

THE UNIVERSITY OF ARIZONA

**DEPARTMENT OF CHEMISTRY &
BIOCHEMISTRY**

**GRADUATE HANDBOOK
CHEMISTRY**

FALL 2014

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A. GENERAL DESCRIPTION OF THE GRADUATE PROGRAM

The major emphasis of the Ph.D. degree in Chemistry, after completion of all other degree requirements, is an original research project culminating in writing and defending a doctoral dissertation. With the help of the Research Director, the Dissertation Committee, and the departmental Graduate Program Committee (GPC), successful students complete the Chemistry graduate program with a solid training in contemporary chemical research, with an emphasis on academic scholarship, the creation of new knowledge, and the dissemination and defense of the product(s) of this research effort.

An alternate track which students may be placed into, or may choose to move into, is the Master of Science degree (M.S.), which involves less time and less course work commitment, but still involves an original research project, and training in research, culminating in writing and defending an M.S. thesis.

For those interested in the study of chemistry beyond the undergraduate level, but who are not interested in a career involving chemical research, the option of a Master of Arts degree (M.A.) is offered.

In addition, the program offers the opportunity for students to participate in an accelerated curriculum that leads to both the Bachelor of Science (B.S.) and Master of Science (M.S.) degrees in Chemistry. This curriculum follows the normal B.S. degree for three years, but adds two graduate level courses during their fourth year that are applied to the subsequent M.S. program.

It is important to realize that successful completion of a graduate degree program in Chemistry is your responsibility as a student. All of the necessary steps that are required to finally receive the degree are important. You should utilize resources the Graduate College makes available, including the Graduate Catalog and the Graduate College Handbook. This Chemistry Graduate Handbook is designed to assist you through the maze of graduate school requirements, but it is not all-inclusive. It is meant to be a useful guide, but does NOT serve as a contractual document.

The Research Director, along with the Dissertation Committee, will serve as guides and mentors to help train you as a scientist. Finally, the Graduate Program Coordinator and the GPC will do everything they can to keep you on track and to point you in the right direction. Nevertheless, you need to be focused and self-motivated to reach your goals.

Ph.D Program Timeline at a Glance

PRE-FIRST SEMESTER

Diagnostic Examinations	Diagnostic Exams, prior to the start of the semester, help define the program of study for the first semester, identify deficiencies in background and possible pathways for remediation.
CBC Research Symposium	Held prior to the start of the semester, the CBC Research Symposium includes a poster session for new graduate students to familiarize themselves with research groups of interest.

FIRST SEMESTER

Course Work, Seminars, and Intermediate Course Work	Course Work for the first semester is chosen in consultation with the GPC and is based on the projected Program of Study and performance on the Diagnostic Exams. All students are expected to attend at least one weekly divisional or programmatic seminar as well as Departmental Colloquia.
Faculty Interviews	All students are required to interview individually with at least 6 faculty members. Begin individual interviews early and meet throughout the period from August-mid-October.
Research Director Selection	Students submit Report of Selection of Research Director form to the Graduate Program Coordinator by October 15, 2014 (for fall admits).
Research	Begin research when Research Director selection is approved (late October)

SECOND SEMESTER

Course Work and Seminars	Advised by Research Director. Submit Plan of Study to GPC. All students are expected to attend at least one weekly divisional or programmatic seminar as well as Departmental Colloquia.
Research	Continue research.
Evaluation of teaching performance – 1st Year	Your performance as a T.A. is considered to be a critical component of your training and your responsibility as graduate student at the University of Arizona

FIRST SUMMER

Research	Continue research.
Dissertation Committee	In consultation with Research Director, a Dissertation Committee must be selected by the first day of fall classes. Submit Proposed Dissertation Committee to the Graduate Program Coordinator and also record it in GradPath.

THIRD SEMESTER

Course Work and 1 st Seminar	Register for coursework according to Plan of Study. Attend appropriate divisional or programmatic seminars as well as Departmental Colloquia. Present seminars according to divisional or programmatic requirements.
Second Year Dissertation Committee Meeting	Schedule a meeting to occur prior to November 15 with your Dissertation Committee and prepare presentation on research progress
Research	Continue research.
Written Comprehensive Examination	Independent Research Proposal and Research Summary, as detailed in Section "J" of this handbook, are due on Reading Day of the third semester in residence.

FOURTH SEMESTER

Course Work and Seminars	Continue coursework as defined in accepted Plan of Study. Attend appropriate divisional or programmatic seminars as well as Departmental Colloquia. Present seminars according to divisional or programmatic requirements.
Research	Continue research.
Written Comprehensive Examination	Independent Proposal must be approved by your Dissertation Committee, subsequent to any revisions required (see Section J).
Oral Comprehensive Examination	Schedule Oral Comprehensive Examination; examinations shall be scheduled for a date as soon as possible (ideally within six weeks) after passing evaluation of the Independent Research Proposal. All students must take their oral examination no later than the end of the fifth semester.

SECOND SUMMER

Research Continue research. A written Annual Research Summary is due to your Dissertation Committee and the Graduate Program Coordinator on July 31.

REMAINING SEMESTERS

Course Work and Seminars Make sure courses in Plan of Study have been completed and required seminars have been presented. Attend appropriate divisional or programmatic seminars as well as Departmental Colloquia.

Research Continue research. A written Annual Research Summary is due to your Dissertation Committee and the Graduate Program Coordinator on July 31.

FINAL STEPS

Fourth Year Committee Meeting Schedule a meeting with your Dissertation Committee to take place during the spring semester of your fourth year in residence. Prepare presentation on research progress and distribute written dissertation outline.

Seminar Schedule and give final seminar as required by your division.

Dissertation Complete dissertation, including proofreading, prior to delivery to Dissertation Committee members.

Final Oral Defense Examination Schedule dissertation defense (final oral). Submit Announcement of Oral Defense Examination at least **two weeks** prior to oral. A penultimate draft of your dissertation should be given to your committee members at this time.

Submission of Dissertation The revised dissertation must be submitted to the Graduate College within one year of the final oral examination. (Normally this should be done within a matter of days or weeks). **Continuous registration is required until the dissertation is submitted.** See the Graduate Program Office for guidelines.

B. EXPECTATIONS OF STUDENT & FACULTY

1. WHAT THE FACULTY EXPECT FROM THE STUDENTS

The faculty expect the students in this program to abide by the University of Arizona Academic Code of Conduct and the Academic Code of Integrity, as summarized in Section C of this Handbook. Failure to do so, at any time, may be grounds for dismissal from the graduate program, and from The University of Arizona. In addition, the faculty's expectations of the graduate students in this program are:

Research

- (a) to discover and enthusiastically pursue a unique topic of research in order to participate in the construction of new knowledge in your chosen field, and in the application of that knowledge to the solving of new problems in the chemical sciences,
- (b) to learn the research methods and historical knowledge basis of the discipline -- honoring the scholarship of those who came before you and learning what is needed to form viable research hypotheses,
- (c) to keep appropriate records of your research design, results and interpretation – this includes laboratory notebooks, regular digital backups, etc.,
- (d) to communicate regularly with faculty mentors and the masters/doctoral committees, especially in matters relating to your research and your progress within the degree program,
- (e) to exercise the highest integrity in all aspects of your work, especially in the tasks of collecting, analyzing and presenting research data,
- (f) to work responsibly toward completion of the degree in a timely fashion,
- (g) to mentor other students in the Department and individual research group and foster the regular exchange of research ideas and teamwork between group members.

Teaching

- (a) to participate enthusiastically in appropriate training and evaluation for all instructional roles you are assigned,
- (b) to perform (as opportunities arise) an appropriately sequenced variety of teaching duties relevant to your career expectations and likelihoods,
- (c) to devote the same seriousness to undergraduate instructional duties that you would expect from your own instructors.

Professional Development/Program Progress

- (a) to develop, to the extent possible, a broad network of professional relations,
- (b) to contribute, wherever possible, to the discourse of the scholarly discipline through conference presentations, publications, collaborative projects, and other means,
- (c) to seek out a range of faculty and peer mentors that can help you prepare for a variety of professional and career roles and responsibilities,
- (d) to take responsibility for keeping informed of regulations and policies governing your graduate studies and to complete all required paperwork and other degree obligations in a timely fashion.

Community

- (a) to create, in your classrooms and laboratories, an ethos of collegiality and collaboration,
- (b) to realize your responsibilities as an individual and professional representative of both the university as a whole, and the department or program in which you are studying,
- (c) to assist graduate student peers in their own professional and scholarly development.

2. WHAT THE STUDENT SHOULD EXPECT OF THE RESEARCH DIRECTOR AND HIS/HER DISSERTATION COMMITTEE

In general, you should expect your Research Director/Dissertation Committee to:

- (a) be willing to meet with you regularly,
- (b) be someone with whom you can talk freely and easily about research ideas, and your professional development
- (c) provide timely feedback on the quality of your work and the direction of your dissertation project
- (d) be someone you can trust to look out for your professional interests,
- (e) be willing and enthusiastic in giving you credit for the work you do,
- (f) be willing to tell you when your work does or does not meet the standards he/she has set for their research program,
- (g) be willing to help you graduate in a reasonable time frame, with a dissertation which tells a complete story, and is representative of Ph.D. level research at all of our peer institutions,
- (h) have an active, well-functioning research group for additional support when you are encountering difficulties.

It is unreasonable to expect one person to have all of the mentor qualities that you desire. You should therefore choose Dissertation Committee members who complement the strengths of your advisor.

3. WHAT THE STUDENT SHOULD EXPECT OF THE DEPARTMENT

- (a) A guarantee of funding for up to 5 years from the time of enrollment, provided that you remain in good standing in the program, and are making adequate progress toward completion of the Ph.D. degree,
- (b) Opportunities to develop skills beyond your specialty through seminars, short courses in department facilities, and interactions with renowned researchers,
- (c) Opportunities to provide feedback to the department and to review policies to ensure the quality of the department,

FALL 2014 INCOMING GRADUATE STUDENTS

Program	First Name	Last Name	School
CHEMPHD	William III	Benson	Univ Of North Carolina At Charlotte
CHEMPHD	Steven	Edwards	University Of Arizona
CHEMPHD	Drew	Farrell	Duquesne University
CHEMPHD	Jessica	Gardin	Northern Arizona University
CHEMPHD	Lindsay	Guzman	University Of Oregon
CHEMPHD	Kimberly	Heisterkamp	University Of Arizona
CHEMPHD	Matthew	Humphries	Augustana College
CHEMPHD	Tyler	Johnson	California State Univ-Sacramento
CHEMPHD	Metin	Karayilan	Koc University
CHEMPHD	Kyle	Kilchenstein	Salisbury State University
CHEMPHD	Tristan	Kleine	CalPolytechnic St U-San Luis Ob
BIOCPHD	Julia	Lewis	Univ Of North Carolina At Chapel Hill
CHEMPHD	David	Livermore	Wayne State University
CHEMPHD	Charles	Luft	Northern Illinois University
BIOCPHD	Mahta	Moinpour	Sharif Univ. Of Technology
BIOCPHD	Rami	Musharrafi	University Of New Mexico- Albuquerque
CHEMPHD	Nanayakkarawasan Pallage	Nanayakkara	University Of Colombo
CHEMPHD	Claire	Nimlos	University Of Colorado-Boulder
CHEMMS	Aaron	Pejlovas	University Of Arizona
CHEMPHD	Sana	Rani	Quaid-i-Azam University
CHEMMS	Jessica	Roberts	University Of Arizona
CHEMMS	Wilfred	Russell	University Of Arizona
BIOCPHD	Jonathon	Sawyer	Providence College
BIOCPHD	Branden	Stepanski	University Of Arizona
CHEMPHD	Yunqiu	Sun	Worcester Polytechnic Institute
CHEMPHD	Wenmo	Sun	Jilin University
BIOCPHD	Matthew	Swan	California State University-San Marcos
CHEMPHD	Yegor	Timofeyenko	Idaho State University
CHEMPHD	Joseph	Torres	University Of Oregon
CHEMMS	Taylor	Youtsler	University Of Washington
CHEMPHD	Xiaoyu	Zou	California State Univ-Long Beach

C. ACADEMIC CODE OF INTEGRITY AND CODE OF CONDUCT

Graduate Students in the Department of Chemistry and Biochemistry, University of Arizona are expected to have read, and understand, at least, the the Academic Code of Conduct for the University of Arizona and the code of conduct sections (5-301 to 5-308) of the Arizona Board of Regents Policy Manual.

