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ABSTRACT

The 12 digests of Computers in Life Science Education from 1990 are presented. The articles found in chronological sequence are as follows: "The Computer as a Teaching Tool--How Far Have We Come? Where Are We Going?" (Modell); "Where's the Software--Part 1"; "Keeping Abreast of the Literature" (which appears quarterly); "Where's the Software--Part 2"; "Computer Assisted Instruction in an Histology Course" (Jensh); "Where's the Software--Part 3"; "Biology Courseware for College Freshmen" (Ralph) "Where Are the Videodiscs?"; "CLSE 1990 Colleague Directory--Part 1"; "CLSE 1990 Colleague Directory--Part 2"; "Designing Computer Based Tutorials to Reinforce Reasoning Skills" (Modell); "CLSE 1990 Colleague Directory- Part 3"; "Integrated Systems for Testing and Grading" (Lombardi); "A Comparison, for Teaching Purposes, of Three Data-Acquisition Systems for the Macintosh" (Swanson); "A Computer-Based Approach to Reinforcing Common Principles in Biology" (Modell); and "Summary of Liquid Crystal Display Projection Pad Vendors." "Keeping Abreast of the Literature" is designed to help readers become aware of current literature pertinent to computer applications in the life sciences by listing citations. "Where's the Software" and "Where are the Videodiscs?" include listings of science software sources and programs available through them. Each listing contains a description and identifies the needec omputer and a contact company, person, or phone number. (KR)

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COMPUTERS IN LIFE SCIENCE EDUCATION

CONTENTS

THE COMPUTER AS A TEACHING TOOL – HOW FAR HAVE WE COME? WHERE ARE WE GOING?

Harold I. Modell
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It seems appropriate when making a transition between decades to reflect on the progress that has been made during the decade just ending and project what might lie ahead in the new decade.

The progress made in the decade just ending has been considerable. The topics covered by articles appearing in Computers in Life Science Education reflect this progress. As we entered the 1980s, use of the computer as an instructional tool was largely limited to environments that supported mainframe computers or minicomputers offering timeshare capabilities. Terminals were generally restricted to text output and were reserved for independent study environments. The majority of applications were tutorial and followed the traditional Computer-Assisted Instruction (CAI) question and answer format. The introduction of the microcomputer, however, changed the way in which educators viewed the utility of computer technology.

MOVING TECHNOLOGY TO THE CLASSROOM

The technology was no longer restricted to rooms that provided "hard-wired" or modem connections between terminal and computer. The microcomputers could easily be moved to where the students were. Furthermore, these machines could be easily programed to include graphic displays and animations. In addition to pursuing the traditional applications of computer-assisted instruction,[23,25,48,51,58,59] educators moved the technology into the classroom. Applications ranged from using simulations in small group[33,52] and lecture[40] settings to foster active learning to using the computer as a "slide projector" to incorporate animation and provide a "building block" approach to developing concepts with students.[18,34] The technology also provided a communication vehicle in the form of an electronic blackboard that could be used during teleconferencing of instructors and students who were separated geographically.[26] Introduction of video projection devices[54,56] provided large screen displays of the computer output so that the class and instructor could work together while viewing the same screen.

The microcomputer also made an impact in enhancing the active learning experience of the student laboratory.[3,7] The technology provided a relatively inexpensive means of acquiring data[2,9,12,30,49] as well as a tool for analyzing data within the time frame of the student laboratory period.[20] Furthermore, by using simulations, students could perform "experiments" that were previously not possible either because of cost of necessary equipment, time available, or risk to the student.[11,13,21,24,57]

QUESTIONS TO BE ANSWERED

Implementation of this technology raised new questions related to delivery of instruction. Is this technology cost effective?[32] Are programs intended for use in one educational environment useful in other environments?[4,37,41] What design criteria should be considered when using graphics in instructional software?[8] What factors should be considered when designing simulations?[38,42] What constitutes "good" educational software?[27] How does one evaluate software?[53,55]

The question of evaluation is a significant issue that has yet to be resolved. NRCLSE addressed this issue[43,39] and established a peer critique mechanism for software review.[44] EDUCOM and NCRIPTAL established a national competition as a mechanism for evaluating software and curriculum innovations incorporating computer applications.[31] However, many authors have yet to avail themselves of these mechanisms, and, as a result, much of the available software has not been subjected to a rigorous evaluation process.

INTERACTIVE VIDEO

Although optical videodisc technology was available at the beginning of the decade, the cost of mastering videodiscs and software support for this medium had not developed to the point where general application of this methodology was practical. By the mid-1980s, however, significant improvements had been made in both areas, and interactive video emerged as a viable mode of delivering instruction where a significant portion of the content was visually oriented.[5,6,14,22,47,61] Interactive video did not require images to be stored on a videodisc, however. Some educators used existing images stored on videotape and were able to couple these images with computer based interactive programs to produce acceptable interactive video instruction.[1,46] Perhaps one of the more intriguing applications of interactive videodisc technology was a series of case studies designed for use in a group setting that incorporated a voice-driven microprocessor. In this system, the user interacts with the program through a series of voice commands.[17]

SOFTWARE DEVELOPMENTS

The tools available for faculty wanting to develop educational software improved significantly during the 1980s. Early in the decade, authoring software was aimed helping educators develop programs that adhered to the tradition CAI tutorial formats.[16,35] Many of these systems did not include arithmetic capabilities necessary for supporting mathematical models. If faculty wished to develop such simulations, it was necessary for them to know how to program using a general purpose computer language (eg, BASIC, FORTRAN, PASCAL).

The introduction of mouse technology and the user interface strategy at the heart of the Macintosh computer fostered development of new authoring tools that provided faculty not familiar with programming techniques the opportunity to author educational software. Some packages offered digitized sound and sophisticated graphics capabilities that allowed movie-like animation.[19] Others, not specifically aimed at, but certainly applicable in the educational arena, were designed to provide a simulation environment to non-programmers.[10,29,36]

Perhaps the single software advancement that has made the biggest impact in educational computing is the implementation of the hypertext concept.[28,60] The crux of the hypertext concept is the idea that users of a database should be able to move through that database in a nonsequential fashion. This has led to computerized versions of syllabi and other textual material with links to associated material so that the student need only choose highlighted words to retrieve related information. The graphics capabilities of this software and the option of accessing information on other media (eg, videodisc, CD-ROM) has extended this organization mode to a wide variety of options.[15] The software also provides authors with a "friendly" development environment in which a variety of interactive modes may be used for tutorial applications.[45]

PROJECTIONS FOR THE 1990s

The hardware and software advances made in the 1980s offer considerable potential for the 1990s. New user interface modalities (eg, the mouse and touch screen), easier graphics generation (eg, "draw" and "paint" programs), the ability to incorporate multimedia resources

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through hypermedia or other applications, and the growing resources available to generate or access visual and audio data have opened new vistas for faculty who are interested in developing instructional materials.

Incorporating these resources with technology designed to foster communication between students and the instructor[50] can result in an active learning classroom environment in which teachers can diagnose and address the progress of individual students during each classroom period.

Hence, the 1990s may see the emergence of classrooms in which instructors have ready access a broad scope of visual, audio, and textual databases with which to encourage active learning experiences within a group or independent study setting.

Real progress will depend, however, on several related factors that are independent of hardware and system software developments. These factors include commitment by faculty to develop high quality, versatile materials, establishing faculty rewards for such efforts, and identifying funding sources to support such efforts.

Developing creative, effective software requires a considerable time investment. If the past decade is any indication, faculty who have developed software have done so with a specific application in mind, usually directed toward a specific course and specific student population. They have not attempted to subject their software to rigorous peer evaluation, nor have they taken advantage of attempts to improve good communication channels to share development ideas and existing software. This has led to unnecessary duplication of software covering concepts in some areas and virtually no software in other, equally important, content areas within the same discipline. To be completely successful, a critical mass of high quality software covering all aspects of a given discipline must be available. This pool must contain software that is versatile enough to be used in different curricula and at different levels of sophistication. To reach this level, faculty must submit their software to peer evaluation, and they must establish collaborative efforts with colleagues so that the time invested may yield maximum benefit.

Peer critique and establishing collaborative efforts go hand-in-hand with restructuring faculty evaluation criteria. Currently, faculty involved in developing computer-based materials do not often receive rewards consistent with their time investment or the impact of their efforts on student learning. Consequently, faculty are not willing to undertake such projects. This situation must be remedied if significant progress is to be made. Part of the reason for the inequity in the reward structure may be that most of these efforts do not extend beyond a single institution. As a result, the body determining faculty rewards (eg, the Appointments and Promotions Committee) are unable to fully evaluate such contributions. If, however, results of peer critique of these efforts were available, and the efforts had a national focus, criteria similar to evaluation of scientific bench research could be applied.

Another criterion often used for faculty promotion is the level of external funding obtained for support of research and development efforts. This is a critical issue for the 1990s. In the past, funding agencies have not supported research and development efforts aimed at applying computer technology to life science education. A concerted effort must be made to help these agencies realize that funding research and development of technology-based applications to life science education is critical to progress in this area.

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NRCLSE ANNUAL REPORT FOR 1989

The overall purpose of NRCLSE is to cultivate collaborative efforts among faculty with expertise in using computers in life science education. The broad goal of the Resource is fourfold:

1) to educate faculty in effective uses of computers in the curriculum;
2) to promote research aimed at evaluating new applications of the computer to life science education;
3) to promote development of a critical mass of high quality, versatile software, and
4) to serve in a consultant capacity for life science faculty currently active or interested in becoming active in this area.

This year's activities continued our efforts to serve the life science community. A statement of NRCLSE's financial status is presented in Table 1.

Table 1. NRCLSE Financial Report for year ending December, 1989.

Fund Balance, December 31, 1988		**$13,702**
Revenues		
Cash donations	1,000	
Subscriptions/Reprints	5,540	
Software/Manual sales	2,882	
Total Revenues	9,422	
Expenses		
CLSE production	3,541	
Postage/Shipping	1,963	
Operating expenses supplies, phone, etc.	725	
Travel	591	
Equipment	1,124	
Total Expenses	7,944	
Increase in fund balance	1,478	
Fund balance, December 31, 1989		**$15,180**

GENERAL OVERVIEW OF ACTIVITIES

During 1989, NRCLSE moved its operation from the University of Washington to larger quarters. The new space arrangement has helped to improve the operation of the Resource by allowing consolidation of our computer, office, and newsletter/software warehousing capabilities into one location.

Publication of *Computers in Life Science Education* continued to be NRCLSE's primary activity in 1989. However, during the past year, we continued to provide information to colleagues throughout the world concerning use of computers in life science curricula, participate in national meetings, conduct demonstrations at several institutions, and distribute our Simulations in Physiology software. We have also embarked on a software development project utilizing the hypertext environment.

Computers in Life Science Education

Subscriptions to CLSE continue at the same level as in previous years, with about 30% of the subscriptions being held by libraries. About half of the subscribing institutions focus on undergraduate education, and about one fourth focus on medical education. The geographic distribution of subscribers continues to be broad. In addition to the U.S. and Canada, subscribers for 1989 included institutions in Denmark, the Federal Republic of Germany, France, Great Britain, Hungary, Israel, Japan, Norway, the Philippines, and Sweden.

Software distribution

In 1989, eighteen sets of our simulations were distributed to institutions in the U.S., Belgium, Italy, Scotland, and Sweden. Currently, over seventy-five institutions representing twelve countries on

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four continents have purchased one of the microcomputer versions of Simulations in Physiology - The Respiratory System.

Resource Information

During 1989, NRCLSE again responded to 50 requests for information concerning use of the computer as an educational tool. As in previous years, the geographic origin of the requests continues to reflect our goal of providing worldwide service. Requests in 1989 were received from fourteen countries in addition to the United States.

Presentations/Consultation

Dr. Modell served as the keynote speaker for a computer assisted teaching workshop sponsored by the International Foundation for Ethical Research (IFER) held in Denver in March, 1989. IFER, recognizing the need for use of live preparations in research and teaching, is concerned with the discovery, development and implementation of *viable, scientifically valid* alternatives to the use of live animals in research, testing, and teaching where such alternatives are feasible.

NRCLSE was instrumental in organizing a tutorial session entitled "Using the microcomputer in the classroom" that was co-sponsored by the Teaching of Physiology Section of the American Physiological Society and held on March 21, 1989 at the 73rd annual meeting of the Federation of American Societies for Experimental Biology (FASEB) held in New Orleans.

NRCLSE also visited four medical schools in 1989 to demonstrate the use of the computer to foster active learning in the classroom and discuss uses of computers in the basic science curriculum.

Peer critique of software

Our program for peer critique of software initiated in October, 1988 received a boost this year. The description of the program (see CLSE, October 1988) was reprinted this year in *Collegiate Microcomputer* (VII(2):181-183, 1989) and *Science Software* (5(3):211-213, 1989).

New software initiative

NRCLSE began work on a new software package this year. The package will use the hypertext environment to incorporate tutorial screens (see CLSE, October 1989) with the Simulations in Physiology models. The package will be intended to serve as resource material for classroom interaction and as a course in respiratory physiology concepts for independent study.

Special thanks

NRCLSE extends a very special "Thank you" to the following people, organizations, and institutions for their support in 1989.

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NATIONAL RESOURCE FOR COMPUTERS IN LIFE SCIENCE EDUCATION QUESTIONNAIRE

It is time once again to update our CLSE colleague directory. Please help ensure that we provide accurate information. Take a few minutes to complete the questionnaire below and return it to the following address:

Harold Modell, Ph.D.
NRCLSE
P.O. Box 51187
Seattle, Washington 98115

Name: ____________________

Address: ____________________

____________________ State ________ Zip ____

Phone: ____________________ BITNET: ____________________

What content areas do you teach? ____________________

What student population(s) do you serve? (Please check appropriate categories)

____ Undergraduate ____ Graduate ____ Nursing ____ Medical

____ Allied Health ____ Dental ____ Veterinary

____ Other (please specify) ____________________

Are you currently using the computer as an educational tool? ___ Yes ___ No

If yes:

How many years have you used the computer in this way? ________

What kind of equipment are you using?

Have you written any software for use in your teaching efforts? ___ Yes ___ No

What commercially available software have you found useful?

Would you be willing to help critique software for peers? ___ Yes ___ No

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

RESPONSIBILITY AND COPYRIGHT

Authors are responsible for accuracy of statements and opinions expressed in articles. All authors submitting manuscripts will be sent a copyright transfer form to complete. The completed form must be returned before the work will be published.

SUBSCRIPTION INFORMATION

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Address orders, changes of address, and claims for missing issues to NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187. Claims for missing issues can be honored only up to three months for domestic addresses and six months for foreign addresses. Duplicate copies will not be sent to replace ones undelivered due to failure to notify NRCLSE of change of address.

Address editorial correspondence to Harold I. Modell, PhD, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187. (BITNET MODELL@UWALOCKE)

POSTMASTER: Send address changes to *Computers in Life Science Education*, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

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COMPUTERS IN LIFE SCIENCE EDUCATION

CONTENTS

WHERE'S THE SOFTWARE? – PART 1

In the past, we have published lists of life science software sources and programs available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

The listings are arranged by content area. Each item includes a vendor name relating the software to the vendors list appearing on page 15.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

ANATOMY

ANATOMY OF A FISH
Tutorial/game presenting information on the external, internal, and skeletal structures of a bony fish. Available for Apple II compatible equipment.
VENTURA EDUCATIONAL SYSTEMS

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM
Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment.
WILLIAMS & WILKINS

ANATOMY OF A SEA LAMPREY
Tutorial/game presenting information on the life cycle and anatomy of a sea lamprey. Available for Apple II compatible equipment.
VENTURA EDUCATIONAL SYSTEMS

BODY LANGUAGE I, II, III, IV
A series of drill and practice reviews of anatomical terms. Available for Apple II and IBM-PC compatible equipment.
EDUCATIONAL SOFTWARE PRODUCTS

GROSS ANATOMY TUTORIAL
Tutorial for gross anatomy review by region and for self-test in National Board format. Program available for Apple II equipment.
LIFE SCIENCE ASSOCIATES

HEART LAB
Animated graphics simulation of human heart. Program available for Apple II, TRS-80 Models I and III, PET, and Atari 800/800XL equipment.
EDUCATIONAL ACTIVITIES, INC.

HUMAN ANATOMY PICTURE FILE
Hi-Res diagrams of heart, brain, eye, ear, respiratory system, kidney, endo-

crine system, neurons, circulatory system schematic, and digestive system. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

LOCOMOTION
Tutorial reviewing types and functions of bones and muscles. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

BIOCHEMISTRY

ANIMATED PATHWAYS OF BIOCHEMISTRY
Simulation of molecules colliding and reacting. Available for IBM-PC compatible equipment. WILLIAMS & WILKINS

ANIMATIONS
Contains animations for demonstrating DNA structure and synthesis, RNA structure and synthesis, and protein synthesis. Program available for Apple II equipment. ALBION

BIOCHEMISTRY
Tutorial covering basic atomic structure, balancing equations, and properties of proteins and carbohydrates. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

BIOCHEMISTRY EXAM/TUTORIAL
Covers basic fuel metabolism. Available for Apple II and IBM-PC compatible equipment. WILLIAMS & WILKINS

CONCENTRATED CHEMICAL CONCEPTS: BIOLOGICAL CHEMIST
Drill and practice program covering an entire introductory course in organic chemistry for health science majors. WILEY PROFESSIONAL SOFTWARE

DNA STRUCTURE AND SYNTHESIS
Tutorial dealing with nucleotide structure and linkage between nucleotide, base complementarity and hydrogen bonding. Program available for Apple II equipment. EDUTECH, INC.

DNA-THE BASICS
Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple //e (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO

ENZKIN: Enzyme Kinetics
Simulation of enzyme-catalyzed reactions. Program available for Apple II equipment. CONDUIT

ENZLAB
Simulations for designing and carrying out enzyme kinetics experiments. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

ENZPACK
An enzyme kinetics teaching and calculation program. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

ENZYME ACTION
Tutorial on the basic nature and function of enzymes. Program available for Apple II equipment. BIOSOFT (UK)

ENZYME-SIMULATION, ENZYME ACTION
Simulation of enzyme action and the effects of inhibitors using acetylcholinesterase. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

GENE MACHINE
Tutorial/Simulation dealing with DNA replication and protein synthesis. Program available for Apple II equipment. HRM SOFTWARE

MOLECULAR BIOLOGY SERIES
Programs demonstrating central processes of RNA and protein synthesis and DNA synthesis and repair. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

MOLGRAF
Molecular graphics package. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

THE NUCLEIC ACIDS
Tutorial/Simulation dealing with principal nucleotides and synthesis of RNA. Program available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

PROTEIN SYNTHESIS
Tutorial dealing with the general structure of the amino acids and formation of peptide bonds. Program available for Apple II equipment. EDUTECH, INC.

RNA STRUCTURE AND SYNTHESIS
Tutorial extending the concept of hydrogen bonding between complementary bases to show the synthesis of RNA on the DNA template and the analogies in structure between DNA and RNA. Program available for Apple II equipment. EDUTECH, INC.

BIOLOGY

ADAPTION AND IDENTIFICATION
Tutorial covering animal adaptation to different environments and animal identification. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

ANIMAL REPRODUCTION
Tutorial reviewing sperm development, egg and fertilized egg. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

ASEXUAL REPRODUCTION
Tutorial reviewing cell division. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

BIOLOGY 1/BIOLOGY 2
Tutorials covering a wide range of topics in biology. Available for IBM-PC compatible equipment. INTELLECTUAL SOFTWARE

BIOLOGY COMPUTER STIMULATIONS
Tutorial covering various biological concepts and experimental areas including enzymes, photosynthesis, respiration, diffusion, meiosis, muscles, nerves, and genetics. Program available for Apple II and TRS-80 Models I and III equipment. LIFE SCIENCE ASSOCIATES

BIOLOGY DISSECTION FROG
Dissection guide that teaches students how to dissect a frog. Available for Apple II compatible equipment. CROSS EDUCATIONAL SOFTWARE

BIOLOGY LAB DISSECTIONS
Seven dissection guides teach students about seven different animals: Frog, Earthworm, Grasshopper, Crayfish, Starfish, Clam and Perch. Available for Apple II compatible equipment. CROSS EDUCATIONAL SOFTWARE

BIOLOGY SIMULATIONS PACKAGE III
Three collections of simulations covering aspects of genetics, natural selection, and predator-prey interaction. Available for Apple //e (enhanced) equipment. ALBION

CREATE A TEST/CREATE A TEST QUESTION FILES-BIOLOGY
Test creation program and 4800 question bank in biology. Available for Commodore 64, Apple II and IBM-PC compatible equipment. CROSS EDUCATIONAL SOFTWARE

DIFFUSION AND ACTIVE TRANSPORT
Tutorial covering diffusion, osmosis,

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and active transport in biological systems. Program av.. 'able for Apple II equipment. SIMPAC EDUCATIONAL SYSTEMS

ENERGETICS AND METABOLISM, GARDEN OF BIOLOGY: VOLUME 1

Data base illustrating reactions of metabolism and interactions between the several metabolic compartments of a cell. Program available for Macintosh equipment. KINKO'S

EVOLUTION, GARDEN OF BIOLOGY: VOLUME 2

Data base illustrating relations among organisms of many kinds, emphasizing the history and mechanics of their evolutionary change. Program available for Macintosh equipment. KINKO'S

FASCINATING STORY OF CELL GROWTH

Tutorial covers surface area/cell volume, experimenting with cell size, chromosomes in cell division and stages of mitosis. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

HOW'S AND WHY'S OF MIGRATING MOLECULES

Tutorial covering transport through a membrane, osmosis and diffusion. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

HUNTINGTON I SIM PROG - BIOLOGY

Seven simulations for use in introductory level biology courses. Available for DEC equipment. HUNTINGTON COMPUTER PROJECT

KNOWLEDGE MASTER - BIOLOGY 2

Test-item database for test generation. Content covers coelenterates, arthropo s, insects, fish, amphibians, and reptiles. Part of a 5-program Biology series for Apple II equipment. ACADEMIC HALLMARKS

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Test-item database for test generation. Content covers birds, mammals, primates, protists, bacteria and taxonomic zoology. Part of a 5-program Biology series for Apple II equipmen.. ACADEMIC HALLMARKS

MARINE INVERTEBRATES

Tutorial covering animals from the 'hylums Porifera, Mollusca, Coelen- ..ata, and Echinodermata. Avaialable for Apple II equipment. VENTURA EDUCATIONAL SYSTEMS

OSMO- OSMOSIS IN RED BLOOD CELLS

Simulation of red blood cells in hypertonic, hypotonic, and isotonic solutions. Program available for Apple II, TRS-80 Model III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

OSMOSIS AND DIFFUSION

Tutorial/Simulation covering effects of temperature, concentration, solubility, molecule size and charge, and membrane pore size on flow of matter across semi-permeable membranes. Program available for Apple II, TRS-80 Models I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

OSMOTIC PRESSURE

Simulation of thistle tube experiments and animation of a molecular model for osmosis. Program available for Apple II equipment. CONDUIT

PASSIVE TRANSPORT

Tutorial-simulation covering diffusion and osmosi.. Program for MS-DOS compatible eq.ipment. CLASSROOM CONSORTIA MEDIA, INC

