TABLE OF CONTENTS

1 **One Sweet History...**
History, Math

3 **Where Does Sugar Come From?**
Geography

5 **Sugar: Captured Sunshine**
Biology, Chemistry, Art

7 **A Closer Look at Sugar**
Chemistry

9 **From the Field to the Table**
Technology, Engineering

11 **It's Sweet to the Environment**
Technology, Engineering

13 **Sugar: More Than Just Sweet Taste!**
Chemistry

15 **Types of Sugar**
Technology, Chemistry

17 **A Sweet Part of a Balanced Diet!**
Nutrition, Math

19 **How Much Sugar Are We Consuming?**
History, Math, Nutrition

21 **Let's Bake!**
Recipes

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TEACHER KEY

One Sweet History... *(p2)*

If you put 2 teaspoons of sugar in your coffee every day for a year, at $5.00 per teaspoon how much would you spend in that year?

$3,650

Where Does Sugar Come From? *(p4)*

Sugar beet growing states: **California, Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, Washington, Wyoming**

Sugar cane growing states: **Florida, Louisiana, Texas**

Sugar: Captured Sunshine *(p6)*

Labels from top to bottom: **Sun, Air, Leaves, Leaves, Stalk, Soil, Root Bulb**

A Closer Look at Sugar *(p8)*

Letters, words and numbers should be matched as follows:

C – Carbon – 12
H – Hydrogen – 22
O – Oxygen – 11

From the Field to the Table *(p10)*

Down
1. Filtered
2. Cossettes
4. Raw
5. Centrifuge
7. Color
9. Naturally

Across
3. Absorbs
6. Evaporated
8. Transform
10. Pulp

It's Sweet to the Environment *(p12)*

1. Nature
2. Co-products
3. Value
4. Residue
5. Caretaker
6. Green
7. Utilize
8. Fodder
9. Molasses
10. Responsible
11. Bagasse
12. Environment

Sugar: More Than Just Sweet Taste! *(p14)*

Which category of foods or beverages leverages the most functions of sugar?

Whole-grain, fiber-rich breads & cereals and breads

Match the following amounts of sugar with the types of bakery product and the resulting texture.

More sugar – Cake – Fluffy
Less sugar – Roll – Dense

The sugar in a recipe contributes to browning of food. This reaction is called the **Maillard reaction** and is the result of sugar reacting with the **protein** in the food.

A Sweet Part of a Balanced Diet! *(p18)*

How many total sugars are in one serving of this yogurt? **11 grams**

How many added sugars are in one serving of this yogurt? **7 grams**

If 10 grams of added sugars = 20% daily value, how many grams of added sugars = 100% daily value? **50 grams**

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One Sweet History...

In Spanish they call it "azucar." "Sucre" is the French word for it, while Germans say "zucker." It's called many things in many places, but as long as it's been around, and it's been a while, Americans have always called it "sugar."

Real sugar comes from sugar beet and sugar cane plants. Sugar is one of the world's oldest documented **commodities**, and at one time it was so valuable that people locked it up in what was called a sugar safe.

SUGAR'S OLD AND ILLUSTRIOUS TIMELINE

8000 BCE While chewing sugar cane for its sweet taste was likely done in prehistory, the first indications of **domestication** of sugar cane were in Papua New Guinea. In the beginning, sugar cane was valued for the sweet syrup it produced. As people migrated to different parts of the world, the good news spread, and eventually, sugar cane plants were found in Southeast Asia, India and Polynesia.

500 BCE A new form of sugar was discovered – sugar crystals! The major breakthrough in ancient **technology** occurred in India, when sugar cane juice was boiled until crystals developed.

325 BCE "Honey without bees?" Could this be true? This is how sugar was first described to Alexander the Great. As his empire spread across Asia and into Africa and Europe, so did the **cultivation** of sugar cane.

Like honey, sugar is a naturally occurring sweetener, and they have around the same calories per teaspoon – sugar has 15 and honey has 20.

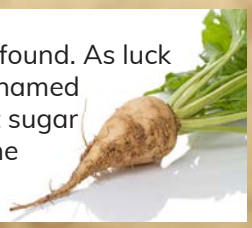
200 BCE A Chinese emperor heard about India's secret for manufacturing sugar, and he sent his **emissary** there to learn about this sweet sensation. Sugar cane was planting roots around the world.

1493 Christopher Columbus is credited with introducing sugar cane to the New World, but that was old news in places like Southeast Asia where sugar had already been making life sweeter for over 8,000 years.

1500 Sugar is a scarce luxury in Europe at this time. One teaspoon of sugar cost as much as $5.00!

Today a teaspoon of sugar costs about one half of one cent ($0.005).

1747 A new source for sugar was found. As luck would have it, a German scientist named Andreas Marggraf discovered that sugar crystals could be extracted from the sugar beets used to feed cows.



1751 Closer to home, Americans first planted sugar cane in Louisiana, and another U.S. industry was born.

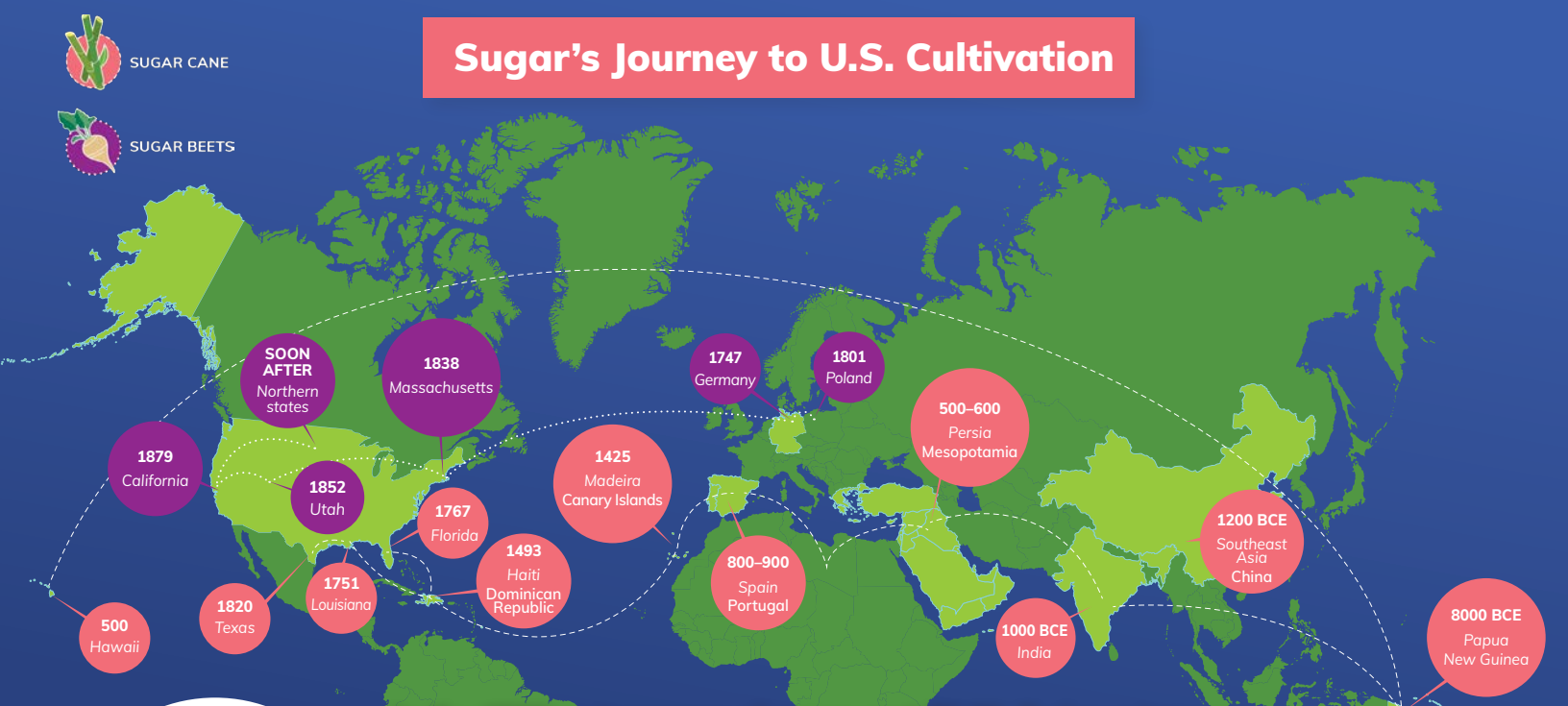
1800 Sugar beets proved to be an **indispensable** resource during the war between France and England when the English stopped the flow of sugar to Europe. By 1811, the French emperor, Napoleon, issued a decree forcing peasant farmers to plant sugar beets. Two years later, France produced 35,000 tons of sugar in over 340 factories.

