

FACT: CORN IS PROCESSED INTO STARCH, SYRUP, SUGAR AND OIL, THEN INTO OVER 3,000 GROCERY STORE PRODUCTS

LESSON 1:	A, B, C...is for Corn!	(Language Arts)*
LESSON 2:	Kernel Surgery	(Science)*
LESSON 3:	Starch Your Day Right!	(Science)*
LESSON 4:	The Great Worldwide Corn Recipe Exchange	(Multidisciplinary)*

*All Lesson Plans are adaptable for all ages!

DAVID MAKES CUPCAKES

It was the night before Thanksgiving, and David was busy in the kitchen. He was wearing an apron that reached his ankles. His shirtsleeves were rolled up, and he was concentrating. He was only six years old, and for the first time had been invited to participate in the Men’s Thanksgiving Dessert Contest.

He was so excited!

He could remember some of the entries from the past. Thick, rich brownies, warm apple pie, layered mint ice cream cake, creamy lemon pie. David had spent a very long time in the grocery store deciding what he would make, and had finally decided to invent his own dessert. He was going to make “surprise cupcakes.”

The “surprise” part was a gummy worm. It was his own idea. He would put one worm in the center of each cupcake. He could hardly wait to watch his cousin’s faces when they bit into a worm!

He’d picked out a mix for white cake. That way the gummy worms, which were red, green, blue, and yellow, would show up better. He chose white frosting too. That was because he had big plans for decorating the top with candy sprinkles. He’d also picked out eight different colors of cake decorating writing gel.

Mixing the batter was easy. He measured the oil, the eggs, the water, then ran the mixer on high, carefully scraping the sides of the bowl.

He filled the paper cupcake cups, then quickly pushed a worm into each one. He didn’t want his sisters to see. In some cups he put two worms.

When the timer buzzed he took them out of the oven. There, before his eyes, were 24 of the most beautiful, light brown, perfectly shaped cupcakes he’d ever seen. He wanted to try one.

He really wanted to try one, just one. He looked at them for a while, wondering if he’d get in trouble. Finally he decided. “Cooks should always taste their food before anyone else. So I will.”

He took the paper off one cupcake. It was still warm. It smelled so wonderful. The cupcake paper was sticky on the bottom but he didn’t care. He opened his mouth and took a big bite.



There was no worm.

There was a hole where the worm should have been. David stood there, speechless. He stared. This was worse than his worst nightmare. The gummy worm was gone. It had melted.

The one in his hand had been blue. He could tell by the blue sticky stuff on the bottom.

It was awful. He called his mom, tears in his eyes. “What happened to my worm? What am I going to do for the contest?”

His heart was broken. His first entry in the Men’s Dessert Contest was a real loser, even though he’d tried so hard.

His mom listened. She felt terrible too. They pulled the empty gummy worm bag from the garbage, talked about the ingredients and why they melted, then thought of a plan.

The next morning was a beautiful November day, with bright sunshine. David’s family drove to his cousin’s house through the Minnesota River valley. The trees were bare, and there were patches of snow in the woods. They drove past field after field that had been harvested and tilled. The earth looked like it was resting.

David proudly carried two trays of cupcakes into the house and arranged them on the special dessert table. He had spent a lot of time decorating those cupcakes, and it showed. The frosting was set in perfect swirls. There were multi-colored sparkles and designs on top.

Everyone stood around the desserts. It was awesome! David’s cousins had made gingerbread houses. His uncles, most of them farmers, had made pecan pie, pumpkin pie, chocolate caramel cake and rhubarb crisp. Everything had taken lots of work.

The meal began and lasted a long time. There was a big turkey with apple stuffing, mashed potatoes with gravy, homegrown green beans and sweet corn, three kinds of bread, and cranberry salad. Everyone ate and ate. But they didn’t forget to leave room for dessert.

The moment arrived. One at a time the contestants stood at the dessert table, held up their creation and described it. Everyone listened, then cheered and clapped.

David was the youngest, so he was last. He proudly held up his plate of cupcakes. They were so beautiful! Everyone cheered! His eyes sparkled.

Then his mom stood by him and said, “David made something very special for all of you today. This is Thanksgiving, and we are grateful for our blessings. David wanted to especially thank all you farmers for helping raise our food. If it weren’t for you, we wouldn’t have had the turkey, or the bread, or any of these desserts. So he made a special tribute. He made these CORNY CUPCAKES for you.”

