UR Department of Chemistry

Learning Objectives and Assessment Plan for the Undergraduate Major

Program learning objectives (PLO):

1. Knowledge- To understand the conceptual foundations of modern chemistry, with particular emphasis on the relationship between molecular structure and chemical reactivity, and to use this knowledge in analysis of chemistry problems.
2. Lab methods- To develop laboratory skills consistent with the experimental nature of chemistry as the central molecular science. Students should gain experience in the methods of synthesis, isolation, and characterization of molecular compounds and materials.
3. Research- Students should learn the methods of research in chemistry: how to read the literature, plan and organize experiments, make valid observations, take reliable data, analyze and interpret the data, and convey findings.
4. Analytical reasoning, critical thinking, modeling systems- To develop the analytical and critical thinking skills that lead to explanation of chemical reactivity in known systems, and prediction of reactivity in new systems.
5. Communication- oral. To be able to communicate technical concepts and findings in a clear, concise manner to a variety of audiences in formal presentations.
6. Communication- written. To be able to communicate technical concepts and findings in a clear, concise manner in written reports.
7. Computing- To be able to use computing tools in analysis of chemistry and other technical problems.
8. Math- To be able to use algebra, calculus, and statistics in the analysis of chemistry and other technical problems.
9. Teamwork- To be able to participate in a productive manner as part of a team in completion of team goals and tasks.

Table 1. Chemistry BS Degree Assessment Plan

Ability Category	Chemistry Program Learning Objective	Courses where ability addressed and developed	Assessment method
1. Knowledge/ Application	To understand the conceptual foundations of modern chemistry, with particular emphasis on the relationship between molecular structure and chemical reactivity, and to use this knowledge in analysis of chemistry problems.	Core degree theory subjects; Labs 210, 231, 232, 234; senior thesis project	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual), senior lunch/ focus group (annual), student science awards (annual). **Direct methods**- successful completion of lab and core theory classes; review of sample of student work from lab subjects for student performance for this outcome and review in faculty course reflective memos; thesis review The thesis will be read by two faculty members, who will comment on the science described by the dissertation, the presentation of the data, and the overall writing style. Specific comments will be offered that will allow the student to improve his/her presentation to bring it to a level that would be suitable for publication in a journal. This assessment will consider the student's knowledge, lab technique, and reasoning ability. The objective of the feedback process will be to advance the quality of the student's work to be consistent with "superior" work. The term "superior" is based on Departmental standards.
2. Lab methods	To be able to use laboratory skills consistent with the experimental nature of chemistry as the central molecular science. Students should gain experience in the methods of synthesis, isolation, and characterization of molecular compounds and materials.	Labs 210, 231, 232, 234; senior thesis project	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual); senior lunch/ focus group (annual), student science awards (annual). **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance for this outcome and review in faculty course reflective memos; thesis review The thesis will be read by two faculty members, who will comment on the science described by the dissertation, the presentation of the data, and the overall writing style. Specific comments will be offered that will allow the student to improve his/her presentation to bring it to a level that would be suitable for publication in a journal. This assessment will consider the student's knowledge, lab technique, and reasoning ability.

3. Research	To be able to use the methods of research in chemistry: how to read the literature, plan and organize experiments, make valid observations, take reliable data, analyze and interpret the data, and convey findings.	Senior thesis project	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual); senior lunch/ focus group (annual), student science awards (annual). **Direct methods**- thesis, review of sample of student work from lab subjects for student performance for this outcome and review in faculty course reflective memos. The thesis will be read by two faculty members, who will comment on the science described by the dissertation, the presentation of the data, and the overall writing style. Specific comments will be offered that will allow the student to improve his/her presentation to bring it to a level that would be suitable for publication in a journal. This assessment will consider the student's knowledge, lab technique, and reasoning ability. The objective of the feedback process will be to advance the quality of the student's work to be consistent with "superior" work. The term "superior" is based on Departmental standards.
4. Analytical reasoning, critical thinking, modeling systems	To develop the analytical and critical thinking skills that lead to explanation of chemical reactivity in known systems, and prediction of reactivity in new systems.	Labs 210, 231, 232, 234; senior thesis project	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual); senior lunch/ focus group (annual), student science awards (annual). **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance for this outcome and review in faculty course reflective memos; thesis review The thesis will be read by two faculty members, who will comment on the science described by the dissertation, the presentation of the data, and the overall writing style. Specific comments will be offered that will allow the student to improve his/her presentation to bring it to a level that would be suitable for publication in a journal. This assessment will consider the student's knowledge, lab technique, and reasoning ability. The objective of the feedback process will be to advance the quality of the student's work to be consistent with "superior" work. The term "superior" is based on Departmental standards.
5. Communication- oral	To be able to communicate technical concepts and findings in a clear, concise manner to a	Workshops in Lab 210 and theory subjects, CHM 203, CHM 204; senior	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual); senior lunch/ focus group (annual), student science awards (annual).

