



# *The Science of Chocolate*

SATISFY YOUR SWEET TOOTH





# THE *Science* OF *Chocolate*

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# 4-H FOOD SCIENCE OF CONFECTIONS SERIES

The science of confections series contains two manuals:

***Satisfy Your Sweet Tooth: The Science of Sugar* for ages 8–18**

***Satisfy Your Sweet Tooth: The Science of Chocolate* for ages 8–18**

The manuals may be used by anyone in these age groups regardless of their prior knowledge of confections.

Each manual lists the objectives for the project and each experiment includes a short lesson, followed by hands-on experiments and questions for further learning. In addition, each manual includes an achievement program to help youth identify their goals and keep track of their accomplishments.

## ABBREVIATIONS

hr	hour
lb	pound
min	minutes
oz	ounce
qt	quart
tbsp	tablespoon
tsp	teaspoon

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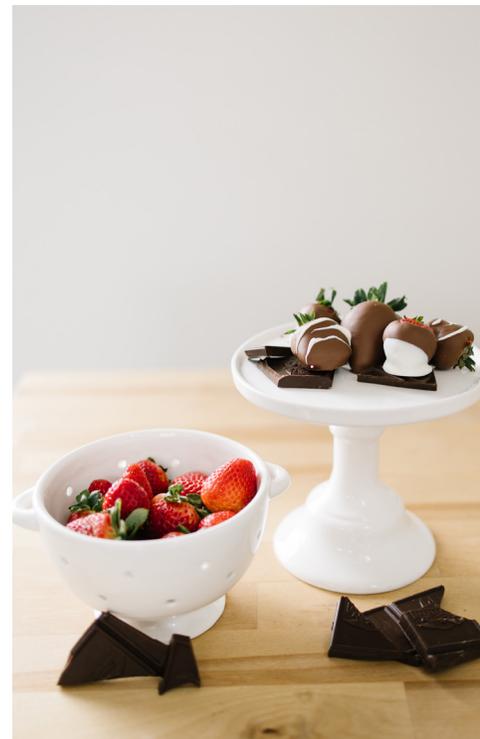
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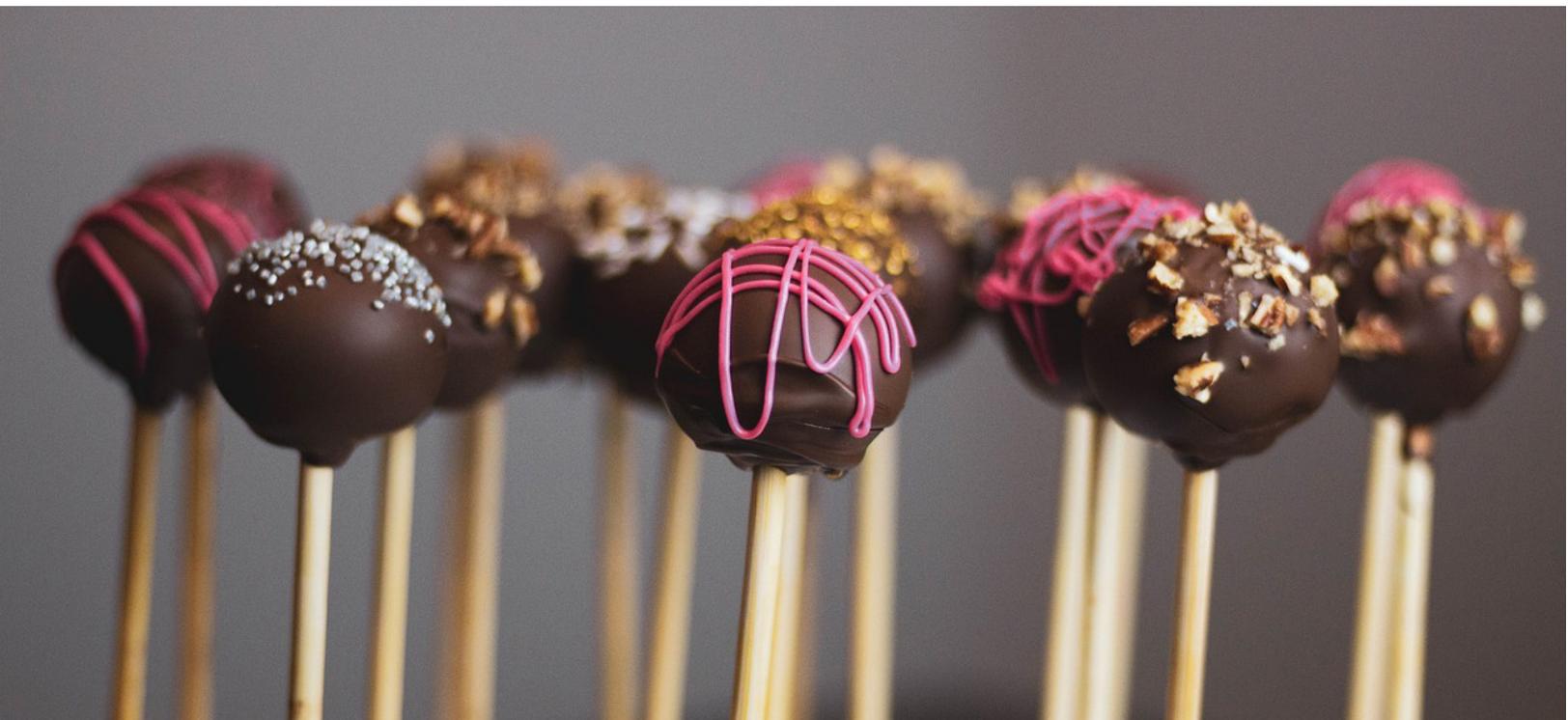
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PART I:

# *Project Essentials*



# NOTES TO PROJECT HELPER

This manual is for youth who want to learn about chocolate. They can't do it without your help. You play a key role in helping them learn the basic information, skills, and safety practices needed to make chocolate. With your help they will set goals, find resources, and evaluate their own progress as they complete this manual. **Note: Youth may use any recipe they want. If they use a recipe that is not in the manual, they need to include the recipe they used with their exhibition materials.**

## Your Responsibilities

- Become familiar with the material in this book.
- Assist youth in selecting and completing chocolate activities appropriate for their skills.
- Guide youth through thinking about why something happens or why it doesn't.
- Encourage youth to complete difficult tasks to expand their skills.
- Help youth learn about their strengths and weaknesses.
- Help youth evaluate the quality of their completed activities. Questions at the end of each activity help youth to think through the steps in the project and how to apply their new skills in their everyday lives.
- Set an example by following kitchen and food-safety rules.

## Using Experiential Learning

Experiential learning is the process of “do, reflect, apply.” It is an inquiry-based approach to learning. Rather than being provided with information, learners experience, share, process, generalize, and apply what they are learning.

**Do.** Experience the activity, perform, do it. This could be a group activity or experience. It involves doing, it may be unfamiliar, and it pushes the learner to a new level.

**Reflect.** Share reactions and observations. Learners talk about their experiences while doing the activity. They share their reactions and observations and freely discuss their feelings.

**Apply.** Generalize to connect the experience to real-world examples. Learners identify general trends and real-life examples of when they could use what they have learned.

## Developing Life Skills

Iowa State University's Targeting Life Skills Model helps identify the life skills that youth attain through the experiential learning process. The life skills targeted in this manual include those listed in the sidebar to the right.

### HEAD

- Wise use of resources
- Planning/organizing
- Goal setting
- Critical thinking

### HEART

- Communication

### HANDS

- Marketable skills
- Self-motivation

### HEALTH

- Healthy lifestyle choices
- Disease prevention

## MY PLANS

This manual teaches youth the scientific concepts related to confections. Youth complete experiments in order to create chemical reactions that produce desirable confections (see My Achievement Program for assignment-tracking aids).

Use this page to help you plan how to finish this manual.

- Select your helper and write down his or her contact information.
- Set goals for each year.
- Complete the number of activities required by your state each year.
- Use any recipe you want. If you use a recipe that is not in the manual, include the recipe used with the materials you exhibit.
- You may utilize videos from the internet to assist with learning chocolatier skills.
- Complete a presentation or demonstration each year.

Project helper: \_\_\_\_\_

Contact information: \_\_\_\_\_

### My Achievement Program

Complete at least one (1) Chemistry Experiment, one (1) Research and Development Experiment, and four (4) Chocolate Experiments each year. Ask your helper to initial each experiment after you've completed it.

My Activities		
Activities	Date Completed	Helper's Initials

## WHAT DO YOU KNOW?

The following is a list of the skills you will learn in the 4-H food science manual, *Satisfy Your Sweet Tooth: The Science of Chocolate*. Before you start working on the project, read through the list of skills below and rate yourself on how much you know now. Then at the end of each project year, rate what you know after completing the activities. Use the following rating scale:

Begin each statement with the phrase, "I know," then circle 1 = not at all; 2 = a little; 3 = a lot.

I Know . . .	Before			After		
How is chocolate made	1	2	3	1	2	3
What happens to chocolate when it melts	1	2	3	1	2	3
What tempering chocolate means	1	2	3	1	2	3
How to temper chocolate	1	2	3	1	2	3
The difference between tabling and seeding chocolate	1	2	3	1	2	3
What bloom means	1	2	3	1	2	3
How to make dipped chocolate	1	2	3	1	2	3
How to make a filled chocolate using molds	1	2	3	1	2	3
What an emulsion is	1	2	3	1	2	3
How to make ganache	1	2	3	1	2	3
How to make different ratios of ganache	1	2	3	1	2	3
The steps to replicate a product	1	2	3	1	2	3
How to conduct a sensory test	1	2	3	1	2	3

# MyPlate

We use it every day — a dinner plate! MyPlate is a visual reminder of how to fill our plate with healthful foods to build and maintain healthy bodies and minds. What you eat and drink matters (United States Department of Agriculture n.d.). Try the following:

- Focus on variety, amount, and nutrition.
- Choose foods and beverages with less saturated fats, sodium, and added sugars.
- Start with small changes to build healthier eating styles.
- Support healthy eating for everyone.

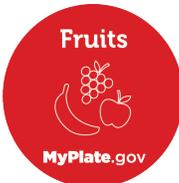
Ready to get started? These images will remind you which steps to take to maintain a healthy body.



Find your healthy eating style and maintain it for a lifetime. Focus on variety, amount, and nutrition. Need quick meals? Try ready-made fresh vegetables. Remind yourself that your healthy eating style over time is what matters most.



Make half your plate fruits and vegetables. Try a variety of vegetables from all five subgroups: dark green, starchy, red, and orange, beans and peas, and other vegetables. Raw, cooked, fresh, frozen, canned, or dried/dehydrated are all good choices.



Make half your plate fruits and vegetables. Focus on whole fruits instead of juices. Fruit is the original fast food. Keep a bowl of fruit on your kitchen table or countertop. Try adding fruit at any meal.



Make half your grains whole grains. Look for the words “100% whole grain” or “100% whole wheat” on the food label. Try brown rice, whole grain bread, pasta, and tortillas for added fiber.



Try to drink or eat more low-fat/fat-free milk or yogurt. Use dairy products on baked potatoes, as a sandwich spread, or in a smoothie. Need lactose-free options? Try fortified soy, almond, oatmeal, or rice beverages.



