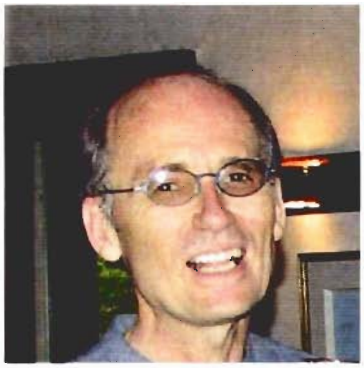
Volume 26, Issue 2

C_3 News

Fall, 2001

Newsletter of College Chemistry Canada/La Chemie Collégialle au Canada



President's Report

Keith Germaine

It was the amazing dedication of Bob Perkins that inspired me to take my turn at some work for C3 and volunteer as president. It's an awesome task to follow someone with so much energy, but it's comforting to know that Bob's not going anywhere and all I have to do is hang on to the steering wheel. In the last few years, I've come to better realize the importance of relating chemical concepts I am teaching, to issues in my own community and global environmental issues. It is important because the information is key in itself, but also it seems to really help students, as the material is alive and relevant. But this presents problems for instructors because good data is sometimes hard to come by. For the last year I've struggled to find out detailed information about depleted uranium that was used in both Bosnia and Iraq. Does anyone have some specific details of the composition of it and the results after detonation? (an army officer once commented that after detonation there is nothing to worry about because the uranium is vaporized!) Could this possibly be a role for the newsletter an exchange of questions and answers and a general discussion of applications of chemical concepts on the world scene? I hope someone can enlighten me about depleted uranium. A further question is whether there is something more we could do as chemists to be more vocal about environmental issues that have a chemical focus? Something to think about! Have a great academic year.

K. Germaine

INSIDE THIS ISSUE

The Joint 28th College Chemistry Canada Conference and the 84th CSC Conference and Exhibition — Chem. Ed. Division Sessions — A Great Success!

Last May, College Chemistry Canada (C3) and the Chemical Education Division of the Canadian Society of Chemistry co-hosted the Chem Ed symposia at the 84th CSC Conference in Montreal. This joint effort (our 28th C3 conference) was a fantastic success; four full-days of presentations by university and college chemical educators, with standing room only at most talks. C3 and CSC members alike were full of praise for an outstanding effort on the part of the organizers and presenters.

The scientific sessions included forty-eight oral presentations and eight posters in the Chemical Education Division as part of six symposia. There also were a large number of excellent papers presented in a multi-day symposium in the Physical Chemistry Division joint with Chemical Education Division on "History and Application of Theoretical Chemistry". A few of the Chemical Education papers that stood out (Editor's opinion!) where: "Elvis and the Myth of the Magic Bond" (W.C. Galley,,McGill University, "Fascin-

C_3 NEWS
VOLUME 26, NO.2
FALL 2001

PUBLISHED BY
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Articles of any length will be accepted. Please send copies to the editor, Dr. Norman Reed at nreed@cariboo.bc.ca in electronic format (preferably Microsoft Word 2000) via e-mail or floppy disk, together with a hard copy mailed to the University College of the Cariboo (see Contact Info on last page of this issue). along with copies of any COLOUR photographs.

PRINTING: UCC PRINT SHOP

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ISSN 0843-4956

ating Demonstrations...with Explanations" (A. E. Fenster, McGill University, "A Novel 1st Year Kinetics Experiment that Shows Rare Zero-Order Behaviour", (R.I. Haines, U.P.E.I.), "37 Semesters of Organic Chemistry" (B. Perkins, Kwantlen University College), "The History of the Pharmaceutical Industry In Canada" (R. Zamboni, Merck Frosst. I for one found several useful teaching tips and information mentioned in these and other presentations that I am now incorporating in to my courses. It is hoped that some of the authors of papers presented at the conference will be willing to submit full length articles for publication in this newsletter based on their presentations in Montreal.

A number of awards were presented at the conference, Bob Browne (Douglas College) received the Nova Corporation Award for excellence in teaching at the CSC Awards banquet; Suzanne Pearce (Kwantlen University College) received the C3 Award for excellence in Chemical Education at the C3 Banquet, and Pat Draper (Champlain College) received the Teacher of the Year Award from Champlain College. C3 members enjoyed a number of social events including the annual banquet, the annual fun run and a tour and lunch in old Montreal. Ed.

