SABBATICAL REPORT

OF

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DEPARTMENT OF CHEMISTRY

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GOALS OF MY SABBATICAL LEAVE

(N.B. The sabbatical leave proposal can be found in Appendix H.)

My one-semester/Spring 1996 sabbatical leave had four(4) goals:

1) to demonstrate the diverse nature of chemistry and chemists

2) to compile an annotated bibliography, citing the contributions of women and minorities to chemistry

3) to organize the bibliography in a variety of formats, using various technologies

4) to develop a series of resource modules for use by faculty teaching introductory and general chemistry courses

Underlying the work of the sabbatical leave is my belief that we all (faculty, staff, managers) must remain focused on the best interests of our students in terms of their academic goals and life skills. My job is to facilitate my students' learning of chemistry by whatever means work. A problem I face every day is their fears and phobias regarding science in general and chemistry in particular. This may be illustrated by this quote,

"Culture can be defined as the integrated pattern of human knowledge, belief and behavior that is transmitted from one generation to another; the customary beliefs, social forms, and material traits of a racial, religious or social group.

One's own culture is difficult to examine simply because everything about it seems so normal and obvious. As a group we have agreed upon ways of thinking and behaving. We usually don't recognize these specifics until we move into another culture where there is suddenly a mismatch. We call that culture shock, or a sense of confusion and uncertainty-sometimes feelings of anxiety that may affect people exposed to an alien culture without adequate preparation." (Virginia H. Pearce, *Salt Lake City Deseret News*, church news section, January 1996). During the leave, I was looking for and developing materials that would assist my students (very diverse in goals, interest, abilities, ethnic/racial background, etc.) in overcoming their "chemistry culture shock".

OVERVIEW

Project Inclusion is an on-going, multi-year effort to develop and disseminate instructional materials that describe the contributions of women and minorities to chemistry and to provide training that will encourage faculty to integrate these materials into their expanded teaching presentations in order to respond to the diversity of students in their classes. The co-directors of the Project are myself and Dr. Janan M. Hayes, professor of chemistry and physical science, Merced College.

The purpose of Project Inclusion is to develop resource materials and strategies for chemistry courses that will stimulate and improve student interest in chemistry, to establish a strong personal bond between students and the course topics, and to increase the success and retention rates of all students, especially those who are from underrepresented groups, i.e., women, ethnic/racial minorities, or physically challenged.

The focus of the Project will be initially on introductory and general chemistry courses in two-year colleges and four-year colleges/universities. As time and funding permit, we hope to expand the focus to include high school, organic, non-science major chemistry and physical science courses.

This overview of Project Inclusion is needed in order to put my sabbatical leave activities of Spring 1996 into the context of the larger Project in which I am involved. I gratefully acknowledge the one-semester leave granted by the District for it allowed a period of intense, focused work. Note that the annotated itinerary found in an upcoming section of the report includes Project Inclusion activities beyond the sabbatical leave time span in order to make sense of the activities and show how the leave fits into the overall picture.

My sabbatical leave quickly became a treasure hunt for clues and information with an ever-changing list of sources and sites. The original, proposed leave was to complete a finite, linear, well-defined project, which included a specific number of activities; however, during the real leave every question asked led to three more. I was quickly bombarded with suggestions and ideas that were all extremely useful and interesting. The actual sabbatical leave was an exciting, dynamic, expanding, open-ended series of activities. Two examples. While preparing the resource module on Ida Tacke Noddack (German chemist who discovered the element rhenium) in February/March for the presentation at the American Chemical Society (ACS) Spring 1996 National Meeting in New Orleans, LA, I could find no death date for this woman chemist(born 1896) on my own. I consulted the science librarian at Xavier University in New Orleans, but to no avail. At the ACS meeting, I found a student poster on Noddack with a possible death date (from a single source). I am still trying to confirm the date, having searched the ACS library in Washington, DC and sent a fax to the executive director of a German chemical society. While on a Science-History Study Tour of England in January, I visited the British Museum. As I often do at museums, I visited their bookstore, searching for books or pamphlets useful to the sabbatical leave and the Project. Coming out of the museum, I saw a row of bookstore across the street, so over I went. Earlier, during the Fall 1995 semester, I had offered an extra-credit assignment to my general chemistry (Chem 1A) students for National Chemistry Week; namely, to research and write a short paper on a topic related to the multicultural/historical aspects of chemistry. One student, Ali Jaffer, chose Islamic alchemy as his topic and submitted an excellent paper. Back to the English bookstore. I discovered and purchased a text on Islamic alchemy. The student paper became the first draft of a resource module on the topic, one that I might have never thought of on my own. Thank you, Ali.

INTERVIEW METHODOLOGY AND RESEARCH DESIGN

The technique developed during the sabbatical leave by way of introduction was to present a 2-page Project Inclusion summary and (in the later part of the leave) the C&E News article on us and the Project to the person(s) being interviewed or consulted and ask a few pertinent, open-ended questions. Questions: In your experience, what person and or events would fit into this Project? How would we find information about a (given) topic? Most persons were eager to share information. The problem was usually to take notes fast enough to document their comments and ideas. Indeed, a highpoint of the sabbatical leave was the willingness of many professional chemists (from the Deputy Secretary of Commerce on down) to share new module topics, leads on current topics, anecdotes, and information that they have found meaningful in support of our common goals. The interviewees rapidly bought into the goals of the sabbatical leave/Project Inclusion. All (each and every one) librarians and professional researchers were eager to share their materials and archives; the problem was finding time to process all their data.

Sometimes the discovery of resources was quite serendipitous. Some examples: the Textile Museum in Washington DC through a hotel's weekly guide magazine; the University of Massachusetts-Lowell Library's resources on textiles and Native Americans, the fact that Lowell, MA was a textile center in a discussion with the head of the Chemistry Department; Clemson University's Department of Textiles and a helpful contact via a casual conversation at the Biennial Conference on Chemical Education; the Los Angeles County Arboretum Library and librarian through a reference librarian at my local public library; the Rancho San Antonio Botanical Gardens Library and librarian through general discussions with Frank Acuna (MSAC's English Department) and Curt Byer (MSAC's Biology Department); Betsy Landis, K-12 educational specialist, and Frank Landis, biologist, in a conversation at my goddaughter's wedding reception.

At each library or archival source visited, I went with a specific topic(s) or focus in mind for research of materials already determined to be of interest and use, then the free flow (flood?) of information quickly began.

ANNOTATED ITINERARY

1-5 Jan 8-12 Jan 15-19 Jan	Science-History Tour of England, a series of lectures, presentations, tours of museums, exhibits, university science departments, including Cambridge University, Oxford University, Science Museum of London, Royal Gardens at Kew, Royal Observatory at Greenwich, British Museum, historical scientific landmarks, etc. In addition, text on Islamic alchemy.
22-26 Jan	Washington DC, review of June 1995 Project Inclusion proposal with Hal Richtol, Division of Undergraduate Education, National Science Foundation (NSF) for specific suggestions re proposal and Project

	Inclusion; research at Smithsonian Museums re Hope Diamond, obelisk quote, connection with John B. Eklund, curator, history of chemistry; reviewer of NSF Instructional Laboratory Instrumentation (ILI) proposals
29 Jan-2 Feb	Preparation of Chemical Heritage Foundation(CHF) Travel Grant proposal ($500, successful); discussion with Arlene A. Russell, associate director, Molecular Science Education Project, UCLA re collaboration
5-9 Feb	Discussion with Stan Pine, professor of chemistry, CSU, Los Angeles, formerly with NSF Division of Undergraduate Education, re 1995 and 1996 NSF proposals; interview Harold Goldwhite, chemical historian/professor of chemistry, CSU, Los Angeles, re sabbatical and Project activities, the sharing of his relevant history of chemistry files with me
12-16 Feb	Discussion with Mark Jordan, program assistant, Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) re collaboration; basic multimedia training in Powerpoint at Merced College
19-23 Feb	Research re Native American plant dyes, medicine, foods at Mt. San Antonio College, Cal Poly, Pomona, Claremont Colleges libraries
26 Feb-1 Mar	work on research modules
4-8 Mar	California Association of Chemistry Teachers (CACT) Mid-Winter Meeting, Merced, CA, co-organizer and co-presider; drafting of 8 women chemist modules for presentation at upcoming ACS meeting
11-15 Mar	Presentation, MSAC Education Fair; work on resource modules
18-22 Mar	Two-Year College Chemistry Conference (2YC3) Regional Meeting, Delgado College, Metairie, LA
25-29 Mar	ACS Spring 1996 National Meeting, New Orleans, LA; 3 presentations; interview for *Chemical & Engineering News*(C&ENews) article(see Appendix A); discussion with Cathy Middlecamp, University of Wisconsin, Madison, re common interests and activities in historical/multicultural chemistry

1-5 Apr	MSAC Spring Break
8-12 Apr	Multimedia training at Merced College
15-19 Apr	Research re Native American plant dyes, Rancho San Antonio Botanical Gardens (RSABG) library
22-26 Apr	Research re Native American plant dyes, MSAC, RSABG, Huntington Park (American Indian Collection), Los Angeles County Arboretum libraries
29 Apr-3 May	Library research; discussion with Stan Israel, department head, University of Massachusetts-Lowell, re resource module field-testing/staff development training; Judith Kelley, UMass-Lowell, project director for alternative assessments in science, editor, *New England Association of Chemistry Teachers* (NEACT) *Journal* re collaboration; library research; discussion with Arnold Thackeray, president, Chemical Heritage Foundation, Philadelphia, PA, and staff re collaboration and dissemination; interview with Mary Virginia Orna, chemical historian/professor of chemistry, College of New Rochelle, New Rochelle, NY, principal investigator, ChemSource, editor-elect, *Chemical Heritage* (CHF newsletter) re sources and dissemination; Katherine Thrush, Easton, PA, re materials on Florence Siebert, TB patch, and Mildred Hicks Braun, first American woman industrial research chemist
6-10 May	Research, presentation, networking with entire staff on various aspects of Project, CHF
13-17 May	Continuing research, RSABG

PROJECT INCLUSION ACTIVITIES BEYOND THE SABBATICAL LEAVE TIME SPAN

20-24 May	Discussion with Ruth Sime, professor of chemistry, Sacramento City College, author re Lise Meitner module and sharing of photos; writing of NSF Course and Curriculum Development (CCD) proposal to obtain funding in support of ongoing Project Inclusion activities

27-31 May	Writing of NSF CCD proposal
3-7 Jun	Dyes short course at RSABG
10-14 Jun	Dyes short course at RSAG
1-5 Jul	Preparation of presentation for upcoming Biennial Conference on Chemical Education (BCCE)
15-19 Jul	Interview with Betsy Landis, K-12 specialist re Native American plants
22-26 Jul	Research in Washington DC re Native American plant dyes at Textile Museum (Mary Samms, librarian) and Olmec/pre-Hispanic Mexico at National Gallery of Art; connection with John B. Eklund, curator, history of chemistry, Smithsonian Museums; interview with Nina Roscher, professor of chemistry, department chairperson, former assistant provost, American University, re women chemists and sharing of her relevant files
29 Jul-2 Aug	Discussion with Dr. Mary L. Good, Deputy Secretary of Commerce for Technology, at her invitation given at ACS meeting, New Orleans re Project Inclusion and sharing of relevant materials; NSF workshop on cooperative learning and small-project assessment, Clemson University, Clemson, SC
5-9 Aug	14th BCCE Meeting, Clemson, SC; 2 presentations; organizer and presider, authors' symposium; dyes workshop; collaborating Cathy Middlecamp to organize historical/multicultural chemistry symposium at ACS Spring 1997 National Meeting, San Francisco, CA; lunch with Darleane Hoffman, nuclear chemist, Lawrence Berkeley Laboratory re sharing of her materials
12-16 Aug	Preparation of prologue (using sabbatical materials) for Chem 2A, Fall 1996 (see Appendix B)

Over the time of the sabbatical leave and beyond, research was continually performed at every imaginable source and at every available moment. This ongoing process, pursuing clues/leads identified before and during the leave, resulted in a list of 30 topics for resource modules, Some of the topics are developed into completed modules, others are in a draft state, still other are topic ideas yet to be written up as modules. The development of resource modules will continue.

A significant amount of time between January and May 1996 was spent researching, writing and otherwise preparing for the five presentations made at various chemical education meetings and conferences. The process of preparing and making presentations will go on in the future.

Although the funding limitations due to an unsuccessful NSF CCD proposal (June 1995) resulted in modification of the original proposed itinerary (see Appendix H), I think that a careful review of the revised annotated itinerary and the products of the sabbatical leave will show that the purpose/goals of the one-semester sabbatical leave were accomplished. It can be noted from the annotated itinerary that not much of the time between January and May (including weekends) was spent doing things unrelated to the sabbatical leave and Project Inclusion.

Note the connections between the goals of the sabbatical leave and materials found in various appendices (as well as the body of the report):

1) bring examples of the chemical work of women and minorities into the current classroom curriculum (see Appendices B,C,E,F)

2) compile the annotated bibliography (see Appendix D)

3) organize the bibliography (see Appendix D)

4) develop resource modules (see Appendices C,E)

A comparison of the proposed itinerary/activities and the actual itinerary/activities shows that the purpose/goals of the one-semester sabbatical leave were substantially accomplished during the time span of the leave:

East Coast activities

(6 weeks)

Proposed	Actual
• Atlanta, GA Miami, FL (29 Jan-9 Feb)	• Los Angeles, Ca (29 Jan-3 Feb)
• New Orleans, LA (24-29 Mar)	• New Orleans, La (18-29 Mar)
• Washington, DC Philadelphia, PA New Rochelle, NY (1-19 Apr)	• Washington, DC (22-26 Jan) Lowell, MA Philadelphia/Easton, PA New Rochelle, NY (29 Apr-10 May)
• Wisconsin (13-20 May)	• Claremont/Sacramento, CA (13-24 May)

West Coast Activities

(3 weeks)

Proposed	Actual
• Honolulu, HA (26 Dec-5 Jan)	• Science-History of England (3-19 Jan)
• Berkeley/Sonoma, CA (26 Feb-9 Mar)	• Merced/Santa Cruz, CA (12-16 Feb, 4-8 Mar, 8-12 Apr)
• Los Angeles, CA (1-8 May)	• San Dimas, CA (26 Feb-1 Mar)
	• Los Angeles, CA (29 Jan-9 Feb)
	• East Coast (1-8 May)

One task of my sabbatical leave was to find a software program that would handle the results of the search for references, make any needed modifications, and become familiar with the program. The program could then be used to develop an annotated bibliography; thus, an ongoing search for the bibliographic software took place during the entire sabbatical leave.

Various existing programs and some data from pre-sabbatical literature searches were reviewed at the beginning of the leave in order to determine the desired format and properties of the required software program. The conclusion was that the program must have the capability to accept entries connected to keywords, to sort by multiple keywords and have a comment field for annotation; further, the program must be pc/Windows-based since the available computers at MSAC/Chemistry Department are IBM pc/Windows.

The software search continued over the Spring 1996 semester. A number of existing programs were looked at and rejected as unsuitable, e.g., ACCESS as part of Microsoft Office requires too much re-programming and formatting, not exactly user-friendly. In addition to the review of existing programs, much consultation with librarians, researchers, computer specialists, chemists, etc. occurred, asking what they used, but the requirements for the Project bibliography were different from those of their projects.

During our visit to the Chemical Heritage Foundation in May, the Foundation's computer consultant recommended the software program, ProCite. Both the Chemical Heritage Foundation and the American Chemical Society use this bibliographic software program in their libraries. These two sites are major history of chemistry resources and excellent sources for the sabbatical project; thus, with ProCite there could be direct access and input of the library data. After the return home from Philadelphia, PA, a trial version of the software program was requested; it seemed to meet the Project's bibliographic requirements and to be user-friendly (a very important attribute to me!). So, the software was ordered; it arrived in July. Then troubles with the computer itself (hardware) began; the laptop probably felt it had been overworked since January.

Thus, only recently (August) has the ProCite program been put on the laptop; the familiarization process is taking place now. Therefore, the preliminary bibliography (see Appendix D) has only two keywords (topic and its modifier). The topic keywords are the ChemSouce headings (ChemSource is a major, national, highly respected chemical education supplement). The preliminary bibliography was done in Microsoft Word, manually sorted, entries with only two keywords. The later permanent annotated bibliography, using ProCite, will have up to 50 keywords. The preliminary bibliography represents less than 1/3 of the resources/entries identified during the sabbatical leave; this limited quantity is due to the manual entry/sorting capabilities. Of course, all data will be reentered, using ProCite, producing a permanent bibliography that will be shared with MSAC's Chemistry Department and Library.

Despite the fact that I was sabbatical leave, my professional obligations continued. I served as co-organizer and presider (with Dr. Hayes) of a two-day meeting of the California Association of Chemistry Teachers (CACT), a potential user/dissemination group for Project Inclusion materials. In addition, I organized and presided over a symposium at the 14th Biennial Conference on Chemical Education, one of only seven(7) two-year college faculty members to do so. My symposium, "Interacting with Textbook Authors and Playing with their Wares", August 5, 1996, brought together eight authors of texts for a variety of courses (high school through sophomore level chemistry) for a dialogue with audience participants re the philosophy and pedagogy behind their books and one-on-one interactions/discussions. The symposium was quite successful with more than 75 chemical educators in the audience. During the half-day symposium, the College's name was mentioned several times (and appeared, of course in the BCCE program book) and discussion regarding Project Inclusion activities and products took place with individual educators.

PRODUCTS

The products of my one-semester leave are a series of resource modules, a preliminary annotated bibliography, and seven (7) presentations at various chemical meetings and conferences. What follows is a brief description of each product.

The current list of the resource module topics (30 topics at present) and copies of some sample modules are found in Appendix C. The series of modules are organized/keyworded according to the typical topics presented in introductory and general chemistry courses (Chem 2A, 2B, 1A, 1B). Each module is 1-3 pages in length and includes the example, supporting background information, selected bibliographic references, visual data (if possible) and course topics where the module might be used to illustrate subject matter. The modules are written in such a way as to be pedagogically-independent and usable in any educational setting. Faculty can include the resource module in their classroom presentation file/notes for use as a class discussion topic or a brief, illustrative example or a topic source for individual/group student projects.