1838 The first U.S. sugar beet factory was built by David Lee Child in Northhampton, Massachusetts.

GLOSSARY

commodity – ***n.*** a raw material or primary agricultural product that can be bought and sold
cultivation – ***n.*** the use of land for growing plants
domestication – ***n.*** the cultivation of a plant for food
emissary – ***n.*** a person who is sent on a mission as a representative for someone else
indispensable – ***adj.*** absolutely necessary
technology – ***n.*** the use of scientific knowledge to make work easier

Sugar's Journey to U.S. Cultivation



In the 1500s a teaspoon of sugar cost $5.00. Today a teaspoon of sugar costs about one half of one cent ($0.005)!

Answer this question and you may be surprised at how much things have changed.

If you put 2 teaspoons of sugar in your oatmeal every day for a year in the 1500s, at $5.00 per teaspoon how much would you spend in that year?

$ _____

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Where Does Sugar Come From?

MAP IT OUT!

Have you ever thought about where sugar comes from? If you think it comes from the grocery store, you're right, but before it's on the grocery shelves, it's in plants that are grown on farms across the United States.

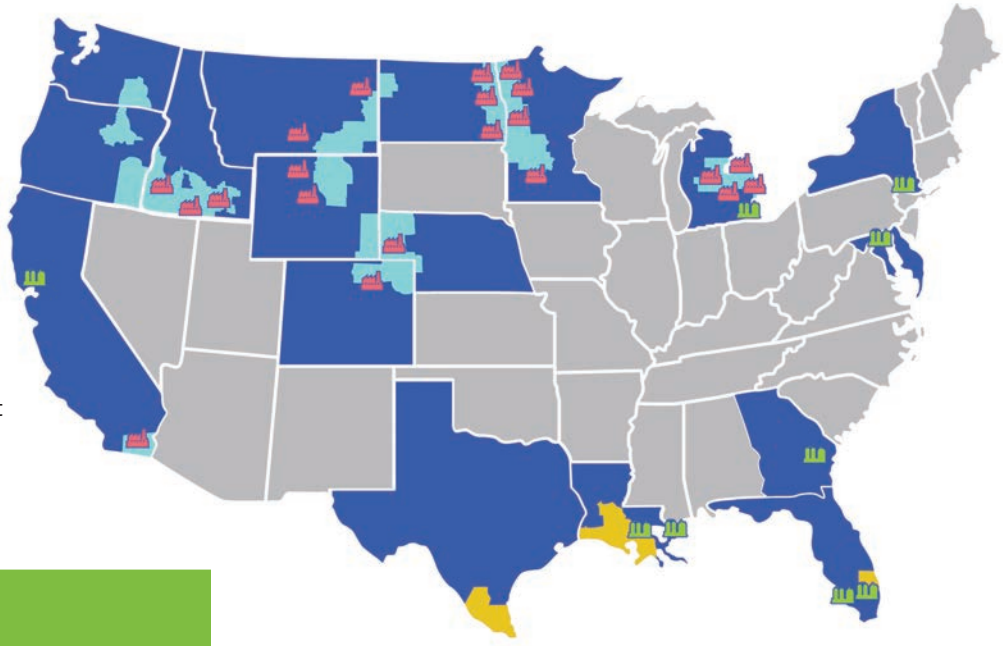
U.S. farmers produce a lot of sugar (the sixth largest **yield** in the world), but many other countries produce real sugar, too. The largest producers of sugar from sugar beets are the European Union, Russia, U.S. and Turkey. The countries that produce the most sugar from sugar cane are Brazil, India, Thailand and China.

In the U.S., sugar beets and sugar cane are grown in 14 states. Our **diverse** climate allows sugar farmers to grow sugar cane in some regions, while other areas provide the perfect conditions for growing sugar beets.

Sugar beets are a root crop, and they typically flourish in places where the temperatures are generally cooler. Farmers in Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, Washington and Wyoming plant the seeds when things are warming up in the spring and harvest the **mature** sugar beets in the fall, before the temperatures drop too low. In California, sugar beets are grown over the mild winter and harvested in the spring.

Sugar cane, on the other hand, is a tropical grass and is grown around the world in a region near the equator known as the tropical belt. A tropical climate is warm and has year-round **temperate** weather. The temperatures rarely dip below freezing. Three states in the U.S. grow sugar cane: Florida, Louisiana and Texas. Additionally, raw sugar (both domestic and imported) is refined in California, Florida, Louisiana, Georgia, Maryland, Michigan and New York.

The next time you see the sugar in your pantry, you may wonder, "cane or beet?" Regardless of the kind of plant or where it was grown, you can be sure it is the same as the real sugar that has been safely consumed by people all over the world for thousands of years.



sugar beet factory **sugar cane refinery**
sugar beet growth **sugar cane growth**

GLOSSARY

diverse – *adj.* of several or many kinds; different
mature – *adj.* fully grown or developed
temperate – *adj.* having a climate that is not too hot or too cold
yield – *n.* an amount produced

For more information about crops and climate, go to https://www.usda.gov/topics/farming/crop-production

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Create a colorful and informative visual aid to accompany any report or project by labeling the states where sugar cane and sugar beets grow. Choose the colors you will use for your map, and don't forget to include them in your map key.

MAP KEY

- [ ] sugar beet growing states
- [ ] sugar cane growing states
- [ ] non-sugar growing states

Sugar: Captured Sunshine

You've probably heard of solar energy, but have you ever heard of sugar energy? Well, guess what? That's what sugar is – pure and simple – it's the plant's energy!

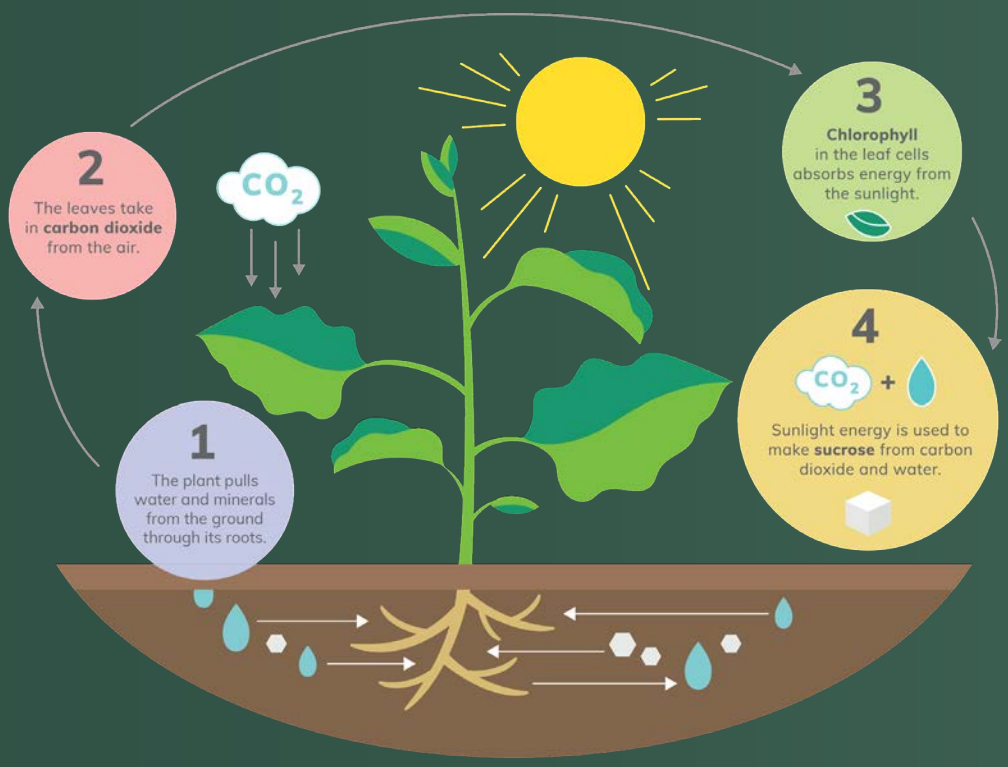
All green plants make sugar through photosynthesis. Photosynthesis is the process plants use to transform the sun's energy into sugar, their stored food and energy supply.

The recipe is pretty easy and contains just four natural ingredients:

- **carbon dioxide**
- soil
- sunshine
- water

This powerful combination is all green plants need to make sugar (or **sucrose**, sugar's molecular name).

