Cacao Grinding
Curriculum

Long Term Goal
Participants will feel a sense of excitement and curiosity about the natural world.

Big Idea
After cacao beans have been harvested, fermented, dried and roasted, they must then be cracked and winnowed. Following that, the next step in chocolate making is to grind the nibs until they liquefy into a cacao liqueur. Once the beans are processed into chocolate liquor, the manufacturing of finished products can begin. Today much of the process happens with the use of sophisticated machines. However, long before water-powered mills existed, the Aztec and Maya were grinding cacao by hand with a *manos* and *metates* just like these.

Understandings

- ***Theobroma cacao*** also **cacao tree** and **cacao tree**, is a small (13–26 ft) evergreen tree in the family Malvaceae, native to the deep tropical regions of Central and South America. Its seeds are used to make cacao powder and chocolate.
- Granite and other stones have been used to grind chocolate (among other things) for thousands of years. It wasn't until almost 1800 that a machine-powered mill was invented.
- The roasted beans must first be harvested from the pods and crushed to remove the nibs from the shells.
- The nibs are then ground until the friction and heat of the milling reduces them to a thick chocolate-colored liquid, known as 'mass.' This contains cacao butter and solidifies on cooling. This is the basis of all chocolate and cacao products.

Essential Questions

- *What is Theobroma cacao* (cacao tree)?
- What is a cacao nib?
- What is the life cycle of the cacao tree – from seed to nib?
- What does the chocolate making process include from raw cacao to smooth chocolate?

Essential Skills

- Imagine Possibilities and Outcomes
- Use What You Know, Transfer Learning
- Step Back and Look at the Whole Picture
- Look Carefully
- Persevere

Engage, Explore, and Explain

- Gallery Interpreters should create an atmosphere of excitement and discovery.
- Gallery Interpreters will show the cacao beans and nibs to participants with a brief explanation of the *Theobroma cacao* plant and its life cycle.

- Participants with take turns breaking a few beans and removing out the shells.
- The Gallery Interpreter will show participants how to use the mano and metate to grind the cacao nibs.
- Participants will be invited to try grinding the cacao for themselves. As participants work, gallery interpreter will discuss the way this cacao liquor will become a chocolate bar eventually.
- Gallery Interpreters will facilitate a discussion and reflection on the crushing and grinding process.

Evaluation

- Did participants engage actively in the program?
- Did participants generate thoughtful questions?
- Did participants leave with a greater sense of excitement and curiosity about the natural world?
- Did the activity lend to learning?
- Did the Gallery Interpreters honor prior knowledge of participants?
- Did the programming suite all learning levels and learning styles?
- Were there any elements of the activity that were a constant issue?
- Did the activity run smoothly in the terrace space provided?

Cacao Grinding
Lesson Plan

Supplies
Curriculum
Signs
2 Mano & Metates
(1 Motor & Pestle – optional)
Cacoa beans
Cacoa pod
Blanket
2 White Developing Trays
½ cup Scoop – 1 scoop of nibs to be ground at a time
Banquet table
Hand wipes
2 Plastic Tupperware (to store the beans & liquor)
Strait Spatula (to scoop ground paste)
Metal Scrapper
Plastic ground cover
Laminated photos of process (Millcreak Cacao, SLC)
Clear tablecloth cover
Gardening Knee Pads
Garbage Bags
Cart

Suggested Set-Up:

- Set up the banquet table with three distinct areas:
  - 1st – Place for participants to get beans
  - 2nd – Place for GI to show cocoa pod, beans, photos, etc. and explain process
  - 3rd – Blanket on ground to grind nibs
- Position 1 GI at table to explain process and help break shells, and the second GI on blanket to help with grinding. If there is a 3rd GI they should help as needed.

Process

1. Gallery Interpreter will introduce the roasted cacao beans to participants with a brief explanation of the *Theobroma cacao* plant and its lifecycle (see background info below).

   Guests should gain an understanding of what cacao beans and nibs are, and also where they come from.
   a. Allow participants to hold and smell the raw cacao beans and nibs
   b. Show participants the photos from Millcreek cacao farm for greater understanding

2. The Gallery Interpreter will use the white developing trays to demonstrate for participants how to use their hands (or a mano and metate) to crush the cacao beans and pick out the broken shells.
   a. The best method is to crack and twist the shells with your fingers.

