; PMCID: PMC6071666.

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Wang Q, Yu M, Ma Y, Zhang X, **Zhang H**, Li S, Lan R, Lu F. PHF20L1 antagonizes SOX2 proteolysis triggered by the MLL1/WDR5 complexes. Lab Invest. 2018 Dec;98(12):1627-1641. doi: 10.1038/s41374-018-0106-8. Epub 2018 Aug 8. PMID: 30089852.

Leng F, Saxena L, Hoang N, Zhang C, Lee L, Li W, Gong X, Lu F, Sun H, **Zhang H**. Proliferating cell nuclear antigen interacts with the CRL4 ubiquitin ligase subunit CDT2 in DNA synthesis-induced degradation of CDT1. J Biol Chem. 2018 Dec 7;293(49):18879-18889. doi: 10.1074/jbc.RA118.003049. Epub 2018 Oct 9. PMID: 30301766; PMCID: PMC6295734.

Zhang C, Leng F, Saxena L, Hoang N, Yu J, Alejo S, Lee L, Qi D, Lu F, Sun H, **Zhang H**. Proteolysis of methylated SOX2 protein is regulated by L3MBTL3 and $CRL4^{DCAF5}$ ubiquitin ligase. J Biol Chem. 2019 Jan 11;294(2):476-489. doi: 10.1074/jbc.RA118.005336. Epub 2018 Nov 15. PMID: 30442713; PMCID: PMC6333883.

Li W, Dick A, Lu F, **Zhang H**, Sun H. Induction of MET Receptor Tyrosine Kinase Down-regulation through Antibody-mediated Receptor Clustering. Sci Rep. 2019 Feb 13;9(1):1988. doi: 10.1038/s41598-018-36963-3. PMID: 30760737; PMCID: PMC6374517.

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ii. Grant Applications/Grant Funding Awarded

<u>Awarded Grants Are Listed Alphabetically, by Faculty Name:</u>

- *Abel-Santos, Ernesto – grants 2013 -2024 with UNLV affiliation:*

The role of calcium-DPA in the virulence of Bacillus anthracis spores
R15 AI103883 01
ABEL-SANTOS, ERNESTO V Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2013 NIAID $398,515

Prophylaxis of Clostridium difficile infection
R01 AI109139 01A1
ABEL-SANTOS, ERNESTO V Principal Investigator(s)/ Project Leader(s)
FIRESTINE, STEVEN M Principal Investigator(s)/ Project Leader(s)
MINTON, NIGEL PETER Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2015 NIAID $692,240

Prophylaxis of Clostridium difficile infection
R01 AI109139 02
ABEL-SANTOS, ERNESTO V Principal Investigator(s)/ Project Leader(s)
FIRESTINE, STEVEN M Principal Investigator(s)/ Project Leader(s)
MINTON, NIGEL PETER Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2016 NIAID $639,084

Prophylaxis of Clostridium difficile infection
R01 AI109139 03
ABEL-SANTOS, ERNESTO V Principal Investigator(s)/ Project Leader(s)

FIRESTINE, STEVEN M Principal Investigator(s)/ Project Leader(s)
MINTON, NIGEL PETER Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2017 NIAID $639,084

Prophylaxis of Clostridium difficile infection
R01 AI109139 04
ABEL-SANTOS, ERNESTO V Principal Investigator(s)/ Project Leader(s)
FIRESTINE, STEVEN M Principal Investigator(s)/ Project Leader(s)
MINTON, NIGEL PETER Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2018 NIAID $639,084

Prophylaxis of Clostridium difficile infection
R01 AI109139 05
ABEL-SANTOS, ERNESTO V Principal Investigator(s)/ Project Leader(s)
FIRESTINE, STEVEN M Principal Investigator(s)/ Project Leader(s)
MINTON, NIGEL PETER Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2019 NIAID $639,084

Effects of estrus cycle stages on murine CDI severity
R16 AI175022 01
ABEL-SANTOS, ERNESTO V Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2023 NIAID $146,071

- *Bhattacharya, Chandrabali – grants 2013 -2024 with UNLV affiliation:*

- *Gary, Ronald – grants 2013 -2024 with UNLV affiliation:*

2013: INBRE: Genomics Core University of Nevada, Reno $180,843
2014: INBRE: Genomics Core University of Nevada, Reno $175,905
2014: High Stability Metal-Protein Interactions Evaluated by Microcalorimetry
U.S. Army Research Office $112,900
2015: Metal-Protein Interactions Coordinated by Beryllium Ion
U.S. Army Research Office $80,000
2016: Metal-Protein Interactions Coordinated by Beryllium Ion
U.S. Army Research Office $110,000
2017: Metal-Protein Interactions Coordinated by Beryllium Ion
U.S. Army Research Office $80,000
2017: Metal-Protein Interactions Coordinated by Beryllium Ion
U.S. Army Research Office $26,700
2018: Metal-Protein Interactions Coordinated by Beryllium Ion
U.S. Army Research Office $63,300

- *Kleiger, Gary – grants 2013 -2024 with UNLV affiliation:*

How linkage specificity is determined during poly-ubiquitin chain formation

R15 GM117555 01
KLEIGER, GARY L. Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2015 NIGMS $347,680

Mechanisms for poly-ubiquitin chain initiation and elongation
R15 GM117555 02
KLEIGER, GARY L. Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2018 NIGMS $437,472

How ubiquitin-carrying enzymes contribute to ubiquitin ligase specificity
R01 GM141409 01
KLEIGER, GARY L. Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2021 NIGMS $460,026

How ubiquitin-carrying enzymes contribute to ubiquitin ligase specificity
R01 GM141409 02
KLEIGER, GARY L. Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2022 NIGMS $353,173

How ubiquitin-carrying enzymes contribute to ubiquitin ligase specificity
R01 GM141409 03
KLEIGER, GARY L. Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2023 NIGMS $353,173

How ubiquitin-carrying enzymes contribute to ubiquitin ligase specificity
R01 GM141409 03S1
KLEIGER, GARY L. Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2023 NIGMS $86,060

Identification of small molecule inhibitors of the DDI2 protease
R01 CA279255 01
RADHAKRISHNAN, SENTHIL KUMAR Principal Investigator(s)/ Project Leader(s)
KLEIGER, GARY L. Principal Investigator(s)/ Project Leader(s)
SERGIENKO, EDUARD A. Principal Investigator(s)/ Project Leader(s)
VIRGINIA COMMONWEALTH UNIVERSITY 2023 NCI $730,979