PLANT AND ANIMAL CELLS

Tutorial covering the general structure of plant cells, photosynthesis, the genral stucture of animal cells, and mitosis. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

SIMULATION OF HEMOGLOBIN FUNCTION

Simulations of hemoglobin and myoglobin functions. Program for Apple II equipment. QUEUE, INC

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Simulation/tutorial covering insect types, body parts, and survival. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

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Simulation of the effects of eight variables on growth of algae. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

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Identifies 125 trees and shrubs. Program available for Atari 400/800 equipment. DYNACOMP, INC

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Simulation of experiments involving interaction between flowering plants. Program available for Apple II equipment. CONDUIT

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Tutorial utilizing the fossil record to explain the development of flowering plants. Available for Apple II compatible equipment. SIMPAC EDUCATIONAL SYSTEMS

EXPLORING THAT AMAZING FOOD FACTORY, THE LEAF

Tutorial covers transport in the leaf, structure of the leaf and stomate action in gas exchange. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

FAMILY IDENTIFICATION

Data retrieval program to review the characteristics of 74 North American flowering p'ant families. Program available for Apple II equipment. CONDUIT

HOW PLANTS GROW: THE INSIDE STORY

Tutorial covers growth of the plant, stem cross section, terminal bud and plant hormones. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

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Tutorial-simulation covering the anatomy and physiology of the leaf with respect to its role as the "chemical factory" of the plant. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC

PHOTOSYNTHESIS AND LIGHT ENERGY

Simulation focuses on characteristics of light and its role as an energy source. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC

PHOTOSYNTHESIS AND RESPIRATION

Demonstration and simulations focusing with light and dark reactions of photosynthesis, respiration, and ATP cycle. Program available for Apple II equipment. SCOTT, FORESMAN & CO

PHOTOSYNTHESIS & TRANSPORT

Tutorial dealing with photosynthesis and transport in plants. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

PHOTOSYNTHESIS: UNLOCKING THE POWER OF THE SUN

Tutorial includes light as energy, light characteristics, wave length of light used by chromoplasts, variables and controls. Available for IBM-PC compatible equipment. THOROUGHBRED EDUCATIONAL SOFTWARE

PLANT ANATOMY PICTURE FILE

Hi-Res diagrams of roots, stem cross-section, leaf cross-section, photosynthesis, flowers, seeds, and germination. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

PLANT CELL CYCLE

Hypercard stack illustrating plant cell division. Available for Macintosh equipment. KINKO'S

PLANT GROWTH

Tutorial-simulation covering physiology of growth beginning with the seed. Covers hormone control, feedback mechanisms, transport, and differentiation. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

PLANT PAINT

A set of 36 graphics images illustrating concepts in plant biology. Available for Macintosh equipment. KINKO'S

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Simulation of the effects of light intensity and duration on growth and development of green plants. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

REPRODUCTION IN PLANTS

Tutorial reviewing asexual and sexual reproduction in plants. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

SEXUAL REPRODUCTION IN PLANTS

Tutorial covering plant reproduction including meiosis, gamete formation, reproduction cycles, and alternation of generations. Available for Apple II compatible equipment. SIMPAC EDUCATIONAL SYSTEMS

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Tutorial/Simulation dealing with photosynthesis. Program available for Apple II equipment. HRM SOFTWARE

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Tutorial/simulation covering flowers, leaves, stems, roots, and cells. Available for Apple II compatible equipment. VENTURA EDUCATIONAL SYSTEMS

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Tutorial presenting basic cardiac electrophysiology. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

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Simulation of uptake and distribution of inhalation anesthetics in a 70 kg subject. Available for Apple II compatible equipment. MEDMAN SIMULATIONS

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Simulation dealing with the principles of inhalation gas uptake. Available for Apple II compatible equipment. ADDISON-WESLEY PUBLISHING CO

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Simulation of surgical correction of an aortic aneurysm. Available for Macintosh equipment. INFORMATION SYSTEMS FOR MEDICINE, INC.

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Tutorial covering various chemical structures. Program available for Apple II and IBM-PC compatible equipment. SLIWA EDUCATIONAL SYSTEMS

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Tutorial covering the chemical and physical processes that occur within cells. Program available for Apple II and IBM-PC compatible equipment. SLIWA EDUCATIONAL SYSTEMS

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Simulation of cell kinetics. Program available for Apple II equipment. UNIVERSITY OF TEXAS SYSTEM CANCER CTR

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Interactive simulation covering surface area-volume ratio, chromosome number, chromosome replication, and cytoplasmic division. Program for IBM-PC (PC-DOS). CLASSROOM CONSORTIA MEDIA, INC.

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Simulation reinforces basic concepts of cell structure, cell functions, water movement and concentration gradients, and diffusion and active transport. Program available for Apple II equipment. SCOTT, FORESMAN & CO.

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Simulation of carbon monoxide pollution in an urban environment. Program available for Apple II and TRS-80 Model I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

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Utilities to perform many of the calculations common to aquatic ecology. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

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25 simulations covering aquatic systems. Program available for Apple II and IBM-PC equipment. OAKLEAF SYSTEMS

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ECOLOGY

Rote drill reviews and reinforces concepts of general terrestrial, and aquatic ecology. Available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

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Simulation dealing with plant population sizes and growth pattern. Available for Apple II equipment. SCOTT, FORESMAN & CO.

ECOLOGICAL ANALYSIS - PC

Utilities that perform life table analysis, interspecific association indices, community similarity, diversity indices, descriptive statistics, mark-release recapture analysis, plus regression and correlation analysis. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

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Utilities that perform community similarity analysis, indices of dispersion, species-area curve, and step-wise multiple regression. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

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Series of 7 programs dealing with a variety of techniques for modeling ecological systems and processes. Program available for Apple II and IBM-PC compatible equipment. CONDUIT

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Game in which students attempt to place an organism in its proper ecological niche correctly by specifying environment, range, and competitor. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

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Simulation of factors affecting water quality. Includes temperature, amount and type of pollutant, and water treatment. Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. COMPUWARE

POLLUTE:IMPACT/WATER POLLUTANTS

Simulation of the impact of various pollutants on typical bodies of water. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

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Simulation of the effects of temperature, type of waste, dumping rate, and method of treatment on the impact of pollution on aquatic life. Program available for Apple II, TRS-80 Models I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

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EVOLUT: Evolution and Natural Selection

Simulation of fluctuations in gene frequencies of wild populations. Program available for Apple II equipment. CONDUIT

EVOLUTION

Simulations covering mutation, gene flow, natural selection, and genetic drift on populations. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

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Simulation of evolution using the Hardy-Weinberg formula and the population model that has evolved from its application. Available for Apple II equipment. CONDUIT

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Simulation using animation to provide a graphic illustration of the origin of biological species by natural selection. Available for IBM-PC compatible equipment. LIFE SCIENCE ASSOCIATES

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Simulation dealing with a ranger district during the forest fire season. Available for TRS-80 III equipment.
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Simulation providing 16 breeding groups of birds with defined phenotypes for exploring genetic principles. Available for Apple II compatible equipment. EDUTECH, INC.

CATGEN

Simulation allowing students to mate domestic cats of known genotypes. Program available for Apple II and IBM-PC compatible equipment.
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Simulation in introductory genetics. Program available for Apple II and IBM-PC compatible equipment.
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Hi-Res diagrams of animal cell, plant cell, mitosis, meiosis, Punnett Square, sex linked traits, DNA replication, protozoa, energy reactions, and pedigree. Program available for Apple II equipment. DATATECH SOFTWARE SYSTEMS

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Simulation of various types of dihybrid crosses. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment.
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Simulation of genetic code to produce protein sequences. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

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Building the DNA molecule from sugars, phosphates and bases; types of mutations and simulation of their effects. Available for Apple //c (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

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Simulation dealing with DNA structure. Programs available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

FLYGEN

Simulation of monohybrid or dihybrid crosses with 25 varieties of Drosophila. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment.
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GENETIC ENGINEERING

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GENETIC ENGINEER'S TOOLBOX

Tutorial introducing the principles and techniques of genetic engineering. Available for Apple II compatible equipment. HRM SOFTWARE

GENETICS

Tutorial/simulation in which the imaginary planet Gensim is a "microworld" in which genetic variation in a native species is determined by patterns of inheritance similar to those of humans. Available for Apple II compatible equipment. AGENCY FOR INSTRUCTIONAL TECHNOLOGY

GENETICS

Tutorial covering various crosses in plants and fruit fly populations. Program available for Apple II and TRS-80 Model III and IV equipment.
J & S SOFTWARE

GENETICS

Tutorial that allows students to explore Mendel's experiments, Punnett Squares, sex linkage in fruit flies, and multiple alleles. Program available for Apple II equipment.
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Tutorial examines DNA molecule and progresses to applied genetics. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

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Simulation demonstrating mitosis, meiosis, DNA replication, and protein synthesis. Program available for Apple II equipment.
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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer appli cations and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

SUBSCRIPTION INFORMATION

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COMPUTERS IN LIFE SCIENCE EDUCATION

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KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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WHERE'S THE SOFTWARE? – PART 2

In the past, we have published lists of life science software sources and programs or program areas available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

This month's listings continue last month's and are arranged by content area. Each item includes a vendor name relating the software to the vendors list appearing on page 22.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

GENETICS (CONTINUED)

MENDELIAN GENETICS
Simulation covering dominance, partial dominance, lethality, linkage, and sex linkage. Program for Apple II equipment. QUEUE, INC.

MONOCROS-MONOHYBRID CROSSES
Simulation of various monohybrid genetic crosses. Program available for Apple II, TRS-80 models I and III, IBM-PC, and Commodore 64/128 equipment.
DIVERSIFIED EDUCATION ENTERPRISES

NATURAL SELECTION
Tutorial/Simulation dealing with genetics and evolution to populations. Available for Apple II equipment.
EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPGEN-POPULATION GENETICS
Simulation of the effects of Hardy-Weinberg Law conditions on gene, genotype, and phenotype frequencies of a population over time. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment.
DIVERSIFIED EDUCATION ENTERPRISES

MICROBIOLOGY

DILUTE-MICROBIAL DILUTION SERIES
Simulation covering design and testing of microbial dilution series to determine concentration of a bacterial solution. Program available for Apple II, TRS-80 Model III, IBM-PC, Commodore 64/128 equipment.
DIVERSIFIED EDUCATION ENTERPRISES

MICROBIOLOGY TECHNIQUES
Tutorial/Simulation covering various laboratory procedures. Available for Apple II equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

NEUROSCIENCE

ANATOMY OF THE PERIPHERAL NERVOUS SYSTEM
Tutorial covering upper extremity, head, neck and thorax, abdomen, and lower extremity. Available for Apple II and IBM-PC compatible equipment.
WILLIAMS & WILKINS

HUMAN BRAIN: NEURONS
Tutorial covering neuronal structure, types of neurons, electrical potentials, synaptic transmission, and neurotransmitters. Available for Apple II compatible equipment. BIOSOURCE SOFTWARE

LOLIGO ELECTRONICUS
Simulation that allows students to run experiments on an electronic squid axon. Program available for IBM-PC compatible equipment. BIOSOFT (SD)

MODEL NEURON
Simulation of the behavior of an isolated neuron. Program available for Macintosh equipment. KINKO'S

NERVE PHYSIOLOGY
Simulation of experiments that can be performed on the isolated frog sciatic nerve to illustrate some of the physiological properties of mixed nerves. Available for IBM-PC compatible, Macintosh, and Acorn (BBC) equipment.
SHEFFIELD BIOSCIENCE PROGRAMS

NEUROMUSCULAR CONCEPTS
Tutorial covering muscle action poten-

tials, use of electromyograph, contraction, muscle action and movement disorders. Program for Apple II equipment. BIOSOURCE SOFTWARE

NEUROSIM

Package of four simulations dealing with passive conduction in along length of axon, the Hodgkin-Huxley equation, post-synaptic potentials, and rhythmic properties of a simple neural network. Available for Apple II and IBM-PC compatible equipment. Available for IBM-PC compatible equipment. BIOSOFT (UK)

NEURO-SYS

Tutorial that teaches the basics of neuroanatomical techniques that are commonly used to trace nerve fibers and their interconnections. Available for IBM-PC compatible equipment. BIOSOFT (UK)

NURSING

For an extensive list of educational software for nursing, consult the Directory of Educational Software for Nursing published annually by the National League of Nursing, 10 Columbus Circle, New York, NY 10019. (800) 847-8480 and Annual software exchange published in Computers in Nursing (March/April, 1989 Supplement)

PHARMACOLOGY

CARDIAC PHARMACOLOGY

Simulation of cardiac activity in response to a variety of pharmacological agents. Available for IBM-PC compatible equipment. WALKER, DR J.R.

CARDIOLAB

Simulation of cardiovascular pharmacology experiments. Available for BBC, Apple II, and IBM-PC compatible equipment. BIOSOFT (UK)

EFFECTS OF DRUGS ON THE UTERUS AND THE INTESTINE

Simulation of uterine activity and intestinal smooth muscle. Available for IBM-PC compatible equipment. WALKER, DR. J.R..

ILEUM

Simulates laboratory experiments investigating effects of drugs on the *in vitro* guinea pig ileum. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

LVP: LEFT VENTRICULAR PERFORMANCE

Simulation of left ventricular performance. Available .or IBM-PC compatible equipment. ANESOFT CORPORATION

MACDOPE

Simulation dealing with absorption, distribution, metabolism, and elimination of drugs. Available for IBM-PC compatible equipment. IRL PRESS

MACPHARMACOLOGY

Tutorial/review of various aspects of pharmacology. Available for Macintosh equipment. UNIVERSITY OF MINNESOTA - DULUTH

PHARMACOKINETICS

Simulation for one-compartment and two-compartment models. Available for IBM-PC compatible equipment. COOKE, DR. WILLIAM

PHARMATUTOR

Five short class exercises that include pharmacokinetic simulations, effects of agents on the cardiovascular system, and regulators of smooth muscle function and neuromuscular transmission. Available of Macintosh equipment. FUND FOR RESEARCH IN ALTERNATIVES TO ANIMAL EXPERIMENTATION

PRINCIPLES OF PHARMACOLOGY

Tutorial covering history, drug absorption and distribution, biotransformation and elimination, mechanisms of action, and drug safety and efficacy. Program for Apple II equipment. BIOSOURCE SOFTWARE

REGULATION OF THE CARDIOVASCULAR SYSTEM

Review of reflex regulation of blood pressure, effects of neurotransmitters and pharmacologic agents. Demonstrates interactions of various elements of the cardiovascular system. Available for IBM-PC compatible equipment. WALKER, DR. J.R.

PHYSIOLOGY

ABGAME

Tut[illegible] and game providing practice in aci[illegible]e principles. Program available [illegible]r IBM-PC compatible equipme[illegible] NEW JERSEY MEDICAL SCHOOL

ACI[illegible] ASE BALANCE

Graphical analysis of Henderson-Hasselbalch equations. Available for Apple II compatible and Macintosh equipment. HEMPLING, DR. HAROLD G.

ACID-BASE PHYSIOLOGY SIMULATION

Simulation of acid-base disturbances based on Davenport Diagram. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

ARTWAVE: THE RADIAL ARTERY PRESSURE WAVEFORM

Simulation dealing with factors influencing the shape of the radial arterial pressure waveform. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

BALANCE: MYOCARDIAL OXYGEN SUPPLY AND DEMAND

Simulation of the cardiovascular system predicting myocardial oxygen supply and demand. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

BASIC HUMAN

Integrated systems model of human physiology. Program available for IBM-PC compatible equipment. RANDALL, DR. JAMES

BIOFEEDBACK

Part of 10 program package Experiments in Human Physiology. Experiments include biofeedback, conditioning, and perception measurements. Program available for Apple II equipment. HRM SOFTWARE

BIOFEEDBACK MICROLAB

Package includes a pulse rate sensor that measures EMG, a thermistor probe to measure skin temperature, and an interface circuit that enables student to connect the sensors to the computer. Program available for Apple II and Commodore 64/128 equipment. HRM SOFTWARE

CALIBRATION

Part of 10 program package Experiments in Human Physiology. Temperature and timing functions are calibrated against standards. Program available for Apple II equipment. HRM SOFTWARE

CAPEXCH

Simulation dealing with exchange at the capillary level. Available for IBM-

PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

CARDIAC MUSCLE MECHANICS

Simulation of heart muscle behavior in response to changes in length, load, and contractility. Available for IBM-PC compatible equipment. QUEUE, INC.

CARDIOCOMP

ECG/EMG data acquisition and analysis system. Available for IBM-PC compatible equipment. INTELITOOL INC.

CARDIOVASCULAR FITNESS LAB

Provides students with everything they need in order to use the microcomputer to monitor cardiovascular activity. Program available for Apple II and Commodore 64/128 equipment. HRM SOFTWARE

CARDIOVASCULAR FUNCTION LABORATORY / PHYSIOLOGY LABORATORY TUTOR

Programs developed to provide problem-based learning in cardiovascular physiology. Available for IBM-PC compatible and Macintosh equipment. FROM THE HEART SOFTWARE

CARDIOVASCULAR INTERACTIONS

Cardiovascular Physiology simulation. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

CARDIOVASCULAR PHYSIOLOGY PART I: PRESURE/FLOW RELATIONS

Tutorial dealing with a variety of calculations in the area of hemostatics/hemodynamics. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

CARDIOVASCULAR PHYSIOLOGY PART II: REFLEX

Tutorial dealing with carotid sinus regulation of blood pressure, and reflex responses in hemorrhage and exercise. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

CARDIOVASCULAR SYSTEMS AND DYNAMICS

Simulation of aspects of cardiovascular physiology. Includes an isolated heart laboratory, heart-lung laboratory, systemic circulation laboratory, and a full circulatory system. Available for IBM-PC compatible equipment. COMMAND APPLIED TECHNOLOGY

CIRCSIM: A TEACHING EXERCISE ON BLOOD PRESSURE REGULATION

Simulated experiment based on a model of the baroreceptor reflex loop. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

CIRCSYST

Simulation of hemodynamics. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

CONCEPTS IN THERMOGRAPHY

Tutorial covering basic DC concepts, peripheral vascular physiology, detecting skin temperature, amplifiers, and processing DC signals. Program for Apple II equipment. BIOSOURCE SOFTWARE

DIGESTION

Tutorial covering digestion in simple organisms and humans. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

ECG TUTOR

Tutorial presenting basic cardiac electrophysiology. Available for IBM-PC compatible equipment. NEOSOFT, INC.

ENDOCRINE SYSTEM

Tutorial covering hormones, effects and problems. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

EXCRETION

Tutorial reviewing metabolic wastes, waste removal, and kidney function. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

EXERCISE EXPERIMENTS

Part of 10 program package Experiments in Human Physiology. The effect of exercise and physical condition on heart rate, breathing rate, and skin temperature is investigated. Program available for Apple II equipment. HRM SOFTWARE

FLEXICOMP

Data acquisition and analysis system for studying the reflex arc. Available for Apple II and IBM-PC compatible equipment. INTELITOOL, INC.

FROG HEART

Simulation of experiments that can be performed on the *in situ* frog heart. Available for IBM-PC compatible and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

GAS DIFFUSION IN THE LUNG

Simulation of oxygen and CO2 transfer between alveolar air and blood. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

GLOMERULAR FILTRATION, CONCENTRATION-DILUTION, Tm

Package of three renal physiology teaching programs. Available for IBM-PC compatible equipment. DIETZ, DR. JOHN R.

GUINEA PIG ILEUM

Simulation of the isolated, transmurally stimulated guinea pig ileum preparation to investigate the effects of drugs on neurotransmitter release in the enteric nervous system. Available for IBM-PC compatible equipment. SHEFFIELD BIOSCIENCE PROGRAMS

HEART RATE

Part of 10 program package Experiments in Human Physiology. Light and light sensor for measuring and recording heart rate. Program available for Apple II equipment. HRM SOFTWARE

HOMEOSTASIS-THERMOREGULATION

Part of 10 program package Experiments in Human Physiology. Students investigate the body's ability to maintain a constant internal temperature by subjecting a volunteer to mild temperature excursion while recording and displaying skin and body temperature. Program available for Apple II equipment. HRM SOFTWARE

HUMAN BODY-STRUCTURE AND FUNCTION

Simulation covering joint movement, movement of food through digestive system, and enzyme activity. Program available for Apple II equipment. SCOTT, FORESMAN & COMPANY

HUMAN CIRCULATORY SYSTEM

High resolution pictorial simulation. Available for Apple //e (enhanced) and IBM-PC compatible equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

LOLIGO ELECTRONICUS

Simulation that allows students to run experiments on an electronic squid axon. Program available for IBM-PC compatible equipment. BIOSOFT (SD)

LVP: LEFT VENTRICULAR PERFORMANCE

Simulation of left ventricular performance. Available for IBM-PC compatible equipment. ANESOFT CORPORATION

MACMAN

Simulation of circulatory system. Available for IBM-PC compatible equipment. IRL PRESS

MACPEE

Simulation of interactions of renal physiology. Available for and IBM-PC compatible equipment. IRL PRESS

MACPUF

Simulation of cardiopulmonary physiology. Available for IBM-PC compatible equipment. IRL PRESS

MECHANICAL PROPERTIES OF ACTIVE MUSCLE

Set of six programs concerned with skeletal muscle contraction. Available for IBM-PC compatible equipment. QUEUE, INC; TRINITY SOFTWARE

MODEL NEURON

Simulation of the behavior of an isolated neuron. Program available for Macintosh equipment. KINKO'S

MUSCLE MECHANICS: A COMPUTER-SIMULATED EXPERIMENT

Simulated experiment that permits the user to determine either the length-tension or the force-velocity relationship of a skeletal muscle. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

MUSCLE PHYSIOLOGY

Simulation of experiments that can be performed on the isolated frog sciatic nerve-gastrocnemius muscle to illustrate some of the physiological properties of skeletal muscle. Available for IBM-PC compatible and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

NERVE PHYSIOLOGY

Simulation of experiments that can be performed on the isolated frog sciatic nerve to illustrate some of the physiological properties of mixed nerves. Available for IBM-PC compatible, Macintosh, and Acorn (BBC) equipment. SHEFFIELD BIOSCIENCE PROGRAMS

NERVOUS SYSTEM

Tutorial covering nerves, reflexes, and chemical transfer of impulses. Program available for Apple II and TRS-80 Model III equipment. J & S SOFTWARE

NEUROSIM

Package of four simulations dealing with passive conduction in along length of axon, the Hodgkin-Huxley equation, post-synaptic potentials, and rhythmic properties of a simple neural network. Available for Apple II and IBM-PC compatible equipment. Available for IBM-PC compatible equipment. BIOSOFT (UK)

PHYSIOLOGICAL DATA SIMULATION

25 simulations covering aspects of physiology. Program available for Apple II and IBM-PC compatible equipment. OAKLEAF SYSTEMS

PROBLEMS IN FLUID COMPARTMENT RE-DISTRIBUTION

Tutorial covering solution of simple problems of fluid compartment changes in the face of perturbations. Program available for IBM-PC compatible equipment. RUSH MEDICAL COLLEGE

PSYCHOLOGICAL STRESS-LIE DETECTOR

Part of 10 program package Experiments in Human Physiology. The physiological response to the stress of a frustrating and abusive quiz is measured. Program available for Apple II equipment. HRM SOFTWARE

PULMONARY MECHANICS

Tutorial and simulation dealing with pulmonary mechanics. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

REGULATION OF THE CARDIOVASCULAR SYSTEM

Review of reflex regulation of blood pressure, effects of neurotransmitters and pharmacologic agents. Demonstrates interactions of various elements of the cardiovascular system. Available for IBM-PC compatible equipment. WALKER, DR J. R.

