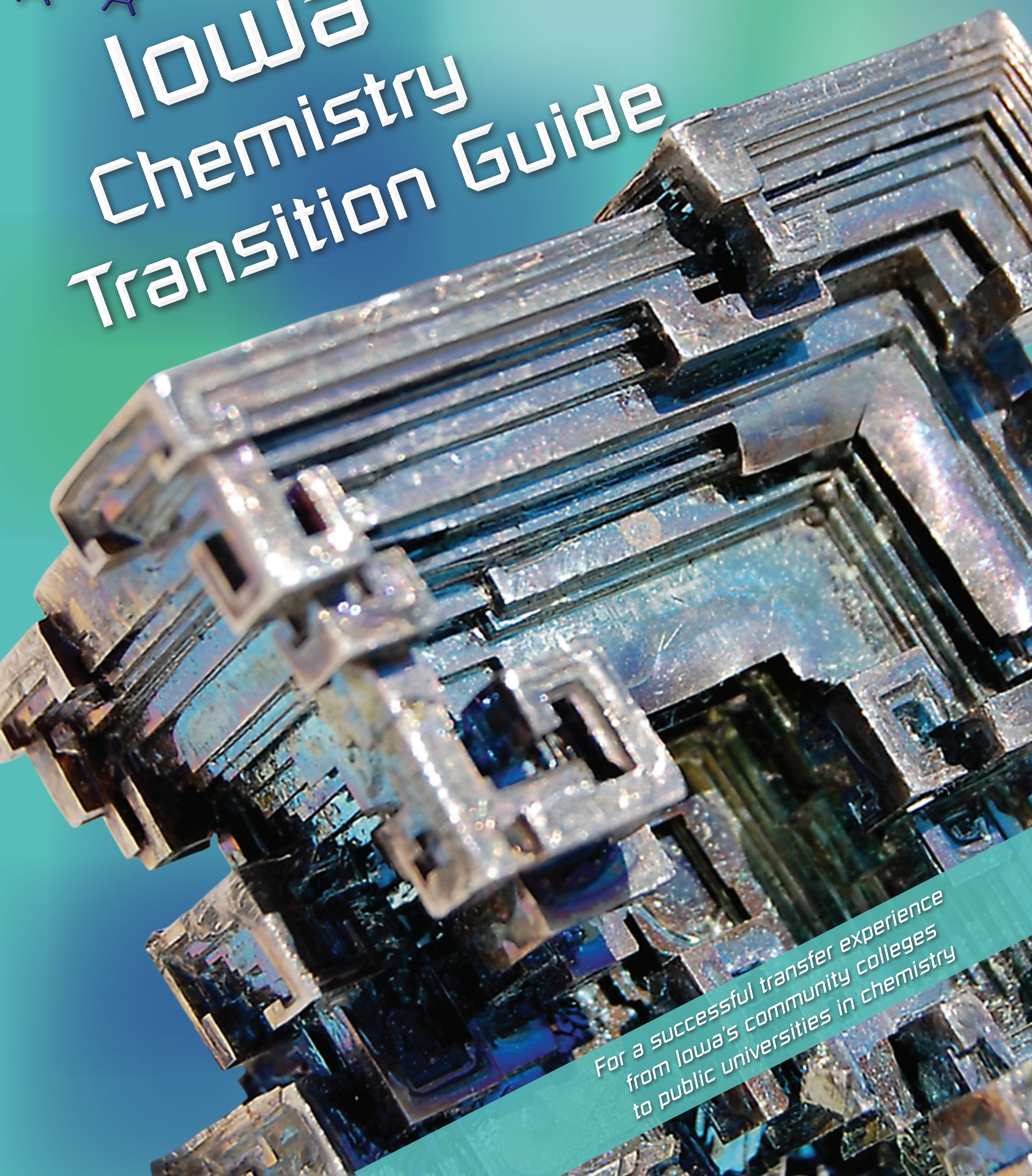


# Iowa Chemistry Transition Guide



For a successful transfer experience  
from Iowa's community colleges  
to public universities in chemistry



# Preamble

The STEM (science, technology, engineering, mathematics) talent pipeline in Iowa depends greatly on successful transfer experiences from community colleges to four-year institutions. Almost half of all bachelor's degree earners in STEM fields nationwide attended community college at some point during their education.<sup>1</sup> Moreover, the essential diversification of the STEM talent pipeline in America is best achieved through strong support of community colleges currently educating the most diverse student body in the history of our nation.<sup>2</sup> Yet the success of transfer students is hindered by many hurdles that can be overcome through communication and attention. For example, it is increasingly important to move beyond mere articulation agreements so that faculty members at the transfer junction may work together and collaborate on alignment of social and psychological components in addition to academic and institutional ones.<sup>3</sup> The function of this Chemistry Transition Guide, authored by and for community college and university faculty, to serve their students as a tool to help all stakeholders to manage a successful transfer experience in chemistry. Evidence more than suggests a call to action.

Here in Iowa, some 150 new freshmen declare chemistry majors at our universities each year, and about 40 more transfer in from community colleges. Hundreds more from both pathways arrive at our universities to take additional chemistry classes to fulfill requirements of related majors including Agricultural Science, Biology, Engineering, Exercise Science, Nutrition and pre-health professional fields. These majors lead to high-value graduates in economically vital sectors of Iowa's industry spectrum: healthcare, advanced manufacturing, bioscience, and information technology. Indeed, studies project that Iowa's STEM employment sector will grow by 16 percent by 2018, four times the rate of growth in other employment sectors.<sup>4</sup> Thus it is both a moral imperative and an economic one that every learner of chemistry, especially our transfer students given their increasing numbers and diversity, be provided the best learning experience possible at our universities. Some indicators suggest that our transfer students are more likely to encounter barriers to success than are students who enroll as freshmen at Iowa's public universities. This is a rallying call for collaboration among community college and university faculty, advisers, mentors and all who impact student success to find solutions.

Our universities' two-year retention rates for entering freshmen are higher overall than the retention rate for transfer students. The university grade point average after the first semester on campus is higher on average for university freshmen versus transfer chemistry majors (2.95 to 2.53, 2010 data). And, the six-year graduation rate from the date of arrival on campus is 2 percentage points higher for university freshmen versus transfer chemistry majors (56.6 percent compared to 54.6 percent, 2005 data). Many variables contribute to these discrepancies, yet some barriers to success are clearly within the control of university and community college faculty, advisers, mentors and students themselves. This Chemistry Transition Guide is a tool for communicating across the transfer bridge in support of all stakeholders responsible for its success. Our students deserve it. Our state depends on it.



*Jeffrey Weld, Ph.D.  
Project Facilitator  
Director, Iowa Mathematics and Science Education Partnership (IMSEP)  
February 1, 2013*

## ABOUT THIS GUIDE

Section I is an extrapolation of basic understandings and knowledge of fundamental science and its mathematical underpinning, as well as key chemistry principles to be possessed by the transfer student upon arrival to the university, on page 4.

