

GRADE 6 COOKING & FOOD

First edition

8 units

32 lessons • one school year

A video for every lesson

FIRST EDITION

COURSE GUIDE

This course follows eight strands of cooking and food through the sixth-grade year: kitchen and food safety, nutrients and the balanced meal, taste and smell, heat and cold, food chemistry, cravings and a balanced way of eating, fire and spice, and planning meals for the family table. Each unit is built around real people and real moments: Joseph Lister bringing clean methods into the hospital, Harvey Wiley feeding his volunteers at a government test table, Christiaan Eijkman noticing that his chickens recovered on brown rice, James Lind running one of the first fair tests in medicine aboard HMS *Salisbury*, Arthur Fox discovering that a bitter powder tasted bitter to only some of his colleagues, Percy Spencer finding a melted candy bar in his pocket, Jacopo Beccari washing a ball of dough until only gluten was left, and Wilbur Scoville measuring the heat of peppers.

Every lesson follows the same path. First comes **the story**. Then **how they figured it out**: the question they faced, what they tried, what they saw and what they learned. Then **the kitchen science**, explained with real vocabulary and a little arithmetic: grams and ounces, degrees Fahrenheit and Celsius, doubling and halving, unit price and cost per serving. Last, **let's cook**: the student cooks a real recipe or meal for the family and records it in a cook's notebook, tasting, rating and improving it the next time. Sixth graders take a real step up this year: a chef's knife after practicing the grips, more of the stove work with an adult nearby, and the grill itself with an adult beside them.

Food is God's good gift, received with thanks and shared with others. We talk about food in terms of skill, safety, nourishment, thankfulness, stewardship and hospitality, never in terms of body size or appearance. The year ends with a family feast: the student plans a three-course meal and a budget, shops with a parent, cooks with an adult present, sets the table, welcomes the family and gives thanks. The old Latin saying *Fabricando fit faber*, "by making, one becomes a maker," fits the kitchen well: by cooking, one becomes a cook.

Most videos come from trusted public and teaching sources: the USDA and its food-safety service, university extension programs, the Culinary Institute of America, America's Test Kitchen, the American Chemical Society's Reactions, TED-Ed, SciShow, the National Fire Protection Association, and careful cooking teachers chosen lesson by lesson. Every video was previewed for content, accuracy and modest dress. A few cooking channels end with an invitation to subscribe or mention their other videos; you can stop the video when the teaching ends. Pause whenever the lesson's note asks the student to predict what will happen next.

Start with Lesson 1.1 →

WHO IT IS FOR

Written for students in grade 6 (about ages 11–12) who read independently, work with fractions and decimals, and are ready for more responsibility in the kitchen. A parent or responsible adult supervises all cooking, teaches and watches the knife grips before the student uses a chef's knife, stays at home and nearby for stove and oven work once the student has shown it can be done safely, and stays beside the student at the grill. Nothing needs to be bought beyond an ordinary kitchen and ordinary groceries; an instant-read food thermometer is the one inexpensive tool we strongly recommend.

HOW TO USE THIS COURSE

1. **The weekly rhythm.** The year has 32 lessons, one a week, in two sessions. Session 1 (about 50–60 minutes) is the warm-up, the video, the teaching and the picture study. Session 2 (about 50–60 minutes, longer for bread and the feast) is the kitchen project: cook the recipe, run the experiment inside it, clean up, and write in the cook's notebook. In the last week of each unit, add a third session for the unit review and the unit challenge.
2. **An adult supervises all cooking.** A parent or responsible adult supervises every kitchen project in this course. Before cooking, check every recipe, taste test and “try a new food” activity against your own family's food allergies; each recipe card names the major allergens it contains and offers swaps where they are easy.
3. **The grade 6 safety ladder.** Sixth graders may use a chef's knife after practicing the claw and bridge grips with an adult (Lesson 1.2), on a board that cannot slide.

They may use the stove and oven with an adult at home and nearby, once that adult has watched them do it safely; until then, the adult stays beside them. Shallow pan-frying is done only with an adult present, and there is no deep frying. At the grill, an adult lights it, and the student may cook on it with an adult beside them. Students never handle lighter fluid; none of our recipes use it.

4. **Story, then science, then cooking.** The core ideas are written for the student to read, or to read aloud together. The paragraphs marked *The story* and *How they figured it out* tell what happened; *The kitchen science* explains what is happening to the food; *Let's cook* names the recipe and the one skill to do well and safely. After each paragraph, ask the student to explain it back in his or her own words.
5. **Picture study.** Each lesson has one painting or historic photograph of a kitchen, a harvest, a market, a fire or a table. Look at it quietly for two minutes. Then put it away and have the student describe everything he or she remembers. Bring it back and work through the “look for” items and questions, which point to the food, the heat, the tools and the people in the picture.
6. **The cook's notebook.** Use one notebook for the whole year. For every recipe, write the date, copy the recipe in your own words, record what you measured and observed (temperatures, times, costs), sketch or photograph the finished dish, collect a family rating, and write one thing you would change next time. Then cook it again and make that change. Cook it, record it, improve it.
7. **How we talk about food and bodies.** This course never discusses weight or how bodies look. We call foods “nutrient-dense foods” and “treats,” never “good” or “bad.” Calories appear only as a unit of food energy (Lesson 2.1), never as something to count or cut. Treats and feasts are good gifts in their place. Grades rest on effort, care, safety, cleanliness and improvement.
8. **Groceries.** The recipes use ordinary grocery-store ingredients and feed a family of four to six, so most weeks the kitchen project is the family's supper, lunch or snack. A typical week's recipe costs about what the family would spend on that meal anyway. Read the recipe card a few days ahead and add its ingredients to the shopping list; in Unit 8 the student plans and prices the shopping list.
9. **Optional books and tools.** Some units list free charts, guides, cookbooks and simple tools. They are extras. Every recipe can be made without them.
10. **Unit review and unit challenge.** Each unit ends with a review worth 100 points, with a few short calculations (doubling a recipe, unit price, cost per serving, a

temperature conversion) and short written answers. It ends with a unit challenge: something real cooked, served and recorded, such as a clean-as-you-go kitchen audit, a balanced week of family dinners, a family taste-across-the-generations survey, or a freezer meal plan. Keep the challenge pages and photographs in a folder for the year.

11. **The family feast.** In the last week the student plans a three-course meal with a budget and a timeline, shops with a parent, cooks with an adult present, sets the table, and leads or joins in giving thanks.

SCOPE AND SEQUENCE

UNIT 1 • WEEKS 1–4

Kitchen & Food Safety

Joseph Lister and the clean-as-you-go kitchen; the chef's knife and its cuts; Harvey Wiley's test table and the Pure Food and Drug Act of 1906; and the Great Fire of London and kitchen fire safety, with a stir-fry, a chopped salad, homemade crackers and skillet potatoes.

- 1.1 Joseph Lister and the Clean Kitchen
- 1.2 The Chef's Knife: Grips, Cuts and Care
- 1.3 Harvey Wiley and the Pure Food Law
- 1.4 The Great Fire of London and Kitchen Fire Safety

UNIT 2 • WEEKS 5–8

Food Groups & the Balanced Meal

Carbohydrate, protein and fat by the gram; Christiaan Eijkman, brown rice and thiamine; James Lind's fair test against scurvy; and Isabella Beeton's orderly household, cooked as a grain bowl, a rice pilaf, citrus chicken and a cottage pie.

- 2.1 Macronutrients by the Gram
- 2.2 Christiaan Eijkman and Brown Rice
- 2.3 James Lind's Fair Test
- 2.4 Mrs. Beeton Plans a Balanced Dinner

UNIT 3 • WEEKS 9–12

Taste, Smell & Your Taste Buds

Arthur Fox and the bitter-tasting PTC; smelling food from the inside (retronasal smell); how taste changes across a lifetime, with a family recipe from an older relative; and contrast in texture in a crisp-topped baked macaroni.

- 3.1 Arthur Fox and the Bitter Taste
- 3.2 Smelling from the Inside: Retronasal Smell
- 3.3 Taste Across a Lifetime
- 3.4 Contrast in Texture

UNIT 5 • WEEKS 17–20

Food Chemistry

Starch gelatinization in a creamy risotto-style rice; emulsions and the mayonnaise legend, with an egg-free Caesar-style dressing; Jacopo Beccari, gluten and yeast in hand-stretched flatbread; and Alfred Bird's eggless custard powder beside a true egg custard.

- 5.1 Starch at Work: Artusi's Creamy Rice
- 5.2 Emulsions and the Mayonnaise Legend
- 5.3 Gluten and Yeast: Hand-Stretched Flatbread
- 5.4 Alfred Bird's Eggless Custard

UNIT 4 • WEEKS 13–16

Heat & Cold

Conduction, convection and radiation on a sheet pan; Percy Spencer and the microwave oven; Napoleon's prize and Appert's jars, with quick pickles; and Clarence Birdseye's fast freezing, with a batch of freezer meatballs.

- 4.1 Conduction, Convection and Radiation in the Kitchen
- 4.2 Percy Spencer and the Microwave Oven
- 4.3 Napoleon's Prize and Appert's Jars
- 4.4 Clarence Birdseye and Fast Freezing

UNIT 6 • WEEKS 21–24

Cravings, Reward & a Balanced Diet

Ivan Pavlov and how the brain learns to expect food; the marshmallow test and self-control, with a portioned fruit crisp; satiety from fiber, protein, water and time, in a vegetable-bean soup; and reading labels for added sugar, with homemade granola.

- 6.1 Ivan Pavlov and Learning to Expect Food
- 6.2 The Marshmallow Test and Self-Control
- 6.3 Satiety: Fiber, Protein, Water and Time
- 6.4 Labels and Added Sugar

UNIT 7 • WEEKS 25–28

Fire, the Grill & Spice

Henry Ford’s charcoal briquettes, the fire triangle and burgers on the grill; Wilbur Scoville and a pepper heat scale, with fresh salsa; direct and indirect heat for grilled chicken thighs; and balancing salt, acid, fat and heat in grilled vegetable tacos.

- 7.1 Henry Ford and the Charcoal Briquette
- 7.2 Wilbur Scoville and the Heat of Peppers
- 7.3 Direct and Indirect Heat
- 7.4 Balance a Dish: Salt, Acid, Fat and Heat

UNIT 8 • WEEKS 29–32

Meal Planning & the Family Table

Sylvan Goldman’s shopping cart, unit prices and burritos with a cost per serving; victory gardens and ration books, with a ration-style carrot cake; Proverbs 31 and the slow cooker, cooking once for two nights; and the family feast.

- 8.1 Sylvan Goldman’s Shopping Cart and the Unit Price
- 8.2 Victory Gardens and the Ration Book
- 8.3 Proverbs 31: Planning Ahead with the Slow Cooker
- 8.4 The Family Feast

WEEKLY PACING CALENDAR

WEEK	PLAN
1	- Session 1: Lesson 1.1 Joseph Lister and the Clean Kitchen: warm-up, video, teaching and picture study - Session 2: Lesson 1.1 kitchen project (cook the recipe) and cook’s notebook <i>Two sessions a week is the usual rhythm: one to learn, one to cook. Younger children can split a long session in two. Cook the week’s recipe again at home whenever you can.</i>
2	- Session 1: Lesson 1.2 The Chef’s Knife: Grips, Cuts and Care: warm-up, video, teaching and picture study - Session 2: Lesson 1.2 kitchen project (cook the recipe) and cook’s notebook
3	- Session 1: Lesson 1.3 Harvey Wiley and the Pure Food Law: warm-up, video, teaching and picture study - Session 2: Lesson 1.3 kitchen project (cook the recipe) and cook’s notebook
4	- Session 1: Lesson 1.4 The Great Fire of London and Kitchen Fire Safety: warm-up, video, teaching and picture study - Session 2: Lesson 1.4 kitchen project (cook the recipe) and cook’s notebook - Session 3: Unit 1 review and unit challenge

