



BROWN

2015 - 2016

**THE DEPARTMENT OF CHEMISTRY
UNDERGRADUATE HANDBOOK**

**Including the Chemistry, Biochemistry and
Chemical Physics Concentrations**

Updated February 3, 2016

TABLE OF CONTENTS

Chemistry Concentration Programs

Chemistry Requirements AB	3
Chemistry Requirements ScB (3 tracks)	4
Chemical Biology Track	5
Materials Chemistry Track	6
Chemistry AB or ScB?	6
Biochemistry Requirements	7
Chemical Physics Requirements	9

Honors

Honors in Chemistry	10
Honors in Biochemistry	10
Honors in Chemical Physics	11

Research

Independent Study	11
Research Practices	13

Department Prizes and Events

Student Undergraduate Prizes	14
Seminars, Colloquia and Special Lectures	15

The Chemistry DUG 15

Beyond Brown

What Becomes of Chemistry Graduates?	16
Applying to Graduate School	17
Applying to Medical School	19
Finding a Job	19

**revised 2/3/16*

CONCENTRATION PROGRAMS

Chemistry AB
Chemistry ScB
 Chemistry Track
 Chemical Biology Track
 Materials Chemistry Track
Biochemistry ScB
Chemical Physics ScB

Chemistry AB

Advisor: Amit_Basu@brown.edu

Course Requirements:

The expectation is that courses required for the concentration will be taken for a letter grade.

CHEM 0330	Equilibrium, Rate, and Structure	1
CHEM 0350	Organic Chemistry	1
CHEM 0360	Organic Chemistry	1
CHEM 0500	Inorganic Chemistry	1
CHEM 1140	Physical Chemistry: Quantum Chemistry ¹	1
CHEM 1150	Physical Chemistry: Thermodynamics and Statistical Mechanics ¹	1
CHEM 1160	Physical Chemistry Laboratory ¹	1
Electives	Two advanced science/math electives. ²	2
Total Credits		9

¹ Note that the physical chemistry courses (CHEM 1140, CHEM 1150, CHEM 1160) have mathematics and physics prerequisites.

² At least one of these electives must be an upper level chemistry course. BIOL 0280 is credited as a chemistry course for Concentration purposes. Non CHEM electives are upper level science/math courses with a significant molecular focus or those that cover tools/techniques that are of utility to a chemist. You should discuss your elective choices with the Concentration Advisor to craft a course of study that is appropriate for your interests.

Chemistry ScB

Advisor: Amit_Basu@brown.edu

The Chemistry Department has three tracks for the Sc.B. Chemistry Concentration – A Chemistry track, a Chemical Biology track and a Materials Chemistry track. These tracks are not separate concentrations – your degree will still be a Sc.B. in Chemistry. The Chemical Biology track is designed for students who have a strong interest in the interface of chemistry with biology. The Materials Chemistry track is designed for students who have a strong interest in the interface of chemistry with nanoscience and materials science.

Course Requirements:

Concentrating in Chemistry – Three tracks

The required/recommended courses for the three tracks are given below. The expectation is that courses required for the concentration will be taken for a letter grade.

Chemistry Track:

CHEM 0330	Equilibrium, Rate, and Structure	1
CHEM 0350	Organic Chemistry	1
CHEM 0360	Organic Chemistry	1
CHEM 0500	Inorganic Chemistry	1
CHEM 0970*	Undergraduate Research	1
CHEM 0980*	Undergraduate Research	1
CHEM 1140	Physical Chemistry: Quantum Chemistry	1
CHEM 1150	Physical Chemistry: Thermodynamics and Statistical Mechanics	1
CHEM 1160	Physical Chemistry Laboratory	1
MATH 0180	Intermediate Calculus or equivalent ³	1
Physics	Two Physics courses ²	2
Electives	7 Electives (at least three must be in Chemistry) ⁴	7
Total Credits		19

*CHEM 0970/0980 should be carried out with a faculty member with an appointment in the Chemistry Department. Research with faculty advisors outside of the Chemistry Department can be arranged upon discussion with the Concentration Advisor. Note: a thesis is required to be eligible for graduation with Honors. CHEM0970/0980 can be repeated for credit.

¹ BIOL 0280 is credited as a chemistry course for Concentration purposes. Non CHEM electives are upper level science/math courses with a significant molecular focus or those that cover tools/techniques that are of utility to a chemist. You should discuss your elective choices with the Concentration Advisor to craft a course of study that is appropriate for your interests.

