EASTERN MICHIGAN UNIVERSITY

HANDBOOK
FOR
UNDERGRADUATE
CHEMISTRY STUDENTS

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I. CHEMISTRY ADVISING

GETTING AN ADVISER

The Chemistry Department would like every student who is majoring or minoring, or considering majoring or minoring, in any of its programs to have an official adviser. To minimize your odds of making a costly scheduling mistake, it is important that you talk to some faculty member about your program plans and uncertainties as soon as possible. The decision is not irrevocable; it is easy to change your adviser at any time.

In every CHEM 121 and 371 section, students who are considering majoring in any of the Chemistry Department's programs are asked to complete an information sheet. Those who do will be notified by mail of their recommended adviser.

If you have not been notified of having been assigned an adviser, please see our undergraduate advising coordinator, Dr. Nicholson, in 219 M. Jefferson (phone 487-2052). She will be happy either to assign one for you or to help you pick one from the list. If you forget who you have been assigned, check the bulletin board across from MJ 225.

ADVISERS AND THEIR SPECIALIZATIONS

Professional and General Chemistry: Armitage, Brewer, Friebe, Heyl-Clegg, Holmes, Howard, Kennedy, Lindsay, Milletti, Nicholson, Nord, Snyder, Vites.
Professional and General Biochemistry: Brabec, Butch, Heyl-Clegg, Nicholson, Pernecky.
Biochemistry/Toxicology: Brabec, Pernecky.
Elementary and Secondary Chemistry Teaching: Kolopajlo.
Organic Chemistry: Friebe, Heyl-Clegg, Howard, Lindsay, Nicholson, Snyder.
Inorganic Chemistry: Kennedy, Milletti, Vites.
Analytical Chemistry: Armitage, Holmes, Rengan, Tornquist.
Physical Chemistry: Brewer, Milletti, Nord, Tornquist.
Computers and Theoretical Chemistry: Brewer, Milletti, Nord.
Polymer Chemistry: Snyder.
Nuclear Chemistry: Contis, Rengan.
Pre-medicine/Osteopathy & Veterinary Medicine: Brabec, Butch, Heyl-Clegg, Nicholson.
Pre-dentistry: Brewer.
Pre-mortuary Science: Holmes.
Pre-pharmacy: Pernecky.
Pre-chemical Engineering: Vites, Snyder

If you want to shop around, feel free to talk to several faculty: Stick your head in an open office door, and try your luck. Tell them your predicament, and ask if he/she would like to be your adviser, or, who they might suggest instead. We're all in this job because we enjoy helping students, and an open door *usually* means we're "interruptable." If you get a grump, try someone else. Notify Dr. Nicholson of your choice, and she will handle the paperwork. If you should ever want to change advisers, just get the approval of the new person, and let Dr. Nicholson know—no problem.

IMPORTANT: If you intend to transfer to some other school's program, be aware that we have no control over those programs, so <u>it is your responsibility</u> to contact the other school, identify its requirements, and make sure that your EMU courses are going to do the job.

OFFICE HOURS

Your odds of finding one of us in our office and with time to talk are best if you come around during office hours. All chemistry faculty post their office hours outside their door. However, most of us are available <u>much</u> more than that, although an appointment may be necessary outside of office hours.

If you have trouble catching the person you want to talk to, double check that you have correctly read the person's office hour schedule. Also, be aware that some busy faculty will not just sit there if no one shows up

near the start of an office hour period; however, they will usually leave a note on their door indicating their availability somewhere else in the building (e.g., research lab or department office). Finally, you can either ask in the department office to leave a message in the faculty mailbox, or you can phone the faculty's office. A complete schedule of chemistry faculty office hours and phone numbers is posted on the hallway window of the department office, room 225.

ABOUT MATH

Chemistry can be used for tremendous good (or evil) because it equips us to go beyond just *talking* about problems, to working out actual solutions. However, whatever the task, the moment you want to go beyond talk, some calculations are going to be necessary. How to assess your math background?

EMU's Math Department has developed an excellent Mathematics Placement System to determine your readiness for their various introductory courses. Use of this system is not optional; all students in MATH 098, 104, 105, 107, 108, 109, 112, 118, 119, 120, 121, 122, 150, 170, or 223 must, on the first day of class, present official documentation certifying their readiness for the course. To begin your placement process, go to the Math Department (515 Pray-Harrold) if you have declared your major, or, if you have not declared your major, go to Academic Advising (301 Pierce Hall). There, you will be assigned a placement level and/or be authorized to take the Computerized Placement Test.

Your math placement level is very helpful in deciding where to plug into our sequence of introductory chemistry courses: For CHEM 117/8 Fundamentals of Chemistry, you should be at Level 3 (or have a C or better in Math 098). For CHEM 121/2 General Chemistry I, you should be at Level 4 (or at least be concurrently enrolled in Math 104). For 123/4 General Chemistry II, you should be at Level 5 (or be concurrently enrolled in Math 105). Physical Chemistry and other advanced courses taken by chemistry majors require one or more calculus courses.