- *Spangelo, Bryan – grants 2013 -2024 with UNLV affiliation:*

- *Sun, Hong – grants 2013 -2024 with UNLV affiliation:*

Novel Regulation of Receptor Tyrosine Kinases by ASM (Acidic Sphingomyelinase)
R15 NS096694 01A1
SUN, HONG Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2016 NINDS $427,951

Novel Regulation of the Activation and Assembly of the Heterimeric Receptor Tyrosine Kinase Complexes for Cell Signaling
R15 CA254827 02A1
SUN, HONG Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2020 NCI $437,152

- *Sznajder, Łukasz – grants 2013 -2024 with UNLV affiliation:*

2024: Delineating pathogenic RNA species in myotonic dystrophy type 2.
Myotonic Dystrophy Foundation (MDF) $50,000

- *Zhang, Hui – grants 2013 -2024 with UNLV affiliation:*

Control of Epigenetic Inheritance By Proteolysis
R15 GM116087 01
ZHANG, HUI Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2015 NIGMS $362,255

Regulation of Stem Cell Protein Stability by Novel Ubiquitin Ligases
R15 GM131255 01
ZHANG, HUI Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2018 NIGMS $437,202

Regulation of SOX Proteins by Methylation-dependent Proteolysis in Stem Cells and Development
R01 GM140185 01
ZHANG, HUI Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2021 NIGMS $309,590

Regulation of SOX Proteins by Methylation-dependent Proteolysis in Stem Cells and Development
R01 GM140185 02
ZHANG, HUI Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2022 NIGMS $309,590

Regulation of SOX Proteins by Methylation-dependent Proteolysis in Stem Cells and Development
R01 GM140185 03
ZHANG, HUI Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2023 NIGMS $309,590

Supplement: Regulation of SOX Proteins by Methylation-dependent Proteolysis in Stem Cells and Development
R01 GM140185 03S1
ZHANG, HUI Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2023 NIGMS $10,130

Regulation of SOX Proteins by Methylation-dependent Proteolysis in Stem Cells and Development
R01 GM140185 04
ZHANG, HUI Principal Investigator(s)/ Project Leader(s)
UNIVERSITY OF NEVADA LAS VEGAS 2024 NIGMS $278,631

iii. Other

c. Teaching/Service (Gathered by Department)

i. Innovative teaching practices

Biochemistry faculty provide consistent and coordinated course content, so that, for example, CHEM 474 (Biochemistry I) covers similar material regardless of which instructor is teaching the class section. However, individual teaching styles vary. During lecture courses, all instructors employ Powerpoint lecture slides, and some employ iClicker personal response systems and Achieve online homework.

ii. Teaching or Service Awards

Ronald Gary received the UNLV College of Sciences Distinguished Service Award in March 2023.

iii. Faculty/Student Collaborations

All of the Biochemistry faculty actively engage in mentoring undergraduate student research in their labs, typically through research credit courses such as CHEM 493 and CHEM 494. These student/faculty collaborative partnerships produce a valuable educational hands-on training experience for the students. These faculty-student partnerships also advancethe faculty member's research program and create an opportunity forundergraduate students to co-authorpeer-reviewed publications or scientific meeting presentations. See section VIII.15 for additional details.

iv. Community Engagement Activities

The College of Sciences plans, coordinates, and hosts the Beal Bank USA Southern Nevada Regional Science & Engineering Fair each year. This involves students from elementary/middle school as well as high schools. The biochemistry group participates in this event as judges, along with faculty from other disciplines. Faculty also engage in occasional outreach activities involving lab tours, etc., although not on a regularly scheduled or annual basis.

V. Student Success

6. Reflect on student success metrics provided.

a. Which metrics are points of strength for the program?

The Biochemistry BS remains a very attractive and popular program for UNLV students. The Department of Chemistry & Biochemistry offers 3 undergraduate degrees: Chemistry BA, Chemistry BS, and Biochemistry BS. During the 10-year review period, Biochemistry majors comprise 64 – 70% of the undergraduate students in the department, depending on year (see Figure and Table below). While 2/3 or more of the department's students are Biochemistry majors, only 1/3 of the tenure-track faculty (7 of 21) are Biochemistry faculty. The Department Chair is released from teaching due to administrative duties, and the current Chair is one of the 7 Biochemistry faculty, reducing the teaching pool to 6. Moreover, the 4 instructional Faculty-In-Residence of the department teach General Chemistry and Organic Chemistry classes, and not Biochemistry classes. Nonetheless, this student-to-faculty ratio in biochemistry has been accommodated acceptably, without detriment to the educational mission.

