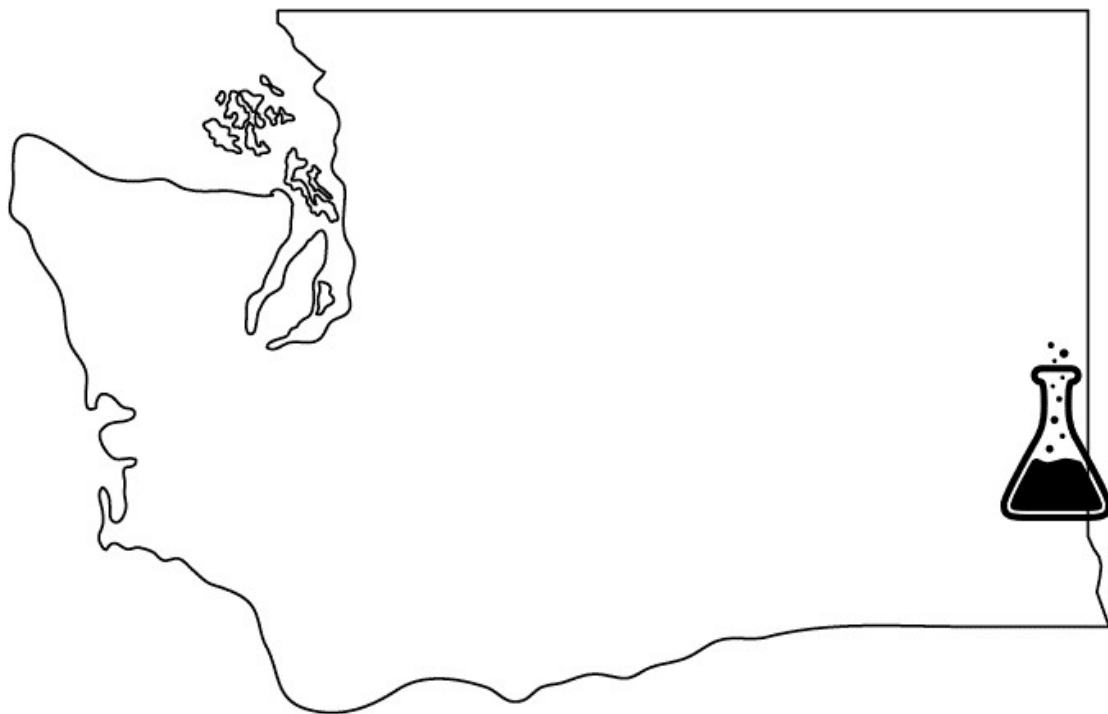


Graduate Studies in Chemistry

Washington State University



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A. GRADUATE STUDENT LEARNING OUTCOMES:

- Achieve expertise in fundamental areas of analytical, organic, inorganic, and physical chemistry
- Apply theory and methodologies within these areas to conduct independent research that addresses scientific and technological problems of broad chemical interest
- Effectively communicate the results of their research in peer reviewed journal articles and in oral presentations to chemistry faculty and students in the department and at local, regional and national conferences
- Become effective members of the scientific community by participating and taking leadership roles in teaching, professional organizations, and service on local, regional and national levels
- Become independent, motivated researchers in a specific area of study with the ability to recognize and address important scientific problems and to make original contributions to the solution of these problems
- Present an original proposal summarizing the existing literature in their area of study, posing an extant question or hypothesis, and presenting their plans for investigating and advancing the state of knowledge in this area
- Conduct independent research using sound methods of data collection and analysis. Maintain high standard on Responsible Conduct of Research (e.g., the practice of scientific investigation with integrity)
- Be prepared to successfully compete for academic, industrial, and government lab positions on graduation
- Perform undergraduate teaching, grading, and mentoring activities

B. GENERAL DEPARTMENTAL REQUIREMENTS

1. General Course Requirements

The Chemistry Department requires all Ph.D. students to complete 28 semester hours of graded (A-F) coursework earning a C or better beyond the bachelor's degree. Up to nine semester hours of this requirement may be selected from non-graduate (300 or 400 level) courses not previously taken by the student and approved by his/her thesis committee. Graded seminar courses numbered 500 or above also meet the requirement (and can be used up to 6 times). A minimum overall GPA of 3.0 out of 4.0 must be maintained for satisfactory progress towards the degree.

The Chemistry Department also requires that all students enroll for one credit of CHEM 590 – Introduction to Research Topics in their first semester. Graduate students who are Teaching Assistants are also required to complete 1 credit of CHEM 555 – Teaching Workshop.

Full-time graduate students in the Chemistry Department are required to enroll in a minimum of 10 credit hours each semester (except summer session) if on an assistantship. CHEM 800 is variable credit, minimum of 2 credits each semester, excluding summer. The credit amount varies depending on course load.

An <u>example</u> of a 1st Fall course load: CHEM 531 (3 credits, elective) CHEM 514 (2 credits, AER elective) CHEM 518 (2 credits, AER elective) CHEM 590 (1 credit) CHEM 555 (1 credit) <u>CHEM 800 (2 credits)</u> Total: 11 credits	An <u>example</u> of a spring course load: CHEM 501 (3 credits) CHEM 510 (2 credits, AER elective) <u>CHEM 800 (5 credits)</u> Total: 10 credits
Please note: These are simply examples and are not a recommended plan as course offerings vary. Students should aim to complete all of their coursework by the end of Fall semester of their 3rd year.	

It is recommended to find a research group as soon as possible; however, students who start in fall semester must be affiliated with a research group by March 1st of their 1st year, while

students who start in spring semester must be affiliated with a research group by April 1st of their first year. This ensures enough time for the department to arrange for summer funding. All first-year students should receive course advising from their research supervisor for their third and later semesters.

2. Seminars

During the academic year, Departmental Seminars are typically held each Monday in Fulmer 201 at 4:10 pm. These are typically presented by invited faculty and scientists external to WSU and involve research topics spanning all disciplines of Chemistry. Unless a student has a conflict due to their teaching assignment or illness, attendance is mandatory for all graduate students.

Each division also has their own individual seminar program that consists of predominately student presentations. These are outlined in the individual program descriptions given below.

