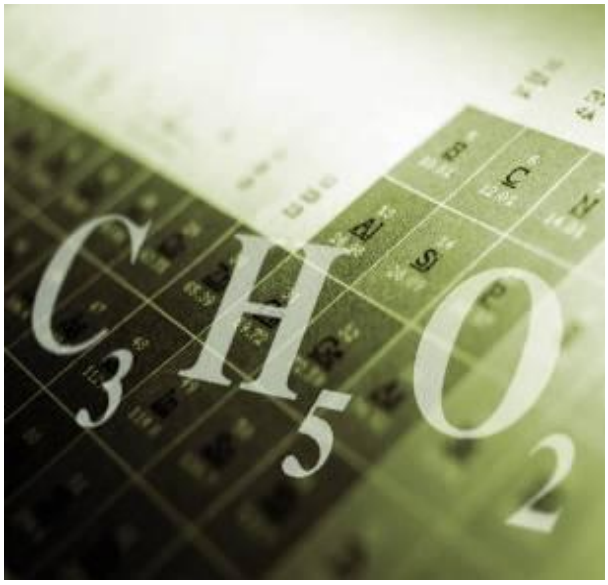
Binghamton University

Department of Chemistry

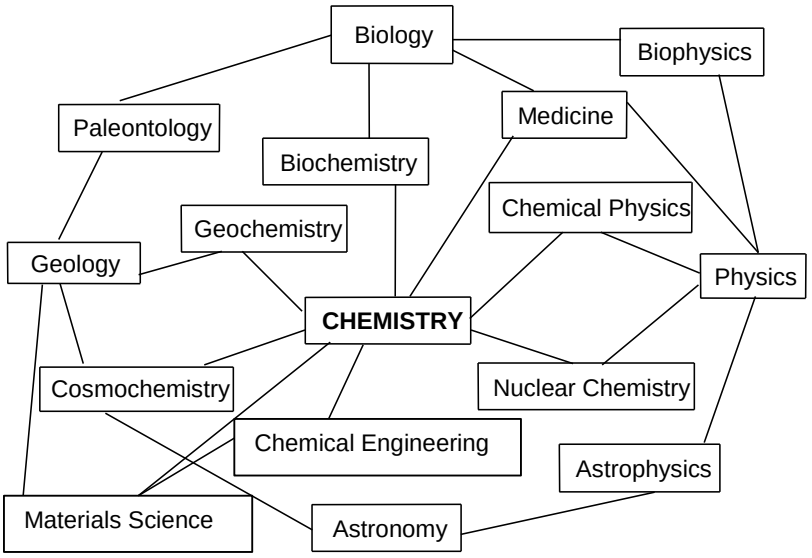


Undergraduate Student Handbook

2009 -2010

WHAT IS CHEMISTRY?

Chemistry is the "Central Science." Such diverse subjects as art, anthropology, geology, biology, materials science, environmental science, engineering, nursing, and psychology have areas in which fundamental principles and process details are understood in terms of chemistry. Though these kindred sciences cannot be completely reduced to chemistry, it is true that in order to comprehend these sciences one must understand the appropriate principles of chemistry. This fact is recognized by the various departments and programs comprising the Division of Science and Mathematics at Harpur College. Of the 16 degrees offered in the Division, 10 require at least introductory chemistry. Some of the most significant developments in science have come at the interface between chemistry and kindred sciences. Examples of these interfacial sciences are biochemistry; molecular biology; geochemistry; materials chemistry; environmental chemistry; neurochemistry; and chemical physics.



CHEMISTRY. THE CENTRAL SCIENCE

The four traditional sub-disciplines of chemistry have had a long history – some predating the development of alchemy in the Middle Ages. The roots of **Inorganic** chemistry are in the ancient arts of metallurgy and ceramics; those of **Organic** chemistry are in the study of substances important to the domestic arts which are involved in or derived from life processes. As chemistry developed, the questions of which substances were present and in what amounts led to the emergence of **Analytical** chemistry, and the questions of quantitative measurement and prediction of the physical properties of matter became the focus of **Physical** chemistry. Other aspects of chemistry cut across these traditional divisions, e.g., electrochemistry and polymers.