² For students with a more Engineering bent, the following substitutions can be made - ENGN 0030/ENGN 0040 can be substituted for PHYS; ENGN 0410 can be substituted for CHEM 1060; ENGN 0720 for CHEM 1150.

³ NOTE: MATH 0180 has additional prerequisites.

⁴ NOTE: Many of the BIOL courses have BIOL 0200 as a prerequisite.

Chemical Biology Track:

CHEM 0330	Equilibrium, Rate, and Structure	1
CHEM 0350	Organic Chemistry	1
CHEM 0360	Organic Chemistry	1
CHEM 0400 or CHEM0500	Biophysical and Bioinorganic Chemistry / Inorganic Chemistry	1
CHEM 0970*	Undergraduate Research	1
CHEM 0980*	Undergraduate Research	1
CHEM 1140	Physical Chemistry: Quantum Chemistry	1
CHEM 1230	Chemical Biology	1
CHEM 1240	Biochemistry	1
BIOL 0280	Introductory Biochemistry ¹	1
MATH 0180	Intermediate Calculus or equivalent ³	1
Physics	Two Physics courses ²	2
	Select three of the following: ⁴	3
BIOL 0470	Genetics	
BIOL 0500	Cell and Molecular Biology	
BIOL 0510	Introductory Microbiology	
BIOL 0530	Principles of Immunology	
BIOL 0800	Principles of Physiology	
NEUR 1020	Principles of Neurobiology	
		3
Electives	Three other electives ¹	
Total Credits		19

*CHEM 0970/0980 should be carried out with a faculty member with an appointment in the Chemistry Department. Research with faculty advisors outside of the Chemistry Department can be arranged upon discussion with the Concentration Advisor. Note: a thesis is required to be eligible for graduation with Honors. CHEM0970/0980 can be repeated for credit.

¹ BIOL 0280 is credited as a chemistry course for Concentration purposes. Non CHEM electives are upper level science/math courses with a significant molecular focus or those that cover tools/techniques that are of utility to a chemist. You should discuss your elective choices with the Concentration Advisor to craft a course of study that is appropriate for your interests.

² For students with a more Engineering bent, the following substitutions can be made - ENGN 0030/ENGN 0040 can be substituted for PHYS; ENGN 0410 can be substituted for CHEM 1060; ENGN 0720 for CHEM 1150.

³ NOTE: MATH 0180 has additional prerequisites.

⁴ NOTE: Many of the BIOL courses have BIOL 0200 as a prerequisite.

Materials Chemistry Track

CHEM 0330	Equilibrium, Rate, and Structure	1
CHEM 0350	Organic Chemistry	1
CHEM 0360	Organic Chemistry	1
CHEM 0500	Inorganic Chemistry	1
CHEM 0970*	Undergraduate Research	1
CHEM 0980*	Undergraduate Research	1
CHEM 1060	Advanced Inorganic Chemistry ²	1
CHEM 1140	Physical Chemistry: Quantum Chemistry	1
CHEM 1150	Physical Chemistry: Thermodynamics and Statistical Mechanics ²	1
CHEM 1700	Nanoscale Materials: Synthesis and Applications	1
MATH 0180	Intermediate Calculus or equivalent ³	1
Physics	Two Physics courses ²	2
BIOL 1090	Polymer Science for Biomaterials ⁴	1
Electives	Five electives, at least two must be chemistry courses. ¹	5
Total Credits		19

*CHEM 0970/0980 should be carried out with a faculty member with an appointment in the Chemistry Department. Research with faculty advisors outside of the Chemistry Department can be arranged upon discussion with the Concentration Advisor. Note: a thesis is required to be eligible for graduation with Honors. CHEM0970/0980 can be repeated for credit.

¹ [BIOL 0280](#) is credited as a chemistry course for Concentration purposes. Non CHEM electives are upper level science/math courses with a significant molecular focus or those that cover tools/techniques that are of utility to a chemist. You should discuss your elective choices with the Concentration Advisor to craft a course of study that is appropriate for your interests.

² For students with a more Engineering bent, the following substitutions can be made - [ENGN 0030/ENGN 0040](#) can be substituted for PHYS; [ENGN 0410](#) can be substituted for [CHEM 1060](#); [ENGN 0720](#) for [CHEM 1150](#).

³ NOTE: [MATH 0180](#) has additional prerequisites.

⁴ NOTE: Many of the BIOL courses have [BIOL 0200](#) as a prerequisite.

Chemistry ScB or AB?

