



## **Minor Challenge Set #4**

**STEM Field:** Food Science

**Level:** Senior

**Challenge Name:** Candy Making Science

**Project Cost:** 0-20 USD

### **Materials Required:**

- Saucepan, or pot
- Kitchen space to make the caramel
- Water
- Sugar
- Stirring equipment
- Containers, or bowls, to leave the caramel to cool down
- Clock, or timer
- Measuring cups
- Candy thermometer (optional)

### **Safety:**

- Adult supervision and assistance are required to make the caramel
- Be very careful when handling the caramel, it can be very hot and can cause burning!

### **Duration:**

- The challenge take approximately 2 hours to finish, however, the time guideline is an estimation only, and students and mentors can complete the tasks around their schedules

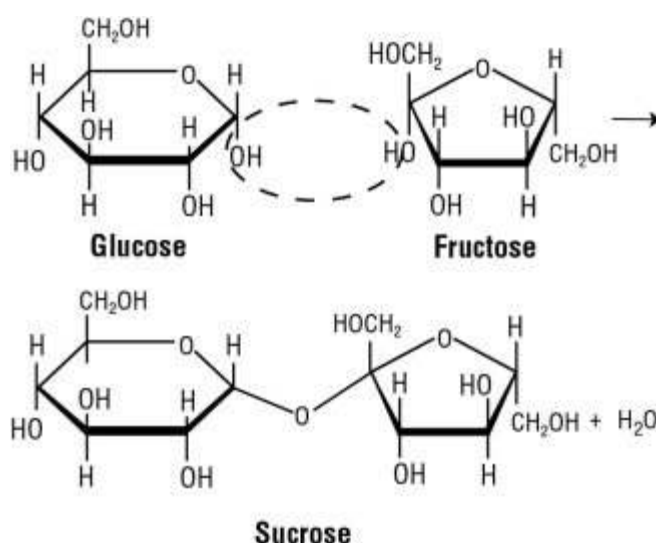
# Introduction:

Your kitchen is full of chemistry. Here is a simple chemical recipe: heat up some water in a saucepan until it boils, add some sugar, stir with a spoon, pour the solution into a container and let it cool. This very simple recipe can be used to make candies. Candies are varied in size and texture, but given they are all made from sugar, what causes their textures so different?

## What are sugars?

Sugars belong to a group of molecules called **carbohydrates**. These carbohydrate molecules are made up of building blocks that are connected to each other in various ways. Some common building blocks are called **glucose**, **fructose**, or galactose. The “regular sugar”, or **sucrose**, that we use is made up of one glucose and one fructose molecule.

These are what the chemical structures of glucose, fructose, and sucrose look like.

