



# What makes food unsafe?

*This module will introduce participants to the basic science of foodborne illness-causing microorganisms in order to understand environmental factors that can mitigate the risks they pose to fresh produce on the farm.*

## TEACHING OBJECTIVES: WHY DO THIS?

- Foodborne illness risk factors are present on every farm.
- While no farm can completely eliminate food safety risk., an understanding of the basic science of foodborne illness-causing microorganisms and the environments in which they thrive can help beginning farmers take steps to reduce the risk of transmitting foodborne illness through fresh produce.

## BEST LOCATION

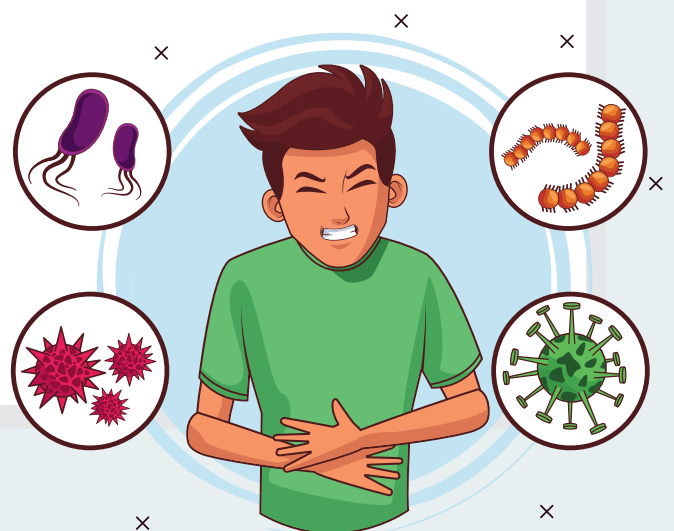
Classroom and/or on-farm

## BEST TIME OF YEAR

Any time works well

## LEARNING OBJECTIVES: WHAT CAN PARTICIPANTS LEARN?

- Name the categories of potentially harmful microorganisms commonly found on farms (bacteria, viruses, parasites), their characteristics, preferred environments and growth factors
- Explain how to reduce the risk of transmitting harmful microorganisms to produce through proper handwashing and sanitation practices





## IMPORTANCE FOR BEGINNING FARMERS

Beginning farmers want to provide fresh, healthy and safe produce for their customers. Understanding the basic science of food safety will help beginning farmers take action to produce safe food and protect their business from the potential liability of people getting sick from eating unsafe produce.

## UNIQUE ASPECTS OF THE CURRICULUM

This curriculum uses interactive, hands-on and visual activities to teach microbiological concepts, rather than abstract descriptions of bacteria, viruses, parasites and their characteristics.

## Facilitator Planning & Preparation

Activity	Est. Prep Time	Est. Instructional Time
Primary Activity 1: Bacterial Growth Simulation	X Hrs, X Min	X Hrs, X Min
Primary Activity 2: Cross-contamination	X Hrs, X Min	X Hrs, X Min
Primary Activity 3: Handwashing	X Hrs, X Min	X Hrs, X Min



## Technical Content

### KEY WORDS:

**Bacteria** single-celled microorganisms that can multiply in environments outside of a host organism as well as inside a host organism, such as a person, farm animal, or wild animal. Most can multiply very quickly, reaching high numbers in a short period of time if they are in the right environment. Examples of bacteria include E.coli, Salmonella, and Listeria monocytogenes.

**Chemical hazards** potentially harmful substances that may be spilled or applied to produce in an improper manner, including: pesticides, herbicides, fungicides, sanitizers, cleaners, fuel, and lubricants

**Cleaning** the physical removal of visible dirt, soil from a surface; generally involves scrubbing with a detergent and rinsing with clean water

### FACILITATOR BACKGROUND INFORMATION:

- All types of produce are susceptible to contamination that can cause foodborne illness.
- Foodborne illness makes people very sick and can result in hospitalization, long term health problems and death.
  - Those who are more vulnerable to severe illness include young children, older adults and immunocompromised individuals.
- All farms, regardless of scale, location or type of produce grown, can reduce risks to produce safety.
- Foodborne illness is caused by contamination of fresh produce by microorganisms, including bacteria, viruses and parasites. A microorganism that causes illness or disease is called a pathogen.



