Chapter 13

Ideas to Stimulate the Non-Major Biology Student

A. Understanding Human Energy Requirements-Roberta B. Williams

B. Ideas to Stimulate the Non-Major Biology Student-Haven Sweet

C. Biology from the Human Perspective-Barbara Newman

Note: This workshop consisted of three separate subtitles and presentations.

Understanding Human Energy Requirements - A Laboratory Exercise

Roberta B. Williams

Department of Biological Sciences
University of Nevada, Las Vegas
4505 Maryland Parkway
Las Vegas, NV 89154

Roberta Williams is an instructor and the undergraduate laboratory coordinator for the Department of Biological Sciences at the University of Nevada, Las Vegas. She recieved a B.S. from chestnut Hill College in Philadelphia (chemistry) and a M.S. from the University of Nevada, Las Vegas (botany). Williams teaches Human Biology, a science course for non-majors, and is involved with teaching post-baccalaureate science classes to primary and secondary teachers. Her research interests are involved with developing new laboratory experinces for all grade levels. Roberta hosted the 1985 ABLE meeting and is currently **Labstracts** editor.

INTRODUCTION

The American public is becoming increasingly more conscious of their individual responsibility for wellness and the role of nutrition and exercise in maintaining good health. The news media bombards us daily with tidbits on the latest research concerning nutrition and exercise and their correlation with cancer and heart disease. We are aware that obesity is American's number one malnutrition problem and that solving this problem is one of the least understood areas in the science of nutrition. We hear that anorexia nervosa and bulimia are increasing at an alarming rate as some of our brightest young females become more and more obsessed with weight. But how many of us know what our own "ideal weight" should be?

Teaching a course in Human Biology to college non-science majors has made me realize how little students really know about their own energy metabolism. They seem to be aware of nutritional requirements, but what happens after they eat is a mystery. To solve this mystery, I designed a laboratory exercise that deals with daily caloric intake, energy metabolism and body composition. This exercise enables the individual student to evaluate his caloric intake and caloric expenditure for an average day and examine why he or she may be gaining or losing weight. The exercise then enables the student to determine his or her percent body fat and calculate what their "ideal weight" should be. Each semester the majority of my 200 students rate this particular laboratory experience as their favorite and the one from which they learn the most.

One of the objectives of the lab is to understand energy metabolism, the process by which the body stores or releases energy from nutrients consumed. Since the body's total energy needs fall into three categories: energy to support basal metabolism, energy for muscular activity and energy to digest and metabolize food. The students are taught how to calculate each of these using their own height and weight.

Basal metabolism is the minimum amount of energy the body needs at rest in the fasting state. Certain processes necessary for the maintenance of life proceed without conscious awareness. The beating of the heart, the inhaling of oxygen and the exhaling of carbon dioxide, the metabolic activities of each cell, the maintenance of body temperature, and the sending of nerve impulses from the brain to direct these automatic activities are some of the basal metabolic processes that maintain life. Their minimum energy needs must be met before any calories can be used for physical activity or for the digestion of food.

The basal metabolic rate (BMR) is the rate at which calories are spent for these maintenance activities. The BMR varies from person to person and may change for one individual with a change in circumstance, physical condition or age. The BMR is lowest when a person is lying down in a room with a comfortable temperature and is not digesting any food. At this time, the least amount of oxygen is needed and the least amount of heat is being generated by the activities of the cells. During sleep, the person is more relaxed, but there is more muscular activity, so BMR tends to be slightly higher.

The BMR is influenced by a number of factors. In general, the younger the person is, the higher the BMR. This is due to the increased activity of cells undergoing division. After growth stops, the BMR decreases about two percent per decade throughout life (Food and Nutrition Board, 1974). Body surface area, but not weight, influences BMR. Two people with different shapes who weigh the same will have different BMR. A short, stout person will generally have a slower BMR than a tall, thin person even if they weigh the same. The tall thin person has a greater skin surface from which heat is lost by radiation and so must have a faster metabolism to generate the lost heat. Another factor that influences BMR is gender. Males generally have a faster metabolism rate than females due to the greater percentage of muscle tissue in the male body. Muscle tissue is always active while fat tissue is comparatively inactive. Conditions such as fever, malnutrition and hormonal secretions can temporarily alter BMR. However, the latest research shows that physical training and conditioning does not seem to influence BMR after exercise has ceased (personal communication, Golding).

The second component of energy metabolism is physical activity voluntarily undertaken and achieved by the use of skeletal muscles. This amounts to an average of about **30%** of the total caloric expenditure, while BMR accounts for 60%. Unlike basal metabolism which cannot be changed at will, physical activity can be increased or decreased by an individual. Contraction of muscles uses a large number of calories, and in a moving body the heart must beat faster, this also accounts for additional caloric useage. A heavier person uses more calories performing the same task in the same time as a lighter person, because it takes extra effort to move the additional body weight. The longer an activity lasts, the more calories are used; therefore, measurement of physical activity is expressed as calories per weight per unit time.

The final component of energy expenditure has to do with processing food. When food is taken into the body, many cells become active. Muscles move the food through the intestinal tract by speeding up their rhythmic contractions, while the cells that manufacture and secrete digestive juice begin to do their jobs. All these cells need extra energy to participate in digestion, absorption and metabolism of food. In addition, the presence of food stimulates general metabolism. All of this is referred to as Specific Dynamic Action of food (SDA) and represents about 10% of the total calories expended by a person per day.

The week before the lab is scheduled, students are told to keep a written diary of thier physical activities for three consecutive days. Every minute of the day should be accounted for (1440 minutes in all). Figure 1 is an example of the activity diary forms I provide my students. In addition to their activity diary, the student are told to keep a written food diary for the same three days. The food diary should list all the food and beverages consumed throughout the three day period. Students are reminded not to forget to include snacks and alcoholic beverages. I use three days activities and food consumption and take an average to represent a typical day. I have found it you ask a student to keep the diaries for only one day, they will pick a very atypical day. Both of these diaries are brought to lab and used to calculate the individual's energy expenditure and caloric intake. The second objective of the laboratory experience is to determine if the individual's energy input balances with their energy output. Weight gain or loss depends on the difference between these two factors. A difference of 3500 calories can mean a pound more or less of body weight.

The third objective of the laboratory exercise is to have the students determine their own percent body fat and to understand the relationship between body fat and body weight. Body fat plays important roles in maintaining health. It serves as an insulator from heat, cold and mechanical shock and as an energy supply to be used when glycogen reserves are exhausted. Without a protective layer of fat, the body is fragile and unable to withstand environmental stresses. Some body fat is essential, but excess body fat serves no useful function in a society where food is abundant and easily obtained and the hazards of being obese are numerous.

Fat normally makes up about 18% of an adult males's body and about 22% of an adult female's body. The rest of the body composition is muscle, bone, other connective tissues and water. The relative amounts of muscle and bone vary widely from person to person. An athlete or person doing heavy physical work, whose skeleton has become dense through constant stress on the bones, may have a slender figure with no excess fat tissue and still be heavier than another person of the same height, sex, age and body shape. An ideal weight for a person cannot be stated on the basis of height alone. The "ideal weight" tables published by insurance companies are merely averages for the U. S. population and have little scientific validity. At best, they can serve as arbitrary measures for too little or too much body weight. A person more than 10% over the weight on the tables is overweight; a person 20% over is obese. Similarly, a person 10% below the weight on the tables is underweight.

A direct measure of the amount of body fat can be obtained by means of the skinfold test. In this lab one student measures three or four skinfolds on another student using inexpensive calipers (Fat-0-Meters). The fat attached to the skin is roughly proportional to total body fat, and the measurements can be easily converted to percent body fat.

PROCEDURES

Basal Metabolic Rate. There are numerous ways to measure BMR some of which entail twelve hours of fasting and elaborate instrumentation. From these methods, Boothy (1936) has developed calculations and charts to give a mathematical estimate for BMR. I have adapted these for use in this laboratory exercise.

Scales and height-measuring devices are set up in the laboratory, and each student determines his or her own height and weight. The calculations required assume the individual is fully clothed and wearing shoes with a one-inch heel. Figure 2 is used to determine body surface area. A straight line drawn from height to weight on Figure 2 intersects the middle column to indicate the corresponding surface area in square meters. Table 1 is used next to determine a BMR constant for the subject's sex and age. The surface area determined in Figure 2 is multiplied by this factor to determine calories per hour. This number in turn is multiplied by 24 hours to obtain the student's BMR in calories per day.

For example, take a 17 year old male who weighs 170 lbs. (77.3 kg) and is 6 feet tall. His body surface area from Figure 2 would be 1.99

square meters. From Table 2, he would have a basal metabolism rate constant of 41.5 calories per square meter per hour. This, multiplied by 1.99 square meters, equals 82.6 calories per hour and, by 24 hours, equals a BMR of 1982 calories per day. Numbers are rounded off because this method is not accurate enough to make decimals meaningful.

Physical Activity. The term physical activity is used in this exercise to mean that energy expended during non-sleeping periods by skeletal muscles. The amount of energy expended will depend on the size of the body, the type of activity and the length of the activity. Table 2 lists the total energy expended (cal/kg) for various activities. Each activity in the diary prepared by the student the previous week should be grouped into one of the categories listed. Multiply the minutes spent in that activity by the appropriate factor and by the body weight in kilograms. Obtain a grand total for the three days and divide that by three to get an average caloric expenditure per day.

If the 17 year old's activities for the three days included:

1440 minutes of sleeping (no activity)
1440 minutes of sitting (very light)
360 minutes of walking (light)
360 minutes of standing (very light)
90 minutes of weight lifting (heavy)

450 minutes of driving (very light)

180 minutes of jogging (moderate)

he would have expended an average of 1044 calories/day calculated in the following manner:

1440 min.	no activity	X 0.0 cal/kg	X 77.3 kg	=	0 cals
2250 min.	very light	X 0.01 cal/kg	X 77.3 kg	=	1739 cals
360 min.	light	X 0.02 cal/kg	X 77.3 kg	=	557 cals
180 min.	moderate	X 0.025 cal/kg	X 77.3 kg	=	348 cals
90 min.	heavy	X 0.07 cal/kg	X 77.3 kg	=	487 cals
		Total expenditure for three days		=	3131 cals
		Average daily expenditure		=	1044 cals/day

Specific Dynamic Action. To estimate the students SDA, add the calories calculated for BMR and those calculated for average daily physical activity and multiply by 10%. For the 17 year old example, this would be: [1982 cal (BMR) + 1044 cal/day (activity)] X 0.1 = 303 cal/day (SDA).

Total Energy Requirement For Average 24 Hour Period. Add all three figures, BMR, physical activities and SDA to obtain the number of calories needed in one day. The average 70 kilogram adult male requires about 2700 cal/day, while the average 55 kilogram adult female needs only 2000 cal/day. Our 17 year old example is younger and somewhat more active than the average person, and therefore, has a higher energy requirement (3329 cal/day).

Energy Intake. Using the data compiled during the week on the subject's food intake, have each student calculate the number of calories consumed from commercial calorie guides. I have found nutrition text books contain excellent appendices that include very complete calorie guides. For my class I have made numerous copies of the calorie guide from Hamilton and Whitney (1985). Measuring the amount of calories consumed is more accurate than measuring the number of calories expended. If the figures are within 10% of each other, the subject is most likely maintaining his or her weight. In order to maintain proper energy balance within the body, the calories expended must be replaced by an equal number of calories from food. If this does not occur, the subject will lose weight. If the number of calories consumed exceeds the number of calories expended, the subject will gain weight. An overage of 500 calories per day for one week can result in gaining a pound (3500 calories equal one pound of body fat). By the same token, expending 500 more calories than are consumed each day for a week can result in the loss of one pound.

Estimation of Percent Body Fat.

When individuals gain fat, much of the adipose tissue is added to subcutaneous accumulations that are found in various parts of the body. This subcutaneous fat can be pinched up by the thumb and forefinger. As an individual gets fatter, these skinfolds get larger. Calipers have been designed to measure skinfolds in several parts of the body. Any single measurement does not give an accurate picutre. At least three measurements, tricep, illium and abdomen must be taken on women and four measurements, chest, abdomen, illium and axilla are necessary for men. All these measurements can be done in the laboratory, provided the females are wearing two piece outfits. The more measurements that are done, the more accurate the results will be, however, these minimal measurements give a fairly reliable estimate.

All measurements are taken on the right side of the person being measured. The fold of skin should be firmly grasped between the left thumb and the other four fingers and then lifted. Pinch and **lift** the fold several times to make certain that no musculature is grasped. Hold the skinfold firmly and place the contact side of the calipers below the thumb and fingers. Do not let go of the fold. Take the reading to the nearest half millimeter. Release the grip on the caliper and release the fold. To make sure that the reading is accurate, repeat the measurement two or three times. Unless each measurement is consistent (within 1-2 mm) reliability will be poor.

The tricep skinfold is measured on the back of the upper right arm, half-way between the elbow and the tip of the shoulder, while the arm is hanging loosely at the subject's side. Grasp the skinfold parallel to the long axis of the arm, and lift it away from the arm to make sure no muscle tissue is caught in the fold. The illium skinfold (hip) is measured with a diagonal fold, just above the crest of the hip bone, on an imaginary line that would divide the body into front and back halves.

The abdominal skinfold is measured vertically one inch to the right of the navel.

The chest measurement is taken diagonally, mid-way between the nipple and the armpit.

The axillary (side) measurement is taken vertically at the level of the nipple on an imaginary line that would divide the body into front and back halves.

When students do skinfold measurements on one another, lack of experience can produce errors. The most common errors occur when the mid-point is incorrectly marked or measured, when the caliper is too deep (muscle involved) or too shallow (only skin grasped), and when the arm being measured is not hanging loosely at the subject's side.

The percent body fat can be determined from these measurements using charts that accompany the calipers or by the use of two equations. The equations were developed by Jackson and Pollock (1978) and are widely used in physical fitness evaluation programs. For males the four measurements are summed and percent fat is calculated (Golding, 1982) as follows:

$$\% \text{ fat} = .27784\ (X_1) - .00053\ (X_1)^2 + .12437\ (X_2) - 3.28791$$

where X_1 = sum of four folds

X_2 = age of subject.

It is suggested that from a health and aesthetic standpoint, adult males should have 16% or less body fat, and adult females should have 23% or less body fat. At no time should the percent body fat of an adult male drop below 5% or that of an adult female below 10%. Severe medical problems can occur with too little body fat as well as with too much body fat. Marginal obesity occurs when the body fat of an adult male increases to over 20% or that of an adult female increases to over 30%. The percent body fat of an individual can change with exercise or diet. You can remain at the same weight while changing your percent body fat. Well conditioned athletes, such as marathon runners and swimmers, usually have about 10-12% body fat, while football players and weight lifters may have as high as 19-20% body fat. Life style can play an important role in an individual's physical makeup (Golding, 1982).

A "target" or "ideal" weight can be calculated using the percent fat figures. Target weight is defined as the lean body weight (LBW) plus a desirable percentage of fat. If a 20 year old male student is 210 pounds and has 23% fat, he may wish to know what he should weigh with 16% fat. To calculate this he would multiply 23% times 210 to determine that he is carrying 48.3 pounds of fat. Subtracting his fat weight from his total weight will give his LBW of 161.7 pounds. At 16% fat, this LBW equals 84% of the student's total weight. To determine what his weight should be with 16% fat, divide the LBW by 84% (161.7/.84 = 192.5). A target weight of 192.5 pounds is thereby obtained.

SUMMARY

What makes this laboratory experience successful? I think it is the fact that although we are all aware of calories, none of us really sit down and evaluate what those calories really mean. Prepared foods give the caloric value on box tops and popular magazines frequently publish calorie expenditure guides. What this means on a day-by-day basis is rarely given more than a passing thought. In this exercise, the students get a chance to see what their actual energy balance is. Even if they only make this calculation once in their life time, it is something they will remember.

We are what we eat, and many researchers are now finding that patterns for both obesity and underweight may be set very early in our life time. Overweight or obesity is seen in more than 10% of school-age children in the United States, in about 15% of people under 30, and in 25 to 30% of adults. Among older people, a third of the men and half of the women are obese. Certain subgroups of the population have a markedly higher incidence of obesity than others: the lower socioeconomic classes, blacks, Mexican Americans, Native Americans and Eskimos (Hamilton, 1985). Statistics show that some people become fat in childhood and others later on. Research has shown that early onset obesity is especially resistant to treatment. According to the fat-cell theory, early overfeeding is is thought to stimulate fat cells to increase abnormally in number. The number of fat cells then become fixed in adulthood. Thereafter, a gain in weight can take place only through an increase in the size of fat cells. The larger the number of fat cells in his body, the more hungry the person will be. Thus, people with abnormally large numbers of fat cells will tend to be abnormally hungry and to overeat.

The causes of underweight are as diverse as those of overeating. Psychological factors may contribute in some cases and metabolic ones in others. Clearly, heredity is involved. Early underfeeding may limit the fat-cell number, just as overfeeding my increase **it.** Habits learned early in childhood, especially food aversions, may perpetuate the problem. The demand for calories to support high levels of physical activity and growth often contributes; an extremely active boy during his adolescent growth spurt may need more than 4000 calories a day to maintain his weight. Such a boy may be too busy to take the time to eat that much. The concepts studied with this laboratory exercise help to make students aware of their body composition. I think this exercise is not only valuable for college students; rather, secondary science and health students can also gain much knowledge that can influence their future lives. A local elementary health and physical education teacher uses parts of this exercise with his students and claims he has had great success.

REFERENCES

1. Boothby, W. M., Berkson, J. and Dunn, H. L, (1936), Studies of the Energy of Normal Individuals: A Standard for Basal Metabolism, with a Nomogram for Clinical Application, American Journal of Physiology, 116. pg. 468-484.
2. Boothby, W. M. in Handbook of Biological Data, ed. W. S. Spector. (1956). Saunder's Publishing Co., Philadelphia, Pa. pg. 259.
3. Food and Nutrition Board, Committee on Recommended Allowances, (1974). Recommended dietary allowances, 8th ed. National Academy of Science, Washington, D. C.
4. Golding, Lawrence, Myers, C. R. and Sinning, W. E. (1982). The Y's Way to Physical Fitness, National Board of YMCA, Chicago, IL.
5. Hamilton, E. M. N and Whitney, E. N. (1979). Nutrition: Concepts and Controversies, West Publishing Co., St. Paul, MN.
6. Hamilton, E. M. N, Whitney, E. N. and Sizer, F. S. (1985). Nutrition: Concepts and Controversies, Third Edition, West Publishing Co., St. Paul, MN.
7. Jackson, A. S. and Pollock, M. L. (1978). Generalized equations for predicting body density of man. British Journal of Nutrition, 40, pg. 497.