Figure 1: Percentage of UG Students in Chemistry Department with BIOCHEM Major

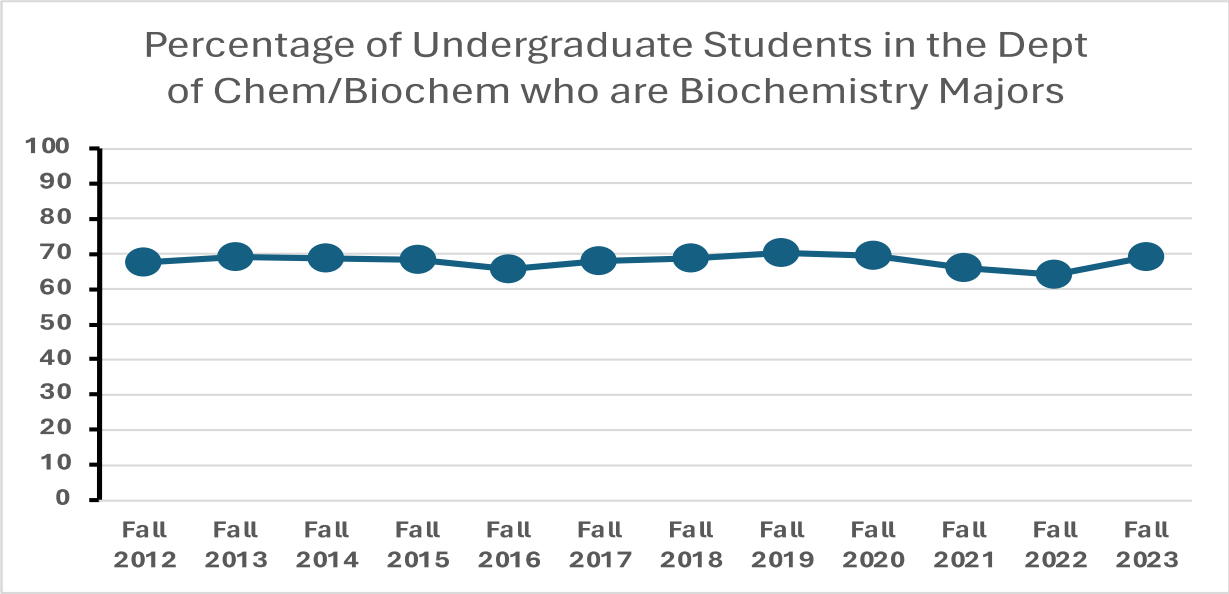


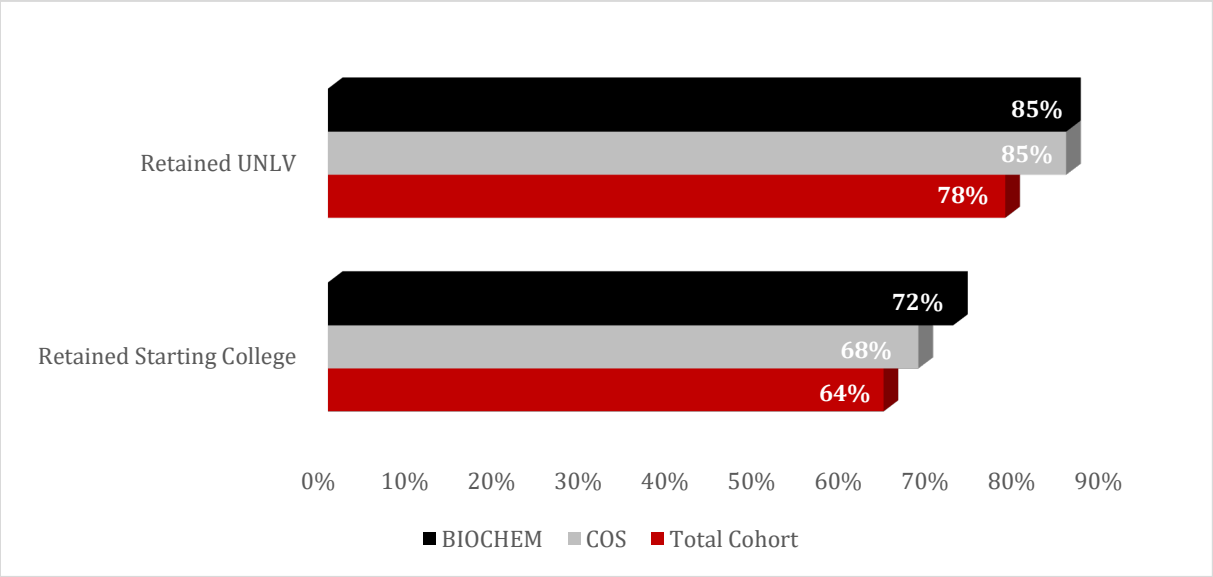
Table 1: Fall Enrollment Chemistry Department, Ten Year Trend

	Fall 2012	Fall 2013	Fall 2014	Fall 2015	Fall 2016	Fall 2017	Fall 2018	Fall 2019	Fall 2020	Fall 2021	Fall 2022	Fall 2023
CHEBA	14	16	17	27	23	19	14	13	13	24	25	22
CHEBIOBS	258	260	237	252	222	228	231	255	283	270	242	227
CHEBS	109	101	90	90	93	88	91	95	110	115	111	80
TOTAL	**381**	**377**	**344**	**369**	**338**	**335**	**336**	**363**	**406**	**409**	**378**	**329**

*Data describing department headcounts by major was provided by Megan Hullinger, Assistant Dean, Student Success & Undergraduate Programs.

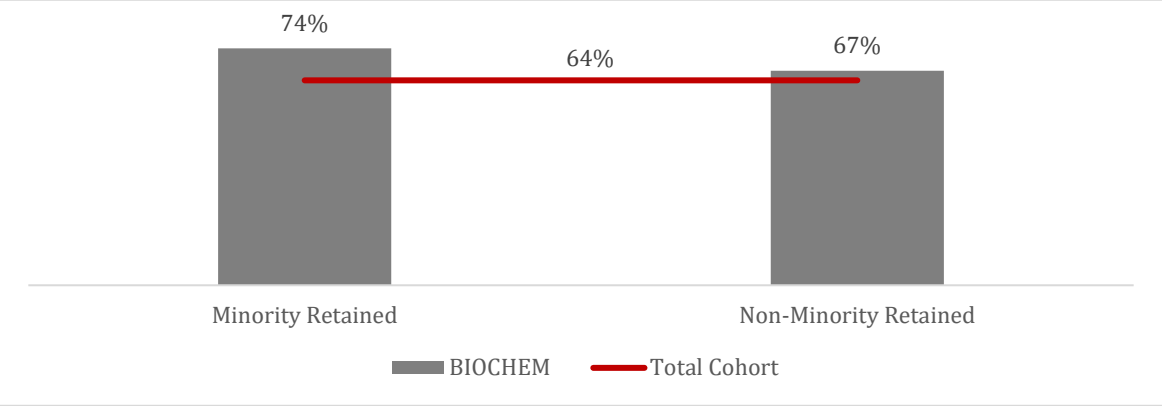
Biochemistry students have a strong one-year retention rate (Figure 2). Using a five-year average of the 2017-2021 cohorts, 72% of Biochemistry students retain in their starting college, and 85% retain at UNLV. In comparison with their peers in the College of Sciences, Biochemistry students retain in their starting college at a higher rate (72% vs. 68%) than their peers. With regard to the total bachelor's GRS cohort, Biochemistry students retain at UNLV at a rate that is 7-points higher than the total cohort.

