Bioscene

Journal of College Biology Teaching

Volume 17 Number 1 • March 1991

Bioscene
Journal of College Biology Teaching

Volume 17(1) **March 1991**

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Cover Illustration: Little Blue Heron (*Egretta caerulea*). These common North American birds inhabit both freshwater formations and coastal saltwater wetlands. Adults are slate blue with dark purple plumage on the head and neck. During high breeding season this plumage becomes reddish-purple.

Cover Credit: Bruce MacAllister, Studio Art, Beloit College, Beloit, WI

Bioscene: Journal of College Biology Teaching

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Suggestions for Manuscripts:

- Announcements
- Laboratories that work
- Courses that work
- Minority Education
- Computer Advice
- Letters to the Editor
- Sources of Funding
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MODIFICATION OF GRAVITROPIC SENSITIVITY OF ROOTS

A LABORATORY EXERCISE

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The gravitropic response of roots is a three phase event (Figure 1). Phase I of the gravitropic response involves sensing the direction of the gravitropic vector; this process occurs in the root cap and requires less than 30 seconds in some species and up to 2 min in other species. The sensor has been the most enigmatic component of the gravitational mechanism. The statolith model involving "falling" cellular organelles is the most widely accepted model for the sensor. The nature of the statocyte has undergone extensive review (Juniper, 1976); plastids,

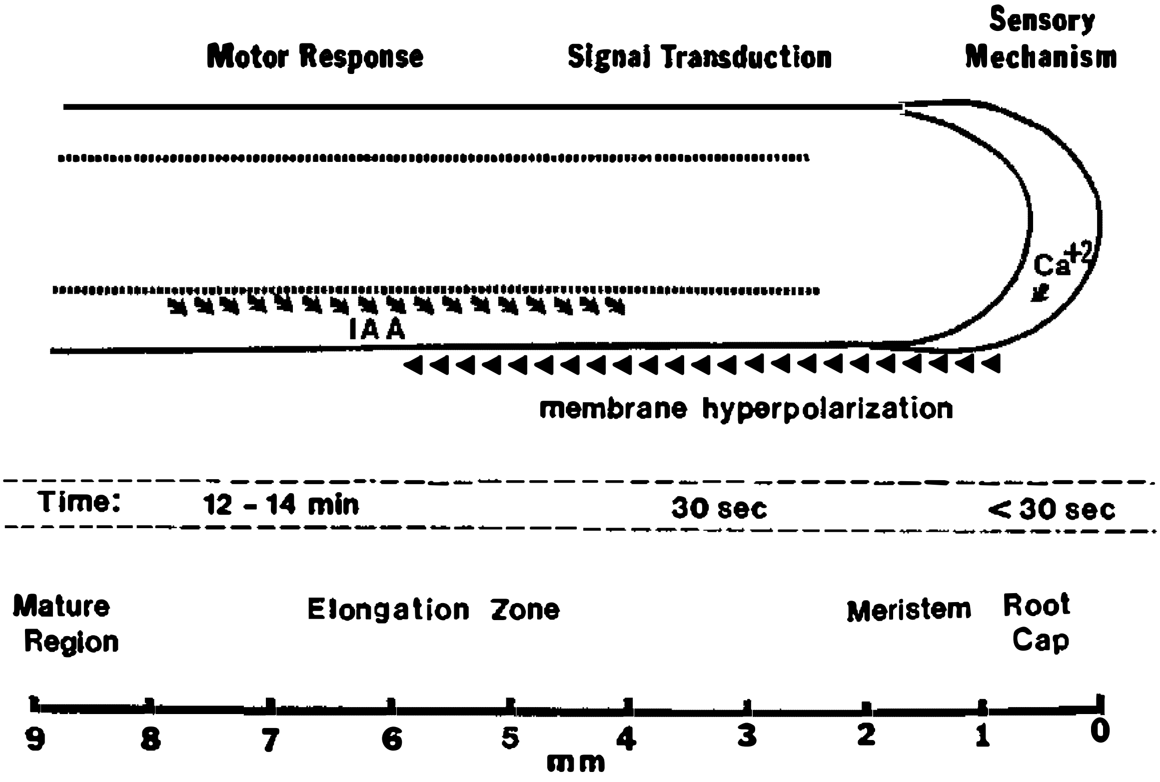

Figure 1. Working model of gravitropism.

organelles, membrane systems, and the cytoplasm have been proposed as possible statocytes in different systems. The search for anatomically identical statocytes common to all plants has delayed progress in determining the physiological and biochemical events involved the sensory mechanism.

Investigators have been slow to arrive at the realization that different statocytes can produce similar results.

Look at the diversity of heart structure throughout the animal kingdom; although structure may differ, the common thread which allows the wide variety of forms to be labelled "hearts" is a similar function. Analogously, the common thread which connects the different statocyte models is the net accumulation of calcium ions in the lower portion of the root cap during the induction of the gravitational response.

Phase II of the response involves the transduction of the orientation signal from the root cap sensor to the elongation zone of the root. By inference from the timing of the gravitational response, this process must occur within 15 to 90 seconds. This rapid transduction has fueled extensive investigations into the role of membrane hyperpolarization as the transduction mechanism; the membrane hyperpolarization could result from calcium ion transport during the sensor phase of the response.

Phase III of the gravitational response is the motor mechanism or growth response. This phase is the most documented phase and results from differential growth rates on opposing sides of the root (Fim and Digby, 1980; Pickard, 1985). The differential growth results from accumulation of auxin (indole-3-acetic acid) along the lower surface of the root. Auxin concentrations greater than 10^{-9} M are inhibitory to root elongation in most species; promotion of root elongation by exogenously applied auxin is rarely observed due to the extreme sensitivity of root elongation to auxin. The motor response is observed 12-14 minutes after reorientation of a root. Based on this observation and limited studies on auxin redistribution during gravitropism, many researchers have postulated that auxin levels of the lower hemisphere of a root increase due to the release of auxin from the vascular stele which normally carries auxin toward the root tip.

This laboratory experiment has been designed to study the role of calcium ions in the sensory mechanism associated with gravitropism. Manipulation of the calcium ion concentration at the root cap allows for alteration of the signal transduction and motor response. One advantage to this type of experiment is exogenous application of hormones is not required; treatments modify endogenous hormone distribution. Thus, "natural" gravicurvature can be studied without complications resulting from application of hormones in non-physiological concentrations.

GOALS OF THE EXPERIMENT --

1. Determine the role of the root cap in the gravitropic response.
2. Observe the effects of application of calcium ions on root curvature.
3. Observe the effects of chelation of calcium ions on root curvature.

TIME REQUIREMENT --

0.25 hour approx. 4 days prior to experiment (soak seeds)
1.00 hour approx. 3 days prior to experiment (plant seeds)
1.00 hour prior to experiment (prepare agar blocks)
2.00 hours experiment running time.

MATERIALS AND EQUIPMENT --

Agar
Calcium chloride
EDTA or EGTA
Disposable plastic petri plates,
  100 x 15 mm
0.1 N HCl
0.1 N NaOH
Paper towels
Parafilm
pH meter
Dissecting scope
Scalpel
Forceps
Mortite caulking cord
Filter paper
Plastic trays and tub
Seed, corn
Optional: radiolabeled calcium chloride
  scintillation vials
  scintillation cocktail
  scintillation counter

METHODS --

Seedling Preparation. For observation of root gravitropism, corn seedlings are recommended. The roots of corn are sufficiently large to allow for easy handling and have root caps which are easily removed. Caryopses of corn are soaked in a beaker overnight under a running tap; running water prevents anaerobiosis. To obtain straight primary roots you should place the corn grains in rows on a tray covered with several layers of paper toweling. Cafeteria trays or lids from plastic shoe boxes work best. Cover the grains with 3 or 4 layers of paper towels; place another tray over final layer of towels to hold the paper towels in place. Position the trays vertically in a shallow tub containing 1-2 inches of water (the bottom of the paper towels should extend into the water). Primary roots of approximately 1.5 cm in length should be used for the experiments; this should require 2-3 days of growth, depending upon the cultivar and temperature.