A copy of the preliminary annotated bibliography is found in Appendix D. The list of references is organized/keyworded by course topic, using the ChemSource (an outstanding, recognized, nationally distributed chemistry faculty resource) keywords with appropriate additions/modifications (see Appendix D). The bibliography will serve as a resource for both faculty and students and support them in further exploration of current module topics, the development of additional modules, and research for a variety of classroom projects and activities.

Between January and August 1996, the following presentations were made (see Appendix E):

Dorothy Crowfoot Hodgkin, Marguerite Perey, Rosalyn Sussman Yalow, presented as a poster, Department of Chemistry, Mt. San Antonio College Education Fair, March 16, 1996

Using Examples from the History of Chemistry to Include Multicultural Experiences in General and Introductory Chemistry, presented in the symposium "Using Historical Chemistry to Teach Chemistry", Division of Chemical Education, American Chemical Society National Meeting, New Orleans, LA, March 24, 1996

The 'Other' Outstanding Women Chemists: Stories to Tell, Achievements to Honor, presented in a poster session before the Division of Chemical Education, American Chemical Society National Meeting, New Orleans, LA, March 24, 1996

The 'Other' Outstanding Women Chemists; Stories to Tell, Achievement to Honor, selected to be presented at SciMix as part of the Division of Chemical Education exhibition, American Chemical Society National Meeting, New Orleans, LA, March 25, 1996

Using Historical Examples to Bring Multicultural Content into Chemistry Courses: Why does it Matter?, presented in a brown bag session, Chemical Heritage Foundation, Philadelphia, PA, May 8, 1996

Multicultural Examples can make Chemistry Relevant to High School Chemistry Students, presented in the symposium "History of Chemistry: a Guide for Change", 14th Biennial Conference on Chemical Education, Clemson, SC, August 5, 1996

Integration of Multicultural Content into Introductory/General Chemistry, presented in the symposium "History of Chemistry: a Guide for Change", 14th Biennial Conference on Chemical Education, Clemson, SC, August 5, 1996

These presentations, made with my Project Inclusion co-director, were made in an effort to share information with chemical colleagues across the nation, to showcase and highlight what can be done by faculty members at public two-year colleges, to continue networking with as many chemical educators as possible, and to begin the dissemination process (building a mailing list of interested persons) for Project materials. We were also trying to persuade our faculty colleagues to rethink their teaching philosophy, to broaden their focus, to change their point of view, to include all and exclude none—not an easy thing to do. "However laborious it is to move an object as massive as the Vatican Obelisk, Edward Hutchins believes it can be more difficult to change someone's mind. Fontana moved the obelisk with ingenious mechanics and hard labor, but to change a person's mind Hutchins subtly attempts to alter mental mechanisms, prejudices, and old habits" (Smithsonian, "Science and the Artist's Book Exhibit", 1996).

BENEFITS

The semester's sabbatical leave was of enormous benefit to me in terms of rest and refreshment, personal and professional enrichment, my contribution to chemical education, an ongoing, professional project until and past the end of my teaching career, networking, making presentations at regional and national chemistry meetings/conferences, intense focus on a different yet related aspect of chemical education (research rather than teaching). An unexpected outcome of the sabbatical leave has been my increasing facility in working with computers and wordprocessing programs, i.e., WordPerfect and Word.

For the Chemistry Department and College, the benefits list includes:

(1) national recognition of MSAC as a model site for the development and implementation of materials and processes re the multicultural and historical aspects of chemistry for use in lower division courses,

(2) development of a course prologue for use in Chem 2A (Introductory Chemistry) that highlights the contributions of number of people and cultures. The prologue (see Appendix B), based on materials from the sabbatical leave, was presented in all my Chem 2A classes on the first day of the semester; I can already see the effect on my students in terms of attitude toward chemistry and a willingness to pursue the course. Dr. Mary Virginia Orna, College of New Rochelle, noted chemical historian and educator, requested the prologue materials (notes and illustrations) for presentation in her classes this semester.

(3) the chemistry products, bibliography and resource modules (see Appendix D and Appendix C) that will be shared with all full- and part-time colleagues in the department and eventually disseminated nationally.

(4) a list of selected, particularly useful references that will be shared with Kerry Stern, Director, Learning Resources, MSAC Library (see Appendix D).

(5) the addition of multicultural and historical materials for inclusion in all departmental courses, Chem 1A, 1B, 2A, 2B, 12A, 12B, using current course outlines and texts.

Looking toward the future, I can see two items for Spring 1997 and others for later years. I am a symposium co-organizer and presenter at the ACS National Meeting in San Francisco, CA in April 1997. The symposium will be focused on using multicultural and historical examples in the chemistry classroom. I have an article on Native American plant dyes in the Spring 1997 issue of *Chemical Heritage*, the newsletter of the Chemical Heritage Foundation. If funding becomes available (a 3-year, $375,000 National Science Foundation Course and Curriculum

Development proposal is pending; see Appendix F), a number of activities are planned for Project Inclusion in order to continue the sabbatical work and meet the Project goals: (1) continued research and writing of resource modules, (2) updating and formatting of the annotated bibliography, (3) making presentations at various chemical education meetings/conferences, e.g., ACS, 2YC3, CACT, (4) networking with as many scientific colleagues as possible, (5) organizing, developing and presenting(in collaboration with my Project Inclusion colleague) four summer, in-service workshops, two on the West coast (Mt. San Antonio College and Merced College), two on the East coast (University of Massachusetts-Lowell and a site in the Philadelphia, PA area) on the development and use of the resource materials and the philosophy underlying Project Inclusion, (6) dissemination of all materials to interested persons and organizations. During the sabbatical leave preliminary discussions with a number of potential distributors (see Appendix G) took place and a series of bilateral, cooperative relationships were established. The status of these discussions is as follows: (1) Molecular Science Education Project, a UCLA-CSUF-CCC consortium for systematic curriculum reform; I will be a contributor of resource modules (in addition to my input as a department member in developing and field-testing MSEP materials), (2) Chemical Heritage Foundation; periodic articles in *Chemical Heritage* and distribution of the annotated bibliography, (3) ChemSource, distribution of resource modules, (4) *Journal of Chemical Education*, periodic articles on Project Inclusion and various resource modules, (5) SACNAS (Society for the Advancement of Chicano and Native American Students) and NOBCHE (National Organization for Black Chemists and Engineers), collaboration on common projects.

APPENDIX A

Published Articles re Sabbatical Leave/Project Inclusion

C & E News article, April 29, 1996

CHED Newsletter article, Fall 1996

Chemical Heritage article re May 1996 presentation, Fall 1996(in press)

Chemical Heritage article re Native American Plant Dyes, Spring 1997(in draft)

Modules Aim To Add Multicultural Dimension To College Chemistry

Two community college chemistry teachers in California have embarked on a project aimed at making general and introductory chemistry more tangible to college students of different ethnic backgrounds.

Photo by Mairin Brennan

Perez (left) and Hayes weave cultural context into chemistry course material.

Janan M. Hayes, professor of chemistry and physical science at Merced College, Merced, Calif., and Patricia L. Perez, professor of chemistry at Mt. San Antonio Community College District, Walnut, Calif., described "Project Inclusion" to a symposium on using the history of chemistry to teach chemistry at the American Chemical Society's national meeting in New Orleans last month. The symposium was sponsored by the Division of Chemical Education.

Mt. San Antonio's student body is 70% minority or foreign born, said Hayes, while Merced's is 25% Hispanic. Many of these college students are contending with culture shock generated by poor skills in English or a lack of support from their families, she said. When they take chemistry, they encounter another round of culture shock "because chemistry is itself a culture," demanding its own vocabulary, ideas, and skills, she explained.

Unlike textbooks for elementary and high school students, college chemistry textbooks lack multicultural or historical inserts that enable students to make a personal connection to the course material, said Hayes. The California teachers hope to fill this void by developing modules that take examples from the history of chemistry in different cultures. In the works are topics they have tested in their classrooms, including salt evaporation from brine springs in pre-Columbian times in Oaxaca, Mexico; production of iron from iron ore more than 1,500 years ago in Tanzania; distillation, sublimation, crystallization, and metallurgical purification as practiced by Arabic alchemists; and extraction and use of Native American plant dyes.

Weaving modular material into classroom discussions gives many students a needed lifeline to chemistry, said Hayes. When she first used the Oaxaca example, Hayes explained, five Hispanic women in her class were about to drop chemistry. While discussing different approaches to evaporation, she told her students how this Mexican community more than 500 years ago had used gravity flow from one pond to another down terraced hills to continually concentrate brine to produce salt. "[The women's] eyes lit up and they connected" with the course, she said, and all five completed it with good grades.

In teaching redox chemistry, Hayes tells her students how the ancient smelting furnaces of Tanzania produced iron using the same chemical principle as modern, open-hearth steel mills. The people in Tanzania used the natural materials around them to create the carbon-rich, oxygen-poor environment that draws oxygen out of iron ore, she said. They lined a hole in the ground with termite residues, then added charred reeds, charcoal, and iron ore before constructing a chimney of slag and mud.

The module on Arabic alchemy began as a student paper in Perez' class. Perez, whose grandparents were born in Oaxaca, was intrigued by Hayes's experience in teaching about evaporation. Perez challenged her students to prepare presentations on multicultural aspects of chemistry for an open house the college held to celebrate National Chemistry Week last year. "Two Egyptian students wrote a very nice paper on Arabic chemistry," Perez said. Later, in London, she found a book on Islamic alchemy that set the wheels in motion for the module.

Hayes and Perez are exploring a module on the Hope diamond that would supplement class discussions on crystal structure and impurities. The diamond's deep blue color is due to 1 ppm boron its carbon structure contains, noted Hayes. An overview of the alluvial deposits in India that produced this and other large diamonds could enliven a chemistry class on solids, she added.

Use of the modules in the classroom would require only a subtle shift in teachers' presentations, Hayes and Perez noted. "But the physical task of introducing new content material is easier than the mental task of changing thought patterns, overcoming biases, and discarding old habits," they argued. They urged teachers to be open to change for the sake of their students. And they invited them to suggest topics for additional modules.

Mairin Brennan

Project Inclusion
Janan M. Hayes and Patricia L. Perez

Project Inclusion, our effort to highlight the contributions of women and minorities (in the broadest sense) to chemistry was featured in a recent (April 29, 1996) issue of C & E News. We, California community college faculty members and long-time DivCHED members, are co-directors of Project Inclusion. Why the project? To help students see that chemistry is an essential part of their everyday lives and to assist students in overcoming significant barriers (poor academic background and skills, cultural/ family difficulties, chemistry phobia, etc.) that are roadblocks to their success. We anticipated that the Project Inclusion products will include an extensive, annotated bibliography, keyworded to the typical topics in introductory and general chemistry courses and a series of brief instructional modules that can be used to enrich a classroom presentation on a given topic with supplemental or alternative examples. Although the project's main target groups will be introductory and general chemistry students, the materials will be suitable for use in high school, nonscience major, organic chemistry, and physical science classes as well. Utilizing the project materials in any of these classes will not change the basic science of the topics commonly presented, but will integrate a multicultural aspect into the mainstream science curriculum via the expanded, illustrative examples. Among the two dozen plus instructional modules currently in development are ones on Native American plant dyes, the Chinese five elements of matter, Islamic alchemy, pre-Hispanic evaporative salt production in Oaxaca, Mexico, early iron technology in sub-Saharan Africa, the contributions of Marguerite Perey (discovery of francium), Agnes Pockels (surface chemistry), Dorothy Crowfoot Hodgkin (molecular structures by X-ray crystallography). If any of you, fellow DivChed members, have some suggestions for module topics or information resources, please contact one of us.

[Janan M. Hayes teaches at Merced College, Merced, CA 95348; 209-384-6345, jmhayes@elite.net. Patricia L. Perez teaches at Mt. San Antonio College, Walnut, CA 91789; 909-594-5611, ext 4532 or FAX 909-594-7661.]

In the previous issue of *CHED News* (Spring 1996), the graphic theme was the 100th anniversary of the discovery of X-rays by Roentgen. Although this picture of Dorothy Crowfoot Hodgkin was included, she did not appear among those cited on p 8 as having won a Nobel Prize for research with X-rays. We apologize for this omission and thank the observant readers who called it to our attention. Ed.

Announcements

APPENDIX B

Prologue for Chem 2A,Fall 1996

Presentation notes(illustrated with appropriate overhead transparencies

PROLOGUE FOR GENERAL/INTRODUCTORY CHEMISTRY F96

INTRODUCTION

Define chemistry: an experimental(lab-based) science that studies matter in terms of its properties, composition, structures and reactions and energy in terms of its properties and interactions with matter

Skills required: Communication--reading, writing, speaking
Logic--analysis, reasoning, explanation, making choices with rationale
Math--isolating and solving for a variable, ratio and proportions, word problems

Why useful: Chemistry touches all/each of us every day of our lives
Food, clothing, medicines, fuels, etc.

Who does it: People in many countries, cultures and times
Professional chemists--education, research, industry, government
Everyday/ordinary persons: cooking, swimming pool, gardening, etc

Course will give more details, explanations/theories and examples. Now a few examples as we make a quick trip through the chemical world

EXAMPLE: Women Discoverers of Elements

COMMENTS: 112 elements known to date, both natural and synthetic
See illustrated table of elements at back of lecture hall and in display case

PIX/TEXT: No pix
Women Who Discovered Elements
Marie Curie, 1867-1934, radium, Ra, and polonium, Po
Lise Meitner, 1878-1968, protactinium, Pa
Ida Tacke Noddack, 1896-197?, rhenium, Re
Marguerite Perey, 1909-1975, francium, Fr

COURSE TOPICS: substances, elements

EXAMPLE: Native American Plant Dyes

COMMENTS: Many peoples/nations use local, available plants to dye baskets, pottery, feathers, fabrics, deerskins, hair, skin, porcupine quills up to the present day
(Point out plant sources and dyed yarns: scarlet bugler, brown onion skin, sagebrush, wild blackberries, sweet clover, navajo tea; note colors of plant part and yarn)

PIX/TEXT: Navajo Dye plant and yarn poster
No text

COURSE TOPICS: color, pH, extraction, redox (electron transfer) reactions

EXAMPLE: Early Salt($NaCl$) Production in Oaxaca, Mexico

COMMENTS: Ancient Oaxacans(pre-Hispanic) obtained valuable(define salt/salary) salt by solar evaporation prior to 15th century AD
Compare with evaporation ponds of Leslie Salt Company(from 1849 gold rush days) in northern CA (San Mateo Bridge near San Francisco airport)
Compare the mining, dissolving, purifying of salt in Europe(Salzburg, Austria)
PIX/TEXT: Cover of American Antiquity journal
Map of Oaxaca, Mexico
Water analysis table(note things other than NaCl)
COURSE TOPICS: evaporation, solutions, solubility

EXAMPLE: Iron(Fe) Production in Sub-Saharan Africa
COMMENTS: Ancient Africans obtained pure metal from an ore
Compare Tanzania, Africa and Bethlehem, PA, USA
Note effect of reaction conditions(temperature, time, oxygen concentration) on purity and amount of product
Same chemistry under different conditions
PIX/TEXT: Schematic of smelting furnace with termite mound(source of C)
Redox equation showing ore to element
COURSE TOPICS: metals, redox reactions

EXAMPLE: Chinese Five Elements of Matter
COMMENTS: All peoples/cultures try to explain the world around them and deal with the organization of matter
Chinese preceded the Greeks(4 elements) by about 150 years, 500 v. 340 BC
Chinese elements have dynamic relationships, e.g., wood changes to fire, fire melts metal
PIX/TEXT: Schematic of 5 elements
COURSE TOPICS: matter, substances, elements

EXAMPLE: Lab Equipment from Islamic Alchemists
COMMENTS: 7th-13th century AD
Equipment used in alchemical, pharmaceutical and metallurgical labs until 19th century, AD
Compare with modern, mass-produced glassware during lab checkin this week
PIX/TEXT: Cover of JCE
List of common equipment
Alembic
Ewer
Sublimation/distillation vessel
Beaker
COURSE TOPICS: lab checkout and processes

APPENDIX C

Current List of Resource Modules

Sample Modules

Pre-Hispanic Evaporative Salt Production

Density

Gerty Radnitz Cori

Irene Joliot-Curie

Dorothy Crowfoot Hodgkin

Maria Goeppert-Mayer

Lise Meitner

Ida Tacke Noddack

Marguerite Catherine Perey

Rosalyn Sussman Yalow

PROJECT INCLUSION
TOPICS PLANNED FOR RESOURCE MODULES

Gerty T. Cori--reaction cycle for body's metabolism of sugars
Maria Goeppert Mayer--nuclear shell model of atom
Irene Joliot-Curie--nuclear chemistry
Dorothy Crowfoot Hodgkin--structures by x-ray crystallography
Lise Meitner--discovered protactinium, atomic fission
Ida Tacke Noddack--discovered rhenium
Marguerite Perey--discovered francium
Rosalyn Sussman Yalow--radioimmunoassay procedures
Agnes Pockels--surface chemistry
Florence Barbara Seibert--tuberculosis patch
Sarah Kleiger Schenk--Grignard reaction catalyst
Stephanie L. Kwolek--Kevlar for bullet-proof vests
Mildred Hicks-Bruun--first woman research chemist in chemical industry
Percy Julian--pharmaceutical chemistry
W. Lincoln Hawkins--polymer chemistry
Mario Molina--atmospheric chemistry/ozone layer
George Washington Carver--agricultural chemistry
Ellen Swallow Richards--sanitation engineering and home economics
Catherine Coleman--astronaut/polymer chemist
Darleann Hoffman--nuclear chemist

Native American plant dyes
Islamic alchemy
Chinese five elements of matter
Pre-Hispanic evaporative salt production in Oaxaca, Mexico
Early Iron technology in Sub-Saharan Africa
Hope diamond
Density
Chinese development of fireworks
Women in space
Ancient Peruvian electrochemistry

Individuals will be identified from the following catagories for module development:
women crystallographers
physically challenged chemists
African-American chemists
Hispanic chemists
Asian chemists

9/96

PROJECT INCLUSION
RESOURCE MODULE

SUBJECT OF ITEM: Effect of Gravity on Plants

TOPIC: Effects of Gravity

MULTICULTURAL REFERENCE: Indians of Amazonia, Suriname

COURSE: Physical Science

REFERENCE: Tales of a Shaman's Apprentice , Mark J. Plotkin, 1993,
Viking Penquin, ISBN 0-14-01.2991 X (paperback)
ISBN - hardback 0-670-83137-9, pg. 108

CONTENT OF ITEM: Author is discussing the importance of the Cassava plant in the Indian culture. First has indicated its importance in all indian cultures.

