Indiana University of Pennsylvania
WAC
Writing Across the Curriculum

IUP Department of Chemistry, Biochemistry, Physics and Engineering

Writing Plan for Chemistry and Biochemistry

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Summary and Goals

The Department of Chemistry, Biochemistry, Physics and Engineering (CBPE) was recently amalgamated from the departments of Chemistry and Physics, and the Environmental Engineering program. The chemistry and biochemistry majors share the majority of their required courses, but the curriculum for Physics and Engineering are largely separate from chemistry and biochemistry. Therefore, this report will detail how writing is used in the courses associated with the chemistry and biochemistry degrees, and courses taught by professors with their specialty in those fields. This report will present both the way writing is used in these courses at present, and our objectives for enhancing the use of writing in these courses in the future.

The survey of writing outcomes was done during summer 2021. At that time 13 of the 19 faculty in CBPE had their specialty in chemistry or biochemistry - of that 13, 11 faculty responded to the survey. These responses indicate that all of the surveyed courses include some level of writing, although in many lecture courses this only consists of essay questions on quizzes and exams. In lab courses, or courses that include a lab component, writing is a significant part of the laboratory experience. This varied from answering essay-type questions on a pre-made report form in a 100-level non-majors lab to long, detailed formal lab reports in upper-level, majors-only lab. What is less common is the use of writing, outside of evaluative exercises, as a teaching tool in chemistry and biochemistry lecture courses.

Writing samples were collected from 11 upper-level chemistry and biochemistry majors in Chemistry Seminar II (CHEM 390 or BIOC 480) during Fall 2021. The assignment was an original research proposal of 8-10 pages, including abstract, background, objectives, methodology, budget and citations. The analysis of these writing samples indicated that while these students followed the format well and used citations correctly, there was room to improve in correct English usage and expressing themselves in the accepted scientific style. Specifically, many of the students fell short of expectations in terms of precision, clarity and objectivity expected in good scientific writing.

Based on the above, the following Writing Across the Curriculum goals are proposed for chemistry and biochemistry: 1) develop the way that writing is used in lectures as an instructional method (writing to learn); 2) make an expectation that students, in their written lab reports, will improve both their English usage and their ability to express themselves in the accepted scientific style (writing to communicate).

Section 1: Writing Characteristics in Chemistry and Biochemistry

The essential first requirement for writing in chemistry and biochemistry, like all writing, is reasonable mastery of written English. Students need to appreciate the importance of effective communication, and that writing is a vital component of communication in any professional setting. Beyond this, what differentiates scientific writing from other writing types is an emphasis on precision, clarity and objectivity. Writing in chemistry and biochemistry may take the form of a manuscript for publication in a journal, a grant proposal or a literature review. However, all of these formats share the need for the reader to clearly understand the specific details of what is being presented, and to be able to assess the information based on the facts alone. Students are not accustomed to expressing themselves to the level of precision, clarity and objectivity expected in scientific writing. Obtaining the ability and discipline to write well in the scientific style is an important milestone in the training of a scientist and should serve our students well in future graduate studies and employment.

Section 2: Desired Writing Abilities

As mentioned in Section 1, the key to effective scientific writing is emphasis on precision, clarity and objectivity:

Precision – one constant of scientific writing is that the language use needs to be specific and unambiguous. For instance, the reliability or feasibility of research frequently is dependent on the specific capabilities of the techniques used, so the ability to give a detailed and precise explanation of experimental parameters conveys mastery of the science that is being presented. Precision also entails the omission of unnecessary information, so that all required details are included without excess text.

Clarity – the heart of any scientific writing is the description of some procedure or phenomenon. These can be very complex, so a clear description of what is being presented is vital. Published research will often be reproduced and expanded upon by other labs, and this is only possible if the experimental procedure is presented in a clear and understandable manner.

Objectivity – the goal of science is to make conclusions based on facts and data, not emotion, bias or preconceived ideas. However, science is a human activity, so maintaining objectivity is a constant battle, and this goal needs to be buttressed by the language used in scientific writing. In an earlier generation, scientists were advised to use the passive voice. Modern scientific writing has moved toward the active voice, but with limitations on the use of “I” or “we.” It is still an imperative that conclusions are based on the data presented, not the opinions or intuition of the author.