Code of Academic Integrity for the University of Arizona:

<http://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity>

Arizona Board of Regents Policy Manual:

<http://www.azregents.edu/policymanual/default.aspx>

D. GRADUATE PROGRAM COMMITTEE (GPC) - STRUCTURE AND FUNCTION

The GPC has several important roles with regard to overseeing the Graduate Program. These include advising new students, monitoring student progress, and recommending awardees for fellowships. The committee consists of faculty members, graduate students who have passed their Oral Comprehensive Examination, and staff members. One of the goals of the committee is to help you tailor an academic program that fits your needs prior to your selection of a Research Director and Dissertation Committee who will guide the research component of your training. The GPC also tracks each student during his or her entire time in the program and meets regularly to discuss student progress. ***If you have a problem that cannot be solved by your advisor, or are unsure about what you need to do to meet departmental or Graduate College requirements, you can talk to one of the faculty, staff, or student representatives on the GPC at any time.***

The following people are serving on the GPC in 2013-2014:

GPC MEMBERS	ROOM	PHONE	E-MAIL
Dr. Dom McGrath, Chair	CSML 630	626-4690	mcgrath@email.arizona.edu
Dr. Craig Aspinwall	OC 322	621-6338	aspinwal@email.arizona.edu
Dr. Vahe Bandarian	BSW 537	626-0389	vahe@email.arizona.edu
Dr. Brooke Beam	KECK	626-2591	bbeam@email.arizona.edu
Dr. Oliver Monti	OC 216	626-1177	monti@email.arizona.edu
Dr. Jon Njardarson	CSML 442	626-0754	njardars@email.arizona.edu
Dr. Anne Padias	KOFF 201	621-9978	anne@u.arizona.edu
Dr. Zhiping Zheng	OC 108B	626-6495	zhiping@email.arizona.edu
Ms. Lori Boyd	CHEM 223	621-4348	lboyd@email.arizona.edu

GRADUATE ADVISOR'S OFFICE

The Graduate Program Coordinator is responsible for keeping all records relating to your academic progress, though you should ensure that you retain duplicates where possible. All the various forms you will need during your career as a graduate student may be obtained from the Graduate Program Coordinator or the Graduate College (Admin 3rd floor).

E. FINANCIAL ASSISTANCE WHILE PURSUING THE PH.D. OR M.S. DEGREES

Most full-time students in good standing in the Ph.D. program in the Department of Chemistry and Biochemistry are provided with some form of financial assistance, typically in the form of an assistantship. Assistantships provide a stipend as well as health care and tuition benefits. The purpose of the assistantship is to provide moderate financial support that requires you to perform suitable tasks that are aligned with your degree program. Generally, financial assistance during the first year is provided in the form of a teaching assistantship for the academic year (approximately August 15 to May 15) and a research assistantship for the summer (May 15 to August 15). The summer research assistantship is generally paid by the student's Research Director. Otherwise, the student may be employed as a teaching assistant in the summer school program. Both In-state and Out-of-state tuition are waived for all teaching and research assistants, though all students are responsible for mandatory fees. A limited number of University Fellowships are available and are awarded competitively. Students should meet regularly with their Research Director and/or teaching supervisor to ensure that their performance is satisfactory. Unsatisfactory performance can result in removal from the program or loss of eligibility for financial support. Adequate performance in our graduate program is a full-time commitment and students are expected to perform all programmatic requirements to ensure that they are making progress towards their degree (coursework, research, etc.) as well as perform all assigned tasks defined for the assistantship. .

Registration for at least 12 units of graduate level credit (audit credits do not count) is required for having an assistantship.

1. TEACHING ASSISTANTSHIPS (TA)

While it is true that the teaching assistantship is a mechanism for supporting students during their graduate training, it can and should be an integral part of the training itself. As a TA you will have the opportunity to further consolidate your understanding of basic chemical principles, develop a formal, professional style of speaking and presentation of technical materials, and learn how to interact with a variety of personalities on a professional level.

Responsibilities and duties of a teaching assistant:

As a condition of a teaching assistantship, TAs are required to perform up to 20 hours of assigned tasks in addition to programmatic degree requirements. . Your actions as a TA reflect on all of us. It is expected that all TAs will demonstrate the utmost in professional behavior.

All TAs are assigned an average task load of 20 hours per week for a half-time position regardless of the assignment. Because of the nature of teaching, the task load will vary from week to week so that the 20 hours is an expected average over the term. Specific descriptions exist for every TA assignment and are available from the Teaching Support Office on request. Further information regarding the duties and responsibilities of TAs is provided in the department's "TA Training Manual".

Students awarded a teaching assistantship must attend the Department of Chemistry and Biochemistry Orientation and Training, Red Cross Multimedia Standard First Aid Course, successfully complete TATO (TA training on line) and on line FERPA (Family Educational Rights and Privacy Act of 1974) training. Additionally, students must

demonstrate suitable proficiency in the English language. Students must provide written evidence of satisfactory completion of each of these requirements. This is required once and is typically accomplished during the weeks prior to the first semester of graduate school.

2. RESEARCH ASSISTANTSHIPS (RA)

Students who have been offered financial assistance are eligible to be paid as graduate research assistants by the Research Director. (A RA during the first year of graduate study must be approved by the Department Head.) Continuation in these research assistantships is based upon availability of research funds and adequate performance of the students in making progress toward completion of their degree program.

F. DEPARTMENTAL AND GRADUATE COLLEGE POLICIES

1. Registration Policy

- a) All students who are accepted into the graduate program in the Department of Chemistry and Biochemistry are expected to have completed one year of **PHYSICAL CHEMISTRY** during their undergraduate studies. Students who lack the physical chemistry requirement are occasionally admitted into the program with the understanding that they will remedy the deficiency during their first year of studies at the University of Arizona by taking CHEM 480a, and CHEM 480b or CHEM 481 or a course recommended by the GPC.
- b) By Graduate College rules, all requirements for the degree of Doctor of Philosophy must be completed within **5 YEARS** of passing the Oral Comprehensive Exam, whether the student is supported financially, or not. Should a student not finish within that time period, he/she may be allowed to re-take the Comprehensive Exams (both written and oral) with the permission of the program, then proceed to complete other requirements. This in no way implies that the Department of Chemistry and Biochemistry is bound to financially support the student for more than five years from the start of their program.
- c) Full-time students must take the appropriate number of graduate level units during a Fall or Spring semester in order to be eligible for either a research or a teaching assistantship. Consult with the Graduate Program Coordinator. Summer registration is not required at this time.
- d) Students past their second semester in residence may drop courses with the approval of their Research Director but the total number of units must remain at a full time level by the addition of other courses or supplemental registration (CHEM 900). First semester students must obtain the permission of the GPC before dropping courses, and in general this is not permitted, except for students leaving the program.
- e) The Graduate College requires registration each fall and spring from original matriculation until all degree requirements, including submission of the final copy of the thesis or dissertation, are completed.

2. Academic Probation Policy

At the end of the first semester:

- a) Full-time graduate students who are placed on academic probation according to Graduate College or Department of Chemistry and Biochemistry rules,* may be recommended for Departmental financial support for a second semester, during which time the **academic probation must be removed**. These appointments are based upon availability of funds and the department's needs for teaching assistants.

*Graduate College rules require a GPA of 3.00 or better in ALL graduate courses; The Department of Chemistry and Biochemistry rules require a grade of B or better in all graduate courses approved by the GPC as counting toward the Ph.D. degree, as well as a minimum GPA of 3.00.

Students whose GPA falls below 3.0 as calculated by the Graduate College OR the Department of Chemistry and Biochemistry may be placed on academic probation or be dismissed from the program depending on the severity of the GPA deficit. Students on academic probation have one semester in which to bring their GPA up to 3.0. No student will be allowed more than one semester on academic probation.

Continuing Graduate Students:

- a) Continuing graduate students who have not previously been on academic probation, but whose cumulative GPA by Graduate College and/or Departmental rules falls below 3.00, and are therefore placed on academic probation, may be eligible for Departmental support as a Teaching or Research Assistant during the subsequent semester, depending upon the support available and the student's overall record.
- b) Probationary status **must** be removed in the semester immediately following its incurrance.
- c) A student may be on probationary status for no more than one semester during their entire graduate program. A second instance of probationary status will result in loss of eligibility for continued Departmental financial support and the student will be counseled to withdraw from the program.

3. Grade Replacement Option

Graduate students are not eligible for grade replacement.

4. Teaching Probation Policy

- a) It is expected that graduate students who are employed as TA's by the Department of Chemistry and Biochemistry will make every effort to perform their duties to the satisfaction of the Department and the University of Arizona. TA performance will be reviewed each term by the TA Evaluation Committee*, which will make its recommendations known to the Department Chair and/or others the Department Chair shall designate.
- b) In the event that the performance of a TA is deemed unsatisfactory in any term, the TA may be placed on teaching probation to alert the TA that improvement in performance of teaching duties is expected. The TA will be informed in writing of the TA's specific teaching deficiencies. Such improvement will be measured in the next term in which the student is employed as a TA. In the event that the deficiencies are remedied, the probationary status of the TA will end. In the event that deficiencies are not remedied, the TA will become ineligible for support as a TA in the Department of Chemistry and Biochemistry at The University of Arizona.
- c) A TA may be placed on teaching probation only once. In the event that the performance of a TA is deemed unsatisfactory in any two terms, the TA will become ineligible for support as a TA in the Department of Chemistry and Biochemistry at The University of Arizona and may be counseled out of the program.

* The TA Evaluation Committee will consist of such faculty, staff, and student members designated by the Department. Current procedures are available from committee

members and the Teaching Service Office (Koffler 201).

5. Continuous Enrollment

Master's Continuous Enrollment Policy

A student admitted to a Master's degree program must register each fall and spring semester for a minimum of 3 graduate units, from original matriculation until all degree requirements are met. If the degree program requirements are to be completed in the summer, the student must register for a minimum of 1 unit of graduate credit during that term.

Doctoral Continuous Enrollment Policy

A student admitted to a graduate degree program must register each fall and spring semester for a minimum of 12 graduate units from original matriculation until the completion of all course requirements, written and oral comprehensive exams, and 18 dissertation units. When these requirements are met, doctoral students **not** on financial assistance and/or needing to maintain appropriate visa status must register for a minimum of 1 unit each semester until final copies of the dissertation are submitted to the Graduate Degree Certification Office. Students receiving teaching or research assistantships/associateships must register for at least 12 units. If degree requirements are completed during summer or an intersession, the student must have been registered during the preceding semester.

6. Leave of Absence

Academic Leaves

Academic LOAs (i.e. leaves to take course work at another university, for research, field work, internships, professional development, etc.) are handled on a case-by-case basis by the student's Department and the Graduate College

Medical Leaves

With appropriate documentation from their medical provider, graduate students in degree programs may be granted a Medical Leave of Absence by the Dean of the Graduate College.

Personal Leaves

Graduate students in degree programs may be granted a Leave of Absence for a maximum of one year throughout the course of their degree program by the Dean of the Graduate College. LOAs are granted on a case-by-case basis for compelling reasons, including birth or adoption of a child, personal or family reasons, military duty or financial hardship. Students will maintain their status without reapplying to the Department and the Graduate College at the expiration of the LOA.

Retroactive Leave of Absence

A retroactive leave request is any request made after the last day of finals in the semester. If a student does not request a leave by the last day of finals, he/she would need to apply for readmission to the program. Under extraordinary circumstances, LOAs may be granted retroactively. In such cases, students will be readmitted without reapplying to the department and the Graduate College.

G. COURSEWORK FOR THE Ph.D. DEGREE IN CHEMISTRY

1. Total Credits

- a) A minimum of 63 units of graduate credit, 510-level or above, are required for a Ph.D. in Chemistry.
- b) A total of 45 graded and ungraded units and 18 dissertation units comprise the 63 overall credits.
- c) At least 18 units must be in courses for which a letter grade (A,B,C,D,E) is awarded. A 'B' or better must be earned in each graded course that is to be counted towards the Major and Minor requirements for graded courses. Note: the Graduate College requires a minimum of 18 graded units, but for some Chemistry programs of study more graded units may be required.
- d) If a 'C' is received in a major or minor course, the student must: 1) repeat the course, or 2) take a different course at the discretion of the division in question and receive at least a 'B' in that replacement course. The GPC must be advised of, and approve of, this change. Note that this does not automatically remediate the GPA, which must be raised to a minimum of 3.0.
- e) The ungraded course work (approx. 27 units) is mostly comprised of seminar, group meetings, college teaching, or research opportunities.
- f) In some divisions, students may take up to two (2) units of "Advanced Seminar" (696e) for a letter grade. (See following pages in this section for detailed programs of study that satisfy these overall requirements).

2. Transfer Credits

It is a Departmental policy that no more than 6 units of graduate credit may be transferred from another institution. All transfer credit must be approved first by division affected, which will compare the content of the course with similar courses taught in our program. The approval process then moves to the GPC, and then finally the Graduate College. The Graduate College determines if the courses are eligible for transfer. You must obtain the Transfer Credit Form from the Graduate College and submit it to that office before the end of the first year of study for courses to be reviewed.

3. College Teaching

One unit of College Teaching (Chemistry 595c) with a grade of S or P is required of graduate students the first semester they hold a teaching assistantship.

4. Research Opportunities

All entering Chemistry students are required to take one unit of Chemical Research Opportunities (CHEM 695a) before selecting a Research Director (**see Section I**).

5. Chemistry Required Coursework in the Major and Minor areas

- a) A minimum of fifteen (15) units of graduate courses in the major, (the sub-discipline of specialization or division) are required for the Ph.D. in Chemistry. Some divisions require more coursework than this minimum (see summary tables in the back of this section). Courses of study other than those shown in the summary tables (e.g. multidivisional courses of study) are possible with the approval of the student's dissertation committee and the GPC. These required courses provide the background necessary for taking the Oral Comprehensive Examination (see Section J) and for initiating independent research. The time required to complete the required coursework will depend upon your

preparedness, as evidenced by your performance on the Diagnostic Examinations. For all full-time students, the required courses should be completed by the end of the second year (other rules apply to students admitted on a part-time basis; see Section M).