Vary your protein routine. Try nuts, seeds, nut butters, beans, and peas occasionally instead of just eating meat, poultry, and seafood. Add protein to breakfast or at snack time.



Make small changes: Cut out one sugary beverage per day, use a lower-salt food, or add a protein food to breakfast. Each healthy choice is a step toward a healthier you!

## Which Food Group Does Candy and Chocolate Fit In?

Chocolate is a functional food, which means it contains an active antioxidant flavanol substance called **catechin**. This antioxidant reduces the destruction of healthy cells. The fat and sugar in chocolate adds calories to our diet, so eat it occasionally (Albrecht et al. 2010).

Candy is sweet and contains a large amount of sugar, corn syrup, and/or fat. This makes the taste very desirable. Sugar is a simple carbohydrate which is quickly digested to provide quick energy and a burst of flavor. Sugar contributes to the formation of dental caries (tooth decay) or cavities and can add extra calories to our diet. Candy should be an occasional food choice to enjoy for celebrations.

### Food Group Review

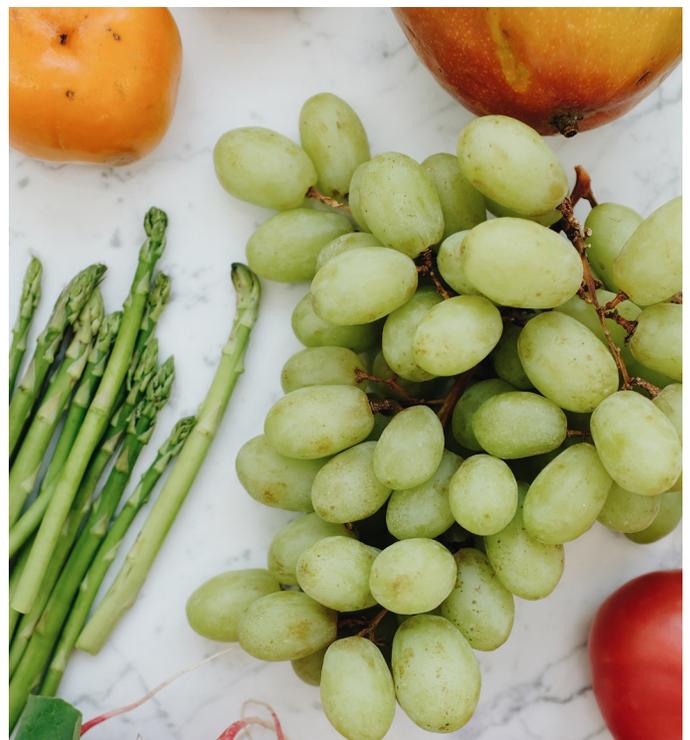
**Protein foods.** Plant and animal sources of protein-rich foods provide our body with nutrients needed to grow and maintain muscles and hair and repair wounds. Select from meat, fish, poultry, seafood, beans, nuts, seeds, and nut butters.

**Dairy products.** Calcium is the main mineral needed for healthy bones and teeth. Dairy products are a rich source of calcium and are fortified with vitamin D. Enjoy low-fat milk, yogurt, and cheese as part of every meal. If you need a dairy alternative, choose lactose-free choices or a nonmilk option fortified with calcium and vitamin D.

**Grains.** Choosing whole grains means our body receives all parts of the edible plant. Look for brown rice, oats, rye, and wheat as a first ingredient in breads and cereals. Rich in carbohydrates, this food group provides energy for our body to work, play, and grow. The fiber helps our digestion to work properly.

**Vegetables.** We all have our favorites, so try a new vegetable each week. Choose a variety of colors to benefit from the plant nutrients in the dark green of spinach and green beans, the red of tomatoes, the orange of winter squash and carrots, and the white of turnips and potatoes, to name a few. Beans and dry peas are also vegetables.

**Fruit.** Fruit choices include fresh, canned, frozen, or dried. You decide whether to eat them whole, cut up, or pureed. Any fruit is a good choice. They may be a deep yellow color and provide vitamin A, such as apricots and mangos, or may be citrus fruits rich in vitamin C, like oranges, lemons, limes, and strawberries.



## Meal-Planning Activity

What's for dinner? It's a popular question that sometimes helps us to decide what to cook. Now that you know which foods are in each food group, plan your meals to include at least one choice from each food group at every meal. Want to make it fun? Include a food that crunches when we bite into it and one with a new color we haven't tried before (for example, celery with hummus dressing or purple cauliflower with low-fat dressing). You can use this as a group activity.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Breakfast							
Lunch							
Dinner							

**Map out your meals.** Plan to eat foods you like and new ones to try. Include beverages and snacks.

**Find balance.** Plan to have the recommended number and size of servings in a twenty-four-hour day. If you miss a vegetable at lunch, have two for dinner. Visit [myplate.gov](http://myplate.gov) to find the calorie-intake level that is best for you.

**Vary protein foods.** We all like variety, so choose different types of protein throughout the week. Challenge yourself to have a different choice each day, i.e., Sunday/fish, Monday/chicken, etc.

**Make a grocery list.** Once your meals are planned, help the adult who does the shopping at your home to make a grocery list. Start by checking your own food supply at home, including the pantry, refrigerator, and freezer.

**Love your leftovers.** To prevent food wastage, enjoy any extra food as a "plan over" meal. This saves you time and money.

# KITCHEN AND FOOD-SAFETY BASICS

Kitchens are safe. It's the people who work in kitchens who can make them dangerous. Prevent that by using equipment and utensils properly and by handling sharp items, hot foods, and liquids carefully. When working in a kitchen, be aware of safety hazards and take precautions to keep injuries or accidents from happening by creating and maintaining a safe working environment.

## Kitchen Safety

Many common accidents happen in the kitchen, such as burns, cuts, and falls. While cooking should be fun, you need to follow a few basic rules:

- Don't be in a hurry. Accidents happen when you're rushing.
- Always clean up spills. Serious injuries can occur when someone falls on a wet floor.
- Never leave food unattended on the stove. Many fires develop while the cook is not paying attention to what is cooking.
- Don't use a towel in place of a hot pad. Always use pot holders for both hands.
- Turn handles to the side and away from the edge of the stove.
- When cutting food, always cut away from you. Learn how to handle a knife properly.
- Never put a sharp knife or utensil in a sink of soapy water. Someone might put his or her hand in the sink and get cut.
- Don't leave a metal spoon in a pot that is boiling.
- When opening the lid on a steaming pan, always lift away from you. Steam can burn just as easily as boiling liquid can.
- Don't use electrical appliances around the sink or water.
- Avoid loose clothing and flowing hair. If you have long hair, tie it back.

## Food Safety

- Wipe up spills when they happen.
- Wash hands with soap under warm water for at least 20 seconds. Dry hands on a disposable paper towel or a towel designated just for hands.
- Use clean towels and dishcloths.
- Never put a spoon in your mouth and then back in the food.
- Keep all preparation and cooking surfaces clean.
- Thoroughly clean all dishes, equipment, and utensils with hot, soapy water after use.
- Check each experiment recipe for the preferred best storage options.

## Chocolate Safety

- Wear latex gloves or a similar cover material on your hands to avoid leaving fingerprints on chocolates.
- When filling in chocolates, follow food-safety principles.
- Use oven mitts when handling bowls used for melting chocolate.
- Avoid storing chocolate in a refrigerator or freezer, because it is more likely to pick up other flavors (Fisher and Medeiros 2010). To extend the life of chocolate, wrap it tightly in plastic wrap and store it in a cool, dry place. Milk and white chocolate have a shelf life of six months and dark and unsweetened chocolate have a shelf life of two years.

## LAB ESSENTIALS

Below is a list of equipment you may need to complete this curriculum.

Equipment	Use
Heavy pot	Heavy-bottomed pans in small, medium, and large sizes. They need to have a smooth, heavy bottom with straight sides so the candy thermometer can clip onto the side.
Double boiler	Two pots: A large one that looks like a saucepan and a shallower one that nestles inside. You can also use a saucepan with a smaller metal bowl that sits on top.
Heat-safe dishes and pans	Bowls of various sizes; glass pan, 9 x 13 inches. Sheet-cake pan.
Metal spoon	Use a metal spoon when melting chocolate as wooden spoon can retain moisture and cause your chocolate to seize up.
Heat-resistant spatulas	A silicone spatula used for mixing high-temperature ingredients.
Hand mixer	For mixing fondant for chocolate-covered cherries.
Cutting boards	Silicone is heat resistant and nonstick. Marble, granite, or vegetable-sprayed parchment paper works well too.
Aluminum foil, wax paper, parchment paper, and plastic wrap	Used to store chocolate and to prevent sticking on work surfaces.
Timer	To time cooking, cooling, or microwaving food products.
Oven mitts	Used to protect hands when working with hot food and pans. Silicone is best.
Candy molds	Make sure molds are heat resistant, durable, and made for candy.
Cooling racks	To cool dipped or rolled chocolates.
Food-safe serving gloves	Latex gloves are best because they are close fitting.

<b>Equipment</b>	<b>Use</b>
Dipping tools	These come in various sets or individual units. Dipping forks with one, two, or three prongs and a circle ring are most common.
Candy thermometer	Used to measure the temperature and therefore the state of the cooked sugar solution.
Stone slab	Used to work chocolate and fondant with a bench scraper.
Bench scraper	Used to work chocolate and fondant on stone slabs.
Dry measuring cups	Used to measure dry and solid ingredients. They usually come in a nesting set of 1 cup, $\frac{3}{4}$ cup, $\frac{1}{2}$ cup, $\frac{1}{3}$ cup, and $\frac{1}{4}$ cup.
Liquid measuring cups	Clear measuring cups used to measure liquid. Recommend a two-cup unit or more. Glass is best, especially when working with hot liquid that needs to be measured.
Measuring spoons	Used to measure dry and liquid ingredients. They usually come in a nesting set of 1 tbsp, $\frac{1}{2}$ tbsp, 1 tsp, $\frac{1}{2}$ tsp, and $\frac{1}{4}$ tsp. When you measure liquid ingredients, measure carefully to avoid spills.