In summary, writing in the scientific style is a specialized subset of quality writing in general. It is a skill that can only be learned through practice and revision, with feedback

from faculty. However, mastery of this skill is an important goal for our students, one that can make the difference in employment and grant applications.

Section 3: Integration of Writing into Undergraduate Curriculum

There are several different types of courses taught by the chemists and biochemists in the CBPE Department. The way the writing is presently used in these courses typically breaks down by these course types:

Laboratory courses – these are primarily part of a lecture/lab combination (with the exception of CHEM 343), but writing is generally used very differently in the lecture and lab portions of the course. All lab courses use some form of a lab report. In service courses such as CHEM 103, this may be largely pre-formatted, but students still need to respond to several essay-style prompts that serve as a check for understanding. In the large freshman and sophomore level courses (CHEM 111, 112, 231, 332), students move from fairly proscribed reports to more independent formatting through the two-semester sequence. Also, communicating in the scientific style is introduced at this level. The lab reports in laboratory courses at the 300- and 400-level require greater independence of the students and further reinforce writing in the style expected by professional scientists. Finally, in CHEM 498 and BIOC 482, the undergraduate research courses, students are required to submit a detailed report of their work, in a format very similar to a manuscript for publication in a scientific journal.

Lecture courses – these courses, whether they are part of lecture/lab combinations or stand-alone lecture courses, have generally used writing less extensively than most laboratory courses. A few courses do employ writing to learn, using short writing assignments to check for understanding of concepts presented in class. However, this is not common in the lecture courses in chemistry and biochemistry. These courses are heavily based on content and often the only required writing is essay-type questions on quizzes and exams.

Seminar courses – BIOC/CHEM 290, BIOC 480 and CHEM 390 are 1-credit seminar courses. The concept of these courses is to give majors a better understanding of what it means to be a chemistry or biochemistry students, and the career paths that are available to our majors. Both writing to learn and writing to communicate are extensively used in these seminar courses, which typically conclude with a multi-page written project.

Poster presentations – An important component of the education of a science student is giving presentations of their undergraduate research. In chemistry and biochemistry, this most often takes the from of a poster. Research posters in the sciences are a very important and accepted presentation format – at an American Chemical Society national meeting, nightly sessions are presented in a huge hall with hundreds of posters from top research programs. Scientific posters consist of both text and data, so this is an excellent opportunity for students to implement scientific writing in a public forum. The

Department of Chemistry, Biochemistry, Physics and Engineering is committed to supporting students in making poster presentations, both at IUP and at external venues.

Students in Chemistry and Biochemistry will not be required to take English 202, Composition II. Instead, students meet the objectives of ENGL 202 through their written assignments in upper-level lab courses, including CHEM 325 (chemistry and biochemistry) and CHEM 343, CHEM 390 and CHEM 498 (chemistry only), or BIOC 412, BIOC 480 and BIOC 482 (biochemistry only). These courses include some writing-to-learn, but the required writing is primarily writing-to-communicate, focusing on the following areas: 1) summarizing pertinent scientific research; 2) clearly explaining experimental procedure; 3) detailing the results of experiments or their own original research (CHEM 498 or BIOC 482). In all cases expression in the accepted scientific style will be stressed, and students will have the opportunity to receive feedback from the instructor and revise their written reports.

Syllabus statement – The Department of Chemistry, Biochemistry, Physics and Engineering is committed to developing student writing throughout the curriculum. In any of our courses, you may be asked to use writing to check for your understanding of concepts presented in lecture and/or lab. Additionally, many courses will require you to write lab reports or papers that will help you learn to communicate in the accepted scientific style. Learning to communicate scientific ideas and data in a written format is an important facet of your education that will help you in applications to graduate school, professional school and employment, and in your interactions with other scientific professionals.

Section 4: Process Used to Create This Writing Plan

This plan was developed in consultation with the chemistry and biochemistry faculty in the Department of Chemistry, Biochemistry, Physics and Engineering over the course of several years. The faculty took part in training on writing across the curriculum using the online course designed by the WAC director. The departmental ad hoc WAC committee consists of four faculty (Fair, Kondo, See, Sobolewski).