3. Gallery Interpreter should also demonstrate the next step of using the mano and metate to grind the extracted nibs into chocolate liquor (or as close as they can get to liquor).

4. Participants will be invited to try grinding the cacoa for themselves. Have them take no more than a pinch of shelled nibs (or the whole nib from no more than 2 beans), and put them on the mano and metate to grind into the liquor (or as close as they can get to liquor).

   This process will take some time: cracking the beans, pulling the shells, grinding the nibs, and slowly drawing out the natural cacao butter until its been turned into a thick, glossy liquid.
   a. The more pressure used, the better the beans/nibs will grind.
   b. For some participants it will be difficult to crush/grind, and for other people it will be easier, that is okay. Each participant should feel *part* of a process and not feel they need to complete the *entire* process of crushing their beans and grinding their nibs into a chocolate sauce.
      i. If someone is struggling use it as a moment to reflect on and appreciate how much work this plant must go through before it can transform into the solid chocolate we enjoy today.

   Note: If participants' are *really* struggling with shelling the beans and removing the nib, they *may grind the entire bean* (shell and all). Just remember to explain that in real chocolate making, the shell must first be *entirely* removed.

5. As participants work, gallery interpreter will discuss the steps that come next in the chocolate making process, after the grinding of nibs into liquor (see background info below).

6. Gallery Interpreters will facilitate a discussion and reflection on the grinding experience.

7. When people are ready to finish, they can simply move on and give the next participant a chance to pick up where they left off. Each participant should only be given one scoop of beans to grind.

**As the mano and metates need to be cleaned off, the Gallery Interpreter should use the spatula to spoon the cacao liquor into the empty Rubbermaid bin.

<u>Example Discussion Prompts</u>

- Have you ever used a mano and metate before?
- What modern cooking tool does this remind you of?
- Was this task easy or difficult? Why?
- What would it be like to have to grind your own beans and nibs to make chocolate like the Aztecs and Mayans?
- What surprised you about grinding cacao?

Cacao Grinding
Background Information

***Theobroma cacao* (cacao tree)**

Species information
Scientific name: *Theobroma cacao* L.
Common name(s): cacao, cacao tree, chocolate tree, cacao tree, food of the Gods.
Conservation status: Not yet of conservation concern.
Habitat: Evergreen tropical rainforest.
Key uses: Food, medicinal, cosmetics, peat mulch alternative.

Known hazards: Cacao is known to have minor or moderate interactions with certain drugs, and it may cause adverse reactions when eaten or applied to the skin. Chocolate is considered a delicacy for humans, but cacao solids contain the alkaloid theobromine, which is toxic to pets such as cats and dogs. Excessive amounts of chocolate and cacao may be harmful during pregnancy and breastfeeding.

Taxonomy
Class: Equisetopsida
Subclass: Magnoliidae
Superorder: Rosanae
Order: Malvales
Family: Malvaceae
Genus: *Theobroma*

About this species
The edible properties of *Theobroma cacao* were discovered over 2,000 years ago by the local people of Central America living deep in the tropical rainforests. In the year 2008-2009 the world cacao production was 3,515,000 tones. This is equivalent to the weight of a line of double-decker buses stretching more than three times the length of Britain!

The scientific name *Theobroma cacao* was given to the species by the Swedish botanist Carl Linnaeus in 1753, when he published it in his famous book *Species Planetarium*. ***Theobroma* means "food of the gods" in Latin, and *cacao* is derived from the Aztec word *xocolatl*, from xococ (bitter) and atl (water).**

Geography and Distribution
Cacao is native to Mexico, Central America and northern South America (Colombia, Ecuador, Venezuela, Brazil, Guyana, Surinam and French Guiana). It has also been introduced as a crop

plant into many tropical African and Asian countries.

In its natural habitat, cacao grows in the understory of evergreen tropical rainforest. It often grows in clumps along riverbanks, where the roots may be flooded for long periods of the year. Cacao grows at low elevations, usually below 300 meters above sea level, in areas with 1,000 to 3,000 mm rainfall per year.

