Right-handed Sugar Doughnuts: Nutritional Food for Undergraduates and Their Faculty

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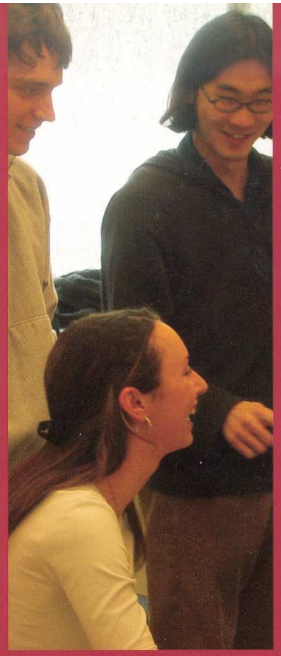
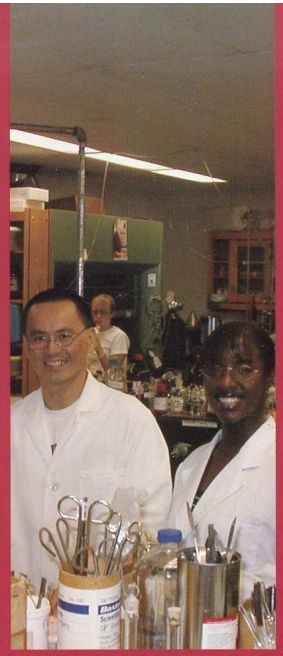




Enhancing Research

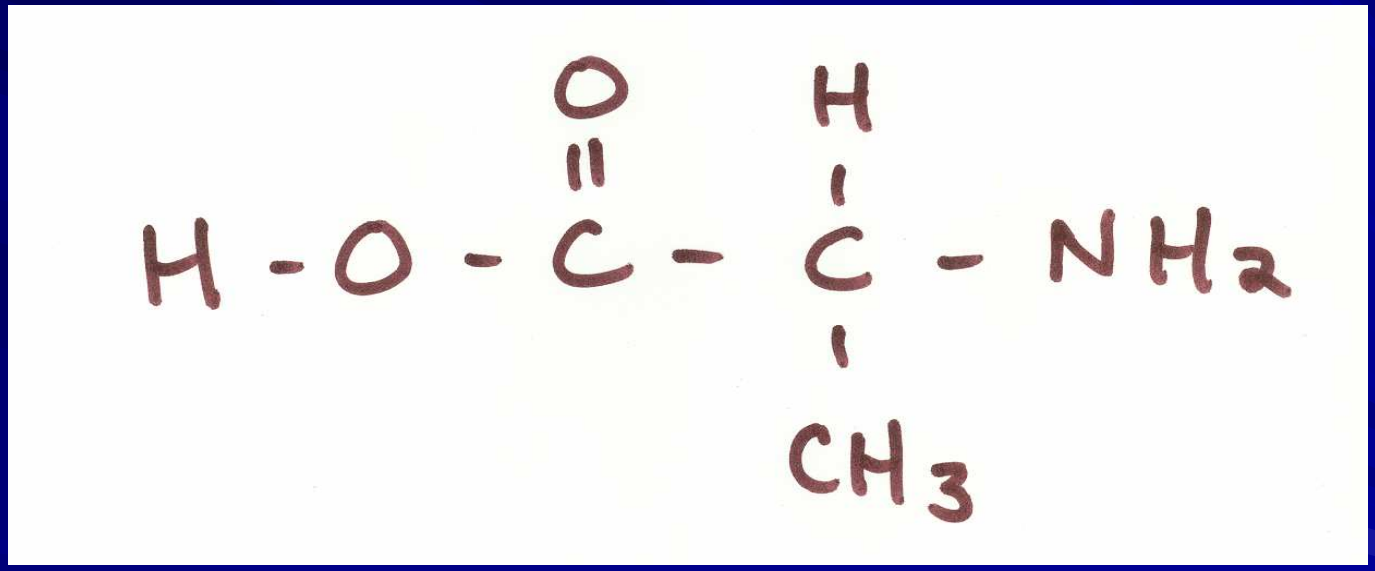
in the Chemical Sciences at Predominantly Undergraduate Institutions

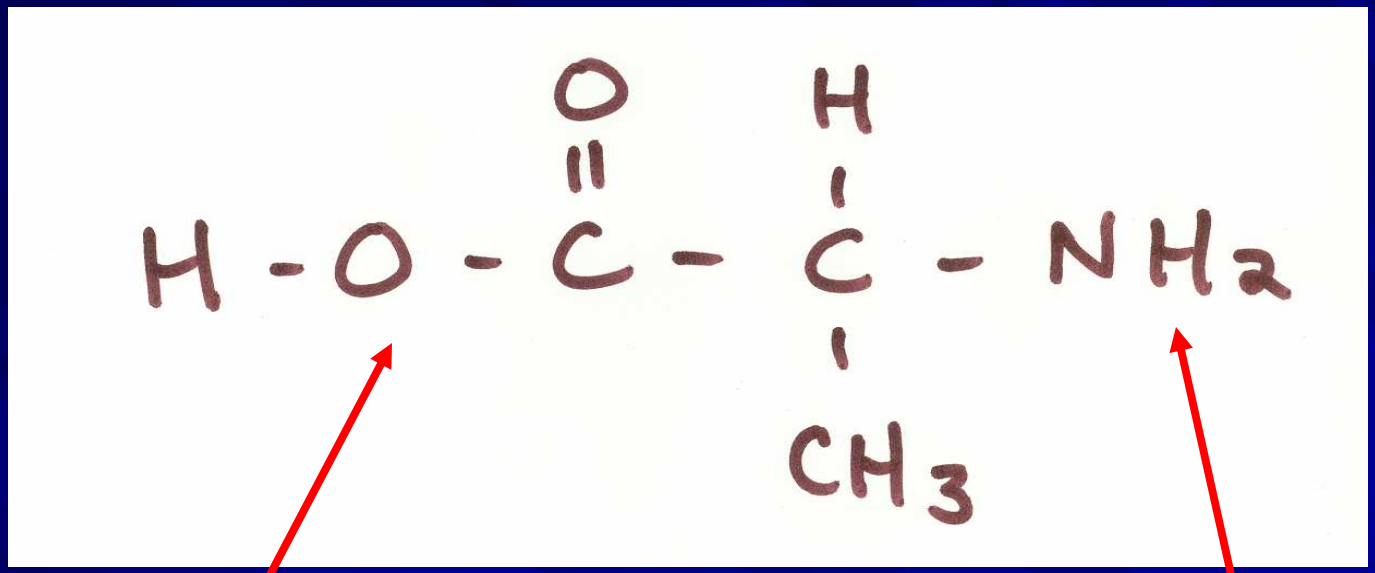
A Report from the Undergraduate Research Summit
Bates College, Lewiston, Maine
August 2-4, 2003

