DOCUMENT RESUME

ED 229 624 CE 035 985

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TITLE Ground to Grits. Scientific Concepts in Nutrition/Agriculture.
INSTITUTION South Carolina State Dept. of Education, Columbia. Office of General Education.
SPONS AGENCY Department of Agriculture, Washington, D.C.
PUB DATE 82
NOTE 232p.; Not available in paper copy due to colored paper.
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Agricultural Education; *Food; *Foods Instruction; Futures (of Society); Instructional Materials; Learning Activities; *Nutrition; *Scientific Concepts; Secondary Education; State Curriculum Guides; *Vocational Education; Water
IDENTIFIERS Carbohydrates; Digestive System; Fats; Food Additives; Food Production; Minerals; Protein; *South Carolina

ABSTRACT

This curriculum guide presents an activity-oriented program designed to give students experiences that will help them understand concepts concerning the relationship between science, agriculture, and nutritional needs. Covered in the six units of the guide are reasons for eating certain foods (taste and smell); the nature of food (the concept of altering raw materials to make a variety of products); differences among foods (chemical differences among carbohydrates, fats, protein, vitamins, minerals, additives, and water); reasons why the body needs different foods (the need for a variety of nutrients, digestion, and metabolism); the ultimate sources of food (sun, soil, and climate or atmosphere); and foods of the future (increasing the food supply and developing new foods). Each unit is subdivided into concepts that are outlined by giving them in behavioral terms. Also included in each unit are a lesson plan containing strategies for implementing the unit, an outline of the purposes of each activity provided, and activities designed for student use. Each activity includes an introduction, a list of materials needed for teaching the lesson, step-by-step directions for completing the activity, a suggested data table for recording results, conclusions resulting from the activity, and suggested supplementary activities to expand the concepts addressed in the unit. (MN)

ED229624

GROUND TO GRITS

SCIENTIFIC CONCEPTS

IN

NUTRITION/AGRICULTURE

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1982

vol 2

SE 035 985

ACKNOWLEDGMENTS

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A grateful acknowledgement to Mrs. Frances Crawford, biology teacher at Richland Northeast High School and Mrs. Maxine Moore, biology teacher at Spartanburg High School who proofread the manuscript and to Mrs. Winnie Ray, Mrs. Carol Rauch, and Miss Marie Carter, of the Curriculum Section who have spent many hours typing and proofreading this nutrition/agriculture activity guide. Their enthusiastic assistance has greatly facilitated the development of this project.

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PREFACE

NUTRITION ACTIVITY GUIDE FOR SCIENCE INSTRUCTION

You are living in a very sophisticated world. The minute an alarm clock sounds, you hop out of a warm bed. Next you flip on the electric lights, put on your machine made clothes, open the refrigerator door for your instant breakfast, and a few minutes later you are on your way to school in a car or bus. Think about the changes in your living style since the time your grandparents were school age. What was their mode of transportation? Did they have all of the appliances that you like to use? Did they have the many textured fabrics with the multicolored dye that are available for purchase in the local mall? Were the fast food chains always moments away? Did they have well stocked supermarkets just around the corner? Were medical aids such as penicilin on the market fifty years ago? You have the advantage of living with all of these technological changes that have occurred in a relatively short period of time. One important aspect of your well being that has not changed: your nutritional needs are identical to those of your ancestors. Your brain, muscles, and body organs require the same nutrients in order to function that were required of people that lived thousands of years ago. They were limited in the variety of food that was available. They had to eat the meat, vegetables, and bread they could produce or find in the wild.

The type of food you eat is different from any other generation. You live in a period where you can take advantage of the many technological advances. Never before has man had such a variety of food to meet the nutritional needs. Wise choices must be made in order for you to have the energy and essential nutrients for your body.

The United States farmer has increased productivity by improving fertilizers, pesticides, herbicides, farm machinery, farming procedures along with great strides in plant and animal breeding so that for a low cost, food is plentiful. The food processing technologies have improved the shelf life, taste, and appearance of these foods. You also have thousands of items ready for your consumption at a neighborhood supermarket.

What makes you choose one food item over the other? Is it simply the taste or do other factors enter into your selection of food such as smell, texture, color, and appearance?

Man has altered food to suit human needs and desires. Raw milk is an example of the many ways it has been changed to appeal to man's needs. Another major food item, corn, also has provided man with a variety of uses. These ideas will be developed through activities.

In order to remain healthy, you must make certain your body has the proper amount of nutrients. To do this you must become aware of the different nutrients. This will be accomplished by completing a series of activities that have been designed for you to become familiar with the properties of the essential nutrients.

These nutrients that are essential for your body are carbohydrates, fats, protein, vitamins, minerals, and water. You will be making chemical tests for these nutrients and finding out the different function of each one. Activities have also been designed to acquaint you with food additives.

You will get a glimpse into how this food turns into you, and how to balance your needs with your intake. It will allow you to select an ideal weight suitable for your build and type of activity by giving you several "rules of thumb" to follow all your life.

Plants supply all of man's food either directly or indirectly. Plants are fundamental to our existance. Early people were food gatherers or hunters. Each individual was totally consumed in finding enough food for their nutritional needs. Civilization began when it was discovered that a food supply could be assured if seeds were planted, cultivated, and harvested. This resulted in the development of agriculture. For nutrients to be present in the plants these same elements must be present in the soil. The plants use certain elements to manufacture the essential nutrients. Animals eat these plants and then produce other essential nutrients for our body needs. Indirectly plants provide essential nutrients through animal products such as meat, eggs, and milk.

Certain elements that are essential for our body's nutrition must be supplied to the plants in the form of fertilizer. These same elements must be available in the soil for plants to use in growth and development, so that in time our body will be furnished with the essential nutrients.

This activity guide will follow several major elements from the soil to the supper table. The components of fertilizer, nitrogen, phosphorus, and potassium will be analyzed in the soil and related to your body needs, thus creating an understanding of the importance of good nutrition through proper food.

The questions will arise: Will there be enough food produced on the planet earth to provide nourishment for all the earthlings? Will there be a food crisis in the future similar to the energy crisis we are experiencing at the present time? How will the food for all the people on this earth be provided in the future? Will this be done through improved farming practices, better breeding methods, preserving the prime farm land, or improved methods in the control of insects and weeds? Will the foods of the future be substantially different from those eaten today? Activities will give an insight to the probable answers of these questions.

The overall purpose of this science in agriculture course is to give you the knowledge and skills necessary to make wise choises when selecting your daily diet. It will ~~take~~ thought and planning on your part.

By the time you have completed this course, you should recognize the relationship between nutrition, agriculture, and science. Without quality production of food we can not have all the essential nutrients available for a healthy body.

INTRODUCTION

The guide is planned as a student activity oriented program. It is designed to give the students experiences in activities that will help them understand concepts concerning the relationship between science, agriculture and their nutritional needs. The guide is divided into six units each answering a question important to the nutritional needs of their body.

I. Why am I eating this?

II. What IS that I am eating?

III. Are foods different?

IV. Why does the body need different kinds of food?

V. What are the ultimate sources of food?

VI. What will I eat in the future?

Each unit is subdivided into concepts that are outlined by giving the objectives in behavorial terms. Sources for the "Background Information for Teachers" are given. Under this category are the "Teaching Strategies" written for the teacher as a lesson plan. The trend of thought is outlined giving the purposes of each activity. Several activities develop each concept and are addressed to the students. Each activity is outlined by:

Introduction -- Gives an overview of the activity.

Materials You'll Need -- Written for a class of 25 to 30 students.

Procedure -- Step by step directions.

Suggested Data Table -- Pragmatic way to record results.

Interpretation -- Conclusions resulting from the activity.

Further Investigation -- Suggested supplementary activities that will expand the concept.

Master copies are available that could be used for making transparencies. These will be helpful when the teacher is developing the concepts.

Several of the student activities are taken from A Consumer Chemistry Learning Activity Package. The three packets that will be used are: "The Chemistry of Food"; "The Chemistry of Food Additives"; and "The Chemistry of Soil and Fertilizers".

Differences in the learning styles have been taken into consideration by the variety of teaching methods used throughout this activity manual. Opportunity is provided for kinesthetic as well as tactile learners. Lessons are also developed through the use of visual and auditory stimuli.

The ultimate carry over goal of this activity program is for the students to gain a continuing interest in their nutritional needs that will last throughout their lives.

GOALS

1. Students will gain knowledge of chemistry, biology, and agriculture concepts through the use of foods and nutrition activities.

2. Students will recognize the reciprocal relationship between nutrition and agriculture.

3. Students will develop a continuing interest in nutrition.

COURSE DESCRIPTION

This activity oriented one semester course is designed to give the high school science students experiences that will help them understand their nutritional needs through the science of agriculture. Essential elements found in fertilizer and necessary for nutrition are followed from the soil to the plants and animals and then on to the human body.

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HOW THIS GUIDE WAS WRITTEN

A group of outstanding science educators were selected by the South Carolina Department of Education to outline a curriculum that would lead to improved student competencies in wiser food choices. The result of this project is Ground to Grits, a nutrition/agriculture curriculum guide using science concepts and principles. The group spent a few days at Clemson University talking with nutrition and agriculture experts and touring the laboratory facilities searching for appropriate activities suitable for their students to perform in a typical high school science classroom. The activities selected are concrete examples of both nutrition and agriculture principles that are germane to the topic and will motivate secondary students.

After the guide was written, a group of ten selected pilot teachers attended a 2-week training session at Richland Northeast High School. Clemson University and Winthrop College staff served as instructors reviewing nutrition/agriculture principles. Along with the cognitive instruction, the group performed the activities that are outlined in this manual. After a critical year of piloting, which resulted in numerous revisions, the activity manual is ready for use in schools by the students.

The funding of this project was made available from the United States Department of Agriculture through the South Carolina Department of Education. It was written, piloted, and printed in cooperation with the Offices of School Food Services and General Education at the South Carolina Department of Education.

UNIT I WHY AM I EATING THIS?

CONCEPT A Taste and smell are major concerns in the selection of food.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Test food scientifically by performing paired taste testing.

2. Apply the triangular taste testing method to determine food preferences.

3. Classify odors according to four groups.

BACKGROUND INFORMATION FOR TEACHERS

Hoff and Janick, Food-Readings from Scientific American, Pages 8-12, Smell and Taste by A. J. Haagen-Smit W. H. Freeman and Company.
Teaching Strategies

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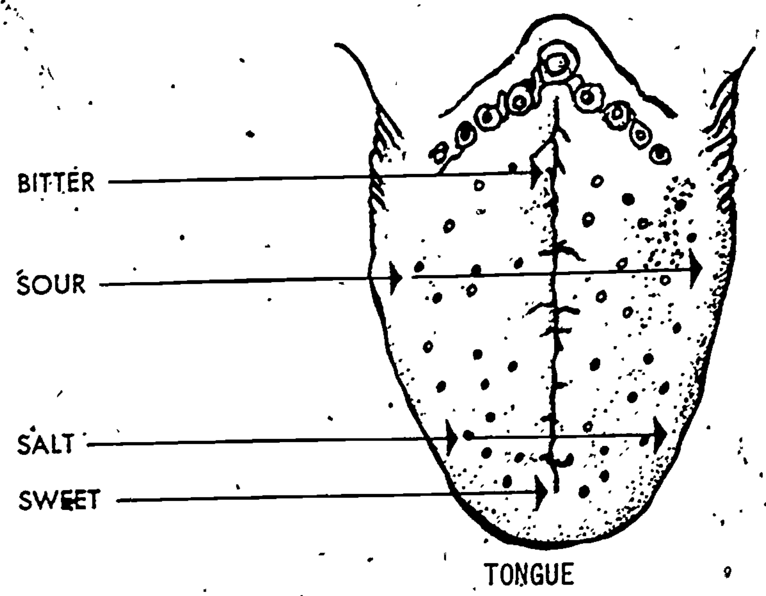
TEACHING STRATEGIES

How do you select food? What makes you go to one fast food place over another? Why do you have a preference for one brand of peanut butter? Ask your students these questions. They will probably come to the same conclusion that research has indicated, the most important factor in the selection of food is flavor. Sensory impressions determine what you eat. There are thousands of flavor sensations that are experienced in a lifetime. Taste is a combination of taste buds on the tongue and olfactory center in the nasal cavity. There are four primary taste sensations involving the taste buds on the tongue. These are sweet, sour, bitter, and salty.



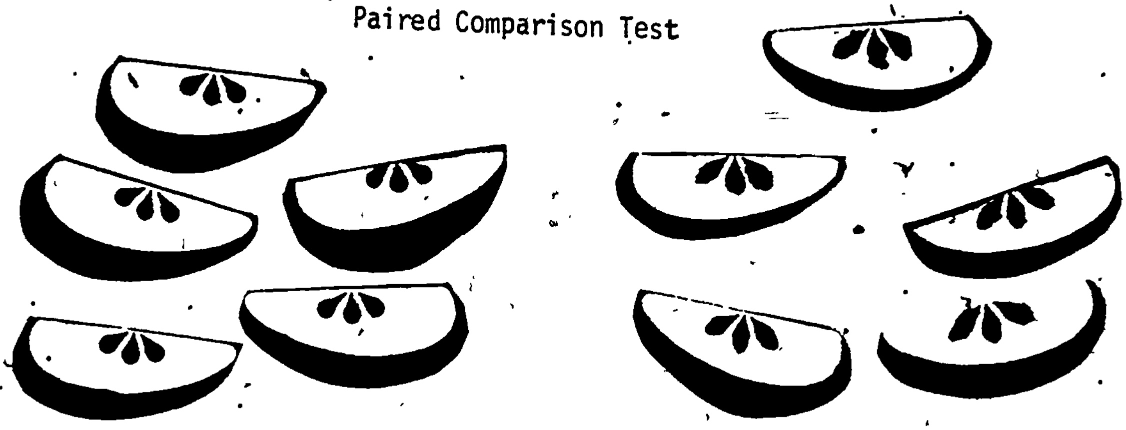
TONGUE

However, what you taste is a combination of these four distinct sensations plus the sense of smell from the olfactory center. All of these factors provide you with the taste sensation in food. Because taste is so important in the selection of food, scientific taste tests have been devised to provide people with palatable food that will lure the customer into buying the product. Three scientific tests are:

- Paired comparison test,
- Triangular taste testing, and
- Comparative testing on a scale of 1-10

It is important for the students to experience scientific taste testing. Red Delicious vs. Jonathan apples makes an excellent combination to use for a paired comparison test. Only one apple of each kind is needed for a class. Perhaps the students can bring apples from home. Slice each apple in small wedges and have the students compare for sweetness. They could compare the crispness or the tartnesss of these apples. Decide on one factor before they begin. If you really want to provide the students with an authentic situation for scientific taste testing, each student should be provided a cubicle where facial expressions can not enter into the selection. However, this is not necessary.

Paired Comparison Test



Red Delicious   Jonathan

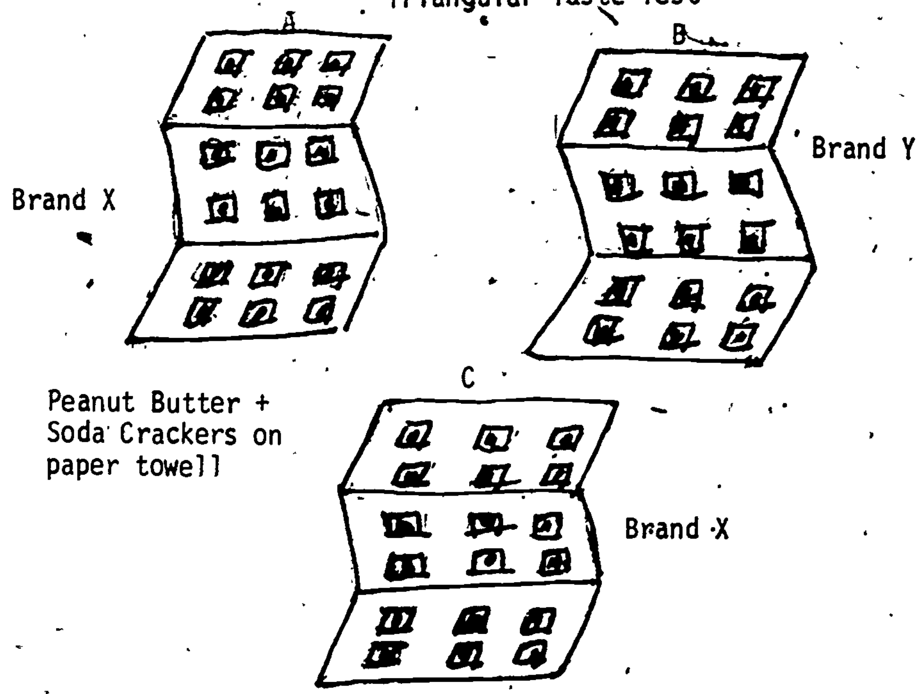
Red Delicious apples are sold in the stores for premium prices because of the appearance, not necessarily the taste. The Jonathan apple has a far superior taste but lacks the appearance. Points on the end of the Red Delicious apple seem to have an effect on the customer's eye. Apple breeders are trying to produce varieties of Jonathan apples with these characteristics so that the customer will have both taste and appearance. You can use a paired comparison test to analyze two kinds of nuts, breads, breakfast cereals, cookies, crackers, kool aid, or orange juice.

Another type of scientific test to use in the classroom is the "Triangular Taste Test". This is a very desirable method often used by food processors. You need saltines and two brands of peanut butter.

If possible, spread the peanut butter on the crackers ahead of time so the students do not see which brands you have placed on the paper towels. Begin this taste test by placing three paper towels labeled "A", "B", and "C" on the desk. You have two brands of peanut butter. Call one Brand "X" and one "Y". Spread the peanut butter on saltines. Make twice as many samples of Brand "X" peanut butter as Brand "Y" and place these on paper towels labeled "A" and "B". Now spread Brand "Y" on saltines and place on the towel labeled "C". Have the students taste one cracker from each of the paper towels.

The students will decide first which two brands are alike and then their preference for one of the brands of peanut butter. In this triangular taste test, the individual is not just concentrating on one factor. By the addition of the second factor the test becomes more interesting.

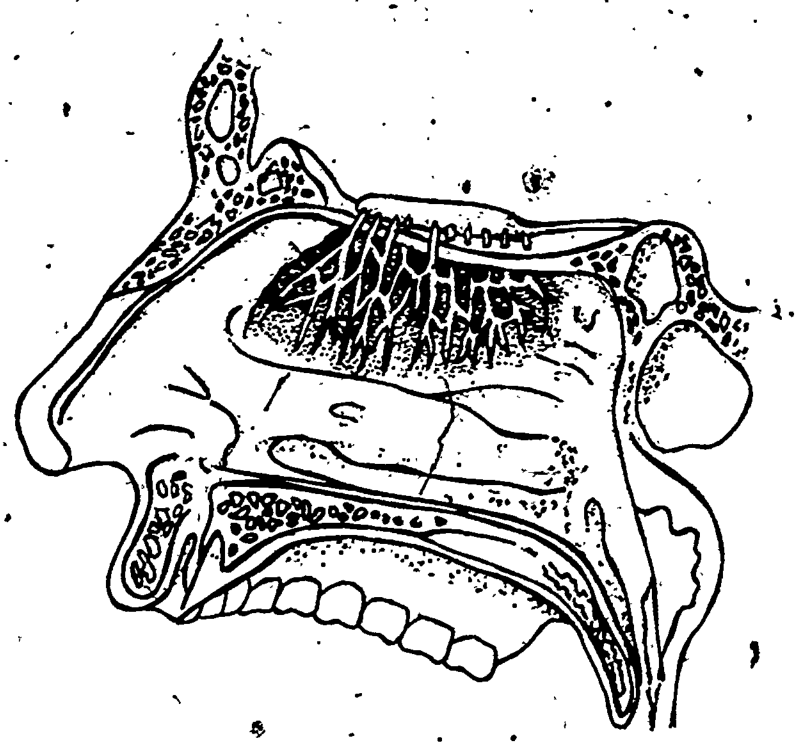
Triangular Taste Test



How much does the olfactory nerves in the nasal cavity enter into tasting can be demonstrated in the classroom by using the Apple-Onion-Potato test. Begin "Blind Truth" by cutting an apple, onion, and potato into very small pieces about the same size. Blindfold several students and while they are holding their nose have them taste a small wedge of an apple, onion, and potato -- one at a time. Can the difference be recognized without the odor? With the exception of the difference in texture, the taste cannot be determined until the odor is detected. In order to stimulate the olfactory centers, substances must be in a gaseous state. It is estimated that the sense of smell is several thousand times more sensitive than that of taste. Cakes, yeast bread, and bacon frying all have aromas that aid in the desirability of foods. Aromas are added to foods as they lure the customer into buying the product.

The senses of taste and smell are an astonishing chemical laboratory. Your olfactory nerves can detect the slightest change in the chemical structure of a substance. Frying or roasting adds new flavors to food by breaking down the structure of the molecule.

As your students have already learned, their perception of flavor depends on both taste and smell and it is hard to distinguish between the part that taste and odor plays. The sense of smell is believed to be due to the millions of molecules found in the air surrounding the food. When these molecules arrive at the olfactory hairs and cells in the upper part of the nose, a message is transmitted to the olfactory lobe in the brain.



Odors have been classified into 4 groups:

1. Sweet or fragrant
2. Sour or acid
3. Burnt or Empyreumatic
4. Goaty or Caprylic

By having your students make this distinction with a few food items, this test will demonstrate the importance of these four classifications of smells.

The strength of each of the four odors can be described numerically on a scale of 1-8. "1" indicates a weak odor while "8" recognizes strength. Assign each of the four groups of odors a number. Each food item will have a set of four numbers. For instance, using this system vanilla has this set of numbers, 7122. It is very sweet, not sour, burnt, or goaty. Now assign a set of numbers for various food items such as vinegar, garlic, peanut butter, lemon, or an orange. Using the four basic groups to describe odors in this manner may be an over simplification. But it has also emphasized that every odor is a combination of impressions. This type of testing will also help your students to recognize the dominant odor in food.

The physical properties of foods also enter into the palatability of foods. This is the desired or expected texture and consistency. We expect crackers to be crisp, meat to be tender, pudding to be smooth, and jello to be firm. All of this enters into our selection of foods.

Your selection of food is governed by taste and smell along with appearance.

UNIT II WHAT IS THAT I AM EATING?

CONCEPT A Basic raw materials have been altered to make a variety of products.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Make several products from milk.
2. Determine that corn has been altered to form a variety of foods.
3. Realize that a large variety of food is made by processing a few raw materials.

BACKGROUND INFORMATION FOR TEACHERS

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Preparing Yoghurt

II. Enzymes for Cheese Production

TEACHING STRATEGIES

Ask your students, "Just exactly, what IS that you are eating? Where does it come from? How is it made? and What are the raw products? Man has learned to alter the taste of foods in order to have a greater variety. By using fairly simple techniques, basic items like milk have been changed into food items that appeal to different sensory impressions. Ask the students to name the variety of products that begin with a milk base. Yoghurt, ice cream, cheese, butter, and buttermilk are examples of how man has altered the taste of milk to produce entirely different foods.

Just exactly what is Yoghurt? Activity I, "Preparing Yoghurt", will give the students an opportunity to see what it takes to make yoghurt. It is a process they could easily repeat in their own classroom. All you need is a heating pad, a quart of milk, a package of dry milk, yoghurt, and a number of clean baby food jars. The two kinds of bacteria necessary for the culture are obtained from yoghurt purchased at your local grocery store. Once the students have made yoghurt, the reasons for it originating in the Middle East will become apparent. The warm climate provided the proper temperature for the bacteria to grow causing fermentation. This changes the sugar found in milk into Lactic Acid. During the day as the bacteria is growing and the fermentation process is progressing, have the students test for acidity. This can be done by dipping a little of the ingredients out of the jar and spotting it on hydrion paper.

Another way of altering the taste of milk is by the cheesemaking process. To make cheese the curd must be separated from the whey. Separation is accomplished by addition of rennet. Where does it come from? It is the digestive juices in the lining of a calf's fourth stomach. Cheesemaking process can be considered a step in the process of the digestion of milk. Have the students imagine how man first learned to make cheese. What made someone use the substance from a calf's stomach in milk is almost uncomprehensible. Now, rennet is made synthetically and sold under various trade names. Activity II, "Enzymes for Cheese Production", will give the students a glimpse into the cheese making process. The rennet that is used has been synthetically made and is sold under the trade name of Rennilase.

Many factors affect the aroma, flavor, and texture of cheese thus giving us the large variety we find at the grocery store. Some of these factors are the kind of milk, the type of bacteria used on the curd, and the length of ripening time.

The taste is changed by using milk from many types of animals. Cow's milk is easier to produce in large quantities so it is most commonly used. However, goat's milk, sheep milk, and camel's milk can be used to produce different cheeses. Blue cheese and roquefort cheese are inoculated with the same type of bacteria but use a different source of milk. Blue cheese is made from cow's milk while roquefort is made from goat's milk. Individual student projects could delve into researching the different bacteria used to produce cheese. The student could select one and purchase this bacteria from a scientific supply company, then culture their own cheese.

Butter and buttermilk can be made during a class period by pouring one cup of cream into a pint jar. You will need an agitator to speed up the process. A clean wooden clothespin can be used for this purpose. Tighten the lid and let students take turns shaking the jar. Shake the jar until lumps of butter form. Pour off the buttermilk. After chilling, allow the students to sample the buttermilk. Put the butter in a small bowl and work out the remaining buttermilk with a wooden spoon. Wash the butter several times with cold water. Add 1/4 to 1/8 teaspoon of salt. Taste butter on school made bun. These are two more products made from milk, adding to the variety of flavors that man has found by altering milk.

Man has altered the taste of food chemically and physically. The students have altered milk chemically by changing it into yoghurt and cheese. But, when they made butter, they altered milk physically by separating the butter fat. Many other raw products are changed physically to make the food the way we like it. Corn can be altered to suit man's taste. They may have eaten corn in one form or another for breakfast, maybe in the form of grits or corn flakes. Even if they didn't, they probably had hot popcorn at the motion picture theater the last time they were there.

Corn is processed and eaten in a number of ways:

- As it comes off the ear --

    corn on the cob

    popcorn

    succatash, and

    cream corn

- By treating it with lye, then washing it carefully --

    corn flakes, and

    hominy (western style)

- By grinding it very fine or coarse --

    corn meal

    hominy (southern style)

- By the refining process --

    Starch,

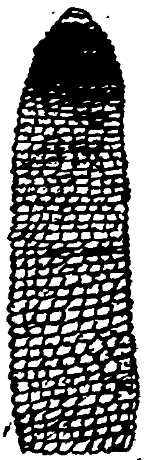
    Sugar,

syrup,

oil,

margarine, and

shortening



Food for man

- fresh corn on the cob
- corn oil
- corn starch — corn syrup
- corn brand
- margarine
- shortening
- hominy
- corn bread

Food for animals

- beef
- pork
- poultry

Point out to your students that milk and corn have been altered to provide man with a large variety of foods. Many other products are made from simple foods. Vinegar is made from apples, sauerkraut is another fermentation process involving cabbage. Flour for bread is made from wheat, prunes are dried plums, raisins are dried grapes, and ham is cured pork. Ask your students to think of other processes that have been devised to preserve foods and also provide us with our multi food products.

This unit should help your students to become aware of the large number of processes that food undergoes before it arrives at their dinner table.

Maybe they will wonder as they crunch down on their next hot dog, "Just what exactly is that I am eating?"

ACTIVITY I Preparing Yoghurt

Introduction

Yoghurt is made from the fermentation of milk caused by two bacteria, Lactobacillus bulgaricus and Streptococcus thermophilus. As this fermentation process occurs at a controlled temperature, the milk sugar, lactose, is changed into Lactose Acid. There are two distinctive flavors that give yoghurt its taste. The Lactic Acid is a sour or tangy flavor and the Acetaldehyde gives it the nutty or green aromatic quality.

Commercial yoghurt is made from cow's milk. However, it can be made from the milk of buffaloes, goats, sheep or other cud-chewing animals. Yoghurt has been popular in the Middle East countries for thousands of years.

Materials You'll Need

1 Quart of milk
1/3 cup of powdered milk
Culture of unflavored yoghurt
  (Sealtest or Dannon recommended)
8 or 10 Baby food jars
Clean towel
1 Teflon pan or liter beaker
Hot plate
1 Thermometer
1 Glass stirring rod
Measuring spoons
Heating pad

Procedure

1. Add to 1 quart whole milk 1/3 cup milk powder (non-fat), and dissolve it thoroughly.

2. In a pan (teflon coated preferred) heat the mixture, stirring constantly with a spatula to keep the milk from scorching. When it reaches a temperature of 80° C (176° F) the milk will start to foam. Use a good thermometer, mercury in glass, to check the temperature.

3. Remove the pan from the heat, cover and let cool on the stove until the temperature of the milk decreases to 45° C (113° F).

4. From a previous yoghurt batch (no more than 7-10 days old) or preferably a commercial unflavored yoghurt, remove 1-2 tablespoons and put this into the mixture. Use a slotted spoon and spatula to thoroughly disperse the yoghurt into the milk. Use plain Dannon or Sealtest yoghurts for starter.

5. Ladle mixture into clean small baby food jars. Cover the jars and incubate at 113° F until the milk coagulates and attains the degree of sourness desired. The 113° F temperature can be achieved in an oven (not turned on) but heated with a 100 watt light bulb or on top of a heating pad (low setting) with a large towel covering the jars and pad. Usually the fermentation is completed in 6-10 hours; the exact time will vary with the activity of your starter culture. A starter culture from an older fairly acidic yoghurt will grow slower and may require 12-14 hours to produce the desired product.

6. When the yoghurt has finished fermenting, the jars should be tightly sealed and refrigerated until used. Do not store for more than 7-10 days for the best retention of quality.

7. Various flavorings can be added such as strawberries to create your own fruit flavored yoghurt at a fraction of the retail cost.

Further Investigation

Test for acidity as the milk is fermenting. As the acidity increases, the bacteria is growing.

ACTIVITY II Enzymes for Cheese Production*

Introduction

Before launching into the cheesemaking process, it's a good idea to spend a few minutes acquiring a basic understanding of the entire process. This makes the whys and wherefores much clearer . . . makes each step easier to follow and simpler to do.

Although cheeses differ widely in texture and flavor, they all begin in much the same way. Different curing methods and subtle variations in certain processing stages are what cause the many differences that distinguish one cheese from the next.

Basically, cheese is a solid portion (curd) of milk which has been separated from the liquid portion (whey). Rennet, an enzyme traditionally extracted from the fourth stomach of the suckling calf, but now produced by microbial fermentation, facilitates this separation of curd from whey.

To do this, the milk is first prepared for curdling by increasing its lactic acid level. A starter culture consisting of selected strains of certain lactic acid-forming streptococci and sometimes Lactobacilli is added to the milk, and allowed to convert part of the lactose into lactic acid. The pre-ripening may last from 10-75 minutes and takes place at a temperature of 82-88° F. The starter culture has not only the function to transform lactose into lactic acid during the early stages of the manufacturing process, but it is also of great importance for the development of the flavor during the ripening of the cheese.

Another approach, more convenient to the amateur, is adding 1% of buttermilk (starter) to the milk and letting it stand at room temperature for at least four, but not more than twelve hours. After this, the temperature is raised to the 86-88° F range and coloring is stirred in thoroughly. Then rennet is added to coagulate the entire mixture. When coagulation is complete, the coagulate is cut into small cubes and stirred while raising the temperature gradually to 100-102° F. This makes the curd separate from the whey as it becomes firm. Additional firming comes from cooking the curd either in or out of the whey depending upon the cheese type desired. Cooling curd out of the whey is a process called cheddaring. Final steps include salting for flavor, pressing for 12-18 hours and drying for another six. At this point, "fresh" cheese may be enjoyed or the aging process begun.

Aging (also called curing) sharpens the flavor of the basic varieties of cheeses. Although it seems at first glance that aging is simply leaving a cheese alone for a period of time, there are, in fact, limitless variations in aging technique. The cheesemaking industry, for example, uses thousands of techniques.

Aging takes place at temperatures between 35° and 55° F with a wide variety of latitude for experimenting. But cheese cures faster at the higher temperatures because the curing agent accelerates its action. Temperature above 55° F may cause the cheese to spoil.

Another important variable in determining taste is time. Most cheeses develop their distinctive flavor after two weeks to several months of aging.

Materials You'll Need

Equipment:

Beakers
Graduated Cylinder (or measuring cup)
Dropper
Heat Source
Thermometer

Reagents:

Milk (for a stronger tighter curd use skim milk or more Rennilase.
"Rennilase": Rennet enzyme

Procedure

NOTE: Cottage cheese can easily be completed in one class period.

A. Coagulation:

1. Place 100 ml to 150 ml of milk in a beaker and warm to 32º C (-8-90º F).

2. Add 0.5 ml (5 drops)of "Rennilase" to the warmed milk while stirring. Remove the beaker from the heat and allow to stand undisturbed for 15 minutes.

3. By this time the curd should have formed. The curd could now be broken up and separated from the whey.

4. Chill for a few minutes and taste.

B. Further Processing:

In regular cheesemaking, the curd is cut up, filtered to remove the whey, and salted for taste development. Then it is placed in a cheese press to further remove the whey, harden the cheese, and dry. The developed cheese block is then wrapped to exclude air and allowed to "age" at 35º as the flavor develops.

*This experiment has been adapted from Experiment #1: Enzymes for Cheese Production, Carolina Biological Supply Company, Burlington, North Carolina 27215 or Gladstone, Oregon 97027.

UNIT III ARE FOODS DIFFERENT?

CONCEPT A Foods are different chemically and tests can scientifically show that this is true.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Determine that foods are chemically different by performing tests.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition Pages 1-17.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Which foods contain Starches, Sugars, Proteins, Fats & Oils, Minerals, and Vitamin C?

TEACHING STRATEGIES

The concepts of this unit are developed around the six nutrients essential for the body to grow properly and stay alive and healthy. The first concept will help your students become acquainted with the major groups of nutrients. After that, each nutrient will be taken up separately. Activities have been selected to help the students to differentiate between these essential nutrients. By completing these activities the students should gain insight as to why their body needs these nutrients, how the body uses them along with the amounts needed daily. Because food additives are used daily, another concept will allow the students to investigate these hidden items found in food.

As an introduction to this unit, have the students perform simple tests for the nutrients found in food. Activity I, "Which Foods Contain Starches, Sugars, Proteins, Fats and Oils, Minerals, and Vitamin C?", should help the students become familiar with the different food nutrients by using chemical tests. Have the students copy the data for their notebook. There is a completed table for your convenience. (Do not allow the students to see your data table.) Divide the students into small groups depending upon the laboratory facilities. Ask the students to bring the food listed in Activity I. Other foods can be substituted. Encourage the students to bring foods they eat in their diet that might not be listed.

Benedict and Iodine solutions can be made in the school laboratory.

To make Benedict's solution, dissolve 173 g of Sodium citrate and 100 g of Sodium carbonate in 800 ml of water. Heat will be necessary, then filter. Dissolve 17.3 g of $CuSO_4 \cdot 5H_2O$ in 100 ml of water. While stirring constantly, pour the Copper sulfate solution into the carbonate-citrate solution. Add enougn water to make 1 liter.

To make the Iodine solution, dissolve 70 g of Iodine, I_2, and 50 g of Potassium iodide, KI, in 50 ml of water. Dilute with alcohol to make 1 liter.

ACTIVITY I Which Foods Contain Starches, Sugars, Proteins, Fats & Oils, Minerals and Vitamin C?

Introduction

~~Most of~~ these tests cause color changes. Tests of this kind are useful as it allows easy identification of the nutrients. For the sake of simplicity, you can assume that the tests you perform on foods will only identify one kind of nutrient even though others are present.

Materials You'll Need

Foods -- bread, rice, butter, lettuce, bacon, apple, carrot, peanut, grapes, hard-boiled egg, cheese, potato, banana, potato chips, orange juice, fresh tomatoes.

- Medicine droppers (3)
- Iodine solution
- Benedict's solution
- Bunsen burner
- Graduate cylinder
- Test-tube holder
- Cornstarch
- Test tubes (3)
- Brown wrapping paper

Procedure

Begin this activity by the students making a copy in their notebook of the chart "Which Foods Contain Starches, Sugars, Proteins, Fats & Oils, Minerals, and Vitamin C?"

Starch Test

Add a drop of iodine solution to the food to be tested. A bluish-black color will indicate the presence of starch. If the students try bread or rice, they will get a positive result. As other food is tested, indicate on the table if there is a slight presence, strong presence, or very strong presence by the degree of color change.

Sugar Test

Benedict's solution or Fehling's solution can be used as a test for glucose. Place a small sample of the food to be tested in a test tube. Add enough water to cover the food. Heat the contents until the water boils. Add 5 ml of Benedict's solution or Fehling's solution. The presence of sugar will be indicated by a yellow or reddish precipitate.

Protein Test

Burn a small piece of food to be tested on aluminum foil. A distintive smell will indicate the presence of protein.

Fats & Oils

Obtain unglazed paper such as wrapping paper or brown grocery store bags. Rub the paper with the food to be tested. Hold it up to the light. A translucent spot indicates the presence of fats and oil or lipids.

Mineral Test

Mash up the food. Place on a piece of aluminum foil in an oven turned on a low heat. If a gray ash remains, minerals are present. This can also be done by placing the food in a crucible and heating slowly with a Bunsen burner.

Vitamin C Test

Mix several grams of cornstarch in about 250 ml of H_2O. Boil for about 5 minutes. Remember to make a paste out of the cornstarch with a few ml of H_2O or it will be hard to dissolve the cornstarch in H_2O. With this mixture, make an indicator solution by using a ratio of 1 drop of iodine solution to 10 ml of the starch solution. Add a drop of this indicator to the foods to be tested. If the blue color disappears, Vitamin C is present.

These common foods may be replaced. Use the foods the students bring in that is part of their daily diet. The food should be cut into small pieces that can be placed in test tubes.

+	Indicates the slight presence of the food nutrients.
++	Indicates the strong presence of the food nutrients.
+++	Indicates the very strong presence of the food nutrients.
-	Indicates a negative test for the food nutrient.

Tests for carbohydrates will be divided into one test for starches and another one for sugar. More than half of your diet consists of carbohydrate foods, which contain only three elements. In the body by the process of digestion, the starches are broken down into sugar, mainly glucose. As the glucose breaks down, energy is released for life's activities.

Suggested Data Table

See table on following page.

Interpretation

Name general group of foods that are rich in Starch, Sugars, Protein, Fats, Minerals, and Vitamin C.

Which Foods* Contain Starches, Sugars, Proteins, Fats and Oils, Minerals and Vitamins?

	Carbohydrates		Proteins	Fats & Oils	Minerals	Vitamin C	Water Content
	Starches	Sugars					
Bread, White (1 slice)							
Rice							
**Water							
Butter							
Lettuce							
Apple							
Bacon							
Carrot							
Grape							
Egg							
Cheese							
Potato							
Peanut							
Banana							
Orange Juice							
Tomatoes (Fresh)							

Amounts of each nutrient will vary with the age, condition, and portion of the food selected for sampling.

*Consider all foods in raw state except bread.
**Depends upon where you live.

UNIT III, CONCEPT A, ACTIVITY I (continued)

Teacher's Key

Which Foods* Contain Starches, Sugars, Proteins, Fats and Oils, Minerals and Vitamins?

	Carbohydrates		Proteins	Fats & Oils	Minerals	Vitamin C	Water Content
	Starches	Sugars					
Bread, White (1 slice)	+++	+	+	+	+	-	-
Rice	+++	-	+	-	++	-	-
**Water	-	-	-	-	+++ to +	-	-
Butter	-	-	+	+++	+	-	-
Lettuce	+	+	-	-	+	+	+++
Apple	+	+++	+	-	+	+	+++
Bacon	-	-	+++	+++	+	-	-
Carrot	+	+	-	-	++	+	-
Grape	+	+++	-	-	+	+	+++
Egg	-	-	+++	-	++	-	+++
Cheese	+	-	+++	++	+++	-	-
Potato	+++	-	-	-	++	++	+++
Peanut	+	-	+	+++	+++	-	+++
Banana	+	+++	-	-	+	+	+++
Orange Juice	-	+++	-	-	+	+++	+++
Tomatoes (Fresh)	+	+	-	-	+	+++	+++

Amounts of each nutrient will vary with the age, condition, and portion of the food selected for sampling.

*Consider all foods in raw state except bread.
**Depends upon where you live.

UNIT III ARE FOODS DIFFERENT?

CONCEPT B The role of carbohydrates in nutrition

OBJECTIVE Upon completion of this concept, the student should be able to:

1. Identify a carbohydrate by chemical tests.
2. Classify carbohydrates as sugars, starches, and cellulose.
3. Classify sugars as monosaccharides and disaccharides.
4. Distinguish between the 6 sugars that are important in nutrition, glucose, fructose, galactose, sucrose, maltose, and lactose.
5. Perform a simple taste test to show the difference in sweetness of these sugars.
6. Construct paper models of the sugars, starch, and cellulose so the students can see how these molecules are formed.
7. Demonstrate the effect of saliva on starches.
8. Identify the products formed as sugar is broken down.
9. Recognize the importance in this group of foods as a necessary part of the diet.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition Pages 9 - 57.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Testing Various Sugars for Sweetness -- Preference Test.

II. Paper Construction Models of Carbohydrates.

III. Laboratory Tests for Sugars and Starches Demonstrating the Effect of Saliva on Starch.

IV. Can Benedict's Solution be Used to Test Different Sugars?

V. Can Sugar be Decomposed?

TRANSPARENCIES

I. Monosaccharides - Glucose, Fructose, and Galactose

II. Disaccharides - Sucrose, Maltose, and Lactose

III. A Complex Carbohydrate Molecule

TEACHING STRATEGIES

It will be important for the students to understand that sugars, starches, and cellulose are carbohydrates. Six sugars are important in digestion and these can be taste tested to show the difference.

Introduce this unit on carbohydrates by setting up Activity I, "Testing Various Sugars for Sweetness -- Preference Test". This should help the students realize that chemically there are different sugars and these can easily be differentiated by tasting for sweetness. It should be pointed out to the students that the preference test is a regular scientific way of taste testing foods.

By using Transparency I, Monosaccharides - Glucose, Fructose, and Galactose, the students actually count the number of carbon, hydrogen, and oxygen atoms. Point out how these 3 sugar molecules have the same number of elements but have slightly different arrangements. Do not have the student memorize the structural formulae of the molecules. This is not the important concept. It is important to stress the slight difference in the structure can cause the difference in the sweetness of the sugar molecules. Make certain that the students see the overall shape of the monosaccharides is a hexagon.

Use Transparency II, Disaccharides - Sucrose, Maltose, and Lactose, to show how monosaccharides combine to form disaccharides. Make certain the students see that 2 hexagon molecules have combined to form disaccharides. The students should now be ready for Activity II, "Paper Construction Models of Carbohydrates." As you discuss molecules being put together, emphasize that the opposite occurs in digestion. It is important to point out that excess carbohydrates are stored in the body.

Activity III, "Laboratory Tests for Sugars and Starches Demonstrating the Effect of Saliva on Starch", can be used to show that digestion takes place in the mouth as saliva breaks down starches into sugars. Use Transparency III, A Complex Carbohydrate Molecule, to illustrate how the sugar molecules (hexagon rings) combine to form a large molecule of cellulose.

By using Activity IV, "Can Benedict's Solution be Used to Test Different Sugars?", the students can understand that not all sugars act alike chemically. Benedict's solution can only be used for testing monosaccharides.

Activity V, "Can Sugar Be Decomposed?", should be used as a teacher demonstration to illustrate that sugar is made up of carbon and H_2O, thus the name "carbo-hydrate". Use care in handling of H_2SO_4 and the residue. Sulfuric Acid, H_2SO_4, is mixed with sugar to dehydrate the sucrose. It will be apparent that carbon, water, and heat energy are given off as a result of adding H_2SO_4 to the sugar. H_2SO_4 serves as a catalyst.

$$C_{12}H_{22}O_{11} \xrightarrow{H_2SO_4} 12\,C + 11\,H_2O + \text{Heat}$$

The black residue will be recognized as carbon, vapors given off can be condensed on a mirror and shown to be water. The beaker will be very warm indicating heat release as this is an exothermic reaction.

If sets of molecules are available, have the students make the sugar molecule.

ACTIVITY I Testing Various Sugars for Sweetness - Preference Test

Introduction

Six sugars are important in nutrition of the human body. These sugars have the same formula but slightly different arrangement of the atoms. Glucose, Fructose, and Galactose are single sugar molecules called monosaccharides. The other three sugars also have the same formula but slightly different arrangement of the atoms. These are the disaccharides and are made up of a pair of sugar molecules. These are Sucrose, Lactose, and Maltose. Each of these sugars differ in sweetness. If Kool-Aid, tea, or some other drink is sweetened with the same amount of each of these sugars, a taste test can be made to determine the sweetness.

Each sugar can be rated on a scale of 1 to 10, just as you would rate Miss Universe or Burt Reynolds. When you rate each sugar on a scale of 1 to 10, it is called a "preference test". This is a regular scientific method of tasting foods.

Before you begin this activity, the Kool-Aid must be mixed and divided into 4 clean jars. Sweeten each jar with the same amount of the different sugars by mass (weight). Label the jars A, B, C, and D. Keep a record of which sugar was put into each jar.

Materials

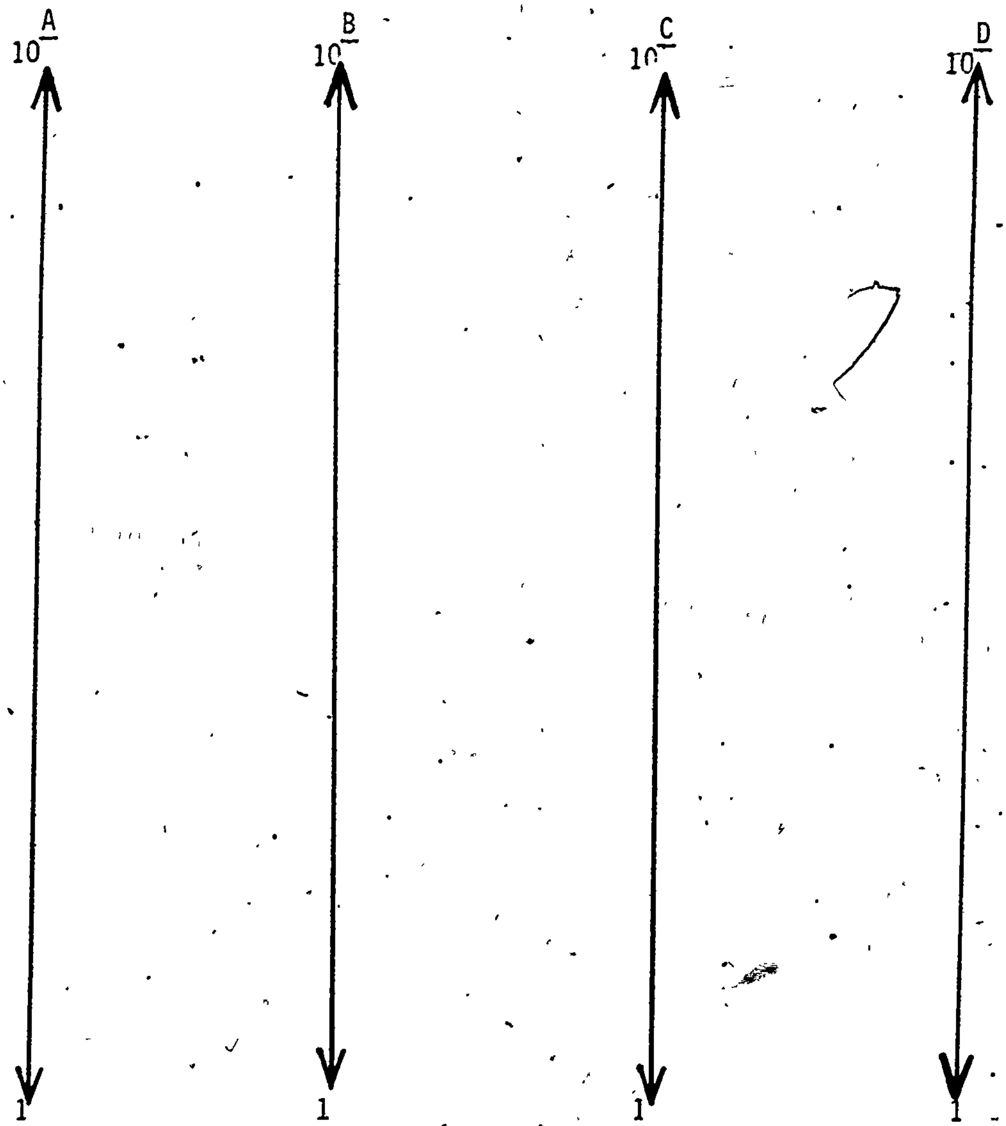
Kool-Aid - 1 package (2 quarts)
40 grams Maltose per 2 cups Kool-Aid
40 grams Sucrose per 2 cups Kool-Aid
40 grams Fructose per 2 cups Kool-Aid
40 grams Glucose (dextrose) per 2 cups Kool-Aid
30 small tasting cups
4 clean jars

NOTE: Only four of the six sugars are used. Substitutions can be made, however, make certain that one sugar is Fructose and another is either Lactose or Galactose, or Maltose. The reason for this will become evident when the sugars are tasted.