Important interfaces have developed in recent years between these traditional areas and kindred sciences: biophysical chemistry, bio-organic and bio-inorganic chemistry, inorganic and organic materials chemistry (including polymers). In modern life, chemistry is involved in the rational design of drugs, the development of new materials (including the new superconductors and materials for microelectronics applications), and in dealing with environmental problems, including measurement of levels of pollutants and their elimination.

Even though most chemists specialize in organic, inorganic, analytical chemistry, physical, polymer, materials, or biological chemistry, a thorough grounding in the first four "traditional" areas is necessary for any career in chemical science. The requirements for the BA and BS chemistry majors reflect this necessity in that certain courses are required of all majors. If all chemists were trained exactly alike, chemistry would lose much of the diversity of its impact. For this reason, there is a measure of flexibility in course requirements once the basic requirements have been met. Hence the student may develop some focus within chemistry or in an interface area, even as an undergraduate. In the section which follows, the requirements for the baccalaureate degrees in chemistry are presented and discussed briefly.

DIFFERENCES BETWEEN BA AND BS DEGREES

One of the most common questions is "Which degree should I get - a BS or a BA?" This is an important question, but also one that does not have a simple answer. Even among the Chemistry Department faculty, there is a difference of opinion. At the same time, the following guidelines may help in your decision.

1. The BA degree gives you exposure to the four main areas of Chemistry (Analytical, Inorganic, Organic, and Physical) but requires fewer courses than the BS degree. As such, it provides more opportunity to explore other areas and interests. This extra flexibility can be quite useful if your goal is admission to a graduate program or professional school outside of Chemistry (for example, Medical School, Law School, Optometry, etc.). For these career goals, a detailed knowledge of Chemistry is not as critical as the breadth of science knowledge.
2. The BS degree, on the other hand, gives you more in depth exposure to the core areas of Chemistry by requiring more courses. This can be of greatest help if you desire to obtain a job in the Chemical industry directly out of college. In such a case, the BS degree does offer some competitive advantage. You might also want to consider the BS degree with ACS certification. There is still sufficient flexibility in the BS degree program to allow you to pursue other interests and also to focus your choice of courses toward the area(s) you find most interesting.
3. If your goal is admission to graduate school in Chemistry, then either the BS or the BA option is open. Your choice depends entirely on what interests you and how many courses outside (and inside) of Chemistry you wish to take. The single largest factor that tends to help graduate school admissions (besides maintaining decent grades) is whether you have done independent research or not. Independent research is viewed quite favorably for admission to graduate school and will also greatly help you to get started quickly in research in graduate school.

In the final analysis, the choice of BA or BS is yours to make. You will want to talk to your advisor in the Chemistry Department as soon as possible about which pathway would be most beneficial to you. Also, it is worth noting that you can change your mind. If you are initially pursuing a BS degree, then the change to a BA is very simple and usually results in no delays as far as graduation is concerned. Changing from a BA to a BS, on the other hand, can be simple early on, but may result in you having to spend an extra semester or two if you make the change late (junior or senior year). But remember, either the BA or the BS degree in Chemistry opens the doors to a wide range of career opportunities.

REQUIREMENTS FOR CHEMISTRY DEGREES

With an idea of what the difference between a BA and a BS degree in Chemistry is, the next most common question is "What are the requirements?" The BA and BS degree programs in Chemistry share a common core set of requirements as seen in the following chart.

CORE COURSES IN CHEMISTRY

Sub-discipline	BA degree	Additional courses for BS degree
General	Chem 111 (or 107-108) and Chem 496	
Analytical	Chem 221	Chem 422
Inorganic	Chem 341	Chem 442, 443, 444, 445, or 484
Organic	Chem 231 and Chem 332	Chem 335
Physical	Chem 351	Chem 455 and Chem (451 or 452)
Math	Math 221 and 222	
Physics	Physics 121 (or 131) and 122 (or 132)	

Beyond the core, the BA degree requires 3½ elective courses in chemistry. Of these electives, 1½ courses (6 credit hours) must be selected from a list of laboratory courses (Chem 335, 422, 445, 455, 462, and 497/498). The other 2 electives can be any courses offered by the Chemistry Department. These courses can include Chem 397 and Chem 497 (independent research), although only 4 credits of Chem 397 can count toward the BA degree. The BA degree also requires that one additional course in the Division of Science and Mathematics (for example, Biol 113, Psyc 111, Math 223, or another chemistry elective) be taken. If Chem 107-108 is chosen as the introductory course, the additional course in the Division of Science and Mathematics is not required.

