Corn & Soybean Processing and Products

Grade Level: 4-8

Lesson Overview

Why do farmers grow so much corn and soybeans? How are these crops used? Students will explore the wealth of products derived from these two humble seeds, research the steps involved in their processing, and conduct experiments to discover why they are so versatile.

Student Objectives

1. Learn about the many products that use corn and soybeans in their ingredients.
2. Learn about the processes used to make corn and soybean products.
3. Use corn and soybeans products to experiment with their uses.

Materials

- ✓ This lesson requires a food product container with an ingredients list for each student. Students can be asked to provide their own or a teacher can save food boxes, wrappers, and bags for students to use.
- ✓ Worksheets (included in lesson)
    - Corn Products
    - Soybean Products
    - Researching Corn & Soybean Foods
    - How is Corn Processed?
    - How are Soybeans Processed and Used?
    - Soybean Flowchart
    - Making Plastic from Corn
    - Soybeans Are Everywhere
- ✓ Corn Plastic Experiment Supplies
    - snack-size Ziploc bag
    - cornstarch
    - water
    - food coloring
    - corn oil
    - eye dropper
    - measuring spoons
    - microwave
- ✓ Soybeans Are Everywhere Experiment Supplies
    - 1 roll paper towels

- 45 plastic cups (9oz. clear)
- 30 6” plates (plastic or styrofoam)
- 30 toothpicks
- 15 eyedroppers
- 1 container NesQuick
- 1 container baking cocoa
- 5 hand pump soap dispensers
- 5 pepper shakers to be shared
- 5 small bottles food coloring
- soybean lecithin granules (available at local health food stores)
- 1 carton SoyMilk
- 15 pennies

Vocabulary

- **cohesion** – the attractive force between water molecules that holds water together.
- **corn** – tall annual cereal grass bearing kernels on large ears; widely cultivated in America in many varieties.
- **cornstarch** – a fine white powder made by grinding the white heart of the corn kernel. Cornstarch is most commonly used as a thickening agent for sauces, soups, and gravies.
- **embryo** – also called the germ, it is the part of a seed that will sprout and grow.
- **endosperm** – the largest part of the corn kernel, made up mainly of starch and protein.
- **germ** – also called the embryo, it is the part of a seed that will sprout and grow.
- **pericarp** – the outer covering of the corn seed, also known as the hull.
- **soy lecithin** – a naturally occurring emulsifier; lecithin is extracted from crude soybean oil through the refining process.
- **soybean** – a pea-sized legume seed that grows on bushy plants, 3-5 feet tall.
- **surface tension** – the attractive force of water molecules displayed in the “skin-like” surface of a waterdrop.
- **surfactant** – wetting agent that will break surface tension and cohesiveness of water.
- **water** – chemical compound comprised of two elements, hydrogen and oxygen.

- **water molecule** – the tiniest possible drop comprised of one atom of oxygen and two atoms of hydrogen.

Background Information

Archer Daniels Midland Company is one of the largest agricultural processors in the world. This company, and companies worldwide like it, serve as a link between farmers and consumers. Their main purpose is to take crops and process them to make food ingredients, animal feed ingredients, renewable fuels and naturally derived alternatives to industrial chemicals.

Everything ADM and similar companies do starts on the farm with their partnership with farmers. They believe farmers are essential to the overall economy. That is why they work to create thousands of products from the crops and hundreds of markets for the crops and products.

Founded in 1902 and incorporated in 1923, ADM is headquartered in Decatur, Illinois. They operate processing and manufacturing facilities across the United States and worldwide. ADM has manufacturing, sales or distribution facilities in 40 states, along with a network of country elevators. While ADM production plants operate in other parts of the world, facilities for the entire ADM product line can be found in the U.S.

Procedure

1. ***This lesson requires a food product container with an ingredients list for each student. Students can be asked to provide their own or a teacher can save food boxes, wrappers, and bags for students to use.***

2. Illinois is famous for having one of the largest corn/soybean processing and manufacturing plants in the world. Archer Daniels Midland in Decatur is famous for processing crops as well as discovering new uses for our agriculture products and marketing them worldwide. Hand out the Corn Products & Soybean Products worksheets. Read through them with your class and then talk about all the products that are listed we use that have corn and soybean ingredients in them.

3. Pass out the Researching Corn & Soybean Foods worksheet. The students will be using the food item that they brought into your classroom or that you provided for them. Look at the food labels to determine which have corn and soybean products in them. Complete the last question together as a class.

4. Follow up this worksheet with a discussion about the number of products your class reviewed that had corn and soybeans in them. To highlight this discussion, pass out the How is Corn Processed?, How are Soybeans Processed and

Used?, & Soybean Flowchart worksheets and continue to answer questions and discuss the importance of corn and soybean products.

5. Follow up this discussion with the included science experiments Making Plastic from Corn and Soybeans Are Everywhere.

   Note:Soybeans Are Everywhere is used with permission from the Ohio Soybean Council https://grownextgen.org/curriculum/beans-about-water-soybeans-and-food-science.

6. Finish up the lesson with a discussion about how corn and soybean products help people throughout their lives.

Extension Activities

1. This lesson correlates well with the Exploring Types of Seeds: Monocots & Dicots lesson.
2. Dissect corn and soybean seeds to better understand the science behind growing corn and soybeans and the processing of these two seeds.
2. Have students visit the Archer Daniels Midland (ADM) website to research more about this company and the products and processes they have developed. Research other companies that are similar.
3. Have students work to develop a new product from corn or soybeans.

