# Information Competencies for Chemistry Undergraduates: *the elements of information literacy*


## Special Libraries Association Chemistry Division, Ad Hoc Committee on Information Literacy


**January 2007**


Available at: http://units.sla.org/division/dche/il/cheminfolit.pdf

Suggested Citation:
Craig, Cory; Maddux, Linda, Eds. *Information Competencies for Chemistry Undergraduates: the elements of information literacy*, January 2007. Special Libraries Association, Chemistry Division, Ad Hoc Committee on Information Literacy. [http://units.sla.org/division/dche/il/cheminfolit.pdf]



Comments on this document should be directed to:
Cory Craig (cjcraig@ucdavis.edu) and Linda Maddux (lbm@reed.edu).

# Information Competencies for Chemistry Undergraduates

*SLA Chemistry Division, Ad Hoc Committee on Information Literacy*

## INTRODUCTION

This document was developed by the Special Libraries Association (SLA), Chemistry Division, Ad Hoc Committee on Information Literacy. The information competencies listed here identify the skills and knowledge that chemistry undergraduates should have by the completion of a bachelors degree in chemistry. Students who achieve proficiency in these areas will have a firm understanding of how to navigate the scientific and chemical literature, and will be well-prepared for graduate work and/or employment as a chemist.

The document is divided into 4 sections: 1) Big Picture: the Library and Scientific and Chemical Literature; 2) Properties, Spectra, Safety Information; 3) Chemical Literature; and 4) Scientific Communication. In addition to listing specific information competencies that students should develop, each section also identifies titles of resources that we recommend. Resources listed are suggested tools; we realize that all resources will not be available at every institution, and that similar resources not listed may be appropriate as well. Similarly, students do not need to know every resource listed here, but should be able to use the skills identified here to find information, using the resources available to them. Resources can be in any format (print, online, CD-ROM), however, students should ideally have significant experience using both online databases and print resources.

The intended audience for this document is librarians and educators that work with chemistry undergraduates. Our expectation is that this list of subject-specific information literacy skills can be used to:

- Improve instruction and assessment of information literacy skills in chemistry undergraduates;
- Provide a list of recommended resources for libraries working with chemistry undergraduates;
- Serve as a bridge between American Chemical Society (ACS) accreditation standards for chemistry programs and information literacy standards developed by the Association of College and Research Libraries (ACRL), including: *Information Literacy Standards for Science and Engineering/Technology,* and *Information Literacy Competency Standards for Higher Education*.
- Assist in developing subject-specific information literacy standards in other scientific disciplines.

We expect this document will be updated regularly, as circumstances warrant. Additional plans for this document include an appendix which will provide full citations for all resources listed. Comments on this document should be directed to: Cory Craig (cjcraig@ucdavis.edu) and Linda Maddux (lbm@reed.edu).

## 1. BIG PICTURE: THE LIBRARY AND SCIENTIFIC AND CHEMICAL LITERATURE

Chemistry undergraduates should understand the nature and purpose of scientific literature and be able to use library tools and services to obtain needed information. This section outlines in broad terms, what students should know about the library, and scientific and chemical literature.

### 1-1. LIBRARY:

Undergraduate chemistry students should have an understanding of, and be able to perform the tasks listed below.

Understand the organization of the library and know how to use library tools (catalogs, databases, library web pages, subject guides, etc.) and library services (reference desk, interlibrary loan, etc.) to obtain desired references and information.

Understand the purpose and characteristics of different information finding tools (e.g. catalogs, indexing and abstracting databases, subject guides, web search engines) and choose appropriate tools for a particular information need.

Get help from librarians, faculty, and teaching assistants, when needed.

**1-2. SCIENTIFIC LITERATURE:**
Chemistry undergraduates should understand the scope and nature of scientific literature, be able to read and evaluate scientific literature, and follow a logical path of inquiry. This includes having an understanding of, or being able to demonstrate the skills listed below.

Understand the flow of scientific information, and how information is communicated among scientists, both formally and informally.
Recommended resource: The Evolution of Scientific Information
URL: http://www.usd.edu/library/subject/Scientific_structure/evolutionof.htm

Understand the nature and purpose of different types of scientific literature, including: journal articles (communications, research articles, review articles), magazines, patents, proceedings, dissertations, monographs, handbooks, encyclopedias and dictionaries, grey literature, and technical reports.