WEEK	PLAN
5	• Session 1: Lesson 2.1 Macronutrients by the Gram: warm-up, video, teaching and picture study • Session 2: Lesson 2.1 kitchen project (cook the recipe) and cook's notebook
6	• Session 1: Lesson 2.2 Christiaan Eijkman and Brown Rice: warm-up, video, teaching and picture study • Session 2: Lesson 2.2 kitchen project (cook the recipe) and cook's notebook
7	• Session 1: Lesson 2.3 James Lind's Fair Test: warm-up, video, teaching and picture study • Session 2: Lesson 2.3 kitchen project (cook the recipe) and cook's notebook
8	• Session 1: Lesson 2.4 Mrs. Beeton Plans a Balanced Dinner: warm-up, video, teaching and picture study • Session 2: Lesson 2.4 kitchen project (cook the recipe) and cook's notebook • Session 3: Unit 2 review and unit challenge
9	• Session 1: Lesson 3.1 Arthur Fox and the Bitter Taste: warm-up, video, teaching and picture study • Session 2: Lesson 3.1 kitchen project (cook the recipe) and cook's notebook
10	• Session 1: Lesson 3.2 Smelling from the Inside: Retronasal Smell: warm-up, video, teaching and picture study • Session 2: Lesson 3.2 kitchen project (cook the recipe) and cook's notebook
11	• Session 1: Lesson 3.3 Taste Across a Lifetime: warm-up, video, teaching and picture study • Session 2: Lesson 3.3 kitchen project (cook the recipe) and cook's notebook
12	• Session 1: Lesson 3.4 Contrast in Texture: warm-up, video, teaching and picture study • Session 2: Lesson 3.4 kitchen project (cook the recipe) and cook's notebook • Session 3: Unit 3 review and unit challenge
13	• Session 1: Lesson 4.1 Conduction, Convection and Radiation in the Kitchen: warm-up, video, teaching and picture study • Session 2: Lesson 4.1 kitchen project (cook the recipe) and cook's notebook
14	• Session 1: Lesson 4.2 Percy Spencer and the Microwave Oven: warm-up, video, teaching and picture study

WEEK	PLAN
	Session 2: Lesson 4.2 kitchen project (cook the recipe) and cook's notebook
15	- Session 1: Lesson 4.3 Napoleon's Prize and Appert's Jars: warm-up, video, teaching and picture study - Session 2: Lesson 4.3 kitchen project (cook the recipe) and cook's notebook
16	- Session 1: Lesson 4.4 Clarence Birdseye and Fast Freezing: warm-up, video, teaching and picture study - Session 2: Lesson 4.4 kitchen project (cook the recipe) and cook's notebook - Session 3: Unit 4 review and unit challenge
17	- Session 1: Lesson 5.1 Starch at Work: Artusi's Creamy Rice: warm-up, video, teaching and picture study - Session 2: Lesson 5.1 kitchen project (cook the recipe) and cook's notebook
18	- Session 1: Lesson 5.2 Emulsions and the Mayonnaise Legend: warm-up, video, teaching and picture study - Session 2: Lesson 5.2 kitchen project (cook the recipe) and cook's notebook
19	- Session 1: Lesson 5.3 Gluten and Yeast: Hand-Stretched Flatbread: warm-up, video, teaching and picture study - Session 2: Lesson 5.3 kitchen project (cook the recipe) and cook's notebook
20	- Session 1: Lesson 5.4 Alfred Bird's Eggless Custard: warm-up, video, teaching and picture study - Session 2: Lesson 5.4 kitchen project (cook the recipe) and cook's notebook - Session 3: Unit 5 review and unit challenge
21	- Session 1: Lesson 6.1 Ivan Pavlov and Learning to Expect Food: warm-up, video, teaching and picture study - Session 2: Lesson 6.1 kitchen project (cook the recipe) and cook's notebook
22	- Session 1: Lesson 6.2 The Marshmallow Test and Self-Control: warm-up, video, teaching and picture study - Session 2: Lesson 6.2 kitchen project (cook the recipe) and cook's notebook

WEEK	PLAN
23	- Session 1: Lesson 6.3 Satiety: Fiber, Protein, Water and Time: warm-up, video, teaching and picture study - Session 2: Lesson 6.3 kitchen project (cook the recipe) and cook's notebook
24	- Session 1: Lesson 6.4 Labels and Added Sugar: warm-up, video, teaching and picture study - Session 2: Lesson 6.4 kitchen project (cook the recipe) and cook's notebook - Session 3: Unit 6 review and unit challenge
25	- Session 1: Lesson 7.1 Henry Ford and the Charcoal Briquette: warm-up, video, teaching and picture study - Session 2: Lesson 7.1 kitchen project (cook the recipe) and cook's notebook
26	- Session 1: Lesson 7.2 Wilbur Scoville and the Heat of Peppers: warm-up, video, teaching and picture study - Session 2: Lesson 7.2 kitchen project (cook the recipe) and cook's notebook
27	- Session 1: Lesson 7.3 Direct and Indirect Heat: warm-up, video, teaching and picture study - Session 2: Lesson 7.3 kitchen project (cook the recipe) and cook's notebook
28	- Session 1: Lesson 7.4 Balance a Dish: Salt, Acid, Fat and Heat: warm-up, video, teaching and picture study - Session 2: Lesson 7.4 kitchen project (cook the recipe) and cook's notebook - Session 3: Unit 7 review and unit challenge
29	- Session 1: Lesson 8.1 Sylvan Goldman's Shopping Cart and the Unit Price: warm-up, video, teaching and picture study - Session 2: Lesson 8.1 kitchen project (cook the recipe) and cook's notebook
30	- Session 1: Lesson 8.2 Victory Gardens and the Ration Book: warm-up, video, teaching and picture study - Session 2: Lesson 8.2 kitchen project (cook the recipe) and cook's notebook
31	- Session 1: Lesson 8.3 Proverbs 31: Planning Ahead with the Slow Cooker: warm-up, video, teaching and picture study - Session 2: Lesson 8.3 kitchen project (cook the recipe) and cook's notebook

WEEK	PLAN
32	• Session 1: Lesson 8.4 The Family Feast: warm-up, video, teaching and picture study • Session 2: Lesson 8.4 kitchen project (cook the recipe) and cook's notebook • Session 3: Unit 8 review and unit challenge <i>Last week. Hold a family feast: the student plans the menu, shops with a parent, cooks a balanced meal with a dish from several units, sets the table, says grace with the family and shows the cook's notebook.</i>

MATERIALS

Cook's notebook (any notebook)

One for the whole year: recipes in your own words, temperatures and times, taste charts, cost calculations, sketches, family ratings and “what I would change next time.”

An instant-read food thermometer

The one tool we strongly recommend. Used all year to check chicken, burgers, meatballs, eggs, custard and leftovers.

A refrigerator thermometer

Optional and inexpensive. Leave it in the fridge to check that it stays at or below 40 °F (4 °C).

Measuring cups (dry and liquid), measuring spoons and a kitchen scale

Used in every recipe. A scale that reads grams and ounces is used in Units 2, 5 and 8 but is not required.

An 8-inch chef's knife, a paring knife, a vegetable peeler and two cutting boards

Used after practicing the grips with an adult in Lesson 1.2. Put a damp towel under the board so it cannot slide. One board for raw meat and one for ready-to-eat foods.

A large skillet with a lid, a medium and a large pot with lids, two rimmed baking sheets, a 9 × 13-inch baking dish and oven mitts

Ordinary kitchen equipment for the stovetop and oven recipes. A lid that fits the skillet is also your grease-fire lid.

Mixing bowls, a whisk, a wooden spoon, a heat-proof spatula, a colander, long tongs and clean jars with lids

For mixing, draining, pickling, grilling and storing.

A box of baking soda by the stove

For smothering a small grease fire (Lesson 1.4). Not flour, and never water.

Clean dish towels, dish soap, a dishpan and paper towels

Cleanup is part of every recipe.

A timer, a calculator and a camera or phone

For timing, cost calculations, and photographing finished dishes and unit challenges.

GRADING

Grades come mostly from the kitchen projects and the cook's notebook, because cooking is learned by doing, recording and trying again. A dish that flops but is honestly recorded and then made again with one improvement earns full credit.

PART	%
Kitchen projects (effort, safety, cleanliness and the improve round)	40
Cook's notebook (recipes in your own words, observations, calculations, taste charts, sketches)	20
Unit reviews	15
Unit challenges	25

Scale: A 90–100, B 80–89, C 70–79, D 60–69. Below 60: cook the recipe again or redo the review with help.

- Grade the cook, not the dish. Did the student wash up first, follow the safety steps, measure carefully, check temperatures, observe and record honestly, clean up, and try an improvement?
- A notebook page earns full marks when it has a date, the recipe in the student's own words, at least one measurement (a temperature, a time, a weight or a cost), a sketch or photo, a family rating and one sentence about what to change.
- A dish that flops but is honestly recorded and tried again earns full credit. A scorched sauce or a flat flatbread teaches as much as a perfect one.

- In the unit reviews, give partial credit on calculations for a correct method with a small arithmetic slip.
- Never grade or comment on anyone's body, size or how much they ate. Grades rest on effort, care, safety, cleanliness and improvement.

A NOTE TO PARENTS

You do not need to be a chef to teach this course. Read the story together, watch the video, and be the student's kitchen partner. This is the year the student takes on more: the chef's knife, more of the stove work, the grill with you beside them. Teach each new step, watch it done safely several times, and only then step back to "nearby." Ask the cook's two best questions often: "What do you think will happen?" and "Why did it happen?" Let the student do as much of the work as the safety ladder allows, including the planning and the cleanup.

Expect some flops. A sauce will scorch, a crust will be pale, a flatbread will shrink back. Cooks learn by tasting, noticing and trying again, and the course is built so that an honestly recorded mistake and a second try earn full credit. *Fabricando fit faber*: by making, one becomes a maker.

Food in this course is a good gift to be received with thanks and shared. We keep the conversation on skill, nourishment, thankfulness, stewardship and hospitality, never on weight or appearance, and we name foods neutrally as "nutrient-dense foods" and "treats." Food allergies and any special medical needs belong to your family and your doctor: please read each recipe card's allergen note and make the swaps your family needs.

UNIT 1

KITCHEN & FOOD SAFETY

A good cook is first of all a safe and clean cook. In this unit you will meet four moments in history when people learned, sometimes the hard way, how to keep food and kitchens safe. Joseph Lister brought clean methods into the operating room and showed that invisible germs could be beaten with careful habits. Harvey Wiley fed a table of volunteers to find out what was really in America's food, and his work led to the first national pure-food law in 1906. And a fire that began in a bakery on Pudding Lane burned much of London in 1666.

This year you also take a real step up in the kitchen. You will learn to hold and use a chef's knife with the claw and bridge grips, practicing with an adult until your grip is safe and steady. You will clean as you go, keep raw meat apart from ready-to-eat food, check chicken with a thermometer, and make a fire plan before you ever heat oil in a pan. Along the way you will cook a chicken stir-fry, a chopped salad, a batch of homemade crackers and a skillet of golden potatoes.

PREREQUISITES

- Washes hands for 20 seconds with soap and water before cooking (Grades 3–5)
- Can measure dry and liquid ingredients with cups and spoons
- Has used a small paring or serrated knife with an adult beside and knows the claw grip (Grade 5)
- Knows the four steps Clean, Separate, Cook, Chill and the 40–140 °F danger zone (Grade 5)

MASTERY CHECKLIST

- ☐ I can tell how Joseph Lister used Pasteur’s germ discoveries to make surgery safer, and I can keep a clean-as-you-go kitchen while cooking raw chicken.
- ☐ I can hold a chef’s knife with a pinch grip, guide food with the claw, and cut a julienne, a dice and a mince safely on a board that cannot slide.
- ☐ I can tell the story of Harvey Wiley’s test table and the Pure Food and Drug Act of 1906, and I can read an ingredient list in order of weight.
- ☐ I can explain the fire triangle and what to do if oil catches fire in a pan: lid on, heat off, never water.
- ☐ I can check chicken at 165 °F (74 °C) with a thermometer and convert a temperature between °F and °C.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **FoodSafety.gov: Safe Minimum Internal Temperatures:** Free. A printable chart from the U.S. government to tape inside a cupboard door. Used all year, starting with the stir-fry in Lesson 1.1. Search “FoodSafety.gov safe minimum internal temperatures.”
- **NFPA: Cooking safety tips:** Free. Tip sheets from the National Fire Protection Association on preventing and handling kitchen fires. Read them together before Lesson 1.4.
- **An 8-inch chef’s knife and a honing steel:** An ordinary, moderately priced chef’s knife is all you need. Keep it sharp; a sharp knife needs less force and slips less.
- **An instant-read food thermometer:** Inexpensive and sold in most grocery stores. Used in Lessons 1.1 and 1.4 and in nearly every unit after this.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

1.1 Joseph Lister and the Clean Kitchen	2 sessions of 50–60 minutes
1.2 The Chef’s Knife: Grips, Cuts and Care	2 sessions of 50–60 minutes
1.3 Harvey Wiley and the Pure Food Law	2 sessions of 50–60 minutes
1.4 The Great Fire of London and Kitchen Fire Safety	2 sessions of 50–60 minutes

UNIT 1 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**

What idea did Joseph Lister borrow from Louis Pasteur, and what did he do with it in 1865?