Supported by the National Science Foundation

Undergraduate research is an inquiry or investigation conducted by an undergraduate that makes an original or creative contribution to the discipline.

Alanine





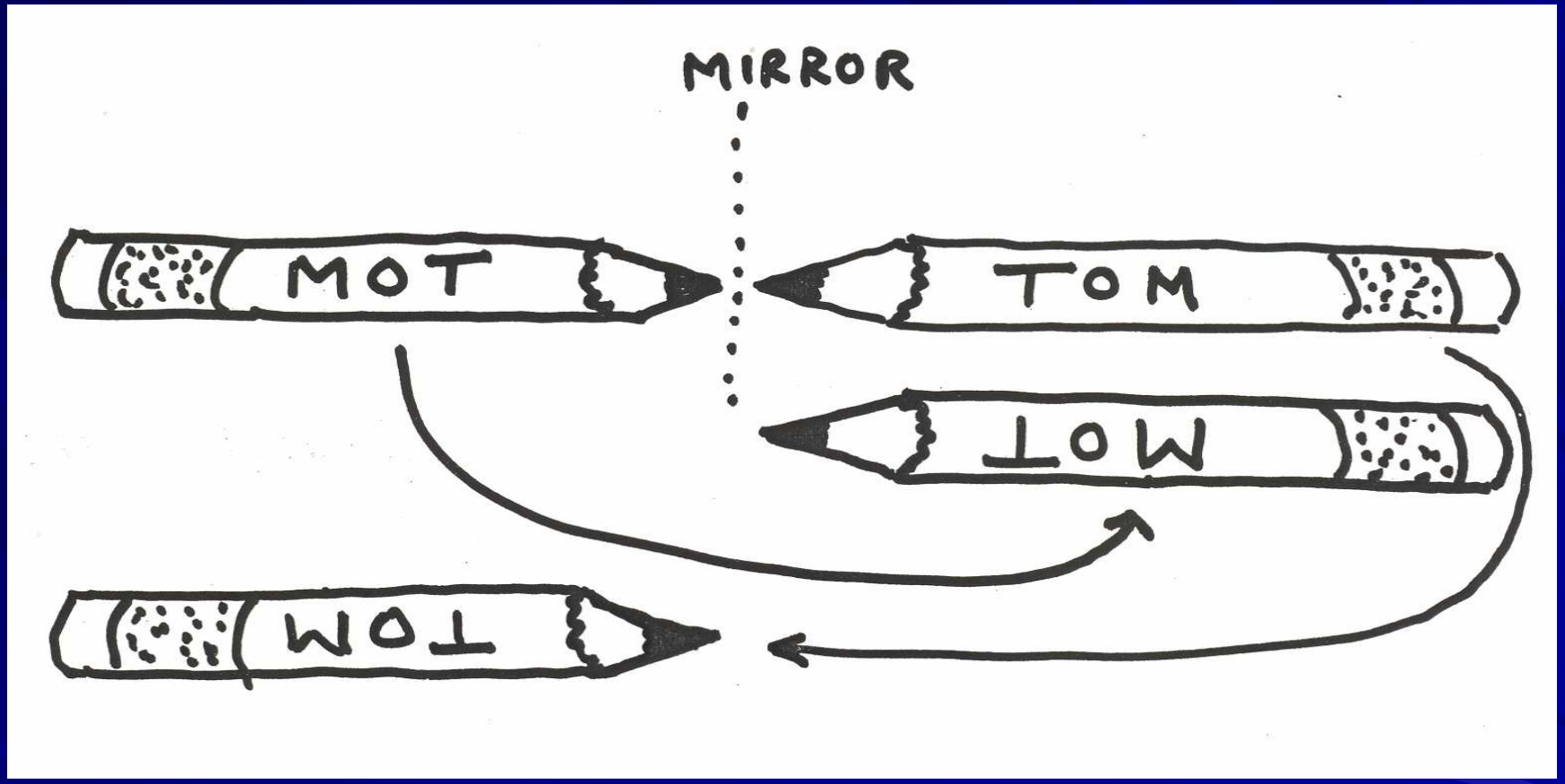