Additional Resources

- adm.com - This website tells more about ADM - the company, their products, and their worldwide status.
- Ilcorn.org - This is the website for the Illinois Corn Growers Association.
- corn.org - This is the website for the corn refiners association.
- Ilsoy.org – This is the website for the Illinois Soybean Association.
- https://publish.illinois.edu/aces-nsrl/- This is the website of the National Soybean Research Laboratory.
- agp.com - This website is from a food processor that works with soybean processing.
- natureworksllc.com - Learn more about how corn plastic is being made and sold.
- http://www.agintheclassroom.org/TeacherResources/TeacherResources.shtml Illinois Agriculture in the Classroom interactive Corn & Soybean Ag Mags & Readers

Standards

Illinois Science Standard

MS.PS1.2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Illinois English Language Arts Standard

ELA.4.RST.1. Cite specific textual evidence to support analysis of science and technical text.

The **M**ultidisciplinary **AG**ricultural **I**ntegrated **C**urriculum (mAGic) was created in 2004 under the leadership of the Illinois State Board of Education (ISBE) and the Facilitating Coordination in Agricultural Education Project (FCAE). Funding was made available through the FCAE grant budget from the agricultural education line item of the ISBE budget. This revision, as printed, was developed in January 2021.

These mAGic lessons are designed to bring agriculture to life in your classroom. They address the Illinois Learning Standards in math, science, English language arts and social studies.

Illinois mAGic project update writers/reviewers: Rhodora Collins – Dekalb County; Suzi Myers – Kane County; Connie Niemann – Montgomery County; Debbie Ruff – Livingston County; Jennifer Waters – Sangamon County; Dawn Weinberg – Hancock County; and Carrie Winkelmann – Menard County.

Corn Products

Corn - A Golden Treasure

A bushel of dent corn weighs 56 pounds (25 kg) and contains approximately 90,000 kernels. These can be broken down into starch, solubles, gluten, hulls, and germ (heart of kernel) to make: 33 pounds (15 kg) of sweetener *or* 31 pounds (14 kg) of starch *or* 2.5 gallons (9.5 L) of ethanol plus 12 pounds (kg) of animal feed, 3 pounds (1.36 kg) of gluten meal, and 1.5 pounds (.68 kg) of corn oil. By processing and refining, a bushel of corn can be used in the following ways:

33 Pounds (15 kg) of Sweetener

CORN SYRUP

Food and Drug Uses:

Baby food
Bakery products (bread, rolls, biscuits, doughnuts, pies, cakes, cookies, pretzels)
Beverages, brewed (beer, ale, etc.)
Beverages, carbonated
Catsup, chili sauce, tomato sauce
Cereals, prepared
Cheese spread and foods
Chewing gum
Chocolate products
Condensed milk, sweetened
Confectionery
Cordials and liquors
Desserts
Eggs, frozen or dried
Extracts and flavors
Frosting and icings
Fruit butters and juices
Fruits (canned, candied, fillings, frozen, etc.)
Fruity drinks
Ice cream, water ices, and sherbets
Jams, jellies, marmalades, and preserves
Licorice
Malted products
Marshmallows and related products
Meat products (sausage, etc.)
Medicinal preparations (drugs, pharmaceuticals)
Mixes, prepared (cake, pie fillings, etc.)
Non-dairy creamers
Peanut butter
Pickles and pickle products
Salad dressing
Sauces (seasoning, specialty, etc.)
Seafood, frozen
Syrups (table, chocolate, cocoa, fruit, medicinal, soda fountain, cordials, etc.)
Soups, dehydrated
Toppings
Vinegar

Industrial Uses:

Adhesives (plasticizing agent)
Chemicals
Dyes and inks
Explosives
Leather tanning (chrome process)
Metal plating
Paper, glassine, and parchment
Plasticizer
Shoe polish
Rayon
Textiles, for finishing
Tobacco and tobacco products

DEXTROSE

Food and Drug Uses:

Antibiotics
Baby foods
Bakery products
Berries, canned and frozen
Beverages, brewed (beer, ale, etc.)
Beverages, carbonated
Breakfast foods
Caramel color
Cheese foods and spreads
Chewing gum
Chocolate products
Citrus juices
Coloring, pure food mix
Confectionery
Cordials, liqueurs and brandy
Cream, frozen
Dairy products
Desserts
Dietetic preparations
Distillation products
Doughnuts (cake, yeast)
Drugs (fermentation process)
Eggs, frozen or dried
Fish, pickled
Flavoring extract
Food acids (citric, ale)
Fruit juices
Fruits and vegetables, canned
Fruits (candied, glaze, frozen)
Gelatin desserts
Ice cream, water ices, and sherbets
Infant and invalid feeding
Jams, jellies, marmalades, and preserves
Lactic acid
Meat products (bacon, bologna, hams, sausage, hot dogs, mincemeat)
Medicinal preparations (intravenous injections, pills, tablets, drugs, etc.)
Mixes, prepared (cake, icings and frostings, infant foods, pie fillings, toppings, etc.)
Mouthwash
Peanut butter
Peas, canned
Pectin, fruit
Pickles and pickle products
Powders (ice cream, prepared dessert, pudding, punch)
Sauces (catsup, tomato, etc.)
Seasoning mixes, dry
Sorbitol (in candies, toothpaste, etc.)
Soups, dehydrated
Spices and mustard preparations
Syrups (table, fountain, medicinal, etc.)
Toothpaste
Vinegar
Wine
Xanthan gums
Yeast

Industrial Uses:

Acids, commercial (lactic, acetic, gluconic)
Adhesives
Boiler compounds
Chemicals (calcium lactate, sodium lactate)
Chemicals, organic
Dyes
Electroplating and galvanizing
Enzymes
Explosives
Fermentation products
Florists' preparations
Leather tanning
Mannitol
Paper
Rayon
Rubber (cold process)
Sizing materials
Sorbitol
Textiles, dyeing and finishing

