The Ph.D. degree in Chemistry is a professional degree that stands for a general mastery of the subject of Chemistry, a specialized knowledge of a field within Chemistry, and the ability to successfully undertake and defend independent research. General requirements for the Ph.D. are described in the Washington University in St. Louis, Graduate School of Arts & Sciences, “GRAD GUIDE”. Specific requirements for the Ph.D. degree in Chemistry are given here. Because of the diversity of sub-disciplines within Chemistry and of individual backgrounds and interests, there will be variations between individual programs.

I. Residence.

The minimum residence requirement for the Ph.D. degree is three full years of graduate study, of which at least two years, ordinarily will be spent at Washington University. Each semester the student’s performance will be reviewed by the Graduate Work Committee and satisfactory progress toward the degree must be demonstrated. If any requirements are not met, the Department will prescribe, on the basis of the recommendation of the Graduate Work Committee or the student’s Thesis Advisory Committee (or the department as a whole if the advisory committee has not been appointed) either 1) a probationary period during which the student will be expected to satisfy the requirements or two) immediate dismissal.

A student in “good standing” in the Chemistry Ph.D. program may receive a regular graduate-student stipend from the Department for a maximum of 5 years (the “Five Year Rule”). A graduate student considering a request for an extension must have an Advisory Committee meeting and obtain the committee’s approval for an extension of a specified period not to exceed two semesters. Then a formal request to extend the Five Year Rule for up to one year must be made by written petition to the Graduate Work Committee. The petition must be counter-signed by the student’s research advisor and must clearly state and describe in detail the unanticipated circumstances leading to the request and the expected time to completion.

In only rare circumstances can a student be granted a second extension that would extend the total duration of study beyond six years. Prior to requesting such an extension, a student must first have an Advisory Committee meeting and obtain the committee’s approval for an extension of a specified period. If approval is deemed appropriate by the Committee, a formal request for an extension beyond the sixth year must be made by written petition to the Graduate Work Committee. Again, the petition must be counter signed by the student’s research advisor and must clearly state and describe in detail the unanticipated circumstances leading to the request and the expected time to completion. If approved by the Graduate Work Committee, the research advisor of the student requesting the extension beyond the sixth year must then present the case to the entire Chemistry Faculty for their consideration at a Faculty meeting. It is only with the approval of the Chemistry Faculty that an extension beyond the sixth year will be granted.

II. Course Work.

Students take placement examinations in Biological, Inorganic, Organic, and Physical Chemistry when first entering the Ph.D. program. The results of these placement examinations, coupled with the student’s disciplinary interests and goals and undergraduate preparation, are to be used by the student and advisor, either the temporary advisor or thesis advisor, as a guide to fill in gaps in the student’s background and to ensure the student has a
sufficient knowledgebase for passing cumulative examinations and conducting independent research in chemistry. Based on the results of these examinations, it may be beneficial for a student to take specific undergraduate or graduate coursework in appropriate fields. Adjustments in the program of study may occur upon selection of a permanent advisor or with the recommendation of the advisory committee (see below).

All Chemistry Ph.D. students should take at least six graduate courses (400 level or higher) at Washington University prior to qualifying for dissertation status, ≥72 credits. At least two of these graduate courses should be outside of a student’s chosen division. For example, an Inorganic student may choose to take Chem 451-Organic Chemistry III (an Organic course) and Chem 402-Thermodynamics (a Physical course). These two courses can also be taken outside of the Chemistry Department, such as in the Biology or Physics Departments or in the Schools of Engineering or Medicine. Typical programs of study for specific sub-disciplines are given in the appendices to this document. Graduate courses are normally graded A, B, C, D, or F with possible +/- sub-partitions. Units of instruction with grades of F are not creditable towards the fulfillment of degree requirements. Grades of A and B are considered satisfactory grades. A grade of C is considered an unsatisfactory grade and each grade of C must be balanced by a grade of A in a course with the corresponding number of credits. Students are also required to have an overall B average (3.0 GPA) in all course work (research and journal club credits are not to be included in determining the average). At the end of the first two semesters of coursework study, students who lack a B average may be asked to leave the program.