PHOTOSYNTHESIS



GLOSSARY

carbon dioxide – *n.* a natural, colorless, odorless gas
chlorophyll – *n.* a green substance in the leaves of plants which helps plants make sugar from elements in air and water
sucrose – *n.* a compound which is the chief component of beet and cane sugar.

Sugar exists naturally in almost every fruit and vegetable, but two special plants are packed full of sugar. Sugar occurs in the greatest quantities in sugar cane and sugar beets.

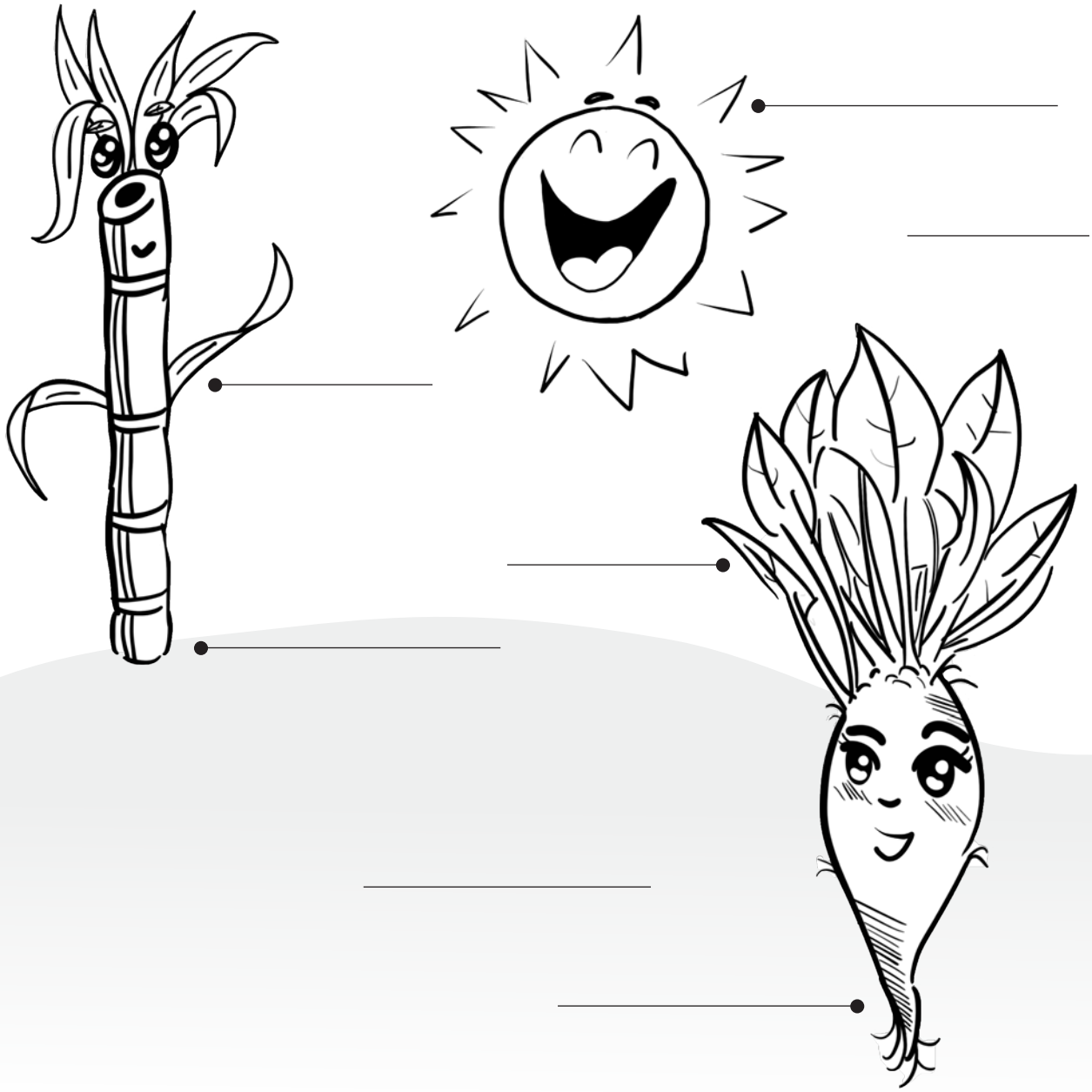
Sugar Beet

A sugar beet is a root crop and grows underground, protected by the soil. The sucrose that is created by the plant is stored in its root. The beet stays in the ground until it matures and weighs 3-5 pounds. A mature beet contains about 16% sucrose.

Sugar Cane

Sugar cane is a tropical grass that grows 10-20 feet high. The sucrose produced through photosynthesis is stored in the thick stalks or canes. A stalk of sugar cane contains around 14% sucrose.

Complete this diagram to help you identify and remember the parts of the sugar beet and sugar cane plants. Use the key below to color different parts of the plants as indicated. Use the word bank to fill in the blanks.



Color Key

YELLOW	Where plants get energy.
GREEN	Where chlorophyll is located.
LIGHT BLUE	Where plants get carbon dioxide.
BROWN	Where plants get water and minerals.
TAN	Where sugar is stored in plants.

Word Bank

One of these words can be used twice.

- **Sun**
- **Leaves**
- **Soil**
- **Air**
- **Stalk**
- **Root bulb**

A Closer Look at Sugar

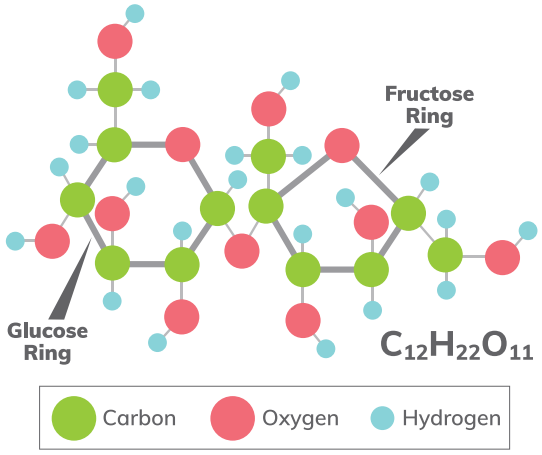
‹‹‹ Sugar crystals under a microscope

$C_{12}H_{22}O_{11}$

Is that some sort of secret code? There's really no mystery. It's simply the scientific code for a sugar **molecule**, the most **abundant**, pure, **organic** substance in the world.

Sugar, or sucrose, is a naturally occurring crystalline **carbohydrate**. Carbohydrates are the foundation of our food chain. They are the chief form in which plants store energy. The energy we get from eating carrots, broccoli, apples, bananas or potatoes comes from the carbohydrates the plant has stored in its roots, seeds, leaves, stems or fruit. When sugar is **refined**, it is simply extracted from the plant and remains in its natural form. The sugar in your pantry is identical to the sugar that's still found intact when you bite into fruits and vegetables.

A Sugar Molecule



Sucrose is made from a combination of carbon, hydrogen and oxygen atoms. The right combination of these atoms makes glucose and fructose, the two molecules bound together by Mother Nature to make sucrose.

While you can't see a carbohydrate, you can see a sugar crystal. A sugar crystal is made from thousands of sugar molecules bonded together. It's what you see when you look at a granule of sugar.

GLOSSARY

abundant – *adj.* in great amounts; plentiful

atom – *n.* the smallest unit of a chemical element

carbohydrate – *n.* a substance, such as sugar, made up of carbon, hydrogen and oxygen. Carbohydrates are made by green plants.

crystal – *n.* a solid substance with sides and angles that naturally form a regular pattern

molecule – *n.* the smallest particle into which a substance can be divided and still remain the same substance

organic – *adj.* of or coming from living things

refined – *adj.* free of impurities; purified

Making Sugar Crystals

Suggested for middle school students with supervision

Materials you'll need:

- 1 piece of cotton string
- 1 pencil or stick
- 1 paper clip
- 1 glass jar
- sauce pan
- measuring cup
- 1 cup water
- 2 cups sugar
- additional sugar (amount will vary)

Tie a short piece of cotton string to the middle of a pencil or stick. Attach the paper clip to the loose end of the string for a weight. Next, moisten the string slightly and roll it in a bit of sugar. Lay the pencil across the top of the jar with the string hanging down inside.

In a sauce pan, heat the water and dissolve 2 cups of sugar in it. Let it cool. Heat the sugar-water solution a second time and dissolve as much of the additional sugar as you can.