The BS core degree requirements are more specific and extensive. In addition to the BA core, this program requires *Organic Chemistry Laboratory* (Chem 335); *Instrumental Methods* (Chem 422); a second course in inorganic chemistry (Chem 442, 443, 444, 445, or 484), a second course in physical chemistry (Chem 451 or 452), and *Physical Chemistry Laboratory* (Chem 455, 4 credits). Besides the chemistry core courses, the BS degree requires four elective courses which are selected from the Division of Science and Mathematics or which are professionally related.

The Chemistry Department also offers a five-year program in Chemistry and Materials Science. Upon completion of this program, students receive a BS in Chemistry and a MS degree in Materials Science. Students interested in this program should consult Professor Stan Whittingham in the Chemistry Department.

Starting in 2007-2008, the Chemistry Department is participating in a five-year program resulting in the combined Chemistry BA degree and School of Education MAT degree. Students who are interested in pursuing a high school teaching career should consider this option. Interested students should consult the Undergraduate Program Director in the Chemistry Department. For the 2009-20010 academic year, the Undergraduate Program Director is Professor Eriks Rozners.

The Chemistry Department offers two physical chemistry courses: Chem 351 (*Physical Chemistry*) and Chem 361 (*Biophysical Chemistry*). Chem 351 is a required course for the Chemistry BA and BS majors. Chem 361 is a required course for Chem BS with Biophysical Emphasis. Chem 351 and 361 are essentially equivalent courses, so that credit is not given for one course if the other has already been taken.

A BS degree can also be certified by the American Chemical Society (ACS) by taking either *Inorganic/Materials Chemistry Laboratory* (Chem 445) or at least 2 credits of Independent Research (Chem 497) involving work in the Inorganic or Materials areas and at least 2 addition credits of Independent research (Chem 397, 497, or 498) in any area of Chemistry. Biochemistry (BCHM 302) is also required for ACS certification.

There are also two more specialized programs in Chemistry: BS with Emphasis in Materials and BS with Emphasis in Biophysical Chemistry. The BS with Emphasis in Materials is program targeted at those students with an interest in the area of solids, polymers, ceramics, and similar materials. This program requires four courses in the area of materials chemistry; one of these courses must be a laboratory course relevant to materials. If you are interested in these degree programs, you should consult faculty associated with the Institute for Materials Research in Room 120, Science II.

The other emphasis is the BS degree with Emphasis in Biophysical Chemistry. This program requires three courses in the area of biophysical chemistry as well as a slightly different Physical Chemistry sequence. If you are interested in this degree program, you should consult faculty in this area (Professors Dix, Starzak, and Stevens).

THE TYPICAL COURSE SEQUENCE

With the type of degree and general course requirements in hand, the obvious question is "When do I need to take all of these courses?" The answer is that there is a great deal of flexibility in building a schedule leading to a degree in Chemistry. The first year, in particular, can vary a lot depending upon your background. A student with a strong high school Chemistry background and AP credit may not need to take General Chemistry (Chem 107/108 or 111) at all and can start in Organic Chemistry (Chem 231). On the other hand, many students may want to start with General Chemistry in their freshman year.

With this in mind, there are four "typical" courses sequences outlined in the following charts (depending upon choice of BA or BS and Chem 111 or Chem 107/108). Probably about half of our Chemistry majors follow one of these sequences, while the other half pick a slightly different pathway. The key factor to bear in mind is that not all of the upper level Chemistry courses are offered every semester. As a result, you will want to plan carefully to make certain that you fulfill the prerequisites in time to take certain courses in the semester in which they are offered.

