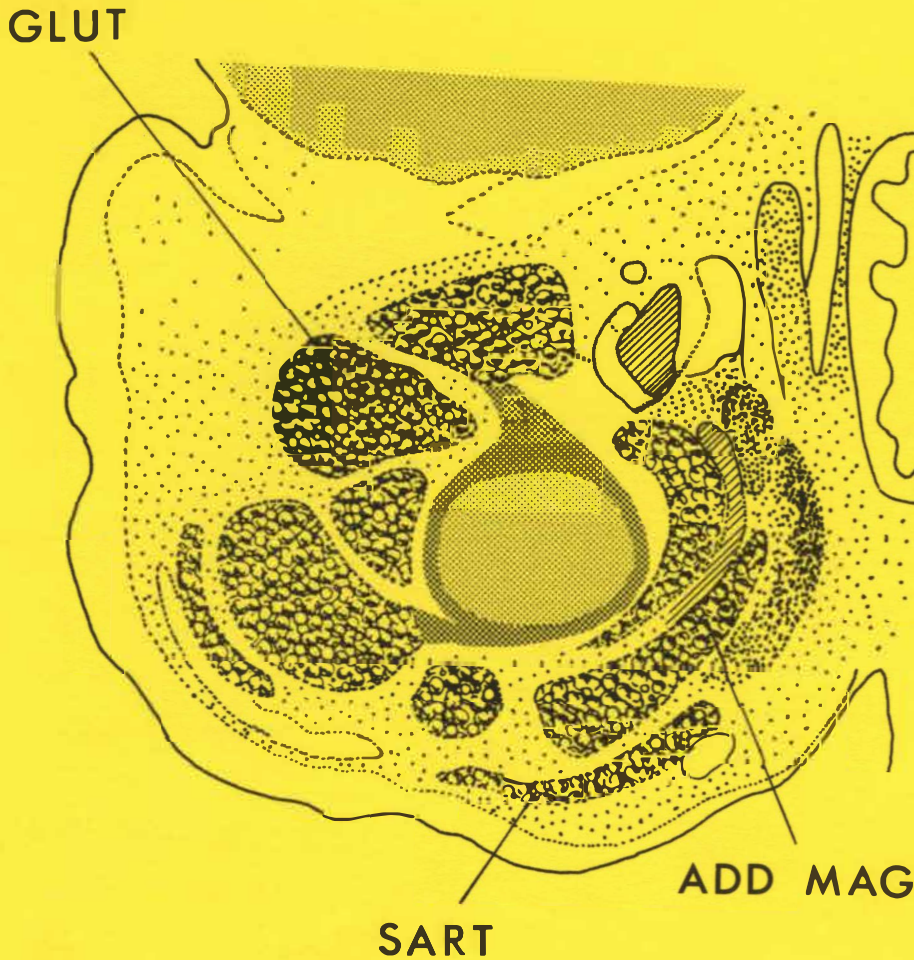
Bioscene



Journal of College Biology Teaching
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Bioscene
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Volume 18 (2) **August 1992**

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Cover Credit: Marshall Andersen, Rockhurst College, K.C., MO 64110
Cross-section through the developing femoral region of a stage 54 *Xenopus laevis* tadpole. The muscle masses for the gluteus(GLUT), sartorius(SART) and adductor magnus(ADD MAG) are shown. Nerve branches are indicated by diagonal hatching--note the branch entering the adductor complex(lower of the two nerves shown). Central stippled area represents femoral cartilage(lighter stippling) and periosteal bone(heavy stippling). From a paper presented at the annual meeting of the American Zoological Society, December, 1990; San Antonio, TX.

Bioscene: Journal of College Biology Teaching

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Please submit all manuscripts directly to the Editor. We prefer receiving two printed copies and one in computer readable form. We work with the following word processors on the following computers: MacWrite and Word on the Macintosh, Appleworks and Applewriter on the Apple IIe/IIc, Word Perfect on IBM PC compatibles, TDP on an HP 3000, and WHIPS Plus on a DEC VAX. Final copy is prepared in Quark Xpress on a Mac II. If you can submit your manuscript only on another system, please check with us beforehand. We can receive manuscripts electronically by connecting through Applelink where our address is BioQUEST. If you are connecting to us from BITNET via INTERNET, then our address is BIOQUEST@BELOIT.EDU. Please address file to AMCBT. All manuscripts will be sent out to two members of the editorial board for review. In the case of a split decision the manuscript will go to a third reviewer. The next deadline in 1992 is October 27.

Suggestions for Manuscripts:

Announcements
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ENERGIZE IT! AN ECOLOGICALLY INTEGRATED APPROACH TO THE STUDY OF THE DIGESTIVE SYSTEM AND ENERGY ACQUISITION

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INTRODUCTION

Physiology and ecology are traditionally taught as separate units in high school and college biology curricula. This separation is largely artificial because an organism's ecology and physiology are interdependent, especially when considered in an evolutionary context (Karasov and Diamond 1988). I believe that the goal of studying physiology is, ultimately, to understand how organisms function and survive in a given environment. Thus, physiological concepts need to be taught and considered in light of whole organisms and their ecology.

Teachers and authors of physiology textbooks have focused generally on organ systems of humans or other species, the relationships between these systems and, to some extent, environmental effects on their function (e.g., Eckert 1988, Fox 1990, Starr and Taggart 1989). Likewise, many researchers of physiology concentrate on components and processes within organisms at the molecular, cellular, tissue, and/or organ level. Yet in published reports of such research, frequently there is little or no consideration of the significance of the results at the organismal level (e.g., Stephenson 1983). Similar problems exist in the teaching and study of ecology. Physiological processes are the mechanisms through which an organism's ecology is mediated. However, the study of organismal physiology is seldom a component of ecology classes and is frequently lacking in ecological research.

To diminish this dichotomy between "the physiological" and "the ecological" approach to biological investigation I am developing a research-oriented method of studying one physiological system, the digestive system, that integrates species' ecology with the form and function of this system. Using the problem-posing, problem-probing, and peer persuasion philosophy of teaching (Peterson and Jungck 1988), this approach allows students to explore and integrate knowledge of various digestive system designs, components, and functions; and how these factors affect an animal's ability to obtain and utilize energy in different ecological settings. Thus, the focus of this unit is on digestive physiology and physiological ecology, in terms of its relationship to energy use. In the following discussion I will present information for mammalian systems. In addition, this approach could be adapted readily to other taxonomic groups.

