# Is the Five Second Rule True? educator guide

By *Science News for Students*

When food slips through your fingers, do you follow the five-second rule and eat it anyway, if you're just fast enough? And if you do so, is your food really free of germs? If you've ever wondered just how long it takes for germs to jump onboard your food, this experiment is for you. Join our resident scientist, Bethany Brookshire, to determine the truth behind the myth. And then test the rule yourself!

**Connections to Curricula (Middle and High School):**

- Microorganisms
- Health and nutrition
- Designing an experiment
- Analyzing data using technology

**Standards Alignment**

| Next Generation Science | Common Core |
|---|---|
| Interdependent Relationships in Ecosystems: HS-LS2-1, HS-LS2-2 | ELA Standards: Reading Informational Text (RI): 1, 4, |
| Engineering Design: HS-ETS1-1, HS-ETS1-2, HS-ETS1-4 | ELA Standards: Speaking and Listening(SL): 1, 4 |
| | ELA Standards: Reading for Literacy in Science and Technical Subjects (RST): 1, 2, 3, 4, 8, 9 |
| | ELA Standards: Writing Literacy in History/Social Studies and Science and Technical Subjects (WHST): 2, 6, 9 |
| | Math Standards: 6.SP.2, 6.SP.4, 6.SP.5, 7.SP.4 |

## Links for the DIY Science video "Is the Five-Second Rule True?"

**DIY Science VIDEO: http://bit.ly/5secvideo**

**Blog #1, "The five-second rule: Designing an experiment": http://bit.ly/5secblog1**

**Blog #2, "The five-second rule: Growing germs for science": http://bit.ly/5secblog2**

**Blog #3, "The five-second rule: Myth busted?": http://bit.ly/5secblog3**

**Blog #4, "The five-second rule: Microbes can't count": http://bit.ly/5secblog4**

## How to use this *Science News for Students* series

The video and blogs can be used together, whether teaching about culturing biological samples, experimental design or data analysis. The following sequence is designed to help you highlight opportunities that these resources provide. Use those that fit best your larger instructional plan.

Introduce the experience:

1. Get a sense of what your students already know. Drop a piece of food and say, "five-second rule!" Take a poll to see how many students would eat that piece of food (or think you should). Ask if they have ever used the five-second rule. If so, when or under what conditions would (or wouldn't) they use it? [*Students will likely say they have used it or at least have heard of it. Some might know that MythBusters did a segment on this. They might have certain conditions for using it (based on type of food, type of surface it falls on, etc.).*]
2. Ask why they think the five-second rule exists. What assumptions does it make? [S*tudents might say parents started it to reduce food waste. The rule it assumes is that it takes more than five seconds for germs to attach themselves to food once it drops.]*
3. Tell students that one role scientists perform is to create tests to see if a belief like the five-second rule can be proven true or false. Ask students to brainstorm how they could test the five-second rule themselves. Have them define independent and dependent variables and then write a testable hypothesis. Chart ideas from the students. They might even rank the ideas in the order of which would most convince them whether the "rule" is valid or not. [*Students could suggest testing different types of food, different types of surfaces, or whether five seconds is the right time limit before food risks becoming too contaminated to eat.*]

Watch the experiment:

4. **Show the DIY Science video**. Depending on your students' background, you might want them to have a reference for academic vocabulary used in the video and in the accompanying blog posts [Blackline Master 1]. Students can define the words before watching and add ideas while they watch. (Power Words — a glossary — are also located at the bottom of each blog post.)
5. Provide students with the set of comprehension questions [Blackline Master 2] to help them capture the main ideas from the video.