2. 8 pts

What is the difference between cleaning and sanitizing? Give one example of each in a kitchen.

3. 8 pts

Name three ways germs from raw chicken can reach a salad, and one way to stop each.

4. 8 pts

Calculation: The USDA suggests 1 tablespoon of bleach per gallon of water for a sanitizing solution. How much bleach would an adult use for half a gallon? (1 tablespoon = 3 teaspoons.)

5. 8 pts

Calculation: Chicken is safe at 165 °F. Convert this to Celsius using $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5 \div 9$. Round to the nearest degree.

6. 8 pts

Describe the pinch grip and the claw grip. Why is a sharp knife safer than a dull one?

7. 8 pts

Give the size of a julienne and a small dice, and explain why cooks cut pieces the same size.

8. 8 pts

What was Harvey Wiley testing at his dining table from 1902 to 1907, and how did he set up the test to be fair?

9. 8 pts

An ingredient list reads: “Enriched wheat flour, vegetable oil, cheese, salt, paprika.” Which ingredient is there in the greatest amount? How do you know?

10. 10 pts

Calculation: Your crackers used flour (\$0.20), cheese (\$1.75) and butter (\$0.65) and made 60 crackers. What did each cracker cost? A store box of 200 crackers costs \$4.00. Which is cheaper per cracker?

11. **10 pts**

Name the three sides of the fire triangle. Then explain why water must never be used on a grease fire and what to do instead.

12. **8 pts**

Short answer: Why did the Great Fire of London in 1666 spread so far, and what did Londoners change when they rebuilt?

ANSWER KEY

1. Pasteur showed that tiny living germs cause spoiling. Lister reasoned that germs also cause wound infections, so he used carbolic acid as an antiseptic to kill germs on wounds, dressings, instruments and hands. His patients had far fewer infections.
2. Cleaning removes dirt, food and most germs with hot, soapy water and scrubbing (washing a cutting board). Sanitizing reduces the germs left on a clean surface to a safe level (wiping the clean board with a bleach solution an adult mixes, or very hot water).
3. Any three: hands (wash with soap for 20 seconds), the cutting board (separate boards, or wash before reuse), the knife (wash it right away), a towel (wash hands instead of wiping them), a plate (never put cooked food on the plate that held raw), splashes from rinsing chicken (do not rinse it).
4. Half of 1 tablespoon is $\frac{1}{2}$ tablespoon = $1\frac{1}{2}$ teaspoons.
5. $165 - 32 = 133$; $133 \times 5 = 665$; $665 \div 9 \approx 73.9$, so about 74°C .
6. Pinch grip: thumb and side of the first finger pinch the blade just in front of the handle, other fingers around the handle. Claw: fingertips of the guiding hand curled under, knuckles against the side of the blade. A sharp knife needs less force and is less likely to slip off the food into a finger.
7. Julienne: about $\frac{1}{8} \times \frac{1}{8}$ inch and 2 inches long. Small dice: about $\frac{1}{4}$ -inch cubes. Pieces the same size cook in the same time, so none are raw or mushy.
8. He tested whether common food preservatives, starting with borax, harmed people. Some meals had measured amounts of the preservative and some did not, and the volunteers were examined and recorded carefully so he could compare.
9. Enriched wheat flour. Ingredients are listed in order from most to least by weight, so the first one is the largest amount.
10. Homemade: $\$0.20 + \$1.75 + \$0.65 = \$2.60$; $\$2.60 \div 60 \approx \$0.043$, about 4 cents each. Store: $\$4.00 \div 200 = \$0.02$, 2 cents each. The store crackers are cheaper per cracker (but have more ingredients and need to stay fresh for months).
11. Heat, fuel and oxygen. Water sinks under the oil, flashes into steam and throws burning oil everywhere. Instead, slide a lid over the pan (cutting off oxygen), turn off the burner (removing heat), and leave it covered until cool; use baking soda for a very small fire; if the fire grows, get out and call 911.

12. Crowded wooden houses (lots of fuel), a dry summer and a strong east wind (oxygen) let it spread for four days. They rebuilt with brick and stone and wider streets, and fire insurance companies formed fire brigades.

UNIT CHALLENGE: A CLEAN-AS-YOU-GO KITCHEN AUDIT AND FIRE PLAN

Inspect your family's kitchen like a food-safety and fire inspector. With an adult, check and record the refrigerator temperature (40 °F or below), the freezer (0 °F), where raw meat is stored (on the bottom shelf), the cutting boards, the hand-washing station, the location of a lid, baking soda and a fire extinguisher, and the smoke alarm.

Then cook one supper using a recipe from this unit while an adult scores you on a clean-as-you-go checklist you write yourself. Finish with a one-page report: what you found, what your family fixed, your posted fire plan, and one habit you improved.

LOOK FOR	WHAT IT MEANS
Inspection	Checks every item on the list, records temperatures honestly, and notes what needed fixing.
Clean-as-you-go supper	Keeps raw and ready-to-eat foods apart, washes hands and tools at the right moments, and cooks chicken or meat to a checked safe temperature.
Fire plan	A clear, posted plan for grease, oven and microwave fires with a meeting place outside, practiced once with the family.
Cleanup	Kitchen left clean, dishes washed and put away, counters wiped.
Report and improvement	A neat report that names one habit improved; honest mistakes recorded and fixed earn full credit.

1.1 JOSEPH LISTER AND THE CLEAN KITCHEN

OBJECTIVES

- Tell how Joseph Lister used Louis Pasteur’s discovery of germs to make surgery safer, beginning in 1865.
- Explain the difference between cleaning and sanitizing, and what cross-contamination is.
- Cook a chicken stir-fry while keeping a clean-as-you-go kitchen, and check the chicken at 165 °F (74 °C).

Warm-up. Look at your kitchen counter right now. Make a quick list: where would raw chicken juice go if you cut chicken here without a plan? Draw a map of the counter and mark a “raw zone” and a “ready-to-eat zone.” Then guess: how many places do your hands touch while you cook one meal?

WATCH

Joseph Lister: Surgeon & Pioneer | Told by Max Brooks | History at Home

HISTORY • 3:30

<https://www.youtube.com/watch?v=eEIAhsSY2KA>

WHEN TO WATCH

After the story of Lister, before you plan your workspace.

Note: From HISTORY’s History at Home series, told by author Max Brooks. It uses a few cartoon emojis to describe infections; there are no surgical images.

BACKUP VIDEO

12th August 1865: Joseph Lister carries out world's first antiseptic surgery

HistoryPod • 2:51

<https://www.youtube.com/watch?v=ZOYA00mE4MQ>

For a second telling: a short audio history of the August 12, 1865 operation, over an old engraving of Lister at work.

KEY TERMS

antiseptic

A substance that kills or stops the growth of germs on skin, wounds or tools. Lister used carbolic acid as an antiseptic.

cleaning

Removing dirt, food bits and most germs with hot, soapy water and scrubbing.

clean as you go

A cook's habit of washing, wiping and putting things away during cooking instead of leaving a mess for the end.

cross-contamination

Moving germs from one food, surface or hand to another, such as from raw chicken to a salad.

sanitizing

Reducing the germs left on a clean surface to a safe level, with very hot water or a sanitizing solution.

CORE IDEAS

The story. In the 1860s, a hospital could be a dangerous place to have an operation. Surgeons were skilled at setting bones and closing wounds, but many patients developed infections afterward, and many died of them. Joseph Lister, a young surgeon at the Glasgow Royal Infirmary in Scotland, was troubled by how often wounds became red, swollen and full of pus. Most doctors thought infection came from “bad air.” Lister was not so sure.

How he figured it out. In 1865 Lister read the work of Louis Pasteur, the French scientist who had shown that tiny living germs in the air make broth spoil. Lister reasoned that if germs spoil broth, germs might also spoil wounds. He needed something to kill them. Carbolic acid was being used to treat smelly sewage, so he tried it. On August 12, 1865, he treated the badly broken leg of an eleven-year-old boy named James Greenlees, dressing the wound with carbolic acid. The wound healed without infection, and the boy walked out of the hospital. Lister went on to clean his instruments, his dressings and his hands, and he published his method in 1867. The number of his patients who died from infection fell sharply. Other surgeons slowly followed, and clean surgery became the rule.

The kitchen science. Your kitchen is not an operating room, but the same germs that worried Lister can live on raw chicken, eggs and unwashed produce. Bacteria such as *Salmonella* and *Campylobacter* are common on raw poultry. They do not jump; they ride. They travel on hands, knives, cutting boards, sponges and towels, and that ride is called **cross-contamination**. Two habits stop it. **Cleaning** means scrubbing with hot, soapy water to remove food and most germs. **Sanitizing** goes one step further: the USDA suggests a solution of 1 tablespoon of unscented liquid chlorine bleach in 1 gallon of water for boards and counters, mixed and used by an adult. Cooking finishes the job: chicken is safe when the thickest piece reaches 165 °F (74 °C).

Let's cook. You will make a chicken and vegetable stir-fry over rice. Before you start, set up your kitchen the way Lister set up his ward: a raw zone with its own cutting board for the chicken, a ready-to-eat zone for the vegetables, a dishpan of hot, soapy water, and a clean towel. The skill to do well is **clean as you go**: every time raw chicken touches something, that thing goes straight into the soapy water, and your hands get washed before you touch anything else.

PICTURE STUDY



The Courtyard of a House in Delft, Pieter de Hooch, 1658 · Oil on canvas · National Gallery, London

Image: [Wikimedia Commons](#), public domain

Visitors to the Netherlands in the 1600s often wrote about how clean Dutch homes were: steps scrubbed, floors swept, pots scoured until they shone. Pieter de Hooch painted the quiet courtyards and kitchens of Delft, the same city where Vermeer lived. In this courtyard, work and order go together.

Look closely

- Look at the paving stones and the path. Do they look swept and scrubbed, or muddy and messy?
- Find the woman carrying a dish. Where might she be taking it? What do you think is in it?
- Find the bucket or broom near the shed. What jobs were done in this courtyard to keep a household clean?
- Look at how everything has its place. How is this like a kitchen where a cook cleans as she goes?

Talk about it

1. Dutch families had no idea that germs existed, yet they kept their homes very clean. Why do you think cleanliness still helped them stay healthy?
2. Which habit from this painting could you bring into your own kitchen this week?

3. How is putting things back in their place a kind of safety, not just neatness?

Safety first. A parent or responsible adult supervises all cooking in this course, and your family checks every recipe against its own food allergies before you begin. Keep raw chicken on its own board, wash your hands with soap for 20 seconds after touching it, and never rinse raw chicken in the sink, which splashes germs. Cook the chicken to 165 °F (74 °C) with an adult beside you at the stove the first time you stir-fry.

KITCHEN PROJECT

Lister's Kitchen: A Clean-as-You-Go Stir-Fry

You will cook a full family supper, a chicken and vegetable stir-fry over rice, while running the cleanest kitchen you can. A family member will be your “inspector,” keeping a tally of every time you wash your hands and every raw-chicken tool that goes straight into the soapy water. At the end you will check your work with a simple glitter test.