Everyone clapped again. “These cupcakes are very, very special,” his mom continued. “You all raise corn in your fields, and these cupcakes wouldn’t have been possible without corn. There is cornstarch in the sprinkles, corn syrup in the writing gel. The frosting is sweetened with corn sugar. There is corn oil in the cake.”

“And hidden inside each cupcake is something else very sweet. Something as light as air, and smooth as syrup.



It's a magic ingredient, and is also made from corn.”

“Without you farmers, the starches, sugars, syrups, and oils we use in our food would not be possible. These cupcakes are corny. You'll find out when you eat one! David offers them to you, and we all say 'thank you'.”



LESSON 1: A, B, C...IS FOR CORN

SUBJECT: Language Arts (English)

OBJECTIVE: Students will learn that corn is in thousands of grocery store products. They can use the names of those thousands of products to play word games, and enhance their spelling or reading skills!

MEASUREMENT: Students will never walk through a grocery store again without an awareness of all the products that utilize corn.

BACKGROUND FOR TEACHERS:

It's hard to find an item in the grocery store that doesn't contain corn. If you learn to recognize corn derivatives on labels, you'll be amazed by its presence in thousands of items. For example:

- Monosodium glutamate and xanthan gum additives are made with corn.
- Instant and ready-to-eat foods use cornstarch to keep their textures during freezing, thawing and heating.
- Cornstarch is a basic ingredient for instant pie and pudding fillings.
- High fructose corn syrups add sweetness to non-diet soda pop.
- Corn syrup also can depress freezing to prevent crystal formation in ice cream.
- Corn syrup is found in salad dressing and condiments, in lunchmeat and in hot dogs.
- Paper products use raw starch in manufacturing.
- Dextrose, a corn sugar sweetener, improves the color and texture of breads.
- Dextrose is also used in vinegar and peanut butter.
- Maltodextrin made from corn syrup is sprayed on instant tea and coffee to keep the granules free flowing.
- Maltodextrin is also used in instant oatmeal and soup mixes.
- Cornstarch is used in dry cell batteries.
- Dextrins, made from starch, are used in crayons as a binder, and on match heads.
- Corn oil is used in potato chips.
- Super-absorbent cornstarch is used in some disposable diapers.
- Sorbitol, produced from the corn sugar dextrose, is used in toothpaste and shaving cream as a water-soluble bulking agent.
- An oxidized cornstarch paste is spread in a thin layer over aspirin.

STUDENT ACTIVITIES:

1. Ask students to read the story David Makes Cupcakes. Ask them to list all the ingredients in the cupcakes that were made from corn—the sprinkles, writing gel, oil, frosting, gummy worms, etc. How many of the other desserts and foods eaten at the Thanksgiving dinner do they think were made from corn or corn products?



2. The following handouts are lists of products made from corn. There is a list for each of the primary products of corn—starches, syrups, and sugars (dextrose). There are also lists for several coproducts—steepwater, gluten, germ—which are byproducts of the refining process. (For more information on corn refining and the resulting products see Unit 9, Lesson 3.) Each list is divided into industrial uses and food, drug, or cosmetic uses. (Example 1 & 2)

These lists can be used in many ways, depending on the age of the students:

- Ask students to find at least one product that starts with every letter in the alphabet. For example: A=aspirin, B=baby food, C=chewing gum... K=ketchup... Q=Quaker brand cereal... Z=zein
 - Use words from this list for a CORNY spelling test or spelling bee.
 - Put some of these words on flash cards for CORNY reading practice.
 - Ask students to practice using a dictionary or encyclopedia by finding these words.
 - Play a CORNY memory game. The first student says, “I went to the store and bought _____ (something made from corn that starts with the letter “a”). The second student says, “I went to the store and bought _____ (something made from corn that starts with the letter “b”) AND _____ (the item the first student bought that begins with the letter “a”). Each student adds an item starting with the next letter in the alphabet, but must remember the items all the previous students bought.
 - Ask students to find words from this list that rhyme with each other, or to think of other words that rhyme with the CORNY words.
 - Students can make their own word scrambles. Use the one on worksheet 1 for an example.
 - Advanced students could use these words to make a CORNY crossword puzzle. (It’s easier if they use graph paper to lay out the words first, then number them, then write the clues!)
3. Ask students to search through their kitchen cupboards at home, and come back to school with a list of 5 items that contain corn. Give them extra credit if they find more than twenty items.
- You might want to have them bring an item or two to school for you to set up a CORNY STORE. Set aside a corner of your room for food and industrial products made from corn. Students could use this “store” to learn to read labels, or to practice skills relating to purchase of those products—counting money, adding up grocery bills, calculating change, as well as to learn about corn in the products they buy.