There is a saying that is more urgently true today than ever before:

Math is the gatekeeper.

You don't need to like it. You don't even need to be particularly good at it. But, you must be able to do it (preferably, without letting it sense your fear). The math choices you make now, while you are in college, will set limits against which you will strain for the rest of your life.

If you are considering a career in any area of science or technology, start the calculus sequence as soon as possible, and go as far as possible. Calculus is the language of choice whenever people get serious about describing quantitatively how something depends on changes in something else. That includes business and the social, biological, and physical sciences. Barbie was right, "Math class is hard,"—but she took it!

THE CHOICE: HARD COURSES AND RISK THE GPA? OR EASY COURSES AND GET BETTER GRADES?

This is a very individual decision. The answer depends on your personal values and what stage of your life you are in. For some, Eastern is a place to have some fun for a few years, while at least creating an illusion of getting an education. For them, the answer is a no-brainer (fortunately)—they should steer clear of chemistry. For others, who are more serious about how they spend their time and money, here are some good reasons to consider chemistry:

- You will learn some *facts* about physical reality, explaining things you've wondered about since you were a kid, and assuring that you won't be totally out of it as you go through life in our modern, technological world.
- You will learn reasoning and problem-solving skills that are valuable in *every* walk of life. For example, one finance employer likes to hire chemists because, "Chemists are not afraid of data, not afraid of numbers and units, and...not afraid of hard work." (*C. & E. News*, May 7, 1990, p 84.)
- You will learn skills you can use to make the world a better place, and there is no doubt that you will be able to get a job related to your degree.
- You will never find yourself sitting across from a job interviewer who is looking at your transcript and wondering, "What use can we make of someone who can get good grades in a bunch of fluff?"

WHICH CHEMISTRY COURSE TO TAKE FIRST

Take **CHEM 121/122** General Chemistry if...

- you have had high school chemistry and place at math Level 4.
- you are a chemistry, biology, pre-med, or pre-dentistry major.
- you want our best first course that will keep all of your options open and count toward a chemistry major or minor.

Take **CHEM 120** Fund. of Organic and Biochemistry if...

- you have had high school chemistry and would like to learn something new and interesting, requiring little math.
- you are in the nursing or sports medicine curricula.

Take **CHEM 117/118** Fundamentals of Chemistry if...

- you have no chemistry background (or a weak one), but place at math Level 3, and want an introduction comparable to a one-year high school course.
- you need to prepare for either CHEM 120 or CHEM 121/122.

Take **CHEM 115/116** Chemistry & Society if...

- you want a general studies course which explores the relationship of chemistry to current affairs, BUT which will not prepare you to go on to CHEM 120 or 121.

Take **CHEM 101** Science for Elementary Teachers if...

- you are planning to teach elementary school.

SCHEDULING PATTERN FOR COURSES AVAILABLE TO UNDERGRADUATES

Course Number	Course Title	When Offered
CHEM 101	Sci for Elementary Teachers	Fall, Winter, Spring
CHEM 115	Chemistry and Society	Fall, Winter, Spring, Summer
CHEM 116	Chemistry and Society Lab	Fall, Winter, Summer
CHEM 117/8	Fundamentals of Chemistry	Fall, Winter, Spring
CHEM 120	Fundamentals of Org/Biochem	Fall, Winter, Spring
CHEM 121	General Chemistry I	Fall, Winter, Spring
CHEM 121H	General Chemistry I (Honors)	Fall
CHEM 122	General Chemistry Lab I	Fall, Winter, Spring
CHEM 122H	General Chem Lab I (Honors)	Fall
CHEM 123	General Chemistry II	Fall, Winter, Summer
CHEM 124	General Chemistry Lab II	Fall, Winter, Summer
CHEM 125	Honors General Chemistry II	Winter
CHEM 126	Honors General Chem. II Lab	Winter
CHEM 177/8/9	Special Topics in Chemistry	As announced
CHEM 270	Organic Chemistry	Fall, Winter, Spring
CHEM 271	Organic Chemistry Lab	Fall, Winter, Spring
CHEM 277/8/9	Special Topics in Chemistry	As announced
CHEM 281	Quantitative Analysis	Fall, Winter, Spring
CHEM 282	Honors Quantitative Analysis	Fall
CHEM 287/8/9	Cooperative Education in Chem	Fall, Winter, Spring, Summer
CHEM 297	Undergrad Research in Chem	Fall, Winter, Spring, Summer
CHEM 332	Inorganic Chemistry	Winter
CHEM 341	Materials Science	Fall