Pictured Above is Dr. Ariel Fenster of McGill University who presented an excellent talk on chemical demonstrations in a conference session, and entertained the C3 group at the annual banquet with an excellent lecture on the history and chemistry of the French wine industry. **Pictured Below** is Dr. Bob Perkins (right) presenting Jason Behrmann with the 2001 C3 Student Scholaship.

Hands On Isomers - Part 3
Stereoisomers (achiral)

By: Bob Perkins, Kwantlen University College

In Part 2 of this series I described the relationship between constitutional isomers; i.e., compounds which have different IUPAC names. Most students (with a little practice) easily master that portion of the course; however, many students have greater difficulty with molecules which have the same IUPAC name. Compounds which fall into this category have the same connectivity of all atoms, but they differ in the way in which the atoms are arranged in space. A stereochemical prefix must preceed the IUPAC name to indicate the exact location (in three-dimensional space) of all the atoms. These compounds are classified as **stereoisomers** of each other and can be broadly labelled as to whether they are **chiral** or **achiral**; i.e., containing an internal plane of symmetry or not. A chiral molecule can be either right or left-handed and I will examine this aspect of stereochemistry in Part 4 of this series.

As we saw in part 2, asking questions forms part of the analysis. The students can consider the structures of two compounds and ask the question:

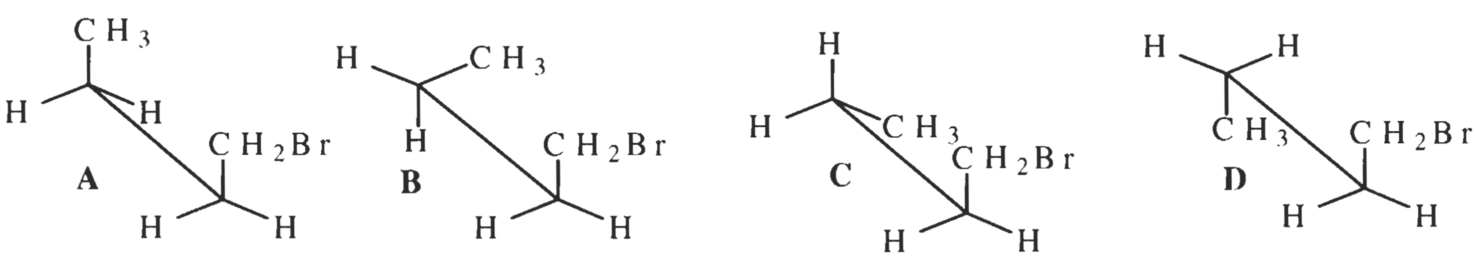
Do these compounds have the same IUPAC name?

If the answer is yes, then the two compounds are **stereoisomers** of each other. If the answer is no, then the two compounds are **constitutional isomers** of each other.

I will now consider the situation where the two compounds have the same IUPAC name and explain how to determine the exact relationship between the two stereoisomers. The new question is:

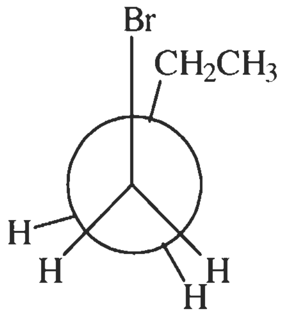
Can the structures be interconverted by simple bond rotation?

If the answer is yes, then the two compounds are **conformational isomers** of each other. We can begin our examination of this difference by considering a molecular model of the compound 1-bromobutane. By sighting along the bond between individual carbon atoms, you will soon discover that there will be a large number of different possible arrangements of the atoms. We can illustrate this **conformational analysis** by considering the bond between carbon #2 and carbon #3. Four of the many possible arrangements are shown below as **sawhorse representations**.