- b) For Ph.D. students in Chemistry who elect a minor in chemistry, a minimum of three units of advanced coursework outside the area of specialization, and for which a letter grade is awarded, are required.
- c) A minor in an area outside of chemistry must be approved in advance by the GPC and must satisfy all the coursework, written and oral preliminary exam requirements of the minor department.
- d) A 'B' or better is required in all graded courses to be counted towards the requirements of the major or minor. An average of 3.0 (B) is required for overall good standing within the program. If a 'C' is received in a major or minor course, the student must: 1) repeat the course, or 2) take a different course at the discretion of the division or program, and the GPC, and receive a at least a 'B' in that replacement course

6. Elective courses

Students are encouraged to broaden their knowledge through participation in courses beyond the minimum requirements. Elective graduate courses are offered on a regular basis to provide students the conceptual background to plan and execute original graduate research and to provide breadth in related areas of chemistry (see the list of course offerings in Section H).

7. Chemistry Seminar

Regular attendance at seminar is expected of all students each semester. Up to ten (10) units of divisional seminar (CHEM 696) may be used to meet graduation requirements. Up to two (2) units of graded seminar (CHEM 696e) may be taken.

In addition to the CHEM696 class, students are required to present a minimum of 2 seminars to the department during their residency, as defined in the divisional or program requirements. The department encourages students to present more seminars than the minimum as a way to develop formal presentation skills and share research within the department.

It is the student's responsibility to contact the seminar coordinator for their division to schedule seminars. This should be done over the summer before the 2nd year and approximately 1 semester before their expected graduation.

8. Group Meeting

At least one unit of Exchange of Chemical Information (CHEM 695b) should be taken each semester in residence after joining a research group. Up to ten (10) units may be used to meet graduation requirements. The format for this course is set by individual Research Directors.

9. Dissertation Research

Independent Dissertation Research (CHEM 920) under the guidance of your Research Director and Dissertation Committee forms the heart of a Ph.D. degree in Chemistry.

H. DIVISIONAL PLAN OF STUDY (DPOS)

In conjunction with his/her Research Director, each student is responsible for developing a Plan of Study during their first year in residence, to be filed with the Graduate College no later than the student's third semester in residence. The Plan of Study identifies (1) courses the student intends to transfer from other institutions; (2) courses already completed at The University of Arizona which the student intends to apply toward the graduate degree; and (3) additional course work to be completed in order to fulfill degree requirements. The Plan of Study must have the approval of the student's Research Director and Department Chair (or Director of Graduate Studies) before it is submitted to the Graduate College.

ANALYTICAL

Major		Minor	Total Graded
CHEM 526b Fall	3	3 credits minimum choose courses to broaden general knowledge of chemistry or to focus on a secondary area that complements the major	
CHEM 527 Fall	3		
CHEM 528 Spring	3		
CHEM 521A Fall	3		
Choose either CHEM 522 or CHEM 525 Spring	3		
Major Courses Total (minimum):	15	Minor Courses Total (minimum) : 3	Graded Courses Total (minimum): 18

Other Courses

Group Meeting	Seminar	Other	Total units
695b 1 credit/semester (after joining a research group)	696a 1 credit/semester	595c College Teaching (Fall I), 1 credit 695a Research Opportunities (Fall I), 1 credit 696e graded seminar at discretion of division 900 Research 1-5 credits per semester	
Maximum counted toward degree: 10	Maximum counted toward degree 10		Ungraded total: 27

Graded (min. 18) and ungraded courses listed in above tables must equal at least 45 credits.
CHEM 920 Dissertation Research must be taken for a minimum of 18 credits. Total: 45+18=63

All students should register for at least 12 credits.

All students must earn a grade of B or better in all required major coursework.

INORGANIC

Major		Minor	Total Graded
510 Fall only	3	3 credits minimum choose courses to broaden general knowledge of chemistry or to focus on a secondary area that complements the major	
514	3		
515	3		
6 credits chosen from 512, 513 (multiple times if different topics), 511A, 518 or course approved by committee	6		
Major Courses Total (minimum):	15	Minor Courses Total (minimum) : 3	Graded Courses Total (minimum): 18

Other Courses

Group Meeting	Seminar	Other	Total units
695b 1 credit/semester (after joining a research group)	696b 1 credit/semester	595c College Teaching (Fall I), 1 credit 695a Research Opportunities (Fall I), 1 credit 696e graded seminar at discretion of division 900 Research 1-5 credits per semester	
Maximum counted toward degree: 10	Maximum counted toward degree 10		Ungraded Courses total: 27

Graded (min. 18) and ungraded courses listed in above tables must equal at least 45 credits. CHEM 920 Dissertation Research must be taken for a minimum of 18 credits. Total: 45+18=63

All students should register for at least 12 credits.

ORGANIC

Major		Minor	Total Graded
550	3	3 credits minimum	
		choose courses to broaden general knowledge of chemistry or to focus on a secondary area that complements the major	
541	3		
545	4		
Courses chosen from 542A, 542B, 640 or 546, 549b, 548 or course approved by committee	5		
Major Courses Total (minimum):	15	Minor Courses Total (minimum) : 3	Graded Courses Total (minimum): 18

Other Courses

Group Meeting	Seminar	Other	Total units
695b 1 credit/semester (after joining a research group)	696c 1 credit/semester	595c College Teaching (Fall I), 1 credit 695a Research Opportunities (Fall I) 1 credit 696e graded seminar at discretion of division 900 Research 1-5 credits per semester	
Maximum counted toward degree: 10	Maximum counted toward degree 10		Ungraded total: 27

Graded (min. 18) and ungraded courses listed in above tables must equal at least 45 credits.
CHEM 920 Dissertation Research must be taken for a minimum of 18 credits. Total: 45+18=63

All students should register for at least 12 credits

PHYSICAL

Major		Minor	Total Graded
580 Fall only	3	3 credits minimum choose courses to broaden general knowledge of chemistry or to focus on a secondary area in chemistry or a related department that complements the major	
582 Fall only	3		
587 Spring only	3		
680 Spring Only	3		
Elective course chosen from 581, 583, 682, 684, 686, 687, or course approved by committee	3		
Major Courses Total (minimum):	15	Minor Courses Total (minimum) : 3	Graded Courses Total (minimum): 18

Other Courses

Group Meeting	Seminar	Other	Total units
695b 1 credit/semester (after joining a research group)	696d 1 credit/semester	595c College Teaching (Fall I), 1 credit 695a Research Opportunities (Fall I) 1 credit 696e graded seminar at discretion of division 900 Research 1-5 credits per semester	
Maximum counted toward degree: 10	Maximum counted toward degree 10		Ungraded total: 27

Graded (min. 18) and ungraded courses listed in above tables must equal at least 45 credits. CHEM 920 Dissertation Research must be taken for a minimum of 18 credits. Total: 45+18=63

All students should register for at least 12 credits

CHEMICAL EDUCATION

The Ph.D. in Chemistry with a research component in Chemical Education is designed for individuals who intend to pursue careers in chemical education research or teaching at the high school, college, or university level. Graduate course work in chemistry is accompanied by courses in education and chemical education, which enable the graduate to undertake research in the teaching and learning of chemistry.

Major	Minor	Total Graded
15 credits minimum complete major course requirements in any of these subject areas: analytical, biological, inorganic, organic, or physical chemistry.	9 credits minimum choose courses to complete a minor in education or science education (must satisfy the requirements of the minor department).	
Major Courses Total (minimum): 15	Minor Courses Total (minimum): 9	Graded Courses Total (minimum): 24

Other Courses

Group Meeting	Seminar	Other	Total units
695b 1 credit/semester (after joining a research group)	696x 1 credit/semester	595c College Teaching (Fall I), 1 credit 695a Research Opportunities (Fall I), 1 credit	
Maximum counted toward degree: 10	Maximum counted toward degree 10		Ungraded total: min 21

Graded (min. 24) and ungraded courses listed in above tables must equal at least 45 credits. CHEM 920 Dissertation Research must be taken for a minimum of 18 credits. Total: 45+18=63

All students should register for at least 12 credits

BIOLOGICAL PHYSICS PROGRAM (BPP)

The Biological Physics Program (BPP) is a multidisciplinary graduate training program that can be joined as a track through three departments: Biochemistry & Molecular Biophysics, Chemistry, or Physics. The course background for BPP students is expected to include a year of introductory Physics, Biochemistry, and a year of Physical Chemistry or equivalent upper division Physics. Additional admission requirements correspond to the home department. The degree is granted in Home Department with a focus in Biological Physics.

Major & Distributed Minor	Introduction to Research	Total Graded
Core courses in Chemistry or Biochemistry & Molecular Biophysics CHEM 565 Proteins and Enzymes 3 CHEM 585 Biological Structure 3	795a 3 credits/semester Laboratory rotations during first and second semester in residence	
Core courses in Physics PHYS 530 Intro to Biophysics PHYS 531 Molecular Biophysics 3		
Chem 580 & 582 6		
Major Courses Total (minimum): 18	Minor Courses Total (minimum) : 6	Graded Courses Total (minimum): 24

Other Courses Required

Journal Club	Group Meeting	Seminar	Other	Total units
BIOC 595B 1 credit/semester (Required attendance for students in Biological Physics Program)	695b 1 credit/semester (After joining a research group)	696c 1 credit/semester	595c College Teaching (Fall I), 1 credit 695a Research Opportunities (Fall I) 1 credit 696e graded seminar at discretion of program	
Maximum counted toward degree: 10	Maximum counted toward degree: 10	Maximum counted toward degree 10		Ungraded total: 21

BIOLOGICAL CHEMISTRY PROGRAM (BCP)

The Biological Chemistry Program (BCP) is a multidisciplinary NIH-supported training program at the Chemistry-Biology interface. Students in the program must satisfy their home program requirements (Biochemistry, Chemistry or Pharmaceutical Sciences) and, as part of CBC, will receive a degree in either Biochemistry or Chemistry. Students in the BCP are expected to undertake graduate coursework in both Chemistry and Biology; undertake research rotations both inside and outside their home program; attend the weekly BCP research forum ("Journal Club"); assemble a thesis committee with representation from more than one program; and complete both the online ethics introduction offered during orientation and an ethics course. Students following the BCP path are eligible for our fellowships and may work with any faculty member in the BCP (see our web page for a current list of participating faculty). Listed below are the approved BCP courses; however, other appropriate graduate courses that provide a foundation in Chemistry or Biology may be substituted with approval from the BCP Director.

Major & Distributed Minor		Introduction to research	Total Graded
Any one from BIOC 565 (Proteins and Enzymes) BIOC 568 (Nucleic Acids and Metabolic Biochemistry) PCOL 630 (Proteins and Nucleic Acids as Drug Targets) PHSC 670 (Principles in drug Discovery, Design, and Development)	3	795a 3 credits/semester Laboratory rotations during first and second semester in residence	
Any one from Fundamental Chemistry Course 550 / 510 / 521B / 580	3		
Courses chosen from upper division chemistry or courses approved by committee.	9		
Major Courses Total (minimum):	15	Maximum counted toward degree: 6	Graded Courses Total (minimum): 21

Other Courses Required

Journal Club	Group Meeting	Seminar	Other	Total units
BIOC 595B 1 credit/semester (Required attendance for students in Biological Chemistry Program)	695b 1 credit/semester (After joining a research group)	696X 1 credit/semester	595c College Teaching (Fall I), 1 credit 695a Research Opportunities (Fall I) 1 credit MCB 695e (Science, Society, & Ethics) 1 credit	
Maximum counted toward degree: 10	Maximum counted toward degree: 10	Maximum counted toward degree 10		Ungraded total: 21

Graded (minimum 21) and ungraded courses listed in above tables must equal at least 45 credits. CHEM 920 Dissertation Research must be taken for a minimum of 18 credits. Total: 45+18=63

All students should register for at least 12 credits

CHEMICAL PHYSICS PROGRAM (CPP)

The Chemical Physics Program (CPP) is a multidisciplinary graduate training program that can be joined as a track through either the Chemistry or Physics departments. Students undertake courses and seminars involving both departments that are optimized for individual student interests with a maximum of flexibility. Admission requirements for CPP students correspond to the Home Department (Chemistry or Physics). The degree is granted in the Home Department with a focus in Chemical Physics.

Major	Minor	Total Graded*
Choose any courses from the following options: Quantum Mechanics CHEM 580 & 680 or PHYS 570A and 570B 3/3 Thermodynamics & Statistical Mechanics CHEM 582 or PHYS 528 3 Kinetics CHEM 583 3 Spectroscopy CHEM 584/587/687 3/3/3 Mathematical Methods CHEM 581 3 Electricity & Magnetism PHYS 515A/B 3/3 Condensed Matter PHYS 560A/B or CHEM 686 3 or course approved by committee	Choose courses from the indicated options to broaden general knowledge of chemistry and physics	* CPP students must take at least 2 major graduate courses from the home department.
Major Courses Total (minimum): 15	Minor Courses Total (minimum): 3	Graded Courses Total (minimum): 18

Other Courses Required

Journal Club	Group Meeting	Seminar	Other	Total units
CHEM 599 or PHYS 599 (CPP seminar) 1 credit per semester (Required attendance for students in CPP)	CHEM 695b 1 credit per semester (After joining a research group)	CHEM 696c (Physical Chemistry or Physics Seminar 1 credit/semester and/or	CHEM 595c (College Teaching, Fall I, 1 credit) CHEM 695a (Research Opportunities, Fall I, 1 credit) CHEM 696e graded seminar at discretion of program	
Maximum counted toward degree: 10	Maximum counted toward degree: 10	Maximum counted toward degree 10		Ungraded total: 27

Graded (minimum 18) and ungraded courses listed in above tables must equal at least 45 credits. CHEM 920 Dissertation Research must be taken for a minimum of 18 credits. Total: 45+18=63

All students should register for at least 12.