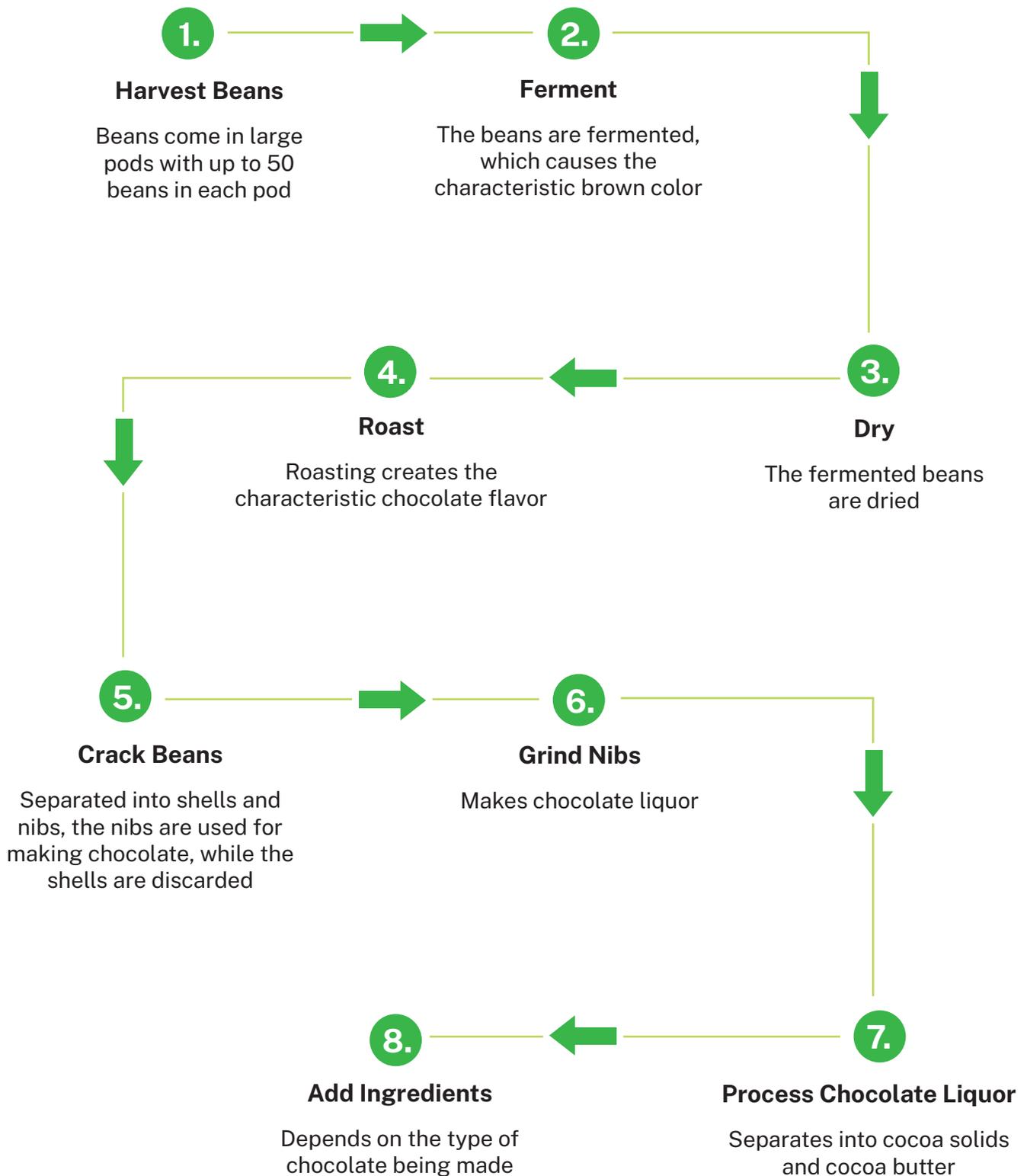
# HISTORY OF CHOCOLATE

The history of chocolate is believed to have begun when Christopher Columbus brought dark brown cacao beans from America in 1492 to the Spanish court of King Ferdinand and Queen Isabella. In 1519 Emperor Montezuma, an Aztec Indian, served it in liquid form to the Spanish conqueror Cortez, who thought the drink very bitter. Cortez took the beverage back to Spain, where it underwent several more changes. Spaniards experimented with adding other flavors, like cinnamon or vanilla, and serving it warm. The chocolate drink's popularity subsequently increased in the country, prompting the Spanish to invest in planting crops overseas with Spanish monks processing the cacao beans. Europeans soon took to the rich chocolate drink, particularly in Great Britain, where in 1657 the first of many famous English chocolate houses appeared. Once a drink for the rich, chocolate became an affordable treat for the common people in 1730, when its price dropped. By 1828, innovations like the cocoa press developed, enabling the production of other chocolate products, like cacao butter.

In 1847 an English company created the first "eating chocolate," followed by Henri Nestlé's invention of milk chocolate in Vevey, Switzerland, in 1876. To supplement US military troops with valuable calories, a sweet chocolate was added to soldier rations during World War II. Today, US Army D-Rations include three four-ounce chocolate bars.

Types of Chocolate	Process to Make
Chocolate chips	Can be any type of chocolate, formed into a drop shape
Chocolate liquor	Fermented and ground chocolate beans (forming a paste)
Cocoa butter	Comes from the fat solids separated from chocolate liquor
European or Dutch cocoa	A much darker cocoa; an unsweetened chocolate that has been washed in a basic solution to make it more basic (versus acidic)
Extra-bittersweet, bittersweet, dark, and semisweet chocolate	Cocoa butter, cocoa solids/powder, chocolate liquor, and sugar; different amounts of sugar for different levels of bitterness
Imitation chocolate	Does not have enough (or any) cocoa solids/powder, chocolate liquor, and/or cocoa butter; instead, other fats or flavors are used; cannot be labeled as chocolate but is sometimes labeled as chocolate flavored
Milk chocolate	Cocoa butter, cocoa solids/powder, chocolate liquor, sugar, and milk or milk solids
Unsweetened chocolate	Cocoa butter and cocoa solids/powder; formed from chocolate liquor
Unsweetened cocoa	Cooked chocolate liquor, a dry powder, also called Baker's Chocolate, cocoa powder, or cocoa solids
White chocolate	Cocoa butter, cocoa liquor, sugar, and milk or milk solids (notice there are no chocolate solids/powder, which is what makes it white instead of brown)

# HOW IT'S MADE – THE CHOCOLATE PROCESS

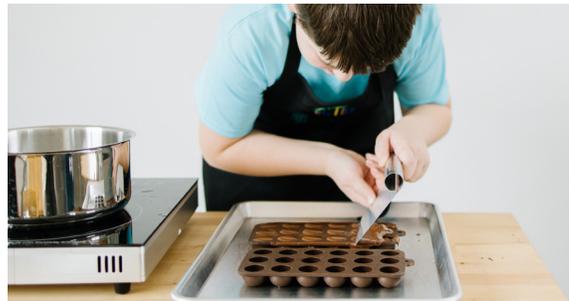


**Figure 1.** The process of making chocolate starts with raw cocoa beans, which are fermented, dried, roasted, ground, and mixed together to create the desired type of chocolate.



PART II:

# *The Science of Chocolate*

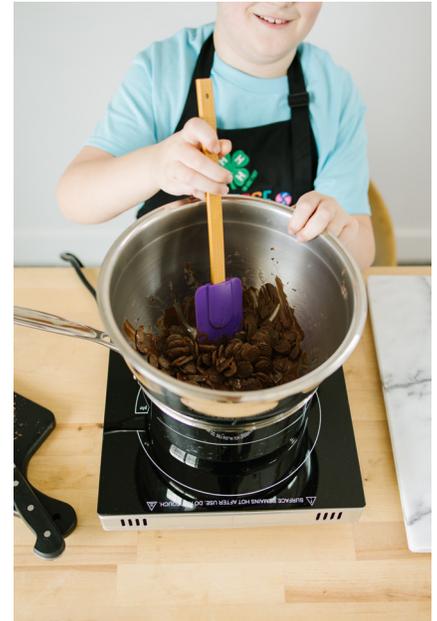


# WHAT HAPPENS WHEN CHOCOLATE MELTS?

For most types of chocolate, cocoa butter is the only source of fat, but for milk and white chocolate milk fat is the source. Since milk fat has a lower melting point than cocoa butter, it causes chocolate with milk fat to have a lower melting point.

Cocoa butter contains several different **fatty acids**, namely oleic acid, stearic acid, and palmitic acid. When chocolate melts, fatty crystals separate. **Tempering** brings the different fatty acids back into one single, stable form. The process is difficult because each type of fatty acid solidifies at a different temperature.

There are six known forms of chocolate crystal (**polymorph**), each producing different properties in the finished product (soft/firm/crumbly, etc.) Only one type of chocolate crystal — type V — is considered “perfect.” While achieving type V is difficult, it is the polymorph that most chocolate makers aim for.



**Polymorph table**, showing the desired temperature of melting chocolate.  
*Adapted from Selinger et al. n.d.*

Polymorph	Melting Temperature	Properties
I	17°C or 62.6°F	Soft, crumbly, melts easily, noticeable blooming
II	21°C or 69.8°F	Soft, crumbly, melts easily, noticeable blooming
III	26°C or 84.2°F	Firm, average snap, melts easily, some blooming
IV	28°C or 82.4°F	Firm, average snap, melts easily, some blooming
V	34°C or 93.2°F	Glossy, smooth texture, firm, melts in the mouth
VI	36°C or 96.8°F	Hard, slow melt, some blooming

## Experiment 1: Quality – Tasting Chocolate

### Supplies

- Various types of chocolate bars (dark, milk, semisweet, unsweetened, etc.)

### Objective:

In this experiment youth will be able to describe the taste of various types of chocolate.

### Instructions:

Taste each type of chocolate. Describe each. “Yucky” and “gross” are not good descriptions of flavor. Use words such as “bitter,” “creamy,” or “sweet.”

Name of Chocolate	Description

What are your thoughts about the different types of chocolate?

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What challenges did you have with trying the different types of chocolate?

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What will you try differently next time?

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## Experiment 2: Melting Chocolate

### Objective

In this experiment youth will determine the melting point of chocolate by melting white, milk, and dark chocolate and record the temperature of each once it has melted.

### Supplies

- White chocolate
- Milk chocolate
- Dark chocolate
- Thermometer
- Double boiler

### Instructions:

Cut the chocolate into small pieces. Set up the double boiler, with water in the bottom pan and one type of chocolate in the top pan or bowl. Heat the water until it simmers (not quite boiling). Keep the water hot but not boiling. Avoid allowing steam to enter the top pan with the chocolate. Stir frequently to evenly distribute the heat throughout the melting chocolate. Record the temperature when the chocolate completely melts and repeat with the other chocolate types.

Chocolate Type	Melting Temperature
White chocolate	
Milk chocolate	
Dark chocolate	

How do the melting points differ?

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Why do you think the different types of chocolate have different melting points?

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# TEMPERING CHOCOLATE

**Tempering** chocolate is the process of heating chocolate. Do you wonder if store-bought chocolate is tempered? If it is shiny and snaps when bent, it is tempered. You can purchase untempered chocolate by looking for baking chocolate and chocolate that contains cocoa butter.

## Benefits of Tempering

- Gives chocolate a smooth, glossy finish, making it easier to dip or coat with.
- Prevents “fat bloom,” which looks like white, foggy patches.
- Gives a crisp texture.
- Does not melt as easily or quickly on your fingertips.
- The chocolate more easily releases from a candy mold.

## Bloom

If chocolate is exposed to rapid changes in humidity or temperature, the surface may “bloom” or become discolored. This means the cocoa butter crystals have moved to the surface of the chocolate, which creates the lighter color. Bloomed chocolate is safe to eat and cook with, but it is no longer “in temper.”