SETTING THE SCENE: ECOLOGICAL CONSIDERATIONS

The study of a physiological system begins with some understanding of the significance of that system to an organism. In the case of the digestive system, the significance lies in the acquisition, metabolism, and synthesis of food energy in order to maintain metabolic activities such as the maintenance of ion gradients, movement of materials between cells, and the formation of ATP for growth, maintenance, and functioning. To place this in an ecological context, variables that affect energy inputs into a living organism are considered with respect to habitat and species' life-style characteristics. The variables of importance are those that affect the availability, intake, and cost of acquisition of food-energy, including home range size, prey density and distribution, prey size, time required for feeding, cost of locomotion, and life-style of the forager (e.g., arboreal, fossorial). As these variables change, so may the digestion strategy used by a species (Eisenberg 1981; McNab 1980, 1983, 1986; Townsend and Calow 1981). This concept may become clear to students as they pose questions and make predictions concerning the components of foraging strategies and the general requirements of digestive systems in different ecological settings. Once these variables and their relationships have been investigated, qualitatively and/or quantitatively, students could construct a more realistic understanding of the ecological framework within which an organism exists and in which its digestive system must function to meet its daily energy needs.

DIET COMPOSITION AND ENERGY CONTENT

My next step to exploring digestive function is to consider the feeding-habits of species and associated energetic parameters, such as body mass, ingestion rate, energy content of the diet, and metabolic rate (Figure 1). Allometric equations that relate body mass to variables such as ingestion rate and metabolic rate, as well as speed and cost of locomotion, growth and reproduction, population density and home range size, and prey size, can be used to obtain realistic estimates for these variables in mammalian species, and others, with specific feeding habits (Calder 1984; McNab 1986; Peters 1983) (Table 1). Likewise, the composition of specific diets can be researched easily by students, using published research papers or texts on animal foraging and nutrition. From such research, students could obtain estimates for the percent content of protein, soluble carbohydrate, fiber, and fat in particular diet types. If, for example, the feeding habit being investigated is granivory, the composition of the diet (% fresh mass) could be 10.9% protein, 58.2% soluble carbohydrates, 15.0% fiber, and 2.4% fat (Peters 1983). Associated with each of these components is a specific energy content (Kleiber 1961) and a range of digestibility values. These could be used by students to investigate the potential energy yield of a specific diet. For example,

Figure 1. A start-up worksheet for a digestive system "problem". The student begins with selection of a feeding-habit. Then values for body mass (Kg), average daily metabolic rate (kJ/d), fractional components of the diet, energy content of the diet (kJ/Kg food), and ingestion rate (Kg/d) are decided upon to begin investigation of the problem posed.

Feeding Habits and Initial Parameters

Omnivore	**Body mass:** ________
Herbivore	
Carnivore	**ADMR:** ________
Granivore	
Frugivore	**Diet content:** ________
Nectarivore	**% fat:** ________
Folivore	**% fiber:** ________
Insectivore	**% protein:** ________
Sanguinivore	**% carbohydrate:** ________
	Ingestion: ________

Table 1. Examples of allometric relationships for groups of mammals. All relationships are of the form $Y=a+Mass^{b}$ where the intercept (a) equals 1 kg. Data are from Peters (1983).

Group	Independent Variable	Intercept (a)	Slope (b)
Carnivores	Resting metabolic rate	2.84 Watts	0.69
Insectivores	Resting metabolic rate	3.22 Watts	0.73
Insectivores	Avg. energy expenditure	4.74 Watts	0.5
Herbivores	Sleep time	32,500 s	-0.145
Carnivores	Sleep time	47,200 s	-0.036
Ruminants	Total gut capacity	0.0896 kg	1.048
Nonruminant	Total gut capacity	0.102 kg	1.080
Mammals	Cost of running	11.3 J/m	0.72
Carnivores	Ingestion rate	11.31 Watts	0.697
Herbivores	Ingestion rate	11.26 Watts	0.728

soluble carbohydrate digestibility might range from 55-95%, fiber digestibility from 0-65%, and protein digestibility from 70-99%, with the variation dependent upon digestive system characteristics within and between species.

As ~~studen's research and evaluat~~the composition and energy content of different food resources they can continue to pose questions, make predictions, and develop hypotheses regarding diet quality and its relationship to species' physiological and ecological characteristics

(e.g., body mass, metabolic rate, digestive system design, utilization of habitat space, foraging strategy) (Eisenberg 1981; McNab 1983, 1986).

While there are no limits on the types of digestive systems and foraging strategies that students may propose, there is one basic energetic criterion that must be considered. To suivive over the long-term, an organism's energy intake must equal or exceed its daily metabolic requirements. This requirement is not static but may change in response to physiological and ecological conditions, including seasonal changes in body mass or reproductive activity, ambient temperature, food availability, or predation pressure.

DIGESTIVE SYSTEM DESIGN

Through the investigations described above students are expected to gain an understanding of factors that affect energy input into an animal and the relationships between these factors and an animal's energy needs. The final step to understanding energy use is to examine the process of food-energy metabolism within an animal; that is, digestive processes. Using the experimental parameters studied previously, students can now construct and explore various digestive systems, investigate their modes of operation, and their digestive efficiencies with respect to different feeding-habits, as well as the ecological ramifications of specific digestive systems. Predictions and hypotheses addressing these topics and the evolution, or lack thereof, of specific systems can be made and tested.

Within mammalian species the gross structural components that I have considered are the oral cavity, esophagus, stomach, reticulo-rumen, omasum and abomasum, caecum, small intestine, and colon. Given these components students will qualitatively design or model a variety of digestive systems, which may or may not occur in extant species. After researching the basic functions of each organ students will have a basis for deciding which combinations of organs to include in their designs in order to test specific hypotheses. As more information is obtained, students may revise their hypotheses and pose new questions concerning digestive systems. Thus, if a student-group investigates the ability of different systems to meet the energy needs of an herbivore, they may discover that at least one organ that can digest fibrous plant matter, a reticulo-rumen or a caecum, is necessary. Likewise, relationships between animal size and digestive systems should become apparent. For example, the long retention time of digesta that is required for efficient nutrient extraction in the reticulo-rumen may interrupt feeding in very small mammals to such an extent that their daily energy needs cannot be met.

Through question posing and hypothesis testing students may develop a surprising array of digestive systems that meet the energy demands of animals found in specific habitats and with specific feeding habits. Some of these systems, however, may not exist in nature. Students can then probe questions concerning the mechanical/functional constraints that could have prevented the evolutionary success of such systems.