Description

Cacao is a spindly, evergreen tree 5 to 8 m tall, found growing in the shade of giant trees occupying the top layer of the rain forest. It has a taproot, which penetrates far below the soil surface.

Its dark green leaves are shiny, leathery, egg-shaped or elliptic in shape and 20 to 35 cm long and 7 to 8 cm wide. The leaf surfaces are hairless or covered in scattered star-shaped hairs. The base of the leaf is rounded or heart-shaped, and the tip is long and drawn out allowing water to drip from it.

Cacao flowers are small, yellowish white to pale pink, and grouped together in clusters arising directly from the trunk (cauliflory).

Flowers are produced throughout the year. In the wild, cacao trees are pollinated by midges, and only about 5% of flowers receive enough pollen to start fruit development. When they are pollinated there is a dramatic change as the tiny flowers develop into massive cacao pods.

Cacao pods: The fruit is an egg-shaped red to brown pod, 15 to 25 cm long, with a more or less knobby surface and lines from top to bottom. The pod contains 30 to 40 seeds, each of which is surrounded by a bittersweet white pulp. In the wild the seeds are dispersed and eaten by different mammals like monkeys. When the seeds are dried and fermented in the sun they are brownish red, and known as cacao beans.

What a Cacao bean is made of:

Cacao beans possess 45-53.2% fat in the form of cacao butter (also known as theobroma oil), which is made up of a variety of fatty acids.

Cacao beans contain up to10% of phenols and flavenoids, which are antioxidants potentially inhibiting cancer or cardiovascular diseases, as well as potassium, magnesium, calcium and iron. Additionally, they contain 1-3% theobromine and caffeine, alkaloids that stimulate the central nervous system. Caffeine has a positive effect on mental alertness, for instance when taken in caffeinated drinks.

The ingredients for chocolate – cacao powder and cacao butter (solids) – are prepared from fermented and roasted cacao seeds. A typical bar of milk chocolate contains around 15% cacao liquor and 20% cacao powder. The distinctive flavor of chocolate develops during the fermentation process.

Brief History of Chocolate

The edible properties of *Theobroma cacao* were discovered over 2,000 years ago by the indigenous people of Central America living deep in the tropical rainforests.

The Olmecs living in Mexico and Guatemala established their first cacao plantations around 400 BC, and by 250 AD the Mayans depicted cacao in their elaborate hieroglyphic writings and on carvings and paintings.
Historical accounts about also point to widespread use of chocolate in Maya and Aztec engagement and marriage ceremonies and religious rituals. In this respect chocolate occupied the same niche that expensive French wines and champagne do in European culture today.

The Aztecs and Maya peoples had many ways of making food and drink from cacao beans. They also used the beans as money, for example exchanging one turkey for 200 beans, or one slave for 100 beans.

Cacao beans were so precious that only the royals, warriors and the wealthy could afford to eat and drink chocolate. The hieroglyphs tell us that the Aztecs and Maya peoples drank cacao powder suspended in water, and used flavourings such as chillies, vanilla and aromatic herbs and honey.

Cacao Grinding
Background Information Continued

What is a cacao nib?
Cacao nibs are basically raw chocolate; pieces of cacao beans that have been roasted, hulled (separated from their husks) and prepped to the point where all that there is left to do is process them into bars.

What is the life cycle of the cacao pod – from seed through nib?
Cacao trees can only grow in a specific area of the world, which is called the cacao belt. It takes 3 to 5 years after the seeds are planted and then the tree produces cacao pods from these flowers. After the pods are harvested from the trunk, they are cut open with cacao beans inside. These cacao beans are covered in a thin layer of white pulp. Farmers will scrape out the pulp and the beans, wrap them in large green plantain leaves and put them under the sun to be dried for 1 week. The package becomes really hot causing the pulp to ferment, like alcohol! During this process, the pulp turns into liquid and seeps out of the tight package. The beans are then spread out to be further dried on a drying table and will be turned frequently. After the cacao beans are completely dry, they reach a factory to be cleaned and roasted. The next step is called winnowing. The beans are blown about to open up their shells and leave the inner part of the cacao bean which is called the nib.