3. Selection of Ph.D. Committees

Ph.D. students are required by the Graduate School to select a Ph.D. Committee by the middle of their third semester and to submit the names and signatures of the committee members, along with a course program, to the Graduate School. The department strongly recommends that the degree program of study be completed by the end of the 3rd semester. The current policy in the Chemistry Department is that the Ph.D. committee should consist of at least **four** members: the research advisor, two faculty from any division in the Chemistry Department, and a fourth person from either a division in the Chemistry Department other than the student's division or from an outside department who is knowledgeable in the student's area of research. The majority of committee members must be active Chemistry Graduate Faculty members and at least one must be a permanent member of the Chemistry Graduate Faculty.

4. Annual Progress Reports

The Graduate School requires the department to annually evaluate the progress of graduate students toward completion of their degree requirements. The evaluation is conducted shortly after the end of the Spring semester each year by the Associate Chair of the department in consultation with a student's research advisor, teaching supervisor, and the graduate faculty. Students should submit a written statement of their progress, as well as a current Curriculum Vita, to their research advisor by the end of the Spring semester each year. Once a committee is selected, the student is also required to meet with them at the end of each Spring semester to discuss his/her progress toward completion of the Ph.D. course and research requirements. Students are expected to perform well in coursework, teaching, and research to remain in good standing in the department and Graduate School. A grade point average of 3.0 or above is formally required to maintain good academic standing. A student's teaching evaluations and research progress will also be considered in the annual evaluation. In addition, the department will hold an administrative review of graduate students at the end of the Fall semester. If a problem is identified, the student will be notified and given an opportunity to improve before the formal spring review. **Poor performance in any one of the three areas (coursework, teaching, and research) may lead to loss of financial support.** Students will be provided with a written evaluation of their progress each year by the department.

5. Preliminary Exams (Proposal Defense)

Advancement to candidacy for the Ph.D. degree is achieved by passing a formal oral Preliminary Exam (Proposal Defense). To qualify to take the Preliminary Exam, each division or degree track has a written and/or oral exam that occurs sometime during a student's second year of graduate study, generally at the end of Spring semester. Explicit details are given below in the divisional requirements section of this handbook. Students are required to schedule and attempt their Preliminary Exam no more than one academic semester after successfully passing their divisional qualifying exams. The formal Preliminary Exam will typically take place in the Fall semester of a student's third year. While each divisional requirement differs (see below), generally it involves a formal written research proposal with an oral defense. The Evaluation Rubric may be found at the end of this handbook. The oral Preliminary exam must take place

prior to final exam week. A scheduling form must be submitted to the Graduate School at least 10 working days (two weeks) before the exam date. Students who do not schedule and attempt the Preliminary exam during the academic semester following the successful passing of the divisional qualifying exams will receive a grade of U (unsatisfactory) for the research credits of that semester and the student must schedule a meeting of his/her dissertation committee at the conclusion of the semester in order to obtain guidance for the successful completion of this requirement in the following semester. Not scheduling and attempting the Preliminary exam in the subsequent semester will generally result in a second grade of U for the research credits of that semester. A student should note that two grades of U will automatically dismiss the student from the graduate program, per the Graduate School Academic Deficiency Policy. To continue enrollment in the graduate program, extenuating circumstances must be detailed in writing by the student and presented to his/her advisor and committee.

C. SPECIFIC DIVISIONAL AND DEGREE-TRACK REQUIREMENTS

Specific course requirements for each division or cross-divisional track can be found in this handbook, as well as on the web:

[Analytical, Environmental and Radiochemistry](#)

[Inorganic](#)

[Materials Chemistry](#)

[Organic and Chemistry of Biological Systems](#)

[Physical Chemistry](#)

Course Requirement Matrix for the Ph.D. in Chemistry (28 minimum graded credits)

	AER	Physical	Organic/CBS	Inorganic	Materials
Intro to Research	CHEM 590 (1 cr)	CHEM 590 (1 cr)	CHEM 590 (1 cr)	CHEM 590 (1 cr)	CHEM 590 (1 cr)
Teaching Assist.	CHEM 555 (1 cr)	CHEM 555 (1 cr)	CHEM 555 (1 cr)	CHEM 555 (1 cr)	CHEM 555(1 cr)
Required courses for each division		CHEM 509 (3 cr) CHEM 531 (3 cr) CHEM 532 (3 cr) CHEM 534 (3 cr) CHEM 564 (3 cr)	CHEM 542 (3 cr.)	CHEM 501 (3 cr) 6 cr. hours of CHEM 503 (3 cr)	CHEM 531 (3 cr) CHEM 480 (3 cr) MATSE 571 (3 cr) MSE 505 (3 cr) Graduate level inorganic, organic, or polymers (3 cr)
Division Electives	<u>10 cr. hours from:</u> CHEM 425 (2 cr) CHEM 426 (2 cr) CHEM 510 (2 cr) CHEM 514 (2 cr) CHEM 517 (2 cr) CHEM 520 (3 cr) CHEM 521 (2 cr) CHEM 522 (1 cr) CHEM 527 (2 cr) CHEM 529 (1-3 cr) CHEM 535 (3 cr) CHEM 550 (1-3 cr)		<u>9 cr. hours from:</u> CHEM 543 (3 cr) CHEM 544 (3 cr) CHEM 545(3 cr) CHEM 546 (3 cr) CHEM 572 (3 cr)		

	AER	Physical	Organic/CBS	Inorganic	Materials
Electives approved by Committee	14 cr. hours of electives approved by committee	7 cr. hours of electives approved by committee	10 cr. hours of electives approved by committee	17 cr. hours of electives approved by committee	6 cr. hours of electives approved by committee
Seminar Credits	3 cr. hours of CHEM 592 (1 cr each)	4crs. up to 6 cr. hrs. of CHEM 593 (1 cr each) 1 cr in 4 th year	3crs. up to 6 cr. hrs. of CHEM 594 (1 cr each)	3 cr. hours of CHEM 591 (1 cr each)	5 cr. hrs. of seminar (any division); 1 cr in year 4

I. Analytical, Environmental and Radiochemistry Division (AER)

1. General Information

The degree of Doctor of Philosophy in Analytical Chemistry is awarded in recognition of distinguished scholarship and original contributions to knowledge. Although formal courses are required, the award is made primarily for creative scholarship rather than for the accumulation of credits in courses or for the completion of the requirements listed in this document. Thus, it is of paramount importance that you begin research in the laboratory at the earliest possible time.

2. Research Program

Normally you should spend the first semester talking with research faculty and graduate students about the research being conducted within the Chemistry Department. You should have selected a research advisor to guide you throughout the Ph.D. program by the end of this First semester. If you have decided on a specialization in the Analytical, Environmental, or Radiochemistry area, you should have discussed your interests with each member of the AER faculty before formally selecting the advisor. During the second semester, you should begin work in your advisor's laboratory.