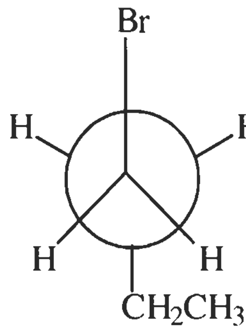


In structure A, the three atoms or groups attached to carbons 2 and 3 are directly in line with each other. This arrangement is not a favourable one as the groups will tend to crowd each other and thus raise the potential energy of this particular conformational isomer, referred to as the fully **eclipsed** isomer. This **steric effect** between the groups/atoms can be reduced by rotation of the bond between carbons 2 and 3. In structure B, the groups/atoms are now offset from each other and the instability resulting from the steric effect will be less than that found for structure A. The groups are now **staggered** with respect to each other. Continued rotation will produce another **eclipsed** isomer (structure C), which will be more stable than structure A as the two large groups (CH_2Br and CH_3) are farther away from each other. The staggered structure D results from a further rotation, and will represent the most stable conformational isomer since the two largest groups are as far away from each other as possible. As structures B and D are both staggered, they require additional prefixes to describe their exact orientations. Isomer B is known as the **gauche-staggered** conformational isomer while isomer D is the **anti-staggered** conformational isomer. At room temperature, all conformational isomers will be present as there will be sufficient thermal energy for free rotation about the bond between carbon 2 and carbon 3. If the temperature is decreased, the percentage of conformational isomer D (**anti-staggered**) will increase as the two largest groups will be as far from each other as possible. By choosing another bond within 1-bromobutane, similar conformational isomers would result. This analysis can only be performed one bond at a time within a molecule, in order to determine the exact overall shape of a molecule a high speed computer would be required.

Another way of viewing the arrangement of groups in space would be to use **Newman Projection formulas**. These can be visualized by viewing a sawhorse projection directly from one carbon atom to the next. The fully eclipsed and anti-staggered conformational isomers of 1-bromobutane, viewed along the bond between carbon 1 and carbon 2 are shown on the next page using Newman Projections.

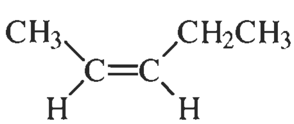


fully eclipsed

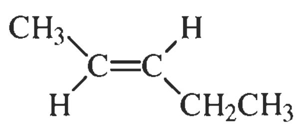


anti-staggered

Notice that these conformational isomers look quite different from those previously portrayed as sawhorse projections; however, please remember that we are now looking along the bond between carbon 1 and carbon 2, rather than carbon 2 and carbon 3. I will now move to consider the case where two isomeric structures which have the same IUPAC name cannot be interconverted by bond rotation. In this case, the two compounds are **configurational isomers** of each other. The only way that the two compounds can be interconverted is by breaking covalent bonds; the isomerism is a result of restricted rotation. One simple example can be provided by the compound 2-pentene, for which there are two possible configuration isomers.



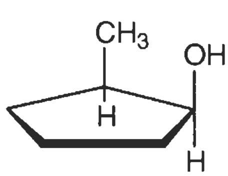
E



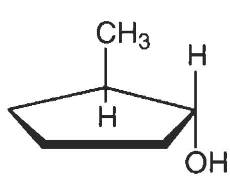
F

Both compounds have 4 groups attached to the carbon atoms of the alkene portion of the molecule. In compound E, the 2 hydrogen atoms are located on the same side of the molecule, while in compound F the two hydrogen atoms are on opposite sides of the molecule. The prefix **cis** is used for identical groups which are on the same side, while the prefix **trans** is used for groups which are on opposite sides. The complete IUPAC name for compound E is cis-2-pentene, while trans-2-pentene is the IUPAC name for compound F. The compounds are also often referred to as **geometric isomers** of each other.

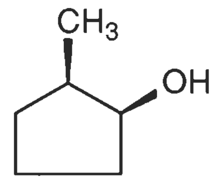
Geometric isomers are also possible for cyclic compounds. These can be drawn in several ways and I will illustrate two of them for cis and trans 2-methyl-1-cyclopentanol.



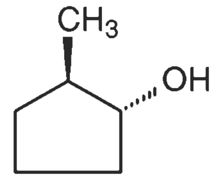
cis



trans

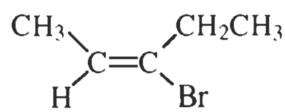


cis

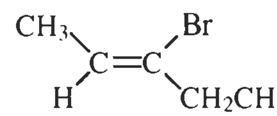


trans

It is important to remember that the prefixes cis and trans must always refer to identical groups (H atoms in the examples above). If the molecule does not contain two identical groups, a different set of prefixes must be used. This situation can be illustrated using the following two geometric isomers.