Procedure

1. Pour a very small amount into a tasting cup, then taste it.
2. Rate it on a scale of 1 to 10 for sweetness.
3. Repeat this for each of the four sugars.
4. Connect these points with a line.

Suggested Data Table



Interpretation

Chemically sugars vary only slightly. However, this can be detected by tasting these sugars. Which sugar is sweeter than the others? Which sugar is not very sweet at all?

Further Investigation

Substitute one of the sugars for saccharine.

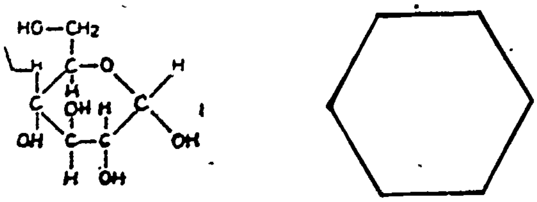
ACTIVITY II Paper Construction Models of Carbohydrates

Introduction

Models of simple sugar molecules can be cut out of construction paper to form larger carbohydrate molecules. Simple sugar molecules can combine to form larger sugar molecules and these combine to form starches or cellulose. These models should help the students understand the composition of carbohydrates and in turn show how these molecules break down in digestions. It will not be necessary to learn the exact position of all the carbon, hydrogen, and oxygen atoms.

A chemist's model of the simple sugar molecule consists of 6 carbon atoms, 6 oxygen atoms, and 12 hydrogen atoms. The formula is $C_6H_{12}O_6$. This formula does not tell about the shape of the molecule or how the carbon, hydrogen, and oxygen atoms are attached.

Consequently, the chemist uses a structural diagram to gain a deeper understanding about the properties of the sugar molecule. This is the structural formula for a simple sugar, Glucose. Note that it is in the shape of a ring.



Glucose　　Glucose

This appears to be very complicated and formidable. However, the overall shape of this molecule is a hexagon. Why not represent the simple sugar molecule by the hexagon shape? To understand sugars, starches, and cellulose, you don't need to know where each carbon, hydrogen, and oxygen atom is located. What you need to know is that there are 3 simple sugars with identical chemical formulae but slightly different structures. These are called monosaccharides. These 3 simple sugars combine with another sugar molecule to form disaccharides. If you have several sugar molecules linked together, it is a polysaccharide. These are starches or cellulose.

1 sugar molecule	monosaccharides
2 sugar molecules	disaccharides
starch and cellulose	polysaccharides

There are 6 sugars that are digested in the body. The 3 simple sugars are Glucose, Fructose, and Galactose, referred to as monosaccharides. The other 3 common sugars important in nutrition are made up of pairs of these simple sugars and are called disaccharides. These are Sucrose, Luctose, and Maltose.

The 6 sugars that are important in the nutrition of our body are as follows:

<u>Glucose</u>					Monosaccharides
<u>Fructose</u>					Monosaccharides
<u>Galactose</u>					Monosaccharides
Fructose	+	Glucose	forms	<u>Sucrose</u>	Disaccharides
Galactose	+	Glucose	forms	<u>Lactose</u>	Disaccharides
Glucose	+	Glucose	forms	<u>Maltose</u>	Disaccharides

<u>Materials You'll Need</u>

Construction paper, 3 colors
Scissors, 7 or 8 pairs per class
Paste, glue, or scotch tape
8 x 11 paper
Molecular Model Sets

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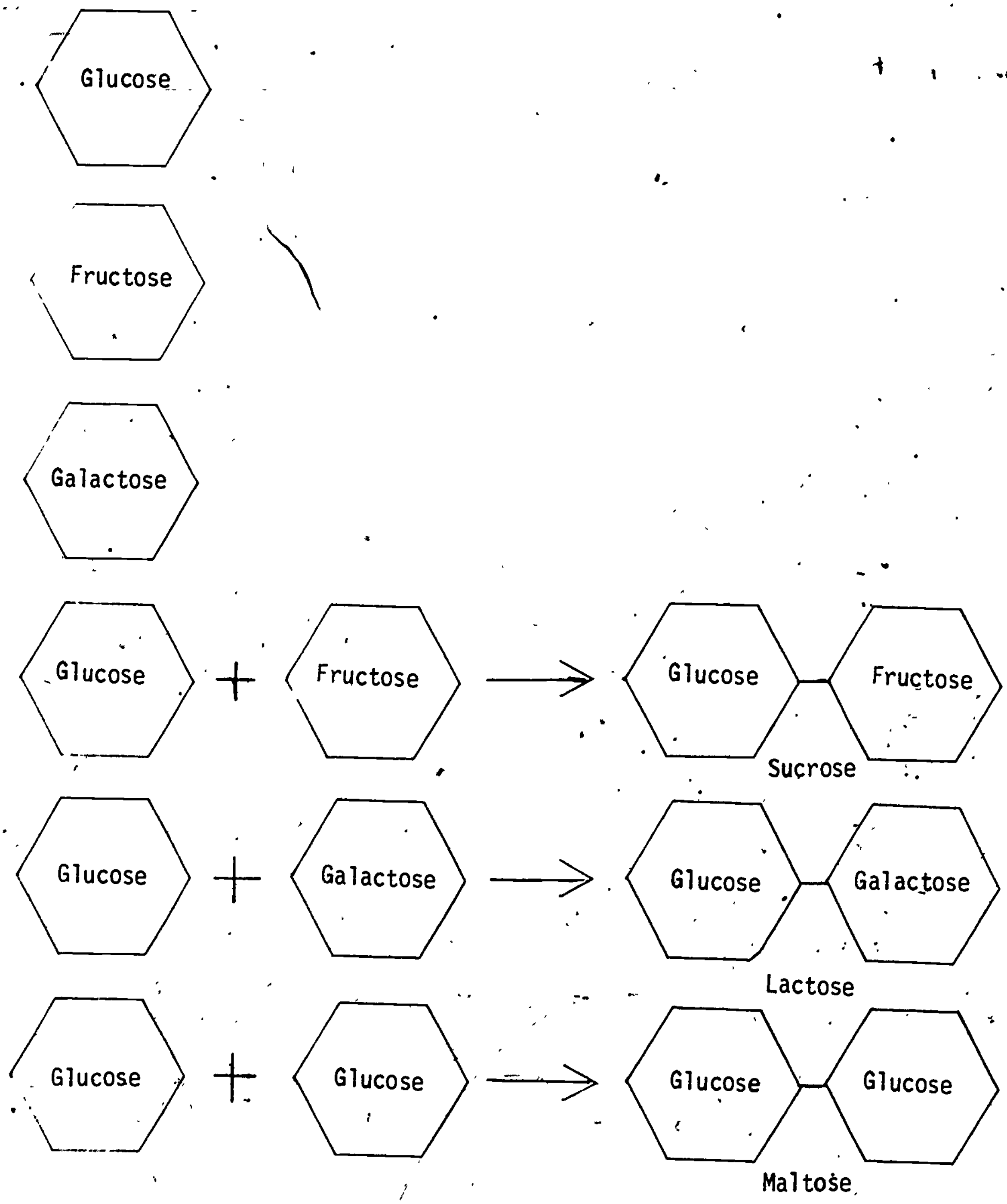
Procedure

1. Have the students cut out the hexagon shape molecules in 3 different colors. e.g. Glucose -- Blue, Fructose -- Orange, Galactose -- Green. Punch a hole in the middle of each molecule to show a ring structure. Use the 3 monosaccharides to form the disaccharides. Use the outline below to illustrate how the sugars combine to form larger more complex molecules.



Glucose is often called blood sugar, grape sugar, or dextrose.

Fructose or fruit sugar is found in fruit.

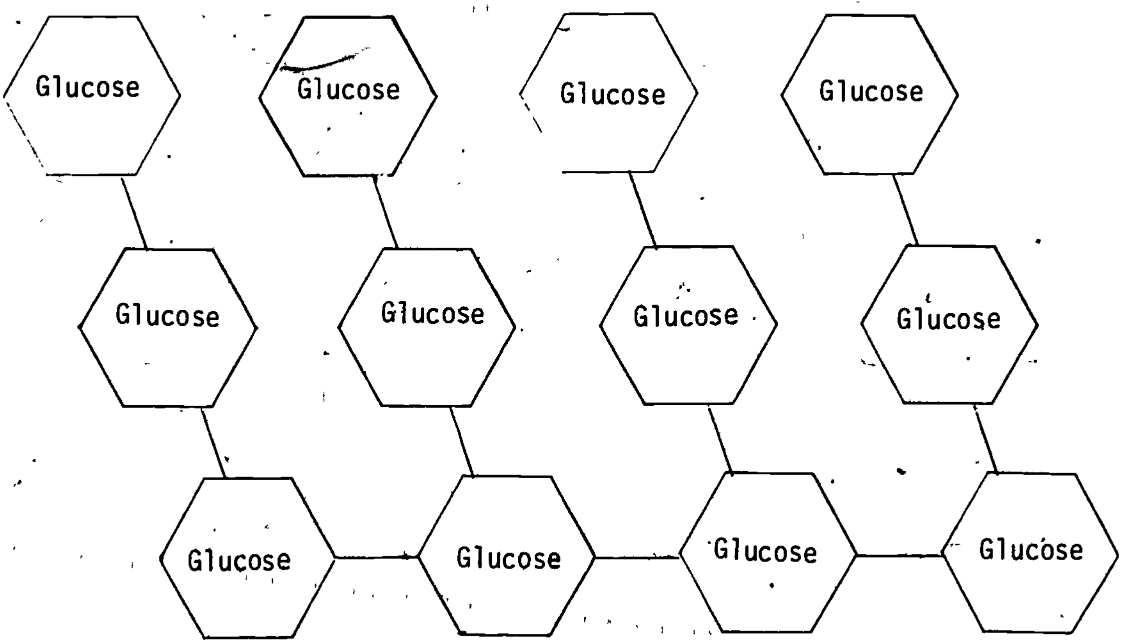
Galactose and Lactose are found in milk.

When you say "pass me the sugar", you could say "pass me the sucrose". It is made up of a molecule of glucose and fructose and comes from sugar beets or sugar cane plants.

Maltose is found only when seeds are germinating. Often called malt sugar, you may have had a malted milk shake or have heard about malt beer.

During the digestions the large sugar molecules, the disaccharides, break apart similar to the way you have just put them together. Energy is given off when these molecules break apart. This is the energy your body needs for activity.

2. Starch is made up of a branched chain of dozens of glucose molecules connected together. One starch molecule could be made up of 300 to 1,000 glucose units linked together. The students can construct a branched molecule by using a number of glucose molecules connected in a branched chain. The branched chain can be made with 10 or 12 glucose molecules.



STARCH MOLECULE

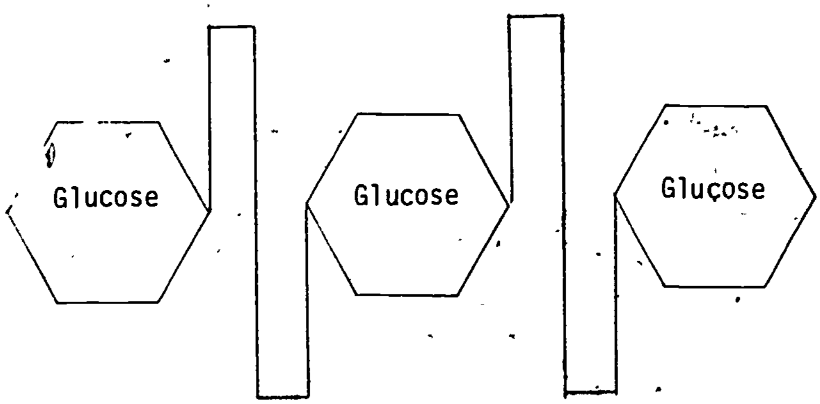
A BRANCHED CHAIN

Starch is stored in plants for use later in growth. Starches break down in digestion just the same way you put them together. These are the grains the world uses as their staple crops. Rice is the staple grain in the Orient, Europe has wheat, and the Mexicans use corn.

During digestions, enzymes break the starch molecule apart forming glucose molecules giving off energy that is necessary for your body.

3. Cellulose is made up of glucose units connected in long straight chains. The bond holding the glucose together is different than in the starch molecule. Therefore, it goes through your body undigested. Did you ever wonder why you don't eat wood?

   Make a long straight chain of glucose units. A heavy line can be drawn between the glucose molecules to show that the bonds do not break apart in digestion. We do need cellulose in our diet. It provides roughage in the form of fiber that stimulates the action of molecules in the intestines. Without fiber, you become constipated as the muscles of the digestive tract have nothing to push against. Foods rich in cellulose are fruits, vegetables, whole grain, and cereals.



CELLULOSE MOLECULE
These bonds are hard to break, therefore cellulose provides no energy for us.

Suggested Data Table

Make a chart of the foods rich in all the carbohydrates. Put this in your notebook.

Sugars	Foods Rich
Glucose	
Fructose	
Galactose	
Sucrose	
Lactose	
Maltose	
Starches	
Cellulose	

Interpretations

1. Which sugars are important in digestion?
2. Now that you have made the complex molecules of sugars, carbohydrates, and cellulose, reverse this process by showing how these large molecules are broken down into simpler glucose units. This is what takes place during digestion.

Further Investigations

How many calories does your body need each day? Use a Recommended Daily Dietary Allowance, RDA'S, chart.

Teacher's Suggested Data Table

Make a chart of the foods rich in all the carbohydrates. Put this in your notebook.

Sugars	Foods Rich
Glucose	dextrose, some fruits and vegetables, honey
Fructose	fruits, honey
Galactose	(none free - part of lactose in milk)
Sucrose	sugar cane and sugar beets; other fruits and vegetables
Lactose	milk
Maltose	germinating grains, cereals
Starches	tuberous vegetables, seeds, grains, beans and peas
Cellulose	structural part of plants, seeds, fruit covering, roots, leaves, stems

Interpretations

1. Which sugars are important in digestion?
2. Now that you have made the complex molecules of sugars, carbohydrates, and cellulose, reverse this process by showing how these large molecules are broken down into simpler glucose units. This is what takes place during digestion.

ACTIVITY III Laboratory Tests for Sugars and Starches. Demonstrating the Effect of Saliva on Starch

Introduction

Iodine, Potassium iodide, and water will turn purple or black in the presence of starch, while Benedict's solution will be used to indicate glucose. By using both of these tests, you will be able to see how digestion takes place by breaking down the starches into small glucose units.

Use the characteristic starch test by placing IKI on cornstarch. The juice from a white potato could also be used. Next try the characteristic test for sugar by using Benedict's solution on glucose. These are tests that can be performed on many foods.

The action of the enzyme, Amylase (ptyalin) on saliva can be demonstrated using IKI before and after the addition of saliva. Synthetic saliva, Diastase of malt, will be used in this activity. It will take about 20 minutes for saliva to turn the starch into sugar. Then Benedict's solution can be used to test for the presence of simple sugars or monosaccharides.

The process of digestion begins as soon as the saliva has come in contact with the starch. It is then rendered into a smaller molecule. This activity should help you understand the relationship between starches and sugars in the presence of saliva during digestion.

Materials You'll Need

Diastase (2% solution)
Beakers
6 test tubes
Test tube rack
Potato or corn starch (1% suspension in water)
5% glucose solution
IKI solution
Benedict's solution
Bunsen burners
Water bath
Wax pencil or labels

Procedure

1. Divide the class into teams of 3 or 4 students. Each team will need 6 test tubes labeled 1 through 6. Each member of the team should make a data table in their notebook.

2. Add 2 ml of glucose solution to test tubes 1 and 2. Add 2 ml of starch solution to test tubes 3, 4, 5, and 6. Be sure to shake the starch solution thoroughly before using.

3. Add 2 ml of diastase to test tube 5 and 6. Allow these tubes to

stand for at least 20 minutes. If there is not time to complete this investigation in one period, the tubes may be left overnight, and the results recorded the next day.

4. Add 2 ml of IKI solution to test tubes 2, 4, and 6. Observe the color in each of these tubes.

5. Add 2 ml of Benedict's solution to tubes 1, 3, and 5. Heat these tubes in a water bath. Boil the water bath gently for about 5 minutes. Observe the color in each tube after heating and record.

Suggested Data Table

Copy this in your notebook.

Test Tube #	1	2	3	4	5	6
Contents	Glucose	Glucose	Starch	Starch	Starch Saliva (diastase)	Starch, Saliva (diastase)
Treatment	Benedict's Solution	IKI	Benedict's Solution	IKI	Benedict's Solution	IKI
Results						

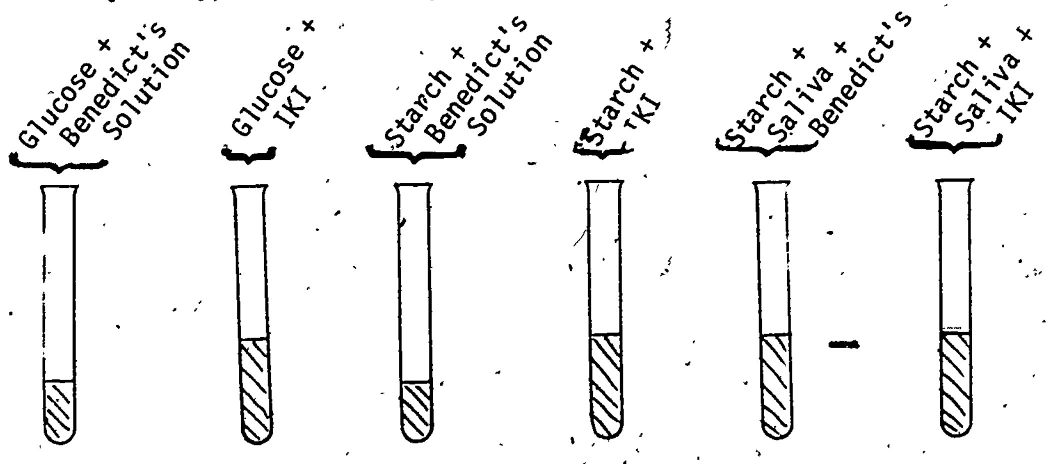
Interpretations

Review the completed data table, and explain the results. What is your hypothesis about saliva?

What is the purpose of test tube #1, #2, and #3?

What appears to be the effect of the saliva on the starch?

Can you think of other experiments that can be performed to check your hypothesis about the effect of saliva?

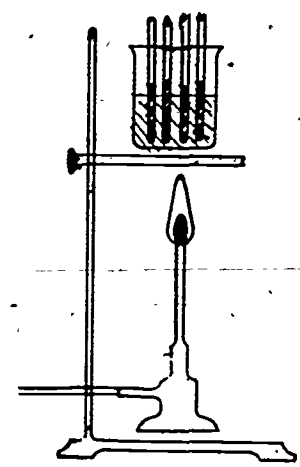


ACTIVITY IV Can Benedict's Solution be used to Test Different Sugars?

Introduction

A chemical indicator, Benedict's solution, may be used to detect the presence of certain sugars. To test for sugar, add Benedict's solution to the different sugar solutions and heat the mixture in a water bath. If the heated solution turns green, orange, or reddish-brown, the presence of sugar is indicated. Not all sugars will react in this manner.

Materials You'll Need



- 4 test tubes (for each team)
- 5% glucose solution
- 5% fructose solution
- 5% sucrose solution
- Water bath
- Ring stand
- Bunsen burner or hot plate
- Graduated cylinder
- Benedict's solution

Procedure

1. The class should be divided into teams of 3 or 4 students. Label the test tubes with the proper contents as shown in the Suggested Data Table. Each member of the team should copy the data table in their notebook.

2. Pour 2 ml of each sugar into each test tube as indicated on the table.

3. Add 2 ml of Benedict's solution to each tube.

4. Place all 5 test tubes in a water bath. Heat the water to boiling, and boil gently for five minutes.

5. After heating, observe the color in each tube and record in the data table.

Suggested Data Table

Tube	1	2	3	4
Contents	2 ml of H_2O	2 ml of 5% Glucose Solution	2 ml of 5% Fructose Solution	2 ml of 5% Sucrose Solution
Results: Before Heating				
After Heating				

Interpretation

Can you use Benedict's solution to test all sugars?

Which sugard did you find that gave a positive test with Benedict's solution?

If you wanted to use Benedict's solution to test for sucrose, what procedure would you use?

Further Investigations

Test gum, sugarless gum, candy bars, mints, cold drinks, pop tarts, cough drops, sugar coated cereal and regular cereals.

ACTIVITY V Can Sugar Be Decomposed?

Introduction

Carbohydrates are one of the six classes of nutrients necessary for the nutrition of your body. Starches are made up of a different number of glucose molecules. You can subdivide carbohydrates into sugars, starches, and cellulose. The chemical composition of sucrose which is called by most people sugar, can be easily understood by a decomposition reaction, as it is made up of one molecule of glucose and one of fructose. Both of these sugars break down into H_2O and carbon. By adding concentrated sulfuric acid to table sugar, you will quickly see that water vapor is given off leaving carbon as a residue.

Materials You'll Need

125 ml Pyrex beaker
Table sugar - enough to half fill a 125 ml beaker
Stirring rod
20 ml concentrated sulfuric acid (H_2SO_4)

Procedure

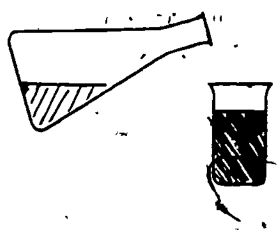
TEACHER DEMONSTRATION ACTIVITY

CAUTION: Sulfuric Acid, H_2SO_4, is a strong acid -- handle with care. Avoid breathing the vapor given off during the reaction.

To a beaker half full of sucrose, table sugar, add 20 ml of concentrated H_2SO_4 and stir until the mixture has the consistency of thick paste. Allow a few minutes for the reaction to take place.

What is given off as a result of this reaction?

What remains in the beaker?



Interpretation of Results

This is a partial equation for this reaction when sulfuric acid is added to sugar.

$$\underset{\text{(table sugar)}}{\text{Sucrose}} \xrightarrow{H_2SO_4} \text{carbon} + H_2O + ?$$

What is the gas given off in the reaction?

What is the residue?

What word should be written in place of the "?"? If there is a doubt in your mind about something else entering into the reaction, then feel the outside of the beaker.

Now, can you see how the word "carbo-hydrate" was derived?

UNIT III ARE FOODS DIFFERENT?

CONCEPT C The role of fats in nutrition.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Identify foods rich in fats.

2. Compare the ratio of Carbon to Oxygen in fats and carbohydrates.

3. Make paper construction models of the fat molecules.

4. Distinguish between saturated and unsaturated fats by chemical tests.

5. Know which foods contain saturated and unsaturated fats.

6. Recognize the role of fats in nutrition.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition Pages 58-94; 208-217.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Paper Construction Models of Fats.

II. How Fat is the Fat? --A Mini-Experiment (page 20), found in The Chemistry of Food, A Consumer Chemistry Learning Activity Package, 1977 Unigraph

TRANSPARENCY

I. The Fat Molecule

TEACHING STRATEGIES

Fats can be very simply tested by using the brown paper method. Remind the students about Activity I, that introduced Concept A, where they used the brown paper method of testing for fats.

Carbohydrates and fats are made up of the same elements - carbon, hydrogen, and oxygen. The difference is the ratio of these elements. Compare the ratio of carbon to oxygen found in fats vs. carbohydrates. This will also serve as a good math review.

The proportion of carbon to oxygen is much higher in fat than it is in carbohydrate.

$\underbrace{C_{57}H_{110}O_6}$	$\underbrace{C_6H_{12}O_6}$
Glyceryl Tristearate (fat)	Glucose (carbohydrate)

$$\frac{C}{O} \quad \frac{57}{6} = \frac{9.5}{1} \qquad \frac{C}{O} \quad \frac{6}{6} = \frac{1}{1}$$

Use Transparency I, A Fat Molecule, to compare the outline of the molecule to the shape that will be used in Activity I, "Paper Construction Models of Fats and Oils, the Lipids". Make certain that they look up foods high in saturated and unsaturated fats in the tables found in "Nutritive Values of Foods", a USDA publication. Relate glycerol to the manufacture of soap. Glycerol is a by-product of the soap industry, and is used in the synthesis of explosives.

Capitalize on current advertising of polysaturated fats. Discuss whether or not the students can depend on the validity of this advertising.

As the students are doing Activity II, "How Fat is a Fat -- A Mini Experiment", have them compare the molecule to those made in Activity I.

Emphasize the importance in nutrition of fats in the diet. Fats provide oil for the skin, keep hair glossy, nourish scalp, protect our body from injury and extreme temperature. Excess amounts of fat in the diet will add to the body weight.

Make it clear that the students need a wide variety of foods in their diet to make certain they have all the nutrients.

Stearic Acid (animal fat) + NaOH (Lye) $\longrightarrow$ Soap + Glycerol (Glycerine)

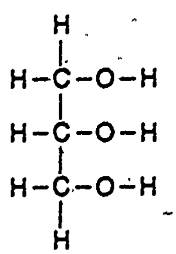
ACTIVITY I Paper Construction Models of Fats and Oils, the Lipids.

Introduction

The shape of the molecules of fat can be cut out of construction paper, so that a visual outline can be used to understand the role these compounds play in nutrition. The family of compounds that include fats and oils is called lipids. These compounds provide oil for your skin, keep hair glossy, and scalp nourished. The fat on your body protects it from extreme temperature, the kidneys from being injured or jarred, and a woman's mammary glands in the breasts from heat and cold. The fat also provides the body with an available supply of energy. This uninterrupted flow of energy is vital to life. A few minutes without this readily available source of energy and the body would die. The main source of energy reserve is stored in the liver. Once this has been used there must be a backup reservoir stored as body fat. A polar bear is capable of storing large amounts of fat in order to maintain his body temperature during winter hibernation. On the other hand when you eat too much fat, it is stored in the body and you gain weight.

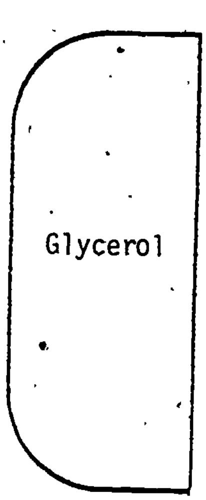
The fat usually flavors food. If chicken is stripped of the fat, it becomes tasteless. The fat on bacon gives the aroma as it cooks. Hamburger needs the fat for taste. Milk without the butterfat becomes tasteless. Four vitamins -- A, D, E, and K are soluble in fat and therefore, are found in the fatty part of the milk and meats. Skimmed milk must be fortified with A and D in order to be equal in vitamins to whole milk.

Fats are made up of the same elements founds in carbohydrates - carbon, hydrogen, and oxygen. The difference is in the ratio of carbon to oxygen. The fats are made up of fatty acids and come in different length molecules. There is a common structure that holds the fatty acids together -- this is glycerol. Below is the structural formula for glycerol.

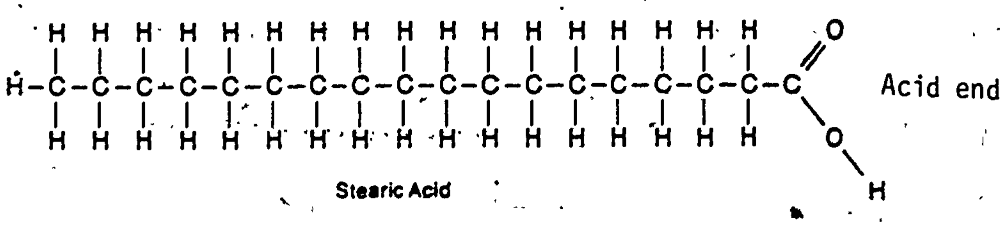


Glycerol

The outline of the molecule can be represented by this shape.



The fatty acids are a chain of carbon atoms with the acid group attached to one end.

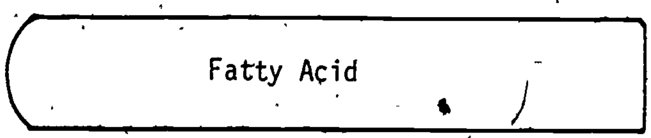


Stearic Acid

Often this molecule is written in a simplified form. Each line represents a carbon bond with hydrogen atoms attached.

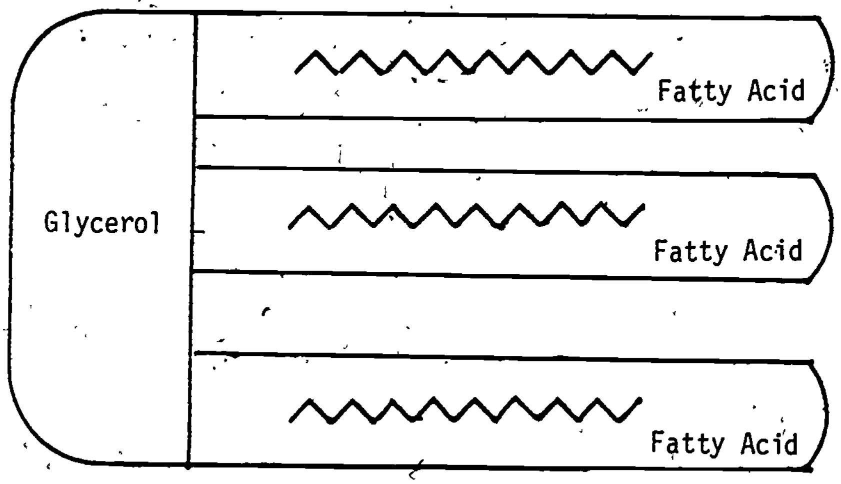
Stearic Acid (simplified)

The shape of this molecule is similar to this.



Three of these fatty acids attach to the glycerol molecule to form a fat, a triglyceride. It could be the one found in butter.

Glycerol + 3 fatty acids ⟶ Fat



A Fat - Triglyceride

This Could Be a Butter Molecule

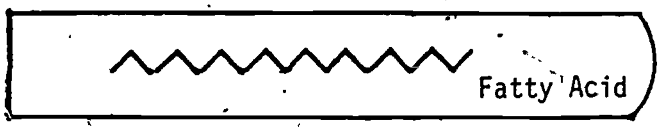
This is only one of the fats. Many different lengths of fatty acids are attached to the glycerol to form numerous other fats. These are saturated fats because as many hydrogen atoms as possible are attached to the carbon atoms. Unsaturated fatty acids are missing one hydrogen atoms. This is represented with two parallel lines which indicates a double bond. Poly-unsaturated fats are missing several hydrogen atoms and can be written with two sets of parallel lines each one indicating a double bond.

Materials You'll Need

Construction paper, 2 colors
Scissors, 7 or 8 pairs per class
Paste, glue or scotch tape
8 x 11 paper for each student

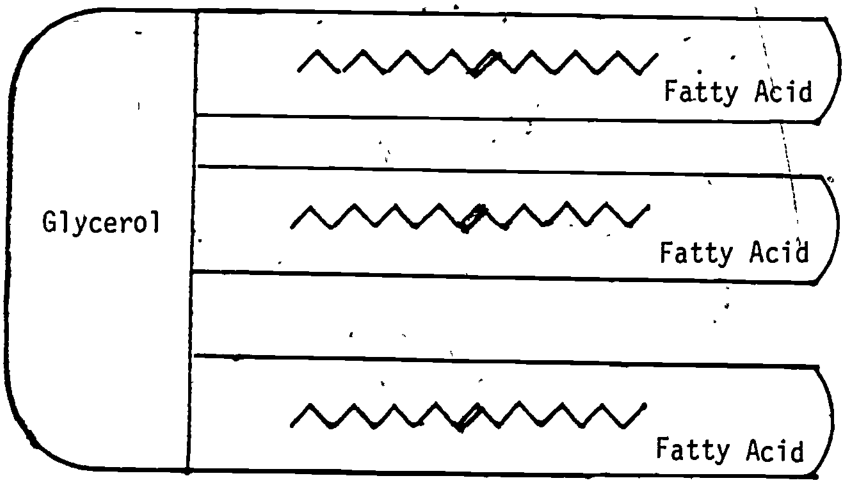
Procedure

1. Cut out several of the shapes that represent the glycerol molecule. Write glycerol on the construction paper. Next cut out a number of fatty acids. Remember there must be 3 fatty acids for each glycerol. You can see why these are called triglycerides. On each of the fatty acids, draw the simplified version for the molecule. Each fat molecule must have the same 3 fatty acids attached.



Draw the simplified version on the outline of the fatty acid.

2. The polyunsaturated fatty acid molecules can be made in a very similar way, just make certain you indicate a double bond - parallel lines. Where you place a double bond, a hydrogen atom is missing. This forms the polyunsaturated fat. For every set of parallel lines, it means that you have a double bond as the fat is unsaturated. If the bond is missing 2 or more hydrogen atoms, it is polyunsaturated.



A Polyunsaturated Fat - Triglyceride

.Olive Oil

People with heart trouble are told by their doctor to reduce the amount of saturated fats in their diets by substituting polyunsaturated fats. Often it is recommended to cut out butter and use soft margarine in its place. Generally speaking, hard or animal fats are saturated while vegetables and fish oils are polyunsaturated.

Another rule of thumb that can be used to remember which fats are saturated and unsaturated is to see if the fat is a solid or liquid at room temperature. If it is a solid, then the fat must be saturated. If the fat is a liquid then it probably is unsaturated. This is because most saturated fats have a high melting point. That means it has a higher melting point than the room temperature.. This will make the fat a solid when you buy it, like shortening. The unsaturated fats have a melting point which is lower than room temperature making it a liquid. An example of an unsaturated fat is corn oil.

Suggested Data Table

Make a chart of the fats used frequently in cooking. Indicate if these are saturated or unsaturated. Use Nutritive Value of Foods. Put this data in your notebook.

Fats	Saturated	Unsaturated
Margarine		
Shortening		
Lard		
Bacon drippings		
Butter		
Corn Oil		
Olive Oil		
Whipped Margarine		
Vegetable Oil		

Interpretation

What fats do you eat that are saturated?
What fats do you eat that are unsaturated?

Further Investigation

Find out how cholesterol is rated to saturated fats.
Does anyone in your family have to be careful not to eat saturated fats?

ACTIVITY II How Fat is the Fat? -- A Mini Experiment, page 16-20, The Chemistry of Food, A Consumer Chemistry Learning Activity Package, 1977 Unigraph.

Introduction

The background information is on pages 16-19. Again it will not be important to learn the chemical formulae of the fats. It is important to understand the difference between a saturated and an unsaturated fatty acid.

The procedure for the experiment is on page 19a-20.

CAUTION: Due to the chemical used, it is suggested that this activity be demonstrated by the teacher before students perform the tests.

Materials You'll Need

Page vii in The Chemistry of Food.

Procedure

Use Dichlormethane as the solvent for the fats and oils, lipids. As a safety precaution, heat the test tubes in a water bath. See Page 20 of The Chemistry of Food for the instructions.

Suggested Data Table

Once the technique has been perfected, a number of fats and oils can be tested. A variety of fats and oils to be tested can be brought in by the students.

Fats or Oils	Results of Test (number of drops of Iodine it takes for the pale violet color to disappear)	Saturated	Unsaturated
Corn Oil			
Olive Oil			
Safflower Oil			
Shortening			
Lard			

Interpretation

Do you see any corollary between state of the oil (liquid or solid) and unsaturated and saturated.

What is a polyunsaturated fatty acid?

UNIT III ARE FOODS DIFFERENT?

CONCEPT D The role of protein in nutrition.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Point out that the elements carbon, hydrogen, and oxygen make up Amino Acids with an added element, nitrogen.

2. Tell the difference in Amino Acids by the shape of the molecule.

3. Designate one end of the Amino Acid as the nitrogen group and the other end as the acid group of the molecule.

4. Distinguish between Amino Acids and a complete protein.

5. Identify proteins by a chemical test.

6. Identify foods rich in protein.

7. Determine the role of protein in the diet.

8. Describe in their own words the protein deficiency disease of Kwashiorkor.

9. Determine the amount of protein needed for their ideal body weight.

10. Use the knowledge to explain how a vegan must be careful to include a complete protein in their diet.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition, Pages 97-151; (pictures of Kwashiorkor 139, 144, 145).

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Construct Paper Models of Protein Molecules.

II. Does Your Fingernail Contain Protein?

III. How Much Protein Do I Need?

TRANSPARENCIES

I. Amino Acid: Structural Formula and Molecular Shape

II. Possible Shapes of Amino Acids

III. The Protein Molecule of Insulin

TEACHING STRATEGIES

Proteins contain nitrogen and are the most abundant organic compound in living things. Introduce the lesson by placing on the overhead projector Transparency I, "Amino Acid: Structural Formula and Molecular Shape." Point out that the same elements carbon, hydrogen, and oxygen are present that make up carbohydrates and fats. However, now they will notice that nitrogen is present in all Amino Acids even though there is a different ratio of carbon, hydrogen, and oxygen. It will not be necessary to learn the position of each element, as the shapes of these molecules will be used to understand how it takes many different Amino Acids to combine to form a complete protein.

Use Transparency II, "Possible Shapes of Amino Acids" to introduce the concept that there are a number of different Amino Acids. Each has a nitrogen group at one end while the other end contains an acid group. Attached to the center of each molecule is another group of atoms that make each structure different. Now outline the shape of the molecule that will be used when construction models of the Amino Acids are used to form protein. Stress the importance that certain Amino Acids must combine to form a complete protein.

Transparency III, "The Protein Molecule of Insulin" is a complete protein. Each of the three letters represents another Amino Acid. This transparency is used to show the complex protein molecule that is made up of Amino Acids. Do not have the students memorize the abbreviations for each Amino Acid. This is not the important concept of this lesson. What is important is for them to see that certain Amino Acids combine in a definite pattern to form protein.

Activity I, "Construct Paper Models of Protein Molecules", will help the students understand how Amino Acids combine to form proteins. Emphasize that in digestion these molecules break down into Amino Acids. Excess nitrogen is released in the urine.

It will be important for the students to do Acivity II, "Does Your Fingernail Contain Protein", as this will give them laboratory experiences testing for nitrogen. Have the students bring the items to class to be tested. Make certain that each student does the fingernail test. This should help them remember that the nail is protein as the yellow spot will last several weeks.

By this time the students may be asking themselves, what are the functions of proteins? Why does the body need protein? Try to leave these questions unanswered at the end of the class period for several days. By doing this, it should lead the students to realize the large number of functions played by protein in the body.

After these questions have been left open for a few days, go over the following functions with them:

1. Proteins act as enzymes.
2. Proteins help maintain the water balance.
3. Proteins help maintain the acid-base balance.
4. Proteins confer resistance to disease.
5. Some hormones are proteins such as thyroid hormone and insulin.

6. Proteins carry nutrients into and out of the cells.
7. Protein carriers transport nutrients in the circulatory system.
8. Proteins carry oxygen.
9. Proteins are involved in the clotting of blood.
10. Proteins help make scar tissue, bones, and teeth.
11. Proteins are necessary for vision.
12. Proteins are needed for growth and maintenance.

Chapter 4 in Understanding Nutrition gives the details of these functions of protein. This should leave no doubt concerning the importance of proteintein in the diet. It will become apparent when you look at the protein deficient diet of the people living in underdeveloped countries. The protein deficiency disease is Kwashiorkor (kwash-ee-OR-core). In the textbook, Understanding Nutrition, are pictures of children with Kwashiorkor. The students need to look at these children.

The word originally meant "the evil spirit which infects the first child when the second child is born". It is easy to see how this happens. The mother has been nursing her first child when she gives birth to a second. She has been providing protein in her milk for the first born. Now with a second child on the way she must wean the first born. After weaning, the first born becomes weak, fretful, apathetic, and belly becomes swollen, often the hair looses color, and the child becomes stunted. No wonder the people thought an evil spirit had infected their first born child.

Another disease that is important is Marasmus (ma-RAZ-mus) a caloric deficiency disease. When the diet is deprived of the necessary calories, protein is used thus causing a wasting away of the body weight. These two disease often go hand in hand. The caloric deficiency, Marasmus, causes the person to use the protein already in the body (the muscles) as energy. Then Kwashiorkor sets in as the body is not getting enough protein. These two deficiency diseases are a tremendous problem in world hunger facing us now and in the future.

The students should be wondering how much protein is needed by their body. By having them determine an ideal body weight, it will eliminate the problem of embarrassing a student that is overweight. Hopefully this will also help the students realize that their ideal body weight requires just a certain amount of nutrients. Any more that is needed will be stored in the body.

The students should be wondering how much protein is required by their body. In Activity III, "How Much Protein Do I Need?", the students will determine exactly how much protein is necessary for their well being. It is important for them to grasp the meaning of nitrogen equilibrium. By using the diet of a vegetarian as an example, you can show how important it is for people to maintain the proper nitrogen balance. Examples of extreme protein deficiency of Kwashiorkor, will illustrate negative nitrogen balance while a positive nitrogen balance will cause excess pounds to be added to their body.

Again emphasize that a proper diet needs a wide variety of foods, so that all the nutrients will be present.

ACTIVITY I Construct Paper Models of Protein Molecules

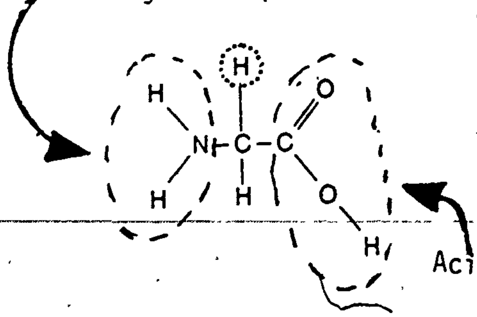
Introduction

A protein compound contains carbon, hydrogen, and oxygen just like the carbohydrates and fats, but it also contains nitrogen. These 4 elements combine to form Amino Acids. Nitrogen is at one end of the molecule and an acid group is at the other end. Transparency I shows the Amino Acid molecule. Note that the nitrogen group is at one end while the acid group is at the other end. Now compare the outline of this molecule. The central part of the molecule is different for each Amino Acid.

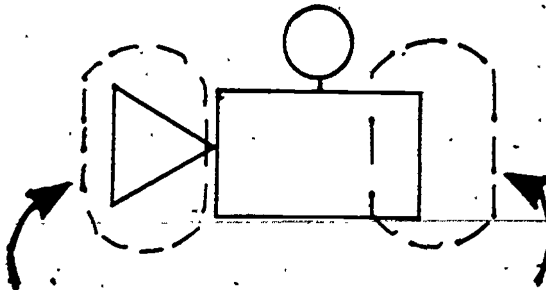
Amino Acid

Nitrogen Group

Glycine



Acid Group



Nitrogen group

Acid group

Use Transparency II to illustrate this difference for each of the Amino Acids. Outline the shape of each molecule as this will be used later.

It takes many Amino Acids to form one protein molecule. There are 22 different known Amino Acids. Eight or nine of these are essential for growth and repair. This means they cannot be synthesized by the body and must be provided through your diet. The other Amino Acids are called non-essential. These can be synthesized from carbohydrates and nitrogen in the body or from other non-essential Amino Acids through molecular rearrangement.

Materials You'll Need

Construction Paper (1 color).
Scissors, 7 or 8 pairs per class
Paste, glue, or scotch tape
8 x 11-1/2 paper

Procedure

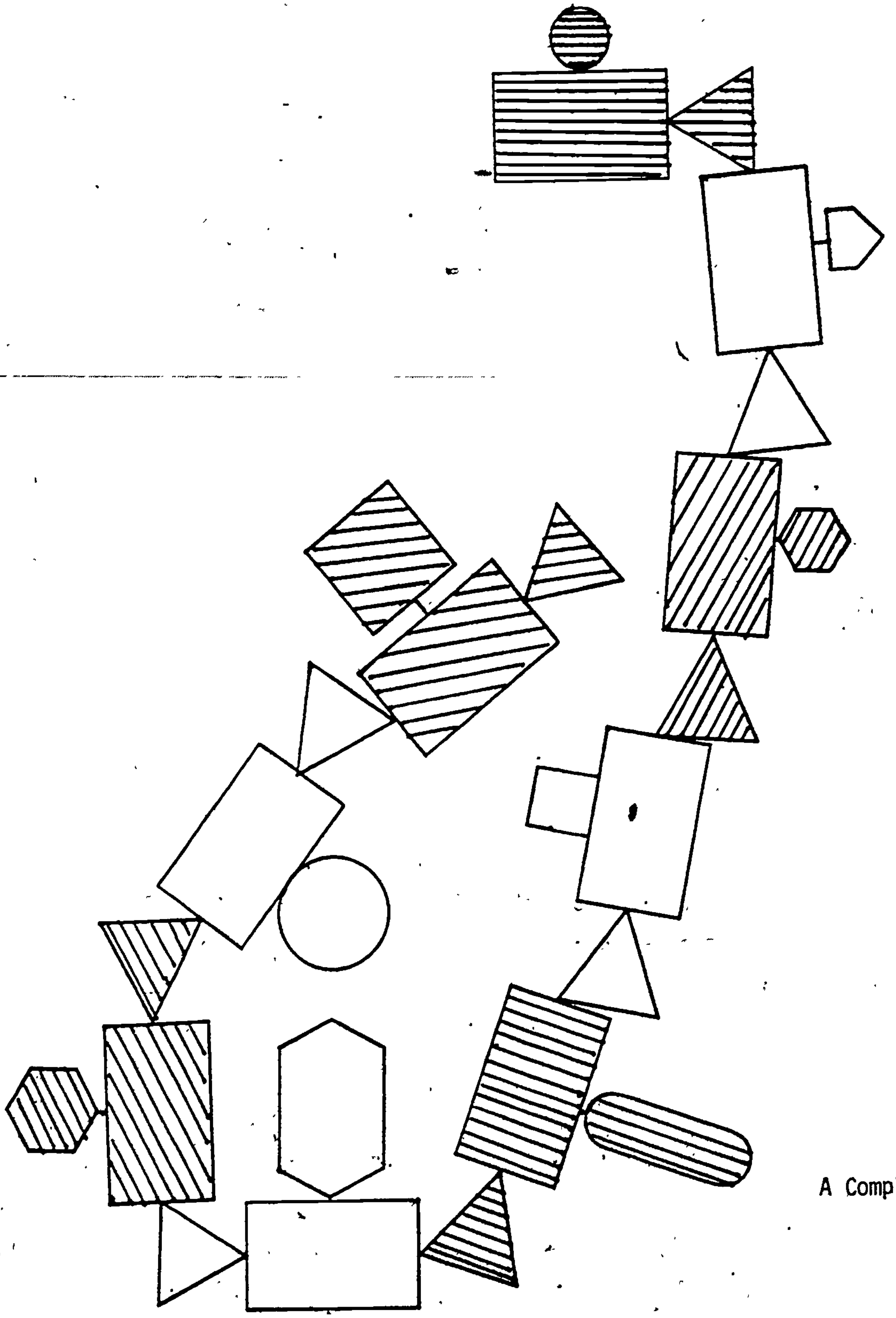
1. Cut out a number of Amino Acids with different central parts.