After an overall understanding of digestive organ and system functions has been obtained, a more in-depth level of investigation follows. This involves experimentation with the functions of each organ within a system. By altering the functional characteristics of an organ, within realistic limits, students can determine the range of digestive capabilities of the overall system, while learning about the contributions and limits of each organ. Such changes in organ characteristics might be directed towards solving problems such as "What is the maximum contribution that this organ can make to digestion of specific diets?" or, "How does a change in the function(s) of this organ affect digestive functions of other organs?". By considering the effects of organ changes students will gain an awareness and understanding of the highly dynamic nature of the digestive system and its components. Additionally, these manipulations will emphasize the concept that digestive organs do not function in isolation, but form a highly interactive system that can affect not only the digestive capabilities of the animal, but also the animal's foraging behavior, time budgets, and other ecological characteristics. For example, if energy demand increases, so does ingestion rate and thus foraging time and its associated costs. If ingestion rate increases and there is no change in gut capacity or mucosal surface area, the transit time of digesta will decrease and theoretically, so will digestive efficiency. However, if the capacity of organs such as the caecum and small intestine increase, along with an increase in mucosal surface area, then transit time decreases to a lesser extent and digestive efficiency is maintained (Hammond and Wunder 1991). These and many other questions of an interactive nature could be investigated.

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ORGAN FUNCTIONS THAT COULD BE MANIPULATED:

1. Oral cavity

Bite size: Instantaneous intake rate varies with differences in the size of bite obtained by a forager. Bite size variation results from differences between food types (e.g., seeds versus plants) and characteristics within a food type, such as the height and density of plants.

Ingestion rate: According to recent models of intake regulation in mammalian herbivores, bite size can be used to accurately predict intake rates in a variety of natural situations (Gross *et al.* 1992).

Enzyme activity: The primary enzyme in the oral cavity is a salivary amylase that acts on soluble carbohydrates. Its activity generally increases with food intake, rumination, and increased ingestion of carbohydrate, yet declines with increased protein intake. The effect of changes in enzyme activity appear at the level of the small intestine because there is little oral absorption of nutrients. In some mammals, such as the ruminants, salivary enzymes are of little digestive importance.

2. Esophagus

Length: The length of the esophagus may affect an animal's ability to acquire food resources (e.g., access to foliage on trees) and, therefore, affect ingestion rate and foraging time.

Volume: The volume of the esophagus will set a limit on the amount of, and rate at which food is passed to posterior portions of the digestive tract.

3. Stomach

Volume: Stomach size varies extensively between individuals and species, but little within a single individual.

Passage rate: Passage rate of food into and out of the stomach depends upon the volume of food already existing in the digestive tract. As digestion rate in the small intestines increases, so does the rate of passage of food from the stomach to the small intestines.

Enzyme activity: The stomach's primary enzymatic action is from pepsin which acts on proteins. As food intake and/or protein intake increases, so does pepsin activity and HCl secretion, thereby increasing the digestibility of the protein fraction of the diet.

Bacterial population: In herbivores such as rabbits and other lagomorphs, the stomach, along with the large intestine, is important as a fermentation chamber. Recent studies of digestive function in herbivorous rodent species and omnivorous species indicate that some bacterial fermentation of food resources occurs in the stomach.

4. Reticulo-rumen

Volume: Volume of the reticulo-rumen varies dramatically between species and with the extent to which a species depends upon foregut fermentation. In cattle the storage capacity of the reticulo-rumen is approximately 15% of the body mass.

Retention time: This organ is of particular importance with respect to the digestion of plant matter as the majority of food ingested by ruminants is digested in the reticulo-rumen. A major factor is the retention time of digesta because this places constraints on ingestion rate and greatly affects digestion of fiber (Karasov 1986). In sheep retention time is on the order of 11-15 h, while in cattle and larger ruminants it can last for days.

Mucosal surface area: Although there is no production of enzymes in the reticulo-rumen there is a good deal of nutrient absorption. Variation in absorptive surface area will affect the rate of absorption of carbohydrates, some peptides, amino acids, and some fatty acids released through microbial fermentation.

Bacterial population: The maintenance of dense bacterial populations, on the order of one million organisms per gram of rumen content, is an important component for efficient functioning of this organ. The bacteria utilize most of the glucose produced by digestive processes. However, sugar catabolism also results in the formation of volatile fatty acids that are utilized by the host. Most of the amino acids liberated by protein catabolism are also utilized by the bacteria (Gordon 1977). Eventually, the bacteria themselves pass to the abomasum and are digested, thus serving as the major source of protein to the host.

Bacteria, therefore, affect digestive function in three basic ways: 1) they are important as "little digestive machines", 2) they utilize some of the host's ingested energy which imposes an energetic cost on the host, and 3) they themselves are digested and serve as an energy source to the host.

5. Omasum and abomasum

Volume: The omasum serves as a short-term storage chamber and passageway to the abomasum. The volumes of these two chambers are much less than that of the rumen and, therefore, the passage rate of digesta through these structures is relatively fast. The omasum receives undigested food particles from the reticulo-rumen along with bacteria. In a ruminant such as the sheep, approximately 50% of the plant materials not digested in the reticulo-rumen are received by the omasum. In addition, it has been estimated that 69% of the reticulo-rumen's bacterial population is passed to the omasum daily in cattle.

Passage rate: The reticulo-omasal orifice restricts particle passage rate through the ruminant digestive tract. In comparison to hindgut fermenters that lack this orifice, ruminants have slower passage rates of digesta and, therefore, typically utilize higher quality food resources.

Enzyme activity: The abomasum is the only portion of the ruminant stomach that produces enzymes and, therefore, digests portions of the digesta that are not broken down through bacterial fermentation.

6. Small intestine:

Volume: The volume of the small intestine can increase substantially due to changes in its length and, perhaps, circumference. Increases in length occur most frequently with increases in food intake (Green and Millar 1987; Hammond and Wunder 1991).

Passage rate: As passage rate increases, digestive efficiency typically decreases unless there is a simultaneous increase in nutrient absorption rate (Hammond and Wunder 1991; Townsend and Calow 1981). Frequently, passage rate increases with increases in ingestion rate.

Mucosal surface area: Among small mammalian species, significant differences exist in mucosal surface area per unit of serosa. These differences are correlated with differences in feeding habit and may have direct or indirect effects on passage rate (Barry 1976). Increase in length, volume , and mucosal surface area of the small intestine is a frequent response to increased energy demand and/or decreased diet quality (i.e., reduced protein, increased fiber) in some mammalian species (Derting and Bogue, in press; Diamond and Karasov 1983). Among mammals, mucosal surface area is allometrically related to the metabolic body mass of an animal (Ferraris *et al.* 1989), but can increase significantly per cm^2 of serosa.

Enzyme activity: This increases primarily with increased dietary fat and proteins. Enzyme activity also affects digestion of soluble carbohydrates and has a negative feedback effect on activities of the stomach.

Bacterial population: The intestine of most animals contains large numbers of bacteria that contribute enzymatically to digestion and, in turn, may be digested themselves. However, in hidgut fermenters such as the horse, dead microbial bodies do not undergo complete digestion and, consequently, contribute less protein to the host.

7. Caecum

Volume: The volume of the caecum can change markedly with increased ingestion of food, particularly plant material. (Gross *et al.* 1985).