31 Pounds (14 kg) of Starch

CORN STARCH

Food, Drug, or Cosmetic Uses:

Antibiotics
Aspirin
Baby foods
Bakery products (bread, rolls, cakes, pies, crackers and cookies)
Baking powder
Beverages, brewed (beer, ale, etc.)
Chewing gum
Chocolate drink
Confectionery
Cosmetics
Desserts (puddings, custards, etc.)
Drugs and pharmaceuticals
Flours, prepared (including prepared mixes)
Food and drug coatings
Gravies and sauces
Mixes, prepared (pancake, waffle, cake, candy, etc.)
Mustard, prepared
Pie filling
Precooked frozen meals
Salad dressing
Soups

Utah Agriculture in the Classroom
UtahStateUniversity Extension

Corn Products

Cleaners
Sugar, powdered
Vegetables, canned

Industrial Uses:
Abrasive paper and cloth
Adhesives (glues, pastes, mucilages, gums)
Batteries, dry cell
Binder of binding agents
Board (corrugating, laminating, solid fiber board, cardboard)
Boiler compounds
Briquettes
Ceramics (as clay binder)
Chemicals
Cleaners, detergents
Coatings on wood, metal, and paper
Color carrier (in paper and textile printing)
Cord polishing, sizing
Cork products
Crayon and chalk (as a binder)
Dispersing and standardizing agent
Dressing, surgical
Dyes (as bodying agent, carrier diluent, etc.)
Fermentation processes
Fiber glass size
Fireworks
Insecticide powders
Insulating material (glass wool, rock wool)
Lubricating agents
Oilcloth
Oil-well drilling (drilling mud)
Ore refining (electrolytic reduction process, flotation process, etc.)
Paints (cleaning compounds, cold water and latex paints, poster, lacquer, etc.)
Paper and paper products
Photographic films (antihalation powder)
Plastics (molded)
Plywood (interior)
Printing
Protective colloids (emulsions)
Textiles (warp sizing and finishing)
Tile, ceiling
Tire, rubber
Wallboard and wallpaper
Water recovery, industrial

2.5 Gallons of Ethanol

Alcoholic beverages
Industrial alcohol
Motor fuel extender

12 Pounds of Animal Feed and 3 Pounds of Gluten Meal

CORN GLUTEN AND HULLS

Products Used by Livestock and Poultry:
Corn germ meal
Corn gluten feed
Corn gluten meal
Corn oil byproducts
Corn sugar (crude and refined)
Hydrol (corn-sugar molasses)
Steepwater for feed (condensed fermented corn extractives)

Other Uses:
Amino acids
Fur cleaner
Zein and other protein products

1.5 Pounds of Corn Oil

CORN OIL FROM GERM

Food and Drug Uses:
Capsules for vitamins and medicines
Cooking oil
Margarine
Mayonnaise
Potato chips
Salad dressing
Sauces, seasoning
Shortening
Soups

Industrial Uses:
Chemicals and insecticides
Lecithin (for pharmaceuticals, cosmetics, linoleum, printing, inks, etc.)
Paint and varnish
Rubber substitutes
Rust preventive (surface coatings)
Soap
Soluble oil (leather and tanning use)
Textiles

Other Uses of Corn:

HIGH FRUCTOSE CORN SYRUP
(FROM CORN SYRUP)
Food Uses:
Bakery products
Canned juices
Canned fruits

DEXTRINS (FROM CORNSTARCH)
Industrial Uses:
Adhesives (glues, pastes, mucilages, gums)
Bookbinding
Briquettes
Candies
Ceramics
Cord polishing
Core binder (castings, mold)
Cork products
Crayons and chalk (as binder)
Dyes (dry, cake, etc.)
Envelopes
Fireworks
Inks, printing
Insecticides
Insulation, fiber glass
Labels
Leather
Linoleum
Magazines
Matches (on head and side of box)
Oil-well drilling
Ore separation
Paints (cold water, poster, etc.)
Paper and paper products
Plastics (molding)
Plywood
Sandpaper
Shoes (counter pastes, polish, etc.)
Silvering compounds
Soaps
Straws (drinking)
Textiles, sizing, finishing and printing
Twine, cord, string, etc.
Wallboard and wallpaper
Window shades and shade cloth

Condiments
Confectionery products
Frozen desserts
Jams, jellies, and preserves
Soft drinks
Wine
Yeast

MALTODEXTRINS (FROM CORNSTARCH)
Food Uses:
Bakery mixes
Beverage powders
Dehydrated foods
Dry soup mixes
Gum confections
Icings and glazes
Instant tea
Instant breakfast foods
Low calorie sweeteners
Marshmallows
Nougats
Pan coatings
Sauce and gravy mix
Snack foods

HYDROL
(CORN-SUGAR MOLASSES)
Organic acids
Organic solvents
Tobacco
Leather tanning

SOLUBLES
(STEEPWATER)
Antibiotics
Chemicals
Pharmaceuticals
Yeast

Adapted from National Corn Grower's Association. Corn Curriculum. Unit 9: Feed Your Face!