Products of Corn

Cornstarch	Corn Syrup	Industrial Uses
<p>Industrial Uses</p> <p>Abrasive paper and cloth Adhesives (glues, mucilages, gums, etc.) Batteries, dry cell Binder or binding agents Board (corrugating, laminating, solid fiber-board, cardboard) Boiler compounds Bookbinding 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 standard-izing agent Dressing, surgical Dyes (as a bodying agent, carrier diluent, etc.) Fermentation processes Fiberglass size Fireworks Insecticide powders Insulating material (glass wool, rock wool, etc.) 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 lacquers, etc.) Paper and paper products manufacture Plastics (molded) Plywood (interior) Printing Protective colloids (emulsions) Textiles (warp sizing and finishing) Tile, ceiling Tires, rubber Wallboard and wallpaper Water recovery, industrial</p> <p>Food, Drug or Cosmetic Uses</p> <p>Antibiotics Aspirin Baby foods Bakery products (bread, rolls cakes, pies, crackers and cookies) Baking powder Beverages, brewed (beer, ale, etc.)</p>	<p>Industrial Uses</p> <p>Adhesives (plasticizing agent) Chemicals Dyes and inks Explosives Leather tanning (chrome process) Metal plating Paper, glassine and parchment Plasticizer Polish, shoe Rayon (viscose process) Textiles, for finishing Theatrical makeup Tobacco and tobacco products</p> <p>Food, Drug Uses; liquid or dried form</p> <p>Baby foods Bakery products (bread, rolls, biscuits, doughnuts, pies, cakes, cookies, pretzels, etc.) Beverages, brewed (beer, ale, etc.) Beverages, carbonated Breakfast foods Catsup, chili sauce, tomato sauce Cereals, prepared Cheese spreads and foods Chewing gum Chocolate products Coffee whiteners Condensed milk, sweetened Confectionery Cordials and liqueurs Desserts Eggs, frozen or dried Extracts and flavors Frostings and icings Fruit butters and juices Fruit drinks Fruits (canned, candied, fillings, frozen, etc.) 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 (cakes, infant foods, pie fillings, pudding, powders, ice cream, etc.) Peanut butter Pickles and pickle products Salad dressing Sauces (seasoning, specialty, etc.)</p>	<p>Industrial Uses</p> <p>Acids, commercial (lactic, acetic, gluconic, etc.) Adhesives Amino acids Chemicals (calcium, lactate, sodium lactate, etc.) Citric Dyes Electroplating and galvanizing Enzymes Lactic acid polymers Leather tanning Lysine Mannitol Paper manufacturing Rubber (cold process) Sizing materials Sorbitol Textiles, dyeing and finishing Threonine Tryptophan</p> <p>Food, Drug Uses</p> <p>Antibiotics Baby foods Bakery products (biscuits, bread, crackers, fillings, icings, macaroons, pretzels, cookies, crackers, wafers, etc.) Berries, canned and frozen Beverages, brewed (beer, ale, etc.) Beverages, carbonated Breakfast foods Caramel color Cheese foods and spreads Chewing gum Chocolate products Citric acid Citrus juices Coloring, pure food mix Condensed milk 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 extracts Food acids (citric, etc.) Fruit juices Fruits and vegetables (canned) Fruits (candied, glace, frozen)</p>