   The Amino Acid molecules are formed by linking together an acid end with a nitrogen end. Each Amino Acid has a different group attached to the center. It takes many different Amino Acids to form one protein molecule. Make certain that one end of the Amino Acid is designated as the nitrogen end while at the other end is an acid group.

   When Amino Acids are joined, a peptide bond is formed. When 2 Amino Acids combine, you have a dipeptide. 3 Amino Acids form a polypeptide. Some polypeptide bonds can be made up of 200 to 300 Amino Acid molecules. To get the true picture of how a protein molecule is produced in the body, put together 8 or 9 different Amino Acids. These form a chain folded over each other, as this happens the molecule becomes tangled.

2. Use the paper models to combine at least 8 or 9 Amino Acids to show how protein are formed.

A complete protein has all of the 8 or 9 essential Amino Acids. Complete protein are found in animal meat, soy beans, peanuts, and nuts. Cereals and grains are incomplete protein. Even gelatin which comes from animal bones lacks one of the essential Amino Acids. Meat, milk, cheese, and eggs are made up of complete proteins as these contain all of the essential Amino Acids.



A Complete Protein

3. The teacher should use Transparency III of the insulin molecule as an example of a complete protein.

   This transparency shows the Amino Acids that make up the insulin molecule. Each of the three letters is the abbreviation for the different Amino Acids, e.g. Glycine is Gly; Aspartic Acid is ASP; Alanime Acid is Ala.

   Vegetarians will eat only vegetables. Their essential protein must come from plants, but this is a lower quality. There are 2 types of vegetarians. A strict vegan eats neither animal flesh or animal products. Their diet consists mainly of cereals, nuts, and legume products. They have to be very careful to include all the essential Amino Acids in their diet. The other type are called lacto-ovo-vegetarians. These will eat animal products like milk, eggs, and cheese. Lacto means milk and ovo means egg. Both of these are included in their diet.

   In recent years, vegans have increased in the United States. Eastern religions have taboos concerning the eating of meat. Anti-establishment feelings have also resulted in an increase of the "vegan fad". Others have been caught up in merely a new fad. All of this has led to vegetarian food stores springing up in the larger cities.

   The vegetarians must become an expert in nutrition in order to have a balanced diet. For a strict vegan to receive the necessary protein, a vitamin B_{12} supplement must be added to the diet. It is well to remember that <u>good nutrition depends upon including a wide variety of foods in the diet</u>.

<u>Interpretation</u>

How are Amino Acids the same?

How are Amino Acids different?

What is the name of the bond that holds the proteins together?

Why do vegetarians have to be so careful with their diet?

Which end of an Amino Acid combines with another Amino Acid?

<u>Further Investigation</u>

What are the names of the 8 or 9 essential Amino Acids that are necessary for a complete protein?

How many grams of protein does your body need each day? Use a Recommended Daily Dietary Allowance, RDA'S, chart. Convert this to pounds.

6

ACTIVITY II Does your Fingernail Contain Protein?

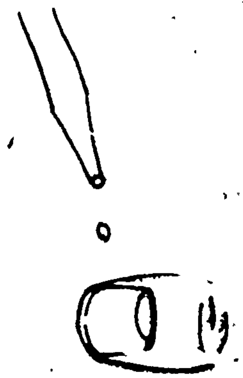
Introduction

Fingernails are protein, just as the muscles in your body. Two simple tests for protein can be made in the classroom. Try it on your fingernail and use it as a test color for other protein.

Protein has many functions in the body. Usually you think of proteins needed for growth, maintenance and repair. Proteins form the matrix or frame for the minerals to lay down on and crystallize, such as calcium, phosphorus, and fluoride. This is how your teeth, bones, and scar tissue are formed.

In this activity you will be able to choose the test that is best for your situation. The two simple tests for protein are the "Nitric Acid" test and "Biuret Test".

Both are colorimetric tests that show a color change. Your fingernail is protein, therefore, it can be used for a test color. Have the students bring in various foods from the protein group of meat, cheese, milk, nuts, and beans as well as some vegetables.



Nitric Acid Test

Materials You'll Need

Conc. Nitric Acid (HNO_3)
Conc. Ammonia water
Paper towels or glass plate
Various foods from the protein group

Procedure

1. Place one drop of Conc. HNO_3 on your fingernail. If protein is present, a yellow color will be noticed.

2. Neutralize the acid with a drop of Conc. Ammonia water. The yellow spot should turn orange.

CAUTION:	Use extreme care with the Nitric Acid. Do NOT allow Conc. HNO_3 to get on your skin or clothing.

Biuret Test (Alternate Test)

Materials You'll Need

.1 M Copper sulfate ($CuSO_4$) } or Biuret's Solution
6 M Sodium hydroxide (NaOH) }
Paper towels or glass plate
Various foods from the protein group

The solutions of .1 M $CuSO_4$ can be made by dissolving 25 grams of $CuSO_4 \cdot 5H_2O$ in 1000 ml of H_2O. The 6 M NaOH solution can be made by using 240 grams of NaOH dissolved in 1000 ml of H_2O.

Procedure

1. Place a drop of $CuSO_4$ solution on the fingernail.
2. Add a few drops of NaOH solution. A reddish-violet to violet-blue color will result indicating the presence of protein.

If liquid protein is used such as an egg white, coagulate it by heating before testing.

Suggested Data Table

Using either one of the above method, you are now ready to test foods for protein. Make a data table in your notebook of the results.

Item Tested	+ will indicate presence of Protein - will indicate absence of Protein
Fingernail	
Egg White	
White Chicken Meat	
Baloney	
Hot Dog	
Fish	
Carrot	
Soy Beans (cooked)	
Lettuce	
Dry Peas (cooked)	
Potatoes	
Rice (cooked)	
Cottage Cheese	
Cheese	

Interpretation

Make a general statement of the foods that contain protein. Your statement should be simple so that it can be remembered for life.

Why was there a caution about getting Nitric Acid on your skin and clothing, yet it didn't hurt to put a drop on your fingernail?

ACTIVITY III How Much Protein Do I Need?

Introduction

Hamburger, steak houses, and fried chicken chains have sprung up all over the country. Their success is due to the people in the United States being "meat and potato eaters".

Most of the people in this country consume a tremendous amount of meat, perhaps more than any other country. Meat is an expensive source of protein as grain has to be grown and then fed to cattle and chicken. Consequently, it takes more energy to produce protein in the form of meat than it does to produce vegetable protein.

How much protein does your body require for growth, maintenance, and repair will depend upon your sex and age. While you are a teenager, your body will need more protein than you will need when you are in your twenties. In order to determine the amount of protein required by your body, multiply a factor of 1 by your ideal body weight in kilograms. Remember your muscles are still developing and will need extra nitrogen in the form of protein. You also need protein to maintain all of your body functions.

When you are in your twenties, this factor will change. Males ♂ will use a factor of 0.9 while females ♀ will use 0.8.

In this activity, you will determine the amount of grams of protein your body needs. Then you will determine how much protein you are actually putting into your body.

After you compare these figures, you will find out if you have a nitrogen equilibrium, a positive nitrogen balance, or a negative protein balance.

Materials You'll Need

"Nutritive Value of Foods", at least 1 per 2 students.

Procedure

1. Decide on an ideal body weight. The weight you would like to maintain all your life.

2. This weight is probably in pounds. It must be converted to kilograms. Use the cross cancellation method to convert your weight in pounds to kilograms.

   $$\underline{\hspace{3cm}} \text{ Ideal Body Weight} \times \frac{1 \text{ kilogram}}{2.2 \text{ pounds}} = \underline{\hspace{3cm}} \text{ kg}$$

   All you are doing is dividing your Ideal Body Weight in pounds by 2.2 pounds.

3. Determine the number of grams of protein you need by multiply-

ing the factor of 1 by your weight in kilograms.

Your weight _______ kilograms x 1 = __________ grams of protein.

Example: Teenager -- 63 kg x 1 = 63 grams

♂ over nineteen 63 kilograms x 0.9 = 56.7 grams

♀ over nineteen 50 kilograns x 0.8 = 40.0 grams

4. List all the food items containing protein that you have consumed in the last 24 hours. This will include milk products (cheese, yoghurt, ice cream), beans, peanut-butter, nuts, and protein enriched bread.

5. Look in "Nutritive Value of Foods" to determine exactly how many grams of protein are in the food that you have eaten.

6. Do you have a Nitrogen equilibrium?

   N in = N out

   Or do you have a positive Nitrogen balance?

   N in > N out

   Or perhaps you have a negative Nitrogen balance?

   N in < N out

Further Investigation

Determine the amount of protein in a hamburger from one of the fast food chain stores. Each time you have to "Think Metric".

Determine the amount of protein in Colonel Sanders' 2 piece chicken dinner.

Why is Kwashiorkor a problem in underdeveloped nations?

UNIT III ARE FOODS DIFFERENT?

CONCEPT E   Vitamins are small organic molecules needed in minute amounts to sustain life.

OBJECTIVES   Upon completion of this concept, the students should be able to:

1. Interpret the vital role of vitamins in nutrition.
2. Distinguish between water soluble and fat soluble vitamins.
3. Realize the importance of the toxic effect of taking vitamins unnecessarily.
4. Use titration to analyze foods for the presence of Vitamin C.
5. Recognize vitamin deficiency diseases.
6. List several foods rich in each vitamin.
7. Explain why it takes a variety of foods to get all the vitamins needed in nutrition.
8. Grasp the meaning of vitamins as coenzymes.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition Pages 317-359; 389-419. RDA Chart - inside front cover.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Analysis of Fruit and Vitamin C Tablet for Vitamin C, The Chemistry of Food Additives, Page 6-8

II. Vitamins: Where Do I Find Them?
What are the Deficiency Symptoms?

TEACHING STRATEGIES

By now the students should have a good understanding of the role played by carbohydrates, fats, and proteins in nutrition. These are all large molecules, consumed in great quantities, and each is vital to life. Vitamins on the other hand are consumed in small amounts, relatively little molecules, and also vital to life. The role of vitamins is that of a "helper" in digestion and absorption of foods. There are 15 different vitamins each with its own special role to play. Vitamins must be handled with care as these can be easily broken down. Food processors as well as cooks must be aware of the destructibility of vitamins.

It is easy to divide vitamins into two groups. The water soluble vitamins are B and C and the fat soluble group are A, D, E, and K. The differences can easily be understood in digestion. The water soluble vitamins go directly into the blood. The fat soluble vitamins are found in the fats (lipids), such as fish oils and plant oils. Once absorbed in the intestinal tract they can not be excreted and are stored in the liver and fatty tissue of the body.

Excess water soluble vitamins, B and C, are eliminated through the urine. Therefore, toxicity is virtually impossible. On the other hand, excess Vitamin A, D, E, and K are stored in the body and can cause toxicity.

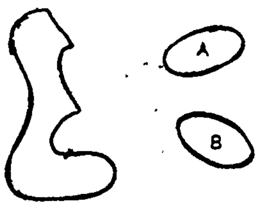
Activity I, "Analysis of Fruit Juice for Vitamin C", is found in The Chemistry of Food Additives, A Consumer Chemistry Learning Activity Package, Page 6-8. This utilizes the chemical process of titration which is an important analysis technique. If the students are not familiar with this process then the teacher should demonstrate the proper technique. Once the technique has been mastered by the students, many foods can be used. For further investigation, heat the orange juice to show that Vitamin C has been destroyed. Fortified carbonated drinks can also be used. Let the students think of other food items to test.

In preparing the students for Activity I, it will be interesting to associate scurvy, limeys, and sauerkraut to Vitamin C. Scurvy is the Vitamin C deficiency disease that sailors developed when at sea for long periods of time. The British ships carried limes on ocean voyages to prevent scurvy. British sailors are still called "limeys". Sauerkraut is made by fermentation of cabbage. It was developed as an inexpensive source of Vitamin C that could be taken on long voyages. It still plays an important part in some people's diet especially those of German descent.

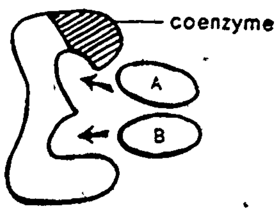
In Activity II, "Where Do I Find Them and What are the Deficiency Symptoms?", the students will view the slides "The Vitamins". The effects of the lack of these vitamins can best be explained by showing the deficiency symptoms and diseases. As you use the slides, point out parts of the narrative information that accompanies the slides and allow the students to make comments. Even though the slides seem grotesque, it may help the students remember these deficiency diseases associated with each vitamin.

Hopefully the students will be wondering which foods contain vitamins. Use Table 2 in Nutritive Value of Foods, as a resource for this part of Activity II. Table 5 can be used as a general check of the foods. Attached is an outline already completed for the convenience of the teacher. Do not let the students see this.

Interest can be generated by asking the better students to find out the action of Vitamin B as a coenzyme. A protein molecule is an enzyme. This aids in combining and breaking apart molecules. A coenzyme is a small molecule that can combine with an inactive protein to make it an active enzyme. All of the B Vitamins are enzyme helpers or coenzymes. Without the coenzymes, enzymes cannot function. A simple diagram is helpful in explaining this action.



Compounds A and B are not attracted to the enzyme.



With the coenzyme in place, A and B are attracted to the active site on the enzyme

The role of these B Vitamins is that of a coenzyme. This will help the students realize the importance of Vitamin B's in the diet.

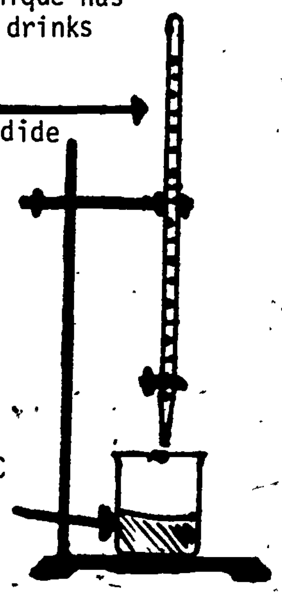
It will not be important for the students to memorize the chemical formulae for vitamins.

ACTIVITY I Analysis of Fruit and Vitamin C Tablet for Vitamin C, pages 6-8, The Chemistry of Food Additives, A Consumer Learning Activity, 1977 Unigraph

Introduction

The background information is on pages 6 and 6a, The Chemistry of Food Additives. It will be necessary to use a 25 mg Vitamin C tablet. If a larger table of Vitamin C is used, it will necessitate a different amount of Potassium iodide and Iodide in the solution.

The procedure for this experiment is on page 7. Once the technique has been perfected, a number of types of brands of orange juice or drinks can be tested.



Materials You'll Need

1 bottle - 100 mg. tablets of Vitamin C (Ascorbic Acid)
1/2 gal. Orange Juice (frozen or fresh)
1 qt. Orange Drink (with Vitamin C added)
1 qt. Tange
1 gram of Potassium iodide (KI) liter of water
0.6 gram of iodine crystals per 10 ml ethyl alcohol
1 gram cornstarch
1 titrating buret for each lab group
1 titrating stand for each lab group

Procedure

Page 7, The Chemistry of Foods
Use 1 gram of Potassium Iodide (KI) in 1000 cm of water.
Since each titration takes time, it might be better to take a class average of the titrations for each lab group rather than have the titrations repeated so many times.

Suggested Data Table

Foods with Vitamin C	Vitamin C in Juice (mg)
Frozen Orange Juice	
Canned Orange Drink	
Tange	
Fresh Orange Juice sold in glass jars	

Interpretation

What is the chemical name for Vitamin C?

What are some other foods rich in Vitamin C?

How much Vitamin C is needed by <u>your</u> body for the Recommended Daily Dietary Allowance, RDA'S?

What deficiency disease is associated with Vitamin C?

Further Investigation

What effect does heat have on Vitamin C? Try heating a sample before titrating.

6J

ACTIVITY II Vitamins: Where Do I Find Them?
What Are the Deficiency Symptoms?

Introduction

Each of the vitamins has a different roll to play in your body. When you tested for Vitamin C, you used certain foods that were rich in this vitamin. In this activity you will watch the slides "The Vitamins". You will see extreme cases of Vitamin deficiency diseases. After the slides have been viewed, look up in "Nutritive Value of Foods" to find out which foods are rich in these vitamins. Use the suggested data table to list the foods rich in each vitamin and the deficiency symptoms or diseases. In digestion of vitamins, there are two ways these are absorbed. The water soluble vitamins go directly into the blood, while the fat soluble vitamins must be absorbed along with the fat molecules. Check the last two columns of your data table for water soluble or fat soluble vitamins.

Materials and Equipment You'll Need

"Nutritive Value of Foods", Table 2
Slides "The Vitamins", Nutrition Education Series, TA YP30A Second Edition, Created and Produced by Nutrition Today, Annapolis, Maryland, by Cortez F. Enloe, Jr., M.D.

Procedure

1. Copy the data table in your notebook.

2. View the slides "The Vitamins".

3. Use "Nutritive Value of Foods", Table 2, to find out which foods are rich in the vitamins.

Suggested Data Table

Vitamin	Name of Vitamin	Where Do I Find Them?	Symptoms & Diseases	Water Soluble	Fat Soluble
A					
B_1					
B_2					
B_3					
C					
D					

Interpretation

Can you make a generalization about the groups of foods rich in each vitamin?

Why is it important to eat a wide variety of foods for a balanced diet?

What amounts of these vitamins are needed daily?

Further Investigations

Report on various vitamin deficiency diseases.

7

Teacher's Data Table

Name of Vitamin	Where Do I Find Them?	Symptoms and Diseases
Vitamin A	Yellow vegetables and leafy vegetables. Also found in fish liver oils, milk, egg yolk, and butter.	Low resistance to infections. Night blindness.
Vitamin B_1 (Thiamin)	Yeast, seafood, fruits, whole grain, leafy vegetables, egg, liver, butter, and milk	Poor growth Loss of weight Beriberi
Vitamin B_2 (Riboflavin)	Lean meat, soybeans, milk, fruit, eggs, liver, carrots	Poor growth Eye lesions Premature aging
Vitamin B_3 (Niacin)	Lean meat, green vegetables, whole grains, and liver.	Skin diseases Nervous disorders Poor growth
Vitamin C	Citrus fruits, berries, leafy vegetables, and tomatoes	Scurvy
Vitamin D	Fish-liver oils, egg yolk, and fortified milk	Soft bones Teeth defects Poor growth

7

UNIT III ARE FOODS DIFFERENT?

CONCEPT F The role of minerals in the diet.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Distinguish between minerals and vitamins.
2. Recognize the importance of calcium in the diet.
3. Recognize the importance of iron in the diet.
4. Analyze tneir blood by using a hematocrit test.
5. Perform simple tests for minerals: Iron and Iodine.
6. Recover Iodine from seaweed.
7. Determine if their diet is mineral rich.

BACKGROUND FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition, Pages 420-492.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Determine Your Hematocrit

II. Testing Foods for Iron -- A Mini Experiment pp. 4a-5, The Chemistry of Food Additives.

III. How Mineral Rich is Your Diet?

TEACHING STRATEGIES

Immediately, make the distinction between minerals and vitamins. Do this by going over organic compounds and inorganic compounds. Organic compounds were once living and contain the element, carbon. These are the vitamins. The minerals are inorganic compounds. These were never living and do not contain carbon. There are 17 minerals that are usually listed as elements although these are taken into your body as compounds.

There are several interesting facts about minerals that are mentioned in the resource book, Understanding Nutrition. Go over them with the students. These are:

- Minerals exist as inorganic compounds.
- Minerals retain their chemical identity.
- Minerals are water soluble.
- Minerals vary in the amounts absorbed and in the routes and ease of excretion.
- Minerals require protein carriers.
- Some minerals are toxic in excess.

Due to the variation in the amount needed in the diet, minerals have been divided into the major minerals and trace minerals.

Major Minerals	Trace Minerals
(daily needs $\cong$ 1/10 gram)	(daily needs $\cong$ 1/100 gram)
Calcium	Iron
Phosphorus	Zinc
Potassium	Selenium
Sulfur	Manganese
Sodium	Copper
Chlorine	Iodine
Magnesium	Molybdenum
	Cobalt
	Chromium
	Fluorine

About 1/10 gram of the major minerals, macronutrients elements, are needed in the diet each day. This would be about 1% of the body weight. About 1/100 gram of the trace minerals, micronutrients elements, are needed in the diet each day. This comprises about 1/100 of 1% of the body weight.

At least two minerals should be discussed. These are the first in each group, calcium and iron. About 99% of the calcium in the body is found in the bones and teeth. One percent is found in body fluids that maintain the blood calcium concentration. A constant supply of calcium must be in the daily diet. Dairy products are rich in calcium. Use "Nutritive Value of Foods" as a resource for the students to make a list of the foods rich in calcium.

Iron is found in the red blood cells. A deficiency will cause anemia. Activity I, "Determine Your Hematocrit", should be done by each student. It is a simple test that can determine the student's ratio of red blood cells to serum which will let them know if they have a tendency to be anemic. Activity II, "Testing Foods for Iron -- A Mini-Experiment", can be used to test foods thought to be rich in iron. Ask the students to bring in raisins and a few slices of bread to use in testing for iron.

Kelp is rich in Iodine and is available at health food stores. The students should taste kelp as it may be a food in their future.

It might be well to point out that South Carolina is called the "Iodized State". WIS radio/TV in Columbia is reported to have taken its call letters from the first letter of each of the words in "Wonderful Iodized State."

Vegetables grown in South Carolina are rich in iodine as trace amounts are picked up from the soil while growing. A deficiency of iodine causes the enlargement of the thyroid gland, a goiter. Native South Carolinians seldom have this problem because they eat locally grown vegetables with a high iodine content. There is a goiter belt around the Great Lakes and St. Lawrence Seaway where the people have a tendency to have goiters. Research indicated that the soil has a low iodine content. Now people use iodized salt in order to have the proper amount in their diet.

Activity III, "How Mineral Rich Is Your Diet?", will allow the students to determine if their diet provides them with enough of the needed minerals. Stress that each of the minerals are only needed in small amounts. However, a deficiency can cause profound effects on the body.

Ask students that have a vegetable garden to bring in foliage, stems, stalks, and roots from a variety of plants so that the class can examine these for mineral deficiencies.

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ACTIVITY I Determine Your Hematocrit

Introduction

The hematocrit test can be made by you in a classroom to determine the ratio of red blood cells compared to the serum. The red blood cells carry the oxygen in the protein molecule known as hemoglobin. If iron storage is low in the body, then the red blood cells are reduced thereby causing a shortage of oxygen.

By comparing the amount of red blood cells vs. the serum, you will be able to determine if anemia is present. Usually anemia is caused by an iron deficiency.

Materials You'll Need

1 per student - Disposable Blood Lancets
1 per student - Capillary tubes length 77 mm
Capillary tube sealer
Isopropyl Alcohol
Cotton
Gauze
Centrifuge (if available)

Procedure

1. Have the students work in pairs. After the middle finger has been wiped with alcohol, have one student pierce the other student's finger. Wipe again with alcohol. The finger should then be milked so that the capillary tube is partially filled with blood. Again wipe the finger with isopropyl alcohol.

2. Place each end of the capillary tube in the sealer.

3. The blood needs to be separated into the two components. This can be done by several methods.

   a. Stand the capillary tubes upright in a beaker and allow them to settle overnight in a refrigerator.

   b. Tape the capillary tubes horizontally to the shaft inside of a washing machine and allow them to spin. This serves as a centrifuge. Usually a washing machine can be found in the athletic department or in the home economics room of your school.

   c. Use a centrifuge found in some school science labs.

4. Once the blood has been separated, you can measure the approximate proportion of red blood cells to serum. Place your capillary tube along side the metric ruler. Determine the length of the red cells in millimeters. Next determine the length of the total amount of serum and red blood cells in your capillary tube.

5. To determine the percentage of red cells in your blood, divide the length of the red cells by the total amount of blood in the capillary tube. Multiply by 100%.

$$\% \text{ Red Cells} = \frac{\text{Length of Red Cells in capillary tube}}{\text{Total length of red cells and serum}} \times 100\%$$

6. Males should have between 40% and 50% red blood cells. Females should have between 36% and 40% red blood cells. <u>These figures are only approximate</u>.

Interpretation

The results of this activity will only be a ball park figure. This is a quick way to determine the red blood cells in your blood and not intended to be an accurate method. Students that are low in red blood cells should have the doctor make a diagnosis. Women need more iron than men. This is due to the loss of blood during menstruation.

1. What foods are rich in iron? Use "Nutritive Value of Foods" to make a list of these foods.

2. How much iron is needed for the Minimum Daily Allowance (MDA)? Compare this amount for men and women.

Further Investigation

Determine the role of hemoglobin in the blood.

ACTIVITY II Testing Foods for Iron -- A Mini Experiment, Page 4a-5, The Chemistry of Food Additives, A Consumer Chemistry Learning Activity, 1977 Unigraph.

Introduction

The background information is on page 4a and 5 of The Chemistry of Food Additives. Foods rich in iron should be tested. This will include organ meats such as liver, and foliage plants like collard greens, mustard, tender greens, cabbage, cauliflower, broccoli, and brussel sprouts. Enriched bread can also be tested. Bring a number of foods thought to be rich in iron from home to test. This is a good way to see for yourself if there is iron present in your diet.

Anemia is often caused by an iron deficiency. But it can also be caused by the lack of one of the B vitamins called Folacin. This word is derived from the word foliage.

Materials You'll Need

1 dropper bottle concentrated Nitric Acid, HNO_3 per lab group
0.1 M Potassium thiocynate, KSCN, (dissolve 9.7 gram KSCN in 100 ml water)
Raisins
Prunes
Cornflakes
Crucible
Enriched white bread
Wheat or Rye bread
Vitamin B - Thiamine and Niacin
Vitamin B_1 and Vitamin B_3 pill (Thiamine and Niacin)

Procedure

Page 5 of The Chemistry of Food Additives.
Follow the CAUTION and allow the crucible to cool before adding the Nitric Acid.

Suggested Data Table

Foods Rich in Iron	Indicate color	Positive test for Iron
Vitamin Pill (B_1 or B_3)		
Raisins		
Prunes		
Cornflakes		
Enriched Bread		
White		
Wheat		
Rye		

Interpretation

What are the general classes of foods that are rich in iron?

What is anemia?

ACTIVITY III How Mineral Rich Is Your Diet?

Introduction

Your body needs minerals in definite amounts daily. You must eat the right kind of food found rich in these minerals. No matter if you have eaten plants or animals both have gotten the minerals from the soil. These minerals are put into the soil when the gardner or farmer uses fertilizer.

Fertilizer is bought at the store by numbers, e.g., 5-10-15. Each number represents an element. These are as follows:

	Chemical Symbol
5 represents the ratio of Nitrogen	N
10 represents the ratio of Phosphorus	P
15 represents the ratio of Potassium	K

Often fertilizer is referred to as "N-P-K" as the chemical symbols are used, Nitrogen-Phosphorus-Potassium.

Many plants and animals are rich in these elements which ultimately end up in your body. Each with a different role to play. Nitrogen as you learned in an earlier unit is found in protein. Phosphorus and potassium are minerals also needed by your body. Phosphorus is necessary in the release of energy from food. Potassium regulates the proper amount of fluids in your body.

In this activity you will investigate the food sources of phosphorus and potassium along with several other minerals, namely calcium and iron. You will also investigate foliage, stems, stalks, and roots for mineral deficiencies. Calcium is necessary for bone and teeth formation and to maintain the proper amount of blood calcium necessary for the prevention of anemia.

Some of the general characteristic symptoms indicating mineral deficiencies are listed below:

Plants stunted, leaves pale green: NITROGEN.

Plants stunted, leaves dark green or tinted with purple: PHOSPHORUS.

Plants stunted, leaves bluish or dark green, margins and areas between veins scorched or brown: POTASSIUM.

Older leaves chlorotic between the veins: MAGNESIUM.

Leaf margins rolled upward: CALCIUM.

Chlorotic mottling or striping (especially on calcareous soils): IRON.

Chlorotic mottling and small discolored spots or lesions: MANGANESE.

Root crops with decayed crown, distorted leaves, and hollow or decayed root: BORON.

7

Materials You'll Need

Nutritive Value of Foods

Procedure

1. Copy the suggested data table in your notebook.
2. Have the students pick out the foods rich in calcium, phosphorus, iron, and potassium from Nutritive Value of Foods. Use the suggested data table or one of your own design to list the foods rich in these minerals.
3. Diagnose foliage, stems, stalks, and roots for various mineral deficiencies.

Suggested Data Table

Edible Parts of Foods	Calcium	Phosphorus	Iron	Potassium

Interpretation

If the foliage indicates a mineral deficiency, will the vegetables from this plant have sufficient mineral content for your nutrition?

Generally, which group of foods are rich in these minerals?

Remember: In order to have a balanced diet, is it necessary to eat a wide variety of food?

Further Investigation

How much of each of these minerals do you need in the Recommended Daily Allowance, RDA?

UNIT III ARE FOODS DIFFERENT?

CONCEPT G The Role of Additives in Nutrition

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Recognize some of the commonly used additives.
2. Evaluate the use of such additives in the modern methods of food production, processing, and distribution.
3. Review the Food and Drug Administration responsibility on controls.
4. Show how the regulations affect them personally.
5. Analyze labels for food additives and use.
6. Make analytical tests for food additives.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition, Pages 438-447.

More Than You Ever Thought You Would Know About Food Additives, Part I, Part II, and Part III, HEW

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. What's On the Label, LAP

II. Food Additives

III. Calcium propionate in Bread, LAP

IV. Is Red Dye in Beet Juice?

V. Synthetic Food Flavors May ~~Be In~~ Your Daily Diet!

TEACHING STRATEGIES

Begin this lesson by having the students read the labels on all the foodstuff they eat. When reading the labels, encourage them to identify the food additives. Ask the students to bring in as many labels as possible. Make a bulletin board of these labels until you are ready to do Activity I, "What's On The Label?". Once the labels have been used, place them back on the bulletin board.

Most food produced commercially contains additives of some kind. The definition of food additives is very broad. It is a substance that is added to the basic foodstuff to improve desirable characteristics. This takes place in production, processing, storage, or packaging. All have a purpose which are classified as follows:

Making food more appealing

a. Colors -- create attractive appearance

b. Flavors -- improve taste

c. Flavor enhancers -- magnify the taste

d. Sweeteners -- improve taste

Emulsifiers -- help liquids mix

Stabilizers -- produce a uniform texture

Thickeners -- give the desired consistency

pH Control Agents -- controls acidity

Leavening Agents -- create a light texture

Bleaching Agents -- whiten food

Anti-Caking Agents -- keep foods free flowing

Humectants -- retain the proper moisture

Preservatives -- control bacteria

For more information on additives the FDA Consumer published by the U. S. Department of Health, Education, and Welfare has three leaflets called More Than You Ever Thought You Would Know About Food Additives, Part I, Part II, and Part III. The purposes of food additives are explained in details in Part III. This could be used as resource material for students that have an interest in this area.

Remind the students that a large part of the world is kept from starving by using the proper preservatives in food processing. After the students have been reading labels for a while, they will soon realize that controls need to be made. Legislative action had to be taken in order to protect the consumer. It might be well for the students to learn about how food is controlled by label legislation.

The agency that has this responsibility is the Food and Drug Administration. The United States government was brought into the picture by the Food, Drug, and Cosmetic Act of 1938 where labels were required on all packaged food. The following information must appear on all food labels.

1. The common name of the product.

2. The name and address of the manufacturer, packer, or distributor.

3. The net contents in terms of weight, measure, or count.

4. The ingredients listed in order of descending predominance.

Another act in 1958, Food Additives Amendment to the Food, Drug, and Cosmetic Act made it mandatory that food additives be listed on the label. This amendment also required food processors wishing to add a substance to submit a petition to the FDA with information on the chemistry, use, function, and safety of the additive. As a result of this, there is a list of food additives known as GRAS, Generally Recognized As Safe. It takes years of proper investigations for new additives to be listed as GRAS.

The Delaney Clause to the 1958 Amendment states that "no additive shall be deemed safe if it is found to induce cancer when ingested by man or animal". Cyclamates were banned in 1969 as a result of tests performed on animals. The amount of daily intake was not made clear in the Delaney Clause. Therefore, extremely large amounts were given to test animals. The quantity given to these animals would have amounted to a human consuming each day 138 - 12 ounce bottles of soft drinks containing cyclamates. This amount would be an unreasonable number of soft drinks for any human to consume. Perhaps changes should be made in the law. This can be discussed by the students.

Hopefully the students are wondering just what food additives are being ingested by them. For Activity I, "What's On The Label?", the students will need the labels from Wheaties, Cheerios, Total, and Sugar Frosted Flakes, along with several other items. Make certain the students understand the term Recommended Daily Allowance, RDA. This term was designed for use on labels in expressing the nutrient contents of foods. Table #4 in Nutritive Value of Foods lists the RDA for males and females of varying ages and heights. The labels also give the percentage of the Recommended Daily Allowance, RDA. This makes the figures on the label more understandable. It is difficult for people to remember just how much of each nutrient is needed daily. However, a percent of the daily amount can be easily understood.

Many labels were not printed in large enough letters to be read. As a result, Congress passed the 1966 Fair Packaging and Labeling Act. Labels had to be in conspicuous places and in large letters that could be easily read.

For Activity II, "Food Additives", the students will use the same labels they collected for Activity I to find the food additives. The leaflet More Than You Ever Thought You Would Know About Food Additives, Part I list most of the food additives. It can be used to look up the purpose for each one.

Activity III, "Calcium Propionate in Bread/Mini-Experiment", Page 11a and 12 in LAP will be an interesting lab for the students to do as this is a common preservative found in bread.

Activity IV, "Is Red Dye in Beet Juice?", is an activity using chromotography. Measurements do not need to be made, as observations of the different colors will be more interesting.

Again point out that it will be important to eat a wide variety of foods so that large quantities of particular additives will not be ingested.

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ACTIVITY I - What's On The Label? The Chemistry of Food. A Consumer Learning Activity, 1977 Unigraph.

Introduction

Before you buy something, don't you want to know what is in it? New items of food are often bought because of advertisement. Now that you have gained added information about nutrition, you will want to read the labels to know just exactly what you are putting into your body. Taste should not be your only concern. You need to know how to interpret this information and look out for false labeling.

Remember according to the Food and Drug Administration the ingredients must be listed in the order of descending predominance. The first item listed is the one that is found in the largest quantity.

Another column lists the ingredients in U.S. Recommended Daily Allowance, RDA. Since most consumers could not remember the amount of each nutrient needed by the body, the labeling is in percent of the RDA. One percent is used for all ages and groups of people. Therefore the RDA for males is used as this is the highest value for each nutrient.

Materials You'll Need

Labels from bread, milk, and cereal brought in by the students.

Each student needs 3 labels from foodstuff.

Procedure

Page 3a, 4, 5, 6, and 7 of The Chemistry of Food.

Suggested Data Table

Page 5 of The Chemistry of Food.

Interpretation

Page 6 of The Chemistry of Food.

ACTIVITY II Food Additives

Introduction

One of the best ways to become aware of the food additives is for you to keep a list of those you ingest into your body daily.

Federal rules and regulations require that the additives be written on the label of everything you eat. It is up to you to keep up with these additives and to become informed concerning the effects.

Materials You'll Need

More Than You Ever Thought You Would Know About Food Additives Part I, Part II, and Part III. U.S. Department of Health, Education, and Welfare, FDA Consumer, U.S. Government Printing Office: 1979- 281-272/39.

Procedure

1. Copy the data table suggested below.
2. Use the same labels that were used in Activity I to look for food additives.
3. List on the data table the additives you find on the labels.
4. Write the purpose in the appropriate column.

Suggested Data Table

Food Item	Additive	Purpose of Additive

Interpretation

Did each food item have an additive?

Did more than one additive appear on the label?

Further Investigation

Find out how the Delaney Clause affects the food additives.

How did our forefathers preserve ham and beef?

Did they use additives?

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ACTIVITY III Calcium Propionate in Bread, LAP, Page 11a, 12, 13, and 14. The Chemistry of Food Additives, a Consumer Chemistry Learning Activity, 1977 Unigraph.

Introduction

Before so many food items were preserved by food additives, our forefathers had many ways to keep food from spoiling. Table salt has been one of the traditional ways to preserve ham in the south. Many of the plantations had a smoke house that was used to coat the ham with smoke from oak or hickory before it was placed in the salt room. Vinegar, acetic acid, was used to preserve cucumbers so that pickles could be eaten all year around. Grapes and plums were dried and afterwards were called raisins and prunes so that these could be preserved. The westerners dried meat and called it beef jerkey so they could eat meat when their prey was scarce. Today, food is preserved and sent all over the world. Many countries are kept from starving by the preservatives in footstuff.

Many kinds of bread are available in your local grocery store. The shelf life must be at least 3 or 4 days. You take it home and it usually lasts several more days. Food preservatives are used to keep it from molding. In this activity you will test for Calcium propionate one of the bread preservatives.

Materials You'll Need

5 ml of 6 M Sulfuric Acid, H_2SO_4. (To 100 ml H_2O add 50 ml conc. H_2SO_4)
5 ml Ethyl alcohol
Several slices of bread with Calcium propionate added
Several slices of bread without preservatives.

Procedure

Page 12 of The Chemistry of Food Additives.

As a safety precaution, be sure to use a water bath when heating the test tubes in alcohol and Sulfuric Acid.

Interpretation

Is Calcium propionate the only preservative used in bread?

What are some preservatives that have bad effects if taken in large quantities?

What does the acronym GRAS mean?

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ACTIVITY IV Is Red Dye in Beet Juice?

Introduction

Maybe you are guilty of adding food additives especially when you ice a cake!

Have you ever used food coloring?

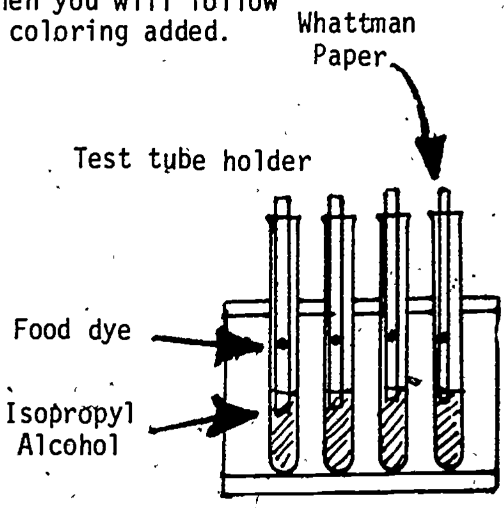
Have you made a red velvet cake for Valentine's Day?

Have you added food coloring to your cookies?

Every time you look at the labels, see if food color has been added. In this activity you will separate the dyes in food color by the technique of chromatography. Then you will follow the same procedure to see if beets have food coloring added.

Materials You'll Need

Food colors (red, yellow, green, blue)
Whattman paper (filter paper)
Isopropyl alcohol (rubbing alcohol)
6 to 8 test tubes or one large beaker
Test tube rack
Pipette or toothpicks
Ruler
Graduated cylinder
Scissors



Procedure

Mixtures of colors can be separated by using the chromatography process. If a drop of dye is placed on Whattman paper and alcohol is allowed to be absorbed by the paper, as the alcohol goes through the spot of dye it will separate the colors. Your observations will indicate different colors in each of the dyes.

1. Cut the Whattman paper into strips about 1 - 2 cm wide and 15 to 18 cm long.

2. Use a pipette or toothpicks to place a drop of the food coloring 3 cm from the bottom of the paper.

3. Pour 5 ml of alcohol in the test tube.

4. Carefully place the strip of paper in the test tube. Observe. Gradually the alcohol will be absorbed by the paper. As it goes through the spot and migrates up the paper, the food coloring will separate into the different dyes. Record the colors that make up the dye on the data table.

5. Repeat the same procedure for other items that contain color additives. However, you will have to place several drops of the food on the strips of paper and allow to dry before putting it into the alcohol.

UNIT III, CONCEPT G, ACTIVITY IV (continued)

Suggested Data Table

Food Coloring	Results -- List the colors
Red	
Yellow	
Green	
Blue	
Foods Tested	
Tange	
Blueberry Pie Mix	
Mustard	
Coca Cola	
Beet Juice	

Interpretation

Why do food processors add dye to food?

What other food items have food color added?

What do you think happens to the food dye as it goes through your digestive track?.

Does dog and cat food have coloring added?

How about bubble gum?

Further Investigation

What is Red Dye #2? How is it restricted from use?

ACTIVITY V Syn-hetic Food Flavors May Be In Your Daily Diet!

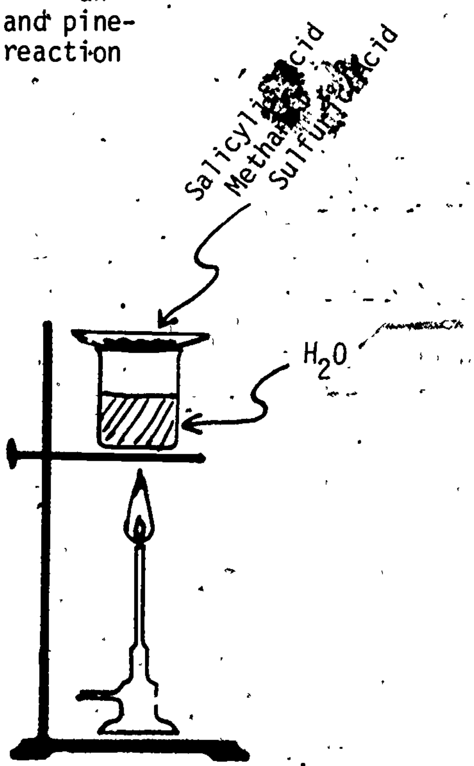
Introduction

Of the taste and smell, foods are improved by the addition of artificial flavors. These additives are called flavor enhancers. There are many natural flavors but synthetic enhancers are cheaper than the real McCoy. Consequently, these are frequently used. You can usually read the label to determine if the flavor is the real thing. "Strawberry Yoghurt" would indicate that natural strawberries were used for flavors. If "Strawberry Flavored Yoghurt" is written on the label, then artificial flavors were used to provide the strawberry flavor.

Artificial flavors are made by analyzing the chemicals present in the "real McCoy". In this activity you will make one of the artificial flavors, wintergreen. This is done by combining an organic acid with an alcohol and forming a compound called an ester. This is called esterification. Banana, apple and pineapple flavors can be synthesized by this same type of reaction along with many other artificial flavors.

Materials You'll Need

1 ml Methanol per lab group
1 gram of Salicylic Acid per lab group
3 drops of concentrated Sulfuric Acid
Evaporating dish or a beaker



Procedure

1. Weigh about 1 gram of Salicylic Acid and put it in evaporating dish.
2. Add 1 ml of Methanol.
3. Add 3 drops of concentrated Sulfuric Acid.
4. Warm gently.
5. Waft the vapors.

Interpretation of Results

Is this a familiar odor? If so, what food item do you associate with this smell?

Further Investigation

Try 10 ml of Acetic Acid with 5 ml of Amyl alcohol.

Banana flavoring can be made by combining Acetic Acid and Amyl Alcohol.

Try synthesizing banana flavoring by combining 10 ml of Acetic with 5 ml of Amyl Alcohol

Apple flavoring can be synthesized by combining 1 ml of Acetic Acid with 3 ml of Ethyl Alcohol.

UNIT III ARE FOOD DIFFERENT?

CONCEPT H The Role of Water in Nutrition

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Realize that the body is approximately 55 - 60% water by weight.

2. Perform a simple test to show that foods contain water.

3. Demonstrate the effect of water in promoting a chemical reaction.

4. Perform a chemical reaction that combines oxygen and hydrogen to form water.

5. Recognize the importance of water in the maintenance of their health.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition, Pages 495-514.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Water as a Medium to Promote Chemical Reaction

II. Reactivity of Alka-Seltzer in Alcohol Compared with Pure Water.

III. % of Water in Food

IV. Rapid Synthesis of Water

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TEACHING STRATEGIES

Stress the unique properties of water. Start out with the rhythmical verse in Activity I.

Go over the properties of water carefully with the students. One of the most fascinating characteristics of water is that it expands as it freezes. This property allows ice to float. Consequently, the pond is covered with a layer of ice protecting the water beneath from the coldness. Thus life goes on in the pond all winter long. Have the students predict what would happen if ice formed on the bottom of the pond instead of on top. What would happen to all the micro-organisms that feed the fish? Where would the fish go?

Water is the universal solvent. It brings to each cell in the body the necessary ingredients and carries away the products that are not necessary for life.

Show the students the diagram of the chemical composition of the human body on page 3 of Understanding Nutrition. Water constitutes 55 to 60% of the body weight. This diagram shows the relative proportion of water, proteins, carbohydrates, fats, and minerals.

Activity I, "Water As A Medium To Promote Chemical Reaction", can be done by the students to illustrate how only a slight reaction takes place when you shake the beaker vigorously. However, when water is added the reaction occurs immediately.

Another concrete example that illustrates the effects of water in a chemical reaction is Activity II, "Reactivity of Alka-Seltzer in Alcohol Compared with Pure Water". Half an Alka-Seltzer will be dropped in water as the other half of the tablet is dropped into alcohol. The comparison of these reactions can be made. Again you will be giving the students concrete experiences of water promoting a chemical reaction.

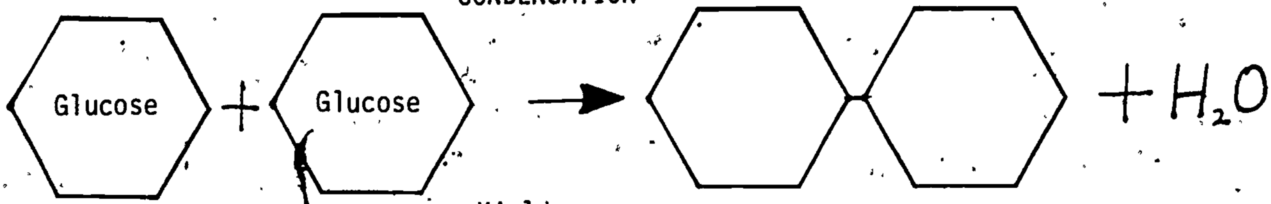
Activity III, "% of Water in Food", is a simple test that can be used to show that foods contain water. A drying oven will be needed. If one is not available, the Home Economics Department may allow your students to use their ovens to dry food samples. This activity is very useful as a math refresher. Percent of water is determined for each of the samples.

The chemical reaction that occurs as water is made by combining hydrogen and oxygen is an excellent demonstration to illustrate the transfer of energy. In Activity IV, "Rapid Synthesis of Water", the students will very dramatically hear the energy released when oxygen and hydrogen are combined to form water.

You may choose to use the terms hydrolysis and condensation as it applies to the breakdown of a compound and building up, condensation, of molecules. By these two processes carbohydrates are put together and taken apart.

When a disaccharide is formed from two monosaccharides a chemical reaction takes place where water is formed. This reaction is called condensation.