Agar Block Plate Preparation. Application of calcium ions, ethylenediaminetetraacetic acid (EGTA) or ethylene glycol-bis(β-aminoethylether) N,N,N',N'-tetraacetic acid (EDTA) chelating agents is achieved from donor blocks. For 30 agar-dye plates, add to a 500 ml beaker 3.0 gm of non-nutrient agar, and enough distilled water to produce 300 ml of solution. The solution is boiled to dissolve the agar. The dissolved agar is divided into three, 100 ml aliquots. To the first aliquot add 0.0735g (5 mM) calcium chloride. To the second aliquot add either 0.1902 g (5 mM) EGTA or 0.1861g (5 mM) EDTA. The third aliquot is used for preparation of the control agar blocks. The each aliquot is adjusted to pH 6.4 with 0.1 N HCl/0.1 N NaOH and poured to a depth of about 2 mm in 100 x 15 mm plastic petri plates (10 ml of solution per plate). The poured plates are placed on a level surface to cool.

EXPERIMENTAL PROCEDURE --

A. Role of the Root Cap in the Gravitropic Response.

1. Select 12 corn seedlings with primary roots approximately 1.5 cm in length.
2. Using a dissecting scope and scalpel carefully remove the root cap from 6 of the roots.

3. Set-up six petri plates with 3-4 disks of moist filter paper in the bottom of each plate. Using caulking cord, attach two seeds by their caryopses to the inside of the lid of each petri plate. You should have three lids containing two roots with root caps or two roots without root caps.

4. Orient two plates (one with caps and one without caps) with the roots pointing down. Orient the two other plates (one with caps and one without caps) with the roots pointing up. Orient the final two plates with the roots pointing horizontal to the gravity vector.

5. Observe and sketch the curvature patterns which occur after 1.0 hour.

B. Effect of Calcium Ions on Gravicurvature.

1. Select 6 corn seedlings with primary roots approximately 1.5 cm in length.

2. Using a Dissecting scope and scalpel carefully remove the root cap.

3. Set-up three petri plates with 3-4 disks of moist filter paper in the bottom of the plate. Using caulking cord, attach two seeds by their caryopses to the inside of the lid of the petri plate.

4. Place an agar block approximately 1.5 mm square containing 5 mM calcium chloride on the left side of one of each pair of seedlings and on the right side of the other member of each pair.

5. Orient one of the plates with the roots pointing down. Orient the second plate with the roots pointing up. Orient the third plate with the roots pointing horizontal to the gravity vector.

6. Observe and sketch the curvature patterns which occur after 1.0 hour. Additional observations can be made after 24 hours if scheduling permits.

C. Effect of Chelation of Calcium Ions on Gravicurvature.

1. Select 6 corn seedlings with primary roots approximately 1.5 cm in length.

2. Using a Dissecting scope and scalpel carefully remove the root caps.

3. Set-up 3 petri plates with 3-4 disks of moist filter paper in the bottom of the plate. Using caulking cord, attach two seeds by their caryopses to the inside of the lid of the petri plate. Three plates lids should contain seedlings with intact root caps and three lids should contain seedlings without root caps.

4. Place an agar block approximately 1.5 mm square containing 5 mM EGTA or EDTA on the left side of one of each pair of seedlings and on the right side of the other member of each pair.

5. Orient one of the plates with the roots pointing down. Orient the second plate with the roots pointing up. Orient the third plate with the roots pointing horizontal to the gravity vector.

6. Observe and sketch the curvature patterns which occur after 1.0 hour. Additional observations can be made after 24 hours if scheduling permits.

OBSERVATIONS AND QUESTIONS --

Sketch the effects of each treatment on curvature of the roots after 1 hour (and 24 hours if possible).

What hypothesis could you develop from your observations concerning the role of the root cap in gravitropism?

Compare the effects of calcium and EGTA/EDTA treatment? How would you explain these observations?

What hypothesis could you develop from your observations relating calcium ions and the root cap?

SUGGESTIONS FOR ADDITIONAL EXPERIMENTS

1. Perform the calcium and EDTA/EGTA experiments on roots which possess root caps. Are the results identical? What factors would account for the differences observed?

2. Perform the calcium and EDTA/EGTA experiments on roots, but place the calcium and EDTA/EGTA sources at the elongation zone instead of the root tip. How would you account for the differences observed? (Remember calcium is associated with the sensor mechanism.)

3. If proper facilities for utilizing radioactive materials are available, prepare an additional set of agar plates and incorporate radiolabeled calcium chloride into the medium. Sufficient label should be used to provide 20,000 - 30,000 CPM per block. Use the same experimental design as procedure A except place a donor block with radiolabel on one side of the root and a receiver block with no additive on the opposite side of the root. After one hour, remove the receiver blocks and count the radioactivity which moved across the root. What is effect of the root cap on transport of the radiolabel?

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Editorial Policy Changes and a New Journal Title

On February 9th and 10th, 1991, the steering committee of AMCBT met at Rockhurst College. We voted to change of the name of our journal from Midwest Bioscene to Bioscene: Journal of College Biology Teaching. The reason for the change was to better indicate the coverage of our journal. Secondly, now that Bioscene is no longer a newsletter and is serving some of our contributors as part of their professional work which counts towards annual activities, reappointment, rank and tenure, we voted to have Bioscene become a refereed journal. Therefore, we decided that all full manuscripts will be sent to two members of the editorial board for review. If there Is a split vote, the manuscript will be sent to a third reviewer at the discretion of the editor. Material can still be printed in the News and Views Section without review beyond the editorial office. We hope that these changes will serve the membership better.

At the annual meeting, it was announced that three members of the editorial board have retired: Robert H. Buchholz, Joe Kapler, and Russ Tepaske. We sincerely thank each of them. Sue Speece has accepted the duties as the new chairperson of the board, Tim Mulkey has accepted the position of secretary of the board (Ray Reed will stay on as a regular member), and Bruce Edinger will serve as the third new member of the board. Welcome!

VISUALIZING ACID EFFLUX PATTERNS DURING TROPISTIC CURVATURES

A LABORATORY EXERCISE

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According to the "Acid Growth" hypothesis of the action of auxin on growth, one of the initial events of the growth response is the stimulation of H^+ efflux from tissues exposed to promoting levels of auxin (Rayle and Cleland, 1977). This enhancement of proton efflux precedes the enhancement of growth (Evans and Vesper, 1980; Mulkey et al., 1982) and its rate depends upon auxin concentration (Rayle, 1973). It has been well documented that application of acid to plant tissues promotes elongation of the plant organ (Edwards and Scott, 1974; Evans, 1976, Rayle and Cleland, 1970). The initial kinetics of acid-induced growth are similar to kinetics of auxin-induced growth, but acid does not trigger cellular mechanisms required for a sustained growth response. If the "acid-growth" hypothesis is valid, growing regions along plant organs should exhibit H^+ secretion into the cell walls and external environment. Non-growing regions should exhibit diminished H^+ secretion (or H^+ uptake) into the cell walls and external environment (Mulkey and Evans, 1981; Mulkey et al., in *Planta*, 1981; Mulkey et al., in *What's New in Plant Physiology*, 1981).

Tropistic curvature is a model system for the study of the "acid-growth" hypothesis.

