

# Training for Educators

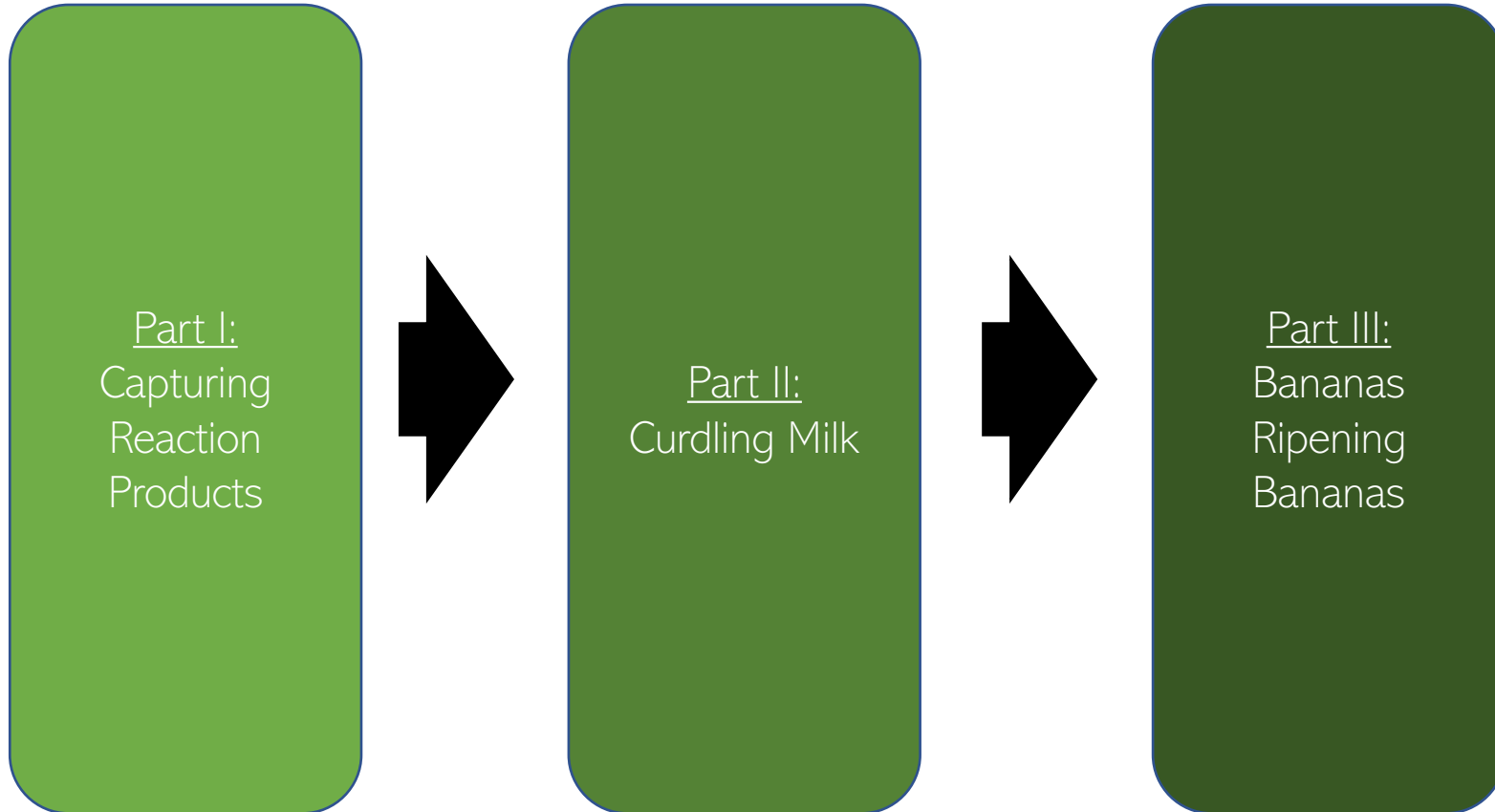
## Food Science - Chemical Reactions

Secondary Level  
Ages 12-18

# Mission of the lab

- This laboratory will teach chemical reactions through experiments related to food ripening and spoilage.
- The main takeaways are:
  - A chemical reaction is a change when the final components (products) are chemically distinct from the starting components (reactants). The mass of the reactants is equal to the mass of the products.
  - Food can undergo many chemical reactions, like spoilage and ripening. Baking and grilling are other examples of chemical reactions.
  - Clues that a chemical reaction has taken place are the release of light or heat, color change, gas or odor production, sound, or formation of solids.