Certificate in Entrepreneurial Chemistry

This program is only offered to PhD graduate students who want to be successful as entrepreneurs or working in start-up companies.

PhD requirements	Business	Other	Total units
Students must fulfill all requirements for the Chemistry PhD program	BNAD 510 Business for Scientists 3 credits MIS578 Management 3 credits ENTR595F Entrepreneurship 1 credit	CHEM 909 One chapter in the doctoral dissertation on the business aspects of the research	
63	7 credits	2 credits	72

Five Year B.S./M.S. Degree

The Chemistry and Biochemistry program offers the opportunity for students to participate in an accelerated curriculum that leads to both the Bachelor of Science and Master of Science degrees in either Chemistry or Biochemistry. This curriculum follows the normal B.S. degree for three years, but adds two graduate level courses during their fourth year that are applied to the subsequent M.S. program. These graduate courses cannot be included in the student's B.S. degree units. The fifth year includes three graduate courses, research credits, and the Master's Thesis. Students must apply to the Graduate College during their fourth year for official admission to the M.S. program immediately following completion of their B.S. requirements

Students must meet the following criteria in order to apply

- Be in their 3rd year at the time of application (that is, student who have completed at least 75 units by the end of their 5th semester but can apply before the required 35 units for a Chemistry or Biochemistry major have been met)
- Exceptions can be made in the case of a 4th year students provided they are enrolled in at least one graduate level course and have at least one more semester remaining in the B.S.
- Be a continuing U of A student working on a Bachelor's degree
- Have a minimum cumulative GPA of 3.5 (NO EXCEPTIONS)
- Have a minimum of one semester of research experience with demonstrated productivity
- Have a thesis advisor who is a primary CBC faculty member

Students are **strongly** encouraged to consult the respective chairs of the UPC and GPC before applying to this accelerated degree program.

The Master of Science degree requires 30 units (minimum) of graduate work in 500-level courses or above, up to 15 of which may be in thesis research. Up to 12 units of graduate credit earned as an undergraduate and not applied toward the baccalaureate degree can be applied for credit toward a master's degree.

Required Courses:

- Graded coursework constitutes 15 units of the Master of Science degree. A plan of study must be approved by the committee. Suggested core courses of study for the respective areas are:
 - Analytical: Choose 3 courses from Chem 522, Chem 523, Chem 525, Chem 526b, Chem 527, Chem 529
 - Biochemistry: Bioc 565, Bioc 568, and one other course by approval
 - Inorganic: Chem 510, Chem 514, and one other course by approval
 - Organic: Chem 550, Chem 541, Chem 545
 - Physical: Chem 580, Chem 581, Chem 582
- Up to 15 units of the Master of Science degree may be in thesis research, group meeting, seminar, etc.

Tuition and Fees:

- The student must pay graduate tuition and fees
- After 12 graduate level credits they will be considered a graduate student.

Application Deadline: April 15

Decision: May 15 pending application review and interview

Requirements for the Graduate Minor in Chemistry

The graduate minor in chemistry for students with a major outside of chemistry will consist of an approved sequence of at least 9 units of chemistry courses, each to be passed with a grade of "B" or better. The written preliminary examination will be comprised of the final examinations on the courses.

Acceptable sequences of chemistry courses include:

- a. Analytical
Three from 522, 526b, 527, and 525
- b. Inorganic
510 and two from 511, 513, 514, 515, and 518
- c. Organic
550 and two from 541, 542a, 542b, 543, 544, 548 and 640
- d. Physical
580, 582, and one from 581, 583, 587, 680, 686, and 687

Other sequences may be accepted to fit special students needs, but it is the student's responsibility to obtain written approval from the minor members of his/her Dissertation Committee and from the GPC of the Department of Chemistry and Biochemistry prior to embarking on such a course of study.

Worksheet to plan schedule:

Courses for which all students should register are listed.

Choose any necessary courses and then use the Program of Study guidelines, by division, on the previous pages to choose additional courses.

Most students will take three, 3-credit courses in the first semester in addition to 595c, 696x, and 695a.

Fall I			Spring I		
Course #	Topic	Units	Course #	Topic	Units
595c	College Teaching	1	900	Research	1-5
696a - Analytical 696b - Inorganic 696c - Organic 696d - Physical	Seminar (Choose one)	1	696a - Analytical 696b - Inorganic 696c - Organic 696d - Physical	Seminar (Choose one)	1
695a	Research Opportunities	1	695b	Group Meeting	1
	Total	12		Total	12
Fall II			Spring II		
Course #	Topic	Units	Course #	Topic	Units
900	Research	1-5	900	Research	1-5
696a - Analytical 696b - Inorganic 696c - Organic 696d - Physical 696e - (Graded)	Seminar (Choose one)	1	696a - Analytical 696b - Inorganic 696c - Organic 696d - Physical 696e - (Graded)	Seminar (Choose one)	1
695b	Group Meeting	1	695b	Group Meeting	1
920	Dissertation Research	1-9	920	Dissertation Research	1-9
Total		12	Total		12

CHEMISTRY GRADUATE COURSE LISTINGS

CHEM 510 -- Advanced Inorganic Chemistry (3 units)

Description: Aspects of modern inorganic chemistry: Structure and bonding, magnetic and spectroscopic properties, and reactions and reaction mechanisms of transition metal compounds. Catalytic properties of transition metal complexes. Selected topics of main group elements and new directions in inorganic chemistry.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 404 or consent of instructor.

Usually offered: Fall.

CHEM 511A -- Designer Inorganic Materials (3 units)

Description: Concepts and practice of molecule-based materials with emphasis on metal-ligand interactions and synthetic methods for selected classes of inorganic and organometallic materials. Interrelationship of structure and bonding to properties and functions of designed materials. Recent developments in materials chemistry, synthetic techniques and self-assembled supramolecular materials.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 404 or consent of instructor.

Usually offered: Fall and Spring

CHEM 512 -- Inorganic Preparations (3 units)

Description: Standard inorganic laboratory preparations, including coordination compounds, isomeric, organometallic, bioinorganic, air sensitive compounds, and compounds typifying the groups of the periodic table. High temperature, inert atmosphere, materials synthesis, and characterization of products by various spectroscopic techniques. Graduate level requirements include an individual synthesis project.

Grading: Regular grades are awarded for this course: A B C D E.

Special course fee required: \$100.

May be convened with: CHEM 412.

Usually offered: Spring, Summer 1 and 2

CHEM 513 -- Current Topics in Inorganic Research (1-4 units)

Description: In-depth treatment of advanced topics in inorganic chemistry. Examples include kinetics and mechanisms of inorganic reactions, bioinorganic chemistry, EPR spectroscopy, solid state materials chemistry, chemistry of particular elements or families of elements, and other topics characterized by faculty expertise. Topics will vary each semester.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 510 or consent of instructor.

May be repeated: for a total of 6 units of credit.

Usually offered: Fall, Spring.

CHEM 514 -- Organometallic Compounds (3 units)

Description: Compounds containing carbon-metal bonds, with emphasis on those of the transition elements, their reactivity, and the determination of their structure.

Grading: Regular grades are awarded for this course: A B C D E.

Usually offered: Fall.

CHEM 515 -- Physical Methods in Inorganic Chemistry (3 units)

Description: Selected topics in the area of physical characterization of inorganic molecules and materials, with particular emphasis on ligand field theory, symmetry aspects, spectral properties and magnetic behavior of transition metal complexes.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 510.

Usually offered: Fall.

CHEM 518 -- Computational Chemistry (3 units)

Description: Molecular modeling and computations in all areas of chemistry and related disciplines ranging from molecular mechanics, conformational analysis and molecular dynamics to advanced electronic structure computations by state-of-the-art methods; the course emphasizes guidance in hands-on experience with modern computational tools and actual practical application of the methods to the student's own research or chemical interests.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): consent of instructor.

Usually offered: Fall, Spring.

CHEM 520 -- Advanced Topics in Analytical Chemistry (3 units)

Description: Special topics in modern analytical chemistry. Recent offerings have included principles of bioanalytical chemistry and mass spectrometry. Students enrolled for 3 units are required to complete an additional research project including a written paper and an oral presentation.

Grading: Regular grades are awarded for this course: A B C D E.

Usually offered: Fall, Spring.

CHEM 521A-- Advanced Analytical Chemistry (3 units)

Description: Principles of electronics, principles of signal processing hardware and software, instrumental principles of atomic and molecular spectroscopy, statistical treatment of data, chemometrics.

Grading: Regular grades are awarded for this course: A B C D E.

Special course fee required: \$50.00

Prerequisite(s): CHEM 325, CHEM 401A, CHEM 480B

Usually offered: Fall.

CHEM 522 -- Electroanalytical Chemistry (3 units)

Description: Principles of electrochemistry and electroanalysis, including topics on electrochemical equilibria, electrode kinetics, potentiometry, coulometry, voltammetry and spectroelectrochemistry.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 401A or consent of instructor.

Usually offered: Spring.

CHEM 523A -- Bioanalytical Chemistry (3 units)

Description: Bioanalytical chemistry covers the principles behind the essential measurements used for analysis of biological systems, including but not limited to separations, mass spectrometry, microarrays, immunoassays, and DNA sequencing. The current literature is examined to understand today's research questions in bioanalysis, developments in the biotech industry, and opportunities to have a creative impact on improving human health.

Grading: Regular grades are awarded for this course: A B C D E.

Usually offered: Fall, Spring.

CHEM 525A -- Mass Spectrometry (3 units)

Description: Modern mass spectrometric techniques and instrumentation.

Grading: Regular grades are awarded for this course: A B C D E.

Usually offered: Spring

CHEM 526B -- Analytical Spectroscopy (3 units)

Description: Principles of molecular absorption, emission and scattering spectroscopies for chemical analysis.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 401A or consent of instructor.

Usually offered: Fall

CHEM 527 -- Analytical Separations (3 units)

Description: Fundamentals of separation processes including single and multistage analytical chromatographic methods.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 401A or consent of instructor.

Usually offered: Fall.

CHEM 528B -- Advanced Analytical Chemistry Laboratory (3 units)

Description: Advanced laboratory experiments in analytical instrumentation.

Grading: Regular grades are awarded for this course: A B C D E.

Special course fee required: \$100.

Prerequisite(s): CHEM 401A4, CHEM 480B, CHEM 521A.

Usually offered: Spring.

CHEM 529 -- Methods of Surface and Materials Analysis (3 units)

Description: Fundamentals of electron, atomic and molecular spectroscopies for surface and materials analysis. This course is suitable for enrollment by advanced undergraduates.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 401A or consent of instructor.

Usually offered: Fall, Spring.

CHEM 530 -- Proteins and Nucleic Acids as Drug Targets (3 units)

Description: [Taught alternate years beginning Spring 2005]. The course will be coordinated through the Medicinal Chemistry Division of Pharmacology & Toxicology and will be Team Taught. Each semester four to five topics will be chosen for which the core areas of (chemistry, biochemistry, and medicinal chemistry) have been brought to bear on a specific biological question. Faculty, from the core areas, will lecture on each topic and lead discussions. Students will present material and lead discussions.

Grading: Regular grades are awarded for this course: A B C D E.

Identical to: C BIO 530, PCOL 530, PHSC 530, PHSC is home department.

Usually offered: Spring.

CHEM 532A -- Chemical Characterization for Cultural Material (2 units)

Description: The class combines lecture and laboratory sessions for hand-on practice in the preparation, testing and interpretation of results for a representative range of organic and inorganic materials. The course work includes the use of a variety of micro-sampling techniques with chemical spot testing methods and analytical instrumentation for the analysis of a range of artifact materials such as metals, proteins, cellulose and plastics; analysis of contextual materials including surface deposits, soils and stains; and interpretation of results, chemical processes and the effects of interference materials. Graduate -level requirements include a presentation of their Materials Characterization Project.

Grading: Regular grades are awarded for this course: A B C D E.

Special course fee required: \$50.

Identical to: ANTH 532A, MSE 532A.

May be convened with: CHEM 432A.

Usually offered: Fall.

CHEM 534A -- Practical NMR Spectroscopy Laboratory (3 units)

Description: This laboratory course will cover a wide variety of nuclear magnetic resonance (NMR) methods useful in organic chemistry research. Both one-dimensional and two-dimensional methods will be covered, with hands-on access to state-of-the-art instruments. Students will have 2 hours of instrument time and a 90 minute lecture each week, covering the practical aspects of setting up each experiment and interpreting the results of the experiment.

Grading: Regular grades are awarded for this course: A B C D E.

Special course fee required: \$100.

Usually offered: Fall, Spring.

CHEM 534B -- Practical NMR Spectroscopy Lecture (3 units)

Description: The course will cover the theory and interpretation of a wide variety of NMR methods useful in organic chemistry research, at a level appropriate for organic chemists. Both one-dimensional and two-dimensional methods will be covered, with emphasis on up-to-date methods with practical application to research problems. A coherent theoretical basis for understanding NMR experiments will be presented, without a rigorous basis in physics and mathematics, starting with the classical spinning-top model and adding just enough of the quantum picture to provide an accurate description.

Grading: Regular grades are awarded for this course: A B C D E.

Usually offered: Fall.

