From corn to plastics

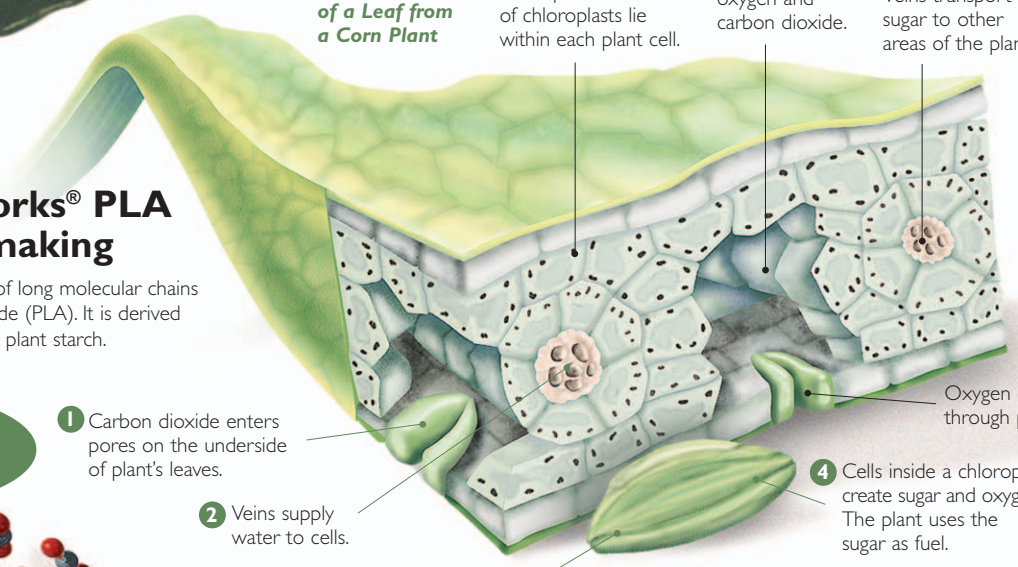
Plastic and fiber products made from corn are on retail shelves and in consumers' homes around the world. Here is a look at how plant sugar is harnessed and transformed into the nature-based plastic NatureWorks® PLA.

NatureWorks® PLA in the making

This plastic is made up of long molecular chains of the polymer polylactide (PLA). It is derived from naturally-occurring plant starch.

PHOTOSYNTHESIS: Nature's Way of Making Starch

Cross Section of a Leaf from a Corn Plant



Photosynthesis takes place in plant structures called chloroplasts. Dozens of chloroplasts lie within each plant cell.

Pockets within leaves allow for exchange of oxygen and carbon dioxide.

Veins transport sugar to other areas of the plant.

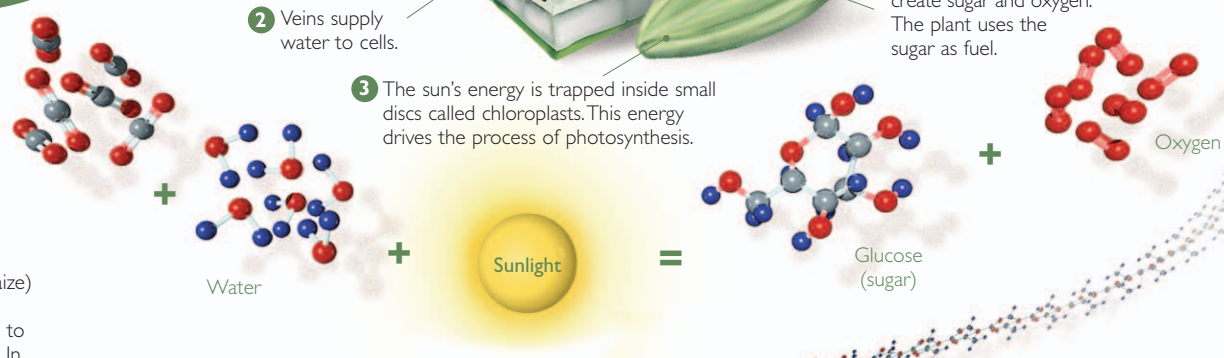
1 Carbon dioxide enters pores on the underside of plant's leaves.

2 Veins supply water to cells.

3 The sun's energy is trapped inside small discs called chloroplasts. This energy drives the process of photosynthesis.

4 Cells inside a chloroplast create sugar and oxygen. The plant uses the sugar as fuel.

Oxygen exits through pores.



Kernel of Corn

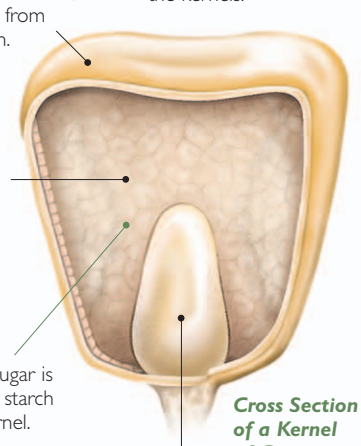
Standard field corn (maize) is used today to make NatureWorks PLA due to its cost and abundance. In the future, PLA could be manufactured from any plant material from which sugar can be harvested.

The hull covers the outside of the kernel, protecting it from deterioration.

The starch for the manufacturing of NatureWorks PLA is removed from the kernels.

The starch stored in the endosperm supplies the germ with the energy needed to grow into a plant.