# Summary of experiments



There are 3 experiments in total.

# Supplies list

- Bananas (alternatives: apples, plantains)
- Lemons (alternatives: limes, grapefruit) and oranges
- Milk
- Vinegar (alternatives: citrus juice, like lemon)
- Baking soda
- Water
- Balloons
- Small clear cups (glass or plastic)
- Cotton fabric pieces (large enough to cover the opening of the small clear cups)
- Rubber bands
- Plastic bags
- Empty clear bottle (glass or plastic)
- Pen/pencils
- Marker
- Knife for cutting produce (optional)

# Safety considerations

- Demonstrate to the students how to safely hold a knife and cut produce to avoid injuries. You may also pre-cut the produce to avoid any safety concerns.
- Lemon and vinegar are acidic and may sting open cuts and wounds as well as if they get into students' eyes.
- While tasting food is part of the food preparation process, please do not taste the food in this lab because the spoiled food may cause the taster to get sick.

# Setting up your space

- Gather your supplies and separate by experiment(s) on your table.
- These are our recommendations:
  - Every student should have a pencil or pen. Manuals can be printed for all students or shared by small groups.
  - Part I - vinegar, baking soda, clear bottle, balloon
    - Each group (2-4 students) will need one balloon and clear bottle. You can prefill 60 mL (~4 T) of vinegar into each bottle. The class can share access to the baking soda.
  - Parts II - milk, lemon, orange, water, clear cups, cotton fabric piece, rubber band
    - We recommend pre-cutting lemon and orange slices that are similarly sized.
    - Each group (2-4 students) will need 4 small clear plastic cups, one rubber band and cotton piece that can cover the top of one cup, one slice of orange and lemon. The class can share access to milk (~45 mL per group) and water (~5 mL per group). We recommend having a couple of small containers of milk.
  - Part III - plastic bags, bananas
    - Each group (2-4 students) will need 2 plastic bags and 4 bananas (preferably from the same bunch). The class can share access to the marker for marking their bags.

# Part I: Capturing Reaction Products

- Set-up:
  - Each group (2-4 students) will need one balloon and clear bottle. You can prefill 60 mL (~4 T) of vinegar into each bottle. The class can share access to the baking soda.
- Procedure:
  - The students will work together to pour baking soda into the balloon, then attach the balloon to the bottle and tip it upright to combine the baking soda in the balloon with the vinegar in the bottle.
- Results
  - Students will notice that the balloon fills with gas from the chemical reaction.
- The takeaway is that the vinegar (acid) and baking soda (base) reacted, and gas was given off that inflated the balloon.

# Part I: Capturing Reaction Products



Before combining



After combining



# Part II: Curdling Milk

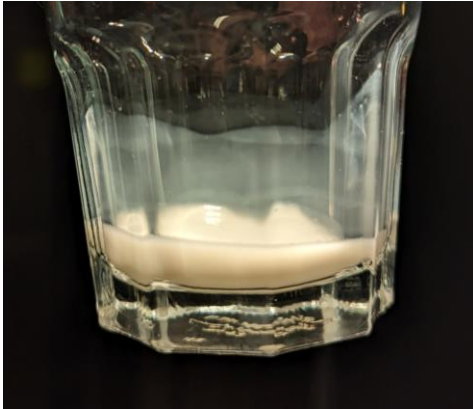
- Set-up:
  - Each group (2-4 students) will need 4 small clear plastic cups, one rubber band and cotton piece that can cover the top of one cup, one slice of orange and lemon. The class can share access to milk (~45 mL per group) and water (~5 mL per group). We recommend having a couple of small containers of milk.
- Procedure:
  - The students should add water, orange juice, and lemon juice to milk in their three cups and swirl the liquids, especially looking for solids that form.
  - After waiting a few minutes, the students should pour the milk mixture over the cup with the cotton fabric attached via a rubber band and look for solids that have formed (curds).
- Results
  - Students should see that acidic liquids (like lemon and orange juice) curdle the milk. The more acidic lemon curdles the milk more.
- The takeaway is that milk spoiling is a chemical reaction. Acids added to fresh milk cause the solids (curds) to separate from the liquid (whey). Curdled milk will taste sour because of the excess acid.