Retention time: As with the reticulo-rumen, retention time affects the efficiency with which fibrous plant material is broken down prior to its return to the intestines. However, unlike the reticulo-rumen, food can bypass the caecum. Therefore, even if food is retained in the caecum for extended periods of time, ingestion can continue.

Absorptive surface area: Caecum length and surface area are known to differ among species according to feeding habit (Barry 1977) and within individuals as energy demand and/or diet quality changes (Green and Millar 1987; Hammond and Diamond, in press).

Bacterial population: In some hindgut fermenters, including lagomorphs, the caecum is specialized as a fermentation chamber selectively retaining solutes and small particles from the coarser, high fiber and high lignin portions of the diet. All mammals that use cecal fermentation are small, the largest being the koala, and engage in some form of fecal reingestion behavior.

8. Colon

Volume: Little change occurs in the length volume of the colon (< 10%) within an individual, even with variation in diet quality and ingestion rate. However, between species the relative size of the colon varies substantially (Barry 1977). In the horse and its relatives, for example, the colon as well as the caecum are enlarged as fermentation chambers.

Retention time: Retention time of digesta, time for fecal formation, and retention of feces can affect the overall passage rate of digesta through the digestive system. For example, as water intake decreases, perhaps due to changes in habitat and/or diet, the retention time of digesta may increase in order to maximize water-reabsorption from the intestinal contents. The amount of ingested energy that is lost in feces varies considerable (> 20%) within an individual, depending primarily on diet quality.

Absorptive surface area: This changes little within an individual even with changes in diet and ingestion rate.

Bacterial population: Microbial fermentation is probably characteristic of the colon of mammals in general, not just of herbivores. Even in some carnivores, volatile fatty acids, from fermentation by colic bacteria, reach a high concentration in the colon where they are then absorbed. As in previous areas of the gut, the major target of microbial fermentation is cellulose.

Throughout this, and previous stages of the study of digestive physiology, students will be encouraged to present the scenarios and/or models that they have investigated and, through peer persuasion, to evaluate the validity of their designs and conclusions. Given their experimentation with not only the physiological system involved, but also the ecological ramifications of such a system, students may more realistically assess the limits, advantages, and disadvantages of a particular system design.

CONCLUSION

Depending upon a teacher's background or area of focus, other digestive functions (e.g., hormones and their interactions) and organs may be studied in a manner similar to that which I have described.

Regardless of the specifics that are investigated, the approach to the study of physiology that I have outlined emphasizes the learning and understanding of physiological systems and processes within the context that they actually occur and function: in whole animals that function within, and are affected by, the environment around them. Therefore, a bridge will be established between two highly interrelated disciplines - physiology and ecology.

This ecological approach applies not only to the study of digestive physiology, but to all components of physiology including the respiratory, circulatory, excretory, and nervous systems.

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Biology Teaching: A Scholarship

AMCBT 1992 Fall Meeting, Tentative Schedule
St. Xavier University
October 8-10, 1992

Thursday, October 8

6:00-8:00 p.m. **REGISTRATION RECEPTION**

8:00 p.m. **OPENING SESSION**
Welcome for AMCBT
Bob Wallace, Program Chair
Stanley D. Boyer and Sister Marion Johnson,
Local Arrangements Co-Chairs

WELCOME To Saint Xavier University
Ronald Champagne, President of the University

OPENING ADDRESS
Dorothy G. May, Park College
"Wild Life of Kenya"

9:30 p.m. **Executive Committee Meeting**

Friday, October 9

7:00 a.m. **REGISTRATION**

7:00-8:15 a.m. **BUFFET BREAKFAST**
(price included in registration)
Interest Groups by Discipline

8:15-9:15 a.m. **CONCURRENT SESSION I**

1. **Cooperative Field Studies: A Practical Approach to Biology**
   Norm Jensen & Ethel Stanley, Millikin University

2. **Teaching Sexual Differentiation in Undergraduate Biology Classes**
   Mark Roy, Beloit College

3. **Teaching Cell Biology Labs from an Inquiry Approach**
   Susan Speece, Anderson University

4. **Beta, Beta, Beta Science Workshop for Girl Scouts**
   Mary Haskins, Rockhurst College

5. **Fractal Dimensions and Biological Levels of Organization**
   Norman Woldow, Maryville University

6. **Alternative Teaching Methods in the Vertebrate Physiology Lab: One Classroom Example & a Round Table Discussion**
   Tom Davis, Loras College

9:15-9:40 a.m. **COFFEE AND EXHIBITOR DISPLAYS**

9:40-10:25 a.m. **CONCURRENT SESSION II**

1. **Perspectives on Teaching: Ecology and Field Biology**
   Malcolm Levin (Sangamon S.U.), Norman Jensen (Millikin Univ.), Wallace Weber (Southwest MO S.), Richard Wilson (Rockhurst Coll.), & Sr. Jeannene Yackey (Fontbonne Coll.)

2. **Perspectives on Teaching: Ecology and Field Biology Continued**

3. **Investigator - Driven Microbiology**
   Frank Pascoe, College of St. Francis

4. **Using Science Fiction Films to Teach Science**
   Edward Kos, Rockhurst College

5. **So You Think YOU Know What Time it is— Teaching Chronobiology in the lab**
   Kathleen Marr, Lakeland College

6. **Restricting Animal Use in Science Classes — Chapter II**
   John Schrock, Emporia State University

10:25-10:45 a.m. **COFFEE AND EXHIBITOR DISPLAYS**

10:45-11:45 a.m. **KEYNOTE ADDRESS**

David Landsdale, Shedd Aquarium
"Temperate Rain Forest: Using Shedd Aquarium as a Teaching Resource"

12:00-1:30 p.m. **OPEN LUNCH & EXHIBITS**

1:30-5:00 p.m. *Possible* **FIELD TRIPS**, *a charge is anticipated is anticipated for each.*

1.	Shedd Aquarium	$10.00	(includes admission & transportation)
2.	Planatarium	$4.75	(includes transportation only)
3.	Field Museum	$4.75	(includes transportation only)
4.	Art Institute	$4.75	(includes transportation only)

1:30 - 4:00 p.m. **WORKSHOP SESSIONS**

1. **Teaching About Human Population Growth in Introductory Biology Courses**
   Wallace R. Weber & Barbara K. Newman, Southwestern MO State

2. **Simulated ABO and Rh Blood Typing Activiy**
   Rick Highberger, Ward's Natural Science Establishment

3. **Does Writing about Biology Enhance Learning: Practical Aspects**
   Randy Moore (Wright State University), Marc Roy (Beloit College), & Robert Wallace (Ripon College)

4. **T. B. A.**
   Harold Wilkinson, Millikin University

1:30 - 4:00 p.m. **POSTER SESSIONS**

1. **Measuring Changes in Enviromental Values**
   Phyllis Kingsbury, Drake University