Carboxylic Acid

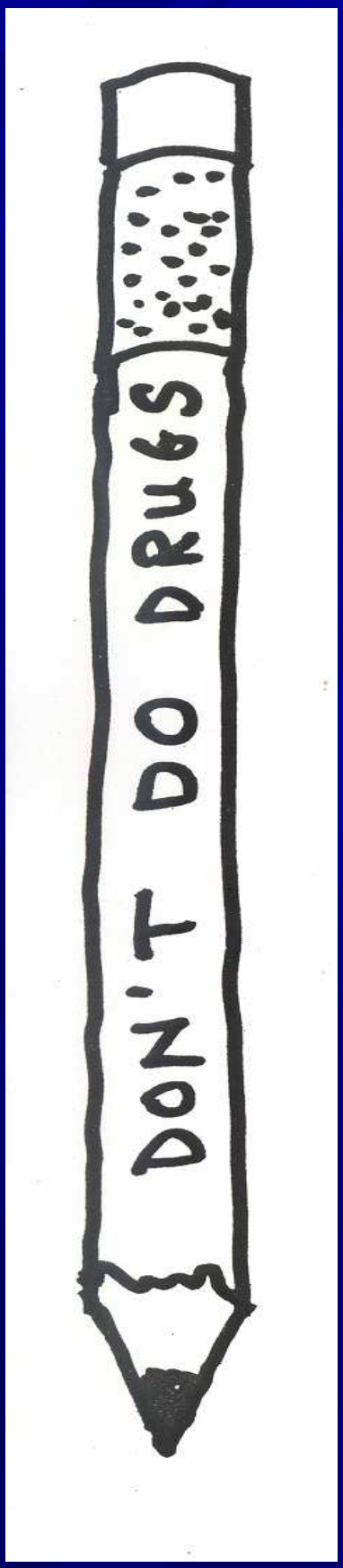
Amine

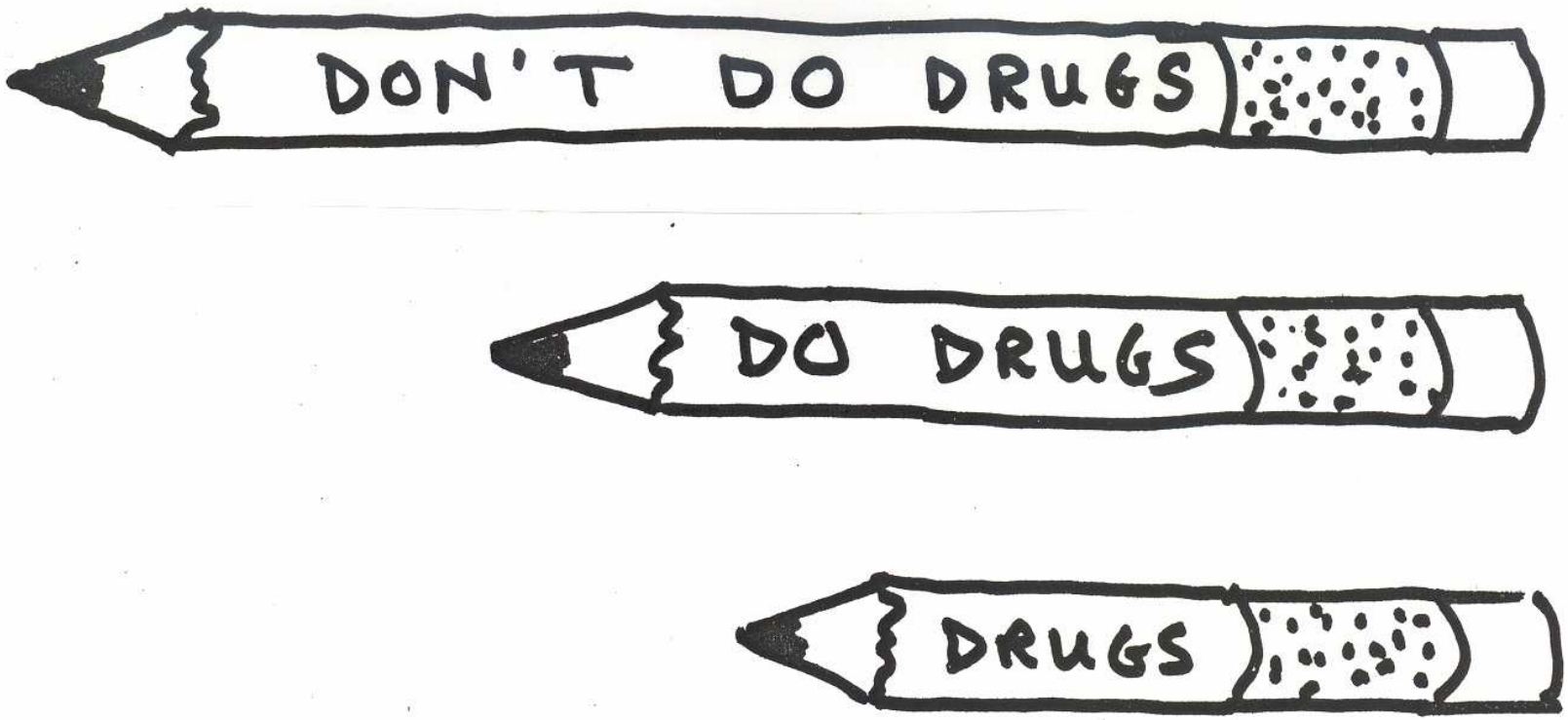
Amino Acid

Non-superimposable mirror images

- Enantiomers
- Optical Isomers
- Chirality


MIRROR
MOT
TOM
MOT
WOT


DON'T DO DRUGS