## Technical Content

### KEY WORDS:

<b>Cross-contamination</b>	cross-contamination means the transfer of harmful microorganisms called pathogens or germs from one person, object or place to another.
<b>Detergent</b>	a cleaning product that helps to lift dirt, soil or other debris off a surface so that it can be brushed, wiped or rinsed off; a common example is dish soap
<b>Microorganisms</b>	organisms including yeasts, molds bacteria, viruses, protozoa and parasites that are so small they can only be viewed through a microscope
<b>Pathogens</b>	commonly called “germs”; microorganisms that are capable of causing disease or illness; examples include bacteria, viruses and parasites

### FACILITATOR BACKGROUND INFORMATION:

- Because these disease-causing organisms are microscopic, a farmer cannot easily know whether they are present. Therefore, practicing good sanitation and prevention is the best way to reduce the risk of produce becoming contaminated..
- Bacteria are single-celled organisms that can multiply extremely quickly in environments that are wet, dark and warm. Some bacteria such as Listeria even thrive in cool environments, making them even more difficult to control once present. Other examples of bacteria include E.coli, Salmonella and Campylobacter.
- Unlike viruses and parasites, bacteria can thrive and multiply outside of a host body (animal or human).



## Technical Content

### KEY WORDS:

<b>Parasites</b>	protozoa (see definition below) or intestinal worms that can only multiply in a host animal (which may be a human); while they cannot reproduce outside of the host, they can survive outside the host for long periods of time; a host can also be affected for a long time without producing any symptoms
<b>Physical hazards</b>	foreign objects that often end up in food due to environmental conditions and equipment that is damaged or not properly protected; examples include: broken glass, metal shards, rocks, wood splinters, artificial fingernails, jewelry
<b>Protozoa</b>	single-celled microscopic animals
<b>Sanitizer</b>	a substance that significantly reduces the amount of microorganisms on a surface; examples include bleach and peroxyacetic acid (PAA); will only work on surfaces that have been cleaned first

### FACILITATOR BACKGROUND INFORMATION:

- Bacteria can reproduce quickly and exponentially on surfaces or in water.
- While viruses and parasites cannot multiply outside of a host, they can still hitch a ride on produce and make a person sick if they eat it.
- Viruses are typically spread when produce is touched by someone who hasn't washed their hands. Only a few virus particles are needed to make someone very sick. Examples of viruses that can be transmitted on produce include Norovirus and Hepatitis A.



## Technical Content

### KEY WORDS:

**Sanitizing** treating a cleaned surface in order to reduce microorganisms present; sanitizing follows cleaning and is often done on food contact surfaces

**Viruses** viruses are small, living particles that can only multiply in a host animal (which may be a human); while they cannot reproduce outside of the host, they can survive outside the host of long periods of time



### FACILITATOR BACKGROUND INFORMATION:

- Parasites are protozoa (single-celled animals) or intestinal worms that are often spread through contaminated water. Parasites can survive for long periods of time in the environment and are difficult to kill, even with chemical sanitizers. Examples of parasites include Giardia lamblia, Cryptosporidium parvum and Toxoplasma gondii. Toxoplasma gondii is often carried by cats.



## KWL Process

*Know, Want to Know, Learn*

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### **Suggested prompting questions for farmers to share from their experience:**

- What do you know about bacteria, viruses and parasites. How does this apply to your farm?
- What have you learned from your past experience in food service roles, or just in general life, about the importance of handwashing and avoiding cross-contamination?
- What kind of cleaning and sanitizing products have you tried on your farm? How did those work out? Do you have any questions about them?