2. **Videotape Introductions to Biology Labs**
   Elizabeth R. Juergensmeyer, Judson College

3. **Fractal Dimensions and Biological Levels of Organization**
   Norman Woldow, Maryville University

4. **An Interdisciplinary Research Course in Biochemistry and Cell Biology: Evolution Toward an Integrated Theme**
   Margaret E. Stevens, Ripon College

6:00 p.m. **OPEN BAR AND SOCIAL HOUR**

7:00 p.m. **BANQUET**
(Price included in Registration)

8:30 p.m. **BANQUET SPEAKER**
Randolph Krohmer, Saint Xavier University
"The Private Lives of Snakes"

9:30 p.m. **CASH BAR AND SOCIAL HOUR**

Saturday, October 10

7:30-8:30 a.m. **BALLOTTING, COFFEE AND DONUTS**
Interest Groups by Discipline

8:30-9:30 a.m. **CONCURRENT SESSION III**

1. **Limitations of Quantification in Biomedical Sciences**
   Richard J. Stevens, University of Wisconsin - Green Bay

2. **Identification of Common Birds**
   Neil B. Schanker, William Rainey Harper College

3. **Biology as Part of a Women's Studies Program**
   Jacqueline Scholar, Bellevue College

4. **Promoting Science as a Process to Elementary Education Majors in a Biology Department Laboratory Course**
   Rudolph Prins & Barbara Kacer, Western Kentucky University

5. **Bioethics: What are they and how can we teach the concept of ethics**
   Terry L. Derting, Beloit College

6. **Biology of Aging**
   William Buckley, Saint Xavier Univesity

9:15-9:45 am **COFFEE AND EXHIBITOR DISPLAYS**

9:45-10:45 a.m. **CONCURRENT SESSION IV**

1. **Characteristics of Scholarship for Teacher-Scholars**
   Richard J. Stevens, University of Wisconsin-Green Bay

2. **Identification of Birds of Prey**
   Neil B. Schanker, William Rainey Harper College

3. **Attitudes in Science — Could You Survive in Beirut?**
   John Schrock, Emporia State University

4. **Attrition Rates in Science, Math, and Engineering Students: What can we do about it?**
   Richard E. Wilson and Anita Salem, Rockhurst College

5. **AIDS: A Laboratory Approach**
   John R. Jungck and Marion Field Fass, Beloit College

6. **Botany Program — A Cooperative Approach**
   Craig Zimmerman, Aurora University

11:00-12:30 p.m. **BRUNCH** (price included in registration fee)

BUSINESS MEETING

Reports:

Presidential Address - Cathy Hunt (Henderson Community College)
Election Results - Malcolm Levin
Bioscene - John R. Jungck, Susan Speece & Tim Mulkey
Executive Secretary Report - Ed Kos
Executive Committee Meeting following Brunch

SAINT XAVIER UNIVERSITY

Saint Xavier University is pleased to host the 1992 meeting of AMCBT. Saint Xavier serves the needs of a diverse student population. Our students are men and women, traditional age and adult, Catholic and other faiths. The enrollment is approximately 3900 students. Saint Xavier is the city's oldest college and now the newest university. On May 1, 1992, the college became officially Saint Xavier University. The Sisters of Mercy founded Saint Xavier College in 1846, inaugurating a remarkable tradition of quality higher education grounded in the liberal arts, academic freedom and the Catholic faith. The Science Department has over 100 majors, and has recently undergone extensive renovation. There are six full time biologists, five full time chemists, a physicist, a laboratory manager and two secretaries. We are looking forward to your visit and will be happy to show you our facilities.

Abstracts of Sessions

Identified by Session Number

I.1. Cooperative Field Studies: A Practical Approach to Biology

Norm Jensen and Ethel Stanley; Millikin University, 1184 West Main, Decatur, IL 62522

A short video presentation will be followed by discussion of Field Methods, a summer course for Elementary Ed. majors, and investigating Lake and Wetland Ecology, a new summer '92 high school outreach workshop with Illinois Power field biologists. Both will be presented as successful examples emphasizing the practical and cooperative nature of biology. Oral Presentation.

I.2. Teaching Sexual Differentiation in Undergraduate Biology Classes

Marc M. Roy; Beloit College, 700 College St., Beloit, WI 53511

There are many controversial issues surrounding discussions of sexual differentiation of human and nonhuman animals. These tend to revolve around differentiation of behavior, cognitive abilities, and gender identity. In this presentation, I will present and critique some of the data, interpretations, and misconceptions from studies in this area. I will also discuss the teaching of sexual differentiation. Participants are encouraged to bring ideas and materials that they use in teaching these subjects. Oral Presentation.

I.3. Teaching Cell Biology Labs From an Inquiry Approach

Susan P. Speece; Anderson University, 1100 E. 5th St., Anderson In 46012

Most of us became excited about biology because of the process of curiosity and discovery, yet we rarely teach biology that way. We offer lecture/discussion and cookbook labs. Where is the excitement and discovery? Cell Biology at Anderson University has been revamped and there is considerably more discussion and the labs are approached from an inquiry basis. We begin with a major concept to be investigated, ask questions about the concept that the students wish to explore and then propose procedures that will attempt to answer the questions. Oral Presentation.

I.4 Perspectives on Teaching: Ecology and Field Biology

Malcolm Levin (Sangamon State University, Department of Environmental Study, Springfield, IL 62794-9243), Norman Jensen (Millikin University), Wallace Weber (Southwest Missouri State), Richard Wilson (Rockhurst College), & Sr. Jeanene Yackey (Fontbonne College)

Panelists will make presentation that focus on what we believe are significant content areas and skills to be acquired by students in ecology and field biology. Panelists will address how we integrate these components into our respective ecology and field biology courses and laboratories. — Two, back-to-back, 45-minute time slots will be used for this oral presentation.

I.5. Fractal Dimensions and Biological Levels of Organization

Normon Woldow; Maryville University, St. Louis, MO 63124

Fractal mathematics corresponds well with Odum's levels of biological organization. One of Mandelbrot's definitions of the fractal dimension can help interpret the complexity of life and its unity with nonliving systems. Modern mathematics can help our students avoid the crude oversimplifications of physicalism and vitalism, increasing the philosophical rigor of biology at all levels from the molecular to the ecological. Oral Presentation with Poster summary.