PERMEABILITY

Simulation of osmotic phenomena in cells. Available for Apple II compatible and Macintosh equipment. HEMPLING, DR. HAROLD G.

PHYSIOGRIP

Data acquisition and analysis system for the muscle physiology lab. Available for Apple II and IBM-PC compitble equipment. INTELITOOL, INC.

RENAL GLOMERULAR DYNAMICS

Simulation of human glomerulus and factors that affect glomerular filtration rate. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

RESPIRATION RATE

Part of 10 program package Experiments in Human Physiology. A napping subject is monitored for heart and breathing rate. Results are compared to the data acquired when the subject is awake. Program available for Apple II equipment. HRM SOFTWARE

RESPONSE-TIME

Part of 10 program package Experiments in Human Physiology. Users measure finger reaction times with a bright light stimulus (sensor included). Program available for Apple II equipment. HRM SOFTWARE

RESPONSE-TIME INVESTIGATIONS

Part of a 10 program package Experiments in Human Physiology. The effects on reaction times of stimulus type and response location are studied. Program available for Apple II equipment. HRM SOFTWARE

RESPSYST, GASEXCH

Simulations dealing with pulmonary gas exchange. Available for IBM-PC compatible equipment. NEW JERSEY MEDICAL SCHOOL

SIMULATIONS IN PHYSIOLOGY - THE RESPIRATORY SYSTEM

Series of 12 simulations dealing with respiratory mechanics, gas exchange, chemoregulation and acid-base balance. Program available for Apple II, IBM-PC compatible, and Macintosh equipment. NRCLSE

SKELETAL MUSCLE ANATOMY/PHYSIOLOGY

Tutorial covering three muscle categories, skeletal muscle microstructure, sliding filament theory, motor units, and lever systems. Program for Apple II equipment. BIOSOURCE SOFTWARE

SKELETAL MUSCLE CONTRACTIONS

Tutorial/Simulation of muscle mechanics. Available for IBM-PC compatible equipment. SIEGMAN, DR. MARION J.

SKILLS IN ELECTROMYOGRAPHY

Tutorial covering skin preparation, reducing EMG artifact, testing a myograph's operation, electrode location, and preventing shock hazards. Program for Apple II equipment. BIOSOURCE SOFTWARE

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SKIN TEMPERATURE
Part of a 10 program package Experiments in Human Physiology. Temperature probe (included) senses body and skin temperatures. Program available for Apple II equipment. HRM SOFTWARE

SPIROCOMP
Data acquisition and analysis system for measuring lung volumes and capacities. Available for Apple II and IBM-PC compatible equipment. INTELITOOL, INC.

THE BODY IN FOCUS
Tutorial for investigating body systems including skeletal, muscular, respiratory, cardiovascular, gastrointestinal, endocrine, and integumentary. Available for Apple II and IBM-PC compatible equipment. NEOSOFT, INC.

POPULATION DYNAMICS

BALANCE-PREDATOR-PREY SIMULATION
Simulation of the effects of food supply, carrying capacity, environmental conditions, and external pressures or predator/prey relationships. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

COEXIST:Population Dynamics
Simulation of the growth of two populations either independently or in competition for the same limited resources. Program available for Apple II equipment. CONDUIT

COMMUNITY DYNAMICS
Tutorial/simulation dealing with interaction of predator and prey systems. Available for Apple //e equipment. EDUCATION MATERIALS & EQUIPMENT CO.

ISLAND BIOGEOGRAPHY
Three simulations of island communities dealing with the relationship between island area and number of species, colonization of a new island, and island immigration and extinction. Program available for Apple II equipment. CONDUIT

LIMITS
Simulation of the effects of growth on world population, pollution, food supply, industrial output, and natural resources. Program available for Apple II, PET/CBM and TRS-80 Model III equipment. COMPUWARE

MARK & RECAPTURE
Simulation of mark and recapture experiments to explore three models for estimating population sizes. Program available for Apple II equipment. CONDUIT

POP
Simulation of three growth models (exponential, logistical, and logistical with low density). Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. COMPUWARE

POPGRO-POPULATION GROWTH SIMULATION
Simulation of unlimited growth (J-curve), limited growth (S-curve) and limited growth with response lag time (S-curve with oscillations) models of population growth. Program available for Apple II, TRS-80 Models I and III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

POPULATION CONCEPTS
Simulation dealing with factors influencing population growth. Available for Apple //e, TRS-80 4, and TRS-80 III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPULATION FLUCTUATIONS
Tutorial covering factors influencing population growth. Program available for Apple II, TRS-80 Models I and III equipment. EDUCATIONAL MATERIALS & EQUIPMENT CO.

POPULATION GROWTH
Simulation dealing with exponential and density-dependent gowth. Program for Apple II equipment. QUEUE, INC.

POPULATION GROWTH
Simulation of population growth. The package compares and contrasts the geometric or exponential growth model with the logistic or Verhulst-Pearl growth model. Program available for Apple II equipment. CONDUIT

POPULATON SIZES
Simulation dealing with a dynamic population. Program for Apple II equipment. QUEUE, INC.

PREDATION
Simulation of predator-prey interactions. Program available for Apple II equipment. CONDUIT

PREDATION EQUILIBRIA
Simulations of equilibrium models of predator-prey interaction. Program available for Apple II equipment. CONDUIT

RABBITS
Wildlife population simulation. Available for TRS-80 III equipment. DUANE BRISTOW

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

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Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

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COMPUTERS IN LIFE SCIENCE EDUCATION

CONTENTS

COMPUTER ASSISTED INSTRUCTION IN AN HISTOLOGY COURSE

Ronald P. Jensh

Department of Anatomy, Jefferson Medical College, Thomas Jefferson University, Philadelphia, Pennsylvania

Computer assisted instruction (CAI) is a valuable addition to methodologies currently available for medical educators. The effectiveness of CAI, however, depends to a great extent on creative planning, effective programming, appropriate content, and an understanding of the nature and background of the users. At the outset, one must be able to clearly identify the needs of the user, the environment in which CAI is to be used, and the goal of CAI programs within the educational environment. Often there has been too much emphasis on the computer as the endpoint instead of as a means to facilitate educational needs.[2]

In 1983, it became evident to us that CAI could be a useful teaching tool in histology. Although there were numerous programs available or being developed at the public school and undergraduate college and univeristy levels, and some programs were being designed for students in the upper two years (clinical) of medical school, there was a paucity of basic science CAI programs for student use during the first two years of medical school. Programs that were available

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were of variable quality and often did not address the needs of schools due to differences in curricula.

During the summer of 1984, the first CAI program was complete at Jefferson Medical College for one topic in medical histology using a commercially available authoring system. Three programs in histology were created in 1985. It became evident, however, that these programs were limited, as computer generated graphics did not adequately address the needs of a morphologic science such as histology. With the advent of videodisc technology and the ability to interface videodisc players easily and inexpensively to computers, CAI became an appropriate educational tool for the morphologic sciences.

Three years ago, an experimental videodisc was produced containing over 1000 photographs that could be used to create computer assisted instruction, interactive video programs (CAI-IV). At that time, the following three common errors were identified and addressed.

- Although commercially available authoring systems were very sophisticated and impressive, they were too complex for faculty who might want to produce programs but did not have the time to learn such complicated systems.
- The cost of many computer system was too high, resulting in limited hardware availability to schools.
- Technology changes so fast that systems and software became "obsolete" in months.

Many people changed systems in order to keep up, the net result often being that projects never could be taken to completion. Therefore, in 1986, decisions were made to a) design an inexpensive workstation and stay with that technology, and, b) instead of concentrating on producing individual programs, create a simple, easy to use authoring system that, although more restrictive, would permit faculty with minimal computer knowledge to produce a tutorial or quiz within a few hours. By the end of the summer of 1987, the authoring system was completed, and two tutorials were created and evaluated.[5] The objective of the present study was to produce a complete set of programs for use by first year medical students in the medical histology course for the fall of 1988 and to solicit student evaluations.

Table 1. Order of topic presentation in the first year histology course.

Epithelium	Integument
Connective tissue	Glands
Adipose tissue	Digestive system
Cartilage	Quiz #2
Bone	Respiratory system
Muscle	Endocrine system
Nerve	Male reproductive system
Quiz #1	Quiz #3
Peripheral blood	Urinary system
Hemopoiesis	Female reproductive system
Circulatory system (vascular)	Special senses (eye, ear)
Lymphatics	Final quiz

METHODS AND MATERIALS

A workstation was created which consisted of an Apple //e computer with an accelerator card, two 5.25" disk drives, a Zenith Data System 12" monochrome monitor (Model ZVM-121), a Sony Trinitron 13" color monitor (Model KV-1311CR), a Pioneer LD-V1000 Video Disc Player, and a Video Microcomputer Interface card (Allen Communications, Inc.). The first three items were readily available in the medical college, so the additional cost to complete the workstation was under $1200. The hardware was placed on a mobile card that allowed transport of the workstation to student laboratories, faculty offices, and study areas, as needed. The workstation and software were made available to the 236 first year students at Jefferson Medical College during the fall, 1988, when the medical histology course was offered.

During the summer of 1988, twenty tutorials and four quizzes were created covering the entire first year medical histology course. The tutorials consisted of written text for each subject in histology with some applicable gross anatomy, biochemistry, physiology, and some clinical information included. Text material was presented on the monochrome monitor paired with a photograph from the videodisc displayed on the color monitor. Sources included textbooks, atlases, lecture notes, and published articles. The order of presentation of the twenty-four programs in the histology course is shown in Table 1. Because up to 40% of the students had little or no computer expertise, the workstation and programs were designed so students only needed to be shown how to insert the videodisk and floppy disk into the drives and turn on the unit.

During the final week of the course, the entire class was asked to complete an evaluation of the CAI-IV program. The questions asked on the evaluation are presented in Table 2.

An objective evaluation of changes in student grades due to exposure to CAI-IV was not done because only one workstation was available for the class, severely limiting the time for students to access the computers. In addition, the medical student population is very homogeneous academically, and, therefore, a major change in test results would not be expected, given the logistical constraint previously mentioned. It was felt that student perception of the effect of CAI-

IV on their learning ability and efficiency was a valid parameter to measure at this time.

RESULTS

Student reaction was uniformly positive, and the workstation was in constant use throughout the teaching block. In many instances, the workstation had to be moved into a hallway to accommodate eight to ten student at a time. When groups used the workstations, the programs became the focus for informative discussions among students.

Ninety students representing 39% of the class, responded to the questionnaire. Forty-five percent used more than nine programs, and 48% used between one and eight programs. Sixty-seven percent found the programs to be helpful, while three percent did not. Twenty-seven percent of the students estimated an increase of five or more points to their grade as a result of exposure to the CAI-IV programs; 31% felt there would be little or no effect on grades. Over 96% of the students responding found the programs informative, personable, and enjoyable. Seventy-four percent felt that the programs inhanced their educational experience, and over 98% believed that more workstations should be built and more programs should be created; 90% affirming that such an activity should take place as a college-wide commitment. Although students felt that CAI-IV should not replace human interaction, almost 75% felt such programs could replace certain lectures that were perceived to be of low quality by the students. All criteria listed, concerning educational activities, were considered extremely to very important with two exceptions. Of moderate importance to students was the form of the content and individualization of programs. Of the responses to questions 21-22, the majority indicated that the students participated in the CAI-IV educational experience to obtain additional help with the subject matter and that their expectations were fulfilled. The only major criticism was the lack of additional workstations.

DISCUSSION

Computer assisted instructional materials are a new and potentially valuable addition to the medical education armamentarium. Today's medical students have been raised in a era in which computer technology has become an ever increasing part of everyday personal and professional life.[1,3,4] Therefore, they feel comfortable with computer programs and are beginning to expect that such programs should be available to them as part of what they consider to be quality education. The workstation with associated software is a step toward providing students with the most up-to-date educational techniques.

There are a number of advantages related to the use of CAI-IV. First, one has control over the content and emphasis of

Table 2. Evaluation survey presented to students following use of CAI-IV.

1. Did you use any of the 24 programs?

2. Do you believe that these programs aided in your understanding of the material?

3. What grade do you expect to receive?

4. By how many points do you estimate your grade increased by use of these CAI-IV programs?

5. Were the programs informative?

6. Were the programs enjoyable and personable?

7. Do you believe more workstations should be built?

8. Do you believe more CAI-IV programs should be developed?

9. Do you believe computer programs in general enhanced you educational experience?

10. Do you believe Jefferson should commit more resources to the development of such technology at the departmental/college level?

11. Should CAI-IV techniques replace lectures?

12 - 20. Evaluate the importance of the following criteria in evaluating educational activities:
- Informational content
- Form in which content is presented (brief/non-redundant)
- Learner active
- Individualized
- Utilization of graphic images
- Connections across different topics emphasized
- Activities enjoyable and personable
- Non-judgmental approach

21. Why did you participate in this activity (reasons/objectives)?

22. To what extent were your expectations fulfilled?

23. What effects, if any, did participation in CAI-IV have on your other study behavior?

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the material being presented. For example, the respiratory system chapters presented in four of the histology textbooks most commonly used by medical schools were compared. Text length varied from about 5,000 to over 13,000 words. Second, the number and quality of illustrations can be planned. Third, the orientation, emphasis, and quality of photographs can be precisely controlled. Light microscopic photographs as a percent of total illustrations in the four texts varies from 21% to 62%, electron photomicrographs from 10% to 58%, and diagrams and drawings from 28% to 66%. Another advantage concerns the elimination of lead time associated with text production, which may be several years behind current concepts. It is important to emphasize, however, that written material cannot be totally eliminated. CAI is a valuable educational addition to existing educational modalities with strengths and limitations, advantages and disadvantages, that must be recognized if it is to be used properly and effectively. Each student has his or her own individual way of using the various educational tools available to maximize his or her learning experience. CAI-IV is a method that students readily accept and that they perceive as being very helpful in assisting them to understand complex material. Ninety-seven percent of the students who used these programs felt that more resources should be committed to develop additional materials.

The process of creating the 24 programs was accelerated by using a very simple, straightforward authoring system. Although the system had to be limited in its options in order to maintain simplicity, the programs were very effective from the user's standpoint. The ojection has often been raised that tutorials are simply pageturners. However, the validity of such programs rests with the nature of the material, the objectives that are to be achieved, and the environment in which the programs will be used. The success of the CAI-IV tutorials amply justifies the format that was used in the design of the authoring system. A second criticism has been that programs that run on older computers are too slow. The present programs have a cycle time (the time taken to present successive pairs of text and photograph on the two monitors) of about five seconds. This was not a problem for the students, and they were generally unaware of the time interval, since they were involved in discussions among themselves.

Computer technology will continue to make an ever increasing impact on the field of medicine and will greatly influence the way students are taught, patients are cared for, and research is conducted. It is important, therefore, that medical educators use this technology and sensitize students and faculty to the advantages that computers offer to the medical community.[6] During the histology teaching block, students were constantly using and reviewing the CAI-IV programs to the extent that it was difficult to find time when the computer could be used for other activities. Clearly, our experience has indicated that students enjoy this type of educational exposure, and the majority feel the use of CAI-IV assisted in their better understanding of the material. This study has indicated, therefore, that CAI-IV is a valuable addition to educational technology. Additional workstations are being assembled, and the content material is being redesigned and updated. The two programs have recently been redesigned using a Macintosh computer and Hypercard®. These programs are currently being evaluated as part of our commitment to meet the continuing needs of today's medical students.

The author wishes to acknowledge the contributions made by the following individuals: David Battaglia, M.D.; Francis Gentile, M.D.; Robert C. Weber, III, M.D.; Timothy J. O'Brien; Michelle Vichnin; J. Jon Veloski; and F. Scott Beadenkopf. Special thanks is also given to the Office of the Dean and to the Center for Research in Medical Education and Health Care. This research was supported through the Summer Fellowship Program for Research in Medical Education and the Mr. and Mrs. Gabriel Lavine Clinical Scholarship Program of Jefferson Medical College of Thomas Jefferson University.

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– NOTICE –

NRCLSE announces a new version of *Simulations in Physiology –The Respiratory System* – for Macintosh computers. Unlike the older version that required Microsoft BASIC, the programs in the new version run as independent applications and, therefore, require no special support software.

WHERE'S THE SOFTWARE? – PART 3

In the past, we have published lists of life science software sources and programs or program areas available through them. The following list is presented as the latest in a continuing effort to make colleagues aware of potential resources. As in the past, no attempt has been made by NRCLSE to review these materials.

This month's listings continue last month's and are arranged by content area. Each item includes a vendor name relating the software to the vendor list that follows the software list.

If you have found specific software helpful in your teaching efforts, please share your good fortune by letting us know about the program(s) and supplier(s) so that we can make this information available through future software lists. Send pertinent information to Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115 or send us a note on BITnet. Our BITnet address is MODELL@UWALOCKE.

SUBSTANCE ABUSE

DRINKING AND NOT DRINKING

Tutorial designed to augment strategies for the prevention of substance abuse. Includes facts about drinking and the effects of alcohol. Program available for Apple II equipment. KINKO'S

INTRODUCTION TO PSYCHOACTIVE DRUGS

Tutorial designed to augment strategies for the prevention of psychoactive drug abuse. Program available for Apple II equipment. KINKO'S

KEEP OFF THE GRASS

Tutorial designed to augment strategies for the prevention of marijuana abuse. Program available for Apple II equipment. KINKO'S

SIX CLASSES OF PSYCHOACTIVE DRUGS

Tutorial designed to augment strategies for the prevention of psychoactive drug abuse. Program available for Apple II equipment. KINKO'S

SUBSTANCE ABUSE DATA BASE

Database containing contact information on substance abuse organizations. Program available for Apple II equipment. KINKO'S

ZOOLOGY

ZOOLOGY I

Tutorial covering the general charactistics, structures, and functions that define the major invertebrate phyla. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

ZOOLOGY II

Tutorial covering physiology in the Phylum Chordata. Program available for Apple II and IBM-PC compatible equipment. SLIWA ENTERPRISES, INC.

MISCELLANEOUS

BAFFLES, BAFFLES II

Game to help students develop deductive reasoning and problem solving skills. Program available for Apple II (BAFFLES) and IBM-PC compatible (BAFFLES II) equipment. CONDUIT

BASIC SCIENCES

Self-assessment package covering anatomy, behavioral science, biochemistry, microbiology, pathology, pharmacology, and physiology. Available for CP/M and IBM- PC compatible equipment. UMKC SOFTWARE SERIES

CLASSIFY-CLASSIFICATION KEY PROGRAM

Presents an unclassified set of characteristics and labels for classification at various levels. Program available for Apple II, TRS-80 Model III, IBM-PC, and Commodore 64/128 equipment. DIVERSIFIED EDUCATION ENTERPRISES

GRADE KEEPER - PC

Grade book manager that handles classes up to 300 students, up to 25 grades per student. Program available for IBM-PC compatible equipment. OAKLEAF SYSTEMS

GRADEBK

Program for the analysis of a large set of grades. Program available for IBM-PC compatible equipment. INDIANA UNIVERSITY SCHOOL OF MEDICINE

LABPLOT

Allows the Apple II with any A/D converter card to be used as a multipen chart recorder or as an X/Y plotter. BIOSOFT (UK)

LIFE TABLES AND THE LESLIE MATRIX

Tutorial-simulation dealing with the basic life table and Leslie Matrix. Program available for Apple II equipment. CONDUIT

MALARIA

Simulation of the effects of various types of malaria epidemic controls. Program available for Apple II, PET/CBM, and TRS-80 Model III equipment. COMPUWARE

MULTI-Q

A general purpose question creation and presentation system. Program available for Apple II and IBM-PC compatible equipment. BIOSOFT (UK)

"Q" EDUCATIONAL AUTHORING SYSTEM

Authoring system for tutorial and assessment material. Allows incorporation of graphics and videodisc material. Program available for IBM-PC compatible equipment. BIOSOFT (UK)

RATS

Simulation of rat control in city or apartment by sanitation and various poisons. Program for Apple II, PET/CBM, and TRS-80 Model III equipment. COMPUWARE

STERL

Simulation exploring effectiveness of pest control methods. Program available for Apple II, PET/CBM, and TRS-

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80 Model III equipment. COMPUWARE

TRACER AUTHORING SYSTEM
Designed for faculty use to develop diagnostic case simulations in any branch of medicine. Available for IBM-PC compatible equipment. HEALTH SCIENCES CONSORTIUM

TRIBBLES, TRIBBLES Revisited
Simulation to introduce students to the scientific method. Programs available for Apple II (Tribbles) and IBM-PC compatible (Tribbles revisited) equipment. CONDUIT

VENDORS

BIOSOFT (UK)
22 Hills Road
Cambridge CB2 1JP, United Kingdom

P.O. Box 580
Milltown, NJ 08850

Compuware
15 Center Road
Randolph, NJ 07869
(201) 366-8540

CONDUIT
The University of Iowa
Oakdale Campus
Iowa City, IA 52242
(319) 335-4100

Diversified Education Enterprises
725 Main Street
Lafayette, IN 47901
(317) 742-2690

Indiana University School of Medicine
Department of Physiology and Biophysics
635 Barnhill Drive
Indianapolis, IN 46223

Health Sciences Consortium
201 Silver Cedar Court
Chapel Hill, NC 27514
(919) 942-8731

Kinko's Service Corporation
4141 State Street
Santa Barabara, CA 93110
(800) 235-6919
in CA (800) 292-6640

Oakleaf Systems
P.O. Box 472
Decorah, IA 52101
(319) 382-4320

Sliwa Enterprises, Inc.
2360-J George Washington Hwy
Yorktown, VA 23666
(804) 898-8386

UMKC Software Series
2411 Holmes Street
Kansas City, MO 64108-2792
(816) 276-1891

NRCLSE SOFTWARE EVALUATION SUBMISSION FORM

The NRCLSE software evaluation program has been initiated (see October, 1988 CLSE) to promote development of high quality, versatile educational software in the life sciences by providing authors with feedback from critiques by life science educators and instructional designers. To ensure that software is reviewed in an appropriate fashion, it is essential that reviewers fully understand the rationale underlying the design criteria chosen by the author and the environment for which the software is intended. Please provide the following information concerning each software package to be evaluated.

Submit 3 complete copies of the software and all supporting documentation along with $25 (to cover handling, mailing, and follow-up costs) **to Software Evaluation Program, NRCLSE, P.O. Box 51187, Seattle, WA 98115.**

Author's name:

Author's address:

Title of software:

Content area:

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Minimum hardware requirements:

Optimal hardware configuration:

Software requirements (operating system, etc):

Student population for which software was written:

Environment for which software is primarily intended (independent study, classroom discussion, lecture enhancement, etc):

How long has this software been used by students?