### **Suggested prompting questions to find out what participants want to learn:**

- Do you have handwashing facilities on your farm? Where are they located? Are they convenient? What do you like or not like about them?
- Do you have a policy about working when sick? What are the challenges with that (prompts if necessary: work not getting done, not being able to pay employees, etc.)



## Primary Activities

*Overview of the main activities in this module*

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### Activity 1

#### Bacterial Growth Simulation

Participants' current knowledge and knowledge gaps around bacteria and bacterial reproduction are identified through a Know-Want to Know-Learn (KWL) process. Jelly beans in containers are used to provide a visual representation of bacteria's exponential growth pattern.

### Activity 2

#### Cross-contamination

Using UV fluorescent powder applied to hands, produce and food contact surfaces, participants will visualize how contamination can spread on the farm.

### Activity 3

#### Handwashing

Using UV fluorescent powder applied to hands, participants will practice various handwashing techniques and receive feedback on how well they work.







## Additional Resources/Activities

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### Resource 1

#### Bacterial Growth Video

This 1 min, 38 second video complements Primary Activity 1: Bacterial Growth Simulation. It provides additional context, including the amount of bacteria that can make someone sick and the conditions in which bacteria thrive (FATTOM).

[bit.ly/4065f3V](https://bit.ly/4065f3V)

### Resource 2

#### Bacteria on the Farm

This infographic complements Primary Activity 1: Bacterial Growth Simulation. It could be used in a slide or as a handout to communicate the rate in which bacteria multiply from one cell to thousands within a matter of hours

### Resource 3

#### Cleaning vs. Sanitizing

This infographic could be used in a slide or as a handout. It describes the distinctly different processes of cleaning and sanitizing and provides examples of detergents and sanitizers that are appropriate and accessible (available at any supermarket or general retailer) for beginning farmers.





## **Review and Encouraging Further Learning**

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### **Module Review and Evaluation Questions:**

- How would you explain bacterial growth and the implications to food safety on the farm to a new employee?
- Why should you only sanitize a surface that has been previously cleaned?
- What are some aspects of your farm's operation that could pose a cross-contamination risk?

### **Activities for Review:**

- Video: Everyone Should wash their hands for at least 20 seconds!  
[bit.ly/3yV4gaV](https://bit.ly/3yV4gaV)
  - Participants pretend to wash their hands as guided by this short video from the Produce Safety Alliance



## **Review and Encouraging Further Learning (cont.)**

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### **Actions to take on their own farm/garden to further understanding:**

- Visit a store to explore the different types of detergents and sanitizers available for purchase. Read the labels and identify which ones would work well for your farm based on what you learned in this module
- Walk through your farm with an eye toward conditions in which bacteria thrive: food, acidity, time, temperature, oxygen, and moisture (F.A.T.T.O.M). What are some areas that will require vigilance to prevent the spread of bacteria?



# 1. Bacterial Growth Simulation

## OVERVIEW

Participants' current knowledge and knowledge gaps around bacteria and bacterial reproduction are identified through a Know-What to Know - Learn (KWL) process. Jellybeans are used to provide a visual representation of bacteria's exponential growth pattern.

## MATERIALS NEEDED

- Clear plastic or glass containers of varying sizes
- (ex. empty food containers with the labels removed)
- Printed container labels
- Jellybeans

## FACILITATOR BACKGROUND INFORMATION

- Bacteria are single-celled organisms that can multiply extremely quickly in environments that are wet, dark and warm. Some bacteria such as Listeria even thrive in cool environments, making them even more difficult to control once present. Other examples of bacteria include E.coli, Salmonella and Campylobacter.
- Unlike viruses and parasites, bacteria can thrive and multiply outside of a host body (animal or human).
- Bacteria can reproduce quickly and exponentially on surfaces or in water.
- Most bacteria reproduce by a process called binary fission, in which the bacteria's single cell divides into two identical cells