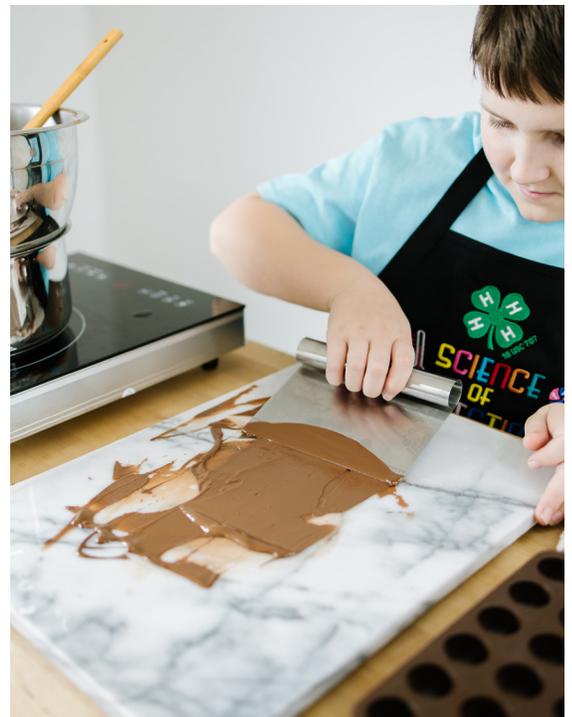
## Two Ways of Tempering Chocolate

### TABLING

One method of tempering chocolate is tabling. This involves melting an amount of chocolate, then spreading two-thirds of it on a clean marble slab and moving it around to cool it until it starts to thicken. It is a great method to use, provided you have lots of space and a large block of marble. Experienced chocolatiers prefer this approach because they can feel how the chocolate moves on a surface.

### SEEDING

Another tempering method is seeding. This involves placing tempered, tabled chocolate back into the pan with untempered chocolate. The solid chocolate encourages stable crystal formation in the melted chocolate. Stir the mixture constantly, heating it slowly (between 86°F/30°C and 90°F/32°C) until you are ready to use it.



## Experiment 3: Tempering Chocolate

### Objective:

In this experiment you will temper chocolate using the appropriate temperatures. The experiment has two parts. The first is to table chocolate and the second is to seed it.

# Tabling

Use the Temperature Chart (see next page) to table chocolate for tempering.

### Instructions

1. To temper chocolate by tabling, melt 2 cups chocolate in pan to Temp 1 for the type of chocolate. This removes all existing cocoa butter crystals.
2. Pour  $\frac{1}{2}$  to  $\frac{2}{3}$  of the melted chocolate onto a very clean and very dry marble slab, table, or countertop.
3. Spread back and forth with a metal spatula/ bench scraper until it begins to barely thicken, approximately Temp 2. The color will become dull and the texture thicken as the **beta crystals** begin to form.
4. Add the tabled chocolate back to the pan with the remaining chocolate and seed and cool it, stirring constantly.
5. After the chocolate is brought to temper, keep it at Temp 3 (the working temperature), while stirring frequently.
6. Maintain the working temperature by placing the pan over a bowl of warm water ( $90^{\circ}\text{F}$ – $95^{\circ}\text{F}$ ), making sure no water gets into the chocolate. A heating pad set on low may work as well.
7. Now the chocolate is ready for dipping, pouring, spreading, or piping. Keep the chocolate in a cool place;  $65^{\circ}\text{F}$  is optimal.

### Supplies

- Smooth table, kitchen countertop, or marble slab
- 2 cups white, dark, or milk chocolate
- Candy thermometer
- Metal spatula or bench scraper
- Heat-resistant spatula or spoon
- 1 qt pan
- Measuring cup



Temperature Category	Dark Chocolate	Milk/White Chocolate
Temp 1	120°F/50°C	104°F/40°C
Temp 2	85°F/29°C	82°F/28°C
Temp 3	90°F/32°C	84°F/29°C

### Tabling Questions

What type(s) of chocolate did you table?

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What challenges did you have with tabling the chocolate?

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What will you do differently next time? Why?

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# Seeding

## Instructions

1. Measure 1 cup of chocolate and carefully chop into pieces on the cutting board using the knife.
2. Melt 1 cup chocolate in pan to 120°F/50°C (for dark) and 104°F/40°C (milk or white).
3. Add the 1 cup chopped chocolate to the pan to seed the melted chocolate. The stable crystals in the chopped chocolate help beta crystals to form in the melted chocolate.
4. Stir continuously to keep the beta crystals suspended to result in a firm, shiny chocolate product.
5. Cool chocolate to 90°F/32°C while stirring continuously.
6. If there are still chunks of chopped chocolate, gently warm to dissolve them by placing the pan of chocolate in a sink of warm water or by using a hair dryer.
7. If the chocolate is too warm, add more chopped chocolate, a few pieces at a time, while stirring.
8. Once completely melted and cooled to 90°F/32°C, the chocolate is ready for dipping, pouring, spreading, or piping.

## Seeding Questions

What type(s) of chocolate did you seed?

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What challenges did you have with seeding the chocolate?

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What will you do differently next time? Why?

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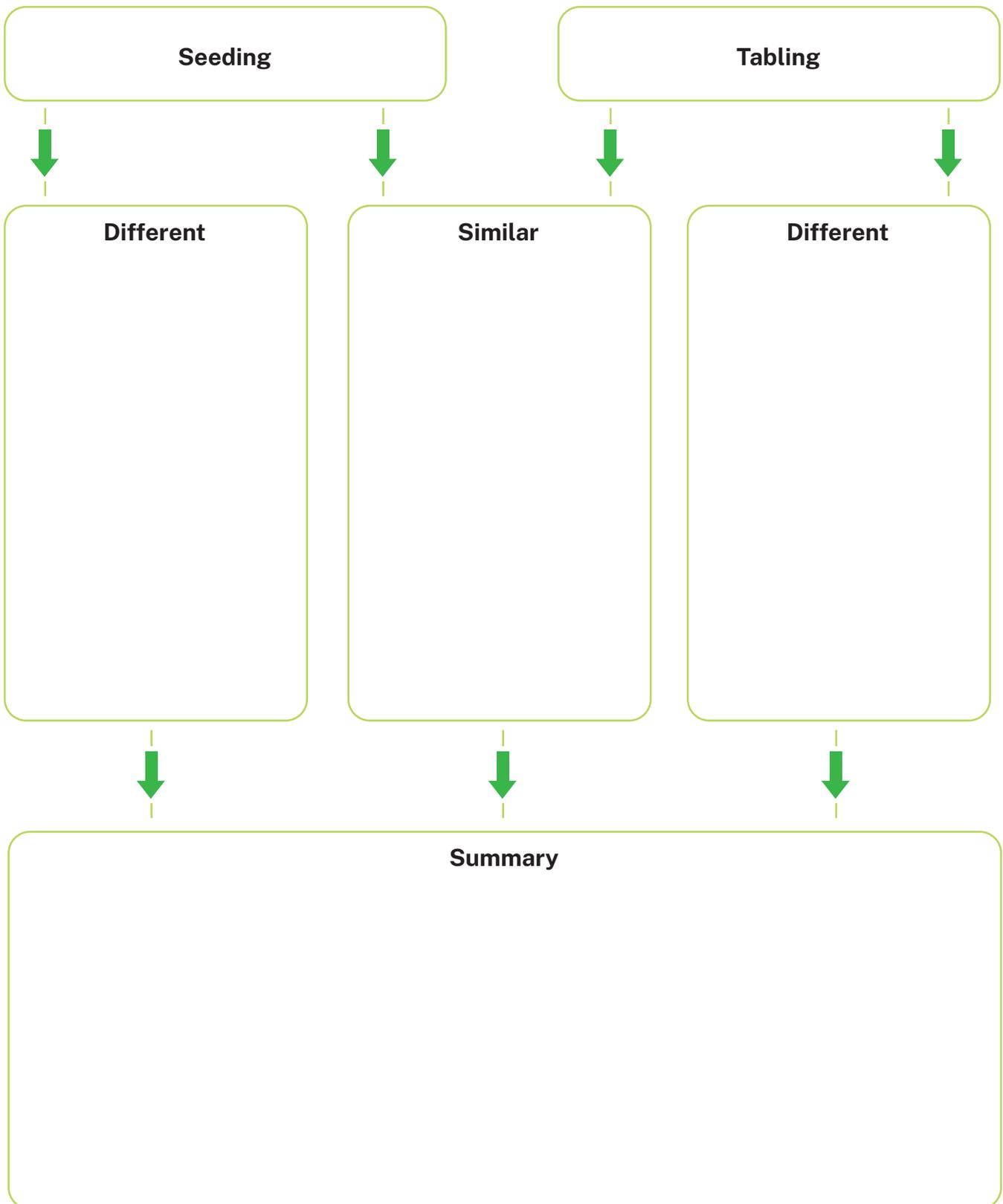
## Supplies

- Measuring cup
- 2 cups white, dark, or milk chocolate (1 cup chopped, 1 cup whole)
- Cutting board
- Knife
- 1 qt pan
- Candy thermometer
- Heat-resistant spatula or spoon



# COMPARE AND CONTRAST TABLING AND SEEDING

Complete this chart by comparing your experiments with seeding and tabling chocolate.



# CHOCOLATE EXPERIMENTS

## The Process of Making Filled Chocolate

There are two types of filled chocolate: dipped and molded. Dipped chocolates are made by submerging a filling into a deep dish of melted chocolate. This works best for fillings that are solid enough that they won't melt during the process. A similar method to dipping is enrobing, which involves pouring chocolate over a solid filling.

Molded chocolates are more delicate confections. Form part of the chocolate shell by solidifying a thin layer of chocolate in a mold. Add the filling on top of the layer and then top that with melted chocolate, enclosing the filling. This method works best when you want a specific shape or clean edges for your chocolate.

### DIPPING

Tips for successful chocolate dipping:

- Controlling the temperature of the room to 60°F–70°F/15°C–21°C makes it easier to handle the chocolate.
- Only melt what you can use for dipping, usually 1–2 lb at a time.
- When melting and cooling, stir continually to keep the cocoa butter moving through the mixture. It also distributes air, which helps with the cooling process.
- Dip quickly! The perfect dipping temperature lies between 86°F and 79°F/30°C and 26°C. Chocolate which is too warm or too cool will not set correctly and may turn cloudy.
- When dipping, before placing candy on wax or parchment paper, let any excess chocolate drip off.
- Be careful to prevent moisture coming in contact with your chocolate. Make sure fruits are completely dried off before dipping.
- Leftover chocolate? No problem.
  - Mix in some toasted coconut and place the chocolate mixture into small muffin cup liners to make haystacks.
  - Drizzle, sprinkle, or mix in the chocolate on ice cream or another chocolate-flavored, food-friendly item, such as waffles.
  - If the chocolate has not “bloomed,” reheat, cool, and scrape it into molds or small cookie cutter shapes until set. Chocolate shrinks as it cools and should release from the molds easily.



## Experiment 1: Dipping Chocolate

### Objective:

In this experiment, you will learn how to dip food with tempered chocolate.

### Instructions:

Temper chocolate based on the type of chocolate chosen. Using various dipping tools, submerge filling item into chocolate in a pot; you can use a spoon if needed to cover item in chocolate. Allow as much chocolate as possible to drip off into the pot and scrape the bottom of the chocolate product on the rim or side of the pan. Place onto wax paper to cool.

Ideally, no puddle of chocolate should surround the item. If puddles or drips develop or appear, let the excess chocolate drip into the pot for a longer time. It takes a little bit of patience to get beautiful-looking chocolates!

Choose two of the following four types of dipped chocolates. Complete the questions at the end of the experiment.