ACTIVITY DIARY

TIME OF DAY	ACTIVITY	TIME SPENT	FACTOR (cal/kg)	TOTAL CAL EXPENDED
			TOTAL OF 3 DAYS	
			AVERAGE	

BODY WEIGHT IN KG ______

Figure 1. An abbreviated sample of student's activity diary.

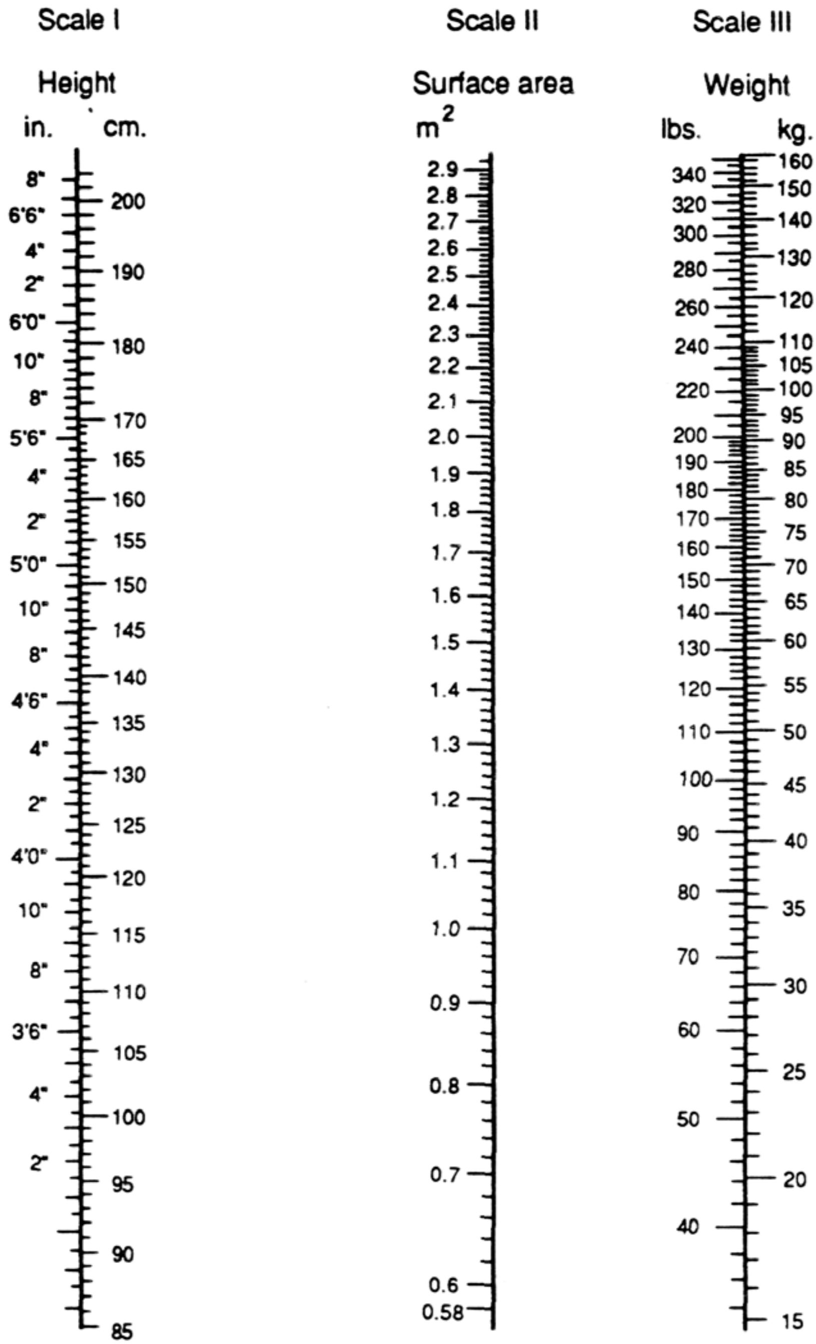

Scale I
Height
in. cm.
Scale II
Surface area
m2
Scale III
Weight
lbs. kg.

Figure 2

Figure 2.

Nomogram to estimate body surface area from height and weight. A straight line is drawn from the subject's heights (Scale 1) to the subject's weight (Scale 3). The point at which the line intersects Scale 2 will give the subject's body surface area in meters squared. Adapted from Boothby, W. M., J. Berkson and H. L. Dunn, Studies of the Energy of Normal Individuals: A Standard for Basal Metabolism with a Nomogram for Clinical Application, American Journal of Physiology, 116, (1936); 468-484 with permission of the publisher.

	BMR,	cal/m²/hr.		BMR,	cal/m²/hr.
AGE	MALES	FEMALES	AGE	MALES	FEMALES
10	47.7	44.9	28	37.8	35.0
11	46.5	43.5	29	37.7	35.0
12	45.3	42.0	30	37.6	35.0
13	44.5	40.5	31	37.4	35.0
14	43.8	39.2	32	37.2	34.9
15	42.9	38.3	33	37.1	34.9
16	42.0	37.2	34	37.0	34.9
17	41.5	36.4	35	36.9	34.8
18	40.8	35.8	36	36.8	34.7
19	40.5	35.4	37	36.7	34.6
20	39.9	35.3	38	36.7	34.5
21	39.5	35.2	39	36.6	34.4
22	39.2	35.2	40-44	36.4	34.1
23	39.0	35.2	45-49	36.2	33.8
24	38.7	35.1	50-54	35.8	33.1
25	38.4	35.1	55-59	35.1	32.8
26	38.2	35.0	60-64	34.5	32.0
27	38.0	35.0	65-69	33.5	31.6
			70-74	32.7	31.1
			75+	31.8	

Table 1. Basal Metabolic Rate Constants

Adapted from W.M. Boothby, Handbook of Biological Data

(1956)

Table 2. Examples of Daily Energy Expenditures

TYPE OF ACTIVITY	TOTAL ENERGY EXPENDED (cal/kg of body weight/min)
NO ACTIVITY: Sleep	0.0
VERY LIGHT: Sitting, standing, driving, typing, playing musical instruments, sewing, ironing, walking slowly	0.01
LIGHT: Walking at moderate speed, light housework, garage work, restaurant trades, golf, sailing, table tennis, volleyball, carrying light loads	0.02
MODERATE: Walking fast or jogging, weeding and hoeing, scrubbing floors, carrying heavy loads, cycling at moderate speed, skiing, dancing	0.025
HEAVY: Walking quickly up hill, climbing stairs, basketball, weight lifting, swimming, climbing, football	0.07
SEVERE: Tennis, running	0.11
VERY SEVERE: Wrestling, boxing, racing	0.14

Modified from Food and Nutrition Board, Recommended Dietary Allowances, 1980.

Ideas to Stimulate the Non-Major Biology Student

Haven C. Sweet

Department of Biological Sciences
University of Central Florida
Orlando, FL 32816-0990

Haven C. Sweet received his B.S. degree from Tufts University (Botany) and his Ph.D. from Syracuse University (Plant Physiology). After completing a Post-Doctoral fellowship at Brookhaven National Laboratory, he worked at the Johnson Space Center with the Apollo program. In 1971 he moved to the University of Central Florida where he developed and teaches the non-majors biology course, along with a variety of upper level biology and computer courses. His creative interests involve developing computer programs for both research and educational purposes.

Ideas to Stimulate the Non-Major Biology Student

ABLE workshop- June 18,1987
Haven Sweet
University of Central Florida
Orlando, FL 32816

Introduction

The computer programs described in this workshop were created as part of a National Science Foundation grant to develop new laboratory exercises involving the computer. As the programs were written, I incorporated them into my non-majors biology course and revised them according to student reactions. After several years of improving these exercises, I evolved an approach which is successful from an educational point of view, is compatible with very limited budgets, and is transportable to other institutions. This discussion presents the philosophy, as well as specific implementation plans, for incorporating computer programs into a non-majors biology teaching laboratory.

All to often, educators assume that using a computer within a course requires enough machines for each student. Although it is possible to have numerous computers in the laboratory and perform very meaningful activities, most schools do not have the necessary resources for this approach. A single computer is often adequate if the computer program compliments the lab exercise. Just as one can develop a meaningful lab experience around a single spectrophotometer or analytical balance, likewise it can be done around a single computer.

In fact, the educational objectives are often better achieved by de-emphasizing equipment, especially when the teacher avoids "showcasing" the computer. If students perceive the computer as the main focus of the laboratory, they tend to do nothing except wait for their turn.

Assuming that only one or two computers are available, the computer programs selected should meet the following criteria; they should accomplish something that could not otherwise be done (or requires additional equipment); they should eliminate repetitive tasks that do not promote learning (remember that repetition, per se, is not bad); they must be very easy to use so the student does not loose sight of the exercise's objective; and the activity must be only a small component of the entire lab experience. The programs described below were designed to meet these criteria.

All programs are written for the Apple][computer and will run with 48K of memory and a single disk drive. Although some programs will display 80 columns if the computer is capable, all work with 40 columns. A machine such as the Apple // C is particularly well suited for use in labs since it is highly portable. While the programs could be adapted to machines other than the Apple, conversion would be a major undertaking with most of the programs.

In the following discussion, I will start with the major programs and then describe the smaller exercises. The exercise instructions which are provided to the students have been abbreviated in this manuscript; the complete versions are available in "Non-Majors Biology Laboratory Notebook" (Burgess Publishing Co., 1984).

A. Analysis of nutrients;

1. General

Using this program, students enter the foods they consumed during 24 hours and the computer lists all the nutrients in each food, gives a daily total, and compares it to the recommended daily allowance (RDA). In addition to allowing students to assess their personal diets, this exercise shows how nutritional needs are usually met, even by the typical diet of a college student.

This exercise requires 1 computer for 6 to 8 students in a 2 hour lab period. Using the computer to look up nutritional data and to perform the menial computations for each element eliminates the tedium from this task. If a fast printer is available, the time spent on the computer is reduced since students would not have to copy information from the screen. Since determining nutrients is easy, and since they are not graded on how they eat, students are more honest about recording the foods they eat.

To insure that students do not sit and wait for a free computer, the computer calculations provide only a portion of the exercise; they are combined with manual calculations of calories burned over a twenty-four hour period. Although I had written a computer program to calculate metabolic rate, I found students derived no understanding from running it. By making the computations, they recognize some factors considered in determining metabolic rates. Alternatively, it would be reasonable to include exercises such as measuring body fat or performing an assay for vitamin C, especially if the lab is three hours long.

2. The program

There are a variety of nutrient analysis programs on the market that run on computers other than the Apple][. Although some trial and error may be necessary to select a program which is easily run by students, it should be possible to purchase a suitable program. The version I developed utilizes nutrition data which were originally derived from the USDA nutrition handbook and were subsequently modified by Dr. Javed Aslam and Apple Computer. My program disk contains 8 files, all of which must be present for the program to function. Nothing else can be stored on the disk due to a lack of space. The disk must not be write protected since data are temporally stored during the program's operation. The RDA values given are those set by the US Academy of Science and are often much higher than found in other countries.

Beginning several weeks in advance, I repeatedly announce in class that the students will need to record their daily activities and diet to insure they come to lab with real data. Encourage the students to be honest when recording their diet since they are usually surprised to find that their nutrient intake is adequate. If they think you will be grading the way they eat, they will not be as honest.

3. The exercise

a. Preface

As a preface to the exercise, I provide excerpts from a series of articles dealing with diets, dieting, and the genetic nature of being overweight. These have been omitted from the following material which is distributed to the student.

b. Introduction

Although it is not possible to taste or otherwise detect the nutrients in foods, chemical tests can measure which are present in what concentrations. Performing these tests are well beyond the scope of this course; however, we can use the data accumulated by others (e.g., the "Composition of Foods," Agricultural Handbook #8) to evaluate our diets. In addition, while the energy you expended over a 24-hour period is also very difficult to measure, we can use indirect methods to estimate approximately how much energy you burned. Thus, the objective of this laboratory is to determine the quantity of nutrients and energy that you received during a typical day, and then to compare these values to the quantity that you require. This exercise should be very illuminating since you may find that the way you eat is actually adequate to meet your needs.

To accomplish these objectives, you will have to accurately record both your activities and foods consumed for a 24-hour period. When you are recording your data, BE HONEST! You will not be graded on the way you eat or on your activities, but rather on the way you complete the lab exercise. For this experience to be beneficial to you, you should try to select a day that is representative of the way you eat and live. Thus, while it would be much easier to record your activities on a day spent sick in bed, or inventory your foods when you didn't have money to eat, the results would be of no value to you.

For maximum accuracy, carry a note pad with you and record throughout the day, rather than trying to recall the information at the end of the day. Record accurate estimates of the quantity of each food eaten, and the intensity of each activity, on Form 1. Please be neat so both you and your instructor can easily check the figures.

When in the laboratory, you will determine the nutritional content of foods using the Apple computer to record and calculate your data. Calculations needed for estimating your energy expenditure will be done by hand (or a calculator if you have one), so while you are waiting for an available computer, you should work on the second section of the exercise.

c. Food Intake

Use Form 1 to record all foods you eat during the day. For nutrient analysis, it is important to estimate as accurately as possible the quantity of each food consumed. Since the data on the computer have been converted to ounces, cups, tablespoons or teaspoons, use the English units of measurement in your estimates. To help you estimate, it may be helpful to measure out a cup, tablespoon, and teaspoon of a food, and then observe it on a plate or in a bowl. A piece of meat the size of your hand is about 3 to 4 ounces, while a single slice of American cheese is about 1 ounce.

When recording your foods, be sure to list any dressings, sauces, spreads, gravies, etc.; also indicate how the food was prepared since fried food has added fat, while other methods remove fat. For mixed dishes, estimate and record the amounts of the major ingredients. For example, one serving of macaroni and cheese might be listed as .05 cup cooked macaroni plus 1 ounce American cheese. For foods that are often served differently, indicate how yours was served.

Thus, include any cream and sugar you use in your coffee, butter and/or spreads used on your toast, the type of salad dressing you used, etc. If you took any vitamin pills, record the ingredients from the label and manually add them to the computerized totals when you are finished.

Once you are in the lab, enter each food type into the computer. Type in the general class of the food rather than the specific name: for example, if you had angel food cake, type "cake," while for brown rice, enter "rice." The computer will list all the types of cake or rice that are on file. Select the appropriate food by entering the number beside the food, then pressing "RETURN." If none are appropriate, press "RETURN" without entering a number. Since you are only permitted to enter a single word, to select peanut butter, type the word "peanut;" then from the displayed list of peanut products select "peanuts, miscellaneous" to see another list which includes peanut butter. If you misspell the word or enter a word that is not in the program, the computer will progressively drop the last letter of the word and scan for a match. If you are not sure of the spelling of the word, you only need to enter the portion of which you are certain.

After selecting the food, you will be asked the quantity you consumed. If the units given seem inappropriate (e.g., you consumed 3 ounces of juice, yet you are asked how many cups you had), press the "ESC" key and select the more appropriate units. Then proceed to enter the quantity that you consumed.

The computer has room for only 40 foods, so you should consolidate your entries. Thus, if you had 3 cups of coffee each with a teaspoon of sugar, one spoonful on your cereal, and one with iced tea, then you only need to enter sugar one time. When asked how many teaspoons of sugar you consumed, enter 5.

After entering all foods for the entire day, press the "ESC" key and verify that the foods you entered are correct. If you decide to add additional foods, press "A." To delete a food, enter "D." If you are satisfied with the list, press "C" to enter the computational portion of the program.

The computer will read the nutritional data from the disk and correct the values for the quantity you consumed. You will then be asked for the information needed to compute your RDA. Summary data which includes both the totals for the foods you consumed, plus the recommended daily allowance that you should strive for are then presented. To observe all three screens of data, press "RETURN" to advance to the next screen of information. Record this summary data using Form 3 in your notebook. If the "ESC" key is pressed, you will see a detailed listing of all the nutrients contained in each food; since there is not enough room to see all 24 nutrients at one time, press the right arrow key to see data to the right. Each time an arrow key is pressed, two new nutrients move onto the screen and two exit from the other side. If the TOTAL of the nutrients is not visible at the screen's bottom, press the "V" key to view the bottom of the listings.

Pressing the "RETURN" key will display the complete name of each food and quantity you consumed. A second press of the "RETURN" key returns you to the nutrient table.

After viewing the detailed data, press "ESC" and you can choose to review the data again, print the data (assuming there is a printer attached), re-enter the food selection program to make minor modification to your diet, or end the program. If you wish to try computing the nutrients from a second day, please wait until everyone else has had a change to accumulate their day's data.

d. Energy Expenditure

Record your activities for the same 24-hour period of Form 1. To record the time spent, you can either enter the actual clock time the task was initiated and completed (best with long activities such as sleeping) or directly enter in the minutes spent doing the activity. Each minute of the day should be accounted for, so the total must equal 1440 minutes. Treat flights of stairs as separate functions. On your Form, record the time spent on stairs as "walking," then also list the number of flights you ascended and descended. Count 14-15 steps as being a flight of stairs.

When you are in lab, use the description in Form **4** to determine what energy level would be most appropriate for each activity you performed. Then transfer the information to Form 2, enter number of minutes spent performing each activity into the box below the appropriate energy class. Total the number of minutes spent in each activity level at the bottom of the sheet. Transfer this data to Form **4** and multiply the minutes spent at each level with the energy consumed per Kg body weight per minute. Be sure to also include the number of flights of stairs traversed. When the total is multiplied by your body weight, you have computed the amount of energy you used for muscular activity for the day.

To estimate your total energy expended, use Form 5. The basal energy used to maintain your body must first be estimated, and then corrected for your age. In addition, since our metabolic rates apparently increase when we eat more calories, and decrease when we consume less, we also need to estimate how much metabolic compensation could occur in your case. When the basal rate is added to your muscular energy consumption, the result is the approximate amount of energy that your body expended during the day. The internal compensation for extra calories serves as an error term.

Form 1. **Work sheet**

Foods consumed during 24 hours.

Food	Quantity Consumed	Food	Quantity Consumed

Activities during 24 hours.