The answer depends on your long-range goals as well as your immediate interests. If you have other interests you want to pursue – perhaps a second concentration in the Humanities or Social Sciences – the ScB program may place too many demands on your time and the AB program may make more sense. The experience of Independent Study is extremely important if you are considering graduate school, but you don't have to be an ScB candidate to do Independent Study. Graduate schools and employers will take a look at your record of courses, not necessarily the degree itself. Ultimately the choice boils down to how many of your courses at Brown are dedicated to your concentration, and how many explore other options.

Biochemistry ScB

Advisor: Christopher_Seto@brown.edu

Standard program for the Sc.B. degree

Students must take twenty courses in biology, chemistry, mathematics, and physics, including the following core requirements; some of these may be fulfilled with AP credits.

Students are expected to take courses that will count toward the concentration ABC/NC. Students should discuss the S/NC option with their concentration advisor if circumstances warrant consideration. Students should not register S/NC for a concentration course without advisor pre-approval.

Three courses in mathematics, statistics and/or computer science, typically including MATH 0090, MATH 0100, or equivalent) ¹		3
Two courses in physics, typically: ¹		
PHYS 0030	Basic Physics or PHYS 0050 Foundations of Mechanics or ENGN 0030 Introduction to Engineering	1
PHYS 0040	Basic Physics or PHYS 0060 Foundations of Electromagnetism and Modern Physics or ENGN 0040 Dynamics and Vibrations	1
Three courses in physical and organic chemistry:		
CHEM 0330	Equilibrium, Rate, and Structure	1
CHEM 0350/0360	Organic Chemistry	2
One course in biophysical or related chemistry:		
CHEM 0400	Biophysical and Bioinorganic Chemistry or CHEM 0500 Inorganic Chemistry or CHEM 1660/GEOL 1660 Instrumental Analysis with Environmental Applications	1
Three courses in biochemistry:		
BIOL 0280	Introductory Biochemistry	1
BIOL 1270	Advanced Biochemistry	1
CHEM 1230	Chemical Biology	1
Select two semester courses of independent research approved by a concentration advisor:		2
BIOL 1950/1960	Directed Research/Independent Study	
-or-		
CHEM 0970/0980	Undergraduate Research	
Suggested Elective Courses:		

Students are required to take six (6) elective courses: four (4) taken from the chart below and two (2) from any science or mathematics course relevant to biochemistry, cell and molecular biology from the suggested courses below:

Biology Electives:

4

BIOL 0200 The Foundation of Living Systems
BIOL 0470 Genetics
BIOL 0500 Cell and Molecular Biology
BIOL 0530 Principles of Immunology
BIOL 0800 Principles of Physiology
BIOL 1050 Biology of the Eukaryotic Cell
BIOL 1090 Polymer Science for Biomaterials
BIOL 1100 Cell Physiology and Biophysics
BIOL 1110 Topics in Signal Transduction
BIOL 1200 Protein Biophysics and Structure
BIOL 1150 Stem Cell Engineering
BIOL 1260 Physiological Pharmacology
BIOL 1290 Cancer Biology
BIOL 1540 Molecular Genetics
BIOL 1560 Virology

Neuroscience Electives: ²

NEUR 1020 Principles of Neurobiology
NEUR 1670 Neuropharmacology and Synaptic Transmission

Chemistry Electives:

CHEM 0500 Inorganic Chemistry
CHEM 1140 Physical Chemistry: Quantum Chemistry
CHEM 1220 Computational Tools in Biochemistry and Chemical Biology
CHEM1230 Chemical Biology
CHEM 1240 Biochemistry
CHEM 1450 Advanced Organic Chemistry

Quantitative Science or Mathematics Electives:

2

Select two electives from any quantitative science or mathematics course relevant to biochemistry (including courses on the preceding list) and approved by a concentration advisor.

Total Credits

20

¹Note that the mathematics and physics requirements may be satisfied by Advanced Placement credit.

²or any NEUR course in Cell, Genetics, Molecular Biology, or Development.

Chemical Physics ScB

Advisor: Richard_Stratt@brown.edu

Standard program for the Sc.B. degree

The expectation is that courses required for a concentration in Chemical Physics will be taken for a letter grade.