CONDENSATION

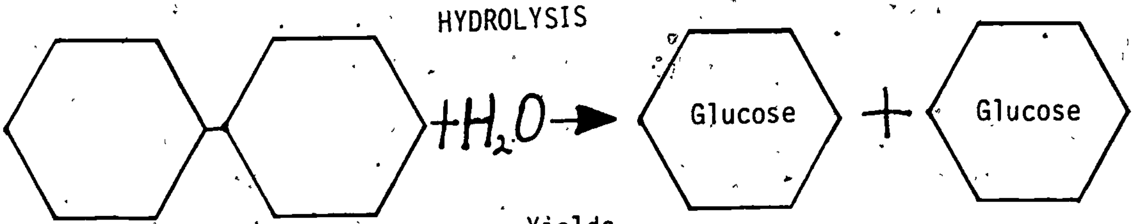


2 Glucose molecules $\xrightarrow{\text{Yields}}$ Maltose + Water

2 Monosaccharides form a disaccharide. Water is formed in condensation.

As disaccharides are broken apart in digestion to form two monosaccharides, water is absorbed. This reaction is called a hydrolysis reaction

HYDROLYSIS



Maltose + H_2O $\xrightarrow{\text{Yields}}$ 2 Glucose Molecules

Water is needed for hydrolysis. As carbohydrates are digested into simpler compounds such as glucose, water is needed for this chemical process.

Water is extremely important to all living things including the human body. Without water we would perish. We must have it in making and breaking apart chemical bonds for growth and maintenance.

ACTIVITY I Water As a Medium to Promote Chemical Reaction

Introduction

Water is UNIQUE!

It freezes at 0° Celsius, but
it has its greatest density at 4° Celsius.
Therefore, ice floats on water
Water has unusually high melting and boiling points,
compared with the molecular weight of other substances.
Water will dissolve more substances than any other liquid,
sometimes called the universal solvent.
Without it, we would perish!

Pure water is transparent, odorless, tasteless, and almost colorless liquid at room temperature. If water has no odor, it is due to dissolved minerals. If water is in large quantities, it has a blue-green color. Water is universal, therefore scientists use it as a standard for:

A. Establishing a Temperature Scale and graduating Celsius thermometers.

Freezing of H_2O = 0° Celsius (also called melting point)

Boiling of H_2O = 100° Celsius

The distance between these two points is divided into 100 units called degrees.

B. Measuring Heat in the metric system.

The calorie that you have been using to measure energy units in food is determined by the amount of heat needed to raise 1 gram of water 1° celsius.

C. Define the relationship between volume and mass in the metric system.

Due to the unique properties of water, it has its greatest density at 4° Celsius. It is at this temperature that:

1 milliliter of H_2O = 1 gram
or 1000 milliliter of H_2O = 1000 grams
or 1 liter of H_2O = 1 kilogram

Medical terminology uses 1 cubic centimeter (1cc) in place of 1 millimeter.

	1 cc	=	1 ml
or	1000 cc	=	1000 milliliters

D. Determining specific gravity of solids and liquids.

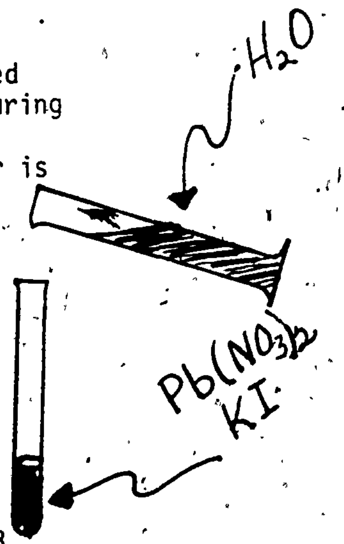
Iron is 7.6 heavier than water, therefore, iron has a specific gravity of 7.6.

Mercury is 13.6 times heavier than water. Mercury has a specific gravity of 13.6.

What does it mean when gasoline has a specific gravity of 0.9? Which is lighter, water or gasoline? When mixed, which floats on top?

Water is very stable. It will not decompose. It takes a large amount of energy to decompose and a large amount of energy is released when oxygen and hydrogen combine.

Water is used to promote chemical reactions. Water is needed in the process of digestion. As the nutrients break down during digestions, water is needed for this reaction. You will see in this activity that water is necessary to promote this chemical reaction.



Materials You'll Need

3 grams Potassium iodide, KI
3 grams Lead nitrate, $Pb(NO_3)_2$
Beaker
50 milliliters of H_2O

Procedure

1. Take 3 grams of Potassium iodide, KI, and combine with 3 grams of Lead nitrate, $Pb(NO_3)_2$.

2. Mix the solid vigorously. Note a faint yellow tinge indicating a slight reaction.

3. Add approximately 50 ml of water to the mixture.

4. Note immediate color change indicating the presence of a chemical reaction (has a new substance been formed?).

Interpretations

Can you think of other reactions that occur when water is added?

Why is water used by earthlings as a universal standard?

Which property of water causes the block in your car to crack when the temperature drops below freezing?

Is water necessary for digestion?

Further Investigation

Why does water promote a chemical reaction? Look this up in a chemistry textbook.

ACTIVITY II - Reactivity of Alka-Seltzer in Alcohol Compared with Pure Water

Introduction

Water is necessary for chemical reactions to occur. This can be understood when you compare the reaction of an Alka-Seltzer tablet that is dropped in water to one that is dropped in alcohol.

Materials You'll Need

1 Alka-Seltzer tablet
50 milliliters ethyl alcohol (ethanol)
50 milliliters water
2 beakers

Procedure

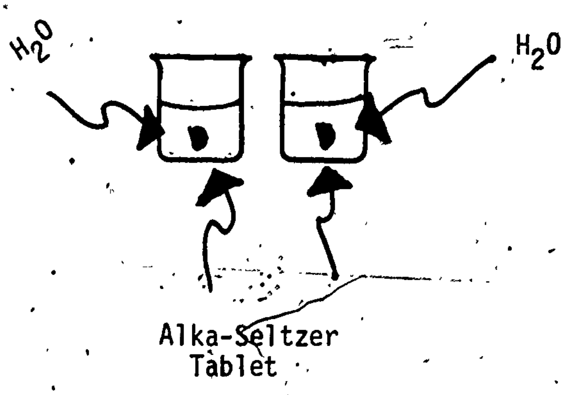
1. Break the Alka-Seltzer tablet in half.
2. Drop half an Alka-Seltzer tablet into two equal volumes of liquids: ethanol and pure water.
3. Compare the reaction in the two containers.

Interpretations

Where was the action?

What promoted the reaction?

What gas is given off?



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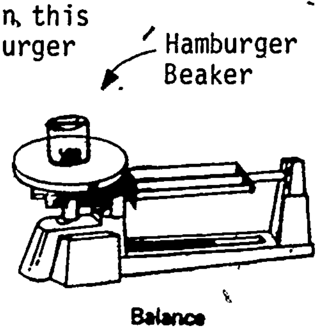
ACTIVITY III % of Water in Food

Introduction

The human body is ≅ (almost equal to) 60% water. Just about everything we eat contains water but in different amounts. Lettuce is almost all water, beef is more than half water, carbohydrate in the form of corn is about 3/4 water. In this activity you will try several different samples of hamburger to determine the % of water.



Materials You'll Need

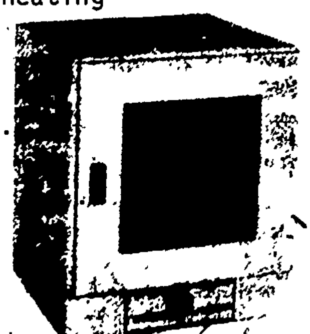
At least 2 samples of hamburger, 5 grams of each
Drying oven
Balance pan
Beakers

Procedure

1. Weight two 5 gram samples of hamburger (use samples from two different sources).
2. Put the samples in a drying oven overnight (or use the oven in the Home Economics Department; set the oven on the lowest setting).
3. Cool and reweigh.
4. Reheat, cool and reweigh until the weight of the containers and samples are constant.
5. Calculate the weight loss and the % of water in the original samples.

Suggested Data Table

	Sample #1	Sample #2
Mass of empty container		
Mass of container and sample before heating		
Mass of sample		
Mass of container and sample after heating		
Mass of sample after heating		
Mass of water (the mass loss)		
% of water in sample		



Plug your figures into this formula

$$\%\text{ of Water} = \frac{\text{Mass of Water}}{\text{Mass of Sample}} \times 100\%$$

Interpretation

Compare the amount of water in the two samples.

What accounts for the difference?

Explain the term, dehydrate.

When plums and grapes are dehydrated, what are they called?

Further Investigations

Try other foods such as fruits or vegetables.

What is the process of freeze dried?

Find out some of the foods that backpackers use.

ACTIVITY IV Rapid Synthesis of Water

Introduction

In the synthesis of water, a large amount of energy is released. Using a word equation

$$\text{Hydrogen} + \text{Oxygen} \longrightarrow \text{Water} + \text{Energy}$$

The hydrogen and oxygen combine in the volume ratio of 2 to 1. Two volumes of hydrogen to one volume of oxygen, as in the formula H_2O.

In this activity oxygen will be generated into a plastic bag. The ratio of volumes will be 2 hydrogen and 1 oxygen. The gases in the bag will then be forced to bubble into a solution of liquid soap. As this is done, the soap bubbles are scooped up by your hand and brought to the flame. A candle will do. The loud "bark" is the energy released as hydrogen and oxygen combine to form water.

If you do not have a 2 to 1 ratio of hydrogen and oxygen in the bag there will only be a small "bark".

Materials You'll Need

Hydrogen in a bottled container (see alternative method for generating hydrogen)

Oxygen in a bottled container
Plastic freezer bag - 2 qt. size
1 hole stopper
8 to 10 cm of glass tubing
30 to 40 cm rubber delivery tube to fit the glass tube
Detergent solution in a container

(see alternative method for generating oxygen)

Procedure

(If bottled gases are not available see alternate procedures.)

1. Cut a small groove around the side of a one hole stopper.

2. Insert glass tubing in the one hole stopper.

3. Squeeze the plastic bag around the rubber stopper. Tightly fasten the bag around the stopper with a rubber band.

4. Pass the gases one at a time through the glass tubing and rubber stopper into the plastic bag so that you have a ratio of 2 volumes of hydrogen to 1 volume of oxygen.

5. Gently press the plastic bag so that you force the hydrogen-oxygen mixture through the delivery tube into the detergent solution.

6. As the bubbles form, scoop up a handful and bring to a lighted burner.

IT WILL EXPLODE

But not dangerously if unconfined!

Interpretations

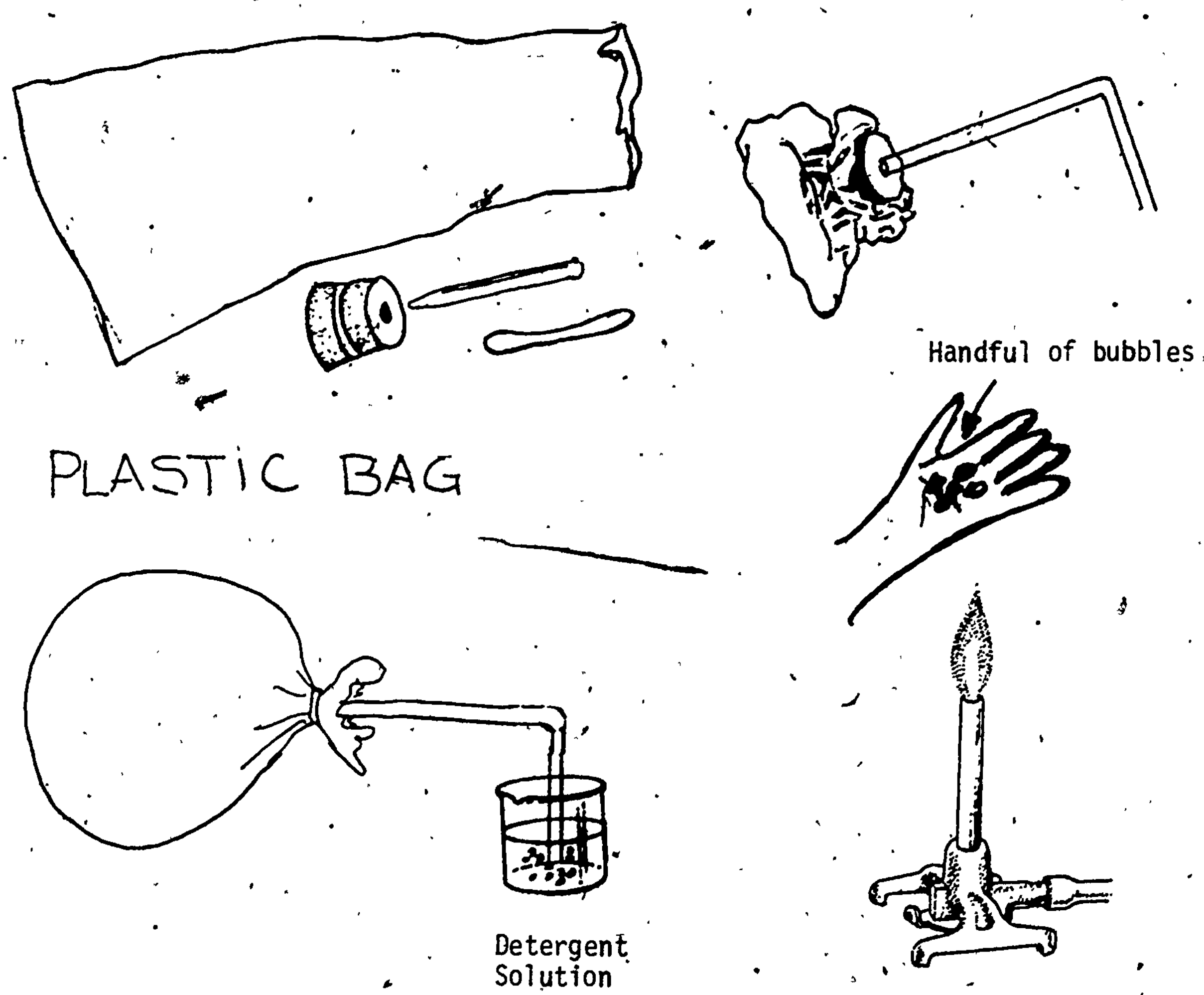
How does this energy release relate to digestion?

Further Investigation

How is water separated into hydrogen and oxygen?

If electrolysis equipment is available hook it up to see what it takes to separate water into hydrogen and oxygen. Notice the ratio of volumes formed.

Write the word equation for this reaction.



Alternate Procedures if bottled gases are not available:

Preparation of Hydrogen Gas

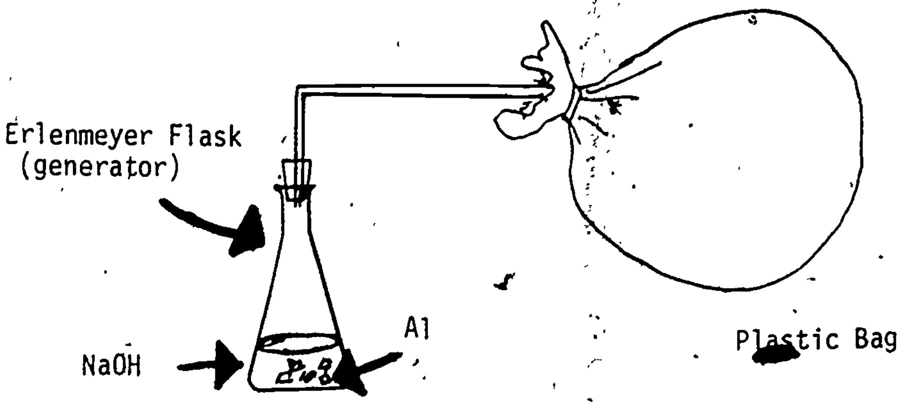
Instead of using the bottled gas you can generate hydrogen by another method. An excellent method for preparing hydrogen is the reaction of aluminum foil with Sodium hydroxide. The hydrogen will be generated into a plastic bag using the procedure already outlined.

Materials You'll Need

150 ml erlenmeyer flask
2 - 1 hole stoppers (rubber) to fit flask
2 qt. plastic freezer bags
Aluminum foil
Sodium hydroxide (6 grams NaOH to 50 ml of water)
2 - 8 cm pieces of glass tubing that fit stopper and delivery tube
30 cm of rubber tubing (delivery)
1 rubber band
1 hose clamp

Procedure

1. Insert the second glass tube in the second stopper.
2. Place 4 or 5 pieces of aluminum foil (approximately 1 cm^2) in an erlenmeyer flask.
3. Add 50 ml of Sodium hydroxide solution (6 grams of NaOH to 50 ml of H_2O) to the generator flask.
4. Place stopper on mouth of flask and connect rubber tubing to plastic bag assembly.
5. Collect approximately 2/3 of a bag of hydrogen.
6. Disconnect and use the hose clamp to prevent leaks.



Preparation of Oxygen Gas

A simple method for collecting oxygen is through the catalytic decomposition of hydrogen peroxide.

Materials

100 ml of 3% hydrogen peroxide
Flask and stopper assembly used in preparing hydrogen
Manganese dioxide (catalyst)
Pinch clamp

Procedure

1. Add 100 ml of 3% Hydrogen peroxide to the flask.

2. Add approximately 2 grams of powdered Manganese dioxide.

3. Place stopper assembly in flask. Insert tube in bag.

4. Swirl contents of flask to hasten reaction.

5. Fill bag with oxygen until it is 1/3 full.

Note:

To some extent these gases can pass through the plastic bag - especially hydrogen. This is due to the small size of the molecule. Hence, limit the amount of storage time.

Further Investigations

Write the balanced equation for the laboratory preparation of hydrogen and oxygen.

UNIT IV WHY DOES THE BODY NEED DIFFERENT KINDS OF FOODS?

CONCEPT A No single food contains all the nutrients.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Determine that some foods provide energy.
2. Show that some foods are necessary for tissue building and repair.
3. Realize that some foods maintain proper body function.
4. Make a test to determine the fat content in a sample of milk.
5. Analyze milk for protein.
6. Chemically analyze a hot dog for fat, water, and protein content.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition, pages 525-565.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Some Nutrients in Milk I and II, LAP

II. A Hot Dog -- What's In It For Me?, LAP

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TEACHING STRATEGIES

So far your students should be getting the idea that good nutrition is very complex and can not be ignored if they want to maintain a healthy body throughout life. There is no food that is perfect. To get all the nutrients we need a variety of food in the diet. Carbohydrates furnish energy to the brain and nervous system. Fats also provide energy along with oil for the skin and hair, nourishment for the scalp, and protection from body injury and extreme temperature. Proteins are necessary to rebuild and repair tissue. Vitamins provide coenzymes that help in digestion along with preventing a number of deficiency diseases. Each mineral has its own function necessary to maintain a healthy body. Without water we would all perish.

There is no one food that supplies us with these nutrients. It takes a well balanced diet to provide our body with all the necessary ingredients.

In Activity I, "Some Nutrients in Milk I and II", the students will test for the fat content in milk. % butterfat is the term used by the dairy industry when specifying the amount of fat in milk. The % butterfat is clearly written on the label. The other nutrient that will be tested is protein. This is the Biuret Test that was performed earlier for protein.

Activity II, "A Hot Dog -- What's In It For Me?", is another analysis of nutrients. This time the students will test for the fat, water, and carbohydrate content of hot dogs. If the students bring hot dogs from home, a comparison can be made between hot dog brands. Cereal is added to many brands to cut the amount of protein and reduce the cost. Be sure to point out that a hot dog is an expensive way to buy protein.

Again a wide variety of food is needed for a well balanced diet.

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ACTIVITY I Some Nutrients in Milk I and II -- Page 22a-25, The Chemistry of Foods, A Consumer Chemistry Learning Activity Package, 1977, Unigraph.

Introduction

In this activity the fat content of milk will be determined. When milk is marketed, it is sold on the butterfat content. The price paid to the farmer for his milk is based on the % of butterfat. This varies with the breed of cows. Jersey cows give higher butterfat content but less volume of milk. Holstein cows give a lower % butterfat but produce a greater volume. The Fair Packaging and Labeling Act, requires that the butterfat content of milk will be clearly stated on each carton.

The second test on the milk sample will be the Biuret Test for protein using Copper sulfate.

This laboratory activity starts with an introduction on page 22a.

Materials You'll Need

See page 22a.

Procedure

Pages 22a, 22b, 23.

Once the technique has been perfected, try other dairy products such as Yoghurt, ice cream, cottage cheese, and whipped toppings.

Interpretation

Which two nutrients have you found in milk?

What are the other nutrients found in milk? (Use as reference "Nutrients Value of Food".)

Further Investigation

Visit a milk processing plant to learn how butterfat content of milk is determined.

How is milk pasteurized and homogenized? Does either process alter the nutrient value of milk?

ACTIVITY II A Hot Dog -- What's In It For Me?

The Chemistry of Food Additives, A Consumer Chemistry Learning Activity 1977 package, Kathleen Dwyer, Unigraf, a Division of United Graphics, Inc., 1428 Harvard, Seattle, Washington, 98122. Pages 18, 18a, 19, 20, and 21.

Introduction

Hot dogs comprise a large portion of the diet for most Americans. This is probably due to our life style of always being on the run and grabbing a quick meal.

By analyzing a hot dog for fat, water, and fillers, you will compare the proportion of these nutrients found in a hot dog. Unless you get all meat or all beef, your hot dog probably will have a large amount of filler in the form of carbohydrates.

Materials You'll Need

1 hot dog per lab group
10 ml Dichloromethane per lab group
1 ml Iodine solution (0.05 gram of Iodine crystals dissolved in 100 ml of Dichloromethane per lab group)

Procedure

See page 19 for procedure and mathematical interpretation of fat content of a hot dog. Make a data table and record your results.

See page 20 for procedure and mathematical interpretation of water content of a hot dog. Make a data table and record your results.

See the bottom of page 20 for the procedure for testing the hot dog to determine if fillers in the form of carbohydrates are present.

Interpretation

What is the function of the solvent, Dichloromethane?

What is the purpose of the iodine solution?

USDA (United States Department of Agriculture) allows up to 30% fat. Did your results of the % of fat fall within this amount?

What is written on the label about the contents of the hot dogs?

Further Investigation

Analyze baloney or sandwich meat by using the same procedures.

Make a cost comparison.

UNIT IV WHY DOES THE BODY NEED DIFFERENT KINDS OF FOODS?

CONCEPT B Digestion of Food Makes You What You Are!

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Compare the digestion of the nutrients to see where each is broken down.
2. Perform chemical tests to show how the food is digested.
3. Follow the diagram of digestion to realize how nutrients break down during digestion.
4. Use the construction models of the nutrients to show how these break down in digestion.
5. Realize how excess carbohydrate, protein, and fats can be stored in the body as fat.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition, Pages 153-187; 220-275; diagram 229 and 235.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. How Does the Food Turn Into You?

II. Let's Break Down the Nutrients.

TRANSPARENCIES

I. The Process of Metabolism

TEACHING STRATEGIES

Everybody has different preferences for food, this is individual, regional, as well as national. In the next unit the students will find out the type of food they eat has a lot to do with the latitude where they live. (This is the number of degrees they live above or below the equator.) No matter what they eat the body composition remains almost the same. The foods they eat turns into flesh, skin, and bones. In Activity I, "How Does the Food Turn Into You?", this will be explained. Besure to review the digestive system with your students.

The purpose of your digestive track is to break the food down into the basic nutrients which are carbohydrates, fats, and proteins. Then your body is ready to absorb these nutrients and eliminate the fluids and fiber as waste products.

Each nutrient is digested in different parts of your GI (gastro intestinal) track.

	Nutrients Digested	How It Breaks Down
In the Mouth	Carbohydrates	Starch → Maltose
In the Stomach	Protein	Protein → Amino Acids
In the small Intestines	Fats	Fats → Glycerol + Fatty Acids

Absorption of the remaining nutrients takes place in the small intestines.

Activity II, "Let's Break Down the Nutrients", will give the students a chance to separate the nutrients into three carbon atoms called pyruvate. In the next step the pyruvate divides into two carbon atoms called Acetyl CoA and finally into one carbon atom that combines with oxygen to form carbon dioxide.

Study the diagram on page 229, Understanding Nutrition and compare it to the one on page 235.

By introducing the number of carbon atoms in each stage, the students should be able to understand how these nutrients are broken down during digestion. Use Transparency I, The Process of Metabolism, to show the paths these nutrients follow. This diagram should help the students to see how excess carbohydrates, proteins, and fats all turn into fats that are stored in the body.

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ACTIVITY I How Does the Food Turn Into You?

Introduction

We all eat different foods. Joe eats a lot of peanut butter, Sally likes an apple a day, John gets a cold drink and package of crackers on the way to school each day. Joseph eats corn-bread with collards almost every night. Henry has eggs, grits, and bacon each morning for breakfast, Jenny has a steady diet of hot dogs and hamburgers. No matter what their diet, it turns into relatively the same amount of flesh, skin, and bones as well as energy for the body.

Let's see how this all happens by comparing the process of digestion to a play. Certain events take place in Act I, "The Mouth." Other events take place in Act II, "The Stomach", still other events take place in Act III, "The Intestines".

All the basic nutrients, carbohydrates, fats, and proteins are broken down into smaller molecules in different places in the digestive track. These smaller units can be absorbed by the body. There are five areas of the digestive system that secrete juices which act chemically on food as you eat. Each digestive juice that is secreted, acts chemically on a particular food nutrient. These events take place as the food is going through your GI (Gastro Intestinal) track. These five juices are found in the:

Salivary Gland
Gastric Glands
Intestinal Glands
Liver, and
Pancreas

ACT I: THE MOUTH

Starches are turned into dextrins by the enzyme, amylase, that is found in the Salivary Glands.

$$\text{Starch} \xrightarrow{\text{amalyse}} \text{Dextrins (simpler carbohydrates, not yet a 2 glucose molecules)}$$

Digestion of starches.

Only cooked starches are digested or broken down in the mouth.

Materials You'll Need

A piece of soda cracker or small piece of bread for each student.

Benedict's Solution.

Test Tubes

Procedure for Act I

1. Place a piece of soda cracker in your mouth.

2. Hold it there a few minutes.

Interpretation of Results

Did it taste sweeter?

The cracker is a starch. What has it turned into?

Further Investigations

Use a drop of iodine on the soda cracker or bread to test for starch as you did in the unit on carbohydrates.

Test the cracker after it has been mixed with saliva for sugar using the Benedict's solution.

ACT II: THE STOMACH

This is where the digestion of protein takes place. Gastric juices are secreted by the gastric gland in the wall of the stomach. These juices are mainly Hydrochloric Acid and pepsin, an enzyme.

$$\text{Protein Molecule} \xrightarrow{\text{Pepsin}} \text{smaller Polypeptide (10-1000 Amino Acids)}$$

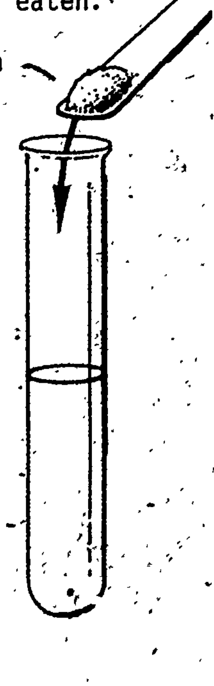
Digestion of Protein

Egg white is mainly protein, by treating it with Hydrochloric Acid and pepsin in a controlled experiment, you will see digestion take place.

To begin with you will make gastric juices. Then you will see how protein is digested by adding these juices to protein. The white of the egg will be used as the protein. The pepsin is the enzyme or catalyst that makes the reaction go to the right. Once you have seen the reaction of digestion on egg white, try other foods rich in protein and watch them digest. Remember all the time that this is taking place in your stomach, along with the muscular action, that is necessary to mix the gastric juices with the protein you have eaten.

Materials You'll Need

Egg white - egg albumin (powdered) (To make your own egg white powder: spread one raw egg white on a plate and allow to dry over night.)
Pepsin
Hydrochloric Acid
6 test tubes
Beaker



Procedure for Act II

1. Place 1 - 2 grams of powdered egg albumin in a test tube.

2. Make gastric juices in a beaker by adding Hydrochloric Acid, pepsin, and water. Use 20 milliliters of water, a few drops

of dil Hydrochloric Acid, and a very small amount of pepsin about 1 gram.

3. Add about 5 milliliters of gastric juices to the powdered egg albumin (egg white).

4. Place it aside until the next day or heat it in a water bath.

A water bath can be made by putting the test tube in a beaker half full of boiling water.

Further Investigation

Experiments and observations on the gastric juices were first made by William Beaumont, a medical doctor. As a result of an accident, Alexis St. Martin, a French Canadian, was left with part of his stomach exposed. When the wound healed, a hole was left in the abdominal cavity which served as a window allowing data to be taken by Dr. Beaumont, the Army surgeon. Through a series of experiments he was able to study the details of the stomach action. Find out the results of this study made in the mid 19th century.

Another interesting activity would be to add pineapple juice to protein. What is in this juice that causes digestion?

ACT III: THE SMALL INTESTINES

Just like a play, the action really comes to a climax in Act III, "The Small Intestines". Enzymes break down carbohydrates, proteins, and fats within the intestines. The three digestive juices in the small intestines are:

1. Pancreatic enzymes produced by the pancreas.

2. Bile produced in the liver but stored in the gall bladder.

3. Enzymes come from the intestinal wall.

Each enzyme has a different purpose.

Pancreatic Enzyme secrete Sodium bicarbonate that neutralizes the mixture of juices and food leaving the stomach. It also contains 3 enzymes that are active on 3 classes of food: carbohydrates, fats, and proteins.

Bile comes from the liver but is stored in the gall bladder. The bile is secreted into the duodenum when fat is present. It breaks down the fat molecule into fatty acids and glycerol.

Intestinal Juices are a combination of 4 enzymes, which complete the digestion of proteins and carbohydrates. Can you guess by the name which nutrient is acted on by these enzymes?

CARBOHYDRASES act on carbohydrates
LIPASES act on fats or lipids
PROTEASES act on protein

Everything that is not digested before it reaches the small intestines is acted upon here. You will discover the action of bile on fats or lipids in this activity. Bile is produced in the liver but stored in the gall bladder and it can be synthesized and bought from a scientific supply company.

Materials You'll Need

Bile
6 test tubes
Corn oil
Bacon drippings
Lard
Sugar (sucrose)
Raw or powdered egg white

Procedure for Act III

1. Make a 5% bile solution.

2. Pour 10 ml of the bile solution into each of the test tubes.

3. Add a small amount of corn oil to test tube #1.

   Add a small amount of bacon drippings to test tube #2.

   Add a small amount of lard to test tube #3.

   Add a small amount of carbohydrate in the form of sugar (sucrose) to test tube #4.

   Add a small amount of protein such as egg white to test tube #5.

   Test tube #6 will be used as a control.

When the fat or lipid are emulsified, these molecules are broken down into small droplets and digestion has occurred.

Suggested Data Table

	Test Tube #1	Test Tube #2	Test Tube #3	Test Tube #4	Test Tube #5	Control Test Tube #6
Food Nutrient	Corn Oil	Bacon Drippings	Lard	Carbohydrate (sucrose)	Protein (egg white)	
Digestive Juice	5% Sol Bile	5% Sol Bile	5% Sol Bile	5% Sol Bile	5% Sol Bile	5% Sol Bile
Results						

Interpretations of Results

What food was digested by the bile solution?

What major groups of nutrients do these represent?

Further Investigation

What effect does varying the temperature have on digestion? Design a controlled experiment to illustrate this.

What effect does pH (acidity) have on digestion? Design a controlled experiment to determine this effect.

Interpretation of the Three Act Play, Digestion

Carbohydrates, protein, and fats continue to digest until all the nutrients are broken down into molecules of glucose, fats or lipids are separated into glycerol and fatty acids, and the proteins are divided into Amino Acids. Some of the vitamins serve as enzymes while others have been absorbed along with the minerals. Absorption is now ready to take place in the small intestines. In the large intestine more absorption takes place leaving the waste to be excreted from the rectum.

The three act play on digestion draws to a close in the small intestines where the nutrients are broken down so that absorption can take place.

Further Investigation

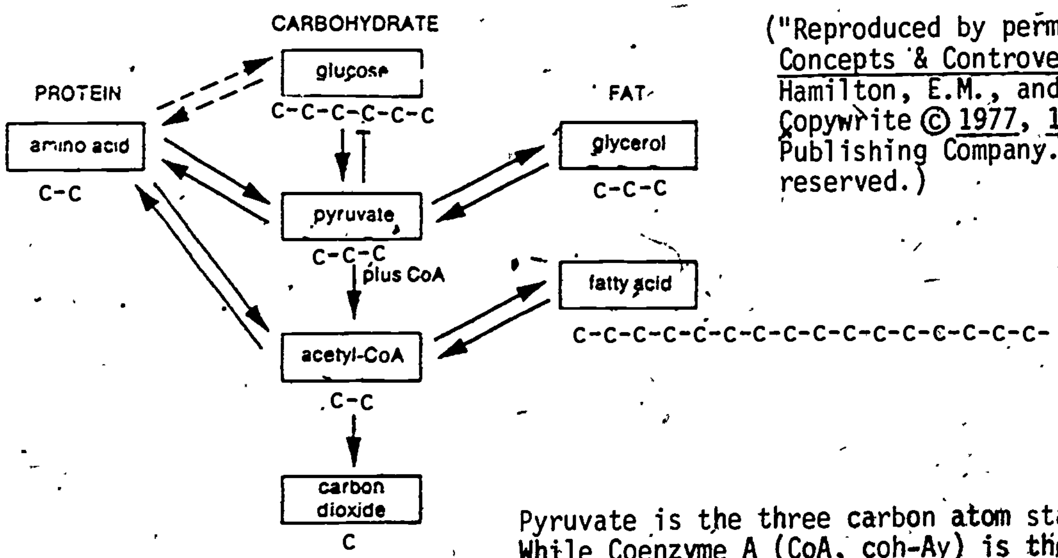
Find out the pH of the different areas of the GI tract. How does the change in pH aid in digestion? Design an experiment to determine the best pH for each nutrient during digestion.

ACTIVITY II Let's Break Down the Nutrients

Introduction

It seems like an enormous task for our body to convert the nutrients we eat into you. Then, too, we don't always eat the right amount of each nutrient. How does this all turn out right or does it?

Many chemical reactions are going on simultaneously in the body. Even though the reactions are very complex you will use a diagram to understand digestion. Use Transparency I, The Process of Metabolism, to show the breaking down of the food nutrients. Follow the arrows in this diagram to see just what happens in digestion to each of the nutrients.



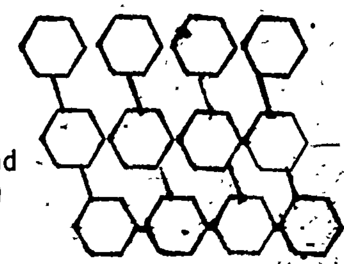
Pyruvate is the three carbon atom stage. While Coenzyme A (CoA, coh-Ay) is the nickname for Acetyl-CoA, the two carbon atom stage.

Materials You'll Need

- Construction Paper
- Glue
- Scissors
- Typing Paper

Procedure

Carbohydrates are complex polysaccharides molecules of sugar, starch, and cellulose. Cellulose does not break down during digestion. This is the fiber our digestive track needs for the muscles to work against as it goes through the stomach and intestines. Starches are made of many glucose molecules arranged in a branched chain. These starches are polysaccharides that break down into the glucose units during the first step of digestion.

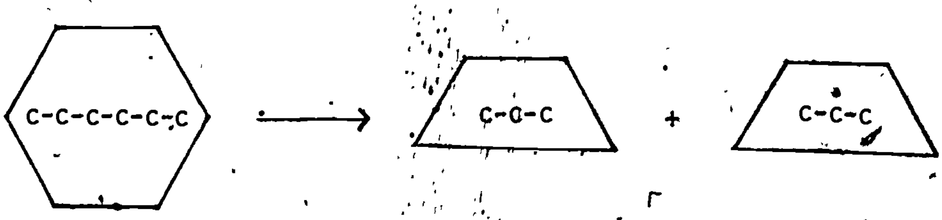


Starch

1. Take the starch molecule you made in an earlier unit and cut the glucose molecules apart, or make another starch molecule from branched chains of the glucose molecule. Cut these apart.

2. Now you have the glucose molecules that are each made up of 6 carbon atoms. Cut each glucose molecule in half.

   In metabolism when glucose breaks in half it then becomes a pyruvate molecule, a three carbon compound.



Glucose

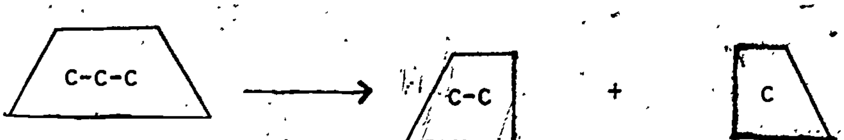
Pyruvate
C-C-C

C-C-C

The 6 carbon molecules of glucose are broken down into a 3 carbon compound called pyruvate.

SIX TO THREE: GLUCOSE TO PYRUVATE

3. In the next step of metabolism pyruvate divides into a 2 carbon compound, Acetyl CoA (coh-Ay). Cut the pyruvate into 2 parts, one representing 2 of the 3 remaining carbon atoms. The other part will represent 1 carbon atom.



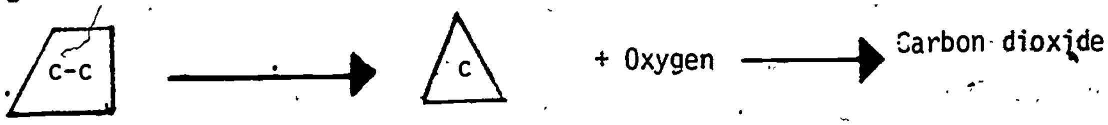
Pyruvate

Acetyl CoA

Three carbon atoms are broken down into two carbon atoms called Acetyl CoA.

THREE TO TWO: PYRUVATE TO ACETYL CoA

4. The next step is for the Acetyl CoA to break down into 1 carbon atom. As this happens two oxygen atoms combine with the carbon atom forming a molecule of Carbon dioxide, CO_2. Cut the Acetyl CoA in half.



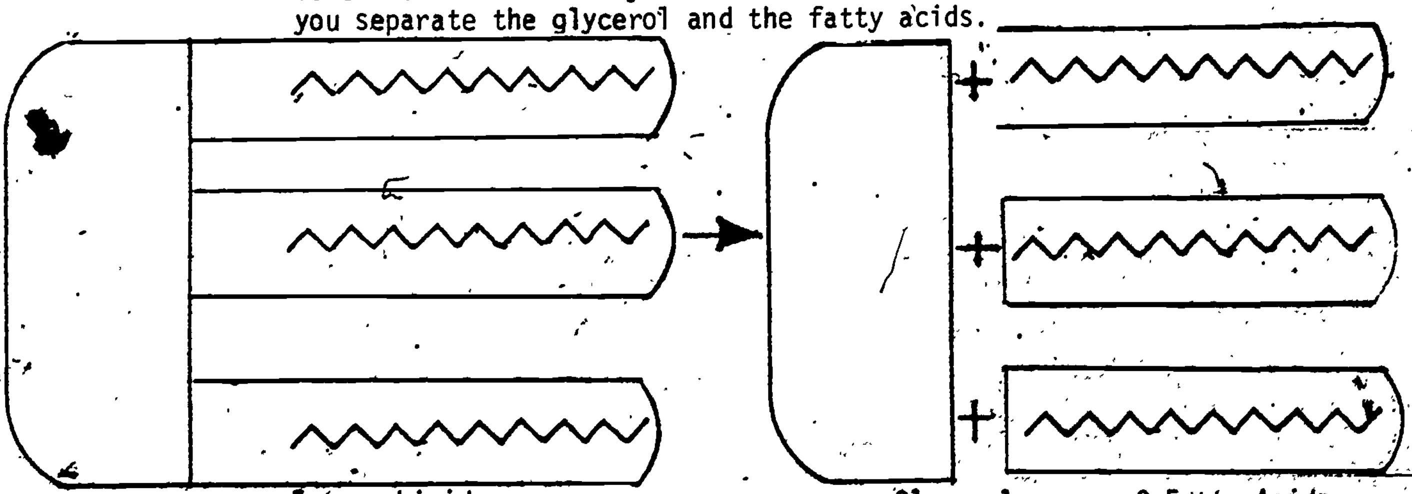
Acetyl CoA $\longrightarrow$ $C + O_2$ $\longrightarrow$ CO_2

1 carbon atom combines with oxygen to form carbon dioxide.

TWO TO ONE: ACETYL CoA TO CARBON DIOXIDE

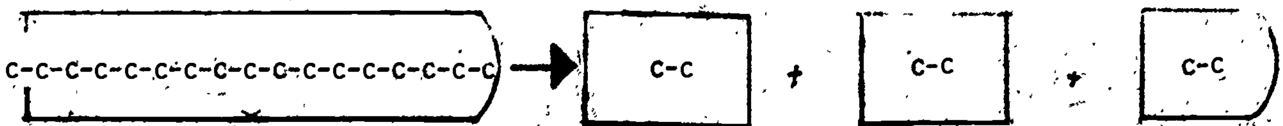
5. Fats are formed by three fatty acids combining with glycerol. This molecule breaks apart just as it was formed. Glycerol separates from the fatty acids. The glycerol which is made up of 3 carbon atoms is transformed into pyruvate also made up of three carbon atoms.

Take the fat molecule you made earlier and cut it so that you separate the glycerol and the fatty acids.



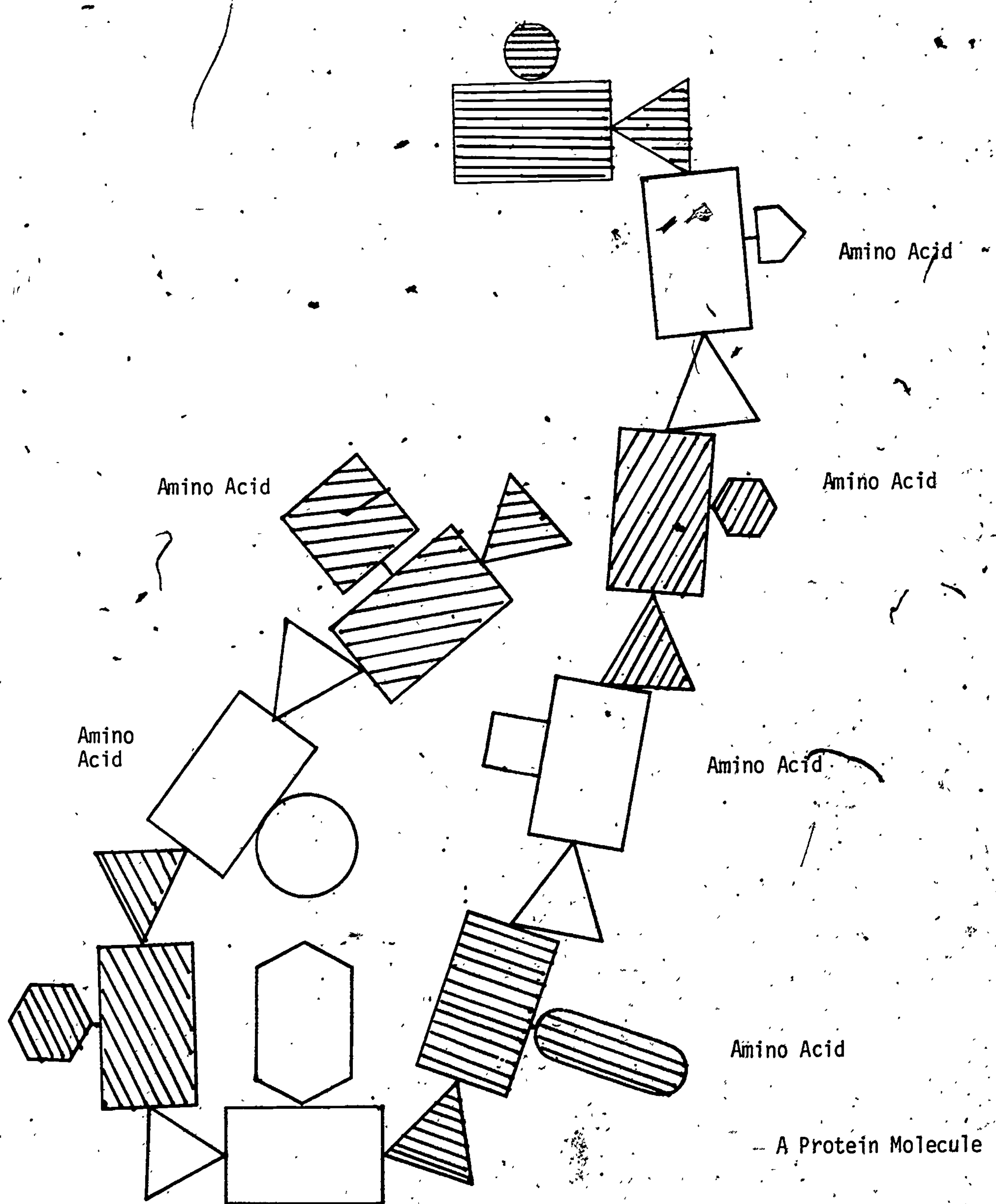
Fat or Lipid Glycerol 3 Fatty Acids

6. The Fatty Acids are made up of long chains of carbon atoms. These break down into 2 carbon atoms to form Acetyl CoA. Look again at the diagram of metabolism. Fatty Acids do not go through the pyruvate state. Cut the fatty acids into small pieces representing the 2 carbon atoms of Acetyl CoA.

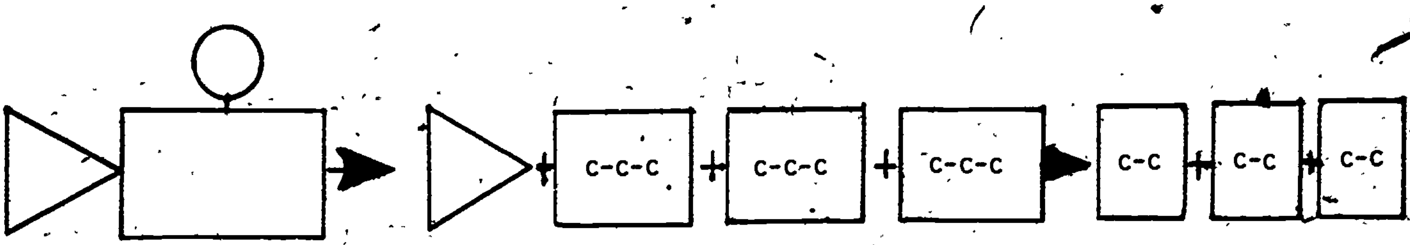


Fatty Acid	Acetyl CoA	+	Acetyl CoA	+	Acetyl CoA
Long Chain Carbon Atoms	2 carbon atoms	+	2 carbon atoms	+	2 carbon atoms

7. Protein breaks apart into the Amino Acids.



Once the Amino Acids loose the nitrogen it becomes the 3 carbon atom pyruvate or can go directly to the Acetyl CoA stage by breaking into 2 carbon atoms. The nitrogen turns into urea which is eliminated through the bladder and kidneys as urine. Follow the diagram.



Amino Acid ⟶ Urea + Pyruvate + Pyruvate + Pyruvate ⟶ CoA + CoA + CoA

8. Cut off the nitrogen end that forms urea. Then cut the rest of the molecule into 3 carbon atoms called pyruvate then into 2 carbon atoms of CoA.

Interpretation of Results

Now look at the arrows on Transparency I, "The Process of Metabolism. By following the diagram you will see that if you eat more glucose than is needed, the excess will turn into fat. Or if you eat more protein than is necessary, the Amino Acids will turn into fat! However, notice that the fatty acids do not directly convert to pyruvate and then turn into glucose. Look at the arrows. A diet of low carbohydrates is dangerous as you need a constant flow of glucose entering your body. This is not possible if you study the diagram.