During tropistic curvature, differential growth rates occur on opposite sides of the plant organ. This allows for observations and comparisons to be made under conditions of varying growth rates in a single experimental system. The classical model for development of curvature during the gravitropic responses in plants is the Cholodny-Went (C-W) model (Digby and Firn, 1980; Went and Thimann, 1937). This model accounts for the differential growth rates via differential hormonal distribution. In stem or hypocotyl tissues, which are relatively less sensitive to auxin (Thimann, 1937), upward curvature of horizontally-placed stems and/or hypocotyls results from an accumulation of auxin in the lower hemisphere of the organ. The increased auxin concentrations promote enlargement of the cells in the lower half of the stem or hypocotyl. The accelerated growth rate in the lower hemisphere of the organ would then result in upward curvature. The same model is applied to roots, except that root tissues are highly sensitive to auxin (Evans et al., 1980; Mulkey et al., in Plant Science Letters, 1982). The accumulation of auxin in the lower hemisphere of the root results in an inhibition of growth. Thus the upper side of roots possess a higher growth rate than the lower side, resulting in downward curvature.

Proton efflux can be observed by a simple method which was introduced by Weisenseel et al (15) for the study of ion currents in plant material. This method was adapted for observing H⁺ efflux associated with growth and gravitropism (6, 7, 8). A pH indicator dye Is incorporated into agar and then tissue is placed on this medium. As tissues alter the pH of the cell wall and surround-ing environment, a color change is observed in the dye-medium. This laboratory exercise is based on this simple but elegant method for observing proton secretion patterns of intact tissues.

GOALS OF THE EXPERIMENT --

1. Determine regions of elongation along plant organs.
2. Observe variations in growth rates on opposite sides of a plant organ during tropistic curvature.
3. Examine the relationship between H^+ and growth.
4. Examine the relationship between H^+ and gravicurvature.

TIME REQUIREMENT --

0.25 hour approx. 4 days prior to experiment (soak seeds)
1.00 hour approx. 3 days prior to experiment (plant seeds)
1.00 hour prior to experiment (prepare agar-dye plates)
2.00 hours experiment running time

MATERIALS AND EQUIPMENT --

Agar
Bromocresol purple indicator dye
Disposable plastic petri plates, 100 x 15 mm
Fingerprint ink or Sanford's Rollon Stamp Pad Ink
Hot plate
Light box
Mirror grinding abrasive (Edmund Scientific, #40016)
0.1 N HCl
0.1 N NaOH
Paper towels
Parafilm
pH meter
Plastic trays and tub
Screws, two machine screws (1.5" x 8/24 or 8/32)
Seed; sunflower and corn
Small block of wood
Thread, cotton

METHODS --

Seedling Preparation. For observation of root gravitropism, corn seedlings are recommended. The roots of corn are sufficiently large to allow for easy handling and for observation of color changes of the indicator dye (bromocresol purple). Caryopses of corn are soaked in a beaker overnight under a running tap; running water prevents anaerobiosis. To obtain straight primary roots you should place the corn grains in rows on a tray covered with several layers of paper toweling. Cafeteria trays or lids from plastic shoe boxes work well. Cover the grains with 3 or 4 layers of paper towels; place another tray over the final layer of towels to hold the paper towels in place. Position the trays vertically in a shallow tub containing 1-2 inches of water (the bottom of the paper towels should extend into the water). Primary roots of approximately 1.5 cm should be used for the experiments; this will usually require 2-3 days of growth, depending upon the cultivar and temperature. For observation of stem or hypocotyl gravitropism, sunflower seedlings are recommended. Sunflower seedlings should be germinated in the same manner as corn grains. The only modification of the germination method which is required is that a layer of cheese cloth or plastic mesh should be secured over the top of the beaker while soaking the seed. Sunflower seed has a tendency to float. Hypocotyls of approximately 2-4 cm should be used for the experiment; this will usually require 4-6 days of growth, depending upon the cultivar and temperature. Prior to use of hypocotyls for these experiments, the waxy cuticle must be removed. This is accomplished by abrading the hypocotyl surface with mirror grinding abrasive. The hypocotyl surface and your fingers should be moist; a small amount of abrasive is taken up on the fingers and all sides of the hypocotyl are gently rubbed; one or two light strokes on each side of the stem is usually sufficient. Care should be taken that all hypocotyls are rubbed in a similar manner and that the hypocotyls are rinsed thoroughly with distilled water after abrasion.

Indicator Plate Preparation. For 20 agar-dye plates, place in a 500 ml beaker: 1.8 gm of non-nutrient agar, 0.12 gm bromocresol purple (0.71 mM), and enough distilled water to produce 300 ml of solution. The mixture is adjusted to pH 5.0 with 0.1 N HCl/0.1 N NaOH. The solution is boiled to dissolve the agar and poured to a depth of about 4 mm in 100 x 15 mm plastic petri plates (15 ml of solution per plate). Plastic petri plates **must** be used because the weak agar mixture does not adhere properly to vertically-oriented glass petri plates. The poured plates are placed on a level surface to cool.

Color Changes. Bromocresol purple indicator dye exhibits color changes over the pH range of 3.5 to 10. The shades or intensities of the colors are dependent upon the illumination and thickness of the indicator-agar. Under the conditions outlined in this exercise, the dye is yellow from pH 3.5 to 4.8, orange from pH 4.8 to about 5.5, and reddish-orange from pH 5.5 to 6.4. As the alkalinity of the media increases from pH 6.4 to 10, the dye becomes increasingly red and then turns to various shades of violet.

Determining Regions of Growth. Prepare a marking block as illustrated in Figure 1. The marking block is constructed of two machine screws which are glued to a small block of wood. The machine screws act as guides and

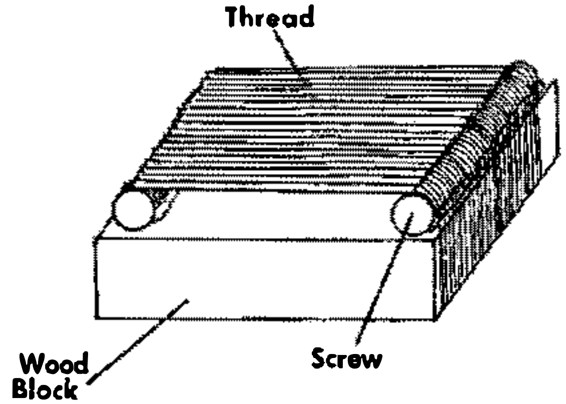

Figure 1. *Design of marking block for application of uniform markings on root surface.*

spacers for cotton thread, which is wrapped around the block/screws. Apply fingerprint ink or India ink to the cotton threads of the marking block and gently press the block to the plant organ to transfer the lines. Fingerprint ink is preferred over India ink since India ink tends to bleed into the medium under acidic conditions.

EXPERIMENTAL PROCEDURE --

A. Visualizing H $^+$ Efflux from Roots.

1. Select 6 corn seedlings with primary roots approximately 1.5 cm in length.
2. Place the seedlings on the agar-dye plates, one seedling per plate.
3. Gently press the seedling into the agar-dye so that one-half to two-thirds of the circumference of the roots is in contact with the medium. Replace the lid of the petri plates and seal the plates with Parafilm to maintain humidity within the plates.
4. Orient three plates with the root in a vertical position and three plates with the root in a horizontal position.
5. Observe and sketch the color patterns which appear around the root during the next 1.5 hours. As the horizontally-oriented roots undergo gravitropic curvature, the seedling will tend to tear the agar-dye medium. The seedling may be gently removed and placed on one of the unused plates; within 3-5 min the color pattern will be re-established. For best results, hold the plates in front of a light box while observing the H $^+$ efflux patterns.