Products of Corn

<p>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 Meat products Mixes, prepared (pancake, waffle, cake, candy, etc.) Mustard, prepared Pie filling Precooked frozen meals Salad dressing Soaps and cleaners Soups Sugar, powdered Vegetables, canned Dextrins Industrial Uses Adhesives (glues, pastes, mucilages, gums) Bookbinding Briquettes Candles Ceramics Cord polishing Core binder (castings, molds, etc.) Cork products Crayon and chalk (as a binder) Dyes (dry, cake, etc.) Envelopes Fireworks Inks, printing Insecticides Insulation, fiberglass 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</p>	<p>Seafood, frozen Soups, dehydrated Syrups (table, chocolate, cocoa, fruit, medicinal, soda fountain, cordials, etc.) Toppings Vinegar</p> <p>High Fructose Corn Syrup</p> <p>Food Uses Bakery products Canned fruits Canned juices Condiments Confectionery products Frozen desserts Jams, jellies and preserves Soft drinks Wine Yeast</p> <p>Maltodextrins Food Uses Bakery mixes Beverage powders Condiments 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 mixes Snack foods</p>	<p>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, frankfurters, mincemeat) Medicinal preparations and intravenous (injections, pills, tablets, drugs, etc.) prepared (cake, icings and frosting, infant foods, pie fillings, toppings, etc.) Peanut butter Peas, canned Pectin, fruit Pickles and pickle products Prepared mixes Powders (ice cream, prepared dessert, pudding, summer drink, powders, etc.) Sauces (catsup, tomato, etc.) Seasoning mixes, dry Sorbitol (in candies, toothpaste, etc.) Soups, dehydrated Spices and mustard preparations Syrups (table, fountain, medicinal, etc.) Vinegar Wine Xanthan gums Yeast</p> <p>Hydrol</p> <p>Corn-sugar molasses Leather tanning Livestock feed Organic acids Organic solvents Tobacco</p> <p>Ethanol Alcoholic beverages Industrial alcohol Octane enhancer Oxygenate in motor fuels</p> <p>Personal care products Mouthwash Toothpaste</p>
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Co-Products of Corn

SOLUBLES	GLUTEN AND HULLS	GERM
<p>Steepwater Antibiotics Chemicals Pharmaceuticals Yeast</p>	<p>Steepwater for Feed Gluten Feed and Meal Oil Meal</p> <p>Products Used by Livestock, Poultry and Dairy</p> <p>Corn germ meal Corn gluten feed Corn gluten meal Corn oil by-products Corn sugar (crude and refined) Hydrol (corn-sugar molasses) Steepwater for feed (condensed fermented corn extractives) Corn Germ Meal, Corn Gluten Feed, Corn Gluten Meal Other Uses</p> <p>Amino acids Fur cleaner Zein and other protein products</p>	<p>Corn Oil</p> <p>Corn Oil, Refined <i>Food, Drug Uses</i> Carriers for vitamins and other medicinal preparations in capsule form Cooking oil Margarine Mayonnaise Potato chips Salad dressing Sauces, seasoning Shortening Soups</p> <p>Corn Oil and Free Fatty Acids <i>Industrial Uses</i> Chemicals and insecticides Lecithin (for pharmaceuticals, cosmetics, linoleum, printing inks, etc.) Paint and varnish Rubber substitutes Rust preventative (surface coatings) Soap Soluble oil (leather and tanning use) Textiles</p>



Word Scramble

Unscramble the following list of food items that contain corn.

nroc sekalf	c _ _ _ f _ a _ _ _
cei earcm	_ c _ _ _ _ m
oads	s _ _ _
nuteap ttreub	_ e _ _ u _ _ u _ _ e _
upchket	k _ _ _ h _ _
alads ingsserd	s _ l _ _ d _ e _ _ _ _ g
ylelj	_ e _ _ _
mallmarowssh	_ a _ s _ _ _ _ l _ _ s
meanrirga	m _ _ g _ _ _ _ _
tcoa hipcs	_ a _ o _ _ i _ _



LESSON 2: KERNEL SURGERY

SUBJECT: Science

OBJECTIVE: Students will learn the four major parts of a corn kernel and the functions of each. They will also be introduced to the awesome potential of those little capsules—their role as a seed for new life, and their potential as a renewable source of energy for the world.

MEASUREMENT: Students are aware of the four major parts of a corn kernel, and can identify some of the ways the kernel is used.

BACKGROUND FOR TEACHERS::

The kernel is the most important part of a corn plant!

It is the SEED! It contains everything necessary for a new corn plant to germinate and begin its life. This small capsule contains all the food needed to provide energy for the germinating plant until it can feed itself. It also contains all the genetic material (See [Unit 4, Lesson 2](#) that will determine the traits of that plant.

It is the PRODUCT! Kernels are full of the nutrients and energy that people (and animals) need from their food. There are over 3000 human food uses for the kernels and their contents. (See [Unit 9, Lesson 1](#)). Ground corn kernels are the major part of the diet for most of the animals raised for meat production. (See [Unit 6](#)). The starch and other components of kernels can also be used for industrial purposes (See [Unit 7](#) for descriptions of the ethanol fuel, plastics, and more that can be manufactured from corn.)