DON'T DO DRUGS
DO DRUGS
DRUGS

63 Post-classical Developments. The experimental image of Viṣṇu Viśvarūpa at Deogarh, U.P.

Courtesy Odette Viennot

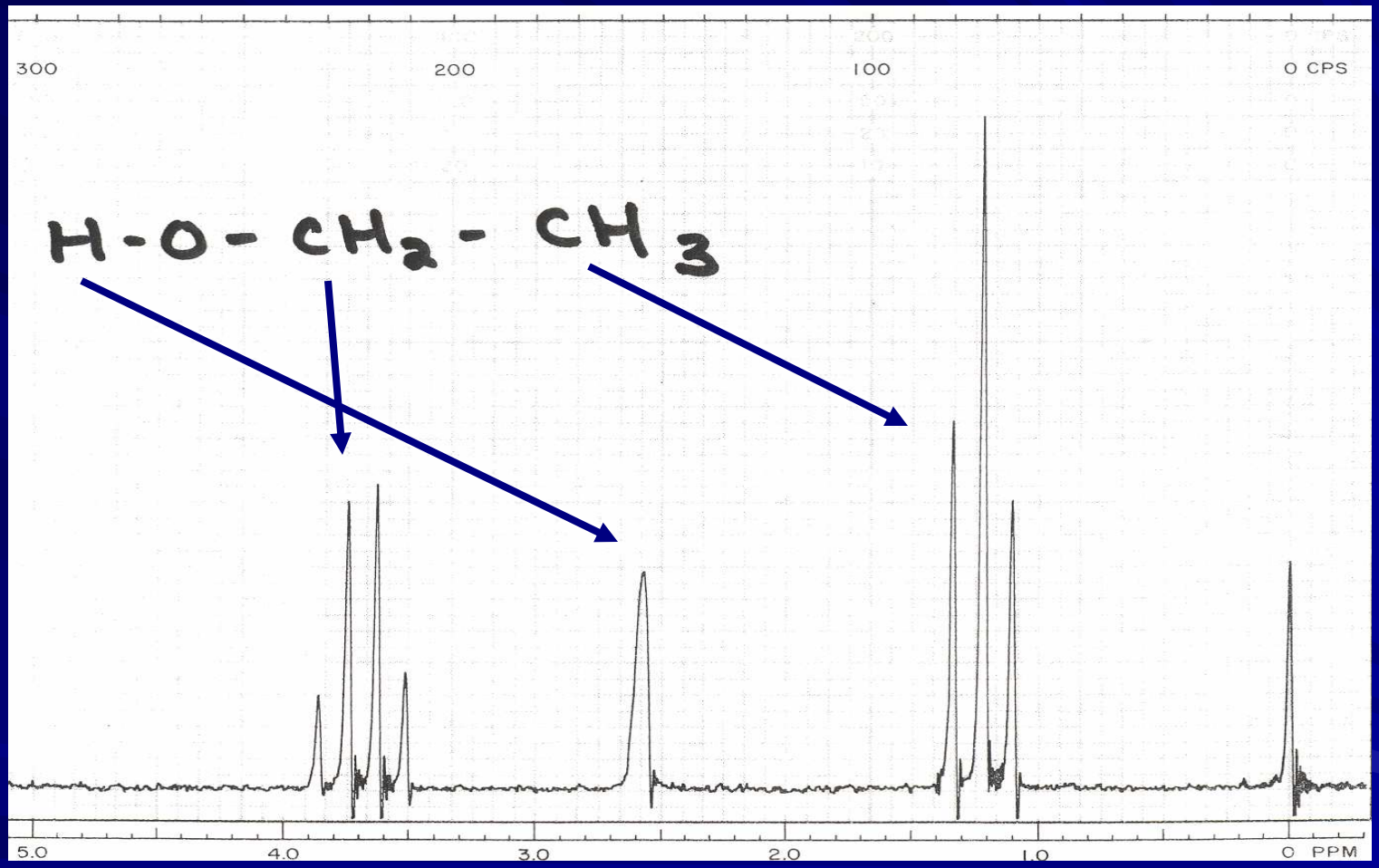

16. ミスジマイマイ Euhadra peliomphala (Pfeiffer)