CHEM 0330	Equilibrium, Rate, and Structure	1
CHEM 0350	Organic Chemistry	1
CHEM 0500	Inorganic Chemistry	1
CHEM 1140	Physical Chemistry: Quantum Chemistry	1
PHYS 0070	Analytical Mechanics	1
PHYS 0160	Introduction to Relativity and Quantum Physics	1
PHYS 0470	Electricity and Magnetism	1
Select one of the following laboratory courses:		1
	CHEM 1160 Physical Chemistry Laboratory	
	PHYS 0560 Experiments in Modern Physics	
	PHYS 1560 Modern Physics Laboratory	
Select one course in statistical mechanics:		1
	CHEM1150 Physical Chemistry: Thermodynamics and Statistical Mechanics	
	PHYS 1530 Thermodynamics and Statistical Mechanics	
MATH 0190	Advanced Placement Calculus (Physics/Engineering)	1
MATH 0200	Intermediate Calculus (Physics/Engineering)	1
MATH 0520	Linear Algebra	1
Seven courses, primarily at the 1000 or 2000 level, in chemistry or physics.		7
Select two semesters of independent study:		2
	CHEM 0970/0980 * Undergraduate Research	
	PHYS 1990 Senior Conference Course	
Total Credits		21

1

Other approved courses in applied mathematics, biology, computer science, geological sciences, or engineering may be substituted for some of the twenty-one.

Students are advised to take at least six courses in the humanities and social sciences.

* CHEM0970/0980 can be repeated for credit.

CONCENTRATION HONORS

The Honors program provides a way of recognizing a student who has performed to a high standard in his or her concentration program. The recognition takes the form of an extra inscription on the diploma: "Honors in Chemistry." Interestingly, this is the only way in which the concentration can be mentioned on the diploma. Otherwise the diploma simply says, "Baccalaureato in Scientia" or "Baccalaureato in Artibus."

Honors Requirements for Chemistry

All ScB Chemistry concentrators, and any AB concentrator who completes the following requirements, are candidates for Honors; no separate application is necessary.

The requirements for Honors in Chemistry are:

- * A strong grade record in concentration courses. This means a grade point average for the concentration that is higher than 3.50.
- * Two semesters of Independent Study (CHEM 0970, CHEM 0980) or equivalent.
- * A Thesis in a form approved by the research advisor, and recommended by the research advisor. Additional information about thesis guidelines will be provided by the Concentration Advisor in the first half of the fall semester.
- * A Poster presentation at the chemistry department's spring undergraduate poster session. The Undergraduate Poster Session will be held on Wednesday, March 23, 2016.
- * Students who wish to be considered for the Leallyn B. Clapp Outstanding Thesis prize must give an oral presentation in early May.

Honors Requirements for Biochemistry

All ScB Biochemistry concentrators are candidates for Honors; no separate application is necessary.

The requirements for Honors in Biochemistry are:

- * A strong grade record in concentration courses. This means a grade point average for the concentration that is higher than 3.50.
- * Two semesters of Independent Study (CHEM 0970, CHEM 0980) or equivalent.
- * A Thesis in a form approved by the research advisor, and recommended by the research advisor. Additional information about thesis guidelines will be provided by the Concentration Advisor in the first half of the fall semester.
- * Students who wish to be considered for the Leallyn B. Clapp Outstanding Thesis prize must give an oral presentation in early May.

Honors Requirements for Chemical Physics

All ScB Chemical Physics concentrators are candidates for Honors; no separate application is necessary.

The requirements for Honors in Chemical Physics are:

- * A strong grade record in concentration courses. This means a grade point average for the concentration that is higher than 3.50.
- * Two semesters of Independent Study (CHEM 0970, CHEM 0980) or equivalent.
- * A Thesis in a form approved by the research advisor, and recommended by the research advisor. Additional information about thesis guidelines will be provided by the Concentration Advisor in the first half of the fall semester.
- * A Poster presentation at the chemistry department's spring undergraduate poster session. The Undergraduate Poster Session will be held on Wednesday, March 23, 2016.
- * Students who wish to be considered for the Leallyn B. Clapp Outstanding Thesis prize must give an oral presentation in early May.

RESEARCH

Independent Study

Independent Study in Chemistry means **RESEARCH** under the direction of a faculty Research Advisor. The choice of a Research Advisor is crucial to your success. Your Research Advisor will suggest a project, provide the space and facilities needed, help with the design and execution of experiments and guide you in the interpretation of your results. The Research Advisor is committed to spending a lot of time with you, and you should do your best to fulfill your end of the bargain.

CHEM 0970, 0980 are courses that (like all Brown courses) are expected to fill about 25% of your time. Unlike most other courses, however, there are no lectures or exams to pace your progress. It is all too easy to put off research when a paper is due or an exam is imminent in another course. Success in Independent Study requires a degree of self-discipline that you may not have had to apply to other courses. Most students find that a *minimum* of 15-20 hours per week is needed to show any progress in research.