There are four major types of corn (and all of them have kernels with the same four parts):

- sweet corn that is eaten as a vegetable
- field corn that is refined for industrial uses in addition to food products and animal feed
- pop corn that is eaten as a snack
- seed corn that farmers plant in the field for crop production

A typical ear of field corn contains 600-800 kernels (See [Unit 1, Lesson 2](#)). There are over 70,000 kernels in a bushel of corn.

A bushel of corn typically sells for \$ 2 to \$ 3. From that bushel of corn, from those 70,000 kernels it is possible to produce 2.5 gallons of ethanol fuel, or 31 pounds of cornstarch, or 33 pounds of corn sweetener, PLUS 11 pounds of animal feed, over 2.5 pounds of gluten meal, and 1.6 pounds of corn oil. (See [Unit 9, Lesson 3](#) for more details.)

Kernels are the seeds of new life. And they are the storehouses of renewable energy. They are truly a-maizing!



STUDENT ACTIVITIES

1. Ask students to read the story David Makes Cupcakes, paying close attention to the last several paragraphs which describe many of the food products made from corn (“There is corn STARCH in the sprinkles, corn SYRUP in the writing gel. The frosting is sweetened with corn SUGAR. There is corn OIL in the cake...”)
2. Hand out ears or kernels of corn to the students for them to see and touch. They will also dissect them if it’s appropriate. (Example 1)

(Note: Field corn will be difficult for young children to dissect, but it is the best for observing the four major parts of a kernel. Mature sweet corn will be soft, so a serrated knife is recommended. Seed corn will be treated with fungicides to prevent seedling disease in the field, so is NOT recommended. Frozen corn from the grocery store will at least allow students to visualize and appreciate the kernel.)

3. This drawing (Example 1) could be used as a handout or as an overhead transparency. Use it to teach the different components of a kernel.
 - The pericarp is the outer skin-like covering of the kernel. It is a layer of fiber. It protects the endosperm and germ from being physically injured, and also from some insects and diseases.
 - The tip cap is the point where the kernel was attached to the corncob. When it was attached, it served as the major pathway for food and water to the kernel.
 - The germ is the only living part of a kernel. It contains all the information the kernel needs in order to grow into a corn plant, plus vitamins and minerals the small plant will need.

The germ also contains corn oil; 25 percent of the germ is oil.

- The endosperm makes up over 80 percent of the kernel. It is the source of energy and protein for the new corn plant.

There are two types of starch in the endosperm, soft and hard. The soft is the white, almost powdery portion. The hard endosperm has starch packed tightly together. When the kernel dries, the soft endosperm collapses and forms a dent in the top of the kernel.

The gluten is the protein layer found on both sides of the germ.

4. Younger students can complete the dot to dot diagram of a corn kernel and fill in the name of the parts. Older students can complete the more detailed drawing. (Worksheet 1)
5. The students can work in teams for the dissection. Ask them to carefully remove several kernels from the



cob (if you have a cob!). The point of attachment is the tip cap. Then ask them to carefully make a longitudinal cut through the center of the kernel. They should now have two equal halves they can examine with a hand lens or microscope. Ask them to locate the pericarp, the germ, and the starch in the endosperm. (Example 1)

6. Ask students to draw a diagram of what they saw.
7. Ask students to discuss the importance of these little kernels. Specifically discuss the importance of them as the SEEDS for new corn plants. Then ask them to discuss the different PRODUCTS that they imagine can be made from the kernels. Units 6, 7, 8, and 9 all deal with these products in greater detail!



The Four Parts of a Kernel of Corn

THE ENDOSPERM

The endosperm is about 82 percent of the kernel’s dry weight and is the source of energy (starch) and protein for the germinating seed. There are two types of endosperm, soft and hard. In the hard endosperm, starch is packed tightly together. In the soft endosperm, the starch is loose. When corn dries in the field before harvest, the moisture loss causes the soft endosperm to collapse and form a dent in the top of the kernel, thus the term “dent” corn.



THE PERICARP

The pericarp is the outer covering of the kernel that protects it from deterioration. It resists water and water vapor and is undesirable to insects and microorganisms.

THE GERM

The germ is the only living part of the corn kernel. It contains the essential genetic information, enzymes, vitamins and minerals for the kernel to grow into a corn plant. About 25 percent of the germ is corn oil. Corn oil is the most valuable part of the corn kernel. It is high in linoleic fatty acid (polyunsaturated fat) and has a bland taste.

THE TIP CAP

The tip cap is the only area of the kernel not covered by the pericarp. It was the attachment point of the kernel to the cob.