5 Unused sugar is stored as starch in the kernel.

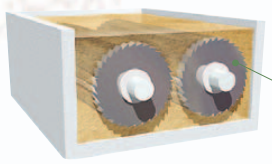


Cross Section of a Kernel of Corn

The germ contains the genetic information, vitamins, proteins and minerals needed for the seed to grow into a plant.

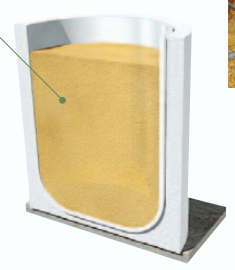
Harvesting Field Corn to Make Starch

6 Farmers harvest the corn and send it to a milling plant.



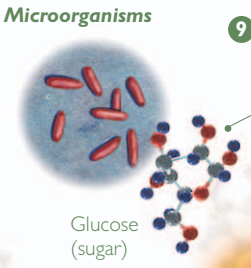
8 Machines grind and screen the corn mixture to isolate the starch. The starch is converted into sugar.

7 The milling plant cooks the corn, which causes it to swell and soften. The corn cooks for 30 to 40 hours at 122 degrees Fahrenheit. Leftover water is used later in the process and in the production of animal feed.



Turning Sugar into Polymer

Microorganisms



9 Microorganisms convert the sugar into lactic acid through fermentation.

Lactic acid molecules

Glucose (sugar)

10 Lactic acid molecules link to form rings called lactide monomer.

11 The lactide ring opens and links together to form a long chain of polylactide polymer. This is the process of polymerization.

Ring

Lactide

12 The plastic is then formed into pellets, which are branded NatureWorks® PLA, and can be used in a wide-range of products including packaging and fibers.

A chain of polymer can consist of tens of thousands of units linked together.

Polylactide polymer (PLA)

Responsible Innovation

The technology to produce NatureWorks PLA allows an abundant, annually renewable resource, corn, to replace finite ones, such as oil and natural gas, in everyday products. NatureWorks LLC is committed to providing and encouraging responsible innovation. This focus on product and process advancement delivers value for the company and its global customer base.

World's First Greenhouse-Gas-Neutral Polymer

- Since corn is the feedstock, NatureWorks PLA inherently offers a significant reduction in energy use and greenhouse-gas emissions as compared to petroleum-based plastics.
- NatureWorks LLC purchases U.S.-based renewable energy certificates (RECs) which offset any remaining emissions from its Blair, Neb., and Minnetonka, Minn., facilities.
- The corn-to-pellet greenhouse-gas-neutral position also further reduces fossil fuel use to a level more than 65% less than traditional plastics, such as PET.

Recycling System Integration

- NatureWorks PLA aids in landfill diversion by offering the widest array of end-of-life options of any plastic.
- It is compatible with existing recycling systems, can be composted, landfilled and incinerates cleanly.
- The company has instituted a "buy-back" program in North America to encourage large-scale recyclers and municipal facilities to separate and bale PLA bottles for alternative uses and disposal.

Source-Options Programs

- NatureWorks LLC offers three source-options programs for customers who view corn variety as an important market issue.
- Available programs include certification, through an internationally recognized third-party organization, that the polymer has no genetic content; a source offset option (guarantees an equal amount of non-genetically modified corn is purchased and delivered to our process facility), and a seed-to-finished-product identity-preserved grade of NatureWorks PLA.
- By allowing customers to select the option that best fits their specific requirements and desired level of market impact, these programs make it even easier for retailers and brand owners to adopt NatureWorks PLA.

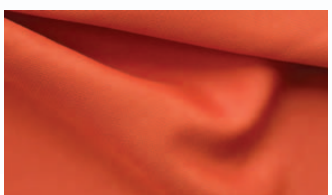
Fresh Packaging from Nature

NatureWorks PLA is a nature-based food packaging resin made 100 percent from field corn, making it a natural fit for fresh, wholesome foods and beverages.

The combination of performance and "responsible" attributes create a natural appeal for NatureWorks PLA in food packaging, bottles, disposable service-ware, labels, specialty cards and consumer goods packaging.

The First Man-Made Fiber from 100% Annually Renewable Resources

NatureWorks PLA can also be extruded into a synthetic fiber branded as Ingeo® that is ideal for applications such as apparel, rugs and carpet, home and office furnishings, and nonwovens, such as baby wipes. Ingeo fiber offers the performance of high-end synthetic materials, with the comfort of knowing it's 100% derived from a natural, annually renewable resource.



About NatureWorks LLC

NatureWorks LLC is dedicated to meeting the world's needs today without compromising the earth's ability to meet the needs of tomorrow. NatureWorks LLC is the first company to offer a family of commercially available polymers derived from 100-percent annually renewable resources, such as corn, with cost and performance that compete with petroleum-based packaging materials and fibers. The company applies its unique technology to the processing of natural plant sugars to create a proprietary polylactide polymer, which is marketed under the NatureWorks® PLA and Ingeo® fibers brand names.

NatureWorks LLC's manufacturing plant is located in Blair, Neb., USA. It has a 300 million pound (140,000 metric ton) capacity.

For more information about NatureWorks and its brands, please visit www.natureworksllc.com.

Illustrations courtesy of South Florida Sun-Sentinel

GSCORP0010206V2

NatureWorks LLC