When to do an Independent Study

Almost all students carry out Independent Study during their senior year at Brown, often for their Senior Thesis. By that time, you will have completed the core courses in Chemistry and will have the necessary background for a research project. However, many students elect to start research during their Junior, Sophomore, or even Freshman year. It all depends on your class and extracurricular schedule, commitment and interest, and time-management capabilities.

The University has a program of Undergraduate Teaching and Research Assistantships (UTRA) for the support of research students during the summer. There are often other sources of funding. In any case, applications for summer support are due early in the second semester (usually the first week in February). Please note: a successful application requires advance planning with your research advisor.

Finding a Research Advisor and Registering for Independent Study

- If you hope to spend the summer on an UTRA, you should start looking for a Research Advisor during the preceding fall so that you can secure permission before the winter break and be ready with an application for support in early February. If you don't plan to spend the summer, you should be looking for an Advisor in the spring and have permission secured before leaving the campus in May.
- Define the general area of chemistry you would like to work in.
- Check out the possibilities in your chosen area. Visit the Chemistry Department individual faculty web sites for information and access recent faculty publications through the department website.

- Consider several possible projects before making up your mind – don't jump at the first opportunity. Choose three or four faculty you might be interested in working with and arrange appointments to discuss possible projects. Then narrow your list to one and return for a more detailed conversation. If you are still interested, ask for permission to enroll in Independent Study. Note that faculty time and lab space is not unlimited and that some faculty members may have to limit the number of undergraduate research advisees. Don't be discouraged if you get turned down – hopefully you will have a second choice as a back up.

Reporting Your Results

- **Poster Presentation:** During the Spring semester, typically March or early April, there will be a departmental poster presentation in which undergraduate researchers in the department present a poster describing the results of their work. A poster presentation is required for all Honors candidates in Chemistry and Chemical Physics. **The Poster Session will be held on Wednesday, March 23, 2016.**
- **Oral Presentation:** Senior oral presentations on their thesis work are held on the Monday and Tuesday of reading period. **The oral presentations for chemistry and chemical physics seniors will be held on Thursday, May 5 and Friday, May 6, 2016** Biochemistry oral presentation dates will be announced at a later date. All students who want to have their thesis considered for one of the departmental Thesis prizes must give an oral presentation of their thesis work.

Research Practices in the Department

For students carrying out research in the department, consult the graduate student handbook on the department website. This handbook contains information regarding laboratory safety, departmental/university policies and procedures, along with important safety information for undergraduates who perform research. All students engaged in laboratory research are required to complete all lab safety trainings before working in the lab. The Undergraduate Research Authorization Form and a volunteer release form must be signed by the research advisor. Please email chemistry@brown.edu for these forms or stop in GeoChem203 and speak with Sheila Quigley. Building access will be granted after all safety trainings are complete.

Independent Study away from Brown

Many universities, government laboratories and industrial research establishments sponsor undergraduate summer research programs. Notices of such programs are posted on the bulletin board outside of GeoChem 351 or are sent to the undergraduate listserv. Some opportunities are on file in Sheila Quigley's office (GeoChem 203) and in Dean Katherine Smith's office (Arnold 124).

Students sometimes develop a project in laboratory away from Brown, continuing over several summers. Very rarely, such a project may be used to satisfy the Independent Study requirements in a Brown concentration program. Since every case is different, no general guidelines have been formulated, but if you would like to pursue such an option, see the Concentration Advisor.

DEPARTMENT PRIZES AND EVENTS

Student Undergraduate Prizes

The Department of Chemistry annually awards a number of prizes to undergraduates:

- **The Freshman Chemistry Achievement Award:** A chemistry book is awarded to the top student in each lecture section of CHEM 0330.
- **The Organic Chemistry Prize for Chemistry Achievement:** A chemistry book is awarded to the top student(s) in CHEM 0360.
- **The New Concentrator with Outstanding Academic Record:** A chemistry book is awarded to the newly declared concentrator with the best overall academic record in CHEM 0330, 0350 and 0360.
- **The Junior Prizes in Chemistry and Biochemistry:** The outstanding Junior concentrators in Chemistry, Chemical Physics and Biochemistry are honored by the Junior Prize; they are selected on the basis of the strength of the academic transcript and GPA in the concentration courses.
- **The Paul Cross Prize in Physical Chemistry:** Awarded to a Senior who has demonstrated special promise in physical chemistry, the Cross Prize carries a cash award of \$100.
- **RI ACS Prize.** The RI ACS Section awardee for top Chemistry graduate is selected by the faculty on the basis of the best poster by a Honors Candidate in Chemistry.
- **The Leallyn B. Clapp Prize:** Awarded for the best Senior Thesis in Chemistry, Chemical Physics and Biochemistry, the Clapp Prize carries a cash award of \$100. Students who wish to be considered for the Leallyn B. Clapp Outstanding Thesis prize must give an oral presentation in May.