Corn Components	
Starch	61.0%
Feed	19.2%
Oil	3.8%
Water	16.0%



Connect The Dots

THE ENDOSPERM

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THE PERICARP

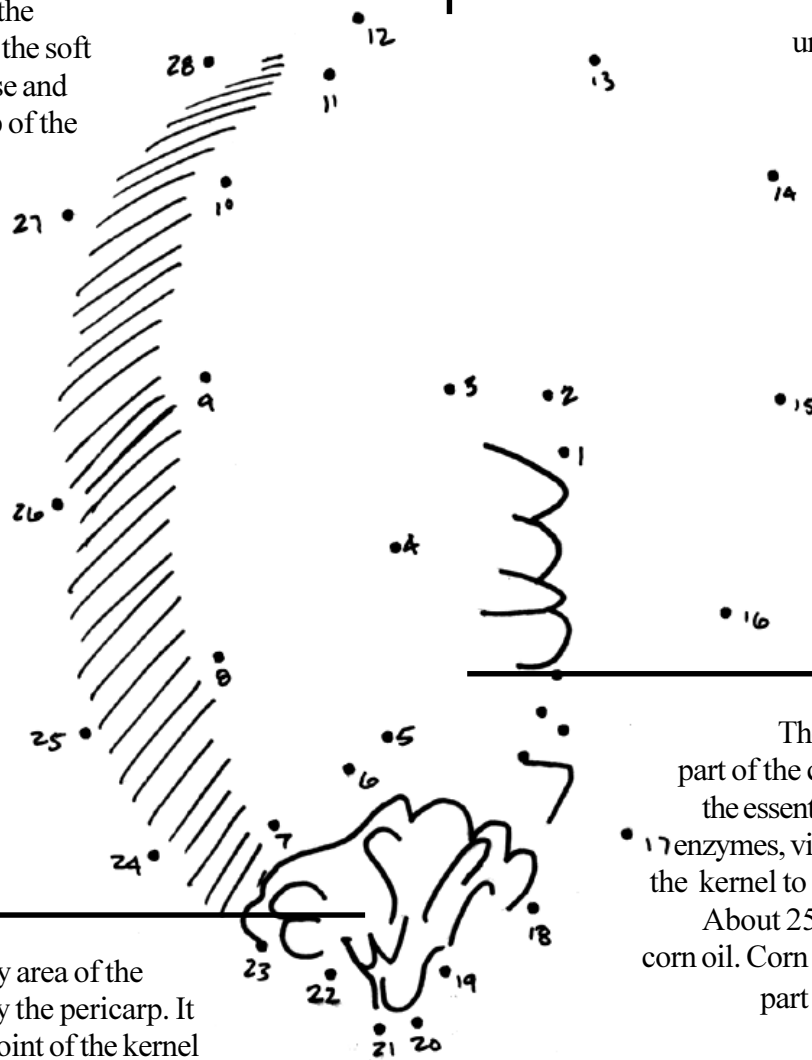
The pericarp is the outer covering of the kernel that protects it from deterioration. It resists water and water vapor and is undesirable to insects and microorganisms.

THE TIP CAP

The tip cap is the only area of the kernel not covered by the pericarp. It was the attachment point of the kernel to the cob.

THE GERM

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LESSON 3: STARCH YOUR DAY RIGHT

SUBJECT: Science

OBJECTIVE: Students will do a simple experiment that produces raw starch, and will then learn about commercial separation in a corn refinery.

MEASUREMENT: Students will understand the refining process for corn, and will appreciate that nothing is wasted! They will also know where cornstarch comes from. They'll be ready to learn some of the uses of this starch. (See [Unit 9, Lesson 1](#) and [Unit 7, Lesson 4](#)).

BACKGROUND FOR TEACHERS:

A key component of the corn kernel is starch. (See [Unit 9, Lesson 2](#))

Cornstarch

- is the food source for the germinating seed.
- is a source of many, many food products for people (See [Unit 9, Lesson 1](#)).
- is a key ingredient in the production of ethanol (See [Unit 7, Lesson 1](#)).
- is a key ingredient in the production of biodegradable plastics (See [Unit 7, Lesson 4](#)).

The refining process described in this lesson is a “wet milling” process. This process soaks the kernels until the components can be separated mechanically. The germ is removed for corn oil, and the starch is removed for industrial or food uses, ethanol, biodegradable plastics, or a variety of other high value consumer products. The remaining components are mainly used in animal feed.