continued

Course Number	Course Title	When Offered
CHEM 351	Foundations of Biochemistry	Winter, Spring
CHEM 361	Fund. of Physical Chemistry	Fall, Spring
CHEM 371	Organic Chemistry I	Fall, Winter, Spring
CHEM 372	Organic Chemistry II	Fall, Winter, Summer
CHEM 373	Organic Chemistry Lab	Fall, Winter, Summer
CHEM 376	Honors Organic Chem Lab	Winter
CHEM 377/8/9	Special Topics in Chemistry	As announced
CHEM 381	Instrumentation for Chem Tech	Fall, Winter
CHEM 387/8/9	Cooperative Education in Chem	Fall, Winter, Spring, Summer
CHEM 397	Undergrad Research in Chem	Fall, Winter, Spring, Summer
CHEM 411	Toxicology I	Fall
CHEM 412	Toxicology II	Winter
CHEM 413	Toxicology Laboratory	Winter
CHEM 415	Environmental Chemistry	Winter
CHEM 432	Advanced Inorganic Chemistry	Winter
CHEM 433	Inorganic-Organic Synthesis Lab	Fall
CHEM 451	Biochemistry I	Fall, Spring
CHEM 452	Biochemistry II	Winter
CHEM 453	Biochemistry Lab	Fall, Winter
CHEM 461	Chem. Thermodyn. & Kinetics	Fall
CHEM 463	Physical Chemistry Lab	Winter
CHEM 465	Quantum & Stat. Mechanics	Winter
CHEM 475	Intro Polymer Chemistry	Fall
CHEM 477/8/9	Special Topics in Chemistry	As announced
CHEM 481	Instrumental Analysis	Fall
CHEM 485	Radioisotope Techniques	Winter
CHEM 487/8/9	Cooperative Education in Chem	Fall, Winter, Spring, Summer
CHEM 497/8/9	Undergrad Research in Chem	Fall, Winter, Spring, Summer
CHEM 510	Computer Applications in Chem	Spring of odd years
CHEM 515	Industrial and Environ Chem	Fall of odd years
CHEM 553	Enzymology	Winter of odd years
CHEM 555	Neurochemistry	As announced
CHEM 561	Quantum Chemistry and Spect	As announced
CHEM 562	Statis Mech and Chem Kinetics	Winter of odd years
CHEM 565	Nuclear Chemistry	Winter of odd years
CHEM 571	Advanced Organic Chemistry	Fall of even years
CHEM 572	Spect. Identif. Org. Compounds	Fall of odd years
CHEM 574	Advanced Organic Topics	Spring of odd years
CHEM 590/1/2	Special Topics in Chem	As announced

You can find the catalogue description of these courses at www.emich.edu/public/chemistry/courses/courses.htm.

EVENING COURSES

We try to have all of our programs accessible to students who must work during normal business hours. Thus, all courses required for our degree programs are made available in the evening—but on a two year rotation. Careful planning is needed to keep in sync with the rotation schedule. See the detailed course scheduling information posted across the hall from the department office.

GETTING CREDIT FOR TRANSFER COURSES

Transfer students must see an adviser as soon as possible to be sure of plugging into our program at the right point. If there is a question about course equivalency, bring your transcripts and as much descriptive material (catalogs, texts, syllabi, exams) as possible. Mismatch problems generally result in some loss of credit.

REGISTRATION COMPLICATIONS

OVERRIDES. Registration limits are set by pedagogical, space, staff, and equipment considerations. No overrides are issued before classes start. After the first class meeting, lecture (but not lab) overrides are possible, but only by written permission of the instructor.

WAITLISTS. We keep waitlists ONLY for classes that Registration has told us are full and which we have then made "Department Permission Required." Normally we do not do this until all sections of a course are full. Therefore, if you are closed out of a course that has been designated "Department Permission Required," ask in the Chemistry Department Office to be put on the waitlist, and attend the first class meeting, but don't get your hopes up too high—a waitlist is not a promise. It may be used by the instructor to fill slots created by withdrawals and no-shows after classes start, or to notify you if by some miracle a new section is opened. For a closed section that has not been designated "Department Permission Required," keep checking with Registration; if an opening appears, jump on it. If you are closed out of a lab, maybe you can use our "First-Lab Rule":

THE FIRST-LAB RULE. There usually are some students who intend to drop, but who might take weeks or months to get around to actually doing it. By then, it's too late for others who have been closed out. Since we can't play the "overbooking" game (as the airlines do), we have adopted the following policy: the lab spot of a student who misses or is late for the first lab meeting will be forfeited to a needy student who is present in a timely manner at that first meeting.

The bumpee's registration will be cancelled, including the lecture part of a lecture/lab course. Each instructor decides the go/no-go point during the first lab meeting. If you must miss or be late for the first meeting of a lab course, be sure to notify your lab instructor well in advance. To get into a closed lab, you must attend the first meeting of the section you want. Chemistry labs normally meet on the first scheduled class day—to assume otherwise is to risk losing your spot! Inquire in the Chemistry Office (225 Mark Jefferson, phone 487-0106) to verify schedules of first lab meetings. A posting of the date of the first lab meeting is posted outside MJ 225 or you may inquire in that office.