# 1. Bacterial Growth Simulation (cont.)

## FACILITATOR BACKGROUND INFORMATION, CONT.

- Bacteria need six things to thrive and reproduce:
  - Food
  - Acidity (bacteria do not like acidic environments)
  - Temperature (generally, bacteria grow best from 40-140 degrees F)
  - Time (bacteria double in population every 20 minutes)
  - Oxygen (some need it, some don't)
  - Moisture
- These are sometimes abbreviated with the acronym FAT-TOM



## PROCEDURE

Prior to the first time conducting this activity, facilitator assembles the containers:

- Count out the following number of jellybeans and place in separate containers:
  - 5
  - 20
  - 80
  - 320
  - 1280
- Affix the appropriate label to each container



# 1. Bacterial Growth Simulation (cont.)

## PROCEDURE

Day of activity:

- Facilitator initiates Know - Want to Know - Learn (KWL) conversation around the concepts of bacteria and bacterial growth.
  - What do participants already know about bacteria and how they reproduce?
  - What types of bacteria are they familiar with?
  - Under what conditions do bacteria thrive?
  - What do participants want to know about bacteria and how they multiply?
    - Facilitator captures what students want to know in a shared document (flipchart, electronic document, etc.) so that these topics can be addressed during the session or as follow-up afterwards.
- Facilitator explains that they have created a tool to help visualize the impact of exponential bacterial growth and the impact that a small amount of bacteria can have toward contaminating fresh produce.
- Facilitator introduces the jar containing 5 jelly beans and the scenario: "Someone didn't wash their hands well before harvesting tomatoes and has transferred 5 Salmonella bacteria to our tomato."
- Next, the facilitator explains while introducing the jar with 20 bacteria: "This tomato was one of the first to be harvested, so it sat in the crate in a nice warm area for a half hour and then there were 20 Salmonella."
- Facilitator introduces the jar containing 5 jelly beans and the scenario: "Someone didn't wash their hands well before harvesting tomatoes and has transferred 5 Salmonella bacteria to our tomato."
- Next, the facilitator explains while introducing the jar with 20 bacteria: "This tomato was one of the first to be harvested, so it sat in the crate in a nice warm area for a half hour and then there were 20 Salmonella."



# 1. Bacterial Growth Simulation (cont.)

## PROCEDURE

- Introducing the jar of 80 bacteria “There were a lot of ripe tomatoes to harvest that day, so one hour later the tomato was still in a shady, but warm area of the farm... now harboring 80 Salmonella.”
- Introducing the jar of 320 bacteria “After an hour and a half, our tomato is on its way to the wash pack area, now harboring 320 salmonella.”
- Introducing the jar of 1280 bacteria “It’s been 2 hours since this tomato was harvested and it’s getting packed to go out to a customer. Our tomato, along with 1,280 Salmonella gets tucked in a box with a few dozen other tomatoes.
  - What are the learners’ reactions?
  - In addition to our tomato, what else potentially became contaminated in this scenario?





# 1. Bacterial Growth Simulation (cont.)

## EXTENSIONS

- Watch the video [Bacterial Growth](#)
- Discuss how worker hygiene and sanitation practices can reduce the risk of bacteria being present on food or food contact surfaces.
- Share some examples, ask learners to contribute others :
  - When you clean leftover plant debris out of bins you remove the food source for bacteria
  - If you spray the bins with a sanitizer after cleaning, you can further reduce the number of bacteria present
  - When you wash your hands before working with produce, you reduce the risk of passing along any bacteria that may be hitchhiking

## VARIATIONS

- Use dry beans, corn kernels, or any other small and uniformly sized object
- Ask participants to take guesses before disclosing the amount of jellybeans in each subsequent jar


## CONNECTIONS

Insert connections to other modules or programs (for example, soil health and land access.)