Glucose ⟶ Glycerol and Fatty Acids

Glucose ⟶ Nonessential Amino Acids

Nonessential Amino Acids ⟶ Glucose

Glycerol ⟶ Glucose

Essential and nonessential Amino Acids ⟶ Fatty Acids

Nonessential Amino Acids ⟶ Glycerol

Glycerol ⟶ Nonessential Amino Acids

From this you can see that your body can gain weight by eating an excess amount of carbohydrates, fats, and proteins.

UNIT IV WHY DOES THE BODY NEED DIFFERENT KINDS OF FOODS?

CONCEPT C Your body needs must be balanced by food intake.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Make an actual measurement of the heat unit.
2. Identify essential foods and relate these to the body needs.
3. Determine their ideal body weight.
4. Determine their basal metabolism rate.
5. Determine the amount of body energy needed daily for their activity.
6. Compare their body needs with food intake.
7. Analyze several typical types of meals for nutrients.

BACKGROUND INFORMATION FOR TEACHERS

Whitney & Hamilton, Understanding Nutrition, Pages 239-248, 277-302.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. How Many Calories in a Peanut?

II. Your "Ideal" Weight

III. Determine Your Basal Metabolism Rate, BMR

IV. How Much Energy Does Your Body Need?

V. Problem Solving Hypothetical Diet Cases

VI. Balancing Activity with Food Intake

VII. Diet Analysis of Your Favorite Meal

TEACHING STRATEGIES

When talking about diets, the Calorie is used by almost everyone. In fact, everyone seems to be calorie conscious. Probably only a few people understand its true meaning, what it really measures, and just why calories are used to measure food.

These questions can best be answered by measuring the calories in a peanut. Activity I, "How Many Calories in a Peanut?" can be done by the students using very simple materials -- a drink can, thermometer, and peanut. The drink can serves as a homemade calorimeter which is the instrument used to measure a calorie by food scientists in a laboratory.

The focal point of this unit is to help the students apply the ideas and concepts of this course. This will enable them to see the importance in their choice of food. It has been proven, that if people maintain a constant body weight, that is, within the weight chart, they feel better, live longer, and are more active than those that become overweight.

It is an important concept for the students to determine their ideal body weight. One they should maintain all their lives. In Activity II, "Your Ideal Weight", the students will learn a quick and easy way to determine this. This quick and easy method in addition to the two "rules of thumb" can be used throughout life as indicators for weight control. The skinfold test which is commonly called the "Pinch Test" is an excellent way to determine the % body fat. Make certain the students understand that low body fat is a much better indicator of good health than low weight. In Understanding Nutrition, Page 536, is a chart of the "Ideal Weights from Life Insurance Statistics." The figures on this chart will be used by the student to compare with their estimated ideal weight.

The concept of balancing food intake with body activity can be introduced by making certain the students understand their body needs energy for three major purposes. One is for Basal Metabolism Rate (BMR), another one is for Daily Voluntary Activities (DVA), and the third one is for Specific Dynamic Action (SDA). The energy needed for BMR keeps their heart pumping, maintains the body temperature, and keeps them breathing while they are awake or asleep. The DVA are determined by the student. It is their choice to play football, tennis, jog, run, walk, sit, write, sew, or read. All of these activities need a different amount of energy above their BMR. The energy for SDA is used to digest and metabolize food. In Activity III, "Determining Your Basal Metabolism Rate", each student finds out just how much energy is needed for the involuntary activities of their body.

Activity IV, "How Much Energy Does Your Body Need?", will have the students look specifically at the energy requirements for their voluntary action. Students will need to make a record of their daily activities. It will be important for them to record the amount of time for each activity. The energy needed for Basal Metabolism Rate will be added to that needed for voluntary activity, plus the specific dynamic action of their body. This will be the amount of energy needed daily for their life style.

ACTIVITY I How Many Calories in a Peanut?

Introduction

Before you do this activity in class, it is important to grasp the concept that the Calorie is a heat unit. This is a unit used by scientists to measure energy. You have heard of a BTU, that is used to measure the amount of heat given off by a furnace or heater. This is an English unit, the metric counterpart is the calorie. Remember that scientists have for several hundreds of years used metric units to record their data. By doing it this way, the measurements become international and can be interpreted by all.

Most of the objects you measure can be felt or seen, but energy is different. You can measure your weight or your height as this is something concrete. Energy on the other hand cannot be measured in a direct way. It must be measured by its effect on matter. The scientists have devised a way to measure heat energy of an object, that is, by burning and measuring the heat given off. As the object burns, it is surrounded by a water jacket. The temperature of the water increases and this can be measured by using a thermometer. If the object (food) is measured in grams, the volume of water is measured in millimeters, and the temperature recorded with a Celcius thermometer, the unit of heat energy will be a calorie.

It is important that the distinction be made between a "little calorie" and a "large calorie". The "large calorie" is often written with a capital "C", Calorie, or with the metric prefix kilo-, kilocalorie, kcal is used for short. The "little calorie" is written with a small "c". This means that:

1000 calories = 1 Calorie or 1 kilocalorie (1 kcal)

1 Calorie is the same as 1 kilocalorie

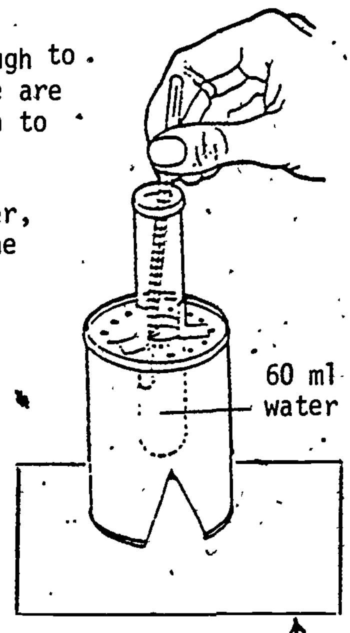
It is the large Calorie or kilocalorie that is used to measure the energy in food. A calorimeter is the instrument used to measure calories. The word comes from "Calorie measure". This instrument is used to burn food in a confined area.

For this activity, a calorimeter will be made out of a drink can. A peanut will be burned. As this is happening, the heat from the peanut will be transferred to the water in the test tube causing a temperature change. Using a simple formula, the number of calories will be calculated.

Materials You'll Need (for each group of students)

1 peanut (pecan half or walnut half)
1 cork
1 drink can
1 thermometer
1 test tube - large
Graduated cylinder
1 needle
Asbestos pad

Procedure



1. Make two holes in the bottom of a drink can large enough to place a cork in this opening. Make certain that there are enough air holes in the top of the can for ventilation to allow the peanut to burn.

2. Measure 60 millimeters of water in a graduated cylinder, pour this into a test tube. Place the test tube in the top of the drink can.

3. Place the drink can on an asbestos pad.

4. Determine the temperature of the water and record it on the data table.

5. Place a peanut on the end of a needle and stick it in the cork. Set fire to the peanut.

6. Quickly place the cork, needle, and peanut in the drink can calorimeter.

7. After the peanut has burned, record the temperature of the water.

   As an alternative method, the nut can be placed on the end of a dissecting needle and held in the opening of the drink can as it burns.

   a. Amount of water ____________ ml

   b. Temperature of H_2O before burning ____________ ^oC

   c. Temperature of H_2O after burning ____________ ^oC

   d. Change in temperature of the H_2O ____________ ^oC

   e. Multiply the amount of water times the change in temperature ____________ calorie

   f. Divide this by 1,000 to convert your figure into a large Calorie ____________ Calories or kcal

Amount of energy in a peanut =

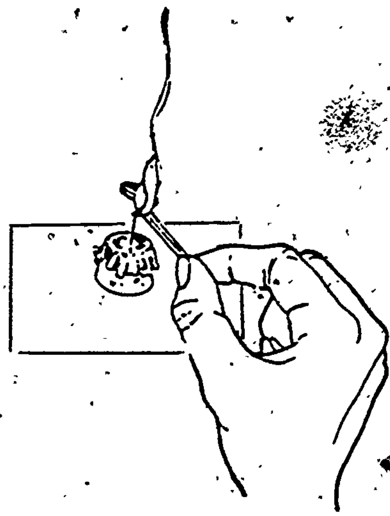
$$\frac{\text{amount of } H_2O\text{(ml)} \times \text{change in temperature } (^oC)}{1000} = \_\_\_\_\_\_\_\_\_\_ \text{Calories}$$

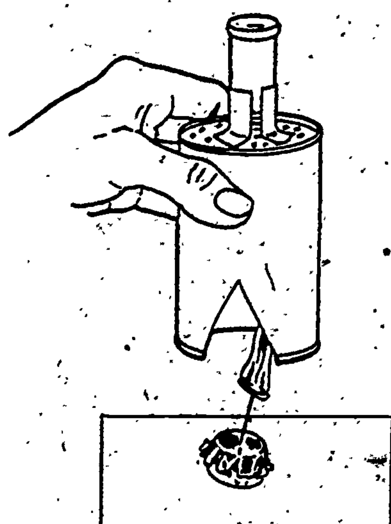
Interpretations

Compare your results to 3 to 7 calories usually accpeted as the number of calories in a peanut. Is there a difference? What are the reasons for this difference? Are all peanuts the same size? How accurate is your calorimeter?

Further Investigation

Potato chips are easy to burn. Try other foods. If necessary, make a trough out of aluminum foil to hold the food.





ACTIVITY II Your "Ideal" Weight

Introduction

In this activity you will estimate your "ideal" weight. This method can easily be remembered throughout life. It is just a ball park figure that can be compared to a more accurate estimate of your weight. Several other "rule of thumb" tests that can be remembered through our life are explained in this activity.

Materials You'll Need

Skinfold Calipers, Fat Control, Inc., P. O. Box 10017, Towson, Maryland 21204. Several will be needed for a class.

Understanding Nutrition, Whitney and Hamilton, Ideal Weight Chart, page 536.

Procedure

♀ For females: If you are five feet tall, you should weigh 100 pounds.

For every inch above 5 feet, add 5 pounds.

Example: If you are 5 feet 3 inches tall, by applying this rule, your ideal weight should be:

		100 lbs.
3 x 5 lbs.	=	15 lbs.
Total Weight		115 lbs.

Another Example: If you are 5 feet 7 inches tall, by applying the rule your ideal weight should be:

7 x 5 lbs.	=	100 lbs.
		35 lbs.
Total Weight		135 lbs.

♂ For males: If you are 5 feet tall, you should weight 110 pounds.

For every inch above 5 feet, add 5 pounds.

Example: If you are 6 feet 1 inch tall, by applying this rule, your ideal weight should be:

		110 lbs.
13 x 5 lbs.	=	65 lbs.
Total Weight		175 lbs.

This rule of thumb for "ideal weight" is only a rough estimate.

Record your ideal weight. Compare the chart on page 536, Understanding Nutrition, with your "ideal weight". Most weight charts have a column for small, medium, or large framed people. Perhaps you have wondered where you fit into this chart. The wrist measurement can be used to determine your frame size. There are several other tests to help you remember when the time comes to watch your diet.

Frame Size Test

Place your index finder (pointer) and thumb around the wrist of the other hand. If the thumb and index finger meet exactly around your wrist, you have a medium build. If the index finger overlaps your thumb, you have a small frame. If your finger and thumb do not meet, then you have a large frame.

Comparison Between Wrist and Upper Arm

Another "rule of thumb" can be used to determine if you are in the ideal weight category. Measure the circumference of your wrist and upper arm. If the difference is more than 3 inches, you need to loose weight.

Skinfold Test

The pinch or skinfold test is an indicator to use when determining your body fat. Several calipers are on the market that will facilitate this test. Skinfold measurements can be made near the triceps, suprailiac, subscapular, thigh, and abdominal region depending on the tables used by the manufacture. The measurements you make in millimeters is easily converted to % body fat by charts. When several measurements are made these can be averaged and your percent body fat can be determined. The following fat norms have been established.

	♂	♀
Very Low	0- 8%	0-10%
Low	9-12%	11-15%
Acceptable	13-15%	16-20%
Fat	16-17%	21-25%
Obese	18 + %	26 + %

When it comes to your health, % fat is a better indicator than low weight. Always remember, if you "pinch an inch" back of your triceps, you need to reduce the amount of fat intake in your diet.

ACTIVITY III Determine Your Basal Metabolism Rate, BMR

Introduction

It is important to know that no matter whether it is night or day, your body is using energy. It is taking heat energy in units called calories to keep you alive. Your body functions go on, no matter if you are sleeping or jogging. Your heart keeps pumping blood, nerves carry messages to the brain, heat is continuously radiated from your body. The Basal Metabolism Rate, BMR, is the energy needed for these body functions. This is usually determined by measuring the heat radiating from the body after a 12 hour fast. You will not be able to do this but you can estimate the amount of energy needed for your body functions to keep going

The rate of BMR varies with individuals but is dependent upon age and sex. A rough estimate is that your body needs 1 kilocalorie of energy for each kilogram of body weight each hour of the day. If you are a female, you will need a little less than this amount, 0.9 kcal. Younger children have a higher BMR.

It will be important to estimate the amount of energy needed for your BMR, so that your total energy needs can be determined in the next activity.

Procedure

1. Determine your Ideal Body Weight. (See the previous activity.)
2. Change your Ideal Body Weight to Ideal Body Mass. (Change pounds to kilograms.)

   Ideal Body Mass = _____ weight (pounds) x $\frac{\text{1 kilogram}}{\text{2.2 pounds}}$ = _____ kilograms

3. Determine your energy needs for Basal Metabolism Rate, BMR.

♂ 1 kcal x Your Ideal Body Mass (kg) x 24 hours = BMR

Example: 1 kcal x 70kg x 24 hours = 1680 kcal

♀ 0.9 kcal x Your Ideal Body Mass (kg) x 24 hours = BMR

Example: 0.9 kcal x 50 kg x 24 hours = 1080 kcal

BMR = ___ mass (kilograms) x _____ (1 kcal for ♂ / 0.9 kcal for ♀) x 24 hours = _____ kcal

Notice the formula called for Ideal Body Mass. When you figured your Ideal Body Weight in Activity II, your figures were in the English system. When you measure something in pounds, it is called a weight. When this figure is converted to the metric units, it now becomes a mass.

Interpretation

Now you have determined the Basal Metabolism Rate, BMR, that your body needs for involuntary action. This is only part of the story. In Activity IV, "How Much Energy Does Your Body Need?", you will add this to the energy your body needs for your Daily Voluntary Activities, DVA, and the Specific Dynamic Action of your body, SDA. Then you will know your total daily caloric needs.

ACTIVITY IV How Much Energy Does Your Body Need?

Introduction

How many calories do you need each day? This depends upon your:

Basal Metabolism Rate (BMR).

Daily Voluntary Activities (DVA), and

Specific Dynamic Action (SDA)

The Basal Metabolism Rate, BMR, is the amount of energy used by your body while you are at rest. This energy is necessary to keep your involuntary functions going such as the heart beating.

The amount of energy for your Daily Voluntary Activities, DVA, will depend upon your interests and life style. It makes good sense that a person playing football, basketball, or tennis will require more food than the student that drives to school, sits all day in class, and then goes home and watches television. Your DVA energy needs can be determined by listing your Daily Voluntary Activities on the suggested data table. Then look on the chart for the energy required for these activities. Record the amount of time in fractions of an hour that you are engaged in each activity. Next, determine the total amount of energy needed by multiplying the kcal per hour for your activities by the fraction of the hour and totaling these figures.

The energy needed for your Specific Dynamic Action, SDA, is used to digest and metabolize your food. SDA can be determined by taking 10% of the addition of the BMR and DVA.

By adding the BMR, DVA, and SDA, you can determine the total amount of calories needed by your body.

Excess food energy is stored in the body as fat. If you start to gain weight, you probably are not balancing your activity with your food intake.

Materials You'll Need

"Amount of Energy Needed for Voluntary Activities" table.

Amount of your Basal Metabolism Rate determined in Activity III "Determine Your Basal Metabolism Rate, BMR".

Procedure

1. Record your BMR from Activity III in your notebook.
2. To determine the Daily Voluntary Activities, DVA, copy the suggested data table in your notebook.

3. Record your activities for the last 24 hour period. Use fractions of the hour if you did not do the activity for the whole hour.

   For example: If you jogged for ½ hour, use .5 hours.

4. Multiply the fraction of the hour or the hour by the amount of energy needed for each activity.

   NOTE: You do not find sleeping on the table as this is accounted for in your BMR.

5. Add the last column of the suggested data table and multiply this figure times your mass in kilograms for the amount of energy needed for your Daily Voluntary Activities, DVA.

   Daily Voluntary Activities = Energy (kcal/kg) x Your Mass (kg)

   DVA = _____ kcal/kg x ________ kg

6. To determine the energy needed for your Specific Dynamic Activities, SDA, take 10% of the sum of the energy needed for BMR and DVA.

Basal Metabolism Rate, BMR	( )	kcal
Daily Voluntary Activities, DVA	( )	kcal
Sub Total	( )	kcal
	x .10	
Specific Dynamic Action, SDA	( )	kcal

7. To determine the total amount of energy needed for your body, add BMR, DVA, and SDA.

Basal Metabolism Rate, BMR	( )	kcal
Daily Voluntary Activities, DVA	( )	kcal
Specific Dynamic Action, SDA	( )	kcal
Energy	( )	kcal

8. Multiply your energy needs by your ideal mass in kilograms.

Your Daily Energy = ______ energy X Ideal Body Mass (kilograms) = ______ kcal

UNIT IV, CONCEPT C, ACTIVITY IV (continued)

Suggested Data Table for Daily Voluntary Activities, DVA.

Specific Activity	A Fraction of hour or hours	B kcal/kg/hr	Energy A x B kcal/kg
		SUBTOTAL	

Interpretation

You know the amount of energy needed for your Basal Metabolism Rate, type of Daily Voluntary Activities, and Specific Dynamic Activities. You must balance this amount of energy with your daily food intake. On the other hand, if you eat more than is necessary for your daily activities, your body stores excess energy in the form of fat.

You are ready for Activity VI, "Balancing Activity with Food Intake", where you will make a list of your daily food intake. This will help you determine if you are balancing the energy that is needed by your body with your food intake.

Further Investigation

Compare your energy needs to that of members of your class who are engaged in other activities.

Amount of Energy Needed for Voluntary Activities

Costs of activities in kilocalories per kilogram per hour exclusive of basal metabolism and specific dynamic action.

Activity	kcal/ kg/hr	Activity	kcal/ kg/hr
Basketball	7.5	Piano Playing (Liszt's "Tarantella")	2.0
Bicycling (century run)	7.6	Reading aloud	0.4
Bicycling (moderate speed)	2.5	Rowing in race	16.0
Boxing	11.4	Running	7.0
Carpentry (heavy)	2.3	Sawing wood	5.7
Cello playing	1.3	Sewing, hand	0.4
Crocheting	0.4	Sewing, machine	0.4
Dancing	3.8	Singing in loud voice	0.8
Dishwashing	1.0	Sitting quietly	0.4
Dressing and Undressing	0.7	Skating	3.5
Driving automobile	0.9	Soccer	7.5
Eating	0.4	Standing at attention	0.6
Fencing	7.3	Standing relaxed	0.5
Football	7.5	Stone masonry	4.7
Horseback riding, walk	1.4	Sweeping w/broom, bare floor	1.4
Horseback riding, trot	4.3	Sweeping w/vacuum sweeper	2.7
Horseback riding, gallop	6.7	Swimming (2 mph)	7.9
Ironing (5-pound iron)	1.0	Talking	0.4
Jogging	7.5	Thinking	0.4
Knitting Sweater	0.7	Typewriting rapidly	1.0
Laundry, light	1.3	Violin playing	0.6
Lying still, awake	0.1	Walking (3 mph)	2.0
Organ playing (30% to 40% of energy hand work)	1.5	Walking rapidly (4 mph)	3.4
Painting furniture	1.5	Walking at high speed (5.3 mph)	9.3
Paring potatoes	0.6	Washing floors	1.2
Playing Ping-Pong	4.4	Writing	0.4
Piano Playing (Mendelssohn's songs)	0.8		
Piano Playing (Beethoven's "Apassionata"	1.4		

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ACTIVITY V Problem Solving Hypothetical Diet Cases

Introduction

By determing diet requirements for specific cases and prescribing a proper amount of caloric intake to fit their needs, you will become aware of the needs for individual cases and in the future recognize these problems in your own diet.

Follow the step by step procedure in selecting the caloric intake needed for each hypothetical case.

A. Basal Metabolic Rate, BMR

1. Determine the ideal weight , use the given weight, or refer to a weight chart.
2. Change pounds to kilograms (2.2 lbs. = 1 kilogram).
3. Determine hourly BMR (multiply weight in kilograms by BMR factor.)
   a. factor for ♂ : 1.0 kcal/hr.
   b. factor for ♀ : 0.9 kcal/hr.
4. Determine daily BMR (multiply by 24 hours).
5. After growth stops, the BMR decreases 2% per decade throughout life. (Even though this varies in individuals, we shall use 22 years as the age when growth stops.)

B. Daily Voluntary Activities, DVA

There is a quick way to determine this without accounting for each minute of the day. Select the appropriate general type of muscular work for each hypothetical case, then multiply this percentage times the BMR which you determine in "A".

1. Sedentary (mostly sitting), add 20%.
2. Light Activity, add 30%.
3. Moderate Activity (a nurse), add 40%.
4. Heavy Work (a carpenter), add 50%.

C. Specific Dynamic Action, SDA

After taking the sum of BMR and DVA you will need to increase or decrease this figure according to the SDA of each case study. The following factors will influence the daily energy requirements of each case study.

1. Diet:	Mixed or balanced	Increase BMR plus DVA by 10%
	Pure carbohydrates	Increase BMR plus DVA by 6%
	Pure fat	Increase BMR plus DVA by 15%
	Pure protein	Increase BMR plus DVA by 18%
	If diet unknown	Increase BMR plus DVA by 10%

2. Body temperature: For each degree above normal, increase BMR plus DVA by 7% (normal is 98.6°F).

3. Climate: If the average annual temperature is 98°F or below increase by 2-5%. If average annual temperature is above 98°F increase by 0.5% for each degree.

4. Stress: If epinephrine from the adrenal glands causes body changes increase by 2%.

5. Pregnancy: Increase 200 calories per day during the last 3 months.

6. Lactating: Increase 500 calories per day.

7. Hyperthyroidism (over secretion): Increase by 75%.

8. Hypothyroidism (under secretion): Decrease by 30-40%.

Remember an energy deficit of 3,500 kcal/week or 500 kcal/day is necessary for the loss of a pound of body fat.

Procedure

Determine the daily kilocalories for each of these hypothetical cases.

Case 1: ♂ 17 year old, 167 pounds, plays football, eats a mixed diet, in good health.

Case 2: ♀ 17 years old, 118 pounds, mixed diet, in good health, mostly sedentary.

Case 3: ♀ 38 years old, 220 pounds, ditch digger, 5 months pregnant, body temperature 101°F, lives in Alaska, eats a pure fat diet.

Case 4: ♂ 55 years old, retired mailman, 6 feet tall, 50 pounds overweight, refinishes furniture, eats a mixed diet, doctor wants him to loose 2 pounds per week.

Case 5: (Make up several unusual hypothetical cases of your own using the unusual factors above.)

Further Investigation

Study the dietary needs of "Real People". Select three people with varying activity to determine their caloric needs. Use close relatives, or friends at school.

ACTIVITY V Balancing Activity with Food Intake

Introduction

By now you should have a ball park figure for the amount of energy your body needs for basal metabolism rate and your type of body activities. You are ready to find out exactly how much energy you are putting into your body every-day. To do this you must write down everything you put into your mouth and ingest for a 24 hour period. This is a "24 hour diet recall". Be sure to write down the quantity you ingest. Your next step will be to look up each item in "Nutritive Value of Foods" and determine the amount of each nutrient. Make certain you include all of your snacks, soft drinks, junk food, or whatever. Add all the columns and compare the energy, calories, to the figure you determined in Activity IV, "How Much Energy Does Your Body Need?"

Materials You'll Need

"Nutritive Value of Foods" as a resource.

Procedure

1. Copy the suggested data table in your notebook.
2. Select a 24 hour period to list everything you put into your mouth.
3. Write the amount by each item.
4. Look up in "Nutritive Value of Foods" the amount of each nutrient.
5. Total each column.
6. Make a comparison of the amount of energy nutrients you found that your body needed in Activity IV, "How Much Energy Does Your Body Need?", write this on the data.
7. Compare the other nutrients to the amount on Table 4 page 32 "Nutritive Value of Foods". Write this on the data table.
8. Find the difference between your food intake and your body needs. Use a + to indicate more of the nutrient than is necessary. Use a - to indicate a shortage of the nutrient.

Suggested Data Table

Following this activity.

Interpretations

Which nutrients are you missing in your diet? What foods will you need to make up these shortages?

The term "empty calories" will soon become obvious as you look at the nutrients found in a soft drink, potato or corn chips, crackers, or candy bar. Compare this to the nutrients in a piece of fruit such as a banana, apple, or orange.

Further Investigations

A quick cost comparison is also important. Compare the cost of a soft drink with an apple, orange, or even a glass of milk. Next, compare the nutritional value of each.

Make a cost comparison of milk and a soft drink using the same volume of each. Compare the nutrient value of each.

UNIT IV, CONCEPT C, ACTIVITY VI
(continued)

24 HOUR DIET RECALL DATA TABLE

Food	Amount	Energy kcal	Protein	Minerals: Calcium	Minerals: Phosphorus	Minerals: Iron	Vitamins: Vitamin A	Vitamins: Thiamin	Vitamins: Riboflavin	Vitamins: Niacin	Vitamins: Ascorbic Acid
TOTAL											
Your Daily Needs according to Table 4 "Nutritive Value of "Foods"											
Difference between food intake and body needs. Use + if over, - if under.											

ACTIVITY VII Diet Analysis of Your Favorite Meal

Introduction

What is your favorite meal?

Is it McDonald's or Hardee's hamburger and french fries?

Is it a Chick-Fil-A sandwich and drink?

Is it a Colonel Sanders fried chicken dinner?

Is it soul food meal (this is considered to be a typical meal in South Carolina)?

Is it a seafood platter at Murrell's Inlet?

Maybe it's Christmas Dinner?

Could it be a Bar-B-Q dinner?

How about school lunches? Everybody eats on fried chicken and cinnamon bun day.

In this activity you will analyze at least one of these meals for all the nutrients and then determine what you need for the rest of the day so that you can balance your activity with your food intake.

Materials You'll Need

Nutritive Value of Foods

Suggested Data Table

Following this activity.

Procedure

1. Copy the data table in your notebook.
2. List the foods and the amounts of each in the appropriate column.
3. Look up in Nutritive Value of Foods for the amount of each nutrient in the meal you selected.
4. Total the nutrients and place this amount in the proper place.

5. In the appropriate place on the data table, put the energy you found necessary for your basal metabolism rate and your type of activities.

6. For the other nutrients necessary for you, use those listed for your body weight, sex, and age on Table 4 <u>Nutritive Value of Foods</u>.

7. Subtract your favorite meal from <u>your</u> daily needs. Use a + if the meal provided more than enough nutrients. Use a - if this meal did not provide enough nutrients.

Interpretation

Which nutrients does <u>your</u> body need for the rest of the day? What type of food will you need to eat for the balance of the day?

ANALYSIS OF YOUR FAVORITE MEAL

				Minerals			Vitamins				
Food	Amount	Food Energy (Calories)	Proteins (grams)	Calcium (Milli-grams)	Phosphorus (Milli-grams)	Iron (Milli-grams)	Vitamin A (Inter-national)	Vitamin B_1 Thiamin (Milli-grams)	Vitamin B_2 Riboflavin (Milli-grams)	Niacin (Milli-grams)	Vitamin C Ascorbic Acid (Milli-grams)

Nutrients needed daily for your body. (__________)

Total nutrients in your favorite meal. (__________)

Difference between your daily needs and your favorite meal. (__________)
Use + if this meal is enough.
Use - if not enough nutrients.

UNIT V WHAT ARE THE ULTIMATE SOURCES OF FOOD: SUN, SOIL, AND ATMOSPHERE

CONCEPT A The sun is an ultimate source of food

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Explain how energy from the sun is converted into energy in the form of plants useful to man as food and fiber.
2. Conclude that man uses the energy stored in the plants for body needs.
3. Realize how only a very small portion of the radiant energy from the sun reaches their dinner table in the form of food.

BACKGROUND INFORMATION FOR TEACHERS

Janick, Schery, Woods, Ruttan; W. H. Freeman and Company, Plant Science, pages 30-54.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Taking the Green Out of Greens

II. Soft Drink Energy Pyramid

TRANSPARENCIES

I. Light-Energy Source for Photosynthesis

II. Transfer and Absorption of Sun's Energy

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TEACHING STRATEGIES

From the sun to the supper table, how does this all take place?

The sun, soil, and atmosphere provide the building blocks and mortar for all food. The CO_2 and H_2O are the building blocks, while the energy from the sun is the mortar. The process of this conversion is photosynthesis, which requires CO_2, H_2O, sunlight, and chlorophyll. The products of photosynthesis are the carbohydrates (sugars, starches, and cellulose). Use Transparency I, Light-Energy Source for Photosynthesis, to illustrate how carbon dioxide and water in the presence of light and the catalysts, chlorophyll, form glucose, a simple form of sugar.

$$6\ CO_2 + 12\ H_2O + 673{,}000 \text{ calories } \xrightarrow[\text{(catalysts)}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

Carbon dioxide + Water + Light Energy Yields Glucose+Oxygen+Water

This means that 673,000 calories is stored in the plant.

Chlorophyll, the green pigment in plants, can be separated by chromotography. Activity I, "Taking the Green out of Greens", will help the students understand the role of chlorophyll in green plants and also give them first hand experiences in analytical procedure of chromotography.

When people eat plants, stored energy is released. Thus by the action of catalyst, chlorophyll, and by the process of photosynthesis the building blocks (CO_2 and H_2O) combine with the mortar (sunlight) to form plants that support all living organisms.

Make certain the students grasp the meaning of "from the sun to the supper table".

The amount of energy from the sun that is used for plant growth is very small, only 1-2%. Transparency II, Transfer and Absorption of the Sun's Energy, illustrates the various amounts of the sun's energy that is exchanged on a summer's day at noon by the width of the arrow. Note that only a small part of this energy is transferred to plants. Where does most of the energy go? The amount of energy captured by photosynthesis is represented by the total biomass. This is the total amount of living organic matter on the earth. It is usually represented by the oven dry mass of all the vegetative material on the earth. Of course this is only a crude measurement.

Of this amount of energy that reaches the plants, only 1 or 2% is stored. Animals and other organisms that feed on green plants are equally inefficient. As the energy progresses through the food chain, only a small percent is transferred. Remember that as energy progresses up the food chain much is lost by indigestible materials such as hide, hair, bones, roots, stalks, and stems.

By a rough estimate it has been determined that it takes 100,000 pounds of algae to produce 1 pound of codfish. The energy lost in the food chain is made clear by Activity II, "Soft Drink Energy Pyramid." Four students will represent each stage of the food chain. One student will represent grass, one the grasshopper, another person will represent the snake person and the fourth will represent the hawk. What will this do to the world demand for food as the population increases?

Make it clear to the students that we lengthen the food chain by eating meat, thus creating another giant energy loss. This will be important as the demand for food increases with world population gains. Orientals have a diet that is primarily made up of plant materials, while in the United States, we have a high capita consumption of meat -- the highest in the world.

Even though the plants provide the link between sunlight and food, there is a tremendous loss of the sun's energy. This concept should be evident to all the students.

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UNIT V What Are the Ultimate Sources of Food: Sun, Soil, and Atmosphere
CONCEPT A The sun is an ultimate source of food

ACTIVITY I Taking the Green Out of Greens

Introduction

The separation of plant pigment from leaves will allow the students to use the technique of chromatography. Chlorophyll, the green pigment in plants, can be separated from the green leaves of collards, turnip tops, mustard, spinach, and tender greens, and serves as a catalyst necessary for photosynthesis.

A catalyst promotes the rate of a chemical reaction without being permanently altered. Many theories exist on the reaction of the catalyst but scientists do not fully understand this action. Catalysts are often used in other disciplines. For instance in politics, it is used to indicate a promoter of a movement. However, catalyst is best understood as a chemical term where it enables a change to occur that otherwise might be difficult or time consuming.

Chlorophyll, the catalysts in photosynthesis, can be separated by the analytical technique of chromatography. This process was discovered by a Russian botanist, Mikhail Tswett, when he separated chlorophyll from foliage by using column chromotography. Tswett placed a glass tube filled with Calcium carbonate in a vertical position and poured the plant extract through the top of the tube. The pigments separated because of the different rate of absorption of $CaCO_3$.

You can separate chlorophyll from greens by making an extract of the plant pigment. This can be done by placing little pieces of crushed leaves from collards, turnip tops, mustard greens, or spinach in a test tube just covered with a 1:3 ratio of water and isopropyl alcohol. Heat the test tube in a H_2O bath until the liquid turns green. This is the extract. Place a drop of this extract on a strip of Whatman paper. Repeat this a number of times until you have a green spot of chlorophyll extract on the paper strip. Next place the strip of paper in a test tube containing a developing solvent such as isopropyl alcohol. The chlorophyll in the solvent migrates up the paper at different rates separating it into individual plant pigments.

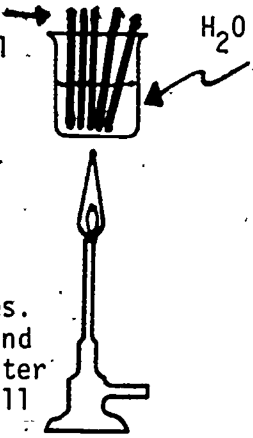
The green pigment in the leaves will separate into:

Chlorophyll A	----	Light yellow green, and
Chlorophyll B	----	Dark yellow green.

Materials You'll Need

Whatman #1 filter paper
Leaves from collards, turnip tops, mustard, tender greens, spinach, or Kudzu.
1:3 ratio of water and Isopropyl Alcohol -- solution for extract

Isopropyl alcohol - developing solvent
Water bath
Test tubes
Glass stirring rod
Bunsen burner
Ring stand
Wire Gauze



Procedure

1. Break the leaves from each of the greens into small pieces. Place the pieces in a test tube with 1:3 ratio of water and isopropyl alcohol. Use enough of the alcohol and water mixture to just cover the greens. Separate test tubes will be used for each of the greens.

2. Place the test tubes in a water bath made from a beaker half filled with water. Bring the water to boil. Soon the pigment will dissolve in the water-alcohol mixture and it will be colored green. This is your chlorophyll extract.

   Warning Isopropyl alcohol will ignite. Therefore be sure to use the water bath. Keep the alcohol away from the flame at all times.

3. Cut the Whatman #1 filter paper into strips about 1 cm by 15 cm. You will need one strip for each test tube.

4. Place a drop of the chlorophyll extract about 1 cm from the end of the strip of Whatman paper. Use a glass stirring rod to spot the paper. Let it dry for a few minutes. Repeat 5 or 6 times. A drying oven will speed up this process but is not necessary.

5. Pour 2 ml of the solvent, isopropyl alcohol, in a test tube. Place the strip of Whatman filter paper that has been spotted with the plant extract in the test tube and stopper. Allow to develop.

6. When the solvent has reached the top of the Whatman filter paper, remove and place on a paper towel to dry. Observations can be made of the chlorophyll. NOTE: Chlorophyll can be extracted and stored in the refrigerator with some success.

Interpretation of Results

Did you have both --

Chlorophyll A	----	Light yellow green, and
Chlorophyll B	----	Dark yellow green?

Further Investigations

The pigments in other vegetables can be separated in this same manner. Try carrots, beets, or tomatoes. Dried parsley can be soaked over night in water then spotted on the filter paper. Try other solvents such as ethyl alcohol or acetone.

ACTIVITY II Soft Drink Energy Pyramid
(taken from NSTA packet on Bioconversion.)

Introduction

The following activities are presented to impress you about the magnitude of the energy lost through the successive levels of a food pyramid. Energy is not transferred. For example: protein in meat takes more energy to produce than the protein in grains or beans.

CAUTION: The success of this activity depends upon secrecy on the part of the teacher! Special instructions are given for the teacher.

Materials You'll Need

1 liter bottle, soft drink
4 paper cups (approximately 120 ml each)
1 - 100 ml graduated cylinder
1 - 25 ml graduated cylinder
1 pipette 1 or 2 ml, graduated in .1 ml (a medicine dropper will do)

Procedure for the Teacher

Part I: Review the basic progression of a food chain from the primary producer to the final consumer, noting that there is a loss of 90% of the energy at each step of the pyramid; then present a chain consisting of (a) grass, (b) grasshopper, (c) snake, and (d) hawk.

Part II: Have the class elect one person to be the grass, one to be the grasshopper, one to be the snake, and one to be the hawk. (Here is where the secrecy comes in. DO NOT TELL THEM WHAT WILL HAPPEN AFTER THEY ARE ELECTED!)

Part III: Open a liter bottle of soft drink. Give each of the characters a small drinking cup (approximately 100 ml). Next using a 100 ml graduated cylinder, a 10 ml cylinder, and a pipette graduated in .1 ml, carry out the following operations:

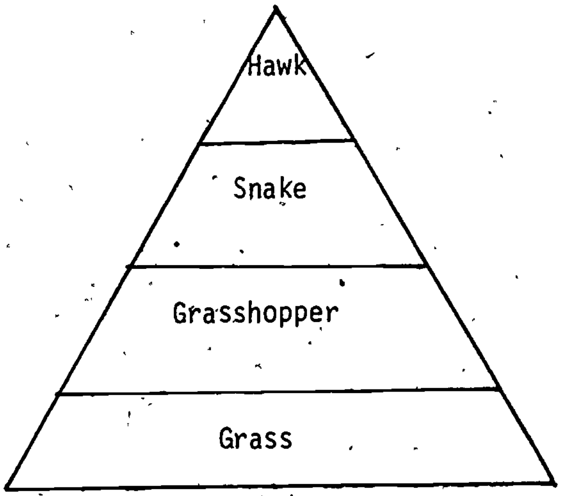
1. Explain that the 1000 ml of the soft drink arbitrarily represents 1000 joules of energy coming from the sun. Pour 100 ml of the drink into the cup of the "grass person". Now dramatically pour the other 900 ml of drink down the drain, explaining that (90%) .9 of the energy falling on agriculatural lands is not fixed by photosynthesis as chemical energy (plant food), and, therefore, does not become part of the food chain. (DO NOT LET THEM TALK YOU OUT OF POURING IT DOWN THE DRAIN. THIS AMOUNT MUST BE DISCARDED.)

2. Have "grass person" pour 10 ml of the drink (measured carefully by the small cylinder) into the cup of the "grass hopper person". "Grass person" may now consume 90 ml of the drink.

3. Have "grasshopper person" measure 1 ml of this drink (with the pipette) into the cup of the "snake person". "Grasshopper" may now drink the remainder of this portion.

4. Have the "snake person" measure .1 ml of this drink into the cup of the "hawk person". "Snake" may now drink their portion.

5. "Hawk" may now drink the last drop (if it can be poured out of the cup).



Energy Pyramid

Each step energy is lost.

Interpretation of Results

Answer questions on "Soft Drink Energy Pyramid".

"SOFT DRINK ENERGY PYRAMID"

Consider the "soft drink" activity you have performed as a class. Then answer the following questions:

1. Three of the scenario characters passed along one-tenth of the energy each had originally received. What part of the original energy received from the sun did each character receive? (not quantitatively, but qualitatively).

2. What happened to the remainder of the energy received by that part of the pyramid represented by each student?

3. How much more energetically efficient would it have been if "hawk person" could just have eaten (consumed the drink passed on by) "grass person".

4. Relate the food pyramid you have demonstrated today to man's energy problems and his possible solutions of them. (Use your imagination, consider ideas you may have heard of new energy sources, and try to predict some of our future technology.)

Teacher's Key

"SOFT DRINK ENERGY PYRAMID"

Consider the "soft drink" activity you have performed as a class. Then answer the following questions:

1. Three of the scenario characters passed along one-tenth of the energy each had originally received. What part of the original energy received from the sun did each character receive? (not quantitatively, but qualitatively).

Ans. This is the only part of the sun's energy fixed by the organism, producing biomass, and containing chemical energy converted from the light component of the sun's radiant energy.

2. What happened to the remainder of the energy received by that part of the pyramid represented by each student?

Ans. It was used for activities of the organism, expended to carry on life activities, and finally lost as thermal reradiation.

3. How much more energetically efficient would it have been if "hawk person" could just have eaten (consumed the drink passed on by) "grass person"?

Ans. It would have been 100 times more effective in amount of energy passed to the hawk. Note that each step in the pyramid approximates a power of 10 in the energy loss.

4. Relate the food pyramid you have demonstrated today to man's energy problems and his possible solutions of them. (Use your imagination, consider ideas you may have heard of new energy sources, and try to predict some of our future technology.)

Ans.

a. Man in the U.S. tends to eat meat as often as possible, thus utilizing at least one more link in the energy flow pyramid. Each step means a 90% loss of the stored energy to a degraded form. If man adopted a cereal grain food source, less land would be needed to support the human population, and other crops. Some crops directly convertible to energy, could be grown.

b. Furthermore, chemical and enzymatic treatment may use cellulose materials for fuels such as alcohols.

c. Large quantities of the residue biomass materials not passed on in the energy flow might be burned directly for fuels. (However, possible environmental effects of not returning biomass materials to the land -- such as soil tilth and nutrient impoverishment.

d. Students will probably come up with other ideas that you may want them to investigate further.

UNIT V WHAT ARE THE ULTIMATE SOURCES OF FOOD: SUN, SOIL, AND ATMOSPHERE

CONCEPT B . Soil as an ultimate source of our body nutrients vary physically.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Realize that the nutrients necessary for gooc health are taken by the plants from the soil.
2. Analyze soil physically.
3. Classify soil by texture, sand, silt, and clay.
4. Explain the physical components of soil necessary to harvest nutritious food.

BACKGROUND INFORMATION FOR TEACHERS

Janick, Schery, Woods, Ruttan; W. H. Freeman and Company; Plant Science, pages 257-281.

SUGGESTED ACTIVITIES FOR STUDENTS

I. Taking Soil Samples

II. South Carolina Soil

III. Determining % of Organic Matter in Soil

IV. Soil Safari

V. Testing Water Absorption and Retention Properties of Soils

TRANSPARENCIES

I. Classification of Soil by Particle Size

II. Soil Texture Triangle

III. Soil Moisture "Feel" Chart

VIDEOTAPES (From the Office of ITV, S. C. Department of Education)

1. The New Life — Videotape available from ITV. 22 min. Developed by Soil Conservation Service. Free distribution.

   Discusses history of South Carolina soils from earliest days of the settlers to the present, outlining problems faced today.

2. The Journey — Videotape available from ITV. 10 min. Developed by Soil Conservation Service. Free distribution.

   Traces the course of the Santee from its source at Grandfather's Mountain to the Atlantic, portraying the problems and abuses of the river, including erosion from cropland practices, as it travels through the Carolinas.

TEACHING STRATEGIES

This course has been helping your students to learn about the essential nutrients necessary to maintain good health.

Where do these nutrients come from?

What are the sources of these nutrients?

Pose these questions to the students. Hopefully they will come to the conclusion that the source of these nutrients is found in the soil.

The functions of soil are to provide the plants a place to anchor themselves, supply nutrients, and water. Soil that produces nutritious food, must have particular properties. These are:

Inorganic Minerals
Organic Matter
Organisms
Air
Water

A proper balance must be maintained. If one should dominate the other then the soil is no longer productive. These are also interdependent upon one another. In the event of flooding, too much water would remove the air and kill organisms. While the lack of organic matter would cut down on the organisms.

Inorganic minerals are the result of millions of years of weathering rocks. As these minerals are taken from the soil, these must be replenished by fertilizer.

When soil is classified by the texture, the particles are arranged according to size. Use Transparency I, Classification of Soil by Particle Size, to show the size dimension of each particle. This goes from a boulder to the fine particles that make up clay. Point out that the three main soil textures are sand, silt, and clay.

By using Transparency II, Soil Texture Triangle, you will be able to illustrate the relationship between sand, silt, and clay. Each one is in a different corner of the triangle. As you follow the triangle clockwise, the percentages of each can be read. When soil is almost equal mixture of sand, silt, and clay, it is a loam.

In order to really understand soil, samples must be examined. Activity I, "Taking Soil Samples", outlines the procedure to follow. Sample at least three distinct areas. It should be pointed out that farmers as well as home gardeners have their soil analyzed by sending the samples to Clemson Extension Service, Clemson University. The boxes can be obtained from your local county agent. If some of your soil samples are sent to Clemson to be analyzed, these can be compared to the classroom tests you will be making in this unit. Keep a large sample of the ones you send for classroom use. Once the soil samples have been taken the students can examine these for the size of the particle using Transparency II.

Another activity that will help your students become familiar with South Carolina soils is Activity II,"South Carolina Soil". South Carolina is divided into three distinct geological areas. The Blue Ridge is the mountainous area designated by green on this map. The other two distinct regions are the Piedmont and the Coastal Plains areas. The last two are divided by the fall line, a sandy area which is yellow on this soil map. At one time the shore line of the Atlantic Ocean was in this area. Many marine shells have been found embedded in this sandy ridge. The Piedmont has a large percentage of clay, while the Coastal Plains have more sand. However, most of these soils are considered loamy as there is a mixture of sand, silt, and clay.

Two videotapes, The New Life, and The Journey, may be shown at this time to help the students grasp an understanding of the soil and water use in different regions of South Carolina.

Organic matter is another main part of soil that is necessary for the growth of nutritious food. Often called humus, it is the decaying plant and roots that contributes to the soil by allowing it to retain water. It acts as a sponge that holds the water. Organic matter also is a source of mineral elements. This is left as the organic matter decomposes.

The amount of organic matter in your soil sample can be determined by the weight loss of the soil after it has been ignited at a high temperature. This procedure is described in Activity III, "Determining % of Organic Matter in Soil". This activity will require a drying oven. A regular stove oven will not be satisfactory as the temperature must be held at 700° C for 1 hour.

Organisms must also be present in soil in order for nutritious food to be harvested. A soil does not become a "good" soil until it is populated by many types of soil organisms, ranging from bacteria (harmful as well as beneficial), fungi, lichens, and algae, as well as many worms, insects, and arthropods. Some are beneficial to the breakdown and cultivation of soil, their decaying bodies adding organic matter, while others may be harmful. Ants, for example, aid by tilling great amounts of soil, yet, the leaf-cutting ants are severe pests in the tropics.

The fire ants have become a nuisance to farmers making cultivation difficult in South Carolina due to their giant ant hills. In Activity IV, "Soil Safari", the students will examine the soil sample carefully for these organisms.

Soil Air is a matter of life and death to plants just as air is life or death to animals. However, the composition of soil air is not equal in proportion to that of the atmosphere. Soil has more Carbon dioxide due to decaying organic material. Flooding for any length of time will deprive the roots of oxygen needed for respiration. A simple demonstration to show air is present in soil can be made by placing some dry soil in a beaker and rapidly covering the soil with water. Air bubbles will be very noticeable.

Water is another necessary component of soil. When your students were studying nutrition of the body they found out that without water people would perish. A large percentage of a plant is water. Water must be available in the soil. It can be in the form of free water or capillary water. Free water percolates or drains through the soil by gravity eventually adding to the underground water table. Capillary water is held in the soil by surface tension and adhesive properties. The capillary water is available to the roots and is the medium for the transportation of the inorganic minerals. Because water is so essential to plant growth, a "feel" test can be made by each student to determine the moisture in the soil. Use Transparency III, Soil Moisture "Feel" Chart, to determine the soil moisture of your samples.