II. CHEMISTRY DEGREE PROGRAMS

The Chemistry Department offers the following bachelor's degree programs:

Professional Chemistry Curriculum
Professional Biochemistry Curriculum
General Chemistry Major
General Chemistry-Secondary Teaching (see Gen. Chem.)
General Biochemistry Curriculum
Biochemistry/Toxicology Curriculum
Chemistry Minor
Biochemistry Minor

A **curriculum** is a program of study that satisfies requirements for *both* the major and minor. Required courses in math, physics, and, in some cases, biology are considered as equivalent to a minor, so no separate minor is needed. Brief descriptions of these programs and suggested schedules are given below. These are *suggested* schedules, and, as long as care is taken to satisfy prerequisites, many variations are possible. See the Catalog and your adviser for more details.

GENERAL *VS.* PROFESSIONAL CURRICULA

The professional chemistry and professional biochemistry curricula provide the traditional strong background expected of someone who is planning a professional career in the field, including adequate preparation for admission to graduate school. Students completing the professional chemistry curriculum, with the proper electives, are certified to the American Chemical Society. The necessary paperwork is automatically completed by the Chemistry Department head upon notification by the EMU Records Office that a student who has declared a professional chemistry curriculum major is about to graduate.

The general biochemistry and biochemistry/toxicology curricula and the general chemistry major, on the other hand, are appropriate for those who anticipate careers requiring less rigorous technical backgrounds than expected of professional chemists or biochemists. Examples would be laboratory technician, medicine (but not medical research), dentistry, business, patent law, technical writing, industrial health and safety, and secondary education.

The programs have most of their lower-level courses in common. The professional students will take a greater number of advanced courses and courses with more math and physics prerequisites.

Essentially all of our graduates are able to find jobs; however, the professional majors definitely have more options. For example, one big employer, the U.S. government, *defines* "chemist" as someone who has had the full year of physical chemistry, instrumental analysis, and other advanced course work found only in our professional chemistry curriculum. If you are in doubt about whether to go professional or general, start out in the professional. It's easy to switch to general later on, but the reverse transition can be difficult.

IMPORTANT RECENT CHANGES

A minimum grade of C- is now required in the first course before taking the second course of the following sequences:

- 121-123 General Chemistry lectures.
- 122-124 General Chemistry labs.
- 371-372 Organic Chemistry lectures.
- 361-365 Physical Chemistry lecture-lab.
- 451-452 Biochemistry lectures.

PROFESSIONAL CHEMISTRY CURRICULUM

YEAR	FALL SEMESTER	WINTER SEMESTER
1	CHEM 121/122 Gen. Chem I	CHEM 123/4 Gen Chem II
	MATH 120 Calculus I	MATH 121 Calculus II
2	CHEM 281 Quant. Analysis	CHEM 372 Org. Chem. II
	CHEM 371 Organic Chemistry I	CHEM 373 Org. Chem. Lab
	PHY 223 Mech., Sound & Heat	PHY 224 Elect. & Light
	MATH 122 Elem. Lin. Algebra	MATH 223 Multivar. Calc.
3	CHEM 461 Chem. Thermodynamics	CHEM 463 Phys. Chem. Lab
	CHEM 433 Inorg.Organic Synthesis	CHEM 465 Quantum Mech.
4	CHEM 481 Instrumental Analysis	CHEM 432 Adv. Inorganic
	CHEM advanced elective[a,b]	

a. May be taken in other semesters, as long as prerequisites are met.

b. Two courses from the following are required, including at least one from chemistry. Note that only those marked with an * are acceptable for ACS certification. Also, the ACS has recently added the requirement of a biochemistry course (CHEM 351 or 451): CHEMISTRY 411/412 Tox. I/II, 413 Tox. Lab., 414 Regulatory Tox., 415 Environmental Chemistry, 351* Foundations of Biochem. or 451*/452* Biochem. I/II, 453* Biochem. Lab., 475* Intro. Polymer Chem., 485* Intro. Radiotracer Techniques, 477/478 Spec. Topics in

Chem., 487/488/489 Coop. Educ. in Chem., 497/498*/499* Undergrad. Research in Chem., 553* Enzymology, 555* Neurochemistry, 561* Quantum Chem. & Spectroscopy, 562* Statistical Mech. & Chem. Kinetics, 565* Nuclear Chem., 571* Adv. Org. Chem., 572* Spectro. Org. Struct. Determ., 574* Adv. Org. Chem. Topics. MATH & COMPUTER SCIENCE: CSC 237 Comp. Prog. & Num. Methods, CSC 337 Prog. Lang., MATH 425 Math. for Sci., other 400-level courses with permission. PHYSICS: 330 Intermed. Mech. I, 440 Optics, 450 Elect. & Mag., 452 Elect. Measurements, 456 Electronics for Scientists, 460 Heat and Thermo., 471 Nuclear Physics, 475 Intro. to Quantum Mechanics.