This proposal was developed using several channels of information and feedback:

1. Discussions with faculty, both before this proposal was developed, and at various points during the drafting of this document.
2. Information collected for the Course Outcomes and Activities Chart in Section 5.
3. Analysis of the initial writing samples collected in CHEM 390/BIOC 480 during fall 2021, as detailed in Section 6.
4. Examples of similar writing proposals and discussions of writing in science, both internal (examples from Biology and Psychology) and external (U. of Minnesota, U. of North Carolina, American Chemical Society).
5. In addition to consulting the faculty, the ad hoc WAC committee sent a questionnaire to departmental alumni, to get their prospective on how writing is used in the careers of chemistry and biochemistry majors. These results are

collected in Appendix A. We feel that the opinions and observations of alumni are very valuable to improving our curriculum, since they have first-hand experience with the skills that are required for success in employment and graduate school.

The proposal was approved by the faculty of the Department of Chemistry, Biochemistry, Physics and Engineering on April 19, 2022.

Section 5: Course Outcomes and Activities Chart

Course	Expected Writing Outcomes (these might be explicitly listed in the course objectives, or implicit through the assignments) "Students will use writing to…"	Writing to Learn Activities (these are ungraded daily, low-stakes, short activities for learning/processing content)	Professional or Academic Genres (major assignments that demonstrate understanding of course content; academic genres are those assigned only in school, such as essays or reading responses; professional genres are those specific to a discipline or career field)
BIOC 290	detail progress in their career exploration.	four short writing assignments based on the exploration of careers based on a degree in biochemistry.	final paper based on the student's research into their chosen career path. Draft will be submitted for feedback before final version is submitted. Student also does a short presentation based on this paper.
BIOC 301	express understanding of biochemical principles and increase familiarity with current biochemical research literature.		research paper based on a literature review for a biochemistry topic related to class discussion and topics
BIOC 311	organize lab results; demonstrate connection	Writing a summary of relevant scientific articles.	Full lab reports on experiments performed including introduction, methods, results, discussion,

	between lab results and biochemical research.		conclusion.
BIOC 402			
BIOC 412	organize lab results; demonstrate connection between lab results and biochemical research	Writing a summary of relevant scientific articles.	Full lab reports on experiments performed including introduction, methods, results, discussion, conclusion.
BIOC 480	explore and discuss scientific (focus on biochemistry/ biomedical) communications and research ethics.	weekly writing assignments of 1-3 pages in response to topics discussed in class	journal club-style presentations on a self-selected biochemical/biomedical topic
BIOC 482	communicate the results of their original research project in the format expected from a professional biochemist.		Formal research report written in the format specified by the American Chemical Society Committee on Professional Training. This report should go through at least one, and usually several, revisions in consultation with the student's research mentor.
CHEM 101	demonstrate understanding of essential concepts in inorganic and nuclear chemistry	After completing each experiment, students provide short answers (1-3 sentences) to a number of questions related to the topic of the lab. There are 12 experiments each semester.	
CHEM 102	demonstrate understanding of essential concepts	After completing each experiment, students provide short answers (1-3 sentences)	

	in organic chemistry and biochemistry.	to a number of questions related to the topic of the lab. There are 12 experiments each semester.	
CHEM 103	express their understanding of chemical principles in the lab and classroom.	After completing each experiment, students provide short answers (1-3 sentences) to a number of questions related to the topic of the lab. There are 12 experiments each semester.	
CHEM 105	apply chemistry to problems in forensic science.	Short writing activities, either in class, or on a discussion board, where the students are asked to react to a video, the forensics of a specific criminal case, or a wider forensic problem (e.g. detecting THC intoxication in people who are driving a vehicle), or to another students post	Students write two reports during the semester for significant portion of their grade.
CHEM 107	show how chemical principles are important to common foods and beverages	In-class homework includes essay-type responses to discuss analytical and instrumental theory	A minimum of two essays/reports will be required to discuss in-depth food/beverage related topics.
CHEM 111	organize and demonstrate understanding of experimental results.		12 lab reports requiring organization of information and text answers to comprehension questions
CHEM 112	organize and demonstrate understanding of experimental results.		12 lab reports requiring organization of information and text answers to comprehension questions
CHEM	demonstrate understanding	No fewer than 8 lab conclusions (1-2 pages)	