One final point - all of the required courses for the Chemistry degree are guaranteed to be offered. However, some of the elective courses (particularly the Topics courses Chem 481-486) may not be offered depending on staffing and student interest. The Chemistry Department has a good idea which electives will be offered by the time of pre-registration and this information can be obtained from either of the Chemistry Department offices (Room 226 or 236, Science II). As always, you should talk with your chemistry advisor regarding course scheduling.

WHEN CHEMISTRY COURSES ARE OFFERED

Course	Name	Semester offered
100	Basic Chemistry	every spring
101	Introduction to Chemistry I	every fall
102	Introduction to Chemistry II	every spring
107	Introductory Chemistry I	every fall; summer term I
108	Introductory Chemistry II	every spring; summer term II
111	Chemical Principles	every fall
180	Freshman Chemistry Semester	every fall
221	Introduction to Analytical Chemistry	every spring
231	Organic Chemistry I	every semester; summer term I
332	Organic Chemistry II	every semester; summer term II
335	Organic Chemistry Laboratory	every semester; summer term II
341	Inorganic Chemistry	every fall
351	Introduction to Physical Chemistry	every fall
361	Biophysical Chemistry	every fall
391	Practicum in College Teaching	every semester
397	Independent Work	every sem.; occasionally summer term I & II
411	Techniques for Studying Solids	alternating years, usually fall
421	Advanced Analytical Chemistry	every year, spring or fall
422	Instrumental Methods of Analysis	every fall
431	Physical Organic Chemistry	occasionally
432	Chemical Synthesis	occasionally
434	Bioorganic Chemistry	usually every spring
442	Introduction to Physical Inorganic	occasionally fall
443	Molecular Photochemistry	usually every fall
444	Chemistry of Solids	every spring
445	Inorganic/Materials Chemistry Lab	occasionally
451	Quantum Chem, Spectroscopy, Kinetics	spring, even number years ('00, '02 …)
452	Thermodynamics Statistical Thermodynamics	spring, odd numbered years (′01, 03 ..)
455	Experimental Physical Chemistry	every fall
462	Biomembranes and Biopolymers	every spring
481	Topics in Materials Chemistry	every year if possible
482	Topics in Analytical Chemistry	every year if possible
483	Topics in Organic Chemistry	every year if possible
484	Topics in Inorganic Chemistry	every year if possible
485	Topics in Physical Chemistry	every year if possible
486	Topics in Biophysical Chemistry	occasionally
488	Special Topics in Chemistry	occasionally
496	Senior Seminar	every semester
497	Advanced Independent Study	every semester
498	Advanced Independent Research - Honors	every semester

- For 2009– 2010, Chem 111 will be offered both Fall and Spring semesters on an experimental basis.
- For For 2009– 2010, Chem 451 will be offered Fall semester and Chem 452 will be offered Spring semester on an experimental basis.

SAMPLE COURSE SEQUENCE FOR BA DEGREE WITH CHEM 107-108

Year	Fall Semester	Spring Semester
Freshman	Chem 107 Math 221	Chem 108 Math 222
Sophomore	Chem 231 Phys 131	Chem 332 Phys 132 Chem 221
Junior	Chem 341 Chem 351	Chem Elective Chem Elective
Senior	Chem 496 Chem Elective	Chem Elective

Chem electives must include 1½ courses selected from Chem 335, 422, 445, 455, 462, 497/498 (these are lab courses). Additional all-college elective courses would be taken to complete a full course load. Physics with calculus (Phys 131 and 132) is strongly recommended but not required (Phys 121 and 122 can be taken instead.)

SAMPLE COURSE SEQUENCE FOR BA DEGREE WITH CHEM 111

Year	Fall Semester	Spring Semester
Freshman	Chem 111 Math 221	Chem 231 Math 222
Sophomore	Chem 332 Phys 131	Chem 221 Phys 132
Junior	Chem 341 Chem 351	Chem Elective Chem Elective
Senior	Chem 496 Chem Elective	Chem Elective Science Elective

Chem Electives must include 1½ courses selected from Chem 335, 422, 445, 455, 462, 497/498 (these are lab courses). The Science Elective can be any course within the Division of Science and Mathematics (e.g., Biol 113, Psyc 111, Math 323 or chemistry elective). Additional all-college elective courses would be taken to complete a full course load. Physics with calculus (Phys 131 and 132) is strongly recommended but not required (Phys 121 and 122 can be taken instead.)