"These root crops have two advantages over species that produce edible fruits above ground. First, the underground food is relatively safe from herbivorous predators. **Second, the force of gravity ceases to be a factor in limiting the maximum size of the edible plant part. The root or underground tuber can grow much larger than a fruit that must be supported by a branch. A mulberry bush cannot grow and support a six-pound mulberry, but a cassava plant can and does produce a six-pound cassava root."**

PRE-HISPANIC EVAPORATIVE SALT PRODUCTION

Example: A common way in many cultures for native peoples to obtain salt is through the solar evaporation of seawater or water from brine springs. One example is the pre-Hispanic peoples of Oaxaca, Mexico.

Background: The area included in the Oaxaca Valley in Southwestern Mexico has long been studied as an example of terraced agriculture by peoples dating back as far as 200 B.C.E. Now in archeological circles, there is an ongoing controversy concerning the canals and terraces of Hierve el Agua just outside the Oaxaca Valley in Mexico. The question is whether salt production or terraced agriculture occurred at this site. Are the travertine falls and deposits currently found at this location the remains of pre-Hispanic salt ponds?

Some researchers contend that the data from the chemical analyses of the water and the travertine rock deposits is the strongest support for the hypothesis that the canals and terraces were designed to transport water from a brine spring at the top of the hill. Evaporation would increase the mineral content in each succeeding pond going down the hill. There is strong evidence that the local people had experience in extracting usable salt from the resulting mineral deposits. Comparison can also be made to salt concentrations in seawater.

The data from an extensive chemical analysis of the waters and deposits found at the site is available for classroom use, e.g., concentration calculations, qualitative analysis, etc. Table 1 from the Hewitt article is included at the end of the module as a source of data for classroom calculations or examples, homework problems on solubility and concentration units, etc.

References: Hewitt, William P, Marcus C. Winter and Donald A. Peterson. "Salt Production in Hierve el Agua, Oaxaca", *American Antiquity*, vol. 52, no. 4, 1982, p. 799-816.

Marcus, Joyce, ed., Debating Oaxacan Archeology, Anthropological Papers No. 84, Museum of Anthropology, University of Michigan, Ann Arbor, 1990.

Course Topics: solutions, solubility, concentrations, evaporation

From: Hewitt, William P., Marcus C. Winter, and Donald A. Peterson, "Salt Production in Hierve el Agua, Oaxaca", American Antiquity, Vol. 52, no.4, 1982, p. 809.

Table 1. Constituents of Hierve el Agua water.

Constituent	Sample 222-68[a]	Sample BEG/MSL #84-793[b]
sodium (Na)	1,688.0	1.610
potassium (K)	nd	211
calcium (Ca)	—	245
magnesium (Mg)	—	43
calcium + magnesium (Ca) + (Mg)	438.0	—
strontium (Sr)	nd	4.5
barium (Ba)	nd	0.3
carbonates (CO_3)	971.1	—
bicarbonates (CHO_3)	—	1.700
chlorine (Cl)	2,238.7	2,280
sulfates (SO_4)	42.2	60
boron (B)	10.0	nd
pH	6.65	6.9

[a] All figures except pH in parts per million (ppm); nd means no information. Sample 222-68 was collected February 26, 1968, and analyzed February 29, 1968, by the Laboratorio Central de Agrología, Secretaría de Recursos Hidráulicos, Mexico. A report by laboratory chief, Ing. Rafael Vásquez del Mercado, includes the data in the table above plus the following information. Electrical conductivity: 8,500 micro-Ohms at 25°C. Dissolved solids in ppm: 5.378. Percent of sodium in the total cations: 79.3. Proportion and adsorption of sodium: 22.2. Residual sodium carbonates Me/lt.: 10.5. Ing. Vásquez's interpretation noted:

> For agricultural purposes this water is considered as C_4S_4 or "not usable" due to high salinity, sodium, residual sodium carbonate and boron.

And

> This laboratory classifies irrigation water in four classes, in accordance with the classification of Manual 60 of the Department of Agriculture, USA, giving them the following names: First Class: GOOD; Second Class: TOLERABLE; Third Class: DANGEROUS; and Fourth Class: NOT USABLE. [Translations from Spanish original by MCW and WPH.]

[b] Sample BEG/MSL #84-793 was collected June 23, 1984, and analyzed October 11, 1984, by the Bureau of Economic Geology's Mineral Studies Laboratory, University of Texas at Austin, and reported by David W. Koppenaal, Chief Chemist. In addition to the counts in the table, Koppenaal noted:

> Precipitated solids were found in the sample when received by us. These were removed prior to analysis and found to be predominantly $CaCO_3$ (as determined by qualitative x-ray diffraction). The data reported were obtained using the following analytical procedures: cationes by inductively coupled plasma emission spectrometry; Cl by argentometric titration; SO_4 by turbidimetry; and HCO_3 by titration to pH 4.5. [personal communication to WPH]

GERTY RADNITZ CORI
1896-1957
Biochemist

Achievements to Honor: Elucidated the Cori cycle, a series of enzyme-catalyzed reactions by which the body metabolizes sugars, thereby supplying energy at appropriate times for life's activities.

Stories to Tell: Gerty Radnitz Cori won the Nobel Prize in Physiology or Medicine, 1947, for her pioneering work on carbohydrate metabolism, connecting glucose, glycogen and lactic acid, and the determination of the structures of the enzymes involved in the metabolic cycle. She was the third woman and first American to be awarded the medicine prize.

Cori was born in Prague, Czechoslovakia, educated at the University of Prague, where she received her MD degree, and emigrated to the United States in 1922, becoming an American citizen in 1928. Together with her husband, Carl (with whom she shared the Nobel Prize), Gerty settled in St. Louis, MO at the Washington University Medical School for most of her career. There she focused on carbohydrate metabolism as an untenured research associate from 1931 to 1947, with only a token salary because she was female and married. It is notable that she was not promoted to full professor until she became a Nobelist.

The Coris established a laboratory that became a world-class center for biochemical research. Over time, six Nobelists in science (in addition to the Coris) worked at the lab. A delightful feature of the Coris' lab was the brown bag lunch, a one hour tutorial on any subject, e.g., science, art, music, etc. From their student days forward, Gerty and Carl Cori maintained a close scientific collaboration. Everything was decided and planned together, the tasks assigned, data analyzed, references shared, papers written.

In pursuing her research, Cori developed extremely accurate analytical techniques. By 1929, the basic ideas of the Cori cycle were established; by 1936, the structures of several enzymes worked out; by 1943, glycogen synthesized from glucose. The Cori cycle is now a basic part

of high school science and introductory college chemistry courses but was revolutionary in the 1920s when the discoveries were made. In addition, Cori studied a group of hereditary diseases in which abnormal amounts of glycogen are stored in the body because of enzyme deficiencies.

Gerty Cori had an indomitable will and great enthusiasm for biochemical research. Although diagnosed with an incurable bone marrow disease, she continued to work in her research laboratory for an additional ten years before her death. Among her many awards and honors in addition to the Nobel Prize was the 1948 ACS Garvan Medal.

IRENE JOLIOT-CURIE

1897-1956

Nuclear Chemist

Achievements to honor: Synthesized the first radioelements and initiated the study of artificial production of radioactive nuclides.

Stories to Tell: Irene Joliot-Curie won the Nobel Prize in Chemistry, 1935, for her pioneering work in nuclear chemistry. She was the second woman to win the chemistry prize, the first being her mother. As the daughter of Pierre and Marie Curie, Irene Curie was raised in an environment which would encourage her native interests and abilities in science and mathematics. Even as a child, letters between Irene and her mother usually concluded with algebraic problems or discussion of scientific questions.

In the summer of 1918, Irene received her *licence es sciences physiques* from the Sorbonne and was appointed as her mother's personal assistant in the university laboratory. Thus she was trained in the experimental chemistry and physics that would form the basis of her doctoral thesis on the properties of polonium.

Frederic Joliot joined the Curie Institute in November 1924. Irene was assigned to teach him the techniques involved in working with radioactive material. They were married in a private civil ceremony in October 1926 and returned to their work at the Institute that same afternoon. Irene had been studying the alpha rays given off by polonium by observing their tracks in a cloud chamber. Fred determined a way to make a photographic record of the clouds and thus have a more permanent record of reactions for study. Irene continued to perfect the purification and isolation of polonium. In their study of the alpha rays emitted from her samples and their discussion of that work with Rutherford, they laid the ground work for Chadwick's discovery of the neutron. A unique feature of scientific research prior to that time had been an open sharing of information and materials (Marie Curie gave radium and polonium samples to many early experimenters). Unfortunately, by the early 1930's competitiveness had decreased this

exchange and the Joliot-Curies were very guarded about their research.

On January 11, 1934, Fred was bombarding an aluminum target with alpha rays from polonium in the basement lab of the Institute. As he withdrew the polonium, the clatter of the Geiger counter did not diminish as it should. Excitedly he rushed to the second floor where Irene was working on radiochemical separations, but he didn't explain the experiment, just repeated it for her. Irene immediately recognized the meaning of the sustained sound - radioactive material had been produced in the aluminum as a result of the alpha ray bombardment. Within four days, two others in the laboratory had repeated the experiment and tested that all equipment was working correctly. Their report on "A New Type of Radioactivity" was presented to the French Academy on January 15th. Now Irene's work intensified. She must use every trick of chemical separation and isolation to verify their discovery of the creation of this new radioelement out of aluminum. She must obtain physical and visual proof of an isotope of phosphorus that is never found in nature because it is too unstable. And all of this work must be done within three minutes because of the rapid decay of the isotope. She was successful and they were recognized with the awarding of the Nobel Prize in December, 1935, less than a year later.

Irene died of leukemia on March 17, 1956, at the age of 59. She, like her mother and her husband two years later, was a victim of radiation research.

DOROTHY CROWFOOT HODGKIN

1910-1994

Crystallographer

Achievements to Honor: Determined the detailed, three-dimensional structures of several biologically important molecules, e.g. penicillin, vitamin B_{12} and insulin, by x-ray methods.

Stories to Tell: Dorothy Crowfoot Hodgkin won the Nobel Prize in Chemistry, 1964, for her outstanding work in x-ray crystallography. She was the third woman and first English woman to be awarded the chemistry prize.

Hodgkin was born in Cairo, Egypt and educated at Oxford University in England. Her father was an archeologist and her mother a botanist and expert in ancient textiles. Hodgkin began her study of chemistry and crystallography as a child. She grew crystals of alum and copper sulfate, set up a chemistry laboratory in the attic of her home with a portable kit given to her by a friend of her father's, and began to read science books, including W. Bragg's Concerning the Nature of Things and T.R. Parsons' Fundamentals of Biochemistry (teaching herself the necessary organic chemistry by reading the Encyclopedia Britannica). She was fascinated with the idea of "seeing" atoms and molecules by x-ray methods. However, her work in archeology with her parents almost led to an entirely different career.

When Hodgkin entered university to study chemistry and physics, x-ray crystallography was in its infancy. The Braggs had begun the study of crystalline solids only a few years before. Her senior project was on the organometallic compounds of thallium. Happily, some of her graduate work was under John D. Bernal, a firm believer in equal opportunity for women, at Cambridge University on the structures of complex organic molecules. The remainder of her research projects were performed at Oxford University, culminating in a doctorate in 1937. Her career as teacher and researcher was centered at Oxford (1937-1977). Her research lab was primitive at best; funds were limited; she was officially barred from research meetings because she was a woman; rheumatoid arthritis crippled her hands and feet; nonetheless, she persevered in her brilliant career.

By 1949, she had worked out the structure of the 90+ atom molecule, penicillin, a long and tedious process with many hand calculations; by 1956, she elucidated the structure of vitamin B_{12}, $C_{63}H_{88}N_{14}O_{14}PCo$, with the help of Kenneth Trueblood, UCLA, and a state-of-the-art electronic computer; by 1969, the 3-D structure of the 777 atom molecule, insulin, was finally determined, 40 years after Hodgkin took her first x-ray photo of the molecule and when computer technology had finally caught up with the complexity of the problem. Each molecule was more complicated than its predecessor. Hodgkin always pushed x-ray crystallography to the limits of its capabilities; she established its importance and utility by analyzing many small molecules. Today, structural determinations by x-ray diffraction are routine.

Meanwhile, she married Thomas Hodgkin, a historian and educator, had three children, and maintained homes in both England and Africa for many years. Hodgkin was a mentor and role model, encouraging other crystallographers, especially women, in her 10 member research group, small so that she could know and work directly with her students. She did not become a full professor until 1957; ten years earlier, she was made a member of the Royal Society of London, the third women in the organization's 287-year history.

In addition to her scientific work, Dorothy Crowfoot Hodgkin was interested in the cause of world peace and improving relationships between East and West. This caused problems for her when visiting the United States; a special waiver, not always granted, was needed each time. Crystallography is a collaborative science, bringing together chemistry, biology, physics, mineralogy, engineering, geology, and mathematics. Hodgkin was a founder of the International Union of Crystallography, open to persons from all countries, holding meetings only in countries that accepted every participant. In 1947, she began a collaboration with Chinese crystallographers; in 1953, she established relationships with Soviet scientists; in 1971, she helped to establish an x-ray crystallography laboratory in North Vietnam. One of her students was Margaret Thatcher, former British prime minister. In the late 1980s, Hodgkin had a conversation with Thatcher about visiting the USSR and meeting some of its people; shortly afterwards, Thatcher met with Gorbachev and the rest is history.

MARIA GOEPPERT-MAYER

1906-1972
Physicist

Achievements to Honor: Developed the nuclear shell model of the atom which is used to explain the organization of nucleons.

Stories to Tell: Maria Goeppert-Mayer won the Nobel Prize in Physics, 1963, for her development of the model for the arrangement of protons and neutrons orbiting in the nucleus of the atom. She was the first woman in theoretical physics to be awarded the prize.

Goeppert-Mayer was born in Kattowitz, Upper Silesia, on the border between Germany and Poland. She was educated at the University of Goettingen, which was rapidly becoming a center for the study of quantum mechanics. Among the University visitors were Bohr, Heisenberg, Pauli, Teller, Dirac, Oppenheimer; the faculty included James Franck and Max Born, her thesis advisor. She spent one semester at Cambridge University with Ernest Rutherford. In 1930, she received her doctorate in physics and married Joseph E. Mayer, an American graduate student in chemistry.

They moved to Johns Hopkins University in Baltimore, MD, where he was an associate professor of chemistry and she a volunteer research associate with a tiny office, no salary (because her husband was a university employee), but the opportunity to do research in physics. During the next seven summers, she returned to Goettingen to work with Born. In 1933, she obtained her U.S. citizenship shortly before the birth of the first of her two children. In 1939, Goeppert-Mayer went to Columbia University in New York with her husband, met Fermi and joined his group as an unpaid member. In 1941, she accepted a half-time, paid position at Sarah Lawrence College, teaching a cross-disciplinary science course. In 1942, she Joined Urey's group at Columbia in the Manhattan Project and worked half-time on the separation of fissionable U-235 from U-238. In 1945, she worked with Teller at Los Alamos and began to think about nuclear structure. After World War II, Goeppert-Mayer went to the University of Chicago Institute of Nuclear Studies,

again as an unpaid volunteer associate professor, working with her colleagues from the Manhattan Project (Fermi, Franck, Teller, Urey, Libby) and was a half-time senior physicist at the Argonne National Laboratory.

In her forties, Goeppert-Mayer began to think about the unusual stability of certain abundant isotopes and their "magic numbers" of protons and neutrons--2,8,20,28,50,82,126. The recognized model at the time was Bohr's liquid drop model of the nucleus, in which the nucleons move randomly in the nucleus. Her explanation of the data involved completed shells of nucleons that spun on their axes and moved in orbits in the nucleus like couples waltzing around a ballroom. The energy decrease as the nucleons spun in a preferred direction accounted for the observed stabilities. Pauli affectionately called her the "Madonna of the Onion" because of the layers of nuclear particles in her model.

In 1959, Goeppert-Mayer moved to University of California, San Diego and finally achieved the status of full professor at full salary; the University of Chicago made a similar offer but too late. It is noteworthy that her husband, a chemist with many women in his group, was supportive of her work and did not collaborate with her so that she could make it on her own. In 1974, UC, San Diego established The Maria Goeppert-Mayer Award to recognize the achievements of women physicists. Of the Nobel Prize she stated that the work itself was more exciting than winning the prize.

LISE MEITNER

1878-1968

Physicist

Achievements to Honor: Co-discover of the element Protactinium and the individual who first understood the nature of and coined the term "atomic fission".

Stories to Tell: Lise Meitner is recognized as an outstanding theoretical physicist, but it is her work as a chemist in isolating and reacting the residual materials in uranium pitchblende ore that resulted in the identification of the element we now know as Protactinium.

Lise Meitner, after obtaining her doctorate under Boltzman in her home city of Vienna, came to Berlin for further study under Planck. In desiring to continue experimental work in radioactivity as she had done in Vienna, she began work with Otto Hahn, a young organic chemist, at the Emil Fischer Institute. Since women were not allowed to study or work in the Institute, she was forced to carry out some experimentation in a carpenter shop on the first floor. Later, Hahn and Meitner would both move to the Kaiser Wilhelm Institute for Chemistry to continue their joint work. By this time, they had theorized that there was a relatively stable isotope of a previously unidentified element which upon beta decay would form actinium. Because its activity was very weak (half-life of 34,000 years) and the new element was found primarily in uranium ores, separation was exceedingly difficult. In addition, since radium was being used in the war effort (to take x-rays), it was hard to obtain raw ore for isolation. Finally they were able to obtain residue after double extraction of uranium and radium. This silica residue gave evidence of actinium; they were on the track to success.

The vast majority of the chemical separation work was accomplished during World War I while Hahn was serving in the German Army. With resourcefulness Meitner was able to find the equipment and supplies to continue the isolation work. She did the chemistry and shared the results with Hahn who only occasionally could return to Berlin from the war front. On March 16, 1918, they submitted for publication their joint paper "The Mother Substance of Actinium, a New Radioactive Element of Long Half-Life".