In Activity V, "Testing Water Absorption and Retention Properties of Soils", your students will learn how to compare the ability of soils to retain water. This is done by timing water as it percolates or drains through the soil.

In order for nutritious food to be eaten, the essential nutrients must come from the soil. These activities should give the students a feeling for the physical properties necessary for fertile soil.

In the next concept your students will be able to make chemical tests for the major elements essential for plant growth.

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ACTIVITY I Taking Soil Samples

Introduction

Only a small amount of soil is needed for making the soil tests, so every practical effort should be made to secure a representative sample. Soil samples will not give reliable tests unless the directions for collecting and for preparing them are accurately followed.

Materials You'll Need

Shovels
Soil Containers
Stirring and mixing tools

Procedure

1. A convenient tool for sampling soils is an auger, soil tube, or spade. If the spade is used, for topsoil samples, dig a V-shaped hole about 6 inches deep and cut a thin slice 1/2 inch thick from the side of the hole at each location sampled.

2. Caution: In taking samples, first scrape away all surface litter. Where crops are planted in rows, take samples from between the rows and avoid sampling in or near the fertilizer bands.

3. Soils that vary greatly in color or texture (sands - clay) must be sampled separately.

4. If the soil is too wet to plow, spread the sample out to dry at room temperature on a clean sheet of waxed paper.

5. After drying, mix the sample thoroughly, remove stones and roots, and pack in a clean container. A pint size ice cream container has been used and provides adequate sample for testing.

6. Mark on each container the sample number, such as 1, 2, 3, and whether top or subsoil. Keep an accurate record of the areas sampled and numbers used for your own identification of test results.

7. To have your samples tested so that the results can be compared with your classroom tests, mail them to the Soil Testing Laboratory, Clemson Extension Service, Clemson, S.C.

Adapted from "Procedure for Taking Soil Samples", prepared by Clemson Extension Service, Clemson University, Clemson, S.C.

ACTIVITY II South Carolina Soil

Introduction

Geologically South Carolina is divided into three major regions; the Blue Ridge, Piedmont, and Coastal Plains. Soil regions are closely linked with the geological regions. The corollary is as follows:

GEOLOGICAL REGIONS	SOIL REGION (LEGEND ON MAP)	COLOR CODE ON MAP
Blue Ridge	Blue Ridge Mountains	Green
Piedmont	Southern Piedmont	Pink and Orange
Coastal Plains	Carolina and Georgia Sandhills	Yellow
	Southern Coastal Plain	Brown
	Atlantic Coast Flatwoods	Blue, Light Green, Purple, and Lavender

The soil regions are subdivided into soil associations as indicated on the map by the color code.

Materials You'll Need

General Soil Map of South Carolina provided by the South Carolina Resources Conservation Commission.

Procedure

The Blue Ridge geological region is made up of soil region areas designated Blue Ridge Mountains. This region is rugged mountains with narrow valleys. The soil is sandy clay loam and is forested along with a few small farms in the valleys.

1. Which counties does this area cover?

2. What percent of the land in South Carolina is classified as Blue Ridge Mountains?

3. How is this land used?

The "Up Country", Piedmont, is pink and orange color coded on this map. It is called the Southern Piedmont region. The land is gently rolling to hilly slopes with narrow stream valleys.

4. Is this land good for row crops?

5. Is there risk of this land flooding?

6. What percent of South Carolina is classified Southern Piedmont?

7. How many counties are in this region? (Include parts of counties.)

8. Which counties are in this region? (Include parts of counties.)

The texture of the soil is sandy loam and sandy clay loam.

9. What % of sand, silt, and clay is sandy loam? (Use the texture triangle.)

10. What % of sand, silt, and clay is sandy clay loam?

The fall line is the division between the Piedmont and the Coastal Plains. This also divides the Southern Piedmont region from the Carolina and Georgia Sandhills. This soil is sand and loamy sand and extends over a small band running parallel to the fall line.

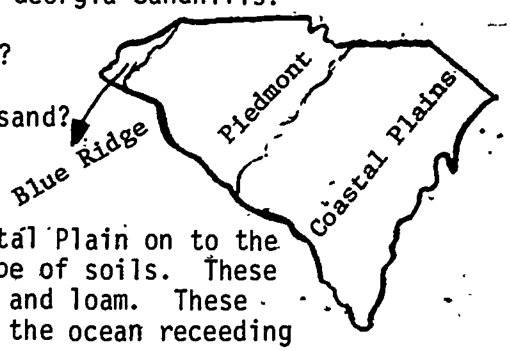
11. How many counties (include parts) comprise this area?

12. Which counties comprise the Carolina and Georgia Sandhills?

13. What % of South Carolina is in this area?

14. What % of sand, silk, and clay is loamy sand?

15. What % of sand, silt, and clay is sand?



The soil associations from the Southern Coastal Plain on to the marshes are made up of generally the same type of soils. These are sandy loam, loamy sand, sandy clay loam, and loam. These were the results of fluvial deposits made by the ocean receeding over a long period of time.

16. What is the color code on this map for the Southern Coastal Plain?

This soil is about one-half forested with significant acreage for cash crops.

17. What percent of the land in South Carolina is in this region?

The Atlantic Coast Flatwoods is lower and wetter than the Southern Coastal Plain. The soil is about the same composition. This area is commonly called the "Low Country."

18. Is there a risk of flooding this land?

19. What percent of South Carolina is in this region?

This area has broad valleys with meandering streams with the land almost level with 1 - 2% slope.

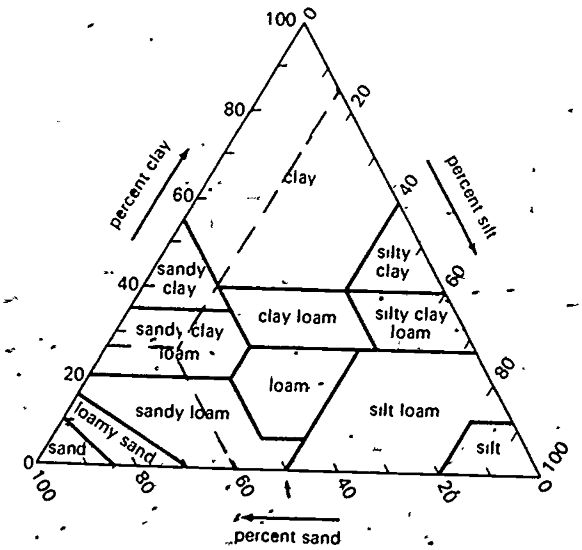
20. What is the color code on this map for the Atlantic Coast Flatwoods?

21. How is this land used?

The purple code in this soil map is the flood plain area of the meandering rivers. The lavender area is the marshes and sand dunes of the South Carolina Coast. This includes the estuaries that are formed by the deposition of silt.

22. What is the depth of the soil to the bedrock for the Blue Ridge Mountains, Southern Piedmont, and Atlantic Coast Flatwoods?

23. Which soil region has the greatest chance of flooding?



Dotted Line Example:

Sand	60%
Silt	15%
Clay	25%
	100%

SOIL TEXTURE TRIANGLE

"From Plant Science, Third Edition, by Jules Janick, R.W. Schery, F.W. Woods, and V.W. Ruttan. W. H. Freeman and Company. Copywrite © 1981."

ACTIVITY III Determining the % of Organic Material in Soil

Introduction

We live on a carbon based planet. All living matter, organic material, contains carbon. Even after this organic material is dead, the carbon material is still present. This organic material found in the soil can be vegetative or animal remains. It may consist of leaves, stems, roots, pieces of decaying wood, insect remains, and perhaps parts of dead animals. As it is decaying it is being recycled into useful nutrients for growing plants. This organic material often called humus improves the soil by adding essential nutrients for the plants and improves the ability of the soil to retain water. "Good soil" must contain humus. What distinguishes top soil from sub soil is the amount of humus present.

In this activity you will ignite your soil sample at a high temperature so that the carbon in the decaying vegetative and animal material will combine with oxygen to form Carbon dioxide. As the gas forms it will escape into the air. Your soil sample will lose mass. By simple calculations, you will be able to determine the % of organic matter in your soil.

Materials You'll Need

Porcelain crucible, 1 per 2 students (Petri dish will do)
Soil samples, 20 to 30 grams
Drying oven
Tongs
Asbestos mat
Balance pan

Procedure

1. The soil must be oven-dry before you take the mass. Place the sample in an oven set at a low temperature, 105^{o} C, for at least 24 hours. This will eliminate the moisture in the soil.

2. Take the mass of your crucible and record. If you have just washed the crucible dry it in the oven before weighing.

3. Place the soil in the crucible and record the mass. You will need between 10-20 grams.

4. Place the crucible and soil sample in the drying oven. Run the temperature up to 700^{o} C for about 1 hour. This will ignite the carbon and allow it to combine with oxygen and escape as Carbon dioxide, CO_2. If you do not have a high temperature thermometer then run the temperature up in the oven as high as you can.

5. If you remove the crucible while it is still hot, place it on an asbestos pad. Allow to cool.

6. Take the mass of the crucible and soil, record.

7. The % organic material in your soil sample can be calculated by using the following:

$$\%\ \text{organic material} = \frac{\text{mass lost by soil sample}}{\text{mass of soil sample}} \times 100\%$$

Suggested Data Table

Soil Sample location	________
Mass of crucible	________ g
Mass of oven-dry soil sample + crucible	________ g
Mass of soil sample and crucible after ignition	________ g
Mass lost by soil after ignition	________ g
% of Organic material in sample	________ %

Further Investigation

Use this technique to determine % of organic material in various locations. Compare soil samples from wooded areas, cultivated fields, school yards, walkways, and under shrubbery.

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Neelus

ACTIVITY IV Soil Safari

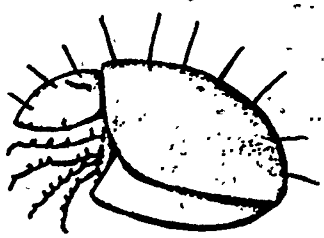
Introduction

Beneath your feet are the organisms in staggering amounts. Think of this activity as a Safari featuring organisms of the soil. These organisms range all the way from protozoa to mammals. The vegetative material in a wooded area provides the special habitat for the animals found in the phylum Arthropodes, These organisms can be collected by using a Berlese funnel. Once you have collected your organisms, use an insect identification book to identify your specimens.

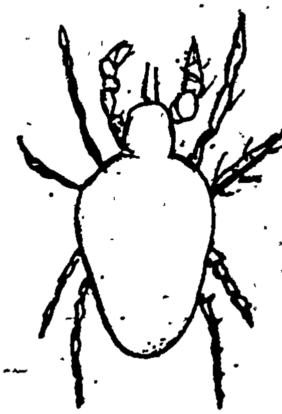
Most of the important soil organisms found this way will be arthropods such as mites, myriapods, and spintails. The insects and larvae of termites, beetles, ants, and flies could be found. Microscopic organisms can be found by using another technique.

Materials You'll Need

Soil samples from cultivated fields, wooded area, and school walkways.
Containers for soil samples
Hand lenses
Funnel
Light
Ring stand
Bottle used to collect speci
Isopropyl alcohol



Oribotridia



Cheyletus

Procedure

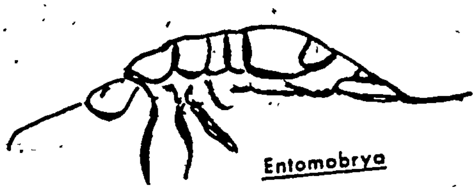
1. Collect a shovelful of soil from at least three different areas. Place the soil in a closed container to prevent loss of moisture.

2. Assemble a Berlese funnel equipment so that the light drives the organisms into a collecting bottle containing a small amount of isopropyl alcohol.

3. Crumble the soil in the funnel, switch on the light, and leave at room temperature for a day.

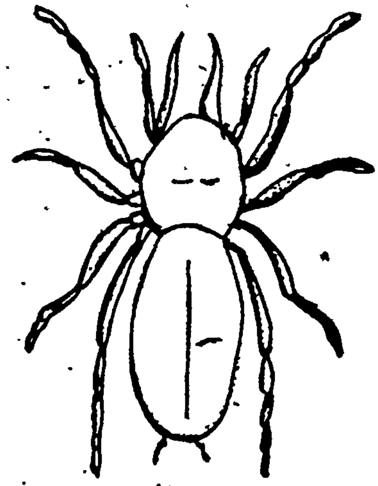
Interpretation of Results

Examine each of your Safari specimens with a hand lens. Identify these organisms by using an insect identification book (A Peterson Guide is excellent). List the organisms found on the Safari for each soil sample. Why does the light force the organisms to the bottom of the container?

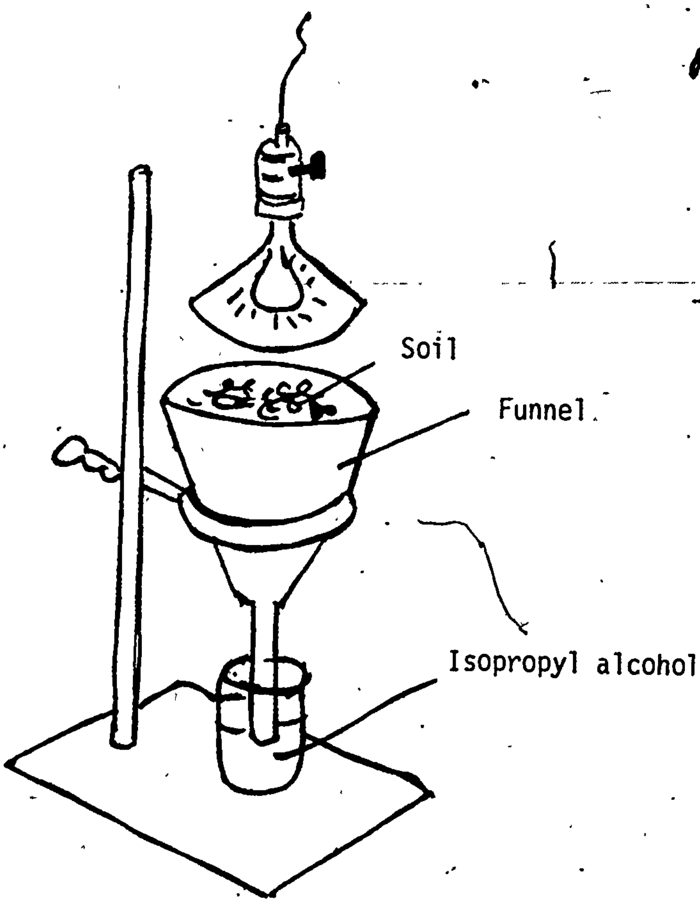


Entomobrya

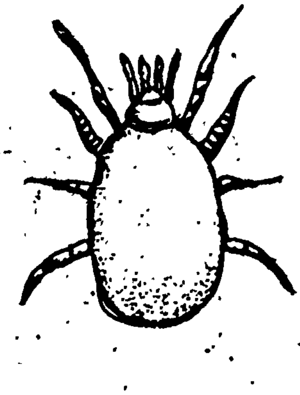
COLLEMBOLA



Atypus



Berlese funnel equipment for your Soil Safari



Asca

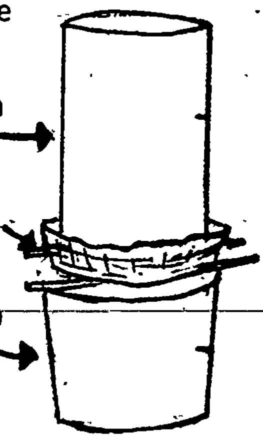
Onychiurus

ACTIVITY V Testing Water Absorption and Retention Properties of Soils

Introduction

Some soils retain the moisture better than others. Water drains quickly through sandy soils. The clay soil retains the water. In this activity you will be able to recognize the difference in the permeability of each type of soil.

Materials You'll Need



- 3 juice cans, approximately 1 qt. each
- Wire screen to cover bottom of each
- 3 basins large enough to catch run-through water
- Large pan-type balance

Procedure

1. Assemble three soil samples in the manner of the sample described in Activity I. One sample should contain soil which has decided clay properties. (You may have to obtain this from the subsoil.) One should have distinct sandy properties, and the third should be as near a loam as possible.

2. Fill 3 cylinders such as large grapefruit juice cans (approximately 1 liter or quart) about one half full with the samples and label each to identify the source. Before filling, remove both ends of the can, placing a wire screen over the bottom and securing it so that the soil will not come through but so that water can percolate.

3. Weigh each can which is approximately one half full of dirt and record this weight. (This may be done on a simple pan balance.)

4. Pour 500 ml water slowly through each can so that the soil is not physically disturbed. Catch the water which percolates through each, and when the water has drained, measure the amount in each catch basin.

5. Weigh each cylinder with the wet dirt. Record the differences in weight from the original dry weight. Determine the relative water retentive properties of the soils.

Identify which has the most sand and which the most clay. Did sand, loam, or clay soil have the most retentive properties?

UNIT V WHAT ARE THE ULTIMATE SOURCES OF FOOD: SUN, SOIL, AND ATMOSPHERE

CONCEPT C Soil as an ultimate source of our body nutrients vary chemically.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Tell why inorganic materials such as nitrogen, phosphorus, and potassium, the main components of fertilizer must be added to the soil.

2. Point out how nitrogen, phosphorus and potassium eventually end up on their dinner table.

3. Explain the functions of nitrogen, phosphorus, and potassium in the body.

4. Make analytical test of soil for acidity, nitrogen, and phosphorus.

5. Make analystical test of plant tissue for potassium.

BACKGROUND INFORMATION FOR TEACHERS

Janick, Schery, Woods, Ruttan; W.H. Freeman and Company, Plant Science, pages 361-392.

Whitney and Hamilton, Understanding Nutrition, Chart, page 381.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Make-It-Yourself pH Indicator, The Chemistry of Soil Fertilizers, LAP p. 10a-14.

II. Testing for Nitrates in the Soil

III. Testing for Phosphates in Soil Samples

IV. Plant Tissue Testing for Potassium

V. A Liquid Diet for Your House Plants, The Chemistry of Soil Fertilizers, LAP p. 16 (Read p. 14a-17).

TRANSPARENCY

I. Approximate pH of Some Common Substances

TEACHING STRATEGIES

For an ultimate source of food to be the soil, then the elements necessary for plant life must be available for the roots to absorb. As you remember the essential nutrients for your body are carbohydrates, fatty acids, proteins, vitamins, minerals, and water. These nutrients must be provided by the food you eat. Your students found out that carbohydrates contained the elements carbon, hydrogen, and oxygen. Fatty acids contain the same three major elements but in different ratios. The protein molecule is made up of Amino Acids which have a nitrogen end. Minerals are the essential elements needed in small amounts and the vitamins act as coenzymes in breaking apart food in digestion. Water is made up of two parts hydrogen and one part oxygen and without it we would perish. These essential nutrients for our body must come from the soil when the plant is growing or from animals eating the plants.

Water makes up about 90% of a plant, with almost 10% carbon, hydrogen, and oxygen. The remaining part of 1% is made up of 13 elements. Carbon, hydrogen, and oxygen are available in the soil. It is the other elements that must be present in order for plants to become nutritious. These elements are nitrogen, phosphorus, potassium, and magnesium. All are needed in large amounts and can be expressed in parts per hundred. The elements needed in small amounts are usually expressed in parts per million (ppm). These are sulfur, iron, boron, manganese, zinc, molybdenum, copper, and chlorine. All of these elements are taken out of the soil as the plants grow and must be replenished by the farmer or home gardner by the addition of fertilizer. This must be added yearly in order to maintain proper plant nutrients.

Three critical elements nitrogen, phosphorus, and potassium, make up the major components of fertilizer. Usually fertilizer is designated by numbers, 5-10-15.

The farmers have soil tests made by highly trained personnel so that the right amount of each element is added. However, these three elements can be tested in the classroom by your students. Soil will be analyzed for nitrogen and phosphorus while potassium will be a plant tissue test.

There is another factor to consider when adding fertilizer and that is the acidity of the soil. If the soil is too acid or not acid enough the plant roots will not thrive. Too many of the important elements are not available for the roots to absorb if the acidity is not within a certain range. If the soil becomes too acid, organisms are not present.

Acidity is measured by the pH scale of 0-14. The neutral point between an acid and a base is 7. The smaller the number the most acid the soil becomes. While the larger numbers indicate a basic soil ranging up to 14. The pH of the soil should be between 4 and 9 for the best plant growth. Each plant has a range of the pH scale that it prefers. Use <u>Transparency I</u>, Approximate pH of Some Common Substances, to relate the acidity to common household substances. Have the students bring items from home to test with hydrion paper or Universal Indicator so that they can become familiar with the pH scale.

In Activity I, "Make-It-Yourself pH Indicator", the students will make a set of eight standard color solutions to use when matching their soil samples. An acid-base indicator will be made by adding the water after boiling red cabbage. The standard solutions will be made out of household items and a few chemicals so that there is a gradient of pH ranges to use for comparison.

Next the students will test for nitrogen in Activity II, "Testing for Nitrates in the Soil". Remind the students that this is the first number designated by the fertilizer analysis of 5-10-15.

Activity III, "Testing for Phosphates in Soil Samples", will be a chemical test of the soil sample for the second number on the fertilizer analysis, 5-10-15.

The test for potassium often called potash will be done on plant tissue rather than on soil. This is Activity IV, "Plant Tissue Testing for Potassium." The third number on the analysis of fertilizer indicates the ratio of potassium.

The numbers on a bag of fertilizer can be understood if the students combine their own chemicals. In Activity V, "A Liquid Diet for Your House Plants", the students will add the three main chemicals in fertilizer, dissolve them in water, and have their own Vigero. Encourage the students to bring a bottle so that they can take home the fertilizer for use on their house plants.

The same elements that are added to the ground as fertilizer are absorbed by the plants. Later these end up on your dinner table in the form of fruits, vegetables, and meats.

Modern agriculture techniques have resulted in crops becoming more abundant as well as more nutritious. It stands to reason that if the soil is fertile, the plants grown in the soil will absorb those elements necessary to become nutritious.

ACTIVITY I Make-It-Yourself pH Indicator

Introduction

In this activity you will make an indicator out of red cabbage. An indicator is a substance that turns one color when it comes in contact with an acid then changes to another color when it is in contact with a base. This will give you a quick check of the pH by color comparison. There are many indicators on the market that can be purchased from a chemical warehouse. But this one can be made in the classroom out of red cabbage. It is called anthocyanin and can be used to test the pH of soil as well as fruits and vegetables.

Materials You'll Need

1 head of red cabbage	Soil	Vegetables
dil HCl	Eggshells	Fruits

For each lab group:

10 cm^3 lemon juice
10 cm^3 white vinegar
8 test tubes
1 test tube rack
1 gram boric acid
1 gram baking soda ($NaHCO_3$)
1 gram borax (sodium tetraborate)
1 gram washing soda (sodium carbonate, Na_2CO_3)
1 gram lye (NaOH)

Procedure

Page 11-14, The Chemistry of Soil and Fertilizers

Suggested Data Table

Items Tested	Color	pH
Soil Sample		
Fruits		
Vegetables		

ACTIVITY II Testing for Nitrates in the Soil

Introduction

Nitrogen as an element is an odorless, tasteless, and colorless gas that is chemically inert (inactive). 78% of the atmosphere is nitrogen in the elementary state. Before it can be used by plants, it must combine with other elements to form a compound.

The soil is the source of nitrogen compounds that eventually end up on your dinner table as meat, milk, eggs, and legunes. These all contain protein which is necessary for so many body functions. The building blocks of protein are Amino Acids which have a nitrogen end.

Nitrogen in the plants is found in the chlorophyll molecules that are made up of four nitrogen atoms for every magnesium atom and in plant protein. Although nitrogen accounts for only 1 to 5% of the dry weight of plants, combined with other elements it accounts for 25%. Plants rich in nitrogen have green leaves. When a deficiency occurs, the plants are usually very light green often becoming yellowish or reddish allowing the color from other pigments to show through. To prevent this from happening, a farmer or home gardener adds fertilizer in the form of nitrate or ammonium to the soil.

Fertilizer may be bought in the store as 5-10-15 or other similar grade. The first number, 5, indicates the percent of nitrogen in the fertilizer, 10 indicates the percent P_2O_5, Phosphorus pentoxide, while 15 indicates the K_2O, Potassium oxide. Often this is referred to as the N-P-K when the chemical symbols of these elements are used. All of these elements are necessary for the proper nutrition of your body. Nitrogen is necessary for protein, phosphorus is necessary for the release of energy during digestion when ATP $\longrightarrow$ ADP, and potassium regulates the water fluids in your body. Therefore, the elements in fertilizer eventually reach your body and play an important part in your nutritional requirements.

In this activity you will analyze the nitrogen found in the soil. This is done by making a stock solution of sodium nitrate containing NO_3-N (Nitrogen in the form if nitrate) with 1000 ppm (1000 parts/million) and diluting it with water so that you have solutions containing 20, 65, and 220 ppm of NO_3-N. When diphenylamine is added to each of the solutions a slightly different color will be observed. These solutions containing known amounts of nitrogen will be used to compare your soil sample that will be treated in the same manner. The three test tubes indicate low, medium, and high concentrations of nitrogen. When you match your soil sample also treated with diphenylamine, you will have a rough estimate of the amount of nitrogen in your soil.

Soil sample tests are made in laboratories for farmers in the same way with the exception that a spectrophotometer (colorimeter) is used to get the exact reading of the wavelength of light that is absorbed. This test will give you an approximate value for the amount of nitrogen in your soil samples by color comparison to known concentrations of nitrogen.

Materials You'll Need

Soil Test Kit - Obtained from a scientific company. OR
Diphenylamine
Conc. Sulfuric Acid, H_2SO_4
Spot plate or glass plates (1 per 2 students -- left over pieces of glass from a hardware store or glass plate company will do fine)
Soil samples from school and home
300 ml beaker for each sample
20 medicine dropper bottles and dropper
30 droppers

Procedure for the Teacher

Before the class begins, make these solutions. Dissolve 0.20 grams of diphenylamine in 100 ml of concentrated H_2SO_4. Pour a small amount of this solution into 15 to 20 medicine bottles for students. Label Diphenylamine solution.

Make a stock solution of Sodium nitrate, $NaNO_3$, by dissolving 1.3 grams of $NaNO_3$ in 1 liter of H_2O. This solution contains 1,000 ppm (parts per million) of NO_3-N (Nitrogen in the form of nitrate). Transfer 3, 13, 44 ml of stock solution into 3 separate containers. Label each one. Add enough water to each of these solutions to make 200 milliliters. The solutions you have made contain 20, 65, and 220 ppm of NO_3-N, respectively. These are standard solutions containing known amounts of Sodium nitrate.

Procedure for Students

1. Place one drop of each of the three standard solutions of Sodium nitrate in the holes of a spot plate. (A flat piece of window glass placed over typing paper will do fine.)

2. Let stand for 2 minutes. You may stir them with a glass rod. Be careful not to mix the samples.

3. Compare the intensity of the blue color developed in the three standards.

4. Use the first solution of 20 ppm as low, the second as 65 ppm is medium, while the third has 220 ppm and is high. Estimate the concentration of nitrogen in the soil samples.

   Soil samples can be taken from the school grounds or brought from home. If your school is located in a good farming area, it will be interesting to use samples from well cultivated fields along with soil from the part of the school yard where nothing has been growing, (walkways, parking lots, etc.)

5. Soil samples can be made by using a spade or trowel. Make certain your tool is clean. Cut a V-shaped hole about 6 inches deep. Take a thin slice 1/2 inch thick from the side. Place this in your container and label the location. You will need at least 5 or 6 samples from different locations for comparison.

6. Mix the sample thoroughly. Weigh 125 grams, place in 300-500 ml beakers. Enrich one of the soil samples with a fertilizer containing nitrogen. Label this one "heavily nitrated soil." Cover the soil with 100 ml of water. Thoroughly stir.

7. Set aside and allow the soil particles to settle.

8. Filter and collect the filtrate.

9. Add a drop of the filtrate from each of the soil samples to the other holes in the spot plate. Next, add 4 drops of diphenylamine solution to each soil sample.

10. Let stand for 2 minutes. You may stir them with a glass rod. Be careful not to mix the samples.

11. Compare the intensity of the blue color developed in the three standards with your soil samples.

12. Compare your results to that of the other members of your class that took samples from different locations.

Suggested Data Table

Color of Standard Solution Sodium nitrate with 20 ppm Low	Color of Standard Solution Sodium nitrate with 65 ppm Medium	Color of Standard Solution Sodium nitrate with 220 ppm High

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UNIT 5, CONCEPT G, ACTIVITY II (continued)

Soil Sample	Color	Your estimate of the results, (Low, Medium, High)
Distilled H_2O		
#1		
#2		
#3		
#4 Heavily nitrated soil		

Interpretation of Results

What was the location of the samples that indicated a high concentration of nitrogen?

What was the location of the sample that indicated low concentration of nitrogen?

Usually soil analysis is made with far greater accuracy. However, in a classroom situation this analysis is satisfactory. If more accuracy is desired, send the soil samples to Clemson Extension Service, Clemson University, Clemson, South Carolina.

Further Investigations

Using this analysis technique, compare cultivated fields with wood lands, sandy soil with clay soil, or soil from the piedmont to that of the coastal plains.

ACTIVITY III Testing for Phosphates in Soil Samples

Introduction

Phosphorus, the second number indicated on the fertilizer analysis of 5-10-15, is also important to the nutrition of your body. It is part of the energy carrier ATP, Adenosine triphosphate, as well as the genetic material in DNA and RNA. It is found in many of the enzymes. Note that P is the chemical symbol for phosphorus. In the fertilizer analysis of 5-10-15, the chemical symbols, N-P-K, represent Nitrogen-Phosphorus-Potassium. When phosphorus combines with oxygen it becomes a phosphate. The main function of phosphate in nutrition is the metabolic transfer of energy.

When a plant is deficient in phosphorus the leaves, stems, and branches have a purplish color. Fruit and seeds are usually small and fruit often drops prematurely. Lack of enough phosphorus results in sour orange juice, small legume seeds, and stunted dark green leaves on tobacco plants.

Phosphorus in the soil originally comes from weathering rocks. Now it is applied as fertilizer to the soil in the form of superphosphate, which is phosphate rock that has been treated with Sulfuric Acid. It is important to have the pH between 4 and 8.5 in order for the phosphorus in the soil to be taken up by the plants. A starter solution of phosphorus is added to the soil to make a good root system.

Materials You'll Need

KH_2PO_4, Potassium di-hydrogen phosphate
Ammonium molybdate
Ammonium vanadate, NH_3VO_3
Nitric Acid, HNO_3
Several liter beakers
6 test tubes for each group of students
1 test tube holder
5 - 100 ml graduated cylinders
Several soil samples from different locations
Extracting solution (.05 NHcl + .025 NH_2SO_4)

Procedure for Teacher Preparation

Prepare phosphorus stock solution by dissolving 0.1098 grams of dried KH_2PO_4, Potassium di-hydrogen phosphate, in 1 liter of water. Most school balance pans will only measure to the 1/100 place; therefore, use 0.10 g of KH_2PO_4. This solution now contains 25 ppm (parts per million) of phosphorus. Now prepare a set of 6 standard solutions ranging from 0-25 ppm concentration of P (Phosphorus) for the students to use in comparing soil samples. This is done by adding a definite amount of stock solution to a 100 ml flask and enough H_2O to make 100 ml of solution.

Use the chart below to make the solutions so that you will have the proper number of ppm (parts per million) of phosphorus in each test tube.

Test Tube		Stock Solution (ml)		Concentration of Phosphorus (ppm)	
1	If you add	0 ml	of stock solution you will have	0 ppm	of Phosphorus in the test tube
2	"	20	"	5	"
3	"	40	"	10	"
4	"	60	"	15	"
5	"	80	"	20	"
6	"	100	"	25	"

(Test tube #1 is a blank or control)

Set these 6 standard solutions aside.

Make reagents as follows:

Reagent #1 — Dissolve 50 grams of Ammonium molybdate in 1 liter of water.

Reagent #2 — Add 500 ml of Conc. HNO_3 to 500 ml of water, you now have 1 liter solution of Nitric Acid 1:1. Dissolve 2.5 grams of Ammonium vanadate in 1 liter of the Nitric Acid solution.

Reagent #3 — Add equal parts of Reagent #1 and Reagent #2. Label this solution "Ammonium molybdate-Ammonium vanadate mixture". This solution will not keep for a long period of time.

Extracting Solution ($.05$ N HCl + $.025$ N H_2SO_4) — To 1000 ml H_2O, add 4 ml conc. HCl and .6 ml conc. H_2SO_4. Label "Extracting Solution".

You are now ready for the students.

Procedure for the students

1. Place 6 clean test tubes in a holder. Now add 20 ml of each solution containing the different phosphorus concentration of Phosphorus (P) in ppm.

2. To each of these 6 test tubes add 5 ml of Reagent #3, the Ammonium molybdate-Ammonium vanadate mixture. Note: This will keep the ratio of solution to Reagent #3 at 4:1.

Solution: Reagent #3 : : 4:1

This factor of 4 will be used in the Interpretation of Results. Allow about 20 minutes for the color to develop. Remember Test Tube #1 is a blank.

These test tubes are your color standards and will be used to compare with your soil sample.

3. Prepare each soil sample by dissolving 5 grams of soil in 20 ml of extracting solution. Add a pinch of charcoal to each solution to absorb the colors in the soil. Stir vigorously with a stirring rod for 5 minutes.

4. Filter each of your soil samples and label. You are now ready to test your soil for phosphorus concentration.

5. Add 4 ml of soil sample extract to a test tube with 1 ml of Reagent #3. Allow 8 minutes for the color to develop. Then compare the color of your soil to the ones you have prepared in the test tube rack.

6. What is the approximate concentrations of phosphorus in your soil sample?

Interpretation of Results

Use this chart to convert ppm to pounds per acre.

Conc. of Phosphorus (ppm)	Times	Extraction Solution: Soil Ratio by Wt.	equals	Amount of Soil in 1 Acre (Million pounds)	equal	Pounds of Phosphorus (Pounds) (acre)
0	x	4	=	0 x 2	=	0 pounds
5	x	4	=	20 x 2	=	40 pounds
10	x	4	=	40 x 2	=	80 pounds
15	x	4	=	60 x 2	=	120 pounds
20	x	4	=	80 x 2	=	160 pounds
25	x	4	=	100 x 2	=	200 pounds

Use the suggested data table for your soil samples.

The factor of 4 converts ppm solution basis to ppm soil basis. Remember a 4:1 ratio was used of the solution to Reagent #3.

The factor of 2 converts ppm to pp2 million because we assume that there are 2 million pounds in an acre of soil, 7.063 inches deep with a bulk of density of 1.25. Check this by multiplying the square feet in an acre, 43560, by the weight of a cubic foot of water, 62.4 lb., by the bulk density of the soil, 1.25, by the fraction of a foot, 7.063643427, and you get 2 million pounds.

Phosphate ratings are different for the Piedmont soil of South Carolina and the Coastal Plain region. Use the chart below to determine if your soil sample has a low, medium, or high concentration of phosphorus.

If your soil is from the Coastal Plain of South Carolina, east of the fall line, use this chart.

Very low	0 - 10	pounds/acre of phosphorous
Low	11 - 30	pounds/acre of phosphorous
Medium	31 - 60	pounds/acre of phosphorous
High	61 - 120	pounds/acre of phosphorous

If your soil is from the Piedmont, west of the fall line, use this chart.

Low	7 - 20	pounds/acre of phosphorous
Medium	21 - 40	pounds/acre of phosphorous
High	41 - 80	pounds/acre of phosphorous

Suggested Data Table

Sample Number	Location of Soil Sample	Approximate reading (ppm)	Phosphorus in Pounds/acre
1			
2			
3			

Further Investigation

Test your spit and perspiration for phosphorus.

Test apple juice or other fruit juice for phosphorus.

ACTIVITY IV Plant Tissue Testing for Potassium

Introduction

Potassium is often found in a school laboratory as an element. It reacts violently with water, therefore, potassium is kept submerged in gasoline or diesel fuel so that it does not come in contact with moisture. It is classified as a metal.

Teacher Demonstration

If there is a bottle of the element, potassium, in the school laboratory stock room, place a piece of it on a paper towel. Be sure to use tongs or forceps when handling potassium. DO NOT PICK IT UP WITH YOUR HANDS. The moisture in your hands will cause a violent reaction. Cut the potassium with a knife while you hold it with forceps. Observe the properties. Does it look like a metal? Drop a small piece of the metal into a beaker with deep sides that has a small amount of water placed in the bottom. WARNING -- MAKE CERTAIN NO ONE IS CLOSE TO THE POTASSIUM WHEN IT IS DROPPED INTO THE WATER. What happens when the potassium comes in contact with the water? Sometimes due to impurities there is an added reaction. REMEMBER ALWAYS TO USE TONGS OR FORCEPS WHEN HANDLING POTASSIUM. There is enough moisture on your hands to cause a reaction.

Potassium is essential for the nutrition of your body. It maintains the water balance. It is necessary for the functioning of cells which in turn regulate the composition of the fluids.

Potassium is not found in nature as an element. It is found as a compound combined with other elements. When it combines with carbon and oxygen, it forms Potassium carbonate. When referring to fertilizer it is Potassium oxide, K_2O, commonly called potash. It is essential in plants to form flowers and seeds and enhances the flavor and color of some fruit and vegetable crops.

If a plant appears to have scorched or burned edges along the tip of the leaves, it is deficient in potassium. It must be added to the soil, so that it is available to the green plants. The last number of fertilizer analysis, 5-10-<u>15</u>, is Potassium oxide, K_2O, (potash). Soils naturally have potassium from micas and feldspars that have been weathered. However, potassium must be replenished in the soil for use by the plants.

In plants, potassium stimulates the synthesis of carbohydrates and it aids in the reduction of nitrates to protein. It concentrates in the parts of the plants where photosynthesis is most active in the leaves and green parts of the stem. Therefore, tissue testing for potassium can produce similar results to soil testing. In this activity you will test the mid rib of the leaf or stem of a plant. These are the nutrient conducting tissue of plants. You will squeeze some of this juice on test papers that have already been prepared. This will give you an indication if the plant tissue has a high, medium, or low potassium content.

Materials You'll Need

0.6 gram Dipicrylamine (Eastman Kodak Research Laboratory, Rochester, NY)
0.6 gram Sodium carbonate, Na_2CO_3
Filter paper
3 - 25 ml graduated cylinders
Plant samples - mid rib of leaves or stem from a plant about to reproduce
Developer solution (.05 N HCl + .025 N H_2SO_4)
Wash bottle

Procedure for the Teacher

Solution A

Dissolve 0.6 grams of Dipicrylamine and 0.6 grams of Sodium carbonate, Na_2CO_3, in 16 ml of water. Stir this as you bring to a boil, cool, and filter. Add enough water to make a final volume of 25 ml.

Solution B

Add 8 ml of Solution A to a 25 ml graduated cylinder and add enough water to make a total volume of 25 ml.

Solution C

Take 10 ml of Solution B and add enough water to make a total volume of 15 ml.

Test Papers

Prepare by cutting filter paper into 2 x 7 cm strips. Place a small drop of Solution A 1 cm from the end of the test paper. Next place a drop of Solution B in the middle of the test paper and a drop of Solution C 1 cm from the other end. Allow to dry in a drying oven (oven from a stove will do fine) at 85° for 3 - 5 minutes.

Prepare at least 10 pieces of filter paper for each group of students.

Developer Solution (.05 N HCl + .025 N H_2SO_4)

To 1000 ml H_2O, add 4 ml conc. HCl and .6 ml conc. H_2SO_4.

LABEL ALL OF THESE SOLUTIONS!!

Procedure for the Students

1. Bring to class the stem or mid rib of a leaf from plants that are beginning to reproduce. For ornamental shrubs, use the current year's growth. Attached is a chart that gives the best time to select plant tissue from field crops, vegetable

crops, fruit and nuts, ornamentals, and flowers.

2. Place the cut end of the plant tissue in contact with the orange-red spot on the end of the test strip. Squeeze enough sap to wet the spot. Repeat using the same plant for the other spots on your test paper. If the plant is not very juicy then squeeze with pliers. If chlorophyll interferes, place the untreated end of a piece of filter paper between the tissue and test spot before squeezing. After the sap has reacted for 30 seconds or more with the test spots, apply just enough developer solution to wet the spot thoroughly. Did any of the spots disappear? If the first spot is sensitive the plant tissue contains 1000 ppm or more of potassium. If the center spot is sensitive, then the plant tissue contains 2000 ppm potassium. The third spot will react only if 3000 ppm or more potassium is present. A spot remains orange-red if it has reacted with potassium.

Spot on Paper	Sensitivity, ppm in solution
Solution A	750 - 1000
Solution B	2000 - or more
Solution C	3000 - or more

Suggested Data Table

Plant Sample	Location of Plant	Part of Plant Tested	Your Estimate of Potassium Content
1			
2			
3			
4			
5			

Interpretation of Results

If the test shows 2000 ppm of potassium in the sap, the plant has sufficient potassium (potash) for normal growth. If it indicates less than this amount, the addition of fertilizer with a high proportion of the last number in the analysis such as 5-10-15 will be necessary.

Further Investigation

Test bananas, apples, oranges, celery, potatoes, lettuce and other fruits and vegetables available at the local market for potassium.

FIELD CROPS

stage of growth	plant part to sample	number of plants to sample
corn		
(1) Seedling stage (less than 12")	All the above ground portion.	20-30
or		
(2) Prior to tasselling	The entire leaf fully developed below the whorl.	15-25
or		
(3) From tasselling and shooting to silking	The entire leaf at the ear node (or immediately above or below it).	15-25
Sampling after silking occurs is not recommended.		
soybeans or other beans		
(1) Seedling stage (less than 12")	All the above ground portion.	20-30
or		
(2) Prior to or during initial flowering	Two or three fully developed leaves at the top of the plant.	20-30
Sampling after pods begin to set not recommended.		
small grain (including rice)		
(1) Seedling stage (less than 12")	All the above ground portion.	50-100
or		
(2) Prior to heading	The 4 uppermost leaves.	
Sampling after heading not recommended.		
hay, pasture, or forage grasses		
Prior to seed head emergence or at the optimum stage for best quality forage	The 4 uppermost leaf blades.	40-50
alfalfa		
Prior to or at 1/10 bloom stage	Mature leaf blades taken about ⅓ of the way down the plant.	40-50
clover and other legumes		
Prior to bloom	Mature leaf blades taken about ⅓ of the way down from top of the plant.	40-50
sugarbeets		
Mid-season	Fully expanded and mature leaves midway between the younger center leaves and the oldest leaf whorl on the outside.	30-40
tobacco		
Before bloom	Uppermost fully developed leaf.	8-12
sorghum-milo		
Prior to or at heading	Second leaf from top of plant.	15-25
sugarcane		
Up to 4 months old	Third or fourth fully developed leaf from top.	15-25
peanuts		
Prior to or at bloom stage	Mature leaves from both the main stem and either cotyledon lateral branch.	40-50
cotton		
Prior to or at first bloom or when first squares appear	Youngest fully mature leaves on main stem.	30-40

VEGETABLES CROPS

stage of growth	plant part to sample	number of plants to sample
potato		
Prior to or during early bloom	Third to sixth leaf from growing tip.	20-30
head crops (cabbage, etc.)		
Prior to heading	First mature leaves from center of whorl.	10-20
tomato (field)		
Prior to or during early bloom stage	Third or fourth leaf from growing tip.	20-25
tomato (greenhouse)		
Prior to or during fruit set	(1) Young plants: leaves adjacent to 2nd and 3rd clusters.	20-25
	(2) Older plants: leaves from 4th to 6th clusters.	20-25
beans		
(1) Seedling stage (less than 12")	All the above ground portion.	20-30
(2) Prior to or during initial flowering	Two or three fully developed leaves at the top of the plant.	20-30

stage of growth	plant part to sample	number of plants to sample
root crops (carrots, onions, beets, etc.)		
Prior to root or bulb enlargement	Center mature leaves.	20-30
celery		
Mid-growth (12-15" tall)	Peticle of youngest mature leaf.	15-30
leaf crops (lettuce, spinach, etc.)		
Mid growth	Youngest mature leaf.	35-55
peas		
Prior to or during initial flowering	Leaves from the third node down from the top of the plant.	30-60
sweet corn		
(1) Prior to tasselling	The entire fully mature leaf below the whorl.	
(2) At tasselling	The entire leaf at the ear node.	20-30
melons (water, cucumber, muskmelon)		
Early stages of growth prior to fruit set	Mature leaves near the base portion of plant on main stem.	20-30

FRUITS AND NUTS

stage of growth	plant part to sample	number of plants to sample
apple, apricot, almond, prune, peach, pear, cherry		
Mid season	Leaves near base of current year's growth or from spurs.	50-100
strawberry		
Mid season	Youngest fully expanded mature leaves.	50-75
pecan		
6 to 8 weeks after bloom	Leaves from terminal shoots, taking the pairs from the middle of the leaf.	30-45
walnut		
6 to 8 weeks after bloom	Middle leaflet pairs from mature shoots.	30-35
lemon, lime		
Mid season	Mature leaves from last flush of growth on non-fruiting terminals.	20-30
orange		
Mid season	Spring cycle leaves, 4 to 7 months old from fruit-bearing terminals.	20-30
grapes		
End of bloom period	Petioles from leaves adjacent to fruit clusters.	60-100
raspberry		
Mid season	Youngest mature leaves on laterals or "primo" canes.	20-40

ORNAMENTAL AND FLOWERS

stage of growth	plant part to sample	number of plants to sample
ornamental trees		
Current year's growth	Fully developed leaves.	30-100
ornamental shrubs		
Current year's growth.	Fully developed leaves.	30-100
turf		
During normal growing season	Leaf blades. Clip by hand to avoid contamination with soil or other material.	½ pint of material
roses		
During flower production	Upper leaves on the flowering stem.	20-30
chrysanthemums		
Prior to or at flowering	Upper leaves on flowering stem.	20-30
carnations		
(1) Unpinched plants	4th or 5th leaf pairs from base of plant.	20-30
(2) Pinched plants	5th and 6th leaf pairs from top of primary laterals.	20-30
poinsettias		
Prior to or at flowering	Most recently mature, fully expanded leaves.	15-20

ACTIVITY V A Liquid Diet for Your House Plants

Introduction

By making your own fertilizer, you will see that it is made up of chemicals containing the elements Nitrogen, Phosphorus, and Potassium. The farmer must add these essential nutrients to the soil as the plants use them in growth and reproduction.

Materials You'll Need

3 grams Sodium nitrate
3 grams Potassium sulfate
3 grams Calcium sulfate)
3 grams Calcium phosphate) Referred to as super phosphate in the directions.

Procedure

Page 16, The Chemistry of Soil and Fertilizers, Learning Activity Package.

Further Investigation

Compare the fertilizer analysis for fruit trees, vegetables, and row crops.

UNIT V WHAT ARE THE ULTIMATE SOURCES OF FOOD: SUN, SOIL, AND ATMOSPHERE

CONCEPT D Atmosphere or climate as an ultimate source of food determine which crop provides nourishment for our body.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Classify climates of the world into 5 major groups.

2. Identify the climate zones of the earth where the 5 staple food crops of man are grown.

3. Compare the staple crops for nourishment.

4. Identify the mainstay for the major countries.

BACKGROUND INFORMATION FOR TEACHERS

Janick, Schery, Woods, Ruttan; W.H. Freeman and Company, Plant Science, pages 461-494, 495-548, 549-605.