Pour the solution into the prepared jar and leave it undisturbed for a couple of days. You should start seeing crystals grow as the water evaporates.

Molecular Formula

In the "secret code" that represents sugar there are three letters. Below, match each of those letters to the correct element and the number of each in one molecule of sugar.

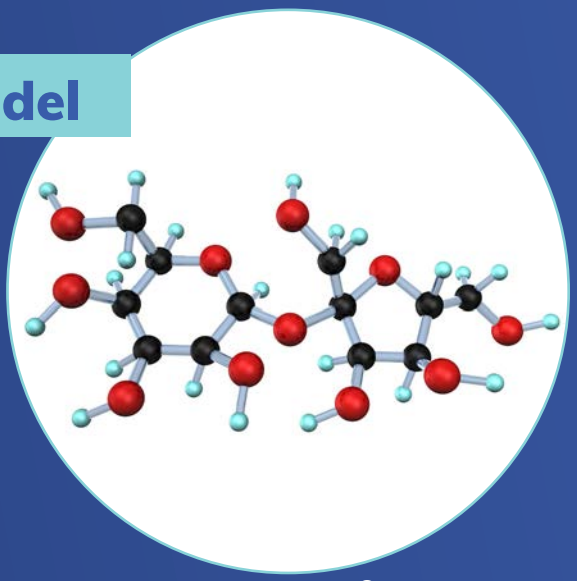
C	Hydrogen	11
H	Oxygen	12
O	Carbon	22

Molecule Model

Suggested for high school students

To make a sugar molecule come to life, construct a 3-dimensional model. What a cool science project!

Use the picture to the right as your guide.



Materials you'll need:

- Styrofoam balls or gumdrops – 3 colors
- 45 toothpicks

Hint:

Remember – use one color for each element: carbon, hydrogen and oxygen.

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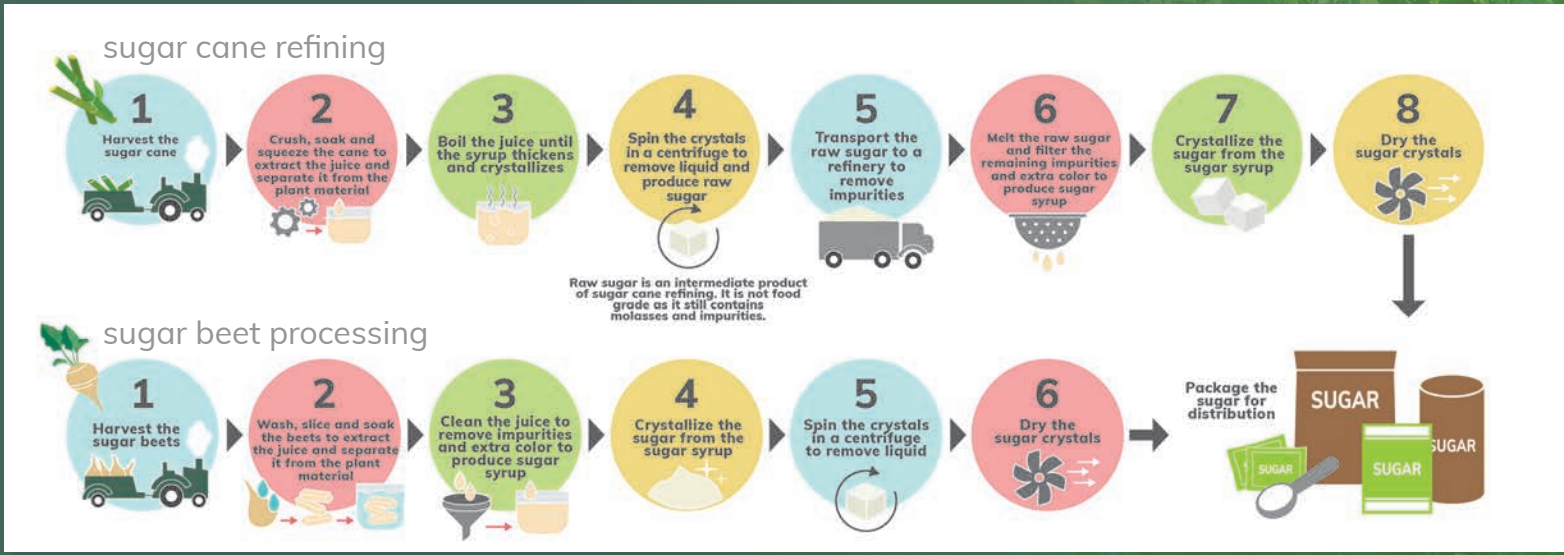
From the Field to the Table

Real sugar comes from sugar beets and sugar cane plants grown on a farm, but how does it get from the field to your pantry? Fortunately, nature has taken care of making the sugar; the beets and cane do that through photosynthesis. We just have to **extract** and **purify** the sugar (sucrose) from the plants. The purification process is similar for each plant, and the result is the same pure sucrose. One difference in processing between the two plants is that sugar beets are processed at a single facility (a sugar beet factory) and sugar cane is refined at two facilities (the process starts at a raw sugar factory and finishes at a refinery).



SUGAR BEET PROCESSING

From the field, sugar beets are delivered to sugar beet processing facilities located near the farms. The beets are cleaned and sliced into thin strips called cossettes (they look a bit like French fries). The cossettes are washed in hot water and this water **absorbs** the sugar, creating a sugar juice. This juice contains the sugar that will eventually find its way to your kitchen pantry. After the sugar juice is drawn off, the beet pulp is left behind. The juice is cleaned to remove the non-sugar particles (like any leftover plant materials) by carbonation and **filtration**. The filtered juice is boiled to evaporate the water and form a thick syrup, something like pancake syrup. Workers repeat this process to ensure that the syrup is pure. Again, the syrup is boiled, and this is when sugar crystals begin to form. The sugar crystals are spun in a centrifuge, a machine that works like the spin cycle on your washing machine, to remove the syrup. As it spins faster and faster, the liquid spins off and leaves the naturally colorless sugar crystals. After one more hot bath, the sugar crystals are dried and then packaged. The next stop is the grocery store shelf.

CO-PRODUCTS OF SUGAR PROCESSING

BEET PULP is a co-product of sugar beet processing. It is processed separately into pellets for livestock feed and other products.
SUGAR BEET MOLASSES is another co-product and can be used to remove or prevent icing of roads during the winter.

BAGASSE is a co-product of sugar cane refining and can be turned into paper, cardboard and cutlery among other uses. It can also be burned to provide heat and electricity to the factory.
CANE MOLASSES is what makes brown sugar brown. It is also used in the baking and brewing industries. (You can find a little more information on molasses on page 16.)

SUGAR CANE REFINING

After it's harvested, the sugar cane goes to a raw sugar factory located near the field, where the raw sugar is separated from the plant before it is shipped to the refinery. At the raw sugar factory, the sugar cane stalks are washed and cut into shreds by rotating knives. Next, huge rollers crush the juice out of the shredded **pulp**. The leftover pulp is called bagasse. The sugar juice is purified by carbonation and filtration. Carbonation removes non-sugar plant material like wax, fats and gums naturally present in all plant cells.

(Continued on back)

The juice is then boiled to remove the water through **evaporation**. This leaves behind a clear, golden syrup. As the water evaporates from the syrup, sugar crystals begin to form. These crystals are spun in a centrifuge, which leaves behind golden, raw sugar.

The raw sugar is transported to a sugar cane refinery where it is washed to remove the brown molasses that naturally surrounds the sugar. The washing **transforms** the crystals back into syrup. After the molasses is removed, the clear syrup is boiled to remove some of the water by evaporation. This thick syrup is then evaporated a second time and sugar crystals are formed. The sugar crystals are spun in a centrifuge again to remove the excess syrup. Then the sugar is dried and packaged. By the time the sugar leaves the refinery, it is ready for the table.

