

**Teacher’s Guide**

**What’s Chocolate, and How Does Its Chemistry Inspire Such Cravings?**

***February 2023***

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Activate students’ prior knowledge and engage them before they read the article.

[***Reading Comprehension Questions***](#_Student_Reading_Comprehension) ***3***

These questions are designed to help students read the article (and graphics) carefully. They can help the teacher assess how well students understand the content and help direct the need for follow-up discussions and/or activities. You’ll find the questions ordered in increasing difficulty.

[***Graphic Organizer***](#_Graphic_Organizer) ***5***

Thishelps students locate and analyze information from the article. Students should use their own words and not copy entire sentences from the article. Encourage the use of bullet points.

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Access the answers to reading comprehension questions and a rubric to assess the graphic organizer.

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Here you will find additional labs, simulations, lessons, and project ideas that you can use with your students alongside this article

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# Anticipation Guide

**Directions: *Before reading the article*,** in the first column, write “A” or “D,” indicating your **A**greement or **D**isagreement with each statement. Complete the activity in the box.

As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. Each year, people in the United States eat more chocolate per person than any other country. |
|  |  | 2. Chocolate was discovered in Mexico. |
|  |  | 3. Chocolate manufacturers today begin processing cacao beans similar to how it was done more than a thousand years ago. |
|  |  | 4. Cacao liquor from roasting the cacao beans contains more than 50% cacao butter. |
|  |  | 5. Cacao butter is used to raise the fat content of eating chocolate. |
|  |  | 6. Dark, milk, and white chocolate contain the same percent of fat. |
|  |  | 7. Chocolate contains vitamins, antioxidants, and caffeine, in addition to other compounds. |
|  |  | 8. Roasting turns aldehydes into amino acids. |
|  |  | 9. The gray or white fat blooms that sometimes form on chocolate are dangerous to eat. |
|  |  | 10. X-ray crystallography studies indicate that fat blooms might be controlled by reducing the porosity of the chocolate. |

# Student Reading Comprehension Questions

**Directions**: Use the article to answer the questions below.

1. What is the key component of chocolate? What is the source of the key ingredient and where can it be found?
2. Chocolate is a popular treat worldwide. However, its popularity seems to peak in regions of Europe. How and when was chocolate introduced to Europe?
3. Compare and contrast how ancient chocolate treats were prepared to modern preparation techniques.
4. List the compounds in chocolate responsible for creating chocolate “cravings” which make us want to consume more of the sweet treat.
5. What factors contribute to the taste of chocolate?
6. Explain the chemical changes that occur in chocolate due to roasting.
7. What are “fat blooms” and how do chocolate manufacturers try to limit/control the blooms in their products?
8. Select two of the compounds responsible for the addictive nature of chocolate (from question #4) and explain the compound's interactions in the body and why those compounds become addictive.
9. Chocolate is known to last a long time on shelves of stores and in people’s homes without going bad as long as simple storage precautions are followed. Are their preservatives found in chocolate? What prevents chocolate from spoiling?
10. The article mentions amino acids and triglycerides. Explain the importance of amino acids and triglycerides in the body.

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

***Write your answers on another piece of paper if needed.***

1. Use the information in the article and additional information found online to create a “Chemistry of Chocolate” infographic. The article should discuss how chocolate is made, the difference between various types of chocolate such as milk, white, and dark chocolate, and the compounds found in chocolate.

# Graphic Organizer

**Directions**: As you read, complete the graphic organizer below to describe the chemistry of chocolate.

|  |  |  |
| --- | --- | --- |
|  | **How obtained** | **Chemicals** |
| **Cacao liquor** |  |  |
| **Cacao butter** |  |  |
| **Cocoa powder** |  |  |
| **Eating chocolate (Dark, Milk, White)** |  |  |
| **Compounds found in chocolate** |  |  |
| **Fat blooms** |  |  |

**Summary:** On the back of this sheet, write a short summary (20 words or less) of the article.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. What is the key component of chocolate? What is the source of the key ingredient and where can it be found?  
   Cacao is the key component of chocolate which comes from the cacao tree. The cacao tree is native to Central America and is also cultivated in West Africa and Southeast Asia.
2. Chocolate is a popular treat worldwide. However, its popularity seems to peak in regions of Europe. How and when was chocolate introduced to Europe?  
   Chocolate was introduced to Europe during the 16th century when Spanish explorers brought chocolate back from the Aztecs.
3. Compare and contrast how ancient chocolate treats were prepared to modern preparation techniques.  
   Ancient: The cacao pods are harvested, the beans are fermented, dried, roasted, and ground into a powder. The powder is mixed with water and other additives such as chili peppers.