Can reviewers keep the review copy of this software?

Use additional pages to describe the underlying philosophy of this software. What need prompted the development of this software? Why was the specific format of the software chosen? What goals did the input/output scheme (or screen design) address? Is documentation an integral part of the package? How is it intended to be used?

Has the software been evaluated by students?

Briefly describe the format and results of any student evaluation.

What attempts have been made to evaluate the impact of the software on student progress?

What were the results of the impact evaluation?

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COMPUTERS IN LIFE SCIENCE EDUCATION

CONTENTS

BIOLOGY COURSEWARE FOR COLLEGE FRESHMEN

Charles L. Ralph

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This article is an account of my use of computer software (courseware) in freshman biology courses and recent development of a large, uniform set of biology courseware. In the evolution of a format for employing computerized instruction, I have formed some pragmatic views on courseware as instructional tools. There are interesting discrepancies between what is perceived as needed and what actually works. Additionally, there is considerable whimsy in the dispensing of accolades for and funding of courseware development.

If one asks college faculty what kind of courseware they would like to see developed, chances are their response will be "simulations." If you ask college students what they find most interesting and useful, after they have experienced a few samples of courseware, they will most likely say "tutorials." Alperson and O'Neil have addressed this issue.[1]

My experience in seeking funding for courseware development suggests that those agencies dispensing such monies, both private and government, are having difficulty defining what they want to see produced. There are shifting emphases and ephemeral interests, due undoubtedly to not knowing what college level courseware really should be, for there are no well tested examples extant. My perception is that funded projects are commonly ones that will result in a piece or a few pieces of comparatively spectacular looking software with little potential for widespread, practical use.

The award and recognition organizations, such as the commendable one of the EDUCOM consortium, likewise appear to commonly select items with much panache but small likelihood of being broadly disseminated.[2,4] That is, a few pieces of courseware, scattered among various disciplines, are not likely

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to fuel a revolution in instruction, no matter how good they are, for unless there is a critical mass of programs that can be assembled to make a functional package, potential users are unlikely to bother tooling up to use them.[6]

What we are now witnessing is the trial-and-error phase of a still relatively new revolution in educational technology. Our acceptance and use of this technology within colleges and universities has been rather fumbling and is appropriately viewed internally with conservatism or even suspicion by many. While the business community has clearly articulated how computers can serve them, educators do not find it easy to voice any collective or majority opinion on what the role of computers might be in their domain.

RATIONALE

In 1984, I became intrigued with the possibility of using courseware as a component of the laboratory with the freshman biology classes I was teaching. My basic assumptions or premises were the following.

1) Much of the understanding of biology depends on grasping the complexities of physical structure or imagining submicroscopic, abstract events. The pictorial and animation capabilities of the computer screen should aid such comprehension.[3]
2) Biological information grows ever more voluminous, and the time allocated for its study has not increased. Indeed, the allocated time has decreased in most schools. The potential efficiencies of computer simulations of long-term events are evident. In some cases, the computer can provide an active learning experience that addresses the same goals as the traditional student laboratory.[5]
3) The cost of materials, equipment, and personnel are increasing, while the relative cost of computers (on a capability basis) is decreasing, so that use of courseware is now, or soon will be, cost effective in instruction.
4) Increasing awareness of ethical concerns about the uses of animals in student laboratories encourage conservation as well as concern about the preparedness of students to employ animals. Appropriate courseware can reduce some uses of animals and better prepare the students for the occasions when they do use animals.

HISTORY OF BICEP

In January, 1985, I modified the laboratory with my freshman biology class to incorporate a few proprietary courseware programs. These were mounted on Apple //e computers. The available appropriate courseware was limited, but I selected what appeared to be the best from some half dozen sources. The format that developed over the next 3 years was to have the 2-hour per week laboratory be a mix of traditional, hands-on exercises and courseware study. There were two students for each of 10 Apple computers (the //es were replaced by IIGSs with RGB monitors in the third year). On average, over the course of the semester, the students spent about half of their time on each two components. Repeated, anonymous questioning of the students revealed a very favorable acceptance of this mix. The design was tried with both the first and second semester biology courses, with a non-majors course and with summer courses for high school teachers. In all cases, student acceptance of the format was very positive.

By the third year, this design was well implemented, our courseware library consisted of 10 copies each of 43 titles. The project came to be known as BICEP for Biological Instruction Computer Enhanced Project.[7]

The major problems with using an assortment of courseware from various providers are non-uniformity of the interfaces, necessitating the use of documentation to know how to control each program's unique features, and the intermixing of color and monochrome programs; many of the monochrome programs that are not updated are very difficult to read on color monitors (especially composite video monitors); switching between color and monochrome monitors is feasible if one has a dual set but is inconvenient. Additionally, there is great variance in scholastic level. Many programs are designed to appeal to as wide an audience as possible (secondary to college), which sometimes results in some unusual mixes of cuteness and rather sophisticated information. Also the run times vary widely among programs. Nevertheless, this phase of my explorations into computer-enhanced instruction was a necessary, useful, and encouraging beginning. It gave me valuable insight and practical understanding about students as they relate to and interact with computers and courseware. In 1988, through a grant from the Colorado Commission on Higher Education, we secured a set of 14 Macintosh Plus computers and began developing plans for creating, in-house, a set of courseware to exploit them. Subsequent donations from Apple Computer, Inc. have added to our set of student computers bringing the laboratory set to 20.

I became interested in the Macintosh as an instructional computer the first time I saw one. Its crisp screen and graphics capability provided, for the first time, a pictorial environment suitable for displaying the visual metaphors that aid in understanding biology. I then began casting about for a framework in which to create courseware for the Macintosh. While despairing of ever producing a significant set of products in my lifetime through coding, my attention was called to an early version of the on-screen, iconographic authoring program that has come to be called Authorware. I recognized that this was the very tool I was seeking, for a non-programmer can create with it dynamic courseware at a pace previously impossible.

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BICEP COURSEWARE

By the summer of 1988, I had resolved to produce, using the Authorware framework, a set of complementary courseware for use in the freshman biology year. To date, there are 40 titles in the set, created over the past two years. These programs cover topics typically taught in basic biology courses (see Table 1).

What remains to be created are programs in plant biology. These are to be done in the coming summer. Twelve titles will be added, bringing the total set to 52. This number allows running two titles per week in each of the 13 laboratory sessions held in each of two semesters.

The success of the project in creating so many programs in a remarkably brief time is largely due to the efficiencies of creation with the iconographic authoring program and the splendid creativity of the undergraduate students who authored most of the programs. I created one-fourth of the programs and edited the remainder, but many of the best features of our programs must be credited to the seven talented undergraduates who have worked in the project. This statement may draw skepticism from some readers. (The use of undergraduate authors has been viewed with doubt by funding agencies, as I will note later.) Nevertheless, I remain convinced that selected, well-trained undergraduates can be the very best hope for the production of excellent, functional courseware in quantities sufficient to be significant. Neither faculty nor graduate students are likely to be the source of any great quantity of software very soon, due to the nature of our academic award structure and traditions.

From the hundreds of students in introductory biology, I encourage a few that are interested to enroll in my one credit applications course. This course formerly used Appleworks with the Apple //es[8] but now uses Microsoft Works on the Macintoshs. The students produce a paper on a biological topic as the final product, having learned some interesting information on a subject and how to present it in good form. At the next level, a one credit drawing, painting, and modeling course, they learn the graphic capabilities of the Macintosh. Then a two credit authoring course instructs in the use of Authorware. From the latter class (usually six to eight students), I select three or four to be paid interns for the summer authoring project. Through this sequence I identify the best candidates for the task. The prime factor to be selected for is creativity. Subject knowledge is essential, but secondary to creativity.

The BICEP programs have a run time of about 40 minutes. Typically there are four topics plus a multiple choice quiz. The programs are mainly tutorial, with generous used of graphics, animations, and a few sounds. The fourth topic commonly is a simulation. All programs have the same style and appearance. Each has a pull-down glossary that defines the arcane words in the program. There is much student interaction, including click-and-drag arrangements, typing of responses to questions, and selection of program sequences.

Table 1. Titles of biology courseware developed to date.

Biochemistry	Adaptations
Cells	Biomes
Membrane Permeability	Population Growth
Enzyme Kinetics	Communities
Oxidation-Reduction	Ecosystems
ATP Synthesis	Behavior
Photosynthesis I	Classification of Animals
Photosynthesis II	Invertebrates
Mitosis	Chordates
Meiosis	Animal Structure
Genetic Experiments	Digestive Enzymes
Molecular Genetics	Countercurrent Exchange
Protein synthesis	Respiration
Viral and Bacterial Genetics	Immune System
Eukaryotic Gene Expression	Osmoregulation
Genetic Engineering	Kidney Function
Microevolution	Hormonal Regulation
Macroevolution	Blood Glucose
Animal Reproduction	Neural Transmission
Animal Development	Muscles

UTILIZATION AND TESTING

In the 1988-89 academic year, the 20 programs then available were used by the students as optional sources of information. A Macintosh facility was available for several hours daily for student to run the courseware. We asked them to report errors and complete an evaluation form on each program to help shape and improve the programs.

In the fall of 1989, a formal test with 26 of the programs was conducted. My lecture section of almost 200 students was subdivided by laboratory sections into half that did traditional two hour laboratory exercises and half that ran two courseware programs in their assigned two hour periods. This design was approved by the university's Human Research Committee, with the proviso that a student's final grade would not be disadvantaged by either set of conditions. The results of this matched-sample study, with pre- and post-test comparisons, as well as computer attitude surveys, are in

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analysis and will be published at a later date. In brief, both groups of students did equally well on the lecture examinations, and the courseware was viewed very favorably as a trade-off for traditional laboratories.

In the present semester, with the second biology course, a format is being tried that I find very satisfactory so far. There are the customary three lectures per week, but the required two hour, weekly laboratory period is devoted to the running of two relevant courseware programs. A written quiz is administered by the supervising teaching assistant at the end of the session. Additionally, there is a one hour, weekly, optional practicum (no attendance check, no exams), in which most of the traditional laboratory activities are done. Only about half the students attend practicums. Presumably, these self-selected students are the better or more motivated ones.

END NOTES

Funding from within my university for BICEP has been generous and unwavering, for which I am most grateful. Because I am a senior faculty member, I was safely able to make a major investment in this project. As it became a consuming activity, I deliberately phased out of an established research career, to the dismay of some of my colleagues. I have found the transition to a more teaching oriented career revitalizing and recommend it to others. However, anyone making a major commitment to implementing computer enhanced instruction should be in a position where such efforts do not require recognition for academic success. Most university communities, especially ones with a research emphasis, are not likely to regard courseware creation as a scholarly activity.[6]

There is considerable resistance to diminishing the traditional student laboratory experience. I understand the concerns of my colleagues in protecting this time honored activity, and I will never claim that computer programs can adequately replace real laboratories. However, I view our educational dilemma as one of how to optimally use limited time to educate a generally illiterate and ill prepared population of students in the intricacies of a complex science. My bias is toward exposure to the comparatively information rich environment of courseware, even at the expense of laboratory time. After all, for the successful student, the first year laboratory will not be the last one — unless there is no second or subsequent year in science, which may well be the case if the student fails to learn a great deal in a brief time.

If one were to emulate the BICEP design and attempt to obtain funding from external sources, the applicant should be aware that the the use of undergraduates as courseware authors is likely to be regarded negatively. I have tried for three years to obtain funding from the U.S. Department of Education Fund for the Improvement of Postsecondary Education (FIPSE). I quote from their most recent rejection: "In your proposal, you describe plans for using undergraduate students to create new biology software ... . This could certainly be a valuable learning experience for the students involved, and it may generate plenty of useable material. Although students can certainly play valuable roles in tasks such as programming or providing feedback, FIPSE staff is nevertheless concerned that in this project, conceptual innovation and pedagogical sophistication would be limited by their lack of teaching experience and disciplinary knowledge. FIPSE only wishes to support software development ... that will lead to curricular innovation."

To the best of my knowledge, our courseware set is the most comprehensive for basic biology in existence. Teachers who have seen the programs usually commend them for attractive appearance, standardization of operation, quality and quantity of graphics, and the high degree of student interaction. By making available a large package of uniform, practical courseware at a reasonable cost, we hope to persuade others to incorporate computer enhanced instruction in their basic biology courses.

The form in which the courseware will be available and the costs for it should be decided by the end of the coming summer. The programs require minimally a 1 MB Macintosh Plus or a 640K IBM-PC equipped with a mouse. Those wishing to obtain samples of the programs should contact me at the following address: Charles L. Ralph, Department of Biology, Colorado State University, Ft. Collins, CO 80523.

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WHERE ARE THE VIDEODISCS?

Applications of interactive video in life science education continues to grow. As the cost of the technology necessary to implement interactive video falls within the feasibility range of institutions and the interest in Hypermedia continues to grow, more educators are looking for sources of video images or interactive video courseware to use in their teaching efforts. Perhaps the best resource for learning what videodisc material is available on the market is *The Videodisc Compendium for Education and Training* published by Emerging Technologies Consultants, Inc. The videodisc information that follows was drawn from that publication and it updates. Each entry in our listing includes the title, a *brief* overview of the content, the vendor, and the vendor's telephone number. The *Compendium* contains a more detailed description of the material. For information concerning the *Compendium* or for assistance in locating appropriate videodisc material, contact Richard Pollak, Emerging Technology Consultants, Inc., P.O. Box 12444, St. Paul, MN 55112, telephone: (612) 639-3973.

ANATOMY AND PHYSIOLOGY

Anatomy and Physiology of the Heart 24 modules covering various aspects of normal and abnormal cardiac anatomy and physiology. *Compatible with:* IBM InfoWindow *Vendor:* British Columbia Institute of Technology (604) 432-8376

Cardiovascular Lab Simulation Simulation of experiments in cardiovascular physiology. Covers experimental preparation, autonomic control, cardiac catheterization, positive pressure ventilation, fibrillation, manometer experiments, the normal and abnormal cardiac cycle, and euthanasia. *Compatible with:* IBM InfoWindow or Matrox VGO-AT overlay board; Pioneer LD-V4200 or LD-V6000 *Vendor:* Dr. Charles Branch, Auburn University (205) 844-5414

Life Sciences Sides 5-6: The Frog Contains anatomy and physiology of the frog as well as comparative human anatomy. *Compatible with:* Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

The Living Textbook - The Frog Interactive MultiMedia Library Contains slides and movie clips covering all basic concepts in the anatomy and physiology of the frog as well as comparative human anatomy. *Compatible with:* Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

Regulating Body Temperature (2nd Ed.)/ Digestive System (2nd Ed.) Deals with temperature regulation in vertebrates and the mechanical and chemical processes of digestion. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

Work of the Heart (2nd Ed.)/Muscles: Structure and Function Animated footage illustrates the parts of the heart and how they relate to the work of the lungs, arteries and veins. Muscle portion deals with the three types of muscles. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

BIOLOGY - GENERAL

Bio Sci Videodisc A visual presentation on the broad scope of biology. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Life Cycles Visual record in both motion picture and still frame images of how life begins. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Life Science Biology I and II Deals with effects of temperature and pressure on respiration rates of a series of organisms and examines the influence of climatic environments on the characteristics of plants and animals. *Compatible with:* IBM-PC; Pioneer LDV-6000 series *Vendor:* GPN (800) 228-4630 (402) 472-2007

Life Science Sides 1-4: Molecular, Cell, Human, Plant and Animal Biology Provides broad basic coverage of all topics in life science/biology. *Compatible with:* Pioneer LDV-2000 or 4020 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

The Bio Libe Encyclopedia Contains 6000 color frames of over 5000 plant and animal species accessible by Genus species names. *Compatible with:* Any player *Vendor:* Image Premastering Services, Ltd. (612) 644-7802

The Living Textbook - Life Science Interactive MultiMedia Library Contains more than 2,700 slides and 164 movie clips covering all basic concepts in life science/biology taught at the secondary and college levels. *Compatible with:* Apple IIGS or Macintosh; Pioneer LDV-2000 or 4200 *Vendor:* Optical Data Corporation (800) 524-2481 (201) 668-0022

Relationships Covers relationships among organisms including parasites, colonies, social insects, predators, prey and competition. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

BIOTECHNOLOGY

Biotechnology: Learning the Techniques Step-by-step presentations of 33 standard laboratory protocols. *Compatible with:* Any player *Vendor:* GPN (800) 228-4630 (402) 472-2007

BOTANY

Exotic Plants: A Videodisc Compendium Contains over 2,000 high quality color photographs of tropical, subtropical and other exotic plants. *Compatible with:* Any player *Vendor:* VT Productions (408) 438-3100

Landscape Plants Over 7,400 views of over 900 species or varieties of cultivated woody plants. *Compatible with:*

Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Pollination Biology Documentary dealing with all facets of flower pollination. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

CELL BIOLOGY

Cell Biology I: Motion and Function of the Living Cell Includes film sequences and still images covering cell types, cell constituents, mitosis and cytokinesis, fission and cell motility. *Compatible with:* Any player *Vendor:* Videodiscovery (800) 548-3472 (206) 285-5400

Meiosis (2nd Ed)/Mitosis (2nd Ed) Microscopic footage and animation dealing with the processes of meiosis and mitosis. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

CLINICAL MEDICINE

Abdominal Stab Wounds Simulation designed to teach the initial assessment process. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Active Knee Series A library of programs examining the diagnosis of knee injuries by any person who is first to respond. *Compatible with:* IBM InfoWindow, Sony and other players *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

American Heart Association: Airway Management Basic non-invasive and specialized invasive procedures of airway management. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Arrhythmia Recognition Material from American Heart Association ACLS text, ECG lessons, ECG static and dynamic examples. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Cardiopulmonary Resuscitation Teaches and tests in CPR and Basic Life Support *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Circulatory Adjuncts and Resuscitation Pharmacology Teaches basic techniques of starting IVs, patient defibrillation and cardioversion, and external and transvenous pacin. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

American Heart Association: Megacode Trains individuals in organizing and managing cardiac emergencies through simulations. *Compatible with:* AHA CPR/ACLS Learning System *Vendor:* Actronics, Inc. (800) 851-3780 (412) 231-6200

A Patient with Diarrhea and Vomiting Presents a patient in the emergency department with flu-like complaints of vomiting and diarrhea. *Compatible with:* IBM InfoWindow; any RS-232 player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Auscultation of Normal Breath Sounds Reviews standard procedures to auscultate the posterior and anterior chest, patient positions, breathing techniques and stethoscope placement. It also reviews intrathoracic dynamics and the physical dynamics of chest tubes. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Balancing for Diabetic Control Designed to teach students principles of diabetic management. Two case studies are presented. *Compatible with:* IBM-PC compatible and Pioneer LDV-6000 series *Vendor:* Stewart Publishing, Inc. (703) 354-8155

Cardiovascular Resources Videodisc Contains a large collection of materials that may be used to teach cardiovascular nursing and medicine. *Compatible with:* any player *Vendor:* University of Washington (206) 545-1186

Care Basics for Nursing Assistants Introductory course to meet training needs of nursing assistants working in longterm care. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems, Online GL512, VAL *Vendor:* Professional Training Systems, Inc. (404) 872-9700

Chest Trauma Presents a patient with respiratory distress and hypovolemic shock resulting from multiple injuries sustained in a car accident. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Dysrhythmia Training and Evaluation Designed to train students in electrocardiography with a focus on dysrhythmia recognition. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Emergency Simulation designed for paramedics, emergency medical technicians, emergency physicians, nurses, and others with a background in emergency training. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers Inc. (403) 462-6365

Emergency Cardiac Maneuvers: A Rescuer's Handbook Covers general information, anatomy and physiology, rhythm problems, and rescue maneuvers. *Compatible with:* any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Estrogen Replacement Therapy Covers the reasons for the therapy, details on the therapy, medical evaluation procedures, and the side effects and risks of using this therapy. *Compatible with:* IBM InfoWindow *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Health History/Physical Exam of the Diabetic Clinical simulation followed by an examination. *Compatible with:* IBM-PC, Pioneer LDV-6000 Series *Vendor:* Stewart Publishing, Inc. (703) 354-8155

Initial Assessment of Respiratory Difficulty Presents a patient involved in a motor vehicle accident. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Intravenous Therapy Teaches intravenous therapy principles and techniques. *Compatible with:* FITNE Interactive System or IBM InfoWindow *Vendor:*

Fuld Institute for Technology in Nursing Education (614) 592-2511

IV Therapy/IV Solutions Reviews overall goals of IV therapy and the major types of IV solutions. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Managing the Experience of Labor and Delivery Simulates normal labor and delivery process beginning with admittance to the hospital of the laboring patient and her husband. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

Mechanical Ventilators Provides brief overview of 10 mechanical ventilators *Compatible with:* IBM InfoWindow, Sony VIEW, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Motor Vehicle Trauma Simulation takes place in an emergency department, beginning with admission of a multiple trauma patient in hypovolemic shock. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Nursing Care of the Elderly Patient with COPD A case study simulation about a 73-year old man with COPD and pneumonia. *Compatible with:* IBM InfoWindow, FITNE, Sony VIEW, Visage *Vendor:* American Journal of Nursing (800) 223-2282 (212) 582-8820 X541

Nursing of the Cancer Patient with Compromised Immunity: The Nursing Process Simulates the five steps in the nursing process. *Compatible with:* IBM InfoWindow *Vendor:* Health Sciences Consortium (919) 942-8731

Obstetrics Simulation of the delivery of a baby in a rural community hospital. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Premenstrual Syndrome: A Clinical Manual Covers various areas of PMS from diagnosis and examination to diet and various drug therapies to assist in coping with it. *Compatible with:* Any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Prevention of Occupational Exposure to the AIDS Virus Explains cause of AIDS, how HIV is transmitted, and how health care workers should protect themselves from exposure to the virus. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems, Online GL512, VAL *Vendor:* Professional Training Systems, Inc. (404) 872-9700

Shotgun Wounds to the Abdomen Presents opportunity to assess and manage a patient with shotgun wounds to the abdomen. *Compatible with:* IBM InfoWindow; any player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

Sterile Technique at the Bedside Instructs health-care professionals in the steps for preparing and applying dressings and maintaining sterile techniques in patient care. *Compatible with:* Sony LDP-1000, 1000A or 2000 *Vendor:* Access Network (800) 352-8293 (403) 256-1100

Urinary Catheterization Instructs health-care professionals in the preparation of the patient and the tray and proper catheterization techniques. *Compatible with:* Sony LDP-1000, 1000A or 2000 *Vendor:* Access Network (800) 352-8293 (403) 256-1100

HEALTH SCIENCE

AIDS - An Educational Program Provides the essential facts about AIDS and how to avoid contracting the disease. *Compatible with:* IBM InfoWindow *Vendor:* Health Edutech, Inc. (612) 881-1926

The Birth Disc A visual database with over 9,000 images of childbirth from hospitals, birth centers, and home environments. *Compatible with:* Any player *Vendor:* Image Premastering Services, Ltd. (612) 644-7802