Be able to read and interpret citations from the scientific literature.

Understand and apply criteria for evaluating the authority and appropriateness of a document or information source.

Understand the general nature of the peer review process.

Understand scientific ethics and accountability as well as copyright and intellectual property issues related to scientific literature.
Recommended resource: ACS Ethical Guidelines
URL: http://pubs.acs.org/ethics/index.html

Demonstrate critical thinking by evaluating information, drawing conclusions from the literature, and following a logical path of inquiry.

**1-3. CHEMICAL LITERATURE:**
In addition to understanding the scope and nature of scientific literature, chemistry undergraduates should have an understanding of the unique features of chemical literature, and be able to use these unique features to find needed information. This includes being able to perform the tasks below.

Understand the various systems used to classify and identify chemical information, know why they are important, and how to use them to find chemical information. This includes: Chemical Abstracts Service Registry Numbers (CAS RN), Hill system order, chemical nomenclature, and other systems as appropriate to specialized areas of chemistry (e.g., Enzyme Commission (EC) Numbers).

Know how to use chemical structures and reactions to find chemical information.

Find full journal titles given an abbreviation by using tools such as: CASSI (Chemical Abstracts Service Source Index), journal abbreviations lists (All That JAS, etc.), article indexes, or library catalogs.

## 2. PROPERTIES, SPECTRA, AND SAFETY INFORMATION

Throughout their coursework, undergraduate chemistry students need to obtain physical and chemical properties, spectra, and safety information for various substances. This section outlines expected skills and recommended resources for finding property data, spectra, and safety information.

### 2-1. PROPERTIES:

Chemistry undergraduates should be able to find property information to conduct laboratory experiments, and to confirm laboratory results. Students should be acquainted with various chemical identifiers (chemical name, CAS RN, structure, molecular formula) and be able to use them as starting points to locate physical and chemical properties using the resources listed below (as available on their campus). Students should be aware that it may be necessary to search a variety of resources, and/or try several different identifiers, before locating the desired property; and that property values reported in the literature (and obtained in their laboratory) can vary due to differing conditions (i.e., using different pressure, temperature, or solvents can lead to different results).

**Basic Property Information – Recommended Resources:**

CRC Handbook of Chemistry and Physics
Lange's Handbook of Chemistry
Merck Index
Perry's Chemical Engineers Handbook

Dictionary of Inorganic and Organometallic Compounds
Dictionary of Natural Products
Dictionary of Organic Compounds
Journal of Physical and Chemical Reference Data (NIST)
URL: http://www.nist.gov/srd/jpcrd.htm
Knovel Critical Tables
URL: http://www.knovel.com/knovel2/Toc.jsp?BookID=761
NCBI Chemical and Molecular Databases
URL: http://www.ncbi.nlm.nih.gov/
NIST Chemistry WebBook
URL: http://webbook.nist.gov/chemistry/
Physical Reference Data (NIST Physics Lab)
URL: http://physics.nist.gov/PhysRefData/contents.html

**Complex Property Information – Recommended Resources:**

When students need more comprehensive property information than the basic handbooks listed above can provide, they should be able to identify and use the resources listed below (or get help from a librarian to do this) to locate additional property information and/or references.

Beilstein and Gmelin (available in print or online through CrossFire/DiscoveryGate interface)
Understand content and organization of Beilstein and Gmelin.
Search for property and reaction information by structure, name, and other chemical identifiers.

SciFinder Scholar / Chemical Abstracts
Search for property and reaction information by structure, name, and other chemical identifiers.

**2-2. SYNTHESES:**
Chemistry undergraduates should be able to locate syntheses for compounds of interest using the resources below:

**Syntheses – Recommended Resources:**

Beilstein and Gmelin (available in print or online through CrossFire/DiscoveryGate interface)
Understand content and organization of Beilstein and Gmelin (print or online).
Search for syntheses by structure, name, and other chemical identifiers (reactant, product, etc).

SciFinder Scholar / Chemical Abstracts
Search for syntheses by structure, name, and other chemical identifiers (reactant, product, etc).