G



H

The complete IUPAC name of compound G (and H) requires the use of a prefix based on the priority of the groups attached to the alkene carbon atoms. The priority of the groups is determined using a series of sequence rules. The Cahn-Ingold-Prelog system requires that the viewer move out one bond at a time from the alkene carbon, comparing the atomic number of each atom. For carbon number 2, the atomic number of H is 1, and the atomic number of C (in the methyl group) is 6; therefore, the methyl group has a higher priority. For carbon number 3, the atomic number for Br is 35, and the atomic number of C (in the methyl group) is 6; therefore, the Br atom has a higher priority. For compound G, the two highest priority groups are on opposite side of the molecule; the prefix used is E (from the German word entgegen which means opposite). For compound H, the two highest priority groups are on the same side of the molecule; the prefix used is Z (from the German word zusammen which means together). The complete IUPAC name for compound G will be E-3-bromo-2-pentene, and the complete IUPAC name for compound H will be E-3-bromo-2-pentene. For a more detailed discussion of the Cahn-Ingold-Prelog system I suggest that you refer to a current second year organic chemistry textbook.

I will conclude my look at the wonderful world of isomers in part 4 of this series by considering stereoisomers which contain chirality centres.

Teaching and Research at Small Colleges
A Chemistry Perspective

Geoff Rayner-Canham
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A recent article in University Affairs (1) reported how small universities are moving into big-time research. I feel the need to comment on the article as, in my view, the presentation is very simplistic. The generalizations in the article are dangerous and show a lack of understanding of the role of small institutions. Such discussion is particularly timely and appropriate to this publication as many two-year colleges in B.C. are undergoing the transition to university college degree-granting status.

First of all, I wish to discuss the role of small universities and colleges. Curiously, there seems to have been very little definition of this in Canada, thus I really have to rely on U.S. data. I have expounded on this topic at length in two publications some years ago so I will not repeat the extensive literature cited therein (2). I will use the term "college" rather than "small university" or "liberal arts (and science) college" for compactness.

The purpose of a college is to provide a high-quality personalized undergraduate teaching environment (I can think of no other general reason for building a small institution). Obviously such an institution demands excellence in teaching from its faculty. But there is much more implied by the mission. First, colleges should be the prime incubator of innovation in teaching. Not the innovations that relate to teaching 200 or 1000 students in a single class, but those involving new courses, new programs, and new methodologies. For example, in Canada, much of the innovative chemistry teaching has come, in fact, not from the universities but the two-year colleges. Second, colleges excel at sending students into higher degree programs. There have been some detailed U.S. studies showing that a higher proportion of graduates from colleges go into higher degree programs than from such august institutions as Harvard and MIT (3).

There are two reasons why colleges excel. The personalized environment specifically benefits the "average student." At Grenfell College, we have had many examples of students who have started out in the C to low B category and who have graduated with strong Bs and even As - and then been accepted into master's programs where they have flourished even more. This I have dubbed the "geese into swans" phenomenon (4). Recent British research has supported the view that good teaching and mentoring does have a significant positive impact on student performance. The other reason is the importance of the research project. The research project which colleges usually require of all students (but big universities often reserve only for honours students) is widely regarded as crucial in student development. It is the importance of the student research project that brings me on to the research aspect.

Research (better described as the more broader term, scholarship) in a college is vital. Again, I won't repeat the numerous citations in the studies that I have previously co-authored (5) showing that scholarly work is an essential part of a faculty member's activities - if nothing else to prevent the faculty member from becoming "brain-dead." But as I have already mentioned, research is also vital for the undergraduate student. For the sciences, this presents a particular set of problems. As de Solla Price pointed out in his classic work *Big Science, Little Science* (6), the nature of science has changed to being one where increasingly large groups use ever more expensive equipment for their research efforts. This is not the research that is of benefit to undergraduate students. They need limited-goal projects that can be completed over a one or two semester period and which use equipment that they can personally manipulate.

In the United States, the National Science Foundation (NSF) recognizes the importance of undergraduate research by funding the purchase of student-friendly equipment and by supporting small-scale research projects (7). NSF also finances innovative science education projects. There is no parallel organization in Canada. NSERC sees itself as the financer of big science - the bigger the better (8) but it does have limited specific funding for small universities (9).