Unfortunately, the rest of the story is not so positive. After World War I, Hahn and Meitner continued to work together on identification of products of nuclear decay. Their work built upon her theoretical background and his experimental background. When Hitler came to power, Meitner - of Jewish origin although a baptized Protestant - was initially protected in Berlin. Fascinated by Fermi's neutron bombardment experiments, Meitner pursued the investigation on her own, then recruited Hahn and Strassmann onto a team working on uranium. In July 1938, she was forced to flee to Stockholm. Five weeks later, Hahn reported the first results of "his uranium experiment". Hahn and Meitner met secretly in Copenhagen in November. She argued against Hahn's contention that the product was radium. In December, Hahn wrote indicating he thought the product was barium, but he could not explain its presence. A few days later, Meitner was vacationing with her nephew Otto Frisch. Over breakfast they puzzled over the barium. There they conceived of the uranium nucleus as an unstable liquid drop, its surface tension so diminished that it was ready to split in two, with the release of enormous amounts of energy. Thus, Meitner was the first to explain and refer to the process as nuclear fission.

Meanwhile, in Berlin, Hahn was feeling politically vulnerable; he began to distance the discovery of fission from physics and himself from Meitner. Meitner at the same time was having a very difficult time in Stockholm establishing any scientific position. The 1944 Nobel Prize was awarded in secret to Hahn for his discovery of fission, not to be announced until the end of the World War II. But Meitner's part in the discovery was not acknowledged. In 1945, there was a movement to include Meitner either with Hahn for chemistry, or with Frisch for physics, but it did not happen. Scholars on Lise Meitner look forward to the release later this year (1996) of the documents leading to the selection of the 1946 Nobel Prize winners. Then we will know if it was politics or bias that denied Lise Meitner proper recognition in the discovery of nuclear fission.

IDA TACKE NODDACK

1896-

Chemist

Achievements to Honor: Co-discoverer of the element Rhenium.

Stories to Tell: Although somewhat younger, Ida Noddack was a contemporary of Lise Meitner in Berlin in the 1920's and 30's. Ida Tacke received her Doctorate of Engineering in 1921 from the University of Berlin-Charlottenburg. Working in the Physico-Technical Testing Office in Berlin, Tacke teamed with Dr. Walter Noddack to study platinum and sulfide ores and the mineral columbite. Their hope was to observe the missing elements 43 and 75 predicted by Mendeleev on the periodic table. Upon studying the relative frequencies of known elements in the earth's crust, Noddack, Tacke, and Dr. Otto Berg of the Werner-Siemens Laboratory found that those elements with odd atomic numbers are less common than those with even numbers. It was assumed that 43 and 75 would be in the manganese group and so they were able to predict physical and chemical properties and the degree of extraction that would be necessary to obtain the missing elements.

In May 1925, they were able to accomplish a 100,000-fold concentration of element 75 in a gadolinite. Measurement of its x-ray spectrum established the existence of this new element. Sufficient quantities were then separated from columbite to begin the chemical verification of the element. They named the element rhenium in honor of the Rhine region of Germany.

Ida later married Walter Noddack and they continued their rhenium studies. While continuing their studies, Ida Noddack also carried on discussions with others on current issues in elemental analysis. For example, in the same 1934 issue of Angewandte Chemie, the Drs. Noddack had an extensive article on analytical techniques for separation of mineral constituents and Dr. Ida Noddack published a paper questioning the work of Hahn, Meitner and Fermi in suggesting the creation of transuranium elements. Her chief criticism was that in their analysis they did not look for elements lighter than lead. When they did this, they observed barium and study of nuclear fission became a reality.

Marguerite Catherine Perey

1909-1975

Chemist

Achievements to Honor: Discoverer of Francium, last element to be discovered in nature without atomic bombardment.

Stories to Tell: As early as 1871, Mendeleev had predicted the existence of an alkali metal that he called "eka-cesium". Although various workers had made efforts to isolate and identify the element, there was no verifiable success. Marguerite Perey, the daughter of a flour mill owner outside of Paris, had been trained as a chemical technician since the family could not afford higher education. In 1929, she joined the Institute du Radium. She became the personal assistant to Marie Curie. Her first task was the purification of actinium. Over the years her technique developed and improved so that she prepared the most intense source of actinium ever available. This allowed Mme. Curie to measure the emission spectrum of actinium. Following Mme. Curie's death, Perey continued the work for the Institute.

In 1938, Perey observed an anomaly in the β-rays emitted by a sample of actinium that had been freshly separated from all its descendants. This led to the verification in 1939 of eka-cesium with a mass number of 223, which, according to the tradition of the time, she named actinium K, as the daughter product of actinium 227. She received her *licence* degree (approximately equivalent to a bachelor's degree) and doctorate in 1946 from the Sorbonne. The last line of the thesis reads, "The name Francium is proposed for box 87" in honor of Perey's native land. All known isotopes of francium are radioactive. Because so little francium exists naturally, there are no known commercial uses of the element.

Perey continued work in nuclear chemistry, as chair of nuclear chemistry at the Universite de Strasbourg and director of the Laboratorire de Chimie Nucleaire of the Centre de Recherches Nucleaires at Strasbourg-Crenenbourg. In 1946, she started to show signs of cancer caused by her many years of working with radioactive materials. She died on May 13, 1975, one of the last survivors of the pre-World War II Laboratoire Curie.

ROSALYN SUSSMAN YALOW

1921-

Medical Physicist

Achievements to Honor: Developed radioimmunoassay, a technique that detects tiny amounts of various substances in the blood and tissues of the human body.

Stories to Tell: Rosalyn Sussman Yalow won the Nobel Prize in Physiology or Medicine, 1977, for developing an analytical method, radioimmunoassay (RIA), that could measure very small quantities of biological substances, e.g., hormones, vitamins, viruses, enzymes, drugs. . . more than 100 different substances. She was the second woman and first native-born American to be awarded the medicine prize.

Yalow was born in the Bronx, NY of poor immigrant parents who had less than a high school education yet instilled love and respect for education and a strong sense of self-confidence to their children. Yalow learned to read before entering kindergarten, using books from the local public library. She graduated from Hunter College in New York, majoring in physics, because of the encouragement of two college physics professors, a seminar by Fermi, and the influence of Eve Curie's biography of her mother. She earned a doctorate in physics from the University of Illinois, Champaign-Urbana in 1945, the second woman to do so. The opportunity to go to medical school was not an option because of lack of money and discrimination (she was female and Jewish). Yalow became a medical rather than nuclear physicist after graduation because of the job situation. She married Aaron Yalow, a physicist, in 1943 and had two children.

From 1946 to 1950, she taught at Hunter College. In 1950, Rosalyn Sussman Yalow began a research career at the Bronx Veterans Administration Hospital and a long collaboration with Soloman A. Berson, M.D. Their work focused on the medical uses of radioisotopes. Yalow was the scientist (physics, mathematics, chemistry, and engineering) with a brilliant, logical, precise mind; Berson was the clinician (biology, physiology, anatomy), thinking in broad sweeping concepts, a complementary blending of talents. They shared credit on

the scientific publications, alternating the order of the names as authors. After Berson's death in 1972, Yalow began again to establish her scientific credibility and position, publishing 60 papers and winning 12 medical awards. She renamed her lab at the VA Hospital in Berson's honor because he did not share in the Nobel Prize.

RIA is based on the idea that one can determine the quantity of a particular substance by measuring the radioactivity in the samples. To prepare a sample, fixed amounts of labeled and unlabeled substances are mixed with blood plasma; the substances are allowed to react with the antibodies; the amount of bound substance is measured by comparing experimental data with data from standard solutions. Originally, the entire procedure had to be done by hand; now the process is automated and computerized. The procedure can be done in a test tube with no radioactivity in the human body and is quite sensitive (10^{-9} g).

RIA was first used in 1959 to detect the high levels of insulin in the blood of adult-onset diabetics. Other uses include the detection of hepatitis, human growth hormone, and HIV in the blood. One notable result of the work is that today manufactured insulin is genetically engineered to be precisely the same as human insulin. Yalow and Berson did not patent their discovery; it did not occur to them to do anything except share the results with humankind. Commercial companies have made lots of money with their RIA kits. Yalow has commented that since they had sufficient funding for the lab and the research, what would they have done with the money.

Rosalyn Sussman Yalow is a trailblazer for women scientists with a strong conviction that one should "feel a personal responsibility to serve as a role model and advisor to ease the path for those who come afterwards". The students in her group became her professional children, her proteges. Yalow has been strong-willed and focused enough to ignore the subtle discrimination through out her life and go forward toward her goal. She says that she knew she was OK so the problem belonged to the discriminator. Further, she commented that she would never retire, that a person doesn't age when learning new things, and that she has had the luck to be a wife, mother, and career scientist.

APPENDIX D

ChemSource Keywords

Preliminary Annotated Bibliography

Selected Items for a College Library

MODULES CONTAINED IN SOURCEBOOK

VOLUME 1

Preface and Acknowledgements (PREF)
Chemical Pedagogy (PEDA)
User's Guide (USER)
Introductory: General Resource (INTR)
Acids and Bases (ACID)
Alkali Metals (ALKA)
Atomic Structure (ATOM)
Biogeochemical Cycles (BICY)
Chemical Bonding (BOND)
Condensed States (COND)
Electrochemistry (ELEC)
Enzymes: Biochemical Catalysts (ENZY)

VOLUME 2

Chemical Equilibrium (EQIL)
Food and Chemistry (FOOD)
Forensic Chemistry (FORS)
Gases (GASS)
Molecular Geometry (GEOM)
Halogens (HALO)
Industrial Inorganic Chemistry (INDL)
Instrumentation (INST)
Materials Science: Ceramics and Glasses (MATR)
Chemistry in Medicine (MEDI)
The Mole (MOLE)

VOLUME 3

Nuclear Chemistry (NUCL)
Organic Chemistry (ORGN)
Oxidation-Reduction (OXID)
Periodicity (PERD)
Photochemistry (PHOT)
Polymers (POLY)
Solubility and Precipitation (PPTN)
Inorganic Qualitative Analysis (QUAL)
Rates of Reaction (RATE)
Chemistry of Rocks, Minerals, and Gems (ROCK)
Simple Chemical Reactions (RXNS)

VOLUME 4

Chemistry of Seawater (SEAW)
Separations (SEPN)
Solutions (SOLN)
Stoichiometry (STOI)
Thermochemistry (THER)
Transition Elements (TRAN)
Computer Uses (COMP)
Chemistry in Your Career (CRER)
Cross-Referencing Modules (CROS)
Teaching Chemistry to Persons with Disabilities (DISB)
Library Resources (LIBR)
Professional Organizations (PROF)
Small-Scale Chemistry (SMSC)
Chemical Safety (SAFE)
Index of Chemicals (INDC)
Index of Demonstrations (INDD)
Index of Experiments (INDE)
Media Index (INDM)
Index of Names (INDN)
Subject Index (INDS)

PROJECT INCLUSION
BIBLIOGRAPHIC REFERENCES BASED ON KEYWORDS
TO INTRODUCTORY/GENERAL CHEMISTRY TOPICS

Keywords	Author, Editor	Reference, Comments, Annotations
ACID,dyes	Bearfoot, Will	Dyes and Textiles, Oliver Press, Willits, CA, 1975, 142 pgs. Excellent, clearly written discussion of fibers, plants and dyes used by Native American people that includes information on the plant, dye color and recipe, and tribes/nations who used the plant.
ACID,dyes	Buchanan, Rita	A Weaver's Guide, Interweaver Press, Loveland, CO, 1987. Contains a fair amount of information on chemical nature of dyes and dying process.
ACID,dyes	Cannon, John Cannon, Margaret	Dye Plants and Dying, The Herbert Press and Royal Botanic Gardens, Kew, London, 1994.
ACID,dyes	Duff, David G. Sinclair, Roy S.	Gile's Laboratory Gourse in Dying, Society of Dyers & Colourists, Bradford, West Yorkshire, England, 4th Ed. 1989, pgs. 95-123. Detailed chemical background of dyes.
ACID,dyes	Epp, Dianne N.	The Chemistry of Food Dyes, The Chemistry of Natural Dyes, and The Chemistry of Vat Dyes. Terrific Science Press, Middletown, OH, 1995. A series of three paperbacks form the Palette of Color Monograph. Each has detailed back-ground information, recipes and classroom activities and links the chemistry classroom to the real world.
ACID,dyes	Ghuznavi, Sayyada R.	Natural Dyes of Bangladesh, Vegetable Dye Project, Bangladesh Small and Cottage Industries Corp., Dhaka, Bangladesh, March 1983, 16 pps.
ACID,dyes	Krochoval, Arnold Krochoval, Connie	The Complete Illustrated Book of Dyes from Natural Sources Doubleday & Company, Garden City, NY, 1974, Chapters 1& 3 of most use.
ACID,dyes	Murphy, Edith Van Allen	Indian Uses of Native Plants, Mendocino County Historical Society, Ft. Bragg, CA, 1959. pgs. 53-54. In addition to dyes, a variety of other uses are discussed.
ACID,dyes	Saltzman, Max	"Analysis of Dyes in Museum Textiles or, You Can't Tell A Dye By Its Color", Textile Conservation Symposium in Honor of Pat Reeves, Los Angeles, 1986.
ACID,dyes	Saltzman, Max	"The Identification of Dyes in Archeological and Ethnographic Textiles", Archaelogical Chemistry, American Chemical Society, 1978, pgs. 173-185.
ATOM,quantum	McGrayne, Sharon G.	"Maria Goeppert Mayer, June 28,1906-February 20, 1972, Nobel Prize Winner in Physics 1963" The Physics Teacher, 33, October 1995, pgs. 424-429.
ELEC,history	Leamon, Kevin ed.	The History of Electrochemistry, 1997 Calendar, Bioanalytical Systems, West Lafayette, IN.,1996. Numerous examples with references.
HIST,chinese	Needham, Joseph	Clerks and Craftsman in China and the West, 1970.
HIST,islamic	Al-Hassan, Ahmad Y Hill, Donald R.	Islamic Technology: An Illustrated History, 1986. An excellent text from Britain, translated from arabic with many pictures and diagrams of early equipment.

HIST,islamic	Burnett, Charles	"The Astrologer's Assay of the Alchemist: Early References To Alchemy in Arabic and Latin Texts", Ambix, **39**, Part 3, November 1992.
HIST,islamic	Forbes, R.J.	"On the Origin of Alchemy", Chymia, **4**, 1953, pgs. 1-11.
HIST,islamic	Levey, Martin	"Arabic Mineralogy of the Tenth Century" Chymia, **12**, 1967, pgs. 15-26.
HIST,islamic	Levey, Martin Al-Khaledy, Noury	"Chemistry in the Medical Formulary of Al-Samarquandi", Chymia, **11**, 1966, pgs. 37-44.
HIST,islamic	Levey, Martin	"Chemical Technology and Commercial Law in Early Islam", Chymia, **9**, 1964, pgs. 19-25.
HIST,islamic	Levey, Martin	"Early Muslim Chemistry: Its Debt to Ancient Babylonia", Chymia, **6**, 1960, pgs. 20-26.
HIST,islamic	Levey, Martin	"The Aqrabadhin of Al-Kindi and Early Arabic Chemistry" Chymia, **8**, 1962, pgs. 11-20.
HIST,precolumb	Robinson, Janet	"Precolumbian Chemistry", Journal of Chemical Education, **72**, (5), May 1995, pgs 416-418.
LIBR	Abir-Am, Prina G., ed. Outram, Dorinda, ed.	Uneasy Careers and Intimate Lives. Women in Science. 1789-1979, Series of chapters on different women scientists. Each relates somewhat, science to society.
LIBR	Brock, William H.	The Norton History of Chemistry, W.H. Norton, New York. 1993. One of the standard reference sources on chemical history.
LIBR	Cobb, Cathy Goldwhite, Harold	Creations of Fire. Chemistry's Lively History from Alchemy to the Atomic Age, Plenum Press, New York, 1995, 475 pgs.
LIBR	Gass-Simon, G., ed. Farnes, Patrinia, ed.	Women in Science. Righting the Record, Indiana University Press, 1960.
LIBR	Gies, Frances Gies, Joseph	Cathedral. Forge. and Waterwheel. Technology and Invention in the Middle Ages, HarperCollins Publishers, New York, 1994, 357 pgs.
LIBR	Grinstein, Louise S. Rose, Rose K. Rafailovich, Miriam H.	Women in Chemistry and Physics: A Bibliographic Sourcebook, 1993. Greenwood Press, Westport, Conn. Collection of extensive articles on many women who have made significant contributions in all areas of science. Each has bibliography on works by and about subject.
LIBR	Hellmans, Alexander Bunch, Bryan	The Timetables of Science: A Chronology of the Most Important People and Events in the History of Science. Simon & Schuster Inc. New York, 1988.
LIBR	James, L. ed	Nobel Laureates in Chemistry. 1901-92, 1993.
LIBR	McGrayne, S.	Nobel Prize Women in Science: Their Lives. Struggles. and Momendous Discoveries, 1993.
LIBR	Nobelsteftelsen	Chemistry. Nobel Lectures including Presentation Speeches and Laureates' Biographies 1922-1941, Elsevier Publishing Company, Amsterdam, 1966.
LIBR	Opfell, Olga S.	The Lady Laureates: Women Who Have Won the Nobel Prize, The Scarecrow Press Inc., 1978.
LIBR	Reid, Struan Fara, Patricia	The Usborne Book of Inventors, EDC Publishers, Tulsa, OK, 1994, 48 pgs. Children's book with a few examples of non-Euro/American inventors.
LIBR	Reid, Struan Fara, Patricia	The Usborne Book of Scientists, EDC Publishers, Tulsa, OK, 1993, 48 pgs. Children's book with a few examples of women in science history.