GLOSSARY

absorb – *v.* to take in or soak up
evaporation – *n.* the process of changing from a liquid into a vapor or gas
extract– *v.* to take or pull out
filter – *v.* to pass through a device that cleans unwanted matter from air or liquid
pulp – *n.* the soft, juicy part of fruits and certain vegetables
purify – *v.* to make pure; to clean out unwanted materials
transform – *v.* to change in form, nature, function or appearance

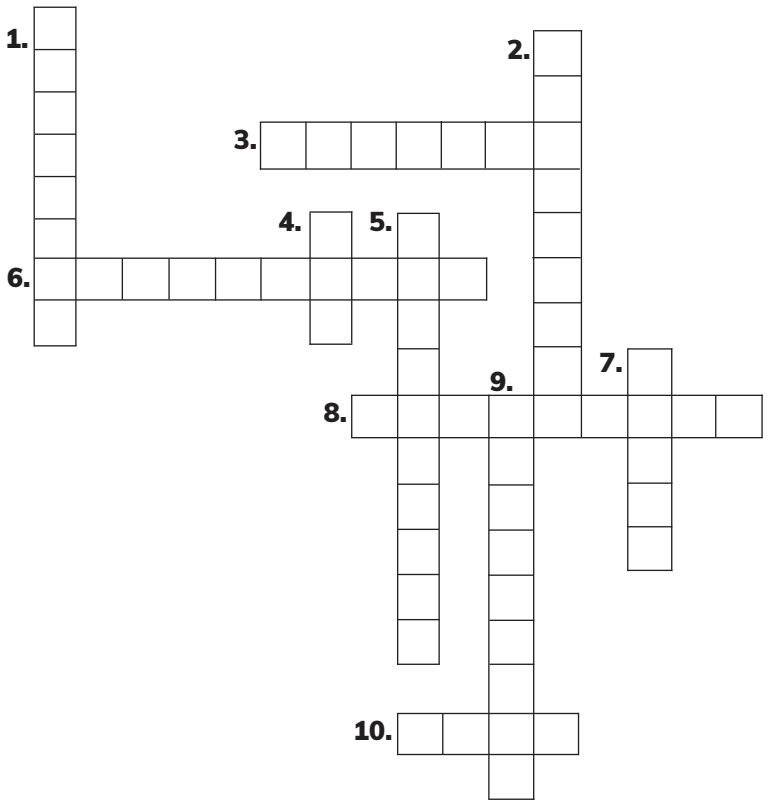
Complete this crossword puzzle, and you've processed a lot of sweet information.

DOWN

1) The sugar juice is _____ then boiled.
2) Thin strips of sugar beets
4) _____ sugar factories are located near sugar cane fields.
5) Works like the spin cycle in a washing machine
7) Sugar crystals are naturally _____-less.
9) Sugar is _____ occurring.

ACROSS

3) Hot water _____ the sugar.
6) _____ water has changed from a liquid to a gas.
8) To change very much in form, nature, function or appearance
10) Soft, juicy part of a fruit or vegetable



It's Sweet to the Environment

Sugar is a gift from nature. The sugar industry, as a responsible **caretaker**, gives back to the environment as much as it can. Sugar farmers, processors, refiners and scientists are respectful of sugar's value and do all that is possible to **utilize** this gift in responsible ways.

Once they leave the field, sugar beet and sugar cane plants are headed for great things. Not only do they provide the sugar we eat, but the parts of the plants that are not used for sugar have important jobs, too. They're not just thrown away.

Would you believe some parts of these plants help power the factories that purify sugar? A fibrous substance called bagasse is one of the **co-products** of sugar cane refining. Bagasse is often burned as fuel to power the processing facilities and can be used to produce electricity for nearby towns! It has also been used to make compostable plates and take out containers.

Cows, horses and other livestock get their energy from sugar beet plants, too. The tops of the plants make nutritious animal **fodder**, and the **residue** from the beet pulp is used in livestock feed. When it's further processed, it can be used as fiber or in other products.

Speaking of other products, molasses (which comes

from the sugar purification process) is used in hundreds of goods. Many of them might be in your home right now! If you like gingerbread, you probably like too since it's one of the key ingredients. Bakers, pharmaceutical companies, distillers and other food processors use this flavorful syrup in many of their products. Some people even use it as syrup on their pancakes! Ask your favorite baker; they probably use it too!

The men and women working in the factories appreciate the value of these plants and help make sure that little is wasted in sugar processing and refining. Even professionals working outside of the factories and refineries "think green." Scientists have been experimenting with sugar for years. They have discovered many products that can be made better by using sugar. But, you may wonder, how does this help the environment? Good question.

The use of **renewable** materials is environmentally responsible. Researchers have discovered a **biodegradable** plastic made from sugar beet pulp that is an environmentally friendly product and helps reduce solid waste.

(Continued on back)

GLOSSARY

biodegradable – *adj.* capable of being broken down by bacteria or other living organisms
caretaker – *n.* one that takes care of the house or land for an owner
compostable – *adj.* can be broken down into nutrient-rich material at a rate similar to paper
co-products – *n.* something produced in addition to the main product
fodder – *n.* dry food used for animal food; feed
renewable – *adj.* capable of being replaced by natural ecological cycles
residue – *n.* the part left after something is removed; remainder
utilize – *v.* to make use of

Solid waste is also reduced when you recycle. When sugar is added to paper, it recycles more easily. Paper made from sugar cane plant fibers is biodegradable, **compostable** and recyclable. How's that for looking out for Mother Nature?

When industries, like the sugar industry, make sure they are doing their best to protect our world, they are promoting environmental stewardship. Just like you, the sugar industry is sweet on nature!

Unscramble the following words, putting one letter in each space. Then unscramble and combine the circled letters to answer the question. This is a really sweet brain twister.

Q: **By using renewable materials and recycling, we help the _____.**

1. tnurea ___ ___ ___ ___ ___ ___
2. ocroctp-dus ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
3. laeuv ___ ___ ___ ___ ___
4. usirede ___ ___ ___ ___ ___ ___ ___
5. trceaakre ___ ___ ___ ___ ___ ___ ___ ___ ___
6. nrege ___ ___ ___ ___ ___
7. tilzieu ___ ___ ___ ___ ___ ___ ___
8. deford ___ ___ ___ ___ ___ ___
9. somslaes ___ ___ ___ ___ ___ ___ ___ ___
10. seobplinser ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
11. asebgsa ___ ___ ___ ___ ___ ___ ___

Now you're ready to unscramble and combine the circled letters to answer the question.

12. ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

WORD BANK

Bagasse	Caretaker	Nature
Responsible	Utilize	Co-products
Value	Fodder	Green
Residue	Molasses	Environment

For thousands of years, sugar has been an important ingredient for people all over the world.

Sugar:
More Than Just Sweet Taste!

Have you been surprised to find sugar in foods that don't necessarily taste sweet? There's a reason for that. You may not know it, but there's a lot of chemistry that takes place when ingredients in a recipe are put together. Sugar plays an **essential** functional role in the way foods look, last and, let's not forget, taste!

Sugar is made of carbon, hydrogen and oxygen atoms. Its molecular structure ($C_{12}H_{22}O_{11}$) makes it easy to **bond** with other molecules. It is also hygroscopic (absorbs moisture), which makes sugar an efficient natural preservative.

What Are Sugar's Amazing Powers in Cooking and Baking?

Sugar grabs the available water in foods. This is important because bacteria grow in moist environments. By soaking up the water, sugar acts as a preservative, which prevents the growth of **microorganisms** that can spoil food. This is true for many products such as jams and jellies and even breakfast cereals, breads and other baked goods.

Sugar reacts with the protein in foods causing the food to become brown when heated, like the crust of bread. The more sugar a food contains, the more brown it will become. The scientific name for this change is the Maillard reaction.

Sugar can also brown foods through a process called caramelization. When the sugar is heated, it breaks down and caramelizes. If you heat white table sugar in a pan, it will turn into a beautiful caramel sauce.

Bread is made with baker's yeast, which feeds on sugar. When the yeast **consumes** the sugar, it releases a gas called carbon dioxide. This gas is what makes the dough rise.

Sugar absorbs water and inhibits flour gluten development, providing the proper texture in baked goods. A little sugar = dense texture like in a roll; a lot of sugar = fluffy texture like in a cake.

Sugar contributes to **texture**. The air pockets formed when you beat together butter or shortening with sugar give cookies a crumbly structure. Sugar absorbs the moisture from other ingredients when baking making cookies crisp.

Sugar helps to retain moisture to extend baked goods' **shelf life**.

Sugar balances sour, bitter and spicy flavors in spaghetti and barbeque sauces and the dressing you put on your salad.

Ice cream is creamy because sugar lowers its freezing point, slowing down the freezing process and preventing the formation of ice crystals. This creates a smooth, creamy **consistency** that's easy to scoop.

Vegetables have that fresh-from-the-garden taste when a little sugar is added. Sugar naturally **enhances** flavors and helps strengthen fiber and cell structure in fruits and vegetables during cooking.

