



# EXPLORING FOOD SCIENCE, SAFETY, + NUTRITION

## Caffeine and Human Health

**Grade Levels:** Grades 4-12

**Duration:** 45 - 60 minutes

**Content Areas**

Biology; Chemistry

**Next Generation Science Standards**

LS 3; 4; 5; 8

### Learning Objectives/Outcomes

- Students will know what beverages contain caffeine and how caffeine consumption can affect their health.
- Students will “experimentally” confirm the hypothesis that caffeine consumption elevates heart rates.
- Students will learn about alternatives to caffeine consumption.

### Lesson Plan Prepared By

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(for FST 385 Spring, 2020)

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### OVERVIEW

In this lesson, students will observe an experiment to measure the differences in heart rates before and after drinking coffee. They will gain an understanding of what common beverages contain caffeine and what the health effects of these beverages are. The goal of this lesson is to inform students' beverage choices and provide alternatives to caffeine consumption.

### USING THIS LESSON

The experiment in this lesson can be easily adapted for different levels. This plan will target middle schoolers in a remote-learning environment through Zoom.

The background section of this lesson plan can be used as an introduction to the lesson.

### BACKGROUND

Ninety percent of Americans consume caffeine in some form every day, making caffeine the most popular drug in America. Caffeine stimulates our central nervous systems (our brain and spinal cords) by tricking our body into thinking it's not time to sleep. The effects of caffeine typically last for 5-6 hours. You can build a tolerance to caffeine, which can lead to withdrawal symptoms including headache and fatigue. Most sources agree that 300-400 mg of caffeine per day is safe for adults (1 cup of coffee has ~100 mg caffeine), but most doctors agree that caffeine is not safe for kids. It can increase their heart rates, change moods, affect sleeping habits, and change appetites—not beneficial for a growing child. Caffeinated beverages like energy drinks and soft drinks also come with a lot of sugar, which can cause weight gain and diabetes.

### ADDITIONAL RESOURCES

- <https://www.kuakini.org/wps/portal/public/Health-Wellness/Health-Info-Tips/Miscellaneous/Caffeine--Americas-Most-Popular-Drug>
- <https://www.sleep.org/articles/what-does-caffeine-do-2/>
- <https://kidshealth.org/en/parents/child-caffeine.html>
- <https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/caffeine/art-20045678>

# EXPLORING FOOD SCIENCE, SAFETY, + NUTRITION

## Materials

- Heart Rate Experiment:
  - 6 oz of brewed black coffee
  - Measuring cup
  - Timer (phones are okay)
- Lesson
  - Caffeinated Beverages Worksheet



## Example Polling Questions:

1. How many days a week do you drink a caffeinated beverage?
2. Which has more caffeine, a cup of coffee or a can of mountain dew?
3. What has more caffeine green tea or a can of coke?
4. What beverage on the list has the most caffeine?
5. What has more caffeine, a cup of coffee or espresso?

## TEACHER INSTRUCTIONS

### Before the Lesson:

- Send out a survey to students on caffeine consumption (see Supplemental Information for an example of a survey).
- Ask parents/guardians if any would like to participate in the heart rate experiment. Send out the "Student Instructions" sheet. Depending on how many parents respond, prepare a set of "pre-collected data" that can be used in the analysis of results. Aim for having a sample size of 30.

**NOTE:** If using this lesson for high school, students may participate in the heart rate experiment themselves.

### Directions

- Adult volunteers (who were previously instructed to not drink any coffee) will measure their resting heart rates (Set a timer for 15 seconds and count the number of pulses, multiply by 4) and report to the class. The teacher may have to demonstrate how to measure heart rate.
- The teacher will instruct the adults to drink 6 oz of coffee. (In a perfect world, it should be the same brand and same brew to assure similar strength, but with remote learning, it should be okay. For older students, it may be valuable to discuss this and why we need to have the same coffee).
- Once the adults finish the coffee, the teacher will set a timer for 15 minutes.
- While they are waiting, the teacher will ask students to make a hypothesis about what will happen to peoples' heart rates, and look at previously collected data. Variation within this data may allow for discussion of differences in responses to caffeine depending on the person. (see Questions section below)
- 5. During this time, the teacher can use the polling questions to facilitate discussion about different types of caffeinated beverages. Rank the caffeine content from low to high.
- After 15 min have elapsed, the adult volunteers will measure their heart rates again (see #1). The teacher will add their data to the existing dataset.
- The teacher will lead the class in analyzing data (share screen to show graphs on Excel). Were there any patterns the students noticed? (See Data Table below)
- The teacher can interview the adult participants. Do they feel "more awake"? Can they feel their heart beating faster?
- Instruct the students to fill out the "Caffeinated Beverages Worksheet" as a take-home assignment.

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## Materials

- Heart Rate Experiment:
  - 6 oz of brewed black coffee
  - Measuring cup
  - Timer (phones are okay)
- Worksheet
  - Caffeinated Beverages Worksheet



## STUDENT INSTRUCTIONS

### Before the Lesson:

- Complete the “Caffeine Consumption Survey” and send it to your teacher.
- Ask your parents/guardians if they would like to participate in the heart rate experiment and have them contact the teacher.
- Print out the Caffeinated Beverages Worksheet.