LIBR	Yost, Edna	Women in Modern Science, Dodd, Mead & Company, New York, 1960. A series of chapters on outstanding women in science.
NUCL,elements	Hurd, Loren	"The Discovery of Rhenium", Journal of Chemical Education October 1933, pgs. 605-608. Refrence to work of Ida Tacke Noddack and discovery of element rhenium.
NUCL,elements	Kauffman, G.B. Adloff, J.P.	"Marguerite Perey and the Discovery of Francium" in Education in Chemistry, September 1989, **26**, 135-7.
NUCL,elements	Noddack, W. Tacke, Ida	"The Ekamanganese Elements", Die Naturwissenschaften, **13** (1925), pgs. 567-574. Translation by G. Michiels & P. Van Assche of original article which relates to isolation of element rhenium.
NUCL,elements	Pflaum, Rosalynd	Marie Curie and Her Daughter Irene, Lerner Publications, Minneapolis, 1993, 144 pgs.
NUCL,elements	Quinn, Susan	Marie Curie, A Life, Radcliffe Biography Series, Addison-Wesley, Reading, Massachusetts, 1995, paperback, 509 pgs.
NUCL,elements	Sime, Ruth	"The Discovery of Protactinium" Journal of Chemical Education, **63** (8), August 1986, pgs. 653-657.
NUCL,elements	VanAssche, Pieter	"The Ignored Discovery of the Element Z=43", Nuclear Physics, A480, 4 April 1988, pgs. 205-214. Includes material on work of Ida Tacke-Noddack
NUCL,elements	VanAssche, Pieter	"Ignored Priorities: First Fission Fragment (1925) and First Mention of Fission (1934)", Nuclear Europe, 6-7, 1988, pgs. 24-5. Focuses on work of Ida Noddack-Tachke in discovery of rhenium and remarks on fission.
NUCL,fission	Sime, Ruth	"Lise Meitner in Sweden 1938-1960: Exile from Physics" American Journal of Physics, **62** (8), August 1994, pgs. 695-701. Paper focuses on period after Meitner left Berlin.
NUCL,fission	Sime, Ruth	Lise Meitner, A Life in Physics, University of California Press, Berkeley, CA, 1996. An excellent, very readable biography of Meitner which discusses discovery of fission and the elemnt protactium as a part of the bigger story of her life in science and the politics that shaped it.
NUCL,fission	Watkins, Sallie	"Lise Meitner, The Making of a Physicist", The Physics Teacher, January 1984, pgs. 12-15. Summary of life, highlights many contributions to entire field of nuclear science.
NUCL,fission	Yost, Edna	"Lise Meitner" in Women in Modern Science, Dodd, Mean & Company, New York, 1960, pgs. 17-30.
NUCL,medicine	Overbye, Dennis	"Rosalyn Yalow: Lady Laureate of the Bronx", Discover, June 1982, pgs. 40-48.
ORGN,structure	Farago, Peter	"Impact - Interview with Dorothy Crowfood Hodgkin", Journal of Chemical Education **54** (4), April 1977, pgs. 214-6.
ORGN,structure	Julian, Maureen	"Dorothy Crowfood Hodgkin: Nobel Laureate", Journal of Chemical Education, **59** (2), February 1982, pgs. 124-5.
ORGN,structure	White, Michael	"Chemistry's Crystal Seer", New Scientist, 23 May 1992, pg. 36-38. Article about Dorothy Crowfood Hodgkin.
OXID,fireworks	Conkling, John A.	"Chemistry of Fireworks", Chemical and Engineering News, June 29, 1981, pgs. 24-32. Overview of chemistry of fire-works for development of information on Chinese history.
OXID,dyes	Gade, Daniel W.	"Red Dye from Peruvian Bugs", Geographica Magazine, **45**, (1), October 1972,pgs. 59-62.

OXID,dyes	Gerhard, Peter	"Shellfish Dye in America", Sobretiro del XXXV Congreso Internacional de Americanistas, Mexico, 1962, Actas y Memorias, Mexico D.F. 1964. pgs. 177-191.
OXID,iron	Schmidt, Peter Avery, Donald	"Complex Iron Smelting and Prehistoric Culture in Tanzania", Science, 1978, vol. 201, pgs. 1085-1089. Article discusses in detail process for refining iron including diagrams of furnace from termite mound.
OXID,iron	VanDerMerwe, Nikolaas	"The Advent of Iron in Africa" in The Coming of the Age of Iron, ed. Theodore A. Wertime & James D. Muhly, Yale University Press, New Haven, 1980, pgs. 463-506.
PHYP,density	Plotkin, Mark J	Tales of a Shaman's Apprentice, Viking Penguin Books, New York, 1993, pg. 108. Effect of density on production of cassava plant, basic food source of Amazonian natives.
PHYP,surfaces	Derrick, M. Elizabeth	"Agnes Pockels, 1862-1935", Journal of Chemical Education, **59** (12), December 1982, pgs. 1030-1031.
PHYP,surfaces	Elder, Eleanor	"Agnes Pockels-Indeed a Lady", Chemistry, **47** (1), 1974, pgs. 10-12.
PHYP,surfaces	Giles, C.H. Forrester, S.D.	"The Origins of the Surface Film Balance, Studies in the early history of surface chemistry, part 3", Chemistry and Industry, 9 January 1971, pgs. 43-53. Opens on Agnes Pockels and further discussion of her interactions with Lord Rayleigh.
PHYP,surfaces	Sabin, Florence R.	"Women in Science", Science, **83** (2141), January 10, 1936. pgs. 24-26. Award address with over half devoted to the story of Agnes Pockels and her impact as a pioneer in surface chemistry.
POLY,history	Morris, Peter J.T.	Polymer Pioneers, Beckman Center for the History of Chemistry, 1990, 88 pgs.
POLY,Kevlar	Kwolek, Stephanie	Oral History Transcript, Chemical Heritage Foundation, recorded 4 May 1986.
PPTN,salt	Hewitt, William P. Winter, Marcus Peterson, David A.	"Salt Production at Hierve El Agua, Oaxaca" in American Antiguity, 52(4), 1987, pgs. 799-816. Article which introduces idea of prehispanic salt production in area that was thought to be example of terraced agriculture. Has good tables of data that can be used for student problems.
ROCK,Hope Di	Hahn, Emily	Diamond, Doubleday & Co., 1956. pgs. 192-5. History of Hope Diamond.
ROCK,Hope Di.	O'Neal, Paul	Gemstones, Planet Earth Series, Time Life Books, 1984, pgs. 33-35, 66. History and physical characteristics of the Hope Diamond.
ROCK,Hope Di	Tolansky, S.	The History and Use of Diamond, Methuen & Co. Ltd., London, 1962. pgs. 96-105, 113-119.Explains nature of Indian alluvial deposits that were source of Hope diamond. Also discusses the social issues that relate to diamond mining in India.
ROCK,Hope Di	Webster, R.	Gems, Their Sources, Descriptions and Indentification, Revised by B.W. Anderson, Butterworths, 1983. pg. 16-19. Indian diamond mining.
ROCK,Hope Di	Wedlake, R.J.	"Technology of Diamond Growth" in The Properties of Diamond, ed. J.E. Field, Academic Press, 1979. Explains point defects and doping that results in blue color of Hope diamond.

Project Inclusion
Selected Items for a College Library

Abir-Am, Prina G., ed. Outram, Dorinda, ed.	Uneasy Careers and Intimate Lives, Women in Science, 1789-1979, Series of chapters on different women scientists. Each relates somewhat, science to society.
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Reid, Struan Fara, Patricia	The Usborne Book of Scientists, EDC Publishers, Tulsa, OK, 1993, 48 pgs. Children's book with a few examples of women in science history.
Yost, Edna	Women in Modern Science, Dodd, Mead & Company, New York, 1960. A series of chapters on outstanding women in science.

APPENDIX E

Presentations

Mt. San Antonio College Education Fair, March 16, 1996

ACS National Meeting, New Orleans, LA, March 24/25, 1996

Chemical Heritage Foundation, Philadelphia, PA, May 10, 1996

14th Biennial Conference on Chemical Education, Clemson, SC, August 5, 1996

Dorothy Crowfoot Hodgkins

1910-1994

Achievement to Honor: Determined the detailed, 3-D molecular structures of vitamin B-12, penicillin and insulin

Story to Tell: Dorothy Crowfoot Hodgkins won the Nobel Prize in Chemistry, 1964, for her outstanding work in x-ray crystallography. Hodgkins was the third woman and first Englishwoman to be awarded the Chemistry Prize.

She was born in Cairo, Egypt and educated at Oxford University in England. Her father was an archeologist and her mother a botanist and expert on ancient textiles. Hodgkins began her work in chemistry and crystallography as a child. She grew crystals, set up a chemistry lab in the attic of her home, and began to read science books.

When Hodgkins entered university, the study of crystalline structure by x-ray diffraction was just beginning. She began her study of insulin in the 1930s, but had to wait until the 1960s for computer technology to be adequately developed so that she could finish the work on this important molecule. It is interesting to noted that she used one of the first high speed computers (at UCLA with a colleague, Kenneth Trueblood) in the 1940s to do the calculations for vitamin B-12's structure. She began her research in a rather primitive lab; over the years she developed rheumatoid arthritis that crippled her hands and feet; she encountered some discrimination as a female scientist. Nonetheless, through her intelligence, her perseverance and her hard work, Hodgkins succeeded brilliantly in her chemical career.

Dorothy Crowfoot Hodgkins was the wife of a historian, mother of three children, and maintained two homes (in Africa and England) for many years. In addition, she was strongly committed to world peace and engaged in much political work for this cause.

Marguerite Catherine Perey
1909-1975

Achievement to Honor: Discoverer of Francium, last element to be discovered in nature, that is, without atomic bombardment.

Story to tell: As early as 1871 Mendeleev had predicted the existence of an alkali metal that he called "eka-cesium". Although various workers had made efforts to isolate and identify the element, there was no verifiable success. Marguerite Perey, the daughter of a flour mill owner outside of Paris, had been trained as a chemical technician since the family could not afford higher education. In 1929 she joined the Institute du Radium. She became the personal assistant to Marie Curie. Her first task was the purification of actinium. Over the years her technique developed improved so that she prepared the most intense source of actinium ever available. This allowed Mme. Curie to measure the emission spectrum of actinium. Following Mme. Curie's death, she continued the work for the institute. During the autumn of 1938, Perey observed an anomaly in the β-rays emitted by a sample of actinium that had been freshly separated from all its descendants. This led to the verification in 1939 of eka-cesium with a mass number of 223, which according to the tradition of the time, she named actinium K, as the daughter product of actinium 227. She received her *licence* degree (approximately equivalent to a bachelor's degree) and doctorate in 1946 from the Sorbonne. The last line of the thesis reads, "The name Francium is proposed for box 87" in honor of her native land. All known isotopes of Francium are radioactive. Because so little Francium exists naturally there are no known commercial uses of the element. Perey continued work in the field of nuclear chemistry, including chair of nuclear chemistry at the Universite de Strasbourg and director of the Laboratorire de Chimie Nucleaire of the Centre de Recherches Nucleaires at Strasbourg-Crenenbourg. In 1946, she started to show signs of cancer caused by her many years of working with radioactive materials. She died on May 13, 1975, at the age of 65, one of the last survivors of the pre-World War II radiochemical pioneers of the Laboratoire Curie.

Rosalyn Sussman Yalow
1921-

Achievement to Honor: Developer of radioimmunoassay, a technique that detects tiny amounts of various substances in blood and tissues.

Story to Tell: Rosalyn Sussman Yalow won the Nobel Prize in Physiology or Medicine, 1977, for developing an analytical method, radioimmunoassay(RIA) that can measure very small amounts of hormones, vitamins, viruses, enzymes, drugs ... more that 100 different substances. Yalow is the second woman and first American-born to be awarded the Medicine Prize.

Her immigrant parents, who had less than a high school education, instilled love and respect for education and a strong sense of self-confidence in their children. Rosalyn learned to read books from a Bronx public library before starting kindergarten. She graduated from Hunter College in New York, majoring in physics because of the encouragement of two college physics professors, a discussion with the physicist Enrico Fermi, and reading a biography of the physicist Marie Curie.

Yalow earned a doctorate in physics from the University of Illinois, Champaign-Urbana, the second woman to do so. She became a medical physicist, rather than a nuclear physicist, because of the scarcity of jobs after completing her education.

In 1950, Rosalyn Sussman Yalow began a research career at the Bronx Veterans Administration Hospital and a long collaboration with Solomon A. Berson. The work focused on the medical use of radioactive isotopes. Yalow was the scientist and Berson the clinician, a complementary blending of skills. They shared credit in their scientific publications, alternating the order of their names as authors. RIA was first used in 1959 to detect high levels of insulin in the blood of adult onset diabetics.

Rosalyn Sussman Yalow is a medical researcher, a wife and a mother of three children. She is a trailblazer for women scientists with a strong conviction that one should "feel a personal responsibility to serve as a role model and advisor to ease the path for those who come afterwards."

USING EXAMPLES FROM THE HISTORY OF CHEMISTRY TO INCLUDE MULTICULTURAL EXPERIENCES IN GENERAL/INTRODUCTORY CHEMISTRY

Presented in the Symposium, "Using Historical Chemistry to Teach Chemistry", Division of Chemical Education, American Chemical Society National Meeting, New Orleans, LA, March 24, 1996.

Janan M. Hayes
Merced College
Merced, CA 95348

Patricia L. Perez
Mt. San Antonio College
Walnut, CA 91789

History can be used to bring a sense of involvement, a sense of inclusion, and a sense of meaning to students in general and introductory chemistry courses. But when we teachers face our classes, most of the examples we use are not representative of or relevant to the majority of the student population that we are facing. This paper shows how carefully selected examples from the world wide history of chemistry can build students' knowledge of chemistry while also demonstrating that peoples from a variety of cultures, times and backgrounds have helped to build that knowledge base called modern chemistry.

This presentation is a part of PROJECT INCLUSION. An annotated bibliographic database is being developed as one component of the project. A key feature of the bibliography is its unique organization that allows selection of references based on the topics that are typically found in the general and introductory chemistry courses. In addition, a series of "replacement instructional modules" are being developed from the bibliographic database which provide the teacher with content and background for the inclusion of specific topics without regard to the particular pedagogical approach used. The examples presented in this talk are: the Chinese five elements of matter; the technology of iron production in sub-Saharan Africa; early salt recovery methods in Oaxaca, Mexico; Agnes Pockels and surface chemistry; Arabic alchemy, its tools and techniques; plant dyes of Native Americans; and the Hope Diamond.

SELECTED REFERENCES AND SUGGESTED COURSE CONTENT TOPICS FOR EXAMPLES USED IN PAPER

1. **Chinese Five Elements of Matter**
   - A. **Topics: Prologue to course; classification of substances; chemical elements**
   - B. **Reference: Needham, Joseph, Clerks and Craftsmen in China and the West, 1970.**

2. **Technology of Iron Production in sub-Saharan Africa**
   - A. **Topics: Redox reactions**
   - B. **Reference: Schmidt, Peter and Avery, Donald, "Complex Iron Smelting and Prehistoric Culture in Tanzania", Science, 1978, *201*, 1085-1089.**

3. **Salt Recovery Methods in Oaxaca, Mexico**
   - A. **Topics: Solutions; solubility; crystal formation**
   - B. **Reference: Hewitt, W.P., Winter, M.C., and Peterson, D.A., "Salt Production at Hierve el Agua, Oaxaca", American Antiquity, 1987, *52(4)*, 799-816.**

4. **Agnes Pockels and Surface Chemistry**
   - A. **Topics: Surface tension, Phases of matter**
   - B. **Reference: Cobb, Cathy and Goldwhite, Harold, Creations of Fire: Chemistry's Lively History from Alchemy to the Atomic Age, 1995.**

5. **Arabic Alchemy**
   - A. **Topics: Prologue to course; substances and mixtures; lab techniques and equipment**
   - B. **Reference: Al-Hassan, Ahmad Y and Hill, Donald R., Islamic Technology: An Illustrated History, 1986.**

6. **Native American Plant Dyes**
   - A. **Topics: Prologue; Dyes; Alternative materials to Red Cabbage for student experiments**
   - B. **Reference: Balls, Edward K., Early Uses of California Plants, 1962.**

7. **Hope Diamond**
   - A. **Topics: Properties of elements; solids; crystal structure;**
   - B. **Reference: Webster, R., Revised by B.W. Anderson, Gems, Their Sources, Descriptions and Identification, 1983.**

USING EXAMPLES FROM THE HISTORY OF CHEMISTRY TO INCLUDE MULTICULTURAL EXPERIENCES IN GENERAL AND INTRODUCTORY CHEMISTRY

Division of Chemical Education, "Using Historical Chemistry to Teach Chemistry", ACS Meeting, New Orleans, LA , March 24, 1996

[A. INTRODUCTION] Ladies and gentlemen, colleagues all, we are pleased to participate in this historical symposium. Our focus in this presentation expands on the topics of the previous presenters in a slightly different manner. What concern does this talk address? History and culture.

Chemistry is itself a culture. In order to gain a mastery of chemistry, a student needs to develop a familiarity with its culture, which involves chemistry's vocabulary, ideas, organization, skills, and history. As the quote from Virginia Pearce points out, culture involves an integrated pattern of human knowledge; in this case, the typical content in a chemistry course. We teachers find the chemical culture normal, familiar and obvious. For our students it is a matter of culture shock, being adrift in an alien world. Many of our students actually are suffering from double culture shock when they come into chemistry, because they also come from inadequate backgrounds in terms of language, ethnicity and/or educational support by their families. In looking at the student demographics from our two particular colleges, we observe that Mt. SAC's student population is 70% minority or foreign, while Merced College is located in the seventh most ethnically diverse city in the nation. Think about your students! The combination of these two culture shocks results in groups of students with great anxiety about a class that is essential to their academic and personal future.

In addressing these concerns, we have found that typical instructional materials do not have an adequate, if any, multicultural component. On these pages from a high school chemistry text, note that the marginal biographical insert has no connection to the chemical content on the page. This is unfortunate because these multicultural/historical inserts could be a potential life-line, enabling students to establish a personal connection to the course material. Many of our students, particularly those with English as a second language, look first to their textbook for support. Let's look at what already exists. Children's books make the first connections. This elementary school science book illustrates many familiar scientific topics but early in the book also includes a segment on Islamic science which is probably less familiar to most people. Returning to the high school chemistry text, note the properly presented multicultural and historical material which makes a logical connection between the biographical information and the textual content. Unfortunately, less of these connections are found in college chemistry texts.