From raw cacao to smooth chocolate, what does the chocolate making process entail?
The nibs are then ground into a thick brown liquid called cacao mass. The cacao mass is then heavily pressed until the cacao butter is squeezed out, and it is separated into cacao liquor (powder) and cacao butter. Cacao butter and cacao mass is combined in varying proportions and the sugar and milk for milk chocolate is added. The next step is conching. When the chocolate is conched, the chocolate is mixed constantly at a warm temperature for a few days. The chocolate then goes to be tempered where the chocolate is warmed and then cooled again for several hours. This is where your chocolate bar gets to it's nice shiny, smooth finish. The chocolate is now ready to go into the chocolate bar molds until they are completely cooled and then they get popped out of their molds, are usually wrapped in foil to keep their freshness.

What is cocoa butter? Where does it come from?
Cocoa butter, also called theobroma oil, is a pale-yellow, edible vegetable fat extracted from the cocoa bean. It is used to make chocolate, as well as some ointments, toiletries, and pharmaceuticals. Cocoa butter has a cocoa flavor and aroma.

Cocoa butter contains a high proportion of saturated fats, derived from stearic and palmitic acids. Cocoa butter, unlike cocoa solids, has no more than trace amounts of caffeine and theobromine.

Cocoa butter is obtained from whole cocoa beans, which are fermented, roasted, and then separated from their hulls. About 54–58% of the residue is cocoa butter. Chocolate liquor is pressed to separate the cocoa butter from the cocoa solids. The Broma process is used to extract cocoa butter from ground cacao beans. Cocoa butter is usually deodorized to remove its strong and undesirable taste.

Cacao Grinding
Chocolate Frequently Asked Questions

- **How did the Aztec and Mayans use chocolate?**
  The Aztec way of making chocolate was very similar to that of the Mayans. Priests presented cacao beans as offerings to the gods and served cacao drinks during sacred ceremonies like weddings. Cacao was used as a gift to the deities, presented at royal burials to ensure comfort in the afterlife. Chocolate was also used as a medicine. All of the areas that were conquered by the Aztecs that grew cacao beans were ordered to pay them as a tax, or as the Aztecs called it, a "tribute".

- **How much did the Mayans and Aztecs have to grind the nibs before they were ready?**
  Writings describe multiple ways of preparing the cocoa resulting in drinks of varying consistencies from a thin liquid to a thick paste, with different flavorings.

- **How many cacao beans does it take to make a chocolate bar?**
  Depending on the type of cacao beans (Bolivia cacao bean is slightly smaller than average), percentage of cacao and other factor, roughly 400 cacao beans can make a pound of chocolate bar.

- **How many pods are on a cacao tree?**
  20~30.

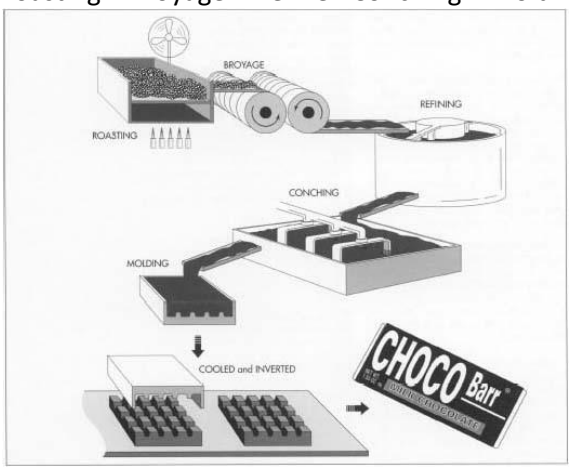
- **How many beans are in a cacao pod?**
  25~40.

- **How big are the leaves on a cacao tree?**
  20 to 35 cm long and 7 to 8 cm wide. What is fascinating about Cacao leaves is that they can move 90 degrees from vertical to horizontal and back to get better sun access and to protect young leaves! This is done with a node at the base of the leaf which changes its stiffness with temperature.

- **Where does chocolate grow?**
  “The cacao belt”. It is located 20 degrees north and south of the equator. The vast majority of the beans come from West Africa, mostly Ghana, and Indonesia and South America.

- **What gets mixed in with ground cacao nibs to make tasting chocolate?**
  Depending on the type of chocolate, most cacao are added sugar and other ingredients, such as milk, vanilla, vegetable or lecithin.