For more information on baking science, go to www.homebaking.org

Now you know that sweetening foods is only one of sugar's amazing powers! Its unique **versatility** makes sugar an essential functional ingredient in many of the foods we eat. They taste better, look more appealing and last longer. Below is a summary of all the different roles sugar plays in various food and beverage categories.

Sugar's Functional Roles in Food Beyond Sweetness

	FLAVOR ENHANCER/ BALANCER, AROMA	BULK	TEXTURE/ MOUTHFEEL	SHELF-LIFE/ MICROBIAL STABILITY	FERMENTATION	FREEZING POINT DEPRESSION	COLOR	MOISTURE RETENTION
Dairy Products	●	●	●		●			
Whole-Grain, Fiber-Rich Breads & Cereals	●	●	●	●	●		●	●
Breads	●	●	●	●	●		●	●
Bakery Products	●	●	●	●			●	●
Salad Dressings, Rubs and Sauces	●	●	●	●				
Preserves & Pickling	●	●	●	●				
Jams & Jellies	●	●	●	●			●	
Canned Fruits & Vegetables	●	●	●	●			●	
Prepared Foods	●	●	●	●			●	●
Beverages	●	●	●	●				
Frozen Beverages	●	●	●			●		
Fermented Beverages	●	●	●		●			
Ice Cream	●	●	●			●		
Confectionery	●	●	●	●			●	●

GLOSSARY

bond – *v.* to stick together
consistency – *n.* the degree of how stiff, thick or firm something is
consume – *v.* to use up
enhance – *v.* to make greater; improve
essential – *adj.* very important, vital
microorganisms – *n.* an organism that can be seen only through a microscope
shelf life – *n.* the period of time a food stays fresh
texture – *n.* the look or feel of something
versatility – *n.* the ability to do many things well

QUIZ TIME!

1. Which category of foods or beverages uses the most functions of sugar?
(Hint: there may be a tie.)

2. We learned that sugar can contribute to the texture of foods, and different amounts of sugar can produce different textures. **Match the following amounts of sugar with the types of bakery product and the resulting texture.**

MORE SUGAR	CAKE	DENSE
LESS SUGAR	ROLL	FLUFFY

3. The sugar in a recipe contributes to browning of food. This reaction is called the _____ reaction and is the result of sugar reacting with the _____ in the food.

Types of Sugar

All sugar is made by first extracting sugar juice from sugar beet and sugar cane plants, and from there many types of sugar can be produced. Through slight adjustments in the process of cleaning, crystallizing, spinning and drying the sugar and varying the level of molasses, different sugar varieties are possible. Sugar of varying crystal sizes produces unique functional characteristics that make the sugar suitable for different foods and beverages. Sugar color is primarily determined by the amount of molasses remaining on or added to the crystals, giving pleasurable flavors and altering moisture. Heating sugar also changes the color and flavor (yum, caramel!).

Let's look at a few of the types of sugar we use most. They can be divided into two categories, white sugars and brown sugars.

WHITE SUGARS

(contain little or no molasses)

Granulated Sugar

- Granulated sugar, or table sugar, is the white sugar you typically find in your sugar bowl.
- It is the most common sugar called for in recipes with cooking and baking.
- These sugar crystals are formed during the purification process when the molasses surrounding the sugar crystals is removed.
- The "regular" sized granules are fine because they are ideal for bulk handling and not susceptible to caking or sticking together.

Powdered Sugar

- Powdered or confectioners sugar is simply granulated sugar ground to a smooth powder, mixed with a small amount of cornstarch to prevent caking and then sifted. The granule size is much smaller than table sugar.
- It is often used in icings, confections and whipped cream.

BROWN SUGARS

(contain varying levels of molasses)

Light and Dark Brown Sugar

- Brown sugars are made by mixing white sugar with various amounts of molasses. More molasses = darker color and stronger molasses flavor.
- Light brown sugar is commonly used in baking.
- Dark brown sugar is used in gingerbread, baked beans and other full-flavored foods.
- Brown sugars tend to clump because they contain more moisture than white sugars because of the molasses. This allows baked goods to retain moisture well and stay chewy.

Turbinado Sugar

- Turbinado sugar, sometimes known as Demerara sugar or raw cane sugar, is a partially processed sugar that retains more of the naturally present molasses.
- It has a light brown/tan color, mild brown sugar flavor and larger crystals than brown sugar used in baking.
- Turbinado sugar is the sugar in your packet of "raw cane sugar." This type of sugar has been processed just enough to make it safe to eat.

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What Is Molasses?

- Molasses is a co-product of sugar refining. During the refining process, it is separated from the raw sugar by spinning the sugar in a centrifuge. The first spin produces light molasses, while later spins produce darker molasses. Molasses is not as sweet as sugar but is used in many recipes for its rich flavor and it is what makes brown sugar brown!
- Molasses is naturally occurring in both sugar beets and sugar cane but they have different flavors and consistencies and are not used interchangeably. Sugar cane molasses is what we use in the food supply.

Here are some pretty cool activities you can do in the kitchen, whether as an experiment or if you are in a pinch when baking! Be sure to have an adult help you. Your friends and family will be impressed with all the things you know about sugar!

1

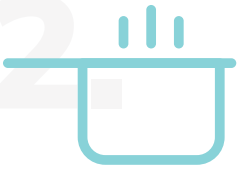
Make Your Own Brown Sugar

This would be a fun demonstration!

Brown Sugar Recipe:
1 cup white, granulated sugar
1 tablespoon molasses

Directions:
Pour the sugar into a food processor or blender. Add the molasses. Blend until the molasses coats the sugar. Ta da!

2



Create Your Own Caramelized Sugar

This is why our cooked foods turn that yummy, golden brown color. Mmmm...

Caramelized Sugar Recipe:
½ cup sugar
2 tablespoons water

Directions:
Cook in a small pan over medium heat, stirring constantly, until the mixture melts and begins to turn brown. It can turn into a dark brown color quickly, so be careful! Remove from heat and let cool.

3

Make Your Own Powdered Sugar

For when you just don't have enough for the frosting on that birthday cake!

Powdered Sugar Recipe:
1 cup sugar
1 tablespoon cornstarch

Directions:
Pour the sugar and cornstarch into a food processor or blender. Blend until very fine to get 1 cup of powdered sugar.

A Sweet Part of a Balanced Diet!

You've probably heard how important it is for you to eat a nutritious, balanced diet. Did you know that sugar can make a healthy diet more **palatable**?

Sugar Is a Carbohydrate

Carbohydrates, along with fat and protein, are **macronutrients** that provide your body with energy. Carbohydrates are found in all plant and dairy foods and beverages that provide your body with calories. Carbohydrates are the preferred source of energy for the body because the majority contain glucose. Glucose is the fuel your brain, organs and muscles need to function and engage in everyday activities.

According to the 2015-2020 Dietary Guidelines for Americans, a healthy diet includes up to 10% of calories from added sugars, allowing room for sugars in nutritious foods and occasional sweets and treats.

A calorie is a measure of energy in food. Carbohydrates and proteins supply your body with 4 calories per gram, while fats provide you with 9 calories per **gram**. A teaspoon of sugar has 15 calories.

All About Balance

If you eat more calories than you **expend**, no matter if the calories come from carbohydrates, proteins or fats, the excess energy is stored as added weight on your body. That's why it's important to balance the food you eat with regular physical activity. And, it's important to remember that foods and beverages that don't provide significant nutritional value (vitamins and minerals) should not be the centerpiece of your diet but consumed as treats.

Sugar, extracted from sugar beet or sugar cane or in fruits and vegetables you bite into, has been incorporated in the diets of people throughout all of time. Like many other foods and ingredients, sugars have been the subject of countless studies. And while new research will help us better understand how our food choices affect our health, the evidence consistently shows that a balanced lifestyle based on moderation, a variety of food choices and physical activity tends to lead to the best outcomes when compared to simply focusing on cutting out or adding one ingredient or another.

Simply put: by practicing **moderation** and portion control, there is room to include an appropriate amount of sugar in a healthful lifestyle.

Remember, making sure that fruits, vegetables, whole grains and other fiber and calcium-rich foods are the centerpiece of your diet is most important. Sugar makes many of these healthful foods more palatable, which helps contribute to intakes of important vitamins, minerals and fiber. Getting ready for breakfast? Go ahead, sprinkle a little brown sugar on that bowl of nutritious oatmeal. Sugar can make healthy foods taste better so you are more likely to eat them.