B. Visualizing H $^+$ Efflux from Hypocotyls.

1. Select 6 sunflower seedlings with hypocotyls approximately 2-4 cm in length. Gently abrade the hypocotyls (see Seedling Preparation above).
2. Place the seedlings on the agar-dye plates, one seedling per plate.
3. Gently press the seedling into the agar-dye so that one-half to two-thirds of the circumference of the hypocotyl is in contact with the medium. Replace the lid of the petri plates and seal the plates with Parafilm to maintain humidity within the plates.
4. Orient three plates with the seedling in a vertical position three plates with the seedling in a horizontal position.
5. Observe and sketch the color patterns which appear around the hypocotyl during the next 1.5 hours. As the horizontally-oriented seedlings undergo gravitropic curvature, the seedling will tend to tear the agar-dye medium. The seedling may be gently removed and placed on one of the unused plates; within 3-5 min the color pattern will be reestablished. For best results, hold the plates in front of a light box while observing the H $^+$ efflux patterns.

OBSERVATIONS AND QUESTIONS --

- Sketch the color pattern surrounding the hypocotyl and root placed in two different orientations every 15 minutes.
- How rapidly does the color pattern appear?
- What causes the color patterns to appear? Are there alternative explanations for the color patterns?
- How do the colored regions correlate with growth rates?
- Is there a difference in the color pattern on the upper and lower surfaces of the hypocotyl? Is there a difference in the color pattern on the upper and lower surfaces of the root? How can any differences be explained?

SUGGESTIONS FOR ADDITIONAL EXPERIMENTS

1. Prepare and additional set of agar-dye plates and add auxin (1µM) to the agar dye medium. this level of auxin is growth promoting to hypocotyl tissues and inhibitory to roots. What effect does the auxin have on the color patterns?

2. Compare the effects of an inactive analog of auxin (indole-3-carboxylic acid) with the effects of the active auxin (indole-3-acetic acid) on the development of the agar-dye color pattern. How do the color patterns differ? How can the differences be explained?

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FROM FOREST TO HOME

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OBJECTIVES:

1. To gain an appreciation for the costs, in trees and land, of building and heating a residential home and all the homes in the United States.

2. To gain some insight into the growth rate of specific lumber trees and the land required for that growth.

3. To obtain an appreciation for the potential of our forests.

INTRODUCTION

Several years ago at the annual meeting of AMCBT, I attended a session in which the presenter told how his family utilized the trees from their property to provide energy for their household needs. During the discussion that followed, the question was posed as to whether this was a possible life style for the many or only for the "Rich and Famous" (rich in land and trees). In attempting to answer that question myself, I developed a laboratory exercise addressing the question, "Can the United States provide for its building and heating needs from its forests?" No answers are provided for the students, but the data necessary to infer answers are.

The instructor can vary this exercise for different classes by changing one or several of the variables (type of tree, type of site, size of home, number of homes, fuel cost to heat the home, utilization of only one ownership class of forest, etc.). The exercise can be expanded by determining: (1) The effect on fuel, and thus wood, of keeping homes at a lower or higher temperature during the winter and/or summer; (2) The economic productivity of a forest crop by utilizing growth rate of specific trees in the area and the cost of wood per cord or cubic ft.; this value can be compared with the value of other crops produced in the area; (3) The types of forests and their uses and the changes that have occurred in the amount of forest acreage and usage over the past 25, 50, or 100 years in a specific county or state; and (4) The relationship of paper production to the available forest crop (it was estimated that paper production required 40 x 10^6 tons of wood for 1986; most of this was softwood).

Hopefully this exercise demonstrates that the average citizen can evaluate the extent and, thus, the potential use of our natural resources; "They are not beyond our poor power to add or detract".

In addition to providing considerable information about the availability and use of wood, the exercise requires a significant amount of mathematical calculations in order to complete the worksheet. At the end of the paper a sheet has been included in order to show the calculations which are required to answer the questions presented in the exercise.

The questions of How?, How much?, When?, and In what way? we should use our forests are ones that continue to confront us. Let us assume that we all want to protect the environment, utilize safe sources of energy, and provide natural areas for recreational purposes. Can the harvesting of our forests incorporate these desirable features? What kind of crop are we considering harvesting? Must the harvesting be done by just a select few?

The following material will help to answer some of these questions and provide a better appreciation of the actual potential of our forestlands.

Historically, wood has been used in a variety of applications ranging from engineering materials to a source of energy. Wood is one of the oldest and most widely used construction materials, and today it is still a valuable engineering material. It also has emotional and psychological value for many persons. Probably most of us, at one time or another, have had the desire to assume the "simpler" and "healthier" life style of our ancestors. Getting back to nature is often associated with spending time in the woods, cooking over a wood fire, and living in a tent or wooden cabin. The presence of fireplaces in many modern, electrically or gas heated homes gives evidence of our desire to recapture some of the methods of our ancestors. There is something comforting about a large, pot-bellied stove in the house and a large, neatly stacked woodpile in the back yard. In addition to the more aesthetic aspects of wood, there are practical aspects. Not to be over-looked is the sense of independence and accomplishment a family gets from obtaining heat from wood logged on its own property. Enter a home in which all the wood or part of the wood for its construction has come from the owner's property and labors and it will be one of the first pieces of information the owner proudly shares.

While modern society is dependent on its ability to use nature's resources, only recently have we realized that our conventional energy resources are not limitless. Concern that the United States is running out of timber has once again achieved some currency. Competing recreational demands on forestland and increasing environmental restrictions on timber production reinforce this concern. President Franklin D. Roosevelt, in a speech to the Society of American Foresters, January 29, 1935, said, "A forest is not solely so many thousand board feet of lumber to be logged when markets make it profitable. It is an integral part of our natural land covering, and the most potent factor in maintaining Nature's delicate balance in the organic and inorganic worlds . . . Such public necessities, therefore must not be destroyed because there is profit for someone in their destruction. The preservation of the forests must be lifted above mere dollars and cents considerations". The same could and should be said today. Timber growth and timber drain must be brought into equilibrium; increasingly, our forests must be managed on a sustained-yield basis. The National Forests provide a refuge for many organisms including humans. They also stand as an attractive source of softwood timber to the wood products industry. Anyone advocating the use of wood, our forests, for building and fuel has quite a bit of explaining to do.

Yet, as all of us are aware, we are faced with a liquid and gaseous fuel crisis. The key to the solution is to discover an immediately available, renewable energy alternative to oil and gas. Coal is one alternative, although it is not renewable. Due to the high sulfur content of much coal, we must pay an environmental cost if it is used. Nuclear and solar energy are other alternatives. Because of environmental and safety issues, we are not proceeding very rapidly with the development of nuclear energy; and our development of methods to efficiently; harness solar energy places this alternative in the somewhat distant future. It would appear that wood is a possible alternative.

Our forests, if managed properly, are a vast and renewable source of energy and building material.

1. Growth Rate of Trees

The growth rate of any plant, including trees, depends upon the hereditary material of the plant and environmental factors. A tree requires

Table 1. Yield by site and age of fully stocked natural stands of Douglas fir. (cubic feet/acre)

	Site Class				
Age (yrs)	IV	III	II	I	I+
20	____	____	____	1,550	1,830
30	____	2,270	3,300	4,110	4,750
40	2,110	3,560	5,250	6,550	7,500
50	2,840	4,780	7,050	8,840	10,150
60	3,500	5,880	8,700	10,860	12,500
70	4,090	6,830	10,150	12,660	14,500
80	4,580	7,690	11,350	14,220	16,350
90	5,000	8,400	12,390	15,540	17,880
100	5,350	9,000	13,270	16,610	19,140

Source: Hyde, 1980

water, minerals, food (produced via photosynthetic processes), and a suitable temperature. It is sometimes difficult, if not impossible, to single out one environmental factor and measure its effect on growth. Three general categories or environmental factors can be employed: climatic, edaphic, and biotic.

Growth data for two trees will be presented: Douglas fir, *Pseudotsuga taxifolia*; and Upland oak, *Quercus sp.* Data for others of the common lumber trees can be obtained, if there is a specific interest.