Replicate the experiment:

6. Tell students that they've been asked to replicate Bethany's experiment. Put them in groups of 3 to 4. Give them **Blog #1** and **#2** to help them create a clear set of procedures from Bethany's experiment. You might give them a template [Blackline Master 3] to help them write out their procedures.
    a. This is a good time to bring up any safety procedures you want students to follow (e.g., seal all petri dishes once the bacteria is applied to the agar,

wear goggles and gloves while agar plates are open, (optional) use of tea lights)

7. Have a group share a description of the procedure and have others check to see if anything is missing. Be sure students have a clear list of materials (and quantities) that match the procedures. If timing does not allow this, compare Bethany's procedure to the procedure that the students come up with.
    a. Decide if students will be using ImageJ software or if you want them to count colonies manually. If manually, one easy technique is to have students place their petri dish onto a piece of graph paper or place graph paper duplicated onto acetate over the dish and photograph. The graph provides a context for determining relative size and distribution of colonies to help students count colonies manually.
8. To save some class time, decide if you want students to make their own incubators and agar plates or if you already have them or will purchase them. If students are making all the components themselves, determine based on numbers of samples and sizes of petri dishes how many groups can use the same incubator. You might consider dividing the class in half and have some students work on building incubators and others make enough agar plates for everyone to use.
9. If your students have done experiments before and you want them to make this their own experimental design, this is a good time to revisit the brainstorm they created (step 3) and have them create a new experiment of their own. To have students expand on Bethany's experiment, there are a few options:
    a. Option 1: Give students **Blog #4.** Have them read about what other studies and lessons learned to improve upon the original experimental design. The students can think about which lessons they can incorporate into their designs and which (like creating a blind study) might be more challenging to implement.
    b. Option 2: Have teams review their brainstormed ideas and decide on a variable they want to focus on for their testing. For example, they might change how long the bologna is on the floor or the type of surface on which they are dropping the bologna.
    c. Option 3: Groups of students might want to share data to test more variables. For example, if testing the type of food, all groups could use the same surfaces, but one group might run its test using bologna, one might use watermelon and another bread. In another case, groups might all use the same type of food but one group might run its test on tile, one on carpet and another on concrete.
10. Plan your implementation. Students will be observing their samples each day for three days, so you will want them to collect their data on a Monday or Tuesday so they can observe for three consecutive days before the weekend. Data analysis can take place the next week.
11. Plan how you will dispose of the petri dishes. Follow all local safety guidelines for your school site.

Analyze the data (High School only):

12. Have students read how Bethany analyzed her data using **Blog #3**. Students can use a template [Blackline Master 4] to follow Bethany's analysis procedure using their own data.
13. Discuss each group's data. In what ways is it similar to and different from Bethany's? What might account for the differences? Ask students whether their data shed new light on the question being tested.
14. Have students read through the limitations that Bethany described in **Blog #4**. Do they agree with this list? Are there any ideas they would now add based on their own experiences?
15. Can students think of any sources of contamination that could impact their conclusions? Are there other issues that could have influenced their results?
16. At the end of Bethany's article, she invites people to let her know about their experience doing the experiment. Challenge students to create a message that Bethany would respond to!

Class or group discussion questions:

17. Although the data Bethany and other scientists collected confirm that the five-second rule is busted, why do students think that this myth persists? [*Students might say the public doesn't think there's enough evidence to combat the myth*.]
18. What do they think is the danger of allowing this myth (or others) to persist?
19. Are the bacteria Bethany grows likely to be harmful? Why or why not? How could this be determined?
20. What do students feel should be done when scientific evidence on its own does not change public opinion? How much evidence is needed to convince the public of an idea? Should scientists get involved? If so, discuss what students could do to raise awareness with their peers and the public. If time allows, pick selected strategies to implement.
21. Under what conditions do students think it might it be okay to eat the food that has been dropped on the floor? What would they test next to answer this question? [*Students might suggest rinsing off the bologna after it dropped or testing whether the temperature of the food affects outcome. Students can brainstorm extensions that could be tested.*]
22. Ask students to brainstorm other myths that can be solved using experimentation. Are there some that can't be solved in this way?