You will need

- Two cutting boards (one for raw chicken, one for vegetables)
- A chef's knife and a paring knife
- A large skillet or wok and a medium saucepan with a lid for rice
- Measuring cups and spoons, a small bowl and a whisk
- A dishpan or sink of hot, soapy water and clean towels
- An instant-read thermometer
- A pinch of fine glitter or ground cinnamon (for the hand test)

CHICKEN AND VEGETABLE STIR-FRY

Serves 4–6 servings · Prep 25 min · Cook 25 min (with the rice)

Ingredients

- 1½ cups (300 g) long-grain white rice and 2¼ cups (530 mL) water, for serving
- 1¼ pounds (565 g) boneless, skinless chicken breasts or thighs
- 1 tablespoon cornstarch and 1 tablespoon soy sauce, for the chicken
- **Sauce:** ½ cup (120 mL) chicken broth, 3 tablespoons soy sauce, 1 tablespoon honey or brown sugar, 1 tablespoon rice vinegar, 2 teaspoons cornstarch
- 2 tablespoons vegetable oil, divided
- 3 cups (about 200 g) broccoli florets
- 1 red bell pepper, cut in thin strips
- 2 carrots, peeled and sliced thin on a slant

- 3 cloves garlic, minced, and 1 tablespoon grated fresh ginger
- 3 green onions, sliced

Method

1. Start the rice: rinse it, put it in the saucepan with the water and a pinch of salt, bring to a boil with an adult beside you, then cover, turn the heat to low and cook 18 minutes. Let it stand 5 minutes off the heat.
2. On the vegetable board, cut all the vegetables first, while your board and knife are clean. Put them in bowls.
3. On the raw board, an adult cuts the chicken into $\frac{3}{4}$ -inch (2 cm) pieces, or you do it with the adult beside you if you have already practiced your knife grips. Toss the chicken with 1 tablespoon cornstarch and 1 tablespoon soy sauce. Put the raw board and knife straight into the soapy water and wash your hands.
4. Whisk the sauce ingredients in a small bowl until the cornstarch dissolves.
5. Heat 1 tablespoon oil in the skillet over medium-high heat. Add the chicken in one layer and cook, stirring every minute or so, 5–7 minutes, until browned and no longer pink. Check the thickest piece: it must read 165 °F (74 °C). Move the chicken to a clean plate (not the one that held it raw).
6. Add the other tablespoon of oil, then the carrots and broccoli. Stir-fry 3 minutes. Add the pepper, garlic and ginger and stir-fry 1–2 minutes more, until crisp-tender.
7. Return the chicken. Whisk the sauce again, pour it in, and stir until it bubbles and turns glossy, about 1 minute. Top with green onions and serve over the rice.
8. Clean up: wash every board, knife and bowl in hot, soapy water. An adult can sanitize the raw board and the counter. Put leftovers in the refrigerator within 2 hours.

Allergy check: Contains soy and wheat (most soy sauce is made with wheat). For a wheat-free version, use tamari labeled gluten-free; for a soy-free version, use coconut aminos. If you add toasted sesame oil at the end, it contains sesame. No milk, eggs or nuts.

Steps

1. **Set up.** Before you touch any food, set up a raw zone and a ready-to-eat zone, a dishpan of hot, soapy water, and a clean towel. Draw your setup in your notebook.
2. **The inspector.** Ask a family member to keep a tally while you cook: hand washes, tools that went straight into the soapy water, and any “slip” where something raw touched something clean.
3. Cook the recipe with an adult beside you at the stove. Record the temperature of the thickest piece of chicken and the time it took to get there.
4. **Glitter test.** After cooking, rub a pinch of glitter or cinnamon on your hands as if it were chicken juice. Touch the faucet, a towel and a spoon the way you would while cooking. Where did it travel? Wash for 20 seconds and check what is left.
5. **Taste test.** Ask your family to rate the stir-fry for flavor and for how crisp the vegetables were, from 1 to 5.
6. **Improve it.** Look at your inspector’s tally. Write one cleaning habit you will improve next time and one change to the recipe.
7. **Clean up:** wash, dry and put away everything, wipe the stove and counters, and take out any trash that held raw chicken packaging.

Tips

- Cut vegetables before raw meat. That way one board stays clean the whole time.
- Partly frozen chicken (about 20 minutes in the freezer) is much easier to cut into even pieces.
- Do not crowd the pan. Chicken packed too tight steams instead of browning; cook it in two batches if needed.

Check your work

- ☐ I can tell how Lister used Pasteur’s idea to make surgery safer.
- ☐ I can explain cleaning, sanitizing and cross-contamination.
- ☐ I cooked a stir-fry with chicken checked at 165 °F and kept a clean-as-you-go kitchen.

COOK'S NOTEBOOK

1. Draw your kitchen setup with a raw zone, a ready-to-eat zone and the dishpan.
Use arrows to show the path the raw chicken took from the package to the pan.
2. Copy the stir-fry recipe in your own words, and mark with a star every step where cross-contamination could happen.
3. Write a short paragraph comparing Lister's operating room with your kitchen: what was the same, and what was different?

From history. Lister was a devout Quaker in his youth and a humble man all his life. When he retired, he was honored around the world; in 1897 he became the first doctor made a lord in Britain. A mouthwash invented in 1879 was named Listerine in his honor, though he had nothing to do with making it.

COMMON MISTAKES

- Rinsing raw chicken in the sink. It does not remove germs; it splashes them up to 2 feet around the sink.
- Putting cooked chicken back on the plate that held it raw. Always use a clean plate.
- Wiping hands on a towel after touching raw chicken instead of washing them. The towel now carries the germs to the next thing you dry.

Make it a game • Clean or Sanitized. Your parent calls out kitchen actions, such as wiping with soap, then spraying a safe sanitizer, rinsing a cutting board, or using one towel for raw chicken. You answer clean, sanitize, or cross-contamination within five seconds. Wrong answers cost a point. Finish by telling the story of Joseph Lister and the germ discovery of Pasteur in your own words.

1.2 THE CHEF’S KNIFE: GRIPS, CUTS AND CARE

OBJECTIVES

- Hold a chef’s knife with a pinch grip and guide food with the claw and bridge grips, practicing with an adult first.
- Cut a julienne, a dice and a mince, and explain why a sharp knife is safer than a dull one.
- Make a chopped salad with a homemade dressing, cutting every vegetable yourself.

Warm-up. With an adult, lay out three knives from your kitchen on a towel (do not pick them up yet). Compare them: which is longest? Which has a straight edge, and which has teeth? Which do you think is best for an onion, a tomato and a loaf of bread? Then look at the tip of a carrot and guess how many cuts it would take to dice the whole carrot into ¼-inch cubes.

WATCH

How to Hold a Knife - Properly Using a Chef's Knife

LeCordon Bleu • 1:36

<https://www.youtube.com/watch?v=20gwf7YttQM>

WHEN TO WATCH

Watch it once all the way through. Then watch the grip section again with your knife on the board in front of you (not in your hand), and copy each grip after the adult has checked it.

Note: A culinary-school chef demonstrates four grips, the rocking motion and the guiding hand. Short and very clear.

BACKUP VIDEO

Jacques Pépin Techniques: Proper Knife Skills for Cutting, Chopping and Slicing

KQED Food • 3:58

<https://www.youtube.com/watch?v=nffGuGwCE3E>

For a master chef’s knife skills: watch Jacques Pépin slice and chop, then practice slowly.

KEY TERMS

pinch grip

Holding a chef's knife by pinching the blade just in front of the handle with the thumb and the side of the first finger, with the other fingers wrapped around the handle. It gives the most control.

julienne

Thin matchstick strips, about $\frac{1}{8}$ inch (3 mm) square and 2 inches (5 cm) long.

mince

To chop food, such as garlic or herbs, into very tiny pieces.

claw grip

Curling the fingertips of the guiding hand under, so the knuckles touch the side of the blade and the fingertips stay safely back.

dice

Even cubes: small dice is about $\frac{1}{4}$ inch (6 mm), medium about $\frac{1}{2}$ inch (1.3 cm), large about $\frac{3}{4}$ inch (2 cm).

honing

Straightening a knife's edge on a steel rod. Sharpening, by contrast, grinds away a little metal to make a new edge.

CORE IDEAS

The story. In the hills of central France sits the town of Thiers, which has made knives since the Middle Ages and still makes a large share of France's kitchen and pocket knives. For centuries its knife makers used the fast-running Durolle River to turn great grinding wheels. Old photographs from about 1900 show the grinders, called *émouleurs*, lying face down on wooden planks above their wheels, pressing blades against the spinning stone for hours, sometimes with a dog lying across their legs to keep them warm in the cold, damp workshops.

How they figured it out. The grinders learned by long practice what every cook learns: the angle and steadiness of the hand make the edge. A blade ground at a low, even angle cuts cleanly; an uneven one tears. French cooks, trained in the great restaurant kitchens of the 1800s, used these blades to develop the classic cuts still taught in cooking schools today: julienne, batonnet, dice and mince. Each cut has an exact size, so that every piece cooks at the same speed.

The kitchen science. A knife edge is a very thin wedge. When it is sharp, the whole force of your hand presses on a tiny strip of metal, so it slides into food easily. When

it is dull, the edge is rounded and wide, so you must push much harder, and the knife can skid off a tomato skin or an onion and into a finger. That is why a **sharp knife is safer**. Honing on a steel straightens the edge between sharpenings. Your guiding hand matters as much as your knife hand: in the **claw grip** the fingertips are tucked under and the knuckles guide the side of the blade, so the edge never reaches your fingertips. In the **bridge grip** the hand makes an arch over the food, and the knife cuts under the bridge. Even pieces matter too: ¼-inch dice cook through in the same time, while a mix of big and small pieces leaves some raw and some mushy.

Let's cook. You will make a chopped salad with a homemade lemon dressing, cutting every vegetable yourself after an adult has watched you practice the grips. You will julienne a carrot and a pepper, dice a cucumber, and mince garlic and parsley. The skill to do well is a **steady rhythm**: knife tip on the board, rock the blade down and forward, move the claw back a little after each cut. Go slowly. Speed comes later; safety comes first.

PICTURE STUDY



Knife Grinders of Thiers, Unknown photographer, about 1900 · Photograph (postcard) · Thiers, Auvergne, France

Image: [Wikimedia Commons](#), public domain

This old postcard shows the *émouleurs*, the grinders who put the edge on knife blades in the workshops of Thiers. Every knife in a French kitchen of the time passed through hands like these. The work was skilled, cold and hard, and the grinders were proud of it.

Look closely

- Find the grinding wheels. What turned them, do you think, before there was electricity in the workshop?
- Look at how the grinders lie on the planks. Why would they lie down instead of standing to do this work?
- Find the blades in their hands. Which part of the knife is touching the stone?
- Look for anything that tells you whether the workshop was warm or cold, light or dark.

Talk about it

1. A grinder had to hold the blade at the same angle for every pass. How is that like keeping your claw grip steady for every cut?
2. Why is a sharp knife safer than a dull one? Use the word “force” in your answer.

3. What would you like to ask one of these grinders about his work?

Safety first. Practice every grip with an adult before you cut with a chef's knife, and keep the adult beside you until they say you are ready. Put a damp towel under the board so it cannot slide, keep the knife flat on the counter when you set it down, and never try to catch a falling knife. Wash knives one at a time by hand; never drop one into a sink of soapy water where no one can see it.

KITCHEN PROJECT

Three Cuts and a Chopped Salad

First you will practice the three classic cuts on carrots and celery, measuring your pieces with a ruler. Then you will use the same cuts to make a big, colorful chopped salad and a shaken lemon dressing for the family supper.

You will need

- An 8-inch chef's knife and a paring knife
- A large cutting board and a damp towel or non-slip mat underneath
- A ruler (for the practice round)
- A vegetable peeler, a large salad bowl, a clean jar with a lid
- Measuring cups and spoons, a citrus juicer or fork

CHOPPED GARDEN SALAD WITH LEMON-HERB DRESSING

Serves 6 servings · Prep 35 min

Ingredients

- 1 large head romaine lettuce (about 10 oz or 280 g), washed and dried
- 1 English cucumber, diced small ($\frac{1}{4}$ inch)
- 2 carrots, peeled and cut in julienne
- 1 red or yellow bell pepper, cut in julienne
- 1 cup (150 g) cherry tomatoes, halved
- 1 can (15 oz or 425 g) chickpeas, drained and rinsed
- $\frac{1}{4}$ small red onion, diced small
- $\frac{1}{2}$ cup (75 g) crumbled feta cheese (optional)
- **Dressing:** $\frac{1}{3}$ cup (80 mL) olive oil, 3 tablespoons fresh lemon juice (about 1 lemon), 1 teaspoon honey, 1 teaspoon prepared mustard, 1 small clove garlic, minced, 2 tablespoons parsley, minced, $\frac{1}{4}$ teaspoon salt, a few grinds of black pepper

Method

1. Wash your hands and all the vegetables under running water. Dry the lettuce well (wet leaves make a watery salad).

2. Set your board on a damp towel. With an adult watching, cut the romaine crosswise into ½-inch ribbons, then turn and chop it into bite-size pieces.
3. Julienne the carrots: cut a 2-inch length, slice a thin strip off one side so it lies flat, cut ⅛-inch slabs, stack two slabs, and cut ⅛-inch sticks. Julienne the pepper the same way, skin side down.
4. Dice the cucumber: cut ¼-inch planks, then ¼-inch sticks, then turn and cut across into ¼-inch cubes. Dice the onion small, using the bridge grip for the first cuts.
5. Halve the tomatoes using the bridge grip, holding each one on the board. Mince the garlic and parsley by rocking the knife over them with your guiding hand flat on the spine.
6. Make the dressing: put all the dressing ingredients in the jar, close the lid tightly and shake hard for 30 seconds.
7. Put everything in the big bowl, add the chickpeas and feta, pour on half the dressing and toss. Taste, and add more dressing if needed. Serve right away.
8. Clean up: wash the knife by hand, dry it and put it away first; then wash the board and bowls.