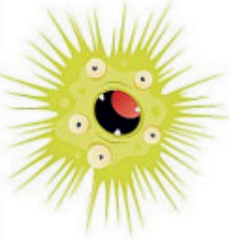
## Container Labels



0 Minutes  
5 Bacteria




30 Minutes  
20 Bacteria



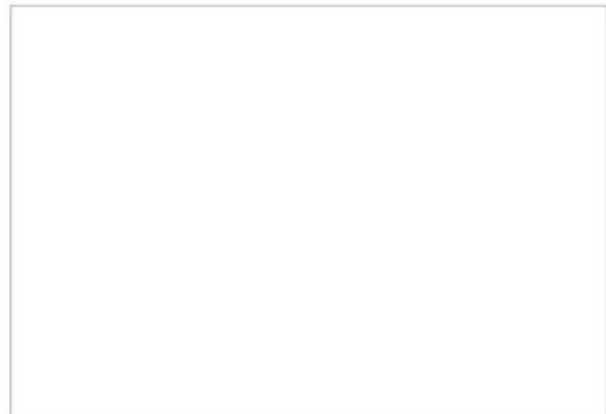
1 Hour  
80 Bacteria



1 ½ Hour  
320 Bacteria



2 Hours  
1280 Bacteria



A printable PDF file with this image can be downloaded from the additional resources page: [LINK](#)



## 2. Cross-contamination

### OVERVIEW

Using UV fluorescent powder applied to hands, produce and food contact surfaces, participants will visualize how contamination can spread on the farm.

### MATERIALS NEEDED

- UV fluorescent powder
- This is sold under brand names such as “Glo Germ” or “GlitterBug” for the purpose of food safety education. It is also available in gel and lotion forms.
- UV light
- Room that can be darkened by turning off lights or viewing box (provide instructional diagram)
- A few pieces of produce (any type will do) and a few produce contact surfaces (ex. harvest knife, harvest bin, countertop)

### FACILITATOR BACKGROUND INFORMATION

- Pathogens, commonly called germs, can be spread via fresh produce and sicken those who eat it, especially if it is eaten raw such as in salad, carrot sticks, etc.
- One way that pathogens can get on fresh produce is through contact with contaminated surfaces such as workers hands, tools, harvest containers, etc. This is referred to as cross-contamination.
- UV fluorescent powder is a commonly used tool in healthcare and food service industries to teach how germs can spread.





## 2. Cross-contamination (cont.)

### PROCEDURE

- Facilitator shows participants the UV fluorescent powder and explains how the harmless powder is made up of tiny particles which are roughly the same size as bacteria.
  - Explain that the powder will be used to demonstrate how germs can spread through everyday farm activities.
    - Explain that this is called “cross-contamination” and define this concept: cross-contamination means the transfer of harmful microorganisms called pathogens or germs from one person, object or place to another.
  - Sprinkle some powder on a surface and shine the UV light on it to demonstrate how the powder glows when illuminated with a UV light, but is otherwise invisible.
  - Explain how germs are microorganisms that are too small to be seen.
  - Darken room and shine UV light on demonstration materials before any powder is applied.
- Facilitator asks for a volunteer or two to have the powder sprinkled on their hands
  - Ask volunteers to hold out their hands and sprinkle a generous amount of powder on them.
  - Ask volunteers to interact with the produce and produce contact surfaces that have been prepared. For example, you may ask them to:
    - Put some produce in a harvest bin
    - Hand a harvest bin to a coworker
    - Harvest some produce
    - Shake a coworker’s hand
- Darken the room and/or retrieve the viewing box
- Shine UV light on the produce, produce contact surfaces, and any other surfaces that you used in your simulation, such as coworkers’ hands, to see how the powder has spread
- Ask participants to share their reactions to this activity and how it may have implications on their own farms. What preventative measures can they take to prevent cross-contamination?



## 2. Cross-contamination (cont.)

### EXTENSIONS

Come up with a list as a group or individually of the various food contact surfaces on a farm that could pose a cross-contamination risk.