### III. Research Advisor/Advisory Committee.

First-year graduate students are required to attend all of the Thursday evening research presentations given by the faculty during the Fall semester, and are required to meet with at least four different faculty members to discuss research directions and opportunities within their first semester in the program. Students are required to fill out advisor selection forms no later than December 15th for students beginning in the fall semester and by June 1st for students beginning in the spring semester. On the advisor selection forms, students must indicate their top three or four choices for advisors in order of priority. The Department Chairman then approves the first choice or makes necessary adjustments. While every attempt is made to grant students their first selection, other considerations, such as numbers of students, funding, and research advisor preferences, are considered when matching students with research groups.

The advisor in consultation with the student will choose an advisory committee, made up of the research advisor and two other chemistry faculty members. Additional members from the Chemistry Department or other departments of the University may be added when appropriate. The committee will meet at least once a year with the student to discuss progress, further course work, and research. It is the student’s responsibility to schedule this yearly advisory committee meeting. Students should also obtain an Annual Committee Meeting Form from the Graduate Coordinator and bring this form to the meeting. The committee may impose or suggest additional requirements, such as further course work. The advisory committee will serve as readers for the doctoral dissertation. A student who desires to change faculty advisors may petition the Department Chairman. In case of an extended absence of a committee member (such as a sabbatical leave), an appropriate substitute will be selected by the student and thesis advisor.

### IV. Cumulative Exams.

Students specializing in the chemistry sub-disciplines of biological, inorganic, organic, nuclear and physical chemistry are required to pass four (4) cumulative exams during his or her first four semesters of residence (two
years). In all disciplines, the cumulative exams will be graded as A (excellent pass), B (normal pass), C (conditional pass), and NP (no pass). Grades of A and B on a particular exam are considered a “pass” for that exam, while C and NP are not; however, a C on one exam can be coupled with an A on another exam in the same sub-discipline to count as a second “pass”. {Note that a C grade on an exam in one sub-discipline cannot be combined with an A grade in a different sub-discipline to be considered as a total of two passes. The exception is in the Biological sub-discipline; in Biological Chemistry a C grade in one sub-discipline can be combined with an A grade in any sub-discipline to count as two passes.} A student must pass at least two of the four required cumulative exams in their chosen sub-discipline area. It may be required that more than two passes must be on exams in a student’s sub-discipline depending on consultation between a student and his or her research advisor.

Up to eight cumulative exams will be given no more than once a month during the academic year in each of the sub-disciplines of Biological, Inorganic, Nuclear, Organic, and Physical Chemistry, provided there are students whose major study is in one of those areas. The number of exams offered by a division shall be determined by that division. Typically, eight exams are offered in Organic Chemistry, six to eight exams are offered in the areas of Biological, Inorganic, and Physical Chemistry, and two exams are given in the area of Nuclear Chemistry, as needed. A period of 120 minutes or less will be provided for the cumulative examinations, which are given in the evenings. When more than one cumulative examination is offered at the same time, the duration of the exam period will be equal to 120 minutes, allowing students time to read all of the exams and decide which exam(s) to take. An attempt is made to minimize the overlap in the topics covered by the cumulative examinations given during a single examination period.

In Nuclear Chemistry and Physical Chemistry, each exam will center on a designated reading assignment, either a literature article or a review chapter in a book. The designated reading material and the faculty exam writer for each exam will be posted approximately the first week of the semester. The written exams are 2 hours long and are comprised of question(s) that refer to any aspect(s) of the reading material, including internally cited literature, and the relevant fundamental underlying principles at the level expected for first and second year graduate students. An exam may be oral rather than written, and this change will be announced on the list posted at the beginning of the semester; details on the nature of an oral exam (and notes on arranging to take the exam) will be posted by the exam writer one month prior to the exam.


Annual Dissertation Advisory Committee meetings are required for all students who have completed their Cumulative Examination requirement. The timing and expectations for the first meeting depend on the sub-discipline of the student, and those requirements are described below. In all sub-disciplines, it is the students responsibility to schedule annual meetings.

A. Students concentrating in the area of Biological Chemistry must have their first Dissertation Advisory Committee meeting in the third full semester of graduate work. In following years, the meeting must be held before Dec. 1. One week before the first meeting, the student must provide to the Committee members a one-page description of the work to be performed (not inclusive of references and figures). Within this space limit, the student must describe the problem to be addressed, provide a summary of background information, and indicate the approach that will be used to solve this problem. At the meeting the student should plan to make a 30-minute presentation regarding the proposed research topic.