Section II is a collection of skills and tools that are expected of the incoming chemistry transfer student in terms of exposure and in some cases, competency, on page 13.

Section III is friendly advice to the community college chemistry instructor from university chemistry instructors intended to provide qualitative background to assure a successful transfer experience, on page 14.

Section IV is friendly advice to the university chemistry instructor from community college chemistry instructors intended to help them understand the unique perspectives, talents, and challenges faced by transfer students, so that university instructors can support a successful transfer experience, on page 15.

Section V is an array of helpful information for the transfer student and advisor, including out-of-class opportunities, support systems in place, and key advice upon arrival at the university, page 16.

APPENDIX is a list of chemistry majors and related majors at Iowa's public universities, on page 23.



# I - General understandings and prerequisites

What follows are foundational skills and understandings that are expected after successful completion of the introductory chemistry sequence (General Chemistry I and General Chemistry II). The primary aim of an introductory chemistry sequence is not simply to expose students to many separate and disconnected terms and concepts. Although many facts are encountered in these courses, the primary goal is to develop comprehension and understanding of the general principles of the science of chemistry. The ability to build upon the foundational knowledge acquired through the introductory chemistry course sequence will be critical to success in upper level courses.

**It is strongly recommended that students complete an entire introductory sequence at a single institution prior to transferring institutions and that students meet with departmental advisers at the new institution prior to taking these courses, if possible, to discuss transfer of these course credits.**

The following concepts and principles are intended only as representative of the knowledge expected of the chemistry learner after completing General Chemistry I and General Chemistry II (or Principles of Chemistry I and II). It should not be considered a standardized and comprehensive list of content covered by all instructors.

**Friendly advice to the student of chemistry:** *Do not be afraid to take intellectual risks. If you take on a problem written or real, and don't instantly know how to do it, don't quit or feel embarrassed. Persevere. Get input. Step back and analyze it. Keep trying!*

*The list of understandings below are adapted from the report "Understanding University Success" a project of the Association of American Universities and The Pew Charitable Trusts. Reprinted with permission of author. See References for full citation.*

## Knowledge & Skill Foundations

A number of subjects come together in chemistry, including mathematics and statistics. Students who are prepared to study the chemical sciences at the college level are capable of integrating scientific methods and contextual understanding, critical thinking and hands-on skills.

### Basic Knowledge

Transfer students who are well-prepared for upper level chemistry generally have acquired the necessary mathematical skills. Those skills include knowledge of basic mathematical concepts and processes in arithmetic, algebra, trigonometry, geometry, statistics and calculus. It is important to be able to translate and transform fairly simple word problems into mathematical equations and vice-versa. In the sciences, as in mathematics, students may often demonstrate a dependency on calculators. Technology can help students with scientific experiments but does not replace the thinking processes required to estimate, question and solve problems.





# General understandings and prerequisites - I

## Thinking about Science

Beyond simple memorization of definitions or theories, successful students understand how scientific processes operate and how those processes relate to one another. Chemistry, like all sciences, is a process, and it requires certain skills.



Students ready to get the most out of science courses have a measure of scientific common sense; an overall understanding of how scientific concepts, definitions and applications fit together.



Students are capable of experimental thinking. They have an understanding that experimentation is an inherent part of the scientific process. Transfer students will benefit greatly from an understanding of the interrelationships among scientific concepts across the sciences.



Successful students use mathematical reasoning as they work with chemical formulas and as they try to solve and explain problems. Once a solution is reached, they can also defend why they chose each math process.



Evaluating scientific issues in daily life and understanding the origins of scientific knowledge is important, as well. As they study, successful students address questions along the way, such as “Do I know for sure?” and “How do I know?” The relationship between a chemical formula and its real-world application is worth thinking about, too. There is a formula behind the process of photosynthesis, and it is applied in plant life all around us. This type of conceptualization helps students to realize the position of humans within a global context and to gain an appreciation for everyday existence. Students who succeed in the sciences employ critical thinking skills as they learn scientific concepts. Beyond mere curiosity, they inquire about their place in the universe and question their own scientific knowledge and beliefs.



Science, like any field of study, carries with it historical and social contexts. Transfer students need not be historians, but they benefit greatly from knowing about the central features of historical traditions and contemporary events that relate to and influence the development of scientific inquiry.

## Solving Problems, Asking Questions

Students are ready to benefit from chemistry courses when they are prepared to solve scientific problems using the approaches commonly known as the scientific method. Examples of scientific problem- solving skills include:



Students are ready to benefit from chemistry courses when they are prepared to solve scientific problems using approaches generally labeled as the scientific method. Examples of scientific problem- solving skills include:

- Drawing a picture to represent a situation described in a chemistry problem.
- Identifying and organizing what is known and not known in a problem.
- Identifying assumptions and relevant equations.
- Testing equations for unknowns.
- Checking units.
- Checking that the answer is physically reasonable.



Successful students know how to design a testable scientific question, refine that question and conduct an experiment to find solutions. They are able to think creatively as they develop hypotheses and estimate potential results. They also show a willingness to question existing results, and then to generate and weigh new options and questions as a result of the inquiry they undertake.

# I - General understandings and prerequisites

## Reading, Writing & Communication

In the sciences, as in other disciplines, successful students write with clarity, cohesiveness and meaning. Good science writers have knowledge of scientific writings and the terminologies used in such texts, and know how to translate this knowledge into non-scientific language. As students write scientific analyses, they need to construct logical and coherent arguments that demonstrate an understanding of causation and of the various levels of abstraction involved in science. These are important tools that enable students to communicate understanding of a scientific process, particularly as they present and defend experiments to teachers and peers.

Basic math skills are, quite possibly, the most important set of skills for students to have mastered transferring into science courses. They need to understand why equations work and what each equation says about the physical world.

Two specific reading skills are particularly necessary for success. First, successful students comprehend what they read. Second, they are familiar with publications that carry articles on scientific findings (for example, *Discover* magazine and the *New York Times*) and understand both scientific terminology and experiments described in such publications. This comprehension of scientific literature with some technical language, content or concepts is useful when students try to explain processes used to test a scientific hypothesis. Also, as students read scientific literature they exercise scientific common sense, or a healthy skepticism. This helps them assess the likely validity of the content of articles and continue to build independent judgment about the validity of scientific reports in general.

## Orientation Towards Learning

Entry-level students often feel anxiety as they tackle a scientific experiment or try to explain a scientific concept. Persistence is vital in the quest for solutions, as is acceptance of failure and ambiguity as part of the experimentation process. Some scientifically well-prepared students have such a fear of failure that they are unwilling to approach new things. They often have trouble investigating alternative solutions to a problem, offering an estimate rather than a precise answer or questioning the credibility of their results. To develop a scientific knowledge base, successful students act on their curiosity and take risks to understand the intricacies and mysteries of science.