Clock Time				Clock Time			
Start	End	Minutes	Activity	Start	End	Minutes	Activity

Flights of stairs: Up:
Down:

Form 2: Activities for 24 hours

Name ______________________________ Date of Record ____________________

Minutes spent at a given energy level

Activity	Sleep	Lying	Sitting	Very Lght	Light	Moderate	Heavy	Severe	Very Severe
TOTALS									

Note: Total of all minutes should be 1440

Form 3. **Nutrients Consumed vs. Those Required**

Nutrient	Consumed	RDA	Units	Nutrient	Consumed	RDA	Units
Calories	________	_____	K cal				
Carbohydrate	________	***	gr	Niacin	________	_____	mg
Protein	________	_____	gr	Pantothenic	________	_____	mg
Saturated Fats	________	***	gr	Vitamin C	________	_____	mg
Unsaturated Fats	________	***	gr	Vitamin D	*	_____	mcg
Total Fats	________	***	gr	Vitamin E	________	_____	mg
Cholesterol	________	_____	mg	Iron	________	_____	mg
Fiber	________	***	gr	Potassium	________	_____	mg
Vitamin A	________	_____	Iu	Calcium	________	_____	mg
Vitamin B1	________	_____	mg	Magnesium	________	_____	mg
Vitamin B2	________	_____	mg	Phosphorous	________	_____	mg
Vitamin B6	________	_____	mg	Sodium	________	_____	mg
Vitamin B12	________	_____	mcg	Zinc	*	_____	mg
Folic Acid	________	_____	mg	Iodine	*	_____	mcg

* Not included in this analysis
*** RDA has not been set

Form 4. **Calculation of Energy used for Muscular Activities**

Age: _____ years Body Weight: _____ pounds x 0.454 = _____ kilograms

Energy Level	Energy Spent (Kcal/kg/min)	# Minutes Spent at that Level	Energy Spent per Kg Body wt.
Sleep	0.000	X _____ minutes =	
Lying still, relaxed	0.002	X _____ minutes =	
Sitting or standing still (include eating, sewing, writing)	0.005	X _____ minutes =	
Very light activity (include driving walking at slow speed)	0.025	X _____ minutes =	
Light exercise (include light house-work such as sweeping, moderate walking on level ground)	0.035	X _____ minutes =	
Moderate exercise (include fast walk-ing, dancing, moderate bicycling)	0.040	X _____ minutes =	
Heavy exercise (include fast dancing, walking to running, uphill walk)	0.065	X _____ minutes =	
Severe exercise (include tennis, running)	0.105	X _____ minutes =	
Very Severe exercise (include wrestling, rowing, boxing, racing)	0.140	X _____ minutes =	
	Subtotal	1440 minutes =	_____ Kcal/kg
Stairs (going down)	0.012	X _____ flights =	
Stairs (going up)	0.036	X _____ flights =	
	Subtotal		_____ Kcal/kg

To compute the total energy 1/kg:

_____________ + _____________ = _____________

Kcal/kg for activity   Kcal/kg for stairs   total Kcal/kg

To compute the total energy spent on muscular activity for the day, multiply the total Kcal/kg that you obtained by your body weight.

________ Kcal/kg X ________ kg = ________ Kcal spent on muscular activities

Form 5. **Estimation of Total Energy Expenditure**

A. Calculate the energy spent on basal metabolism; the basal metabolism rate (BMR) for males is 1.0 Kcal/kg body wt./hour while the rate for women is 0.9 Kcal/kg body wt./hour.

_____ Kcal/kg/hour **X** _________ kg **X** 24 hours = ____________________ Kcal
(BMR) (your body weight) (energy for basal metabolism per day)

(should be 1000-3500)

B. Correct BMR for age; approximately 8 fewer Kcal are needed each year after 18.

_________________ Kcal- (_____ X 8 Kcal) = ______________________ Kcal
(Energy for basal metabolism) (# years you are older than 18) (age corrected energy for basal metabolism)

C. Compute the range that your metabolism rate could vary in response to an increase in diet; if you are of normal weight, use a metabolic compensation factor of 0.2. If you are overweight, use a factor of 0.1.

_________________ Kcal **X** _____________ = _____________Kcal
(age corrected energy for basal metabolism) (metabolic compensation factor) (compensation energy)

D. Compute your total energy expenditure for the day.

______________ Kcal + _____________ Kcal = ___________ ± _____________
(energy for muscular activity) (age corrected energy for basal metabolism) (energy expenditure) (compensation energy)

e. Discussion

How many Kcal did you consume during 24 hours (see Form 3)? ______________________. How many Kcal did your body burn during the same period (see Form 5)? _________. Assuming that these values are typical for you, and that your metabolism runs at a constant rate, what is the difference between your intake of calories and the calories required for your activities plus BMR? (Use negative numbers if your metabolism consumes more than you took in) _______________________________________. If this discrepancy were repeated daily for five years, how many surplus (deficit) Kcalories would you have eaten? __________________ Considering that one pound of fat contains 4,090 calories, how many pounds of weight gain (loss) could this discrepancy translate into? ________________. If you continued to consume foods at the same rate and you kept your activity level unchanged over the next fifty years, what would your weight be? _______________

Now return to Form 5 and recompute what your energy expenditure would be in five years assuming your body weight had increased by this amount, and your age was five years older. How many calories would your body be burning per day five years from now? _______________. Why is this value different from your present metabolic rate?

What internal compensation rate did you compute for your caloric intake? (see Form 5) _______________. Is this value large enough to permit you to maintain a stable weight without changing your activity level and/or food consumption? _______________. Do these calculations agree with your own personal experience? I.e., do you find you tend to gain (lose) weight unless you work at maintaining a stable weight? _______________. Please explain.

Our diets should provide less than 30% of the total calories needed in the form of fat. How many grams of fat did you consume (Form 3)? _________. Since fat contains 9 calories/gram, how many calories of fat did you consume? _______. How many total calories did you consume (Form 3)? ______. What percentage of your calories were derived from fat? _______. Is this value within the recommended limits of fat? ______. What foods were the major source of fat in your diet?

VITAMINS

Do you feel that your nutrient intake as recorded during this study is typical of your normal eating habits? _______________. If not, please explain.

Reviewing Form 3, did you meet the RDA for all nutrients? _______________ Which nutrients were consumed at levels less than approximately 80% of your RDA?

Which nutrients were consumed at levels which exceeded the RDA by more than approximately 50%?

Do you see a need to take nutrient supplements?

B. Health Hazard Appraisal

1. General

With this program, students answer a set of questions depending on their age, sex and race (the 3 major risk factors which affect mortality). Then, depending on the student's family history and personal habits, the computer provides a personalized assessment of their risk of death. The three objectives of this exercise are to convince an 19 year old he/she is mortal; to show how one's activities can influence survival; and, to show how changing life style can improve life span.

There should be 1 computer for at least every 7 students if this is to be done in a two hour lab period. If a printer is available, it should be used since there is much text for the student to read. To insure that students learn additional material while waiting for the computer, I combine this exercise with a variety of investigations that relate to common causes of mortality. Thus, the students use the microscope to compare lung tissue from smokers' and non-smokers' lungs, view lung tissue damaged by emphysema, observe a variety of cancerous tissues, compare coronary arteries with various states of atherosclerosis, survey attitudes on risk factors, and measure cardiovascular fitness. Other exercises that might be appropriate are measuring body fat, observing the effects of nicotine on ciliated organisms, or studying heart anatomy.

This program performs an enormous number of calculations and looks up a vast quantity of information. It would be unreasonable to expect students to perform this amount of work manually, so the use of a computer is appropriate. The resulting information is personalized, and as such, is more meaningful to the student.

2 The program

Students of different races, ages and sexes will be asked different questions. Some of the questions for females are very personal since the program is looking for links to cervical cancer and breast cancer; it is probably best to encourage people not to look over each other's shoulders while they are at the computer. Sometimes I designate separate machines for males and females.

One factor that hurts students is their excessive driving which can skew the data; a 15 year old who drives 60,000 miles per year could have the same risk of death as a 41 year old male. Another confusing aspect is that there are no listed risk factors for certain causes of death. This is an omission of the original study, presumably due to a lack of data. Thus, while logic would assume that not knowing how to swim would be a risk factor in swimming deaths, non-swimmers are less likely to go near the water, so it may not be a risk factor.

There are 32 files on the disk, all essential for the program to work. There is no room on the disk for anything else. The disk must not be write protected since data are stored during the program's operation. These data files are from "Prospective Medicine" by J. Hall and J. Zwemer, Methodist Hospital of Indiana, 1979, and represent the best correlations between observed mortality and associated risk factors.

3. The exercise

a. Preface:

-Readings omitted -

b. Introduction

The objective of this week's laboratory is to observe some of the factors which present a risk to our survival. Due to our myopic perspective, we tend to accept or ignore risk factors which are of enormous significance, while being unduly concerned about factors having a minimal effect on survival: In addition, there is also a tendency to assume that we are condemned by our genetic heritage. Thus, some people assume that since cancer or heart disease runs in their family, there is nothing they can do to avoid a similar fate.

Fortunately this is not the case. For example, although a woman's risk of breast cancer is approximately two to three times greater if a mother or sister also had the disease, 90% of the women contracting the disease have no relatives with the breast cancer; in addition, of those who do develop tumors in one breast, very few will also form a mass in the other breast. This evidence indicates that, although the disease has a genetic component, most people contract breast cancers due to environmental reasons. Thus, instead of resigning yourself to the fate of your ancestors, you should attempt to modify your environment and reduce your chances of such a fate.

Hopefully, at the completion of this exercise, you will have a better understanding of the causes of death that are most prevalent for persons like you. In addition, you should understand which factors influence survival and which are most important for you to modify.

c. Causes of Death

1. Major risk factors

The three risk factors which have the most influence on our mortality are beyond our capability to change; these are our age, sex, and race. To demonstrate their influences, I have selected a few conditions as examples. In all of the following discussions, the numbers presented for death rates are based on actual mortality data. They represent the number of people who died out of a population of 100,000 persons of the same sex, age and race.

The effects of age can be seen in this data derived from a white male;

CHANCE OF DEATH WITHIN 10 YEARS DUE TO:

CURRENT AGE	HEART DISEASE	LUNG CANCER	AUTO ACCIDENTS	SUICIDE	CIRRHOSIS
20	17	3	581	250	11
30	254	46	325	244	98
40	1,629	348	275	260	343
50	5,001	1,188	248	301	580
60	11,273	2,561	258	207	667

Note that while the death rate due to most conditions increases with age, some, such as auto accidents, decline with maturity. In addition, suicide appears to be independent of age.

To demonstrate the effects of sex on death rates, consider the following data derived from 20-year old whites.

CHANCE OF A 20-YEAR OLD DYING BY:

	AGE 50		AGE 60	
CAUSE	MALE	FEMALE	MALE	FEMALE
Heart Disease	1,829	361	6,398	1,565
Lung Cancer	382	172	1,467	541
Breast Cancer	4	441	10	1,094
Homicide	442	125	524	149
Suicide	739	322	1,014	447
Vascular Lesions of C.N.S.	244	251	738	654

Note that females have a much lower incidence of many diseases. However there are examples of males having similar rates (lesions of the central nervous system--i.e., strokes) and reduced rates (breast cancer) when compared to females.

The effects of race are also pronounced, although for many of the factors, the difference appears to be cultural in origin.

CHANCE OF A 20-YEAR OLD DYING BY:

	AGE 50		AGE 60	
CAUSE	BLACK	WHITE	BLACK	WHITE
Homicide	4,038	442	4,683	524
Cirrhosis	1,241	436	1,947	966
Vascular Lesions of C.N.S.	848	244	2,117	738
Auto Accidents	1,290	1,164	1,691	1,390
Suicide	505	739	602	1,014

Many mortality factors are very much weighted against blacks. Some (auto accidents) are about equal for both groups, and a few (suicide) affect whites more than blacks. The prevalence of strokes in blacks is probably due to genetic causes, since more blacks have high blood pressure.

The tables that follow show the death rates that a 20-year old could expect up through age 60. Similar data are also available for other age groups.

-Tables omitted -

2. Other risk factors

Numerous other factors have been correlated with different diseases; i.e., persons with a particular trait, condition, habit, occupation, etc., are noted to have a higher incidence of a given disease. However, our interest is in those factors that are responsible for causing the disease, and not those traits which result from the illness. For example, severe weight loss is correlated with many diseases, although the weight probably reflects the progression of the disease rather than the cause of it.

The field of prospective medicine deals with determining which environmental, background and health factors are significant in increasing or decreasing mortality. The primary interest is to identify those traits that could be altered and thereby result in an increased life span and improved quality of life. Remember that a shortened life span is frequently preceded by illness and debilitation. Since the quality of life is very difficult to measure, we will limit our concern to life span.

The fundamental assumptions of prospective medicine are:

a. Everyone is subject to the risk of death.
b. The risk of death can be described by an average for a person of a given race, sex and age. This risk is based on actual mortality figures for people in that group.
c. This average risk can be adjusted for an individual according to key factors such as the person's family history, health condition and personal habits. Some factors will increase the person's chance of death, while others will reduce it.
d. If intervention changes some negative factors, the person's chance of survival will increase.

Subjective Rating of Risk Factors

- Section omitted -

RISK OF DEATH ASSESSMENT

After entering your age, sex and race in the Apple computer, you will be asked a series of personal questions. The particular questions asked will differ depending on the basic parameters of sex, age and race. Your responses to the questions permit the program to assess your risk of dying from the ten most common causes of mortality for persons of your age, sex and race. Your answers are strictly confidential since all data is erased at the completion of the program.

Because most deaths of persons under 25 are due to conditions for which risk factors have not been derived, you may find it more informative to enter your age as 25 if you are younger.

You will then be shown in descending order of frequency the ten most common causes of death for persons with your basic parameters. Your personalized risk of death over the next ten years is given as a percentage, followed by how the value compares to that of others with your characteristics. If your personal percentage of survival is less than one, your chances of surviving the next ten years is greater than that of the sample population; if it is greater than one, your risk of death is greater.

The remaining information presents the data on which the percentage of survival was based. Listed under "FACTORS INFLUENCING RISK" is each of the risk factors and a risk value. A risk value of less than one means that your response to this risk factor has improved your chance of survival. The composite risk value is the sum of all risk values greater than one added to the product of all those less than or equal to one. This composite risk is then multiplied by the number of persons (out of a sample of 100,000 of your age, sex and race) who would be expected to die. This new value is then converted to a percentage to assess your probability of death.

The second phase of the program will permit you to determine the effects of intervention. If you were to immediately correct those risk factors that are in your power to alter, your survival rate should improve. Finally, the program will give you an attainable age. This value is your mortality age assuming you correct the stated risk factors.

RESULTS SUMMARY

AGE ______ SEX ______ RACE ______

Cause of Death	Deaths/100,000 People in Your Age Group	Your Risk Assessment: Present	After Intervention
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Given your current habits, the potential number of years you have left is equivalent to those of a ______ year old. How could intervention influence your potential life span?

If you were to institute a public health campaign to encourage people in your age group to alter two or more personal habits, what would you focus on?

C. Reaction meter

1. General

This program tests students' reaction time as they are presented increasingly more complex tasks to perform. The program simulates a reaction meter, although the computerized version does a great deal more than reaction meters. Since this exercise comprises a small portion of a larger exercise on physiological testing, only one computer is needed for 15 to 20 students. This program is also used in our Human Physiology course.

2. The Program

The program is self contained, and as such, can be copied to any disk without fear of loosing essential program files. The program and how to modify it have been described in the fall 1986 issue of Labstracts.

3. The exercise

a. Introduction

The objective of this week's laboratory exercise is to let you try some tests that are often run by doctors. The tests are used to diagnose illness or abnormalities since they indicate if the patient's values are within ranges that are considered normal. Although some of these tests are part of routine physical exams, do NOT consider this lab exercise a substitute for such an exam. We are doing the tests for demonstration purposes only and will not attempt to diagnose or interpret the values.

b. Human Reflexes

A reflex mechanism requires an organ for perceiving a stimulus, an organ which can react, and a communication network in between. The communication system can range from very simple reflex loops (arcs) to highly integrated networks involving higher brain functions.

Many reflexes appear programmed; that is, the appropriate response to a given stimulus has been built into the nervous system. The spinal reflexes serve as an excellent example. For instance, if you burn a finger on a hot object, the spinal reflex immediately causes withdrawal of the finger from the hot object. By the time the higher levels of the nervous system are notified of the event by sensations of pain, the finger is well away from danger.

Other reflexes, such as eye reflexes, require that the brain evaluate the stimulus and determine the proper response.

In addition to observing some reflexes, we will measure reaction time of both simple reflex arcs and those involving the higher brain centers.

1. Pupillary Reflex - *omitted* -
2. The Blink Reflex - *omitted* -
3. Patellar Reflex - *omitted* -
4. Plantar Reflex - *omitted* -

5. Reflex and Reaction Times

A person's reaction time depends on numerous factors which vary depending on the reflex type; for example, the response speed of the perceiving organ, the speed that nerves conduct the impulse, the number of jumps the impulse must make (synapses) from one cell to another, the speed with which the effector muscle contracts, and the health of the organs involved. Thus, when dealing with a fairly simple reflex arc with few synapses, response time will be rapid. However, if a response requires thought or decision making, more neural pathways must be traversed and the response time is longer.

To demonstrate the influences of these various factors, we will use the Apple computer to simulate a reaction time meter. Simply press "RETURN" to start each test. When you perceive the signal, press the space bar. The computer will tell you how long it took you to react. Be careful not to accidentally press the key while resting your hands on the keyboard.

After one or two practice tries with a section, record the reaction time for three runs and average them. Also note the number of erroneous key presses. Then press the "ESC" key to go to the next test.

PLEASE DO NOT BANG ON THE KEYS!!!

a. Reaction time to sight

Test the subject's reaction to the "X" that appears on the screen. Does it make a difference if it is positioned at random on the screen? ________________

b. Reaction time to sound

How does the reaction time with sound compare to that with vision? ________ ____. Look in your book at the portions of the brain which are involved with hearing and vision. With this information in mind, how do you account for the differences in reaction time?

When both vision and hearing are used, which are you responding to? ______. Which do you perceive as appearing first, the bell or the "X"? ___________

It will probably surprise you to find that the computer prints the letter first, then makes the beep! How do you account for this discrepancy in what your senses are telling you? ____

c. Reaction times involving decisions

How does having to choose before responding affect the reaction rate? _____ ____

d. Rate of nerve conduction

How much longer does it take for a impulse to reach the brain from your feet than your face? ___________________________________

e. Involvement of the higher centers

How is your reaction time influenced when complex interactions are involved? ____. By subtracting the time needed to just find the correct number key from the time needed with the math problems, it is possible to determine how much time is needed just for computation.

f. The action of stimuli and depressants

Although the tests in this section are strictly optional, please try to complete the questions below.