# Part II: Curdling Milk

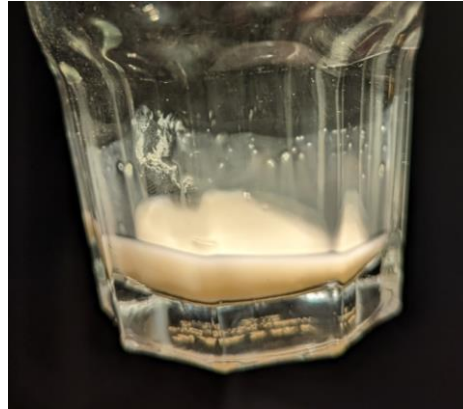


Some experiment supplies, including one clear cup covered with cotton and secured by a rubber band (left), lemon and orange slices (middle), and one clear cup with milk (right)

# Part II: Curdling Milk



Added liquid: water  
No solids collected.



Added liquid: orange  
A few solids on sides of cup.  
Very few solids collected (do not include the orange pulp as a solid collected).



Added liquid: lemon  
Many solids on sides of cup.  
Many solids collected.

# Part III: Bananas Ripening Bananas

- Set-up:
  - Each group (2-4 students) will need 2 plastic bags and 4 bananas (preferably from the same bunch). The class can share access to the marker for marking their bags.
- Procedure:
  - Students should place one banana in a plastic bag (label bag #1) and two bananas in the second plastic bag (label bag #2). The final banana will sit out.
  - The students will observe the changes to the bananas over five days.
- Results
  - Students should see that the banana that sat out has ripened the most, followed by the two bananas in the bag, followed by the single banana in the bag.
- The takeaway is fruit ripens by oxidation and exposure to ethylene gas (ripening with other fruit).

# Part III: Bananas Ripening Bananas

After 3 days



After 5 days



# Design challenge

- Background
  - Students are asked to imagine making a complicated dish that involves ricotta cheese (basically the curds from milk) and fresh, ripened pears as fast as possible. Students have access to the following supplies: milk, vinegar, under-ripe pears, lemons, oranges, paper bags, and plastic bags, plus a stove top for heating ingredients and other kitchen supplies.
- Questions to ask the students
  - What results will you use from the experiments to design your solution to making the ricotta cheese and ripening the pears quickly?
  - What other information do you need to know in order to design your solution?

# Extension Experiment

- Background
  - A compost is prepared by decomposing plant and food waste with recycled organic material. Besides composting, one might also throw food waste into trash, which ends up in a landfill. This extension lesson will demonstrate the difference between throwing our food waste in a compost pile versus in a landfill.
- Time frame: 8 weeks
- Materials: 1 glass jar with lid, 1 glass jar without lid, soil, bulking agents (newspaper, wood shavings), food scraps/skins, water

# Extension Experiment: Compost vs Landfill

- Set-up:
  - Each group (2-4 students) will need one 2 glass jars, one with a lid, soil, bulking agents, food scraps/skins, and water.
- Procedure:
  - Soil, bulking agents, and food scraps are added to both jars one handful at a time, repeating this order until the jars are full. One cupful of water is added to both jars. One lid is put on one jar (landfill jar) and the open jar is the compost jar. Place on a windowsill exposed to sun. Shake the landfill jar and stir the compost once a week for 8 weeks.
- Results
  - Students will notice that the food scraps are decomposed in the compost jar and the level of the jar decreased more over 8 weeks as compared to the landfill jar.
- The takeaway is that composting is a chemical reaction that turns food scraps into valuable products that can be added to gardens.



# Troubleshooting

- For Part I, make sure the balloon is snug on the bottle opening so that gas does not escape. You can use a rubber band to secure the balloon. If you do not have vinegar, you can also use lemon juice.
- For Part II, you may not see many solids collected after adding the orange juice. Ask students to swirl their liquid to check if any curds are collected on the sides of the cup.
- For Part III, try to use bananas (for each group) from the same bunch so that they have similar starting conditions prior to the ripening. Otherwise, it may be hard to distinguish changes over the 5 days.
- For Parts II and III, substitutions for produce can be made, like limes and grapefruit for lemons and plantains for bananas.