I.6. Alternative Teaching Methods in the Vertebrate Physiology Lab: One Classroom Example and a Round Table Discussion

Tom Davis; Department of Biology, Loras College, Dubuque, IA 52004 0178

The session leader will present several successful methods he has used in the laboratory periods of his vertebrate physiology course for majors. About one half of the session will involve participants in a sample classroom exercise the objective of which will be to develop their biological knowledge regarding euthanasia. Additional teaching methods considered will include (1) discussion of other controversial, ethical topics, (2) critical analysis of a published article, (3) design of an experiment to test kidney function, and (4) additional discussion of lecture material. The second half of the presentation will be a round table discussion with all participants to exchange ideas and suggest alternative teaching methods that have been used successfully in vertebrate physiology laboratory. Oral Presentation.

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II.1. Beta, Beta, Beta Science Workshop for Girl Scouts

Mary Haskins; Rockhurst College, Kansas City, MO

Rockhurst College in cooperation with the Mid-Continent Girl Scout Council offers one-day workshops for Junior Girl Scouts in which the scouts may earn science merit badges. Beta Beta Beta students and volunteers serve as instructors. The program provides hands-on experience for the scouts and an opportunity for Rockhurst students to understand the joys and challenges of teaching. We offered four workshops in 1991-92, in which approximately 40 Rockhurst students assisted over 600 scouts in earning the Water Wonders Badges. Laboratory experiments for the Water Wonders Badge included: making clouds in 2-liter bottles, determination of boiling points and densities of salt and fresh water, identification of major bodies of salt and fresh water, identification of microscopic pond life, and a bingo game in which the scouts identified terminology associated with the water cycle. Four workshops are planned for the 1992-93 year. Oral Presentation.

II.2 Using Science Fiction Films to Teach Science

Edward S. Kos; Department of Biology, Rockhurst College, Kansas City, MO 64110

Many of our students, and a large portion of the general public harbor an enormous amount of misinformation about science. Years ago most of this was obtained from printed matter, today it comes from films and TV. What persists is the notion that if it's in the media it is correct. It is possible to use materials containing "bad" science and teach good science. This presentation will look at a concept that was developed at Temple University and has slowly been spreading. Examples will be presented and experiences discussed. Oral Presentation.

II.3. Investigation Driven Microbiology

Frank Pascoe; College of St. Francis, Joliet, Il 60435

In an effort to avoid teaching microbiology techniques in the disconnected, "cook-book" fashion so common in published laboratory manuals, I have develop ed an approach which allows the students to learn basic microbiology laboratory skills in the context of individual and group investigations (e.g., "Getting to know your body bacteria"). The emphasis in this approach is to involve the students in open-ended investigations rather than weekly exercises which simp ly demonstrate what is already known. By engaging the students in a process which seeks to answer meaningful questions the students learn the role of the techniques in the scientific process as well as practicing the technique. My presentation will include specifics of course design. Oral Presentation

II.4. Perspectives on Teaching: Ecology and Field Biology (Continued). See II.4.

II.5 So You Think YOU Know What Time it is — Teaching Chronobiology in the Laboratory

Kathleen M. Marr; Biology Department, Lakeland College, Sheboygan, WI 53082-0359

Natural, endogenous rhythms have been demonstrated in many laboratory animals. Physiology courses often are limited to anatomical demonstrations or ablation experiments that emphasize functional relationships. Here, pseudopregnancy in rodents has been used as a model system for an experimental model in biological rhythms and regulation thereof in instructional undergraduate settings. Model systems, protocols and animal care and maintenance are incorporated into this exercise. Oral Presentation.

II.6. Restricting Animal Use in Science Classes — Chapter II

John Richard Schrock; Emporia State University, Emporia KS, 66801

This update on current challenges to laboratory dissection and animal experimentation in education includes background on the recent U.S.D.A. regulations that drastically limit the supply of cats used in dissection in undergraduate anatomy and physiology classes. While various organizations are effectively defending animal use in research and other areas, there is no machinery in place to effectively advocate and defend animal use in education. Oral Presentation.

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III.1. Limitations of Quantification in Biomedical Sciences

Richard J. Stevens; University of Wisconsin - Green Bay, Green Bay, WI 54311

The need for careful teaching of limitations of quantitative methods as applied to human phenomena in biomedical and biobehavioral sciences is considered. A partial analysis of the limited and selective nature of statistics is presented. Statistics is a valuable tool in science. However, statistical methods require a bias in information selected for simple, recurrent, common phenomena and a bias against, individual complex qualitative phenomena. The latter group of phenomena are highly significant to human health and behavior. Thus, quantitative methods tend to de-value human experiences and to ignore information of significant concern to individual cases. Thus, biology teaching must have more serious concern for divergence of individual experiences from statistical models than physical sciences.

Examples are given from public health, such as Raeye's disease, diagnostic related groups (DRGs), contaminants in food supply, and views of human sub-populations. The focus of this presentation is the need for greater clarity and caution in teaching of quantitative findings in biological sciences. Oral Presentation.

III.2. Identification of Common Birds

Neil B. Schanker; William Rainey Harper College, Palatine, IL 60067

This slide show will illustrate about 70 of the most often seen bird species of the Chicago area. The more obvious field identification marks will be emphasized. This program is appropriate for beginners although experienced birders might also pick up some identification tips. Oral Presentation.

III.3. Biology as Part of a Women's Studies Program

Jacqueline Scholar; Bellevue College, Bellevue, NE 68005

A course called Biology of Women was developed by a biology professor for the Women's Studies Department. The 3-hr. course is cross-listed in both departments and fulfills upper division and general education requirements. This course has become very popular with non-science majors of both sexes. It is intensive and focuses on topics such as anatomy, physiology, nutrition, drug use, diseases, and disorders relative to women. Writing is an integral part of the class. The benefits and problems of such a course will be discussed. Oral Presentation.

III.4. Promoting Science as a Process to Elementary Education Majors in a Biology Department Laboratory Course.

Rudolph Prins and Barbara Kacer; Department of Biology and Teacher Education, respectively, Western Kentucky University, Bowling Green, KY 42101

An Introduction to Biology course for Elementary Education Majors only was introduced into the Biology curriculum in the Fall of 1991 to meet increasing enrollment demands of this major and to separate these students from the biology-track students. The laboratory operation is innovative and the particulars will be discussed in this presentation. As part of the course students are required to complete three major research projects and at least three mini-projects. For the major projects students had to propose, design, implement, and report on their research as a team. Mini-projects could be done as part of a team or individually. The mini-projects were based on observations kept in a log of events that were observed to occur in an aquarium and terrarium that the team had maintained for about 10 weeks. A final report, based upon observations accumulated in the log, is also required by each student. Oral Presentation.

III.5. Bioethics: What are They and how can we Teach the Concept of Ethics

Terry L. Derting; Department of Biology, Beloit College, Beloit, WI 53511

Ethical issues in biology are becoming more numerous and complex. Accordingly, course offerings on ethical issues have risen dramatically in the past decade. Typically, such courses expose students to a variety of biological issues, addressing them from several viewpoints. Although students gain an understanding of the complexity of such issues, they frequently fail to grasp a meaningful understanding of what constitutes an ethic itself. I will discuss methods of teaching that facilitate student comprehension of, and personal identification with, the concept of "an ethic" within the framework of biology. Oral Presentation.