231	of **chemical separations** and ability to critically reflect on data, results and propose next steps.	requiring organization of data, their meaning in relation to **chemical separations**, and proposed next steps based on their own chemical data.	
CHEM 255	reinforce their understanding of specific biochemical pathways	answering open-ended essay questions on worksheets and lecture summaries	
CHEM 290	detail progress in their career exploration	four short writing assignments based on the exploration of careers based on a degree in chemistry.	final paper based on the student's research into their chosen career path. Draft will be submitted for feedback before final version is submitted. Student also does a short presentation based on this paper
CHEM 314	organize their lab results and express their understanding of inorganic chemistry principles in lecture and lab.	answering open-ended essay questions on worksheets and lecture summaries	Students write 11 full lab reports emphasizing components of a scientific paper (Introduction, methods, results, tables, figures, discussion, and literature cited).
CHEM 325	organize their lab results and express their understanding of analytical chemistry principles in lecture and lab.	In-class homework includes essay-type responses to discuss analytical and instrumental theory	Students are required to complete a minimum of six formal lab reports during the semester to report the results of experiments and answer in-depth questions regarding their results and the theory of the lab topic performed. These lab reports are generally 5-10 pages in length.
CHEM 332	demonstrate understanding	No fewer than 8 lab conclusions (1-2 pages)	

	of **chemical reactions** and ability to critically reflect on data, results and propose next steps.	requiring organization of data, their meaning in relation to **chemical reactions**, and proposed next steps based on their own chemical data.	
CHEM 341	demonstrate understanding of concepts in physical chemistry	Students write responses to critical thinking questions on worksheets or on topics presented in lecture.	Students are asked to write short sentences to describe what equations and graphs mean in plain English, or to describe chemical phenomena related to energy and transformations.
CHEM 343	organize their lab results and express their understanding of physical chemistry		Students write 4 Formal lab reports, ~10 pages, organized like a standard scientific paper, with an abstract, an Introduction with background and theory, an experimental section, results, and discussion and conclusion. Students are required to do preliminary lab reports, which they revise to complete their formal reports.
CHEM 351	express understanding of biochemical principles discussed in class.		research paper based on a literature review for a biochemistry topic related to class discussion and topics
CHEM 390	apply their knowledge of chemistry to the practical problems of a professional chemist; detail a plan of original research in chemistry or chemical	several assignments requiring students to research, create, and discuss scientific material. Essay questions and/or discussion of professional practice and scientific and professional ethics will be included among these assignments	Students write a research proposal for a novel project in chemistry or chemistry education, subject to instructor approval. This will serve as a possible basis for a future CHEM 498 independent study

	education.		
CHEM 401	organize the results from the lab and express these results in the format expected from a professional chemist.	essay type assignments on weekly basis/topic	1) Students are required to complete a minimum of eight formal lab reports that detail the results of experiments and answer in-depth questions regarding their results and the theory of the lab topic performed. These lab reports are generally 5-10 pgs in length. 2) Two research projects (one in each half-semester) submitted as full, formal written report, following the American Chemical Society format / manuscript ready for submission and publication.
CHEM 431			
CHEM 435			
CHEM 442	demonstrate understanding of concepts in physical chemistry	1) Students write responses to critical thinking questions on worksheets or on topics presented in lecture; 2) Students are asked to write short sentences to describe what equations and graphs mean in plain English, or to describe spectroscopic phenomena.	
CHEM 460			
CHEM 461			
CHEM 498	communicate the results of their original research		Formal research report written in the format specified by the American

	project in the format expected from a professional chemist.		Chemical Society Committee on Professional Training. This report should go through at least one, and usually several, revisions in consultation with the student's research mentor
SCI 102	demonstrate understanding of basic chemical concepts and how those concepts could be communicated to elementary-age students	After completing each experiment, students provide short answers (1-3 sentences) to a number of questions related to the topic of the lab. There are 12 experiments each semester	At several points in the semester, students write a reflection on ideas for lessons or activities based on recent course topics that they could perform with the elementary-age students they will teach once certified.
SCI 107	apply essential concepts of chemistry to issue in society		Students work in groups on topics related to chemistry in the news or write position papers on issues related to chemistry
SCI 117	demonstrate understanding of essential concepts in introductory chemistry	After completing each experiment, students provide short answers (1-3 sentences) to a number of questions related to the topic of the lab. There are 12 experiments each semester	

Section 6: Assessment

For our initial assessment, student research proposals were collected from the seminar course CHEM 390/BIOC 480. (note: there are no senior-only courses in CHEM and BIOC. All upper-level courses contain both juniors and seniors.) The directions for this assignment included the following:

> One of your major assignments this semester is to create and polish a research proposal of an original research idea that you might wish to carry out in a future semester (or semesters) of CHEM 498 independent study. This document outlines the sections of a good proposal and conveys the types of materials found within each section.