Hormonal Contraceptions: Pills, Injections and Implants Covers various aspects of hormonal contraceptives *Compatible with:* Any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Infection Control Provides basic information on how an infection is transmitted, how to isolate an infection, and how to prevent an infection from spreading. *Compatible with:* IBM InfoWindow or PTS Pro-Vision systems; Online GL512, VAL *Vendor:* Health Edutech, Inc. (612) 831-0445

Slice of Life III Over 26,000 still images drawn from various areas of medicine, dentistry and allied health education. *Compatible with:* IBM, Macintosh; Any player *Vendor:* University of Utah (801) 581-8052

STD: Sexually Transmitted Diseases Information Program Provides the facts about the eight most common sexually transmitted diseases. *Compatible with:* IBM InfoWindow *Vendor:* Health Edutech, Inc. (612) 831-0445

HEMATOLOGY

Basic Hematology Tutorial, drill and practice, and simulation program that utilizes the "Medical Applications Videodisc: Hematology 2nd Ed. (University of Washington) *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers Inc. (403) 462-6365

Introduction to Case Studies in Hematology A series of 20 case studies designed to acquaint students with basic problem-solving techniques involving cell identification and clinical correlations *Compatible with:* Macintosh; Pioneer or Sony player *Vendor:* Edudisc, Inc (615) 373-2506

Laboratory Medicine Video Library: Atlas of Hematology Contains over 6,000 images forming a comprehensive library of hematologic findings which can be used for education, testing and reference. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

Medical Applications Videodisc: Hematology, 2nd Edition Contains the entire American Society of Hematology morphology collection, the World Health Organization International Histologic Classification of Tumors, frames from the Western Universities' Physical Diagnosis Slide Bank, and extensive morphological study of acute leukemias, and the film "Red Cell Shapes" *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

PATHOLOGY AND PATHOPHYSIOLOGY

Acute Leukemia Morphology II Contains numerous exemplary peripheral blood smears, bone marrows and special stains for instruction and reference in the differentiation of acute leukemias. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

Cardiology Series A 12 disc course designed to develop in a logical way the consequences following the creation or establishment of heart defects. *Compatible with:* IBM InfoWindow, Sony VIEW 5000, Visage System, FITNE Workstation, Matrox *Vendor:* Training Information Centers, Inc. (403) 462-6365

Disorders of the Nervous System: Mentation Six patients are shown who demonstrate a variety of disorders of mentation. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

Disorders of the Nervous System: Motor A compilation of material from a "visual glossary" collection of neurological dysfunction. *Compatible with:* Any player *Vendor:* University of Washington (206) 545-1186

International Veterinary Pathology Slide Bank, Ed. 4 Contains still frames of lesions from domestic, laboratory and wild animals from contributors in the U.S., Canada, and Europe. *Compatible with:* IBM-PC; Pioneer LDV-4200 *Vendor:* University of Georgia (404) 542-5837

Management of Heart Failure Covers the definitions and causes of heart failure, the signs and symptoms, pathophysiology and therapy. *Compatible with:* Any player *Vendor:* The Alive Centers of America, Inc. (216) 869-9623

Pathophysiology of Shock/Pathophysiology of Cardiac Tamponade Looks at physiologic effects of shock and the body's compensatory responses to the syndrome. Provides 3 cases that demonstrate how cardiac tamponade presents itself and when to suspect tamponade. *Compatible with:* IBM InfoWindow; any RS-232 player *Vendor:* Intelligent Images (800) 733-1010 (619) 457-5505

WILDLIFE MANAGEMENT

Yellowstone in Winter Provides insight into the work of Yellowstone's rangers in their management of wildlife. *Compatible with:* Any player *Vendor:* Encyclopaedia Britannica Educational Corp. (800) 554-9862 Ext 6554

ZOOLOGY

Encyclopedia of Animals Eight discs covering mammals, birds, reptiles, insects, and marine life. *Compatible with:* Any player *Vendor:* Pioneer LDCA, Inc. (213) 835-6177

Whales Motion footage and still pictures to take students into the underwater world of whales. *Compatible with:* Pioneer LDV-6000 series Level II, Any player Level 1 *Vendor:* National Geographic (800) 368-2728 (301) 921-1330

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COMPUTERS IN LIFE SCIENCE EDUCATION

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KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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CLSE 1990 COLLEAGUE DIRECTORY – PART 1

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is updated from the 1988-89 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 8 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights. Part 2 of the directory will appear next month.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 8 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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or let us know via BITNET. NRCLSE's BITNET address is MODELL@UWALOCKE.

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The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

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Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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COMPUTERS IN LIFE SCIENCE EDUCATION

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CLSE 1990 COLLEAGUE DIRECTORY – PART 2

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is a continuation of the 1990 directory published last month. It is updated from the 1988-89 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 8 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights. Part 3 of the directory will appear next month.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 8 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

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COMPUTERS IN LIFE SCIENCE EDUCATION

CONTENTS

DESIGNING COMPUTER BASED TUTORIALS TO REINFORCE REASONING SKILLS

Harold I. Modell

National Resource for Computers in Life Science Education, Seattle, Washington

Ralph, in his recent description of biology courseware development for undergraduates, made the interesting observation that college students seem to prefer working with courseware having a tutorial rather than a simulation format.[4] What distinguishes a "tutorial" from a "simulation"? From a student's perspective, the "tutorial" is designed to impart specific information, while the simulation is designed to provide an environment in which the student "discovers" information. Perhaps the apparent preference for tutorials reflects the training that most students receive, beginning in high school and continuing through their undergraduate (and, in some cases, their graduate) careers. The entering medical student, for example, is a highly competitive individual whose learning skills have been directed toward achieving high scores on fact oriented, multiple choice examinations.[1,3] How many times have we heard students say, "Just tell me what I need to know to pass the exam!"

The traditional tutorial format does just that. Screens of information are presented, sometimes with color illustrations, animation or other attention-getting devices, followed by a series of questions. Based on the student response to the questions, additional information is presented, again in a manner that requires the student only to serve as a receptacle for the information.

A successful science curriculum should

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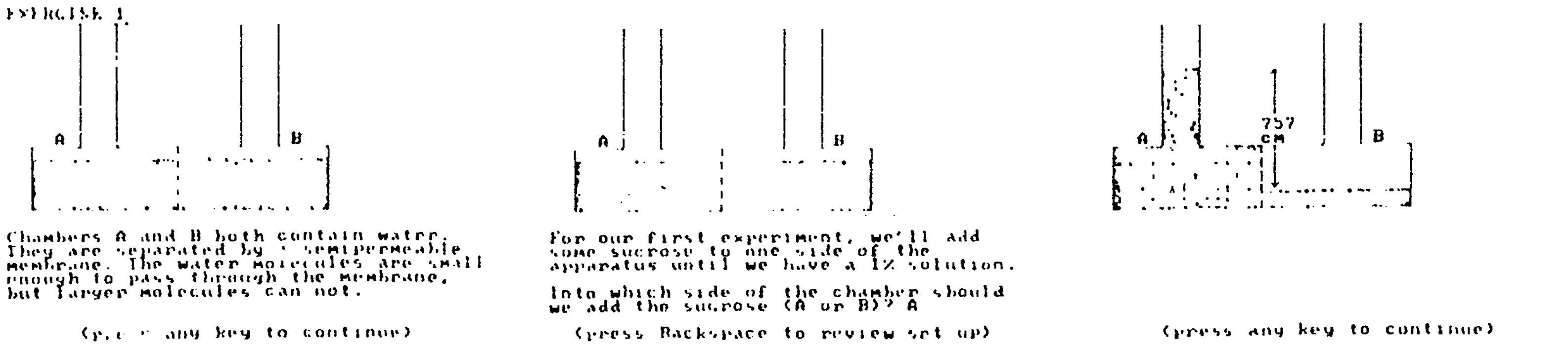

FIGURE 1. Series of screens from osmosis tutorial demonstrating the result of placing a 1% sucrose solution on one side of a semipermeable membrane. *Left Panel:* The experimental setup is explained. *Middle Panel:* The experiment is defined. *Right Panel:* The results of the experiment.

be directed toward helping the student develop investigative problem solving skills in addition to providing content information in a specific discipline and promoting a positive attitude toward science. In other words, the curriculum should deal with the scientific reasoning process as well as specific factual content. Computer-based learning materials, as part of such a curriculum, should also help students develop their reasoning skills.

Traditional tutorials, however, seldom include a component designed to reinforce scientific reasoning or problem-solving skills. What options are available for including such a component? Some authors have incorporated simulations into teaching programs.[2,5] In these programs, students predict how the model will behave under a specific set of conditions. The model is then run, and descrepancies between the predictions and the actual model results are "discussed" with the student. The objective in these exercises is to help students develop the ability to analyze the behavior of complex systems.

Another approach is to reinforce the notion of posing and testing hypotheses by having the students test their answers (hypotheses) to the tutorial questions by running experiments. In this case, simulations are again incorporated into the tutorial. A recently developed tutorial dealing with osmotic pressure and osmotic relationships serves to illustrate this approach.

The tutorial begins with a demonstration of water movement in an osmometer after a 1% sucrose solution is added to one side of the semipermeable membrane (Figure 1). The next several screens ask the student what took place, explain the phenomenon, and define osmotic pressure. In asking the student what happened, the program begins to deal with the process of data gathering. The student is then asked whether the size of the particles, the number of particles, or both determine the osmotic pressure (Figure 2). No information regarding the answer to this question is presented in the previous screens. Thus, the student must form an hypothesis. In the example shown in Figure 2, the student has hypothesized that the size of the molecules is an important factor. The program then allows the student to test this hypothesis by providing a simulated osmometer with several choices for the molecules placed on one side of the osmometer membrane (Figure 3). Upon completing the experiment, the student may choose to run another experiment or choose to stop gathering data. If the student has not run at least two experiments, the program reminds him that there is insufficient data with only one experiment to test the proposed hypothesis. The student must then run a second experiment. If sufficient data have been gathered to test the hypothesis, the program asks if the data support the proposed hypothesis. The program response provided following the correct choice reinforces the observed results of the experiment rather than only restating the correct answer.

PROS AND CONS

It is clear that this approach forces the

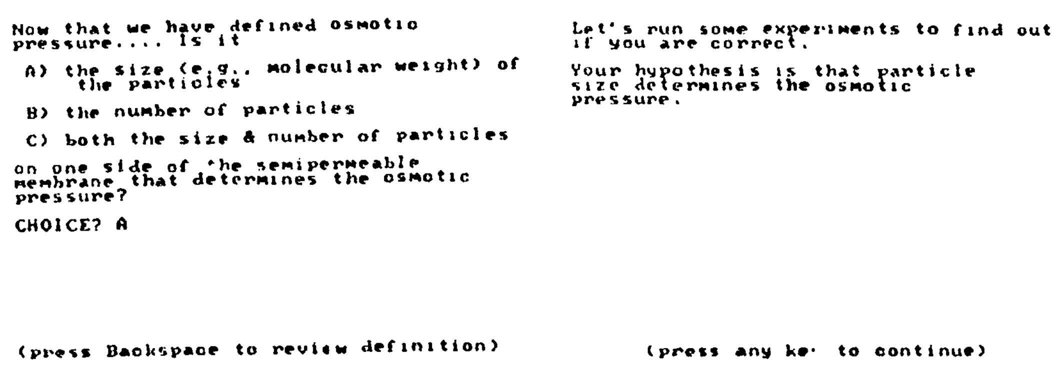

FIGURE 2. The student is asked a question without the benefit of prior information from the tutorial. The answer becomes an hypothesis to be tested (see text).

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student to engage more actively in a scientific reasoning process than the more traditional format that presents information and reinforces that information by asking fact-based questions. It is also clear that this tutorial takes more time to complete than a traditional tutorial covering the same information. One must ask if this time is well spent. That is, will students using tutorials of this design begin applying the hypothesis posing-testing approach to other modes of study? It is doubtful that one tutorial would have such an impact. However, when a critical mass of tutorials with this design have been developed, studies can be designed to address this question.

CONCLUSION

We must, when designing tutorials, address the issue of whether such software should focus exclusively on content or should process also be an important consideration. If, as teachers, we feel that knowing how to deal with information is as important a lesson as the specific facts of a content area, we must do more to incorporate process into our teaching materials. Perhaps using "simulations" as a vehicle for assessing responses in "tutorials" will provide the added ingredient that truly distinguishes the computer tutorial from the high-tech textbook.

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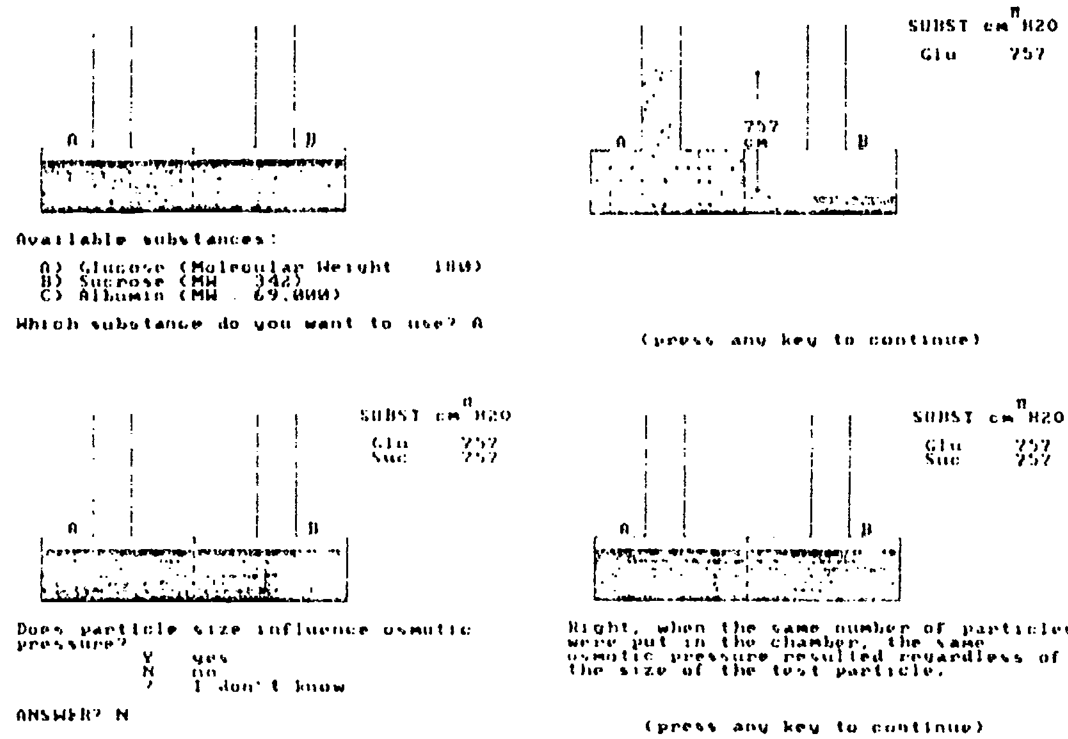

FIGURE 3. A series of screens presented in response to the student's hypothesis that particle size determines osmotic pressure. *Upper left:* The available experiments are defined. *Upper right* The student has run an experiment with glucose. *Lower left* The student has decided to stop collecting data and must make a conclusion based on the observed data. *Lower right* The program reinforces the correct conclusion.

CLSE 1990 COLLEAGUE DIRECTORY – PART 3

The primary goal of the National Resource for Computers in Life Science Education (NRCLSE) is to cultivate collaborative efforts among life science faculty interested in using the computer as a teaching tool.

The listing that follows is a continuation of the 1990 directory published last month. It is updated from the 1988-89 directory and was drawn primarily from respondents to questionnaires printed in CLSE (see page 8 in the January CLSE). It is intended to help readers identify colleagues with common interest areas.

The listings are arranged by the content areas identified in response to the question, "What content areas do you teach?" As a result, entries may appear under more than one heading.

Although every attempt has been made to ensure that the information is current and correct, it is likely that some errors appear in this list. We apologize in advance for any inconveniences that may arise due to such oversights.

If you are aware of other colleagues that should be listed, please encourage them to return the questionnaire that appeared on page 8 of the January issue of CLSE, or send their names, addresses, phone numbers, BITNET addresses, and teaching content areas to:

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AIMS AND SCOPE

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PREPARATION AND SUBMISSION OF MATERIAL

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COMPUTERS IN LIFE SCIENCE EDUCATION

CONTENTS

INTEGRATED SYSTEMS FOR TESTING AND GRADING

Gloria H. Lombardi
County College of Morris, Randolph, New Jersey

Personal computer based programs are available that permit test preparation, test delivery, test scoring, test analysis, and grade management. One or more of these functions such as test banks and test scoring have been previously available. Now, integrated software packages provide a fully automated system for test administration and grading. This allows an educator greater flexibility in test design and enhances the quality and reliability of the exam. In addition, the rapid access to the test data and the automation of record keeping frees the educator to do tasks that improve the quality of education.

The integrated systems manage all the details of producing a test in an interactive form. The educator creates a test from an existing test bank. The test is graded, the item analysis is updated, and the point valued is placed in the grade book within a very short time. The key can be corrected, the test rescored, and the roster updated in a few seconds.

There are several systems on the market that have these capabilities. These include the Par System, examSYSTEM, MicroTim, MicroPac, and the Examiner. These systems are user friendly, require

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no programming skills or sophisticated computer skills, and prompt the user at every step. There are other systems on the market. However, because this author is not familiar with them, they will not be included in this discussion.

There are features common to all integrated software packages for the components of test preparation, test delivery, test scoring, test analysis, and grade management. There are also features unique to specific packages. How does one decide on a package? Some considerations will be discussed including features of specific packages.

SYSTEM REQUIREMENTS

Only MicroPac can be purchased for the IBM or Apple. The rest are IBM compatible. All of the programs support popular optical scanners. Although speed of optical scanning is dependent on the hardware available, the convenience of having an automatic class roster and an automatic input of student responses generated is significant. If you give a test of more than 100 questions, you must consider a scanner model that reads two columns of answer forms (ParScore delivers 200 questions per test).

PRICE

The software package prices begin at about $1200 and range to over $2000. The Examiner is the most expensive of the packages. One needs to consider the price of the microcomputer, scanners (which begin at about $1300), answer forms, and special cards and cables necessary for the computer.

DOCUMENTATION

How well is the program described? Does it lend itself to staff and faculty training? The better the documentation, the easier it is to educate new staff and faculty. Are the developers available for consultation? Our institution uses the Par System which has excellent documentation and user support.

TEST PREPARATION

The preparation of tests can be streamlined through the use of test item banks. Test item banks are a collection of coded test items where the number of test items is larger than the number of items used in a test.

As educators, we want to use a variety of test questions. The software testing programs should allow matching, multiple choice, fill in the blank, true-false, and case presentations. You might want to consider the inclusion of graphics into items. The more restrictive the format, the least likely the software package will be accepted by the faculty.

What means does the program have of entering test questions? How easy is it? How do you make changes? Is the software compatible with other word processors? Is there a built-in editor?

Test security needs to be considered especially when building a very large pool of items over an extended period of time. The Examiner meets the most stringent security requirements. It is protected by passwords, and all the items are encrypted when stored on disk.

The method of coding, selection of items, and type of items to include in a test varies greatly from program to program. I would suggest conducting a needs analysis of the potential users, and then looking for the program that best meets their needs. MicroTim includes a biochemistry item bank of 7,000 questions.

TEST DELIVERY

Once the instructor develops a test, it can be delivered to the student via computer (on-line testing), or in printed form (off-line testing). Careful consideration of available hardware must be taken into account before the faculty makes a decision to test students on-line. The Par System and the Examiner allow for on-line testing. For off-line testing, the software package should be flexible to meet the unique needs of all faculty. The features of the test generating package should be evaluated to ensure that directions, titles, graphics, and test format all conform to the desired style of the instructor.

ParScore allows "on the spot" on-line correction of errors and prints an error log for later reference. The student responses are also recorded. This is an especially important feature if a student tries to alter the answer sheet.

TEST ANALYSIS

After scoring a test, the results can be used for item analysis. A statistical analysis is also used to analyze the results of the test. All the programs put the results of an item analysis directly into the test item bank. Each program differs in the analysis of the test. ParScore includes the mean, median, standard deviation, and the KR-20 reliability ratio in the analysis of the test. In ExamSystem, all classes taking the same test can be combined for statistical summary reports.

GRADE MANAGEMENT

Once a test has been delivered, student grades may be accumulated using several methods. Does the software package provide for test grade averaging, ranking and so forth? In the examSystem, the grade book can handle up to 90 different scores per student per class. Grade criteria can be changed at any time. Letter grades are automatically assigned based upon the instructor's grading criteria.

FEEDBACK OPTIONS

Does the software provide student feedback to each question? MicroTim allows automatic display of instructor generated error explanation upon entry of an incorrect student response. It also allows student feedback to the instructor about particular questions through a comment facility.

The interactive microcomputer software systems offer a faculty a decision

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making tool for flexible test design and construction, provide rapid access to test data, and are a tremendous savings in faculty time. I feel that the time saved in test construction, and the improved quality of the test, as well as the ability to track students far outweighs the costs incurred by the system.

VENDORS

Examiner
Media Computer Enterprises, Ltd.
880 Sibley Highway, Suite 102
Mendota Heights, MN 55118
(612) 451-7360

ExamSystems
National Computer Systems
11000 Prarie Lakes Drive
P.O. Box 9365
Minneapolis, MN 55440
(800) 447-3269

MicroPac
MicroSystems Software, Ltd.
Educational Systems
P.O. Box 3123
Tempe, AZ 85281
(602) 966-8615

MicroTim
JL Educational and Computer Services
P.O. Box 35142
Dallas, TX 75235
(214) 351-1283

Par System
Economic Research Inc
P.O. Box 7200
Costa Mesa, CA 92626
(714) 641-3955

KEEPING ABREAST OF THE LITERATURE

The following citations are presented as part of a quarterly feature in CLSE designed to help readers become aware of current literature pertinent to computer applications in life science education.

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WANTED

– Feedback –

- Is CLSE meeting your needs?
- Have important topic areas been overlooked?
- Should more regular features (eg, Keeping Abreast of the Literature) be added?

To serve you best, we need your input. Please send comments and criticism to:

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THE BULLETIN BOARD

The Bulletin Board is published periodically to inform readers of upcoming meetings of interest. If you know of meetings, symposia, continuing education courses, etc, of interest to life science educators, and they do not appear in The Bulletin Board, please let us know. Send pertinent information to:

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OCTOBER 2-3, 1990. EdNET 90: The Educational Technology and Telecommunications Markets Conference. Washington, D.C.

Contact:

Nelson B. Heller and Associates
Suite 600
707 Skokie Boulevard
Northbrook, IL 60062
(708) 205-4390

OCTOBER 4-6, 1990. "Information Systems and Technology for the 1990's" Annual conference, Association for Computer Educators. Minneapolis, MN

Contact:

Tom Seymour
College of Business
Minot State University
Minot, ND 58701
(701) 857-3110

OCTOBER 9-11, 1990. 3rd Annual Multimedia Expo. San Francisco, Ca.

Contact:

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110 Greene St. #703
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(212) 226-4141

OCTOBER 14-17, 1990. EDUCOM '90. Preparing for the renaissance.