III.6. The Physiology of Human Aging

William J. Buckley; St. Xavier University, Chicago, IL 60655

As human life expectancy increases, there is a need for better understanding of age-related biological changes. Information on aging is now incorporated into introductory as well as advanced biology courses. An overview of the aging process and suggestions of ways to modify aging will be presented.

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IV.1. Characteristics of Scholarship for Teaching - Scholars

Richard J. Stevens; University of Wisconsin - Green Bay, Green Bay, WI 54311

Numerous calls have been made urging college faculty to focus more on quality of college teaching. However, research, scholarship, and grantsmanship pressure frequently detract time and effort from teaching. A particular conflict with teaching is a requirement for research publications in scholarly journals without which quality teaching professors may not be promoted or retained.

This presentation focuses upon defining an additional area of scholarly endeavor. the teaching-scholar, which is more compatible with teaching loads at many colleges and universities, and which can also be used to judge quality of scholarship for promotion and tenure. Characteristics of scholarship closely tied to classroom teaching include keeping up to date, communicating scholarly findings, research for new information and generation of new syntheses all of which satisfy the concerns which keep scholarship as a promotion requirement at many colleges and universities. The presentation argues that adoption of standards for scholarship which included teaching-scholarship, in addition to laboratory research scholarship, is necessary for improvement in quality of college science teaching. Oral Presentation.

IV.2. Identification of Birds of Prey

Neil B. Schanker; William Rainey Harper College, Palatine, IL 60067

This slide show will illustrate about 25 raptor species seen in Illinois. We will learn to differentiate falcons, accipiters, buteos, eagles, vultures, and owls. The more obvious field identification marks will be emphasized. Oral Presentation.

IV.3. Attitudes in Science — Could You Survive in Beirut?

John Richard Schrock; Emporia State University, Emporia KS, 66801

Among current "critical thinking" and "science decision-making" educational fads are teaching strategies that lead students to premature speculation and also confuse science with socialization. A brief exercise is used to clarify the universality of science, and 20 additional science attitudes are summarized including: empiricism, determinism, parsimony, scientific manipulation, skepticism, precision, respect for paradigm, loyalty to reality, awareness of assumptions, quantification, tolerance limits to knowledge, etc. Oral Presentation.

IV.4. Addressing the Attrition Rate in Entering Science, Math and Engineering — What can our Campuses do About it?

Richard E. Wilson and Anita Salem; Rockhurst College, Kansas City, MO 64110

Examination of the data shows attrition in science, math, and engineering is highest at grades 6, 11 and 13. Rockhurst has inaugurated a program across the sciences to initially answer Shiela Tobias's charge [Their not dumb, their different] to alleviate the loss on our campus at the rising sophomore level, and have a five year plan to help area precollegiate units upgrade and address the problem at their level. Data showing the scope of the national and local problem will be presented, a short description of our program and plan, and some time for the exchange of ideas among the participants will be provided. Oral Presentation.

IV.5. AIDS: A Laboratory Approach

John R. Jungck and Marion Field Fass; Beloit College, Beloit, WI 53511

We have taught (2X) a Biological Issues course on AIDS as a laboratory experience that counts towards the college-wide distribution requirements. We will share our lab write-ups and briefly outline what we do in each lab. Exercises include condom testing (with a focus on experimental design and hypothesis testing), two labs on microbiology (microscopic examination of pathogens associated with secondary infections in AIDS patients, Koch's postulates, serial dilution, and replica plating with and without an antibiotic), phylogenetic systematics of HIV sequences and inferences about source of infection (the Florida dentist case), statistical and geographic analysis of morbidity data, epidemiological modelling, human variation analysis, risk analysis, nutrition, action of drugs, selective permeability, a group AIDS educational outreach project, and a library research exercise on patient education. We will discuss more about the impact of these experiences on the students than the technical details of specific experiments because we were impressed with the student reactions and the activities that they constructed. Oral Presentation.

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W.1. Teaching About Human Population Growth in Introductory Biology Courses

Wallace R. Weber and Barbara K. Newman; Dept. of Biology and Dept. of Biomedical Sciences respectively, Southwest Missouri State University, Springfield, MO 65804-0095

This workshop will include topics on exponential growth, carrying capacity, population growth and environmental cost, and sustainability. Ideas as to how these topics may be introduced and activities illustrating these concepts will be presented. Videos, books, and other publications useful in teaching these concepts also will be emphasized. Time will be allotted for discussion of other ideas from the participants, as well as the pros and cons of this sometimes controversial topic. Workshop.

W.2. Simulated ABO and Rh Blood Typing Activity

Rick Highberger; Ward's Natural Science, 1745 Ellendale, Northbrook, IL 60065

Using a simulated blood product, we will count red and white blood cells, perform blood smears and explore Rh typing. In addition, numerous new Macintosh products are now available. Workshop.

W.3. Does Writing about Biology Enhance Learning: Practical Aspects

Randy Moore; Wright State University, Dayton, OH 45435 [with Marc Roy, Beloit College, & Robert Wallace, Ripon College]

One of us (RM) studied how different kinds of writing - instruction affect how students learn about biology. One group of students were required to write essays, but received no feedback or instruction about how to write-to-learn. These students scored no better on exams than did students who did no writing. However, another group received instruction in the principles of writing-to-learn; these students scored significantly higher on exams than did students in either of the other groups (i.e., those who did no writing or who had writing assignments but no instruction in how to write-to-learn). These results indicate that (1) merely writing about biology does not ensure that students learn about biology, and (2) students who understand how to use writing as a tool for learning can use writing to learn biology. The workshop participants will discuss the relevance of these data to writing assignments and writing programs such as writing - across the curriculum (WAC). Synopses of two WAC programs with long track records of success (Beloit and Ripon) will be presented. All praticipants are encouraged to bring their ideas of what works and what doesn't. Workshop.

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P.1. Measuring Changes in Environmental Values

Phyllis Kingsbury; Drake University, Des Moines, IA 50311

Pre-test/Post-test comparisons were examined to see if an environmental course for general students influenced environmental values. Ten questions were created with alternative answers based on Miller's "Four Levels of Environmental Awareness". Slight improvements were observed which was attributed to the open enrollment and the attractiveness of the course to students with already formed environmental interests. Poster Session.

P.2. Videotape Introductions to Biology Labs

Elizabeth R. Juergensmeyer; Judson College, Elgin, IL 60123

I have developed a series of videotapes coordinated in the laboratories in Principles of Biology, with the objectives of (1) stimulating interest in the week's topic, and (2) demonstrating techniques and materials for that specific laboratory. These videos were prepared with relatively inexpensive equipment and were designed specifically for the course taught at Judson College. Video, Poster Session.