This has led to our project of developing a series of multicultural examples that can be used to illustrate chemical topics and support all students in overcoming their culture shocks and mastering the course material. We've tried some of these in our classes in a variety of teaching situations, including a student search on a few examples as an extra credit assignment in general chemistry for last year's National Chemistry Week. We have found these examples in many places that would not be anticipated by college instructors preparing their class presentations. Let's look at a few of these historical examples from different peoples, cultures and times.

[B. EXAMPLES TO DO WORK]

[1. CHINESE FIVE ELEMENTS OF MATTER]

All of us discuss at some point in the course the Greek four elements of matter, but there were other early explanations for the organization of matter. One of us recently was reminded of this while reading a Pearl S. Buck novel in which the characters discuss the five elements and their interactions. According to Chinese alchemy (dating from about 500 BCE), all material substances are combinations of 5 elements--metal, wood, earth, water, fire--in the appropriate amounts. These elements are in dynamic relationships with one another: one element can give rise to another, e.g., wood to fire, and each element can conquer another, e.g., fire melts metal. These elements underlie all traditional Chinese science, medicine, and technology, and predate the Greek 4 elements of matter--earth, air, fire and water.

[2. IRON TECHNOLOGY IN AFRICA] The study of redox reactions is another topic common to introductory and general chemistry courses. Many of us discuss the rusting of iron as a chemical process observed by all students. Some of us still talk about the reverse reaction of obtaining metals from their ores as a significant step in the development of technology in any culture. Anthropologists and historians of technology have looked with interest at the observation that in the process of technological development in sub-Saharan Africa there was essentially no Bronze Age. But, iron was the catalyst which woke the southern half of the continent from the Stone Age. For example, one can utilize a diagram of a Haya iron smelting furnace from Tanzania to discuss the impact of temperature, time, oxygen concentration and the presence of carbon on the reduction reaction products. The process in the African furnace is parallel to that in the open hearth furnace which was so crucial to the development of American and European technology. The chemistry is the same, the product is similar, the environment is different; the level of interest is increased when students find that chemical reactions are not geographically dependent.

[3. SALT PRODUCTION IN OAXACA, MEXICO] For many years, I have utilized my students' experience of driving over the San Mateo Bridge to the San Francisco Airport to introduce solubility and saturation by discussing the Leslie Salt evaporating ponds on the East side of the bridge. For contrast I will refer to the salt production near Salzberg, Austria as the opposite process of dissolving mineral salt and then purifying it. Both are historically significant chemical processes. Recently, I introduced an alternative example which I happened to see in an anthropology journal on a colleague's desk. This comes from a controversy in Mexican archeological research. The area around Oaxaca, Mexico has long been studied as an example of terraced agriculture. But various lines of evidence including chemical analysis of the water, support the hypothesis that the canals and terraces of Hierve el Agua just outside the Oaxaca Valley were actually designed for salt production through solar evaporation. Traverstine falls and deposits now fill what may have been pre-Hispanic salt ponds. This particular article was very useful because besides the qualitative description of the refinement processes, it also gave an extensive chemical analysis of the waters and deposits. Students are asked to use these data from archeological research reports to calculate concentrations and see the impact of various elements in mineral waters and salts.

[4. AGNES POCKELS AND SURFACE CHEMISTRY] Question: Did you know that one of the pioneers of surface chemistry was Agnes Pockels, who did all of her experiments at home at the kitchen sink...literally! Born in 1862 in Germany, Pockels received a high school education but did not go to university because they would not admit a woman and later when they would, her parents did not give their permission. A member of a chronically ill family, she remained at home throughout her life, taking care of her parents. However, she had an enthusiastic interest in science, especially physics, and read her brother's university textbooks in order to learn as much science as possible. Because of her household tasks, she spent a lot of time at the kitchen sink looking at greasy dishwater.

By age 20, Pockels had invented a surface film balance (still in use today). She began conducting studies of surface films and monolayers, including surface tension measurements, some twenty years of experimentation. At her brother's urging, she wrote to Rayleigh, who was beginning to do similar work. After reviewing Pockels' data, Rayleigh saw to it that her work was published. In 1932, three years before Agnes Pockels' death, Ostwald published a tribute to honor her pioneering work in surface chemistry.

[5. ARABIC ALCHEMY] We previously referred to material on Islamic science in an elementary school book. But, you may not be aware of the direct impact it has on the content of our chemistry courses. Arabic alchemy was practiced between the 7th and 13th centuries CE, and containing Chinese, Indian and Greek influences is the basis for European alchemy. Two major Islamic alchemists were Rhazes (850-925 CE), author of the Book of Secrets, a compilation of chemical classifications and practices, and ibn Sina/Avicenna (980-1037 CE), author of the Canon of Medicine, a systematic encyclopedia of Arabic, Greek and Roman knowledge used until the 16th century CE. A few laboratory techniques practiced by the alchemists included distillation, sublimation, dissolving, crystallization, metallurgical purification, and combustion, things that we recognize and our students might even recognize; lab equipment used by the Islamic alchemists included the beaker, flask, crystallization dish, casserole, alembic (still), filter, funnel, etc., the basic apparatus found in alchemical, pharmaceutical and metallurgical labs until the 19th century CE. Imagine a student's reaction if she/he had to pay for the replacement prive of this beautiful beaker.

[6. NATIVE AMERICAN PLANT DYES] Color is an extremely useful and eyecatching property of chemical compounds. To illustrate this, let's move to a different people, culture and geographical location, in California, of course. California Native Americans used local, available plants as sources of many items needed in everyday living, e.g., food, clothing, baskets, medicines, soap and dyes. Rather than the traditional example (that we've all used) of red cabbage as a natural material with color significance, we can take our examples from the locally occurring plants used by Native Americans as sources for dyes.

A brilliant yellow dye was obtained from the stems and roots of the Barberry or Oregon Grape and used for baskets and fabrics; a purple dye comes from its crushed berries. Mesquite yielded a black dye from bark gum for hair coloring, a blue dye from the leaves and fruit for tattooing and a black dye from the roots for pottery designs. A bright yellow-brown dye from the branches of the Indigo plant was used for baskets and deerskins.

[7. HOPE DIAMOND] Speaking of color, this is the Hope Diamond. As beautiful as it is, in a chemistry class the diamond is a wonderful example for use in discussion of crystal structure, the impact of impurities (the fact that one part per million of boron in place of carbon in the diamond structure is the source of the deep blue color), or even the effect of this crystal structure on properties such as intense orange fluorescence following ultra violet light exposure. But, how is it a multicultural example in chemistry? Well, where do diamonds come from? If they know, most of my students would answer South Africa. (How about you?) South Africa is the major source for much of our current gem diamond production, and that's a multicultural connection because some of my students are from South Africa. But historic diamonds such as the Hope predominately came from India. A brief discussion of the occurrence of these large diamonds in alluvial deposits and their mining processes as a major impact on commerce between India and Europe can enliven a presentation on solids. This historical gem can also be the basis of discussions on the difference between gem size diamonds and commercial diamonds.

These are just a few samples of how different examples can be used to bring the impact of chemistry (in a very short period of time in leacture) into the realm of all of our students. As we started to use several of these examples and saw their positive impact on our students, we sought a larger source of examples.

[C. PROJECT DESCRIPTION] Our original idea was that these multicultural and historical materials and examples would be found in existing bibliographies. So, we would just need to follow up with lots of library work. However, our preliminary research showed that the bibliographies that do exist, and there are few, are not keyworded by detailed chemical topics as would be found in a typical introductory or general chemistry course outline. These findings led us to initiate PROJECT INCLUSION. Two proposed outcomes of the project, are (1) an annotated bibliography which allows keyword access to the references based on chemical topics, names, cultures and times; and (2) a series of "replacement instructional modules" (one or two pages in length) that can easily be included in faculty members' notes for their classroom presentations. These modules will include the specific example, background information, and selected references. Each module will also include suggested topical placement in the chemistry course. The modules will allow instructors to supplement their presentations with alternate examples that address the double culture shock of our students. We are actively involved in PROJECT INCLUSION and invite your contributions and suggestions. It is our hope and belief that the products of this project can serve as a hook to draw in and keep all students in their chemistry courses.

[D. CONCLUSION] We know that what we are proposing appears to lead to only a subtle shift in most instructors' current presentations. But to bring change for our students demands a significant shift in thought on the part of us faculty.

The physical task of introducing new content material is easier than mental task of changing thought patterns, overcoming biases and discarding old habits. But, for the sake of all our students we teachers must accomplish both tasks.

We have available a handout which summarizes our presentation and provides some references to our examples.

THE "OTHER" OUTSTANDING WOMEN CHEMISTS: STORIES TO TELL, ACHIEVEMENTS TO HONOR

Presented before the Division of Chemical Education, American Chemical Society National Meeting, New Orleans, LA, March 24, 1996.

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When chemistry students and teachers are asked to name outstanding women chemists or scientists whose work has had a significant impact on chemistry - for example, those who have won Nobel Prizes or discovered elements - most can name one - Marie Curie. As one part of a broader project to bring multicultural examples into general and introductory chemistry courses, materials are being developed which will provide teachers with sufficient information to include the life and work of "other" outstanding women chemists and scientists in their class presentations. The intent of this material is to help faculty see how to present the material so that their students will see the chemical contributions of these women as a part of the normal flow of the course and not just as "special" or supplementary information. The examples can then be presented on a topic or content basis rather than a biographical basis. Women portrayed in this paper include: Gerty Radnitz Cori, Maria Goeppert-Mayer, Dorothy Crowfoot Hodgkin, Irene Joliot-Curie, Lise Meitner, Ida Tacke Noddack, Marguerite Perey, Rosalyn Sussman Yalow.

THE OTHER "OUTSTANDING" WOMEN CHEMISTS: STORIES TO TELL, ACHIEVEMENTS TO HONOR

Cori, Gerty Radnitz, 1896-1957, Biochemist
Elucidated the Cori cycle, a series of enzyme-catalyzed reactions by which the body metabolizes sugars, thereby supplying energy at appropriate times for life's activities.
Grinstein, L., Rose, R., and Rafailovich, M., Women in Chemistry and Physics: A Bibliographic Sourcebook, 1993.

Goeppert-Mayer, Maria, 1906-1972, Physicist
Developed the nuclear shell model of the atom.
McGrayne, S., Nobel Prize Women in Science: Their Lives, Struggles, and Momendous Discoveries, 1993.

Hodgkin, Dorothy Crowfoot, 1910-1994, Crystallographer
Determined the detailed, three-dimensional structures of several biologically important molecules, e.g., penicillin, vitamin B_{12}, and insulin, by x-ray methods.
James, L. ed., Nobel Laureates in Chemistry, 1901-92, 1993.

Joliot-Curie, Irene, 1897-1956, Nuclear Chemist
Synthesized the first radioelements and initiated the study of the artificial production of radioactive nuclides.
Nobel Lectures including Presentation Speeches and Laureates' Biographies - Chemistry 1922-1941, 1966.

Meitner, Lise, 1878-1968, Physicist
Co-discoverer of the element Protactinium and the individual who first understood the nature of and coined the term "atomic fission".
Sime, R.L., "The Discovery of Protactinium", J. Chem Ed., 1986, *63*, 653-7.

Noddack, Ida Tacke, 1896- , Chemist
Co-discoverer of the element Rhenium.
Gass-Simon, G. and Farnes, P., ed., Women of Science, Righting the Record, 1990.

Perey, Marguerite, 1909-1975, Chemist
Discoverer of Francium, last element to be discovered in nature, i.e., without atomic bombardment.
Kauffman, G.B. and Adloff, J.P. "Marguerite Perey and the Discovery of Francium", Education in Chemistry, 1989, *26*, 135-7.

Yalow, Rosalyn Sussman, 1921- , Medical Physicist
Co-developed radioimmunoassay, a technique that detects tiny amounts of various substances in the blood and tissues of the human body.
Opfell, O., The Lady Laureates: Women Who Have Won the Nobel Prize, 1978.

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BROWN BAG LUNCHEON

"Using Historical Examples to Bring Multicultural Content into Chemistry Courses: Why Does It Matter?"

Do you know about Agnes Pockels, a pioneering surface chemist; ancient salt production in Oaxaca, Mexico; or Islamic alchemy?

Speakers: **Janan Hayes, Merced College**
Patricia Perez, Mt. San Antonio College
Travel Grant Recipients
Chemical Heritage Foundation

Location: Chemical Heritage Foundation
315 Chestnut Street

Date and Time: Wednesday, May 8, 1996 at 12:00 Noon

See you there!

For more information call Laurel Adelman at (215) 925-2222 Ext. 222

"USING HISTORICAL EXAMPLES TO BRING MULTICULTURAL CONTENT INTO CHEMISTRY COURSES: WHY DOES IT MATTER?"
OUTLINE OF BROWN BAG TALK, CHF, WEDNESDAY, MAY 8, 1996

INTRODUCTION: Friends for over 20 years; met at a California Association of Chemistry Teachers summer conference; both were CACT state presidents in the 70s; when we meet we talk shop, discuss current education issues, compare notes

A) Series of observations that laid ground work for this project.
--increased diversity of our students over the years
faces on the first day of classes each semester
changing statistics of general college population
- Mt. Sac over 70% minority & foreign
- Merced 7th most culturally diverse city in US - 25% Hispanic, 10% Hmong, plus IndoChinese, Punjabi, Sikhs, Russians, etc.
--textbook review
missing faces, mismatch of student faces and textbook faces
often improper placement of historical/multicultural material on page - no connection with the textual material and chapter topics
--our affirmative action committee work
increased awareness of data
sensitivity to problems beyond our own discipline of science
--five Hispanic women in Jan's class
prepared to drop course but Jan used Oaxaca example (to be discussed in detail later) in class, there was an immediate connection for them, all passed the course and got into nursing programs

B) Why does it matter?
--define "it" - materials are often available of a historical and increasingly multicultural nature, but the key is how they are used in the courses, methodology is the operative word, "it"
--define "minority" -in the broadest terms, ethnic, physically challenged, women, etc. One of our concerns in this Project has been the terminology. Multicultural is a very "loaded" term in our area. DO YOU HAVE A BETTER TERM?
--California is a large state and thus a microcosm of the entire country & its problems
--multiple shocks for some students - based on our observations as teachers for more than 25 years apiece
---new country with different customs
---language
---academic deficiencies perhaps present in both native & foreign students
---missing educational tradition and support by family
(1st generation college, female, choice of major, money impact)
--students often come into a science course with idea of scientists as individuals working independently in isolated labs

--our view is that science is a collaboration among many people, cultures, and nations over time

--our aim is to increase student interest and improve student success and retention rates in chemistry/physical science courses by giving students a new perspective

---a sense of history

---science has had logical, incremental development that has been occurring simultaneously in many parts of the world

---science is putting puzzle pieces together

--perhaps this is the only science course some students will take in college; we all want to make the course interesting, relevant, and worthwhile

C) How did the Project evolve?

--thought bibliographic materials existed; we would just expand them and find ways to use in our classes

--informal library research in spare time, over summer

--called CHF, left message, Dr. Benfey returned call, Pat had lunch with him at Fall 1994 ACS National meeting, then we came for first CHF visit...great success (Dr. Benfey with ideas, articles, books in never ending stream)

--presentation in History of Chemistry symposium that Jan organized at ACS Western Regional meeting, Oct 94; following talks, Dr. Harold Goldwhite suggested sabbatical leaves because of time constraints, which is why we are able to be here at CHF today

--responses of colleagues nationwide & audience members at various presentations very positive...we're on to something!

--sought funding to support sabbaticals and Project; this focused our attention on groups/persons/times/cultures...

thus, a name, Project Inclusion (to include as many as possible, and to exclude no one)

D) Project Inclusion description - 2 basic products

1) Annotated bibliography:

---keyworded to course topics as well as gender, ethnicity, culture, historical period, etc.; but not just a list of references (some of these are available); we feel this is what will make our bibliography unique

---format and software to support that part of Project is still a concern

---dissemination form has yet to be determined

2) Set of Replacement Instructional Modules:

---modules to provide additional/alternate examples

---materials must first be easily accessible by multiple course topic keywords but also by name, ethnicity, date, cultural group, etc.

---module format so it fits into teacher's lecture file on given topic

---materials will be useful in several courses (introductory chem, general chem for science majors, chem for nonscience majors, organic chem, history of chem/science, high school chem, physical science, etc.)
---module description--[length] 2 - 3 pages; [organization] title, summary of module content, background information, place(s) in course outlines, references, [length in lecture] 2-3 minutes
---module to illustrate/enrich topic, not change its chemistry; to give chemistry a face/humanizing it on a level recognizable by our students
---set of modules not a bound textbook, rather a set of flexible inserts
---module information to be a normal, mainline part of course, not an irrelevant set of marginal notes

SAMPLE MODULES

A) Agnes Pockels
1862-1935, Germany, early surface chemist
invented a surface film balance by 20 years of age (still used today); high school education; worked at kitchen sink; Rayleigh (after exchange of letters) saw that her work was published in Nature
topics: surface tension, phases of matter, lab equipment

B) Ancient salt production in Oaxaca, Mexico
pre Hispanic Mexico, initially thought to be terraced agriculture, chemical analysis of water and residue provides evidence that was early salt production facility
topics: solutions, crystal formation, evaporation, solubility

C) Islamic alchemy
basis (with Chinese, Indian and Greek influences) for European alchemy; practiced 7th-13th centuries, CE; many laboratory techniques; many pieces of lab equipment used until 19th century; compilations of classifications of materials, alchemical practices, medical information in use through 16th century
topics: prologue, lab techniques and equipment, matter

WHERE DO WE GO FROM HERE?
--we can't do it all, we know that
1.5 days at CHF, 5.5 days at CHF....still not enough time -- and this is just one of our library/research resources
--materials not intended for our exclusive use
--must get others interested and involved; process is interactive and they need to be involved in development and sharing of information
--continuous flow of suggestions all the time, everywhere, in any situation
we carry notebooks and pens/pencils at all times as ideas seem to flow, e.g., CHF Monday tea time, Sunday lunch with friends, etc.