Figure 2: Fall-to-Fall Retention Average for 2017-2021 Cohorts



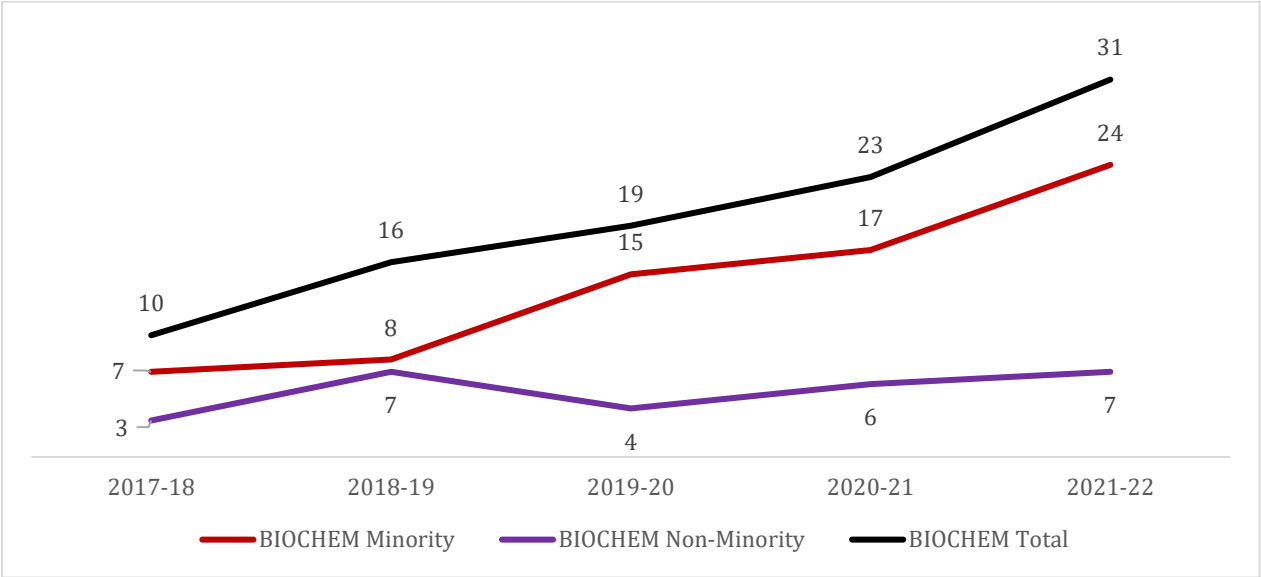
Approximately 77% of undergraduate students in BIOCHEM are from minority groups. This proportion has been relatively stable over the last five years, ranging from 75-79%. Thus, congruent success rates between minority and non-minority students are exceptionally important from an equity perspective but also because continued growth and success of the program depends in large part on the success of minority students in the program. As shown in Figure 3, minority students in BIOCHEM retain in their starting college at higher rates than their non-minority BIOCHEM peers (74% vs. 67%). Both groups of BIOCHEM students retain in their starting college at higher rates than their peers in the total cohort, which has a starting college retention rate of 64% for minority and non-minority students. These patterns suggest that minority students in BIOCHEM are currently outperforming their peers in the total cohort as well as their non-minority peers in BIOCHEM.

Figure 3: Fall-to-Fall Retention in Starting College by Minority Status (2017-2021 Cohorts)



The success of minority students in BIOCHEM is also evident in the number of degrees earned. As shown in Figure 4, the number of degrees earned in Biochemistry increased by more than 200% since 2017-2018. This growth rate is much higher than the institutional growth in bachelor's degrees earned over this period, which increased by 13% at the institutional level. Of the 31 bachelor's degrees earned in BIOCHEM in 2021-2022, 77% (24), were earned by minority students. Figure 4 also shows that BIOCHEM bachelor's degrees earned by minority students rose in tandem with total bachelor's degrees earned in the program. Thus, minority students are driving the significant growth in the number of BIOCHEM bachelor's degrees.

Figure 4: Bachelor's Degrees Awarded in BIOCHEM



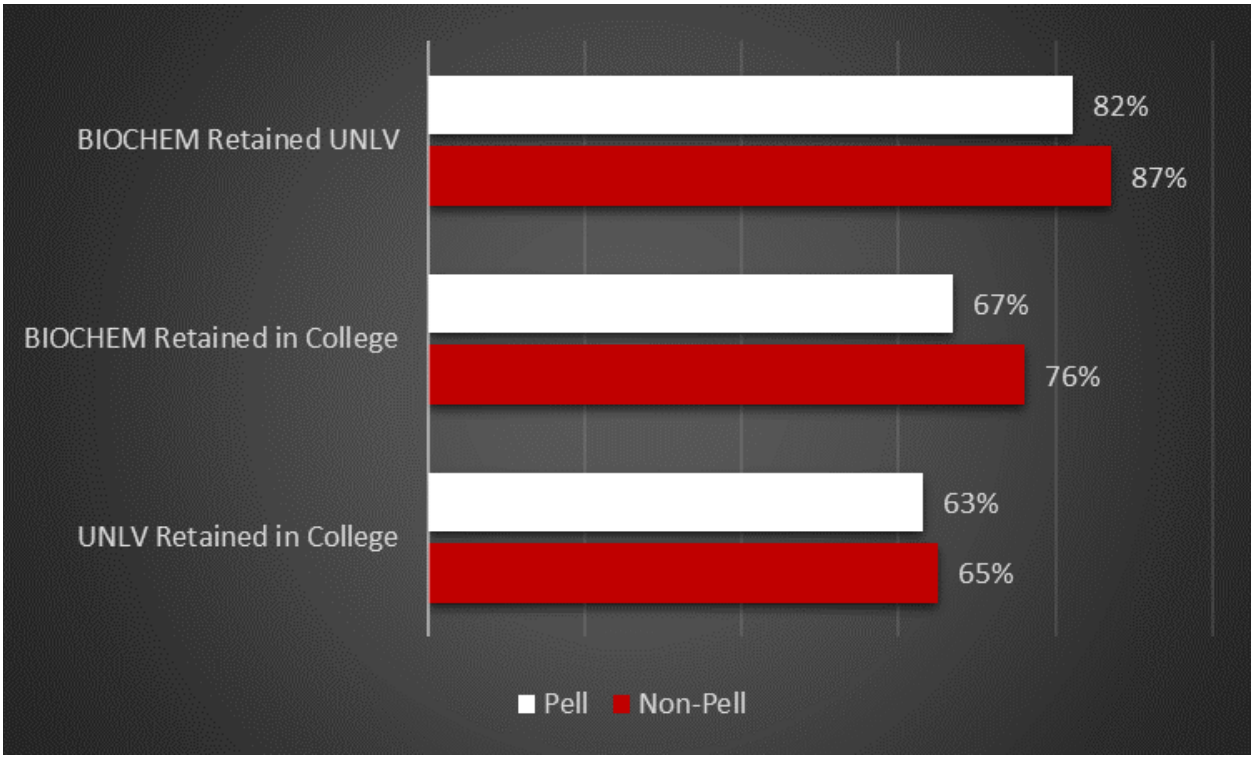
Graduation rates for BIOCHEM students are slightly higher than the institutional average. Using a five-year cohort average, 47.8% of BIOCHEM students graduate at UNLV within six years in comparison with a 45.3% graduation rate for the total cohort. Nationally, institutions are pushing to enhance 4-year completion rates because finishing faster saves students time and money. Using a five-year average (cohorts 2015-2019), 25% of cohort students who begin in the College of Sciences graduate at UNLV within four years. Cohort students who start in BIOCHEM graduate at UNLV a rate of 21%, which is slightly lower than COS peers, but this difference is not large enough to constitute a concern.

b. Are there areas of concern for the program?