How would you expect alcohol to influence reaction time?

Alcohol will slow down nerve conduction and also the rate of synapses. Since driving a car requires the higher brain centers, evaluate visual impres- sions and perform the correct response, which of the above tests would you assume would be most similar to driving?

If your overall reaction time was slowed by only one second, how much further would you travel if you were driving at 60 miles/hour? ________________

RESULTS

TEST	REACTION TIMES 1	2	3	AVERAGE	NUMBER OF MISSES
Stationary X					
Random X					
Click					
Click & X					
Arrows					
Random 0					
Words in center					
Random words					
Select number					
Solve Math					
Touch cheek					
Touch ankle					

D Field of vision

1. General

This program simulates an expensive piece of specialized equipment for measuring 'a visual field of view. Due to the inability to vary and control the spot brightness, it could not be used in a clinical setting; however, it is very informative to students. The computer flashes spots of light around the screen, and if it is in the students field of view, he/she presses a key. The program intelligently tries to define the limits of the visual field. If fewer spots are sampled, the exercise can be completed in five to ten minutes and only one computer is needed for 15 to 20 students. This program should be combined with other measurements of human physiology.

2. The program

VISION requires a series of graphics programs which are run by the HELLO program. If it is to be moved to a separate disk, be sure the necessary programs are also present.

VISION permits students to measure their field of view if the room is darkened (overhead lights wash out the top of the screen). The intensity of the screen is important because if the spots are too bright, persons with poor visual fields may still be able to see them. The number of spots tested is set at 120, but this can be altered when the program begins to run. When the program is finished, it will display the spots seen with a + , those missed with a box; a / indicates it was both missed and selected at different times. I currently attempt to interpolate the actual field of view based on the spots seen and missed. However, this routine is very slow and can be eliminated by inserting a line **4001 GOT0 4246** It is also possible to save the pictures on disk, but this is not a good idea for most labs since the disk will quickly fill up. To include this option, delete the line **4275 GOT0 4300**

3. The exercise

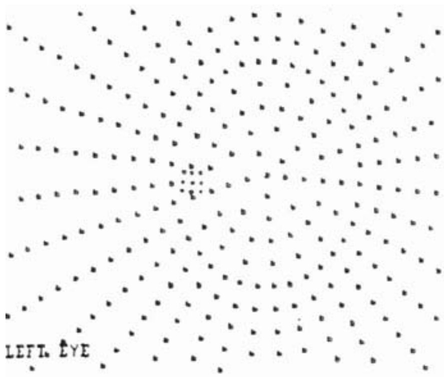
Vision testing is a routine part of any examination. However one aspect which is frequently overlooked is measurement of the visual field. Many diseases cause a gradual, progressive loss of peripheral vision (the ability to see to the sides) which is unnoticed by the patient. Checking the visual field is very tedious, so it is an ideal task for the computer,

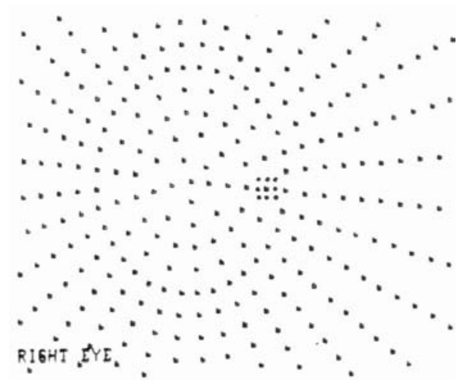
Position yourself directly in front of the Apple computer's screen and cover one eye. A flickering spot will appear at the center of the screen and remain there through the test. Adjust your distance from the screen until the "twitching" spot is at the center of your vision, and the off center point of light disappears in your blind spot (about 4 inches from the screen). Don't worry if the dots are out of focus. Eliminate reflections of room lights from the screen, and be sure that the intensity of the screen is turned down.

Once in proper position, press "RETURN" and wait; be sure to keep your gaze on the twitching spot at all times. You will be shown approximately 150 spots located apparently at random around the screen. When you see a spot appear, press "RETURN" before it disappears. If you press the key when there is no spot on the screen, you will hear a beep. The points will appear at a more rapid pace, and remain on the screen for a shorter period of time, as you become used to the test. Depending on your peripheral vision and on the intensity setting of the monitor screen, you may be unable to see some of the peripheral spots. To insure that you have not shifted your position, your blind spot will be tested 9 times.

When the computer has tested you with enough points, it will give a double beep, then plot all the points that were tested. If you saw a point, it will be represented with a plus (+). If you missed the point, it appears as a box. Points which were both seen and missed at least once are designated with a slash *(/).* Your maximum field of vision is then plotted by connecting the appropriate points. If the line appears at the perimeter of the screen, it indicates that your peripheral vision is excellent. Using the diagrams below, indicate approximately your field of view for the eye you tested.

Do these results appear normal? ___________________________________





E Measure body fat

1. General

This program provides an alternative to using calipers for measuring fat and eliminates tedous and confusing calculations. Depending on student's age and sex, he/she measures the circumference at 3 locations on their body. The computer calculates the percent body fat. An interesting exercise can be constructed where this method is compared to results from use of calipers. The exercise can be combined with a variety of different physiological or health-related exercises. Only one computer is needed for 15 to 20 students.

2. The program

BODY FAT also requires a series of graphics programs which are run by the HELLO program. If it is to be moved to a separate disk, be sure the necessary programs are also present.

3. The exercise

Standard weight tables are misleading since they tend to underestimate weight. In addition, persons with well developed musculature will usually be classed as overweight because muscles weigh more than fat. However, our concern is not with weight, but rather the proportion of the body that is fat.

There are two indirect means of measuring fat; both are based on the principle that excess body fat is deposited just under the skin. The first method involves making a series of circumference measurements on the limbs and/or torso. The second method uses calipers to measure the thickness of the sub-dermal layer of fat. Both techniques have been calibrated according to the only accurate measurement technique; the method is based on Archimedes principle and involves weighing a person in air and while submerged in water. Since fat is less dense than muscle, the difference between these two weights indicates the proportion of fat. Although the indirect methods are not as accurate, they are easier to perform.

To use the circumference method, follow the instructions given on the Apple computer. According to these measurements, what proportion of your body is fat? _________ Does this agree with your assessment of your excess or lack of body fat?

Skinfold calipers are valuable to use since, if properly used, they differentiate between the underlying muscle and fat. Using calculations, the overall percentage of total body fat can be determined.

Four sites will be used: (1) triceps (halfway between elbow and shoulder on the back of the arm); (2) biceps (halfway between elbow and shoulder on the front of the arm); (3) subscapular (diagonal fold below shoulder blade); and (4) iliac crest (diagonal fold on the side, above the hip bone).

To do skinfold measurements, take hold of the skin and subcutaneous fat (no muscle) in the left thumb and forefinger; be sure you are measuring directly on the skin since clothing thickness can skew the results. With the right hand, slowly close caliper tongs around the fold and measure to the nearest .5 mm. Total the four readings from the calipers and use the appropriate table (below) to estimate your percentage of fat.

How do these readings compare to those obtained with the tape measure? Which method do you think would be more accurate? Why?

DETERMINING % FAT IN MEN

TOTAL MM	% FAT	TOTAL MM	% FAT
20	9	90	27
25	11	100	28
30	13	110	29
35	15	120	30
40	17	130	31
45	18	140	32
50	20	145	32
55	21	155	33
60	22	165	34
65	23	180	35
70	24	185	36
75	25	200	37
80	26	210	38

DETERMINING % FAT IN WOMEN

TOTAL MM	% FAT	TOTAL MM	% FAT
15	15	60	31
18	16	63	33
21	17	64	34
24	18	69	35
27	19	72	36
30	20	75	37
33	22	78	38
36	23	81	39
39	24	84	40
42	25	87	41
45	26	90	42
48	27	93	43
51	28	96	44
54	29	99	45
57	30		

F lung capacity

1. General

This program simplifies calculations required to derive lung capacity using a Collins respirometer.

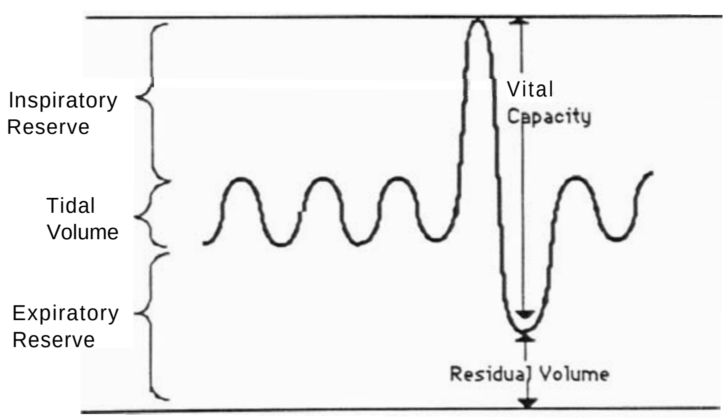
2. The program

LUNG also requires a series of graphics programs which are run by the HELLO program. If it is to be moved to a separate disk, be sure the necessary programs are also present.

3. The exercise

The exchange of oxygen and carbon dioxide between the body and the atmosphere occurs in the lungs. While evaluation of this transfer would be the most meaningful indication of the lung's health, it is difficult to measure directly. However, many conditions which affect gas exchange also influence both the amount of air that enters and leaves the lungs, and the volume of air that the lungs can hold. Thus, by measuring the capacities of the lung and the rate at which air can be moved into and out of the lung, an estimation of the lung's health can be assessed.

We will be using a spirometer to measure how much air is transferred between your body and the atmosphere. The device is an inverted bell which floats in a can of water; as you exhale air into the mouth piece, it enters the bell, raising it upward. The bell is attached to a pen so that as the bell rises, a pen moves down on graph paper. There are several volumes that we can measure.



1. Tidal volume is the amount of air that is inhaled and exhaled during normal breathing.
2. Inspiratory reserve volume is the maximum amount of air that can be taken in during exertion.
3. Expiratory reserve volume is the amount of air that can be exhaled during maximum exertion.
4. Vital capacity is the sum of these three volumes and represents the most amount

of air your body can consume.
5. Residual volume cannot be measured by spirometers. This is the amount of air that always remains in the lungs.
6. Total lung capacity is the sum of the residual volume and the vital capacity. Capacities for these measurements vary with a person's height, sex and age.

Typical values are:

	MALES	FEMALES
TIDAL VOLUME	500 ml	400 ml
INSPIRATORY RESERVE	3000 ml	2250 ml
EXPIRATORY RESERVE ..	1000 ml	750 ml
VITAL CAPACITY	4500 ml	3400 ml
RESIDUAL VOLUME	1500 ml	1200 ml
TOTAL CAPACITY	6000 ml	4600 ml

With the valve near the mouthpiece open, gently press the respirometer chamber down to force out the trapped air, then raise it to bring in fresh air. Set the respirometer chamber so that the pen is about 1000 ml above the bottom of the graph. Remove a mouthpiece from the alcohol and wash it well before placing it on the spirometer. After taking a few breaths through the mouthpiece, close the valve so the chamber moves with each breath. Sitting erectly, inhale as deeply as possible and then exhale as completely as possible; record these two values. Using the Apple computer, enter your height, sex and age; then enter the value at maximum inspiration and that for maximum expiration. The program will compute your vital capacity, and then compare it to your predicted volume.

What is your tidal volume? ______________

What is your vital capacity? ____________

What vital capacity was predicted for you by the computer? _________________

What percentage of the predicted value was your actual vital capacity? ____

Considering values of less than 75% to indicate potential problems, are your values too low? ___________

If yes, then do you know of any personal health problems which could account for this? __________________

G. Line fit

1. General

LINE FIT is a simple statistics program that we use in the beginning classes to introduce the concept of variability. Students collect data, then enter the X and Y values in the computer. The program calculates the best fitting line to the data. The program can be combined with any exercise where data are collected.

2. The program

LINE FIT is a free-standing program and can be transferred to any disk as needed.

3. The exercise

No student hand-outs are provided.

H. cluster analysis

1. General

CLUSTER ANALYSIS is a program that demonstrates simple taxonomic principles using calculations too complex for students to perform. The program's concept was described in great detail in The American Biology Teacher (47(1), 41-47; 1985). Students first determine which are the significant characteristics that differentiate a series of objects or species (eg. number of leaveslnode, color etc). Then the characteristics of each object is quantified (plant A has 10 leaves/node and is red {red=1}, plant B has 1 leaf/node and is white {white=2} etc.). The data are entered in the computer and the program clusters the data by similarity. A dendrogram visually presents the relationships. Depending on the complexity of the data used, one computer could provide for the needs of ten to fifteen students. This exercise could be combined with manual methods of developing taxonomic keys.

2. The program

Included with this program is the sample data file, HARDWARE.RAW DATA, which is referred to in the article. This version of the program does not permit students to save data on the disk. If you want to enter a data set and save it for students to process, do the following; press **CTRL RESET** as soon as the program begins to run. Type the number **7** and press **RETURN,** they type **RUN** and press **RETURN.** This deletes a program line that tells the program not to ask if the data should be saved.

3. The Exercise

No student hand-outs are available.

References:

Gealler, H. and G. Steele: *The* 1974 *Probability Tables of Dying in the Next Ten Years From Specific Causes.* Methodist Hospital of Indiana, Indianapolis, Indiana. 1974

Hall J. and J. Zwemer: *Prospective Medicine* Methodist Hospital of Indiana, Indianapolis, Indiana. 1979

Sweet, H. *Non-Majors Biology Laboratory Notebook.* Burgess Publishing Co. Minneapolis, Minnesota. 1984

Sweet, H. "The Use of Clustering Techniques by Students on an Apple Computer". The American Biology Teacher 47(1), 41-47; 1985

Sweet, H. "Use of a Computer as a Reaction Meter". *LabStracts;* Fall, 1986

Biology from the Human Perspective

Barbara Newman

Biomedical Sciences Department
Southwest Missouri State
901 South National Avenue
Springfield, MO 65804-0094

Barbara Newman received her B.S. Ed. and M.S. Ed. degrees from Southwest Missouri State University, Springfield, Missouri. Her areas of emphases are social studies, biology, chemistry and secondary education. Since 1986, Barbara has taught and/or been lab coordinator for general biology for non-majors, genetics, botany, zoology, anatomy and physiology. Currently, she teaches and coordinates laboratory sections for human anatomy and concepts in biomedical sciences. Her research interests include science education at the elementary and collegiate levels. She is currently developing a series of instructional videotapes for human anatomy.

This Material is Part of the Unit: "METHODS OF SCIENCE'

Objectives: 1) to realize need for tools to extend our senses:

2) to realize need for precise language in conveying ideas.

Laboratory Activity: the Black Bag Investigation

A. Problem: Each student will be given a sealed black plastic bag containing a number of objects, some of which may be fragile. Close your eyes and use only your sense of touch through the bag surface to determine what is in the bag without opening it or destroying its contents.

Mentally assign numbers to each object and write word descriptions of the objects next to each number. If possible, use these descriptions to identify the object. Identification of coinage and paper money as to denomination and country of origin entitles you to keep it!

Tentative descriptions and identifications:

1.

2.

3.

4.

5.

6.

B. Language is an important tool in conveying specific ideas efficiently. Choose three of the objects tentatively identified. Now assume that you are a caveman living about 10,000 BC, and using language relating to their experience describe each of the three objects. You may not use any term that a primitive man would not be familiar with (i.e., hard as metal, smooth and round like a marble). In what way does the caveman's description differ from yours?

Object No. 1

Object No. 2

Object No. 3

Open the bag.

1. Was any object damaged by crude manipulation?

2. Was your touch sensitive enough to locate every object?

3. Did past experience bias your identifications?

4. In what way would you further investigate the natural objects?

5. Is there an item that requires more than one sense to identify it?

6. How does this activity compare to the scientist investigating a living cell, the ocean floor, outer space?

Steps in the Effective Establishment of Safety Rules for the Laboratory

A Model Experiment

LABORATORY SAFETY

This group activity, when carried out as described, will not only introduce students to some common laboratory safety rules, but can at the same time encourage students to cooperate in groups and serve as an introduction to the scientific method. (3-4 students per group)

LEARNING OBJECTIVES

After this activity, students should be able to: 1) list at least six (6) common laboratory safety rules in their own words; and 2) set up an experiment following the scientific method.

PREPARATION

Instructors should be familiar with common laboratory safety rules and procedures. Instructors should know the location of safety equipment such as the fire extinguisher and the first-aid kit. Instructors should be familiar with any specific institutional safety policies.

DEFINE THE PROBLEM

The problem is to develop an effective way of teaching and reviewing laboratory safety rules.

RESEARCHING THE PROBLEM

Review of the literature related to science teaching indicates little available data on this type of problem. (Discussion of safety devices evident in the lab -- signs, first-aid kit, fire extinguisher, exits, etc.)

IDENTIFY THE HYPOTHESIS

Direct student involvement using group cooperative effort to produce a list of 10 common laboratory safety rules can be more effective in teaching and reviewing laboratory safety rules than other methods commonly used.

EXPERIMENT

Test group -- Sections of BMS* 110 labs taught by instructor X using the methods just presented.

Control group -- Sections of BMS 110 labs taught by instructor X using any other method.

The same laboratory exams with questions covering lab safety will be given to both groups.

OBSERVING AND STATING RESULTS

The number of correct responses to lab safety questions will be tallied for both groups and compared.

FORMULATION OF A THEORY

Probably not applicable due to the numerous uncontrollable variables. (Discuss several variables.)

* BMS (Biomedical Sciences)

STUDENT-GENERATED SAFETY SUGGESTIONS

for use in the

BMS 110 LABORATORY

1. Know the location of safety devices (fire extinguisher, first-aid, safety glasses, emergency exits and telephone with emergency number(s) EXT 5911.
2. No smoking in lab.
3. No "horseplay" in lab.
4. Be alert--know the correct way to use chemicals and equipment BEFORE using them.
5. Pay attention to and follow instructions for lab activities, especially when helpful suggestions are given during the course of the laboratory period. If you happen to be out of the laboratory, make sure that someone else covers for you if important instructions were given during your absence.
6. Keep the working area as clean and uncluttered as possible. Make sure area is clean and equipment is left in the proper condition at the completion of the lab period.
7. Be alert to personal safety, i.e., wash hands after lab, wear appropriate protective clothing, don't pick up broken glass with your hands, confine long hair and loose clothing.
8. When possible, work with a partner.
9. Ask for help when uncertain.
10. ENJOY LAB!