--number of proposed modules steadily increasing
Dec. 94 sabbatical proposal suggested 5-6 to be prepared;
before this research trip had identified 16 modules;
by Sunday afternoon we were up to 20 modules;
now 23 modules and growing...
--how are we going to use the Project materials? some examples
Prologue to course - 1st week of classes, quick snippets of examples from around the world over time; stay with course and learn the details
in Chem: homework, in-class examples
in Physical Science - gravity example
--dissemination process
---publication of Project products in format to be developed
---presentations at national, regional, local meetings
---journal articles
---(if funded) summer workshops: 1 week, both coasts, re: project philosophy, module preparation methodology, development of own module, results shared

CONCLUSION:
--a vital component of the Project, its success and continuation, is the faculty member as teacher and facilitator
--we believe that the Project's success depends on a subtle shift in the faculty member's approach to his/her classes, outlook, thinking, philosophy and response to the Project's demand that the faculty member be willing to explore, risk, share, work
--this isn't easy and we know it's not, but we all must do it for the students
--one day in January 96 on the first research trip of our sabbatical leaves to Washington DC, we went to the Smithsonian to an exhibition entitled "Science and the Artist's Book". A variety of artists had been selected to create a piece of art in response to various items from the Smithsonian's archives. The artist Edward Hutchins reacted to the engineer Fontana's drawings about the technology of moving the Vatican Obelisk, a significant engineering achievement. Part of the artistic work is the quote: "However laborious it is to move an object as massive as the Vatican Obelisk, Edward Hutchins believes it can be more difficult to change someone's mind. Fontana moved the obelisk with ingenious mechanics and hard labor, but to change a person's mind Hutchins subtly attempts to alter mental mechanisms, prejudices, and old habits."
--changing people's minds...isn't that what teaching is all about?

M-AM-SY-5

Multicultural Examples Can Make Chemistry Relevant to High School Chemistry Students

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The careful use of historical examples from various cultures, times and peoples can provide a linkage between the students in our classrooms and chemistry in terms of its relevance to their everyday lives, their academic success and their interest in the fascinating world of chemistry. If the choice of examples selected to illustrate course topics truly reflects the breadth of chemical experiences all over the world, then the students can see the connection to and importance of the chemistry presented in the course to themselves. In order to accomplish this, correctly researched and properly documented examples must extend beyond historical materials traditionally used in classrooms. An immediate obstacle that arises is how and when a teacher, particularly at the high school or community college level, can find the resources and time to develop the examples.

Project Inclusion is our effort to provide the necessary materials and methodologies to do this...for any and all interested chemistry teachers. The proposed products include an extensive, annotated bibliography of primary and secondary resources and a selection of instructional materials that can readily and conveniently be used by a teacher in any classroom situation. At present, these instructional materials include a series of resource modules (1-3 pages in length, consisting of an example with background information and a few good references) and a set of homework problems. All Project materials will be connected to specific topics in a typical course outline.

Students are the center of Project Inclusion and have been involved early on. They triggered our seeking of information. For example, a group of five Hispanic women in an introductory chemistry course were ready to drop the class but remained and completed the course after hearing about pre-Hispanic evaporative salt production in Oaxaca, Mexico in the presentation on solutions; an Egyptian student in a general chemistry course wrote a short paper on Islamic alchemy as an extra credit assignment, which later became the initial draft of a resource module.

How can the Project materials be used in the classroom? Teachers can use the bibliography and modules in their presentations/lectures as a resource for supplemental/ alternative examples to illustrate a given chemical topic in the course. Potential student activities include the researching, writing and/or presenting of short papers on various topics of interest and relevance to the chemistry course, e.g., a poster session in a departmental open house for National Chemistry Week or an extra credit option as an in-class oral presentation. Teachers of beginning chemistry courses can use the Project materials to develop and present an introductory prologue to the course, consisting of brief glimpses of a few of the contributions of women and minorities to chemistry, thereby enticing students unfamiliar with and afraid of chemistry to remain in the course and try their best.

Any of these uses of Project Inclusion materials can serve as a "hook", directed at student enrollment and retention so that the course, perhaps a program or major prerequisite, is successfully completed. From the beginning of the course, the teacher can help build in the students a positive attitude toward science in general and chemistry in particular. Further, the chemistry teacher can confront and acknowledge the students' initial fears and phobias and begin to assist the students to face and deal with them. These activities will work for both high school and college/university students. Chemistry teachers can use Project Inclusion materials to make the subject intriguing, interesting, meaningful, applicable to the students, to show that chemistry relates to all students, no matter who they are or what their goals, needs and interests are.

The resource modules, bibliographic entries and homework problems are being researched and developed from a variety of materials: primary and secondary sources at many types of institutions (public and academic libraries, book stores, the Chemical Heritage Foundation); books intended for both adults and children; discussions and conversations with colleagues, students, audience members and friends. A list of selected secondary sources is found at the end of this handout.

Much of the work of Project Inclusion was done during the Spring 1996 sabbatical leaves of both presenters. During the Fall 1996 semester we intend to use the completed resource modules in our introductory chemistry classes to illustrate various course topics and to have our students work in small groups to produce brief papers on topics chosen from the current module list for inclusion in a National Chemistry Week poster session. The results of this field-testing of the instructional materials in our classrooms, the progress of the continuing work on Project Inclusion (searching for additional bibliographic entries, writing of more resource modules, developing of homework problems) and information on the dissemination (assuming adequate funding) of Project Inclusion instructional materials will be shared with interested teachers across the country via presentations at regional and national ACS meetings, articles in CHED Newsletter and Chemical Heritage and periodic updates to those on the Project mailing list.

SELECTED SECONDARY SOURCE LIST:

Cathy Cobb and Harold Goldwhite, Creations of Fire. Chemistry's Lively History from Alchemy to the Atomic Age. (Plenum Press, New York, 1995. ISBN 0-306-45087-9. 475 pgs.) This book was written as a text for a history of chemistry course, but it also serves very well as a secondary resource for information about the entire span of chemical history. It does have good selections on both early chemistry beyond Europe and women chemists in more modern eras. This is a very readable book.

G. Kass-Simon and Patricia Farnes, ed; Deborah Nash, assoc. ed., Women of Science: Righting the Record. (Indiana University Press, Bloomington, IN. 1990. ISBN 0-253-20813-0. 398 pgs.) Eleven essays by a variety of contributors covering most areas of science. Of particular interest to chemistry teachers are the three chapters: "Intellectual Contributions of Women to Physics" by L.M. Jones; "Women in Chemistry" by Jane A. Miller, and "Women in Crystallography" by Maureen M. Julian. All chapters have extensive bibliographic notations.

L.S. Grinstein, R.K. Rose, and M.H. Rafailovich, ed., Women in Chemistry and Physics: A Biobibliographic Sourcebook. (Greenwood Press, Westport, CT, 1993) This is a most useful source of short, informative articles about many individuals. Always an excellent place to start any research project.

Laylin K. James, ed., Nobel Laureates in Chemistry, 1901-1992. (History of Modern Chemical Sciences, American Chemical Society and Chemical Heritage Foundation, ISBN 0-8412-2459-5 cloth-also available as paperback. 1993, 798 pgs.) Extensive article and bibliography on each laureate.

Ahmad Y. al-Hassan and Donald R. Hill, Islamic Technology: An Illustrated History. (UNESCO, Paris. 1986. Reprinted in paperback, Cambridge University Press, 1994. ISBN 0-521-42239-6. 304 pgs.) Current photographs and historic art illustrate a well-written history of Islamic technology. Chapters on "Chemical Technology", "Textiles, Paper and Leather", "Agriculture and Food Technology", and "Mining and Metallurgy" are of greatest interest to chemistry teachers.

Two recent biographies of women are also recommended. Both deal extensively with the cultural surroundings which shaped the women and their careers in science.

Ruth Lewin Sime, Lise Meitner, A Life in Physics. (California Studies in the History of Science, Volume 13, University of California Press, Berkeley, CA. 1996. ISBN 0-520-08906-5. 526 pgs) This is a very readable biography of an under-recognized woman physicist whose work had many influences on modern chemistry. With access to Meitner's papers and through interviews with many contemporaries, Sime has painted a detailed portrait of Meitner, as a person and as a scientist, in light of the extraordinary political and social forces that affected her life.

Susan Quinn, Marie Curie, A Life. (Radcliffe Biography Series, A Merloyd Lawrence Book. Softback: New York, Addison-Wesley Publishing Co., 1996. Hardback: New York: Simon & Schuster, 1995. ISBN 0-201-88794-0. 509 pgs.) First extensively researched book on Marie Curie since 1937's Madame Curie by Eve Curie. With the advantage of time, Quinn has been able to utilize recently released manuscripts, journals, etc. from Marie Curie and her contemporaries.

M-AM-SY-6

Integration of Multicultural Content into Introductory/General Chemistry

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Patricia L. Perez
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Close your eyes a moment and think about the students in your chemistry classes. See all the different faces; recall all the individual needs and interests. What challenging diversity! Now focus your attention a little more closely. Remember that although we faculty find chemistry familiar and comfortable, most students find chemistry an unknown and scary culture with new vocabulary, complicated concepts, demanding tasks. Further, many of our students have limited academic abilities and nonscientific backgrounds; some of them are from other countries with a language and customs different from those of the native-born students. Talk about a culture shock/ clash!

These are the students we get in our classrooms. What can we faculty do to assist our students to overcome the barriers? to move along the road toward success? One response to the multicultural challenge in chemistry is Project Inclusion. The Project's goal is to develop and disseminate materials and methodologies that faculty can use to establish a connection between their students and chemistry, to demonstrate the importance and relevance of chemistry to everyday life, to highlight the contributions of women and minorities to chemistry. Let's stop a moment to consider the term, "multicultural". Unfortunately, the word is often fraught with burdens and problems. For many persons, multicultural has a negative meaning, is an empty bureaucratic phrase, and describes a thoughtless process of following rules with no consideration of the fine details of the real, individual situation. Perhaps a new, better term is needed to describe the situation. Any ideas?

We all use examples to illustrate particular concepts and topics. Are the examples useful and appropriate? Do they demonstrate the diversity of chemical contributions from many cultures, peoples and times? Current examples found in textbooks are often used poorly (a mismatch between the example and the chapter topic) or are limited in diversity (little connection between the face in the example and the students' faces). The products of Project Inclusion are an extensive, annotated bibliography, a series of resource modules, a set of homework problems, all keyed to the topics presented in a typical introductory or general chemistry course. Each resource module, 1-3 pages in length, will consist of the chemical example with appropriate background information, a few good references and suggestions for course placement. There are currently 30 topics on the proposed module list, in various stages of preparation.

Here are some sample module topics with a few details.
--Chinese five elements of matter: metal, wood, earth, water and fire; contemporaneous

with Greek four elements (earth, air, fire and water), about 500 BCE.
--Women crystallographers: Kathleen Lonsdale, Dorothy Crowfoot Hodgkin and Rosalind Franklin used x-ray crystallography to determine the 3-D structures of a variety of materials, e.g., benzene, vitamin B12, penicillin, insulin, coal, DNA, plant viruses.
--Pre-Hispanic evaporative salt production in Oaxaca, Mexico: chemical studies indicate that salt was obtained by evaporation through gravity feed to a series of ponds that had previously been considered as terraced agricultural sites.
--Early iron technology in Sub-Saharan Africa: the same chemical reactions are involved in the production of carbon steel in Tanzania using natural materials such as termite hills as in open-hearth steel production.
--Native American plant dyes: the flowers, leaves, stems, or roots of local plants are used by native peoples to produce dyes in a variety of colors for use on animal skins, baskets, pottery, fabrics.
--Lise Meitner: a co-discoverer of protactinium; the first to explain the process of atomic fission as a result of scientific investigation with Otto Hahn.
--density: the impact of gravity on density, a property of all materials, can be better understood using an example of primitive food cultivation from Tales of the Shaman's Apprentice by Mark Plotkin.

A true history of chemistry is more than a list of names, dates and accomplishments. It must be broad and wide-ranging, the data vital, useful, intriguing, covering all continents, times and cultures. We faculty must expand our vision of chemical history. In this way, the history of chemistry can be a vehicle for change for us faculty and our students.

SELECTED REFERENCES TO RESOURCE MODULES:

Chinese Five Elements: C. Cobb & H. Goldwhite, Creations of Fire, Plenum Press, New York, pp. 20-21, 43-44.

Women Crystallographers: M. M. Julian, "Women in Crystallography", in G. Kass-Simon & P. Farnes, Women of Science, Indiana University Press, Bloomington, IN, pp. 335-383.

Pre-Hispanic Evaporative Salt Production: W.P. Hewitt, M.C. Winter, & D. A. Peterson, "Salt Production at Hierve El Agua, Oaxaca", American Antiquity, 52(4), 1987, pp. 799-816.

Early Iron Technology: P. Schmidt & D. H. Avery, "Complex Iron Smelting and Prehistoric Culture in Tanzania", Science, vol. 201, 22 Sept. 1978, pp. 1085-1089.

Native American Plant Dyes: W. Bearfoot, Dyes & Fibers, Oliver Press, Willits, CA, 1975. (Out of print; check local public library or botanical garden library).

Lise Meitner: R. L. Sime, Lise Meitner, A Life in Physics, University of California Press, Berkeley, CA, 1996.

Density: M. J. Plotkin, Tales of a Shaman's Apprentice, Penguin Books, New York, 1993.

APPENDIX F

NSF CCD proposal

Cover Sheet

Abstract

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e., program, division, etc.)	FOR NSF USE ONLY
Division of Undergraduate Education, Course and Curriculum Development Program	NSF PROPOSAL NUMBER
PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/If not in response to a program announcement/solicitation enter GPG, NSF 95-27 Closing Date - 10 June 1996	

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	FILE LOCATION

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)	SHOW PREVIOUS AWARD NO. IF THIS IS	IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY?
77-0362218	☐ A RENEWAL OR ☐ AN ACCOMPLISHMENT-BASED RENEWAL	YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE	ADDRESS OF AWARDEE ORGANIZATION, INCLUDING ZIP CODE
Merced Community College District	3600 M Street Merced, CA 95348
AWARDEE ORGANIZATION CODE (IF KNOWN)	

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE	ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING ZIP CODE
Merced College, Science Division	
PERFORMING ORGANIZATION CODE (IF KNOWN)	

IS AWARDEE ORGANIZATION (Check All That Apply)
(See GPG II.D.1 For Definitions) ☐ FOR-PROFIT ORGANIZATION ☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINESS

TITLE OF PROPOSED PROJECT

Project Inclusion

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE
$ 364,264	36 months	1 January 1997

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

- ☐ BEGINNING INVESTIGATOR (GPG I.A.3)
- ☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.D.1)
- ☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG II.D.10)
- ☐ NATIONAL ENVIRONMENTAL POLICY ACT (GPG II.D.10)
- ☐ HISTORIC PLACES (GPG II.D.10)
- ☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.12)
- ☐ GROUP PROPOSAL (GPG II.D.12)
- ☐ VERTEBRATE ANIMALS (GPG II.D.12) IACUC App. Date ______
- ☐ HUMAN SUBJECTS (GPG II.D.12) Exemption Subsection_____or IRB App. Date ______
- ☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES ______
- ☐ FACILITATION FOR SCIENTISTS/ENGINEERS WITH DISABILITIES (GPG V.G.)
- ☐ RESEARCH OPPORTUNITY AWARD (GPG V.H)

PI/PD DEPARTMENT	PI/PD POSTAL ADDRESS
Chemistry Department	Chemistry Department Science 38, Merced College 3600 M Street, Merced, CA 95348
PI/PD FAX NUMBER 209-384-6362	

NAMES (TYPED)	Social Security No.*	High Degree, Yr	Telephone Number	Electronic Mail Address
PI/PD NAME Janan M. Hayes	561-56-5198	Ph.D. '71	209-384-6345	jmhayes@elite.net
CO-PI/PD Patricia L. Perez	555-62-7413	M.S. '68	909-594-5611, x.4532	
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

NOTE: THE FULLY SIGNED CERTIFICATION PAGE MUST BE SUBMITTED IMMEDIATELY FOLLOWING THIS COVER SHEET

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE NSF INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

PROJECT INCLUSION

PROJECT SUMMARY

A gradual shift from an instruction to a learning paradigm is now taking place in education. The demographics of the student populations in California and the nation are rapidly changing. Increasingly, students in chemistry classes are members from underrepresented groups. Resource materials that deal effectively with all these trends must be developed since they do not currently exist. The overall goal of Project Inclusion is to provide appropriate materials and strategies to deal with the student diversity. The Project products will be an annotated bibliography, a series of resource modules, and a collection of homework problems that will support faculty in focusing students' attention on the chemical contributions of women and minorities. All Project materials will be connected to the typical topics presented in introductory/general chemistry. The resource materials will undergo review by the Project PIs and editor, a set of external faculty members, and a group of faculty participants from a summer workshop program as well as extensive field-testing by a number of interested faculty. Four summer workshops will provide faculty with an opportunity to learn how to prepare and integrate Project materials into their classes. Project Inclusion will be publicized in presentations at chemistry conferences, in announcements to a comprehensive mailing list, and through journal articles. Preliminary work for the Project supports the belief that utilization of Project Inclusion materials and strategies will result in greater student interest and success in their chemistry classes. Evaluation will primarily be focused on measuring attitude changes in faculty and students through use of CBAM (Concerns Based Adoption Model). The potential impact of the Project will be tremendous as its audience is every lower division college chemistry classroom in the nation, perhaps even beyond.

APPENDIX G

Letters from Potential Distributors

UNIVERSITY OF CALIFORNIA, LOS ANGELES

UCLA

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO

SANTA BARBARA • SANTA CRUZ

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY
405 HILGARD AVENUE
LOS ANGELES, CALIFORNIA 90095-1569

May 30, 1996

National Science Foundation
Division of Undergraduate Education

Dear Review Committee:

From its inception, we have followed the development of Janan M. Hayes' and Patricia L. Perez' cultural applications for chemistry project. It is a valuable and timely project. Last year when they asked if we could see a place for their work in our Molecular Science Systemic Reform it was easy to answer with a resounding, "Yes." In fact there are many places that their work fits our goals. Nowhere in the country is cultural diversity more a way of life than in California. Even if a student is the sterotypical white male, most of their friends are not. Thus, the Inclusion Project should appeal to all students as well as provide an opportunity to personalize chemistry for many whom we have never reached before.