PROFESSIONAL BIOCHEMISTRY CURRICULUM

YEAR	FALL SEMESTER	WINTER SEMESTER
1	CHEM 121/122 Gen. Chem I MATH 120 Calculus I	CHEM 123/124 Gen Chem II MATH 121 Calculus II BIOL 110[a]
2	CHEM 281 Quant. Analysis CHEM 371 Org. Chem. I PHY 223 Mech., Sd. & Heat MATH 122 Elem. Lin. Alg.	CHEM 372 Org. Chem. II CHEM 373 Org. Chem. Lab PHY 224 Elect. & Light MATH 223 Multivar. Calc.
3	CHEM 461 Chem. Thermodynamics CHEM 451 Biochemistry I	CHEM 463 Phys. Chem. Lab CHEM 452 Biochemistry II CHEM 465 Quantum Chem.
4	CHEM 453 Biochem. Lab[b] BIOL advanced elective[a,c]	BIOL 301 Genetics[a,b] CHEM advanced elective[b,c]

a. Completion of BIOL 110, or equivalent coursework, is required for Biochemistry students to seek Biology departmental permission for 300-level and 400-level Biology courses.
b. May be taken in other semesters if more convenient.
c. Choose one course from the following: CHEM 411, 412 Toxicology I and II, CHEM 413 Toxicology Laboratory, CHEM 414 Regulatory Toxicology, CHEM 415 Environmental Chemistry, CHEM 433 Inorganic-Organic Synthesis Laboratory, CHEM 475 Introduction to Polymer Chemistry, CHEM 477, 478 Special Topics in Chemistry, CHEM 481 Instrumental Analysis, CHEM 485 Introduction to Radiotracer Techniques, CHEM 487, 488, 489 Cooperative Education in Chemistry, CHEM 498, 499 Undergraduate Research in Chemistry, CHEM 553 Enzymology, CHEM 555 Neurochemistry, CHEM 572 Spectrometric Organic Structure Determination.
d. Choose three credits from any Biology Department courses numbered 300 or above.

GENERAL CHEMISTRY MAJOR

YEAR	FALL SEMESTER	WINTER SEMESTER
1	CHEM 121/122 Gen. Chem I MATH 120 Calculus I[a]	CHEM 123/124 Gen Chem II
2	CHEM 281 Quant. Analysis CHEM 371 Org. Chem. I PHY 221 or 223 Mech., Sd. & Heat	CHEM 372 Org. Chem. II CHEM 373 Org. Chem. Lab PHY 222 or 224 El.& Lt.
3	CHEM 361 Fund. Phys. Chem.	CHEM 381 Inst. Chem. Tech.
4	CHEM elective[a,b,c]	CHEM elective[a,b,c]

a. May be taken in other semesters if more convenient.
b. Choose five credits from 300- and 400-level courses in chemistry.
c. NCATE standards require 32 hours in chemistry, including biochemistry (e.g., 451).

GENERAL BIOCHEMISTRY CURRICULUM

YEAR	FALL SEMESTER	WINTER SEMESTER
1	CHEM 121/122 Gen. Chem. I MATH 120 Calculus I[a]	CHEM 123/124 Gen Chem II BIOL 110[b]
2	CHEM 281 Quant. Analysis PHY 221 or 223 Mech., Sd. & Heat	CHEM 270/271 Org. Chem.[c] PHY 222 or 224 Elect.& Lt.
3	CHEM 361 Fund. Phys. Chem. BIOL 301 Genetics[a,b]	CHEM 381 Inst. Chem. Tech. BIOL elective[a,b,d]
4	CHEM 451 Biochemistry I BIOL elective[a,b,d]	CHEM 452 Biochemistry II CHEM 453 Biochemistry Lab

a. May be taken in other semesters if more convenient.
b. Completion of BIOL 110, or equivalent coursework, is required for Biochemistry students to seek Biology departmental permission for 300-level and 400-level Biology courses
c. Pre-meds, pre-dents, and some other pre-professionals are advised to take 371/2/3 Organic Chemistry, to satisfy requirements of most professional schools.
d. Choose five credits from any Biology Department courses numbered 300 or above.

BIOCHEMISTRY/TOXICOLOGY CURRICULUM

YEAR	FALL SEMESTER	WINTER SEMESTER
1	CHEM 121/122 Gen. Chem. I MATH 120 Calculus I[a]	CHEM 123/124 Gen Chem II BIOL 110[b]
2	CHEM 281 Quant. Analysis CHEM 371 Org. Chem. I PHY 221 or 223 Mech., Sd. & Heat BIOL 305/306 or ZOOL 326 Phy.[a,b]	CHEM 372 Org. Chem. II CHEM 373 Org. Chem. Lab PHY 222 or 224 Elect.& Lt.
3	CHEM 361 Fund. Phys. Chem. ZOOL 431 anatomy[a,b] CHEM 411 Toxicology I CHEM Toxicology elective[b,c]	CHEM 381 Inst. Chem. Tech. ZOOL 404 Mammal. Hist.[a,b] CHEM 412 Toxicology II CHEM 413 Toxicology Lab
4	CHEM 451 Biochemistry I MATH 270 or PSY 205 Stat.[b]	CHEM 452 Biochemistry II CHEM 453 Biochem. Lab CHEM 414 Regulatory Tox.[b,d]