Allergy check: Contains milk (feta). Leave out the feta for a milk-free salad. The mustard contains mustard seed, which some people are allergic to. No eggs, wheat, nuts, soy or fish.

Steps

1. **Grip check.** With the knife on the board, show the adult your pinch grip, your claw and your bridge. Cut only when the adult says each grip is right.
2. **Practice round.** Cut one carrot into julienne and one celery stalk into small dice. Measure ten pieces of each with a ruler and record how close they were to the target size.
3. **Cooking test.** Drop a handful of your most even dice and a handful of uneven pieces into a small pot of simmering water (with the adult). After 3 minutes, test them with a fork. Which batch cooked evenly?
4. Make the salad and dressing for your family.

5. **Taste test.** Ask your family to rate the salad for crunch, color and flavor. Did the dressing need more lemon, salt or honey?
6. **Improve it.** Write one knife habit you want to improve (for example, keeping the claw tucked or the tip on the board) and practice it twice this week on vegetables for family meals.
7. **Clean up:** wash and dry the knife first and put it away, then the rest of the tools.

Tips

- Make a flat side first. A round carrot or onion that rolls is the most dangerous thing on a cutting board.
- Let the knife do the work. If you must push hard, the knife needs honing or sharpening.
- Leftover practice pieces go into soup, stir-fry or a snack plate. Nothing is wasted.

Check your work

- ☐ I can show the pinch, claw and bridge grips.
- ☐ I can cut a julienne, a dice and a mince of the right size.
- ☐ I can explain why a sharp knife is safer than a dull one.

COOK'S NOTEBOOK

1. Draw your hands in the claw grip and the bridge grip, labeling where the knife goes.
2. Make a chart of your practice-round measurements: target size, your ten pieces, and how many were within $\frac{1}{8}$ inch of the target.
3. Copy the chopped-salad recipe in your own words and write which cut you used for each vegetable.

From history. The French word *julienne* appeared in cookbooks in the 1700s for a soup of thin-cut vegetables, and later came to mean the cut itself. Today culinary students around the world still practice the same cuts on bags of carrots and onions before they ever cook for guests.

COMMON MISTAKES

- Flat fingers on the food. Fingertips must be curled under, with the knuckles guiding the blade.

- Cutting on a board that slides. Always use a damp towel or a non-slip mat underneath.
- Using a dull knife because it “feels safer.” A dull knife needs more force and slips more.

Make it a game • Cut Names Quiz. Using a carrot cut into pieces ahead of time by an adult, lay out a julienne, a dice and a mince on a plate. Your parent shuffles them and you name each cut and how it was made. Then describe the pinch, claw and bridge grips with your hands, with no knife in sight. Explain why a sharp knife is safer.

Scripture. “Seest thou a man diligent in his business? he shall stand before kings; he shall not stand before mean men.” (Proverbs 22:29, KJV)

Skill is built by diligent, careful practice. A cook who practices the grips patiently becomes both safe and skillful.

1.3 HARVEY WILEY AND THE PURE FOOD LAW

OBJECTIVES

- Tell the story of Harvey Wiley’s test table (1902–1907) and the Pure Food and Drug Act of 1906.
- Read an ingredient list, knowing that ingredients are listed from most to least by weight, and explain why some foods contain preservatives.
- Bake homemade cheese crackers and compare them with store crackers for ingredients, cost and how long they stay crisp.

Warm-up. Find a box of crackers or cereal in your pantry. Read the ingredient list out loud. Which ingredient is first? Which words do you know, and which are new to you? Make a guess: why might a cracker that sits on a store shelf for months need different ingredients than a cracker you bake today?

WATCH

Dr. Harvey Wiley: Father of Pure Food | The Poison Squad | American Experience | PBS

American Experience | PBS • 1:09

<https://www.youtube.com/watch?v=BB3csbKFb-k>

WHEN TO WATCH

After the story of Harvey Wiley, before you read the labels in your pantry.

Note: A one-minute clip from PBS’s American Experience about Wiley’s career. It uses the newspapers’ nickname for his volunteers, which the lesson explains.

KEY TERMS

preservative

An ingredient that slows spoiling, such as mold growth, bacteria or fats turning stale. Salt, sugar and vinegar are old preservatives; others are newer.

adulteration

Making a food impure or false, such as watering down milk or adding cheap fillers and hiding them.

ingredient list

The list on a package of everything in the food, in order from the most to the least by weight.

Pure Food and Drug Act

The 1906 United States law that made it illegal to sell adulterated or falsely labeled food and medicine across state lines.

rancid

Stale and bad-smelling because the fats in a food have broken down in air and light.

CORE IDEAS

The story. In the late 1800s, Americans could not trust what they bought. There were no national food laws. Some milk was watered down and whitened with chalk; some “honey” was mostly corn syrup; some foods were kept from spoiling with chemicals such as borax and formaldehyde that no one had tested on people. Harvey Washington Wiley, a doctor and chemist from Indiana, became chief chemist of the U.S. Department of Agriculture in 1883. His laboratory tested foods and found fraud after fraud.

How he figured it out. Wiley wanted to know whether the preservatives in common foods were harmful. In late 1902, with money from Congress, he set up a dining room in the basement of his government building in Washington, D.C. Twelve young men, government clerks who volunteered, ate all their meals there. Some of their meals contained measured amounts of a preservative, beginning with borax, while others did not. The cooks served good, plain food, and the men were weighed, examined and carefully recorded day after day. Newspapers loved the story and gave the volunteers a dramatic nickname. Over five years Wiley tested several preservatives, and he found that some of them made the men unwell at the doses used. His careful trials, and the work of many others, helped pass the Pure Food and Drug Act, signed into law on June 30, 1906. Wiley’s chemistry bureau enforced it, and that bureau later grew into today’s Food and Drug Administration (FDA).

The kitchen science. Foods spoil in three main ways: microorganisms (molds and bacteria) grow in them, fats turn **rancid** in air and light, and moisture makes crisp things soft. People have always fought spoiling with **preservatives**: salt, sugar, vinegar, smoke, drying and cold. Modern packaged foods may contain other

preservatives too, and since 1958 a new food additive must be shown safe before it can be used. Most foods are processed in some way (bread, cheese and yogurt are all processed), so the useful questions are what nutrients a food gives and how it fits in a balanced meal. To learn what is in a packaged food, read the **ingredient list**: the law requires ingredients to be listed from most to least by weight, so the first few ingredients make up most of the food.

Let's cook. You will bake homemade cheddar crackers with only six ingredients, then compare them with a store-bought box. The skill to do well is **rolling the dough evenly thin**, about $\frac{1}{8}$ inch (3 mm), so every cracker bakes crisp at the same time. You will also find out how long your crackers stay crisp without any preservatives.

PICTURE STUDY



Harvey Wiley and the Volunteers of the Hygienic Table, U.S. Department of Agriculture, Bureau of Chemistry, about 1902–1907 · Photograph · U.S. Food and Drug Administration History Office

Image: [Wikimedia Commons](#), public domain

This photograph from the FDA's history office shows Harvey Wiley with the volunteers of his test table. The table in front of them looks like an ordinary boarding-house table, but every meal they ate there was weighed and recorded as part of an experiment.

Look closely

- Look at the table. What is set out on it? Does it look like a laboratory or a dining room?
- Look at the young men's faces. How old do they look? Do they seem worried, cheerful or serious?
- Find Harvey Wiley in the back row. How is he different from the volunteers?
- Look for the napkin rings. Why might each man have his own napkin and place at this table for months?

Talk about it

1. Why did Wiley give the preservative to some meals and not others? What would he compare?
2. Today new food additives must be tested and shown safe before they are used. How does that protect your family?

3. Would you have volunteered for Wiley's table? Why or why not?

Safety first. An adult is nearby whenever you use the oven, and you use oven mitts to move the hot pans. Do not taste the raw cracker dough, because uncooked flour can carry germs. Check every store box you compare for your family's allergens before anyone tastes it.

Homemade Crackers and the Label Detective

You will be a label detective like Harvey Wiley's chemists: compare the ingredient lists of three packaged foods in your pantry. Then you will bake your own cheddar crackers and run a five-day crispness test against a store-bought box, and work out what each cracker costs.

You will need

- A food processor (optional) or a large bowl and a pastry blender or two forks
- A rolling pin, a ruler and a pizza cutter or knife
- Two baking sheets lined with parchment paper
- A skewer or chopstick, oven mitts and a cooling rack
- Two airtight containers and masking tape for labels
- A box of store-bought cheese crackers for comparison (check allergens)

HOMEMADE CHEDDAR CRACKERS

Serves About 60 small crackers · Prep 20 min · Chill 15 min · Bake 15–18 min

Ingredients

- 1 cup (125 g) all-purpose flour, plus a little for rolling
- 4 ounces (113 g) sharp cheddar cheese, finely grated (about 1 cup packed)
- 4 tablespoons (57 g) cold butter, cut in small cubes
- ½ teaspoon salt
- ¼ teaspoon paprika
- 2–3 tablespoons cold water

Method

1. Wash your hands. An adult turns the oven to 350 °F (175 °C).
2. Put the flour, cheese, butter, salt and paprika in the food processor and pulse until it looks like coarse crumbs (or rub the butter in with your fingertips or a pastry blender in a bowl).

3. Add 2 tablespoons of cold water and pulse or stir just until the dough holds together when squeezed. Add the last tablespoon only if it is too dry.
4. Press the dough into a flat disk, wrap it and chill 15 minutes so it is easier to roll.
5. On a lightly floured piece of parchment, roll the dough to $\frac{1}{8}$ inch (3 mm) thick, checking with a ruler. Cut 1-inch (2.5 cm) squares with the pizza cutter. Slide the parchment onto a baking sheet and separate the squares a little. Poke a hole in the center of each with the skewer.
6. Bake 15–18 minutes, until the crackers are golden at the edges and crisp. Use oven mitts to move the pan to a rack. Let cool completely: they crisp up as they cool.
7. Clean up: scrape dough off the counter and rolling pin before washing, and wipe up flour.

Allergy check: Contains wheat and milk. For a wheat-free version, use a 1-to-1 gluten-free baking flour. There is no easy milk-free swap, since cheese is the main flavor. No eggs, nuts or soy.

Steps

1. **Label detective.** Copy the ingredient lists from three packaged foods in your pantry. Circle the first three ingredients of each. Underline anything you think is a preservative, then look up one of them with an adult on the FDA's website or in a dictionary.
2. Bake the crackers. Before baking, measure the thickness of your dough in three places. Was it even?
3. **Crispness test.** Put 10 homemade and 10 store crackers in separate labeled containers. On days 1, 3 and 5, taste one of each and rate it for crispness from 1 to 5.
4. **Cost.** Add up what your crackers cost (use the price of the flour, cheese and butter you used) and divide by the number of crackers. Do the same for the store box. Which costs more per cracker?
5. **Taste test.** Ask your family to compare the homemade and store crackers for flavor and crunch.

6. **Improve it.** Write one change for your next batch: thinner dough, a different cheese, or a whole-wheat version.

7. Clean up: wash, dry and put away everything.

Tips

- Cold butter makes flaky, tender crackers. If the dough gets soft and sticky, chill it again.
- Crackers at the edge of the pan brown first. If they are done before the middle ones, take them off with a spatula.
- Store crackers airtight. If they soften, an adult can re-crisp them for 5 minutes in a 300 °F oven.

Check your work

- ☐ I can tell the story of Harvey Wiley and the 1906 Pure Food and Drug Act.
- ☐ I can read an ingredient list and explain why the first ingredient matters most.
- ☐ I baked crackers, rolled evenly, and compared them with a store box for crispness and cost.

COOK'S NOTEBOOK

1. Make a table of the three ingredient lists you copied, with the first three ingredients highlighted.
2. Draw a crispness graph for the homemade and store crackers on days 1, 3 and 5.
3. Write your cost-per-cracker calculation for both kinds, showing your work.

From history. Harvey Wiley left the government in 1912 and spent many years writing about food for *Good Housekeeping* magazine. The same day the Pure Food and Drug Act was signed, June 30, 1906, a meat inspection law was also signed, requiring government inspectors in meat-packing plants.

COMMON MISTAKES

- Thinking every word you cannot say easily is harmful. Many ingredient names are just the chemical names of vitamins or ordinary things; look them up.
- Rolling dough thick in the middle and thin at the edges. The edges burn while the middle stays soft.