B. Students concentrating in the area of Inorganic Chemistry must prepare and distribute to the advisory committee one week before the meeting a one-page abstract plus a list of references, describing the problem
chosen for the student’s research. The student then presents a 30-minute “chalk-talk” at the first meeting of the Dissertation Advisory Committee. It is intended that this presentation should describe the problem, survey the background literature, and describe the approach that is proposed to solve the problem. The abstract and the list of references should be approved by the research advisor. This meeting will take place before December 1 of the student’s second academic year.

C. Students concentrating in the area of **Nuclear Chemistry** must prepare and distribute to the advisory committee one week prior to the meeting a one-page abstract plus a list of references, that gives a broad description of their research plan. The student prepares a 30-minute oral presentation to be given at the first meeting of the Dissertation Advisory Committee. Although preliminary results are encouraged, they are not necessary for this meeting. The abstract and the list of references should be approved by the research advisor. This meeting will take place within one semester of the completion of the cumulative exam requirement.

D. Students concentrating in the area of **Organic Chemistry** must select a topic for an oral presentation to be made before their advisory committee during the summer between the 1st and 2nd years of study. (Students who have entered in January may have their first committee meeting delayed until the fall semester.) The subject matter of this oral exam, which will typically involve a literature survey and introductory material for the proposed thesis research topic, is to be determined in consultation with the research advisor. Typically, the presentation will be made as part of the Monday noon journal club.

E. Students concentrating in the area of **Physical Chemistry** must prepare and distribute to the advisory committee a one-page abstract plus a list of references that gives a broad description of their research plan. The student should prepare a 30-minute oral presentation for the first meeting of the Dissertation Advisory Committee. Preliminary results are encouraged but not necessary for this meeting. The abstract and the list of references should be approved by the research advisor. This meeting will take place within one semester of the completion of the cumulative exam requirement.

**VI. Teaching.**

A student must satisfy the Departmental teaching obligations. This obligation is three or four semesters of serving as a teaching assistant, usually within the first two years of residence in the program. Students will be informed of the number of semesters required prior to the beginning of their first semester in residence. Changes may be made after this time in rare circumstances, but a student’s advisor will be consulted prior to any changes. In all teaching assignments, a student’s performance is required to be of sufficiently high quality to be deemed acceptable by the faculty. **Poor teaching performance will result in dismissal from the program.**

**VII. Laboratory Safety.**

Each student must fully comply with the safety requirements established by Washington University and the Department of Chemistry in order to undertake research or to work as a Teaching Assistant in the Department. At the time of this revision, each student must:

A. Take the Environmental, Health, and Safety (EH&S) Seminar Course given during orientation and pass the associated examination. Students must take and pass the EH&S on-line safety course each year thereafter.

B. Take and pass the American Red Cross First Aid and CPR training courses during their first year in the Department.

C. Participate in the Fire Extinguisher training exercises during their first year of residence.
D. Participate in the yearly “Laboratory Specific Safety Training” that is provided by each research group. Each student should keep copies of the documentation for completing each of the above requirements, and the original documentation should be included in the EH&S Bluebook that is located in the research laboratory of the student.

VIII. Doctoral Dissertation.

A student must demonstrate the ability to carry out independent research through the preparation and defense of an acceptable dissertation.

IX. Doctoral Oral Examinations Committee.

Committees normally contain at least six (6) tenured or tenure-track faculty members in residence at Washington University, four (4) from within the Chemistry Department and two (2) from outside the department. With agreement of the department and the Dean of the Graduate School, the Committee may be expanded to include more University faculty, research professors, and/or members from outside the University. In consultation with the student the department may recommend Committee members from outside the department, but it is the obligation of the student to secure the appropriate Committee members. The Chemistry Department then approves the Committee, and ordinarily the Dean follows the Department’s recommendations for Committee membership. The Graduate School will send to all members an official appointment notice including information about the candidate and his/her dissertation. The Chairperson of the Oral Examination Committee will also be sent an Examination Approval Form. It is strongly recommended that the dissertation be made available to committee members at least one-month before the examination, and it must be available to members of the Oral Examination Committee at least one week before the scheduled date of the examination.*

*“Instructions for Doctoral Dissertations and Oral Examinations” from the Graduate School of Arts and Sciences, Washington University.
Specialization in Biological Chemistry requires completion of standard departmental requirements and the items listed below. Coursework in Biological or Biophysical Chemistry should be completed with a ‘B–‘ or better.