Soybean Products

Soy Products: *To produce 1,366 gallons of soybean oil, 10,973 pounds of shortening, 13,148 pounds of margarine, or 13,073 pounds of mayonnaise, all that is needed is 25 acres of wonderful soybeans.*

SOYBEAN MEAL PRODUCTS, SOY FLOUR, CONCENTRATES, AND GRITS

EDIBLE USES:
Bakery ingredients
Alimentary pastes
Noodles
Meat products
Cereals
Prepared mixes
Food drinks
Baby food
Hypo-allergenic milk
Confections
Candy products
Special diet foods
Meat analogs

FEED USES:
Calf milk replacers
Livestock feeds
Poultry feeds
Protein concentrates
Pet foods
Fox and mink feeds
Fish food

INDUSTRIAL USES:
Adhesive
Plywood
Wallboard
Insecticide sprays
Particle board
Tape joint cements
Linoleum backing
Texture paints
Nutrient
Yeast
Antibiotic
Beer and ale

Soybean Oil Products

TECHNICAL USES:
Anti-foam agent
Yeast manufacture
Alcohol manufacture
Anti-spattering agent
Margarine manufacture
Caulking compounds
Core oils
Disinfectants
Electrical insulation
Dispersing Agent
Paint manufacture
Ink manufacture
Insecticides
Rubber manufacture
Emulsifying agent
Bakery products
Candy products
Chocolate coatings
Pharmaceuticals
Fungicides
Herbicides
Insecticides
Linoleum backing
Nutritional
Medical use
Dietary use
Oiled fabrics
Pesticides
Printing inks
Protective coatings
Plasticizers
Putty
Soap
Stabilizing agent
Shortening
Tin and terne plate oils
Waterproof cement
Wallboard manufacture
Wetting agent
Cosmetics
Pigments (paint)
Calf Milk replacers

EDIBLE USES:
Cooking oils
Mayonnaise
Margarine
Pharmaceuticals
Salad dressings
Salad oils
Sandwich spreads
Vegetable shortening
Medicinals
Filled milks
Coffee whiteners
Creamers
Liquid shortening

WHOLE SOYBEAN OIL PRODUCTS
Baked soybeans
Seed soy sprouts
Stock feeds

FULL FAT SOY
Flour
Bread
Candy
Doughnut mix
Frozen desserts
Pancake flour
Pan grease extender
Pie crust
Sweet goods
Low-cost gruels
Instant milk drinks

ROASTED SOY BEANS
Candy ingredients
Confection
Cookie ingredient
Cookie topping
Cracker ingredient
Fountain topping
Soy coffee
Soy nut butter
Spite base
Dietary items

SOYBEAN DERIVATIVES
Oriental foods

Name _____

Researching Corn & Soybean Foods

Directions: Using the food item that you brought into class and the Corn and Soybean Products worksheets, answer the following questions about your food item.

1. What food item did you bring into your class?

2. List the ingredients of your item.

3. List the ingredients of your item that are corn and soybean products.
   Corn Soybean

4. How many students in your class do you think had an item that contained a soybean product?

5. How many students in your class do you think had an item that contained a corn product?

6. How many students in your class do you think had an item that contained a corn and soybean product?

7. Record the actual findings together as a class.
   a. Total number of students in class _____
   b. Number of students with item that contained soybean product_____
   c. Number of students with item that contained corn product_____
   d. Number of students with item that contained both corn & soybean product____

Corn & Soybean Foods ANSWER KEY

Directions: Using the food item that you brought into class and the Corn and Soybean Product Worksheets, answer the following questions about your food item.

1. What food item did you bring into your class?
   Twix Candy Bar

2. List the ingredients of your item.
   Milk Chocolate (Sugar, cocoa butter, chocolate, skim milk, lactose, milkfat, soy lecithin, pgpr, artificial flavors), Sugar, Enriched Wheat Flour (Wheat Flour, niacin, reduced iron, thiamine mononitrate, riboflavin, folic acid), Hydrogenated Palm Kernel Oil, Corn Syrup, Skim Milk, Dextrose, Salt, Cocoa Powder, Baking Soda, Soy Lecithin, Artificial Flavor

3. List the ingredients of your item that are corn and soybean products.

Corn	Soybean
Corn Syrup	***Soy Lecithin***
Dextrose	***Soy Lecithin***

4. How many students in your class do you think had an item that contained a soybean product?
   Answers will vary

5. How many students in your class do you think had an item that contained a corn product?
   Answers will vary

6. How many students in your class do you think had an item that contained a corn and soybean product?
   Answers will vary

7. Record the actual findings together as a class.
   Answers will vary for all
   a. Total number of students in class
   b. Number of students with item that contained soybean product_____
   c. Number of students with item that contained corn product_____
   d. Number of students with item that contained both corn & soybean product___

How is Corn Processed? – Page 1

There are many ways to process corn. The information you are reading is provided by the Corn Refiners Association. For more than 150 years, corn refiners have been perfecting the process of separating corn into its component parts to create a large number of value-added products. The corn wet milling process separates corn into its four basic components: starch, germ, fiber and protein.

INSPECTION AND CLEANING

Refinery staff inspect arriving corn shipments and clean them twice to remove cob, dust, chaff and foreign materials before steeping, the first processing step, begins. Corn refining has been the fastest growing market for U.S. agriculture over the past twenty years, and refiners now use around 14% of the $19 billion U.S. corn crop. Each day the production of about 33 thousand acres of corn arrives at corn refining facilities before conversion to food, industrial and feed products.

STEEPING

Each stainless steel steep tank holds about 3,000 bushels of corn for 30 to 40 hours of soaking in 50 degree Celsius water. During steeping, the kernels absorb water, increasing their moisture levels from 15 percent to 45 percent and more than doubling in size. The addition of 0.1 percent sulfur dioxide to the water prevents excessive bacterial growth in the warm environment. As the corn swells and softens, the mild acidity of the steepwater begins to loosen the gluten bonds within the corn and release the starch. After steeping, the corn is coarsely ground to break the germ loose from other components. Steepwater is condensed to capture nutrients in the water for use in animal feeds and for a nutrient for later fermentation processes. The ground corn, in a water slurry, flows to the germ separators.