In addition to the willingness to try, successful students have the ability to conduct honest and sustained inquiry and to engage in the scientific process for long periods of time as hypotheses are tested over and over. They understand that scientific learning is ongoing. It is a scholarly activity that requires time, sustained engagement, reflective study skills, patience and persistence.

Beyond good study skills, successful students of chemistry take responsibility for their own education. They structure and manage time according to course expectations. They know how and when to ask for help. Study in any field of




# General understandings and prerequisites - I







science requires hard work, a focused curiosity and a willingness to dedicate the time necessary to follow through on a scientific inquiry.

## General Foundation Skills





Successful students understand the processes generally known as the scientific method. These students are able to observe, hypothesize, test and revise, and they know the difference between a hypothesis and a theory. They can:

-  design and conduct scientific investigations during which they formulate and test hypotheses (formulate and clarify the method; identify the controls and variables; collect, organize, display and analyze data; make revisions of hypotheses, methods and explanations; present the results; and seek critiques from others).



Successful students know basic mathematics conventions. They can:

-  understand the real number system and its properties.
-  use exponents and scientific notation.
-  understand ratios, proportions and percents and how each is related to the other.
-  use proportional reasoning to solve problems (e.g., equivalent fractions, equal ratios, constant rate of change, proportions and percents).
-  add, subtract, multiply and divide with a high, consistent degree of accuracy.
-  simplify rational expressions.


Successful students are able to recognize and use basic algebraic forms. They can:

-  know ways that variables can be used (e.g., as a placeholder for an unknown, such as  $x + 2 = 9$ , or to represent a range of values, such as  $-3m - 8$ ).
-  know when it is possible to simplify, solve, substitute in or evaluate equations and expressions and when it is not. For example, expand, but not solve, the expression  $(x + 1)(x + 4)$ ; substitute  $a = 2$ ,  $b = 4$  into the formula  $a^2 + b^2 = c^2$ ; solve the equation  $0 = (x + 3)(x + 1)$ ; and evaluate the function  $f(x) = (x + 1)(x + 4)$  at  $x = -1$ .
-  represent functions, patterns and mathematical relationships using a variety of models (e.g., statements, formulas, and graphs).
-  understand various types of functions (e.g., direct and inverse variation, polynomial, radical, step and sinusoidal), and have a deep understanding of exponential and logarithmic functions.


Successful students demonstrate the ability to work algebraically with formulas and symbols. They:

-  are familiar with the concept of continuity.
-  use formal notation to describe applications of sequences and series.

Successful students know and understand basic trigonometric principles. They:

-  know the definitions of sine, cosine and tangent in relation to right triangle geometry and similarity relations.

Successful students understand the relationships between geometry and algebra. They:

-  understand that a curve drawn in a certain location is fully equivalent to a set of algebraic equations.



# I - General understandings and prerequisites



possess the ability to represent a geometrical figure (e.g., a triangle or a circle) on a plane using a set of equations, as in descriptive geometry.



understand vectors and how they can be used (e.g., representing velocity and force).



use operations on vectors (e.g., vector addition and scalar multiplication).

Successful students demonstrate an ability to problem-solve. They:



use various strategies to approach problem-solving situations and to revise solution processes.

Successful students understand that mathematics is a symbolic language, that fluency requires practice and that mathematics is the language of all scientific pursuit. They:



know the definition of a mathematical expression (a statement using numbers and symbols to represent mathematical ideas and real-world situations).



understand the use of written symbols and the limitations on appropriate uses of such symbols (e.g., equal signs, parentheses and superscript).

Successful students understand and apply concepts of probability and statistics. They:



understand and use data represented in various ways (e.g., charts, tables, plots and graphs).



understand descriptive statistics (e.g., mean, median, mode and standard deviation).



understand that predictions based on sample data are inferential.

Successful students understand and apply concepts of measurement. They:



select and use appropriate units to express measurements for real-world problems.



know how to make estimates and approximations and when to use those approaches to solve problems.



use unit analysis in problem-solving.



understand the differences between the metric and the traditional U.S. measurement system and are able to perform simple conversions between the two.



know the difference between accuracy and precision, as well as how to use significant digits appropriately.

## Science and Society

Successful students understand the scientific enterprise. They:



understand that science and the theories of science are not absolute and should be questioned and challenged. This includes the ideas that:

- new theories will continue to replace current or older ones.
  - scientific theories must stand up to the scrutiny of the entire scientific community.
  - acceptable validation includes reproduction and internal consistency.
  - science and society influence each other. For example social and economic forces strongly influence which science and technology programs are pursued, invested in and used.
- Understand that science involves different types of work in many different disciplines.



understand that interactions between science and technology have led to refined tools (e.g., precision instruments, measuring techniques, data processors, etc.) and the means for a safer, more comfortable life for more people (e.g., electricity, transportation, medical advances, etc.).



# General understandings and prerequisites - I

- know that investigations and public communication among scientists must meet certain criteria in order to result in new understanding and methods.

## Chemistry-Specific Content Understanding

The following list provides some examples of topics and their associated proficiencies for which you should have achieved a sufficient degree of competency after completing the General Chemistry sequence. This is not intended to be an exhaustive list, but gives an idea of many of the foundational concepts that you will be expected to know for subsequent chemistry (and many biology) courses.

### • Matter and Measurement

Topics:

- o Density, specific gravity
- o Temperature units/conversions
- o SI units and metric prefixes
- o Uncertainty, accuracy, and precision
- o Significant figures
- o Units of concentration
- o Molecules, elements, ions, diatomic elements

Proficiencies:

- o Classify matter, states, chemical and physical properties
- o Use conversion factors in calculations

### • Atoms Molecules and Ions

Concepts:

- o Atomic Theory, structure of atoms
- o Atomic number, mass number, isotopes
- o Atomic electron orbitals, quantum numbers
- o Moles, Avogadro's Number

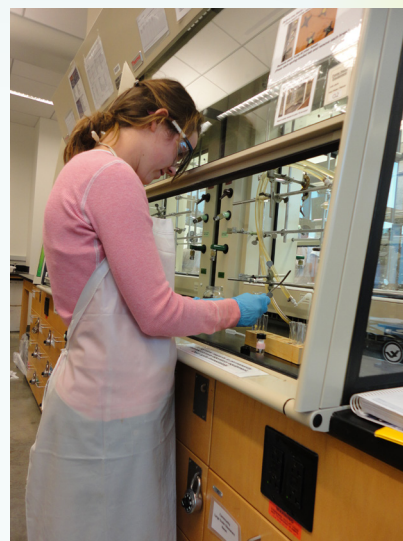
Proficiencies:

- o Recognize and classify polyatomic ions, molecular compounds, acids, bases, hydrates
- o Use the organization of the Periodic Table of Elements to predict properties of atoms and ions
- o Predict and write chemical formulas and name compounds
- o Determine and define empirical and molecular formulas
- o Determine electron configurations for atoms and ions
- o Determine molar mass

### • Chemical Bonding and Structure

Topics:

- o Characteristics of covalent, ionic and metallic bonding
- o Electronegativity, ionization energy and electron affinity
- o Valence Bond Theory – sigma and pi bonds



# I - General understandings and prerequisites

- o Molecular Orbital Theory
- o Resonance structures
- o Formal charge

## Proficiencies:

- o Recognize types of bonds in terms of electron behavior
- o Draw Lewis structures for molecules and polyatomic ions
- o Predict molecular shape and draw 3D structures of molecules
- o Use structure and electronegativity to determine polarity of molecules

## Chemical Reactions and Mixtures

### Topics:

- o Mass relationships in chemical reactions
- o Total, complete and net ionic reaction equations
- o Precipitation reactions
- o Limiting reactants
- o Theoretical, actual and percent yield
- o Concentration units (molarity, molality, etc)
- o Colligative Properties

### Proficiencies:

- o Classify types of chemical reactions
- o Write and balance chemical reactions in equations
- o Calculate amounts of products and reactants in a reaction

## Intermolecular Forces

### Topics:

- o Phase diagrams
- o Crystalline structures
- o Mixtures, aqueous solutions
- o Solubility of covalent and ionic compounds

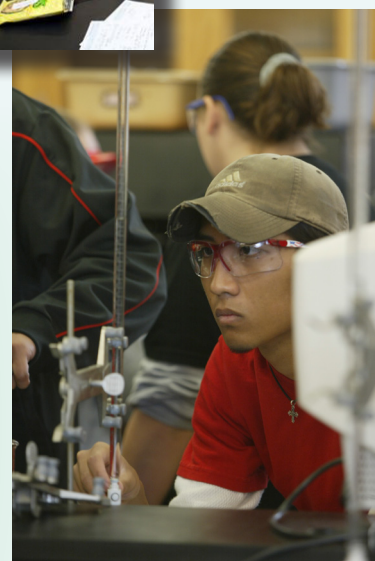
### Proficiencies:

- o Identify types of intermolecular forces
- o Use intermolecular forces to predict properties

## Gases

### Topics:

- o Ideal gas law
- o Dalton's Law of Partial Pressures, gas diffusion
- o Gas reaction stoichiometry





# General understandings and prerequisites - I

## Proficiencies:

- o Define units of pressure
- o Use kinetic molecular theory to explain gas laws and deviations from ideality in gases
- o Apply gas laws to determine various quantities related to gases

## Rates of Reactions

### Topics:

- o Reaction rates, Rate Law
- o Catalysis
- o Reaction mechanisms, rate limiting steps
- o Reaction quotient
- o Activation energy, transition state, Arrhenius equation

### Proficiencies:

- o Use integrated rate laws to find concentrations or time of reaction
- o Determine reaction order



## Thermochemistry

### Topics:

- o Laws of Thermodynamics
- o Energy changes in reactions
- o Calorimetry
- o Enthalpy
- o Endothermic and exothermic reactions

### Proficiencies:

- o Use Hess' Law to determine heat of reaction
- o Predict spontaneity of reactions – Gibbs free energy
- o Solve problems involving specific heat capacity, changes in temperature and heats of reaction



## Acids and Bases

### Topics:

- o Arrhenius, Bronsted-Lowry and Lewis definitions of acids and bases
- o Acid-Base chemistry – reactions and equations, titrations
- o Acid/Base strength
- o pH and pOH calculations
- o Buffers
- o pKa and pKb

### Proficiencies:

- o Find  $[H_3O^+]$ ,  $[OH^-]$ , pOH, and pH in aqueous systems given the value of one of these
- o Identify acids/bases and their conjugates

# I - General understandings and prerequisites

## Equilibrium

### Topics:

- o LeChartelier's Principle
- o Factors affecting  $K_p$  and  $K_{eq}$
- o Dynamic equilibrium
- o  $K_{sp}$  and solubility

### Proficiencies:

- o Predict direction of reversible reactions
- o Use a reaction table to determine quantities of unknown equilibrium quantities

## Electrochemistry

### Topics:

- o Redox reactions
- o Voltaic Cells, Nernst equation
- o Reduction potentials, Cell potential
- o Half-reactions

### Proficiencies:

- o Assign oxidation numbers
- o Identify and balance oxidation-reduction reactions
- o Predict red-ox reaction in combination of half cells

## Nuclear Chemistry

### Topics:

- o Modes of decay
- o Calculations relating to radioisotopic decay

### Proficiencies:



- o Write nuclear decay reactions
- o Calculate half-life








**S**kills and tools that are expected of the incoming chemistry transfer student in terms of exposure and in some cases, competency.





Computer skills should include being able to...

-  use common computer applications such as word processing, spreadsheets/graphing programs and presentation programs.
-  use appropriate library/internet search tools to find and retrieve scientific information.








Reading/Interpretation/Comprehension skills should include being able to...

-  critically interpret the meanings and results of scientific writings.
-  interpret and use data presented in the form of graphs and tables.
-  identify the key components of a problem.





Problem solving skills should include being able to...

-  identify the key elements of a problem.
-  develop and apply a suitable strategy for solving the problem.
-  effectively communicate the solution of a problem by articulating the solution in a clear and logical format.
-  evaluate the reasonableness/correctness of a solution to a problem.

Laboratory skills should include being able to...

-  understand the goals of an experiment.
-  properly use standard laboratory equipment.
-  properly record the results of an experiment.
-  analyze and evaluate the results of an experiment.
-  summarize experimental results through the appropriate use of tables and graphs.
-  use data and results to support conclusions
-  follow correct procedures for laboratory safety.

And if Organic Chemistry is completed, these additional skills and experiences are desirable...






-  IR, NMR, GC
-  Interpret mass spectra
-  Solvent extraction
-  distillation

# III - Advice to Community College Chemistry Instructors






*Friendly advice to the community college chemistry instructor from university chemistry instructors intended to provide qualitative background to promote a success transfer experience.*

Our advice to the community college chemistry instructor is much the same as would be our advice to any introductory-level chemistry instructor. The primary goal of general chemistry is to provide students with a firm understanding of basic chemistry fundamentals and to prepare them for future chemistry or chemistry-related coursework. An important secondary goal of general chemistry and other foundational science course is to help students develop strong problem-solving and critical-thinking skills that are applicable in many disciplines.

The following suggestions are meant to help students succeed in courses and disciplines that have general chemistry as a prerequisite.

-  Command of material rather than effort should be reflected in the course grade.
-  Problem-solving and critical-thinking skills are the underpinning of success at the upper level so the more experience students get at these skill sets, the better.
-  Future chemistry courses assume basic coverage and breadth to be standardized in introductory chemistry sequences.
-  Chemistry can be hard, but accessible and rewarding. It is best to come right out with it. Perseverance is a valuable trait in chemistry (as in life!).
-  Preparedness for class by working daily outside of class on readings, problems, and other homework sharply differentiates the successful from those not so.