Mature Douglas fir trees in the Willamette National Forest in Oregon range from 100 to 400 years of age; maximum height growth is 3 feet or better per year. Upland oak (white oak, *Quercus alba*) has a maximum rate of height growth of about 2-3 feet per year; mature trees commonly reach 80-100 feet in height with a trunk diameter of 3-4 feet. Table 1 shows yield by site and age for fully stocked natural stands of Douglas fir, and the effect different types of growing conditions have on the productivity of the forest.

The yield for upland oak on a quality growing area, Site Index 70, which compares to a Site I in the system used for Douglas fir, is shown in Table 2. It is readily apparent that Upland Oak grows much more slowly than Douglas fir. Site index (45-70) refers to the height of the dominant portion of a forest stand at a specific standard age (in this case, 50 years); whereas, site class (IV-I+) refers to the overall quality of the site. The site index and site class, which are determined by the amount of growth of

Table 2. Yield by age for Upland oak of Site Index 70. (cubic feet/acre)

Age (years)	Vol/ acre	Age (years)	Vol/ acre
30	1,429	70	3,429
40	1,950	80	3,929
50	2,500	90	4,357
60	3,071	100	4,643

Source: Meyer, .et. al., 1952

Table 3. Gross yields per acre for Douglas fir and Upland oak at Site Index 70. (bd. ft./acre)

Trial Rotation (years)	Douglas fir Yield	Douglas fir Mean Annual Increment	Upland oak Yield	Upland oak Mean Annual Increment
40	17,882	447	5,333	133
50	34,564	691	9,778	196
60	48,761	831	13,778	230
70	64,819	926	17,555	251
80	75,650	945	20,889	261
90	87,024	967	24,400	271
100	97,833	978	27,333	273

Source: Meyer, et. al., 1952

the trees on that type of site are the composite of many environmental factors; therefore, any attempt at precise determination of wood production must include this type of data. For our purposes, we will use designated values for wood production; actual values for a particular type of site or tree can be readily substituted for the values used in this exercise.

2. Lumber Required to Construct a House

The house to be constructed will be a three-bedroom, one-story, frame house containing 2,000 square feet of living space. It is estimated that it requires 21 to 23 (we will use 22) board feet of lumber per square foot of living space. The task is to estimate how many acres of land would be tied up for how many years to produce the amount of lumber required for the house. There are methods for computing board feet of lumber from a known log length and diameter. As our tables indicate the specific board feet for various aged trees/acre of tree, we will not include the calculations necessary to determine board feet for a specific sized tree or log. We will use growth figures for a 40 year rotation of either Douglas fir or Upland oak growing on Site 70 land (Table 3). It has been estimated that North America utilized 20,287,000 houses during the decade 1980-1990. Assuming that these houses averaged 1,200 square feet of living space, how many acres of forest were required for how many years to produce the lumber for these houses? Table 4 shows the commercial forest land acreage in the United States including inventory, growth, and removal from a 1970 census. What percentage of the sawtimber growth and of the sawtimber removals were required to supply the projected housing needs? Make the assumption that 2,028,700 houses were built each year during the 1980-1990 decade. Use the following values for these determinations:

1) 494.6 million acres total commercial forest area
2) 40 year rotation gives 12.365 million acres (494.6/40)
3) Site 70 land produces about 5,333 board feet/acre of Upland oak
4) Site 70 produces about 17,882 board feet/acre of Douglas fir
5) It requires 22 board feet/square foot of living space

Note that lumber for homes is but one of the many uses of lumber in the United States. In addition to commercial buildings, boats, furniture, and transport vehicles of many kinds, wood and its related products are used in the manufacture of a multitude of products. We will consider one of these uses, wood for energy in the following exercise.

Table 4. Inventory, growth, and removal for U.S. commercial forests in 1970. (Growing stock in billions of cubic feet and sawtimber in billion of board feet)

Ownership class	Area (millions of acres)	Growing stock I	Growing stock G	Growing stock R	Sawtimber I	Sawtimber G	Sawtimber R
Softwood types	207.2	431.9	10.7	9.0	1905.2	40.5	48.9
National forest	66.8	199.9	2.0	1.9	982.0	8.6	12.5
Other public	21.7	48.4	1.0	0.7	223.3	4.2	4.2
Forest industry	36.4	73.2	2.6	2.9	317.8	10.0	16.4
Other private	82.3	110.5	5.1	3.5	382.1	17.7	13.8
Hardwood types	266.7	216.9	7.9	4.4	514.8	19.6	15.1
National forest	16.8	17.5	0.6	0.1	39.6	1.2	0.5
Other public	19.8	19.6	0.8	0.2	39.3	1.7	0.0
Forest industry	29.4	27.0	0.9	0.6	68.8	2.4	1.0
Other private	200.7	152.8	5.6	3.5	367.0	14.2	12.1
Unstocked areas	20.7						
Total	494.6	648.8	18.6	13.4	2420.0	60.1	62.0

I = Inventory G = Growth R = Removal
Source: Barney, 1974

3. Heating with Wood

Wood as a heating fuel has both advantages and disadvantages. Wood has little or no sulfur, thus no SO_2 emission. Also, there is relatively little ash from wood (wood about 1% and bark about 2-10%) when compared to coal (5-25%). Fuel transportation costs are reduced when a local supply of wood is available. As fuel costs for oil and natural gas rise, wood may become a less expensive fuel. In the Terre Haute, Indiana area oil runs 75 cents per gallon and wood is $75 and $105/cord for softwood and hardwood respectively; thus in the Terre Haute area, the cost of the two is about the same. If one harvests his or her own crop of wood, then costs must be calculated differently;. What is the land worth that is producing the wood? One needs to determine the relative costs in his or her area.

There are disadvantages to heating with wood. Wood will never be as convenient to burn as oil or gas; it is bulkier and less efficient. It takes work to get wood, and it takes space to stack it. Also, there is much more care demanded of the heating unit than with oil or gas. And although stoves and furnaces are being designed to burn wood more efficiently, they do not have automatic feeding systems. Wood heating requires a great deal of vigilance.

To determine the amount of heat that can be obtained from a pound of

Table 5. Energy equivalency of wood to other fuels

Fuel	Wood equivalency in pounds
1 lb. coal	1.56
1 kilowatt-hour electricity	0.59
1 gallon propane gas	14.60
1 gallon #2 fuel oil	22.20
100 cubic feet natural gas	14.00

Table 6. Relative values of different types of firewood.

	Ratings for Firewood					
	Relative amount of heat	Easy to burn	Easy it to split	Does give heavy smoke	Does it pop or throw sparks	General rating and remarks
Hardwood						
Ash,birch red oak white oak hickory hard maple beech dogwood	High	Yes	Yes	No	No	Excellent
Soft maple cherry walnut	Medium	Yes	Yes	No	No	Good
Elm,gum sycamore	Medium	Medium	No	Medium	No	Fair
Aspen basswood cottonwood yellow poplar	Low	Yes	Yes	Medium	No	Fair-good kindling
Softwood						
Southern yellow pine Douglas fir	High	Yes	Yes	Yes	No	Good-but smokey
Cypress redwood	Medium	Medium	Yes	Medium	No	Fair
White & red cedar	Medium	Yes	Yes	Medium	Yes	Good-excellent kindling
Balsam fir eastern white pine hemlock red pine	Low	Medium	Yes	Medium	Yes	Fair-fair kindling
Tamarack larch	Medium	Yes	Yes	Medium	Yes	Fair
Spruce	Low	Yes	Yes	Medium	Yes	Poor-good kindling

Source: Twitchell, 1978

wood, one must be aware of both the species of wood and its moisture content. Table 5 provides some specific values comparing the energy equivalency of wood with some other sources of energy.

Table 6 provides information about the relative values of different types of firewood including relative amount of heat, ease of burning, amount of smoke produced, etc.