# Chocolate-Covered Strawberries

Prep: 10–20 min   Melt: 5–10 min   Dipping: 30 min   Total: 45–60 min



## Directions

1. Wash and dry the strawberries. Make sure they are completely dry.
2. Prepare your workspace with a parchment-lined baking tray.
3. Melt the chocolate in a double boiler or in the microwave.
4. Dip strawberries in the melted chocolate.
5. Coat in desired toppings (optional).
6. Lay strawberries on prepared tray and allow them to rest until the chocolate has set.
7. Once set, drizzle with one of the other melted chocolate types, if desired.
8. Store chocolate-covered strawberries in an airtight container in refrigerator. (Chocolate-covered strawberries only last a few days in the refrigerator, so don't make them too far in advance.)

## Materials Needed

- Paper towels
- Glass bowl for microwave or double boiler for stove
- Baking trays
- Parchment paper
- Utensils for dipping
- Little bowls for toppings (optional)

## Ingredients

- Strawberries
- Dark, milk, and/or white chocolate for melting
- Toppings (optional): chopped nuts, toasted coconut, sprinkles, graham cracker crumbs, crushed candy canes, colored chocolate, etc.

## Notes:

- Choose, firm, ripe strawberries without bruises and that are red all the way up to the stem.
- Take the strawberries out of the fridge 15–30 minutes before dipping them.
- Gently dry them all over with a paper towel. Dry the strawberries very well; otherwise, the chocolate won't set on them properly.
- Do not let any water get into the chocolate. This will cause the chocolate to seize up.

# Chocolate-Dipped Pretzels

Prep: 10–20 min    Temper: 10–20 min    Dipping: 30 min    Total: 50–70 min



## Directions

1. Line baking trays with parchment paper or foil.
2. Temper chocolate.
3. Add a small amount of shortening or coconut oil to smooth out the chocolate and create a high gloss.
4. Submerge one pretzel at a time.
5. As you lift out each pretzel to dry, let the excess chocolate drip back into the pot. Forks work really well for dipping pretzels.
6. Add any toppings to the pretzel tops (optional).
7. Dry the pretzels on the trays for about one hour after they are dipped.
8. Store in a sealed container or bag.

## Pretzel rod variation:

- Place chocolate into a mug or quart jar. Repeat steps 2 and 3 above.
- Tilt the mug or jar so the chocolate moves as close to the edge of the mug or jar as possible.
- Place one pretzel end into the chocolate and turn it so that the end is completely coated.
- Keep turning the pretzel as you pull it out of the mug, while leaving the very tip of the pretzel touching the side of the mug or jar.

## Materials Needed

- Baking trays
- Parchment paper
- Double boiler
- Utensils for dipping
- Bowls or plates for toppings (optional)
- Mug or quart jar

## Ingredients

- Chocolate of choice, tempered (not chocolate chips)
- Shortening or coconut oil
- Pretzels or pretzel rods
- Toppings (optional): chopped nuts, toasted coconut, sprinkles, graham cracker crumbs, crushed candy canes, colored chocolate, etc.



# Chocolate-Covered Cherries

Prep: 30 min   Dipping: 30–60 min   Total: 60–90 min   Servings: 25

## Directions

1. Drain the cherries and reserve the juice for later use. Gently dry cherries with a paper towel. Set them aside on paper towels and continue drying them while you prepare the filling.
2. In a medium- to large-size mixing bowl, mix together 3 cups powdered sugar, butter, and reserved cherry juice. Add the remaining 1 cup of sugar,  $\frac{1}{4}$  cup at a time, until you have a soft dough. Refrigerate the dough for 20 minutes.
3. Dust your hands with powdered sugar and roll the dough into 1-inch balls. Flatten the dough balls with a small rolling pin (dusting with powdered sugar) or with your hands.\* Fold the dough around one cherry, covering it completely, and roll to make smooth.
4. Refrigerate covered cherries for 20 minutes.
5. In a microwave, melt chocolate and shortening; stir every 30 seconds until smooth. Using the chocolate dipping tool, dip cherries into chocolate; allow excess to drip off. Place onto parchment paper to allow to dry.
6. Allow the chocolate to set completely before storing the cherries in an airtight container in the refrigerator for 1–2 weeks before serving.

**Note:** you can use maraschino cherries with stems, if you'd like.

\*Try to make the dough fairly thin. You want the dough balls to roll flat enough to go around the cherry, but not so thin that holes in the dough appear when you wrap them around the cherry.

\*\*If you don't have a chocolate dipping tool, use a regular fork or a plastic fork and remove the latter's center tines.

\*\*\*You can substitute 1 tbsp 2% milk and  $\frac{1}{2}$  tsp almond extract for the cherry juice.

Adapted from "Amish Chocolate Covered Cherries," *Tastes of Lizzy T*, <https://www.tastesoflizzyt.com/amish-chocolate-covered-cherries/#recipe>.

## Materials Needed

- Measuring cup and tablespoon
- Paper towels
- Baking trays
- Medium- to large-size mixing bowl
- Hand mixer, wooden spoon, and/or rolling pin
- Parchment paper
- Microwave-safe bowl
- Chocolate dipping tool\*\*

## Ingredients

- 1 jar maraschino cherries (reserve  $\frac{1}{4}$  cup cherry juice\*\*\*)
- 4 cups powdered sugar
- 4 tbsp salted butter, softened
- 2 cups semisweet chocolate chips
- 2 tbsp shortening

# Chocolate-Covered Cake Pops

Prep: 40 min    Cooking: 30 min    Dipping: 30 min    Total: 1 hr 40 min

## Directions

1. In a large bowl, crumble the cake into fine crumbs.
2. Add 2 tbsp of prepared frosting to the cake-crumble mixture. Combine the crumbs gradually, adding more frosting until the crumbs hold together when squeezed.
3. Form cake balls from the crumbs and place them on parchment-covered trays and chill them for about 2 hours.
  - Small cake pops: 1 tbsp of crumbs rolled into a ball makes about 48 pops
  - Medium cake pops: 2 tbsp of crumbs rolled into a ball make about 24 pops
  - Large cake pops: 3 tbsp of crumbs rolled into a ball make about 16 pops
4. Begin the cake pop-dipping process by melting a few of the dark and white wafers in separate microwave-safe bowls: heat 30 seconds and then stir. Repeat until you have the amount you need to cover at least a few of the cake balls.
5. Dip the tip of the cake pop stick into the melted chocolate and then into a cake ball. Then dip the cake pop into the chocolate, making sure you coat the stick just below the cake ball. Repeat with all the cake balls and let chill until set, about 10 minutes.
6. If you need to warm the chocolate because it has solidified, reheat it in the microwave slowly for 10–15 seconds at a time until it reaches the consistency you desire. Dip the cake pops, one at a time, into the remaining chocolate, lightly tapping on the bowl's edge to remove excess. Only work with about five cake pops at a time. Keep the rest in the refrigerator or freezer.
7. Immediately cover the cake balls with sprinkles or other topping of choice.
8. Push each cake pop stick into a Styrofoam block or use a glass filled with rice to hold them upright. Let the chocolate set for about an hour.
9. Store 3–4 days in an airtight container.

## Materials Needed

- Large mixing bowl
- Parchment paper
- Baking trays
- Microwave-safe bowls
- Utensils for dipping
- Bowls or plates for toppings (optional)
- Styrofoam block or glass(es) filled with rice

## Ingredients

- One 9" x 13" prebaked and completely cooled cake
- 2–4 tbsp buttercream frosting
- Cake pop sticks
- 10 oz package of dark chocolate wafers
- 10 oz package of white chocolate wafers
- Sprinkles or other desired decorations



### Dipped Chocolate Questions

What item(s) did you dip in chocolate?

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What challenges did you have with dipping the item(s) in chocolate?

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What will you do differently next time? Why?

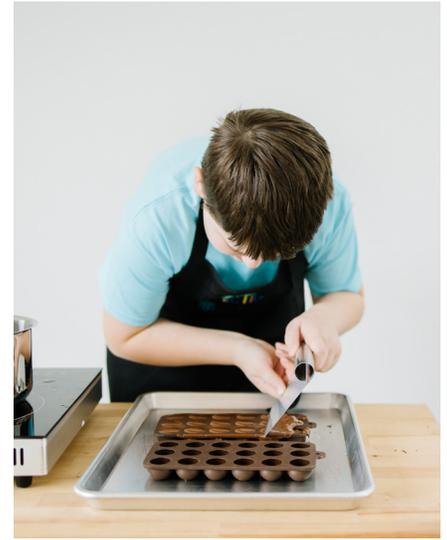
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## Experiment 2: Chocolate Molds

### Objective:

In this experiment you will use chocolate molds to shape melted chocolate.

### Instructions:

Chocolates can also be poured into molds instead of dipped. This allows you to set layers upon layers and create a uniform size and shape every time. In order to prepare molds, pour a small amount of chocolate into the bottom of a mold and turn the mold onto its sides to allow the melted chocolate to cover the sides of the mold as well. Then pour out the excess chocolate. You can also use a brush to spread the chocolate onto all the sides. Next, fill the mold with the desired fillings, followed by a poured layer of chocolate on top. Some types of fillings for chocolates include caramel, fondant, and fruit. Typically, allow each layer to harden before adding the next, which can be done by chilling the mold in the refrigerator.

Choose two of the following molded chocolate recipes and complete the questions at the end of the experiment.



# Fondant and Caramel Recipes

(if you will be molding fondant or caramel)

## Basic Water Fondant

**Prep:** 5 min   **Cooking:** 25 min   **Cooling:** 45 min   **Mixing:** 30 min   **Total:** 1 hr 45 min

### Directions

1. Mix all ingredients (except the candy flavoring) together in saucepan. Cook on med/low heat until dissolved.
2. Bring to a boil and cover for 5 minutes. Uncover and boil to soft-ball stage (232°F/111°C).
3. Allow mixture to be almost cool in pan, about 45 minutes.
4. Pour onto marble slab or other flat, hard surface that you can scrape on (could be glass baking pan).
5. Use a bench scraper, wooden spoon, or spatula to knead the mixture. The mixture will be shiny and stiff. As you knead, the mixture becomes thin and loses its gloss. Keep kneading until the mixture is firm and white.
6. Working with your hands, add flavoring, coloring, and place fondant in a tightly covered bowl until you are ready to dip it or use it in a molded chocolate.

*Source: From a submission based on an out-of-print Idaho church cookbook, circa 1960s.*

### Materials Needed

- Measuring cups and spoons
- Medium-size heavy saucepan with lid
- Thermometer
- Bench scraper, wooden spoon, and/or spatula
- Marble slab or flat, hard surface (glass cake pan or baking sheet)
- Mixing bowl with lid

### Ingredients

- 4 cups granulated sugar
- 1⅓ cups water
- ¼ cup glucose syrup
- 4 tbsp butter
- Dash of salt
- Candy flavoring
- Coloring (gel and paste work the best)

# Basic Cream Fondant

Prep: 5 min    Cooking: 25 min    Cooling: 30 min    Mixing: 30 min    Total: 1 hr 30 min

## Directions

1. Combine sugar, cream, syrup, 1 tbsp butter, and salt in saucepan.
2. Boil until mixture reaches the soft-ball stage (230°F–240°F/110°C–115°C).
3. Drop the rest of the butter (1 tbsp) into the hot syrup. DO NOT STIR. Place a tight-fitting lid over pan.
4. Cool as rapidly as possible by setting the pan in ice water. Let it cool thoroughly until the mixture is cool to touch.
5. Pour mixture onto a marble slab (flat, hard surface) that you can scrape on (could be a glass baking pan or baking sheet). Use a bench scraper, wooden spoon, or spatula to knead the mixture. The mixture will be shiny and stiff. As you knead the mixture, it will become thin and lose its gloss. Keep kneading it until it is firm.
6. Add the flavoring and coloring and place in a zipper bag or a tightly sealed bowl until ready to use.