## Related stories in *Science News for Students*

DIY Science: Snot Science
https://www.sciencenewsforstudents.org/collections/diy-science-snot-science

Cool Jobs: Finding foods for the future
https://www.sciencenewsforstudents.org/article/cool-jobs-finding-foods-future

The bugs within us
https://www.sciencenewsforstudents.org/article/bugs-within-us

Superbugs: A silent health emergency
https://www.sciencenewsforstudents.org/article/superbugs-silent-health-emergency

Don’t Eat That Sandwich!
https://www.sciencenewsforstudents.org/article/dont-eat-sandwich

## Blackline Master 1: Vocabulary

**Directions:** Below are some words used in the video you may not be familiar with. Take a look and write down what you think they mean, then confirm your thinking when you watch the video.

| Word | What I think it means | What it means in this context |
|---|---|---|
| Agar | | |
| Control | | |
| Culture | | |
| Germs | | |
| Hypothesis | | |
| Incubator | | |
| Microbes | | |
| Protocol | | |
| Replicate | | |

## Vocabulary answer key:

- **Agar:** A substance made from seaweed and full of nutrients that can be used for growing bacteria
- **Control:** Something that is not changed during an experiment
- **Culture:** To grow cells outside their normal environment, like in a petri dish
- **Germs:** A general term for one-celled microorganisms
- **Hypothesis:** A prediction or statement that can be tested
- **Incubator:** A device that keeps a constant temperature and can be used to grow cultures
- **Microbes:** (short for microorganisms) Living things too small to be seen with the unaided eye
- **Protocol:** An accepted or agreed-upon procedure for doing a task
- **Replicate:** A copy of something. In an experiment, this copy can be redoing the test in the same way to determine if the same result occurs

## Blackline Master 2: Comprehension Questions

**Directions:** Use these questions to track the main ideas from the video and blogs:

1. What is the five-second rule?

2. What is the hypothesis that Bethany tests? Also, have the students define all variables by specific type here, too (don't forget to have them define any potential confounding variables as well).

3. Why can't someone just count the bacteria to answer the hypothesis?

4. How do scientists determine the quantity of bacteria in a sample?

5. What are the key elements of an incubator and how are they combined to achieve a constant temperature?

6. What is agar and why is it used?

7. What are the variables that are being tested?

8. How many experimental groups are needed to test this idea and how are they defined?

9. How is contamination of the samples minimized? Why is this important?

10. What do the candles Bethany lights around the petri dishes of agar do? If you don't (or can't) use candles, how else can you protect your experiment from contamination?

11. Why do you think Bethany removes the petri dishes from the incubator each day and photographs them?

12. Explain Bethany's results as they relate to her hypothesis.

13. If you eat food that's been on the floor, are you going to get sick?

## Comprehension Questions answer key

1. What is the five-second rule? [*If a piece of food drops on a clean surface, it will be fine to eat if you pick it up quickly enough because it takes more than 5 seconds for germs to attach to the food.*]
2. What is the hypothesis that Bethany tests? [*Food picked up after 5 seconds will collect fewer bacteria than food picked up after 50 seconds.*] Also, have the students define all variables by specific type here, too (don't forget to have them define any potential confounding variables as well).
3. Why can't someone just count the bacteria to answer the hypothesis? [*Bacteria are too small to see with the unaided eye, or even using a microscope.*]
4. How do scientists determine the quantity of bacteria in a sample? [*Scientists grow bacteria cultures in an incubator and then count the colonies.*]
5. What are the key elements of an incubator and how are they combined to achieve a constant temperature? [*A closed, insulated space is created using a Styrofoam drink cooler. Heat is created with an incandescent light bulb. Temperature is regulated by poking holes in the chest and reading the temperature using a digital thermometer.*]
6. What is agar and why is it used? [*Agar is made from seaweed and contains nutrients to help bacteria grow.*]
7. What are the variables that are being tested? [*length of time the bologna is on the floor and clean versus dirty floor*].
8. How many experimental groups are needed to test this idea and how are they defined? [*Six groups are needed to isolate each of the variables: no treatment, bologna that's never been dropped, bologna dropped on a clean floor for 5 seconds, bologna dropped on a clean floor for 50 seconds, bologna dropped on a dirty floor for 5 seconds and bologna dropped on a dirty floor for 50 seconds.]*
9. How is contamination of the samples minimized? Why is this important? [*Bethany is wearing gloves and a lab coat, she lights candles around the experiment, she uses clean cotton swabs for each sample, etc. Contamination must be minimized to prevent foreign microbes from interfering with results.*]
10. What do the candles Bethany lights around the petri dishes of agar do? [*Candles heat the air around them. Hot air rises, helping to keep foreign bacteria (not involved in the experiment) away from the petri dishes.*] If you don't (or can't) use candles, how else can you protect your experiment from contamination? [*Keep lids on the petri dishes except for the moments when you are applying the swab sample to the agar.*]
11. Why do you think Bethany removes the petri dishes from the incubator each day and photographs them? [*Bacteria may not all grow at the same rate. By photographing the petri dishes each day, she can monitor the rate in which the bacteria grows for each test group.*]
12. Explain Bethany's results as they relate to her hypothesis. [*Bacteria can grow anywhere; it takes time for bacteria to grow; bacteria are found on the clean and dirty floor; there are more bacteria on the bologna that is left on the floor for 5 seconds than for 50 seconds*]