Seminars, Colloquia and Special Lectures

Regularly scheduled seminars in physical, organic and inorganic chemistry and biochemistry, as well as a Departmental Colloquium feature talks by faculty, graduate students and visitors from other institutions. The seminar program is intended to supplement and enrich the material available through formal course offerings. Suggestions for topics or speakers are welcome and should be brought to the attention of the seminar organizers. Notices of the seminars and colloquia are posted a week in advance on the bulletin boards on each floor and can be found on the department online calendar. Seminars are usually held in GeoChem 351 and Friday Colloquium is held in MacMillan 115.

The Chemistry DUG usually sponsors a Colloquium each year, choosing the topic, inviting the speaker and arranging for his or her entertainment.

Lecture series honoring John Howard Appleton (who taught at Brown from 1862 to 1914) and Leallyn Burr Clapp (who taught at Brown from 1941 to 1988) are often of special interest to undergraduates. Both lectures are followed by a reception to honor the guest lecturer. The Appleton Lecture is preceded by a reception especially for undergraduate concentrators and is followed by a dinner to which senior concentrators are invited.

CHEMISTRY DUG

The Chemistry Departmental Undergraduate Group (Chem DUG) allows Chemistry, Chemical Physics and Biochemistry concentrators (and prospective concentrators) to get together on a monthly basis, usually over an informal dinner. Besides providing an alternative to dormitory food, the meetings serve as a source of information about topics such as summer research opportunities (at Brown and elsewhere), the best ways to apply to graduate schools and the pros and cons of MD/PhD programs. Roughly once a year, the DUG invites an outside speaker to Brown for the purpose of giving a general interest seminar. The DUG also arranges Brown faculty research presentations, a chemistry demonstration night and other fun activities like making liquid nitrogen ice cream. In addition, the DUG selects several alumni to return to campus each spring for a Brown Degree Day dinner.

All declared concentrators are added to our chemistry department listserv. Additionally, students may email chemistry@brown.edu to be added to the listserv. The department hosts a Facebook page and a LinkedIn group for chemistry alumni. Please follow us on Facebook, join the listserv and LinkedIn group to keep up to date with all chemistry events. More information can be found on the department website, www.brown.edu/academics/chemistry/.

The DUG representatives for Academic Year 2015-16 are Tess Carter, Daniel Erdosy, Aida Feng, Trung Ho.. The faculty advisors are Professors Sandra Russo Rodriguez, Li Qiong Wang and Kathleen Hess.

BEYOND BROWN

What Becomes of Chemistry Graduates?

About two thirds of chemistry majors go on to further education including Graduate School for chemistry, biochemistry, engineering, business, law, education and medical/dental school. Brown's CareerLab lists Post Grad Outcomes on its website:

http://www.brown.edu/campus-life/support/careerlab/post_grad_data/list

Ultimately, nearly 60% of all people working as chemists or biochemists earn a PhD degree, about 20% get an ScM and the remaining 20% work with a bachelor's degree. About 10% of chemists and biochemists (almost entirely PhDs) end up in academic jobs. About 40% work for hospitals (clinical chemistry, pharmaceutical chemistry, etc.) or for government agencies (research laboratories such as the Argonne National Laboratory and the National Institutes of Health labs, enforcement agencies such as EPA or FDA, state health departments and environmental agencies and a variety of other jobs). The remaining 50% work in industry. The chemical industry includes companies producing "heavy chemicals" (sulfuric acid, sodium hydroxide, etc.) petrochemicals (plastics, dyes, etc.), synthetic fibers and other polymers, pharmaceuticals and a wide variety of specialty chemicals. Chemists and biochemists are also mainstays in the emerging industries that exploit biotechnology and in companies involved with microelectronics, batteries, fuel cells and solar cells, ceramics, cosmetics, food processing, pollution control, environmental analysis and coating technology.