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Atlanta, GA

Contact:

EDUCOM '90
P.O. Box 364
Princeton, NJ 08540

OCTOBER 24, 1990. Videoconference - Educational Technology for Nursing: A Solution for Today's Problems. Cupertino, CA

Contact:

Gladys Penner, Teleconference Coordinator
De Anza College Television Center
Cupertino, CA 95014
(408) 864-8300

OCTOBER 28 - NOVEMBER 1, 1990. 32nd Annual ADCIS Conference: Restructuring Training and Education Through Technology. San Diego, CA

Contact:

ADCIS International Headquarters
229 Ramseyer Hall
29 West Woodruff Avenue
Columbus, OH 43210-1177
(614) 292-4324

November 7-11, 1990. IFER Workshop on Alternatives in Education. Houston, TX

Contact:

International Foundation for Ethical Research
53 W :t Jackson Blvd.
Suite 1542
Chicago, IL 60604
(312) 427-5025

NOVEMBER 15-16, 1990. Western Educational Computing Conference - "The 90's: The Decade for Transition", Irvine, CA

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Gene Dippel
Computer Center
California State University, Fullerton
Fullerton, CA 92634
(714) 773-3263

JANUARY 18-20, 1991. Association of Biologists in Computing, Los Angeles, CA

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Bob Desharnais
Biology Department
California State University, Los Angeles
5151 State University Drive
Los Angeles, CA 90032-8201
(213) 343-2056

FEBRUARY 5-8, 1991. 11th Annual Florida Educational Technology Conference. Tampa, FL

Contact:

Barbara Ann Cox
Conference Coordinator
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FEBRUARY 20-22, 1991. Fifth Annual Conference - Learning Technology in the Health Care Sciences and Eighth Annual Conference - Interactive Instruction Delivery. Orlando, FL

Contact:

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ERRATUM

Modell, Harold I: Designing computer based tutorials to reinforce reasoning skills. *Computers in Life Science Education* 7(8):57-59, 1990.

The citation of references in the body of the article do not correspond to the order in which the references are listed. The following list properly identifies the references as cited.

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To be effective in our effort to promote a communication network among life science educators interested in using computers in their educational efforts, ***we need your help.*** If you have not completed our questionnaire this year, please take a few moments to complete the questionnaire below and return it to the following address:

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What content areas do you teach? ____________________________

What student population(s) do you serve? (Please check appropriate categories)

____ Undergraduate ____ Graduate ____ Nursing ____ Medical

____ Allied Health ____ Dental ____ Veterinary

____ Other (please specify) ____________________

Are you currently using the computer as an educational tool? ___ Yes ___ No

If yes:

How many years have you used the computer in this way? ______

What kind of equipment are you using?

Have you written any software for use in your teaching efforts? ___ Yes ___ No

What commercially available software have you found useful?

Would you be willing to help critique software for peers? ___ Yes ___ No

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COMPUTERS IN LIFE SCIENCE EDUCATION

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A COMPARISON, FOR TEACHING PURPOSES OF THREE DATA-ACQUISITION SYSTEMS FOR THE MACINTOSH

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As the first phase of studying how computers might be used for data acquisition in teaching laboratories of the Biology Department of Drake University (and as a necessary prelude to purchasing a system for doing that), I conducted a "hands-on" comparison of two systems that seemed especially suited for this purpose, coupled with a more limited comparison of a third system.

Each of the three systems proved to have many virtues, but they differed in several important respects and in how suitable we judged them to be for our department and program. One widely advertised and much acclaimed system, LabVIEW software and accompanying hardware from National Instruments, we judged the most versatile and powerful but far too difficulty to learn to fit our needs. A less well-known system, Analog Connection WorkBench software and accompanying hardware from Stawberry Tree Computers, was judged easy to learn and use and powerful enough for all our anticipated uses; it was the one

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chosen for purchase. The system seen in less detail, MacLab hardware and software from World Precision Instruments, was judged to be the one best preadapted for routine physiological recording and to have the easiest instruction manual to use. But it is so much less powerful and flexible than the other two programs that we judged it less suitable for our immediate project of investigating the whole range of possible applications of computers to teaching laboratories.

The conditions and results of the comparison are presented here in some detail, in the hope they might aid other departments in judging which of the systems is most likely to fit their particular uses.

BACKGROUND

Data from instruments can be read directly into computers to be stored, processed, and graphed. Signals from the computer can be used to control the experimental procedures and measuring instruments. Both these functions of computers have become increasingly important in research and testing laboratories, usually with expensive computers dedicated to specific tasks.[4,5] Such technology, however, is rare in physiological and other biological teaching laboratories, both because of expense and because of the difficulty of making appropriate hardware connections and writing the necessary programs.

All these barriers to the use of computers in teaching laboratories — for controlling instruments and acquiring data from them— are now becoming much less formidable. Powerful and versatile systems are now available for these purposes, using the same relatively inexpensive microcomputers used for other purposes. Several of these systems are advertised as being user friendly, requiring little electronic knowledge and no familiarity with programming languages.[2,3,7] Most of these systems present menus for choices about their operation.

THE CONTESTANTS

The claim to be user friendly is made with special strength by the two systems for the Macintosh that were the primary subjects of my comparison. With both of them, the details of operation are programmed by means of icons, similar to those familiar to users of the Macintosh. These icons can be combined in flowcharts to create unique programs. In addition, many choices are presented in menus. The two systems include much the same sorts of hardware and software. The hardware consists of a board inserted in the computer and fastened by a cable to an external connection block, which has screw-terminals accepting wires from any external source. The software includes "drivers" for the board (invisible to the unsophisticated user) and the iconic programming language.

The better known system is from National Instruments of Austin, TX; the programming language is called LabVIEW. It may be used either with one of the National Instruments boards or with boards supplied by certain other companies.[8] (I will, somewhat inaccurately, refer to the whole package tested, both hardware and software, as Labview.)

Less well publicized is the system supplied by Strawberry Tree of Sunnyvale, CA, whose software is called Analog Connection WorkBench. It supports only the boards from Strawberry Tree. (I will call the whole system Workbench.)

These systems were compared directly with each other and less directly with MacLab from World Precision Instruments (WPI) of New Haven, CT. This was seen in a demonstration by a WPI representative, in a "demo-disk," and in a colleague's laboratory. MacLab is menu driven; yet it cannot be programmed in the sense the other systems can be (although many options are presented) and does not have much capability of controlling instruments (although this is promised for the future). It is mentioned in this comparative study because, in conspicuous contrast to the two systems being primarily considered, it was designed specifically to fit the needs and expectations of physiologists and biologists and is accompanied by instructions biologists have little trouble reading.

BASIS OF COMPARISON

The three systems were compared on the basis of versatility, suitability, and feasibility; they showed differences with regard to all three.

Versatility was judged with respect to possible uses in the Drake Biology Department, on the basis of trials of a few of the possible applications, and of information in the instruction manuals supplied with the various systems. Our student laboratories include a variety of measuring instruments, all of which generate data that might usefully be analyzed with the computer. Most obviously, the laboratories in physiology, cell biology, and occasionally in general biology measure quantities that change in minutes or fractions of a second, including both biopotentials and physiological actions detected by transducers. In these and other areas of study, various instruments need to be turned on and off or triggered to perform particular operations, all at particular times and under particular circumstances. The need for power and versatility in student laboratories is increasing for our department as we increasingly involved undergraduate students in research activities.

Suitability was judged by comparing the capabilities of the hardware and software (according to specifications and descriptions supplied by the manufacturers) with what were assumed to be the most difficult uses to which we might expect to put them, and by testing a few of these challenging applications. the three areas of greatest concern were frequency response (how fast changing a signal could be faithfully recorded), sensitivity (how small a voltage change could be detected), and data manipulation (how many of the desired analyses of data and comparisons between sets of data could be performed and how easily). Feasibility was a judgement of how user friendly the systems really are — whether it will be practical to try to use them for our purposes. This judgement was based on my personal experience in the comparison project. Answers to questions of feasibility of such systems are very much a function of the individual people who would actually use them. Can I, as the department member first involved in trying to use the systems, succeed in doing so in the time available? Can I expect other members of the department, with a little bit of help from me, to develop and apply the necessary skill to use the system in their laboratories? Will our students be able to do some of their own

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programming for their own projects?

My personal capabilities for learning to use such systems are probably not unusual among physiologists and biologists. I have long used, and occasionally tinkered with, a variety of instruments including physiological recorders. Many years ago I took two coursed in physics and one in electronics, and I have taken (but not used) three courses in simple computer programming. Just by using manuals and occasionally asking questions of the experts, I have taught myself to do what I wanted to do with the Statistical Package for the Social Sciences, and with Microsoft EXCEL, as well as learning to use three word processing programs on three different computers. Thus if I can use these data-acquisition systems, most biologists can. If I cannot do so without extensive training, many others cannot either!

Just on the basis of catalog descriptions and of the reviews that were available,[8,9] it seemed fairly evident that the three systems constitute a progressive series in both power and ease of use, with MacLab the least powerful and easiest to use and Labview the most powerful and the most difficult to use. But catalogs and reviews can be misleading. Some reviews in trade magazines are even written by representatives of the company promoting the product[1] or are based heavily on the specifications furnished by various suppliers. Even the objective reviews of new technology, generally written by engineers, may not be realistic about the suitability of a product for the final user.

The purposes of this comparison project were, first, to determine whether the published comparative descriptions of these three systems are correct, and second, to assess how critical are the differences among these systems in power and ease of use. The conclusion was that the comparative series is correct and that the differences can be critical.

CONDITIONS OF THE TEST

Representatives of Strawberry Tree and of National Instruments allowed me to borrow hardware, software, and manuals for two months in the summer of 1989. The two systems were installed in a Macintosh II computers with a 20Mb hard disk, furnished by a grant from Drake University Computer Intensive University Project. I worked principally from the manuals but made a few telephone calls for programming advice from the representative of the two companies. (Both Strawberry Tree and National Instruments supplied competent, quick, courteous, and imaginative advice by telephone.) The MacLab system was demonstrated to several faculty members a couple of months before the comparative study began; a demonstration disk and a manual continue to be available for reference, and a colleague in a neighboring department has just begun working with MacLab.

The two systems, Labview and Workbench, were compared by setting up each one to accomplish two tasks. The first task was to receive an electrocardiograph signal, display it in real time, and record it for more detailed computer analysis. The second task was to supply power to a force transducer, receive, display, and record the signal, and facilitate zeroing and calibration. The capabilities required by these two tasks are basic for physiological teaching laboratories and resemble the capabilities of popular physiological recorders (plus the ability to record data in a form suitable for direct analysis using the computer). In addition, the capabilities tested broadly overlap with those of MacLab, making that further comparison possible.

It was originally intended that Labview and Workbench would be studied in an evenhanded way, but there came to be two expectations to that policy. First, Labview was installed and demonstrated by a company representative, who used it to program a "virtual instrument" (a software program controlling acquisition and use of data) for displaying and recording electrocardiograms (ECGs). (I later modified this virtual instrument for use with the force transducer.) Workbench, however, was shipped to me, and I installed it and started using it on my own. The second exception was that I spent about twice as much time during the trial period working of Labview as with Workbench.

COMPARATIVE DESCRIPTIONS

Hardware

The differences in hardware between Labview and Workbench are not critical, but the MacLab hardware is significantly different from the others.

The particular National Instruments (Labview) and Stawberry Tree (Workbench) data acquisition boards that were compared are very similar in capabilities. Both provide for eight channels of analog input (recording of quantitative electrical signals), and two channels of analog output [controllable direct current (DC) voltage up to ~10 V]. Each also offers eight channels of digital output or input (pulses that trip switches or signal the state of switches). The one important difference between the two is that the Labview board (NB-MIO-16L-25) is described as having a maximum sampling rate of 40 kHz on a single channel, whereas the Workbench board (ACM2-12) can sample at a rate of only 10 kHz. This difference is critical for recording the shape of a nerve impulse. (Workbench promises a new board soon, capable of more than 40 KHz.) (For recording on multiple channels simultaneously, the sampling frequencies possible may be reduced by as much as a factor of five.)

Either board is connected by cable to an external panel with screw-terminals for wires to and from laboratory instruments. The Labview connection panel is a little easier to connect wires to but is not as well labeled as the Workbench panel; labels facilitate using the right terminal. The Workbench panel offers 5, 12, and 6.9-V fixed power sources, the Labview panel only 5 V. The 5-V source is intended for use with the digital signaling system, but can be used to supply excitation voltage to a bridge-type transducer, as can the 12-V source. The 6.9-V supply in the Workbench board is described as regulated, to give an especially steady excitation. But the manuals for both systems warn that the power sources available on the connection panel might not supply a full eight transducers at once — perhaps only two or three. (With the 12-V supply from the Workbench board, transducers might be connected both in series and in parallel, to a fairly large total, depending on their resistances and voltage requirements.) Thus for multiple transducers, it may be necessary to use an external battery or power supply anyway; so the differences between connection panels are not critical.

In contrast to these two systems, MacLab has no internal board for the computer; the hardware is external, with connections by way of the serial port. (this means that data may be acquired using a Mac Plus; a Mac SE or Mac II is not required, but the hardware is much more expensive.) The external hardware includes a power supply for transducers and circuitry for balancing, zeroing, and calibrating them, preamplifiers for magnifying weak signals, and a stimulator. The frequency response on one channel is 40 kHz, sufficient for nerve impulses. There are no provisions for digital input or output for us in controlling instruments, although the stimulator output can be used for some kinds of control. The model I have seen provides only four channels of analog input, one channel of analog output, and no digital input or output (compared with 8,2, and 8, respectively, for the other two systems.) A newly available version offers eight channels of analog input, but still no digital capability.

Software

Both Labview and Workbench can be described as programming languages that use Macintosh icons instead of written commands. The programmer selects icons from a menu and arranges and connects them by "wires" into a flowchart. The software instantly creates a program that carries out the operations indicated. The flowchart remains as an easily readable documentation of how the program works. National Instruments uses the term "virtual instrument" for these programs and for their visual representation as flowcharts. LabVIEW is an acronym for Laboratory Virtual Instrument Engineering Workbench. For some particular instruments, National Instruments offers prewritten virtual instruments in which the appearance of the computer screen closely mimicks the front panel of the instrument being controlled and monitored. In this discussion, I will occasionally use the term "virtual instrument" for flowchart programs of either system.

For building a virtual instrument, there are icons representing particular analog input channels (for receiving electrical signals that may vary in any pattern), analog output channels (for emitting electrical signals in some pattern), and digital input and output channels (for signals that are either on or off). Each of these external icons represents one of the sets of screw-terminals on the external panel. There are also internal icons for generating values or pulses, turning parts of the program on or off, and performing a great variety of mathematical and logical operations on signals coming to them. Finally, there are icons for logging data onto disk and for displaying it in meters or charts.

Once the programmer has in mind which icons to connect in what order, this is easily accomplished with either Labview or Workbench, using the mouse. A particular setup might take 15 minutes to construct with Labview as opposed to only 5 minutes with Workbench, because in Labview the mouse must be changed into particular "tools", and because "wires" must be removed from them before icons can be shifted. But the result is a somewhat more readable flowchart. Similar tradeoffs without great advantage to either system can be noted with regard to many other small differences in the styles of the flowcharts of Labview and Workbench.

The really critical difference between Labview and Workbench is in the number of different icons. Workbench has only 14 (although some of them represent a great variety of functions that can be chosen), whereas Labview offers many more, many hundreds, often with multiple options. A large fraction of the Labview icons perform functions that can be duplicated by combining two or more Workbench icons; another large fraction perform functions and manipulations of data that cannot be so duplicated with Workbench.

Its many functions make Labview not only a data-acquisition system but a powerful data-processing program as well. It can perform not only algebraic manipulations but sophisticated statistical analysis and several kinds of Fourier analysis, among others. It appears that most often these analyses would be performed on already-collected data, but some might be important on-line for changing, automatically, some aspect of the whole setup.

Workbench, in comparison, has limited data-processing capabilities. Many algebraic functions or two streams of data may be calculated and then logged, displayed, or used to control something, but statistical and other analyses are hardly represented. Thus any detailed analysis of data acquired from Workbench requires logging the data and entering them into a spreadsheet, statistical, or graphics program.

Any analysis of recorded data that is done by a data-acquisition program can be done equally well by one of these other programs, so the critical importance of capabilities for data analysis concerns what can be done on-line. The first important reason for a data-acquisition program to include some processing abilities (as both Labview and Workbench do) is to give immediate display of the derived output of some instruments, for immediate use. The second reason, potentially much more important, to use the results of calculations to turn on logging or fast recording, to prompt the sending of a digital control pulse, or to control the response to an incoming signal pulse. Labview offers a greater variety of calculations that can be used for such purposes.

The problem with having multiple icons for programming and multiple choices for calculations, as Labview does, is that there is so much to learn before a virtual instrument can be constructed. Although the manual describes each icon, it is difficult to know which description to look up, and in what sequence the descriptions must be studies to be intelligible. Furthermore, the manual is uneven in its treatment. It gives a good description of how to manipulate and "wire" icons on the screen and how to use simple calculation icons to achieve a result. However, it gives very little guidance in the use of the more advances features, i.e., multiple icons for controlling analog input and output, and "structures" for defining the sequence or duration of particular operations. Consequently, it is just not practical to use the manual to teach oneself to use Labview to construct a variety of virtual instruments. In sharp contrast, on can easily learn to build virtual instruments with Work-

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bench, using just the manual.

Feasibility: hands-on experience

These opinions are based on and illustrated by my hands-on experience during the summer of 1989. Workbench manual in hand, I created, in a few hours, a virtual instrument that displayed my ECG very well, and I added a feature that kept the mean voltage at zero. In a few days, I modified and augmented this into a virtual instrument that supplied excitation to a force transducer and displayed its output, that corrected the output to zero when no load was applied, and that calibrated the virtual instrument to give a display in grams. At first, I had to type in values (generated by the instrument) for zeroing and calibrating, but in another day's work I modified the virtual instrument, so that when I pressed a button (with the mouse) when there was no load, the instrument zeroed itself; with a 2-g standard added, I pressed another button, and the instrument calibrated itself. I am now confident that I can learn to perform a greater variety of such control and data manipulations and can show my colleagues and students, in minutes or hours, how to begin to do this for themselves.

My experience with Labview was different. The National Instruments representative had used Labview to create for me a couple of virtual instruments for displaying ECG (it took him a number of minutes). Using the manual, I worked for several weeks to modify and augment one of these to display calibrated data from a force transducer. For 2 weeks I was frustrated as I have ever been; then I began to understand how to do such simple things and construct a quite satisfactory virtual instrument that I could zero and calibrate by typing values from a display into an icon. I spent a week or two trying to duplicate my Workbench provision for automatic zeroing and calibrating, but I was not successful. (I think I was pretty close when I decided to quit!) I would guess that if I spent 2 or 3 months doing nothing but read the manual and tinker with Labview, I could learn to use it quite effectively (and so could some other biologist). But it would not be an efficient thing to do (and might not yield a sane biologist!)

National Instruments offers 3-day training courses in Labview for about $500 per person; in retrospect, it would have been wise for me to include a Labview training course in my evaluation project. It is my judgement that a department should plan to use Labview only if it can provide such training for everyone who is expected to create new virtual instruments. I suspect that even with the training it would require quite a bit of practice to become and remain proficient in Labview. Given the slim budget of our department and the only tentative interest on the part of some members who might profit from a data-acquisition system, I was not able to recommend that we choose a system that requires so much training for its users.

How much did our department lose by not choosing Labview, the more powerful system? I cannot give a clear answer to that question. For data that have previously been gathered, Labview has many provisions not provided by Workbench for processing, comparing, and displaying them. However, the most important of these processing capabilities are otherwise available. Faculty and students at Drake University have Microsoft EXCEL available to them; this or another spreadsheet program can perform most of the manipulation, statistical analysis, and graphing in which we might be interested. Also, quite a number of the functions of which Labview is capable, fast Fourier analysis is an example, are more commonly used by physicists and engineers than by physiologists and biologists.

The third system, MacLab is, again, quite different. There is no programming (iconic or otherwise) to perform special tasks, although there is a great deal of choice about such things as amplification, calibration, sampling rate, and display. MacLab can perform several analyses of data, different but somewhat comparable to the capabilities of Workbench, but not approaching the variety of Labview. MacLab has several built-in functions — difficult or perhaps impossible to duplicate with Labview or Workbench — that a physiologist might find very attractive. Most notably, one can review a complicated curve on the screen, use the mouse to select a portion of it, display that portion in greater detail, and store just that portion on spreadsheet form. Also, if one points with the mouse to a particular point on a curve on the screen, the program will display the numerical value (to several decimal places) of the coordinates at that point, and if desired, the slope. Other provisions similarly mimic and facilitate the kinds of examination commonly made of data gathered with physiological recorders and oscilloscopes. Data is logged to disk for further analysis on a spreadsheet just as with the other two systems. If one wishers only to duplicate (at a saving) the actions of physiological recorders and simple oscilloscopes, to add a few new analyses, and to record data for computer processing, MacLab is the easy way to do it. Its manuals are detailed and well written, specifically for physiologists and their projects. But one must then settle for the (very nice) options that MacLab offers, and for only a very limited ability to control instruments. (World Precision Instruments now offers a software program, WaveEdit, that costs $400 and is said to work on any data in spreadsheet form and that includes many of MacLab's abilities to display data in graphic form for closer examination, selection, and storage. This capability may prove useful whatever system is used to acquire the data.)

Speed

All three systems can record data for a limited period in a "fast mode", with sampling frequency limited only by the hardware: 40 kHz for Labview and MacLab, 10 kHz for Workbench. I presume they all function as advertised. (I have used this capability of Workbench, quite successfully, to record, calculate, and eventually display the "loop" of electrical axis of the heart.)

During normal (as opposed to fast operation, however, the three systems differ significantly in "cycle time" and, hence, in how faithfully any rapid changes of a signal are displayed or recorded. The cycle time is a function of how fast the software performs various calculations and adjustments. The effect of cycle time can be illustrated by my experience with displaying the ECG. A virtual instrument made with Workbench displayed an acceptable ECG on a continuous basis. Similarly, one of the standard options of MacLab did this at least as well.

By contrast, the similar Labview virtual instrument displayed ongoing ECG very imperfectly and inaccurately, not much more than an occasional blip on the line. This was not due to any deficiencies in the virtual instrument made for me by the National Instruments representative; rather, it was because Labview is very slow and cannot handle such rapidly changing signals. To understand this difference in effective speed, I compared cycle time (time between successive sampling of data) for my Workbench and Labview virtual instruments that zeroed and calibrated the output from a force transducer. The rival setups were nearly identical in number of icons and equally straightforward. However, the cycle time of the Workbench instrument was only 35 ms, whereas that of the Labview instrument was 1.1 s, nearly 30 times as long. It was only by accident that a sampling rate in this range would detect any indication of an ECG pattern! (This shows why, for rapidly changing data, the analytical and processing power of Labview cannot be used on line and must be applied only to data already recorded. This applies to complicated Workbench manipulations as well.)

Inventing new capabilities

The Workbench literature includes fairly detailed instructions to programmers who wish to create new functions to use; such functions become new options within the calculation icon. But programming such new functions requires skill with a programming language. Thus the level of difficulty of using Workbench increases abruptly form "iconic programming" to "new function ."