13. If you eat food that's been on the floor, are you going to get sick? [*Not necessarily. It depends what types of microbes get transferred to your food and whether your body is able to fend them off.*]

# Blackline Master 3: Experimental Design

**Directions:** Use the space below to recreate the steps from Bethany's experiment

**Purpose of the experiment:**

**Hypothesis:**

**Materials:**

**Procedures:**

1.

2.

3.

4.

5.

6.

7.

8.

**Data collection table: Number of Bacteria Colonies**

| Variable tested | Sample | After 24 hours | After 48 hours | After 72 hours |
|---|---|---|---|---|
| **Control** | **1** | | | |
| | **2** | | | |
| | **3** | | | |
| **Balogna in package** | **4** | | | |
| | **5** | | | |
| | **6** | | | |
| **5 seconds clean floor** | **7** | | | |
| | **8** | | | |
| | **9** | | | |
| **50 seconds clean floor** | **10** | | | |
| | **11** | | | |
| | **12** | | | |
| **5 seconds dirty floor** | **13** | | | |
| | **14** | | | |
| | **15** | | | |
| **50 seconds dirty floor** | **16** | | | |
| | **17** | | | |
| | **18** | | | |

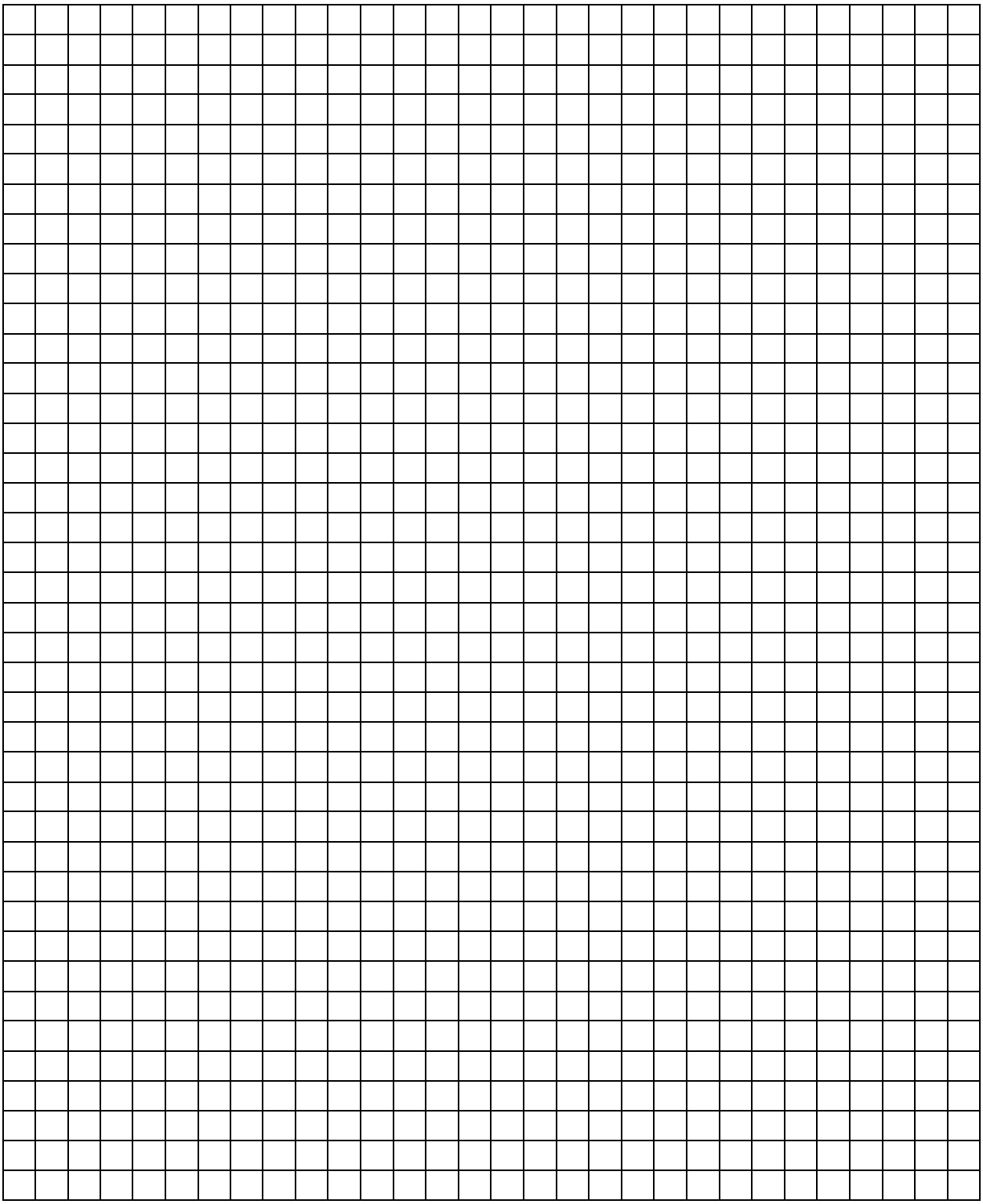
**Notes:**
Here is a good place to keep track of observations, unexpected challenges, or thoughts that come to mind when doing the experiment.

## Blackline Master 4: Analyzing Data

**Directions:** Use **Blog #3** to follow Bethany's process for analyzing data. You can use her process to teach yourself what to do. Then, repeat the process using your data.

| | | | | Clean floor | | Dirty Floor | |