a. May be taken in other semesters if more convenient.
b. Completion of BIOL 110, or equivalent coursework, is required for Biochemistry students to seek Biology departmental permission for 300-level and 400-level Biology courses
c. A two- or three-credit enrollment in either a toxicology cooperative education project (CHEM 488, 489) or toxicology research project (CHEM 498, 499) is required.
d. Might be offered in fall or winter; check schedule booklet.

CHEMISTRY MINOR (20 hours)

COURSE	CREDIT HOURS
CHEM 121-124 General Chemistry I-II with labs	8
CHEM 270-271 Organic Chemistry with lab[a]	5
CHEM 281 Quantitative Analysis	4
Electives: CHEM courses numbered above 200	3

a. CHEM 371/2/3 may be substituted to provide a stronger background.

BIOCHEMISTRY MINOR (22 hours)

COURSE	CREDIT HOURS
CHEM 121-124 General Chemistry I-II with labs	8
CHEM 270-271 Organic Chemistry with lab[a]	5
CHEM 281 Quantitative Analysis	4
CHEM 351/451, 453 Biochemistry I and lab	6/5

a. CHEM 371/2/3 may be substituted to provide a stronger background.

III. OTHER OPPORTUNITIES IN THE CHEMISTRY DEPARTMENT

HONORS PROGRAM

In 1973 the Chemistry Department started EMU's first honors program. At the time, the University was under pressure to "downsize," so we had to create this new program somewhat on the sly. Fortunately, times have changed, and since 1983 our program has been allied with a University-wide Honors Program.

Our goal with this program has always been to provide our best students with the highest quality educational experience that is possible, and that can only be accomplished in the context of small groups of motivated students with dedicated instructors. Honors sections of General Chemistry, Quantitative Analysis, and Organic Chemistry Laboratory are available. These sections permit greater student-teacher interaction, more sophisticated coverage of lecture topics, use of more advanced instrumentation, and the option for earlier participation in advanced courses and research projects. Honors students are strongly encouraged to become involved in an undergraduate research project, which often results in their names appearing as co-authors of publications in scientific journals and presentations at professional meetings.

Admission to the honors section of CHEM 121 General Chemistry I is through acceptance in the University Honors Program or department permission. Students who show special abilities and interest in any of our lower-level courses are routinely invited to apply for admission to the appropriate follow-on honors courses. It is not necessary to be a chemistry major; in fact, most of the students in our honors courses are not. See Dr. Holmes (212 Mark Jefferson, 487-2027) for more details.

UNDERGRADUATE RESEARCH

If you are considering a career in scientific research, you are encouraged to participate in an undergraduate research project. These projects involve both one-on-one instruction by a faculty member and independent lab, library, or computer work by you. You will register for one of the research courses: CHEM 297, 397, or 497/8/9 Undergraduate Research in Chemistry. These projects often extend for more than one semester, so multiple research course registrations are permitted. Ideally, if enough is accomplished, you will become co-author of a publication in a scientific journal and/or co-presenter of your work at a professional meeting.

The first step is to identify a faculty member with whom you think you'd like to work, and who is interested in directing a project for you. Brief descriptions of faculty research interests are given in the "More About the Chemistry Faculty" section of this Handbook; more detailed descriptions are in the Graduate Student Handbook (ask in office). Pick out a few whose work interests you, and go talk to them. These projects are always highly individualized and by mutual consent only. The details of what you will do, the time commitment and degree of independence expected, which research course is most appropriate, and the basis of your grade will be worked out between you and and the faculty member.

COOPERATIVE EDUCATION PROGRAM

Need money? Wondering what it's like to work in a lab? Look into the Chemistry Department's cooperative education program. Many local companies are eager to hire our students, either on a part-time basis or full time for a semester or summer. They pay decent wages, and you earn college credit toward graduation, up to

three hours applicable to chemistry majors. EMU students have been placed in chemical laboratories at a variety of local employers, including Pfizer and the Canton Analytical Laboratories, and as far away as the U.S. Drug Enforcement Agency in Chicago. Returning students agree the co-op education experience is extremely valuable. Several of our students, upon graduation, have been offered permanent employment by their co-op employers. This is a great way to get some relevant work experience on your resume, and to get your foot in an employer's door. See Dr. Nicholson, 219 M. Jefferson, 487-2052, for details.

JOB OPPORTUNITIES IN THE DEPARTMENT

Many part-time employment opportunities are available in the department, including: secretary, stockroom assistant, tutoring, and laboratory assistant. If you are interested, apply in the department office.