3. Ph.D. Advisory Committee

With the aid of the research advisor, a Ph.D. Advisory Committee should be selected during the second semester of graduate study. This Committee must consist of at least four graduate faculty members, two of whom must be members of the AER faculty.

4. Formal Course Program and Other Requirements

With the aid of the Ph.D. Advisory Committee, a formal course program must be selected and filed with the Graduate School by the end of the first summer. This formal program must include 28 semester hours of 400 and 500 level graded courses beyond the bachelor's degree. These courses must be listed in the Graduate Study Bulletin or be approved for graduate credit since publication of the last Bulletin. 300 level courses in departments other than Chemistry may be counted if they are approved by your Ph.D. Advisory Committee. Specific requirements for the formal course program are listed below:

1. Three hours of Chemistry 592 “Analytical Seminar”. Every AER student must give a minimum of three seminars during the Ph.D. program: a literature seminar, a proposal seminar, and a final research seminar. These seminars may be taken for credit and must be listed on the formal course program. Participation in informal seminars, group discussions, etc. are a normal part of every student’s program. AER students are expected to attend all Chem 592 activities whether enrolled in the course or not.
2. Ten hours (of coursework) selected from the following analytical courses (Note: Analytical courses are revised periodically, but the 10-hour requirement will remain in effect):

Chem 425	(2 cr)	Instrumental Analysis
Chem 426	(2 cr)	Instrumental Analysis Laboratory
Chem 512	(2 cr)	Bioanalysis
Chem 514	(2 cr)	Mass Spectrometry
Chem 517	(2 cr)	Chromatography
Chem 521/522	(3 cr)	Radiochemistry and Radiotracers – Lecture and lab
Chem 527	(3 cr)	Environmental/Aquatic Chemistry
Chem 529	(2 cr)	Selected Topics in Analytical Chemistry
Chem 535	(3 cr)	Applied Spectroscopy
Chem 550	(3 cr)	Nuclear Fuel Cycle

Each student will present an oral research report to the analytical faculty and students during the 3rd semester.

5. The Ph.D. Preliminary Examination

All AER graduate students must complete the Ph.D. qualifying and preliminary exam for advancement to candidacy, normally by the end of the fifth semester of graduate study but no later than the end of the third year.

The Preliminary Examination consists of two basic components:

1. A written qualifying examination during the fourth semester administered during Spring break.
2. Submission of a research proposal and an oral examination during the fifth semester.

A. Written Examination.

Written Examinations will be taken in the fourth semester (normal progress). These examinations will cover the basic fields of analytical chemistry and related disciplines and the level of competency will be set at the advanced graduate level.

B. Research Proposal.

During the fifth semester of study, you must submit a research proposal. This proposal will normally be related to the thesis project and must be approved by the Doctoral Committee. The proposal must contain some original work performed by you at WSU. The proposal must also contain an authoritative review of the topic, extensive bibliography, and experimental details of proposed research. Contact your PI for proposal outline and guidance.

The research proposal will be formally submitted to the AER faculty at the beginning of the 5th semester and a 45-minute seminar will be presented to the faculty and students. The Doctoral Committee must approve the research proposal before you can continue to the oral examination. Evaluation Rubric for the Preliminary Exam that research committees use to evaluate a student is at the end of this handbook.

C. Oral Examination.

The Oral Examination will be scheduled to take place after submission of the research proposal. The Oral Examination will be basically a defense of the research proposal, but questions may be asked on the written examination or in any area the Committee feels is appropriate. If the Oral Examination is passed, the Ph.D. Preliminary Examination is complete, and you advance to Ph.D. candidate status.

D. Unsatisfactory Performance.

If the Preliminary Examination is failed, the Committee may advise the termination with a M.S. degree or may recommend that the Examination be retaken. If the Oral Examination is failed, only the Oral Examination needs to be rescheduled.

6. Ph.D. Thesis

Each student will write a Ph.D. thesis in a form determined by the Advisory and the student's Committee. An AER divisional seminar must be given prior to the final thesis defense Oral Examination.

II. Inorganic Chemistry

The requirements for a Ph.D. in Inorganic Chemistry include the preliminary exam, a minimum of three formal seminars (literature review/early research presentation, proposal defense, dissertation defense), and completion of all relevant course requirements.

Given below is a general outline of the requirements. There is significant flexibility in the system to accommodate the wide range of interests included in the Division of Inorganic Chemistry. Each student will prepare an individualized program appropriate to his or her interests and inorganic subject matter preparation before coming to WSU.

Course requirements include Chem 410, Chem 501, and Chem 503 (twice) as these special topics' courses are offered. Possible special topics courses could include kinetics & mechanisms, organometallics, x-ray crystallography, solution chemistry, and lanthanide & actinide chemistry. Other courses would depend on the individual's research interests and individualized degree program.

The qualifying exam in Inorganic Chemistry consists of a one-day written exam and a subsequent oral prelim exam contingent upon successfully passing the written qualifying exam. The written qualifying exam must be passed within the first two attempts, which can be made on an annual basis adhering to the standard schedule. The written qualifying exam should be taken by the end of the fourth academic-year semester (Spring semester of year two), the oral prelim exam in the fifth semester, after the second summer in residence. The qualifying exam system is made flexible to accommodate the individualized degree programs of our students, but the written qualifying exam is only offered once annually within one month after conclusion of the Spring academic semester. The written qualifying exam covers basic core knowledge of

inorganic chemistry, typically emphasizing (but not limited to) that material covered in conventional courses (including the nuclear chemistry and radiochemistry coursework, when offered). It is also likely that there will be some emphasis on the student's area of specialization. The oral prelim exam is based on the defense of a short research proposal on a topic approved by the members of the student's committee. This proposal must include preliminary results from the student's laboratory (experimental and/or computational) studies and should conform to the format of a proposal for the Petroleum Research Fund (<http://www.acs.org/content/acs/en/funding-and-awards/grants/prf.html>). This proposal is to be submitted to the committee at least two weeks before the oral preliminary exam and must be officially scheduled with the graduate school. Students are expected to discuss their proposal with others, including their advisor and committee prior to submission.