Pell recipients made-up approximately 35% of BIOCHEM students in fall 2022. Over the last five years the percent of BIOCHEM students who receive Pell generally varied within a margin of 25-40%. Regardless of this variation, Pell recipients are an important group to consider with regard to equity and success. As shown in Figure 5, BIOCHEM Pell recipients retain at UNLV at a rate that is five percentage points lower than their non-Pell peers in BIOCHEM (82% vs. 87%). This retention gap is should be monitored for further changes. Despite this gap in achievement between BIOCHEM Pell and non-Pell students, BIOCHEM students continue their studies at UNLV at rates that are higher than the total cohort.

Figure 5 also shows a more consequential difference between Pell and non-Pell recipients with regard to retention in starting college. Pell recipients in BIOCHEM retain in their starting college at 67% whereas their non-Pell BIOCHEM peers retain at 76%. This nine-point difference in starting college retention suggests that Pell recipients in BIOCHEM are less likely to retain in the College of Sciences than their BIOCHEM peers who are not Pell recipients. As with UNLV retention, BIOCHEM students retain in their starting college at higher rates than their peers in the total cohort, regardless of Pell status; however, it should be noted that the retention gap between Pell recipients in BIOCHEM and Pell recipients in the total cohort is only 4 percentage points suggesting minimal differences in achievement.

Figure 5: One Year Retention by Pell Status (Cohorts 2017-2021)



Aggregated responses from the last two graduate exit surveys suggest additional areas for exploration. This survey is administered annually to graduating seniors, and the response rate is generally quite strong. In fact, approximately 68% of graduating BIOCHEM students completed the survey in 2021-2022 and 2022-2023. Overall, many of the results suggest that BIOCHEM students are less satisfied with their experience than their graduating peers. The table below summarizes the areas that have substantial differences between UNLV students in the general population and graduating BIOCHEM students. The areas where BIOCHEM students are less satisfied than their peers include:

- Acquire knowledge and skills for career
- Develop effective job-seeking skills
- Quality of instruction
- Quality of program of study
- Availability of courses
- Faculty interest in students
- Quality of academic advising by faculty
- Satisfaction with overall academic experience

Table 2: Exit Survey Results for Graduating Students

Survey Item	UNLV	BIOCHEM
Acquire knowledge and skills for career (strongly agree)	51% (n=3,356)	24% (n=10)
Develop effective job-seeking skills (strongly agree)	37% (n=2,387)	22% (n=9)
Quality of instruction (strongly satisfied)	28% (n=1,789)	7% (n=3)
Quality of program of study (strongly satisfied)	38% (n=2,429)	7% (n=3)
Availability of courses (strongly/somewhat disagree)	36% (n=2,303)	63% (n=26)
Faculty interest in students (strongly satisfied)	33% (n=2,098)	12% (n=5)
Quality of academic advising by faculty (strongly satisfied)	42% (n=2,616)	30% (n=12)
Satisfaction with overall academic experience (strongly satisfied	35% (n=2,264)	15% (n=6)

The final piece of data worth noting is that a few courses have large differences in the DFWIC- rates (combined total of students receiving grades of D, F, Withdrawal, Incomplete, and C-minus) between online courses and face-to-face courses. For instance, the face-to-face version of CHEM 103 (Preparatory Chemistry) had a DFWIC- rate around 50% in three semesters, whereas the online version of CHEM 103 had a DFWIC- rate between 15-33%. In two semesters, CHEM 121A showed a DFWIC- rate that favors online students with an achievement gap of 9% in spring 2022 and 17.9% in 2023. Because these differences occur several times, they suggest a need for a focused comparison between the online courses and face-to-face courses to ensure that students are receiving a congruent experience regardless of their modality.

c. Describe changes or improvements would you like to see in student success metrics.

It is notable that the unprecedented COVID pandemic occurred during the program evaluation period. This generated curricular as well as extracurricular (medical, financial, family, etc.) disruptions in the lives of students. Despite this set of circumstances, student numbers for retention, progression, and completion in the program were maintained reasonably well. At times, for example Fall 2020 especially, face-to-face courses were forced to change to online delivery mid-semester, often on short notice. The faculty and students in the program navigated these challenges fairly well, all things considered. This demonstrates flexibility and resilience by both faculty and students. There was a general philosophy, at the individual faculty level as well as at the UNLV administrative level, to try to minimize hardships to students and to give students the benefit of the doubt whenever possible in order to accommodate the pandemic. For example, the time to remediate Incomplete grades was extended, special temporary policies affecting S/U grading options were enacted, and so on. The disparity in DFWIC- rates noted above, comparing face-to-face versus online instruction, may have been impacted by some of these factors.

VI. Assessment

7. The program has an assessment index score of (provided by IE). Identify areas to improve/enhance the assessment score (if applicable).

No assessment index score was available. The "Ten Year Program Review Data" document stated: "Assessment plan should be renewed and/or updated." It appears that the most recent Assessment Report covering the Biochemistry BS program was submitted in April 2018.

8. Describe how assessment findings have been used to identify gaps or weaknesses in student learning. What changes were made to address these issues?

The department needs to coordinate with the appropriate university areas that help with assessment to improve utilization of this process.

VII. Curriculum

9. Evaluate the complexity of the program curriculum. Are there a lot of prerequisites or corequisites that are no longer vital/or may prevent student progress? Are any of the required courses on the high DFWIC- rate list (data provided by Academic Effectiveness)?

The current design of the Biochemistry degree is constructed to preserve the academic rigor of the program. Specifically, the structure of prerequisite courses builds a foundation of knowledge that frames student learning as they advance through the program. Thus, as students navigate upper division courses, their success depends on mastery of content from lower division prerequisites.

There are a number of courses that appear on the high DFWIC- list in at least three of the four semesters for which data was provided (Table 2). Science courses, particularly General Chemistry and Organic Chemistry, have to retain performance standards to ensure that students build knowledge and critical inquiry skills that are appropriate in this rigorous field of study; however, advancing student achievement is central to UNLV's mission as an educational institution. Thus, the data suggests a need to explore additional approaches to student support, so more students can learn the content without inflating grades or degrading academic standards.