- Tasting unbaked dough. Uncooked flour can carry germs; wait for the baked cracker.

Make it a game • Harvey Wiley's Test Table. Play the Poison Squad story as a two-person drama. You are Harvey Wiley explaining your test table, and your parent is a skeptical senator. Present reasons for the Pure Food and Drug Act of 1906. Then read an ingredient list aloud and say which ingredient is most by weight. Name one preservative and its job.

1.4 THE GREAT FIRE OF LONDON AND KITCHEN FIRE SAFETY

OBJECTIVES

- Tell how the Great Fire of London began in a bakery on Pudding Lane in 1666 and why it spread.
- Explain the fire triangle and what to do if oil catches fire in a pan: lid on, heat off, never water.
- Make a kitchen fire plan, then pan-fry potatoes in a shallow layer of oil with an adult present.

Warm-up. Walk through your kitchen with an adult and find: the fire extinguisher (if you have one), a lid that fits your biggest skillet, the box of baking soda, the smoke alarm and two ways out of the house. Write them down. Which one took the longest to find?

WATCH

Kitchen Grease Fire Safety

PBC Fire Rescue · 2:12

<https://www.youtube.com/watch?v=PoGkFxtV9Uw>

WHEN TO WATCH

After the kitchen-science paragraph, before you make your fire plan. Pause before each demonstration and predict what will happen.

Note: From Palm Beach County Fire Rescue. Firefighters demonstrate what happens when water is thrown on a grease fire, in a safe training setting. Never try any of this at home.

BACKUP VIDEO

The Great Fire of London How did it start? | What happened next?

Twinkl Educational Publishing · 6:24

https://www.youtube.com/watch?v=8CASn6_jZ4U

After the story, for the history of the fire, its spread and the rebuilding of London. Made for younger students, but clear and accurate.

KEY TERMS

fire triangle

The three things every fire needs: heat, fuel and oxygen. Take away any one and the fire goes out.

smoke point

The temperature at which a cooking oil begins to smoke. Far above it, oil can burst into flame.

grease fire

A fire in hot cooking oil or fat. It must be smothered, never put out with water.

smother

To put out a fire by cutting off its oxygen, for example with a lid.

pan-fry

To cook food in a shallow layer of hot oil in a skillet, turning it so each side browns.

CORE IDEAS

The story. Very early on Sunday, September 2, 1666, a fire started in the bakery of Thomas Farriner on Pudding Lane in London. Farriner was the king's baker, and his oven had been used the night before. London was a city of crowded wooden houses with tar-coated walls, and the summer had been long and dry. A strong east wind blew the flames from roof to roof. The fire burned for four days and destroyed about 13,200 houses, 87 parish churches and the old St Paul's Cathedral. A man named Samuel Pepys wrote in his diary how he watched the flames from a boat on the river and buried his valuables, including a wheel of Parmesan cheese, in his garden to save them.

How they figured it out. Londoners fought the fire with leather buckets, hand squirts and long hooks for pulling down houses, but the fire moved faster than they could. At last, the fire was stopped by blowing up and pulling down houses to make firebreaks: gaps with nothing left to burn. People had learned the hard way that a fire needs fuel. After the fire, London was rebuilt in brick and stone, with wider streets, and the first fire insurance companies began to keep their own fire brigades. The Monument, a stone column 202 feet tall, still stands 202 feet from where the bakery stood.

The kitchen science. Every fire needs three things, the **fire triangle**: heat, fuel and oxygen. Remove any one, and the fire goes out. Cooking is the leading cause of home fires and home-fire injuries in the United States, according to the National Fire Protection Association, and most start when cooking is left unattended. Oil heated far past its **smoke point** can catch fire. Never throw water on a grease fire: water is heavier than oil, so it sinks to the bottom of the pan, flashes into steam in an instant, and throws burning oil into the air. Instead, **smother** it: slide a lid over the pan to cut off oxygen, turn off the burner to remove heat, and leave the lid on until the pan is cool. Baking soda can smother a very small grease fire; flour cannot, and can make it worse. If a fire grows, get everyone out, close the door behind you, and call 911 from outside.

Let's cook. You will pan-fry crispy skillet potatoes in a shallow layer of oil, with an adult present the whole time. Before you turn on the burner, you will make a **fire plan**: the lid within reach, the baking soda nearby, towels and paper away from the stove, the handle turned in, and the adult in the room. The skill to do well is **drying the food** before it goes into hot oil, because water droplets make oil spatter.

PICTURE STUDY



The Great Fire of London, Unknown Dutch artist, about 1675 · Oil on canvas · Museum of London

Image: [Wikimedia Commons](#), public domain

This painting shows the Great Fire as it might have looked from a boat near the Tower of London. Thousands of Londoners escaped onto the river in boats, carrying whatever they could save. The fire that began with one baker's oven is now a wall of flame across the city.

Look closely

- Find the river and the boats. What are the people in them doing and carrying?
- Find the old London Bridge with houses built on top of it. Why would houses on a bridge be in danger?
- Look at the direction the smoke is blowing. What does that tell you about the wind?
- Find the church towers. Which ones are already burning?

Talk about it

1. Use the fire triangle to explain why the fire spread so fast in 1666. What was the fuel? Where did the oxygen come from?
2. The firefighters made firebreaks. Which side of the fire triangle were they taking away?

3. What is one habit in your own kitchen that keeps a small fire from ever starting?

Safety first. Shallow pan-frying is done only with an adult present in the kitchen the whole time; this course never uses deep frying. Keep a lid that fits the pan within reach, never leave hot oil alone, and if oil smokes heavily, turn off the heat. If oil catches fire, slide the lid on and turn off the burner; never use water. Cool a minor burn under cool running water for 10 minutes, not ice or butter.

KITCHEN PROJECT

A Fire Plan and Crispy Skillet Potatoes

You will make a written fire plan for your kitchen, practice the lid move with a cold pan, and then pan-fry a skillet of golden potatoes for the family. Along the way you will test why dry food fries better than wet food.

You will need

- A large heavy skillet (cast iron or stainless) and a lid that fits it
- A box of baking soda and an oven mitt
- A large pot for par-boiling, a colander and clean kitchen towels
- A chef's knife and cutting board
- A thin metal spatula, measuring spoons and a timer

CRISPY SKILLET POTATOES WITH ONION AND PAPRIKA

Serves 4–6 servings · Prep 15 min · Cook 30 min

Ingredients

- 2 pounds (900 g) Yukon Gold or red potatoes, scrubbed
- 1 tablespoon salt, for the boiling water
- 3 tablespoons vegetable oil
- 1 tablespoon butter
- ½ medium onion, diced medium
- 1 teaspoon salt
- ½ teaspoon paprika
- ¼ teaspoon black pepper
- 2 tablespoons parsley, minced

Method

1. Wash your hands. Cut the potatoes into ¾-inch (2 cm) dice with your chef's knife, using the claw grip.
2. Put the potatoes in the pot, cover with cold water and add 1 tablespoon salt. With the adult in the kitchen, bring to a boil and cook 5 minutes,

just until the edges soften. Drain in the colander.

3. Spread the potatoes on a clean towel and pat them dry. Let them steam dry 5 minutes. Dry potatoes spatter less and brown better.
4. Check your fire plan: lid beside the stove, baking soda nearby, towels away, handle turned in, adult present.
5. Heat the oil in the skillet over medium-high heat until it shimmers (about 2 minutes). Do not let it smoke. Carefully lay the potatoes in, lowering them close to the pan and placing them away from you.
6. Cook without stirring for 5 minutes, until the bottoms are golden. Turn them with the spatula and cook 10–12 minutes more, turning every few minutes.
7. Turn the heat to medium, add the butter and onion and cook 3–4 minutes more, until the onion is soft. Sprinkle with salt, paprika, pepper and parsley.
8. Turn off the burner. Let the oil cool completely in the pan before an adult wipes it out with paper towels (never pour oil down the drain). Then wash everything.

Allergy check: Contains milk (butter). Use 1 more tablespoon oil instead of butter for a milk-free version. No eggs, wheat, nuts, soy, fish or sesame.

Steps

1. **Fire plan.** Write a one-page fire plan for your kitchen: where the lid, baking soda and extinguisher are; what to do for a grease fire, an oven fire (keep the door closed and turn it off) and a microwave fire (keep the door closed and unplug it if safe); and your family's meeting place outside.
2. **Lid drill.** With a cold, empty skillet, practice sliding the lid on from the side (not dropping it from above) and reaching for the knob to turn off the burner. Do it three times.
3. **Dry vs. wet test.** With the adult, drop one dried potato cube and one wet potato cube into the hot oil at the side of the pan, away from you. Which one spatters more? Write down why.
4. **Cook the potatoes.** Record how many minutes it took for the first side to turn golden.

5. **Taste test.** Ask your family to rate the potatoes for crispness, saltiness and flavor.
6. **Improve it.** Write one change for next time: longer drying, a hotter pan, or a different seasoning such as garlic or rosemary.
7. Clean up: let the oil cool, wipe the skillet, wash everything and wipe the stove.

Tips

- Shimmering oil is ready; smoking oil is too hot. Turn the heat down if you see smoke.
- Leave the potatoes alone at first. Moving them too soon tears the crust before it forms.
- Leftover skillet potatoes make a good breakfast hash with an egg, cooked until the yolk is firm.

Check your work

- ☐ I can explain the fire triangle and the three steps for a grease fire.
- ☐ I wrote and practiced a kitchen fire plan.
- ☐ I pan-fried potatoes safely with an adult present and dried the potatoes first.

COOK'S NOTEBOOK

1. Draw the fire triangle and label how a lid, turning off the burner and a firebreak each break one side of it.
2. Copy your fire plan neatly and post it near the stove.
3. Write the skillet-potato recipe in your own words and record your crisping time and your family's ratings.

From history. After the Great Fire, the architect Christopher Wren designed 51 new churches for London, including the new St Paul's Cathedral, finished in 1711. The rebuilding rules required brick or stone walls, which is one reason London never again burned that way.

COMMON MISTAKES

- Throwing water on a grease fire. It flashes to steam and throws burning oil; use a lid and turn off the heat.

- Carrying a burning pan to the sink or outside. It spills flaming oil; leave it on the stove with the lid on.
- Using flour to put out a grease fire. Flour can burn; use a lid or baking soda.

Make it a game · Pudding Lane Plan. Draw a quick map of your kitchen and mark where a pan fire could start. Your parent describes a grease fire and you say what to do in order: heat off, lid on, never water. Explain the fire triangle and smoke point. Then tell in sixty seconds how a bakery on Pudding Lane began the Great Fire of London in 1666.

Scripture. “While the earth remaineth, seedtime and harvest, and cold and heat, and summer and winter, and day and night shall not cease.” (Genesis 8:22, KJV)

God made the world with heat and cold in good order. A wise cook uses heat as a servant and respects it, keeping it in its place.

UNIT 1

KITCHEN & FOOD SAFETY

A good cook is first of all a safe and clean cook. In this unit you will meet four moments in history when people learned, sometimes the hard way, how to keep food and kitchens safe. Joseph Lister brought clean methods into the operating room and showed that invisible germs could be beaten with careful habits. Harvey Wiley fed a table of volunteers to find out what was really in America's food, and his work led to the first national pure-food law in 1906. And a fire that began in a bakery on Pudding Lane burned much of London in 1666.

This year you also take a real step up in the kitchen. You will learn to hold and use a chef's knife with the claw and bridge grips, practicing with an adult until your grip is safe and steady. You will clean as you go, keep raw meat apart from ready-to-eat food, check chicken with a thermometer, and make a fire plan before you ever heat oil in a pan. Along the way you will cook a chicken stir-fry, a chopped salad, a batch of homemade crackers and a skillet of golden potatoes.