In preparing the chemistry student for successful transfer to an Iowa university, it is helpful for the community college instructor to counsel students regarding the following:

-  Competition can be ramped up considerably in comparatively large chemistry classes of the university, though support is plentiful for those who ask.
-  The pace of coverage at the university chemistry class can be accelerated compared to that of the community college, putting more responsibility on learners.
-  Students should be prepared to devote a minimum of 2-3 hours of study outside of class for every hour of lecture.
-  Students will do well to keep in mind that although faculty have significant research and service responsibilities, most will first and foremost respond to a student who seeks their help.
-  Please see Section VI for information on virtual laboratory learning.

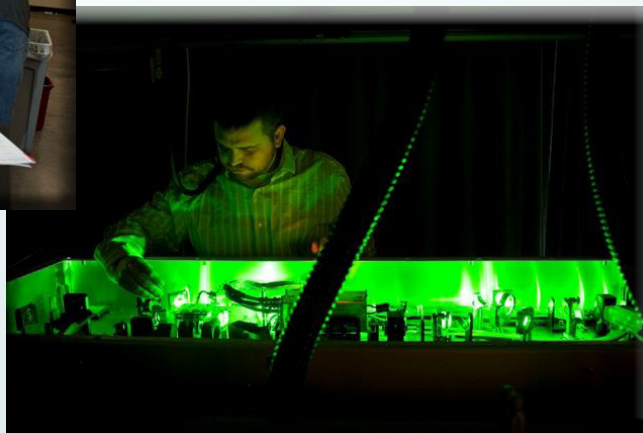
Chemistry faculty at Iowa Regents Universities encourage all chemistry instructors who are teaching a college level general chemistry course at community colleges or at high schools to administer one of the ACS general chemistry examinations as part of their final exam.



# IV - Advice to University Chemistry Instructors

*Friendly advice to the university chemistry instructor from community college chemistry instructors intended to help understand the unique perspectives, talents, and challenges faced by transfer students, so that university instructors can promote a successful transfer experience.*

- Most transfer students from Iowa's community colleges are accustomed to instructors whose offices are easy to find and help is easily accessed.
- They need explicit instructions as to how to access your time.
- Transfer students should be informed as to the availability of tutors and/or learning centers on campus.
- Students need to know when they should expect results of evaluations and where and how they can access that information.
- They are accustomed to quick feedback since the class sizes at community colleges are smaller.
- Transfer students may be intimidated by the large class sizes of the university and the relative detachment between students and faculty.
- More often the transfer student as opposed to the "native" university student may be of nontraditional background – a career-changer, a veteran, a parent of grown children, a head-of-household, etc. University instructors will do well to get to know transfer students and work with them from the context of life experiences.
- Since transfer students are more likely to be nontraditional, they may be more likely to work a full-time job which may be important to keep in mind when it comes to attendance and test make-up, etc.
- Please see Section VI for information on virtual laboratory learning.














# V - Advice to the Transfer Student & Advisor

## Friendly advice to the transfer student of chemistry

*An array of helpful information for the transfer student including out-of-class opportunities, support systems in place, and key advice upon arrival at the university.*

Many chemistry courses at large universities have two or three components – lecture, discussion/recitation, lab. Typically the lectures are large sections. Lower level courses can have 200-400 students in a section, while upper level courses are more likely to be 30-100 students. The lecture portion of the course will meet two or three times a week and is usually taught by a faculty member in the department. The discussion/recitation portion of the course usually meets once a week and is a much smaller section with 20-30 students and will be taught by a teaching assistant (TA), usually a graduate student. The laboratory portion of the course will also be taught by TAs, and may or may not be directly connected to the lecture portion of the course. UNI will typically have smaller classes (60 or fewer students in chemistry lectures) and both lecture and lab are taught by faculty members. The structure of these courses has several implications for the student:

-  Time management is a difference-maker for those who can balance classes, studying, employment, extracurricular activities, family life and socializing. Communicate your schedule to your university instructor if commitments impact class, recognizing that you're ultimately responsible for material and assignments
-  Keep close track on exam and assignment dates. Information will be provided in the syllabus and/or the course management site.
-  University chemistry courses tend to be fast-paced and cover a lot of material.
-  Previewing or reading chapters prior to class enhances the likelihood of success especially since it permits visiting the professor in office hours if questions should arise.
-  Expect to spend at least 6-8 hours a week outside of class working on chemistry. Frequent small homework sessions are much more effective than "cramming" at week's or unit's end.
-  Discussing concepts and working through material in a study groups is a very successful learning strategy.
-  Most faculty welcome student questions (it is often the only way they know whether students understand the material) and it's likely that your question is shared by many others in class.
-  Though professors may not take attendance (or even notice if you are missing), lecture is the time when important information is shared.
-  More emphasis is likely to be placed on a few exams to determine the course grades. With a thin margin for error, preparation is doubly important.
-  Universities have many support structures in place, including office hours of faculty and teaching assistants, to help struggling students. Just be sure not to wait until the semester is winding down to reach out.
-  University professors have significant research and professional service responsibilities that command their time outside of class. The best approach outside of office hours is to make an appointment.



# Advice to the Transfer Student & Advisor - V

Iowa's public universities offer a great deal of academic support for student success. You are strongly encouraged to take advantage of these services. Examples of support programs are listed below.

- Academic advisers
- Tutoring
- Chemistry Help Centers
- Academic Success Centers
- Supplemental Instruction/Peer-led Team Learning
- Learning Communities
- Study Skills Courses and Workshops
- Writing, Math and Media Help Centers
- Counseling Services
- Disability Resources/Accommodations
- Multicultural Student Affairs/Center



# V - Advice to the Transfer Student & Advisor

## Scholarships, research and other opportunity alerts

### Scholarship Opportunities

There are many opportunities for scholarships for students who transfer to the Regent's Universities. A key thing to remember is filling out the appropriate scholarship request form. Information about scholarships for upper level chemistry majors can be found on the following web pages:

- University of Northern Iowa Chemistry and Biochemistry: <http://www.uni.edu/chemistry/student-scholarships.html>
- Iowa State University Chemistry: <http://www.chem.iastate.edu/undergrad/scholarship.html>
- University of Iowa Chemistry: <http://www.chem.uiowa.edu/stdsrvc/ugprogram/ugawards.html>

### Undergraduate Research

All three Regents University programs strongly encourage undergraduates to become involved in research with faculty-led research groups. Details about research opportunities can be found by following the links below. Both academic year (for credit) and summer (paid \$ and/or credit) research opportunities are available at each of the Regents Universities.

- University of Northern Iowa Chemistry and Biochemistry:  
<http://www.uni.edu/chemistry/student-research-projects.html>
- Iowa State University Chemistry: <http://www.chem.iastate.edu/undergrad/research>
- University of Iowa Chemistry: <http://www.chem.uiowa.edu/stdsrvc/ugprogram/ugprogres.html>
- In addition, you may want to check into summer research opportunities offered across the country at [www.getexperience.dreamhosters.com](http://www.getexperience.dreamhosters.com).