SAMPLE COURSE SEQUENCE FOR BS DEGREE WITH CHEM 107-108

Year	Fall Semester	Spring Semester
Freshman	Chem 107 Math 221	Chem 108 Math 222
Sophomore	Chem 231 Phys 131	Chem 332 Chem 335 Chem 221 Phys 132
Junior	Chem 341 Chem 351 Chem 422	Physical Chem II Inorganic Chem II Science Elective
Senior	Chem 455 Chem 496 Science Elective	Science Elective Science Elective

Physical Chem II can be Chem 451 or Chem 452.
Inorganic Chem II can be Chem 442, 443, 444, 445 or 484.
The Science Electives can be any course within the Division of Science and Mathematics (e.g., Bio 113, Psyc 111, Math 323, or chemistry elective).
Additional all-college elective courses would be taken to complete a full course load.
Physics with calculus (Phys 131 and 132) is strongly recommended but not required (Phys 121 and 122 can be taken instead.)

SAMPLE COURSE SEQUENCE FOR BS DEGREE WITH CHEM 111

Year	Fall Semester	Spring Semester
Freshman	Chem 111	Chem 231
	Math 221	Math 222
Sophomore	Chem 332	Chem 221
	Chem 335	Science Elective
	Phys 131	Phys 132
Junior	Chem 341	Physical Chem II
	Chem 351	Inorganic Chem II
	Chem 422	Science Elective
Senior	Chem 455	Science Elective
	Chem 496	Science Elective

Physical Chem II can be Chem 451 or Chem 452.
Inorganic Chem II can be Chem 442, 443, 444, 445 or 484.
The Science Electives can be any course within the Division of Science and Mathematics (e.g., Bio 113, Psyc 111, Math 323, or chemistry elective).
Additional all-college elective courses would be taken to complete a full course load.
Physics with calculus (Phys 131 and 132) is strongly recommended but not required (Phys 121 and 122 can be taken instead.)

OTHER USEFUL INFORMATION

AP Credit - Binghamton University recognizes good performance on the Advanced Placement (AP) exam in Chemistry. For a score of 5 on this exam, Binghamton University gives 8 credits of Chem 107/108, thereby fulfilling the General Chemistry requirement. For a score of 4, the Chemistry Department will grant credit for Chem 111, Chem 107, or unspecified chemistry credit. The assignment of credit will be made after a student consults a chemistry advisor. For a score of 3, 4 credits equivalent to Chem 101 is awarded, which can be counted toward the number of credits required for graduation, but does not count toward the Chemistry major.

Pre-Health Curriculum - Most students interested in a health career major in one of the sciences. For those who major in Chemistry, all of the science requirements are fulfilled with the exception of two courses in Biology - Biol 117 and 118. Fortunately, these courses can be used to fulfill the science elective requirements of the BS degree (as well as the BA degree with Chem 111). Students interested in a pre-health curriculum should contact the Pre-Health Advisor in the Harpur College Advising office.

WHAT IF I DECIDE TO BECOME A CHEMISTRY MAJOR LATE?

A lot of students do not know what major they want to choose right away. In that case, the best option is to take a general mix of courses in the first couple of years. That works fine for the Chemistry major, provided that you take General Chemistry, Organic Chemistry, Math and Physics in the first couple of years. Fortunately, these are the same basic requirements for a number of the science majors, so there is still a lot of room for changing majors in the first two years without much problem.

But, if you have not completed all of those courses by the end of your sophomore year, all is not lost. At Binghamton University, General Chemistry, Organic Chemistry, Physics, and Calculus are all offered during the summer. You can also take these courses at another college or university over the summer as well. If you pursue this last option, however, you will want to fill out the appropriate Binghamton University transfer credit form and talk to the Chemistry Department Undergraduate Program Director before you take courses at the other college or university This will require a copy of the catalog description of the course that you wish to take.