|---|---|---|---|---|---|---|---|
| **Day** | **Test** | **Control** | **Bologna** | **5 seconds** | **50 seconds** | **5 seconds** | **50 seconds** |
| 1 | Mean | | | | | | |
| | Standard deviation | | | | | | |
| 2 | Mean | | | | | | |
| | Standard deviation | | | | | | |
| 3 | Mean | | | | | | |
| | Standard deviation | | | | | | |

Graph your data. There are many online tools for doing this in Excel or GraphPad Prism. Otherwise, you can build one by hand:



Compare data to determine statistical significance (*warning: you may find this too advanced for some middle-school students*):

A one-way analysis of variance (ANOVA) is used to determine whether there is an overall difference between groups of data.

| **ANOVA summary** | **Day 1** | **Day 2** | **Day 3** |
|---|---|---|---|
| F-value | | | |
| P value | | | |
| Significant difference among means (P>0.05)? | | | |
| R square value | | | |

If there are differences between groups of data, you will want to know which groups differed from each other. That requires a post hoc test. The Tukey's Test is the most likely type of post hoc to run (as its purpose is to compare every mean to every other mean to determine the distance between your groups).

**Conclusions:**

Have students state: their results, how certain they are about their data, possible errors, and future experimental modifications and explorations. Then have them sum up what they feel they can safely say about the five-second rule, based on their data.