1. Students are expected to participate in Biological Chemistry Journal Club (Chem 515) in the first four semesters. In semesters 2 and 4, each student will present papers from the literature. In the fall semester of the second year in residence, students will present a formal seminar on their proposed Ph.D. thesis project. This seminar will serve as the first meeting of the Dissertation Advisory Committee. In consultation with the research advisor, a student must select a Dissertation Advisory Committee prior to this first meeting.

2. Students must pass with a grade of ≥B or better four cumulative exams by the end of the fourth semester. Cumulative exams are graded A, B, C, or F. An A and a C in any sub-discipline can be combined to count as two passing grades. Students must take and pass at least two cumulative exams in the biological chemistry area.

3. Recommended coursework within Biological Chemistry is listed by subdivision. Coursework must be approved by the student’s advisor.

**BIOORGANIC:**

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<th>Fall</th>
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<td>2. BME 530A – Molecular Cell Biology for</td>
<td>2. Chem 558 – Spectral Methods in Organic</td>
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<td>Bio 5357 – Chemistry and Physics of</td>
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<td>Biomolecules</td>
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<td>4. Chem 515 – Biological Chemistry Seminar</td>
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BIOPHYSICAL:

Fall
1. Chem 401 – Physical Chemistry I
2. BME 530A – Molecular Cell Biology for Engineers
   or
   Chem 481 – Biochemistry I
3. Bio 5357 – Chemistry and Physics of Biomolecules
   or
   Elective, such as
   Bio 5146 – Principles and Applications of Biological Imaging
4. Chem 515 – Biological Chemistry Seminar

Spring
1. Chem 402 – Physical Chemistry II
2. Chem 475 – Chemical Biology
3. Chem 578 – Nuclear Magnetic Resonance Spectroscopy
   or
   Chem 584 – Molecular Spectroscopy
   or
   Chem 5312 – Macromolecular Interactions
   or
   Chem 482 – Biochemistry II
4. Chem 515 – Biological Chemistry Seminar

BIOINORGANIC: Students should follow either the bioorganic or the biophysical chemistry curriculum, however they should take Chem 461 (Inorganic) for their third course in the fall semester, and Chem 464 in the spring semester.

BIOANALYTICAL: Students should follow either the bioorganic or the biophysical chemistry curriculum.

The Inorganic Faculty expects that graduate students who are planning to specialize in inorganic or organometallic chemistry will, in addition to fulfilling Departmental requirements, undertake the following:

1. Enroll in Inorganic Chemistry (Chem 461) or pass with an exceptional score the Inorganic Placement Exam, given in the fall prior to the start of classes.

2. Complete the inorganic core curriculum by taking at least three of the following six "specialty" inorganic chemistry courses.
   - Organometallic Chemistry (Chem 459)
   - Inorganic Biochemistry (Chem 464)
   - Solid State and Materials Chemistry (Chem 465)
   - Inorganic Chemistry Laboratory (Chem 470)
   - Advanced Inorganic Chemistry (Chem 541)
   - Special Topics in Inorganic Chemistry (Chem 542) (topic varies)

   In general, students should plan to complete the core curriculum during their first two years in residence.

3. Participate in the "Inorganic/Organometallic Chemistry Seminar" (Chem 540) each semester, through the third year in residence. This one-credit student-led informal seminar meets one hour per week. Student participants in the seminar present topics from the current literature or their own research. Normally, first-year students audit the seminar in their first semester and take it for credit in their second semester and in subsequent years.

4. Make appointments with at least four chemistry department faculty members to discuss research opportunities before formally selecting a research advisor. First-year graduate students should make a serious effort to become acquainted with the work of as many faculty members as possible. This includes attending ALL of the department-sponsored faculty research talks. Traditional boundaries between sub-disciplines are disappearing, and interesting projects with a strong component of inorganic chemistry are being pursued by groups throughout the department. Normally, a first-year student chooses a research advisor no earlier than December 1 and no later than December 31.