Table 3: Courses with DFWIC- Rates above 20% in 3 or 4 Semesters

Course	Semesters on DFWIC- List	Range DFWIC-
CHEM 103: Preparatory Chemistry	3	20%-50.5%
CHEM 108: Introduction to Chemistry	4	25% -49.4%
CHEM 121A: General Chemistry I	3	20.3%- 38.3%
CHEM 122A: General Chemistry II	3	23.8%-36%
CHEM 241: Organic Chemistry I	4	33.6%- 63.2%
CHEM 242: Organic Chemistry II	4	43.2% - 64.1%
CHEM 347: Laboratory Techniques of Organic Chemistry I	4	21.1% - 29.4%

.

It should be noted that CHEM 108 is intended mainly for non-science majors and students majoring in nursing and allied health. This course gives non-majors exposure to biochemistry (along with general chemistry and organic chemistry). CHEM 103 (Preparatory Chemistry) is not required, but it is offered to help students prepare for success in CHEM 121A. The Department offers a Placement Exam to assist students in determining whether their high school chemistry experience has them ready for CHEM 121A directly, or whether CHEM 103 would be a better option. CHEM 347 is occasionally taken by Biochemistry majors, but it is principally intended for Chemistry majors; Biochemistry majors typically take CHEM 241L and 242L to satisfy their organic chemistry lab requirements.

10. (Undergraduate only) Does your program have a course to meet the culminating experience requirement? Which course? Describe how the course meets the culminating experience requirement.

CHEM 476 (Advanced Topics in Biochemistry) is the culminating experience course for the Biochemistry BS program. In this course, a single "special topic" in biochemistry is examined in detail. Since 2015, the topic has been "Chemical Biology" (Instructor: Ronald Gary), but "Enzyme Kinetics" and "DNA Repair Biochemistry" are two topics that have also been taught under CHEM 476. CHEM 474/475 (Biochemistry I and II) are pre-requisites for CHEM 476, which is typically taken during the student's final year. Whereas CHEM 474 and 475 are "broad" (covering a wide variety of material), CHEM 476 is "deep", enabling students to cover a narrower range of topics but at a deeper or more sophisticated level. Additionally, CHEM 476 provides an outstanding opportunity to review, apply, and extend subjects that were first learned in Organic Chemistry, Quantitative Chemistry, Physical Chemistry, and Biochemistry.

11. (Undergraduate only) Does your program have a course that meets the milestone experience requirement? Which course is the milestone course, and how does it meet the requirements?

CHEM 474 (Biochemistry I) serves as a milestone course for the Biochemistry BS program. It directly builds on prerequisite material, such as thermodynamics, organic chemistry, etc. It also provides the foundation for biochemistry (protein structure and function, enzyme kinetics, principles of metabolism, etc.).

12. Are all required courses offered on a regular schedule? Please identify required courses and describe the teaching schedule. Does the mix of course sections, days, times, modalities meet student needs?

Yes. Courses are offered on a regular predictable schedule, and efforts are taken to avoid time and day conflicts with other required courses.

13. How many courses are low yield? Are these low yield courses necessary for degree paths or electives? How much faculty resources are required to maintain these courses? Is there a way to increase yield for these courses?

None, there are no low-yield courses that are required for the Biochemistry BS. However, some explanation is in order. In the "Ten Year Program Review Data" that was supplied, several CHEM courses were listed, and 2 are relevant to the Biochemistry BS. (1). The course CHEM 472 (Biochemistry Laboratory) is required for the Biochemistry BS, and it was flagged as low-yield (defined as enrollment less than 15) during Spring 2022 (enrollment = 13, barely missing the threshold) and Fall 2022 (enrollment = 6). This course is always offered in the Spring, and an additional section was offered during Fall 2022 for the first time. This unusual and out-of-the-normal-sequence offering no doubt accounts for the low enrollment that semester. CHEM 476 (Advanced Topics in Biochemistry) is required for the Biochemistry BS, and it had enrollment of 6 in Spring 2023. However, this was an unusual off-sequence extra section, created on a one-

time basis to accommodate a special UNLV postdoc program that includes a teaching component for the postdoctoral fellow. CHEM 476 is always offered each Fall semester.

CHEM 476 enrollment numbers over the past few years are as follows:

- F2018 = 29
- F2019 = 35
- F2020 = 24
- F2021 = 39
- F2022 = 30
- F2023 = 20 (no doubt a little low due to the Sp23 offering)

CHEM 472 (Biochemistry Lab) and CHEM 476 (Advanced Topics in Biochemistry) are each courses that benefit from lower enrollments and higher instructor-to-student ratio, when staffing permits. Each of these classes involves interactive discussions between students and faculty. Under typical circumstances, each is offered only one semester per year, but when special circumstances allow an off-cycle addition, this is deemed desirable by the department.

14. Is the program planning curriculum changes in the next few years? If yes, please describe these changes.

No.

VIII. Post-Graduation Outcomes

15. What does the data documenting student outcomes suggest about the current structure of the program in preparing students to enter the workforce or pursue additional education opportunities?

A search of Lightcast produced a sample of job titles and employers for Biochemistry graduates. Twenty-one alumni were matched, which is approximately 10% of Biochemistry graduates within the last ten years. Program graduates show job titles, such as: research assistant, teaching assistant, project engineer, computer and information scientist, medical scientist, pharmacist, radiologist, and environmental scientist and specialist. Employers include UNLV, CVS Health, Southern Nevada Health District, Mayo Clinic, and University of California. The breadth of jobs and the prestige of employers on the list show that UNLV Biochemistry students extend their education into a myriad of employment opportunities.

At the department level, there is no systematic department-wide attempt to maintain records of post-graduation outcomes. However, one of the Biochemistry faculty (Dr. Abel-Santos) maintained and provided highly detailed records on this topic for the UG students he has mentored in his research lab during the past ten-year period. This compilation is shown below, with outcomes described by the "Current position" column of the table.