### CONNECTIONS

Use this activity in combination with Primary Activity 3: Handwashing, which also utilizes UV Fluorescent powder.

### VARIATIONS

- Designate participants into various roles (harvester, packer, etc.). Have them conduct harvest and packing activities as usual, while adding UV fluorescent powder to the harvesters' hands and/or tools. Afterward, shine the UV light on all food contact surfaces as well as participants' faces, clothing, cell phones, etc.
- Simulate the customer receiving and using the produce. Designate one or two participants as customers. Add additional powder to the seller's hands if desired. Give the customers shopping bags with other produce items in them for receiving the contaminated produce. Have them cut up the produce and use the UV light to see how the powder transfers to a cutting board, knife, shopping bag and other produce in the bag.



# 3. Handwashing



## OVERVIEW

Using UV fluorescent powder applied to hands, produce and food contact surfaces, participants will visualize how contamination can spread on the farm.

## MATERIALS NEEDED

- UV fluorescent powder
- This is sold under brand names such as “Glo Germ” or “GlitterBug” for the purpose of food safety education. It is also available in gel and lotion forms.
- UV light
- Dark room or viewing box
- Handwashing sink or portable handwashing station
- Soap
- Hand sanitizer
- Printed or electronic Handwashing Playlist

## FACILITATOR BACKGROUND INFORMATION

- Pathogens, commonly called germs, can be spread via fresh produce and sicken those who eat it, especially if it is eaten raw such as in salad, carrot sticks, etc.
- Following good handwashing practices is an effective way to reduce the risk of pathogens getting on to fresh produce that comes into contact with workers’ hands or surfaces that hands have touched.
- UV fluorescent powder is a commonly used tool in healthcare and food service industries to teach how germs can spread.



## 3. Handwashing (cont.)

### PROCEDURE

- Facilitator shows learners the UV fluorescent powder and explains how the harmless powder is made up of tiny particles which are roughly the same size as bacteria.
  - Explain that the powder will be used to demonstrate germs on their hands. Explain how germs are microorganisms that are too small to be seen and how handwashing is an effective way to remove germs from hands--though not all handwashing techniques are equally effective.
    - Ask, have you ever been in a public restroom and see someone do the “Splash & Dash”? Explain that the use of soap and scrubbing all parts of the hand thoroughly for 20 seconds is the most effective way.
- Facilitator asks for a volunteer to have powder applied to their hands
  - Sprinkle a generous amount of powder on the person’s hands. Have them rub their hands together and show them to the class.
  - Darken the room and/or retrieve the viewing box. Shine the UV light on the person’s hands to demonstrate how the powder glows when illuminated with a UV light, but is otherwise invisible.
- Facilitator asks for two additional volunteers to have powder applied to their hands as well. Once three participants have powder on their hands give each volunteer one of the following sets of instructions:
  - Rinse hands with water only
  - Use hand sanitizer only
  - Wash hands using soap and water
- Invite each participant to apply powder to their own hands and test out different handwashing scenarios and techniques.
  - Washing for 2 seconds, 5 seconds, 10 seconds, 20 seconds
  - Do different scrubbing techniques work better than others?



## 3. Handwashing (cont.)

### PROCEDURE

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- Facilitator concludes the activity by going over recommended handwashing technique:
  - Wet hands and apply soap
  - Rub hands together for 20 seconds
  - Rinse hands
  - Turn off the faucet with a paper towel
  - Open door with a paper towel
  - Dispose of paper towel in wastebasket
- Ask participants to share their reactions to this activity.
  - What did you learn?
  - What surprised you?