### Directions

#### If your parent/guardian is participating in the experiment:

- 15 minutes before class, brew a pot of coffee according to the instructions provided.
- Measure out 6 oz (3/4 cup) of coffee with a measuring cup.
- Measure your parent/guardian’s resting heart rate. Set a timer for 15 seconds. Locate their radial artery (on the thumb side of their wrist) and count the number of beats you feel during 15 seconds. Multiply that number by 4 to get the heart rate (in beats/min). Report that value to your teacher.
- The volunteers will drink 6oz of the brewed coffee and a timer will be set for 15 minutes.
- Use this time to construct a hypothesis on what you think will happen to the heart rate of the volunteers by the end of the 30 minutes.
- Once the 15 minutes have elapsed, the volunteers will measure their heart rates once more and allow the instructor to add this information to the existing dataset, giving you the opportunity to compare the results to your hypothesis.
- You will then be led by your instructor in analyzing the data and to determine the average increase in heart rate for the three participants and how much this increase may have varied between the participants.
- Finally, your instructor will interview the participants on how they feel after drinking the coffee and allow you to compare their responses to the data you had previously analyzed.
- Complete the “Caffeinated Beverages Worksheet” as a take-home assignment.



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## QUESTIONS

### Questions for Heart Rate Experiment - During

*Ask these questions during the 15 minute waiting period for the heart rate experiment. These questions can be tailored depending on the students' familiarity with experimental design (concept of controls, variation in human response, confounding factors).*

- What is your hypothesis? Will participants' heart rates decrease, stay the same, or increase after drinking coffee?
- Why is it important that everyone drinks the same amount of coffee and that the coffee is prepared in the same way?
- Why is there variation in the changes in heart rates?
- What are possible factors that might change the effect caffeine has on someone (gender, weight, how often they have caffeine, if they ate food recently)?

### Questions for Heart Rate Experiment - After

*Ask these questions after the experiment is completed to prompt discussion about results. End with a summary of what you learned. In the case that the data does not support that caffeine increases heart rate, you will have to explain that due to the small sample size and variation in coffee preparation etc., the results may not have been in agreement with the widely-recognized fact that caffeine increases heart rate.*

- What patterns did you notice in the data?
- Did the results support your initial hypotheses?
- Were there any outliers in the data?
- What conclusions can you make from the data?

### Summary Questions

- What were similarities and differences between the caffeinated beverages discussed in the polling questions?
- What are the potential health effects of caffeine for kids?
- Rank the beverages from lowest to highest mg caffeine per serving.
- Does this information change your perspective on caffeine consumption? If so, are you going to change your caffeine consumption habits?



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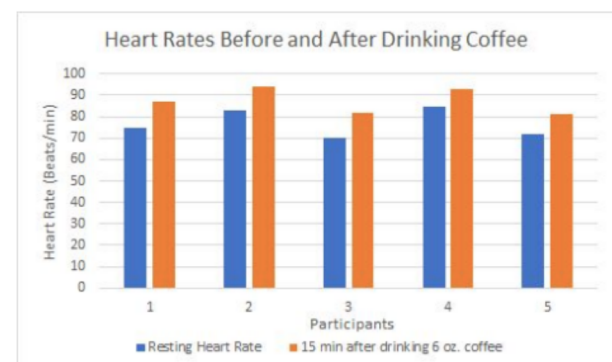
## Data Table for Heart Rate Experiment

**Instructions for Use:** Ideally, you will have a larger sample size ( $n=30$ ). You can prepare a graph on Excel showing the before (blue bars) and after (orange bars) heart rates of participants. Were the students' initial hypotheses supported by the data? Use this information to discuss the average increase in heart rate. Depending on your students' experience with statistics, you can also discuss values like mean, median, and mode.

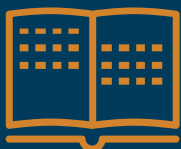
Participant #	Resting Heart Rate (beats/min)	Heart Rate After Coffee (beats/min)	Difference in Heart Rates (beats/min)

**EXAMPLE:**  
(example data from:  
<https://www.youtube.com/watch?v=JiQ4BhwfuVg>)

Participant #	Resting Heart Rate (beats/min)	Heart Rate after Coffee (beats/min)	Difference in Heart Rates (beats/min)
1	75	87	12
2	83	94	11
3	70	82	12
4	85	93	8
5	72	81	9



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## Data Table for Heart Rate Experiment

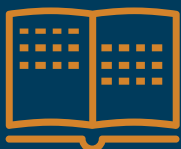
**Instructions for Use:** This worksheet can be used to help keep students engaged during the lesson. Have the students begin filling out this worksheet during the lecture portion of the lesson. All the information required to fill out this worksheet should be included either in the lecture materials or from the polling questions provided.

**Table 1 - CAFFEINE AND HUMAN HEALTH**

Beverage	Caffeine Content (mg/serving)	Beverage	Health Risks	Other?
Coffee	95 mg / 8 oz cup	Energy Boost & Small Boost of Fiber	High Blood Pressure	
Espresso	64 mg / 1 oz	Strengthens Memory	Heart Disease	
Green Tea	30-50 mg / 8 oz	Antioxidant	Constipation & Nausea	
Black Tea	47 mg / 8 oz	Can Lower Bad Cholesterol	Nervousness & Restlessness	
Red Bull	111 mg / 12 oz	Mental Focus	Obesity	
Mountain Dew	55 mg / 12 oz		Diabetes	
Coco Cola	29 mg / 12 oz		Diabetes	

\*\*Obtained from USDA - FoodData Central database

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## Data Table for Heart Rate Experiment (partially filled)

Table 1 - CAFFEINE AND HUMAN HEALTH

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