CHEM 535A -- Chemistry of Electronic and Photonic Materials - Part A (3 units)

Description: Introduction to the basic chemical and physical concepts impacting the properties of organic and inorganic materials with specific electronic and optical response. The course is designed to provide a broad perspective with discussion going from synthetic aspects to electronic-structure characteristics and device fabrication aspects. Materials under scrutiny include e.g. high-T_c superconductors, conducting polymers, nonlinear optical compounds, liquid crystals, optical fibers, luminescent and photochromic compounds.

Grading: Regular grades are awarded for this course: A B C D E.

Usually offered: Fall, Spring.

CHEM 536 -- Scientific and Ethical Aspects of Modifying Human Behavior (3 units)

Description: Scientific and Ethical Aspects of Modifying Human Behavior. Modern chemistry, biology and medicine in conjunction with the neuroscience revolution are providing tools which can modify basic human behaviors (learning, addictive, aggressive, feeding, etc.). An examination of the scientific, cultural, religious and ethical issues related to this emerging science will be examined. Basic knowledge of chemistry and biology (two years of each) and of social sciences (psychology, philosophy, religious studies, etc.) are useful prerequisites or consent of instructor. Graduate-level requirements include a more extensive term paper.

Grading: Regular grades are awarded for this course: A B C D E.

Identical to: RELI 536.

May be convened with: CHEM 436.

Usually offered: Spring.

CHEM 537 -- Surface Science (3 units)

Description: Fundamental material, electrical, and chemical properties of solid metal, semiconductor, insulator, and organic surfaces applied to selected gas/solid surface chemical reactions important in semiconductor processing and heterogeneous catalysis. This course is designed to introduce students to the chemistry and physics of solid surfaces and interfaces with an emphasis on the gas/solid interface. The first half of the course will be devoted to learning the fundamental material, electrical, and chemical properties of solid surfaces. The fundamentals will be applied in the second half of the course to topics in chemical catalysis and integrated circuit manufacture. Graduate-level requirements include completion of two projects of their choice with the approval of the instructor.

Grading: Regular grades are awarded for this course: A B C D E.

Identical to: CHEE 537 and MSE 537; CHEE is home department.

May be convened with: CHEM 437.

Usually offered: Spring.

CHEM 541 -- Mechanisms of Organic Reactions (3 units)

Description: Detailed analysis of the factors which influence the rates and courses of organic processes.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 241B or CHEM 242B or CHEM 246B and CHEM 480B or consent of instructor.

Usually offered: Spring.

CHEM 542A- Polymer Chemistry (3 units)

Description: Synthesis, stereochemistry, and mechanisms of formation of high polymers. Condensation and ring-opening polymers.

Grading: Regular grades are awarded for this course: A B C D E.

Usually offered: Fall.

CHEM 542B -- Polymer Chemistry (3 units)

Description: Synthesis, stereochemistry, and mechanisms of formation of high polymers. Vinyl polymers.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 542A is not prerequisite to CHEM 542B.

Usually offered: Fall.

CHEM 544 -- Heterocyclic Compounds (3 units)

Description: The behavior of the more important heterocyclic systems.

Grading: Regular grades are awarded for this course: A B C D E.

Usually offered: Fall.

CHEM 545 – Laboratory Methods for Organic Chemistry (4 units)

Description: Substantial training with the methods that are most useful and commonly encountered in organic research laboratories. Students will gain experience using the proper equipment and techniques for carrying out a broad range of organic synthesis reactions, purifications, and characterizations, and learn spectroscopic techniques from a theoretical and practical perspective.

Grading: Regular grades are awarded for this course: A B C D E.

Usually offered: Fall.

CHEM 546 -- Advanced Organic Chemistry (3 units)

Description: Advanced topics in organic chemistry, such as peptide chemistry, computer simulations, bio-organic chemistry, and other topics characterized by faculty expertise. Topics will vary each semester.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): consult department before enrolling.

May be repeated: for credit 1 time (maximum 2 enrollments).

Usually offered: Fall.

CHEM 547 -- Organic Structural Analysis Laboratory (3 units)

Description: Determination of structure and composition of organic compounds and mixtures using modern spectroscopic and separation methods. Graduate-level requirements include additional laboratory experiments.

Grading: Regular grades are awarded for this course: A B C D E.

Special course fee required: \$100.

Prerequisite(s): consent of instructor.

May be convened with: CHEM 447.

Usually offered: Spring.

CHEM 548 -- Advanced Synthetic Chemistry (3 units)

Description: Reactions and methods used for organic synthesis. Emphasis is placed on the development and application of modern methods for the synthesis of complex organic compounds.

Grading: Regular grades are awarded for this course: A B C D E

Prerequisite(s): CHEM 450 or CHEM 550 or consent of instructor.

Usually offered: Spring

CHEM 548A – Plant Biochemistry and Metabolic Engineering (3 units)

Description: Covering topics in plant metabolic engineering; photosynthesis; carbohydrate, nitrogen and lipid metabolism; specialized metabolism. This course covers biochemical processes specific to plants and allows students to gain an understanding and appreciation of how (bio)chemical components are synthesized and utilized by plants during growth and development and in their interactions with their environment, as well as how these processes can be manipulated. A background in plant biology, general biochemistry or chemistry is expected. Note that concurrent registration in any of these courses will NOT meet this requirement. Students must have completed both semesters of O-chem and a biochemistry course that covers general metabolism prior to taking this course. Graduate-level requirements include 2 or 3 short individual oral presentations and a term paper.

Grading: Regular grades are awarded for this course: A B C D E

Identical to: BIOC 548A, ECOL 548A, MCB 548A, PLS 548A

Usually offered: Fall

CHEM 549A -- Topics in Chemical Biology (3 units)

Description: This course is focused on Organic chemistry as it applies to mimicking and understanding biological systems (bioorganic) and for developing new chemical methodologies to probe biological systems (chemical biology).

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): BIOC 462A, BIOC 556, or consent of instructor.

Usually offered: Fall, Spring.

CHEM 550 – Synthetic and Mechanistic Organic Chemistry (3 units)

Description: Graduate-level requirements include mastery of additional topics from the textbook and writing a term paper based on these topics.

Grading: Regular grades are awarded for this course: A B C D E.

May be convened with: CHEM450

Usually offered: Fall.

CHEM 570A – Advanced Chemistry 1 (3 units)

Description: Fundamental principles of physical chemistry as applied to chemical systems of central importance in our world. This course is designed for prospective and in-service science teachers who need to develop a deeper understanding of central ideas in physical chemistry. Core topics in the course include thermodynamic and chemical kinetics. This course is designed to be on-line. In-service science teachers may take the course for graduate credit by completing additional graduate level course work. Graduate-level requirements include: Students taking the course for graduate credit will be asked to complete a research project at the end on each major course unit. They will be asked to demonstrate that they can apply their understanding of the central ideas in each unit to the analysis of a relevant system or problem in our world.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): Excluded majors and minors: Chemistry and Biochemistry.

May be Convened With: CHEM 470A.

Usually offered: Fall, Summer 1 and 2

CHEM 570B- Advanced Chemistry 2 (3 Units)

Description: Fundamental principles of organic chemistry and biochemistry as applied to systems of central importance in our world. This course is designed for prospective and in-service science teachers who need to develop a deeper understanding of central ideas in biochemistry. Core topics in the course include structure function relationships in biologically important macromolecules and metabolism. This course is designed to be on-line. Graduate-level requirements include developing a lesson plan at the end of each major unit that incorporates the key biochemistry concepts of the unit into their curriculum.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 152 and 241B. Credit allowed for only one of: CHEM 470B, BIOC 384, BIOC385, BIOC 462A/B, BIOC 466. Chemistry & Biochemistry minors excluded.

Usually offered: Fall, Spring, Summer 1 and 2

CHEM 580 -- Introduction to Quantum Chemistry (3 units)

Description: An introduction to quantum mechanics, with applications to atomic structure and spectra, the nature of chemical bonding and molecular structure.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 480B or consent of instructor.

Usually offered: Fall.

CHEM 581 – Mathematical Methods for Chemists (3 Units)

Description: The course covers the fundamentals and techniques of mathematics with applications to common problems in chemistry and chemical physics.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 480B or consent of instructor.

Usually offered: Fall.

CHEM 582 -- Statistical Thermodynamics (3 units)

Description: Introduction to classical and quantum statistical thermodynamics with application to ideal gases and simple solids; equations of state and elementary solution theory.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 480B or consent of instructor.

Usually offered: Fall.

CHEM 583 -- Chemical Kinetics (3 units)

Description: Classical and modern techniques in studies of chemical reactions.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 480B or consent of instructor.

Usually offered: Spring.

CHEM 584 -- Nuclear Magnetic Resonance Spectroscopy (3 units)

Description: Basic theory and interpretation of nuclear magnetic resonance (NMR) methods from a multidisciplinary perspective. The course covers experimental NMR methods; nuclear spin interactions; relaxation and dynamics; solid state NMR; liquid state NMR; and magnetic resonance imaging (MRI). Emphasis is placed on a unified description of magnetic resonance phenomena at a level appropriate for chemists, physicists, biochemists, and engineers.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 480B or CHEM 481; or PHYS 371 or equivalent or consent of instructor.

May be repeated: Course may be repeated for a maximum of 6 unit(s) or 2 completion(s).

Identical to: BIOC 584, PHYS 584.

Usually offered: Fall.

CHEM 587 -- Introduction to Molecular Spectroscopy (3 units)

Description: Modern molecular spectroscopy including rotational, vibrational, and electronic spectroscopy and their various combinations.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 480A, CHEM 480B or consult department before enrolling.

Usually offered: Spring.

CHEM 591C -- Professional Services (1 unit)

Description: Specialized work on an individual basis, consisting of instruction and practice in actual service in a department, program, or discipline. Teaching formats may include seminars, in-depth studies, laboratory work and patient study.

Grading: Alternative grades are awarded for this course: S P F.

May be repeated: Course may be repeated for a maximum of 2 unit(s) or 2 completion(s).

May be convened with: CHEM 491C.

Usually offered: Fall, Spring, Summer 1 and 2

CHEM 593 -- Internship (1-3 units)

Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.

Grading: Alternative grades are awarded for this course: S P F

May be repeated: an unlimited number of times, consult your department for details and possible restrictions.

Usually offered: Fall, Spring, Summer 1 and 2

CHEM 595B -- Journal Club (1 unit)

Description: The exchange of scholarly information and/or secondary research, usually in a small group setting. Instruction often includes lectures by several different persons. Research projects may or may not be required of course registrants.

Grading: Regular or Alternative Grades: ABCDE or SPCDE

May be repeated: Course may be repeated for a maximum of 6 unit(s) or 6 completion(s).

Identical to: BIOC 595B and MCB 595B; BIOC is home department.

Usually offered: Fall, Spring.

CHEM 595C -- College Teaching (1 unit)

Description: This course serves as the weekly group meeting for those who are currently teaching Chemistry laboratory courses, and serves the purpose of maintaining consistency in the delivery of education in chemistry labs. Weekly discussions address how to prepare for lectures, grade lab reports using an established rubric, assess student learning and performance, and how to navigate safety issues relevant to the experiments. Current issues in teaching college-level labs and development of the teaching skills and methods utilized by course participants are also discussed as necessary. Graduate level enrollment requires students to be teaching assistants in the Chemistry Department.

Grading: Regular or Alternative Grades: ABCDE or SPCDE

May be repeated: Course may be repeated for a maximum of 2 unit(s) or 2 completion(s).

May be convened with: CHEM 495C.

Usually offered: Fall, Spring, Summer 1 and 2

CHEM 595D -- Advanced College Teaching (1 unit)

Description: This course provides students with an interest in a teaching career the opportunity to continue to develop their understanding of current chemical educational theory and practice. Graduate-level requirements include four additional reading assignments and one additional evaluation.

Grading: Regular or alternative grades can be awarded for this course: A B C D E or S P C D E.

May be repeated: for a total of 2 units of credit.

May be convened with: CHEM 495D.

Usually offered: Spring.

CHEM 599 -- Independent Study (1-3 units)

Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.

Grading: Alternative grades are awarded for this course: S P F.

May be repeated: an unlimited number of times, consult your department for details and possible restrictions.

Usually offered: Fall, Spring, Summer 1 and 2.

CHEM 640 -- Advanced Organic Synthesis (3 units)

Description: Theory and practice of molecular design and construction as applied to synthesis of complex organic molecules.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 540 or consult department before enrolling.

Usually offered: Spring.

CHEM 680 -- Quantum Chemistry (3 units)

Description: Principles of quantum mechanics with applications to the properties of molecules.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 580.

Usually offered: Spring.

CHEM 686 – Chemical Physics in the Condensed Phase (3 units)

Description: Applications of Quantum Mechanics to the interpretation of structure and dynamics in condensed phase systems (liquids and solids).

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 580, CHEM 582 or consent of instructor.

Usually offered: Spring.

CHEM 687 -- Molecular Spectroscopy (3 units)

Description: Applications of quantum mechanics to the interpretation of the spectra of molecules of chemical and biological interest.

Grading: Regular grades are awarded for this course: A B C D E.

Prerequisite(s): CHEM 580.

Usually offered: Fall

CHEM 694 -- Practicum (1-3 units)

Description: The practical application, on an individual basis, of previously studied theory and the collection of data for future theoretical interpretation.

Grading: Alternative grades are awarded for this course: S P F.

May be repeated: an unlimited number of times, consult your department for details and possible restrictions.