Although chemistry is not one of the very highest paying professions, chemists generally do all right. The chart shown below gives median base salaries as of 2014, as determined by the American Chemical Society's Employment & Salary Survey.

For additional information, please visit:
<http://cen.acs.org/articles/92/i35/2014-Salaries-Employment.html>

MEDIAN BASE SALARIES

Industry and government salaries are far higher than those in academia.

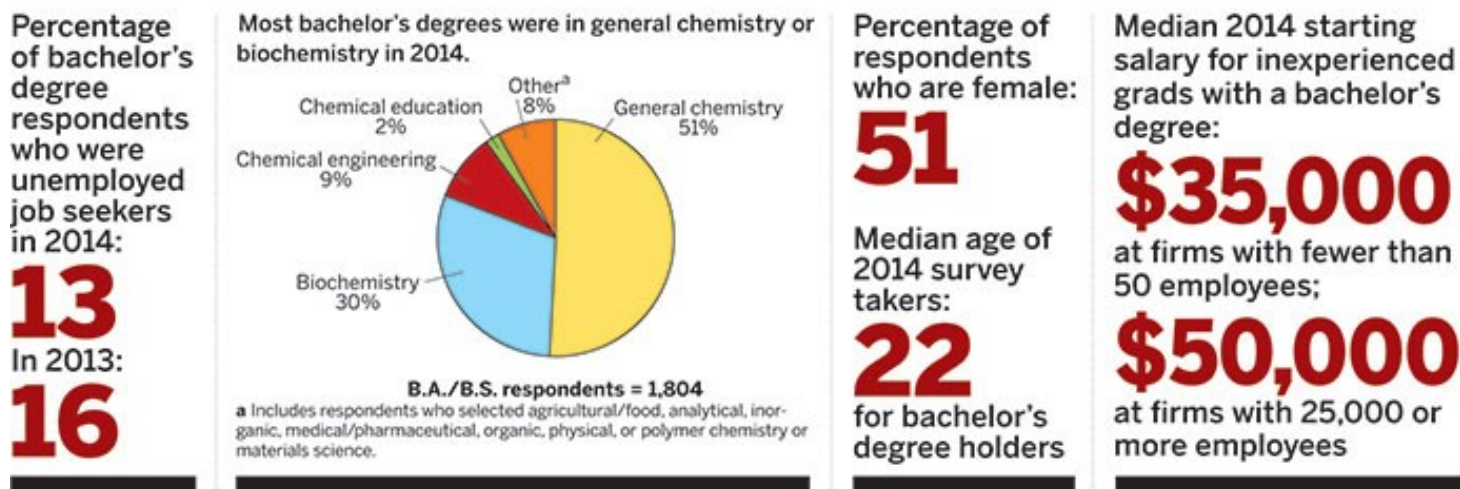
NOTE: Median annual base salaries for chemists employed full-time as of March 1, 2014.

SOURCE: ACS salary and employment survey 2014

The survey statistics show a financial incentive toward getting a higher degree. The statistics may be somewhat misleading, however, in that (i) it is often easier to find a job at the Bachelor's level than at the ScM or PhD level and (ii) ScB chemists often cease being chemists (in the eyes of the ACS) after several years in industry. The jobs available to people with ScB degrees tend to be somewhat limited in scope (sales, quality control, analytical chemistry, etc.) so that many ScBs move out of chemistry and into business after a few years in industry. In that sense, an ScB offers an entry into the technology-based industries that is parallel to that for people with engineering, business, law or economics training. Careers in industry often start with an ScB in chemistry or biochemistry.

New Graduate Salaries:

The ACS released another interesting survey of recent graduates; the graphic below summarizes the data. More detailed information can be found at : <http://cen.acs.org/articles/93/i26/New-Grad-Salaries-Employment.html>



Applying to Graduate School

If you plan to go on to graduate school in chemistry, biochemistry or related discipline, you should begin serious work in the fall of your Senior year with the intention of submitting applications before the holiday break. ***Speak with your research advisor and other faculty members and solicit their suggestions about the application process.*** Here is a list of steps for Graduate School applications.

Define a Direction: Your first step is to define your goals and the constraints on your choice of institutions. What field do you want to pursue? Do you have regional requirements? Are your grades and research experience good enough to get into a first rank school? Choosing a graduate school is rather different than choosing a university with a good undergraduate institution. When you applied to Brown, you were choosing a university with a good undergraduate program with strength in the

sciences; after you got here, you narrowed the choice to a concentration program. When you apply to Graduate School, you are choosing a department or program within a university and, after getting there, you will narrow the choice to a particular Research Advisor. Thus, in applying to a Graduate School, you should look beyond the university to the department and even more narrowly at the research faculty within the department.