Three formal seminars are required. The first would normally be given during the student's first three academic-year semesters (earliest possible is recommended) and should focus either on an advisor-approved topic from recent inorganic literature. The seminar should be timed to last about 45 minutes, allotting 5-10 minutes for questions. The second seminar should be completed by the end of the first academic-year semester after successfully completing the written qualifying exam (representing the oral proposal defense [oral prelim examination]). The final (third) seminar precedes the final defense of a completed dissertation. Evaluation Rubrics for the proposal defense and final defense that research committees use to evaluate a student is at the end of this handbook.

PROPOSAL OUTLINE

The research proposal should be limited to 4,000 words, double-spaced, in 12-point font (Times New Roman, Arial, or Courier), with 1-inch margins, for the scientific text of the proposal (Sections II-VI seen below), excluding figures and references. The word count is entered at the end of the proposal narrative. Proposals that exceed this limitation will not be considered. The abstract of the proposal should not exceed 250 words. In the proposal, the student should demonstrate a thorough knowledge of the chemistry involved, and the creativity to recognize a problem and a method of solving it. Although there is some room for deviation, in general the proposal should be divided into the following sections:

- I. **Abstract:** This section should summarize the importance of the proposed research and the critical results. This section is not to exceed 250 words.

- II. **Objectives and Hypotheses:** This section should be a statement of the research objectives to be achieved, the hypotheses to be tested, or the questions to be answered. Cite and evaluate related work that provides useful and relevant supporting information. At least three hypotheses/big problems to be solved should be presented.

- III. **Procedure:** Give enough detail to indicate the logic of the suggested approach, how you would test your hypotheses, and show that your approach is adequate to achieve the objectives.

- IV. **Justification:** Summarize why this work should be undertaken, in terms of its impact on current knowledge in chemistry and in the broader context of science in general.

- V. **Preliminary Results:** Describe the experimental results you have obtained up to this point and how they are relevant to the proposed research.

- VI. **Expected Outcomes and Timeline:** Describe the key outcomes of the proposed research and the suspected times for completion. A graphic depicting the timeline can be helpful.

- VII. **References:** References should be presented in ACS (American Chemical Society) style, providing the article title and html link.

- VIII. **Five Suggested Reviewers Outside of WSU:** List five leading researchers in the field of your proposed research who could act as external reviewers, and briefly (a few words/one sentence) state their specific expertise and its relevance. FYI, the proposal will not be sent to them.

- IX. **Curriculum Vitae in NSF (National Science Foundation) Format**

III. Materials Chemistry Track

Graded Course Requirements (Minimum)

<u># of Courses</u>	<u>Type of courses</u>
5	3 Credit Lecture Courses
5	1 Credit Seminar Courses (division determined by committee)
--	6 credits of electives
1 cr	CHEM 590
1 cr	CHEM 555

Total = 28 graded credit hours

The Committee and the Preliminary Exams

The committee MUST consist of at least one member from two of the divisions of the chemistry department and will have at least 4 committee members in total. The student should select a committee by the start of the second year. The qualifying exam will be written by the student's Dissertation Committee and will be offered whenever the committee determines that the student is prepared to take it. The qualifying exam will consist of one written^a and one oral portion. Once a student qualifies for the prelims, they will write a proposal^b and submit it to their committee. An oral exam based on the proposal content will constitute the preliminary exam. Thus, passing prelims entails written and oral qualifying exams, an original proposal, and an oral exam based generally on the content of the proposal.

Students are expected to attend seminar every semester. Students are required to enroll and present at least 5 times during their graduate career and at least once in their 4th year.

a. A 6-hour written exam based on the content of four of the required courses. The student's committee selects which courses best reflect the student's research goals and will provide the student with that list at least 1 semester prior to the date of the written exam

b. A proposal that follows NSF format and must contain original preliminary data.

Required Courses

CHEM 590 (1)

CHEM 555 (1)

CHEM 531 – Advanced Physical Chemistry (3)

Either CHEM 501 (Advanced Inorganic Chemistry) or an Organic Chemistry or Polymers course^c (3)

CHEM 480 – Solid State Chemistry (3)

MSE 505 – Advanced Materials Science (3)

MATSE 571 – Microscopic Analysis of Solids and Surfaces (3)

Seminar in any division of chemistry – to be taken 5 times and at least 1 semester in the 4th year

Total = 22 hours

plus 6 credit hours of grades electives drawn from the Colleges of Arts and Sciences or Engineering.

= 28 hours

c. This may be a 300-level course if the committee chooses

IV. Organic and Chemistry of Biological Systems (CBS)

The curriculum for Organic and Chemistry of Biological Systems (CBS) PhD is flexible and will vary based on each student's previous course experience and career goals. The Organic/CBS degree has the following recommendations in addition to the requirements of the graduate school and the department of chemistry.

1. A research advisor must be chosen before the end of the second semester of the first year. It is appropriate and encouraged to ask a faculty member for a chance to have a short rotation in his or her laboratory.

2. A dissertation committee of at least four faculty members must be selected by the student in consultation with their advisor in the second year. The committee chair will be the student's research advisor. Other committee members may be selected from outside of the Organic Division and Department.
3. Passing the *Preliminary Examination* advances a student to the rank of "doctoral candidate" and consists of a written qualifying examination followed by an oral examination.
 - a. The written qualifying examination will be scheduled to take place on a Friday in mid to late May after completing the second year of course-work. This examination will test general Organic/CBS background as well as areas related specifically to the student's area of specialty, including current literature. As an aid to students preparing for their qualifying examinations, a suggested reading list may be obtained from each faculty member on the student's committee. The dissertation committee will write and grade the examination. If successful, the student will move on to the oral examination described below. If the student fails the written exam, two outcomes are possible: 1) the student may be allowed to retake the written qualifying exam, or 2) the student will end their progress towards earning a PhD and may complete a Master's.
 - b. The oral preliminary examination will consist of the defense of a written research proposal. The scope of this proposal must be acceptable to the student's advisor and committee and the proposal should adhere to the format described for NSF or NIH (National Institute of Health) predoctoral fellowships (a limit of 10 pages). The proposal may be related to the student's dissertation research and if so, should contain preliminary results while extending beyond the expected scope of the dissertation. The defense of this proposal will be conducted in the form of an open public seminar and immediately followed by a closed meeting with the dissertation committee. During the exam, students should be prepared to answer questions concerning their proposed research. The oral preliminary examination should be completed by the end of the fifth semester. If the student passes the oral exam, he or she is advanced to doctoral candidacy. If the student fails the oral exam,

he or she may be permitted to retake the exam. This decision is made by the student's committee immediately following the oral preliminary exam. The Evaluation Rubric for the Preliminary Exam that research committees use to evaluate a student is at the end of this handbook.