THE WRITING REQUIREMENT

To obtain a baccalaureate degree at Harpur College, you must complete the writing requirement. Courses satisfying this requirement are designated composition (C) or writing (W). The requirement can be satisfied by of the following three combinations: 2 C and 3 W courses, 3 C and 1 W courses, or 4 C courses. The Chemistry Department offers several courses that can be used to satisfy the writing requirement as seen in the following table. Although it is possible to satisfy the writing requirement by using all Chemistry courses, this is not necessarily the best option since the Chemistry courses are all upper level courses that would normally be taken as a junior or senior. To obtain early instruction in writing (and to avoid delays in graduation), it is wise to take some writing (W or C) courses early in your career at Binghamton University.

WRITING COURSES
OFFERED BY THE CHEMISTRY DEPARTMENT

Course	Name	Writing Requirement	Chemistry requirement
Chem 422	Instrumental Methods of Analysis	C	Required for BS; elective for BA
Chem 445	Inorganic/Materials Lab	C	Elective for BS and BA
Chem 455	Physical Chemistry Lab	C	Required for BS; elective for BA
Chem 462	Biopolymers and Biomembranes	L	Elective for BS and BA
Chem 496	Senior Seminar	O	Required for BS and BA

INDEPENDENT STUDY AND HONORS

There is another exciting aspect to pursuing at degree in Chemistry that many students find the most interesting and satisfying part of their studies - independent research. There are three courses that fall into this category - CHEM 397, 497, and 498. In any of these courses, you will be working directly in the research group of one faculty member on a real research project. This gives you the chance to obtain real research experience and to more fully understand what all goes into a well planned and executed series of experiments.

The details of the independent study courses in the Chemistry department are described in greater detail in another handout (The Guide to Undergraduate Research), but a few of the highlights are outlined below.

CHEM 397 - this is the typical first course for independent study and requires no advance preparation other than finding a faculty member who is doing research that you think is interesting and obtaining permission from them to do research in their group.

CHEM 497 - this is a more advanced level of independent study and requires you to write a brief outline of what research project you intend to pursue and what some of the key experiments will be. This course can be repeated several times.

CHEM 498 - this is a special independent study course for students who decide (with their faculty advisor's consent) to pursue honors in Chemistry by writing and defending an honors thesis. Successful completion of these requirements will result in the honor "Distinguished Independent Work in Chemistry" being awarded.

As for what research the different faculty members in the department are pursuing, a brief guide follows, but more details can be found in the "Guide to Undergraduate Research" or on the different faculty members web sites (http://chemistry.binghamton.edu/). Note that only a maximum of 4 credits of Chem 397 can count toward chemistry degrees, and a maximum of 12 total credits of independent study can count toward chemistry degrees.

FACULTY AND RESEARCH INTERESTS

The following list describes briefly each faculty member's research. For a more detailed description, refer to the "Guide to Undergraduate Research" available from the department office or visit our web site at: http://chemistry.binghamton.edu/

FACULTY MEMBER	ROOM	PHONE	RESEARCH INTEREST
Susan L. Bane	320	72927	Bioorganic and Biophysical Chemistry; ligand receptor mechanisms
Nikolay G. Dimitrov	G37	74271	Electroanalytical Chemistry and Electrochemistry
James A. Dix	808	72480	Biophysical Chemistry; Computational Chemistry
David C. Doetschman	B28	72298	Materials and Physical Chemistry; molecular reorientation, interactions and reactions in porous aluminosilicates, photochemistry, electron paramagnetic resonance and dielectric spectroscopy
John J. Eisch	328	74261	Organic Chemistry; synthetic and mechanistic studies of organometallic and heterocyclic compounds
Jiye (James) Fang	G33	73752	Inorganic and Materials Chemistry, Nanotechnology
Christof T. Grewer	816	73250	Biophysical Chemistry
Wayne E. Jones, Jr.	609	72421	Inorganic Chemistry; materials science, inorganic photochemistry and photophysics
Alistair J. Lees	815	72362	Inorganic Chemistry; synthesis, photophysics and photochemistry of transition metal organometallic complexes
Zhitao Li	332	74825	Organic Chemistry; carbohydrate chemistry and natural product synthesis
Eriks Rozners	315	72441	Organic, Bioorganic and Biophysical Chemistry of Carbohydrates and Nucleic Acids; Organic Synthesis and Assymetric Catalysis
Omowunmi A. Sadik	708		74132 Analytical Chemistry; environmental chemistry, interfacial molecular recognition processes, chemical sensors
Michael E. Starzak	129	72089	Biophyscial Chemistry; biophysical chemistry of membranes
Eugene S. Stevens	128	74244	Biophysical Chemistry biophysical chemistry of saccharides and polysaccharides
M. Stanley Whittingham	120	74623	Materials and Inorganic Chemistry; synthesis and properties of new materials
Chuan-Jian Zhong	713	74605	Analytical Chemistry, Materials Chemistry, Electrochemistry, Nanotechnology