GERM SEPARATION

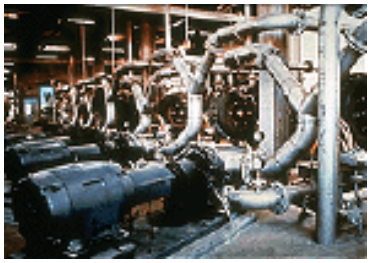
Cyclone separators spin the low density corn germ out of the slurry. The germs, containing about 85% of corn's oil, are pumped onto screens and washed repeatedly to remove any starch left in the mixture. A combination of mechanical and solvent processes extracts the oil from the germ. The oil is then refined and filtered into finished corn oil. The germ residue is saved as another useful component of animal feeds.

FINE GRINDING AND SCREENING

The corn and water slurry leaves the germ separator for a second, more thorough, grinding in an impact or attrition-impact mill to release the starch and gluten from the fiber in the kernel. The suspension of starch, gluten and fiber flows over fixed concave screens (illlustrated) which catch fiber but allow starch and gluten to pass through. The fiber is collected, slurried and screened again to reclaim any residual starch or protein, then piped to the feed house as a major ingredient of animal feeds. The starch-gluten suspension, called mill starch, is piped to the starch separators.

How is Corn Processed? - Page 2

STARCH SEPARATION



Gluten has a low density compared to starch. By passing mill starch through a centrifuge, the gluten is readily spun out for use in animal feeds. The starch, with just one or two percent protein remaining, is diluted, washed 8 to 14 times, re-diluted and washed again in hydroclones to remove the last trace of protein and produce high quality starch, typically more than 99.5 percent pure. Some of the starch is dried and marketed as unmodified corn starch, some is modified into specialty starches, but most is converted into corn syrups and dextrose.

SYRUP CONVERSION

Starch, suspended in water, is liquified in the presence of acid and/or enzymes which convert the starch to a low-dextrose solution. Treatment with another enzyme continues the conversion process. Throughout the process, refiners can halt acid or enzyme actions at key points to produce the right mixture of sugars like dextrose and maltose for syrups to meet different needs. In some syrups, the conversion of starch to sugars is halted at an early stage to produce low-to-medium sweetness syrups. In others, the conversion is allowed to proceed until the syrup is nearly all dextrose. The syrup is refined in filters, centrifuges and ion-exchange columns, and excess water is evaporated. Syrups are sold directly, crystallized into pure dextrose, or processed further to create high fructose corn syrup (illustrated).

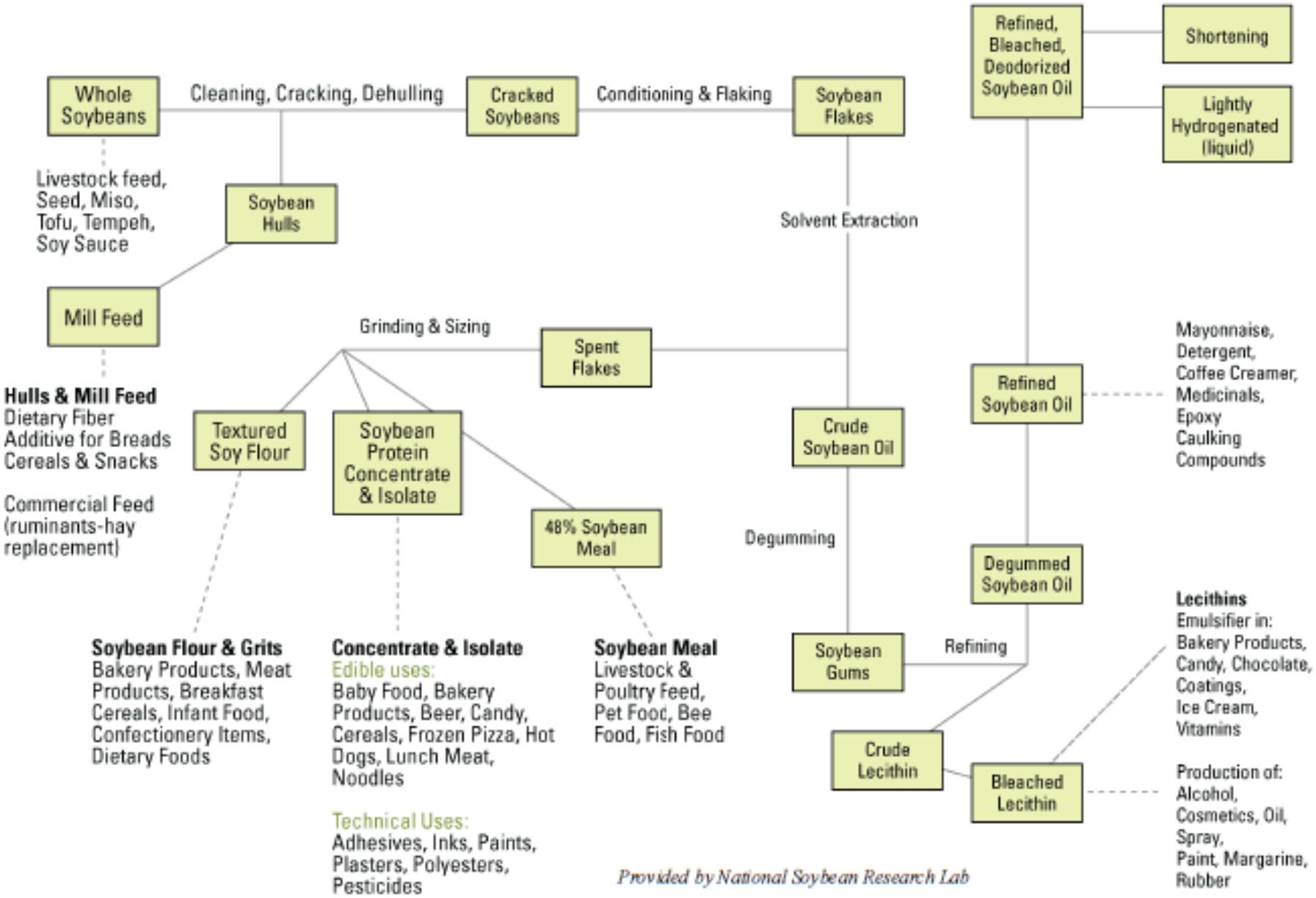
FERMENTATION Dextrose is one of the most fermentable of all of the sugars. Following conversion of starch to dextrose, many corn refiners pipe dextrose to fermentation facilities where the dextrose is converted to alcohol by traditional yeast fermentation or to amino acids and other bioproducts through either yeast or bacterial fermentation. After fermentation, the resulting broth is distilled to recover alcohol or concentrated through membrane separation to produce other bioproducts. Carbon dioxide from fermentation is recaptured for sale and nutrients remaining after fermentation are used as components of animal feed ingredients.