Organic Syntheses
Inorganic Syntheses
Fieser And Fieser's Reagents For Organic Synthesis
Encyclopedia Of Reagents For Organic Synthesis (print and online)

**2-3. SPECTRA:**
Students should be able to identify and use resources available at their campus library to locate spectra as needed for their laboratory and coursework. Recommended resources are listed below.

**Spectra – Recommended Resources:**

Sadtler spectra collections

Aldrich Library of spectra

NIST Chemistry WebBook: free online resource.
Spectra for organic compounds (and some small inorganic compounds).
URL: http://webbook.nist.gov/chemistry/

Spectral Database for Organic Compounds (SDBS): free online resource
Provides spectra for 32,000 organic compounds.
URL: http://www.aist.go.jp/RIODB/SDBS/cgi-bin/cre_index.cgi

Sigma-Aldrich Catalog: free online resource.
Includes spectra for many compounds, and references to spectra for most compounds.
URL: http://www.sigmaaldrich.com/

SciFinder Scholar: includes spectra for some compounds

**Spectra and Spectral Data – Recommended Resources:**
If spectra are not found, or if additional references are needed, students should be able to use the resources below (or get help from a librarian) to locate references to spectra or spectral data in the literature.

Beilstein and Gmelin (available in print and CrossFire/DiscoveryGate online interface)

SciFinder Scholar / Chemical Abstracts

**2-4. SAFETY INFORMATION:**
Undergraduates should be able to identify and locate resources on their campus which provide information on how chemical substances can be safely handled, stored, and used. Recommended resources include:

**Safety Information – Recommended Resources:**

Sigma Aldrich Library of Chemical Safety Data

Sax's Dangerous Properties of Industrial Chemicals (print or online)

Material Safety Data Sheets (MSDS):
Resources include:
Cornell University MSDS:
URL: http://msds.ehs.cornell.edu/msdssrch.asp
University of Vermont SIRI MSDS Collection:
URLs: http://siri.org/msds/ or http://hazard.com/msds/
Sigma-Aldrich Catalog:
URL: http://www.sigmaaldrich.com/ (Free, but must register to view MSDS)

CRC Handbook Of Laboratory Safety (print or online)

Bretherick's Handbook Of Reactive Chemical Hazards

## 3. CHEMICAL LITERATURE

Throughout their course and laboratory work chemistry undergraduates need to obtain various types of chemical literature using the resources available at their campus library. This section assumes students understand the nature and purpose of different types of scientific literature; are able to read and interpret citations from the scientific literature; and understand the unique features of chemical literature (as noted in Section 1), or can ask a librarian for help in these areas. This section lists expected skills and recommended resources for finding chemical literature, including background information, articles and other chemical literature, and patents.

**3-1. BACKGROUND INFORMATION:**
Chemistry undergraduates should know how to find chemistry-specific sources of background information such as encyclopedias, treatises, compiled works, and review articles. Students should be able to use these resources as a starting point for gathering information, by using them to obtain an introduction or overview for an unfamiliar topic, and taking advantage of the extensive bibliographies many of these resources provide. Students should also be able to identify additional resources for background information by: asking a librarian for assistance, browsing their library's reference area, and/or consulting online subject guides available at their library.

**Background Information – Recommended Resources:**

Kirk-Othmer Encyclopedia of Chemical Technology

Ullmann's Encyclopedia of Industrial Chemistry

Annual Reviews in Biochemistry
Annual Reviews in Physical Chemistry
(and other "Annual Reviews" titles as appropriate)

Chemical Reviews [American Chemical Society journal]

Chemical Society Reviews [Royal Society of Chemistry journal]

Hawley's Condensed Chemical Dictionary

Review articles: See Section 3-2

**3-2. ARTICLES AND OTHER CHEMICAL LITERATURE:**
In order to identify and obtain various types of scientific literature (including journal articles, communications, reviews, magazine articles, patents, proceedings, dissertations, monographs, handbooks, encyclopedias and dictionaries, grey literature and technical reports) chemistry students should be able to use the resources listed below (as available on their campus), and demonstrate the skills indicated for each resource.

**Articles and Other Literature – Recommended Resources:**

SciFinder Scholar / Chemical Abstracts
- Understand content and organization of SciFinder and Chemical Abstracts.
- Search for literature by: author, topic, chemical (name, CAS RN, structure, formula) and reaction.
- Search for substances and reactions.
- Refine/limit literature searches (by topic, author, year, document type, language, etc).
- Refine/limit substance/reaction searches (by structure, yield, steps, classification, etc.).