These Activities are Part of the Unit: "METHODS OF SCIENCE"

The material used for the following activity has been adapted from a 1975 NABT workshop, "Biology Teaching and the Development of Reasoning," developed by Anton Lawson, University of California, Berkeley, et al. It is patterned after Piaget's theories concerning the mental processes used in problem solving.

Distinguishing between students using concrete and formal reasoning patterns is important in structuring laboratory experiences. The majority of concepts taught in biology are formal while the majority of students use concrete reasoning patterns to interpret them. (Lawson & Renner, 1975). Characteristics of students using concrete reasoning patterns include: the need for reference to familiar actions, objects, and observable properties; the need for step-by-step instruction in a lengthy procedure; and inability to recognize their own reasoning inconsistencies. Students who use a formal reasoning pattern can reason with concepts, relationships, abstract properties and theories, and use symbols to express ideas. Given certain overall goals and resources, they can plan a lengthy procedure and they are critical of their own reasoning.

The series of problems should be reviewed with particular emphasis given to the written explanations requested at the end of each problem. The first problem illustrates the student's ability to use combinatorial logic--the ability to link a set of associations or correspondences with each other in many possible ways. The second problem explores the reasoning processes used to separate and control variables. Isolating variables is difficult for many beginning biology students and is critical to many introductory experiments. The third problem deals with proportional reasoning. Can the student recognize and interpret the relationship between relationships?

Objectives: 1) to stimulate thinking about problem solving;

2) to introduce methods of problem solving;

3) to assist the instructor in discriminating various thought patterns used by the students, i.e., concrete or formal reasoning.

A. The Fruit Problem

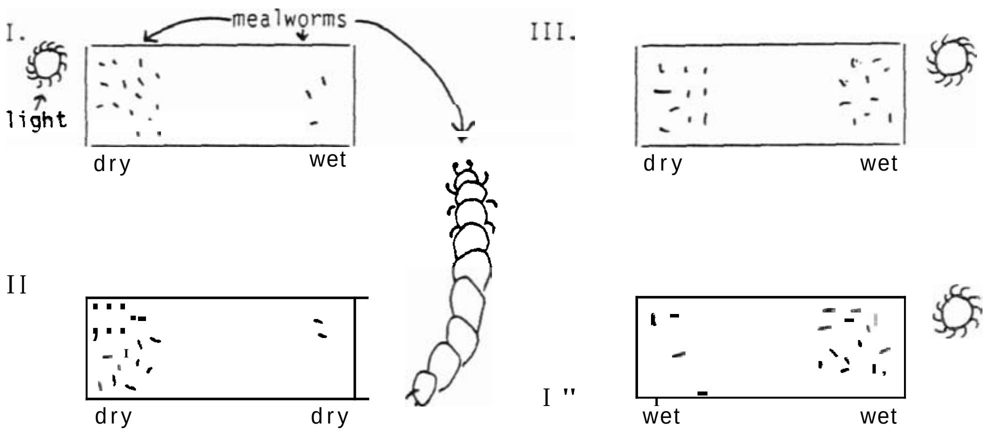
A small population of individuals isolated on a Pacific Island have a diet limited to the fruit of four different plant species. You as an investigator wish to study the effects of their diet on longevity. In preparation for this study, you'll want to compile a list of all the possible combinations of these fruits in their diet. Write down each possible combination of fruit. Use the letters to save space:

Eam = E Nassel = N Arro = A Volam = V

Looking back, how did you approach this problem: Did you think at once of a way to do it? Did you first think of a way that had to be modified?

B. The Mealworm Problem

An experimenter wanted to test the response of mealworms to light and moisture. To do this, he set up four boxes as shown in the diagram below. He used lamps for light sources and constantly watered pieces of paper in the boxes for moisture. In the center of each box he placed 20 mealworms. One day later he returned to count the number of mealworms that had crawled to the different ends of the boxes.



The diagrams show that mealworms respond to (response means move toward or away from):

a) light but not moisture

b) moisture but not light

c) both light and moisture

d) neither light nor moisture

Please explain your choice.

C. The Frog Problem*

Professor Ranidae, a herpetologist, conducted an experiment to determine the number of frogs that live in a pond near the field station. Because he could not catch all of the frogs, he caught as many as he could, put a white band around their rignt front legs, and put them back into the pond. A week later he returned to the pond and again caught as many frogs as he could. Here is the Professor's data:

First trip to the pond: 55 frogs caught and banded

Second trip to the pond: 72 frogs caught. Of those 72 frogs, 12 were banded.

Estimate the total number of frogs in the pond. Total = ____________________

The professor assumed that the banded frogs had mixed thoroughly with the unbanded frogs, and from his data he was able to approximate the number of frogs that inhabit the pond. If you can compute this number, please do so. In the space below, explain how you calculated your results.

* This problem can be made more interesting by using a population of 'pill' bugs housed in an aquarium containing sphagnum. Sample the population, mark the sample with nail polish, return them to the tank. Take the second sample a week later and estimate the population. However, the problem will no longer as clearly separate the concrete vs formal reasoners.

This Material is Part of the Unit: "METHODS OF SCIENCE"

Objectives: 1) to improve skills in critical reading;

2) to improve skills in evaluating evidence;

3) to create awareness of the difference between fact and inference;

4) to learn specific meaning of common words used in science.

Below is a statement of facts. Following that is a list of inferences supposed to have been drawn solely upon the basis of the facts given. Mark with the letter C the inferences that may be correctly drawn solely from the facts given; with the letter N those that are not proved solely by the facts given.

FACTS: A grain of corn and a marble were placed upon moist blotting paper in a glass dish in a warm (20°C) dark room. Another grain of corn and a marble were placed upon moist blotting paper in a glass dish in a warm (20°C) sunlighted room. Both grains germinated (the embryos grew). This experiment was repeated many times with the same results.

INFERENCES:

______ 1. Grains of corn will germinate on moist blotting paper.

______ 2. Corn grains will not germinate unless they are in glass dishes.

______ 3. Moist blotting paper is necessary for germination of grains of corn.

______ 4. Light is not necessary for the process of growth.

______ 5. The presence of a marble is necessary for germination of grains of corn.

______ 6. Moisture is necessary for germination of grains of corn.

______ 7. All seeds will germinate in both light and darkness.

______ 8. Glass dishes do not prevent germination of grains of corn.

______ 9. The presence of a marble is not necessary for germination of grains of corn.

______ 10. Light has no effect whatever upon growth of embryos of grains of corn.

______ 11. Light does not prevent germination of grains of corn.

______ 12. Glass dishes have no effect whatever on germination of grains of corn.

______ 13. Heat and moisture increase growth of embryos of grains of corn.

______ 14. Grains must have heat to germinate.

______ 15. Grains of corn germinate in either light or darkness.

______ 16. Grains of corn must be placed in moisture in a warm room to germinate.

______ 17. Light is not necessary for germination of grains of corn.

______ 18. A grain of corn placed on moist blotting paper in a wooden dish in a warm (20°C) dark room will germinate.

Laboratory Activity and Assignment:

Certain common words in science have specific meanings that are important in conveying ideas. Similar words tend to be confused with these by the novice. Learn the definitions and distinctions between the following "confusing word pairs". Write a sentence that illustrates the correct usage of the term.

A1. Accuracy - the degree of correctness of a measurement or a statement. Accuracy means closeness to the true or established value or truth. (a result)

A2. Precision - the degree of refinement with which a measurement is made or stated. Precision implies "repeatability" or "obtaining the same value over and over with repetition". (an action)

B1. Qualitative (an adjective) - relating to distinctions of type, not amount. Ex. A qualitative assay procedure would indicate what different types of compounds are present.

B2. Quantitative (an adjective) - relating to a measurable amount or quantity. A quantitative procedure is concerned with the measurement of phenomena, either amount of mass or number of items. Ex. A quantitative assay procedure would indicate how much of a particular substance is present.

C1. Error - the difference between a measured, observed, or calculated value and the real or true value. Errors are usually random and more difficult to detect or minimize than mistakes. (result, the distance from accuracy)

C2. Mistake - a mistabulation or miscalculation of figures. Mistakes can be corrected by checking each item and computation. (action)

D1. Analytical Technique - a technique designed in scope to determine the quantitative and/or qualitative aspects of a small sample, usually for assessment. Analytical techniques use samples of a larger amount to determine what is in that larger amount. ("taste test"!)

D2. Preparative Technique - a technique designed in scope to separate qualitative aspects of a mixture, usually for purposes of isolation or purification. Preparative techniques use as large a sample as permitted by the particular technique so as to recover as much of the separated material as possible. (wine making!; ultracentrifuge)

E1. Fact - A real event observable in past time that can be described without mental elaborations.

E2. Inference - a deduction or conclusion drawn from facts. Inferences tend to be more mentally predictive as to future events and situations and do not describe real events occurring in past time.

This Material is Part of the Unit: "SCIENTIFIC MEASUREMENTS"

The occupational metric problems are adapted from ideas in: Metric Measurement in Food Preparation and Service, Lynne Nannen Ross, Registered Dietitian, Iowa State University Press, 1978.

PROBLEM: Brownies are on the school lunch menu. The cook must prepare one brownie (5cm X 5cm) for each of the 200 children. The new British cook is familiar only with metrics.

1. Convert the recipe to metric.
2. Convert the baking temperature to Celsius degrees.
3. Determine the (minimum) capacity of the bowl needed for mixing the ingredients.
4. Determine the size of pan or pans needed for baking. (NOTE: The oven dimensions are 2 feet X 3 feet)
5. Brownies must be ready by 11:30 a.m.! TODAY!!!

Recipe for Brownies

25	ounces unsweetened chocolate	(______ g)
4½	cups shortening	(______ g)
12½	cups sugar	(______ g)
25	medium eggs	(1.6 kg)
9½	cups flour	(______ g)
6¼	tsp baking powder	(______ g)
6¼	tsp salt	(______ g)
6¼	tsp vanilla	(______ ml)
6½	cups broken nutmeats	(______ g)

Temperature: 350°F (_____ºC)

Time: Bake 30 minutes

Amount: 200 5cmX5cm squares

ANALYSIS OF THE PROBLEM:

1. The total volume of the brownie batter will be __________ liters.
2. That volume of batter will require a mixing bowl with a minimum capacity of __________ gallons.
3. How many servings are to be prepared__________
4. What size is each serving? _____cm X_____ cm.
5. How many square centimeters of brownies will be needed?________________
6. What size pan(s) will the oven accommodate? __________ cm^2
7. What pan or pans will accommodate the brownie batter and fit into the oven?

____

CONVERSION AIDS:

1 tsp = 5 ml 1 oz = 28g 1 cup = 250 ml(g) ºC = 5/9(ºF-32)

POSSIBLE SOLUTIONS:

1. Prepare brownies in 2 batches using a _____ liter bowl and bake in _____cm X_____cm pan.
2. Prepare brownies in a _____ liter mixing bowl and one _____ cm X _____ cm pan or two _____ cm X _____ cm pans.

PROBLEM: The mobile clinic serves several communities in southwest Missouri. You must try to spend a minimum of two hours at each of the 14 small town clinics each week. Is it possible to serve each of the 14 clinics two hours each week? If not, how many clinics can you visit in a forty-hour week? Your home and office are in Springfield.

ANALYSIS OF THE PROBLEM:

1. What is the speed limit in Missouri? 65 m/hr = ____ km/hr
2. What is the speed limit on winding roads? 45 m/hr = ____ km/hr
3. What is scale on maps? 1 cm = ____ km
4. How is distance converted to time? Determine kilometer distance and divide by kilometers/hour. Multiply the decimal part of an hour by 60 to find minutes.

POSSIBLE ITINERARIES:

1. MON: Springfield → Nixa → Highlandville → Spokane → Return to Springfield
   TUE: Springfield → Reeds Spring → Cape Fair → Cassville → Return to Springfield
   WED: Springfield → Purdy → Monett → Aurora → Return to Springfield
   THR: Springfield → Marionville → Crane → Elsey → Return to Springfield
   FRI: Springfield → Billings → Clever → Return to Springfield
2. MON: Springfield → Billings → Clever → Nixa → Highlandville → Return to Springfield
   TUE: Springfield → Spokane → Reeds Spring → Cape Fair → Cassville → stay
   WED: Cassville → Purdy → Monett → Aurora → Marionville → Springfield
   THR: Springfield → Crane → Elsey → Springfield

EVALUATION OF ITINERARIES:

Using a 15 centimeter ruler and the following information, determine:

1. the distance between towns
2. the time required to travel those distances
3. the cost of traveling each route

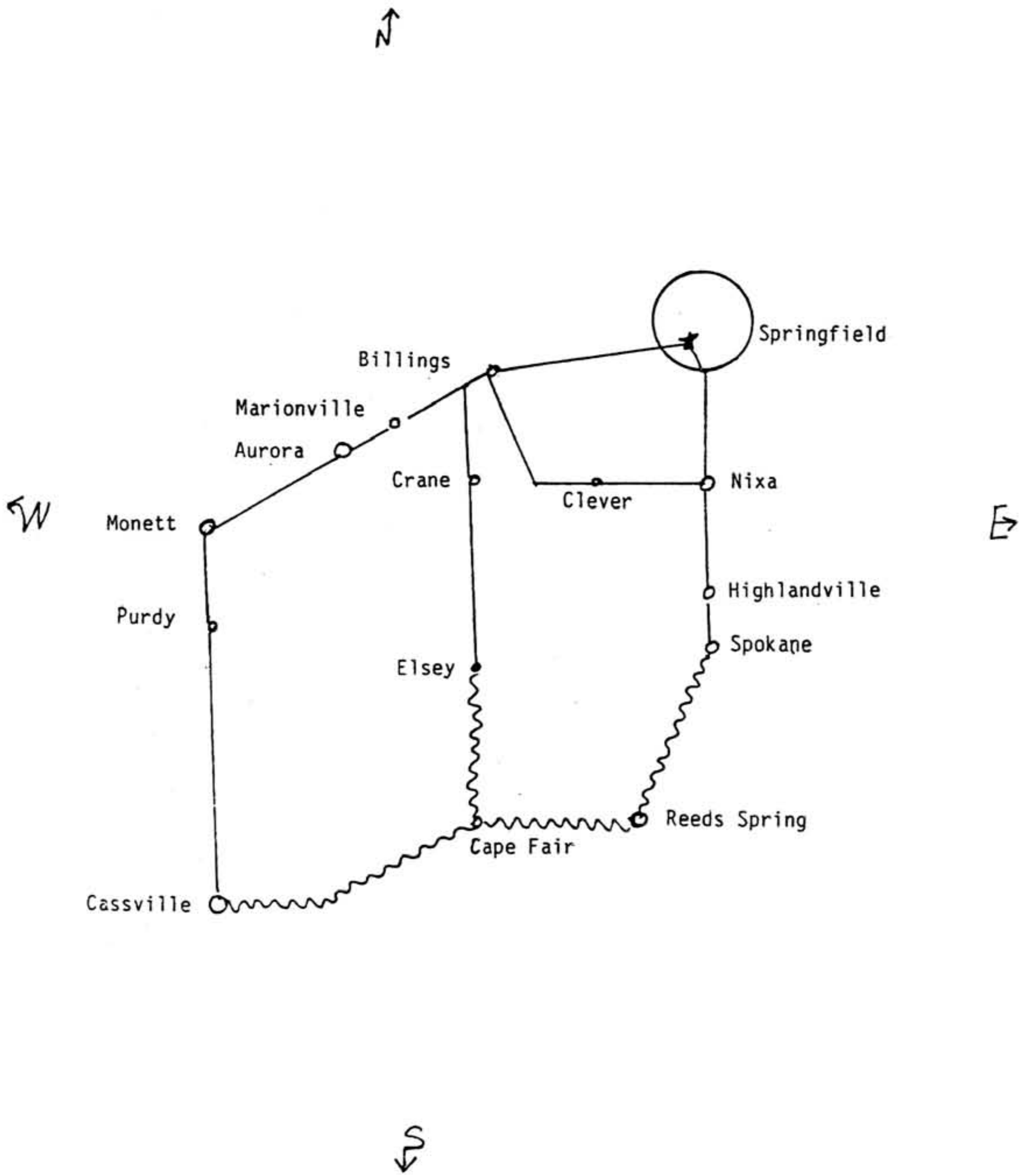
map:	1 cm = 6 km	car averages 40 miles/gallon
	1.6 km = 1 mile	gas averages 75 cents/gallon
		lodging averages 25 dollars/night

RECOMMENDATION: The most efficient route for time and money:

Route 1 _____ hours cost _____

Route 2 _____ hours cost _____

Other _____ hours cost _____


N
W
E
S
Springfield
Billings
Marionville
Aurora
Crane
Clever
Nixa
Monett
Purdy
Highlandville
Spokane
Elsey
Reeds Spring
Cape Fair
Cassville

THE METRIC SYSTEM REVIEW

1. Some things that won't change (much)! Replace the English term with the most appropriate metric term. Identify your calculations by number and letter on the bottom and back of the pages.

a. milestone ____________________
b. 10-gallon hat ____________________
c. foot-long hot dog ____________________
d. pound cake ____________________
e. inch worm ____________________
f. an ounce of prevention is worth a pound of cure ____________________
g. don't budge an inch ____________________
h. give him an inch, he'll take a mile ____________________
i. Denver is the Mile High City ____________________

2. a. What is the temperature for boiling eggs? ____________________ °C
b. What is normal body temperature? ____________________ °C
c. Comfortable room temperature is 76°F or ____________________ °C

3. What is the numerical value indicated by the following prefixes?

Example: micro = 0.000001; hecto = 100

a. kilo = ____________ b. deci= ____________ c. milli = ____________
d. centi = ____________ e. deka = ____________

4. Approximately (within reason!) how many?

a. liters in a gallon of gas ____________________
b. liters in a quart of milk ____________________
c. milliliters in a cup of coffee ____________________
d. grams in a quart of milk ____________________
e. kilograms in 5 pounds of flour ____________________
f. yards in a football field ____________________
g. kilometers in a football field ____________________
h. inches longer is a cigarette that has an extra millimeter ____________________
i. cubic centimeters in a 10-gallon hat ____________________
j. dollars to make "megabucks" ____________________

5. One mile equals 1.6 kilometers, so 65 miles per hour now reads _____ kilometers per hour.

This Material is Part of the Unit: "MICROSCOPE USE AND CARE"

Objectives:
1) to introduce the topic of microscopy;
2) to demonstrate how lenses work;
3) to increase the working vocabulary;
4) to promote the use of inquiry in investigation.