- **What are the basic steps of modern chocolate manufacturing?**
  Roasting > Broyage > Refine> Conching > Molding > Cooling and Inverted > Packaging



- **What is the difference between white, milk and dark chocolate?**
  Dark chocolate contains the least amount of added ingredients, milk chocolate has the most amount of milk and about 30% cacao solids, and white chocolate contains cacao butter the most flavorings and no cacao liquor.

- **Is white chocolate really chocolate?**
  No. White chocolate contains no cacao liquor and gets its ivory color from the cacao butter. According to FDA standards, real chocolate must contain chocolate liquor (the solid that results from finely grinding cacao bean nibs). For years, The U.S. barred manufacturers from calling this product "chocolate" as it is called in Europe. If the "white chocolate" looks bright white, not ivory, it probably doesn't contain cacao butter. They may have substituted a mixture of other vegetable fat.

- **What are the health benefits of chocolate? Which type of chocolate is the healthiest?**
  All chocolate was not created equal! Dark chocolate (70% or higher) packs more of a health punch overall, providing antioxidant benefits and help prevent cancer, high-blood pressure and heart diseases. Dark chocolate can also boost your mood and lower stress! Most chocolate contains sodium, riboflavin, vitamin E, calcium and potassium and protein.

- **What does it mean when my chocolate gets gray and streaky?**
  That's called 'bloom' and it happens when the chocolate melts or gets warm, and then cools again without being tempered.

- **How long does chocolate last?**
  Always follow the expiration date on the packaging. Depending on the climate and other factors, dark chocolate usually lasts for a couple years. That's in part due to the high amount of antioxidants, as well as the sugar, which is a preservative. Milk chocolate and white chocolate contain milk solids and should be used within a year.

- **What is the difference between bittersweet and semisweet chocolate?**
  Technically nothing. Both chocolates must contain a minimum of 35% *cacao* solids in the US. Some manufacturers that make both will often call their sweeter chocolate 'semisweet', although it's totally arbitrary and they can be used interchangeably in recipes.

- **How can I tell the quality of the chocolate I have?**
  3 steps!
  1) How quickly does it **melt** in your mouth? The quicker the better. *(good chocolate have cacao butter which melts at a much lower temperature than oil which is a substitute used in cheap chocolate.)*
  2) How **smooth** does the chocolate feel as it melts? The smoother the better. *(Good chocolate goes through a longer conching)*
  3) How intense is the **flavor**? The more intense the better. *(Poor quality chocolate will have a less intense taste and usually will be covered up with more sugar and vanilla to make up for the intensity of taste.)*

- **What is the best way to store chocolate?**
  Ideally, chocolate should be stored in a slightly cool, dry, dark place. The perfect environment would be 60-70 degrees Fahrenheit, have low humidity, be out of direct sunlight, and away from any other foods or substances with strong odors that could be absorbed by the chocolate. Chocolate does not refrigerate or freeze well, do so only when you have to.

- **What is lecithin and why is it in my chocolate?**
  Soy lecithin is a food additive extracted from soybeans, and is a by-product of soybean oil. Soy lecithin is an *emulsifier*, so it's added to chocolate to keep the cacao and the cacao butter together.

- **Is chocolate bad for my dog?**
  It is poisonous to dogs! However, the hazard of chocolate to your dog depends on the type of chocolate, the amount consumed and your dog's size. In large enough amounts, chocolate/cacao products can kill your dog. The toxic component of chocolate is *theobromine*. Humans easily metabolize it but dogs process it much more slowly, allowing it to build up to toxic levels in their system.

- **When it says that a chocolate bar is 65%, 70%, or 85% cacao, what does that mean?**
  It refers to the total percentage of ingredients by weight in that product that comes from the cacao bean, including the chocolate liquor and cacao butter.

- **What is conching?**

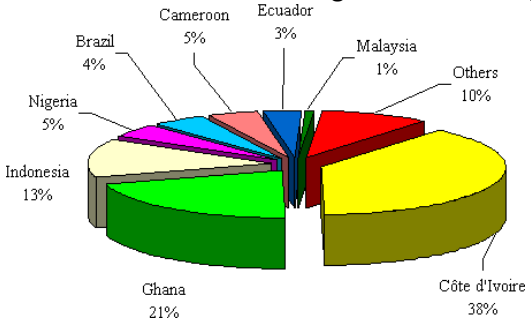
Conching is a process in the manufacture of chocolate. This is where the flavor and texture is refined by warming and grinding.