Usually offered: Fall, Spring, Summer 1 and 2

CHEM 695A -- Chemical Research Opportunities (1 unit)

Description: Enrollment is restricted to new students in the Chemistry graduate program. This course involves weekly attendance at group meetings, and the exchange of scholarly information in the form of lectures and presentations by group participants involved in chemical research with specific faculty members. Participants will be expected to identify a Research Director at the end of this experience.

Grading: Regular or alternative grades can be awarded for this course: A B C D E or S P C D E.

Usually offered: Fall.

CHEM 695B -- Exchange of Chemical Information (1-3 units)

Description: Enrollment is restricted to students in the Chemistry graduate program. This course involves the weekly attendance at group meeting, and the exchange of scholarly information in the form of lectures and presentations by group participants involved in chemical research with specific faculty members.

Grading: Regular or alternative grades can be awarded for this course: A B C D E or S P C D E.

May be repeated: Course may be repeated for a maximum of 10 unit(s) or Unlimited completion(s).

Usually offered: Fall, Spring, Summer 1 and 2.

CHEM 696A -- Analytical Chemistry (1-3 units)

Description: Enrollment is restricted to students in the Chemistry graduate program or to those with instructor approval. The scope of work shall consist of attendance at the weekly seminar associated with the Analytical division; along with individual research by course registrants within their groups, and the development and exchange of scholarly information through discussion, reports, and/or papers.

Grading: Regular or alternative grades can be awarded for this course: A B C D E or S P C D E.

May be repeated: Course may be repeated for a maximum of 10 unit(s) or Unlimited completion(s).

Usually offered: Fall, Spring.

CHEM 696B -- Inorganic Chemistry (1-3 units)

Description: Enrollment is restricted to students in the Chemistry graduate program or to those with instructor approval. The scope of work shall consist of attendance at the weekly seminar associated with the Inorganic division; along with individual research by course registrants within their groups, and the development and exchange of scholarly information through discussion, reports, and/or papers.

Grading: Regular or alternative grades can be awarded for this course: A B C D E or S P C D E.

Prerequisite(s): students in the Chemistry graduate program or consent of instructor.

May be repeated: Course may be repeated for a maximum of 10 unit(s) or Unlimited completion(s).

Usually offered: Fall, Spring.

CHEM 696C -- Organic Chemistry (1-3 units)

Description: Enrollment is restricted to students in the Chemistry graduate program or to those with instructor approval. The scope of work shall consist of attendance at the weekly seminar associated with the Organic division; along with individual research by course registrants within their groups, and the development and exchange of scholarly information through discussion, reports, and/or papers.

Grading: Regular or alternative grades can be awarded for this course: A B C D E or S P C D E.

Prerequisite(s): Students in the Chemistry graduate program or consent of instructor.

May be repeated: Course may be repeated for a maximum of 10 unit(s) or Unlimited completion(s).

Usually offered: Fall, Spring.

CHEM 696D -- Physical Chemistry and Chemical Physics (1-3 units)

Description: Enrollment is restricted to students in the Chemistry graduate program or to those with instructor approval. The scope of work shall consist of attendance at the weekly seminar associated with the Physical division; along with individual research by course registrants within their groups, and the development and exchange of scholarly information through discussion, reports, and/or papers.

Grading: Regular or alternative grades can be awarded for this course: A B C D E or S P C D E.

Prerequisite(s): students in the Chemistry graduate program or consent of instructor.

May be repeated: Course may be repeated for a maximum of 10 unit(s) or Unlimited completion(s).

Usually offered: Fall, Spring.

CHEM 696E -- Advanced Seminar (1-3 units)

Description: Enrollment is restricted to students in the Chemistry graduate program or to those with instructor approval. The scope of work shall consist of preparing and presenting a seminar on individual research conducted by course registrants within their divisional research groups.

Grading: Regular or alternative grades can be awarded for this course: A B C D E or S P C D E.

Prerequisite(s): students in the Chemistry graduate program or consent of instructor.

May be repeated: Course may be repeated for a maximum of 10 unit(s) or Unlimited completion(s).

Usually offered: Fall, Spring.

CHEM 795A -- Introduction to Research (1-6 units)

Description: The exchange of scholarly information and/or secondary research, usually in a small group setting. Instruction often includes lectures by several different persons. Research projects may or may not be required of course registrants.

Grading: Regular or alternative grades can be awarded for this course: A B C D E or S P C D E.

Prerequisite(s): open to MCB, CHEM, PHSC, and BIOC majors only.

May be repeated: Course may be repeated for a maximum of 10 unit(s) or Unlimited completion(s).
Identical to: BIOC 795A, MCB 795A, PHSC 795A; BIOC is home department.
Usually offered: Fall, Spring.

CHEM 900 -- Research (1-9 units)

Description: Individual research, not related to thesis or dissertation preparation, by graduate students.

Grading: Alternative grades are awarded for this course: S P C D E.

May be repeated: an unlimited number of times, consult your department for details and possible restrictions.

Usually offered: Fall, Spring, Summer 1 and 2.

CHEM 908 -- Case Studies (3 units)

Description: Individual study of a particular case, or report thereof.

Grading: Alternative grades are awarded for this course: S P E K.

May be repeated: an unlimited number of times, consult your department for details and possible restrictions.

Usually offered: Fall, Spring, Summer 1 and 2.

CHEM 909 -- Master's Report (1-5 units)

Description: Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.

Grading: Alternative grades are awarded for this course: S P E K.

May be repeated: an unlimited number of times, consult your department for details and possible restrictions.

Usually offered: Fall, Spring, Summer 1 and 2.

CHEM 910 -- Thesis (1-12 units)

Description: Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.

Grading: Alternative grades are awarded for this course: S P E K.

May be repeated: an unlimited number of times, consult your department for details and possible restrictions.

Usually offered: Fall, Spring, Summer 1 and 2.

CHEM 920 -- Dissertation (1-12 units)

Description: Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).

Grading: Alternative grades are awarded for this course: S P E K.

May be repeated: an unlimited number of times, consult your department for details and possible restrictions.

Usually offered: Fall, Spring, Summer 1 and 2.

I. CHOOSING A RESEARCH PROJECT AND RESEARCH DIRECTOR

1. Selecting a Research Director – 1st semester in residence

- a) Prior to selection of a Research Director, you will become familiar with the research interests of the faculty through attendance at Department of Chemistry and Biochemistry Research Symposium, held the week before classes begin in the fall semester. Part of this Research Symposium will consist of poster presentations from graduate students and faculty in the department where you will have an opportunity to talk informally with presenters from multiple research groups about their research interests.
- b) Following this poster session you must make individual appointments to discuss research opportunities with at least 6 faculty, during which time you will narrow your choices for Research Director.
- c) Near the middle of the first semester, you will complete the process of selecting a Research Director. Your 1st, 2nd and 3rd choices for Research Director should be indicated on the Report of Selection of Research Director form and returned to the Graduate Program Coordinator by October 15 (fall entrance) or March 15 (spring entrance). Extensions will be granted at the discretion of the Director of Graduate Studies. Once your choices have been submitted, the Professor(s) selected will discuss this selection process with their division. The Division Chair will then forward their recommendations to the GPC and the GPC will make a final recommendation of Research Director selection to the Department chair.
- d) To complete the process, the student and Research Director will define a dissertation research problem. A one-page statement describing the areas to be explored and the techniques to be utilized must be presented to the GPC by April 1 of the first semester in residence.

NOTE: For students in interdisciplinary programs that require rotations, the Report of Selection of Research Director form should be returned to the Graduate Program Coordinator no later than April 15. You are encouraged to make your choices as early as possible.

Selection of the Research Director is an important step in your career and it deserves careful consideration. Several aspects of this decision should be kept in mind.

- It is important to meet with several potential faculty research directors prior to finalizing your decision.
- You should attend group meetings and interact with students from individual research groups prior to finalizing your decision.
- This decision is a mutual one between you and the chosen professor(s). The Research Director will be responsible for your training through a mentoring relationship.
- It is very important that you and the professor discuss the expectations each has for the dissertation research and that both agree on general policies that affect the "working environment". See section B for further expectations to consider when choosing a Research Director.

2. Selecting a Dissertation Committee

Graduate student Dissertation Committees for both the Comprehensive Examination and Final Oral Defense Examinations will consist of a minimum of four faculty members,

consisting of the student's research advisor, two in the student's major area of study and one in a minor area of study. The latter may be from a department other than CBC. The Proposed Dissertation Committee form must be submitted by first day of classes of the third semester in residence. The form will be approved and signed by the Chair of the GPC. The Dissertation Committee advises you, helps plan the remaining graduate program and evaluates your progress during all phases of training.

Deviation from these guidelines requires written justification submitted to the GPC from both student and mentor. All four committee members must be present for the entirety of the preliminary and final oral examinations. Inclusion of additional committee members is allowed, but the minimum composition specified in the above paragraph must be maintained. Changes to the committee membership at any point must conform to this policy.

3. Changing Research Directors

In unusual circumstances, a student may consider changing Research Directors. This is a decision that has profound implications and should be undertaken only after thoughtful discussion with faculty members in the department who can guide the student and discuss the pros and cons of the situation.

Graduate school is challenging and worthwhile research projects are not easy. Researchers often encounter rough spots or tedious sets of experiments on the way to the Ph.D. Research directors who push students to perform quality research and write quality manuscripts generally have the best interests of the students in mind. Students who have thoughtfully considered whether a change is necessary should meet with a faculty member who can provide guidance. A member of the student's dissertation committee, the GPC chairperson, or one of the division heads would be appropriate. The initial contact person will undoubtedly suggest others who may be able to provide valuable input. The processes of separating from one advisor, and selecting a new advisor should be sequential, not concerted processes.

- a) The Research Director and the GPC should be made aware of the situation at the earliest stage possible. Once it is clear to the student that this change is needed, a short memo should be delivered to the GPC explaining the need for a change in advisor. The GPC will consider the case on its merits, and then, if it is clear that a change is warranted, will act to facilitate the change of Research Directors.
- b) Once the GPC has ruled on the need for the student to select a new advisor the student should pick up a Research Director selection form from the Graduate Program Coordinator. Next, the student should meet with and obtain signatures from at least 3 faculty members and turn in the completed form with the selected advisor listed to the Graduate Program Coordinator. Finally, a letter must be submitted to the GPC explaining the reasons for the selection of the new advisor.
- c) Once the new Research Director has been selected, and a new Dissertation Committee constituted, it is an extremely good idea for the student to meet with this committee, to map out exactly what the new research effort will involve, and the expected time to completion of the degree.

4. Keeping the Dissertation Committee Updated on your Progress Toward the Ph.D. Degree

It is important that your Dissertation Committee remains updated of your progress during

your time in the Department. This committee serves many roles in your journey toward graduation including:

- a secondary source of counsel, in addition to your primary advisor;
- a source of letters of recommendation for your future career;
- an evaluation committee for your Comprehensive Exam, Doctoral Dissertation and Final Oral Defense Exam.

There are three mandated mechanisms for maintaining contact with and drawing support from your Dissertation Committee:

(1) Second Year Dissertation Committee Meeting. Chemistry Graduate Program students must have a short (1 hour) meeting with their Dissertation Committee in the fall semester of their second year. This meeting must be scheduled to take place between **September 15** and **December 15** (or the date of the preliminary oral exam, whichever is sooner). The purpose of this meeting is to discuss your progress to date in the program and your plans for the future. This meeting will consist of:

- a 15-20 minute presentation on research progress and plans
- a discussion of classes taken, the plan of study, and any future classes
- a discussion of proposal ideas for the Comprehensive Exam
- a discussion with the committee in the absence of the primary advisor

Postponement of the Second Year Dissertation Committee Meeting is possible only with prior consent of the GPC.

(2) Annual Research Summaries. Department of Chemistry and Biochemistry rules state that, starting in the 2nd year of the program, all Chemistry Program Ph.D. students should prepare an Annual Research Summary, due at the end of July. One copy of the summary should be given to each committee member and to the Graduate Program Coordinator.

The format of the summary should be as follows: On page 1, list the student's name, the advisor's name and names of the committee members. This is followed by a listing of the student's progress on the formal requirements for the Ph.D. (courses taken with grades earned, cumulative exam record, date the preliminary oral is planned (or date(s) taken and result(s)), presentations given locally or at conferences, manuscripts submitted or published. On the following pages (2-3 suggested), summarize research progress made in the past year, describe future research objectives and discuss problems. The student or committee members may choose to hold a meeting to discuss the student's progress.

(3) Fourth Year Dissertation Committee Meeting. Chemistry Graduate Program students must have a short (1 hour) meeting with their Dissertation Committee in the spring semester of their fourth year. This meeting must be scheduled to take place between **January 15** and **May 15**. The purpose of this meeting is to discuss your progress to date in the program and your plans for the future in anticipation of graduation. Alteration of the timing of the Fourth Year Dissertation Committee Meeting is possible with prior approval of the GPC. This meeting will consist of:

- a 15-20 minute presentation on research progress and plans
- a discussion of a dissertation outline
- a discussion of future plans post-graduation
- a discussion with the committee in the absence of the primary advisor

J. DIAGNOSTIC EXAMINATIONS, COMPREHENSIVE EXAMINATION, AND ADVANCEMENT TO CANDIDACY

1. Diagnostic Examinations

The Department of Chemistry and Biochemistry Diagnostic Examinations are equivalent to the Qualifying (Diagnostic) Examinations required by the Graduate College. All entering students will take Diagnostic Examinations in the five core study areas: Analytical, Biological, Inorganic, Organic and Physical Chemistry. The exams will be ACS standardized examinations to allow comparison to national norms.