Modern: The cacao pods are harvested, fermented, dried, roasted, ground. Additives such as milk, sugar, and other ingredients are added based on what manufacturers are making.

The modern process is very similar to ancient techniques with the major difference being the finishing techniques and products.

1. List the compounds in chocolate responsible for creating chocolate “cravings” which make us want to consume more of the sweet treat.  
   Caffeine, theobromine, phenylethylamine, anandamide
2. What factors contribute to the taste of chocolate?  
   Factors include the origin of the cacao, roasting conditions, processing techniques, and additives.
3. Explain the chemical changes that occur in chocolate due to roasting.  
   Tasteless and odorless amino acids are converted into 3-methyl butanal, phenylacetaldehyde and aldehydes which have flavor and pleasant aroma.
4. What are “fat blooms” and how do chocolate manufacturers try to limit/control the blooms in their products?  
   Fat blooms are white/gray film on the chocolate that impacts the appearance, taste, and texture of chocolate. Fat blooms are fat and oil molecules that move to the surface of the chocolate from the interior over time. Manufacturers try to control fat blooms by limiting porous holes in the interior of chocolate which allow fat and oil to migrate.
5. Select two of the compounds responsible for the addictive nature of chocolate (from question #4) and explain the compound's interactions in the body and why those compounds become addictive.   
   Answers may vary. Compounds become addictive when they affect the brain or nervous system which increases a desire to consume the compound. An example would be an increased level in dopamine release after consuming a drug which causes people to “chase” that feeling.
6. Chocolate is known to last a long time on shelves of stores and in people’s homes without going bad as long as simple storage precautions are followed. Are their preservatives found in chocolate? What prevents chocolate from spoiling?   
   Chocolate does not contain preservatives. It contains high levels of fat, oil, and sugar and low levels of water which is not a conducive environment for mold growth.
7. The article mentions amino acids and triglycerides. Explain the importance of amino acids and triglycerides in the body.  
   Amino acids are responsible for synthesizing protein and other nitrogen containing compounds inside the body.

Triglycerides store extra calories and provide the body with energy.

1. Use the information in the article and additional information found online to create a “Chemistry of Chocolate” infographic. The article should discuss how chocolate is made, the difference between various types of chocolate such as milk, white, and dark chocolate, and the compounds found in chocolate.  
   Answers will vary. Check that students discussed all the necessary information.

**Graphic Organizer Rubric**

If you use the Graphic Organizer to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

# 

# Additional Resources and Teaching Strategies

**Additional Resources**

* **Articles and lesson plans**
  + Related article: Chocolate the New Health Food

<https://teachchemistry.org/classroom-resources/chocolate-the-new-health-food>

* + Lesson plan for the Related Article

<https://teachchemistry.org/news/love-is-in-the-air>

* + Amino Acid Article

<https://teachchemistry.org/chemmatters/april-2015/left-life-right-life-chirality-in-action>

* + Addictive Compound Article

<https://teachchemistry.org/chemmatters?page=27>

**Teaching Strategies**

Consider the following tips and strategies for incorporating this article into your classroom:

* **Alternative to Anticipation Guide:** Before reading, ask students if they enjoy eating chocolate, and what types of chocolate they have used. Ask them how long they think people have been enjoying chocolate and how it is produced. Their initial ideas can be collected electronically via Jamboard, Padlet, or similar technology.
  + As they read, students can find information to confirm or refute their original ideas.
  + After they read, ask students what they learned about chocolate refining and the different kinds of chocolate.
* After reading, consider showing the ACS Reactions video “Is White Chocolate Actually Chocolate?” (3:16)<https://youtu.be/4qI8qbfTkys>. The video explains how chocolate is made, reinforcing information in the article.

# Chemistry Concepts and Standards

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Separating mixtures
* Molecular structure
* Saturated vs. unsaturated

**Correlations to Next Generation Science Standards**

This article relates to the following performance expectations and dimensions of the NGSS:

**HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

**HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

**Disciplinary Core Ideas:**

* PS.1.A: Structure and Properties of Matter
* ETS1.C: Optimizing the Design Solution

**Crosscutting Concepts:**

* Structure and function

**Science and Engineering Practices:**

* Constructing explanations (for science) and designing solutions (for engineering)

**Nature of Science:**

* Science is a human endeavor.

See how *ChemMatters* correlates to the[**Common Core State Standards** online](https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/teachers-guide.html).