	variety of audiences in formal presentations.	thesis project presentation	**Direct methods**- workshop leader review of student participation; thesis review The thesis will be read by two faculty members, who will comment on the science described by the dissertation, the presentation of the data, and the overall writing style. Specific comments will be offered that will allow the student to improve his/her presentation to bring it to a level that would be suitable for publication in a journal. This assessment will consider the student's knowledge, lab technique, and reasoning ability. The objective of the feedback process will be to advance the quality of the student's work to be consistent with "superior" work. The term "superior" is based on Departmental standards.
6. Communication- written	To be able to communicate technical concepts and findings in a clear, concise manner in written reports.	Labs 210, 231, 232, 234 (W subjects); senior thesis project	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual); senior lunch/ focus group (annual), student science awards (annual). **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance for this outcome and review in faculty course reflective memos; thesis review. Since we expect at least 80% of students to receive grades of B or better, we expect the quality of the writing to be at the level of an "advanced" student. Comments offered by faculty will be of such a nature as to allow a student to improve his/her writing to make it consistent with the highest level of communication, or "superior" category.
7. Computing	To be able to use computing tools in analysis of chemistry and other technical problems.	Labs 231	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual); senior lunch/ focus group (annual), student science awards (annual). **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance for this outcome and review in faculty course reflective memos.
8. Math	To be able to use algebra, calculus, and statistics in the analysis of chemistry and other technical problems.	Labs 232, 251, 252	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual); senior lunch/ focus group (annual), student science awards (annual). **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance

			for this outcome and review in faculty course reflective memos. The physical chemistry courses 251 and 252 require students to be proficient in the use of mathematics. Exams provide the best assessment of a student's ability to use mathematics, and graded exams will provide written assessment and feedback to him/her.
9. Teamwork	To be able to participate in a productive manner as part of a team in completion of team goals and tasks.	Labs 210, 231, 232, 234	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual) **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance for this outcome and review in faculty course reflective memos. Students who are workshop leaders for undergraduate courses such a general and organic chemistry usually take CAS 352 and/or 355, in which students are trained in leadership skills. Peer observations as well as faculty and staff responses to journal entries provide direct feedback of the mastery of those skills.

Table 2. Chemistry BA Degree Assessment Plan

Ability Category	Chemistry Program Learning Objective	Courses where ability addressed and developed	Assessment method
10. Knowledge/ Application	To understand the conceptual foundations of modern chemistry, with particular emphasis on the relationship between molecular structure and chemical reactivity, and to use this knowledge in analysis of chemistry problems	Core degree theory subjects; Labs 210, 231, 232, 234	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual) **Direct methods**- successful completion of lab and core theory classes; review of sample of student work from lab subjects for student performance for this outcome using department developed scoring rubric for novice, intermediate, advanced, superior levels of performance.
11. Lab methods	To be able to use laboratory skills consistent with the experimental nature of chemistry as the central molecular science. Students should gain experience in the methods of synthesis, isolation, and characterization of molecular compounds and materials.	Labs 210, 231, 232, 234	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual) **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance for this outcome using department developed scoring rubric for novice, intermediate, advanced, superior levels of performance.
12. Research	To be able to use the methods of research in chemistry: how to read the literature, plan and organize experiments, make valid observations, take reliable data, analyze and interpret the data, and convey findings.	CHM 210	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual) **Direct methods**- successful completion of lab class; review of sample of student work from lab subject for student performance for this outcome using department developed scoring rubric for novice, intermediate, advanced, superior levels of performance.
13. Analytical reasoning, critical	To develop the analytical and critical thinking skills that lead to explanation of chemical reactivity in known systems, and prediction of	Labs 210, 231, 232, 234	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career

thinking, modeling systems	reactivity in new systems.		data (annual) **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance for this outcome using department developed scoring rubric for novice, intermediate, advanced, superior levels of performance.
14. Communication - oral	To be able to communicate technical concepts and findings in a clear, concise manner to a variety of audiences in formal presentations.	Workshops in Lab 210 and theory subjects, CHM CHM 203, 204	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual) **Direct methods**- workshop leader review of student participation.
15. Communication - written	To be able to communicate technical concepts and findings in a clear, concise manner in written reports.	Labs 210, 231, 232, 234 (W subjects)	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual) **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance for this outcome using department developed scoring rubric for novice, intermediate, advanced, superior levels of performance.
16. Computing	To be able to use computing tools in analysis of chemistry and other technical problems.	Labs 231	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual) **Direct methods**- successful completion of lab classes; review of sample of student work from lab subject for student performance for this outcome using department developed scoring rubric for novice, intermediate, advanced, superior levels of performance.
17. Math	To be able to use algebra, calculus, and statistics in the analysis of chemistry and other technical problems.	Labs 232	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual) **Direct methods**- successful completion of lab

			classes; review of sample of student work from lab subjects for student performance for this outcome using department developed scoring rubric for novice, intermediate, advanced, superior levels of performance.
18. Teamwork	To be able to participate in a productive manner as part of a team in completion of team goals and tasks.	Labs 210, 231, 232, 234	**Indirect methods**- senior survey (annual), alumni survey (every 4 years), course evaluations (each term), post-graduate career data (annual) **Direct methods**- successful completion of lab classes; review of sample of student work from lab subjects for student performance for this outcome using department developed scoring rubric for novice, intermediate, advanced, superior levels of performance.