## The ACS Chemistry Examinations

The ACS Exams Institute is unique among academic disciplines. It produces nationally normed exams for most chemistry courses, ranging from high school through the entire undergraduate chemistry curriculum in the United States. Many graduate programs use ACS Exams to measure the content knowledge of students starting graduate school.

All ACS Exams are created and developed by committees of scientists and educators who teach the course for which an exam is intended. No governance body of the American Chemical Society dictates content coverage of any exam. The exams produced by the Institute are standardized



# Advice to the Transfer Student & Advisor - V










exams because the questions are representative of the topics, concepts and principles taught in a typical course. Each exam is pilot tested and the results of the pilot tests are used to improve and focus the exam. As soon as enough data is collected from participating institutions, national test norms and item statistics are calculated for each examination. Student names are never recorded at the ACS Exam Institute. A new committee is commissioned approximately every four to five years to write a new exam.

Chemistry faculty at Iowa Regents Universities encourage all chemistry instructors who are teaching a college level general chemistry course at community colleges or at high schools to administer one of the ACS general chemistry examinations as part of their final exam. When community college students transfer to a Regents University, academic advisers at the Regents need to know the ACS Exam score in order to help students be placed in the correct chemistry course. Chemistry instructors should compare their class average to the national average in order to help align the course scope and objectives to what the Regents Universities are doing with their general chemistry courses

## Learning Communities

What is a Learning Community?

Learning communities are small groups of students who generally take one, two, or three courses together and may live in the same residence hall. Typical characteristics of Learning Communities include one or more of the following:

-  common courses.
-  common place of residence.
-  study groups -- informal or formal gatherings with your classmates.
-  career exploration.
-  introduction to university resources.
-  peer mentoring and/or tutoring.
-  faculty mentoring.
-  social activities -- attend sporting events, plays, or speakers on campus; have dinners with each other and professors; just hang out with each other.
-  community service projects -- get involved and help the community.

The faculty and staff involved with Learning Communities are devoted to enhancing student learning. Some learning communities are focused on a specific major while others include people from many different major, some have their members live together (or near each other) in a residence hall and others do not. Being in a learning community should not take any more time than you would expect to spend as a successful student. It can help you manage your schedule and time by providing you built-in opportunities for study groups and building connections with your classmates.



# V - Advice to the Transfer Student & Advisor




At the University of Iowa there are over 30 unique living-learning communities (LLC): <http://fye.uiowa.edu/admitted-now-what/living-learning-communities>

*The Road Less Travelled LLC* is designed specifically for transfer students who are new to the University of Iowa, but not new to college. Transfer students are also welcome to join a variety of other LLCs. The LLCs available to you will be indicated in your housing application.

At Iowa State University there are over 80 CLCs: [http://www.lc.iastate.edu/lc\\_index.html](http://www.lc.iastate.edu/lc_index.html)

The Chemistry Learning Community (CLC) seeks to build a community environment that fosters the educational and emotional growth of chemistry students. Because of the strong emphasis on research in the chemistry community, it is centered around a research theme. The CLC consists of weekly meetings with freshmen and transfer students in Chem 101X "Chemistry Learning Community: Orientation" and activities in the Fall semester and enrollment in Chemistry 110X "Cutting Edge Chemistry: Research and Career Opportunities" and activities in the Spring semester.

Our goals include:

-  building a supportive community for our freshmen and transfer students by creating and promoting connections among the majors, peer mentors, faculty and staff.
-  exposing freshmen and transfer students to undergraduate research opportunities.
-  helping students learn coping, problem-solving and communication skills.

We will introduce students to support services at ISU and WebCT, develop team-building and problem solving skills, provide educational- and service-based field trips, and invite faculty to discuss their research.

## Importance of hands-on laboratory learning versus online courses

**A**n online course is a special learning environment calling for special skill sets to maximize learning. It is intended for the student who may not have access to a regular classroom and who possesses strong independent learning skills. If you are able to attend a face-to-face course that is always the best option for you.

From ACS Public Policy Statement 2011-2014

### IMPORTANCE OF HANDS-ON LABORATORY ACTIVITIES

*Hands-on activities enhance learning significantly at all levels of science education. These activities are usually the basis for a "laboratory" class or laboratory portion of a class. In a hands-on*



# Advice to the Transfer Student & Advisor - V

*chemistry course, students directly experience laboratory chemicals and their properties, chemical reactions, chemical laboratory apparatus, and chemical laboratory instruments. These activities are essential for learning chemistry.*

*Computer simulations have been developed that can mimic laboratory procedures and have the potential to be a useful supplement to these hands-on activities in American classrooms. They are often used as a pre- or post-lab exercise to reinforce the procedural and safety issues of a laboratory experience. However, these simulations, by their very nature, do not involve contact with laboratory chemicals or equipment and thus should not be considered equivalent replacements for hands-on experiences critical to chemistry courses at any level. With the increasing availability, sophistication and power of web-based tools and computer simulations, a growing number of academic programs are offering “virtual” chemistry laboratory courses. They often are intended to affordably increase student exposure to chemistry, to reduce costs, or to eliminate hazardous wastes and safety concerns.*



















*Because computer simulations are not a substitute for hands-on laboratory experience, academic transcripts should clearly disclose whether a chemical laboratory course is hands-on or simulated. To meet the needs of potential employers and academic institutions evaluating potential transfer of credits, academic transcripts should reflect an applicant’s laboratory experience. Thus, the Society believes that computer simulations are not a substitute for student hands-on laboratories from the kindergarten level through undergraduate education. Furthermore, ACS supports identifying designations for laboratory courses that involve the substitution of simulations for more than {a significant proportion of} the hands-on, laboratory activities.*

## The A.S. degree at CC - more science focused

Students interested in chemistry may choose to earn an Associate of Science (A.S.) degree at the community college. The A.S. degree is designed for community college students who plan to transfer into four-year programs of study in science or mathematics. This degree option allows students to take more math and science courses at the community college than would be possible if they completed the requirements for an Associate of Arts (A.A.) degree. There may be some variations in availability and design of the A.S. degree at each community college but the statewide transfer agreement among Iowa’s 15 community colleges and public universities (University of Northern Iowa, Iowa State University and University of Iowa) establishes that a minimum of 20 semester hours be completed in math and science with at least one course in each area. The A.S. degree also includes 20 semester hours of electives that can come from math and science. The availability of this number of semester hours in math and science is helpful for chemistry students to complete sequences of courses in chemistry, biology, physics and mathematics at their community colleges which is highly recommended. Students transferring an A.S. degree to an Iowa public university must have maintained a minimum cumulative GPA of 2.0 on all graded arts and science courses acceptable for transfer. Students who satisfy the requirements of the A.S. degree and have maintained the 2.0 GPA in their arts and sciences courses, will be enrolled at the junior level status in the college of liberal arts within the university. Additional general education requirements may be required by the public university so students should check with each of the universities for details. If a student chooses not to earn either an A.S. or an A.A. degree at the community college, her/his admittance will require a course-by-course evaluation of the student’s transcripts thus risking their junior level status upon transfer.