Below are listed some figures that will help determine the relation between volume and weight of wood.

1) a cord of wood is 4' x 4' x 8' and includes 80 cubic feet (cord is 128 cubic feet of air and wood; the actual volume of wood for split firewood is closer to 80 cubic feet)
2) a cord of hardwood weighs between 3,000 and 4,000 pounds when air dried; therefore, one can use 3,500 pounds as the average weight of a cord

Table 7. Relative energy (BTU/cord) for various woods.

Type of wood	BTUs/cord
Apple	26,800,000
Black birch	
Hickory	
Hophornbean	
Locust	
White oak	
Black beech	
White ash	23,400,000
Beech	
Yellow birch	
Sugar maple	
Red oak	
Black ash	19,900,000
White birch	
Grey birch	
Norway pine	
Pitch pine	
Black cherry	
Elm	
Soft maple	
Tamarack	
Aspen	14,500,000
Basswood	
Butternut	
Hemlock	
White pine	
White cedar	
Balsam fir	

Source: Twitchell, 1978

3) a rick of wood is usually 8' x 4' x 16" (about 42.7 cubic feet of air and wood)

There is considerable variation in the energy value of wood; Table 7 provides general categories for determining energy content of various types of wood. An important factor to remember is that species of wood that are best for firewood are not best for sawlogs. White ash and yellow birch should be kept for timber; whereas, beech, and red maple are better used for firewood.

4. Amount of Wood to Heat a House

The house that was built, containing 2,000 square feet floor space, is the house that will be heated. This house is located in midcentral Indiana. It is a relatively easy matter to adjust the calculations to a larger or smaller house located anywhere in the United States. Simply determine the heating costs in oil, gas, coal, or electricity for the house for an average year and convert these to units of wood. Knowing the native trees would then permit determination of the amount of wood that would supply these units.

The house we have chosen, when well-insulated, requires 13,720 kilowatt-hours or 122 thousand cubic feet, MCF., of natural gas a year to heat. This does not take into consideration cooling the house. It takes 3,720 kilowatt hours or 38 MCF of natural gas to cool the house. There are 3,412 BTU/kilowatt-hour, thus based upon average electrical usage 59.5 x 10^6 BTUs from wood are required to heat and cool this house for one year. Using natural gas values, it requires 160 x 10^6 BTUs to do the same job (160 MCF x 1 million BTUs/1,000 cubic feet). The large difference in the amount of BTUs to heat by electricity or gas is probably due to several factors: (1) electrical usage is determined on the basis of new homes with a great deal more insulation; and (2) the efficiency of some of the older gas furnaces is not good. More exact BTU values can be obtained by determination of actual heating costs divided by cost per heating unit and multiplying this value times 3,412 BTUs per kilowatt of electricity and times 1,000,000 BTUs per 1,000 cubic feet of natural gas. Pick the type(s) of wood to be used and determine how many cord or cubic foot will be necessary to supply this amount of energy. Having determined this, it is necessary to determine the acreage of forest to supply this volume of wood. Although there is considerable difference in the growth rate for various species of hardwoods and softwoods, the Douglas fir will be used as a representative softwood and the Upland oak as a representative hardwood for these calculations. To obtain the volumes in cubic feet/acre of different aged trees for these representative species, refer to Tables 1 and 2. These values permit determination of how many acres of land must be tied up for a given period of time to provide the wood necessary to heat the house. It is possible to use more land for a shorter period of time, but in general, land usage is determined on the basis of having so many acres in trees of different ages and then harvesting so many acres of a specific, aged tree each year.

5. Amount of Wood Necessary to Provide Energy for United States.

Maybe individuals with a considerable amount of property can afford to heat their homes with home-grown wood, but what about the prospect of heating the homes of the entire population of the United States? The total consumption of fuel in million of metric tons oil equivalent for the United States for 1987 was 1,849.3 (a metric ton = 2,205 pounds; there are 308 U.S. gallons of oil per metric ton; and 12,987 BTUs/gallon). This value is exclusive of fuels such as wood, peat, and animal wastes which are difficult to document. But heating of residential buildings is only one use of energy in the United States. Using 66,000,000 homes (each equivalent to the 2,000 square foot home in Terre Haute) as the number of homes in the United States, it would take 39.27 x 10^{14} BTUs to heat and cool them for a year. This is only 5.3% of the total fuel consumption of the United States, 739.72 x 10^{14} BTUs (1,849.3 million metric tonnes at 40 x 10^6 BTUs/million tonne = 739.72 x 10^{14} BTUs).

Regardless of whether a significant percentage of the American people switch to wood as a source of heat, in the near future, all of them will have to face decisions about alternate methods of heating. The world's reserves of fossil fuels are limited and many experts emphasize that the day of cheap petroleum products is coming to an end. Our country has changed its fuel habits in the past as illustrated by Table 8.

6. Forest and/or Wood Available in the United States

Table 4 lists the ownership of commercial forests. The classification of commercial forest is rather misleading in that it is defined as "Forestland consisting of acres that are capable of producing in excess of 20 cubic feet of industrial wood fiber/annum" (this would not be considered "decent" forest by most standards). Nevertheless, there are 494.6 million acres of commercial forest. Using Tables 1 and 2 and a 40 year stand as desirable cutting age, it is possible to determine the volume/acre harvest (about 1,950 and 6,550 cubic feet for Upland oak Site 70 and Douglas fir Site class 1 respectively). We will assume a normal even-aged forest with an even distribution of all age classes. Every year a stand of the desired cutting age is available for harvesting. This desired cutting age is called rotation. After cutting the oldest stand, the bare soil is immediately replanted. Every year a stand will reach the desired age for cutting. As soon as the volume/acre of an even-aged stand of a certain species of forest type is known for all ages (as given in yield tables), it is possible to calculate the mean volume/acre of a normal forest. Using values listed in the various tables in this unit, you can determine the total heating value of our forests/year, and how many homes could be heated by wood. This is making the assumption, which is incorrect, that all the available acres of commercial forest area are stocked with either Douglas fir or Upland oak on a Site 70 or Site class 1 respectively.

The following values must be utilized:

(1) 494.6 million acres of total commercial forest area
(2) 40 year rotation gives 12.365 million acres (494.6/40) that can be harvested each year
(3) site 70 lands produce 1,950 cubic feet/acre/year of Upland oak
(4) site I land produces 6,550 cubic feet/acre/year of Douglas fir
(5) there are 80 cubic feet in a cord of wood
(6) there are 26.8 x 106 BTUs/cord of Upland oak wood
(7) there are 14.5x106BTUs/cord of Douglas fir wood
(8) it takes 59.5 x 106 BTUs for a 2000 square foot house
(9) there are 66,000,000 houses in the United States

Table 8. United States Consumption of Energy Types by %.

	1850	1895	1970	1986	1987
Oil			41	41.6	41.3
Natural gas			33	23.3	23.4
Coal	10	65	20	24.1	24.5
Hydroelectric			4	4.8	4.2
Nuclear energy				6.2	6.7
Wood	90	35	?	?	?

QUESTIONS

1. How much wood would be required to build a house containing 2,000 square feet of living space? ____

2. How many acres of land would have to be tied up for how many years to provide the wood for this house?

   Douglas fir? Acres ______________ for years ____ ____
   Upland oak? Acres for years __________.

3. How much wood would be required to build 20,287,000 houses with an average of 1,200 square feet floor space?

4. How many acres of land would have to be tied up for how many years to provide the wood for all of these houses? Assume that 2,028,700 are constructed each year.

   Douglas fir? Acres ____ ________ for years ________.
   Upland oak ? Acres for years ______ ____.

5. What percentage of our total commercial forest area would be required to build this number of houses each year?

   Assuming forest all Douglas fir____ ________.
   Assuming forest all Upland oak ____ _____.
   Values for the Terre Haute area will be used for the following questions; values for your specific area should be substituted.