Survey the Possibilities: Graduate school searching in chemistry and biochemistry (and chemical engineering) is made much easier by a publication of the ACS, the *Directory of Graduate Research* (<http://dgr.rints.com/>). The ACS Directory lists all MS or PhD-granting Departments of Chemistry, Biochemistry, Chemical Engineering, Pharmaceutical, Pharmaceutical Chemistry, Clinical Chemistry and Polymer Science in the US and Canada. The listing includes brief descriptions of faculty research interests and recent publications. It is worth spending some time with this Directory. Here are some things you will want to consider with answers easily found in the Directory:

- **Size of Program:** How many faculty? How many graduate students? Student to faculty ratio? The size of a program is important. Big programs generally will have a diversity of interests, but may be impersonal; in a small program, you may not get lost in the shuffle, but research facilities may be less extensive.
- Are most faculty actively involved in research or are there just a few active people?
 - Generally speaking, the best departments are those where everybody is involved in
 - research.
- Is the department a group of individual research groups with little interaction or is there active collaboration? Publications with two or more faculty names can be taken as evidence of a collaborative atmosphere.
- Perhaps most important of all, there should be at least two faculty with whom you could imagine working. Read some recent papers to test your interest. Don't consider a place with only one possible Research Advisor – when you get there, you may find that he or she just moved or that you can't get along with that individual.

After narrowing your choices to 5 – 7 schools, talk with faculty at Brown. We have contacts in many departments and will be able to offer you further insights.

At the very end, consider finances. If you are admitted, you **will** be offered a Teaching Assistantship or Fellowship; find out the stipend. Stipends don't vary that much from department to department – whatever differences there are will be small compared with your post-PhD salary – but there may be differences in the cost of living (big cities are generally more expensive than rural communities).

The Application Process

- You should plan to take the Graduate Record Examination. Generally speaking, the GRE is not as important as the SATs were for college or the MCATs are for medical school admission, but most of the better graduate schools require it.
- Letters of recommendation are by far the most important component of a Graduate School application. You should get a letter from your Research Advisor. Choose other

references from faculty who know you and can speak glowingly about your accomplishments and potential.

- Send in the application. Most departments have deadlines for receipt of graduate applications. Although these are frequently flexible, your chances of success are generally better if you adhere to the deadline.
- Although you shouldn't take admission for granted, don't lose any sleep over the process. Remember that you are coming from a first-rate institution at a time when most institutions desperately want well-qualified graduate students.

The Final Choice

If at all possible, visit the departments to which you have been admitted. Most departments encourage visits by prospective students and will pay some or all expenses. Some have special days set aside for orientation of admitted students. Ask about the possibility of visiting if the offer isn't made explicitly. When you visit, you should be thinking of whether you are going to be happy and productive as a graduate student. Talk with graduate students to get their reactions. What is the tenor of the place? Are faculty accessible? Are the facilities good? Is the load for Teaching Assistants reasonable? How many courses will you be expected to take? When do you start research? What exams – comprehensives, cumulatives, and research propositions – must you pass along the way? How long does it take to get a degree? Where do the graduates of the program go – post-doctoral, industry?

A final word of advice: Go to the best program you can get into and be the best student there!

Applying to Medical School

For advice on medical school applications, you should contact Assistant Dean George Vassilev, Director of Pre-Professional Advising. All meetings with Dean Vassilev regarding health careers questions/issues are by appointment. The Health Careers website has valuable information, the link is <http://brown.edu/academics/college/advising/health-careers/>. In addition there is now a Health Careers Advising at Brown Facebook page that announces upcoming events. Call or stop by the Health Careers Office (863-2781; University Hall 213). Email: hco@brown.edu. But please don't hesitate to ask for help and further advice from your Research Advisor or from other Chemistry or Biochemistry faculty.

Finding a Job

The CareerLab@Brown (<http://brown.edu/campus-life/support/careerlab/>) has many ways to help with a job search. In addition, you should check the online classified ad sections in the ACS's weekly news magazine, *Chemical and Engineering News*, as well as those in major newspapers such as *The Boston Globe* and *The New York Times*. The ACS operates an Employment Clearinghouse at its Fall and Spring National Meetings. Many companies have interviewers on hand to recruit scientists. Finally, the department has a Chemistry Department Alumni LinkedIn group, consider becoming a member. Access to the group is on the department homepage.