# V - Advice to the Transfer Student & Advisor

## Checklist for the student upon transferring to a university

-  Attend the earliest possible Transfer Orientation session. The longer you wait, the fewer course options you may have.
-  Ask adviser about:
  - the registration process.
  - your degree audit and transfer credits.
  - student clubs related to your department/major/career interests.
  - research opportunities on campus and in the community.
  - transition courses and supplemental instruction services.
  - opportunities to join a peer group of students that have also transferred from community colleges.
-  If you are employed during the semester try to work fewer hours. You will need to accomplish more out-of-class studying and participating in experiential opportunities.
-  Become familiar with the services available online: e-mail, course material and grades, online course management systems, course schedules, degree requirements and university calendar/deadlines.
-  Find out how to sign up for a tutor even if you don't think you'll need one.
-  Write down all university academic deadlines in your student planner.
-  Learn where everything is located on campus such as buildings, advisers, classes, tutoring centers, health center and computer labs.
-  Create a binder or electronic folder to store all handouts and information relating to academic policies and advising.
-  Look over department, college and university policies. Inquire if you have any questions.
-  Look over materials from the science prerequisite courses for the course you will be taking at the university. Make sure you are comfortable with and knowledgeable of all the subject areas. If not, seek advice from advisers or the faculty in those courses about how you can bridge the gap.
-  **GO TO CLASS.** Even if the instructor won't know if you are there, it makes a DIFFERENCE.
-  Get to know and exchange contact information with at least two people in every class that you are in.
-  Approach instructors and/or teaching assistants with questions on material you find difficult to understand.
-  Determine the office hours of each of your instructors and make a visit to each of them.
-  Visit your career services office.
-  Attend a department social event or research seminar.
-  Attend a career fair.
-  Keep in touch with your community college instructors. They may be good mentors and references even beyond your graduation.



## APPENDIX I

| Majors requiring Chem I and Chem II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| University of Iowa                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Iowa State University                                                                                                                                                                                                                                                                                                                                                                                                           | University of Northern Iowa                                                                                                                                                                                                                                                                                                                                                                                    |
| Biology<br>Chemistry<br>Communication Sciences and Disorders<br>Computer Science<br>Environmental Sciences<br>Geoscience<br>Health and Human Physiology<br>Interdepartmental Studies (only some tracks)<br>Physics and Astronomy<br>Science Education<br>Biomedical engineering<br>Chemical and Biochemical Engineering<br>Civil and Environmental Engineering<br>Electrical and Computer Engineering<br>Mechanical and Industrial Engineering<br>Biochemistry<br>Microbiology<br>Nuclear Medicine Technology<br>Radiation Sciences<br>College of Nursing (prior to admission to program)<br>College of Pharmacy (prior to admission to program) | Agricultural Biochemistry<br>Bioinformatics and Computational Biology<br>Biology<br>biophysics<br>Civil Engineering<br>Chemical Engineering<br>Chemistry<br>Culinary Science<br>Diet and Exercise<br>Dietetics<br>Earth Science<br>Environmental Science<br>Food Science<br>Genetics<br>Geology<br>Horticulture<br>Insect Science<br>Kinesiology<br>Materials Engineering<br>Microbiology<br>Meteorology<br>Nutritional Science | Majors requiring Chem I:<br>All-Science Teaching<br>Biochemistry<br>Biology<br>Chemistry<br>Construction Management<br>Earth Science<br>Physics<br><br>CHEM 1020 - Chemistry Tech required for Manufacturing Technology majors or Technology Education majors. CHEM 1110 can be substituted.<br><br>Nursing majors take CHEM 1010 Principles of Chemistry followed by CHEM 1040 Applied Organic & Biochemistry |

## University of Iowa Chemistry-Related Majors and Associated Departmental or Program of Study Websites

Athletic Training - <http://clas.uiowa.edu/hhp/tracks/athletic-training/>  
Biochemistry - <http://www.biochem.uiowa.edu/>  
Biology - <http://www.biology.uiowa.edu/>  
Chemistry - <http://www.chem.uiowa.edu/>  
Chiropractic (pre-) - <http://www.uiowa.edu/~uaactr/prechiropractic.htm>  
Clinical Lab Sciences - <http://www.medicine.uiowa.edu/pathology/education/clsp/clsp/>  
Dentistry (pre-) - <http://www.uiowa.edu/admissions/undergrad/majors/at-iowa/DentPre.html>  
Engineering - <http://www.engineering.uiowa.edu/>  
Environmental Sciences - <http://www.uiowa.edu/~envsci/>  
Geoscience - <http://geoscience.clas.uiowa.edu/>  
Health & Human Physiology - <http://clas.uiowa.edu/hhp/>  
Human Physiology - <http://clas.uiowa.edu/hhp/tracks/human-physiology>  
Medicine (pre-) - <http://www.uiowa.edu/~uaactr/premedical.htm>  
Microbiology - <http://www.uiowa.edu/microbiology/>  
Nuclear Medicine Technology - <http://www.uiowa.edu/admissions/undergrad/majors/at-iowa/NuclearMedTechGroup.html>  
Nursing - <http://www.nursing.uiowa.edu/>  
Optometry (pre-) - <http://www.uiowa.edu/~uaactr/preoptometry.htm>  
Pharmacy - <http://pharmacy.uiowa.edu/>  
Physical Therapy (pre-) - <http://www.uiowa.edu/~uaactr/prephysicaltherapy.htm>  
Physician Assistant (pre-) - [http://www.uiowa.edu/~uaactr/prephysician\\_assistant.htm](http://www.uiowa.edu/~uaactr/prephysician_assistant.htm)  
Podiatry (pre-) - <http://www.uiowa.edu/~uaactr/prepodiatry.htm>  
Veterinary Medicine (pre-) - <http://www.uiowa.edu/~uaactr/preveterinary.htm>

## Iowa State University Chemistry-Related Majors and Associated Departmental or Program of Study Websites

Agricultural and Biosystems Engineering - <http://www.abe.iastate.edu/>  
Agronomy - <http://www.agron.iastate.edu/>  
Animal Science - <http://www.ans.iastate.edu/>  
Biochemistry, Biophysics & Molecular Biology - <http://www.bbmb.iastate.edu/>  
Bioinformatics and Computational Biology - <http://www.bcb.iastate.edu/>  
Biology - <http://www.biology.iastate.edu/>  
Biological Systems Engineering - <http://www.abe.iastate.edu/undergraduate-students/biological-systems-engineering/>  
Biological & Pre-Medical Illustration - <http://www.bpmi.iastate.edu/>  
Biophysics - <http://www.bbmb.iastate.edu/>