The microscope is an important optical tool that performs two functions in biological studies:

1) The microscope increases the ability to resolve details that cannot be observed because of the limits of our own biological optical sense organ, the eye. To resolve is the ability to separate and make visible the individual parts of an image i.e., the headlights of an approaching vehicle appear as one until they are within our ability to resolve them as two. The human eye resolves spaces between two real objects if they are more than .2 mm apart. If objects are closer together than this, our eyes see them as touching. We cannot resolve biological cells with our eyes alone as most cells are smaller than .2 mm and average 0.02 mm in diameter.

   The primary function of the compound microscope is to increase the resolving power (or resolution). The degree of resolving power is determined by the quality of the lens system and the light used. The practical limit of resolution of any optical system using white light is about 0.0001 mm or 0.1 µm (1 micrometer = 0.001 millimeter).

2) The second function of the microscope is to increase the apparent size or to magnify the object being resolved. Magnification produces an image that is large enough for us to resolve when cast upon the retina of our eye. Because our eyes cannot resolve objects below .2 mm, the microscope lens system must magnify objects so that their apparent size is at least as large as this.

   Magnification is achieved by refraction of light on curved lens surfaces. The phenomenon of refraction causes a bending of light as it moves from one curved transparent substance (glass lens surface) into another substance (air). The amount of magnification is determined by the arrangement and curvatures on the surfaces of the lens system of the microscope.

   The measure of magnification is determined by how many diameters the objects image appears to increase. For example, if the real diameter of an object observed under the microscope os 20 micrometers and its image appears to be 2.0 millimeters, it is said to be magnified 1000 diameters or 1000 times or 1000X. When using the compound microscope, the total magnification of an object is determined by multiplying the magnification value of the ocular lens by the magnification value of the objective lens.

   EXAMPLE: Ocular 10X times objective 45X = 450X (total magnification)

The relationship between the function of resolution and magnification is an important one. One can continue to magnify an object and reveal new detail and information only to a limit determined by the resolving power of the lens systems of the instrument. For example, recalling the resolution of the eye at .2 mm and the maximum resolution of the microscope at 0.1 micrometers, it is easy to calculate the maximum useful magnification of 1000X with a good optical system. it is possible to produce lenses that magnify greater than this but the images become "fuzzy" and no new information can be seen. Using magnification greater than the resolving power of the instrument can support results in "empty magnification". The lack of "crispness" in many photographs taken through a microscope occurs because of empty magnification.

Laboratory Activity: Investigations of a micro-scope ("little viewer")

This exercise does not require the microscope, so place it aside to make a work area. You will be given two sandwich packets containing a piece of plastic wrap. Do not touch the surface of the plastic wrap with your fingers or you may change its interaction with water in this investigation. Note that the bottom inside cover of the paper wrap has a series of letter "e's" that can be seen through the plastic wrap.

Lay the #1 sandwich on the desk top and fold back the top paper cover to the letters in the inside cover can be observed without disturbing the sandwich. Beginning with the second letter from the left, add a drop of water (using a droper pipet) to the plastic and look carefully at the letter "e" through the water drop. Compare the first dry letter to the second letter "e". Are there any differences?

Repeat the procedure placing two drops of water over the third letter "e" and four drops over the fourth letter. What differences to you observe? Do all the letters appear the same size?

Compare the size of the water "puddles" and the curvature of their surfaces by observing them from the top and from the side. Which letter appears to be magnified most? Which water puddle has the most depth, i.e., the greatest curve? What part of the microscope does the water represent?

Remember that light is refracted (bent) as it passes from one medium into another. When passing through a convex surface (rounded outwardly), the rays are bent inward. When the light rays pass through a concave surface (rounded inwardly) they are bent outward. The objective of the microscope collects light rays coming from the object being studied.

Are light rays coming from the letter "e" passing through a convex or concave surface? Using the above information, draw a lateral (side) view of the one-, two- and four-drop puddles that illustrates how refraction and magnification are related to the curvature of the water surface.

How could you increase the magnification (distance of drop from letter "e") of the letter "e" using these same materials? Use the second sandwich to experiment.

This Activity is an Excerpt from the Unit: "FUNDAMENTALS OF THE RESPIRATORY AND EXCRETORY SYSTEM"

Objectives:
1) to identify the organs of the excretory system and their relative positions within the human;
2) to identify structures and learn their functions within the kidney;
3) to demonstrate an understanding of the nephron by assembling one.

Activities:
1) Locate and identify organs of the excretory system on human torso model.
2) Using pork kidneys and kidney model, identify structures in the kidney.
3) Using prepared slides of kidney tissue, locate ultrastructures.
4) Using a collection of items given, assemble a nephron*

*ITEMS:
(2) 40 cm strands of 2 shades of red yarn knotted together at intervals
(1) Thistle cup
(1) 20 cm piece of glass tubing bent into U-shape
(1) 15 cm convoluted tube
(1) 25 cm convoluted tube

The assembled nephron should include the:

afferent arteriole	loop of Henle
flomerulus	distal convoluted tubule
Bowman's capsule	efferent arteriole
proximal convoluted tubule	peritubular capillaries

Suggest to the students that they assemble the filtration apparatus first, then place the vascular component.

These Activities are Excerpted from the Unit: "ANATOMY AND RESPONSES OF THE NERVOUS SYSTEM"

Objectives:
1) to understand the processes of simple versus choice reaction time;
2) to demonstrate the effect of learned reflexes on reaction time;
3) to demonstrate the effect of cold on reaction time;
4) to demonstrate left or right side dominance;
5) to demonstrate the importance of binocular vision for depth perception.
6) to investigate how fine a discrimination can be made in judging weights.

REACTION TIME:

Procedure: Student holds thumb and forefinger of his preferred hand about 1 cm apart while the experimenter suspends a new dollar bill vertically between them, with the center of the bill level with the thumb and finger. Student is to grasp the bill as soon as the experimenter releases it. (Most students are unable to do so.)

Now the student holds a meter stick between the thumb and index finger; then releases his grip and then as quickly as possible tries to grasp it again. The distance the stick travels before it is stopped is measured. Repeat several times. Average distance the stick falls is a measure of reaction time. Compare your results with several other students. Repeat the test after chilling your hands in ice water. What effect does this have on the results? Why?

Simple and Choice Reaction Times: To show the differences between simple and choice reaction time, line up 10 students, single file, with each person placing his right hand on the shoulder of the student in front of him. The first person raises his arm so that it can be seen by all. Students are told that each person will be tapped on the shoulder and that he is to respond as quickly as possible by dropping his arm. Instructor then taps the right shoulder of the last person in the line, starting a stop-watch at the same time, and stopping it when the last arm in line drops. Time ten trials. Average the results and compute the mean time taken for each person to respond. This is the simple reaction time. To measure choice reaction time, subjects place both hands on the shoulders of the person in front. This time subject is to respond by tapping the shoulder opposite the one which received the stimulus, but the location of the stimulus will be unknown in advance and will vary from trial to trial. Make ten trials and compare results with those obtained for simple reaction time.

Which reaction time is faster? What are the neural explanations for the differences in the two situations?

EYE DOMINANCE:

Procedure: Cut a 3.5 cm diameter hole in a large sheet of cardboard. Using both eyes, sight a distant object through the 2.5 cm hole while the cardboard is held at arm's length. Hold the cardboard with both hands and move it gradually toward the face, keeping the distant object sighted. Determine which eye is used. Repeat several times. Do you always use the same eye to keep the object in sight? Is your dominant eye on the same side as your dominant hand? The dominant food-chewing side of the mouth? Make a record of eye, hand, and side-of-mouth dominance for your laboratory group. Does a consistant pattern emerge? With family?

DEPTH PERCEPTION:

Procedure: Prop a large sheet of white cardboard (60 cm X 90 cm) about 5 meters in front of the class, and several feet from the front of the room. The top of the cardboard should be about 10 cm above eye level of students.

Trial #1: Hold a strip of black paper 1 cm wide and 30 cm long, 10 cm behind the large white cardboard, with 5 cm showing above the card. Students are now to judge the distance between the card and the black strip under four conditions:

1) looking with one eye, holding the head still;
2) looking with one eye, moving the head back and forth;
3) looking with both eyes, holding the head still; and
4) looking with both eyes while moving the head back and forth.

Trial #2: Repeat the above procedure with the strip 30 cm from the card.

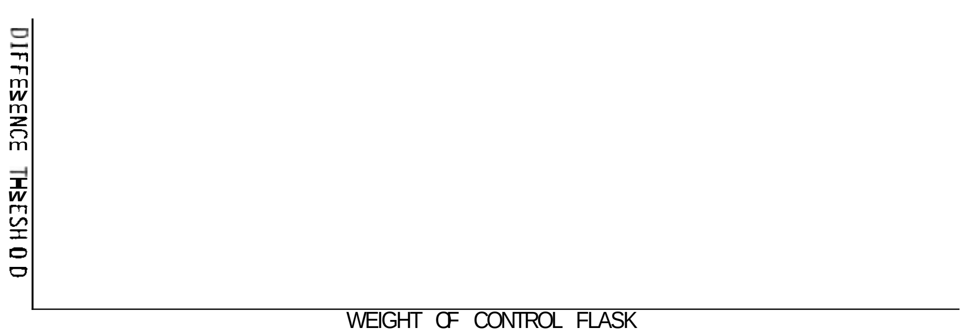
Trial #3: Repeat at 2.5 cm.

Now repeat Trials 1 through 3, but use a pencil instead of the black strip. Hold the pencil so that 5 cm shows above the card, use the same distances, but vary the order. Each student records his judgments (16 for black strip and 16 for the pencil trials). After the trials are completed, students are told the actual distances and asked to compute their errors. What is the average error for the entire class? Which conditions produced the poorest judgment? Which the best? Were there any differences between accuracies of judgment with the black strip and for the pencil? Why? (Discuss binocular vision)

JUDGING WEIGHTS:

Procedure: To determine the limit of man's ability to judge whether two objects are of different weight -- Student closes his eyes and holds two 125 ml Erlenmeyer flasks, one in each hand. One is marked Control and the other Test. Each containg 50 grams water. Student reports if he considers them to weigh the same. Then the experimenter adds water to the test flask in 5 ml portions, each time handing the flasks back to the student but randomly mixing the right and left and each time asking the student to determine relative weights. When the test flask feels heavier, record the weight of added water. The difference between the weight of the test and control flask weights is the "difference threshold" for 50 g. Repeat this procedure, starting with 100, 200 and 500 g of water (using larger flasks). Be sure that each pair of flasks are of equal weight.

How fine a discrimination can be made in judging weights? Does the difference threshold vary according to the initial weights used? Make a graph, plotting weight of control flask on the horizontal axis and difference threshold on the vertical axis. Do the results vary much from student to student? What are some variables that could affect the weight discrimination?



The instructional periods of genetics fundamentals are followed by discussion of human genetics and problems concurrent to them. This attitudinal survey is a tool that is used as an aid for introspection and to stimulate discussion of ethics and genetic technology.

ETHICS AND GENETIC TECHNOLOGY
AN ATTITUDINAL SURVEY

INSTRUCTIONS: The following statements concern ethical and moral decisions relative to genetic diseases. Circle A of you agree or agree more than disagree with the statement. Circle D if you disagree or disagree more than agree with the statement. Circle U **if** you have no tendency to either agree or disagree with the statement.

Please respond as honestly as you can.

Hemophilia is an inherited disease in which trauma produces excessive bleeding because there is a deficiency of one of the clotting factors. Death usually occurred in childhood until the recent institution of therapy consisting of frequent injections of highly con-centrated and purified clotting factor. Only males have this problem because the abnormal gene causing the deficiency is on the X chromosome. Before this new therapy was available, males usually died before they married and had children. Every daughter of a male with hemophilia will be a carrier of the gene and will pass it on to half her sons. The sons of hemophiliacs are not affected. The treatment of this disease currently costs $10,000 per year.

Below are listed some actions that might be taken with regard to reproduction and treatment of men with this disease:

1. Males with hemophilia should be sterilized so they won't pass on the gene.

   A D U

2. Since the sex of offspring can be determined by amniocentesis early in pregnancy, all female offspring of hemophiliacs should be aborted.

   A D U

3. Female offspring of males with hemophilia and all females known to be carriers of the gene for hemophilia should be sterilized.

   A D U

4. The sex of the fetuses of known female carriers of hemophilia should be identified by amniocentesis and all male infants should be aborder. (There is currently no reliable test for hemophilia in the fetus).

   A D U

5. Since treatment is available, no intervention in reproduction should be allowed.

   A D U

6. The parents should always decide what action should be taken in any case.

   A D U

7. Since the treatment for this disease is so expensive that the state will usually have to pay for it, society (State or Federal Government) or insurance companies should decide what action should be taken.

   A D U

With the new techniques in biochemistry, cell culture and chromosome analysis, it is often possible to detect inherited conditions soon after birth or in utero before 20 weeks of pregnancy. It may soon be possible to detect some inherited disorders that don't show up until early or even late adulthood.

Genetic screening tests have been used in some cases and might be used in others to detect these conditions. Please indicate in which of the following conditions or situations you feel genetic testing should be MANDATORY.

8. Screening tests for inherited disease should never be mandatory.

A D U

9. Screening tests for inherited disease should sometimes be mandatory depending on the situation.

A D U

10. If the screening test will detect an inherited metabolic disorder at birth affecting one in 15,000 newborns which if untreated may result in mental retardation, but which can be treated by a special diet. (Example: phenylketonuria)

A D U

11. If the screening test will detect an inherited blood disorder affecting one in every 500-600 U.S. Blacks for which there is no effective treatment but whose Symptoms (intermittent pain, recurrence of infections) physicians feel can be ameliorated and whose lives can be prolonged from 25 to 30 years to 30 to 40 years. It costs about $4,000 to $5,000 per year to treat. (Example: sickle cell anemia)

A D U

12. If the screening test will detect a complex inherited disease affecting one in every 2,500 whites, causing a debilitating disease of lungs and digestive tract. The usual life expectancy is for about 20 years. Doctors don't know whether or not life can be prolonged by medical therapy. Treatment costs about $4,000 to $5,000 per year. (Example: cyctic fibrosis)

A D U

13. If the screening test will detect a nervous disorder that affects the individual from age 30 onwards in which there is gradual loss of control of hands, feet, chewing, swallowing and finally brain function. Persons usually die in mental institutions. No treatment is available. Each child of these individuals has a 50-50 chance of inheriting this condition and they are usually born before the person knows they have the disease. (Example: Huntington's Disease)

A D U

14. If the screening test will detect sex chromosome abnormalities at birth which occur in about one in 500-600 infants (mostly in males) and these can be partially corrected by surgery and/or hormone treatment. (Example: XXY, Klinefelter's Syndrome, which in males produces slight breast development, small testes and sterility)

A D U

15. If the screening test involves amniocentesis (taking out fluid and cells from around the fetus) in women over 38 years and detection of severe chromosomal disorders that are associated with birth defects and mental retardation. These cannot be treated and if found, fetuses would be aborted.

A D U

16. If the screening test detects normal people who carry an inherited disease which has a 25% or 1 in 4 chance of being inherited by the children if two carriers marry. Fetuses with the disease can be detected in early pregnancy and aborted if the parents wish. There is no treatment for the disease which leads to mental deterioration and death by 3-4 years of age.

A D U

17. If the screening test detected at birth an abnormality of fats in the blood that markedly increases the chance of a heart attack in men (and, to a lesser extent, women) before age 50 and in which the effectiveness of a low fat diet, which would have to be followed throughout life, was unknown. (Example: type II Hyperlipoproteinenia)

A D U

18. If the screening test detects normal people who carry a gene for an inherited blood disease which cannot be detected in early pregnancy by amniocentesis and which cannot be treated. If two carriers marry, each of their children will have a 25% or 1 in 4 chance of inheriting this disease. (Example: sickle cell anemia)

A D U

19. Society should determine the type or kind of disease to be tested for in genetic screening.

A D **U**

20. Society (government, institutions) should determine who should be screened for genetic diseases.

A D U

21. Individuals should determine whether or not they wish to be screened.

A D U

22. Every effort should be made to eradicate genetic disease.

A D U

23. It is more important to control diseases that can be treated than to try to control hereditary diseases.

A D U

24. It is essential to pass on genetic information to relatives who might inherit or have children with the condition even if the person who has the disease objects strenuously.

A D **U**

25. Before marrying, it is very important to know whether or not they are carriers of or have a family history of an inherited disease.

A D U

In each case below, legitimate rights are in conflict. Indicate your agreement or disagreement in each case with which rights should predominate.

26. The freedom of the individual predominates over his or her responsibility to society.

A D U

27. The rights of the parents predominate over the rights of their children.

A D U

28. The rights of the parents predominate over the rights of the fetus

A D U

29. It is better to have no life at all if it is not of a reasonable quality.

A D **U**

30. The rights of parents are more important than their obligation to future generations.

A D U

31. The rights of persons with normal intelligence predominate over those who are mentally retarded.

A D U

Those individuals who are willing to consider abortion under certain circumstances should indicate whether they agree, disagree or are uncertain about choosing to abort a fetus who has an inherited condition that would result in the following situations if he or she is born.

32. The child will die at birth or within a few days, no matter what measures are taken. (Example: anencephaly, in which the brain hemispheres don't develop)

A D U

33. Development is normal for about six months after birth then there is retrogression of brain function and death by 3 years of age. (Example: Tey-Sach's disease)

A D U

34. After birth there is a life expectancy of 18 or more years with complicated and expensive medical treatment with a normal but restricted life. (Example: cystic fibrosis)

A D U

35. Life is normal until 35-40 years of age then Huntington's disease begins (a progressive loss of control of arms, legs, chewing, swallowing and brain function with bizarre movements. Death in a mental institution).

A D U

36. Life expectancy is relatively normal but there is severe mental retardation requiring guardianship at home or in an institution.

A D U

37. Life expectancy is normal but there is some retardation in which the individual can be trained and work in a sheltered workshop.