PREREQUISITES

- Washes hands for 20 seconds with soap and water before cooking (Grades 3–5)
- Can measure dry and liquid ingredients with cups and spoons
- Has used a small paring or serrated knife with an adult beside and knows the claw grip (Grade 5)
- Knows the four steps Clean, Separate, Cook, Chill and the 40–140 °F danger zone (Grade 5)

MASTERY CHECKLIST

- ☐ I can tell how Joseph Lister used Pasteur’s germ discoveries to make surgery safer, and I can keep a clean-as-you-go kitchen while cooking raw chicken.
- ☐ I can hold a chef’s knife with a pinch grip, guide food with the claw, and cut a julienne, a dice and a mince safely on a board that cannot slide.
- ☐ I can tell the story of Harvey Wiley’s test table and the Pure Food and Drug Act of 1906, and I can read an ingredient list in order of weight.
- ☐ I can explain the fire triangle and what to do if oil catches fire in a pan: lid on, heat off, never water.
- ☐ I can check chicken at 165 °F (74 °C) with a thermometer and convert a temperature between °F and °C.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **FoodSafety.gov: Safe Minimum Internal Temperatures:** Free. A printable chart from the U.S. government to tape inside a cupboard door. Used all year, starting with the stir-fry in Lesson 1.1. Search “FoodSafety.gov safe minimum internal temperatures.”
- **NFPA: Cooking safety tips:** Free. Tip sheets from the National Fire Protection Association on preventing and handling kitchen fires. Read them together before Lesson 1.4.
- **An 8-inch chef’s knife and a honing steel:** An ordinary, moderately priced chef’s knife is all you need. Keep it sharp; a sharp knife needs less force and slips less.
- **An instant-read food thermometer:** Inexpensive and sold in most grocery stores. Used in Lessons 1.1 and 1.4 and in nearly every unit after this.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

1.1 Joseph Lister and the Clean Kitchen	2 sessions of 50–60 minutes
1.2 The Chef’s Knife: Grips, Cuts and Care	2 sessions of 50–60 minutes
1.3 Harvey Wiley and the Pure Food Law	2 sessions of 50–60 minutes
1.4 The Great Fire of London and Kitchen Fire Safety	2 sessions of 50–60 minutes

UNIT 1 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**

What idea did Joseph Lister borrow from Louis Pasteur, and what did he do with it in 1865?

2. 8 pts

What is the difference between cleaning and sanitizing? Give one example of each in a kitchen.

3. 8 pts

Name three ways germs from raw chicken can reach a salad, and one way to stop each.

4. 8 pts

Calculation: The USDA suggests 1 tablespoon of bleach per gallon of water for a sanitizing solution. How much bleach would an adult use for half a gallon? (1 tablespoon = 3 teaspoons.)

5. 8 pts

Calculation: Chicken is safe at 165 °F. Convert this to Celsius using $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5 \div 9$. Round to the nearest degree.

6. 8 pts

Describe the pinch grip and the claw grip. Why is a sharp knife safer than a dull one?

7. 8 pts

Give the size of a julienne and a small dice, and explain why cooks cut pieces the same size.

8. 8 pts

What was Harvey Wiley testing at his dining table from 1902 to 1907, and how did he set up the test to be fair?

9. 8 pts

An ingredient list reads: “Enriched wheat flour, vegetable oil, cheese, salt, paprika.” Which ingredient is there in the greatest amount? How do you know?

10. 10 pts

Calculation: Your crackers used flour (\$0.20), cheese (\$1.75) and butter (\$0.65) and made 60 crackers. What did each cracker cost? A store box of 200 crackers costs \$4.00. Which is cheaper per cracker?

11. **10 pts**

Name the three sides of the fire triangle. Then explain why water must never be used on a grease fire and what to do instead.

12. **8 pts**

Short answer: Why did the Great Fire of London in 1666 spread so far, and what did Londoners change when they rebuilt?

ANSWER KEY

1. Pasteur showed that tiny living germs cause spoiling. Lister reasoned that germs also cause wound infections, so he used carbolic acid as an antiseptic to kill germs on wounds, dressings, instruments and hands. His patients had far fewer infections.
2. Cleaning removes dirt, food and most germs with hot, soapy water and scrubbing (washing a cutting board). Sanitizing reduces the germs left on a clean surface to a safe level (wiping the clean board with a bleach solution an adult mixes, or very hot water).
3. Any three: hands (wash with soap for 20 seconds), the cutting board (separate boards, or wash before reuse), the knife (wash it right away), a towel (wash hands instead of wiping them), a plate (never put cooked food on the plate that held raw), splashes from rinsing chicken (do not rinse it).
4. Half of 1 tablespoon is $\frac{1}{2}$ tablespoon = $1\frac{1}{2}$ teaspoons.
5. $165 - 32 = 133$; $133 \times 5 = 665$; $665 \div 9 \approx 73.9$, so about 74°C .
6. Pinch grip: thumb and side of the first finger pinch the blade just in front of the handle, other fingers around the handle. Claw: fingertips of the guiding hand curled under, knuckles against the side of the blade. A sharp knife needs less force and is less likely to slip off the food into a finger.
7. Julienne: about $\frac{1}{8} \times \frac{1}{8}$ inch and 2 inches long. Small dice: about $\frac{1}{4}$ -inch cubes. Pieces the same size cook in the same time, so none are raw or mushy.
8. He tested whether common food preservatives, starting with borax, harmed people. Some meals had measured amounts of the preservative and some did not, and the volunteers were examined and recorded carefully so he could compare.
9. Enriched wheat flour. Ingredients are listed in order from most to least by weight, so the first one is the largest amount.
10. Homemade: $\$0.20 + \$1.75 + \$0.65 = \$2.60$; $\$2.60 \div 60 \approx \$0.043$, about 4 cents each. Store: $\$4.00 \div 200 = \$0.02$, 2 cents each. The store crackers are cheaper per cracker (but have more ingredients and need to stay fresh for months).
11. Heat, fuel and oxygen. Water sinks under the oil, flashes into steam and throws burning oil everywhere. Instead, slide a lid over the pan (cutting off oxygen), turn off the burner (removing heat), and leave it covered until cool; use baking soda for a very small fire; if the fire grows, get out and call 911.

12. Crowded wooden houses (lots of fuel), a dry summer and a strong east wind (oxygen) let it spread for four days. They rebuilt with brick and stone and wider streets, and fire insurance companies formed fire brigades.

UNIT CHALLENGE: A CLEAN-AS-YOU-GO KITCHEN AUDIT AND FIRE PLAN

Inspect your family's kitchen like a food-safety and fire inspector. With an adult, check and record the refrigerator temperature (40 °F or below), the freezer (0 °F), where raw meat is stored (on the bottom shelf), the cutting boards, the hand-washing station, the location of a lid, baking soda and a fire extinguisher, and the smoke alarm.

Then cook one supper using a recipe from this unit while an adult scores you on a clean-as-you-go checklist you write yourself. Finish with a one-page report: what you found, what your family fixed, your posted fire plan, and one habit you improved.

LOOK FOR	WHAT IT MEANS
Inspection	Checks every item on the list, records temperatures honestly, and notes what needed fixing.
Clean-as-you-go supper	Keeps raw and ready-to-eat foods apart, washes hands and tools at the right moments, and cooks chicken or meat to a checked safe temperature.
Fire plan	A clear, posted plan for grease, oven and microwave fires with a meeting place outside, practiced once with the family.
Cleanup	Kitchen left clean, dishes washed and put away, counters wiped.
Report and improvement	A neat report that names one habit improved; honest mistakes recorded and fixed earn full credit.

UNIT 2

FOOD GROUPS & THE BALANCED MEAL

Food is God's good gift, and He made it wonderfully varied. In this unit you will look inside your food to see what it gives your body. You will meet the three big nutrients that make up most of what we eat, carbohydrate, protein and fat, and learn how scientists first sorted them in the 1820s. Then you will meet two small but mighty nutrients through two great detective stories: Christiaan Eijkman's sick chickens and the brown rice that cured them, and James Lind's fair test of twelve sailors with scurvy aboard HMS *Salisbury* in 1747.

Finally you will meet Isabella Beeton, whose enormous cookbook of 1861 taught British households to plan meals, list ingredients first, and know what a dish would cost. Along the way you will cook a balanced grain bowl, a brown rice pilaf, orange-glazed chicken with a citrus salad, and a cottage pie supper planned with MyPlate. You will use a little arithmetic too: grams, energy, water-to-rice ratios and cost per serving.

PREREQUISITES

- Knows the five MyPlate food groups: fruits, vegetables, grains, protein and dairy (Grade 5)
- Can read a Nutrition Facts label for serving size and grams
- Can use a chef's knife with the claw grip and an adult nearby (Unit 1)
- Checks chicken at 165 °F and ground beef at 160 °F with a thermometer (Unit 1)

MASTERY CHECKLIST

- ☐ I can name the three macronutrients, give foods rich in each, and explain that carbohydrate and protein give about 4 Calories of energy per gram and fat about 9.
- ☐ I can tell how Christiaan Eijkman discovered that polished white rice lacked something found in brown rice, and name the parts of a whole grain.
- ☐ I can tell how James Lind ran a fair test in 1747 and explain what vitamin C does and where to find it.
- ☐ I can plan and cook a balanced family dinner with a MyPlate check and figure its cost per serving, as Mrs. Beeton taught.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **USDA FoodData Central:** Free. The U.S. Department of Agriculture’s searchable database of nutrients in thousands of foods. Use it in Lesson 2.1 to look up grams of carbohydrate, protein and fat.
- ***Dietary Guidelines for Americans*:** Free. The official guidelines behind MyPlate, with sections for children and families. For parents who want to read the source.
- ***The Book of Household Management* by Isabella Beeton (1861), free at Project Gutenberg:** Free to read online. Look at how she lays out a recipe with ingredients, time, cost and servings for Lesson 2.4. Some old recipes use ingredients this course leaves out, so families may want to browse it together.
- **A kitchen scale that reads grams:** Inexpensive. Weigh a serving of rice, beans or cheese and see what “grams” on a label really look like.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

2.1	Macronutrients by the Gram	2 sessions of 50–60 minutes
2.2	Christiaan Eijkman and Brown Rice	2 sessions of 50–60 minutes
2.3	James Lind’s Fair Test	2 sessions of 50–60 minutes
2.4	Mrs. Beeton Plans a Balanced Dinner	2 sessions of 50–60 minutes

UNIT 2 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. 8 pts

Name the three macronutrients and give one food rich in each, and one job each does in the body.

2. 8 pts

Why did William Prout choose milk as his model food in 1827?

3. 10 pts

Calculation: A bowl contains 60 grams of carbohydrate, 20 grams of protein and 15 grams of fat. How many Calories of energy does each supply, and what is the total? (Use 4, 4 and 9.)

4. 8 pts

Name the three parts of a whole grain and what polishing rice removes.

5. 8 pts

What clue led Christiaan Eijkman to suspect the chickens' food, and how did he test his idea?

6. 8 pts

Calculation: Brown rice needs 2 cups of liquid for every 1 cup of rice. How much broth do you need for $1\frac{1}{2}$ cups of rice? For $\frac{3}{4}$ cup?

7. 8 pts

What made James Lind's 1747 test a fair test? Name two things he kept the same and the one thing he changed.

8. 8 pts

What does vitamin C do in the body, and why do we need some every day? Name three foods rich in it.

9. 8 pts

Predict: You leave a bowl of cut apple slices brushed with lemon juice and a bowl of plain slices on the counter for an hour. What will happen, and why?

10. 10 pts

Calculation: A cottage pie used beef (\$7.50), potatoes (\$2.00), vegetables (\$2.40), broth and pantry items (\$1.30) and milk and butter (\$0.80). It serves 6. What is the cost per serving?

11. 8 pts

List the parts of a recipe in the order Mrs. Beeton set them out, and say why the ingredient list comes first.

12. **8 pts**

Short answer: Plan a balanced dinner for your family using MyPlate. Name a food for each of the five groups.

ANSWER KEY

1. Carbohydrate (bread, rice, fruit): main fuel for the body and brain. Protein (beans, eggs, chicken): builds and repairs the body. Fat (olive oil, nuts, avocado): rich energy, carries vitamins A, D, E and K, builds cells. Other correct examples are fine.
2. Milk is meant to keep a baby growing on its own, so it should be complete, and it contains all three classes: milk sugar (carbohydrate), butterfat (fat) and curd (protein).
3. Carbohydrate $60 \times 4 = 240$; protein $20 \times 4 = 80$; fat $15 \times 9 = 135$. Total $240 + 80 + 135 = 455$ Calories.
4. Bran, germ and endosperm. Polishing removes the bran and germ, with most of the fiber, thiamine (vitamin B1) and minerals, leaving the starchy endosperm.
5. The chickens fell ill while eating leftover polished white rice and recovered when a new cook switched them back to brown rice. He fed some chickens only white rice and others brown rice (or white rice with bran added) and compared them: the white-rice chickens became ill.
6. $1\frac{1}{2} \times 2 = 3$ cups of broth. $\frac{3}{4} \times 2 = 1\frac{1}{2}$ cups of broth.
7. He chose sailors with similar scurvy, kept them in the same place and gave them the same basic meals (kept the same); he changed only the remedy each pair received.
8. It helps build collagen, which holds skin, gums, blood vessels and bones together. The body cannot make it and cannot store much, so we need it from food regularly. Examples: oranges, lemons, red bell peppers, strawberries, kiwi, broccoli, tomatoes, potatoes.
9. The plain slices will turn brown; the lemon slices will stay pale much longer, because vitamin C (and the acid) in lemon juice slows the browning reaction with air.
10. $\$7.50 + \$2.00 + \$2.40 + \$1.30 + \$0.80 = \$14.00$. $\$14.00 \div 6 \approx \$2.33$ per serving.
11. Ingredients, mode (method), time, average cost, servings (and when in season). The ingredients come first so the cook can gather and buy everything before starting.
12. Answers vary. Example: baked chicken (protein), brown rice (grain), green beans and salad (vegetables), orange slices (fruit), a glass of milk (dairy).