4. Once the preliminary exam is complete, graduate students are expected to petition to the graduate school for All but Dissertation (ABD) status that will result in a tuition waiver and lessen the expense of graduate support. An ABD request should be submitted to the graduate school as soon as possible following completion of the preliminary exam and coursework, excluding Seminars.
5. The Division recognizes the importance of being able to effectively convey ideas and information in a public forum and uses this course to teach students this valuable skill. Beginning with the second semester, all students must register for Chem 594, Organic Seminar. Students enrolled in this course are required to give literature-based presentations and, typically commencing in their third semester, research-based presentations. The faculty in attendance will provide constructive feedback. Once a student has mastered presenting literature and research talks, he or she will be exempted from continued enrollment in Chem 594. Regardless of whether a student has enrolled in Organic Seminar, his or her regular attendance is expected. The Organic Seminar gives more senior students the chance to mentor less experienced graduate students.
6. The *Final Examination* consists of the presentation and defense of the student's dissertation. This presentation will be conducted in the form of an open public seminar, which will be immediately followed by a closed meeting with the dissertation committee. This exam must be scheduled with the Graduate School at least 10 working days before the exam date. Evaluation Rubric for the Final Exam that research committees use to evaluate a student is at the end of this handbook.

Graduate Student Curriculum in Organic Chemistry

An *example* program of study is shown below that meets or exceeds this graded credit requirement. As an Organic/CBS student, you will find our curriculum very flexible beyond the first semester

of Year 1. You should consult with your research advisor to select electives that support your dissertation research.

Year 1

1st semester; 8 graded credit hours

Chem 542	(3)	Advanced Organic Chemistry
Chem 546	(3)	Spectroscopic Identification of Organic Compounds
Chem 555	(1)	Teaching Chemistry (TA training and one semester of TA duties)
Chem 590	(1)	Introduction to Research
Chem 800	(2)	Dissertation Research (variable credit to bring total credits to 10-12)

Year 1

2nd semester; 10 graded credit hours

Chem 543	(3)	Bioorganic Chemistry
Chem 545	(3)	Synthetic Organic Chemistry
Chem 594	(1)	Seminar in Organic Chemistry
Chem 800	(3)	Dissertation research (variable credit to bring total credits to 10-12)

Year 2

1st semester; 7 graded credit hours

Chem 572	(3)	Enzyme Reaction Mechanisms
MbioS 513 or elective	(3)	General Biochemistry I
Chem 594	(1)	Seminar in Organic Chemistry
Chem 800	(3)	Dissertation research (variable credit to bring total credits to 10-12)

Year 2

2nd semester; 7 graded credit hours

Chem 501	(3)	Advanced Inorganic Chemistry
Elective	(3)	Course related to research
Chem 594	(1)	Seminar in Organic Chemistry
Chem 800	(3)	Dissertation research (variable credit to bring total credits to 10-12)

Your PhD degree should be complete within 4 to 5 years of beginning graduate school. You are considered a senior graduate student beginning in your third year. In consultation with your advisor, you will select elective classes that strengthen your foundational knowledge while you increasingly devote much of your time to research. By the end of your third year, you will likely have finished taking courses other than seminars and be solely committed to completing your degree. Typical Electives Include but are not restricted to:

- Chem 510 (2) Introduction to Proteomics
- Chem 514 (2) Mass Spectrometry
- Chem 532 (3) Advanced Physical Chemistry II
- Chem 544 (3) Special Topics

- MbioS 513 (3) General Biochemistry I
- MbioS 514 (3) General Biochemistry II
- Phys 566 (3) Biological Physics
- PharmSci 512 (V) Topics in Pharmacology
- PharmSci 573 (3) Principles of Pharmacokinetics / Toxicokinetics
- PharS 546 (3) Selective Toxicology
- PharS 541 (3) Pharmacological Basis of Therapeutics
- PharS 544 (2) Toxicology

V. Physical Chemistry

Eligibility for Study in the Physical Chemistry Division:

All students formally admitted for graduate study by the Department of Chemistry are eligible to complete their graduate course and research requirements in the Physical Chemistry division. Students with undergraduate degrees in Chemistry or related fields are eligible for admission into the graduate program of the Department of Chemistry. Students in unrelated fields who have completed significant undergraduate coursework in Chemistry are also eligible for admission. Students who do not hold ACS certified degrees in Chemistry may be asked to include selected undergraduate courses in Chemistry in their graduate course program.

Course Requirements for the Ph.D. in Physical Chemistry

The Physical Chemistry division requires students to complete:

Chem 490 – Math prep for P Chem
 Chem 509 – Chemical Group Theory
 Chem 531 – Advanced Physical Chemistry I (Thermodynamics)
 Chem 532 – Advanced Physical Chemistry II (Quantum Mechanics)
 Chem 534 – Statistical Mechanics
 Chem 564 – Molecular Phenomena (Spectroscopy)

These above five courses constitute the core knowledge in physical chemistry that will be tested in the qualifying examinations.

Chem 593 is a graded student seminar course designed to provide students with the opportunity to develop speaking and presentation skills in research areas of interest to them. After their first

year, students should register for credit each semester (for a maximum of 6 times) and will deliver a 45-minute seminar each year. Their 1st seminar may be 20 minutes in duration. Students must give a seminar on their research in their 4th year of participation in the program. Attendance is mandatory for all Physical Chemistry students. First year students should also enroll in Chem 490, which is a mathematics for physical chemistry course.

Timetable for Progress toward the Ph.D. in the Physical Chemistry Division:

First year: Placement in courses based on a review of the student's previous coursework is made. Graduate students in the Physical Chemistry division are expected to complete three courses in each of their first two semesters of study. Formal Ph.D. course requirements in the Physical Chemistry division are listed below. First year students are also expected to meet with all faculty in the Physical Chemistry division in the first semester to discuss potential Ph.D. research projects. The selection of a research supervisor should be made by the start of the second semester and must be made by the end of the second semester. Once the decision to join a group has been made, the student is expected to initiate research activities. The summer of the first year is normally devoted to full-time research.