Products Made from Corn

Corn refiners use shelled corn which has been stripped from the cob during harvesting. Refiners separate the corn into its components -- starch, oil, protein and fiber -- and convert them into higher value products. **Corn sweeteners** are the most important refined corn products. Last year, corn sweeteners supplied more than 56 percent of the U.S. nutritive sweetener market. The second major refined corn product is **Ethanol**, which is gaining increasing acceptance as a cleaner burning option for motor fuels. The third major corn product -- a mainstay of the industry and of the U.S. economy -- is **Starch**. Americans rely on corn refiners for over 90 percent of their starch needs. Corn refining is America's premier **Bioproducts** industry, with increasing production of amino acids, antibiotics and degradable plastics adding further value to the U.S. corn crop.

In addition to starches, sweeteners and ethanol -- all made from the starch portion of the corn -- refiners produce **Corn oil** and a variety of important **Feed products**.

How are Soybeans Processed and Used?



Name _____

Making Plastic from Corn

Materials Needed: Snack size Ziploc bag, cornstarch, water, food coloring, corn oil, eye dropper, measuring spoons, and a microwave.

Directions: Follow the directions on this worksheet and answer the questions as you go along.

1. In a snack size Ziploc bag add one tablespoon of corn starch. Describe the corn starch.

2. Add two drops of corn oil to the corn starch and 1 ½ tablespoons of water to the cornstarch. Release excess air and close the bag and mix all three ingredients together using your fingers to mix it through the bag. Describe what happens to the mixture.

3. Microwave the mixture for 20-25 second on high in a microwave. (Watch out when you take it out of the microwave, it will be HOT!!) Take it out of the microwave. What has happened to the mixture?

4. Form the warm plastic into a ball. What else could you do with the plastic?

5. What happens as the plastic hardens?

6. Keep one sample in your classroom for at least a month to watch what happens. Any predictions?

7. On the back of this paper, write a paragraph to answer this question, “Why might a plastic made from corn be better for the environment than a plastic made from petroleum?”

Corn Plastic Experiment ANSWER KEY

Materials Needed: Snack size Ziploc bag, cornstarch, water, food coloring, corn oil, eye dropper, measuring spoons, and a microwave.

Directions: Follow the directions on this worksheet and answer the questions as you go along.

1. In a snack size Ziploc bag add one tablespoon of corn starch. Describe the corn starch.
   Answers will vary, but should say something like, "Corn starch is white and powdery."

2. Add two drops of corn oil to the corn starch and 1 ½ tablespoons of water to the cornstarch. Close the bag and mix all three ingredients together using your fingers to mix it through the bag. Describe what happens to the mixture.
   The water is absorbed into the starch very slowly. It eventually mixes together to make a liquid.

3. Microwave the mixture for 20-25 second on high in a microwave. (Watch out when you take it out of the microwave, it will be HOT!!) Take it out of the microwave. What has happened to the mixture?
   It has turned into a solid plastic.

4. Form the warm plastic into a ball. What else could you do with the plastic?
   Form it into many shapes. Answers will vary.

5. What happens as the plastic hardens?
   As the plastic hardens it gets more solid and hard and will sometimes start to crumble. Answers will vary.

6. Keep one sample in your classroom for at least a month to watch what happens. Any predictions? ***It will start to break down over time.***

7. On the back of this paper, write a paragraph to answer this question, "Why might a plastic made from corn be better for the environment than a plastic made from petroleum?
   Answers will vary.

Soybeans Are Everywhere!

Beans About Water Activity Guide

INSIDE

YOU WILL FIND:

- 5 Experiments About The Properties Of Water
- 5 E's Learning Cycle
- Resources/Web Sites
- Soy Facts
- Science Fair Ideas

Soybeans are everywhere!
Check ingredient labels on a variety of cookies, peanut butter, soups, chips, chocolate candy, microwave popcorn, and other processed snacks. Many of the foods kids eat include soy ingredients: soy protein, soy flour, soy grits, soy lecithin, soybean oil. Learn about the properties of water to discover why food technologists use soy products.