Undergraduate and post-baccalaureate students mentored by Dr. Abel-Santos (2013-2024)

Name	Training dates	Terminal degree, year	Position as mentee	Current position
Horacio Guerra[1,3]	2013-2014	M.D., 2021	Undergraduate researcher	Chief Resident, UNLV School of Medicine
Mujahid Ryan[1,4]	2014-2014	B.S., 2015	REU intern	Biotechnology I. CalState Northridge
Greg Brittenham[3]	2014-2014	D.O., 2019	Undergraduate researcher	Vascular Surgery Resident; Sacramento, CA
Deaudre Lecato[3]	2013-2014	DMD/MBA, 2021	Undergraduate researcher	Secretary, Nevada Academy of General Dentistry
Sean Tanzey[4]	2014-2015	Ph.D., 2021	Undergraduate researcher	Post-doctoral fellow-University of Washington
Michael Briones[3]	2014-2015	M. D., 2021	Undergraduate researcher	Anesthesiology Resident, Portland, OR
Jessica Sasaoka[3]	2015-2015	2018	Undergraduate researcher	DPT; Physical therapist, Las Vegas, NV
Adam Dick[4]	2015-2015	B.S., 2015	Undergraduate researcher	Ph. D. student in Biochemistry, UNLV, Las Vegas,
Minh Chau Truong[2,3]	2015-2016	D.O., 2020	Undergraduate researcher	Internal Medicine, Honolulu, HI,
Marc Torred	2015-2016	B.S., 2016	UROP intern	Unknown, Las Vegas, NV
Elias Benjelloun	2015-2016	B.S., 2016	Undergraduate researcher	Founder & Chief Digitalist at Tech Start Marketplace
Julian Phan[2,3]	2015-2017	B.S., 2017	Undergraduate researcher	Dental student, Las Vegas, NV
Fernando Flores[1,2,3]	2015-2017	M.D., 2021	Lab manager	Emergency Medicine resident, Oak Lawn, IL
Dana Sanchez[1,4]	2016-2018	B.S., 2017	Undergraduate researcher	Medical Technologist at St. Luke's Hospital Anderson,
Ian Laughrey[3]	2016-2018	M.D., 2023	Undergraduate researcher	Medical Resident of Psychiatry, UNLV School of Medicine
Natiera Magnuson[4]	2011-2018	B.S. 2011	Undergraduate/ Graduate researcher	QA Coordinator at Intrepid Potash, Carlsbad, New Mexico
Lina Chen	2017-2018	B.S., 2018	Undergraduate researcher	Sales Associate, Eli Lily, Las Vegas NV
Alyssa Bui[3]	2017-2018	B.S., 2020	Undergraduate researcher	Nursing student, Las Vegas, NV
Mai Aoki[2,4]	2016-2018	B.S., 2019	Undergraduate researcher	Lab coordinator, UNLV, Las Vegas, NV
Connie Ngo[2,3]	2015-2018	B.S.N, 2016	Undergraduate researcher	Registered Nurse, Las Vegas, NV
Jenny Do[2,3]	2016-2021	B.S., 2020	Undergraduate researcher	Medical Student, Arkansas College of Osteopathic Medicine
Tiffany Mata[1]	2018-2021	B.S., 2020	Undergraduate researcher	Senior Associate, In-N-Out Burger Las Vegas, NV

Name	Training dates	Terminal degree, year	Position as mentee	Current position
Guillermo Michel[1,2,4]	2015-2019	B.S., 2021	REU intern	Health Inspector Southern Nevada Health District
Michael Consul[3]	2021-2022	B.S., 2021	Undergraduate researcher	M.D. student, John Hopkins University
Tayler Dickerson	2021-2021	B.S., 2021	Undergraduate researcher	Managing Member, Magic Hands, LLC
Trae Hill[3]	2019-2021	B.S., 2021	Undergraduate researcher	MD student, Wayne State University
Samrawit Misiker[1,3]	2018-2021	B.S., 2021	UROP intern	Medical Student at University of Nevada, Las Vegas
McKensie Washington[1,4]	2019-2022	B.S., 2021	Undergraduate researcher	Senior Microbiologist at DigiPath Labs
Tre'Shur Williams[1]	2023-2023	2025 (expected)	REU intern	Undergraduate student at Fort Valley State University
Robert Soriano[1]	2022-current	2024 (expected)	Visiting researcher	Undergraduate student at Nevada State University
Katrina Valadez[1]	2023-current	B.S., 2023	Undergraduate researcher	Post-bac student at UNLV
Joelyne Contreras[1]	2023-current	B.S., 2023	Undergraduate researcher	Post-bac student at UNLV
Liahm Blank	2023-current	2024 (expected)	Undergraduate researcher	Undergraduate student at UNLV
Stephanie Yang	2023-current	2025 (expected)	Undergraduate researcher	Undergraduate student at UNLV

1. Underrepresented minority student
2. These students are authors on one or more peer-reviewed publications
3. Active careers in clinical sciences
4. Active careers in biomedical sciences

16. Identify the skills students acquire through their program of study. How do these skills map onto workforce needs?

Biochemistry BS students acquire knowledge of biochemistry along with general and organic chemistry, biology, molecular biology, genetics, etc. They develop quantitative skills that are in-demand for the modern workforce. They have extensive hands-on laboratory experience, completing required lab courses in general chemistry, organic chemistry, physics, biology, quantitative chemistry, instrumental, and biochemistry labs. In addition, many undergraduates conduct mentored research in a faculty lab during their time at UNLV, although research is elective (not required) for the Biochemistry BS degree. Many students develop presentation skills through CHEM 489 (Senior Poster Seminar).

17. What is the demand trajectory and employment opportunities in this area over the next 3-5 years? Identify the most important local employers for program graduates.

Biochemistry is a "hard science", and a STEM field. Demand is strong and expected to remain so in the future. Regarding "local employers", Las Vegas is not currently a biotech mecca compared to areas such as San Diego, Los Angeles, San Francisco, Boston, New York/New Jersey, etc., although growth of local opportunities in biotech/pharma is anticipated and desirable. Healthcare-related industries are bigger in the Las Vegas region, and certainly biochemistry is a relevant training for careers in those areas. The water district and police forensics are additional local employers for biochemistry graduates.

18. Are there skills/areas of study that can be added or enhanced to meet evolving workforce needs?

The Biochemistry BS program consists almost entirely of required courses, with few electives, so there is little opportunity to offer entirely new courses without displacing existing courses. However, the Biochemistry faculty strive to modernize and incorporate recent developments in their courses as the field progresses.

IX. Budget and Resources

19. What are the primary funding sources for this program?

The program is primarily funded through three sources: (1) the annual state account that funds all departmental activities including the Biochemistry program; (2) the department's summer surplus account that is supplied by net proceeds from summer session course offerings; and (3) the department's indirect costs account. In general, these accounts supply Biochemistry faculty with office supplies, materials and resources that are necessary to promote teaching mission, faculty recruitment and a portion of startup funding to equip laboratories, and the solicitation of outside speakers for the department's seminar series.

20. Describe how revenue is allocated to support program activities.

The program's undergraduate laboratory course, CHEM 472 (Biochemistry Lab), is entirely funded through the acquisition of fees collected at the beginning of each semester. These funds are self-sustaining and are expected to be increased throughout the years to track with commonly used measures of inflation.