A D U

38. Life expectancy is normal with normal intelligence but the individual is markedly incapacitated. (Example: paraplegic without control of urine or bowels as in spina bifida - failure of normal closure of the spinal column).

A D U

39. Life expectancy and intelligence are normal but the fetus is a sex not wanted by the parents.

A D U

40. Life expectancy and intelligence are normal but fetus just not wanted by the parents.

A D U

41. The recurrence risk for an hereditary condition is the chance that it will occur a second time if it has occurred once. It is sometimes used to indicate the chance that a condition will occur at all. What is the maximum (highest recurrence risk that you would be willing to take for a serious genetic condition in one of your children? (Circle your choice)

100% 50% (1 in 2) 25% (1 in 4)

10% (1 in 10) 5% (1 in 20) 1% (1 in 100)

BMS 110: Biology From the Human Perspective
Laboratory Topics Listing

*Unit 1. Methods of Science
Unit 2. Scientific Measurements
Unit 3. Microscope Use and Care
Unit 4. Cell Observations
Unit 5. The Procaryotic Plan
Unit 6. The Eucaryotic Plan
Unit 7. Cell Reproduction
Unit 8. Membrane Properties
Unit **9.** Enzyme Activity
Unit 10. Gross Vertebrate Anatomy
Unit 11. Digestive Systems
Unit 12. Nutrition and Energy
Unit 13. Respiratory/Excretory
Unit 14. Metabolic Rates
Unit 15. Circulatory System
Unit 16. The Nervous System
Unit 17. Reproduction/Meiosis
Unit 18. Developmental Biology
Unit 19. Mendelian Genetics
Unit 20. Mendelian Genetics continued
Unit 21. Genetic analyses
Unit 22. Biodiversity
Unit 23. Principles of Ecology
Unit 24. Ecosystems and Energy Flow
Unit 25. "Extinction"

Appendix A. Tools and Instruments

* The following activities were taken from Units 1, 2, 3, 13, 16, 20

General Biology for Elementary Education

Laboratory Topics

1. Introduction: Plants and Animals in the Classroom
   Discussion of Semester's Activities
   Begin Library Survey and Resource Search
2. Animal "sets"/Missouri Animal Diversity,
   "Invent An Animal" (OBIS) **
   "What Animal Am I?" (Sharing Nature with Children)
3. "Sassafrass" Ozarks Ecology (Multimedia production) or
   Hillcrest Field Trip: Habitats, "Litter Critters" (OBIS)
4. Community Interaction, "Nothing Lives Alone", "Microtrails"
   (Acclimatizing)
   Film: "More Than Trees" (Missouri Conservation)
5. Introduction to Microscopy and Cytology
6. Survey Kingdoms Monera and Protista/Library Survey due
7. Plant "sets"/Plant Diversity/Begin Plant Projects
8. Plant Morphology, "Tree Walk", "Invent A Plant" (OBIS)
9. Plant Physiology, "Desert Water Keepers" (OBIS), "Gift of Life"
10. Plant Reproduction and Growth, "Grocery Bag Botany"
11. "Functioning Human": Reception and Motor Responses
12. Human Circulatory and Respiratory Systems/Plant Projects due
13. Human Digestive System/Nutrition/Film, "Snack Facts"
14. "Urogenital System/Heredity: <u>Why You Look Like You Whereas I Tend to Look Like Me"</u>
    (Charlotte Pomerantz)
15. Animal Life Cycles: Comparative Development
    <u>The Caterpillar and the Polliwoq</u> (Jack Kent)

Goals:

1. Develop a positive attitude toward biological science.
2. Learn content sufficiently well to be comfortable teaching biology concepts.
3. Learn biology activities to support those concepts and that may be used in the elementary classroom.

** OBIS (Outdoor Biology Instructional Strategies)

General biology for teachers in elementary education is designed with the conventional lecture-lab format. The three hours/week of lecture are traditional but the three-hour lab is eclectic.

There are three primary objectives for the lab: 1) to gain an understanding of the basic biological concepts; 2) to develop a file of resources available to teachers; and 3) to learn various activities useful in the elementary science classroom. Where possible, lab activities used to explore biological concepts are presented in a manner that can be adapted to the elementary classroom. No published manual meets these objectives, so each lab is designed to meet the particular need.

A variety of outside activities are assigned to broaden the scope of the lab experience. The library survey requires that each student select five biological concepts, locate two different resources that can be used to teach them, and prepare a reference card for each. This activity initiates familiarity with the curriculum center and an exposure to available literature. As part of the resource search, the students must obtain resource materials from five off-campus sources such as government publications, state departments, county extension, manufactureres, service agencies, etc. in an area of their interest.

Following discussion of scientific methods and measure, each pair of students is given a mini-experiment or investigation to complete. A scientific report and a brief oral presentation conclude that activity. Later, the students are given a container, soil, and packet containing three kinds of seeds to plant. They are asked to make observations and keep growth records. The project is complete when all three types of seed have germinated and at least one reaches fifteen centimeters in height. They are quite proud of this.

Pets in an elementary classroom are quite common and sometimes disastrous. To enable students to gain first-hand knowledge of pets, their life cycles, requirements, etc., there are aquaria of fish (native) and turtles, terraria of salamanders and lizards, and cages of gerbils and guinea pigs in the classroom. On occasion there are also snakes, tadpoles and insects. The students are each assigned a week to care for the animals and water plants.

One-time extra credit is available for designing and crafting a bulletin board illustrating a biological concept. Creation of an attractive and informative display requires an understanding of the concept.

Outdoor activities include identification of native trees on campus, fifteen spring (or fall) wildflowers and fifteen Missouri birds. A three-hour field trip to a local nature trail provides opportunity to study several plant communities -- cedar glade, creek area, oak hickory woods and prairie. This activity follows discussion of plant communities of the Ozarks area.

The activities selected from Acclimatizing, Sharing Nature with Children and Outdoor Biological Instructional Strategies usually require little time to complete. The effectiveness for some of them lies in their brevity. Others are easily adapted to various levels of difficulty as well as time span. Some, especially OBIS, may be combined to compliment an entire unit.

The lab is very eclectic depending upon the semester's students. Each planned activity (or most of them) may be completed during the semester. New ideas are explored and original themes modified. The schedule of topics is reversed from fall to spring to accommodate the seasons.

General Biology for Elementary Education

Address List for Resource Material

Below is a list of some governmental agencies and private industries who offer free materials on request. Many of these are appropriate for use in the elementary classroom. This list is given to you as a starting point and not at all intended to delineate the only resources available to you. As a courtesy, in making your requests, please be specific as to the topic and age level you are trying to reach.

American Bakers Association, 1700 Pennsylvania Avenue NW, Washington, DC 20006

American Dental Association, 211 East Chicago Avenue, Chicago, IL 60611
"Learning About Your Oral Health"

American School Food Service Association, 4101 East Iliff Avenue, Denver, CO 80222

The American Humane Association, List of Educational Materials, 5351 South Roslyn Street, Englewood, CO 80111

American Humane Education Society, Department BA, 350 South Huntington Avenue, Boston, MA 02130

American Institute of Baking, 400 East Ontario Street, Chicago, IL 60611

American Medical Association, Order Department, P. O. Box 821, Monroe, WI 53566
"Your Body and How It Works"

Animal Welfare Institute, P. O. Box 3650, Washington, DC 20007
"First Aid and Care of Small Animals"

Arby's, Inc., Consumer Affairs, One Piedmont Center, 3565 Piedmont Road NE, Atlanta, GA 30305 "Eating Right Is Easy"

Chevron Chemical Company, P. O. Box 3744, San Francisco, CA 94119
A Child's Garden by Lou Czufin

Consumer Information, Pueblo, CO 81009

Department of Health and Human Services, 5600 Fishers Lane, Rockville, MD 20857

Division of Health of Missouri, Broadway State Office Building, P. O. Box 570, Jefferson City, MO 65102 "A Boy Grows Up" and "A Girl Grows Up"

The Garden Club of America, 598 Madison Avenue, New York, NY 10022
"The World Around You - An Environmental Packet"

Kellogg Company, Public Affairs Department, Battle Creek, MI 49016

Eli Lilly & Company, Public Relations Department, 307 East McCarty Street, Indianapolis, IN 46285 "Kidney in Action/The Fact of Life," "Children's Zoo/Biology at the Molecular Level"

Oscar Mayer & Company, Consumer Affairs, P. O. Box 7188, Madison, WI 53707

McDonald's Action Packs, Box 2594, Chicago, IL 60690 (Information for Action Packs)

Missouri Department of Conservation, P. O. Box 180, Jefferson City, MO 65132

Missouri Department of Natural Resources, Box 176, Jefferson City, MO 65101
"Environmental Education Resources"

National Audubon Society, Education Division, 950 Third Avenue, New York, NY 10022

National Bureau of Standards, Metric Information, Washington, DC 20234

National Foundation/March of Dimes, Box 2000, White Plains, NY 10602
"Genetic Counseling"

National Peanut Council, 1000 16th Street NW, Suite 506, Washington, DC 20036
"Peanut Portfolio"

National Wildlife Federation, 1412 - 16th Street NW, Washington, DC 20036
Environmental Discovery Units, Conservation Education Catalog

Population Reference Bureau, Inc., 777 - 14th Street NW, Suite 800, Washington, DC 20005

Purina Cat Care Center, Checkerboard Square, St. Louis, MO 63188
"Handbook of Cat Care"

Soil Conservancy Society of America, 7515 NE Ankeny Road, Ankeny, IA 50021

Sergeant's, P. 0. Box 25595, Richmond, VA 23260

U. S. Department of Agriculture, Box 385, Vandalia, OH 45377
"Great American Farm"

U. S. Department of Agriculture, Forest Service, P. 0. Box 2417, Washington, DC 20013

U. S. Department of Agriculture, Publications, Office of Information, Washington, DC 20250

U. S. Department of Commerce, National Oceanic & Atmospheric Administration, Rockville, MD 20852 "Fish: Wet & Wild, Teachers Guide K-6"

U. S. Department of Health and Human Services, Bureau of Health Education, HHS Publication No. (CDC) 80-8359 and 80-8382, Atlanta, GA 30333
"School Health Cirriculum Project"

U. S. Government Printing Office, Superintendent of Documents, Washington, DC 20402
Marine Mammals of the Western Hemisphere (poster) #003-00106-8
"Soozie" #027-004-00024-5; Also, "Fun With The Environment (EPA)"

University of Missouri Extension Service, University of Missouri, 1408 1-70 Drive SW, Columbia MO 65203

Wildlife Management Institute, 1000 Vermont Avenue, Suite 709 Wire Building, Washington, DC 20005

Xerox Education Publications, 1250 Fairwood Avenue, Columbus, OH 43206
Information for Science Unit Books
"What Insect is That?"
"The Body Machine - Parts & Functions"
"Ecology: Man Explores Life"

RESOURCE MATERIALS: Bonus 25 points

- must be biological in nature
- five different cources
- must have information card with: 1) topic; 2) name of publication; 3) source of publication; 4) cost, if any; 5) grade level; 6) classroom use.
- Please use only one resource per agency, recently published material (last five years), and no commercial magazines, texts or old lesson plans.

LIBRARY SURVEY

The intention of this project is to make you aware of the variety and quantity of resource material that is available to you. It may also impress you with the amount and depth of content to be taught in the elementary classroom.

Select five biological concepts. Locate two different resources which teach each of the concepts. These resources may be elementary science and health texts, OBIS activities, or periodicals such as "Science and Children". Make a file card (5x7 preferably) for each of the ten resources.

First, state the concept. (A scientific concept is a concise statement of a single principle, fact, or idea.) Then, make a complete bibliographic entry which includes author, title, publisher, date of publication, and page number. State the grade level and briefly summarize the activity. The activity should not exceed one hour of class time.

To the best of your ability, evaluate the resource. Be brief. Consider the following questions:

* Was **it** appropriate for the grade level?
* Was the student actively involved?
* Was the equipment easy to collect? available? simple to use?
* Were the directions clear?
* How well did the activity teach the concept?
* Would you consider using this resource? Why or why not?

GENERAL BIOLOGY FOR ELEMENTARY EDUCATION

"Mini" Investigations

REMOVAL OF SEED EMBRYOS

MATERIALS: 12 bean seeds, 4 pots with soil, plastic wrap, paper toweling, petri dish, scalpel.

DIRECTIONS:
a) Place 12 bean seeds on wet paper towels in petri dish. Cover with plastic wrap.
   1) When seed coats split and beans appear swollen (2-3 days), carefully open a seed and look at the parts.
      Examine with a magnifying lens. Draw what you see.
   2) Carefully dissect the plant embryo from 3 seeds.
      Carefully dissect the root embryo from 3 seeds.
      Carefully dissect the shoot embryo from 3 seeds.
b) Plant 3 bean seeds in each pot.
   Provide a good growing environment for the seeds.
   Observe for one week.

QUESTIONS: Identify the parts in the seed by using the text. Do all 4 sets show growth? Dig up the seeds. What part of the seed shows growth? Would seeds die if cotyledons are removed? Why or why not? What is necessary for a healthy seed?

A PICKLE TREE!

MATERIALS:

1 cucumber	200 ml vinegar
15 ml salt	15 ml pickling spices
150 ml sugar	2 500-1111 jars

DIRECTIONS: Wash the cucumber. Cut slices about 2 ml thick. Put ½ of them in each jar.

Mix together the sugar, vinegar, salt, and pickling spices and put them in ONE jar with the cucumber. Mix it well. Put the lid on it.

Put an equal volume of water into the second jar, mix well. Put the lid on it.

Put both jars into the refrigerator for one week before tasting!

QUESTIONS: Describe the texture of the cucumbers in each jar. What physical changes occurred? What conditions are the same for both jars? What conditions are different? Is there a control for this investigation? What can be said about cell membranes in cucumbers (the permeability). By what plant process does pickling take place? Why should uncanned pickles be stored in the refrigerator? Why will there never be a pickle tree?

THE EFFECTS OF GRAVITY ON PLANT GROWTH

MATERIALS: 10 bean seeds, 2 small wide mouth jars, paper toweling.

DIRECTIONS: Soak the seeds overnight.

Line the insides of both jars with a piece of wet paper towel, folded to **fit.** Fill the middle of each jar with crumpled towel, enough to hold the outside layer in place.

Saturate the paper with water, pouring off the excess.

Push 5 seeds between the glass and the towel (outside layer) about 3 cm from the top of each jar.

Put the lid on each jar until the seeds sprout, then leave them open.

Set ONE jar on its side and maintain this position throughout the experiment.

Set the other jar upright and maintain that position throughout the experiment.

Put both jars in moderate sunlight and BE SURE TO KEEP THE PAPER MOIST during the experiment. Check the jars each day to collect data.

QUESTIONS: Is there a control for this experiment? If so, what? What is the variable for the experiment? **If** these jars were in a space capsule, describe the plant growth. Could the light source be a possible cause for this growth pattern? How could this be eliminated?

WHAT WILL THEY WEIGH?

MATERIALS: About 450 grams of green leaves with stems and big leaf-ribs removed. Cookie sheet and oven for drying leaves; large inexpensive piece of paper on which to chart the experiment for the class. Small note-size piece of paper for the class. Scales for weighing.

DIRECTIONS: Collect and weigh the leaves. With a colored marker, chart the weight (in grams) on the bulletin board graph. Pass out note-size paper to each pupil. Ask the pupils to estimate the gram weight of the leaves when all the water has been removed. Collect the estimates and place them in a box or drawer. Explain to pupils that at the end of the experiment you will determine whose estimate came closest to the actual dry weight.

Dry the leaves in a warm (66°C) oven. After two hours, weigh the leaves again. Chart the weight loss on the bulletin board. Announce the winner of the "Winning Weight Award".

INFORMATION: Most plants require an amazing amount of water! People who study plant life say that for every pound of dry matter the plant produces, **it** requires 500 to 1,000 pounds of water. The plant does not retain all the water, because most of it is returned to the air as the plant respires. Just as animals return vapor to the air when they breathe, so do plants. Instead of a nose or mouth, plant leaves have tiny openings called "stomata" through which they respire.

AREA OF ROOT GROWTH

MATERIALS: Petri dish, paper towel, 3 bean and 3 corn seeds, permanent ink, thread, cm ruler.

DIRECTIONS: Soak the seeds for 24 hours.
Cut 2 layers of paper towel to **fit** the petri dish, wet it and put it into the dish. Place the soaked seeds on the paper, cover them with another layer of damp towel, replace the lid, and set the dish aside to germinate.
Check the plate in 2 to 3 days to see that the seeds are still moist and if germination has occurred.
When the roots of the seeds are about 2 cm, measure and mark them at 2 mm intervals. Use the cm ruler, and dip the thread into the ink to make the mark. Put the seeds back into the dish, cover them with a damp towel, and observe them for another four days.

QUESTIONS: Where have the roots grown the most? How do you know this! How are the corn and beans alike in the way that they grow? What kind of plant tissue must be concentrated here?

HOW DOES WATER GET INTO A PLANT?

MATERIALS: Radish seeds, wet paper towel, petri dish, a magnifier.

DIRECTIONS: Cut the paper towel to fit the dish.
Put two layers of wet towel on the bottom of the dish.
Arrange about 15 seeds on the wet towel.
Cover the seeds with another damp paper towel.
Place the cover on the plate and set aside at room temperature and light.
Observe for several days, recording your observations.
Use a dissecting microscope whenever possible, (or a hand lens).

QUESTIONS: What do you notice about the roots? What are the small fuzzy projections from each root called? What is the function of these structures? What happens to the roots of a plant when it is transplanted? What will happen **if** these structures are removed from the root? How far from the root tip do these structures extend?

EFFECT OF LIGHT ON GERMINATION OF SEEDS

MATERIALS: Bean seeds, two pots with garden soil.

DIRECTIONS: Soak the seeds overnight.
Plant three seeds in each pot of soil, add 125 ml water to each pot.
Place one pot in lighted area.
Place the other pot in a dark place away from light.
Keep both pots at room temperature, water 50 ml every other day.

QUESTIONS: What things are the same for each pot? What is different? Do you have a control? If so, what is it? If not, why not? What concept does this experiment illustrate? Why do we wait for spring to plant seeds? Could seeds germinate in a cave? What is germination?

DIRECTION OF ROOT GROWTH

MATERIALS: Corn seeds, damp paper towel, petri dish, cotton, masking tape.