*Source: From a submission based on an out-of-print Idaho church cookbook, circa 1960s.*

## Materials Needed

- Measuring cups and spoons
- Medium-size heavy saucepan with tight-fitting lid
- Thermometer
- Pan of ice water
- Marble slab or flat, hard surface (glass cake pan or baking sheet)
- Bench scraper, wooden spoon, and/or spatula
- Zipper storage bag or tightly sealed bowl

## Ingredients

- 4 cups granulated sugar
- 1½ cups cream (or half-and-half or milk)
- 2 tbsp glucose syrup
- 2 tbsp butter
- Dash of salt
- Candy flavoring
- Coloring (gel and paste work best)
- Coloring (gel and paste work best)

# Easy Caramels

Prep: 5 min    Cooking: 1 hr    Total: 1 hr 5 min    Yield: 128 1-inch caramels

## Directions

1. Mix together sugar, syrup, cream, butter, and salt in saucepan.
2. Stir until it begins to boil.
3. Cook slowly and keep boiling until mixture reaches 240°F–245°F/115°C–118°C.
4. Add vanilla and nuts. Pour mixture into a buttered pan and cool.
5. Cut in squares. Wrap in waxed paper or dip in chocolate and roll in chopped nuts.

\*You can double this recipe to fit onto a cookie sheet. For a thicker caramel, use an 8" x 8" pan (yields about 64 1-inch caramels).

*Courtesy of the Lucy Price Anderson family (Burley, Idaho).*

## Materials Needed

- Measuring cups and spoons
- Medium- to large-size heavy saucepan
- Wooden spoon
- Thermometer
- 9" x 13" pan or baking dish, buttered\*

## Ingredients

- 4 cups granulated sugar
- ½ cup glucose syrup
- 1½ cups heavy cream
- 1 cup butter
- Pinch of salt
- 1 tsp vanilla
- ½ cup chopped nuts (optional)



## *Fondant- or Caramel-Filled Chocolates*

**Prep:** N/A   **Melting:** 15–30 min   **Dipping:** 30–60 min

### Directions

1. Prepare fondant, caramel, or other preferred filling (see three previous recipes).
2. Temper the chocolate in a double boiler.
3. Pour tempered chocolate into the molds. Fill each to the top. Once filled, tip the mold upside down over the bowl you stirred the chocolate in and drip out any excess. You are trying to make a hollow shell.
4. Once the excess has dripped out, check to see if any of the molds have holes. If so, pour in a little more tempered chocolate and tip again to remove the excess.
5. When the molds are complete, use a sharp knife to scrape any excess chocolate from the top of the mold.
6. Put the molds into the refrigerator for at least a half an hour to set.
7. Remove the molds from the fridge.
8. Gently push a small amount of fondant or caramel into each mold. Be sure none of the filling sticks up higher than the top of the mold.
9. Retemper the chocolate.
10. Spoon or pipe the chocolate carefully over the top of the filling. You want the chocolate to come above the top edge of the mold.
11. Once all the chocolates are covered, use a sharp knife to scrape off any excess chocolate.
12. Put the molds into the refrigerator for 30 minutes to set.
13. Once the chocolate has completely set, turn the mold over on a work surface. If using a silicone mold, carefully push each chocolate out of the mold.

### Materials Needed

- Previously prepared fondant/caramel
- 10½ oz package of 70% or higher cocoa dark chocolate
- Double boiler
- Large mixing bowl
- Thermometer
- Chocolate molds
- Sharp knife
- Parchment paper
- Baking trays

# Homemade Chocolate Bars

**Prep:** 10 min   **Melting:** 5 min   **Assembly:** 60 min   **Total:** 75 min

## Directions

1. Melt melting chocolate (milk, white, or dark) in a microwave-safe bowl for 30 seconds at a time, stirring with spatula each time until melted.
2. Once melted, pour into the mold, coating with a good amount of chocolate and dumping out the excess. Put into refrigerator to set.
3. After the chocolate in the mold has set, add a good amount of the ingredient(s) of choice to the mold, keeping their level to just below the top edge of the mold. Make sure that you have finely chopped nuts, dried fruit, and/or any other bulky ingredients.
4. Pour more of the chocolate over the top of the ingredients. Tap the mold on your countertop to remove air bubbles. Make sure the chocolate is level with the candy bar mold's top edge before putting it back into the refrigerator to set.
5. Let set in the refrigerator until solid (about 10 minutes) or until the candy bars can be easily released from the molds.
6. Remove the bars from the molds by gently twisting the plastic or silicone until the bar loosens from the mold and you can lift it out with your fingers. You can also flip the mold over and let the bar fall onto your cutting board, countertop, or a parchment-lined baking sheet.
7. Wrap each bar in foil and create a fun paper wrapper to cover the foil.

## Decoration Ideas

- Purchase stencils at a crafts store or online or make them yourself by cutting shapes out of parchment paper. If you want to add candy sprinkles, do this when the chocolate is still soft, so that they will stick. Use a paintbrush to add color to the chocolate into your molds prior to adding the first chocolate layer. Just remember to let the color set before pouring the chocolate into the mold.
- Use melted chocolate in an icing bag to write words, draw shapes, or anything else you want to create. If you want to add color, use white chocolate and add food coloring, gel, or a food paste. Decorate the bar while it is still setting or after it is completely set.
- Sprinkle cereal, chips, and/or finely chopped nuts, dried fruit, candy, etc. onto the bar while it is setting.



## Materials Needed

- Melting chocolate (milk, white, or dark)
- Microwave
- Microwave-safe bowl (choose the right size for the amount of chocolate needed)
- Heat-resistant spatula
- Chocolate bar mold (plastic or silicone)
- Add-ins, such as toffee bits, rice cereal, nuts, crushed cookies, coconut, etc., or your favorite ingredient
- Baking sheets
- Parchment paper
- Aluminum foil

# Hot Chocolate Bombs

**Prep:** 10 min **Cooking:** 5 min **Assembly and Cooling:** 1 h **Total:** 1 hr 15 min

## Directions

1. If working on a stove: Create a double boiler by setting a bowl over a pot of boiling water. Place dark chocolate chips into bowl. Stir often with spatula until chocolate is melted.
2. If using a microwave: Place dark chocolate chips in a microwave-safe bowl. Heat the chips on high in 30-second intervals, stopping between each interval to stir with spatula. Continue to heat until the chocolate is melted.
3. Add a large spoonful of the melted chocolate into each of the cavities of the bomb mold. Smooth the chocolate up the sides of the mold with the back of a spoon, making sure to completely coat the sides of each cavity.
4. Refrigerate for a few minutes to set.
5. Reheat the chocolate, if necessary, then repeat the process by adding another spoonful of melted chocolate to each of the chilled mold cavities. Return the molds to the refrigerator to set.
6. Remove the half rounds of set chocolate from the molds. **DON'T FORCE THEM!** They should come out easily.
7. Choose three of the half rounds as bottom halves and fill each with 2 tbsp of hot cocoa mix and 12 mini marshmallows.
8. Heat a plate over a pot of boiling water until warm enough to melt chocolate.
9. Working with one bomb at a time, press one of the empty-half rounds against the heated plate to slightly melt the rim. Place the empty-half round over the filled bottom-half round to seal. Repeat with the remaining two chocolate bombs.
10. If your seams are not tight enough or if they look messy, warm a spoon (dip in hot water or run the spoon under a hot faucet), then run the back of the spoon along the seam to melt the chocolate and seal the edge. Once the hot chocolate bombs are filled and edges are sealed, place them on a parchment-lined baking sheet to set completely.
11. Optional: Melt the white chocolate and drizzle over the filled chocolate bombs or decorate as you like. Return bombs to the refrigerator to set.



## Materials Needed

- Microwave
- Double boiler (or pot and large mixing bowl) or microwave-safe bowl
- Heat-resistant spatula
- Silicone chocolate bomb mold
- Baking sheets
- Parchment paper
- Tablespoon measure
- Favorite mug

## Ingredients

- 6 oz dark chocolate melting chips
- 6 tbsp hot cocoa mix
- 3 dozen mini marshmallows
- 3 oz white baking chocolate or other decorations, for topping (optional)

### To Make into Hot Chocolate

- 1 homemade hot chocolate bomb
- 1 cup hot milk\*

### Directions

1. Heat the milk on the stovetop or in the microwave. Be careful not to burn or scald it.
2. Place one hot chocolate bomb into your favorite mug. Pour the hot milk over the ball. The bomb should burst open, releasing the hot cocoa and marshmallows. Stir until smooth.

\*Adjust the liquid to make your drink as more (or less) chocolaty as you desire. For a less rich option, make it with part milk and part boiling water.

Adapted from “How to Make Homemade Hot Chocolate Bombs,” Renee Nicole’s Kitchen, <https://reneenicoleskitchen.com/how-to-make-homemade-hot-chocolate-bombs/>.



### Chocolate Mold Questions

What chocolates did you mold?

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What challenges did you have with molding chocolates?

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What will you do differently next time?

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## Enrobing

Most commercial candy bars are coated in chocolate using a process called **enrobing**. Enrobing involves pouring chocolate over a confectionary food item instead of dipping it into chocolate. Often the bottom of a bar is formed using a chocolate mold, onto which other ingredients are stacked. Then melted chocolate is poured over the top of the bar to cover it in chocolate (enrobing it) as the bar moves along a conveyor belt. The bar rests on a slotted rack, which allows the excess chocolate to drip off, leftovers which are then reused to pour over the next bar. This allows a smooth finish with as little chocolate wastage as possible.

Traditionally, enrobing is done by hand, covering the center with chocolate and then allowing the excess to drip off. You can also put it onto a rack to allow the excess to continue to drip off instead of allowing the chocolate to pool around the bottom.

The process gives chocolate confections a smooth finish, forming a thin, yet solid chocolate finish.

### Experiment 3: Experimenting with Enrobing

#### Objective:

In this experiment you will learn how to enrobe nuts, candies, and cereal, etc. with tempered chocolate.

#### Instructions:

Use the Homemade Chocolate Bars recipe from the Chocolate Mold Recipes section or another of your choosing. Try using the enrobing process to cover the bar in chocolate.

#### Enrobing Questions

What chocolate bar did you enrobe?  
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What challenges did you have with enrobing chocolates?  
\_\_\_\_\_

What will you do differently next time?  
\_\_\_\_\_

## Emulsions

How do emulsions relate to chocolate? Most foods, such as water and oil, do not normally mix. Thus when you try combining them, they immediately separate. But there are processes that enable two ingredients, like water and oil, to mix. When this occurs, it is called an **emulsion**.

It is important to understand emulsions so that you'll know how to mix chocolate with a water-based food. In fact, you need to create an emulsion when working with chocolate, particularly when you mix chocolate with liquids (such as cream or juice). If you don't create one, the two foods will separate, since chocolate is high in fat and contains very little water.

### Experiment 4: Experimenting with Emulsions

#### Objective:

In this experiment, you will learn what an emulsion is by mixing two or more food items.