A “dry milling” process is a lower cost option if corn is being processed for ethanol. In that process, the corn is ground into flour, and the entire product goes through the fermentation procedure. After the ethanol is distilled off, the remainder is dried and sold as a 30 percent protein product called Dried Distillers Grains (DDGs).

STUDENT ACTIVITIES:

1. Ask students to read the story [David Makes Cupcakes](#), paying close attention to the last several paragraphs which describe many of the food products made from corn (“There is cornstarch in the sprinkles...”)
2. Conduct the experiment explained on the following worksheet to demonstrate to students the separation of starch from the corn kernel. (Worksheet 1)
3. Use the following handout to explain the three major steps in commercial corn refining: steeping, germ separation, and starch and gluten separation. This may make more sense to students if it is used in conjunction with the Kernel Surgery ([Unit 9, Lesson 2](#)) experiment where students learn the four major parts of a corn kernel.

The handouts state that the most important refined corn products are corn sweeteners, starch, oil, ethanol,



and feed products. The sweeteners, starch, and oil are discussed in this unit (Unit 9). Ethanol is discussed in Unit 7. Animal feed products are discussed in Unit 6. These might help the students understand what happens to the corn after it's refined! (Example 1)

4. Older students can complete the fill-in-the-blank worksheet and essay questions. (All can be answered from the above handouts.)
5. If possible, schedule a field trip to a corn refinery or any corn processing plant to see actual processing of food products, ethanol, biodegradable plastics, etc.



STARCH YOUR DAY RIGHT

Discovering the Starch in a Kernel of Corn:

1. Thaw a package of frozen corn and place in a bowl.
2. Crunch up the corn with a potato masher and cover with water.
3. Let stand about 24 hours.
4. Remove the corn from the bowl with a slotted spoon.
5. Allow the water to stand another 15 minutes.
6. Very slowly, gently pour the water through a piece of cheesecloth (allowing the starch to become trapped in the cloth).
7. You can feel and see the starch left in the cloth.
8. On a small portion of the cheesecloth place a drop of iodine. (If starch is present, the iodine changes from a reddish-brown to a blue-black.)
9. Allow the remainder of the cheesecloth to dry overnight.
10. In the morning, feel and taste the powder remaining on the cheesecloth.
11. You've made cornstarch!! (For experiments using cornstarch to make plastic see [Unit 7, Lesson 4](#)).



STARCH YOUR DAY RIGHT

REFINING CORN

INTRODUCTION:

Corn refiners purchase shelled corn from farmers, corn elevators, or grain companies.

The first purpose of corn refining is to separate the four parts of the corn kernel:

1. The pericarp, the outer skin-like covering of the kernel.
2. The tip cap, the point where the kernel was attached to a corncob.
3. The germ, the living part of a corn kernel containing genetic information and corn oil.
4. The endosperm, the protein and starch that make up over 80% of the mass of a kernel of corn.

The next purpose is to convert these parts into higher value products. Today the most important refined corn products are corn sweeteners, starch, oil, ethanol, and feed products.

STEP ONE: STEEPING

1. At the refinery, the corn is inspected and cleaned.
2. Then the corn is steeped, or soaked, in cool water for 30 to 40 hours.
3. The kernels double in size as they absorb the water.
4. As the kernels swell, the gluten (protein) bonds loosen and the starch is released.
5. The steep water is drained and used in animal feeds.
6. The corn is coarsely ground to separate the germ from the rest of the kernel.

STEPTWO: GERM SEPARATION

7. The coarsely ground corn is mixed with a small amount of water.
8. The mixture is moved to a germ separator that spins the corn germ out of the water.
9. The germ is screened to make sure no starch is present.
10. Corn oil is then extracted from the germ.



11. Any remaining germ is used in animal feeds.

STEP THREE: STARCH AND GLUTEN SEPARATION

12. After the germ has been removed from the coarsely ground corn, the rest of the kernel is ground again.

13. It is mixed with a little more water.

14. The fiber is screened out of the corn, so that only a starch-gluten mixture remains.

15. The gluten has a lower density than starch so a centrifuge is used to separate the two.

16. The gluten is a protein used in animal feed.

17. The starch can be dried and marketed as unmodified cornstarch, or

18. it can be modified into specialty corn starch, or

19. it can be converted into corn syrup or sugar, or

20. it can be processed into biodegradable plastics, or

21. it can be fermented and used in ethanol.