Sections of a Research Proposal

I. Title Page

A title page is a single page that contains the title of your research project, followed by the author's name, followed by the date of submission.

II. Purpose (preview of what and how)

A statement of purpose if a brief paragraph (a sentence or two) that explains in simple, concise language **what** this proposal is about and **how** you plan to address it. This is your abstract. Suggested length: one-half page.

III. Introduction/Background (details on what and how was done before)

The introduction of your proposal should be a short paragraph that is a sweeping statement or two about the proposal you about to present.

The background will be probably the longest section of your proposal. In this section (several paragraphs), you will 'set the stage' for the rest of the proposal by giving some information about the problem you're going to address (i.e., why is this research important), what has been done so far to work on this problem (citing previous studies, etc.), what methods/instruments have been used so far, and any other information the reader might need to know in order to understand the rest of your proposal. It is usually in the background where the majority of references are cited – both to show that you've done your homework on the problem, and to give the reader a source of information that they can research, too. Suggested length 4 pages

IV. Objectives (details on what you plan to do differently)

In this section, you will list the specific objectives for carrying out the study. Previously, you've addressed and explained the problem you're tackling. You've given background information on past research and the methods that have been used or you plan to use. In this section, you'll now tell the reader the steps/goals for **this particular study** which you plan to carry out/achieve. Suggested length 1 page

V. Methodology (details on how you plan to do the work)

In a research paper, you would describe in detail all of the materials, methods, and instrumentation that you **did** use. In a proposal, however, this is the section to lay out, step by step, all of the materials and methods that you **plan** to use to meet your goal. You should list the experiments you plan to carry out, including chemicals, instruments and proposed parameters/set-up of those instruments, etc. This will be the framework that you will use to carry out your project in a future semester. Suggested length 2-3 pages

VI. Budget Proposal

In order for one to carry out a proposal in real life, one must adequately budget resources for every foreseeable expense to ensure success. In this section, you will construct a detailed, line-item budget that describes all the materials and overhead you might need to carry out the methods in the section above.

VII. References

List all references cited in the text, including all authors and the full title of the publication. Please use the ACS Style Guide for proper formatting of the references listed, including the proper way to cite website access. End note should be used for citation.

Eleven research proposals were submitted in this class. These proposals were anonymously assessed by the writing across the curriculum committee, based on the rubric below.

	1 = Below Expectations	2 = Emerging	3 = Meets Expectations	4 = Exceeds Expectations
Abstract (Purpose) - clearly and succinctly summarizes the proposal	Abstract does not summarize the proposal, or uses ambiguous language	Abstract summarizes proposal poorly, misses points or is overly verbose	Abstract summarizes proposal well, but could use more precise language	Abstract summarizes proposal well and the language used is precise and succinct
Introduction – gives a survey of work done concerning the objective	clearly insufficient background, few or missing references	some background information but points or references missing	background information and references reasonably complete	copious background information, well supported by references
Methodology – clear, specific statement of how work will be done	methodology not specified or does not make sense with objective	methodology stated only in vague terms, techniques cited are unrealistic	methodology explained in specific terms using available techniques	methodology explained in detail and is an excellent fit for objectives
Citations	missing literature cited or references in the narrative, serious formatting errors	literature cited and narrative references are present, but with serious formatting errors	formatting of citations mostly correct with sufficient number of citations	copious literature citations with all formatting correct
Grammar and English Usage	Serious errors are common, little evidence of proofreading	some errors that detract for the work, insufficient proofreading	some errors that have minimal impact on work, strong evidence of proofreading	very few errors