5. Select a Dissertation Advisory Committee in consultation with the research advisor as soon as possible after choosing a research mentor. The student's "Committee" consists of the research advisor (who serves as the Committee chair) and two other faculty members. The Committee meets with the student annually to hear progress reports on the student's research. The same Committee reads and approves the student's dissertation and serves on the final oral examination.

6. Pass with a grade of B or better four cumulative examinations by the end of the second academic year. Six inorganic cumulative examinations will be given in each academic year, during the months of September, October, November, February, March, and April. The grades employed are A, B, C, and NP. A and B are passing grades, and C can be brought up to a passing grade by being averaged with an A. Thus a student who receives an A and a C on two cumulative examinations will be credited with having passed two examinations. Students may take cumes in any sub-discipline but at least two of the passes must be on inorganic cumes.
7. Prepare a 30-minute chalk-talk presentation, accompanied by a one-page abstract plus a list of references, describing the problem chosen for the student's research. It is intended that this presentation should describe the problem, survey the background literature, and describe the approach that is proposed to solve the problem. The abstract and the list of references should be approved by the research advisor. The presentation will be given at the first meeting of the Dissertation Advisory Committee, which will normally take place during the semester immediately following the completion of the cumulative exam requirement. Other meetings of the Committee will be held annually. It is the student's responsibility to schedule these meetings.

8. Meet with the Dissertation Advisory Committee approximately six months prior to the expected date of the dissertation defense. At this meeting, the Committee will identify any final experiments that need to be completed prior to writing the dissertation.

9. Present the dissertation to the Dissertation Advisory Committee for comments at least two weeks prior to the scheduled date of the dissertation defense. (The research advisor must approve the dissertation before distribution to the full committee.)

10. Defend the dissertation in front of the Dissertation Advisory Committee and three outside readers (one from chemistry and two from other departments).
NUCLEAR CHEMISTRY

Nuclear Chemistry Cumulative Exams will be given twice a year, as needed. Students interested in pursuing a nuclear-chemistry degree should inform the nuclear-chemistry faculty of his/her intention. The exam dates will be determined by mutual consent of the nuclear chemistry faculty and students entering the nuclear-chemistry subdiscipline.

Each exam will center on designated reading of either a literature article or a review chapter in a book. The designated reading material and the faculty exam writer for each exam will be posted the first week of the semester. The exam question(s) can refer to any aspect of the reading material, including internally cited literature, and the relevant fundamental underlying principles at the level expected for first and second year graduate students. Occasionally, an exam may be oral rather than written, as noted on the list posted at the beginning of the semester; details on the nature of an oral exam (and notes on arranging to take the exam) will be posted by the exam writer one month prior to the exam.

Both written and oral nuclear-chemistry cumulative exams will be graded A (excellent pass), B (normal pass), C (conditional pass, and NC (no credit). Grades of A and B on a particular exam are considered a “pass” for that exam, while C and NC are not; however, a C on one exam can be coupled with an A on another exam to count as a second “pass”. In order to fulfill the Department’s Ph.D. candidacy requirement, a student must pass a total of four cumulative exams (see below) during the first four semesters in residence (4 opportunities on nuclear chemistry exams, 12 opportunities on physical chemistry exams, 12 opportunities on inorganic chemistry exams, and 16 opportunities on organic chemistry exams). For students in nuclear chemistry, at least two passes must be solely on the nuclear chemistry cumulative exams described above. [Note that an A or C grade on an exam in another chemistry subdiscipline cannot be combined with a C or A grade on a nuclear chemistry exam for either of these two required nuclear chemistry passes]. It may be required that more than two passes must be on nuclear chemistry exams depending on consultation between a student and their research advisor. The remaining passes may be on cumulative exams in nuclear chemistry or other chemistry subdisciplines, and A and C grades may be combined in these cases.

Nuclear chemistry students must give an oral presentation that gives a broad description of their research plan to their Ph.D. thesis committee within one semester of completing the cumulative exams.
ORGANIC AND BIOORGANIC

The Organic Faculty expects that graduate students who are planning to specialize in organic or bioorganic chemistry will, in addition to fulfilling Departmental requirements, undertake the following:

1. **Courses.** Enroll in the four courses that are regarded by the Organic Faculty as the core curriculum for Ph.D. work in organic and bioorganic chemistry during the first two years of graduate study. Additional elective courses will be chosen by students in consultation with their advisors and can consist of courses offered by other departments such as the Biomedical Science Division, Engineering and Physics. The core curriculum is:

   Organic Chemistry III     Chem 451 (Fall)
   Mechanistic Organic Chemistry (Physical Organic I) Chem 5511 (Fall)
   Kinetics and Mechanism (Physical Organic II)  Chem 556* (Spring)
   Spectral Methods in Organic Chemistry   Chem 558 (Spring)

   *A course in enzyme kinetics may be substituted for Chemistry 556 by bioorganic chemistry graduate students with the permission of their advisor.