Although MacLab does not have a provision for simple iconic programming, the company offers (at a cost of $595) a programming system using Pascal for creating new applications.

This is where Labview is clearly superior to the other two systems. All the new functions one might need are already available, symbolized by icons. Although it is more difficult to learn and to use for simple applications, Labview would seem to be no more difficult for complicated applications than for simple ones.

Like everything else in the computer world, data-acquisition systems are changing rapidly. All three companies considered here have recent or expected innovations in both hardware and software. National Instruments' newest catalog offers new, less expensive boards for classroom use. Strawberry Tree says a board with higher frequency response is imminent. World Precisions Instruments now offers eight channels, and, eventually, digital control.

It would be comparatively simple for both National Instruments and Strawberry Tree to make their systems far more attractive to physiologists and biologists than they are now. They could create half a dozen virtual instruments to gather the kinds of data most commonly of interest to physiologists and biologists, supply these virtual instruments on a disk, and accompany them with detailed instructions for their use. The virtual instruments would not need to be much more sophisticated than those I made last summer. Given such aids, new users could begin to use LabVIEW or Analog Connection Workbench immediately. Some users would never need to create new virtual instruments for themselves; these would fill all their needs. Those who wanted innovations could easily copy and then modify these standard virtual instruments or follow their patterns in creating new ones.

Costs

Any of these systems could replace, at considerably lower cost, most or all of the functions of standard physiological recorders and simple oscilloscopes, while adding the capability of reading data directly into computers for further detailed analysis. Comparative cost among the three systems depends not only on the list prices, but also on particular components chosen and any educational discounts that may be available.

The list prices (in US dollars) for the configurations compared in this article are as follows, based on the most recent price lists I was given.

National Instruments:

Board	1,195
Connector	150
Labview	1,995
Total	3,340

Strawberry Tree Computers:

Board	1,190
Connector	179
Workbench	995
Total	2,364

(The cost of a spreadsheet program for analyzing the data must be added to this.)

World Precision Instruments:

MacLab	2,925
MacBridge	975
Total	3,900

(As with Workbench, detailed data analysis requires additional software.)

The most expensive component of any of these systems is the computer itself, preferably with a hard disk, if any amount of data is to be collected. That is where WPIs MacLab has the advantage, since it can be used with any Macintosh. The particular boards for Labview and Workbench whose properties have been compared here are for a (relatively expensive) Mac II. For multiple use in a student laboratory, it would be preferable to be able to use the same iconic programming capabilities in a (less expensive) Mac SE (the smallest Macintosh that will accept an internal board.) Both companies make boards for the SE that might be suitable for student use, but with limitations.

National Instruments offers the Lab-SE board for only $595. It has the same numbers of analog input, analog output, and digital input-output (I/O) lines as the board for the Mac II, and an even faster sampling rate of analog input, i.e., 125 kHz. But the analog input channels are single-ended instead of differential. It is my understanding that it is either difficult or impossible to use single-ended channels for signals from bridge-type transducers, a major part of physiological instrumentation. So their suitability is doubtful. (A representative of National Instruments informs me that it would be possible to construct a virtual instrument that converted the 8 single-ended channels into 4 differential ones. If that virtual instrument is supplied, the Lab-SE board would be much more suitable for use in physiology laboratories.)

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Stawberry Tree Computers offers the ACSE-12-8 (for the SE) for only $695. Its analog input channels and digital I/O channels are like those of the board for the Mac II. But the SE board does not support any analog output channels, a moderately serious deficiency. The use of analog output to supply excitation current for bridge transducers can easily be replaced by connecting these to the several fixed-voltage supplies present on the connecting panel. Uses of analog output for providing stimulating impulses at programmed times can probably be replaced by using an external power supply (such as a stimulator) and regulating it by way of the digital output. I suspect that these substitutions would prove practical in student laboratories, so that this board would be useful.

COMPARATIVE SUMMARY

All three systems were judged suitable for use in student laboratories; they will gather the kinds of data we are likely to want for the kinds of experiments routinely done. Each system, however, has limitations. The MacLab system cannot be used for digital control of instruments, which may be important for some teaching purposes. The suitability of Workbench for recording nerve impulses depends on a new board with higher frequency response. The Labview system does not work well for displaying a fast signal on-line. But it is the only one of the three capable, by itself, of doing nearly all the kinds of data manipulation and analysis which might be of interest; the other systems must be supplemented with other analytical software such as a spreadsheet.

The versatility of both Labview and Workbench was judged quite sufficient for all our anticipated needs (although that of Labview is quite a bit greater). The versatility of MacLab is much less than that of the other two: this difference was decisive in eliminating it from consideration for our immediate purposes of investigating all possible applications.

The feasibility (ease of use) also differed decisively. MacLab is much superior in this regard, whereas Workbench requires more effort than MacLab but is still quite acceptable. By contrast, it would be feasible to use the Labview system only if all those people putting it into operation took a training course in its use. On this basis, Labview was eliminated from considerations for our department at the present time.

USING COMPUTERS IN TEACHING LABORATORIES

It has now become truly feasible for physiologists and other biologists — with no special training in either electronics or computer programming — to use computers in teaching laboratories for acquiring as well as manipulating data. The three systems reviewed here can, to different degree, make such use feasible. Just what applications of this technology are practical, and how much these applications can improve the educational process, are matters still to be determined. Our department will be considering these questions intently in the near future and probably for a long time to come. Other departments will need to make the same judgements. The following possible uses are among those that need to be evaluated.

Recording data for later analysis

Data recorded directly into a computer are stored in a form directly accessible to spreadsheet and statistical programs, eliminating the necessity of keying in the data. For isolated values, this is of limited value, except that the values are presented in numerical form and need not be estimated from a tracing. The real utility comes of there is interest in a continuous stream of data or a whole sequence of sampling points or if the computer can be used to pick out the points of interest from such a stream or series. Some laboratory exercises may be devised or improved by taking advantage of these capabilities. All three systems reviewed here record data quite satisfactorily, but only Labview provides, of itself, a wide choice of further analyses.

Constructing physiological simulations

Any physiological process or control system that might be simulated with an electromechanical model can be even more easily simulated with a virtual instrument constructed using Workbench or Labview. Kiel and Shepherd,[6] using Labview, have published a simulations of several cardiovascular functions. Constructing such simulations is much easier using iconic programming than with conventional programming languages. The available options for display will probably not allow the simulations to appear either realistic or esthetic, but the available labeling capabilities can allow them to be quite informative. With Workbench (but not with Labview) it would be suitable to assign the construction of simple simulations as student exercises.

Enhancing and replacing instruments

Any device that emits an electrical signal in proportion to some quantity of biological interest can be connected to the computer with one of these systems reviewed here and be zeroed and calibrated. The data can be sampled and recorded continuously or at chosen intervals or circumstances, all with minimal difficulty and at no expense after the initial investment. This means that it may be cost effective to replace physiological recorders (and some associated equipment such as preamplifiers and stimulators) with computer systems. Beyond this, it is possible to take antiquated but still functional measuring instruments already available in a teaching laboratory and, by connecting them to a computer system, turn them into modern "smart" instruments capable of various calculations and enhancements. The Labview and Workbench systems lend themselves well to this kind of use. With Workbench, it would even be possible to have students plan and program the enhancements to be made with certain instruments; this would be a way of assuring that the students understand what their instruments are doing. In contrast, MacLab can receive, amplify, and record the output from instruments, but the connection cannot be as thoroughly customized as with the other two systems.

Automating laboratory manipulations and data gathering

Many experiments that might be of interest in a teaching laboratory require several hours of elapsed time, during which conditions are manipulated and data is gathered. Such an experiment cannot be fitted into a 2- or 3-h laboratory session, and there are often many practical difficulties to having even a few of the students work during the extended period necessary. Such computer systems as those described here may make such extended experiments more feasible. Many experimental manipulations (turning lights on or off, adding some ingredient to a solution, even adjusting the tension of a connection) can be performed by electronically controlled switches, pumps, or motors. With computer systems (Labview and Workbench) that can send and receive digital signals, it seems as though it would be relatively easy to prepare a program that would control such manipulations and record the ensuing data (which could be scrutinized during the following session of the laboratory.)

There are, however, several immediately obvious problems to such an ambitious scheme. How to make connections of digital control-signal devices to the computer is not intuitively obvious, and the manuals of both Labview and Workbench lack a complete discussion. Even more importantly, the various peripheral devices needed for such automation come with many different specifications, and the physiologist/biologist is unlikely to be confident of which ones are most suitable. Because the costs of such devices range from fairly expensive to very expensive, it is not cost effective to learn which are suitable by buying many kinds and trying them all. It will require efforts by many people to determine whether such automated arrangements are suitable for student laboratories and to instruct biologists in setting them up.

I look forward to reading, in future issues of *Advances in Physiology Education*, many descriptions of the successful use of computers in teaching laboratories.

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COMPUTERS IN LIFE SCIENCE EDUCATION

CONTENTS

A COMPUTER-BASED APPROACH TO REINFORCING COMMON PRINCIPLES IN BIOLOGY

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Students often approach each course in a curriculum as a body of completely new information that has little in common with previous or future courses. In doing so, they fail to realize that our understanding of biological phenomena is based on a set of basic principles that are applied in a variety of ways. For example, the rate of molecular movement in biological systems by diffusion is governed by the same factors regardless of whether that movement is in a plant or in an animal system. Our task as "teachers" of biology is to help students recognize the existence of these common principles so that they can develop a conceptual framework in which what they now perceive as new knowledge is, instead, viewed as an extension or application of prior knowledge. Many colleagues would argue that they do, indeed, reinforce the notion of common principles by referencing prior applications when presenting new topic material. For example, when a pulmonary physiologist discusses gas exchange, he may mention at some point in the presentation that the equations governing alveolar gas exchange are based on the same principle of conservation of mass as the "Fick" equation for cardiac output or renal clearance equations. This reminder is often one sentence in a stream of information that contains unfamiliar symbols and certainly not the same symbols that were used when conservation of mass was presented previously. It may precede or follow presentation of the new application of the principle. In either case, the student must associate the system spe-

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cific equation name (eg, Fick) with the principle before the similarity between applications can be made. As a result, the student often treats the new application as completely new information with a mental note to look back to find out what the Fick equation is all about. The student has again failed to apply prior knowledge to a new situation.

One approach to this problem may be to "precondition" students by exposing them to common principles in the context of the course material prior to the actual presentation of the course material. The purpose of this exposure would be two-fold; first, to expose students to the underlying principle, and, second, to make them aware that these principles are applied in a variety of ways in different aspects of the course material. Taking this approach, we have begun to develop a series of computer exercises designed for use in an independent study setting focusing on common themes in mammalian physiology. The purpose of this article is to describe the underlying philosophy and the key elements of the program developed to make students aware of the variety of ways in which conservation of mass is applied to physiological systems.

```
INDICATOR DILUTION EXPERIMENTS

    1) GENERAL
    2) BODY FLUID VOLUMES
    3) LUNG VOLUMES

MASS BALANCE EXPERIMENTS

    4) MIXING FLOWS
    5) BLOOD-TISSUE GAS EXCHANGE
    6) MASS BALANCE IN THE KIDNEY
    7) PULMONARY GAS EXCHANGE
    8) QUIT

CHOICE?
```

FIGURE 1. Main menu from conservation of mass program The menu follows several text screens defining conservation of mass and emphasizing its importance in physiology.

TUTORIAL, DRILL AND PRACTICE, OR SIMULATION?

The overall goal of the program was to acquaint students with the principle of conservation of mass and demonstrate to them that even though specific applications of the principle may appear different, the underlying concept is still the same. To do this effectively, the student, of course, must be an active participant in the exercise and must be able to control the flow and extent of the experience. The first design question then became, "Can these goals be best met by using a tutorial, drill and practice, or simulation format?"

A traditional tutorial format in which information is presented and its acquisition tested is best suited for a progression of new information. However, the goal of this exercise was to promote the impression that the content underlying each aspect of the exercise was the same. Thus, although components of the program could certainly contain tutorial aspects, the overall thrust of the program should not be that of a tutorial.

If the goal of the program was to help students become adept at applying the principle to physiological situations, the program should certainly provide repeated opportunities to work problems. In that sense, it should contain some aspects of drill and practice. Only, in this case, the student should play a role in defining the problem, and she should be able to control the total number of problems to be attempted.

The program should also contain some aspects of a simulation, for if applications of the principle are to be illustrated within the context of an experimental science, the student should participate in designing and conducting experiments.

The format of the program, then, contains aspects of all three approaches. The overall context of the exercises is that of a series of simulated experiments, all requiring some aspect of a conservation of mass analysis for determining the value of the parameter being sought. In defining the specific experiment, the student provides descriptive data about the subject or conditions of the experiment. From this description, the program calculates values for the physiological parameters within the system being tested. Thus, the simulated experiment leads to a drill and practice problem. Each drill and practice problem contains appropriate feedback for reinforcing the how conservation of mass is applied to the problem, should that be necessary.

PROGRAM OVERVIEW

The program begins with several text screens defining conservation of mass and emphasizing the range of applications to which this principle can be applied. This introduction ends by alerting the student to the overall goal of the program. The main menu, shown in Figure 1, shows the organization of the exercises. Two general aspects of conservation of mass are illustrated. The first is use of an indicator to determine an unknown volume. Three experiments are included. The goal of the first experiment is to demonstrate the use of the indicator dilution technique using a simple experimental design. The other experiments in this series illustrate appli-

```
EXP. 1:      INDICATOR DILUTION - GENERAL

PURPOSE:     To demonstrate that, in a well
             mixed system, volume can be
             determined from a known
             quantity of indicator and the
             final indicator concentration

MATERIALS.   Beaker, liquid, indicator,
             stirrer, concentration meter

PROCEDURE:   Place a volume of liquid in
             the beaker. Add a known
             amount of indicator.
             Mix well. Measure the
             concentration of indicator
             in the beaker. Calculate the
             volume of liquid from the
             starting amount and final
             concentration of indicator.

          (PRESS ANY KEY TO CONTINUE)
```

FIGURE 2. Screen introducing Experiment 1 focusing on the application of conservation of mass to indicator dilution techniques.

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cations of this technique in physiological systems. The program flow then leads to application of mass balance relationships under various steady-state conditions. In this series of experiments, mass balance relationships are applied in a variety of ways using examples from cardiovascular, respiratory, and renal physiology.

INDICATOR DILUTION EXPERIMENTS

In this series of experiments, the student begins by confirming for himself that he can determine a unknown volume by adding a known amount of indicator to that volume, and, after the indicator is evenly distributed within the volume, measuring the final concentration (Figure 2). In a laboratory setting, the student would take a beaker containing a known amount of water, add a known amount of indicator, mix the system, measure the final indicator concentration, and calculate the original volume put into the beaker. The program provides a simulation of this experiment and shows the student the calculations involved (Figure 3). The student can either repeat the same experiment, change the volume in the beaker, change the quantity of indicator, or stop the exercise (Figure 4). When the student elects to return to the main menu, he is presented with one additional experiment in which an unknown volume has been put into the beaker. The student must then apply the calculation that has, so far, only been presented to him. If the student supplied answer in incorrect, the rationale underlying the calculation is reviewed, and the program suggests further examination of the principle with this set-up.

Having focused on the basic principle of indicator dilution, the next step is to deal with indicators that have specific volumes of distribution. Body fluid volumes serves as the context for this exercise. The student may measure plasma volume, extracellular fluid volume, or total body water using an indicator with the appropriate volume of distribution. The student defines the subject by providing the subject's weight. The program calculates values for various fluid volumes using standard relationships between body weight and individual fluid volumes, but it does not reveal these values to the student. The student then defines the volume of interest that will be measured and the amount of indicator added (Figure 5). The experiment is conducted, and the student is presented with the final concentration of indicator in the plasma. The student must then calculate the volume of interest (Figure 6). If the calculated answer is correct, the correct answer is confirmed, and the student is allowed to continue. If the answer supplied is incorrect, tutorial assistance is provided. The student may then elect to repeat the experiment using a different subject, a different volume of interest, or a different quantity of indicator. In this format, the student may generate a large number of problems dealing with the same relationships. To extend this range, the program includes a small amount of noise in the calculated volumes to account for biological variation. Hence, repeating the experiment with two subjects of the same weight does not necessarily yield the same values for the various volumes.

The next exercise provides another example of an application of indicator dilution techniques. In this case, the volume is the lung volume at end-expiration, and the indicator is a tracer gas. The student again provides data describing the subject from which the program calculates the "unknown" value of the volume of interest. The experiment is a rebreathing experiment, and the student must also supply the volume of the rebreathing bag and the amount of the tracer gas to be used. In this exercise, the pictorial representation looks very different from that in the previous exercise (Figure 7). Although the problem "looks" different, the principle applied is the same.

```
OPTIONS:

V = CHANGE VOLUME IN BEAKER
I = CHANGE QUANTITY OF INDICATOR
G = GO AGAIN
M = RETURN TO MENU

CHOICE?
```

FIGURE 4. Options menu for Experiment 1. This screen follows the one shown in Figure 3. The student can choose to change experiment variables, repeat the experiment, or return to the main menu.

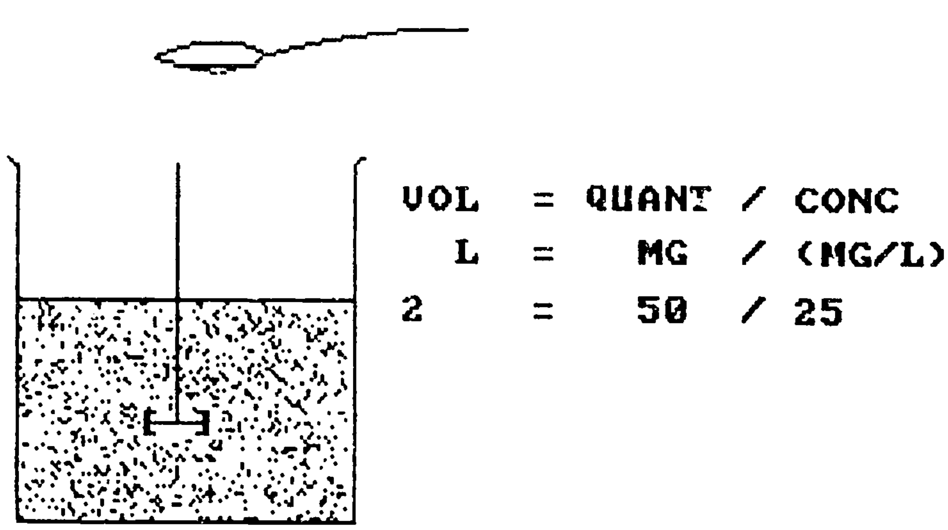

FIGURE 3. Final screen showing general indicator dilution experiment. Earlier screens show the indicator being added to the beaker and the solution being stirred until the indicator is well mixed within the system.

```
SUBJECT'S BODY WEIGHT (KG)? 70

BODY FLUID VOLUMES:

      VOLUME              INDICATOR

 1) PLASMA VOLUME         EVANS BLUE DYE
 2) ECF VOLUME            INULIN
 3) TOTAL BODY WATER      ANTIPYRINE

CHOICE?
```

FIGURE 5. Input screen from Body Fluid Volumes experiment. After designating the subject's body weight, the student can choose to measure plasma volume, extracellular fluid volume, or total body water. After choosing the volume of interest, the student is prompted for the amount of indicator that will be used in the experiment.

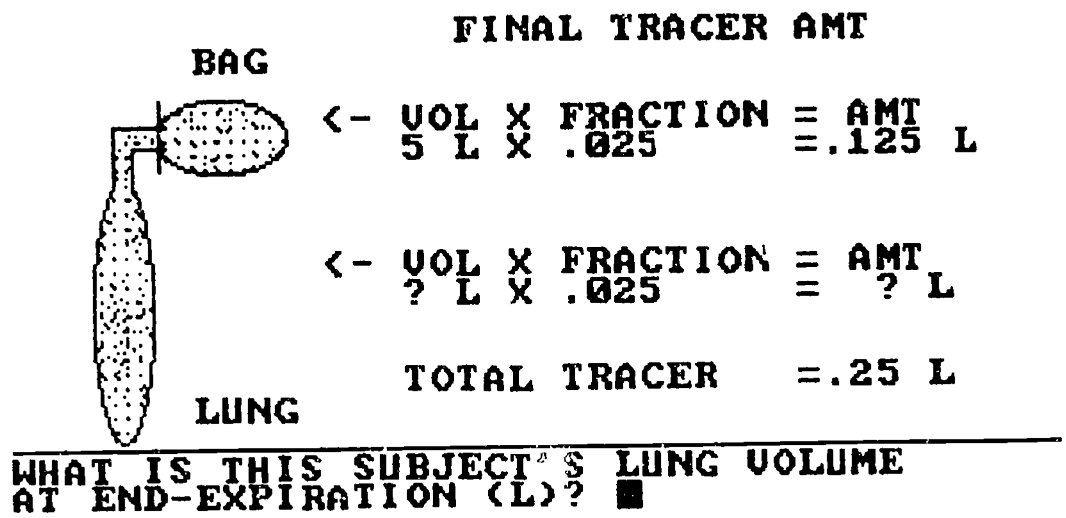

FIGURE 7. Final pictorial screen from lung volume indicator dilution experiment. Previous screens show the initial conditions with all of the indicator in the rebreathing bag and an animated sequence depicting rebreathing to mix the indicator with lung gas.

MASS BALANCE EXPERIMENTS

The experiments in this portion of the program present the student with examples of situations from various areas of physiology that utilize mass balance calculations under steady-state conditions to determine values for desired parameters. In each case, the student defines specific aspects of the problem from which the correct value of the unknown parameter is calculated. Data are presented to the student, and he must calculate the correct value. The purpose of each experiment, the experimental situation, the student supplied variables that define the experiment, and the parameter value to be calculated for the experiments in this section of the program are presented in Table 1. The exercises illustrate applications of mass balance in cardiovascular, renal, and respiratory physiology. In each case, the pictorial representation of the experiment includes an animation to illustrate schematically the movement of mass within the system. These representations are designed to appear very different from each other (Figure 8) to further emphasize the point that even though the viewpoint may be different, the underlying principle is the same. Tutorial help follows any incorrect answers supplied by the student (Figure 9).