OTHER OPPORTUNITIES

Undergraduates often wish to work during the summer months on a research project in chemistry. There are several ways that this can be accomplished. A faculty member may have a grant which includes summer support for undergraduates. Typically, these openings are filled by students who have done independent research with the particular faculty member during the academic year. A second possibility for summer research is to apply to other universities to work in a research laboratory. Many universities have federally-funded programs which encourage applications nation-wide. A third possibility is to apply to industrial chemical companies that often have a summer internship program. Notices of summer research opportunities are posted on department bulletin boards.

UNDERGRADUATE CHEMISTRY SOCIETY

The Undergraduate Chemistry Society offers a way for interested students to become an integral part of the SUNY Binghamton Chemistry Department. One vital function of the Undergraduate Chemistry Society is to represent student interests in the operation of the Department of Chemistry. The organization chooses representatives to departmental committees such as the Undergraduate Program Committee and coordinates student evaluation of faculty members who are candidates for contract renewal or tenure.

The Undergraduate Chemistry Society also offers to students new to Harpur College and the Chemistry Department the experiences of upper-class members.

Finally, members of the Undergraduate Chemistry Society enjoy the privileges of belonging to a chartered organization of the Student Association (SA). SA affiliation enables the Undergraduate Chemistry Society to sponsor trips to industrial laboratories such as Proctor & Gamble, Norwich.

THE FUTURE

What jobs are there for someone with a Chemistry degree?

One of the attractive features of a chemistry degree is the flexibility it gives one in terms of career paths. It will allow entry into many types of graduate and professional schools, as well as provide immediate entry into an industrial position.

The major employers of BS chemists are the pharmaceutical, petroleum, and large chemical industries, as well as private laboratories and small industries. Depending upon the industry, the responsibilities of the bachelor degree chemist range from being completely independent to functioning as a technician. In general, regulated industries such as pharmaceuticals will utilize Ph.D chemists as group leaders, heading teams of 3-10 BS, MS and PhD chemists on specific projects. In such industries, your career path to management will be limited without a PhD. The jobs available can be extremely challenging. You will often learn entirely new skills, and utilize specialized state of the art instrumentation.

Another major career path for baccalaureate chemists is sales and marketing. The size of the instrumentation, chemicals, and supplies market is very large. In these jobs, a BS or BA degree will not limit your career path.

The job market for BS or BA chemists is excellent. There is currently a shortage of good BS and BA chemists, and that this situation will continue into the foreseeable future. The unemployment rate for chemists of all types tends to be well under the national average.

In terms of finding a job, there are a few good resources that are readily available. One is *Chemical and Engineering News* (C&EN). In every issue (weekly), there are a number of job advertisements in the back section. A second source of information about jobs is your Chemistry advisor or any other faculty member. The Chemistry Department also maintains a bulletin board posting of current job openings. Finally, this University also has an excellent Career Development Center (LSG-500, Ext. 7-2191) which can help you in your search as well as in preparation of a resume and interview training.

Summer employment during your sophomore or junior years is also an excellent way to gain experience, and to develop a relationship with a potential employer. If you are from the metropolitan NY/NJ area, you should be aware that there are numerous summer job positions in major pharmaceutical companies. Even in the Binghamton area, many potential opportunities exist, such as Proctor & Gamble, Norwich, several private laboratories, NYSEG and others. One of the best sources of information on such jobs is through your professors, who often have professional contacts with other scientists in various industries. These summer jobs often lead to permanent employment.

What about graduate school?