It is very attractive for a college to receive a large research grant - or be involved in one. Extra income and prestige are obviously why administrations have suddenly become so enthusiastic about research. But there are several problems with the science grants. First, will the instrumentation really benefit the institution and be suitable for undergraduate project use? Second, will the college researcher be part of a large multi-university group in which they may play a minimal technician role? Third, without graduate students and post-doctorals will the workload impinge significantly upon the teaching role (10)? Or will full-time researchers (such as postdoctorals) be hired to perform the research work, changing the very nature of the institution?

The article in *University Affairs* also argues for faculty in colleges to be focussed in one direction so that they can put together collaborative proposals. A tight single focus can, in fact, be very dangerous for a college. First, and most important, it means there is little choice of research projects for undergraduate students (11). Second, if the focus does not attract major grants or the focus becomes outdated, what then? It is only large institutions that can afford the luxury of clusters of faculty.

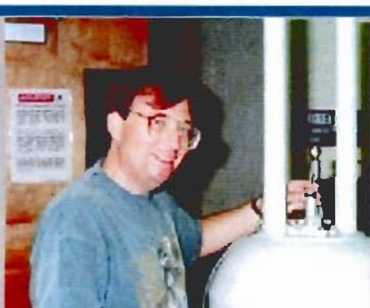
It is the middle ground that I am arguing is essential for a college. This is the hardest path and one that must be in the consciousness at all times but especially in the context of hiring and in the focus of grant applications. I have personal knowledge of several institutions that started out as having teaching-oriented missions but then flipped to becoming research powerhouses (12) or at least developed a very divided faculty. It is of note that the University Affairs article (1) quotes: "She [research faculty member, Dr. Klentrou] adds that there is no need for long-time teaching-oriented faculty to feel threatened. 'Nobody became obsolete. We still need teachers.'" - as if there is a total dichotomy between teaching and research. In my view, this viewpoint is dangerous for any institution but deadly for a college.

In conclusion, then, I would argue that, though a diversity of abilities is desirable, a faculty member at a college needs to see the teaching role as their prime purpose for being at such an institution. Nevertheless, research (scholarship) is essential at a small college but not necessarily the research that is appropriate to a large research institution (13). Thus chemistry faculty at such institutions should focus on small projects suitable for student work and acquire the equipment that is appropriate.

References and Notes

1. T. Frank, "Big-Time Research at Small Universities," *University Affairs*, April 2001, 10-11, 30, 32.
2. G.W. Rayner-Canham, "The Liberal Arts College and Its Potential Role in Canadian Chemical Education" *Canadian Chemical News*, **39**(8), 9-12 (1987). G.W. Rayner-Canham and M.F. Rayner-Canham, "Chemistry Teaching in US Liberal Arts Colleges" *Education in Chemistry*, **25**, 148-150 (1988).
3. See references cited in papers in ref 2.
4. In the 1930s at the University of Cambridge, some biochemists were enviously complaining that F. Gowland Hopkins always had the best research students. One of them interjected that it was not that Hopkins "stole" the best students, it was that Hopkins used the hormone of encouragement to turn the geese into swans. See: M.F. Rayner-Canham and G.W. Rayner-Canham, "Hoppy's Ladies," *Chemistry in Britain*, **35** (January), 47-49 (1999).
5. M.J. Webb, A.M. Last, R.R. Perkins and G.W. Rayner Canham, "Integrating Science Teaching and Research in a Small, Two-Year College" *Journal of College Science Teaching*, **12**, 437-441 (1983); S.B. Abhyankar, A.M. Last, P.K. Monaghan, R.R. Perkins, G.W. Rayner-Canham, J.N. Reed, M.J. Webb,"Scholarship and Chemistry Teaching in the Two-Year College" *Journal of Chemical Education*, **68**, 145-148 (1991).
6. D.J. De Solla Price, *Little Science, Big Science and Beyond*, New York: Columbia Univ. Press, 1986.
7. Small science can be good science. For example, at The King's University College, Edmonton, Peter Mahaffy devised a project involved the study of lead pollution by collecting dryer lint from households in different parts of the city. The lint was then analyzed by a general-purpose atomic absorption spectrometer and the results plotted by district. All the work was performed by undergraduate students. See: P.G. Mahaffy et al., "Laundry Dryer Lint, A Novel Matrix for Non-intrusive Environmental Lead Screening," *Environmental Science and Technology*, **32**, 2467-74 (1998).
8. Both NSERC and SSHRC have very high minimum funding requirements. Small scale requests are automatically ineligible. Ironically, such an attitude encourages grant "padding" to provide a budget in excess of the minimum. We at SWGC had raised the topic of the need for an NSF equivalent in Canada when the director was Janet Halliwell. She promised to address our concerns. Shortly after, she was replaced. Her successor was totally opposed to any recognition of the needs of small colleges.
9. Judith Poe, during her Union Carbide award address at the CSC Conference, Montreal, May 2001, mentioned that there is now hope that either NSERC will acquire the "NSF" mandate or that a separate Federal granting agency will be set up to provide such funding.
10. In this author's view and experience, it is impossible to sustain the necessary level of publications to maintain an NSERC grant without graduate students and/or post-doctorals working on the topic year-round.
11. As an illustration of the benefits of diversity, students in the Environmental Science (Chemistry) stream at Grenfell College (S.B. Abhyankar, J.M. Dust, D-R. Parkinson, and G.W. Rayner-Canham, "Environmental Chemistry at Sir Wilfred Grenfell College," *Canadian Chemical News*, **50**(3), 16-17 (1998)) have a choice of many research topics, including: pesticide decomposition in cold environments, use of biomass to remove heavy metal contaminants, trace atmospheric gases, wood chemistry, and soil chemistry.
12 See also, L. Cuban, *How Scholars Trumped Teachers*, Teachers College Press, New York, 1999.
13. U.S. Colleges tend to hire graduates of other small colleges. Thus their incoming faculty are already imbued with the duties and responsibilities (such as mentoring and student-oriented research) in such an environment. In Canada, college faculty are often hired from research institutions having a very different viewpoint of a faculty role.