The outcome of the Diagnostic Exams will not affect a student's standing in the Ph.D. program. The performance on the Diagnostic Exams is used as one of the criteria (in addition to the student's interest) in advising the student on their plan of study, specifically on what coursework they should take in their first semester.

2. Description of the Comprehensive Examination

Students must pass a Doctoral Comprehensive Examination before they can be advanced to formal candidacy for the Ph.D. degree. This examination is intended to test the student's comprehensive knowledge of the major and minor subjects of study, both in breadth across the general field of study and in depth within the area of specialization. The Comprehensive Examination provides evidence that the candidate can independently analyze and solve complex chemical problems that may or may not be directly related to his or her own dissertation research problem. The Comprehensive Examination is considered a single examination, although it consists of a written portion and an oral portion.

(A) The Written Portion of the Comprehensive Exam

The process of the Written Comprehensive Exam will stimulate the student to take independent responsibility for personal growth in building their comprehensive knowledge of their field, outside and beyond the organized structure of the classroom, so that they can discuss their subject, answer questions, and solve problems at a professional level. The Written Comprehensive Exam consists of the Research Summary and Independent Proposal.

The student will submit a written document that consists of two parts: (a) a Research Summary (5 -10 pages) and (b) an Independent Proposal (10-12 pages). The due date is Reading Day of the third semester in residence.

(a) Guidelines for the Research Summary

A suitable research summary will be written using the Template for Submission of Manuscripts to American Chemical Society Journals (see: http://pubs.acs.org/page/jacsat/submission/jacsat_templates.html) and should include an appropriate literature background section and sections describing the goals and significance of the research, experimental details, and results obtained or anticipated.

(b) Guidelines for the Independent Proposal

The Independent Proposal is a written proposal of an original, but hypothetical, research project in an area that **may or may not be directly related to the student's own research program**. This Independent Proposal may be a revised version of an independent proposal that the student has completed for

one of his/her classes.

Students will prepare and submit the research proposal in NIH format. The proposal must be 10-12 pages in length with appropriate references. **Failure to heed the guidelines on page length will result in your proposal being returned without review.** The proposal should be formatted as follows:

Format:	1" margins in all directions
Font:	11 pt Arial or 12 pt Times New Roman
Spacing:	1 - 1.5*

[*Note: You may be requested to submit a copy that is double-spaced to facilitate handwritten comments.]

Abstract: A brief summary of the problem and the proposed approach to investigate this problem. *The abstract must be less than 250 words.*

Specific Aims: Provide a brief description of the overall problem and research question to be addressed. Then provide clear, concise descriptions of the specific research sub-questions that must be addressed to achieve the overall goals of the project. *This section is limited to 1 page.*

Background and Significance: Clearly define the project and clearly state the significance of this research question. Describe what has been done in the area before and the advantages offered by the proposed approach. Briefly define the key innovations in the proposed approach. *This section is limited to 3 pages.*

Research Design and Methods: Describe the research plan that will be pursued to address the specific aims. Provide key details of experimental design and suggest alternate approaches to achieve the same goals. Details such as buffer compositions or descriptions of common experimental protocols (e.g. HPLC, gel electrophoresis, etc.) are not necessary to include. Where appropriate, provide reference to key works that describe the proposed methodological approach. For particularly innovative and novel aspects of the project, provide sufficient detail to evaluate feasibility. Be sure to describe key figures of merit, evaluative criteria, etc. If the proposed work involves animal or human models, justify why these are used. *This section is limited to 6-8 pages.*

References: Provide key references for all necessary points in the proposal using a suitable reference format. Provide full titles and complete author information for each reference. *There is no page limit for this section.*

Topic. The process of choosing a proposal topic should begin early. Most students find that this process consumes far more time than they had anticipated. Students may begin working on the Proposal at any time. ***A student should discuss the suitability of the proposal topic with the members of the Dissertation Committee before devoting a substantial amount of time to it.*** Thus, scheduling the Second Year Committee meeting earlier in the third semester is highly advantageous.

Suitable proposals may take a variety of forms. For example, an original interpretation or a reinterpretation of existing data; a proposed series of experiments to test a theory or hypothesis; a new theoretical approach to a problem; the design of new instrumentation. This proposal should be treated as if it were a potential dissertation project—students should not propose a study that would take 10 years to complete. The student is advised to develop a well-focused proposal that is not overly broad.

In order to facilitate an oral exam of appropriate scope, depth, and rigor, students are encouraged to propose research that is feasible (i.e., could conceivably be carried out in a research group in CBC, although not restricted to currently available instrumentation). Students who wish to pursue work relatively distant from their field of interest are advised to ensure that faculty members with relevant expertise and experience to evaluate the proposal are available to consult and/or serve as an additional examiner during their preliminary oral exam.

The student is free to consult with anyone, including the advisor, in developing the proposal, but the advisor's role should be non-directive, and the work should represent the student's own creative thinking.

Evaluation. The student must submit the Research Summary and Independent Proposal electronically to the Graduate Program Coordinator who will distribute it to the faculty on the respective Dissertation Committee. The Research Summary will not be formally evaluated. By the beginning of the fourth semester in residence, the members of the Dissertation Committee will provide an evaluation of the Independent Proposal based on the follow criteria:

- Technical quality
- Significance of Proposed Research
- Feasibility of Approach

A score of 3 (passing), 2 (revisions required), 1 (major revisions required), or 0 (not passing) will be assigned by each committee member of the Dissertation Committee with the exception of the Research Director, (total of three). In the event that a student has two Research Directors on their Dissertation Committee, and the committee only has four members total, a member of the GPC that is not a member of the student's Dissertation Committee will serve as a third voting member for the purpose of Independent Proposal evaluation. The scores will be summed.

A score of 8-9 will be considered passing. The student may schedule their preliminary oral for within six semester weeks pending availability and recommendation of the faculty committee, but no later than the end of the fifth semester in residence.

A score of 3-7 will be considered a provisional pass. The student will have up to four weeks to provide a revised version of their proposal for re-evaluation. If a passing evaluation (score of 8-9) is not obtained after the first revision, the student is transferred to a terminal M.S. program at the discretion of the advisor.

A score of 0-2 will be considered failing. A student who fails the first round of evaluation will be required to write an entirely new proposal (i.e. new topic).

Failure to meet the due date for submission of the Independent Proposal and Research Summary will jeopardize your good standing in the Department. Consequences include, but are not limited to, reduced priority for assistantship funding, ineligibility for Departmental awards and fellowships, and the possibility of dismissal from the Ph.D. program.

(B) The Oral Portion of the Comprehensive Examination

The oral portion of the Comprehensive Examination shall be scheduled for a date as soon as possible (ideally within six weeks) after a passing evaluation of the Independent Proposal. **All students must take their oral examination no later than the end of the fifth semester.** Students cannot schedule an Oral Comprehensive Examination while on academic probation as defined by the Department of Chemistry and Biochemistry or by the Graduate College.

The Oral Comprehensive Examination is administered by the student's Dissertation Committee.

The Oral Comprehensive Examination begins with a presentation and defense of the **Independent Proposal**. An explanation and defense of the Independent Proposal will be a significant part of the Oral Comprehensive Examination. It is expected that the student will be able to explain and justify the proposal and demonstrate a reasonable knowledge of the literature and special techniques of the field. In addition, a portion of the examination will consist of general questioning in the student's major and minor course areas which test the student's comprehensive knowledge both in breadth across the general field of study and in depth within the area of specialization.

The examination will not focus on the student's research progress but may use the student's **Research Summary** as a springboard for questions that examine the student's ability to understand the scientific process, to formulate a logical research plan, and to think creatively.

At the end of 1-1.5 hours of examination the Dissertation Committee typically takes a break to discuss the student's performance. For the second half of the exam the committee can continue to question the student on their research proposal, or (as is typically done) focus on the student's general understanding of the chemical sciences, most often drawing upon their coursework background for questions to be addressed.

The Oral Comprehensive Examination will last a minimum of one hour but not more than three hours. If a student does not pass the exam on their first try, their Dissertation Committee may recommend a second trial, and can dictate the scope and focus of questioning to be conducted in that second exam.

3. Preparing for the Oral Comprehensive Examination

The Oral Comprehensive Examination is scheduled by submitting the **Application for Comprehensive Oral Examination** form to the Graduate College via GradPath. **A student will not be allowed to officially schedule the oral examination until the written portion (Independent Proposal) of the examination has been passed,**

although a tentative date can be arranged at any time with the Dissertation Committee. The student is responsible for scheduling the room for the oral examination.

The best way to study for this examination is to: (1) know the proposal thoroughly, including all related topics, (2) review class notes and lecture material from all the classes taken as a graduate student up to that point, (3) review the general principles of major and minor areas of interest; sometimes perusal of a textbook can help guide this studying, and (4) be familiar with the recent literature (particularly in the fields represented by the committee members). **It is important to plan one's studying to avoid "burn out" before the examination. Know what material you want to cover and then systematically go through it.** It is an excellent idea to have several "practice oral examinations" with other graduate students and postdocs before the scheduled examination. This can be very helpful for identifying weaknesses and providing practice for thinking on one's feet.

4. Re-taking the Oral Comprehensive Examination

In the event that a student fails the Oral Exam, s/he may be granted a second attempt by their Dissertation Committee. No student will be permitted a second attempt to pass the Oral Comprehensive Examination unless it is recommended by the Dissertation Committee, endorsed by the major department and approved by the Dean of the Graduate College. The second attempt may require a re-draft and defense of the original proposal, or may consist only of general questions. A new Research Summary will also be required. The student should contact each committee member individually to find out what areas need to be improved and what expectations each may have for the second attempt. If a student passes the second attempt at the oral exam, s/he proceeds to the Ph.D. program. If the student fails the second attempt also, s/he is not granted advancement to the Ph.D. program and enters the terminal Master's Degree program.

K. DISSERTATION AND FINAL DEFENSE

1. General Description of the Dissertation and Final Oral Defense Exam

Your dissertation is the culmination of your degree program, and is the document required by the Graduate College for the awarding of your degree. The Graduate College expects you to present your work in the best form for your discipline and your intended audience, following the guidance of your committee. The recommended style of the Department follows a traditional style with an introduction, materials and methods, results and discussion sections (see Section K.5 below).

A formal defense of the dissertation research constitutes the Final Oral Defense Examination. This consists of a public seminar by the candidate followed by an oral examination by the candidate's dissertation committee and other interested faculty. Be sure to bring all the necessary paperwork that requires signatures from members of the Dissertation Committee to the examination.

2. Requirements for Ph.D.

There are a number of requirements that need to be met to satisfy both the Department of Chemistry and Biochemistry and the Graduate College. Ultimately, you will earn your degree by meeting all the requirements of the Graduate College which by design, incorporates Departmental requirements. **It is very important to familiarize yourself with the most current Graduate College guidelines, specifically with regard to preparation of the Dissertation.** You should also download the formatting guide for dissertations, which is available at <http://grad.arizona.edu/degrecert/formattingguide>.

3. List of Specific Steps Necessary for Graduation

The following list shows the major steps that need to be taken once your Research Director and Dissertation Committee agree that your dissertation research is defensible:

<u>WHEN</u>	<u>WHAT</u>
penultimate semester	File Committee Formation form with the Graduate College.
4 th year of residence	Submit a detailed Dissertation Outline to your Dissertation Committee and schedule a meeting with your committee.
5 weeks prior to oral defense	Submit a penultimate draft of the dissertation to the Dissertation Committee

No later than 2 week prior to oral defense Submit Announcement of Oral Defense Examination form to the Graduate College.

Final semester Upon successful completion of the Final Oral Defense Examination, the candidate submits the dissertation **electronically** to the Graduate College for forwarding to the Library of The University of Arizona and to University Microfilms, Inc. A **processing and microfilming fee** also must be paid to the University Bursar. Upon receipt of the finalized dissertation, the Dean of the Graduate College will recommend conferral of the doctoral degree by the Arizona Board of Regents.

Provide a bound copy of the dissertation to the Research Director, at their discretion. (Microfilming of the M.S. thesis is also at the discretion of the Research Director.)

Before the last week of final semester all fees must be cleared with the Bursar's Office.

4. Guidelines for Preparation of the Dissertation

In the fourth year of residence the candidate should submit a 5-10 page detailed **Dissertation Outline** to the Dissertation Committee outlining the research progress to date. This document should clearly list those studies that the student intends to complete prior to writing the dissertation. The candidate then meets with the Dissertation Committee to discuss the outline during the spring semester of the fourth year in residence. It is common for the Committee to recommend a limited number of experiments and to make specific recommendations regarding a timeline for writing of the dissertation.

The candidate submits a completed, penultimate draft to each member of the Dissertation Committee at least **five weeks** prior to the final examination. It is anticipated that the Dissertation Committee will be able to read the dissertation and return it to the candidate within two weeks of receipt. This timing allows the candidate to make any suggested changes, provided they are minor, and to obtain final approval of the penultimate draft three weeks prior to the final examination. Then, no later than two weeks before the proposed date of the examination, the student must submit the form **Announcement of Oral Defense Examination** to the Graduate College.