Chemical and Biological Engineering - <http://www.cbe.iastate.edu/>  
 Chemistry - <http://www.chem.iastate.edu/>  
 Chemistry, Secondary Education - <http://www.education.iastate.edu/te/programs/secondary-education/#chemistry-grades-5-12-liberal-arts-and-sciences>  
 Civil, Construction, and Environmental Engineering - <http://www.ccee.iastate.edu/>  
 Culinary Science - <http://www.fshn.hs.iastate.edu/undergraduate-programs/culinary-science/>  
 Dentistry (pre-) - <http://www.las.iastate.edu/academics/prehealth/>  
 Diet and Exercise - <http://www.fshn.hs.iastate.edu/undergraduate-programs/diet-exercise/>  
 Dietetics - <http://www.fshn.hs.iastate.edu/undergraduate-programs/dietetics/>  
 Engineering - <http://www.engineering.iastate.edu/>  
 Entomology - <http://www.ent.iastate.edu/>  
 Environmental Science - <http://www.ensci.iastate.edu/>  
 Food Science - <http://www.fshn.hs.iastate.edu/undergraduate-programs/food-science/>  
 Genetics - <http://www.public.iastate.edu/~ugradgen/>  
 Geology - <http://www.ge-at.iastate.edu/geoughome.shtml>  
 Geological and Atmospheric Sciences - <http://www.ge-at.iastate.edu/geoughome.shtml>  
 Horticulture - <http://www.hort.iastate.edu/about>  
 Insect Science - <http://www.ent.iastate.edu/>  
 Kinesiology - <http://www.kin.hs.iastate.edu/>  
 Materials Science and Engineering - <http://www.mse.iastate.edu/>  
 Medicine (pre-) - <http://www.las.iastate.edu/academics/prehealth/>  
 Meteorology - <http://www.ge-at.iastate.edu/>  
 Microbiology - <http://www.micro.iastate.edu/>  
 Natural Resource Ecology and Management - <http://www.nrem.iastate.edu/>  
 Nutritional Science - <http://www.fshn.hs.iastate.edu/undergraduate-programs/nutritional-science/>  
 Optometry (pre-) - <http://www.las.iastate.edu/academics/prehealth/>  
 Pharmacy (pre-) - <http://www.las.iastate.edu/academics/prehealth/>  
 Physical Therapy (pre-) - <http://www.las.iastate.edu/academics/prehealth/>  
 Physician Assistant (pre-) - <http://www.las.iastate.edu/academics/prehealth/>  
 Podiatry (pre-) - <http://www.las.iastate.edu/academics/prehealth/>  
 Pre-Health Professions - Food Science and Human Nutrition - <http://www.fshn.hs.iastate.edu/undergraduate-programs/nutritional-science/pre-health/>  
 Pre-Health Professions - Kinesiology - <http://www.kin.hs.iastate.edu/programs/kinesiology-health/prehealth/>  
 Premedical and Preprofessional Health Programs - <http://www.las.iastate.edu/academics/prehealth/>  
 Secondary Education - <http://www.education.iastate.edu/te/programs/secondary-education/>  
 Teacher Education - <http://www.education.iastate.edu/te/>  
 Veterinary Medicine (pre-) - <http://www.ans.iastate.edu/>  
 Veterinary Medicine - <http://vetmed.iastate.edu/>



## University of Northern Iowa Chemistry-Related Majors and Associated Departmental or Program of Study Websites

Department of Chemistry and Biochemistry - <http://www.uni.edu/chemistry/>

B.S. Chemistry ACS Certified - <http://www.uni.edu/chemistry/pdf/BS%20Chem%20ACS%20Certified%208-11.pdf>

B.S. Biochemistry ACS Certified - <http://www.uni.edu/chemistry/pdf/BS%20Biochem%20ACS%20Cert%208-11.pdf>

B.A. Biochemistry - <http://www.uni.edu/chemistry/pdf/BA%20Biochem%208-11.pdf>

B.A. Chemistry - <http://www.uni.edu/chemistry/pdf/BA%20Chemistry%208-2011.pdf>

B.S. Chemistry - B.A. Teaching - <http://www.uni.edu/chemistry/pdf/BS%20ACS%20Chem%20teaching%207-12.pdf>

B.S. Biology - <http://www.biology.uni.edu/>

B.A. Biology - <http://www.biology.uni.edu/>

B.A. Biology: Biomedical Emphasis - <http://www.biology.uni.edu/>

B.A. Biology: Ecology and Evolution Emphasis - <http://www.biology.uni.edu/>

B.A. Biology – Teaching - <http://www.biology.uni.edu/>

Combined B.A./M.S. or B.S./M.S. Program Biology - <http://www.biology.uni.edu/>

M.S. Biology - <http://www.biology.uni.edu/>

P.S.M. Biotechnology - <http://www.biology.uni.edu/>

P.S.M. Ecosystem Management - <http://www.biology.uni.edu/>

Biology Clubs: [http://www.uni.edu/biology/current\\_biologyclubs.html](http://www.uni.edu/biology/current_biologyclubs.html) (includes pre-pharmacy and pre-veterinary)

Pre-med Club: [https://cgi.access.uni.edu/cgi-bin/student\\_orgs/student\\_orgs.cgi?oid=123](https://cgi.access.uni.edu/cgi-bin/student_orgs/student_orgs.cgi?oid=123)

B.S. Construction Management - <http://www.uni.edu/tech/>

B.S. Manufacturing Technology - <http://www.uni.edu/tech/>

B.A. Graphic Technologies - <http://www.uni.edu/tech/>

B.A. Technology Education - <http://www.uni.edu/tech/>

B.A. Technology Management - <http://www.uni.edu/tech/>

B.S. Physics - <http://www.physics.uni.edu/>

B.A. Earth Science - <http://www.uni.edu/earth/>

B.A. Earth Science – Teaching - <http://www.uni.edu/earth/>



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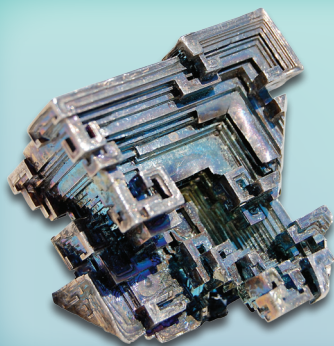
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- Design: Tonja Richards, Iowa Mathematics & Science Education Partnership
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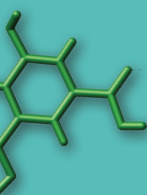
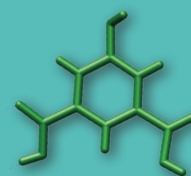
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Cover Photo:

**Bismuth** (symbol **Bi** and atomic number 83) forms beautifully colored and geometrically intricate hopper crystals as it slowly cools and solidifies from its molten state. The distinctive shape of a Bismuth crystal results from a higher growth rate around its outer edges than on its inside face. The crystal's eye-catching array of colors results from the formation of a thin oxide layer on its surface.



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