Since Pat Perez is on the faculty at Mount San Antonio Community College, one of our core institutions for Molecular Science, the Inclusion Project materials will be easily integrated into the new Molecular Science modules. It is our intention to do so. Once there, the dissemination is enormous. Through our joint collaboration, we gain a new viewpoint for students and the Inclusion Project reaches all the courses that come under the purview of Molecular Science: general chemistry, environmental chemistry, materials science, molecular life science as well as teacher preparation and the general education courses. We consider it a win-win synergism.

Sincerely,

Arlene A. Russell

Arlene A. Russell
Co-Director, Molecular Science Systemic Reform
Director Lower Division Laboratory Programs
Specialist in Chemical Education

ChemSource

NSF: Education and Human Resources

May 24, 1996

Mary Virginia Orna, OSU
Principal Investigator
Department of Chemistry
College of New Rochelle
New Rochelle, NY 10805
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Dorothy Gabel
SourceView Director
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Henry Heikkinen
SourceBook Director
MAST
University of
Northern Colorado
Greeley, CO 80639
(303) 351-1289

National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230

Dear Sir or Madam:

I am writing this letter in support of the course and curriculum project called "Project Inclusion" which is being proposed by Professors Patricia L. Perez and Janan M. Hayes. I am familiar with the abilities and the professional experience of both of these project directors, having worked with them on major committees of the American Chemical Society for almost a dozen years.

In addition I have been familiar with the aims and the development of "Project Inclusion" from its beginning. It grew out of a grassroots realization that if we are ever going to see people of diverse ethnic/gender backgrounds enter the fields of scientific endeavor, it has to be by relating the science that is taught in our high schools, and our two-year and four-year colleges to personal experience and identity. While many others have paid lip service to this belief, this project is the first one that I have seen that seeks to incorporate the means of achieving this identification into existing curricula. I am totally supportive of these aims. Given the energy, the expertise and the enthusiasm of the project directors, I have no doubt whatsoever that the project will do what it proposes to do.

On the issue of dissemination, I have had some preliminary discussion with the project directors regarding the possibility that their curriculum modules could be incorporated into the *SourceBook* component of *ChemSource*, an NSF-supported resource and support strategy for teachers of introductory chemistry. *SourceBook* is moving into its third version and has already been distributed to thousands of teachers of introductory chemistry through the fulfillment offices of the American Chemical Society. Incorporation of the "Project Inclusion" modules into the curricular modules of *SourceBook* would allow us to expand our existing sections on "History - On the Human Side" with some methodology incorporated. It would also provide the project with its broadest distribution base - and we would also provide for publication of the modules on a standalone basis for those who have already obtained previous versions of *SourceBook*.

As Principal Investigator of *ChemSource*, I have provided and will continue to provide professional assistance to the "Project Inclusion" directors and look forward to the day when we can utilize their materials in our current curricula. I support this project with unbounded enthusiasm.

Sincerely,

Mary Virginia Orna

Mary Virginia Orna
Principal Investigator, *ChemSource*

UNIVERSITY OF WISCONSIN MADISON

DEPARTMENT OF CHEMISTRY

1101 UNIVERSITY AVENUE
MADISON, WISCONSIN 53706

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May 28, 1996

Janan M. Hayes
Science Division
Merced College
3600 M Street
Merced, CA 95348

Patricia L. Perez
Department of Chemistry
Mt. San Antonio College
1100 North Grand Avenue
Walnut, CA 91789

Dear Jan and Pat,

We are pleased to support Project Inclusion, your NSF Course and Curriculum proposal. When we first learned about this project in casual conversation at the recent ACS Meeting in New Orleans, this sounded like a very interesting idea. Reading the Project Summary and seeing the list of topics planned for instructional modules have confirmed, even strengthened, that enthusiasm.

What you propose to do is very much needed by the chemistry community: we are at a stage where heightened awareness has encouraged many chemists to want to include cultural diversity in books, classroom presentations, activities, homework assignments, etc. But there is an enormous hurdle to doing so—information is not readily available with the result of either omission or the re-telling of one of the few time worn examples that exist.

If modules were researched, written, and made available to the chemistry community this would be of great service. As editors, we of course cannot guarantee publication of anything that has not been submitted and reviewed. However, we can say that these modules are greatly needed by the community and that the *Journal of Chemical Education* is very interested in disseminating them. Indeed, this is just the sort of information that the *Journal* has published in the past and intends to do with increased vigor. We can also say that the community needs to be kept up to date about Project Inclusion progress, and the *CHED Newsletter* of the ACS Division of Chemical Education is an important place for such information to appear.

Each of us in our respective roles looks forward to working with you to accomplish these goals.

Sincerely,

John W. Moore
Professor of Chemistry and
Editor Elect, *Journal of Chemical Education*

Sincerely,

Elizabeth A. Moore
Editor, *CHED Newsletter*

SACNAS

Society for Advancement of Chicanos and Native Americans in Science

SACNAS
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1156 High Street
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Gopher: gopher-biology.ucsc.edu

May 24, 1996

CCD Program Review Committee
Division of Undergraduate Education
National Science Foundation
Arlington, VA 22230

Dear Review Committee:

It is with great enthusiasm and hope for the future success of Project Inclusion that I write this letter. The project will provide a much-needed resource for the growing pool of underrepresented students in chemistry and other science fields, a resource that will allow our students to realize that they *can* aspire to be scientists. The United States Department of Education reported last year that between 1986 and 1993, the number of enrolled Latino K-12 students went from 492,093 to 631,272. For Native American populations in those same years, the number went from 44,736 to 54,677 students enrolled. It is through programs like Project Inclusion that we can hope to inspire these new students to continue on to careers in science fields.

There are many affiliates of the Society for Advancement of Chicanos and Native Americans in Science who would be interested in incorporating the modules of Project Inclusion into their own curriculum. For a number of years, SACNAS has been involved in a project called Teaching Culturally Relevant Science, which has goals parallel to those of Project Inclusion. The philosophy behind Teaching Culturally Relevant Science is that our children will learn, through experience, that prominent scientists from their own community exist. It is only then that a student can dream of reaching his or her true potential as a scientist.

SACNAS is very interested in collaborating with Project Inclusion in the hopes that the program can be expanded and tailored to the diversity represented by the communities we serve. Besides the Teaching Culturally Relevant Science project, there are at least two points of common interest between SACNAS and Project Inclusion: The SACNAS Scientist Biography Project and the SACNAS K-12 Teacher Workshops.

Through the Biography project, SACNAS seeks to compile a data base of Latino and Native American scientists which will serve two purposes. The first is to provide a resource for K-12 educators who are searching for a way to motivate their Latino and Native American students. The second is to maintain a valuable reference for governmental and private agencies who are looking for qualified scientists to work on their research projects. The SACNAS K-12 Teacher Workshops are designed to provide teachers with classroom techniques and resource material designed to improve the performance of Latino and Native American students in science.

Each of the SACNAS projects mentioned above could have a symbiotic relationship with Project Inclusion. The Biography project would provide topics for additional

Project Inclusion modules, and would benefit from increased use in the classroom. The Teacher Workshops would be able to highlight another resource for our educators while providing a forum for the distribution of the Project Inclusion Modules.

We at SACNAS believe in Project Inclusion. It is only through such innovation that we can reach the ever-growing population of underrepresented youth in our school systems. There are simply not enough minority teachers to allow personal contact with these students. In the absence of these mentors, we need an effective, efficient means of encouraging more students from underrepresented groups to continue along the pipeline of higher education until they too become role models. Project Inclusion is an important part of the solution, and we look forward to its implementation.

Sincerely,

John P. Alderete
Premio Encuentro Professor of Microbiology,
University of Texas Health Science Center
President-Elect, SACNAS

APPENDIX H

Sabbatical Leave Proposal

SABBATICAL PROPOSAL

Background

The proposed sabbatical leave will involve the development of an annotated bibliography and "replacement instructional modules" related to the contributions of women and minorities to the field of chemistry.

Some preliminary work (research and discussion with professional colleagues) was done on the proposed project in Summer 1994 in order to explore the feasibility and interest in the project. A paper summarizing preliminary findings was presented at the American Chemical Society (ACS) Western Regional Meeting in Sacramento, CA in October 1994. A number of suggestions and resources were obtained from chemists in the audience. The positive response from professional colleagues and potential users over Summer/Fall 1994 has been overwhelming and encouraging.

Goals

This proposed, one-semester sabbatical leave has four goals:

(1) To demonstrate the diverse nature of chemistry and chemists by bringing examples of the chemical work of women and minorities into the current classroom curriculum. This new awareness is particularly appropriate here in California, given its rapidly changing demographics in both the student and the general populations.

(2) To compile an extensive, annotated bibliography citing the contributions of women and minority persons (ethnic, physically challenged, etc.) to chemistry for use in introductory and general chemistry courses.

(3) To organize the bibliography in a variety of formats (topic, name, minority category, etc.) using multiple technologies (paper, disk., CD-ROM, if possible, etc.) in order to encourage use by other chemistry instructors.

(4) To develop "replacement instructional modules" so that the bibliographic information can be easily used by any instructor in a chemistry classroom. The concept of the "replacement instructional modules" is that from this

bibliographic information, a series of short (1-2 pages) descriptions of the woman or minority persons and the chemical contribution(s) will be developed. Chemistry instructors can use these descriptions to present alternative examples to the "standard canon" of white male chemists when discussing how an experiment was performed and/or a theory developed. The modules will focus on specific instructional topics, e.g., nuclear chemistry, crystallography, biochemistry, etc., normally taught in an introductory or general chemistry course.

Methodology

The project will be a collaboration with my colleague, Dr. Janan M. Hayes of Merced College, a community college in northern California. Dr. Hayes is a professor of chemistry and physical science whom I have known and worked with for more than twenty years. Together, Dr. Hayes and I have over the years developed a network of professional contacts throughout California and across the United States, including a large number of minority chemists and minority societies/organizations.

Gathering data for inclusion in the bibliography will require traveling across the country to a selected number of scientific libraries and institutions, which have extensive collections in appropriate branches of chemistry. At these libraries and educational institutions I will perform both electronic and hand searches of the chemistry collections with a focus on preidentified names and/nor topics; a review and annotation of particular references and documents; personal interviews of recognized science historians and science librarians.

As a result of the proposed visits, I will continue to contact individuals and institutions recommended as potential resources; some of these contacts will most likely include the traditional minority institutions. The follow-up work on these new contacts will be by site visits, telephone interviews, or written communication.

The interviews of science historians/librarians (only a part of the proposed activities) will be focused on achieving the project goals, e.g., gathering materials, resources, and ideas for the bibliography and modules. The interviews must be flexible and free-flowing, yet focused. The person will be asked,

a) who in a specific group could serve as examples, current or historical,

b) what the chemical contribution(s) is(are),

c) what additional resources (names, places, documents, photos, etc.) might be shared with me.

The following is an example from my preliminary work that illustrates how the interview process works. Last summer I telephoned the Chemical Heritage Foundation (formerly the Center for the History of Chemistry) to see what materials might be available and how access could be obtained. Dr. Theodore Benfey returned my call; we had a brief conversation about my project and his Foundation and agreed to meet me for lunch in Washington D.C. before an upcoming ACS meeting we both planned to attend. Lunch turned into an afternoon as I gave him an overview of the project, he asked a lot of questions (and made notes of my answers), and we discussed what resources the Foundation had available. Dr. Benfey is a retired college chemistry professor and recognized chemical historian. A rapport was quickly established because he immediately understood the project goals, made many suggestions, and was enthusiastic about sharing. As a result of the afternoon's conversation, when Dr. Hayes and I arrived at the Foundation for two days' work, we found several boxes of materials awaiting our perusal, Dr. Benfey's assistant waiting to help us, and on his arrival back from the ACS meeting Dr. Benfey serving as a continual resource. Every single time he walked by our work table he had another piece of information, another reference, another question. Needless to say, a two-day site visit barely scratched the surface of the Foundation's resources. Dr. Benfey has expressed some preliminary interest in publishing/disseminating the bibliography and in supporting our project with travel funding. All of this from one simple phone call.

<u>Timeline</u>

The eighteen(18) week semester of the proposed leave will be utilized as follows:

- six(6) weeks of research on the East Coast in appropriate site clusters

- three(3) weeks of research on the West Coast in appropriate site cluster
- four(4) weeks of data analysis and compilation of the bibliography
- five(5) weeks of development and writing of the "replacement instructional modules"

A tentative travel itinerary follows:

Date	Location	Library/Person
26 Dec-5 Jan	Honolulu, HA	University of Hawaii Library(Asian collection)
29 Jan-9 Feb	Atlanta, GA	Morehouse College, Spelman College (traditional African American colleges)
	Miami, FL	Zaida Morales, professor, Florida International University(large Hispanic population)
26 Feb-9 Mar	Berkeley, CA	University of California, Berkeley Chemistry Library and University Research Library
	Sonoma, CA	Rudy Marquez , chemical historian and editor, *Journal of Chemical Technology*
24-29 Mar	New Orleans, LA	American Chemical Society Spring 1996 National Meeting (presentation of paper outlining progress to date)
1-19 Apr	Washington, D.C.	John B. Eklund, curator, history of chemistry, Smithsonian Museums; Nina Roscher, chemical historian and professor, American University (women in chemistry); Library of Congress
	Philadelphia, PA	Theodore Benfey, chemical historian and assistant director, Chemical Heritage Foundation; Othmer Library
	New Rochelle, NY	Mary Virginia Orna, chemical historian and professor, College of New Rochelle
1-8 May	Los Angeles, CA	UCLA Chemistry Library and University Research

		Library; Harold Goldwhite, chemical historian and professor, CSU, Los Angeles; Huntington Library(American and British chemistry)
13-20 May	Wisconsin	University of Wisconsin Library; *Isis* editorial office (*Isis* is a journal of Chemical history); History of Science Society headquarters; Women's History Center

An updated and more detailed itinerary will be developed as the Spring 1996 semester approaches. A copy will, of course, be submitted for approval to the Salary and Leaves Committee.

Analysis of the gathered material and compilation of the bibliography, development and writing of the "replacement instructional modules" will be done in the weeks between trips and in the evenings while on the road. These project activities will require periodic travel between Merced, CA and San Dimas, CA, our two places of residence, for collaboration. Presentation and dissemination of the project bibliography and modules will require travel to a variety of scien tific meetings, e.g., the ACS Spring 1996 National Meeting in New Orleans, LA, in March 1996; a Spring 1996 National Science Teachers Association(NSTA) Regional Meeting; the ACS Division of Chemical Education Biennial Meeting in July 1996.

A limited amount of research will be done locally during the interval before the Spring 1996 semester, most of it Summer 1995. However, my experience of Summer/Fall 1994 showed me that a sabbatical leave with no teaching responsibilities and focused only on the project is needed in order to properly achieve the professional goals of the project. I recognize that some of the project's activities will occur outside of the specific semester of the sabbatical leave; therefore, these are not part of the formal leave. These activities are included in the proposal for clarity and completeness.

<u>Benefits</u>

This project will establish the College as a model site for multicultural implementation within traditional chemistry courses.

The development of these materials will allow the addition of a multicultural component to the chemistry courses within the current course outlines.

The annotated bibliography and "replacement instructional modules" will be made available to all(full- and part-time) colleagues in the department and disseminated as widely as possible throughout the state and country.

I will greatly expand my knowledge and teaching resources to meet the broad spectrum of needs of my students.

As the next century rapidly approaches, the changing demographics of the student and general populations as well as changing employment requirements will require major innovation and revision in chemical education. This project is an initial step in that direction. The annotated bibliography and "replacement instructional modules" will be a resource for my colleagues to continue to provide excellent instruction in chemistry.

MT. SAN ANTONIO
COMMUNITY COLLEGE DISTRICT

TO: Peter L. Parra
Chairperson, Salary and Leaves Committee
FROM: Patricia L. Perez PLP
Professor, Department of Chemistry
DATE: 22 April 1996
RE: Modifications to Sabbatical Leave Itinerary, Spring 1996

Per our earlier conversation, here is the revised itinerary with rationale for my Spring 1996 sabbatical leave; but first, a quick summary of progress to date. So far, I have given three(3) presentations at the Spring 1996 National Meeting of the American Chemical Society(ACS), interviewed a number of chemical historians, participated in a Science and History of England, begun multimedia training, put together and run the 1996 California Association of Chemistry Teachers Mid-Winter Meeting--a potential dissemination group, made a multicultural/historical presentation at the Mt. SAC Education Fair, established connections with the Society for the Advancement of Chicano and Native American Students and the Molecular Science Education Project as a potential materials contributor, with the Chemical Heritage Foundation and the Journal of Chemical Education as a potential author, drafted sixteen(16) replacement instructional modules, and, of course, continued the literature search for additional items for the expanding bibliography. The following tasks remain to be done: additional bibliographic research at the Chemical Heritage Foundation, the Smithsonian Museums, and the Library of Congress, interviews with additional chemical historians, preparing final drafts of the replacement instructional modules, entering items into the bibliographic database, presenting one(1) paper at the Chemical Heritage Foundation and two(2) papers at the Division of Chemical Education Biennial Conference.

Because the first grant proposal to the National Science Foundation, submitted in June 1995, was not successful, the resulting limited funding has forced some modifications to the original proposed itinerary. Note, however, that the four goals of the project and most of the travel plans remain intact. These modifications are proposed: deletion of a visit to the University of Hawaii Library's Asian collecion due to the illness of my sabbatical partner; deletion of a visit to Atlanta, GA due to the Olympic GAmes, however, a phone call and letter to a chemist I met at the ACS meeting will access materials from Spelman College; deletion of a visit to Miami, FL due to limited funding, but phone contact will be attempted; deletion of a visit to the University of Wisconsin Library due to limited funding, however, a phone call to a chemist I met at the ACS meeting will access materials; deletion of attendence/presentation at the Spring 1996 National Science Teachers Association meeting due to a conflict with the ACS meeting and MSAC Department of Chemistry's hiring schedule. Finally, a revised proposal will be submitted to NSF by June 1996 to seek funding so that the work of the project can be continued. As you know, the sabbatical leave granted by the College was only one segment of the overall project, although a significant one.

I trust that the Salary and Leaves Committee members will find the proposed modifications acceptable; I certainly want to produce the best materials I can for the use of my departmental and professional colleagues.

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