Second year: Continue coursework and research activities. According to Graduate School requirements, students who intend to pursue a Ph.D. degree must submit a Program for Doctoral Degree form to the Graduate School by the end of the third semester, but we recommend that it be filed the end of the second semester. The form requires the student to supply the names and signatures of Ph.D. committee members (see below) and to present a list of completed and future courses that are intended to satisfy the Department of Chemistry and Graduate School Ph.D. course requirements. Students may take more courses than listed but must take all courses listed.

Admission to candidacy in Physical Chemistry is based upon a written and oral qualifying exam, a written research proposal, and an oral defense of the proposal.

The written portion of the qualifying exam will take place in the week after the Spring Final exam week. The exam will consist of a total of 8 questions (4 each day), which will be based on the content of the five PChem core courses (Chem 509, 531, 532, 534, and 564). Each question will be graded by at least two PChem faculty members and assigned a score of 2 (pass), 1

(marginal pass), or 0 (fail). A total score greater than 8 will constitute a pass, a score equal to 8 a marginal pass, and less than 8 will constitute a failure. Students who obtain a full pass will automatically be allowed to go on to the oral component of the exam. In the case of a marginal pass, these students will be allowed to take the oral exam, but they will be expected to show proficiency in the subjects that were incorrectly addressed in the written portion. Students who obtain a failing score on the written exam will have the opportunity to retry, but usually (barring special circumstances) not until the following spring. The oral portions of the qualifying exam will be held the week following the written exam. These will be held in front of the entire PChem faculty and will primarily focus on any deficiencies identified in the written exam. The oral exam will be graded as pass/fail. A failed oral exam may be repeated after at least 1 month has passed.

Third year: Students who successfully pass the qualifying examinations (written and oral) are expected to complete the oral preliminary examination by the end of the 2nd month of the 2nd semester after completing the qualifying exams (generally in October of the 3rd year). The oral preliminary examination will be based on the content of the research proposal (see Appendix C) submitted by the student as part of the application to complete the oral examination. The oral examination will be conducted before the student's Ph.D. committee in accordance with the rules set forth by the Graduate School, i.e., using the official preliminary exam scheduling form from the Graduate School giving an examination date that has been agreed to by the student and his/her Ph.D. committee. A valid program of study must have been on file with the Graduate School at least one semester prior to scheduling the oral examination. The oral examination is an opportunity for the student to express his/her potential for original creative research, for communicating his/her thoughts clearly and concisely, and for utilizing his/her background to solve problems. The oral examination will consist of a 45-minute presentation by the student based on the research proposal followed by a question-and-answer session by the Ph.D. committee. Student performance on the oral preliminary examination will be rated pass or fail by the Ph.D. committee. The Evaluation Rubric for the Preliminary Exam that research committees use to evaluate a student is at the end of this handbook. Students who pass are granted formal candidacy for a doctoral degree. Students who fail will be eligible to re-take the oral preliminary examination at a later time under conditions set forth by the Ph.D. committee in accordance with

Graduate School policies. Students who fail the oral preliminary examination a second time will be placed in the M.S. degree track and will no longer be eligible for Ph.D. studies.

Students are expected to vigorously pursue their research during their third year.

Fourth and fifth years: Students are expected to complete original research leading to a doctoral thesis in the fourth and fifth years. Doctoral dissertations are normally completed by the end of the fifth year. The research advisor and thesis committee monitor research progress during this period. A final oral defense of thesis completes the Ph.D. requirements. The Evaluation Rubric for the Final Exam that research committees use to evaluate a student is at the end of this handbook.

Teaching Requirements

Teaching is an important mechanism for reinforcing basic knowledge and developing the communication, presentation, and interpersonal skills necessary for future success. Most students find teaching to be a rewarding and satisfying endeavor and consider it to be a valuable component of their educational experiences in the department. Accordingly, the Physical Chemistry division requires all graduate students to complete at least one year of teaching duties in the department.

Research Proposal

The oral preliminary examination for formal Ph.D. candidacy will be based on a written research proposal submitted by the student **not later** than the beginning of the 2nd month of the 2nd semester after completing the Cumulative Examinations (generally September of the 3rd year).

The research proposal should be based on the student's intended Ph.D. thesis research project, but of course it is not expected to cover all aspects of the planned thesis. The style, content, format and length of the research proposal should conform to current National Science Foundation guidelines. The guidelines are contained in NSF's Grant Proposal Guide which can be obtained at <http://www.nsf.gov>. There is no need, however, to address the NSF broader impacts criterion and the proposal may be limited to the NSF project description section and

references. Students will find it extremely useful to complete the budget and facilities section (not required). In general, this should be a technical document in any area of Physical Chemistry with significant space devoted to the fundamental theoretical and experimental principles involved in the planned research.

Specifically, the research proposal should include a review of the scientific literature relevant to the proposed project, a presentation of preliminary results obtained by the student, a discussion of the proposed Ph.D. research problem and particularly its significance in the larger context, and an outline of the procedures and timeline for completing the proposed research. The content of the research proposal will be the basis of the oral preliminary examination. Again, the Evaluation Rubric for the Preliminary Exam that research committees use to evaluate a student is at the end of this handbook.

D. TIMELINE OF ACTIVITIES AND REQUIREMENTS

Year I

Fall

Students are provided financial support through appointment as a teaching assistant (in which case approximately 20 hrs/week is spent as a TA in an undergraduate chemistry course) or as a research assistant in a specific research laboratory (in which case you will be conducting research in that laboratory for at least 20 hrs/week).

The remainder of your time is involved in taking courses, attending departmental seminars and researching which laboratory you'd like to join. Get in the habit of attending seminars faithfully; you should do so throughout your graduate career.

1. Departmental seminars are held at 4:10pm on Mondays in Fulmer 201.
2. Attend a weekly divisional seminar of your area(s) of interest:
 - a. Analytical, Environmental, Radiochemistry/Inorganic – Fridays at 3:10pm
 - b. Organic/Chemistry of Biological Systems – Tuesday 12:30pm
 - c. Physical – Fridays at 4:10pm
3. Talk to other graduate students, interview faculty to collect information about laboratories that match your interests.

By November you should have narrowed your faculty research areas and your interests, please take the time to read their publications, attend group meetings, and meet with faculty to discuss possible projects and support.

Spring

By the start of the spring semester, you should have reached a decision about which laboratory you'd like to join. You will need to reach an agreement with your research supervisor about support for the upcoming summer.

Summer

Intensive research.