CONFERENCE PHOTOS: Clockwise from the top left are the C3 Fun Run Group for 2001, the 2001 Conference Tour Group and the 2001 C3 Banquet Group arriving at Fritz Farm, Baie D'Urfe, Quebec.



Notes From the Editor

Norm Reed, University College of the Cariboo

No doubt this issue of C3 News finds you as busy as ever with academic term activities. With the excellent joint C3 / CSC conference in Montreal behind us, thoughts now turn to the next joint venture with CSC next June in Vancouver. In this issue you will find a brief summary of some of the highlights of the Montreal conference, along with some initial details of the upcoming conference in Vancouver. The response to the many excellent Chem Ed presentations in Montreal was incredible, with standing room only for the vast majority of the talks. On another note, I still desperately need articles for this newsletter. The publication of this issue was delayed partly because, until recently, I had very little material for another issue. With the excellent printing avaliable at UCC, it would be worthwhile getting enough submissions so that I can move publication back to four times per year. Please support YOUR newsletter with submissions!! N.R.

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The Second Joint Conference: The 29th College Chemistry Canada Conference and the 85th CSC Conference — University of British Columbia, June 1st to 5th, 2002.

C3 will again be co-hosting the Chemical Education symposia at the 85th CSC Conference at the University of British Columbia from June 1 - 5, 2002. Bob Browne (Douglas College) and Bob Perkins (Kwantlen University College) will be the co-chairs (along with Gordon Bates from UBC) for the Chem Ed symposia. Arrangements will again be made for C3 members in good standing to take advantage of a reduced conference registration fee for Chem Ed Affiliates. More information will be avaliable in the next issue of C3 news, along with any additional details of the symposia titles for the chemical education portion of the conference. Please strongly consider submitting a poster or oral presentation for the conference!

Currently, the following is the Preliminary Program listed for the Chemical Education section of the conference:

- **Higher-Level Teaching/Learning/Evaluation Strategies** - How to accomplish them without all of the work

- **Resource/Learning Centres** - How do they work? How do students use them?

- **Introductory Organic Chemistry is Different.** How do we get students to accept this idea and begin to think "outside of the box"?

- **The Research Experience in Undergraduate Laboratories**

The preliminary programs for other areas of chemistry, a contact list of the conference organizing committee, accommodation and travel information are all currently avaliable at the CSC conference website, www.chem.ubc.ca/csc2002/.

Ed