- **What does the word "chocolate" mean?**
  (Still in debate, the most cited version) The word Chocolate comes from the Aztec word *chocolātl*. This word comes from the Mayan word *xocolātl* meaning "bitter water". Chocolate was drunk bitter by the Aztecs.

- **Why do we "crave" chocolate?**
  Chocolate, as it turns out, is a bubbling brew of 380 chemicals, a bunch of which are known to have an effect on mood. Researchers point to phenylethylamine (PEA), the so-called "love chemical" that people produce when they're in love or feeling especially happy and excited. A more likely story is the cannabinoids that chocolate contains. These chemicals, related to the THC found in marijuana, triggers a high of happiness and well-being that a lot of people feel after eating chocolate. Chocolate also contains theobromine, a compound similar to the caffeine that gets people addicted to coffee.

- **How long does it take for a cacao tree to grown fruit?**
  Most cacao trees begin to bear fruit in their 5th year.

- **Where does most of the world's chocolate come from?**
  75% of the world's cacao is grown in Africa. (Ghana and Ivory Coast)



- **What are some local Utah artisan Chocolate companies?**
  Chocolot (Ogden) , Amano Artisan Chocolate (Orem, AWARD WINNING!), Hatch Family Chocolates, L.L.C. (SLC) etc.

- **Who consumes the most chocolate?**
  Europeans account for nearly half of all the chocolate the world eats (US alone- 20%). On average, every German consumes 11.39 kg of chocolate every year! (US, 5.09kg). (CNN 2008/9)

Cacao Grinding
Key Chocolate Vocabulary

- **Cacao**: Refers to the bean, which is the source of chocolate liquor, cacao butter and cacao powder.
- **Chocolate Liquor**: Produced by grinding the nib to a smooth, liquid state.
- **Cacao Butter**: The fat naturally present in cacao beans that melts at body temperature and gives chocolate its unique mouth-feel.
- **Cacao or Cacao Powder**: The product made by pressing most of the cacao butter out of the cacao bean and grinding the rest to a powder.
- **Winnowing:** Process in which the cacao beans are passed through cones that crack the brittle shell and fans that blow and separate the hard outer shell from the cacao nib.
- **Fermentation:** The fermentation process transforms the flavor to what we associate with cacao and chocolate through naturally occurred yeast and bacteria. Without the fermentation process there will not be any chocolate flavor.

Cacao Grinding
Fun Facts About Chocolate

- The biggest bar of chocolate ever made was created in 2000 and weighed 5,000 pounds. Turin is the city in Italy that can be proud of this accomplishment.
- Chocolate manufactures use 40% of world's almonds and 20% of world's peanuts.
- Chocolate is technically responsible for the microwave. Scientists were experimenting with micro waves in hopes of creating better radar detectors and in the wake of WWII, scientists were testing devices called magnetrons. A scientist named Percy Spencer entered the lab with a chocolate bar in his pocket and realized it quickly began to melt. Spencer then realized that the magnetron could potentially be used to cook food.
- Every Russian and US space voyage included chocolate bars.
- 17,000 people in Belgium work in the chocolate industry.
- The cacao flower, only about the diameter of a nickel, is complex in design and behavior, necessitating a special kind of animal to pollinate it. Midges, tiny flies that inhabit the damp, shady rain forest, are the only animals that can work their way through the complex cacao flower and pollinate it.
- Theobroma Cacao is the tree that produces cacao beans, and it means "food of the gods ."
- Cacao trees can live to be 200 years old, but they produce marketable cacao beans for only 25 years.
- German chocolate cake was named after Sam German, an American, and did not originate in Germany.
- Chocolate has evolved into such a massive industry that between 40 and 50 million people depend on cacao for their livelihood.
- During WWII, the Germans designed an exploding, chocolate-covered, thin steel bomb designed to blow up seven seconds after a piece was broken off.
- One chocolate chip can give a person enough energy to walk 150 feet.

Notes

Please leave any comments (good or bad), observations, questions, successes, or struggles you discover while running this activity.