If you've had four years of undergraduate school, perhaps the last thing you want to do is start all over again and commit yourself to graduate school. At the same time, your opportunity for advancement is limited with a BA or BS, so you will want to decide if you will be doing chemistry as a profession for a number of years and how high you wish to go. If you love the field and want to advance beyond the bench, then why not continue to learn in graduate school, do truly independent research, and be paid for studying at the same time?

That's right. In the sciences, you are in the enviable position that graduate school will usually be "free." Almost invariably, you will be offered a stipend, ranging from about $15,000 to $25,000 per year (plus a tuition waiver) for a Teaching Assistantship (TA) or for a Research Assistantship (RA). Most universities will support a graduate student for up to four years, usually as a TA. However, typically you will join a research group by your second year, and if the group is well funded, you will be supported by an RA through a grant and be able to work full time on your research without the teaching responsibilities. In addition, there are usually fellowships available, through the university or through agencies like the National Science Foundation (NSF), although some fellowships like the NSF fellowships are very competitive.

The average time required to obtain an MS degree should be two years. A Ph.D. usually takes about five years.

Selecting a graduate school

You have more control (and responsibility) over the direction of your graduate career than you did with your BS or BA degree. Probably the most important decision you will make will be to select your research advisor. A graduate degree is much like an apprenticeship, and the research group you choose will influence your career for many years. However, there is no crystal ball to help you select the school and the group where you wish to pursue your degree. Some people know exactly what area of specialization they wish to pursue, perhaps by undergraduate research in a given area. If so, selecting a graduate school will be easier, since various universities tend to have strengths in the various fields. If you are not sure of your specific interests (like most people) you should at least be able to narrow your interests to broad areas like organic, inorganic, physical, analytical chemistry or some interdisciplinary area such as nanotechnology or environmental chemistry. Selecting a school with a strong representation in any of these areas is much easier, and can usually be narrowed to two to three good choices. A good source of information on graduate departments is

the *ACS Directory of Graduate Research*. Talk to your professors, who can help guide you in matching your personality and interests to those of the departments you are considering.

How does one apply to graduate school?

The procedure is similar to applying to an undergraduate school. Scores from a Graduate Record Exam (GRE), consisting of Verbal, Quantitative and Specialized sections, will usually be required, along with the admissions application. The career development office can assist you in locating where and when GRE's will be given. You should write to the departments in which you are interested, and arrange to visit. Given the paucity of undergraduates wanting to attend graduate school in chemistry, you may be given an all-expense-paid trip to visit the graduate school. You should also talk to the professors in the department who do research in areas that match your interests.

The criteria for acceptance to graduate school vary. Your undergraduate record, consisting of courses taken, grades, undergraduate research, extracurricular activities, etc., weighted by the general strength of your school, will be a strong consideration. A second consideration will be your GRE scores. Finally, letters of recommendation count very strongly. The admissions committee will be looking not only for strong grades. They will also try to determine your motivation and perseverance, since these qualities, probably as much or more so than academic skills, will determine your success both in graduate school and in your career.

Student Statistics

When choosing which of the 64 Harpur College degree programs is suitable for your particular interests, you may want to consider what other students in the chemistry degree program have done.

Over a recent five-year period, graduating seniors have been accepted into chemistry, bio-physical chemistry and materials chemistry programs at the following universities: Brown, Columbia University, Dartmouth, Kansas State, New York University, Northwestern, SUNY Binghamton, SUNY at Brooklyn, Syracuse University, University of Michigan, University of Pennsylvania, University of Toronto, Washington University, UCLA, Berkeley.

Over the same period around one-fourth of our graduates have gone directly into industrial, government or non-academic university positions (Corning, General Electric, Visco-Alpha, U.S. Government, Interventional Infometric Institute (Syracuse University)).

About one quarter of graduating chemistry majors enter into schools of medicine or related fields. Over a recent three year period, students have been accepted into Columbia (dental), New York Medical College (medical research), New York University (dental), SUNY Buffalo (medical), SUNY Optometry, Syracuse University (medical).

This Handbook was written by the Chemistry Department Undergraduate Program Committee (UPC) in 1992 and revised by the UPC in 2008.