   Also required are the following:
   Chemical Reaction Mechanism Journal Club  Chem 458 (Fall and Spring)

   There are many possible elective courses, some taught in other departments, and the elective courses available vary from year to year. An incomplete list of course titles includes:

   Synthetic Polymer Chemistry Chem 452 (Spring)
   Bioorganic Chemistry Chem 453 (Spring)
   Organometallic Chemistry Chem 459 (Fall)
   Inorganic Chemistry Chem 461 (Fall)
   Inorganic Biochemistry Chem 464 (Spring)
   Nucleic Acid Chemistry Chem 465 (Fall)
   Nucleic Acid Chemistry Chem 466 (Spring)
   Special Topics in Mass Spectrometry Chem 550 (Alternate Fall)
   Special Topics in Organic Chemistry Chem 555 (TBA)
   Advanced Organic Synthesis Chem 557 (Fall)
   Nuclear Magnetic Resonance Spectroscopy Chem 578 (Alternate Springs)

   A total of 72 credits is required for completion of the Ph.D. degree. An average of B or better, GPA of ≥3.0, must be maintained for coursework, exclusive of research (Chem 590) credits.

2. **Journal Club.** Participate in the Chemical Reaction Mechanisms Journal Club, Chem 458, each semester, at least until the cumulative examination requirement is completed. This informal seminar meets one hour each week. Student participants in the seminar present topics from the current literature and discuss proposed thesis projects.

3. **Graduate Student Seminar.** Attend (audit) the Organic Chemistry Seminar course, Chem 559, during the first academic year, and enroll in the course during the second year of graduate work. At present, Chem 559 meets in the spring semester. In the second year, organic and bioorganic graduate students present a seminar on a topic that is not directly related to their chosen research subject. Attend also the Department of Chemistry Seminars.

4. **Selecting an Advisor.** Make appointments with at least four faculty members during the 1st semester of graduate study to discuss research opportunities before formally selecting a research advisor. First-year graduate students should make a serious effort to become acquainted with the work of as many faculty members as possible. Traditional boundaries between subdisciplines are disappearing, and interesting
projects with a strong component of organic chemistry are being pursued by inorganic, physical and radiochemists, as well as by organic chemists. Interdisciplinary areas such as materials chemistry and biological chemistry also offer important research opportunities for graduate students who are interested in organic chemistry. First-year students are required to choose research advisors by December 15\textsuperscript{th} if they begin the program in the Fall semester and by June 1\textsuperscript{st} if they begin the program in the Spring semester. There are also opportunities to work for two advisors who are collaborating in their research programs.

5. **Selecting an Advisory Committee.** Select a Ph.D. Advisory Committee by April 1 of the 1\textsuperscript{st} year, in consultation with the research advisor. This committee consists of the research advisor and two other faculty members. The committee is called together by the student to hear progress reports on the student’s research. The same committee reads and approves the student’s dissertation and serves on the final oral examination (along with a fourth faculty member and two outside tenure-track faculty members).

6. **Research Presentation.** Present to the students and faculty members in the Chemical Reaction Mechanisms Journal Club, an overview of the dissertation research project that is to be carried-out. This presentation is to take place during the summer of a student’s first year in residence, in preparation for the initiation of research, and will be scheduled by the faculty member in charge of these committee meetings. The Ph.D. Advisory Committee should be selected prior to this presentation.

7. **Cumulative Exams.** Organic Students are expected to pass with a grade of B or better, four cumulative examinations, at least two of which are organic, by the end of the second academic year. Eight cumulative examinations will be given in each academic year, during the months of September, October, November, December, January, February, March, and April. The grades employed are A, B, C, and NP. A and B are passing grades, and a C can be brought up to a passing grade by being averaged with an A. Thus, a student who receives an A and a C on two cumulative examinations will be credited with having passed two examinations.