5. Description of the Format Recommended by the Department

The Graduate College policy states that in addition to required elements of specifically formatted front matter (see Dissertation Formatting Guide at <http://grad.arizona.edu/degrecert/formattingguide>), each Department can establish their own guidelines for the Dissertation format. The Department of Chemistry and Biochemistry has the following list of guidelines for preparation of a traditional dissertation:

A. The suggested Dissertation format should include the following components, either

as a single document, or subdivided into chapters that each have these components:

- **ABSTRACT** - describing the problem, the results and the interpretation
 - **INTRODUCTION** - general introduction to the field
 - **MATERIAL AND METHODS** - a complete description all in one section
 - **RESULTS** - should be logically divided into separate chapters with an introductory paragraph at the beginning of each chapter and a summary paragraph at the end
 - **DISCUSSION** - a thorough analysis of the data and its implications, this section should tie the Dissertation together into a cohesive theme/thesis
 - **SUMMARY** - a short synopsis, including future directions that should be taken
 - **LITERATURE CITED** - should follow the format of the Journal of the American Chemical Society
- B. Figures and tables should be included in the chapters rather than as an appendix. Permission to use copyrighted material is the responsibility of the student.
- C. If appropriate, the dissertation may include portions of manuscripts being prepared for submission, but the text should reflect the student's own writing. The Dissertation Committee has the responsibility of checking the Dissertation for adherence to Graduate College specifications and for approving the overall appearance and format.

6. Committee Composition and Attendance at Final Defense.

The Department of Chemistry and Biochemistry requires students to compose a committee of four members: three within the major and one in the minor.

The student should make all attempts to have the four members attend the final defense. If, however, a scheduling conflict exists, there must be at least a minimum of three members in attendance, two of which must be in the major. If a committee member is unable to attend the defense because of unforeseen circumstances a substitution is allowed, provided that the originally scheduled committee member has read and approved the dissertation.

7. Policy on Inclusion of Published Papers as Appendices to Dissertations and Theses.

Note: The following rules have no impact on the body of the dissertation or thesis. The dissertation or thesis must stand on its own even without the appendices described here.

1. Subject to the approval of the Dissertation Committee, material published, or accepted for publication, in a refereed journal may be included as an appendix in the dissertation/thesis.
2. The dissertation/thesis author need not be the primary author of the publication(s).
3. The dissertation/thesis author need not be the principal contributor to the publication(s) as long as the Dissertation Committee agrees that the author's contribution is sufficient to warrant inclusion in the dissertation/thesis.
4. Since the appendices contain supplementary material, there is no conflict of interest when the Research Director is coauthor of the publication(s).
5. The Research Director's signature on the dissertation/thesis approval form will certify that the Dissertation Committee has approved the published material in the appendix.

L. REQUIREMENTS FOR A MASTER'S DEGREE

1. Master of Science and Master of Science with Emphasis in Chemical Education

This information is a supplement to the general regulations for graduate study as set forth in the catalog of the Graduate College. In addition to the classical M.S. degree in Chemistry, the Department of Chemistry and Biochemistry also offers an M.S. degree program with emphasis in Chemical Education. This program is designed as a component of an M.S./Ph.D. program that affords students additional training in Chemical Education. Terminal M.S. students may also elect to follow this program.

By Department of Chemistry & Biochemistry rules, all requirements for the degree of Master of Science must be completed within **3 YEARS** of joining the program, whether the student is supported financially, or not. Should a student not finish within that time period, he/she may appeal to the GPC for a one year extension. The student must provide a research update including a time line of completion that has been approved by his/her committee. This in no way implies that the Department of Chemistry & Biochemistry is bound to financially support the student for more than three years from the start of their program.

- a) **Diagnostic Examinations:** All entering students for a M.S. degree in Chemistry will take Diagnostic Examinations in the five core study areas: Analytical, Biological, Inorganic, Organic or Physical Chemistry. The Diagnostic Exams will be ACS standardized examinations to allow comparison to national norms.
- b) **Advisement:** The GPC is the academic advisor to all new students. The student and the Committee plan a program of course work based on the results of the Diagnostic Examinations and the student's interests. The GPC continues to serve as the student's advisor until the student selects a Research Director.
- c) **Selecting a Research Director – 1st semester in residence**
 - a) Prior to selection of a Research Director, you will become familiar with the research interests of the faculty through attendance at Department of Chemistry and Biochemistry Research Symposium, held the week before classes begin in the fall semester. Part of this Research Symposium will consist of poster presentations from graduate students and faculty in the department where you will have an opportunity to talk informally with presenters from multiple research groups about their research interests.
 - b) Following this poster session you must make individual appointments to discuss research opportunities with at least 6 faculty, during which time you will narrow your choices for Research Director.
 - c) Near the middle of the first semester, you will complete the process of selecting a Research Director. Your 1st, 2nd and 3rd choices for Research Director should be indicated on the Report of Selection of Research Director form and returned to the Graduate Program Coordinator by October 15 (fall entrance) or March 15 (spring entrance). Once your choices have been submitted, the Professor(s) selected will discuss this selection process with their division. The Division Chair will then forward their recommendations to the GPC and the GPC will make a final recommendation of Research Director selection to the Department chair.
- d) **Thesis Committee:** A Thesis Committee consists of three members, no more than two of whom can be from the student's major division. The Research Director will

serve as chair of this Committee. The student and Research Director will, shortly after the latter is selected, define a thesis research problem. A one-page statement describing the areas to be explored and the techniques to be utilized must be presented to the GPC by **April 1** of the second semester. The proposed thesis committee members and their signatures should be presented to GPC by the first day of fall classes of the third semester in residence. The GPC reviews the proposed Thesis Committee in the context of the proposed research and makes suggestions where appropriate.

- e) Plan of Study:** The student will consult with the Thesis Committee shortly after it is formed to prepare a Plan of Study which should be submitted to the GPC. A total of 30 units of credit is required and at least 15 units must be in courses for which a letter grade (A,B,C) is awarded. Attendance at seminar (Chem 696) is also required of all students, but no more than 4 units of Chem 696 can be applied toward the 30 unit requirement. A maximum of 8 units of Thesis (Chem 910), 4 units of Exchange of Chemical Information (Chem 695b) and 2 units of College Teaching (Chem 595c) can be counted in the 30 unit total.

In addition a minimum of two graduate courses in education, approved by the Thesis Committee, is required for students (M.S./Ph.D. or M.S. in chemistry) who elect an emphasis in Chemical Education.

- f) Thesis:** Original research and reporting the results of the research in a Thesis are the most important parts of the M.S. degree. Additional information about preparing theses may be obtained from the Graduate Program Coordinator or the Graduate College or at <http://grad.admin.arizona.edu/degrecert/formattingguide>.

Approximately one semester before the student expects to complete the thesis research, the student meets with the Thesis Committee. At this meeting the student summarizes the completed research and outlines the goals and proposed approaches for the remainder to the project. The Committee reviews this information and advises the student on the completion of the thesis research.

Thesis research and the thesis for the M.S. with emphasis in Chemical Education degree must represent original work in Chemical Education and must conform to the same high standards as for the traditional M.S. degree in Chemistry. The Chemical Education research must be separated and apart from any work the student is assigned as a Departmental Teaching Assistant.

- g) Final Oral Examination:** After a candidate's thesis has been reviewed and accepted by the Thesis Committee, a final public oral examination covering the research and field of major interest will be administered.
- h) Graduate Student Support:** Graduate students in the M.S. program who remain in good standing and are making adequate progress in their degree program may be eligible for support as Graduate Teaching Assistants (TA) and/or as Graduate Research Assistants (RA). TA support is generally not available beyond a student's third year. Extensions of this time limit must be through a letter of appeal to the GPC. In addition to the requirement of being in good standing, the TA's teaching performance is evaluated each year. RA positions are provided at the discretion of the Research Director and are renewed subject to demonstrated productivity as

measured by the Research Director.

2. Master of Arts

The Master of Arts Degree is a non-thesis degree that is awarded for advanced study in chemistry beyond the bachelor's degree. This degree is typically awarded after two years of graduate study if the following have been satisfied.

- a) **Diagnostic Examinations:** All entering students for a M.A. degree in Chemistry will take Diagnostic Examinations in the five core study areas: Analytical, Biological, Inorganic, Organic or Physical Chemistry. The Diagnostic Exams will be ACS standardized examinations to allow comparison to national norms.
- b) **Advisement:** The GPC is the academic advisor to all new students. The student and the Committee plan a program of course work based on the results of the Diagnostic Examinations and the student's interests. The GPC continues to serve as the student's advisor until the student selects a Faculty Mentor
- c) **Faculty Mentor:** The student's choice of mentor should be indicated on the Report of Faculty Mentor form and returned to the Graduate Program Coordinator by the October 15 (fall entrance) or March 15 (spring entrance). Once the choice has been submitted, approval by the Professor, the GPC and Department Head are needed.
- d) **Plan of Study:** The student will consult with the faculty mentor to prepare a Plan of Study, which should be submitted to the GPC for approval. A total of 30 units of credit is required and at least 15 units must be in courses for which a letter grade (A,B,C) is awarded. Attendance at seminar (Chem 696) is required, but not more than 4 units of Chem 696 can be applied to the 30-unit requirement. Up to 4 units of Chem 695b (Exchange of Chemical Information) and 2 units of Chem 595c (College Teaching) can be counted in the 30 unit total.

An overall 3.0 (B) GPA must be maintained for all courses in Chemistry, cross listed in Chemistry, or those approved by the GPC.

Graduate students admitted to Ph.D. candidacy are encouraged to apply for an M.A. degree. Students should be aware that they cannot use the same course work to obtain both an M.A. and an M.S. degree.

M. PART-TIME GRADUATE PROGRAMS

1. Policy on Part-Time M.A./M.S. Graduate Students

The Part-Time M.A./M.S. program is designed for students who are working full-time in “permanent” jobs in or near Tucson and wish to pursue the M.A. or M.S. degree part-time. Employment constraints may make it impossible for these students to take more than one course per semester and it is not expected that they would be able to take more than two courses per semester.

- a) **Diagnostic Examinations:** All entering students for a M.A. degree in Chemistry will take Diagnostic Examinations in the five core study areas: Analytical, Biological, Inorganic, Organic or Physical Chemistry. The Diagnostic Exams will be ACS standardized examinations to allow comparison to national norms.
- b) **Advisement:** The GPC is the academic advisor to all new students. The student and the Committee plan a program of course work based on the results of the Diagnostic Examinations and the student's interests. The GPC continues to serve as the student's advisor until the student selects a Faculty Mentor (M.A.) or Research Director (M.S.).
- c) **Research Director and/or Faculty Mentor Selection:** Selection and approval of Faculty Mentors/Research Directors is discussed in Section L of this Handbook.
- d) **Plan of Study:** Plan of Study requirements will follow that discussed in Section L of this Handbook. A total of 30 units of credit are required for the M.A. and M.S. degrees, of which at least 15 units must be in graded courses A, B, C, etc. Part-Time M.A./M.S. students are expected to enroll in Chemistry 696 (seminar) and/or Chemistry 695b (Exchange of Chemical Information) each semester and may include up to 6 units of each in the required 30 units.
- e) **Time Limits:** The M.A. degree must be completed within three years from the first date of enrollment.

M.S. students must complete the course work requirements within three years.

2. Policy on Part-Time Ph.D. Program

The Part-Time Ph.D. Program in Chemistry is designed for students who are working full time in “permanent” jobs in or near Tucson and wish to pursue the Ph.D. degree part-time. Employment constraints may make it impossible for these students to take more than one course per semester and it is not expected that they would be able to take more than two courses per semester.

[Students must apply specifically to the Part-Time Ph.D. Program. Students who have been admitted to, and have begun, the regular, full-time, Ph.D. Program may not transfer into the Part-Time Ph.D. Program. Students in the Part-Time Ph.D. Program are not eligible for TA support. Students must take at least one major or minor course each semester until coursework is complete].

- a) **Diagnostic Examinations:** Students must take Diagnostic Examinations on

entrance into the Part-Time Ph.D. Program. (Students are encouraged to make up as many known or expected deficiencies as possible before application. This can be accomplished by registering as non-degree seeking students).

- b) **Coursework:** The minimum level of coursework can be completed in four and one-half years [two and one-half years at the rate of two courses per semester].
- c) **Seminars:** Students will be expected to participate (attend and give) the seminars in their area(s). They will take the same number of units of seminar (10 units) as full-time students.
- d) **Research Director Selection:** Students will select a Research Director by following the guidelines in Section J.
- e) **Committees:** The student and the Research Director will recommend a Dissertation Committee by **first day of classes** of the third semester in residence.
- f) **Plan of Study:** Students must file a Plan of Study before the end of their first year.
- g) **Written Comprehensive Examination:** The Independent Proposal and Research Summary will be prepared according to the guidelines for full-time students. Standards will be the same as for full-time students.
- h) **Oral Comprehensive Examination:** The oral comprehensive exam shall be scheduled for a date as soon as possible (ideally within twelve weeks) after a passing evaluation for the Independent Proposal. The standards will be the same as for full-time students.
- i) **Research:** Research may begin very early in the program. Standards for acceptable dissertation research (quantity and quality) will be the same as for full-time students.

Control and direction of the research must reside with the Research Director. Issues, such as publication, patents, etc., must be agreed upon, in writing, beforehand by the Research Director, the University, and the student's employer.
- j) **Group Meetings:** Students will be expected to take the same number of 695b units as full-time students. Attendance at group meetings will be agreed upon by the student and the Research Director.
- k) **Dissertation:** Same standards as full-time students.
- l) **10 Year Limitation:** Students applying for the Part-Time Ph.D. Program need to be aware that course credit expires after ten years. It is possible to petition for an extension, but approval of the extension is not guaranteed.
- m) **Final oral:** Same standards as full-time students.

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