21. Is the current revenue allocation sufficient to support the program? If additional resources are necessary, please describe the changes that are necessary.

The continued success of the Biochemistry BS program requires outstanding instructors. At first glance, it might be thought that faculty research is central to graduate education but only peripheral for undergraduate education. However, teaching and research are inextricably linked in the academic environment. First of all, many biochemistry majors benefit from undergraduate research opportunities in faculty research labs. Even more fundamentally, research support

and infrastructure directly impact the recruitment and retention of instructional faculty in this field.

At UNLV, the job description for tenure-track faculty in biochemistry is formally defined as 40% Teaching, 40% Research, and 20% Service. The department has successfully recruited two junior faculty in the general area of Biochemistry and had sufficient funds to provide 25% of the startup costs. The department also pays for renovations to various laboratories that are purposed specifically for the Biochemistry program. Nevertheless, lab renovations can be expensive, and it appears that the University is moving towards a model where a greater fraction of the costs are expected to be covered by the department. Eventually this will be unsustainable (see Item 22, below).

22. Discuss strengths or concerns in the following areas:

a. Library resources
b. Equipment
c. Space
d. Other nonacademic sources

Library:

The UNLV library maintains subscriptions to an outstanding selection of Biochemistry-related journals and offers funding to pay for single articles if the University does not have a subscription to a specific journal.

Equipment:

The Biochemistry program has several shared equipment resources. While there are always additional equipment items that could be put to good use, the current resources are sufficient to support the research and instructional efforts of all the faculty within the program.

Space:

In terms of space, there are multiple rooms within the Chemistry building that will require substantial renovation before they can be occupied by incoming Biochemistry faculty. In total, these costs are outside of what the department can afford by itself, and support from the College of Sciences and the offices of the Vice President for Research and the Provost will be necessary to produce space that can be offered to newly recruited Biochemistry faculty.

X. Summative Evaluation

23. Summarize the areas of excellence and/or strengths of this program.

As noted earlier, approximately two of every three Chemistry and Biochemistry department undergraduate students are Biochemistry majors, despite the number of faculty within the program representing perhaps only one-third of the total. Furthermore, CHEM 474 (Biochemistry I) is an important service course that is typically required by professional schools such as Medical, Dental and/or Pharmacy (to name only a few), placing even greater demand on the Biochemistry faculty. The Biology BS program has the largest enrollment of any science major at UNLV, by far, and CHEM 474 is required for all biology majors. Moreover, CHEM 475 (Biochemistry II) is required for the BS in Biology - Cell and Molecular Biology Concentration program, and recommended for all other Biology degree Concentrations. Although this creates enrollments in these courses that dwarf the number of biochemistry majors, it also represents a strength of the program, by providing exposure of our curriculum to students outside the department, and by integrating our courses with other major programs on campus.

24. Identify opportunities to improve this program.

Regarding opportunities to improve the program, two key areas can be identified. The first is ensuring that we have sufficient numbers of instructional personnel to thrive going forward. Currently, the department uses tenure-track faculty exclusively for the biochemistry-specific courses, which are all upper-division classes (i.e. CHEM 472, 474, 475, and 476). Thus, these faculty have significant research commitments along with teaching commitments. Increases in faculty head count would improve student-faculty ratios, and allow even more time to be dedicated to instructional quality (lecture prep, office hours, course modifications, etc.) While the Biochemistry faculty have been successful in the various responsibilities, including extramurally funded research programs and serving the teaching requirements of both Biochemistry majors as well as students from various other departments, it is noteworthy that sections of CHEM 474 and even CHEM 475 have been encroaching on 200 students the past couple of years. It may be beneficial to consider adding excellent non-tenure track instructors to the mix. The program could put one or two faculty-in-residence hires to good use in this regard. The second major area for consideration is to investigate the student survey responses more deeply. Table 2 summarizes Exit Survey results for graduating students in biochemistry. We can deduce that a total of 41 surveys were collected, based on the percentage and n values shown. Only 3 of these 41 individuals (7%) rated themselves as "Strongly Satisfied" with "Quality of instruction". This seems an unacceptably low percentage, but it raises several important follow-up questions: (1) Is this representative of student perceptions, or are the dissatisfied subset more likely to respond to surveys? (2) What are the rates of "Moderately Satisfied", "Strongly Dissatisfied", etc.? This would better indicate whether there is widespread dissatisfaction or merely a tendency to withhold the highest grades. In other words, Table 2 indicates that few students are giving "Quality of instruction" an A grade in this survey, but are they giving B's? Or C's and D's? (3) It would be helpful to attempt to obtain more details regarding satisfaction. Why are students unsatisfied? For example, do they feel that instructors are unprepared? Not knowledgeable in the subject matter? Devote too little time for office hours help? Exams too difficult? Grading too hard? It would be valuable to try to dig deeper into these survey metrics. The department

administers its own end-of-semester Teaching Evaluation surveys for every course, and the results of those surveys seem divergent from the results of the Table 2 surveys. The department surveys are anonymous, standardized (i.e. identical for every class in the department), administered during the 15th week of the semester, and administered without the instructor present to promote impartiality. A Teaching GPA (1–5 scale, 5 being best) is calculated based on the question "OVERALL INSTRUCTOR EVALUATION", with the available response choices: Excellent (5 pts); Good (4 pts); Satisfactory (3 pts); Poor (2 pts); Very Poor (1 pts). The CHEM 476 instructor has offered to provide his survey results as an example to support the Self Study. CHEM 476 (Advanced Topics in Biochemistry) is a good choice, because this class consists almost entirely of biochemistry majors who are close to graduating.

Teaching GPA for CHEM 476 (Advanced Topics in Biochemistry):

F2018 = 4.93	(28 responses out of 29 enrollment)
F2019 = 4.76	(34 responses out of 35 enrollment)
F2020 = 4.95	(19 responses out of 24 enrollment)
F2021 = 4.76	(25 responses out of 39 enrollment)
F2022 = 4.83	(23 responses out of 30 enrollment)
F2023 = 4.93	(18 responses out of 20 enrollment)

These departmental surveys also include an open-response comment section, and the written student comments are consistent with very high satisfaction and the high Teaching GPA scores tabulated above.

25. Based on this analysis, what are the top three priorities/needs for this program in the future?

Additional faculty to help with teaching, most likely in the form of multiple faculty-in-residence hires. Outside funds to help renovate space in the Chemistry building to outfit existing labs in preparation for incoming junior Biochemistry faculty. Additional funds to acquire equipment that would benefit both research-intensive faculty as well as the undergraduate teaching lab (CHEM 472).