Random Bit of Chemical Trivia

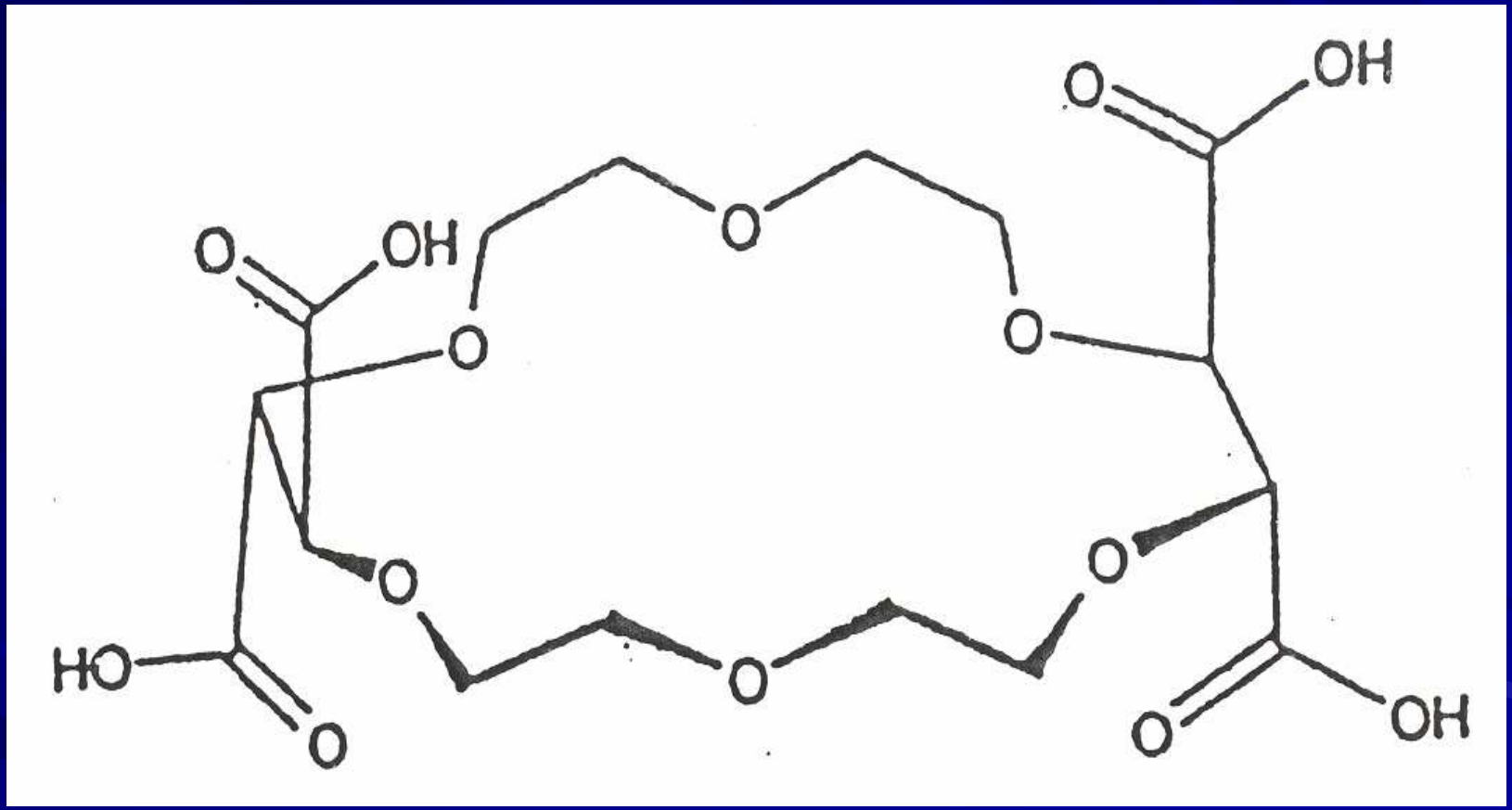
Organic = $(RBCT)^n$

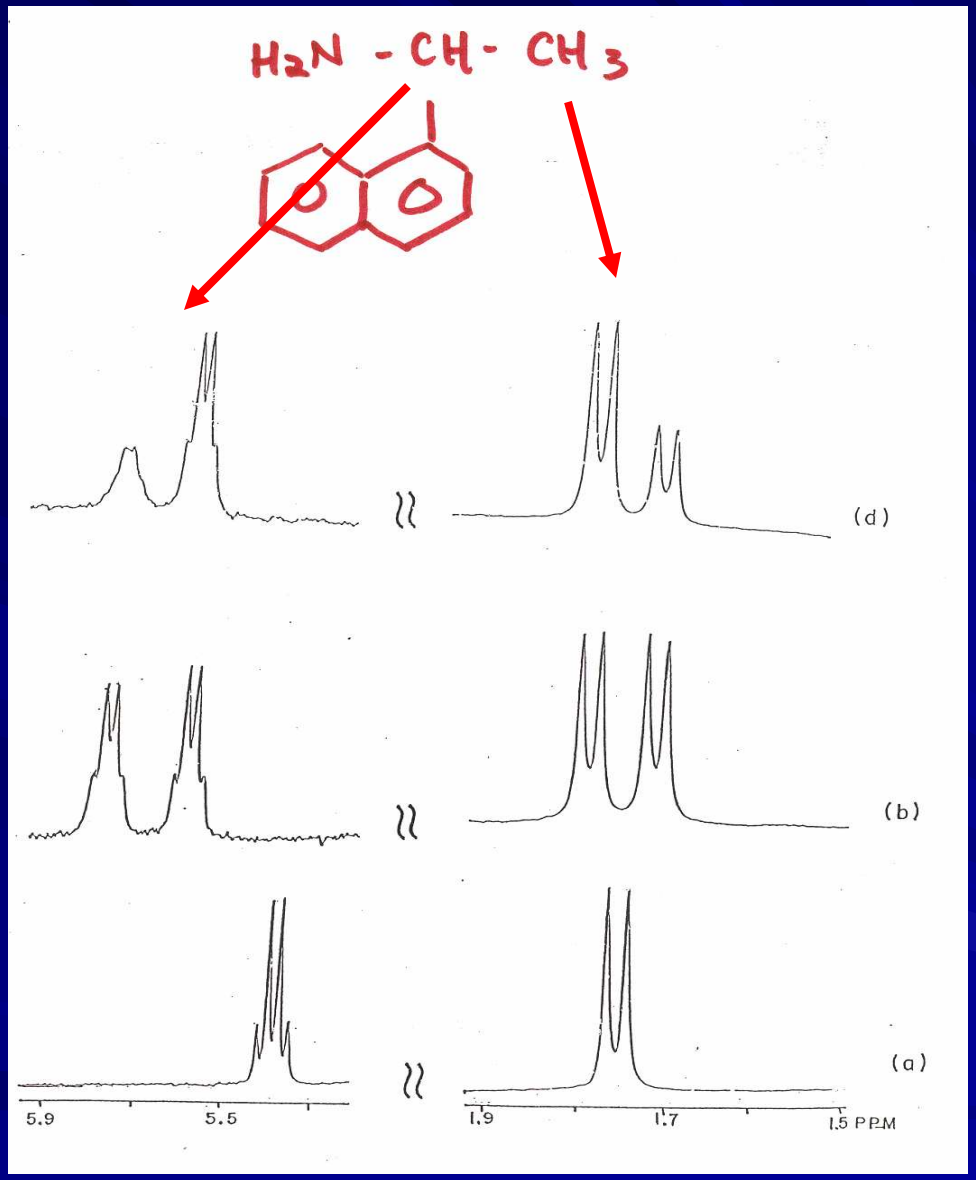
Where n is a very large number

Ethanol

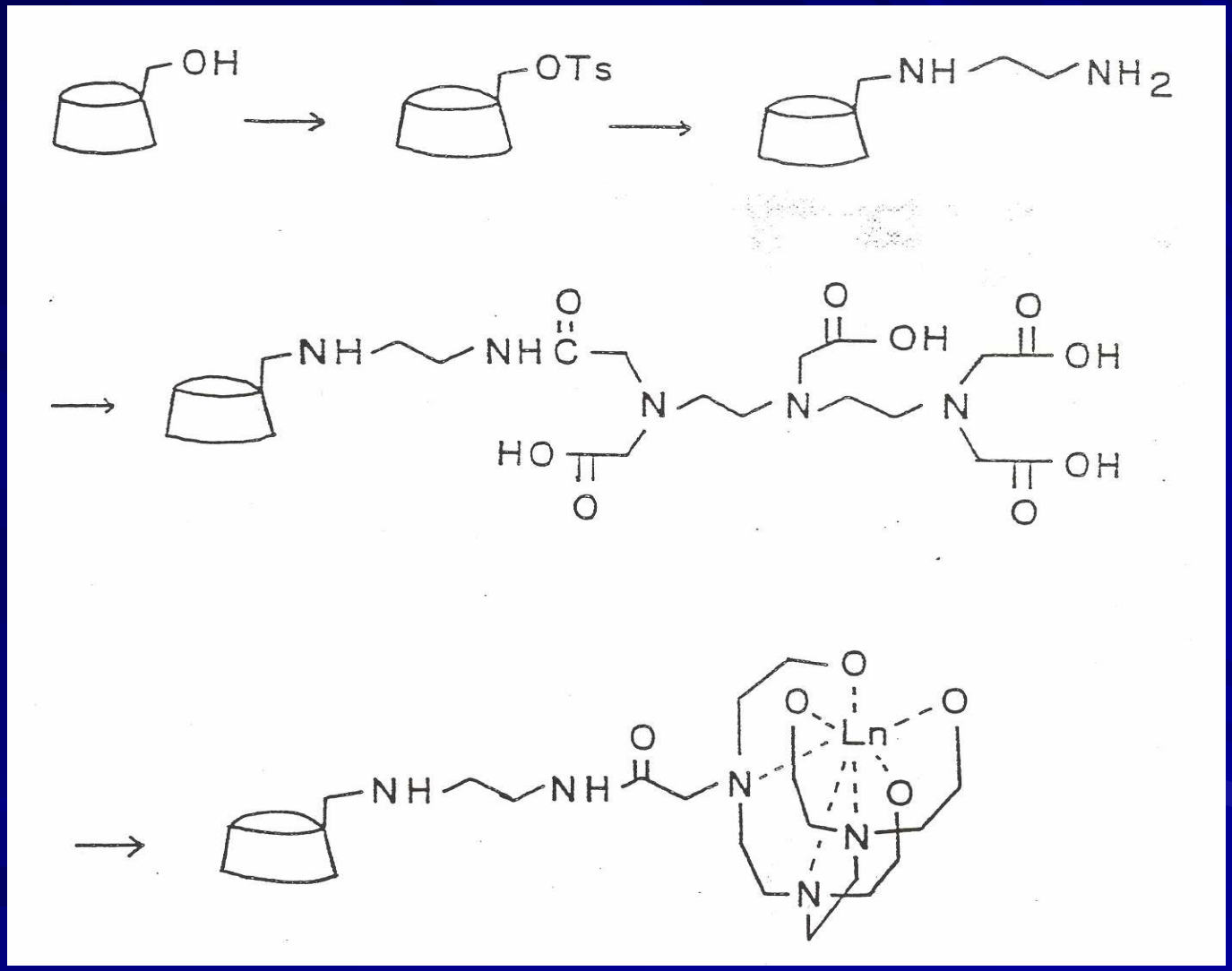


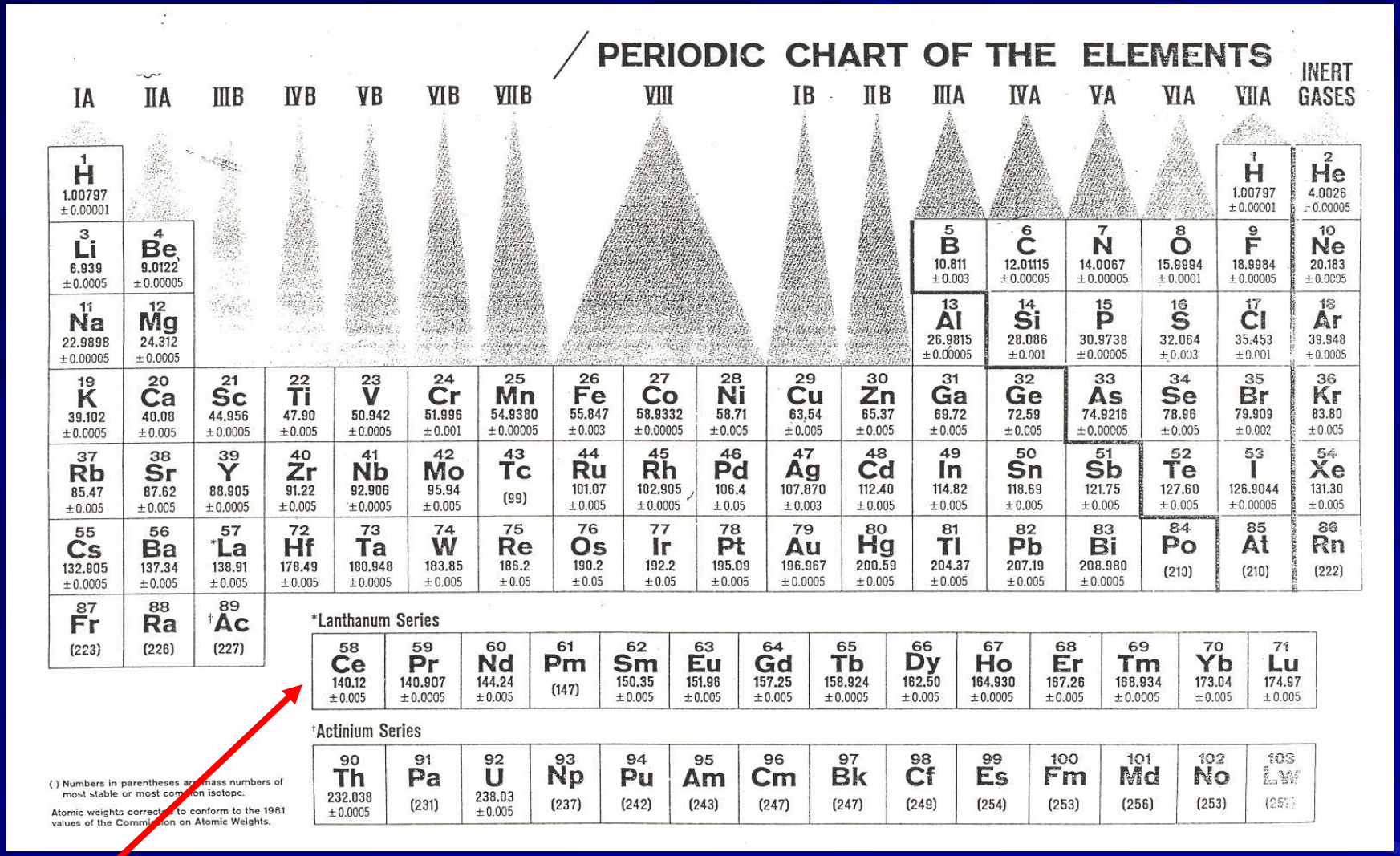
Crown Ether



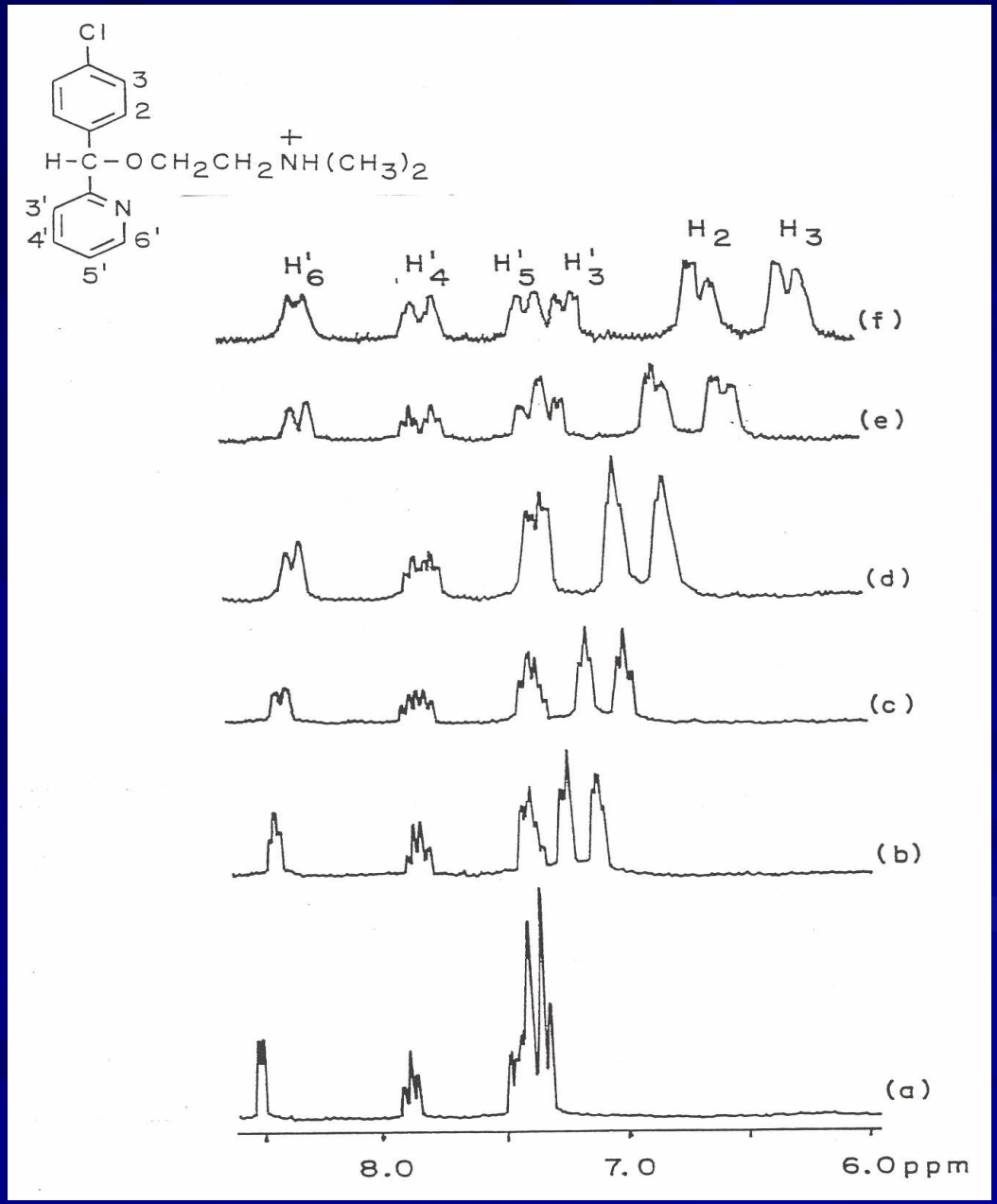

H2N - CH - CH3
(d)
(b)
(a)
5.9
5.5
1.9
1.7
1.5 PPM

β-Cyclodextrin


OH
OTs
NH
NH2
NH
NH
C
O
N
N
N
HO
OH
OH
OH
O
O
O
O
O
O
Ln
N
N
N
NH
NH



Lanthanides


Cl
3
2
H-C-OCH2CH2NH(CH3)2
+
3'
4'
N
6'
5'
H'6
H'4
H'5
H'3
H2
H3
(f)
(e)
(d)
(c)
(b)
(a)
8.0
7.0
6.0ppm

Education is what's left over after you've forgotten everything that you learned.

Traditional Science Courses

Knowledge outcomes – "..particular areas of disciplinary or professional content that students can recall, relate, and appropriately deploy."

Research Experience

Knowledge outcomes – "..particular areas of disciplinary or professional content that students can recall, relate, and appropriately deploy."

Traditional Science Courses

Skills outcomes – "the learned capacity to do something – for example, think critically, communicate effectively, productively collaborate, or perform particular technical procedures – as either an end in itself or as a prerequisite for further development

Research Experience

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Traditional Science Courses