Year II

Fall

1. If you have not already done so, meet with your research advisor to decide which courses you should take to complete your program.
2. Before the end of this semester, you should formally appoint your committee and file the "Program for Doctoral Degree" forms with the Graduate School. You can obtain these forms online at: <http://www.gradschool.wsu.edu/Forms/>.

Spring

1. Qualifying exams (generally at end of Spring semester)

Summer

More intense research.

Year III

Fall

1. Oral Preliminary exams (these are the graduate school's official Preliminary Exams)
2. You must have an approved Program of Study on file with the Graduate School before you can schedule your exams. You will need to submit a completed scheduling form with an approved examination date to the Graduate School at least 10 working days (two weeks) prior to the examination date.
3. Keep in mind that you have a maximum of three years to complete your degree from the date you pass this preliminary exam. Any extension of time must be approved by the faculty and the Graduate School.

Subsequent Years

1. Focus on your PhD research
2. Meet with your dissertation committee at least once each year (usually in the spring) to present a summary of your progress.
3. Continue to attend departmental seminars faithfully.

Notes on your Dissertation:

A dissertation should describe a significant body of scientific research. The adequacy of work is determined by the advisor, your dissertation committee and the entire graduate faculty. As a rough guideline, the amount of work should be equivalent to **at least** two first author published papers.

If papers have been published or manuscripts submitted these can be included in the dissertation, but the student must also write a cogent introduction to put the work in context, describe unpublished results and write a discussion interpreting the body of the work.

The dissertation/thesis is presented first as a written document provided to each committee member and made available to the entire graduate faculty. It is then presented orally as a seminar, following which the committee and all interested graduate faculty evaluate the work by an oral examination of the candidate.

E. M.S. DEGREE REQUIREMENTS

1. General Information

The degree of Master of Science is awarded in recognition of scholarship and contributions to knowledge in the field of Chemistry. The Master's Degree is based on research carried out in the laboratories of the Department and allows students to gain experience in modern experimental techniques and to familiarize themselves with the daily workings of a laboratory.

At WSU earning your PhD is separate from earning an MS degree and it is not necessary to complete an MS before pursuing your PhD – although some students choose to follow this path. In some cases, the Department will require a student to complete an MS before entering candidacy for the PhD. We rarely admit students to the MS program and often an MS degree can be awarded if a student on the PhD track fails the written qualifying exam or oral preliminary exam.

Master's Degree students (on either the thesis or non-thesis track) must carry out a research project under the supervision of a member of the Chemistry Department faculty.

Master's students are expected to participate fully in the scientific life of the Department and to attend the various meetings and seminars that take place.

2. Research Advisor

Normally you will spend the first semester talking with research faculty and graduate students about the research being conducted within the Chemistry Department. By the end of the first semester, you should have selected a research advisor to guide you throughout the MS program. Please discuss your research interests with at least three members of the Chemistry faculty before formally selecting your research advisor. This interview process will serve as an important criterion in determining the composition of your committee. During the second semester of your first year, you should begin working in your advisor's laboratory.

3. Committee

With the aid of the research advisor, a student's MS Committee should be selected during the second semester of graduate study. This Committee must consist of at least three WSU faculty members, two of whom must be members of the Chemistry Graduate Faculty.

4. Formal Course Program and Other Requirements

With the aid of the MS Committee, a formal course program must be selected and filed with the Graduate School by the end of the first summer of graduate study. This formal program must include at least 30 semester hours of approved graduate-level courses including a minimum of 21 hours of graded coursework for the thesis option or 26 graded credit hours for the non-thesis option. Up to six hours of non-graduate (300- or 400-level) courses may be included if they are approved by your MS Advisory Committee. A minimum of four hours of CHEM 700 (thesis) or CHEM 702 (non-thesis) must be included in your program in the semester in which you graduate.

Specific requirements for the formal course program are listed below:

1. 21 hours (with thesis) or 26 hours (without thesis) of graded coursework earning a C or better selected on the advice of the student's committee.

5. Communication of Research Results

Each student will write either a thesis or a project report to summarize and communicate the results of your research.

The Chemistry Department requires that your research work be written up in the form of a master's Thesis or a Project Report and that the candidate give a public presentation that is judged by a committee. The written report can be in one of two forms:

A. Thesis – please see the WSU Graduate School homepage for information on thesis guidelines.

B. Project Report

The style, content and format of the research project report should conform to current scientific guidelines and is subject to approval by the student's committee.

The length of the report should be at least 20 pages. The research report should include a review of the scientific literature relevant to the project, a presentation of results obtained by the student, a discussion of the research problem and its significance.

F. Graduation

It is strongly advised that the application for degree be submitted at least one semester before the final examination is scheduled so that the student can be notified of graduate requirements (“To-Do List”) before enrolling for the last semester.

Submit a completed scheduling form (including approved examination date, time and location) and a copy of the thesis/dissertation to the Graduate School Office at least 10 working days (two weeks) prior to examination date. It is required that a copy of the thesis/dissertation be cleared by the Graduate School for compliance of format at the time of scheduling the final examination. A copy of the thesis/dissertation must be available for public inspection at least 5 working days prior to the final examination in the department office or location designated by the department. The student must provide a copy of the thesis/dissertation to each member of the committee **at least 5 working days before submitting a final examination scheduling** form to the Graduate School.

The thesis/dissertation final draft should be turned in within five working days of successful completion of the final oral examination.

G. RESIDENCY REQUIREMENTS FOR DOMESTIC STUDENTS

Please visit the link below to see requirements for establishing residency if you are financially independent.

<http://gradschool.wsu.edu/establishing-residency/>

Students who are US citizens or permanent residents need to become residents of Washington State as soon as possible.

Establishing residency is a rather laborious process, so PLEASE read the residency website thoroughly and start preparing now!

To become a resident, you must:

- live in Washington for one full year; you may not leave for long periods of time during summer
- keep your lease and/or all rental receipts or canceled checks
- get a Washington state driver's license immediately
- license your car in Washington within 30 days of moving here
- register to vote
- keep your tax returns showing a Washington address
- parents SHOULD NOT claim you on their taxes, unless they moved to Washington

After you have lived here for one year, you will need to find your lease, your driver's license, your income tax return, a voter registration card and proof that you've licensed your car and complete the residency forms **no later than August 1**. Submit to the Graduate School in French Administration Building, Room 324.

The department can only guarantee it will pay the difference between resident and non-resident tuition for your first year while you are establishing residency. In your subsequent years of graduate school, if you are not a resident and not granted a waiver you will be responsible for the difference in tuition (over \$12,000 per year).

