

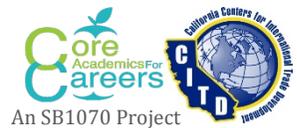
Name(s):

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Fresh Fruit for All

Providing unblemished ripe fruit to the store all year long

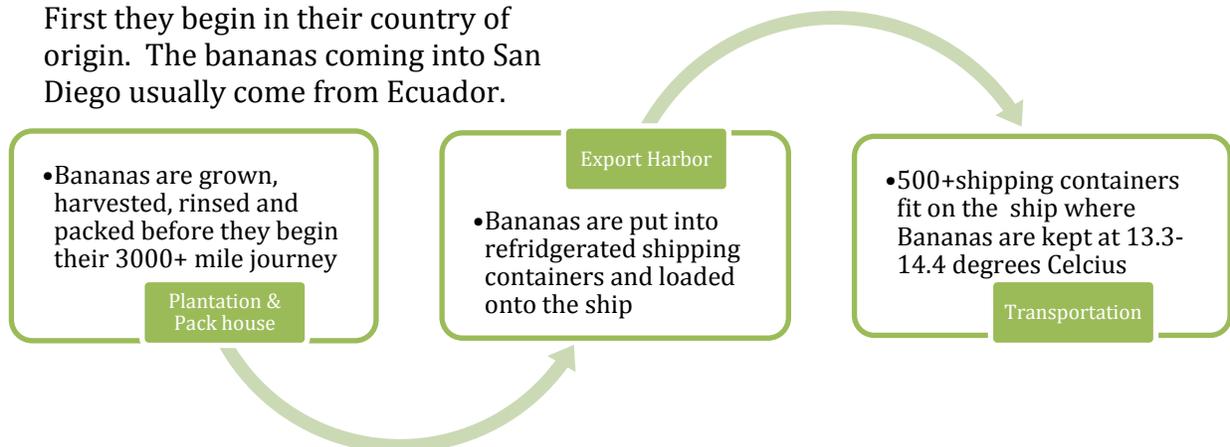


Case Study - Banana Logistics

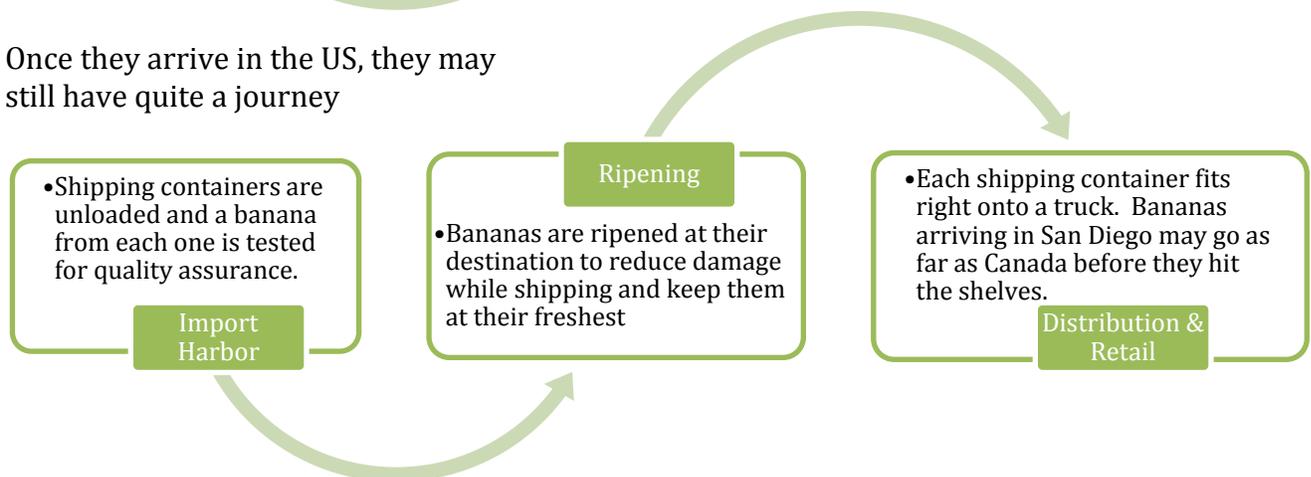
If you have ever tried to start a garden you know that each type of fruit or vegetable has a certain season. You may be able to get strawberries from your own yard all summer long, but once winter sets in those strawberries will not grow. Historically, the fruits and vegetables in the local stores were limited to what was in season nearby. In the global market place we can get fruits and vegetables year round as many foods are imported from the southern hemisphere, where summer has just begun when our winter sets in.

One example of a fruit that comes from South or Central America all year long is Bananas. Bananas have their own typical transport chain. This can vary from company to company, but they generally go through the following steps.

First they begin in their country of origin. The bananas coming into San Diego usually come from Ecuador.



Once they arrive in the US, they may still have quite a journey



All of the bananas that Dole imports into the western United States and Canada come through the Port of San Diego. 500 or more containers of bananas per week are shipped from Ecuador and Peru into the Port of San Diego on a large shipping freighter with refrigerated shipping containers. These containers are then carried by truck to the store so that you can buy fresh bananas all year long.