SEMINARS: CHEMISTRY, FREE COOKIES, NO EXAMS!

The department has an active visiting seminar speaker program. This helps faculty stay up to date, and provides students the opportunity to hear about the latest research at other universities and what's going on in industry. This is the easiest way to learn what is going on at the frontiers of chemistry and biochemistry. The seminars are open to the public, and have free coffee and cookies. They are normally from 4 to 5 p.m. Mondays in 104 M. Jefferson.

Frequently, seminar speakers have an ulterior motive of recruiting students (you!) for their graduate programs. If so, a block of time before the seminar is reserved for them to talk to students. If you are considering graduate school, go to as many of these as you can; pick their brains or just listen—they're always talkers.

GRADUATE COURSES YOU MAY TAKE

Upper-level undergraduate students are allowed to enroll in 500-level graduate courses. We particularly encourage those who are thinking of going to graduate school to consider these courses, all of which are included in the scheduling pattern table on page 3. Special permission will be required for registration. For details, see your adviser, look in the Graduate Catalog, or talk to the person who normally teaches the course.

THE CHEMISTRY CLUB

Are you finding that you are sort of enjoying your experience in the Chemistry Department, and would like to spend time with some kindred spirits? Check out the Chemistry Club, EMU's oldest continually-in-existence club. They meet regularly and even have access to a room in Mark Jefferson. See the club bulletin board opposite the reading room for activities and membership information. In recent years, the club has arranged trips to the Dow Chemical Research Labs in Midland, the St. Joseph Mercy Hospital Clinical Research Labs, and the Ypsilanti Water Treatment Plant; participated in Saturday Morning at the Lab; helped at the Ann Arbor Hands-On Museum during National Chemistry Week; organized department picnics; and raised money for undergraduate research projects.

AWARDS BANQUET

The department hosts an annual Alumni and Awards Banquet each spring, at which outstanding chemistry students are recognized. Awards are presented for high performance at all course levels, from freshman through senior. Parents and friends are welcome, and many alumni return to renew old friendships. If you have declared a major in the Chemistry Department, you may attend the banquet free of charge as our guest. Watch for announcements.

IV. CHEMISTRY CAREERS

Chemists, like snowflakes, are all different. A great variety of employment directions are possible. Duties commonly expected of chemists include the following:

- Performing laboratory analyses related to industrial, governmental, pharmaceutical, or medical research.
- Monitoring water treatment and waste disposal facilities, and compliance with environmental pollution standards.
- Working with complex electronic instrumentation, including computers.
- Preparing the materials, standards, and specifications for chemical processes, facilities, products, and tests.
- Testing production samples for quality control.
- Synthesizing new materials for industrial, commercial, or medical use.
- Developing new equipment and methods for solving chemical problems.
- Collaborating with engineers and others on solutions to problems.
- Technical writing for both reports and professional publications.
- Preparing and presenting findings of tests or experiments, in both written and oral forms.
- Teaching and lecturing.
- Maintaining accurate and detailed records.

What you do will depend on two things: (1) how much training you have, and (2) your area of specializtion.

SIGNIFICANCE OF YOUR DEGREE

Four years of college nets you a **bachelor's degree** (B.A. or B.S.). With approximately two more years you can earn a **master's degree** (M.S.), or, with approximately four or more years (M.S. not necessary), a **doctorate** (Ph.D.). People with more training tend to be "people in charge" in a work situation.

Although most B.S.-level chemists work in laboratories, there are many other possible directions to go: Combining chemistry with interests in business leads to employment in sales, personnel, purchasing, advertising, and other areas of business where a knowledge of chemistry is required. Some chemists become technical writers. A particularly attractive combination is a chemistry degree and a law degree. Such people are scarce and are needed for patent law, environmental law, and other legal fields. High school teachers with a chemistry degree are also in more demand than those with less technical training.

The M.S. degree is intermediate between the B.S. and the Ph.D, although a review of employment ads shows that most employers consider the M.S. to be closer to the B.S. than to the Ph.D. M.S. degree-holders tend to do much the same work as B.S. degree-holders, although they are likely to have somewhat greater responsibilities and earn higher pay.

The jobs available for Ph.D. degree-holders most commonly involve research, in either an industrial or university setting. Typically a Ph.D. will be responsible for the design and supervision of a project. They are likely to be directing the work of other people in a laboratory even if they continue to work at the bench. Some industrial Ph.D. scientists move into management in mid-career.

The performance of original research in a specialized area to generate new knowledge is always the primary emphasis in Ph.D. training. Thus, Ph.D. students not only learn what is already known about a subject, but are trained and required to discover new knowledge about the subject.

SPECIALIZATIONS

ORGANIC CHEMISTRY. Organic chemistry is the chemistry of carbon compounds, including plastics, adhesives, coatings, agricultural products, dyes, medicines, and many others. Most of the known chemical substances are organic chemicals. The specialization known as polymer chemistry involves the synthesis and study of the very large molecules used in plastics, and is the biggest employment area for chemists.