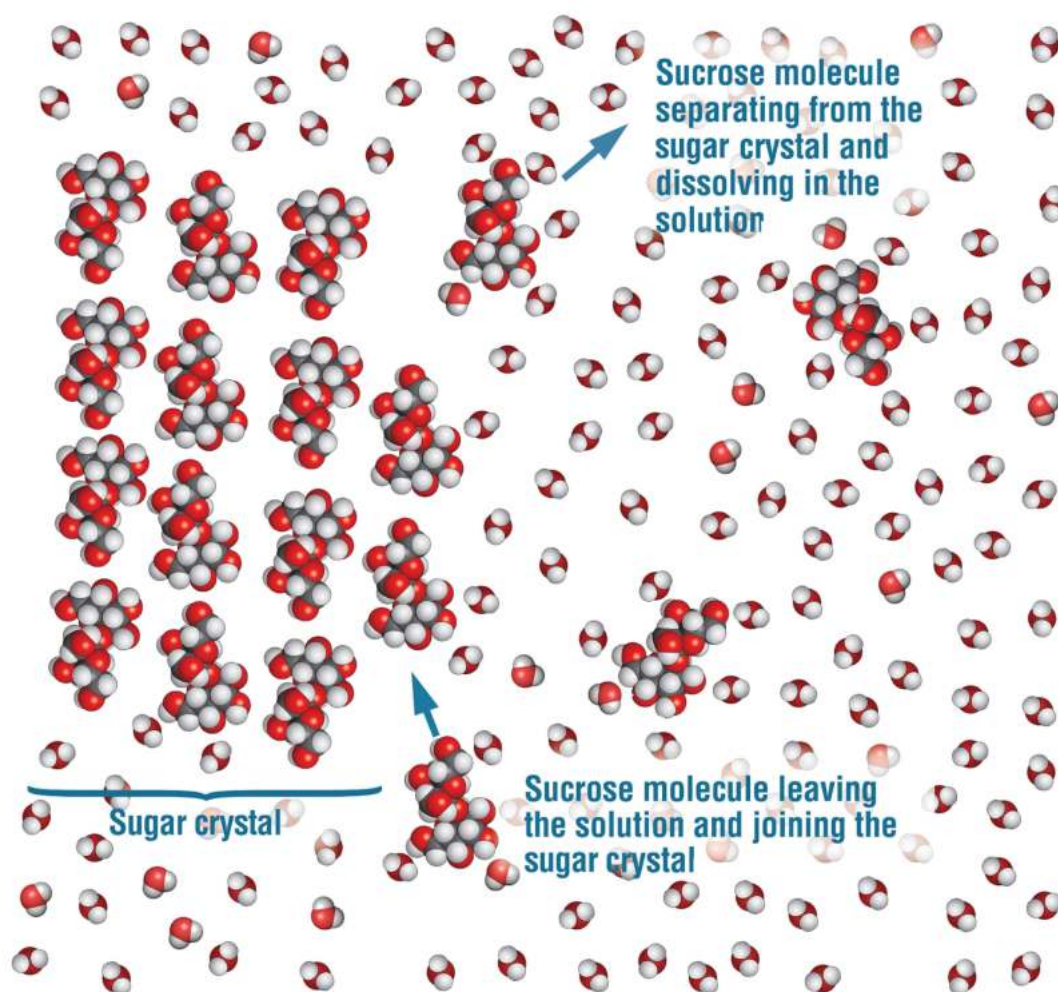


## What happens when sugar is mixed with water?

When you add sugar to water, some of these sucrose molecules are attracted to the water molecules, and so, they start to separate from each other. This then forms a solution of sugar and water.

### The catch is...

Only some amount of sugar can be dissolved in water at a given temperature and volume. This is because **not all** sucrose molecules are attracted to, and connected to the water molecules. Some sucrose molecules join other sucrose molecules to form sugar crystals. The figure below shows what happens at a molecular level.



## How are candies made?

Initially, we used more sugar than water. To get all the sugar dissolved, we heat up the water. By increasing the temperature, we are increasing the amount of sugar to be dissolved in water.

After cooking, we leave the solution to cool down. At this stage, by decreasing the temperature, we are decreasing the amount of sugar to be dissolved in water. However, more sugar molecules are still connecting to one another, forming sugar crystals. This is how candies are made.

To make **rock candy**, the solution is left to cool down over a longer period of time (over a few days), which allows larger sugar crystals to be formed. If you want to make smaller sugar crystals, you can continuously stir the solution to prevent the sugar crystal from growing too big. By stirring, you are also allowing more small sugar crystals to form.

In other candies where you don't want the sugar crystals to form at all, you would aim to cool the sugar syrup to cool down as fast as possible. When this happens, the sugar crystals will not have time to form.

## Instructions:

- 1) Think about whether you want to make rock candy, or other types of candy. From the background information in the Introduction section, what do you think you need to do to achieve the type of candy you want to make?
- 2) With an adults' help, dissolve water and sugar in a ratio of 1:3 or 1:4 in a saucepan. For example, for the 1:3 ratio, for  $\frac{1}{3}$  cup of water, you would need 1 cup of sugar.
- 3) Heat the mixture in the saucepan on high heat. Use a candy thermometer (if you have one) to track the temperature. Otherwise,

keep the temperature constant throughout the process, and keep track of the time you let the mixture cook on high heat for.

- 4) Record the temperature, or the time you cook the mixture. The time and temperature depends on how you want to make your sugar mixture.

**Note:** Allow the mixture to cool for 10-15 minutes before touching the mixture!

- 5) Record your observation of the mixture, in particular, the texture, and colour of the mixture. Record how long you let the mixture cool down before checking the texture and colour.
- 6) Modify your recipe if needed. Record the process of cooking the sugar water mixture, and how long you let the mixture cool down. Record your results.

## Reflection Questions:

- Are there any improvements you would make to this challenge?
- What are the key science and engineering concepts that relate to this challenge?
- Can you explain your results based on your research on chemistry of candy making, or from the background information given?
- Glucose is the main source of energy in biological systems. In plants, glucose is generated through photosynthesis. Some plants store glucose in linked chains called starch. Can you give some examples of food where you can find glucose and fructose?
- More than just adding sweetness, why do you think sugar is added to different types of food? Food science is about handling, preserving, and processing food. Food scientists study properties of food to ensure their safe use and consumption, while

maintaining nutritional value, texture, and flavour. How does sugar help us achieve this?

## Submission Guidelines:

- Submit photos of the experimental setup, your observations and results. Include a short summary that addresses the reflection questions.

Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your parent or guardian first.

- The submission form is on the Minor Challenges page:  
<https://sciencechallenge.org.au/index.php/minor-challenges/>  
Fill out the details and make sure you upload your submission.

## Learn More! Resources:

- This article features the career of a food scientist:  
<https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/past-issues/2019-2020/feb-2020/chemistry-in-person.html>
- This article includes more details on what happens when you heat a sugar solution:  
<https://www.exploratorium.edu/cooking/candy/sugar.html#:~:text=The%20white%20stuff%20we%20know,elements%2C%20sugar%20is%20a%20carbohydrate>

# Bibliography:

- Husband, T., 2014. *The Sweet Science of Candymaking* - American Chemical Society. [online] American Chemical Society. Available at: <<https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/past-issues/archive-2014-2015/candymaking.html>> [Accessed 10 April 2022].
- Science Buddies. 2017. *The Sweet Beginnings of Caramelization* | Science Project. [online] Available at: <[https://www.sciencebuddies.org/science-fair-projects/project-ideas/FoodSci\\_p018/cooking-food-science/caramelization](https://www.sciencebuddies.org/science-fair-projects/project-ideas/FoodSci_p018/cooking-food-science/caramelization)> [Accessed 10 April 2022].