GLOSSARY

expend – *v.* to burn up or use up

gram – *n.* a unit of weight measurement. A gram weighs about as much as a small paper clip.

macronutrient – *n.* a nutrient (a carbohydrate, protein or fat) that is present in large quantities in foods

moderation – *n.* the avoidance of excess or extremes, especially in one's behavior

palatable – *adj.* pleasant to taste, acceptable or satisfactory

How Can I Tell How Much Sugar Is In My Food?

Using the Nutrition Facts Label

The goal of the Nutrition Facts Label is to provide you with access to the information you need to make informed decisions about the foods you eat. However, all that information can be confusing! Understanding and knowing how to use the numbers on the label is the only way the information can actually inform your food choices. It is important to look at how each food and beverage fits into an entire day's intake and not just focus on the Nutrition Facts Label of one product. It's also helpful to examine the entire nutrient package of a product and consider how it fits in you total daily diet instead of focusing on one nutrient.

When it comes to sugar, there are some definitions you need to know to be able to use the information on the label. See if you can answer the questions by using the Nutrition Facts Label for strawberry yogurt:

Nutrition Facts

1 serving per container

Serving size **1 container (150g)**

Amount Per Serving

Calories **130**

	% Daily Value*
Total Fat 2.5g	**3%**
Saturated Fat 1.5g	**8%**
Trans Fat 0g	
Cholesterol 15mg	**5%**
Sodium 45mg	**2%**
Total Carbohydrate 15g	**5%**
Dietary Fiber 0g	**0%**
Total Sugars 11g	
Includes 7g Added Sugars	**14%**
Protein 12g	**24%**

Vitamin D 0% • Calcium 15% · Iron 0% · Potassium 6%

INGREDIENTS: CULTURED PASTEURIZED GRADE A LOW FAT MILK, WATER, SUGAR, STRAWBERRIES, CORN STARCH, LEMON JUICE CONCENTRATE, NATURAL FLAVOR, VEGETABLE JUICE COLOR, CAROB BEAN GUM
CONTAINS: MILK.

Total Sugars

This number includes the total of both naturally occurring sugars and sugars added for sweetening or other functional purposes. For example, in strawberry yogurt the naturally occurring sugars come from both the milk and the strawberries, and the added sugars come from the sugar added to balance and enhance flavors.

? **How many total sugars are in one serving of this yogurt?**

Added Sugars

Added sugars are listed to help you know how much you are consuming. The 2015-2020 Dietary Guidelines for Americans recommend limiting added sugars to no more than 10% of calories per day from added sugars. That is because it may be difficult to get the nutrients you need for good health while staying within calorie limits if you consume more than 10% of your total daily calories from added sugars.

? **How many added sugars are in one serving of this yogurt?**

Added sugars refers to a category that includes a variety of caloric sweeteners, including sugar and many other sweeteners that are classified as sugars. Added sugars do not include low- and non-caloric sweeteners; those are only found on the ingredient list.

Percent Daily Value

Shown as a general rule, the percent daily value tells you how much a nutrient in a serving of food contributes to a daily diet, based on a target of 2,000 calories per day.

? **If 10 grams of added sugars = 20% daily value, how many grams of added sugars = 100% daily value?**

Ingredient List

While not technically a part of the Nutrition Facts Label, ingredients are listed in descending order by weight on the back (or side) panel of packaged goods.

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How Much Sugar Are We Consuming?

Since 2000, added sugars intake in the United States has decreased by nearly 25%, from 21 teaspoon equivalents per day to 16.1 teaspoon equivalents per day.

Intake data for total added sugars is a combination of the intakes of all caloric sweeteners, including sugar (sucrose from sugar beets and sugar cane), high-fructose corn syrup (HFCS), honey, maple syrup and others.

In 2016, added sugars was reported to be about 12.6% of total calories, just slightly above the 2015-2020 Dietary Guidelines for Americans recommendation of 10% of calories from added sugars per day.

PERCENT OF CALORIES FROM ADDED SUGARS

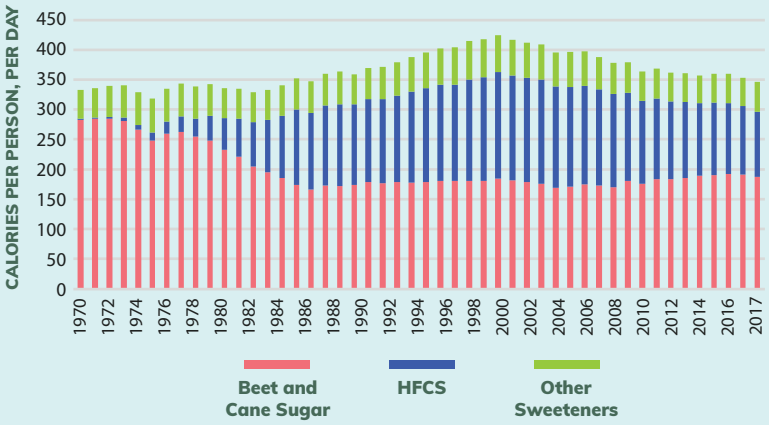
YEAR	% OF CALORIES FROM ADDED SUGAR
1999-2000	18.1
2001-2002	17.1
2003-2004	15.9
2005-2006	14.5
2007-2008	14.6
2009-2010	13.9
2011-2012	14.1
2013-2014	13.4
2015-2016	12.6

A LITTLE HISTORY

In the 1990s, added sugars consumption increased sharply as soda consumption increased and manufacturers raced to change their recipes and develop new products during the "low-fat era." Removing fat from a product requires replacing it with something. The same is true of removing sugar. Data has shown that the seesaw effect of focusing on removing or decreasing one nutrient only leads to **overcompensation** with another, whether sugar for fat or **vice versa**.

As long as dietary data have been collected, added sugars intake has never been below 10%.

CONSUMPTION OF CALORIC SWEETENERS IN THE UNITED STATES, 1970-2017



GLOSSARY

estimating – *v.* roughly calculate or judge the value, number or quantity
overcompensation – *n.* try too hard to correct a real or imagined problem, and therefore produce a new difficulty or lack of balance
proxy – *n.* a figure that can be used to represent the value of something
survey – *v.* investigate the behaviors or opinions of a group of people by asking them questions
vice versa – *adv.* the other way around

WHERE DO THESE NUMBERS COME FROM?

What We Eat in America (WWEIA) captures U.S. dietary intake as a part of the National Health and Nutrition Examination Survey (NHANES). This **survey** is conducted every 2 years in partnership with the United States Department of Agriculture (USDA) and Health and Human Services (HHS) to assess the health and nutritional status of Americans.

Loss-Adjusted Food Availability is another **proxy** for **estimating** intake. This number is calculated using food and nutrition availability for consumption and considers estimated loss or waste. The downward trend in availability of caloric sweeteners mirrors the NHANES consumption estimates.

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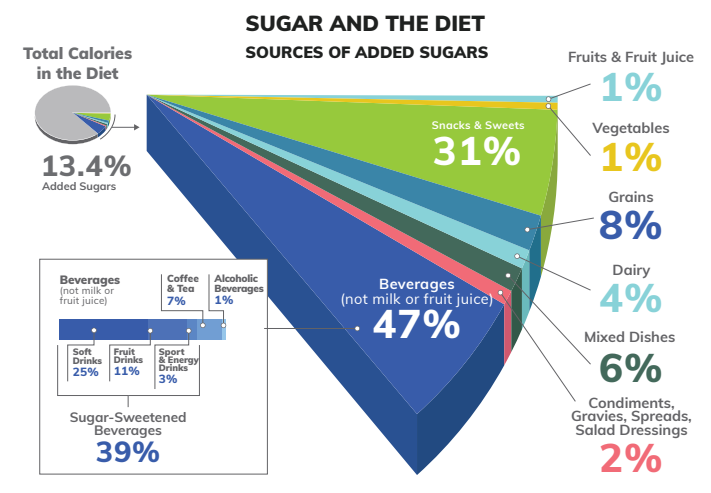
Where Do We Get Our Added Sugars?

Added sugars are found in a variety of foods and beverages for different reasons. Real sugar from sugar beets and sugar cane is often added for functions beyond sweetness.



Calorically sweetened beverages such as soft drinks, tea and fruit drinks are the main source of added sugars in the diet for all age groups in the U.S. (older than 2 years), making up almost half of the calories from added sugars. These beverages are often sweetened with high-fructose corn syrup. While these beverages continue to be the largest contributor to added sugars intakes, there has been a significant decline in calorically sweetened beverage consumption since 1999.