DIRECTIONS: Soak the seeds overnight.
Place four corn seeds in a petri dish with each seed pointing toward the center.
Cover the corn with a damp paper towel cut to **fit;** cover the towel with damp cotton until seeds are held securely in place.
Tape the lid on dish and set dish on edge. Fix securely in position so that there is no rotation during the experiment.
Observe the growth.

QUESTIONS: What physical response is at work in this experiment? How do you account for any unexpected results in this experiment? If the dish was rotated on its edge, describe the position of the roots.

DO PLANTS GIVE OFF WATER?

MATERIALS: Two potted coleus plants, 2 quart jars, plastic bag or plastic wrap.

DIRECTIONS: Add 125 ml water to the soil in the pots.
Wrap the plastic around the entire pot, tying securely around the plant stem. Remove all leaves from one plant.
Invert the glass jars over the plants.
Place in the sun or under grow light in the lab.
Observe.

QUESTIONS: Why were the pots covered with plastic? Does the water get out of the plant? What is the evidence for this? What tissue is involved in water transport? **If** water leaves the plant, how does it? Why remove the leaves from one plant?

BEHOLD THE MOLD!

MATERIALS: Homemade wheat bread, commercially baked wheat bread, wet paper towel, 3 petri dishes.

DIRECTIONS: Place 1 layer of wet paper towel in the bottom of each of the three petri dishes.
Place a 5 cm square of homemade bread in 1 dish, and a 5 cm square of the commercially baked bread in the second dish.
Leave the third dish with just the wet paper towel
Put the lids on the dishes and set aside at room temperature and normal light for approximately three days.

QUESTIONS: What things are the same for all three petri dishes? What is different? What is the purpose for the third dish? In which dish did mold grow? In which dish did the mold show first? the most? Why put wet paper towel in each dish? Where could the mold have come from? From this experiment, what inferences can be made about the effect of light on mold growth? the effect of temperature? the effect of moisture? the effect of time? the effect of the nutrients for mold growth?

SEEDS 'N SOIL

MATERIALS: 20 radish seeds, 4 containers each of gravel, sponge, sand and potting soil.

DIRECTIONS: Soak the seeds overnight.
Fill each container 2/3 full of potting material.
Plant **5** seeds into each pot.
Add 100 ml of water and set aside in **a** warm (not hot) sunny place.
Water as needed, being sure that each one gets the same amount.

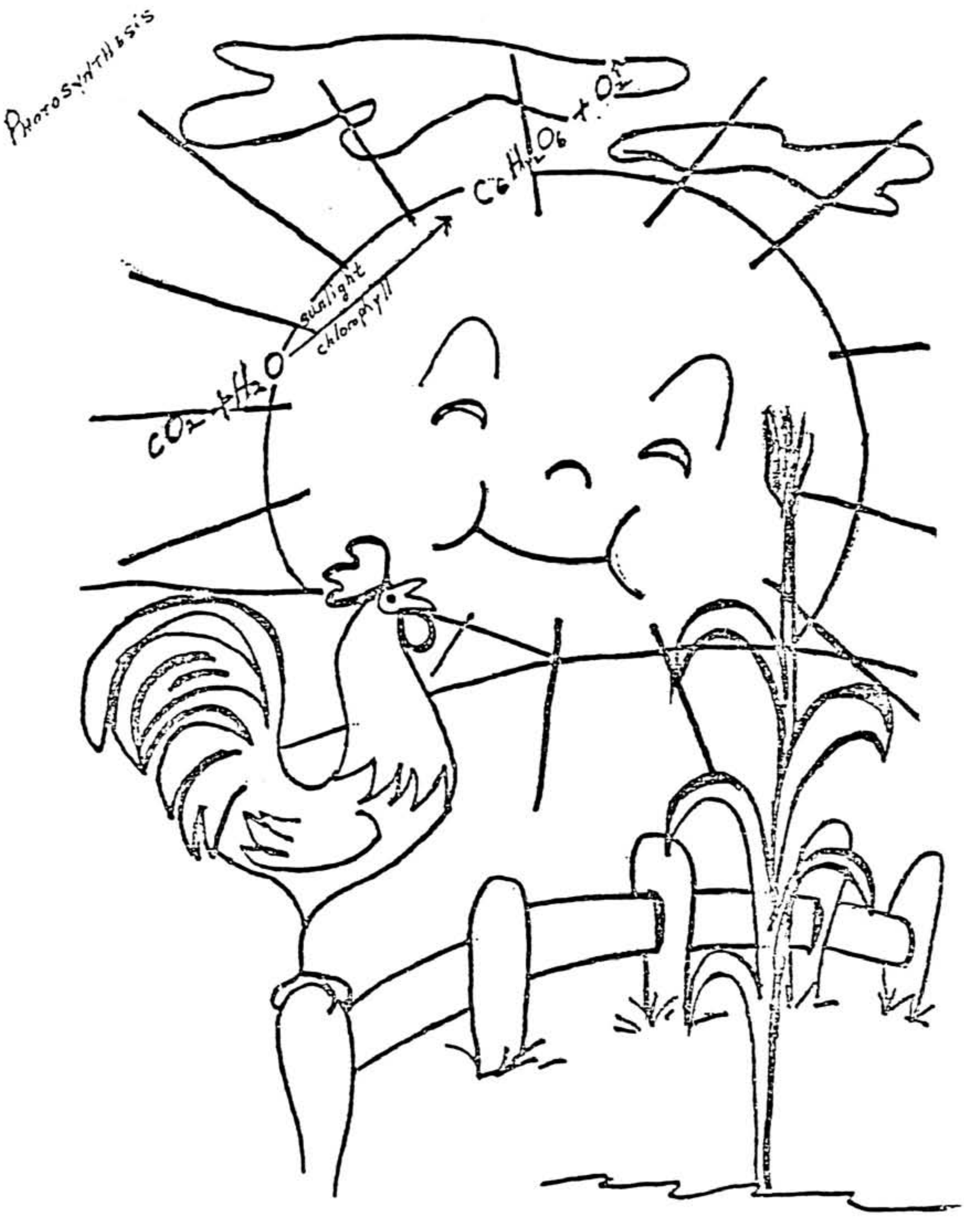
QUESTIONS: In which pot did the seeds sprout first? second? etc. Did all of the seeds in each pot sprout? Did all the seeds grow at the same rate? What is the same for all 4 pots? What is different? Why plant five seeds instead of one? Are all of the seeds the same? How do you know? From this experiment, what can be inferred about the effect of water on radish growth? the temperature? the amount of light? about the potting material.

EFFECT OF HEAT ON GERMINATION OF SEEDS

MATERIALS: Bean seeds; 3 flower pots with soil.

DIRECTIONS: Soak the seeds overnight.
Plant 3 seeds in each of the pots of soil, add 125 ml water.
Place one pot in a refrigerator (record the temperature).
Place second pot in warm or hot spot (record the temperature).
Keep the third pot at moderate room temperature (not in sun).
Water each of the pots daily (the same amount of water for each one).

QUESTIONS: What is the known variable? constants? control? What concept does this experiment illustrate? why soak the seeds overnight? Why plant more than one seed in each pot?


PHOTOSYNTHESIS
CO2 + H2O
sunlight
chlorophyll
C6H12O6 + O2

PLANT PHYSIOLOGY

There are many chemical reactions necessary to maintain life within the plant cell. The term metabolism has been used to describe the sum total of all these diverse chemical changes. As in other living cells, some chemical reactions are constructive and are termed anabolic. Some of these are photocynthesis and assimilation of nutrients for growth and repair. Destructive processes essential to survival are respiration and digestion. These are called catabolic reactions.

Respiration

Plant cells use energy to aid in building and maintaining protoplasmic structures and cell walls. Within each cell, energy is obtained by a slow and very controlled process of "burning". This oxidation reaction is called respiration. It combines oxygen with glucose and produces carbon dioxide, water, molecules of chemical energy (ATP) and heat energy. The process is represented by the following equation:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy (ATP \& heat)}$$

Animal cells have the same basic cellular respiration. Their method of obtaining oxygen may often be different. The lower animals get oxygen by simple diffusion of gases from their environment across a moist membrane and into their system. Higher animals have a mechanical means of obtaining oxygen; that is, by breathing.

Lenticels in stems and stomata in the leaves are openings which allow for the exchange of gas in plants. There are two guard cells which border and regulate the opening and closing of each stoma. When the crescent shaped cells are turgid, the stoma is open. When the cells are flaccid, the opening is closed.

Heat energy produced by cellular respiration is considered to be wasted energy. However, it can be very important commercially. **If** the heat is confined in an enclosed area, it can: a) aid growth of bacteria and fungus, b) raise temperature to above the death point and kill the seeds or plants, or c) cause spontaneous combustion, i.e., fires in hay barn!

Two demonstrations illustrate evidence of respiration. The simple rise in temperature within the vacuum containing living seeds indicates active respiration. What is the purpose of the other two containers? What will be the limiting factor in the thermos of living seeds.

Another product of cellular respiration is carbon dioxide. Carbon dioxide in phenol red solution forms carbonic acid which changes the pH and turns the solution color from red to yellow. When the air from a closed bottle of germinating seeds is forced through the phenol red, a color change occurs. Air from a closed bottle of "killed" germinating seeds forced through phenol red solution remains red in color indicates no carbon dioxide present. How can you demonstrate the reaction of pehnol red to carbon dioxide?

Photosynthesis

Green plants have the ability to manufacture food from raw materials found in their environment. This process is called photosynthesis. It is the manufacture of sugar from carbon dioxide and water in the presence of chlorophyll and sunlight. A sobering thought is that the life of plants, animals and all of mankind depends on this activity. It is the most important chemical process known to man. The equation for this reaction is:

$$6CO^2 + 6H_2O = \text{radiant energy} \xrightarrow{\text{chlorophyll}} C6H_{12}O_6 + 6O_2 \uparrow$$

Photosynthesis proceeds in two series of reactions. In the "light" reaction, specific wavelengths of light energy are captured by chlorophyll and stored in chemical bonds of ATP and NADPH. Second, in the "dark" reaction, the energy in ATP and the reducing agent NADPH, is used to convert the carbon dioxide and water into organic molecules. In turn, those sugar molecules can be converted into cellulose molecules, other kinds of building materials, or hooked together and stored as starch.

A simple demonstration using a healthy variegated Coleus leaf can illustrate photosynthesis activity by locating areas containing chlorophyll and where starch has been formed.

EVIDENCE OF PHOTOSYNTHESIS IN A COLEUS LEAF

1. Remove the leaf from the plant. Remove the black circle of paper from the leaf. Draw a picture of the leaf, noting the various areas of color. Turn the hot plate to medium heat.
2. Put the leaf into a 250 ml beaker containing about 100 ml water. Let it boil 4 or 5 minutes. Using tongs or forceps, remove the leaf and lay it flat in a petri dish. Draw a picture of the leaf. Why is the leaf limp? Have the areas of color changed? Why? What colors are still in the leaf?
3. Put the leaf into a 250 ml beaker containing about 75 ml of alcohol. Boil for 3 or 4 minutes. Using forceps, remove the leaf and lay it flat in a petri dish. Turn OFF the hot plate. Draw a picture of the leaf. What color is present now? Is chlorophyll water soluble? Can chlorophyll be in plant cells and not be visible?
4. Iodine has a brown color. When it is put on a starch, it turns a dark blue-black color. Therefore, it can be used as a reagent to detect the presence of starch. Using iodine from the dropper bottle, cover the leaf with iodine. Let it stand a couple of minutes, then examine the leaf for color again. Draw the leaf. Where is it darkest? What does that indicate? Was chlorophyll located uniformly in the leaf? What purpose was served by the black circle covering an area of the leaf? Does this experiment have a control? <u>Be sure to clean up the area after the experiment!</u>

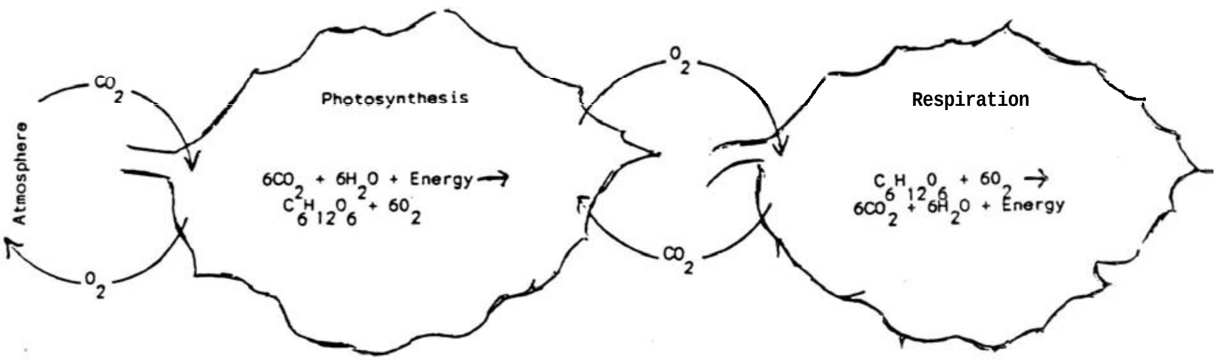


Diagram showing gas exchanges due to photosynthesis and respiration in a green leaf in the light. Carbon dioxide is used five to ten times as fast as it is produced.

Photosynthesis and Respiration Compared. The facts on photosynthesis and respiration can be presented in tabular form to contrast these two processes:

Photosynthesis	Respiration
1. Occurs only in the green cells of plants	1. Occurs in every active, living cell of both plants and animals
2. Takes place only in the presence of light	2. Takes place during the life of the cell both in the light and the dark
3. Uses water and carbon dioxide	3. Uses food and oxygen
4. Releases oxygen	4. Releases water and carbon dioxide
5. Solar (radiant) energy is converted into chemical energy	5. Chemical energy is converted into heat and useful (ATP) energy
6. Results in an increase in weight	6. Results in a decrease in weight
7. Food is produced	7. Food is broken down

Review:

Handouts from previous lab
Slide survey of Animalia Kingdoms.

Game*: "What Animal Am I?"

Pin a picture or name of an animal onto the back of one of the persons in the group. Don't show him the picture. He then asks questions to discover his own identity. The other persons can answer only yes, no or maybe.

Because we are studying properties of animals, when asking for information, use the terminology appropriate for classification.

Example:		
	Do I have radial symmetry?	yes
	Do I have an external skeleton?	no
	Am I warm blooded?	no
	Am I an Echinoderm? (a starfish)	yes

Topic: Animal Adaptations

Adaptation - any change or modification of the organism which aids in its survival and reproduction. Adaptations may enable the animal to survive short periods of stress such as hibernating in the winter and estivating in the summer. Or, anatomical and physiological modifications may result in the animal being better suited for survival on a daily basis. The owl with the keenest vision will catch the most mice and in so doing better his chances to live, reproduce and add his genes for keen vision to the next generation.

Because the environment is continually changing, adaptation is a dynamic process. Those organisms which survive and reproduce add the most beneficial hereditary material to the gene pool, i.e., "Survival of the fittest." (or, survival of the best adapted.)

Today we will study some adaptations and design a few of our own.

Demonstration materials: How are these special? (Bird heads and feet from Ornithology lab)

** Activity: Using materials provided, create predator devices that can catch and pick up prey.

What do you think?

1. Why are there so many different kinds of predator devices?
2. What would happen if every animal had the same predator device?
3. What adaptations do prey have to avoid being eaten by predators?
4. What would happen if the "unfit" were nurtured to survive and reproduce?

* Cornell, Joseph. Sharing Nature With Children
** Adaptation-Predator-Prey, OBIS I

GROCERY BAG BOTANY

Grocery Bag Botany is exerpt from the plant reproduction lab which follows a brief study of plant morphology. It is a fun way to conclude the botany section of labs. It can also be challenging.

When used in second and third grade science, we first discuss whether the produce is fruit or vegetable in common use, then determine whether the items are fruit or vegetable in the botanical sense. We review the organs of plants and their primary functions. The students then determine which plant organ is represented by each item. (Keep everything inside a large paper grocery bag and present one item at a time.)

Select a mixture of common and exotic items (more of the common for the elementary grades and more of the exotic for the college students): leaf lettuce and spinach (leaves); artichoke, onions, garlic (fleshy leaves); brussel sprouts, cabbage (leaf buds); beets, carrots, sweet potatoes (roots); celery, rhubarb (petioles); cauliflower, broccoli (flowers); strawberry, tomato, cucumber (seeds and ovary); corn on cob, shelled peas, walnuts, coconut (seeds); irish potato, asparagus (stems); green pepper, apple, orange, squash (ovary). Peanuts in the hull are interesting be- cause of their underground development. Be sure to include a mushroom--it creates discussion (and an egg for laughs).

Most college students seem to enjoy this exercise as an informal quiz. However, questions may be more specific. This activity may be as involved or as brief as you want to make it.

Brown Paper People

This short activity is used to introduce the series of labs reviewing human systems. The first system of study is the skeletal. The only materials required initially are 6'x3' lengths of brown paper, pencils with erasers, and felt marking pens or crayons. A large picture of a skeleton or actual skeleton is needed to complete the activity. The disarticulated skeletons are optional. At SMSU these are borrowed from Anatomy lab.

Working in groups of two or three, one student must lie down on the paper (dorsal down), in anatomical position. Using marking pens, the other student(s) carefully draw(s) his outline. The prone student gets up and the two or three of them procede to sketch in the skeleton as they perceive it to be. Their only resource being recall and palpating their own skeleton where possible. Be sure to have them sign their drawings. (Allow about 15 minutes.)

As the students are finishing their drawings, set out two or three boxes of disarticulated skeletons. Select two or three drawings and have the students (now in larger groups) attempt to assemble the bones in correct fashion within the human outline. (Allow about 10 minutes.)

Uncover the articulated skeleton and as a class discuss which bone goes where and why. Each group shows their work or if room permits I hang them on the walls.

After lab, the paper people are rolled up and saved for another system. Cutouts of organs of the digestive, respiratory, reproductive and urinary system can be placed using glue sticks. On the reverse side another outline is made and the circulatory system drawn in using red and blue crayons or markers.

While this is a very elementary activity, it serves several purposes. There is active student involvement first as small groups, then larger groups, and ultimately as a class effort. Lying on the floor in one's stocking feet while your classmates draw around you tends to soften defensive/"stand offish" attitudes. Pooling efforts of recall and creativity in making that brown paper person assume a personality make a shared experience. Finally, displaying all the originality of forms makes the students aware of their need to learn about the human system(s).