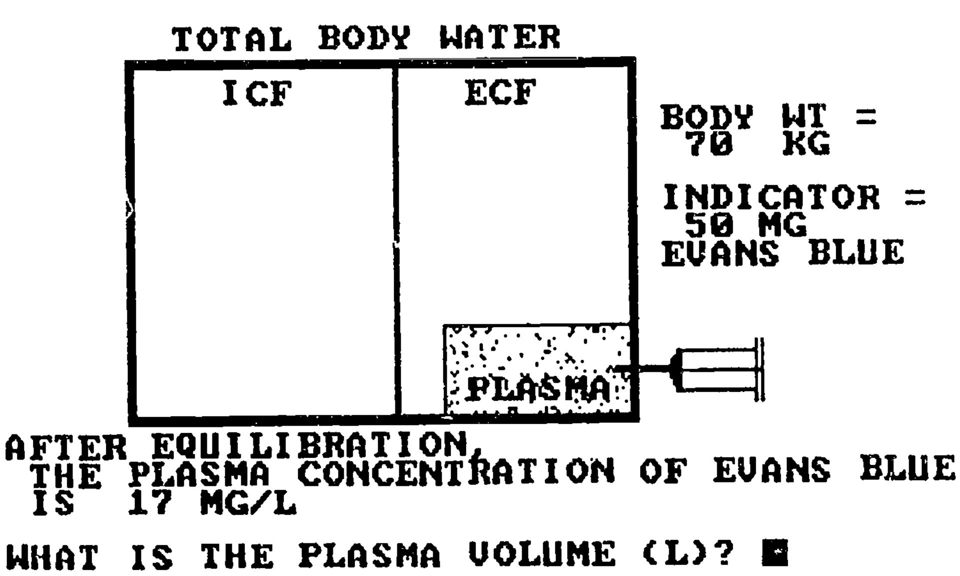

FIGURE 6. Screen depicting the Body Fluid Volumes experiment. In this case, the student chose to measure plasma volume in a 70 Kg subject using 50 mg of Evans Blue dye. A previous screen showed the dye being injected into and distributing within the plasma volume. The student must now calculate the plasma volume for this subject. If the student had chosen to measure extracellular fluid or total body water volume, the pictorial would have shown the indicator distributing within the appropriate volume following injection into the plasma volume.

ERROR MESSAGES

Although tutorial help is provided when students respond with an incorrect value for the requested parameter following each experiment, error messages must also be provided when the student enters inconsistent or unphysiological values while defining the conditions of the experiment. These error messages are also designed to provide information related to the feasibility of running a successful experiment under the conditions described. For example, if the quantity of indicator chosen results in concentrations that are too low for measurement with common laboratory equipment, an error message is presented alerting the student to the problem.

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TABLE 1. Overview of mass balance experiments.

Exp't	Purpose	Situation	Assumptions	Student inputs	Value to calculate
4	To examine mass mixing from two flow sources	Patient with lung disease in which part of the total flow (cardiac output) bypasses the gas exchange areas of the lung (shunt).	Hemoglobin concentration = 15 gm/100 ml blood; Oxygen consumption = 300 ml/min	Patient's body weight; Per cent of flow that is shunt	Arterial oxygen content
5	To determine the cardiac output (total blood flow) in a normal 30 year old individual	The subject's oxygen consumption has been determined by applying mass balance principles to gas exchange in the lung. Mixed venous (pulmonary artery) blood has been sampled, and its oxygen content (ml O_2/ml blood) has been determined.	Hemoglobin concentration = 15 gm/100 ml blood; Arterial O_2 content = 0.20 ml O_2/ml blood	Patient's body weight	Blood flow
6	To apply the principle of conservation of mass with selective indicators to the kidney to measure effective renal plasma flow and glomerular filtration rate in a 30 year old subject.	The appropriate indicator is administered to a subject with functioning kidneys. A blood sample is obtained to determine the concentration of indicator in the plasma, and urine is collected over a period of time to determine how much indicator has been "cleared" by the kidney.	1) Any PAH entering the kidney is completely excreted in the urine. 2) Inulin is neither secreted nor reabsorbed by the kidney. Hence, any inulin reaching the nephron is removed from the plasma by filtration.	Subject's body weight; Indicator to use PAH or Inulin); Quantitiy (mg) of indicator to administer	Effective renal plasma flow (PAH); Glomerular filtration rate (Inulin)
7	To illustrate mass balance applications in respiratory physiology	You are in a laboratory equipped with a treadmill, a weather balloon, a one-way breathing valve, a stopwatch, and an oxygen analyzer. Your task is to determine a subject's oxygen consumption during steady state, moderate exercise. While breathing room air through the one-way breathing valve. the subject runs on the treadmill. After a steady state is reached, expired gas is collected and analyzed.		Treadmill speed (Km/hr); Collection time for expired gas	Oxygen consumption

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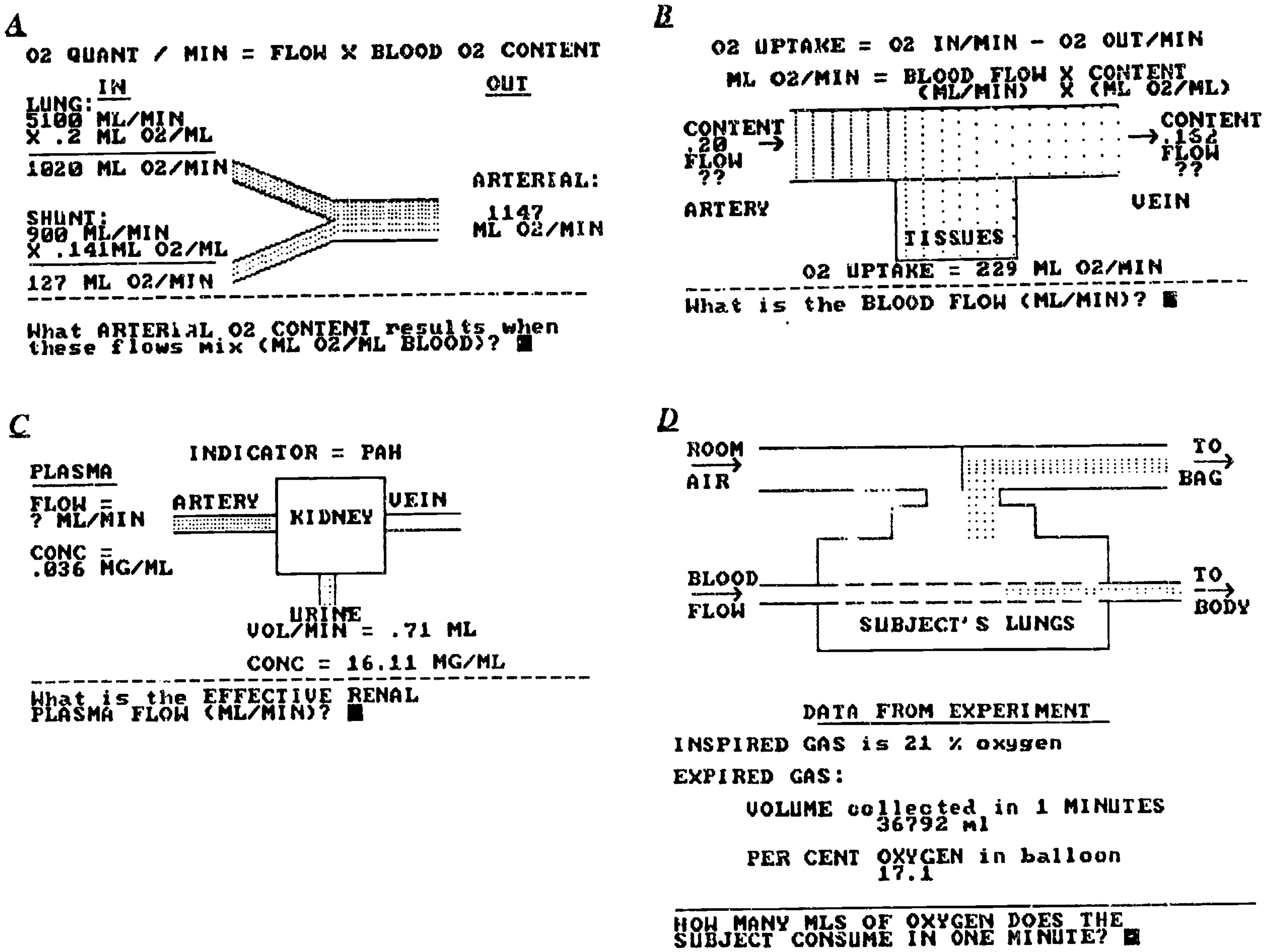

FIGURE 8. Representative output screens from the four mass balance experiments summarized in Table 1. *Panel A:* Experiment 4, Mixing flows. *Panel B:* Experiment 5, Blood-tissue gas exchange. *Panel C:* Experiment 6, Mass balance in the kidney. *Panel D:* Experiment 7, Pulmonary gas exchange. The screens are designed to appear very different from each other to emphasize the point that even though the viewpoint may be different, the underlying principle is the same.

CALCULATOR FUNCTION

Most of the problems in this program require the student to carry out at least one calculation. To facilitate this, a simple calculator is incorporated into the the program. It can be accessed by one keystroke at any time that the program is seeking input. The student can use the calculator mode to do simple addition, subtraction, multiplication, and division problems and then return to the question from which the calculator was called.

CONCLUSION

The conservation of mass program represents one component of a series of exercises designed to redirect the way in which students approach biological information. The underlying premise of this and its companion programs is that if students are aware that our understanding of biological phenomena is based on a set of common principles or common themes, they will change their approach to "new" information. Instead of viewing this information as a new database, unrelated to their current database, they will view the new information as an extension of their current database. The goal of the software is not to teach specific applica-

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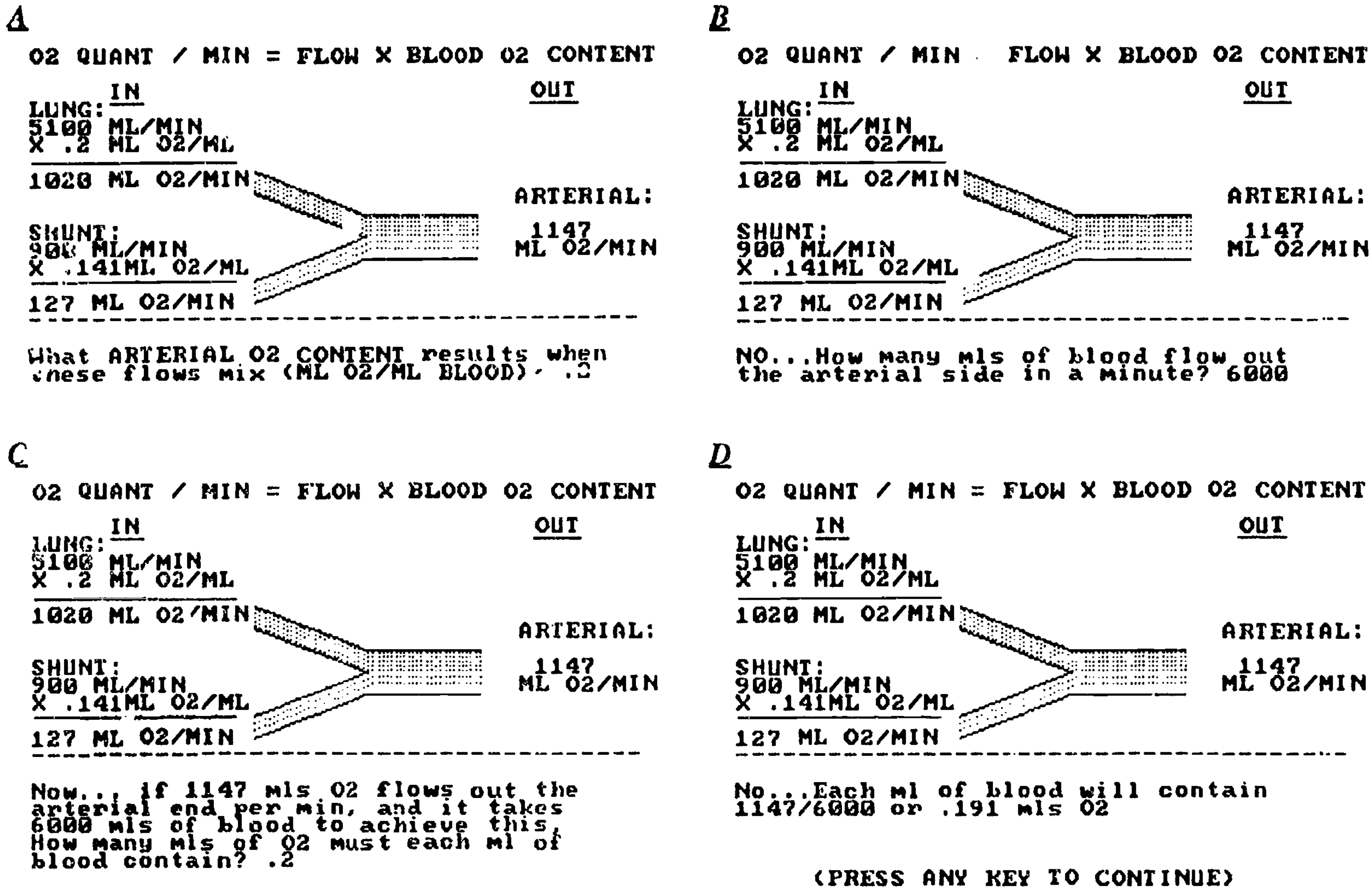

FIGURE 9. Representative example of tutorial aid offered in response to an incorrect answer. This series is from Experiment 4 - Mixing Flows. *Panel A:* The student enters a value of .2 ml O_2/ml blood for the calculated arterial oxygen content. *Panel B:* In response to the wrong value, the program begins to lead the student through the calculation. *Panel C:* The tutorial process continues, and the student is again asked to calculate the arterial oxygen content. The entered response (.2) is again in error. *Panel D:* The correct answer is calculated and displayed for the student.

tions of the principle, but rather to heighten awareness of the range of applications of the principle. The target student population could be high school, undergraduate, or graduate level biology students. However, the choice of examples is oriented toward students studying mammalian physiology. The underlying premise remains to be tested, however, and will be the focus of a future study that will be conducted when the software series is completed.

PROGRAM AVAILABILITY

Additional topic areas that will be included in the Common Themes in Physiology series include osmotic pressure relationships, pressure-volume relationships, pressure-flow relationship, and feedback mechanisms. The conservation of mass and osmotic pressure relationships programs are currently available for MS-DOS systems from the National Resource for Computers in Life Science Education. A Macintosh version will be developed in the future. For further information, contact NRCLSE.

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COMPUTERS IN LIFE SCIENCE EDUCATION

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P.O. Box 51187
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or let us know via BITnet. NRCLSE's BITnet address is:

MODELL@UWALOCKE

JANUARY 7-9, 1991. Introduction to Interactive Video workshop, Bloomsburg, PA

Contact:

Dr. Harold Bailey
Institute for Interactive Technologies
1210 McCormick Center
Bloomsburg University
Bloomsburg, PA 17815
(717) 389-4506

JANUARY 18-20, 1991. Association of Biologists in Computing, Los Angeles, CA

Contact:

Bob Desharnais
Biology Department
California State University, Los Angeles
5151 State University Drive
Los Angeles, CA 90032-8201
(213) 343-2056

JANUARY 22-24, 1991. Sixth International Conference on Multimedia and CD-ROM, San Francisco, CA

Contact:

Mark LoGiurato
Conference/Marketing Manager
Cahners Exposition Group
Cahners Plaza
999 Summer St.
P.O. Box 3833
Stamford, CT 06905
(203) 352-8224

FEBRUARY 5-8, 1991. 11th Annual Florida Educational Technology Conference. Tampa, FL

Contact:

Barbara Ann Cox
Conference Coordinator
Suite B1-54
Florida Education Center
325 West Gaines Street
Tallahassee, FL 32399
(904) 488-0980

FEBRUARY 20-22, 1991. Fifth Annual Conference - Learning Technology in the Health Care Sciences and Eighth Annual Conference - Interactive Instruction Delivery. Orlando, FL

Contact:

Program Coordinator
Society for Applied Learning Technology
50 Culpeper Street
Warrenton, VA 22186

FEBRUARY 24-28, 1991. Seventh IEEE Conference on Artificial Intelligence Applications, Miami Beach, FL

Contact:

CAIA-91
The Computer Society of the IEEE
1730 Massachusetts Ave, NW
Washington, DC 20036-1903
(202) 371-1013

MARCH 4-8, 1991. Basic Skills Videodisc Design/Production Workshop, Lincoln, NE

Contact:

Nebraska Videodisc Group

0742-3233/90/$0.00 + 2.00

1800 North 33rd Street
Lincoln, NE 68583
(402) 472-3611

APRIL 22-25, 1991. Communicating Disney Style Seminar, Lake Buena Vista, FL

Contact:

Walt Disney World Co.
Seminar Productions
P.O. Box 10,000
Lake Buena Vista, FL 32830-1000
(407) 363-6620

APRIL 6, 1991. The Social Creation of Knowledge: Multimedia and Information Technologies in the University, Cambridge, MA

Contact:

Edward Barrett
Conference Director
Massachusetts Institute of Technology
160 Memorial Drive 14N-336
Cambridge, MA 02139

APRIL 19-20, 1991. Intellectual Property and Authorship, Cleveland, OH

Contact:

Professor Martha Woodmansee
Department of English
Case Western Reserve University
Cleveland, OH 44106
OR
Professor Peter A. Jaszi
Washington College of Law
American University
Washington, DC 20016

MAY 6-9, 1991. Nebraska Interactive Media Symposium, Lincoln, NE

Contact:

Nebraska Videodisc Group
1800 North 33rd Street
Lincoln, NE 68583
(402) 472-3611

MAY 13-15, 1991. Introduction to Interactive Video Workshop, Bloomsburg, PA

Contact:

Dr. Harold Bailey
Institute for Interactive Technologies
1210 McCormick Center
Bloomsburg University
Bloomsburg, PA 17815
(717) 389-4506

JUNE 18-20, 1991. National Education Computing Conference, Phoenix, AZ

Contact:

NECC
(602) 965-7363

AUGUST 21-23, 1991. 13th Annual Conference on Interactive Videodisc in Education and Training and 7th Annual Conference on CD-ROM Applicatoins in Education and Training, Arlington, VA

Contact:

Society for Applied Learning Technology
50 Culpeper Street
Warrenton, VA 22186
(703) 347-0055

OCTOBER 16-19, 1991. EDUCOM '91, San Diego, CA

Contact:

EDUCOM '91 Program Committee
San Diego Supercomputer Center
University of California at San Diego
La Jolla, CA 92093-0505

NOVEMBER 10-14, 1991. 33rd International ADCIS Conference: Connections and collaborations – Technology and people for the 90's, St. Louis, MO

Contact:

ADCIS International Headquarters
229 Ramseyer Hall
29 West Woodruff Avenue
Columbus, OH 43210-1177
(614) 292-4324

NRCLSE RELEASES NEW SOFTWARE

NRCLSE announces the availability of the first two programs in our new series entitled "Common Themes in Physiology." The first program is a tutorial dealing with osmosis and osmotic pressure relationships (see CLSE, August, 1990). The second program is a problem set focused on applications of the principle of conservation of mass (see CLSE, November, 1990). Current versions of the programs are available only for IBM compatible equipment. Macintosh versions of the programs will be available late in 1991. The cost of each program is $30.00 (US). Permission to copy the programs is included in the purchase price.

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SUMMARY OF LIQUID CRYSTAL DISPLAY PROJECTION PAD VENDORS

Liquid crystal display (LCD) projection pads have improved considerably since their introduction several years ago. In 1987, Stull and Knoll surveyed this market and listed 5 distributers of LCD projection panels (see CLSE 4:76-77, 1987). The number of distributors has since more than doubled. Resolution has improved; units are available for a broader range of graphic output modes (CGA, EGA, VGA, Macintosh); and many units now offer "color" display. Last year CLSE presented our first list of LCD projection pad vendors to help CLSE readers identify sources of LCD projection pads that will meet their projection requirements. The following is an updated version of that list. If you are aware of other vendors that we have failed to list, please let us know about them. Send appropriate information to:

Dr. Harold Modell
NRCLSE
P.O. Box 51187
Seattle, WA 98115-1187

or let us know via BITnet. NRCLSE's BITnet address is:

MODELL@UWALOCKE

Apollo Audio-Visual
60 Trade Zone Court
Ronkonkoma, NY 11779
(516) 467-8033

ASK LCD Inc.
5 Dunwoody Park, Suite 116
Atlanta, GA 30338
(800) 255-1379

Computer Accessories
6610 Nancy Ridge Dr.
San Diego, CA 92121
(619) 457-5500

Comtrex Accessories
P.O. Box 1450
El Toro, CA 92630
(714) 855-6600

Dukane Corporation
Audio Visual Division
2900 Dukane Dr.
St. Charles, IL 60174
(800) 356-6540
(800) 634-2800
(708) 584-2300 (Illinois)

Eastman Kodak
343 State St.
Rochester, NY 14650
(800) 242-2424

Eiki International
27882 Camino Capistrano
P.O. Box 30000
Laguna Niguel, CA 92677-8000
(714)582-2511

In Focus Systems, Inc.
7649 S.W. Mohawk At.
Tualatin, OR 97062
(503) 692-4968
(800) 327-7231

MECC Etc.
3490 Lexington Avenue North
St. Paul, MN 55126
(800) 228-3504 ext 693
(612) 481-3500 ext 693
(800) 782-0032 ext 693 (Minnesota)

nView Corp.
11835 Canon Blvd., Suite B-107
Newport News, VA 23606
(804) 873-1354

Sharp Electronics Corp.
Sharp Plaza
P.O. Box 650
Mahwah, NJ 07430
(201) 529-8731

Telex Communications
9600 Aldrich Ave. So.
Minneapolis, MN 55420
(612) 887-5531
(612) 884-4051
(800) 828-6107

Toshiba America
1101A Lake Cook Rd.
Deerfield, IL 60015
(708) 945-1500

Visualon, Inc
3044 Payne Ave.
Cleveland, OH 44114
(800) 321-3860
(800) 362-3108 (Ohio)

SHARE YOUR EXPERIENCE

NRCLSE wants to know about *your* experiences with LCD projection pads. What brands and models have you used? How were they used? How well did they meet your needs? How have they changed you approach to teaching?

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AIMS AND SCOPE

The goal of *Computers in Life Science Education* is to provide a means of communication among life science educators who anticipate or are currently employing the computer as an educational tool. The range of content includes, but is not limited to, articles focusing on computer applications and their underlying philosophy, reports on faculty/student experiences with computers in teaching environments, and software/hardware reviews in both basic science and clinical education settings.

INVITATION TO CONTRIBUTORS

Articles consistent with the goals of *Computers in Life Science Education* are invited for possible publication in the newsletter.

PREPARATION AND SUBMISSION OF MATERIAL

Articles submitted for publication should be typewritten, double spaced, with wide margins. The original and two copies including two sets of figures and tables should be sent to the Editor: Dr. Harold Modell, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

Title page should include full title, list of authors, academic or professional affiliations, and complete address and phone number of the corresponding author.

Illustrations should be submitted as original drawings in India ink or sharp, unmounted photographs on glossy paper (Laser printer output is acceptable). The lettering should be such that it can be legible after reduction (width of one column = 5.7 cm).

Reference style and form should follow the "number system with references alphabetized" described in the Council of Biology Editors Style Manual. References should be listed in alphabetical order by the first author's last name, numbered consecutively, and cited in the text by these numbers.

RESPONSIBILITY AND COPYRIGHT

Authors are responsible for accuracy of statements and opinions expressed in articles. All authors submitting manuscripts will be sent a copyright transfer form to complete. The completed form must be returned before the work will be published.

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POSTMASTER: Send address changes to *Computers in Life Science Education*, NRCLSE, P.O. Box 51187, Seattle, WA 98115-1187.

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