To get a better idea of the types of foods and beverages those who eat very little sugar are choosing compared to those who eat a lot of sugar, researchers divided the study population into 10 groups, ranging from those who don't consume much added sugars to those who consume a lot, and looked at the top sources of added sugars in each group. You can read more about the research on this topic at https://www.sugar.org/blog/where-do-kids-get-their-added-sugars/

Here is a snapshot of the top sources of added sugars in adolescents and how much they each contribute to the total amount of added sugars consumed.

The percent of total calories contributed by added sugars for adolescents and teens (ages 9-18) ranged from <11.9 to ≥19.6%, with an average of 16.2%.

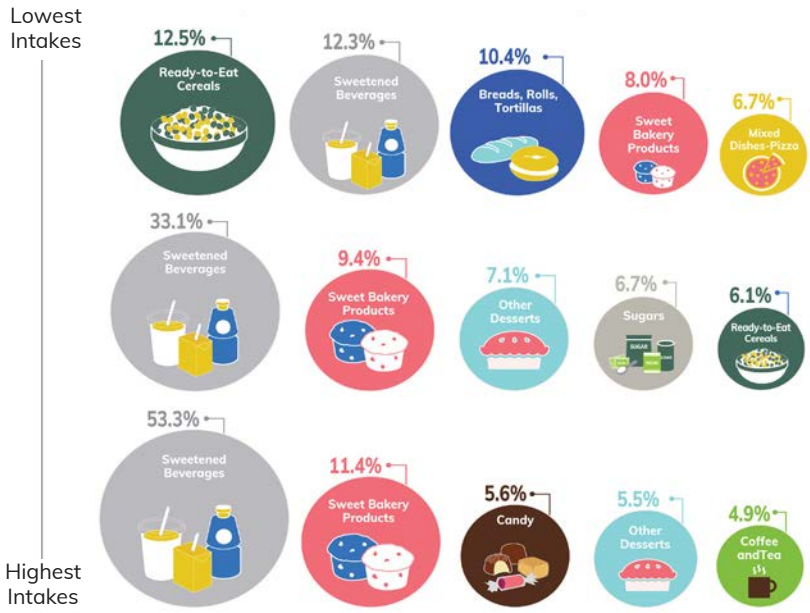
The findings show that for adolescents and teens, ***sweetened beverages are the primary source of added sugars except for the lowest added sugars consumers.***

The second largest source was sweet bakery products. Candy was also among the top 10, ranking increasingly higher with increasing added sugars intake.

It is worth noting that ***the list of top 10 sources of added sugars also includes foods that contribute important nutrients*** such as fiber, vitamins and minerals, like ready-to-eat cereals and flavored dairy. Both were in the top 10 sources of added sugars for adolescents and teens.

Top 5 Food Sources of Added Sugars for Adolescents and Teens 9-18 Years from Low to High Intake

(% TOTAL ADDED SUGARS FROM FOOD CATEGORY)



ACTIVITY

Keep a food journal for a week and see if you can identify what your top sources of added sugars are. Which of these sources contribute important nutrients? Which of these sources are considered treats?

Let's Bake!

Try these recipes that use various types of sugar (with appropriate supervision).

On-the-Fence Brownies

Recipe courtesy of Whole Grains Council (via HomeBaking.org)

Prep Time: 15 minutes
Cook Time: 28 minutes
Serves: 24

INGREDIENTS

1 cup unsalted butter
2 ¼ cups **granulated sugar**
1 ¼ cups Dutch process cocoa
1 teaspoon salt
1 teaspoon baking powder
1 tablespoon vanilla extract
4 large eggs
1 ½ cups white whole wheat flour
1 cup chopped walnuts or pecans (optional)
1 cup chocolate chips (optional)

INSTRUCTIONS

1. Preheat the oven to 350°F.
2. Lightly grease a 9 x 13-inch pan.
3. In a medium-sized microwave-safe bowl, or in a medium saucepan set over low heat, melt the butter.
4. Add the sugar and stir to combine.
5. Return the mixture to the heat (or microwave) briefly, just until it's hot (110°F to 120°F — about 40°C), but not bubbling; it will become shiny looking as you stir it. Heating this mixture a second time will dissolve more of the sugar, which will yield a shiny top crust on your brownies.
6. Stir in the cocoa, salt, baking powder and vanilla.
7. Whisk in the eggs, stirring until smooth.
8. Add the flour, nuts and chips, again stirring until smooth. Spoon the batter into the prepared pan.
9. Bake the brownies for 28 to 30 minutes, until a cake tester inserted into the center comes out clean. The brownies should feel set on the edges and in the center. Remove them from the oven and cool on a rack before cutting and serving.

Oatmeal Bread

Recipe courtesy of FCCLA (via HomeBaking.org)

Serves: 12

INGREDIENTS

1 cup rolled oats
1 teaspoon salt
1 ½ cups boiling water
1 packet dry yeast (active)
¼ cup warm water (105°F to 115°F)
¼ cup **molasses**
1 ½ tablespoons vegetable oil
2 cups whole wheat flour
2 ½ cups flour (all-purpose)

INSTRUCTIONS

1. Combine rolled oats and salt in a large mixing bowl. Stir in boiling water; cool to lukewarm (105°F - 115°F).
2. Dissolve yeast in ¼ cup warm water in a small bowl.
3. Add yeast water, molasses and oil to cooled oatmeal mixture.
4. Stir in whole wheat flour and 1 cup all-purpose flour. Add additional all-purpose flour to make a dough stiff enough to knead.
5. Knead dough on a lightly floured surface until smooth and elastic, about 5 minutes.
6. Place dough in a lightly oiled bowl, turning to oil top. Cover with a clean towel; let the dough rise in a warm place until double, about 1 hour.
7. Punch dough down; turn onto a clean surface. Shape dough and place in a greased 9 x 5-inch pan. Cover with a clean towel; let rise in a warm place until almost double, about 1 hour.
8. Preheat the oven to 375°F.
9. Bake for 50 minutes or until bread sounds hollow when tapped. Cover with aluminum foil during baking if bread is browning too quickly.
10. Remove bread from pan and cool on a wire rack.

Easy Apple "Doughnuts"

Recipe courtesy of The Family Dinner Project (via HomeBaking.org)

Prep Time: 7 minutes
Cook Time: 2 minutes
Serves: 14-16

INGREDIENTS

2 medium-sized apples, peeled, cored and cut crosswise into rings (about ¼-inch thick)
½ cup all-purpose or whole wheat flour
½ teaspoon baking powder
¼ teaspoon baking soda
¼ teaspoon nutmeg
½ teaspoon vanilla extract
1 large egg
6 tablespoons apple cider
2 tablespoons unsalted butter

Topping:
½ cup **granulated sugar**
1 teaspoon cinnamon

INSTRUCTIONS

1. In a medium bowl, whisk together the flour, baking powder, baking soda and nutmeg.
2. Add the egg and vanilla and mix.
3. Add the apple cider and whisk slowly until a smooth batter forms.
4. Melt the butter in a skillet over medium-high heat.
5. Dip the apple slices into the batter to coat them. Let excess batter drip off.
6. When the butter in the skillet starts to bubble, add the apple slices in a single layer. You may have to work in batches.
7. Let the apple slices cook for about 2 minutes on the first side, just until golden brown and set. Flip and cook for another 1 to 2 minutes on the second side, until golden brown.
8. Remove the apple "doughnuts" from the pan and set on paper towels.
9. In a shallow dish, mix together the cinnamon and granulated sugar. Toss the apple "doughnuts" in the cinnamon sugar, sprinkle with **powdered sugar** and serve.

Whole Wheat Jam Bars

Recipe courtesy of Texas Wheat (via HomeBaking.org)

Prep Time: 15 minutes
Cook Time: 35 minutes
Serves: 12

INGREDIENTS

½ cup packed **brown sugar**
¾ cup to 1 cup whole wheat flour
¼ teaspoon baking soda
⅛ teaspoon salt
1 cup rolled oats
½ cup butter, softened
Use scant ⅔ cup seedless raspberry jam, or other jam of choice

INSTRUCTIONS

1. Preheat the oven to 350°F.
2. Grease one 8-inch square pan.
3. Combine brown sugar, flour, baking soda, salt and rolled oats.
4. Add butter using your hands or a pastry blender to form a crumbly mixture.
5. Press 2 cups of the mixture into the bottom of the prepared pan.
6. Spread jam over the mixture to within ¼ inch of the pan edge.
7. Sprinkle the remaining crumb mixture over the top, and lightly press it into the jam.
8. Bake for 35 to 40 minutes or until lightly browned. Allow to cool before cutting into bars.