Scientific style – uses language that is precise, clear and objective	written primarily in conversational English, using ambiguous terms and displaying biased language	attempts to use but often falls into common unscientific language, many ambiguous terms	generally uses precise, clear and objective language, complex ideas may be somewhat unclear	information stated in precise scientific terms, clear and unambiguous without bias
Format – follows format assigned by instructor	missing some components, some information in wrong category	all components included but some information in the wrong category	all components present and in the correct category, acceptably logical flow to proposal	all components present and in the correct category, components form a clear, logical whole

The data collected via this process is given in the table below:

criteria	# below expectations	# emerging	# meets expectations	# exceeds expectations
Abstract (purpose)	2 (18%)	2 (18%)	3 (27%)	4 (36%)
Introduction	0	2 (18%)	7 (64%)	2 (18%)
Methodology	2 (18%)	5 (45%)	0	4 (36%)
Citations	1 (9%)	2 (18%)	1 (9%)	7 (64%)
Grammar and English Usage	2 (18%)	3 (27%)	2 (18%)	4 (36%)
Scientific style	2 (18%)	6 (55%)	1 (9%)	2 (18%)
Format	0	0	4 (36%)	7 (64%)

The criteria that were achieved at a high level (>80% combined “meets expectations” and “exceeds expectations”) were the following:

> Introduction – a survey of previous work done in the area of the proposed research (82%)
>
> Format – proposal follows the formal outlined by the instructor (100%)

The criteria achieved at a moderate level (60% - 80% combined “meets expectations” and “exceeds expectations”) were the following:

> Abstract (purpose) – a brief synopsis of the proposed research (63%)
>
> Citations – literature cited in the approved American Chemical Society format (73 %)

The criteria achieved at a low level (<60%) were the following:

> Methodology – explanation of the techniques that will be used in the proposed research (36%)

Grammar and English Usage – grammatically correct sentences and paragraphs (54%)

Scientific style – using language that is precise, clear and objective (27%)

Analysis by the Program Faculty

The writing samples show positive results in several areas where writing components are included in the chemistry and biochemistry curriculum. First, these majors are accustomed to working with citations of previous work. The introduction section was the longest part of the proposal, but 82% the students were able to meet or exceed the goal for this section. Secondly, the students showed a strong mastery of citing the publications they used in the specified format. Finally, a moderately high percentage (64%) of students were able to meet or exceed the expectation for summarizing their proposal in the abstract, which is an important skill for any scientist.

One area in need of improvement appears to be associated with correct English usage. The lack of correct English is troubling, since this is the basis of any good writing, and for an educated person to be taken seriously, they must be able to use the English language correctly. This is possibly a difficult area for the faculty in our department, since they are unsure of their ability to teach English grammar and usage. However, it is clear that we need to work toward improving our student's ability to express themselves in correct written English.

The other area in need of improvement is the ability of our students to write in the scientific style. In particular, the Methodology section of proposal, which requires the students to explain the details of their proposed research, presented a significant challenge. This is no surprise – writing in the scientific style take practice, as it is so different from the way we express ourselves on a day-to-day basis. Using clear, unambiguous language and precise explanations that are free from bias is not easy, particularly when the student is trying to express something as complicated and detail-intensive as a proposed research plan. Given the results of our assessment, this is an area we need to stress in our courses. This initiative dovetails well with the laboratory component of our courses, since these all contain significant writing requirements.

Analysis by the WAC Director

The program has discovered some important findings through their assessment process. Here, I will comment on several of them:

1. The programs should be commended on the strengths of their students' writing, especially in important areas like summarizing for an abstract and citations. Students across the university are struggling with citations, so the fact that these students are excelling in this area is a testament to the exceptional education they are getting in research methods.

2. English usage is an area of student struggle: I highly recommend that faculty in these programs partner with the Writing Center director to coordinate student visits. Specific courses could require tutoring as part of their curriculum, or faculty overall could develop some criteria by which they would send certain students to the writing center. The WAC director and Writing Center director are also available to do professional development with the faculty should the desire a more general approach.
3. Students are struggling with writing in scientific style, one of the key areas that the programs have identified as an important writing ability. I encourage the faculty to use their writing outcomes map (above) to trace where and how scientific style is being taught so that they can revise curriculum as necessary to enrich more of their courses with the teaching of this important skill.
4. There is excellent information that can be gleaned from the alumni survey (below) and can support better student writing outcomes. In particular, notice that students are asking for more writing and more feedback on their writing. The WAC director is available to provide faculty development on feedback and response to student writing.