6. What is the cost of gas in your area? ______________________________.
   Oil? ____________ . Electricity? ____ ____________.

7. What is the cost of softwood in your area? __________ ____.
   Hardwood? .

8. What would be the wood equivalent to heat your home or the 2,000 square foot home?

   Douglas fir? ______ ____.
   Upland oak? ________.

9. What would be the wood equivalent to cool your home or the 2,000 square foot home?

   Douglas fir? ____ ______.
   Upland oak? ____ ____ ____.

10. What would be the wood equivalent to heat and cool 66,000,000 houses (assuming 2,000 square feet floor space/house) houses?

    Douglas fir? ____ ____ ____.
    Upland oak? ____ ____ ____.

11. What percentage of our total commercial forest area would be required to provide this heating and cooling energy for 66,000,000 assuming all trees were

    Douglas fir? __________ ____.
    Upland oak? ________ ________.

12. Assuming that home fuel consumption is only 5.3% of the total fuel consumption in the United States, what percentage of our total commercial forest area would be required to provide the total energy requirement of the United States?

Douglas fir? ____________________.
Upland oak?____________________ .

13. On the basis of the information obtained from this exercise, write a paragraph commenting on wood as an alternative fuel to replace oil and gas. Also consider the need for lumber for building purposes. Remember that the best scenario was presented in the exercise by counting all commercial forests as being quality timber land.

ANSWER SHEET

1. How much wood would be required to build a house containing 2000 square feet of living space? ***44,000.***

2. How many acres of land would have to be tied up for how many years to provide the wood for this house? Douglas fir: Acres ***2.46*** for Years ***40*** (44,000/17,882) or Acres ***98.3*** for Years ***1*** (44,000/447); Upland oak Acres ***8.25*** for Years ***40*** (44,000/5,333) or Acres ***330.8*** for Years ***1*** (44,000/133).

3. How much wood would be required to build 20,287,000 houses with an average of 1,200 square feet floor space? ***53.56 x 1010*** (22 x 1,200 = 26,400 bd.ft/home x 20,287,000 = 53.55768 x 1010 bd.ft.).

4. How many acres of land would have to be tied up for how man years to provide the wood for all of these houses? Assume that 10% are constructed each year. Douglas fir? Acres ***11.98 x 107*** for Years ***1*** (53,55768 x 109/447 = 11.98 x 107 acres); Upland oak? Acres***40.27 x 107*** for Years ***1***_ (53,55768 x 109/133 = 40.27 x 107).

5. What percentage of our total commercial forest area would be required to build this number of houses each year? Assuming forests are all Douglas fir? ***24.22%*** (11.98 x 107/494.6 x 106 = 22.22%); Upland oak? ***81.42%*** (402.7 x 106/494.6 x 106 -= 81.42%). Values for the Terre Haute area have been used for the following questions; values for your specific area should be substituted.

6. What is the cost of gas in your area? ***57 cents/100 cubic feet.*** Oil? ***75 cents/gallon.*** Electricity? ***6.56 cents/kilowatt hour.***

7. What is the cost of softwood in your area? ***$75.00/cord.*** Hardwood? ***$150.00/cord.***

8. What would be the wood equivalent to heat your home or the 2000 square foot home with electricity? Douglas fir? ***3.23 cords*** (13,720 kilowatt hours x 3,412 BTU/KW = 46,812,640 BTUs/14,500,000 BTUs per cord = 3.23 cords); Upland oak? ***1.75 cords*** (46,812,640 BTUs/26,800,000 BTUs per cord = 1.75 cords). With natural gas? Douglas fir? ***8.4 cords*** (122 MCF x 1 x 106/MCF = 122 x 106 BTUs/14,500,000 BTUs per cord = 8.4 cords). Upland oak? ***4.55 cords*** (122 x 106 BTUs/26,800,000 BTUs per cord = 4.55 cords.

9. What would be the wood equivalent to cool you home or the 2000 square foot home with electricity? Douglas fir? ***0.875 cords*** (3,720 KWH x 3,412 BTUs/KWH = 12,692,640BTUs/14.5 x 106 BTUs per cord = 0.875 cords); Upland oak? ***0.474 cords*** (12,692,640 BTUs/26.8 x 106 BTUs per cord = 0.474 cords). With natural gas? Douglas fir? ***2.62 cords*** (38 MCF x 1 x 106BTUs/MCF = 38 x 106BTUs/14.5 x 106 BTUs per cord = 2.62 cords). Upland oak? ***1.42 cords*** (38 MCF x 1 x 106 BTUs/MCF = 38 x 106 BTUs/26.8 x 106 = 1.42 cords).

10. What would be the wood equivalent to heat and cool 66,000,000 (assuming 2000 square feet floor space/house) houses by electricity? Douglas fir? ***2.71 x 108 cords*** (3.23 cords to heat + 0.875 cord to cool = 4.105 cords x 66,000,000 houses = 2.71 x 108); Upland oak? ***1.47 x 108 cords*** (1.75 cords to heat + 0.474 cord to cool = 2.224 x 66,000,000 = 1.47 x 108). By natural gas? Douglas fir? ***7.27 x 108 cords*** (8.40 cords to heat + 2.62 cords to cool = 11.02 cords x 66,000,000 = 7.2 x 108). Upland oak? ***3.94 x 108 cords*** (4.55 cords to heat + 1.42 cords to cool = 5.97 x 66,000,000 = 3.94 x 108).

11. What percentage of our total commercial forest area would be required to provide this heating and cooling energy assuming all trees were Douglas fir and you were using electricity? ***26.78%*** (494.6 x 106 acres x 6550 cubic ft./40 years = 80.00 x 109 cubic ft./80 cubic ft. per cord = 10.12 x 108 cords which divided into 2.71 x 108 = 26.78%. Using natural gas? ***71.83%*** (7.27 x 108 divided by 10.12 x 108 = 71.83%).

    Assuming you were heating and cooling with electricity and all trees were Upland oak? ***48.77%*** (494.6 x 106 acres x 1950 cubic ft./40 = 24.11 x 109 cubic ft./80 cubic ft. per cord = 30.14 x 107 which divided into 1.47 x 108 = 48.77%). Using natural gas? ***130.7%*** (3.94 x 108 divided by 30.14 x 107 = 130.7%).

12. Assuming that home fuel consumption is only 53% of the total fuel consumption in the United States, what percentage of our total commercial forest area would be required to provide the total energy requirement of the United States. Using values obtained by use of electricity? Douglas fir? ***50.53%*** (53%/100% = 26.78%/x = 50.53%); Upland oak? ***92.02%*** (53%/100% = 48.77%/x = 92.02%). Using values obtained by use of natural gas? Douglas fir? ***135.66%*** (53%/100% = 71.83%/x = 135.53%). Upland oak? ***246.60%*** (53%/100% = 130.7%/x = 246.60%).