#### Instructions:

We are going to learn more about emulsions by mixing oil and water together in different ways. First, mix together each of the combinations listed below. Time how long it takes for the items to separate and then record the information in the table below (if it takes longer than 5 minutes, mark as more than 5 minutes).

1. Mix  $\frac{1}{2}$  cup oil and  $\frac{1}{2}$  cup water together.
2. Mix  $\frac{1}{2}$  cup oil,  $\frac{1}{2}$  cup water, 1 tsp salt, and 1 tsp pepper together.
3. Mix  $\frac{1}{2}$  cup oil,  $\frac{1}{2}$  cup water, and 1 tsp mustard together.
4. Mix  $\frac{1}{2}$  cup oil,  $\frac{1}{2}$  cup water, and 1 egg together.
5. Mix 1 egg,  $\frac{1}{2}$  cup water together, and slowly add  $\frac{1}{2}$  cup oil while beating vigorously with an electric mixer.

Experiment	Time to Separate	Comments
Oil and water		
Oil, water, salt, and pepper		
Oil, water, mustard		
Oil, water, egg		
Oil, water, egg, mixed vigorously		



## Ganache

Ganache is an emulsion that uses a combination of cream and chocolate. Depending on how thick you make it, it can be used as a cake filling, cake frosting, truffle filling, ice cream sauce, or many other confections. The more cream used, the thinner the ganache, while the more chocolate used, the thicker the ganache.

### Common ratios (chocolate to cream):

**1:1 ratio** (equal amount of chocolate and cream). This makes a ganache that can be poured over a cake and that forms a thick glaze.

**2:1 ratio** (twice as much chocolate as cream). This makes a ganache that has an almost fudge-like consistency, so it is used for fillings and truffles.

**1:2 ratio** (twice as much cream as chocolate). This makes a sauce for ice cream or dipping foods.

These ratios work best as weights and will need to be adjusted if you use volume instead. If you do not have a kitchen scale, you can still use these ratios. Chocolate often comes divided into 1 oz sections that you can break or cut off. Cream can be measured in ounces too. It is like water, in that 1 cup of cream is about 8 oz.

The difficult part about making ganache is that you are forming an emulsion. Recall that when you melt chocolate you want to be careful not to get water into it. This is because the fat in the chocolate and the water won't mix. But there is water in cream, so how do we get these two ingredients to mix? By mixing them with certain foods in the right way or by including an emulsifier.

# Ganache

**Prep:** 5 min   **Cooking:** 5 min   **Cooling:** 4 hr   **Total:** 4 hr 10 min

### Materials Needed

- Knife and cutting board
- Double boiler or microwave and microwave-safe bowl
- Heat-resistant spatula
- Measuring cups

### Ingredients

- 8 oz chocolate
- 8 oz heavy cream

### Directions

1. Chop chocolate. The finer you chop the chocolate, the better it will mix into the cream.
2. Heat the cream in a double boiler on the stove or in a microwave-safe bowl in a microwave. Stir with the heat-resistant spatula. Either way, be careful not to scorch the cream. Bring the cream to steaming, where it is almost boiling.
3. Remove the cream from the heat and add the chocolate. Allow the chocolate to melt in the cream without stirring it.
4. Allow the mixture 30 minutes or more to set, leaving it out on the counter. The longer it sits, the thicker it becomes.

## Experiment 5: Ganache Ratios

### Objective:

In this experiment you will mix cream and chocolate to test for emulsion.

### Instructions:

Prepare a batch of ganache according to the previous recipe, then make another batch but adjust the ratio of chocolate to cream. Compare the results.

The emulsifiers (lecithin and surfactants) are already in chocolate. To make a ganache, water needs to be correctly mixed in to form a stable emulsion of fat and water. To create an effective emulsion with the cream and chocolate, make sure that they are at the ideal temperature range for emulsification: between 90°F and 110°F (32°C and 43°C). When the two maintain this temperature range, vigorously stir the chocolate and cream together until they are forced to mix.

### Ganache Questions

How did the ganache turn out?

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How did the different types of ganache compare to each other?

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What challenges did you have with making the ganache?

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What will you do differently next time?

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## Truffles

A truffle is a ganache that has added flavoring. You can mix in other ingredients into the chocolate, like orange juice, before emulsification or combine flavorings (such as peppermint or vanilla extract) or jams afterward. But to finish making a truffle, you must cover the ganache with another ingredient (such as cocoa powder, coconut, nuts, or melted chocolate).

### Experiment 6: Using an Emulsion to Make a Truffle

**Objective:** In this experiment you will use a ganache and add other ingredients to make a truffle.

# Truffles

**Total:** 2 hr 20 min

### Directions

1. Begin making the ganache (from previous recipe). After the ganache is creamy, add in desired flavoring(s).
2. Scoop the ganache into little balls; tablespoons or a small ice cream/cookie scoop can help with this. Roll them into smooth balls. You may want to coat your hands with cocoa powder to keep the ganache from sticking. It helps to put them in the refrigerator for about 20 minutes so that they don't melt quite as much.
3. Roll the chocolate balls in the desired topping(s). If the toppings won't stick, let the chocolate melt a tiny bit to soften it up (it may help to hold it in your hands). If there's too much cocoa powder on the truffles from rolling them smooth, you may need to reroll them. You can also dip the truffles in the chocolate of your choice. Use chocolate-dipping tools to help cut down on the mess.



### Materials Needed

- Small bowl
- Small cookie scoop or tablespoons
- Parchment paper-lined sheet pan
- Chocolate-dipping tools

### Ingredients

- 2:1 ganache (chocolate:cream; premade)
- Desired flavorings
  - Orange, lemon, coconut, or other flavors (about  $\frac{1}{4}$ – $\frac{1}{2}$  tsp per 8 oz chocolate)
  - Peanut butter, chocolate hazelnut spread, or other nut butters (about  $\frac{1}{3}$  cup per 8 oz chocolate)
  - Nuts, coconut, peanuts, citrus zest, etc.
- Desired toppings: nuts, coconut, cocoa powder, melted/tempered chocolate, sprinkles, etc.

## Truffle Questions

What flavor(s) of truffles did you make?

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What challenges did you have with making the truffles?

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What will you do differently next time?

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# RESEARCH AND DEVELOPMENT EXPERIMENTS

## Experiment 1: Copy a Product on the Shelf

### Objective:

In this experiment you will examine a commercial candy bar and determine its individual components. You will then find a recipe for each component you want to make.

Imagine that you are starting your own chocolate candy shop. You know that your customers love several commercially sold candy bars, such as Snickers or Caramello bars. And you want to re-create this chocolate for your customers. How would you go about this?

**Step 1:** Examine the chocolate bar that you want to copy. What kind of chocolate is it made of? What other components are present? Is there caramel, nuts, nougat, and/or marshmallow, etc.?

**Step 2:** Break the candy bar into its individual components and describe that component. For example, is it chewy? Is it soft?

**Step 3:** Find recipes for each component. You can use recipes found in this manual, but for those found elsewhere, please include them with your manual at project completion.

Component	Description

**Step 4:** Replicate each component until it matches the original.

**Step 5:** Combine the components.

**Step 6:** Compare your creation with the original. Ask yourself,

How is it different?

Do you like the differences?

What changes do you need to make?

Make any necessary changes until you are happy with your copycat. Then answer the following questions:

What candy did you replicate?

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What challenges did you have with replicating this candy?

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What will you do differently next time? Why?

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## Experiment 2: Create a New Product

### Objective:

In this experiment you will conceptualize a chocolate product you want to create, from recipe to name.

The copycat chocolate was a huge success — but now you want to create something of your own. What chocolate combination might taste good? Maybe swirled dark and white chocolate with mint and pretzels. What chocolate candy do you want to try? Give it a go, using the skills you learned from copycatting.

**Step 1:** Come up with an idea, including a name for your creation.

**Step 2:** Outline the details of your idea.

**Step 3:** Create the individual components.

**Step 4:** Combine the components into your new candy.

**Step 5:** Determine if the combination meets your expectations. Do you need to make changes? What changes are needed?

**Step 6:** If complete, enjoy and share your new product with others.

### New Product Questions

What candy did you create?

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What was the recipe? Include all components.

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What challenges did you have while creating this candy?

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What will you do differently next time? Why?

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## Experiment 3: Sensory Testing

**Objective:** In this experiment, you will use four types of tests to set up a sensory-tasting experience.

Part of research and development is sensory testing. Sensory testing includes having others taste the product that you have created.

### Types of tests:

- Paired Comparison test
- Preference test
- Hedonic test
- Descriptive test

**Paired Comparison Test:** A paired comparison test is used to compare two items to see if consumers think they are the same or different. In this test, two samples are given to participants. About half of the participants receive the same item in each sample, while others receive different ones. The participants are asked if the items are the same or different. They have a 50% chance of randomly selecting the correct choice. If less than 50% of participants identify the correct choice, the items are not statistically different. If more than 50% of participants identify the correct choice, the items are statistically different.

Paired comparison is often used when a company is trying to match two items and they want to see if consumers can tell the difference. They might do this if they are changing the supplier for the flavoring used and they want to see if consumers can taste the difference between the old and new flavoring.

**Preference test:** With a preference test, participants are given between two and six different items (too many different items become difficult to rank). They are then asked to rank each item, from favorite to least favorite.

This type of test indicates which items consumers like compared to others. Usually, similar items are compared to each other (for example you can compare different brands of hot chocolate). This test is useful for when you want to identify consumer preferences.

**Hedonic test:** A hedonic test is like a preference test, except it provides more information. In a preference test you don't know how much more someone likes different items from each other. Perhaps the degree of difference between first and second place is very small, but the one in third place is disliked a lot more.

With a hedonic test, participants taste each item one at a time (do not use more than six items, which can skew the results — items sampled later may not be enjoyed as much simply because they are given last). Participants then rank how much they like each item, using a scale. This is typically a five-point hedonic scale (although either more or fewer points can be used):

- 1: dislike extremely
- 2: dislike slightly
- 3: neither like nor dislike
- 4: like slightly
- 5: like extremely

The points for each item are added up (or can be averaged). The item with the highest points is the most-liked item, while the one with the least is the least-liked item. You then know how much more consumers like one item compared to another. Both this test and the preference test can be used for items that are like each other or that are very different from each other.

**Descriptive test:** The final type of test is a descriptive test. This test is used when you want to find out what people do or do not like about a product. With this test, a group of people try a product, describe it, and report what they do or do not like about it. This type of test can involve more than one product's evaluation.

## GENERAL TESTING REQUIREMENTS

Typically, you want to conduct “blind” product tests. This means that the participants do not know which item they are testing. Sometimes this means that you literally need to blindfold participants. If you're testing differences in taste, smell, and/or the texture only, using them is a good idea. If a product's brand is visible to participants, blindfolding is a must. For example, it would be difficult for participants to test M&M candies fairly versus other candy-coated chocolates due to the fact that the letter “M” appears on each piece of candy. In this case and others like them, blindfold participants to strengthen the integrity of your study.

But often you won't need to use blindfolds. You can just remove any identifying marks from the products – for example take all the test items out of their distinctive packaging and serve them on the same type of plate. If you choose that “blind” set up, keep track of which product is which by coding each plate with a unique number or letter.

Another helpful strategy is to mix up the order that items are presented to participants. Sometimes participants prefer the first item the most or are tired by the time they get to the last item. In order to avoid “order preference” from creating bias, place the items in a different order for each participant.