Appendix A: Survey of Chemistry and Biochemistry Alumni

A questionnaire was sent out to chemistry and biochemistry alumni via Qualtrics during March 2022; the questions and responses are given below:

IUP chemistry/biochemistry alumni survey on writing and curriculum

1. Which best describes your position at present?

chemical industry/private sector	1
biochemical or pharmaceutical industry/private sector	0
other industry/private sector	0
governmental agency	2
graduate school (Master's, PhD)	3
professional school (medical, pharmacy, etc.)	0
high school teaching	0
university teaching and/or research	1

2. What types of writing do you use in your present position (circle all that apply)?

technical reports based on published research	1
technical reports based on work done by you and your co-workers	4
internal research/project proposals (for review inside your organization)	4
external research/project proposals (for funding from outside sources)	4
manuscripts for publication in scientific journals	6
other (please specify) - patents	1

3. Using a scale of 1 to 5 stars, rate how well your IUP education (both science and Liberal Studies courses) prepared you with the following writing skills:

using correct English grammar and structure	4.14 (mean)
using accepted scientific style	3.57
summarizing published research	3.43
writing proposals for research/projects	2.43
summarizing results of your research or project	3.57

4. Based on your experiences since graduation from IUP, what suggestions do you have to improve the writing skills of chemistry and biochemistry majors?

> Students should look more into published research articles to understand what type of discoveries are happening
>
> This shouldn't be a suggestion but actually a requirement for all IUP Chem majors: Take a writing intensive class taught by Dr. Kondo. I learned the most out of any class from her editing of my assignments and class materials and I really did not get the constructive criticisms towards my writing that I (desperately) needed until I took a lab class with her. My writing tone, style, and technique would not be what it is today without her. My PI consistently tells me I am one of his best students in his 36 year career in academia when it comes to how little he has to edit my manuscripts before submission. I don't mean to mention this as a brag, but as a true testament to how much I absorbed from my phys chem lab with Dr. Kondo.
>
> The more experience the better.
>
> Science communication, specifically writing about science for lay people

More high level liberal arts classes….the 101 classes are a waste--no one will read their papers and provide feedback on their ideas or writing.

5. Based on your experiences since graduation from IUP, rate the distribution of credits to various parts of the degree:

	need more credits in this area	about right	need fewer credits in this area
chemistry courses	0	7	0
biochemistry courses	0	7	0
chemistry/biochemistry seminars	1	5	1
physics courses	1	6	0
math courses	3	4	0
biology courses	1	4	2
liberal studies courses focused on writing	2	4	1

6. Are there courses or academic areas other than what you took in your degree program that you now realize would have been helpful to your career?

   No

   No. I truly can say that my chemistry degree at IUP was extremely well-rounded and wholly prepared me for my time in graduate school.

   Coding, statistics, and polymer or industrial chemistry would help

   I took a math minor and it has been incredibly helpful.

   Being able to choose a position and persuasively write to defend it with facts. Honors college curriculum did this.

7. Do you have any additional suggestions on how courses and curriculum could help prepare IUP chemistry and biochemistry majors for the challenges of a career in the sciences?

   Students should participate in literature reviews

   Perhaps an extension in one of the seminar classes on how to do literature searches and the different types of academic journals would be helpful. Along with explaining what the review process of a submitted manuscript is like, what an impact factor is, etc.

   Do more summer research/experiences

An optional course in grant writing and manuscript prep for students planning on grad school.

Work with students in developing lab intuition and what to do in the lab. Procedures are extremely rote--you don't always have that in research.

8. What Degree did you earn from IUP?

   Chemistry BS or BA – 6 Biochemistry BS – 1

9. How long has it been since you graduated from IUP?

   0-4 years – 3 5-10 years – 3 over 10 years – 1

Appendix B – Bibliography

Web-based:

American Chemical Society, ACS Webinars - Scientific Writing Series (https://www.acs.org/content/acs/en/acs-webinars/collections/writing.html)

The Writing Center, University of North Carolina at Chapel Hill – Scientific Reports (https://writingcenter.unc.edu/tips-and-tools/scientific-reports/)

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