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Growth Regulator Comparison on Monocots and Dicots

II. Testing Hardiness of Seeds at Low Temperature

III. Testing Hardiness of Lettuce at High Temperature

TRANSPARENCIES

I. Climate Zones of the Earth (also a student handout).

II. Approximate Cropland Area

III. World Rice Production

IV. World Wheat Production

V. World Corn Production

VI. World Potato Production

VII. World Soybean Production

TEACHING STRATEGIES

Atmosphere is an ultimate source of our food supply. Foods produced throughout the world are controlled by the local climatic conditions of the atmosphere. Crop production is limited by the climate: Hot or Cold, Wet or Dry, Cloudy or Wet. Of course the latitude, altitude, bodies of water, and neighboring earth forms such as mountains give rise to the qualities of specific climates. For instance, tropical rain forests are found, with few small exceptions, between the Tropic of Cancer and the Tropic of Capricorn. Polar climates are found at high altitudes and high latitudes. Marine climates are usually found along the west coasts of middle latitude lands. Continental climates, with their wide annual ranges of temperature are found only on the large continents, Eurasia and North America. Most of the world's food is grown between the 30th and 40th parallel in the north latitude.

Use Transparency I, Climate Zones of the Earth, on the overhead projector and as a student handout. Climate classifications for agriculture purposes are based on interactions of temperature and precipitation. The climate classifications are:

A. Tropical rainy

B. Dry

C. Humid, mild-winter temperate

D. Humid, severe-winter temperate

E. Polar

Each classification can be subdivided; however, this course will be limited to only the large groups. Have the students color the major climate classification on their student handout. The map does not show detail but this will provide the students with the major differences in climates of the world. Five colored pencils or pens will be necessary.

Have the students find the areas of the world similar to their own. Do latitudes of equal distance north and south have similar climates? Point out that most of the land masses are in the northern hemisphere. Also, the population is concentrated in the temperate zones.

Generally the eastern part of the United States has a humid, mild-winter temperate climate, while the western part of the country is classified as a dry climate. Note a strip on the west coast is in a humid mild-winter temperate belt.

Climate is the single most important factor in limiting crop production. When climate systems are studied versus crop distribution, this becomes evident. Compare Transparency II, Appproximate Cropland Area, with the map of Transparency I. It shows that the United States produces most of the crops in the area that is classified as the humid, mild-winter temperate not in the dry climate area. Now compare the world crop production areas that are shaded gray on Transparency II with the student handout of Climate Zones of the Earth. Man's food must be produced in this part of the world.

Not only is the area of food production limited to certain parts of the world but earthlings are limited to the number of plants that are used as the mainstay. Of the estimated 350,000 plant species found on the earth, 15 provide the bulk of the world's food crops. All of these 15 fall into the class Angiospermae, flowering plants. These are divided further into monocots and dicots. There is one leaf on the young plant of a monocot, while the dicot has two leaves. Activity I, "Growth Regulator Comparison on Monocots and Dicots", will give the students first hand experiences in identifying the difference between these two subclasses of Angiospermae. Then a growth regulator will be used on the plant tissue.

It will be interesting to point out that a plant regulator like 2-4-D has been used extensively as weed killers allowing the crop to grow. The farmer must use herbicides or weed killers to cut down the cost of cultivation in order to provide the world with the necessary food at a low cost. Even though 2-4-D has been banded, there are other plant regulators that are used both as herbicides and as a stimulus for plant growth.

Seeds must be germinated under the proper temperature conditions. This will be demonstrated in Activity II, "Testing the Hardiness of Seeds at Low Temperature". Students will be able to see for themselves the effect of low temperature after germinations. This is a controlled experiment where all of the seeds are germinated and then one group is exposed to freezing temperatures. The hardiness of the seeds can easily be determined. This activity should help the students understand the importance of proper handling of seeds in storage and during the germination period.

Activity III, "Testing Hardiness of Lettuce at High Temperatures", will give the students experiences with wilting of lettuce at high temperatures.

A comparison will not be made of five of the world's mainstay food crops and the countries where these crops are produced. Refer to Transparency I and the student handout often, so that the students can grasp a better understanding of the climates required by these crops.

Rice

The staple grown throughout much of the tropical rainy climate is the number one agricultural product of the world. Rice is the principal food of many of the people living in Asia which is about 60% of mankind. Rice can grow in many types of soil if the land has one characteristic in common -- the farmer must be able to flood the land with water for a considerable amount of time. Rice can grow over a rather wide range of temperatures. California grows large amounts of rice for foreign consumption.

Use Transparency III, World Rice Production, to show the world's rice producing areas. Ask your students these questions:

Which two countries produce one half of the world's rice?
Why is rice a staple crop in South Carolina?
What part did rice play in the history of South Carolina?
If rice is your main staple, what must you add to have a balanced diet?
Is rice a monocot or dicot?

Wheat

In the dry climates where there is desert and steppes, the higher latitudes were originally covered with sturdy short grasses which required very little moisture. Today this area produces large quantities of the second most widely grown staple -- wheat. Remember that wheat belongs to the grass family, Graminae. The high protein crop grows on the dark rich soils of the great prairies supported by the moisture of winter snows. Point out on Transparency IV, World Wheat Production, the area where wheat is produced. Ask your students these questions:

Which countries are the major wheat producers?
Where is wheat produced in the United States?
Was this once prairie land?
What is the difference between winter wheat and spring wheat?
Why is flour enriched?
What is added to flour to enrich it?
Is wheat a monocot or dicot?
Besides bread, what is made out of flour?

Corn

Corn is grown in the humid mild-winter temperate, tropical, and subtropical climates. Use Transparency V, World Corn Production, to show that half of the world's corn is grown in the United States. Corn is a highly sophisticated crop as it is a hybrid. Maize was discovered by Scandinavian explorers in the new world. Hybridization of maize is the product of man's ability to produce a superior plant by selective breeding. Without careful planning, corn would soon disappear. Superior varieties cannot be grown from one crop alone. A farmer cannot save seeds from year to year as with other crops. Corn seed must be purchased each year from a breeder as corn is a hybrid product of cross pollination over several years. The corn of today only resembles the maize that the Indians were using when the new world was discovered. It is the product of superior agriculture techniques developed by man.

Corn, a grass, is a long season, moisture loving crop. It must be planted in the early spring and have plenty of rain to produce a crop that will average 100 bushel per acre or better.

Corn is a staple for South Carolinians as it is eaten in several forms. It is cooked and eaten as hominy and it is used to make cornbread. When corn is ground into a fine texture, it is used to make cornbread. A coarser texture is grits or hominy grits, a favorite breakfast food in the south. Corn mills or grits mills are located all over South Carolina where water could be used to grind the corn. Ask the students:

Is there an old grits mill near your school?
Why is some hominy yellow?
What is sweet corn?
Are your hominy grits enriched?
Is corn a monocot or dicot?

Potatoes

Potatoes were first introduced into the European diet when explorers went to Columbia, South America. It was growing in the mountainous area too high for maize. One reason for the sudden acceptance in the European diet were the attempts to increase basic food supplied because of a famine. The royal edicts in Germany and Sweden in the 18th century required the German and Swedish people to plant potatoes. Ireland found the growing conditions extremely favorable consequently this plant acquired the name of the Irish potato.

Use Transparency VI, World Potato Production, to show the main countries that produce potatoes. This is a plant that is grown from a stem section (tuber) called a seed potato. It is cut in sections so that each one has an eye. Using the fleshy part of the potato as nourishment, the eye sprouts until the roots and leaves have developed. This can be demonstrated in class with a potato that is beginning to sprout. A pot or plastic cup can be used to begin the potato plants.

Potatoes intended for french fries and potato chips must be held in cold storage for a couple of weeks. This eliminates the brown discoloration when the potato is cut. This discoloration is caused by sugars being reduced. When allowed to store in a cold place, the glucose and fructose are converted into starch which eliminates the discoloration problem when cut.

Ask your students these questions about potatoes:

How are potatoes harvested?
Is it a monocot or a dicot?
Is a potato high in calories?
Compare the calories in a baked potato (or boiled) to the amount found in french fries or potato chips.
Compare the nourishment between baked vs. french fries.

Soybeans

Soybeans is in the legume family, Leguminosae. It is not high in world usage, but the major importance is due to the amount of protein provided by this plant.

The addition of soybeans to the diet of people living in the protein deficient countries would eliminate the dreaded disease of Kwashiorkor. The high protein content of the legume is accounted for by the ability of the plant to fix gaseous nitrogen found in the soil air into nodules attached to the roots. This is done by a symbiosis relationship where bacteria modify the root tissue of the legume. Nodules are found on the root where the free nitrogen in the soil air combines with other chemicals to form nitrates of ammonia. The bacteria lives on the food which they get from the plant. The plants use the nitrogen fixed by bacteria. This is a symbiosis relationship where the two organisms work to aid each other. Have a student dig up a mature soybean plant so that all of your students can identify the nitrogen-fixing nodules on the roots.

Use Transparency VII, World Soybean Production, to locate the countries that produce the soybeans in this world.

Ask your students these questions:

Which country produces the most soybeans?
Which country is next in world production?
Are soybeans a monocot or a dicot?
In what form do we eat soybeans?
How does the protein content of soybeans compare with the grasses?

It is appropriate at this time to make a comparison of the nutrients found in each of the mainstay crops that supply the food for most of the world. Use Nutritive Value of Foods as a source. Soybeans is not listed in the data table because it is processed and later appears on your dinner table as margarine or in cooking oils.

	Energy (calories)	Protein (grams)	Carbohydrate (grams)	Phosphorus (milligrams)	Potassium (milligrams)
Rice (1 cup cooked)					
Wheat (2 slices white enriched bread)					
Corn (1 cup enriched hominy)					
Potato (1 boiled potato)					

Seldom do we eat rice, bread, hominy, or a boiled potato by itself. Usually we eat it with gravy, butter, or butter (margarine). By itself which one has the most calories? Which one has the most protein? Carbohydrates? Phosphorus? and Potassium? Which one does the students consider their mainstay?

Our diet is not limited to one mainstay as it is in many countries. The diet of most South Carolinians consist of the staple crops of wheat, rice, corn, and potatoes. Soybeans are harvested in South Carolina and later appear in the grocery store as margarine, shortening, and salad oils. All of these mainstays are plentiful and relatively inexpensive. This provides us with more than enough carbohydrates for our diet.

The polar climates, naturally, are useless for the growth of man's plant foods, but the Arctic, which has no forest resources, supports a rich growth of lichens, mosses, sedges, grasses, dwarf willow, and birch. This supports the herbivorous animals such as reindeer and caribou which is the food for the native people. Review the polar climates while using Transparency I.

The United States is considered the bread basket of the world as our farmers have learned how to produce abundant crops. We must provide the third world nations with these crops. Our meat supply in the United States is abundant providing us with plenty of protein. However, the third world nations must depend upon legumes for protein instead of animal meat. This does not always provide them with a sufficient amount of protein.

Vegetables that provide us with minerals and vitamins are plentiful in South Carolina. Land is available and the soil is relatively rich so that with a little bit of effort vegetables can be grown in home gardens for their family during most of the year.

Climate, a condition of the atmosphere, is a limiting factor concerning production of food. However, soil is also a prime consideration when planting crops. Improved agriculture practices in the United States have produced an abundance of carbohydrate food supply for a large portion of the world. If there is a population explosion, this supply of carbohydrates may not be sufficient for all, just as many people are not getting enough protein even today. What will happen if the world gets too crowded? Will there be enough food for all? Is world food supply going to be the crisis of the 21st century?

ACTIVITY I Growth Regulator Comparison on Monocots and Dicots

Introduction

There are an estimated 350,000 plant species in this world. Of those, only 100-200 are of major importance in world trade. Fifteen species provide the bulk of the world's food crops. These are rice, wheat, corn, sorghum, barley, sugar cane, sugar beet, potato, sweet potato, cassava, bean, soybean, peanut, coconut, and banana. These are all flowering plants and in the class, Angiospermae. These plants may grow upright, climb, or creep, but they all reproduce rapidly because they flower, fruit, and form seeds.

The flowering plants in the class Angiospermae provide us with most of our food crops. This class is subdivided into Monocotyledonae and Dictotyledonae. Use the shortened name of monocots and dicots. The last part of the word cotyledons means the first leaf of the young plant. Some flowering plants have one while others have two. Remember that mono- is the prefix for one and di- indicates two. Cotyledons act as the food supply for the seedling. This is also man's food supply. By examining the seeds as they germinate, you will quickly be able to identify the differences in seed structure, early development, roots, stems and leaf structure, and the patterns of the leaf veins. The number of flower parts can also be used to identify the difference between monocots and dicots.

Most of the staff of life for the world are monocots. These have one cotyledon and the veins in the leaves are parallel. In this subclass is the family of grasses, Graminae. This includes grains that are easily stored and handled such as rice, wheat, corn, sorghum, barley, oats, and rye. Also in this family are sugar cane and sugar beets. Dicots have two seed leaves and provide most of the balance of the food supply. The Legume family, Leguminosae, includes beans, peanuts, clover, vetch, and alfalfa. The last three provide animal feed that eventually end up on your dinner table as protein.

In this activity you will observe monocots and dicots as they germinate. You will germinate seeds in a clear plastic bag, where the roots and leaves can develop. You will be able to compare the differences between the monocots and dicots.

As the seeds germinate you will put a drop of Gibberellic Acid, a plant hormone, on the tissue of the young plant. Some can "gib" the root, while others can put a drop on the young leaf formation. Do not "gib" all of the germinating seeds. This will give you the normal development of the seeds to compare with the action of this growth regulator.

The most widely studied plant hormone are auxins. These are really regulators which can increase or slow down the growth process. Different parts of the plant react to auxins in opposite ways. Usually a high concentration of auxins stimulates stem growth, while root tissue is often stunted. 2-4-D, the weed killer, inhibits the growth of the roots thus killing the weeds. It only works on dicots or broad leaf plants. It has no effect on the grasses such as corn. Some auxins prevent fruit from falling off the trees. Thus farmers treat the fruit trees with certain auxins so they can harvest the fruit all at one time.

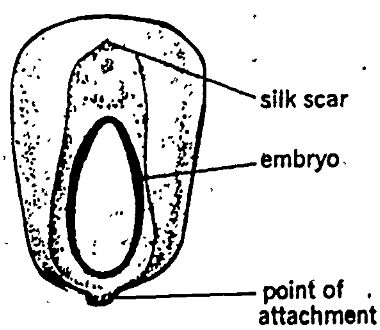
If you are interested in plant regulators, visit a feed and seed store to read the labels of the various products on the market. Also, try experimenting with other plant hormones to determine how specific plant species are affected.

Materials You'll Need

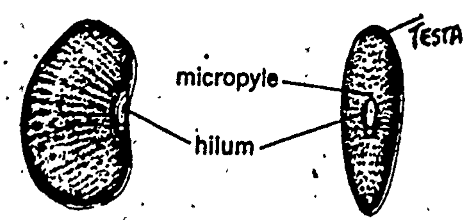
- Magnifying lens
- Bean seeds
- Corn seeds
- Clear plastic bags - one per student
- Paper towels
- Large grocery store bags
- Gibberellic Acid

Procedure

1. Examine your corn and bean seeds. Identify these parts.



A MONOCOT SEED



A DICOT SEED

Monocot

Silk Scar - The style or stalk of the pistil
Embryo - The place where the new plant is formed.
Point of attachment - Place where it is attached to the cob.

Dicot

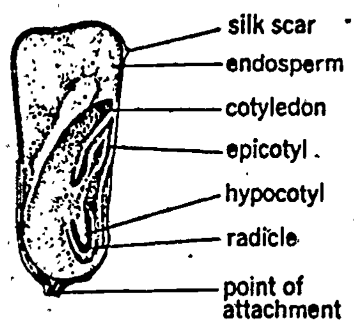
Testa - Outer coat
Hilum - Place where the bean was attached to the pod wall.
Micropyle - Small opening just above hilum where the pollen tube grew, just before fertilization.

2. Prepare a plastic bag for seed germination by placing a paper towel in the bag. Then staple the bag about 5 cm across the bottom of the bag. Now place about 8 corn seeds and 8 bean seeds next to this row of staples. Pour about 10 ml of water in the plastic bag, just enough water to be absorbed by the paper towel. Place the plastic bag in a large grocery store bag and hang on a nail in a verticle position. The grocery store bag will provide a dark place for germination to take place.

3. Examine your seeds every day and take data.

4. As soon as your seeds begin to swell, remove one of each kind and examine closely and find the following parts.

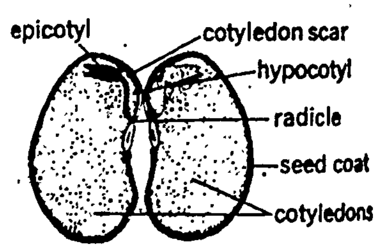
A MONOCOT - CORN SEED



cross section

Endosperm - The part that contains sugar and starches that is your food.
Cotyledon - Seed leaf.
Epicotyl - The early leaf formation.
Hypocotyl - A finger like projection that is the embryonic stem.
Radicle - The embryonic root.

A DICOT - BEAN SEED



Seed coat -- as your kidney shaped bean seed swells this part is the smooth testa that easily peels off.

5. Draw the Monocot and Dicot seed in your notebook and label the parts. What is the major difference between the monocots and dicots?

What conditions are necessary for germination?

UNIT V, CONCEPT D, ACTIVITY I (continued)

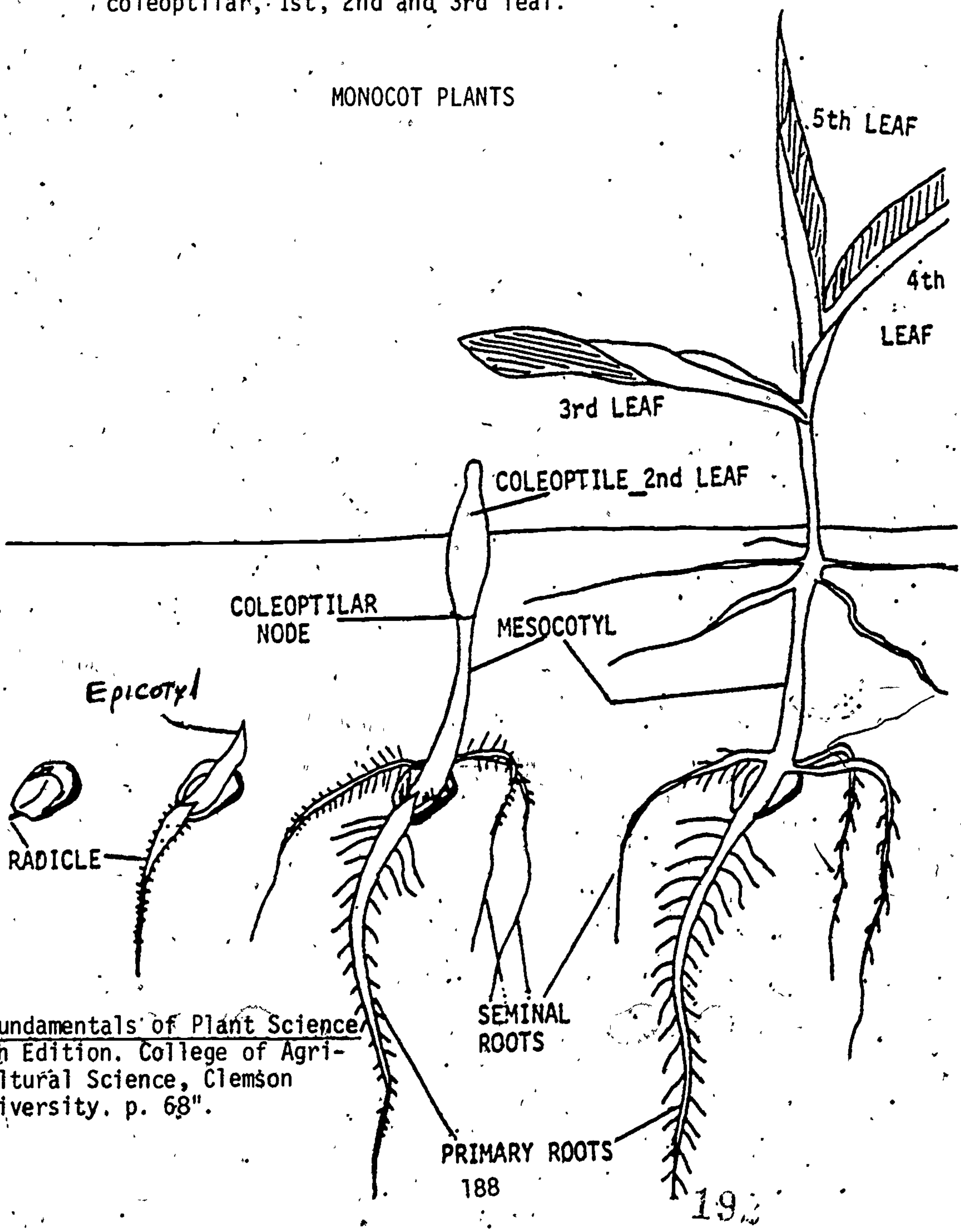
6. After your seeds have germinated in the grocery store bag, remove the plastic bag and hang it on a nail around your classroom. Make day by day observations and measurements of your seeds. Watch very closely for the root and leaf formation.

   In what direction did the radicle grow?
   In what direction does the epicotyl grow?

7. Draw day by day diagrams of the development of the seeds.

8. Label the following parts: radicle, epicotyl, mesocotyl and coleoptilar, 1st, 2nd and 3rd leaf.

MONOCOT PLANTS



"Fundamentals of Plant Science 4th Edition. College of Agricultural Science, Clemson University. p. 68".

and record.

Interpretation of Results

What do you eat that are not classified as Angiospermae? How about a mushroom?

Compare the germination and development of the seeds.

	Monocot	Dicot
Number of cotyledons.		
Presence of outer coat (testa)		
Number of first leaves		
Appearance of early root system		
Appearance of early leaves		
Veins in leaves		
Action of Gibberellic Acid on root		
Action of Gibberellic Acid on leaf		

Further Investigation

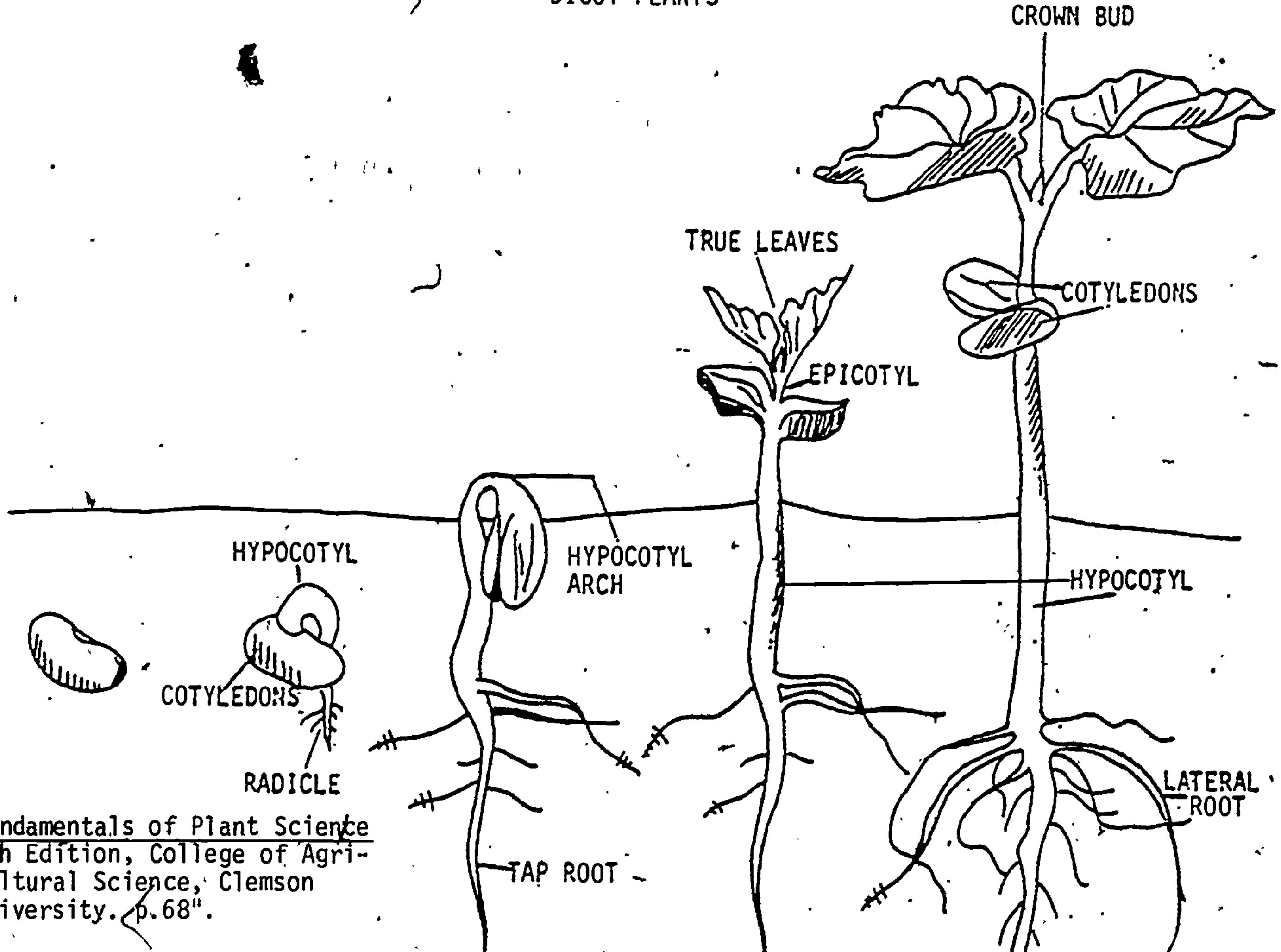
Set up a controlled experiment to test other auxins that are on the market.

Examine as many seeds as you can and determine if these are monocots and dicots.

Investigate the reasons for taking 2-4-D off the market.

9. Draw day by day the development of the Dicot plant formation.

DICOT PLANTS



"Fundamentals of Plant Science 4th Edition, College of Agricultural Science, Clemson University. p. 68".

10. Use the diagram to label the radicle, hypocotyl, cotyledon, epicotyl, tests, cotyledons, first true leaves, and crown bud.

    What happens to the cotyledon in each stage?

    Observe the radicle formation for the monocot and dicot with a magnifying lens. What are the characteristic differences?

11. Draw the leaf pattern of a monocot.

12. Draw the leaf pattern of a dicot.

    What is the major difference?

13. As soon as the seed has sprouted, remove one or two seeds and place a drop of Gibberellic Acid on either the root or the leaf formation. Do not "gib" both the root and the leaf area. Place it back in the plastic bag. Make day by day observations,

ACTIVITY II Testing Hardiness of Seeds at Low Temperature

Introduction

. Many seeds have a thick coating that protects it from damage. This activity will help you determine the hardiness of seeds when exposed to freezing temperature.

Materials You'll Need

Tomato seeds
Corn seeds
Alfalfa or green seeds
Potato eyes
Paper towels
Container for seeds (petri dishes)
Access to a refrigerator

Procedure

1. Divide a patch of seeds into several equal groups. Soak each group a different length of time, keeping one set dry for comparison.

2. Expose each set of seeds to freezing temperatures for the same length of time, such as 1 hr. or one class period.

3. Put the seeds on damp paper towels in covered dishes. Keep a record of the number of seeds that develop into seedings.

4. Try a variety of seeds.

Suggested Data Table

Time Soaked (Hrs.)	Kind of Seeds	% Lived
0		
1		
2		
3		

Interpretation of Results

What conclusions can be drawn?
How does the hardiness of different seeds compare?
How does the dry dormant seed help a plant survive?

ACTIVITY III Testing Hardiness of Lettuce at High Temperature

Introduction

Lettuce must be properly handled in order for it to be crisp when it gets to your dinner table. In this activity you will determine the temperature the lettuce can stand before it wilts.

Materials You'll Need

Fresh lettuce
Thermometers
Bunsen Burners (alcohol burner will do)
Ice water
Beakers
Test tubes

Procedure

1. Put strips of fresh lettuce in test tubes and raise each to a different temperature. Compare each strip with unheated lettuce.

   At which temperature did the lettuce begin to wilt?

2. Put the strips in cold water. Which strips become crisp again? Which are dead?

   What is the killing temperature of lettuce?

3. Raise the temperature of several strips of lettuce leaves to the wilting temperature as before, but keep them at this temperature for different lengths of time. Which leaves recover?

4. Repeat the experiment at higher temperatures.

   What is the value of wilting to the plant's survival?

Suggested Data Table

LETTUCE Sample:	Temperature	Condition when placed in cold water
1		
2		
3		

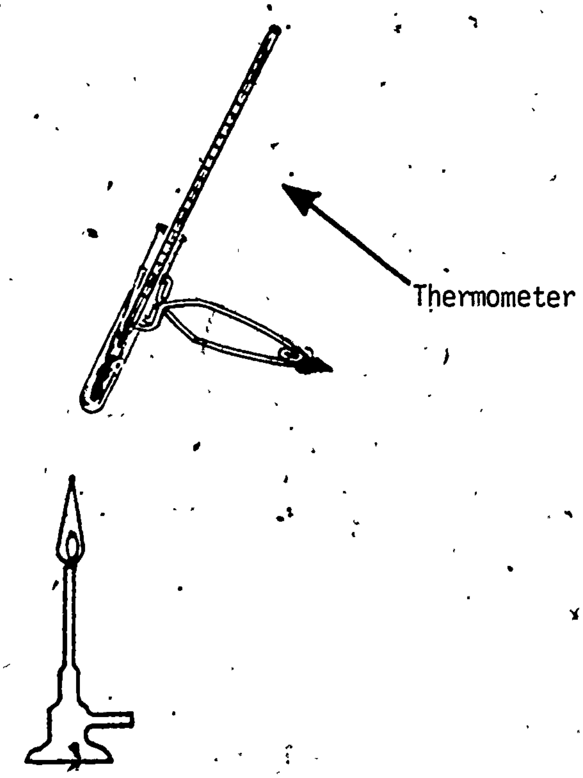
UNIT V, CONCEPT D, ACTIVITY III (continued)

Interpretation of Results

What is the temperature that can be tolerated by lettuce?

Further Investigations

Repeat this experiment using cabbage leaves.



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UNIT VI WHAT WILL I EAT IN THE FUTURE?

CONCEPT A The same foods will be eaten, however, an increase in food supply will be needed.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Recognize the importance of protecting our prime farm land in the production of food supply.

2. Explain the relationship between hybridization and increased food supply.

3. Analyze the bug population and their impact on our food supply.

4. Measure the estimated amount of water consumed by their family.

5. Recognize the magnitude of the problems involved in increasing food supply.

BACKGROUND INFORMATION FOR TEACHERS

Resource Inventory South Carolina, 1977
U. S. Department of Agriculture, Soil Conservation Service, Columbia, South Carolina

Hoff, Johane and Janick, Jules, Readings From Scientific American, W. H. Freeman and Company, San Francisco, 1973

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. Estimating % Farm Land in Your County

II. Crop Improvement Through the Genetics of Corn

III. Good Guys and Bad Guys!

IV. Bugs Follow You Through Life!

V. How Much Water Does Your Family Need?

TRANSPARENCY

I. Double Cross - Corn

TEACHING STRATEGIES

What will be the foods of the future? At the rate of a 2% increase each year the population will double every thirty years. This population increase will require more food. Will the American farmers be able to keep up with the increased food demands? Will the foods be relatively the same? Or will we be eating considerably different types of food?

Since carbohydrates are plentiful and relatively easy to produce, our major concern will be the type of protein. Fifty years ago in South Carolina, more pork was eaten as beef and chicken were expensive and not readily available. Mass production and marketing had not begun. Now, ground beef and chickens are the main source of protein. If your students were living in a third world nation today, their main source of protein would not be meat. For a complete protein in rice eating countries, their diet would be supplimented with beans. In other countries beans are complimented with corn products. Remind the students that it takes 8 or 9 amino acids to make a complete protein. Vegies must be careful to eat all of these amino acids. Here in the United States most people are meat and potato eaters. Our fast food restaurants specialize in meats such as beef or chicken which are plentiful and reasonably priced.

Meat is considered an extravagant means of obtaining protein in the diet. As an example, let's compare the production of beef to that of corn and beans. In order for a farmer to produce beef, corn and hay must be grown. The farmer must cultivate the soil, sow the seeds, fertilize the plants and later harvest and store the crop. Barns, pastures, and feed lots must be provided for the cattle along with the hay and corn. The cattle must be marketed, graded, inspected, and butchered before the meat is shipped to the grocery stores. Remember once it is butchered, the meat must be refrigerated until it reaches your dinner table. On the other hand, corn and beans are grown in the same way the farmer produces hay and corn for the cattle except when the harvest time comes the corn and beans are transported to a grain storage elevator and remain in a humidity and temperature controlled place until ready for use. As you can see it takes a lot more energy and farm land to produce protein in the form of beef that it does to grow corn and beans. Meat is not an efficient way of obtaining our protein needs. Our desire for meat is ingrained in us and is not likely to change. Make certain you leave the questions open for student answers. Will our protein and other nutrients always be the same? Will they eat different foods in the future?

If our foods are to remain relatively the same, several factors will affect the availability of what we eat in the future. These are supplies of oil and gas, availability of prime farm land, improved breeding of plants and animals, control of insects, sufficient water supply, production of fertilizers, preservation and proper storage of crops and products, and distribution of food products.

Gas and oil supplies are rapidly depleting. A major problem we witness daily is the disappearance of our prime farm land. It has been estimated that each year thousands of acres are lost to urban and industrial developments. Activity I, "Estimating % Farm Land in Your County", will help the students realize the importance of prime farm land in their area. Be sure to make a comparison between state wide figures for land use in South Carolina and your county.

There is a danger of losing our prime farm land. If this happens along with a population increase, then how will we possibly get enough food for our needs. One solution could be the practice of improved breeding of both plants and animals. As an example of man's ability to change significantly the yield of crops, let's look at corn. The new varieties of corn have doubled and redoubled in the number of bushels per acre over the last 50 years.

In the 1930's, a crop that yielded 20-30 bushels of corn per acre was considered excellent. Now crop productions are considered to be good if the yield is between 120-160 bushels per acre. Just twenty years ago there was an organization formed of farmers that made yields of 100 bushels per acre called the "One Hundred Bushel Club." It was quite a distinction to become a member of this club. Now the prestigious club is called the "Two Hundred Bushel Club". Record crops have been reported to be as much as 300 bushels per acre. For corn to jump in yield this rapidly over a relatively short span of time, scientific principles have been utilized by American agriculture experts.

The corn seeds that the farmers use today are the result of improved breeding called hybrid vigor. Because corn is a hybrid, the farmer can not use these seeds for the next year's crop. They must buy new seeds each year from a corn breeder. In order to supply the world with hybrid seeds the breeder must begin by producing pure strains of corn which exhibit specific characteristics year after year. In the first generation these pure strains of corn are crossed, carefully selected and crossed again the second generation. The hybrid vigor corn seeds are produced in the second generation. These are the seeds that under the proper conditions can produce yields of over 200 bushels per acre.

Activity II, "Crop Improvement Through The Genetics of Corn", will give the students an idea of the way crosses are made to produce hybrid vigor in corn. This same technique is used to produce hybrid vigors in both plants and animals. These improved breeding practices could provide us with increased production but this will be a slow process, and it may only offset the loss of our prime farm land.

There are many other factors that inhibit the production of food. Farmers are constantly having problems with insects, fungus, and weeds. As a result, there has been a tremendous amount of research on insecticides, fungicides, and herbicides. Let's take a closer look at insects, because the bugs' nutrition may be your nutrition unless we understand the lifecycles and habitats of insects. Activity III, "Good Guys and Bad Guys", will give the students field/laboratory experiences in collecting, mounting, and preserving insects.

Storage is another concern. If we increase the supply of grains and beans, can we store it with protection from bugs, rodents and microorganisms? Activity IV, "Bugs Follow You Through Life", will show the students that even though we have established quality standards, bugs exist as part of our food. Beans and grains in our country turn over relatively fast. However, if we grow and store for a minimum of 4-6 months, how do we protect them from aflatoxin and other mycotoxins? The aflatoxin is the most potent carcinogen that we have. Liver cancer is increasing in Africa where grains are grown with poor storage facilities. Their facilities do not have controlled temperature and humidity. In the United States, we protect our grains and beans in elevators (silos) where the humidity and temperature are controlled. This too takes energy but still less than the amount needed to produce meat!

Water is a necessary resource for increasing our food supply. Water in the south has not become a problem. However, many other areas in the United States experience periodic droughts that drastically affect the production of crops. Even though South Carolina has an abundant supply of water it could become contaminated. Our water resources could dwindle. There are several areas in the United States where there is a critical water shortage. Activity V, "How Much Water Does Your Family Need?", will give the students an opportunity to approximate the amount of water their family uses for one week. This is not taking into account the amount of water that is necessary to produce the food that is consumed daily by their family. It takes 12 to 25 acre-inches of water to produce a corn crop. Milk producing cows must drink at least 20 gallons of water a day. Abundance of water is necessary for increasing food supply as well as maintaining our current productions.

The problem of what will be eaten in the future is still an unanswered question. Make certain your students understand that there are so many variables that could alter the outcome. Several factors should be clear from the students' activities. We must protect our prime farm land in South Carolina, as well as the rest of the United States. Research must continue to improve breeding practices. Indepth studies must be made of crop production practices so that we will make the proper use of insecticides, herbicides, and fungicides. We must have an abundant supply of water. We still have to consider the production of fertilizers and the distribution of food products. All of these factors are important if we are to continue to put the same type of foods on our dinner table.

ACTIVITY I Estimating % Farmland in Your County

Introduction

Prime farland is one of the most important resources of our nation. This is the land that produces the food, fiber, and forage necessary for your livelihood by utilizing the least amount of energy. If you are to continue to be a meat and potato eater, you must protect this prime farmland so that these crops will supply your needs. Only one out of five acres in South Carolina are considered prime farmland. This is only 20% of the total acres in South Carolina. The other land is either too hilly, lacks the proper soil characteristics, or does not have suitable moisture content.

What is Prime Farmland?

Prime farmland have soils that meet the following criteria:

1. Have an adequate moisture supply.

2. Have a mean annual temperature higher than 32° F (0° C) and a mean summer temperature higher than 59° F (15° C).

3. Have a pH that is favorable for growing a wide variety of crops without adding large amounts of nutrients.

4. Maintain a water table at a sufficient depth during the growing season to support the crops.

5. Can be managed so that the exchangeable sodium percentage (ESP) is less than 15.

6. Are not flooded frequently during the growing season (less often than once in two years).

7. Do not have a serious erosion hazard.

8. The surface layer contains less than 10% of rock fragments larger than 3 inches (7.5 cm.). These soils present no particular difficulty in cultivating with large equipment.

The U.S. Department of Agriculture and the Soil Conservation Service, SCS, has made an inventory of prime farmland in this area. Based on this survey they have compiled maps for most of the counties in South Carolina illustrating the prime farmland. There are approximately 19 million acres in South Carolina. If you take out the large bodies of water and the land in Federal ownership, this leaves about 18 million acres that have been used for this inventory. Of this amount we are losing thousands of acres per year to urban development, which includes land taken out of farming for industrial, residential, commercial, institutional, and public administrative sites, as well as railroad yards, cemeteries, airports, golf courses, sanitary landfills, and sewage treatment plants. Every 5 years an appraisal of prime farmland will be made. The figures will be used to update the assessment and reevaluate our soil, water, and related resources.

In this activity you will be estimating the % of prime farmland in several counties.

Materials You'll Need

5 or 6 county maps of Important Farmland printed by the U.S. Department of Agriculture and Soil Conservation Service
1 - 3 x 5 card per lab group
Scissors
Rulers

Procedure

1. Cut a window in a 3 x 5 card that is 5/8" square. This will represent 1 $mile^2$ or 640 acres.

2. Place this over a section of your map and count the number of green boxes. Each of these boxes represents 10 acres. The possible number of green blocks in your window is 64 or 8 x 8. (Verify this!)

3. To determine % of prime farmland:

$$\% \text{ Prime Farmland} = \frac{\#\text{ of green boxes in your window}}{64} \times 100\%$$

4. Repeat this in several areas of the county and average your figures.

5. What is your estimate of % Prime Farmland?

6. How does this compare to the figures given in the legend of your map?

Suggested Data Table

Area	# of Green Boxes	% Prime Farmland = # of Green Boxes / 64
1		
2		
3		

American agriculture is hailed as the most productive in the world. In 1980, the value of our agriculture exports exceeded 40 billion dollars. American farm products feed our own population in addition to a significant part of the Second and Third World Nations. This means the difference between life and death to millions of less fortunate people whose lives are marred by chronic hunger. Our farm products are essential to a favorable balance of trade.

But as populations expand and need for food increases at home and abroad, one wonders: What does the continuing loss of our best farm lands portend for the future? How long will it be before prime farmland loss severely cripples our agriculture production?

ACTIVITY II Crop Improvement Through the Genetics of Corn

Introduction

Hybrid corn is a product of man's ability to use technical knowledge to improve the world's food resources. Over a period of 50 years corn yields have gone from 20 - 30 bushels per acre to 120 - 160 bushels per acre. In recent years, record crops of over 500 bushels per acre have been recorded. It has been through applied biological techniques that the agricultural experts have developed strains of seeds that have significantly increased these corn yields.

When the settlers came to the new world, they found the Indians growing maize, an early form of corn. It was soon discovered that different varieties were being planted close together to increase yields. The Indians had begun to improve yields through cross pollinization. Since that time, the process of corn genetics has become very technical with many people contributing to the development of hybrid corn. Some of these scientists have worked through the U.S. Department of Agriculture, state experiment stations, universities, and others through private industry. It is interesting to note the part that Henry A. Wallace played in the development of hybrid corn. He was an early corn hybridizer and started the Pioneer Brand Seed Company. It was because of his work in the development of hybrid corn seeds that he was selected to be the Secretary of Agriculture. Later he became Secretary of Commerce and Vice President of the United States during the administration of President Franklin D. Roosevelt.

Through the study of corn genetics, "hybrid vigor" seeds have been developed. Hybrid vigor indicates that the seeds produce plants that are better than either of the parent strains. This begins with the process of inbreeding specific desirable characteristics so that pure strains are developed. Next, seeds from two of these strains are grown to form a single cross. The next year these new seeds are grown to form a double cross. These are the seeds that produce the hybrid vigor plants with high corn yields. The whole process must be tightly controlled during the eight years that it takes to develop these hybrid seeds.

The corn plant is interesting and unique to examine as there are male and female parts. If you can find an old corn stalk, examine it carefully. The tassel is designated as the male part while the female part is the ear. The many flower clusters found in the tassel provide the pollen. The ear (female part) contains the silk, one for each kernel of corn which must be fertilized independently. Because there are so many flowers on a single tassel, the large amount of this small grain pollen is spread by the wind over a large area, the same plant seldom pollinizes its own silk. Consequently, pollinization can be controlled. This is done by certain varieties being designated as male plants where the tassel is used, others are designated as female plants where only the ear is used. When the tassel of the plant is used, the ear is disregarded or not used for corn seed. Remember that each silk needs only one grain of pollen to form a kernel of corn. In order to produce a pure strain of corn the variety must be grown in isolation. This is accomplished by removing the tassels from the female corn plants and only harvesting that corn.

Superior varieties are produced by this process of inbreeding called mass selection. These are some of the characteristics that are inbred and the purpose of each.

Characteristic	Purpose
Stiff Stalks	Remain upright far into the fall for easy mechanical harvesting
2-3 small ears (instead of 1 large ear)	Easier to machine harvest
Drought resistant	Necessary for hot dry summers
Disease resistant	Various diseases can result in crop loss
Long tight husks	Protects ear against worms and weevils
Bitter taste of folliage	Becomes unattractive to grasshoppers

The "2-Bean Seed Activity" will help you understand the corn inbreeding process by positive selection. Next you will follow the "Double Cross" diagram that will illustrate just how the four superior characteristics are grown, first by a single cross and later the next year by utilizing a double cross.

Materials You'll Need

1 stalk of corn (can be a dried stalk)
50 red bean seeds per lab group
50 white bean seeds per lab group
1 small paper cup per lab group

Both seeds must be the same size.

Procedure

1. Select 50 red and 50 white bean seeds. These will represent the starting gene pool. The red bean will represent the gene characteristic of a strong stalk, while the white bean will represent the gene characteristic carrying a weak spindly stalk.

2. Place the 100 beans in a container and shake well.

3. Without looking, withdraw 2 beans from the container at a time. As possible combinations you will have either 2 red beans, 1 red and 1 white bean, or 2 white beans.

   The 2 red beans will represent the plant with the genes carrying the desirable characteristics of a stiff stalk.

   The 1 red bean and 1 white bean will represent the plant that appears to have the desirable characteristic of a strong stiff stalk but has a hidden gene containing the undesirable characteristic of a weak spindly stalk.

   The 2 white beans will represent the undesirable characteristic of a weak spindly stalk.

   As you withdraw the beans, place them in the proper designated column. This will represent the first, F_1, generation derived from the starting gene pool.

4. Record the number of each group of beans in the Suggested Data Table.

5. Remove the pairs of white beans as these have the undesirable characteristic you are trying to eliminate by inbreeding.

6. Repeat this process for the F_2 and F_3 generations. It will soon become obvious that continuation is futile as you have eliminated the undesirable characteristics.

By thinking of your desirable characteristic as a strong stalk, after each successive generation you have eliminated most of the weak spindly stalks through inbreeding and selecting the best seeds. This same process can be repeated for other characteristics such 2 - 3 small ears, drought and disease resistance, long tight husks, and bitter taste to the foliage.

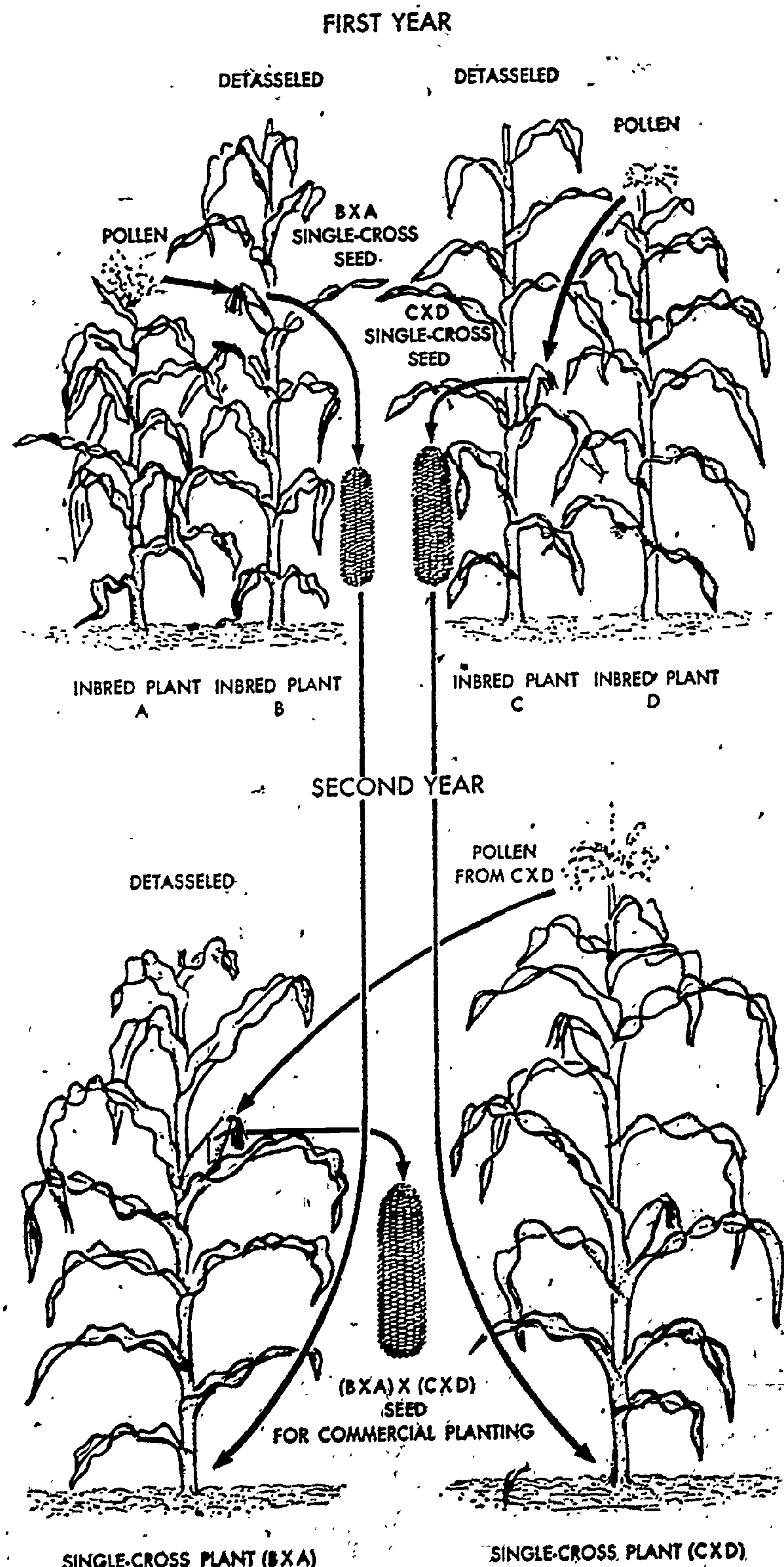
The next step in developing hybrid corn seed is to grow two pairs of inbred corn plants to form a single cross. In the next generation these pairs are crossed with another pair of inbred plants to form a double cross. It is these seeds that produce hybrid vigor plants that carry all four of the inbred characteristics.