SHOPPING LIST

(listed per classroom of 30 students)

- 15 copies of experiments #1 – #5
- 1 roll of paper towels
- 45 plastic cups (9 oz. clear)
- 30 6" plates (plastic or styrofoam)
- 30 toothpicks
- 15 pipettes or eyedroppers
- 1 container NesQuik™
- 1 container baking cocoa
- 5 hand pump soap dispensers to be shared
- 5 pepper shakers to be shared
- 5 small bottles food color to be shared
- Soybean lecithin granules (a pinch per team) (available at local health food stores)
- 1 carton soy milk – less than 1/4 C. per team
- 15 pennies

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Brought to you by Ohio's Soybean farmers and their checkoff.

5 E's Learning Cycle

ENGAGE

Begin with Experiment #1 to discover why food technologists use soy as an ingredient in many foods.

Engage
- Create interest
- Raise curiosity

Experiment #1, Penny Prediction, investigates surface tension by counting the number of water drops students can get on a penny. They will **predict, observe,** record **data,** and identify **variables** and **controls.** Introduce this activity with a discussion about science skills: following directions, making good observations and being safe. Students work in paris to read directions, perform the investigation and record their results. Data can be collected on a classroom chart, graphed and calculated in terms of median, mean and average. Data from different classrooms can form large samples for study. Differences in data results lead to a discussion on variables (i.e., clean coin vs. dirty coin, heads vs. tails, size of water dropped, height from which water is dropped, etc.) Students should control variables and test their ideas.

Henry Ford built a car out of soybean plastic in 1935.

EXPLORE

Learn about soy lecithin, a surfactant used in many food and industrial products such as chocolate, candy, paints, adhesives, vitamins and medicines.

Explore
- Test predictions
- Record observations

Experiment #2, Attractive Molecules explores other properties of water: **molecules** and **cohesion.** Students will observe the nature of water cohesion as they try to move drops of water with toothpicks.

Experiment #3, Dancing Pepper and **Experiment #4, Color Swirls** test two **surfactants,** wetting agents that break surface tension and water cohesion. **Dancing Pepper** tests the surfactant, soap. **Color Swirls** tests lecithin, a soybean surfactant used in many food products such as chocolate. In both experiments students can observe the movement of water molecules when surface tension and cohesion are broken.

Soy ink is used by more than 90% of our nation's newspapers

EXPLAIN

Students can demonstrate the way soy lecithin disrupts the surface tension of water.

Explain
- Share ideas
- Listen to others' ideas

Kinesthetic Model:
Students "act out" their observations. They might link arms to show that water molecules are cohesive. Student "water molecules" can fly apart when a student "surfactant" is added to visually demonstrate the **Dancing Pepper** activity.

Artistic Model:
Students can draw models of their observations. What do water molecules look like? How can movement be shown?

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5 E's Learning Cycle

Representative Materials Model:
Students can use a variety of materials to create models of their observations. Use small candies to illustrate cohesion of water molecules. How can the model show what happens when surface tension is broken by a surfactant?

Verbal or Written Model:
Students can use scientific language to create a model of their observations. Teacher criteria can establish the length of writing and the choice of vocabulary words. Students can make oral presentations combined with one of the above models for demonstration purposes.

ELABORATE

Soybeans are used in biology, chemistry, food technology and engineering. Many new products are being developed by soybean scientists.

These optional activities can be used to extend concepts before or after evaluation.

- Challenge students to find other water-soluble drinks on grocery shelves. Do they contain soybean surfactants? Why or why not?
- Explore other properties of water using soybeans such as: adhesion, absorption, density, specific gravity, solution, emulsion, and coagulation.
- Provide opportunities for older students to teach younger students these activities.
- Create soybean science fair experiments related to these concepts.

EVALUATE

What makes NesQuik™ quick? Soy lecithin! Soy lecithin acts as a surfactant to mix the chocolate into the water easily.

Experiment #5, Why is NesQuik™ quick? provides an opportunity for authentic assessment. Each team performs the experiment and answers the question, "What makes NesQuik™ quick?"

Vocabulary Words

- **WATER:** chemical compound comprised of two elements, hydrogen and oxygen
- **WATER MOLECULE:** the tiniest possible drop comprised of one atom of oxygen and two atoms of hydrogen
- **COHESION:** the attractive force between water molecules that holds water together.
- **SURFACTANT:** wetting agent that will break surface tension and cohesiveness of water
- **SURFACE TENSION:** the attractive force of water molecules displayed in the "skin-like" surface of a water drop

SCIENCE SKILLS

- predict
- observe
- record data
- identify variables and controls

George Washington Carver discovered the soybean was a good source of protein and oil in 1904.

Elaborate
- Extend concepts
- Apply skills

Every person in the U.S. consumes an average of 260 pounds of soy each year.

Evaluate
- Demonstrate understanding
- Ask related questions

Soy crayons are made in Sandusky, Ohio

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Experiment #1
PENNY PREDICTIONS

Gather these materials: 1 pipette • 1 penny

1. Predict how many drops of water you can fit on the penny. _____
2. Use the pipette to add drops of water to the top of the penny.
3. Count each drop until the water leaks off the side of the penny.
4. Were your predictions correct? ***yes*** ***no*** (circle one)
5. Repeat this test 3 times and record your data on the chart.

TEST 1	TEST 2	TEST 3

Draw here

6. Look at the water on top of the penny. Draw what you see here.
7. Compare your test results to other teams. Why are the results different? Be ready to discuss variables.
8. Try more experiments, changing only one variable each time. The other things in the experiment will stay the same. These are the controls.

Control: things that stay the same—*person using the pipette; height of pipette from coin; size of drop, type of coin*

Variable: thing that changes—*side of the coin*

DATA	TEST 1	TEST 2	TEST 3
	Heads		
	Tails		

Now try your own! Change one variable only.