RESULTS

One bushel of shelled corn weighs about 56 pounds. Through refining, one bushel of corn can make :

31 pounds of starch,
 or
 33 pounds of sweetener (enough to sweeten 324 cans of cola),
 or
 2.5 gallons of ethanol fuel,
PLUS
 11 pounds of animal feed,
 and
 over 2.5 pounds of gluten meal,
 and
 1.6 pounds of corn oil.

Nothing is wasted!



REFINING CORN

Fill-in-the-Blank:

One bushel of corn weighs approximately ___ pounds.

Corn oil is found in the _____ of the kernel.

The endosperm contains _____ and makes up over 80% of the mass of the corn kernel.

The five most important refined corn products are

_____ purchase shelled corn and separate the parts of a kernel of corn during the refining process.

In the _____ process the corn is soaked in cool water for 30-40 hours, where the kernels swell to double their size.

One bushel of corn can be refined into ___ pounds of cornstarch plus ___ pounds of animal feed, ___ pounds of gluten meal, and ___ pounds of corn oil.

The starch can be dried and marketed as unmodified or specialty cornstarch, or it can be converted into



LESSON 4: THE GREAT WORLDWIDE CORN RECIPE EXCHANGE!

SUBJECT: Multidisciplinary

OBJECTIVES: Students will use CORN recipes as a way to improve reading skills, math or measuring skills, and social skills. They will try corn recipes from other countries. They will use the Internet for a recipe exchange with other schools.

MEASUREMENT: Students will learn that corn is a very versatile ingredient, and can be used in many, many recipes!

BACKGROUND FOR TEACHERS:

Everyone, young and old, has a favorite recipe, and because corn is the ingredient in so many products (See Unit 9, Lesson 1 for a list of corn products), it will be easy to find favorite recipes made from corn!

STUDENT ACTIVITIES:

1. Ask students to read the story David Makes Cupcakes. David is only six years old, but is already learning to cook. Ask students if they like to cook, and what kinds of things they like to make.
2. Tell students you're going to create a CORN COOKING CLUB in your school, and they're invited to join. Set up a schedule for every student to bring their favorite recipe to share with the class. Then set aside special times when club members can meet to cook (and eat) their recipes!
 - Remind students that the only rule for club membership is that the recipes must have an ingredient made from corn. It's likely they'll think of corn only as a vegetable, so remind them that corn is also the ingredient in many, many products made from corn sugars, cornstarches, or corn oils. (See Unit 9, Lesson 1.)
 - The CORN COOKING CLUB is an opportunity for students to work together. They might like to create a club logo, mission statement, or theme song. They might want to make posters, invitations, or a recipe book. (They could even print and sell copies of the recipe book!)
3. Worksheet 1 has recipes to try.
 - Note that there are recipes for bubbles and playdough, as well as a more traditional corn vegetable recipe! The bubbles are made from corn syrup and the playdough includes corn oil.



BUBBLES

1 cup dishwashing detergent
 3 cups water
 6 tablespoons white **corn syrup**

- Combine ingredients in a large jar or container, cover, and shake well.
- Let the mixture settle for four hours.
- Pour the bubble soap into a large pan or plastic tub.
- After using the bubble soap, store it covered and labeled in the refrigerator.
- Try to let the bubble soap come to room temperature before you use it again.
- Enjoy!

- Make your own blower by cutting the bottom off a polyfoam cup, place the wide end in the soap, and blow from the cut end.
- Or make a gigantic wand by bending a wire coat hanger into a circle.

COOKED PLAYDOUGH

Mix together:

1 cup flour
 ½ cup salt
 2 teaspoons cream of tartar

Then add:

1 cup water
 1 tablespoon **corn oil**
 Food coloring*

**You may use food coloring paste (used for cake decorating) for more vivid colors.*

- Cook over medium heat, stirring constantly until a ball forms.
- Knead until smooth.
- Store in an airtight covered container.



EASY S'MORES

5 small marshmallows (*They're made from corn syrup!*)
 2 squares of graham crackers
 10 chocolate chips

- Place the marshmallows on one graham cracker.
- Put the chocolate chips around the marshmallows.
- Microwave on high for 30 seconds.
- Place the other graham cracker on top.
- Enjoy!

FREEZER CORN

20-22 cups of raw **sweet corn** (approximately 2½ to 3 dozen ears)
 1 pound butter
 1 pint half and half

- Mix ingredients and place in a large roaster.
- Bake at 350 degrees for 1 hour, stirring two or three times.
- Eat!
- Or cool, then divide into freezer bags and freeze.