Web of Science / Science Citation Index
- Understand content and organization of Web of Science and/or Science Citation Index.
- Understand what a cited reference search is, why it is important, and how to do it.
- Search for literature by author, and topic

Additional Article Databases Useful in Chemistry:
PubMed, Compendex, INSPEC, BIOSIS (also known as Biological Abstracts)
(print equivalents may also be used)
- Understand content and organization of these databases.
- Search for literature by author and topic

Undergraduate students should also be able to identify and use other article databases (or print equivalents) available at their institution.

**3-3. PATENTS:**
Chemistry students should be able to locate patents, by patent number or topic, and ask a librarian for additional help if needed (i.e., to identify different types or parts of a patent).

**Patents – Recommended Resources:**

United States Patent and Trademark Office (USPTO) database: URL: http://www.uspto.gov/

European Patent Office Database (esp@cenet) URL: http://ep.espacenet.com/

SciFinder Scholar

## 4. SCIENTIFIC COMMUNICATION

Chemistry undergraduates should understand that being able to clearly and concisely present research is imperative to a scientist. Students should also: be aware of the different methods for presenting research (articles, posters, oral presentations at scientific conferences, etc); understand the reasons for citing the literature in one's own writing; and demonstrate the ability to cite in appropriate situations and using appropriate formatting.

**Scientific Communication – Recommended Resources:**

ACS Style Guide

ACS Online Reference Style Guidelines
URL: http://pubs.acs.org/books/references.shtml

ACS Scientific Writing Resources on the Web:
URL: http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?id=e5cada7e8b6b11d5f7eb3fba9e800100

*How to Write and Publish a Scientific Paper* by Robert A. Day

Introduction to Journal-Style Scientific Writing
URL http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWgeneral.html

*On being a scientist: responsible conduct in research*
Committee on Science, Engineering, and Public Policy
URL: http://books.nap.edu/openbook.php?isbn=0309051967

*On Writing Well : An Informal Guide To Writing Nonfiction* by William Zinsser

*Style: Toward Clarity And Grace* by Joseph M. Williams

Writing Guidelines for Engineering and Science Students
URL: http://www.writing.eng.vt.edu/

*The Craft of Scientific Writing* by Michael Alley

# Ad Hoc Committee for Information Literacy
## Chemistry Division of the Special Libraries Association

**Cory Craig (Co-Chair)**
University of California, Davis
cjcraig@ucdavis.edu

**Linda Maddux (Co-Chair)**
Reed College (OR)
lbm@reed.edu

**Ted Baldwin** (ex-officio)
University of Cincinnati (OH)
ted.baldwin@uc.edu

**Beth Blanton-Kent**
University of Virginia
blanton@virginia.edu

**Margarete Bower**
University of Pittsburgh (PA)
bower@pitt.edu

**Bob Buchanan**
Auburn University (AL)
buchara@auburn.edu

**Bartow Culp**
Purdue University (IN)
bculp@purdue.edu

**Judith Currano**
University of Pennsylvania
currano@pobox.upenn.edu

**Dawn French**
Millennium Chemicals
dawn.french@millenniumchem.com

**Donna Hudson**
Emory University (GA)
libdth@emory.edu

**Meghan Lafferty**
University of Minnesota
mlaffert@umn.edu

**Jim Martin**
University of Arizona
martinj@u.library.arizona.edu

**David Peck**
University of Michigan
drpeck@umich.edu

**Lee Pedersen**
Brown University (RI)
Lee_Pedersen@brown.edu

**Deb Peoples**
Ohio Wesleyan University
dapeople@owu.edu

**Marion Peters**
UCLA (CA)
mpeters@library.ucla.edu

**Dana Roth**
California Institute of Technology
dzrlib@library.caltech.edu

**Nancy Simons**
Georgia Institute of Technology
nancy.simons@library.gatech.edu

**Kiem Ta**
Oklahoma State University
kiem.ta@okstate.edu

**Teri Vogel**
University of California, San Diego
tmvogel@ucsd.edu

**Ben Wagner** (ex-officio)
University of New York, Buffalo
abwagner@buffalo.edu