Control: things that stay the same _____

Variable: thing that changes _____

DATA	TEST 1	TEST 2	TEST 3

Control: things that stay the same _____

Variable: thing that changes _____

DATA	TEST 1	TEST 2	TEST 3

Surface Tension and Cohesion: Water molecules like to stay together. They are cohesive. The surface tension can be seen in the little dome of water on top of the penny.

Experiment #2
ATTRACTIVE MOLECULES

Gather these materials: 1 empty plastic cup
1 cup with water
1 pipette • 2 toothpicks

1. Turn over the empty plastic cup.
2. Use the pipette to place 2 drops of water about 1 inch apart on the bottom of the cup.

3. Use the toothpicks to try to move one drop of water over to touch the other drop. How easy was that?
4. Next, use the toothpicks to separate the one big droplet back into 2 drops. How easy was that?
5. Dry off the bottom of the cup and try this again.

Cohesion: This investigation demonstrates cohesion. Water molecules like to stay attached and are hard to separate.

One bushel (60 pounds) of soybeans produces 2,112 soy crayons.

Try This!! STICKING TOGETHER

Gather these materials:
2 pieces of aluminum foil or paper
1 cup water

1. Hold the pieces of foil or paper up and place them side-by-side. Do they stick together?
2. Rub water onto one side of each piece of foil.
3. Place the two wet sides together and hold them up. Now do the pieces of foil or paper stick together?

Cohesion: Two pieces of foil or paper do not stick together when they are dry. When coated with water, the water molecules on each surface join together and hold the pieces in place. Water molecules are cohesive. They stick together.

Can you think of other ways to demonstrate cohesion?

Soy can be found in:

- crayons
- sunscreen
- lip balm
- building materials
- protective coating on CDs
- ink base for 80,000 newspapers

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Experiment #3
DANCING PEPPER

Gather these materials: 1 small plate • water pepper • 1 soap dispenser

> **Clean-up hint:** Don't pick up the plate of water. Slide it to the edge of the table and into a waste can.

1. Fill the plate with water.
2. Sprinkle pepper evenly over the surface of the water.
3. Using the soap dispenser, squirt one drop into the middle of the pepper.
4. What happens?
5. Draw a picture of the plate, pepper and water **before** adding the soap

6. Draw a picture of the plate, pepper and water **after** adding the soap.

Surfactant: Soap contains a surfactant. A surfactant causes water molecules to separate. It breaks surface tension. By watching the pepper, you can see the water molecules moving apart.

Experiment #4
COLOR SWIRLS

Gather these materials: 1 small plate • soy milk 1 bottle food coloring • lecithin

1. Fill the plate with soy milk.
2. Place 3 equally spaced drops of food coloring in the soy milk.
3. Predict: You are going to add a **surfactant** to the soy milk. Remember what happened to the pepper when you added the soap surfactant? What do you predict will happen when you add the lecithin surfactant?

4. Write your prediction here: _____
5. Add a little bit of lecithin onto each drop of food coloring. What happens? Was your prediction correct?
6. Draw a picture of the plate, milk and food coloring **before** adding the lecithin.

7. Draw a picture of the plate, milk and food coloring **after** the lecithin.

Surfactant: Lecithin, a surfactant, separated the water molecules in the milk causing the color to move. Lecithin, made from soybeans, is used when fats and oils need to be mixed with water and other ingredients. It is found on ingredient labels of chocolate candy because it keeps the candy smooth and creamy.

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Experiment #5
WHY IS NESQUIK™ QUICK?

Gather these materials: 2 empty plastic cups
1 pipette • water
1 container baking cocoa
1 container NesQuik™

1. Turn over the empty plastic cups.
2. Use the pipette to place 1 large drop of water on the bottom of one cup.
3. Use your fingers to pinch a small amount of cocoa and sprinkle it on the drop. What happens?

4. Use 3-4 words to describe the cocoa when you sprinkled it on the water:

_____

5. Now use the pipette to place another large drop of water on the bottom of the second cup.
6. Use your fingers to pinch a small amount of NesQuik™ and sprinkle it on the drop. What happens?
7. Use 3-4 words to describe the NesQuik™ when you sprinkled it on the water:

_____

8. Think about what you have learned and answer the question: Why is NesQuik™ quick? Use 2-3 of these science vocabulary words in your answer: cohesion, surfactant, water molecules, surface tension.

   Why is NesQuik™ quick?

_____

_____

_____

NesQuik™ is a registered trademark of Nestle.

Science Fair Ideas!

Projects in the areas of food technology, soybean germination and plant science, industrial and other non-food uses of soybeans:

Is the soybean crayon a better crayon?

Environmentally Friendly: Soy Ink vs. Petroleum Ink.

Kitchen as Lab: Experiments with Soy Snacks.

Non-Stick cooking sprays: Does Soybean Lecithin Make it Work?

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Cruising Clipboard CHART

Names	Follows directions	Makes careful observations	Collects and records data	Asks questions	Works well with others			

NOTES:

Gathering Information

ONLINE

Ohio Soybean Council
www.soyohio.org

Ohio Farm Bureau Federation
www.ofbf.org

Our Ohio Grow it. Know it. Live it.
www.ourohio.org

United Soybean Board
www.unitedsoybean.org

Soyfoods Association of North America
www.soyfoods.org

The Solae Company
www.solae.com

ADM
www.admworld.com

RESOURCES

Breads of the Harvest
www.ag.ohio-state.edu/~breads

Project Food, Land & People
www.foodlandpeople.org

SOY OHIO
Ohio Soybean Council
918 Proprietors Rd., Suite A
Worthington, Ohio 43085
www.soyohio.org

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