From Freight to Food- The Art of Ripening

Have you ever picked up a piece of fruit to see if it is ripe? You probably looked for fruit that was just barely squishy. As fruit ripens it becomes softer, however, this poses a big problem for shipping fruit. A piece of fruit that is ripe bruises more easily. Also – if one piece of fruit goes bad and begins to mold, it can affect the other fruit around it and cause them to mold as well. This adds an extra concern when transporting fruits and vegetables over long distances.

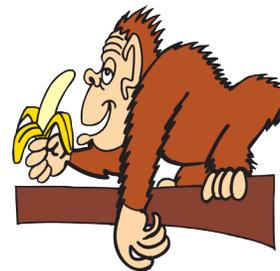


Some fruits, like bananas, can be picked when they are still green. This means they can ship them while they are firm and unripe so that there is less of a chance for the fruit to be damaged or spoil. But we don't like to eat the hard green starchy bananas, so logistics managers had to work with food scientists to devise a way to trigger ripening when the bananas are ready to be sold.

To really understand ripening, the first question is, what is the point of a piece of fruit? We enjoy it and received nutrients from it, but why would a plant put all that energy and nutrients into something that will be eaten by another organism?

Fruit is full of seeds, which are the key to plant reproduction. In order for the plant to have a chance of reproducing, those seeds need to get into the ground. Ideally, it is best for the seeds to be spread out, farther away, so that multiple plants can grow without competing for resources.

Ultimately, this means that the goal of the plant is to have their seeds eaten. This is why it is beneficial to entice predators with sugary fruit. Once eaten, the undigested seeds of the fruit will be deposited in the animal's defecation, surrounded by rich nutrients and ready to grow more plants wherever the seeds were deposited.



Fruits and vegetables will begin to ripen once they are exposed to specific chemicals. Specifically the plant hormone called ethylene is responsible for ripening bananas. Carbon Dioxide helps to inhibit the production of ethylene, so bananas or other fruits in transit are often exposed to higher levels of CO₂ in order to slow their ripening.



Ethylene is produced in many plant tissues, and production increases whenever the plant is exposed to excessive heat or is damaged. It prompts seeds to germinate, it is part of the process of leaves changing colors in the fall, and it can trigger the death of flower petals. Ethylene causes ripening because it begins production of amylase, which will break down the starches to make sugar – which is why ripe fruit tastes sweeter.

Hormones travel throughout the plant from cell to cell. There is a great advantage of having a signal to encourage quick ripening. If the parent plant dies it helps ensure that animals eat the fruit and spread the seeds so that more plants will grow.

Ethylene is also emitted as a gas into the air around the plant and can help warn nearby plants that danger is near so they should activate their defenses. This causes nearby plants to begin ripening their own fruit.

Understanding the role of Ethylene has allowed scientists to develop processes for ripening bananas. They are able to produce ethylene synthetically, and when they want the bananas to become ripe, they only need to put them in a sealed room or container with an Ethylene source and they will ripen quickly.

This is also how we keep North American fruit for so many months after harvest. By picking apples before they naturally ripen, then storing them in an Ethylene free area, they can survive for months. Right before they are taken to market they are exposed to Ethylene and they begin to turn sweet and ripe.

Case Study Questions

1. Define the following terms using context or a dictionary

Logistics	Import	Export	Ripe	Transport chain
Amylase	Germinate	Ethylene	Freight	Hormone
Polymer	Monomer	Sugar	Starch	Shipping freighter
Synthetic	expose			
2. Where are many foods imported from during our winter? Why can they grow food when we can't?
3. Where do many of our bananas come from? How many miles away is it?
4. At what temperature are bananas kept while being shipped?
5. What is the hormone that plants produce that begins the ripening process?
6. What can be done to slow ripening?
7. What can be done to speed up ripening?
8. What are some of the processes that Ethylene causes?
9. Using the terms "polymer" and "monomer" describe the relationship between sugar and starch.
10. Why does ripe fruit taste sweeter than unripe fruit?

Academic Career Connections

Chemistry Connections

- Apply scientific principles and evidence to provide an explanation about the effects of
- HS-PS1-5.** changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- HS-PS1-6.** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

There are a number of things that can be done to change the rate of a reaction. The Carbon Dioxide in the container can inhibit ethylene production,. In this case, by reducing the amount of ethylene present there is decreased production of amylase and other chemicals that increase the rate of spoilage. Read more in depth about this process at <http://ucce.ucdavis.edu/files/datastore/234-267.pdf>

Chemical agents have an essential role in biological processes. Biochemistry is an important field of study, because chemical processes are integral in any living thing. Starches are a macromolecule that can be broken down by an enzyme like amylase into sugars. This is the reaction that occurs in fruit ripening.

Biology Connections

- Construct and revise an explanation based on evidence for how carbon, hydrogen, and
- HS-LS1-6.** oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
- HS-LS2-8.** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Starches are large macromolecules found in many plants. Fruits have many starches early on. A chain of biological reactions is started when the plant is damaged which causes the ethylene hormone to be produced which then stimulates amylase production. This enzyme breaks down the starches

Engineering Connections

- HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Designing an experiment is a key part of acting as a scientist and engineer. By analyzing the global challenge of getting fruit from farm to table while crossing oceans, mountains and more, you will challenge yourself to creating solutions just like people do in real life. Many businesses rely on scientific skills or procedures and it is essential that they have leadership and management in place who can understand and manage these logistical situations. Engineering is solving problems using science & math, and it is essential to many different jobs, including positions like this in international business!