INORGANIC CHEMISTRY. Inorganic chemists' turf is the entire periodic chart except for carbon. They could be involved in synthesis and study of practically anything. Some modern important applications include

catalytic converters, superconductors, and metals-based cancer and arthritis drugs.

ANALYTICAL CHEMISTRY. Analytical chemists are experts in measurement of the kinds and amounts of chemicals in a sample. Their craft has many applications, including industrial quality control, sports and police drug testing, and environmental pollutant monitoring. Consequently, analytical chemists have traditionally been in high demand.

PHYSICAL CHEMISTRY. Physical chemists are interested in understanding the behavior of chemicals in terms of the underlying principles of physics. They measure, calculate, and try to make sense of chemical structures and reactions. Theoretical chemists, computer jocks, and laser chemists are likely to be physical chemists.

BIOCHEMISTRY. Biochemists specialize in the chemistry of living systems, and can interface with biology, medicine, environmental studies, nutrition, and many other fields. University biochemistry programs might be either a separate department or part of a chemistry department (as at EMU).

CHEMICAL ENGINEERING. Chemical engineers design and run chemical plants. Their training focuses as much on engineering as on chemistry.

MEDICINAL CHEMISTRY. Medicinal chemists are organic chemists bent on the synthesis of new or better drugs. This is not to be confused with *pharmacology*, which centers on the effectiveness and toxicity of drugs.

BIOENGINEERING. Bioengineers study a diverse range of problems at the interface of biology and engineering, ranging, for example, from the design of artificial body parts to the design of waste treatment facilities.

MATERIALS SCIENCE. These scientists create new materials including ceramics, composites, and polymers having new properties and uses. This is expected to be one of the "hot" areas of the future.

TOXICOLOGY. Toxicologists are concerned with the effect of chemicals on the health of living creatures, especially humans. They advise industry, government, and consumers about potentially harmful levels of chemical exposure. Toxicologists are trained in chemistry, statistics, biology, and medicine.

EMPLOYMENT OPPORTUNITY OUTLOOK

According to the Michigan Occupational Information System 1995, the national employment of chemists is expected to increase about as fast as the average for all occupations through the year 2005, while chemist employment in Michigan is expected to increase at a higher rate. An average of 140 annual job openings is projected for the state. That growth is attributed to increasing demand for industrial products, including plastics, drugs, and fertilizers, and to rising concern about pollution control and health care. Slower growth is expected in governmental and industrial research and development.

CONSIDER GRADUATE SCHOOL

Students in our professional curricula are encouraged to consider going on to graduate school to earn a Ph.D. The educational experience and intellectual stimulation are absolutely unbeatable, and your long-range potential for a satisfying career, and—depending on how you play it—more money, will be greatly enhanced. A typical Ph.D employed in the chemical industry (NOT teaching!) is expected to make 1.6×10^6 more dollars over his/her lifetime than if he/she starts work with the B.S. (*J. Chem. Ed. 70,* 469 (1993)).

For most students nearing the end of their undergraduate careers, the prospect of four-or-so more years of school might seem unthinkable. However, consider the following facts before you make up your mind.

- *YOU GET PAID!* Essentially all full-time Ph.D. students in the chemical sciences are supported by teaching or research assistantships throughout their entire graduate school program. In addition, full waiver of tuition and fees is common. Typical yearly stipends range from about $8,000 to $20,000. That's not a *lot* of money, but it beats what you got paid to earn your B.S, and you can live on it.
- *IT'S NOT JUST ANOTHER BUNCH OF COURSE WORK*. There is a lot of variation, but a typical Ph.D. program involves a maximum of two years of half-time course work. The rest of the time is spent on teaching assistant duties (for the first year or two) and doing research. Summers are usually spent just doing research.

- *GRADUATE SCHOOL IS LIKE AN APPRENTICESHIP,* so you can adopt the psychologically advantageous attitude of thinking of it as your first job, rather than more school. In the skilled trades, an apprentice works for a few years for a low wage, while learning the journeyman's skills. The Ph.D. is like a journeyman's union card with respect to employment doors it opens and wage scale it sets you on.
- *GRADUATE STUDENTS ARE IN GREAT DEMAND* (you don't need to be an all-A student). Some of our seniors have been flown out, put up in hotels, and provided meals and a rental car (expenses paid by the recruiting school) to interview for graduate assistantship positions.

Interested? See your adviser. Also, check out our bulletin boards and magazine racks displaying graduate school ads. *Peterson's Annual Guides to Graduate Study* contains brief descriptions of most U.S. graduate programs. The latest edition is on reserve in our library, and earlier years' are in the stacks.

V. FACULTY INFORMATION

For a description of current faculty members and their research interests, please go to www.emich.edu/public/chemistry/people/people.htm.