P.3. Fractal Dimensions and Biological Levels of Organization See I.5.

Norman Woldow; Maryville University, St. Louis, MO 63124

Oral Presentation, with Poster summary.

P.4. An Interdisciplinary Research Course in Biochemistry and Cell Biology: Evolution Toward an Integrated Theme

Margaret E. Stevens; Ripon College, Ripon, WI 54971

Through a Instrumentation and Laboratory Improvement grant from the National Science Foundation, Ripon College was able to purchase equipment to update a laboratory course in biochemistry and cell and molecular biology. The project goal is to offer a research experience while teaching students widely used techniques such as cell culture, electrophoresis, gradient centrifugation, radioisotope labeling, and chromatography. Team taught by faculty in the Biology and Chemistry Departments, the course consists of a series of class exercises built around a common theme and culminating in an independent research project. The basic exercises have been developed, and this year's theme simulates a research program investigating the characteristics of a single enzyme. A future goal is to incorporate recombinant DNA technology into the same unified approach. Poster Session.

In Memoriam: John Bennett "Ben" Olson, 74, artist, retired biology professor

John Bennett "Ben" Olson, 74, died Saturday, January 4 in his home at 320 Brown St., West Lafayette. He had been in failing health the past year.

He was a professor of biology at Purdue University from 1964 until retiring in 1981.

Dr. Olson, an artist, founded the Watson's Crick Gallery in the Lilly Hall of Science on the Purdue campus, and he was an active member of the University Visual Arts committee. He also led workshops in creativity for people of all ages, including the Lafayette Urban Ministry camp program and at Circle Pines Center in Michigan.

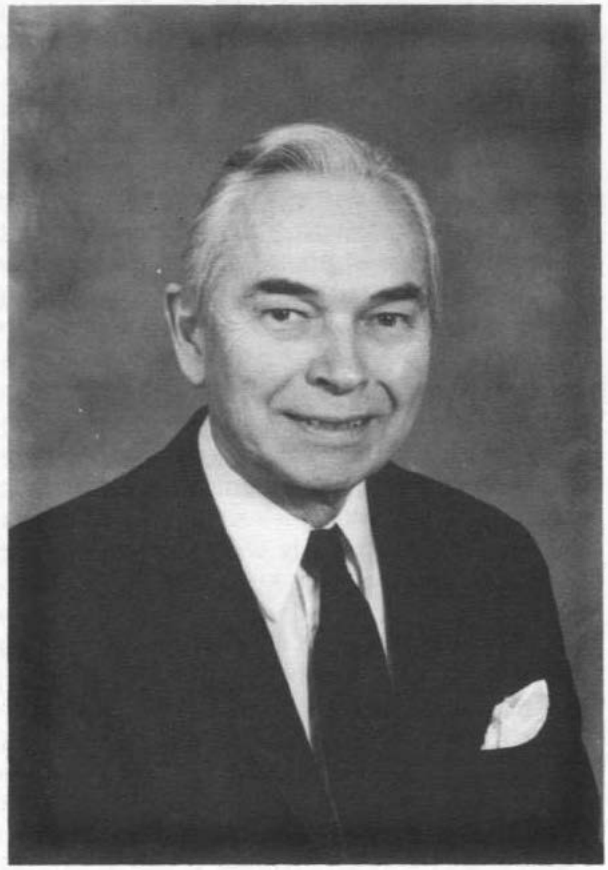
He came to the university to direct the National Science Foundation master's degree program and held a joint appointment between the departments of biology and education. For many years, he served as head of biological sciences for the Purdue regional campuses.

As president of the Indiana College Biology Teachers Association, Dr. Olson led a successful effort to defend the First Amendment by filing suit to prevent the state of Indiana from adopting a religious text for use in teaching biology to public high school students.

Before joining the Purdue faculty, he taught at Brooklyn College, San Jose State College and Shimer College, where he was chairman of the natural sciences division. His research included study of heart defects while he worked at Children's Hospital in Los Angeles, and of the central nervous system while he worked in the lab of Linus Pauling at Cal Tech. In 1983, Dr. Olson's doctoral thesis and specimens of the microscopic marine organisms that were the object of his study were incorporated in the invertebrate collection of the Smithsonian Institution.

Dr. Olson served as a lay minister for the Unitarian Fellowship, and later he and the Rev. Leo Haigerty organized the Science and Theology seminar, which continues at the Wesley Foundation.

He was a Red Coat volunteer at Home Hospital, played flute and tap danced with the Cherry Lane Dudes at local events, the senior citizens center and nursing homes. Dr. Olson was an army veteran of World War II.



Born Feb. 13, 1917, in Minneapolis, Minn., he grew up in South Bend and Rockford, Ill., and came to the area from Mount Carroll, Ill., in 1964. He graduated from Beloit College, Beloit, Wis., with a degree in biology. He continued his studies at UCLA and earned his doctorate in invertebrate zoology from Scripps Institution of the University of California.

He married Dorothy Daggett in Los Angeles in 1942. She survives.

Also surviving are three daughters, Mrs. Alfred (Loren Olson) Pounders of West Lafayette, Mrs. Sydney (Christina) Spiesel of New Haven, Conn., and Mary Olson of Washington, D.C.; two brothers, Munthe Victor Olson of Palm Desert, Calif., and David Darrel Olson of Paradise, Calif., and a sister, Mary Lou Branaum of Hemet, Calif.

Application For Membership

ASSOCIATION OF MIDWESTERN COLLEGE BIOLOGY TEACHERS

NAME:______________________________ DATE:______________

TITLE:____

DEPARTMENT:____

INSTITUTION:____

STREET ADDRESS:____

CITY:______________________________ STATE:______________

ZIP CODE:___________________

ADDRESS PREFERRED FOR MAILING:__________________________

CITY:______________________________ STATE:______________

ZIP CODE:______________________

WORK PHONE:__________________ FAX NUMBER:_______________

HOME PHONE: __________________ E-MAIL ADDRESS:___________

MAJOR INTERESTS:

( ) 1. Biology
( ) 2. Botany
( ) 3. Zoology
( ) 4. Microbiology
( ) 5. Pre-professional
( ) 6. Teacher Education
( ) 7. Other

RESOURCE AREAS:

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RESEARCH AREAS:

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Have you been a member before?__________ If so, when?______________

PLEASE MAIL

MEMBERSHIP APPLICATION

FORMS TO:

Edward S. Kos
Executive Secretary, AMCBT
AMCBT Central Office
Department of Biology
Rockhusrt College
Kansas City, MO 64110

CURRENT DUES ARE **$25.00**