Affective Outcomes – "..usually involve changes in beliefs or in the development of particular values, for example, empathy, ethical behavior, self respect, or respect for others."

Research Experience

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Traditional Science Courses

Learned abilities – "..typically involve the integration of knowledge, skills, and attitudes in complex ways that require multiple elements of learning. Examples embrace leadership, teamwork, effective problem-solving, and reflective practice"

Research Experience

Learned abilities – "..typically involve the integration of knowledge, skills, and attitudes in complex ways that require multiple elements of learning. Examples embrace leadership, teamwork, effective problem-solving, and reflective practice"

From:

Ewell, P.T., *Accreditation and Student Learning Outcomes: A Proposed Point of Departure*, Council for Higher Education Accreditation (CHEA) Occasional Paper, Washington, DC, September 2001

Analytical Chemistry Course

- Analysis of benzene and toluene in air
- Analysis of trihalomethanes in drinking water
- Amino acid content of foods (popcorn and beer)
- Caffeine, theophylline, and theobromine levels in chocolate
- Analysis of nitrate and nitrite in hot dogs
- PAHs in burgers, oysters, diesel exhaust and wood smoke
- Toxic metals in sludges from waste-water treatment plants

Cooperative Learning

- Class divided into small groups (3-5)
- Presented with a problem or question
  - I serve as a facilitator
  - If one student sees the point, she or he is to explain it to the others
  - When the groups appreciate the point, I call timeout and highlight the concept

Advantages of Cooperative Learning

- More "teacher" resources because the students are teachers as well
- Less formal
- Active learning – I know what they do/don't understand – they know what they do/don't understand
- Students spend more time on class material
- Cooperation, not competition
- Students learn more

Outcomes of Cooperative Learning from Prior Research Studies

- Statistically significant improvements in academic achievement
- Better reasoning and critical thinking skills
- Proposed more new ideas when presented with problems
- Transferred more of what was learned in prior situations to new problems
- Reduced levels of stress

- Promotes more positive attitudes toward subject and instructional experience – faculty get to know students better
- Decreased absenteeism
- Improved student commitment
- Greater motivation toward learning
- Better student retention (especially for women and minorities)
    - -Socially involved
    - -Academically involved

Introductory Course

- Thematic version of general chemistry – fundamentals of chemistry related to the study of the environment
- Counts for the chemistry major
- Pre-requisite for all upper-level chemistry courses
- 60 students in class (20/lab)

Course Goals

- Learn fundamental concepts of chemistry
- Learn that science does not know all the answers
- Participate in and learn about the process through which scientists undertake investigations and create knowledge
- Learn in interaction with, rather than in isolation from, other students
- Appreciate that science occurs in a social context

Laboratory Project

- Do plants grown in soil contaminated with lead take up more lead?
- Does the uptake of lead vary with the acidity of the rain water?

Some questions the students need to answer:

- What to grow?
- What soil to use?
- How to mimic acid rain?
- How much lead to add?
- What watering schedule?
- What to use as a control?

Some advantages of the project:

- Conduct a real investigation
- Ask/answer questions
- Design experiments
- Unanticipated problems
- Teamwork
- Communication – Informal/formal
- Opportunity for leadership

Uncertainty

- 26 of 29 contaminated samples had higher lead

  -other three?

- Acidity trend is inconclusive

Summary Comments

- We need to design an undergraduate curriculum in which students begin scholarly-like activities in their first year and progress through to an original project by their senior year

- We need to encourage cooperation and collaboration among our students


CAUTION