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Teaching Biology to Majors and Nonmajors

And gladly...lerne, and gladly teche.
-Chaucer

AMCBT Fall Meeting
Rockhurst College
October 17-19, 1991

Thursday, October 17:

6:00-8:00 PM	**REGISTRATION RECEPTION**	Sedgwick Hall Lobby
8:00 PM	**OPENING SESSION** •Welcome for AMCBT •P. Bowne, Program Chair •Mary McCairel, Local Arrangements Chair **WELCOME TO ROCKHURST COLLEGE** -Jan Sheeran, Dean of Arts and Sciences **OPENING ADDRESS:** - Sue Speece - Slide Presentation on the Grand Canyon	Maybee Theatre, Sedgwick Hall
9:30 PM	**INFORMAL SOCIAL HOUR AND CASH BAR**	Massman Gallery

Friday, October 18:

7:00 AM	**REGISTRATION**	Sedgwick Hall Lobby
7:00-8:15 AM	**BREAKFAST** (price included in registration) Interest Groups by Discipline	Massman Formal Dining Room

8:15-9:15 AM: **CONCURRENT SESSION I** Sedgwick Hall, Third Floor

1. ***Honors Biology: Teaching Research Design***
   Richard Wilson, Rockhurst College
2. ***Use of the Winogradsky Column to Demonstrate Biodegredation***
   Dorothy May, Park College
3. ***Teaching Biology to Nontraditional Students***
   Larry Padberg, Rockhurst
   and Kathy Hunt, Henderson Community College
4. ***Roundtable Discussion on Designing Effective Field Trips***
   Ethel Stanley & Norm Jensen, Millikin
   Wally Weber, Southwest Missouri State

9:15-9:40 AM **Coffee and Exhibitor Displays** Sedgwick Hall 319

9:40-10:25 AM **CONCURRENT SESSION II** Sedgwick Hall, Third Floor

1. ***Cellulose and Toxin Metabolism by Bacteria/Fungi from Woodrats***
   Ali Hekmati, Wayne State College
2. ***General Education Biology***
   Bill Brett, Indiana State University
3. ***The Communities of the Biological Crossroads***
   Charles Maier, Wayne State College
4. ***Roundtable Discussion on Designing Effective Travel Courses***
   Bruce Edinger, Valparaiso University
   Ted Michaud, Carroll College
   Rudy Prins, Western Kentucky University

10:25-10:45 AM **Coffee and Exhibitor Displays** Sedgwick Hall 319

10:45-11:45 PM **KEYNOTE ADDRESS** Maybee Theatre, Sedgwick Hall

12:00-1:30 PM **OPEN LUNCH & EXHIBITS**

1:30-5:00 PM **FIELD TRIPS**

To be announced: we will likely choose between trips to Burr Oaks, the Prarie Foundation, the National History Museum in Lawrence, Kansas, the Truman Museum and House, Westin Distillery, Mobay, and Marion/Merrill/Dow.

1:30-5:00 PM **WORK SHOP SESSION 1**

1. ***Plant Physiology***
   Tim Mulkey, Indiana State University
2. ***Chorio-allantoic Transplants in Chick Embryos***
   Marshall Anderson, Rockhurst College
3. ***Using Cooperative Learning in Biology Teaching and Assessing***
   Leona Truchan, Alverno College
4. ***The Fungus Among Us***
   Don Huffman, Central College

- Potentially, some commercial workshops may also be offered at this time. Marc Roy, Beloit College, may illustrate the use of Thorton's MacScope for physiology.

6:00 PM	**CASH BAR AND SOCIAL HOUR**	Massman Gallery
7:00 PM	**BANQUET** (Price included in Registration)	Massman Formal Dining Room
8:30 PM	**BANQUET SPEAKER**	
9:30 PM	**CASH BAR AND SOCIAL HOUR**	Massman Gallery

Saturday, October 13:

7:30-8:30 AM	**BALLOTING, COFFEE AND DONUTS IN INTEREST GROUPS**	Sedgwick Hall 319

8:30-9:30 AM **CONCURRENT SESSION III** Sedgwick Hall, Third Floor

1. ***Burnout: Causes, Preventions, and Interventions***
   Judy Brett, Hamilton Center (Indiana)

2. ***AIDS***
   Susan Speece, Anderson University

3. ***Teaching the Difference Between Science and Religion: Evolution and Creation***
   Malcolm Levin, Sangamon State

4. ***Roundtable Discussion on Outreach to Highschools***
   Kathleen Hunt, Henderson Community College
   Ann Larson, Sangamon State
   Leona Truchan, Alverno College

9:45-10:45 AM **CONCURRENT SESSION IV**

1. ***Preparing for Careers in Physical Therapy and Occupational Therapy***
   Neil Baird, Millikin University

2. ***Labor Demonstrations and Hormonal Rhythms***
   Kathleen Marr, Lakeland College

3. ***Thoughts on Presenting Biology Workshops for Highschool Teachers***
   Ben Dolbeare, Lincoln Land Community College

4. ***Women in Science***
   Faith Wilson, St. Theresa's Academy

5. ***From Food Webs to Restriction Maps***
   John Jungck, Beloit College

6. ***Microbiology Experiments***
   Ed Kos, Patti Lorenz, and Ann Larson

11:00 AM-12:30PM **BRUNCH** (Price Included in Registration Fee) Massman Formal Dining Room
BUSINESS MEETING
Reports:
Presidential Address--John Jungck
Bioscene--Sue Speece & Tim Mulkey
Election Results--Dave Finley
•Steering Committee meeting following brunch•

Resolutions

Recently passed by AMCBT

1. Resolution # 1 October 13, 1990

WHEREAS:
The Association of Midwest College Biology Teachers recognize that Americans are now staying healthier, living longer, and controlling chronic ailments more effectively, in part, because of the availability of drugs and devices developed with the use of animals in biomedical and behavioral research, and;

WHEREAS:
The Association of Midwest College Biology Teachers supports examination and enforcement of appropriate standards for the use of laboratory animals to ensure that they are treated humanely and that consideration is given to alternative research methods when feasible:

NOW, THEREFORE, BE IT RESOLVED THAT:
The Association of Midwest College Biology Teachers advocates strongly that the public interest in the expansion of scientific advances should continue to be served by the appropriate use of animals in *biomedical and behavioral research, technology development and medical* education.

Motion - To accept the resolution by Ann Larsen. Seconded by Harold Wilkinson.

Discussion - A friendly amendment was suggested to replace the italicized section above with *biological research and education.*

Motion - To table the discussion until next years meeting by Pat Bowne. Second by Mike. **Motion failed.**

•Previous motion with amendments was passed.

2. Resolution # 2 October 13, 1990

WHEREAS:
The Association of Midwest College Biology Teachers recognizes the severity of current environmental causes and our obligation to our students to provide examples of concern for the environment,

BE IT RESOLVED THAT:
The Association of Midwest College Biology Teachers discontinue the use of pressed-foam *and plastic* products at its meetings and that the AMCBT documents and Bioscene shall henceforth be presented on recycled paper.

Motion - To accept the resolution by Pat Bowne. Seconded by Leona Trouchan.

Discussion - suggested to add the words *and plastic* not in the original.

•Motion was passed.

3. Resolution # 3 September 30, 1989

WHEREAS:
-the majority of elementary education teachers are required to teach science in the elementary classroom, and whereas the attitudes towards science are essentially acquired during the elementary school training,

BE IT RESOLVED THAT:
We highly recommend that science should be given adequate emphasis in the college preparatory program of elementary education majors and that we go on record as supporting the concept that the science preparation of elementary teachers be given priority and that they be required to complete a minimum of 24 semester hours of science, exclusive of methods teaching courses. These courses should be divided equally, with 8 hours in earth science, 8 hours in life science and 8 hours in physical science.

Motion - To accept the resolution by Marvin Williams. Seconded by Dick Wilson.

•Motion was passed.

Application for Membership

ASSOCIATION OF MIDWESTERN COLLEGE BIOLOGY TEACHERS

NAME ________________________________ DATE _________

TITLE ____

DEPARTMENT ____

INSTITUTION ____

CITY__________________________ STATE ________________

ZIP CODE ________________

ADDRESS PREFERRED FOR MAILING ______________________

CITY__________________________ STATE ________________

ZIP CODE ________________

PHONE NUMBER ____

MAJOR INTERESTS:

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

RESOURCE AREAS:

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RESEARCH AREAS:

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Have you been a member before?______ If so, when?______

Mail To

Edward S. Kos
Executive Secretary, AMCBT

AMCBT Central Office
Department of Biology
Rockhurst College
Kansas City, MO 64110

CURRENT DUES ARE $15.00