To help even the testing field further, provide plain water and a nonsalted saltine cracker so participants can rinse out their mouth in between tasting each item. That helps to keep participants from tasting any carryover flavors as they test each item. Also, participants should not be starving nor full when they start tasting, because hunger affects how food tastes.

### Sensory Test

Create a sensory test to analyze one of the products that you made and gather at least five people to test your product.

**Step 1:** Determine what you want to test (a chocolate that you created or different brands of chocolate, etc).

**Step 2:** Determine the type of test you want to use (difference test, preference test, hedonic scale, or descriptive).

**Step 3:** Determine how you want to blind your test. Are you going to remove labels? Blindfold participants? Identify the products using numbers?

**Step 4:** Gather participants. The more people you can get, the better results you will have.

**Step 5:** Perform the sensory test, as planned.

**Step 6:** Calculate and record the results.

**Sensory Test Questions**

What product(s) did you test?

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What sensory test did you use?

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What challenges did you have with sensory testing?

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What will you do differently next time? Why?

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## Experiment 4: Exploring Food Regulations

### Objective:

In this experiment, you will select chocolate products at a store, read the label, and determine how to name the chocolate product based on the Code of Federal Regulations (Food and Drug Administration 2023).

If you want to sell chocolate, you need to comply with specific laws and regulations. This includes obeying general laws for any food manufacturing, such as ensuring safety and having a proper nutrition facts label, and meeting specific standards of identity in order to legally label your creation as chocolate. Products labeled “chocolate flavored,” for example, distinguish them from actual chocolate. And those labeled “milk chocolate” differ even further, for they must contain at least 10% chocolate liquor, 3.39% milkfat, and 12% milk solids. You can read these requirements in the [Code of Federal Regulations, Title 21, part 163](#).

Table 1 summarizes the requirements that need to be met for each type of chocolate to be labeled as chocolate:

Table 1. Code of Food Regulations (CFR) standards of identity summary table.

Type of chocolate	Unsweetened Chocolate	Cacao Fat	Milkfat	Sweetener	Other Ingredients
White chocolate	None	At least 20%	3.5%–14.0%	Less than 55%	Less than 1.5% emulsifiers
Milk chocolate	At least 10%	50%–60%	3.4%–12.0%	Can vary	Less than 1% emulsifiers
Semisweet chocolate	At least 35%	50%–60%	Less than 12%	Can vary	Less than 1% emulsifiers
Sweet chocolate	At least 15%	50%–60%	Less than 12%	Can vary	Less than 1% emulsifiers
Unsweetened chocolate	N/A	50%–60%	N/A	None	Less than 1% emulsifiers

Unless you have the actual recipe used to make the chocolate you won't know the exact percentages of each ingredient. But you can determine if each item is in the correct range, based on where it falls on the ingredient declaration. For example, you know that there always needs to be more cacao fat than milkfat in white chocolate, but there can be more sugar than cacao fat. Thus, it can be labeled as white chocolate if the ingredients list sugar, then cacao fat, and then milkfat. But it cannot be labeled as white chocolate if the ingredients list sugar, then milkfat, then cacao fat.

**Procedure:**

Go to the store and look at the ingredient declarations (ingredients list on food labels) for different chocolate types. Ingredients are listed in order by weight, so those listed first on the label will be present more (by weight) than ingredients that come later. For instance, if milkfat comes before chocolate or cocoa fat, that means the chocolate product contains more milkfat than chocolate. Determine, based on the ingredients and the CFR summary table (Table 1), if the product you're examining could be labeled as "chocolate" and, if so, what type of chocolate. Determine if it qualifies only as "chocolate flavored" or if other nonchocolate names are merited.

**Food Regulations Questions**

What items did you examine?

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What challenges did you have determining the naming of chocolates?

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What will you do differently next time? Why?

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## Experiment 5: Labeling Chocolate

### Objective:

In this experiment, you will select a chocolate you made and create a label.

If you want to create confections to sell, then you need to follow all the rules and regulations based on where you live. Most states have “cottage food laws” that apply only if you sell a small amount of food prepared in your home directly to a consumer or if you sell less than a certain dollar amount of products.

Cottage laws vary by state; make sure you are following the ones governing the state in which you will be selling your product. This usually requires having an inspected, commercial kitchen and displaying written procedures to ensure food safety.

Learn more about food laws and cottage food laws in your state by Googling “cottage food laws” for your state. Sites that end in .gov or .edu are typically trusted sites.

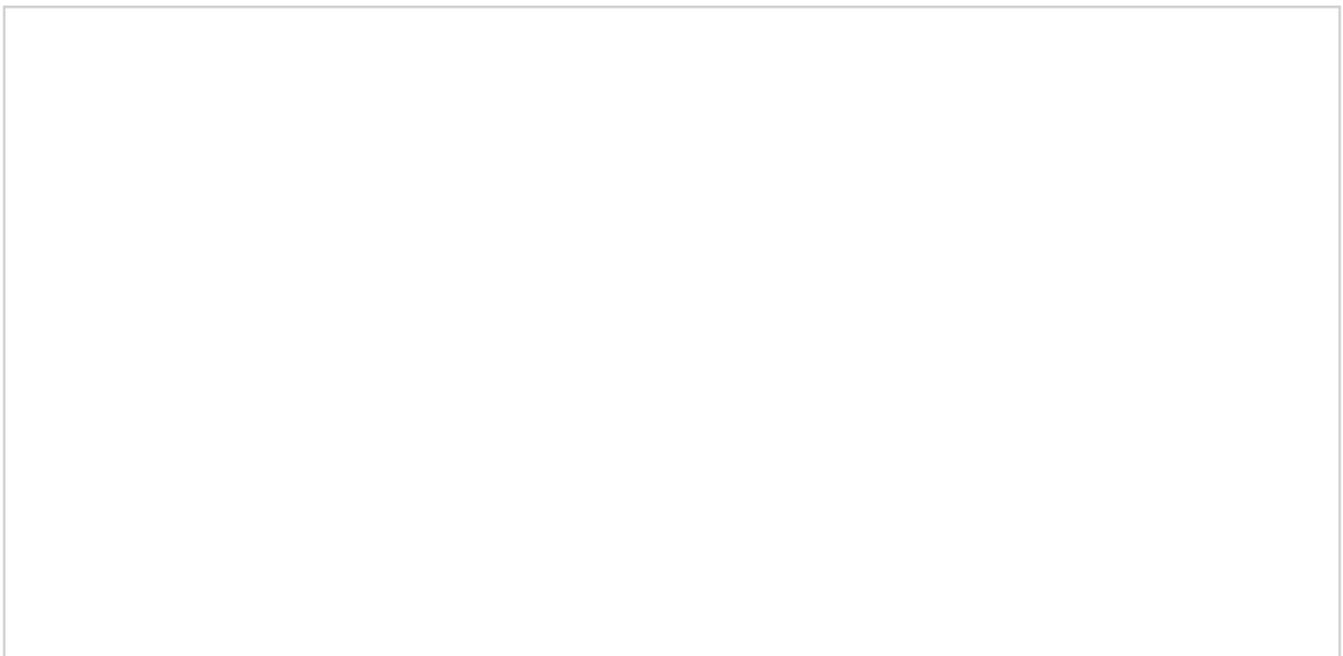
### Instructions:

Choose one of the chocolates that you made and create a label for it. Include these items on your label:

- Name of chocolate
- Ingredients, list in order of most to least
- Allergens present
- Nutritional facts (use an online tool to calculate; try searching the web for a recipe nutrition calculator)
- Serving size

Remember to follow all naming rules as found in the CFR.

Use your creativity and create a label and display it below.



## GOING FURTHER

### Starting Your Own Confections Company

Do you have a family favorite recipe that has been passed down through the generations? Do you enjoy making confections and then giving them to friends and neighbors? Do your friends and neighbors tell you that you should make and sell this stuff? Do you have a dream to start your own confections company?

If you answered yes to either of the last two, there are a few different paths you can take in order to make confections for a living. If you want to create new flavors of candy bars or new chocolate/candy concoctions, consider working in a candy manufacturer's research and development division. There you ensure the quality and safety of the confections the factory produces (includes taste testing). Another option is to work for a large candy company such as Storck, Haribo, the Hershey Company, or Mars. Or open your own confections shop in your hometown.

Although there are numerous ways to begin making confections a career, two traditional paths to breaking into the confections industry include getting a degree in food science or the culinary arts. Several universities offer food science degrees (as a bachelor's, master's, or doctorate) and/or culinary degrees (often as a formal bachelor's degree). Or you can receive training through a trade school. A degree in food science teaches you about food laws and regulations, how to ensure food safety and quality, the science behind how food works, and how to create new products. If you take the food science path, after graduation you will probably start out working in food manufacturing. You can then work with ensuring food quality (including any type of confections), managing the manufacturing of foods, or researching and developing new products. A culinary arts degree teaches you how to cook and plate foods. If you take this path, after graduation you will probably start out working in restaurants. From there, try branching out by making confections in restaurants or bakeries or start selling them yourself at farmers markets or even start your own catering business).

Dream Big, start small!

- ❖ If you need more space, add additional pages.

Ways to learn more about making confections as a career:

- Learn about your local cottage food laws, develop a business plan, and sell the confections that you make.
- Find a local company that makes confections, ask to interview the manager/confections maker, and see if you can tour their facilities.
- Find any food manufacturing company in your area, ask to interview someone from their research and development team or talk to their quality assurance manager to learn more about food science.
- If you have a university in your area, see if they offer a food science program. Talk with a food science advisor and tour their facilities.

## Career Development Questions

What did you do to learn more about a confections careers?

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What did you learn about a future career in confections?

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What challenges did you have in learning about a confections careers?

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## GLOSSARY

**beta crystals.** A polymorph of chocolate whose molecules have a shiny, crisp chocolate texture. According to sciencefriday.com, a beta crystal is the most desirable form of crystal in chocolate and results when tempering is done properly. When chocolate cools after tempering, “it recrystallizes using the remaining beta-crystals as a template. The resulting structure is almost entirely made up of mostly beta-crystals, which are what make chocolate bars hard and shiny” (<https://www.sciencefriday.com/educational-resources/chocolate-crystal-concoctions/>).

**descriptive test.** An evaluative method wherein trained panelists quantify or rate a product’s attributes (appearance, flavor, texture, and aftertaste).

**emulsifier.** A compound that possesses both water-loving (hydrophilic) and water-fearing (hydrophobic) properties so that it dispenses in either water or oil (Brown 2019).

**emulsion.** A liquid dispersed in another liquid with which it is usually immiscible (incapable of being mixed) (Brown 2019).

**fatty acids.** Part of the molecular structure of fat – the building blocks of fat.

**hedonic test.** An evaluative method that indicates the extent of a consumer’s overall like or dislike of a product.

**polymorph.** The crystalline structure or form of chocolate molecules.

**preference test.** An evaluative method that identifies an individual’s product preferences from a group of two to six alternatives and what that choice might indicate behaviorally or affectively.

**seeding.** A method of tempering, in which chocolate with beta crystal formation is added to melted chocolate to encourage an additional formation of beta crystals.

**tempering.** A method of changing the texture of chocolate (or other materials) by altering chocolate’s temperature.

## FURTHER READING

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# University of Idaho Extension

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