The University provides a very limited number of non-resident tuition waivers. Waivers are administered by the Graduate School and are not guaranteed. Students who could establish Washington residency and do not will have low priority for such waivers. Non-resident tuition waivers will not be awarded for more than four semesters to students who are not residents of the State of Washington.

After reading the instructions that come with the form, you may conclude that you cannot become a resident of Washington because you came here to be a graduate student. THIS IS NOT THE CASE: you CAN become an official resident. You do not have to fabricate a reason for coming to Washington. You can record that you came to Washington “to teach and to perform research in Chemistry”; or if you prefer you can record “to attend graduate school in Chemistry”. You must sign a statement of intent to make Washington your true fixed and permanent place of habitation. We believe that you can sign this statement with as clear a conscience as any employee or faculty could sign it. For the undefined future, it is a true statement and most of you do not have definite arrangements after you receive your degrees. You are as permanent as any other citizen of the state.

H. WORKPLACE ENVIRONMENT & RESOURCES

The Chemistry Department Faculty and Staff strive to make the working environment pleasant and congenial so that we can all achieve our maximum productivity. Rarely, there are challenges to this positive atmosphere. If you feel that you are in a situation that is not appropriate for our profession, please help us fix it. Your first line of assistance is always your PhD/MS research advisor. If you feel that avenue is not appropriate, or is not working, the Associate Chair for Graduate Studies is your next level of contact. Either alternatively, or in addition to, seeing the Associate chair, Professor Ursula Mazur is currently the Department ombudsperson. If all of these channels do not resolve your issue, please see the Department Chairman. We hope we will have fixed any problem by that level; but, if we have not, the Dean’s office should be your next stop.

I. CHEMISTRY GRADUATE STUDENT SOCIETY (GCS)

The Graduate Chemistry Society at WSU (chemistry.gcs@wsu.edu) is committed to improving the social and academic life of chemistry graduate students.

To fill out our social schedule and ensure that no one buries themselves in the lab 24/7, the GCS organizes and sponsors activities such as barbecues, social evenings out, and departmental events. GCS also has intramural sports teams in soccer and softball, and sometimes flag football. The GCS has its own library in Fulmer Hall 162 which is available to graduate students for studying, meetings and social gatherings. Students have access to the books and handouts needed for classes and preliminary exam preparation; as well as a quiet area to study alone or in groups away from common distractions (such as professors or undergraduates). A key to the GCS library is available by contacting the GCS President.

To fund all of this, the GCS raises money through goggle and notebook sales each semester; these sales are staffed by graduate student volunteers.

The current officers are:

President: Nate Morgan

Vice President: Byron Fisher

Secretary: Tori Lee

Librarian: Neetika

Public Relations: Min Wang

Treasurer: *vacant*

The GCS [Constitution](#) and [Bylaws](#) are online.

J. EVALUATION RUBRIC: PRELIMINARY EXAM – PROPOSAL PRESENTATION

Doctoral Candidate: _____

Committee Member: _____

Date of Preliminary Exam: _____

	Poor	Fair	Competent	Good	Excellent
States a research problem clearly within the context of the literature in the given area of study					
Demonstrates the potential value of the solution to the research problem in advancing knowledge within the area of study					
Provides a sound plan for applying research methods/tools to solving research problems and shows a good understanding of how to use methods/tools effectively					
Provides a sound plan for analyzing/interpreting research data					
Communicates research proposal clearly and professionally in both written and oral forms appropriate to the field.					
Demonstrates capability for independent research in the area of study, the ability to develop and apply substantial expertise in that area and to make an original contribution to it					
Comments:					

K. EVALUATION RUBRIC: DISSERTATION/THESIS AND FINAL DEFENSE

Doctoral Candidate: _____

Committee Member: _____

Date of Preliminary Exam: _____

	Poor	Fair	Competent	Good	Excellent
Demonstrates high level of expertise in a specific, defined area of chemistry and a mastery of knowledge in the general field of chemistry					
Reviews the literature in a way that demonstrates comprehensive knowledge of previous and current research in the field of study					
States a research problem in such a way that it clearly fits within the context of the literature in an area of study					
Demonstrates the potential value of the solution to the research problem in advancing knowledge within the area of study					
Applies sound research methods/tools to problems in an area of study and describes the methods/tools effectively					
Communicates research clearly and professionally in both written and oral forms appropriate to the field					
Has demonstrated capability for independent research in the area of study, applying substantial expertise in that area and making an original contribution to it					
Comments:					

L. CONTACT INFORMATION

Prof. Cliff Berkman (Department Chair)	335-7613 (Fulmer 468)	cberkman@wsu.edu
Prof. Brian Clowers (Associate Chair)	335-4300 (Fulmer 414)	brian.clowers@wsu.edu
Janelle Sordelet (Graduate Academic Coordinator)	335-0946 (Fulmer 305B)	janelle.sordelet@wsu.edu chem.grad@wsu.edu
Nikki Clark (Undergrad Academic Coordinator)	335-1516 (Fulmer 319A)	nikki_clark@wsu.edu
Yoshi Kodama (IT Manager)	335-5864 (Fulmer N105)	Chem.FulmerIT.Help@wsu.edu
Lauren Hatley (Finance/Budget Manager)	335-2229 (Fulmer 305F)	Lauren.hatley@wsu.edu
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Fulmer Information Technology	335-5864	www.Chem.wsu.edu/FulmerIT
Graduate School	335-6424	www.gradschool.wsu.edu
Grad. Professional Student Assoc.	335-9545	www.gpsa.wsu.edu
Graduate Writing Center	gpwc@wsu.edu	writingprogram.wsu.edu/graduate-writing-center/
Heath Insurance - Questions	335-5834	student.insurance@wsu.edu
Health and Wellness Services	335-3575	www.hws.wsu.edu
Payroll and Benefits	335-9575	www.payroll.wsu.edu
Pullman Regional Hospital	332-2541	www.pullmanregional.org
Student Recreation Center	335-UREC	www.urec.wsu.edu
Cougar Safe Rides	978-267-7233	www.cougarsaferides.wsu.edu/
WSU Child Care Resource/Referral	335-7625	www.wsu.edu/CCRR/
WSU Compliance and Civil Rights	335-8288	www.ccr.wsu.edu
WSU Ombuds	335-1195	www.ombudsman.wsu.edu/
WSU Pharmacy	335-5742	hws.wsu.edu/pharmacy/