As you look at the diagram on the following page, follow the arrows which show Inbred Plant A pollinates the silk of Inbred Plant B. The pollen from Inbred Plant D pollinizes the silk on Inbred Plant C. In the next generation, the pollen from the seeds planted with single cross C X D fertilize the silk from the single cross of plant A X B. This ear produces seeds containing all four inbred characteristics of (A X B) X (C X D).

These biological principles have revolutionized farming methods. Remember that the seeds from these double crosses are hybrids and cannot be saved for replanting. Corn hybridizers must produce new seeds each year.

By following these methods the yield of corn has risen from 22 bushels per acre in the 1920's to record crops of up to 500 bushels per acre. The same principles used to improve crop production through the genetics of corn have been tried on varieties of wheat, oats, barley, rice, and sorghum. But the success has not been so dramatic. Hybrid forms of cucumbers, squash, and watermellons are now on the market. Only plants with separate male and female parts can be hybridized in this manner as self pollinating plants are not suitable.

Hybrid animals have long been used such as the mule which is a cross between a male donkey, a jackass, and the female horse, a mare. Other crosses have proven successful such as hybrid chickens, cattle, and pigs.



"From <u>Scientific American</u>, <u>Food</u>, "Hybrid Corn" by Paul Mangelsdorf, August 1951.

Perhaps in the future most of our domestic animals will be from hybrid vigor stock, as many have proven to be more efficient producers.

Plant breeding has become a specialized technology that is responsible for a large part of the current progress in crop production. These breeding practices may provide us with an increased food supply for our future needs.

Suggested Data Table

Generation	2 Red Seeds	1 Red and 1 White seed	2 White Seeds
F_1			
F_2			
F_3			

Further Investigations

What is the difference between a genotype and a phenotype?

Find out which crosses produce the Brahman and Santa Gertrudis cattle?

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ACTIVITY III Good Guys and Bad Guys

Introduction

Will there be enough food for all the people in this world? The availability of food is a major concern. In order for the farmer to produce a bumper crop, insect damage must be kept to a minimum. Insect life cycles and habits must be understood. As you learn more about the field of Entomology, you will realize that not all insects are bad. Some are necessary for pollinization, others as predators, still others provide us with food.

Your nutritional needs are dependent upon the presence of insects. This can be a positive as well as negative influence. In other words, there are insects that can be considered as "good guys" and others you may think of as "bad guys".

Think of the time you have enjoyed eating honey. The bees that made the honey are interesting to study as they have definite social habits. Find out all the ways beeswax is used. The cold cream industry would never have risen to such prominence if it had not been for the availability of beeswax. Silk is another useful item produced by insects. Other insects pollinate crops, serve as food for fish and birds, eat harmful insects, and improve the physical conditions of soil by aiding in fertility. Some insects are scavengers and eat the bodies of dead animals and plants, all of which are necessary for life as we know it today. These are all the "good guys".

There are plenty of "bad guys" in the insect world. In fact, you have heard more about these insects than the good guys. Certain insects destroy or damage growing crops and other valuable plants. Some insects are annoying because they crawl over the furs of animals, pierce the skin by injecting venom, thus spreading disease. Often they make their homes in the host body by laying eggs. Insect damage can destroy whole crops, stored food products, wood in buildings, or furniture.

Entomology, the study of insects, will provide you with many interesting and varied experiences. Keep in mind that there are a number of "good guys" along with the "bad guys".

Some insects are beneficial and necessary for your existance along with the ones considered as harmful pests. As you begin to look for and collect insects, remember that many of them do the same things that you do. They build apartments, raise crops, keep cattle that they milk, live in colonies, and have carpenters, papermakers, guards, soldiers, nurses, slaves, hunters, trappers, thieves, and undertakers. Often they go to war against one another.

An insect must have six legs and three body sections. This eliminates spiders, centipedes, mites, and ticks. In this activity, you will be collecting houseflies, dragonflies, mosquitoes, silverfish, grasshoppers, lice, crickets, walking sticks, fleas, and beetles.

Entomology is the study of insects, while the person who makes a study of insects is an entomologist. You will become an amateur entomologist as you delve into the study of insects. Dr. Richard C. Fox has prepared this activity on collecting, preparing, and preserving insects. He is Professor of Entomology at Clemson University. To aid in the rapid collection of these insects, pheromone bags can be purchased so that many specimens can be collected. This will provide you with plenty of insects to inspect.

Materials You'll Need

Ethyl acetate (fingernail polish remover)
Collecting jars (old mayonnaise or jam jars will be fine)
Mounting pins (a scientific company)
Mounting board (made out of insulation scraps or pieces of styrofoam from an old ice chest)
Construction paper to make envelopes

Procedure

All of us know insects and have for most of our lives. This is that multitude of critters that plague our pets, our plants, our houses, and our food as well as ourselves. Some of us develop more of an interest in them than others and this activity is aimed toward those whose interest has been aroused by the habits, antics, or colors of them. No one will ever have to go far to collect insects for several hundred separate species may be found in just our own backyard.

The greatest essentials for insect collecting are the eyes, fingers, and an inquiring mind. Even though most insects can be collected easily by hand, tools are generally handy. Insect nets and tweezers can be purchased or made and the beginner should select the banks of streams, open fields that are not too dry, open woodlands, weedy roadsides, and flowering shrubs. Search under stones, logs, loose bark and rotting leaves for ground dwelling insects. Flying insects can be caught by using a net.

Regardless of how insects are collected, great care should be taken to keep them as perfect and life-like as possible. Neatness and accuracy cannot be overemphasized. The beginner should set a high standard for his collection and should discard any broken or discolored specimens. Also, if you are unsure of the locality or date of collection for a given specimen, it should be thrown out. Learning to mount insects and to label them properly will lead to a neat collection which is a thing of beauty, a source of personal pride and may be a valuable scientific contribution.

A few tips on collecting may be of value:

1. Use ethyl acetate as a killing agent in kill bottles or jars rather than cyanide. It can be obtained from a pharmacy generally as fingernail polish remover and although it is a poison, it is far safer to use than cyanide. Baby food jars make ideal kill jars. They are tight, sturdy and easily fit into a pocket.

2. Keep one or two loose strips of tissue in each kill bottle. This prevents insects from damaging each other and reduces moisture in the bottles. When specimens are removed and these tissues are damp, replace with dry ones.

3. Use separate kill bottles for moths and butterflies. Many times the scales that come off their wings will spoil other insects. To prevent excessive beating of their wings, simply pinch the thorax slightly when removing from the net.

4. It is wise to have a separate bottle for flies and bees and to remove such specimens soon after killing them.

Relaxing

Often one collects more insects than can be mounted at any one time and the specimens that have dried out need to be made soft and pliable again. For this, a refrigerator crisper or other waterproof and airtight container can be used. Simply put about an inch of sand or vermiculite in the bottom and moisten thoroughly. Add a few drops of carbolic acid or household bleach to prevent mold growth. Cover substrate with a piece of cardboard. Specimens should be placed inside in small boxes or on paper towels and the container then covered. Usually 12-24 hours are necessary to soften the insects so that they can be handled without damage. Do not relax more than can be mounted at one time for sometimes insects will be ruined if they get too wet.

Envelopes

Moths, butterflies, and dragonflies are hard to handle when collected because their wings are so fragile and easily damaged. Collectors have learned that if these specimens are "papered" immediately after collecting, they can be handled more easily or stored without fear of damage.

Paper envelopes can be made quickly as shown in Figure 1. It is best to use coarse construction paper for it provides good protection and also absorbs excess moisture. Envelopes should be made up in good supply before a collecting trip and pressed tightly to prevent unfolding. Several sizes of envelopes can be made to accommodate insects of different sizes, but the ratio of the long edge of the original rectangle to its short edge should be about 5:3 to insure enough overlap of the folded sides to keep the envelope closed. Collection data common to all specimens in a given envelope should be written on the edge of the envelope before inserting specimens.

"Papered" specimens can be kept indefinitely if packed loosely in a sturdy box and kept dry. If mounting must be delayed, boxes should be treated liberally with moth balls or crystals

Making Paper

Evelopes

Fig. 1a.

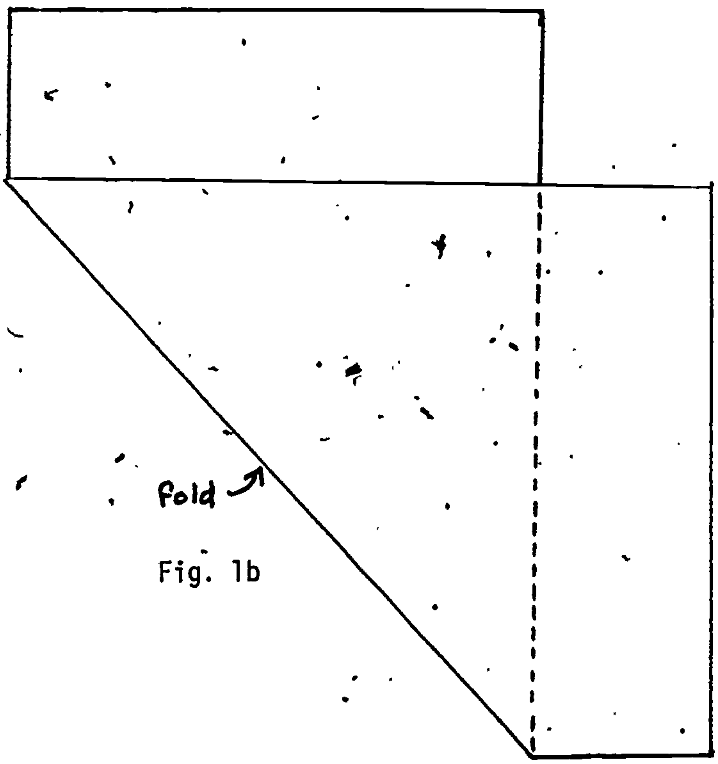

Fig. 1b

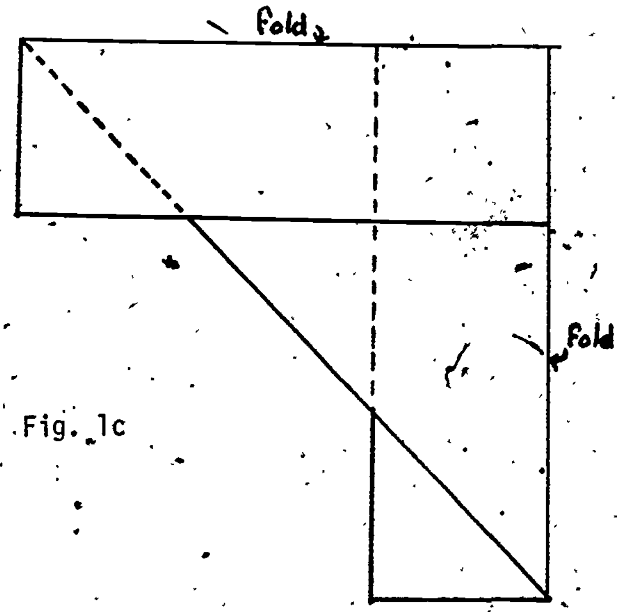

Fig. 1c

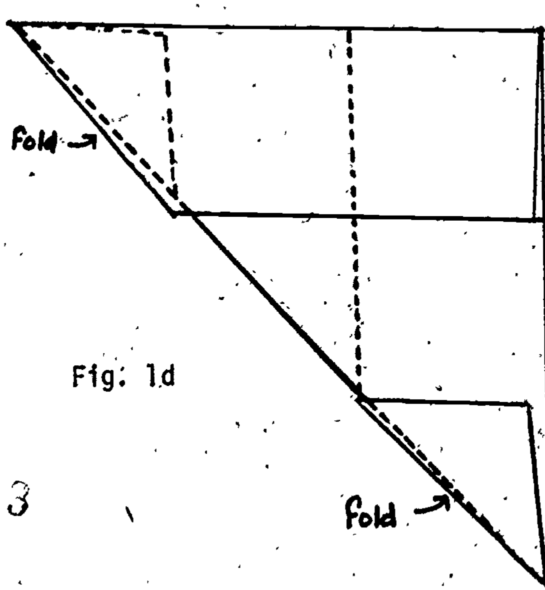

Fig. 1d

to keep out "museum pests" and to prevent mold. Keep the boxes away from ants and mice for these pests dearly love to feed on drying, large-bodied insects.

Spreading

Moth and butterfly collectors invariably open a training session in the spreading of moth or butterfly wings with the statement, "It's easy!" This is basically true but only after a good bit of practice with common specimens before tackling the more valuable ones. Practice and experience will develop personal tricks and/or preferences, so only the fundamentals are presented here.

First, one needs a spreading board (Fig. 2a) which can be purchased or "made to measure". If you wish to make one or more, look at a commercially made one to get the idea and then fabricate to suit your purposes. The only "must" is a porous surface to hold firmly the insect pin on which the specimen is mounted and top pieces of soft wood that will take pins readily. The whole thing should be sturdy but need not be expensive.

All specimens need to be freshly killed or thoroughly relaxed. If the wings are extended over the back, squeeze (with tweezers) the sides of the thorax below the bases of the wings. This will open the wings up so that the spreading procedure can continue. Pin the specimen in the proper place and at the proper height as shown in Figures 3-4. Insert this pin into the spreading board so that the bases of the wings are just above the top of the board. As shown in Figure 2b, insert CAREFULLY a fine pin just back of the leading vein of each front wing and move each wing forward until the back edges are in a straight line with each other and at right angles to the insect's body (2b). Fasten them in place with fine strips of paper. Similarly pull up the hind wings, being careful to insert the pulling pin behind the first vein, and not merely in the wing membrane. The hind wing should be pulled forward until the hole made by the pulling pin is barely concealed by the hind edge of the front wing (2c). The hind wings are secured by diagonal strips of paper, and when these are in place the traction pins are removed. While drying, a date and locality label (Fig. 2d) should be pinned adjacent to each spread specimen.

Let the caution be made again! Keep spreading boards with their drying insects where ants, mice and roaches cannot get to them. Mice especially are attracted to these and can destroy fine specimens easily.

Specimens will dry usually in a week or two. Experience will dictate how long to leave them but when dry, remove the specimens, apply date and locality (Figure 7) and store in insect-proof boxes.

Spreading Board for Specimens

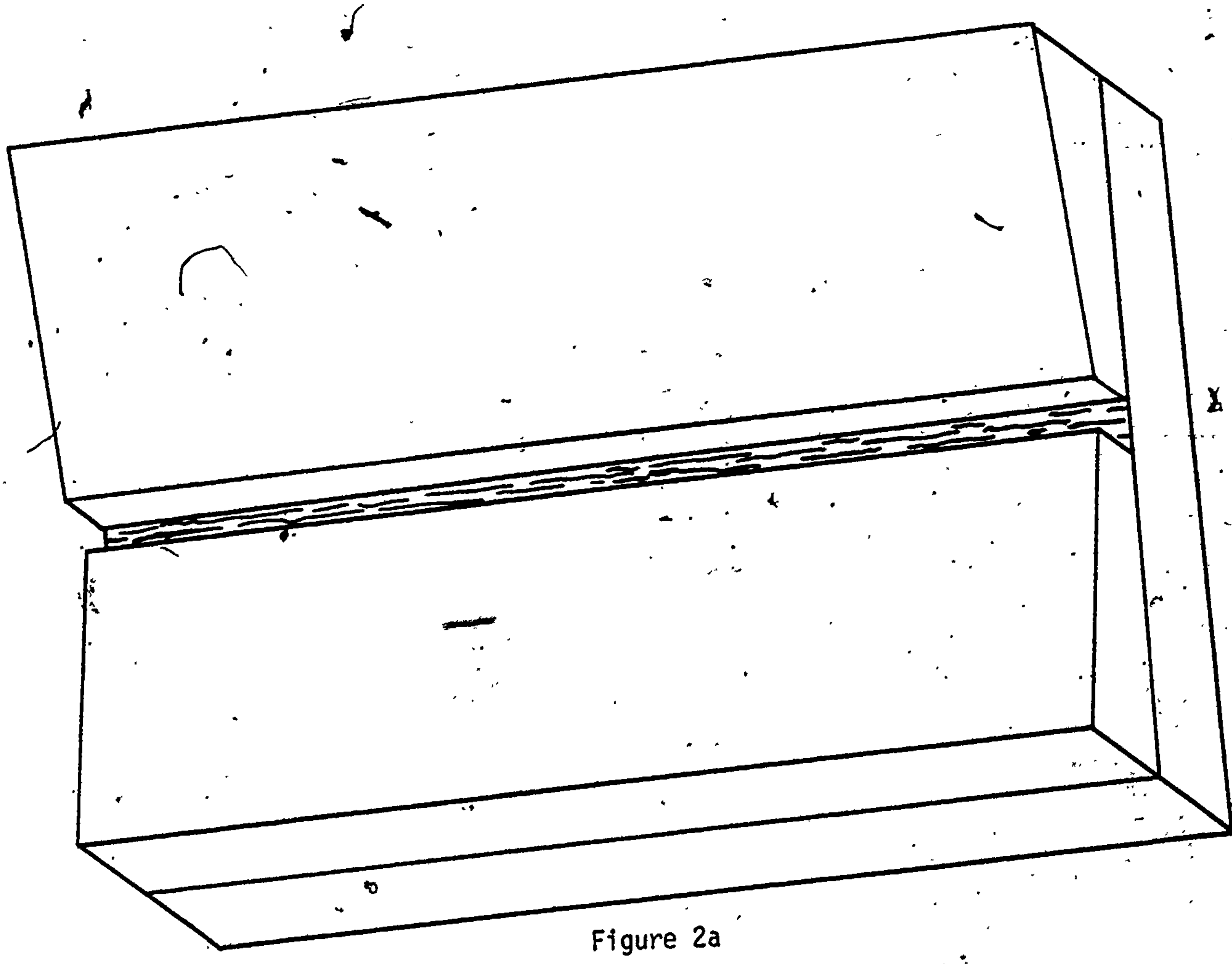

Figure 2a

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Spreading Moths and Butterflies

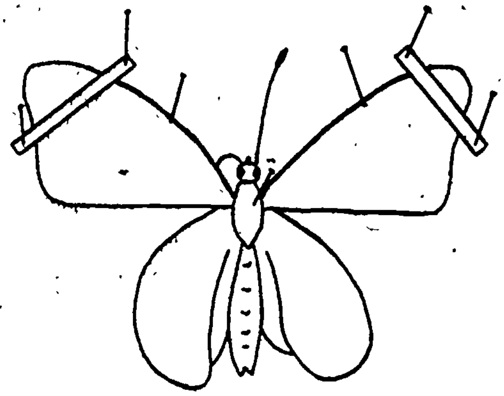

Figure 2b

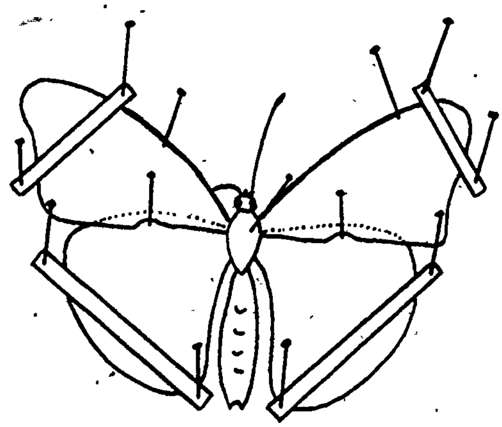

Figure 2c

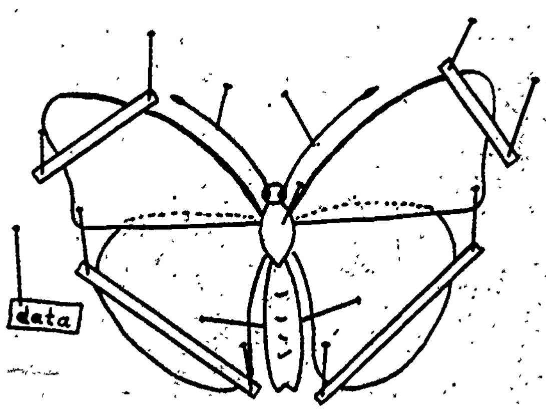

Figure 2d

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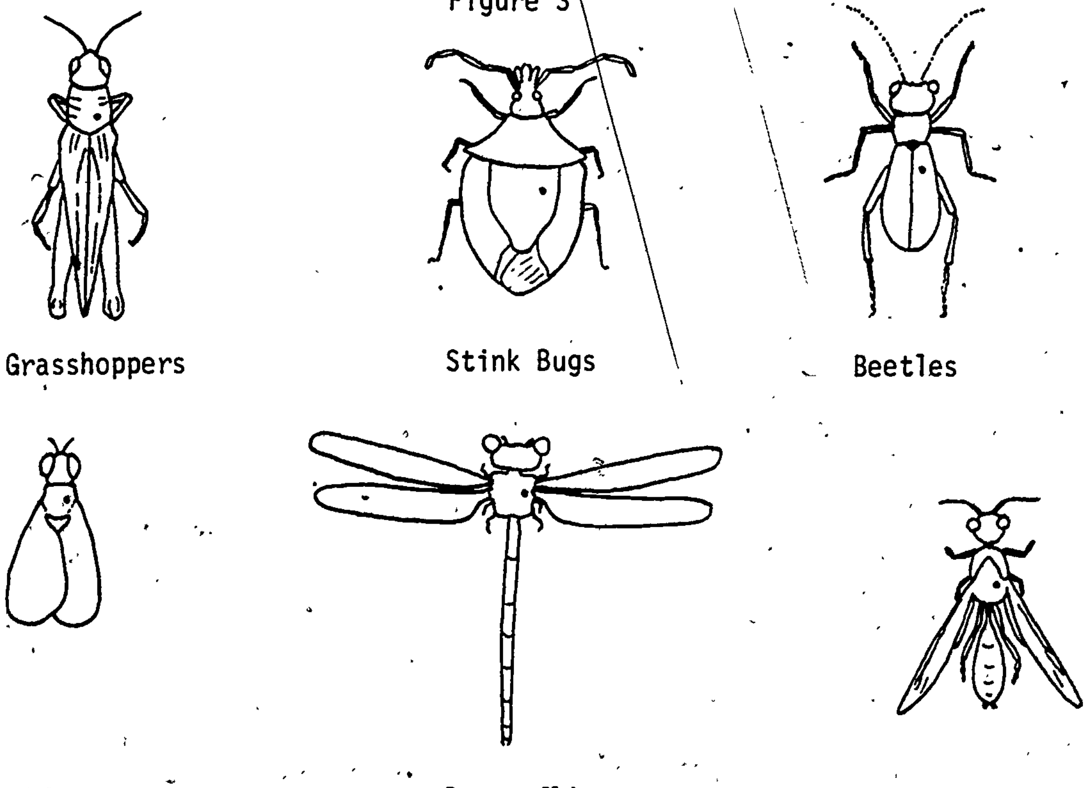
Direct Pinning

Adult insects should be mounted before drying on special spring steel "insect" pins that are longer than common pins and are nearly rustproof. These can be purchased in several sizes from a biological supply house. For any specimen, the largest pin that does not cause excessive damage should be used. These pins are numbered 00, 0, and 1 through 8 with size 8 being the heaviest. For most insects, 2's and 3's can be used by the general collector.

Uniformity and neatness is the trademark of a good insect collection. It is wise for the beginner to look at professional collections and to set the same high standards for himself. Over the years, entomologists have developed standards of pinning that cause the least damage to the specimens. These techniques should be followed closely with a sharp eye toward neatness.

The general principle in pinning all insects of moderate size is that the pin is inserted through the thorax to the right of the midline. This avoids destruction of midline features. Typical insects of several orders are shown in Figure 3; the dot in each case shows the proper position of the pin.

Figure 3

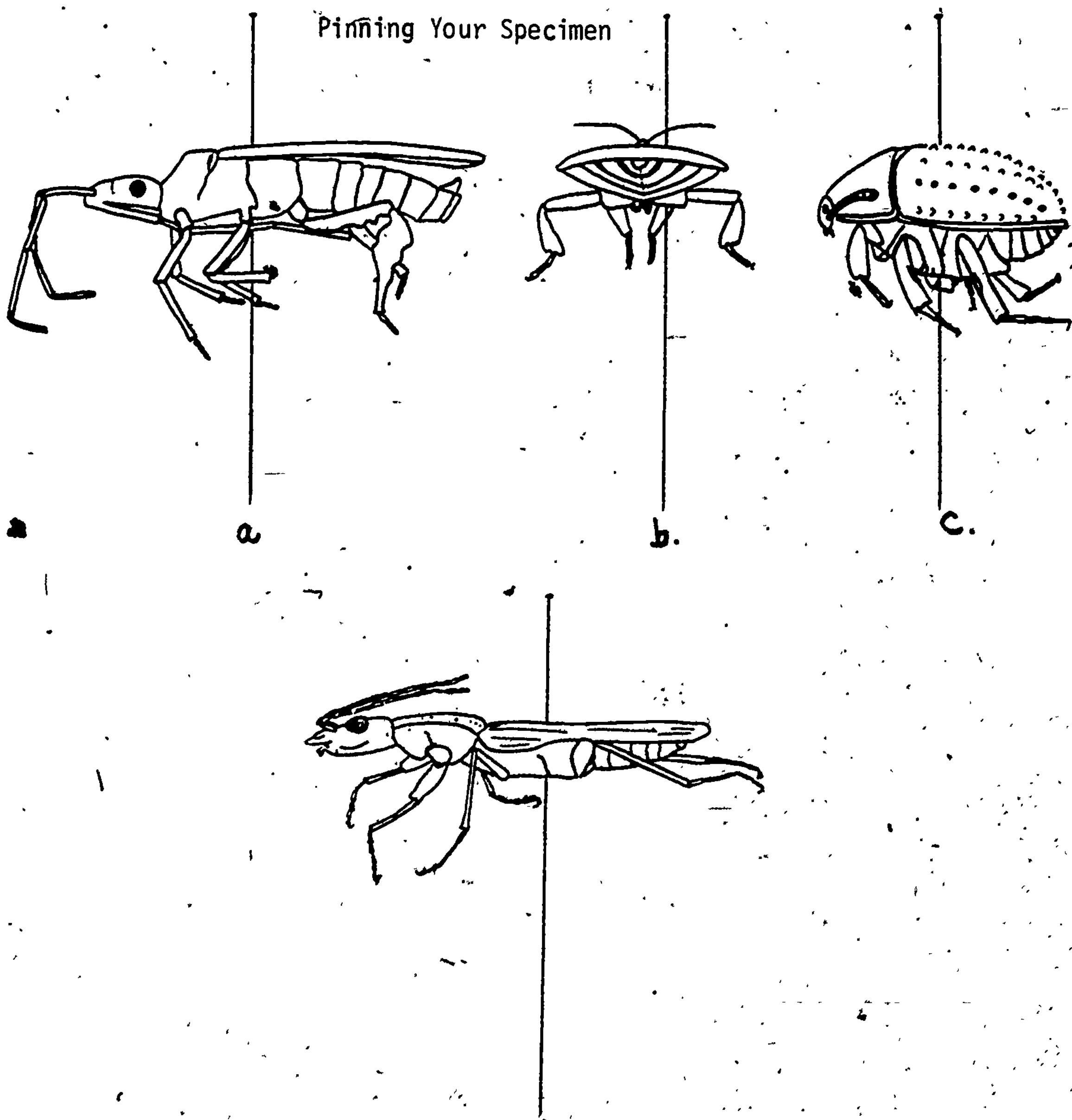


Care should be taken that the position of the pinned insect is exactly horizontal, both front-to-back and side-to-side (Figure 4a,b). The height of the insect on the pin should be standardized from the top of the insect to the top of the pin, not from the point of the pin to the bottom of the insect, since specimens vary in their thickness or depth (Figure 4c,d). There should be enough pin above the insect to permit the top of the pin to be grasped firmly without touching the specimen. The distance is usually about 3/8 inch, but may vary with the dexterity of the collector.

Uniformity and neatness are more important here than comformity to any exact rule.

Figure 4

Pinning Your Specimen



Small stepped blocks of wood called pinning blocks (Figure 5) are used to standardize the heights of insects and labels on pins.

Pinning Blocks

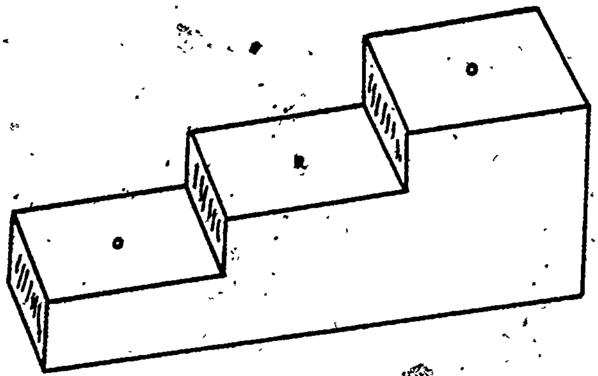


Figure 5

Labeling

When insects are to be used for display purposes only, labeling is desirable but not necessary. However, for any other purpose, every insect specimen should have a locality label showing where it was caught, when it was caught, and the collector's name as shown in Figure 6. In making date and locality labels, use a good quality paper (like linen ledger S-36) and preferably India ink which won't smear or run when dry. It is necessary when buying black India ink that "acetate" India ink be avoided. Some of your labels may be put in vials containing alcohol and this type of ink will dissolve very quickly making the labels worthless.

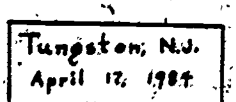


Figure 6a

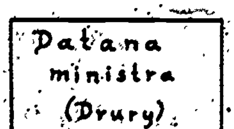
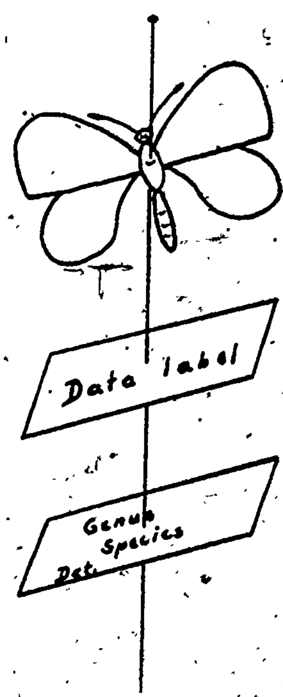


Figure 6b

Labels can be made by hand with a crow quill or 00 Rapidograph-type pen and seldom should exceed 1/4" x 1/2" (6.5 x 13 mm) in size. For large numbers of labels from the same area, typewritten sheets can be photographically reduced and printed in quantity and then only the date needs to be inserted by hand. When using a pinning block, date and locality labels are positioned on step 2.

When an identification is made, the scientific name can be put on a separate determination label (6b) and pinned (on step 1) below the locality label. Some collectors use a black or red bordered label for scientific names. Some collectors like to record host data also and this can be placed on another label between the locality and determination labels. An example of a finished specimen is shown in Figure 7.



Finished Specimen

Figure 7

Shipping

The insect collector commonly must ship specimens to identification experts or to insect museums for deposit. Changes in postal regulations and the automated handling of parcel post increases the chances of package damage making it necessary to reexamine procedures for shipping of dead insects. Most of the techniques described below apply both to dry and liquid shipments.

Mounted insects should be pinned firmly into a sturdy box lined with cork or similar material known to resist loosening of the pins. Heavy specimens should have supporting pins set on each side to prevent any lateral movement. It is important to keep all specimens firmly in place to prevent breakage of all of the insects in the box. Some workers place a layer of paper toweling or cardboard over the tops of pins to reduce the chances of them jarring out of place. Vials of insects should be separately wrapped in paper toweling and then packed in a mailing tube with additional packing which prevents their movement. It is important also that all vials be filled to overflowing and re-stoppered to prevent sloshing and specimen breakage. Be certain that all stoppers and caps are set tightly.

Boxes containing specimens should be placed into another strong container with at least 3 inches of crumpled newsprint or other packing material that will hold the inner box firmly but will absorb shipping shocks.

Additional information should be sent either plainly visible inside, attached to the inner box, or sent separately to the specialist. Make certain there is no chance for mistaking your shipment.

Interpretation

You will need some identification books to aid in identification. Some of these are as follows:

The Golden Nature Guide Series
A Field Guide to the Insects: Borror and White.
Reference Material for 4-H Entomology Leaders, Clemson University Extension Service, Wayne T. O'Dell, Director, Clemson, SC.
Entomology Unit 1, Unit 2, Clemson University Cooperative Extension Service, Clemson, SC.
4-H Entomology 1 Collection and Study, H. Eldon Scott and Charles H. Brett: North Carolina Agricultural Extension Service, North Carolina State University, Raleigh, NC.
Handbook of the Insect World, National 4-H Service Committee, 59 East Van Buren Street, Chicago, IL 60605

Further Investigations

The life cycle and habits of insects can be investigated. Because many insects will be collected during different stages of metamorphosis, these insects should be studied. An excellent table is found in the booklet, 4-H Entomology 1 Collection and Study.

By using "A Key to Adult Insect Orders" found in this same booklet, the collected insects could be easily separated into orders.

UNIT VI, Concept A

ACTIVITY IV Bugs Follow You Through Life

Introduction

In our society, we spray for bugs and have a different attitude about bugs in our environment compared to other cultures. Although we process our food commercially, it is impossible to remove all bug fragments from the food. Therefore, FDA has a standard referred to as parts per million for inspecting our food.

If our food is to be increased, we must maintain storage facilities that will decrease bug and rodent contamination. The saying goes in many countries, "The rodents and bugs eat first. We get what is left over." Storage requires money and energy. In our country, we store the best and use the rest in many other types of products. If we do not like the food we tear it apart and make it into another product. We have technology, water, energy, and capital available. In other countries, they do not have the capacity to process their food. This capacity involves trained personnel, water energy, and processing plants, as well as jars and cans.

In our country you don't think that you eat bugs. Other countries use them as a major part of their protein consumption. For example, grasshoppers, grubs, larvae and locusts. This activity will show you that a certain percentage of our environmental bugs do follow you through life.

Materials You'll Need

Corn meal
Petri dish
Microscope or tripod lens

Procedure

Make a very thin slurry of corn meal and water. When this is diluted, pour it onto a petri dish and observe it under a microscope. The corn meal is yellow. How many black dots do you see? These black dots represent bug fragments.

Interpretation

How do you feel about the bug fragments in your life?

If we are to increase our food supply through increased mass production, we will have to put up with the bugs that follow us through life.

ACTIVITY V How Much Water Does Your Family Need?

Introduction

A water recall for your family will help you become aware of how much is used by the American family. Water will be one of the major resources in limited supply in the future and impacts on our ability to increase our food supply.

Water is necessary for crop irrigation. In addition, water is necessary for processing the food and preserving it for future use. Much of our land which has limited water supply is used for raising cattle and other animals that require a minimum amount of water.

Procedure

Record the amount of water used in gallons by you and family members for the suggested activities. Add others that may be unique to your family. Then compare your figures to others in your class.

Water Recall Record for One Week

Activity	Family Member #1	Family Member #2	Family Member #3	Family Member #4	Family Member #5	Total Family Activity
Cooking						
Toilet						
Bathing or Showering						
Drinking						
Dishes						
Pool						
Lawns						
Washing Clothes						
TOTAL						

Further Investigations

How much water is used at your school?
How much water is needed for your city, town, or community. Find out from your local water department. Where does this water come from?

UNIT VI WHAT WILL I EAT IN THE FUTURE?

CONCEPT B Different foods will be consumed than we are currently eating.

OBJECTIVES Upon completion of this concept, the students should be able to:

1. Recognize that the possible foods of the future will probably look similar to our current foods.

2. Recognize analogs as a source of substitutes that may taste, smell, and have the same texture and appearance as the foods we are eating.

3. Recognize analogs in our present food supply.

4. Evaluate specific characteristics of food analogs in taste sessions.

5. Conclude that there are many unanswered questions and only time will show us the answers.

BACKGROUND INFORMATION FOR TEACHERS

Chou, Marilyn and Harmon, David P., Jr., Critical Food Issues of the Eighties, Pergamon Press, N.Y. 1979 pages 234-264

Hill, Gladwin, National Wildlife's Tenth Annual Environmental Quality Index: 1969-1979 a Decade of Revolution

Lappe, F. M., Diet for A Small Planet (New York; Ballentine Books, 1971

Teaching Strategies

SUGGESTED ACTIVITIES FOR STUDENTS

I. How Much Fat is in Your "Butter" spreads?

II. Is There Only Peanut Butter?

III. Soybeans Do Not Appear, Taste, Smell, or Feel Like Beans Anymore

FILMSTRIP & CASSETTE

I. Beans, Beans, Beans, 1981, Encore Visual Educational, Inc., Burbank, CA 91502

II. Soy Protein: You'll Be Surprised, Food Protein Council

TEACHING STRATEGIES

What will be the foods of the future? Will the American farmer be able to produce enough for our increase in population or will the foods be different than those we are eating today? The students should be given an opportunity to taste some of these new foods.

Analogs are becoming more important as the number on the market increases. Analogs are food products that have a similar function yet have a different origin. Margarine is a classic example of an analog as it is a substitute for butter. Margarine was developed as a butter substitute during World War II when butter became very expensive and scarse. Margarine is made from vegetable oil rather than animal fat. It has been colored to give the appearance of butter, therefore, it can be called an analog of butter. It has the same function as butter but has a different origin. The dairy industry limited the definition of butter to protect their interest consequently margarine has a much broader definition. The acceptance of margarine by the public quickly changed our diet to include more vegetable and less animal fat. In recent years as the population has become more diet conscious the public demanded a spread that has less calories, the manufacturer whipped the oil with water to reduce the number of calories per serving. This has been successful because it feels, smells, tastes, and appears the same as butter or margarine to most people. Activity I, "How Much Fat is in Your 'Butter' Spreads?", will give the students an opportunity to measure the amount of fat, water and milk solids in samples of "butter". In addition, they will have the opportunity to evaluate the characteristics of various "butter" spreads our first major analog.

As we increase our food supply, the number of analogs must also rise. There are analogs that can be made in the classroom. Activity II, "Is There Only Peanut Butter?", will give the students a chance to make an analog from nuts or seeds that can be used as a spread. Be sure to use the "Scientific Taste Test" to analyze the merit of spreads that they make.

Soybeans have been coined as the protein "gold" of the future. Show the filmstrip and cassette, "Beans, Beans, Beans". Soy products have been generally accepted as high quality vegetable protein source and are very easy to grow especially in South Carolina. As our traditional protein sources dwindle in supply and continue to rise in cost, we will utilize increasing amounts of soy protein to meet our nutritional needs.

Presently, soy protein is found in a wide variety of products. Some of these products are very acceptable especially if the individual has not been conditioned to other foods. A good example of this is baby formula. Babies are fed a nutritionally balanced diet - soy protein base - when they are found to be allergic to a milk base formula. If possible have the students try one of the soy protein substitutes. How does it taste compared to regular milk?

Soy protein has the capability of being mixed with a wide variety of other protein sources. It can be used to extend animal protein or mixed with another vegetable protein such as corn. Soy protein is not complete, it must be complemented with nuts, grains, or other beans. Soy protein is high in the essential amino acid, lysine. When combined with corn which is low in lysine, the biological protein quality is increased. Conversely, corn is high in methionine and this complements the soy protein which is low in this amino acid.

This new protein combination is comparable to milk protein (casein). This same relationship is formed when soy products are used with wheat gluten, meat, and other foods. To maintain acceptability, these products must be combined at levels that do not inhibit palability.

Activity III,"Soybeans Do Not Appear, Taste, Smell, or Feel Like Beans Anymore", provides an opportunity for the students to taste a variety of soy based products. Some examples that are available on the market are: Morning Star Farms -- Bacon, Sausage Patties, and Sausage Links; Tofu; N.S.B. Bacon Crumble; Bacon or Pepperoni Bits; Soy-Joys; soy formulas; oriental pepper steak; soy meatballs; and soy chili. In the future many new products will be introduced. Emphasize with the students the importance of reading labels as a way of investigating new products.

The Food Protein Council has released a filmstrip "Soy Protein: You'll Be Surprised". This will provide additional ideas on soy protein substitutes.

Will the people in the United States consume less animal and more plant protein? Due to economic factors we are already eating more casseroles. As animal protein becomes more expensive, consumers may choose to combine nuts, seeds, legumes, and grains to meet their quality protein needs. Emphasize that amino acid ratio must be met at each meal. Complementary proteins must be provided to maintain a proper diet. As an example, peanut protein must be accompanied with wheat, oats, corn, rice, or coconut. Soy protein must be complemented with corn, wheat, rye, or sesame. A complete protein consists of all the essential 8 or 9 amino acids. A proper diet must be maintained. Our acceptance of vegetable substitutes for animal protein will depend greatly upon the rise in the cost of meat. Technologists will continue to improve the foods we consume and create new foods to extend our supply.

By now your students should have the answers to a number of questions. Why are eating! What they are eating! How foods differ! Why the body needs different kinds of food! The ultimate sources of food. Now the question remains what will be the foods of the future. The demand of the public, economic factors such as increased population, and the possibility of advanced technological gains will determine the answer to this question.

ACTIVITY I How Much Fat Is In Your "Butter" Spreads?

Introduction

Margarine is an analog of butter. An analog is an item which has a similar function but different origin. This analog has been a successful product because it feels, smells, tastes and appears the same as butter. It has the same number of calories but the fat source is different. Margarines are made from vegetable oils which have been hydrogenated. This process changes the oil to a solid at room temperature. Butter is made from milk fat called butter fat.

Margarine is very diverse. It has a broader definition as a product than butter. Therefore, industry can change it to meet the demands of the customer. As our population became "diet" (weight reduction) conscious, we demanded a spread with less calories. Now you are able to purchase diet margarines. Butter does not have this diversity because the dairy industry wrote tight specifications, which protected butter as they defined it.

In this activity you will determine which "butter" bread has the greatest amount of fat. Then you will use comparative taste testing on a scale of one to ten to determine which "butter" spread you prefer while considering a number of factors such as taste, smell, appearance, mouth feel, and spreadability. Decide for yourself which you prefer, the analog or the real butter.

Materials You'll Need

Samples of butter, margarine, whipped margarine, diet margarine
Several beakers, 1 for each sample
Bunsen burner, ring stand or hot plate
Saltines

Procedure A

Carefully measure the same amount of each spread. Melt these samples of margarine and butter in separate beakers. Heat these long enough in a beaker to evaporate the water. The popping sound is the water evaporating. Allow the sample to stand. Measure the quantity of fat, milk solids and water.

Spread Sample (1 stick)	Amount of fat	Amount of water	Amount of milk solids
Butter			
Margarine			
Diet Margarine			
Whipped Margarine			

Interpretations

How many calories are in each sample?

What is the caloric difference?

If you use a whipped or diet margarine in a recipe, do you think you would use the same amount?

Look at the ingredients listed on each package. Are these the same for each spread?

Procedure B

Spread a small amount of the following "butter" spreads on a saltine cracker. Taste the sample. Rank each characteristic from one to ten, ten being the highest and one the lowest. Note: Mouth feel means how does it feel in your mouth.

Characteristic	Butter	Margarine	Whipped Margarine	Diet Margarine
Taste				
Smell				
Appearance				
Mouth Feel				
Spreadability				
Total Score				

Interpretations

Would you select the one with the highest total score?

What factor may contribute to a choice of one product, which received a lower total score?

What is the cost per serving? Would this affect your choice?

Which did you prefer? Was it an analog or the real butter?

ACTIVITY II Is There Only Peanut Butter?

Introduction

Peanut butter sandwiches are very popular today and have been a food "jag" for quite sometime. You may also purchase other types of butters which are made from nuts and seeds. You can create analogs of peanut butter by changing the peanut to other types of seeds or nuts. (Ex: almonds or sesame seeds)

Materials You'll Need

Blender
Almonds
Sesame or pecan seeds
Peanut oil
Salt

Procedure

In a blender, place one cup dry roasted peanuts, 1 tbs. peanut oil (other plain oil may be substituted), and ½ tsp. salt. Blend until mixture forms a paste that is spreadable. If mixture is too stiff, add several drops of oil at a time and continue blending. Continue to blend until spread reaches the proper consistency. Store in the refrigerator. The spread will separate. Stir before serving after it has been stored. Make "almond butter", "sesame butter", or "pecan butter" in the same way.

Interpretations

Will you accept an analog for peanut butter?

Are there some other nuts you could use to make a spread?

What are the possibilities for increasing analogs for spreads?

How do commercial companies keep the peanut butter from separating?

ACTIVITY III Soybeans Do Not Appear, Taste, Smell, or Feel Like Beans Anymore!

Introduction

Will soybeans be your food protein "gold" of the future? Soybeans have been generally accepted as the highest quality vegetable protein source and are very abundant. As our traditional protein sources dwindle in supply and continue to rise in cost, will you utilize increasing amounts of soy protein to meet your nutritional needs?

There are many soy products on the market. Soy protein has the capability of being mixed with a wide variety of other protein sources. To maintain acceptability, these products must be combined at levels that do not inhibit palatability.

Materials You'll Need

Morning Star Farms - Bacon, Sausage Patties, and Sausage Links
Tofu
N.S.B. Bacon Crumble
Bacon or Pepperoni Bits
Soy-Joys
Soy formulas
Oriental pepper steak
Soy meatballs
Soy chili
Bunsen burner or hot plate, ring stand
aluminum pie pans

Procedure

If the product must be prepared, do so according to the directions on the label. Divide each sample, into taste size servings. Taste the samples. Rate each product as to acceptability using a score of one to ten.

Product	Smell	Taste	Appearance	Texture	Mouthful	Overall Acceptability

Interpretations

What words would you use to describe the taste of the products?

Do you prefer these over traditional products? Why?

Which products fulfill the functional characteristics, they were intended to meet?

How do the calories, cost, and nutritional value compare?

Technology will continue to improve products. Many more analogs that resemble our traditional foods will appear on the market. Be sure to look for these products at your local grocery store and continue to try them, you may "like 'em". These may be the solution to our current/future "nutrition crisis".

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