## 3. Handwashing (cont.)

### EXTENSIONS

Watch the purple paint handwashing video to observe an ideal method for distributing soap and scrubbing

[https://www.youtube.com/watch?v=nEzJ\\_QKjT14](https://www.youtube.com/watch?v=nEzJ_QKjT14)

### VARIATIONS

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### CONNECTIONS

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## Handwashing Playlist

*Hum or sing (aloud or in your head) to any of these hits to time your 20 second handwashing session.*

- “Happy Birthday” (twice)
- “Twinkle Twinkle Little Star”
- “The ABCs”- including the “now I know my ABCs” part
- “If You’re Happy and You Know It”
- The chorus of the following tunes:
  - “Thriller” by Michael Jackson
  - “Truth Hurts” by Lizzo
  - “Let it Go” from Disney’s Frozen
  - “Jolene” by Dolly Parton
  - “Hands Clean” by Alanis Morissette
  - “Raspberry Beret” by Prince
  - “Love on Top” by Beyoncé
  - “Africa” by Toto
  - “Landslide” by Fleetwood Mac
  - “Heaven on Earth” by Belinda Carlisle
  - “Bye Bye Bye” by NSYNC
  - “Shake It Off” by Taylor Swift
  - “Sweet Caroline” by Neil Diamond
  - “No Scrubs” by TLC
  - “I Want it That Way” by The Backstreet Boys
  - “Oops...I did It Again” by Britney Spears
  - “Lose Yourself” by Eminem
  - “Karma Chameleon” by Culture Club
  - “Just the Way You Are” by Bruno Mars
  - “Mr. Brightside” by the Killers
  - “Some Nights” by Fun
  - “Can’t Hold Us” by Macklemore





# Bacteria on the Farm Infographic

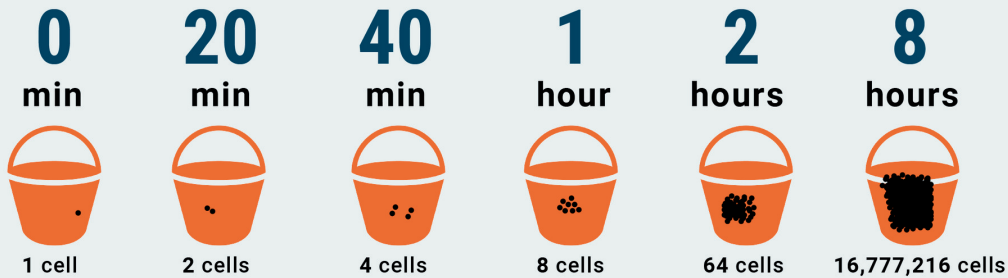
## BACTERIA ON THE FARM

IT ALL STARTS WITH

**ONE...**

Bacteria can multiply **once every 20 minutes.**

One bacterium can turn into thousands in the matter of hours.



Sanitizing your equipment, tools, and other food contact surfaces often can help slow multiplication rates or prevent contamination from occurring.



**Your equipment may be visibly free of dirt,  
but that doesn't mean it isn't covered in bacteria.**



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Source: Produce Safety Alliance Grower Training Module 1

**A .png file of this infographic can be downloaded from the additional resources page: [LINK](#)**



# Cleaning vs. Sanitizing Infographic

**CLEANING**  
The physical removal of dirt from surfaces, using a detergent

**VS.**

**SANITIZING**  
Treating a cleaned surface with an antimicrobial product in order to reduce or eliminate microorganisms

**USING A DETERGENT:**

- Needs to be food grade
- Must be approved for use on food surfaces to clean harvest implements
- Any dish soap is a good choice

**READY TO USE SANITIZERS:**  
(Approved for use on food contact surfaces)

- Purell Fragrance Free Food Service Surface sanitizer
- SaniDate Ready to use Hard Surface Sanitizer
- Clorox Anywhere Daily Disinfectant and Sanitizer



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Use of trade names is purely for example and is not an endorsement or condemnation on the part of MSU or any partnering organizations.

Source: Produce Safety Alliance Grower Training Module 6

A .png file of this infographic can be downloaded from the additional resources page: [LINK](#)