8. **Dissertation Draft.** Present research results in written form to the Ph.D. Advisory Committee at least six months prior to the expected date of dissertation completion, and in no case later than February 1\textsuperscript{st} of the fifth year of graduate study. Normally, a draft of the results and experimental sections of the dissertation will be given several days in advance to the Ph.D. Advisory Committee in preparation for their consideration at the scheduled meeting with the graduate student. The purpose of this review meeting is to provide the graduate student with assistance and advice at a stage when most of the research has been completed, but when it is not too late for some additional work, if this is found to be necessary.
Physical Chemistry Cumulative Exams will be given at least three times per semester. Each exam will center on a designated reading assignment, either a literature article or a review chapter in a book. The designated reading material and the faculty exam writer for each exam will be posted approximately the first week of the semester. The exam question(s) can refer to any aspect(s) of the reading material, including internally cited literature, and the relevant fundamental underlying principles at the level expected for first and second year graduate students. Occasionally, an exam may be oral rather than written, as noted on the list posted at the beginning of the semester; details on the nature of an oral exam (and notes on arranging to take the exam) will be posted by the exam writer one month prior to the exam.

Both written and oral physical-chemistry cumulative exams will be graded A (excellent pass), B (normal pass), C (conditional pass), and NC (no credit). Grades of A and B on a particular exam are considered a “pass” for that exam, while C and NC are not; however, a C on one exam can be coupled with an A on another exam to count as a second “pass”. In order to fulfill the Department’s Ph.D. candidacy requirement, a student must pass a total of four cumulative exams (see below) during the first four semesters in residence (≥12 opportunities on physical-chemistry exams). For students in physical chemistry, at least two passes must be solely on the physical-chemistry cumulative exams described above. [Note that an A or C grade on an exam in another chemistry subdiscipline cannot be combined with a C or A grade on a physical-chemistry exam for either of these two physical-chemistry passes.] It may be required that more passes must be on physical-chemistry exams depending on consultation between a student and their research advisor. The remaining passes may be on cumulative exams in physical chemistry or other chemistry subdisciplines, and A and C grades may be combined in these cases.

Physical-chemistry students must give an oral presentation that gives a broad description of their research plan to their Ph.D. thesis committee within one semester of completing the cumulative exams. Annual Advisory Committee Meetings are to be held each year thereafter.

Physical Chemistry students are encouraged to take a curriculum that is aimed at supporting their research endeavors while also spanning the major areas within Physical Chemistry. Each student should consult their advisor in setting up an appropriate curriculum. A typical Physical Chemistry student will take the following coursework

First Year:
  Fall Semester:
    Physical Chemistry I (Chem 401) – “Introd. to Quantum Chemistry and Molecular Spectroscopy”
    Elective
    Elective
  Spring Semester:
    Physical Chemistry II (Chem 402) – “Thermodynamics”
    Quantum Chemistry and Spectra (Chem 571)
    Spectroscopy (either Molecular Spectroscopy – Chem 584 or NMR Spectroscopy – Chem 578)

Second Year:
  Fall Semester:
    Advanced Quantum Mechanics (Chem 581)
    Statistical Thermodynamics (Chem 562)

Electives in Physical Chemistry include, but are not limited to:

Spectroscopic Analysis (Chem 405)  
Electron Spin Resonance (Chem 5762)

Radioactivity and Its Applications (Chem 436)  
Special Topics in Physical Chemistry (Chem 580)

Molecular Reaction Dynamics (Chem 585)
Students are also encouraged to take electives in interdisciplinary courses that are offered by other sub-disciplines in the Chemistry Department or by other departments or schools at Washington University. The approval of the student’s advisor is required to take these electives. Such courses include, but are not limited to:

- **Inorganic Chemistry** (Chem 461)
- **Solid State & Materials Chemistry** (Chem 465)
- **Advanced Inorganic Chemistry** (Chem 541)
- **Mass Spectrometry** (Chem 550)
- **Mechanics** (Phys 411)
- **Electricity and Magnetism I** (Phys 421)
- **Solid State Physics** (Phys 472)
- **Classical Electrodynamics I** (Phys 505)
- **Solid State Physics I** (Phys 549)
- **Nuclear Magnetic Resonance** (Phys 536)