UNIT CHALLENGE: A BALANCED WEEK OF FAMILY DINNERS

Plan five family dinners for one week, using MyPlate so that each dinner has at least four food groups and the week includes at least two whole-grain dishes and two dinners with a vitamin C-rich vegetable or fruit. Write the plan on a chart with each dinner's food groups checked off.

Cook at least two of the dinners yourself with an adult nearby (one may be a recipe from this unit). Write a Beeton-style recipe card for each, with the cost per serving, and collect your family's ratings. Finish with a paragraph on what you learned about planning balanced meals.

LOOK FOR	WHAT IT MEANS
Balanced plan	Five dinners planned; each has at least four food groups, with whole grains and vitamin C-rich foods included.
Cooking and safety	Two dinners cooked with safe temperatures checked, clean-as-you-go habits and a clean kitchen afterward.
Recipe cards and cost	Two Beeton-style cards with ingredients, method, time, cost per serving (calculated correctly) and servings.
Reflection and improvement	Family ratings recorded and one honest improvement named; a dish that flopped but is recorded and tried again earns full credit.

2.1 MACRONUTRIENTS BY THE GRAM

OBJECTIVES

- Name the three macronutrients, carbohydrate, protein and fat, and tell what each does for the body.
- Use the energy values of about 4 Calories per gram for carbohydrate and protein and about 9 for fat as units of food energy.
- Build and cook a balanced grain bowl with all five food groups and figure the grams of each macronutrient in one bowl.

Warm-up. Look at the Nutrition Facts labels on three foods: a box of pasta, a jar of peanut butter and a carton of milk or yogurt. For each one, find the grams of total carbohydrate, protein and fat in one serving. Which food is mostly carbohydrate? Mostly fat? Which has a good mix? Write your guesses before you check.

WATCH

Macronutrients - Carbs, Protein, and Fat Explained

Miacademy & MiaPrep Learning Channel • 9:34

<https://www.youtube.com/watch?v=uSMvgpxYDnc>

WHEN TO WATCH

After the story of William Prout, before you look up your grain bowl ingredients.

Note: From Miacademy's health course. A clear teacher-led explanation of carbohydrates, protein and fat with food pictures. It speaks of healthy choices, not weight.

KEY TERMS

macronutrient

A nutrient the body needs in large amounts, measured in grams: carbohydrate, protein and fat.

carbohydrate

Sugars, starches and fiber. Starches and sugars are the body's main everyday fuel; fiber helps digestion and fullness.

protein

Long chains of amino acids that the body uses to build and repair muscles, skin, blood and many other parts.

fat

A rich source of energy that also carries certain vitamins (A, D, E and K) and helps build every cell.

Calorie

A unit of energy in food. One food Calorie is the energy needed to warm 1 kilogram of water by 1 °C.

CORE IDEAS

The story. In 1827 William Prout, a London doctor and chemist, read a paper to the Royal Society that changed how people thought about food. Doctors of his day knew that people needed food, but not what food was made of. Prout had spent years analyzing foods in his laboratory, and he proposed that nearly all the food we eat is built from three great classes of substances. He called them the “saccharinous” (sugary and starchy), the “oily” and the “albuminous” (like egg white). Today we call them carbohydrate, fat and protein.

How he figured it out. Prout looked for a food that was clearly meant to be complete, and he chose milk, the food that keeps a baby growing for months. Milk, he found, contains all three: milk sugar, butterfat and curd (protein). He reasoned that a good way of eating for anyone should contain all three classes too. Later in the 1800s scientists learned to measure the energy in each by burning dried food in sealed containers, and by the 1890s they had settled on simple averages still used on food labels today.

The kitchen science. Carbohydrates (in grains, fruits, vegetables, beans and milk) are the body’s main fuel; the brain runs mostly on glucose made from them, and fiber keeps digestion moving. Protein (in meat, fish, eggs, beans, nuts, dairy and grains) builds and repairs the body. Fat (in oils, butter, nuts, avocados, meat and cheese) packs the most energy and carries vitamins A, D, E and K. Each gram of carbohydrate or protein gives about 4 **Calories** of energy, and each gram of fat about 9. A Calorie is simply a unit for measuring energy, like a mile for distance or a degree for temperature; growing bodies need plenty of energy, and a balanced meal supplies it from all three. Vitamins and minerals, needed in tiny amounts, come along with them, especially from fruits and vegetables.

Let's cook. You will build a balanced grain bowl for the family: quinoa for the grain, roasted sweet potatoes and fresh vegetables, black beans for protein, cheese for dairy, avocado for healthy fat, and a bright yogurt-lime sauce. The skill to do well is **cooking quinoa** so each grain is tender with a little “tail” (the germ curling loose), and then arranging a bowl that shows every food group.

PICTURE STUDY



Market Woman at a Vegetable Stall, Pieter Aertsen, 1567 · Oil on panel · Gemäldegalerie, Berlin

Image: [Wikimedia Commons](#), public domain

Pieter Aertsen worked in Antwerp and Amsterdam in the 1500s and was one of the first painters to make a market stall the main subject of a large picture. This market woman sits among her vegetables and fruit as if she were a queen on a throne of food.

Look closely

- Name as many vegetables and fruits as you can find. Which ones do you eat today?
- Which foods here are rich in carbohydrate? Can you find any that would give protein or fat?
- Look behind her. What other people and animals are at the market?
- Look at the colors of the produce. Which colors do you see most?

Talk about it

1. If this woman made a meal from her own stall, which food groups would be missing? What would she need to trade for?
2. Why do you think a painter would make vegetables the hero of a painting?
3. How is choosing at this stall like building a balanced grain bowl?

Safety first. An adult is nearby while you use the oven and the stove; use oven mitts for the hot pan of sweet potatoes. Cut the round sweet potato in half first so it lies flat before you cube it. Check toppings against your family's allergies.

KITCHEN PROJECT

Build a Balanced Grain Bowl and Count the Grams

You will cook a grain bowl dinner with every MyPlate group in it. Then you will be a nutrition scientist: use the labels on your ingredients (or USDA FoodData Central) to add up the grams of carbohydrate, protein and fat in one bowl, and see how much energy each one supplies.

You will need

- A medium saucepan with a lid and a fine-mesh strainer
- A rimmed baking sheet and oven mitts
- A chef's knife, a cutting board and a can opener
- A small bowl and whisk for the sauce
- A kitchen scale (optional), a calculator and the food labels

SOUTHWEST QUINOA GRAIN BOWLS

Serves 5 bowls · Prep 20 min · Cook 30 min

Ingredients

- 1½ cups (255 g) quinoa, rinsed well, and 3 cups (710 mL) water or broth
- 2 medium sweet potatoes (about 1¼ lb or 565 g), cut in ¾-inch dice
- 2 tablespoons olive oil, ½ teaspoon salt and 1 teaspoon chili powder, for roasting
- 1 can (15 oz or 425 g) black beans, drained and rinsed
- 1 cup (150 g) corn kernels (frozen and thawed, or canned and drained)
- 1 cup (150 g) cherry tomatoes, halved
- 1 avocado, sliced
- 1 cup (115 g) grated cheddar or Monterey Jack cheese
- **Yogurt-lime sauce:** ¾ cup (180 g) plain yogurt, juice of 1 lime, ¼ teaspoon salt, 2 tablespoons chopped cilantro or parsley

Method

1. Wash your hands. An adult turns the oven to 425 °F (220 °C).

2. Toss the sweet potatoes with the oil, salt and chili powder on the baking sheet. Roast 25–30 minutes, turning once with a spatula, until browned at the edges and tender inside.
3. Meanwhile, put the rinsed quinoa and water in the saucepan. Bring to a boil, then cover, turn to low and simmer 15 minutes, until the water is absorbed and the grains show little curly tails. Let stand covered 5 minutes, then fluff with a fork.
4. Warm the black beans and corn together in a small pan or the microwave.
5. Whisk the yogurt, lime juice, salt and herbs in a small bowl.
6. Build each bowl: about $\frac{3}{4}$ cup quinoa, then sweet potatoes, beans and corn, tomatoes, avocado and cheese in sections. Drizzle with sauce.
7. Clean up: wash the pans, wipe the counters, and refrigerate leftovers within 2 hours.

Allergy check: Contains milk (cheese, yogurt). For a milk-free bowl, leave out the cheese and make the sauce with a plain plant-based yogurt or mashed avocado with lime. No eggs, wheat, nuts, soy, fish or sesame.

Steps

1. **Predict.** Before you calculate, guess which part of your bowl gives the most protein, the most carbohydrate and the most fat.
2. Cook the grain bowls and serve them to your family. Check each bowl: does it have all five food groups?
3. **Count the grams.** Using the labels or USDA FoodData Central, fill in a table for one bowl: each ingredient, the amount in your bowl, and its grams of carbohydrate, protein and fat. Add each column.
4. **Energy math.** Multiply total grams of carbohydrate by 4, protein by 4 and fat by 9. Which macronutrient supplies the most energy in your bowl? Was your prediction right?
5. **Taste test.** Ask your family to rate the bowl and name their favorite part.
6. **Improve it.** Plan a second bowl with a different grain (brown rice or farro) and protein (chicken or eggs) and write it down.
7. Clean up: wash, dry and put away everything.

Tips

- Rinse quinoa well in a fine strainer. Its natural coating, called saponin, tastes bitter and soapy.
- Spread the sweet potatoes out with space between them. Crowded vegetables steam instead of browning.
- Grain bowls make an easy packed lunch. Keep the sauce in a separate small jar.

Check your work

- ☐ I can name the three macronutrients and a food rich in each.
- ☐ I can use 4, 4 and 9 to find the energy from carbohydrate, protein and fat.
- ☐ I cooked a balanced grain bowl with all five food groups.

COOK'S NOTEBOOK

1. Draw your grain bowl from above and label each section with its food group.
2. Copy your grams table and energy math neatly, with a pie chart or bar graph of which macronutrient supplied the most energy.
3. Write two sentences about William Prout and why he chose milk as his model food.

From history. The energy averages of 4, 4 and 9 Calories per gram are often called the Atwater factors, after Wilbur Atwater, an American chemist who measured the energy in food and in the people who ate it in the 1890s. You will meet him if you take the Grade 8 course.

COMMON MISTAKES

- Thinking one macronutrient is “bad.” The body needs all three, in balance, every day.
- Treating Calories as a score to beat. They are simply a unit of energy, and growing bodies need plenty of it.
- Forgetting the serving size. Label numbers are for one serving, which may be less or more than what is in your bowl.

Make it a game • Gram Energy Estimator. Pick five foods from the pantry and guess which macronutrient dominates each: carbohydrate, protein or fat. Check the label with your parent. Then work out the Calories from grams, using four for carbohydrate and protein and nine for fat. Closest estimate scores a point. Explain what each macronutrient does for the body.

Scripture. “He causeth the grass to grow for the cattle, and herb for the service of man: that he may bring forth food out of the earth;” (Psalm 104:14, KJV)

Grains, beans, fruits and vegetables come out of the earth by God’s design, each with its own gifts for the body. A balanced meal enjoys many of them together.

2.2 CHRISTIAAN EIJKMAN AND BROWN RICE

OBJECTIVES

- Tell how Christiaan Eijkman noticed in the 1890s that chickens fed polished white rice became sick and recovered on brown rice.
- Name the three parts of a whole grain (bran, germ and endosperm) and explain what is lost when grain is polished or refined, and what enrichment adds back.
- Cook a brown rice pilaf and compare it with white rice for cooking time, texture and flavor.

Warm-up. Put a few grains of white rice and a few grains of brown rice side by side on a white plate. Look at them with a magnifying glass if you have one. Draw what you see. What is different about the color, the surface and the tip of each grain? Which do you think will take longer to cook, and why?

WATCH

The Chemist Who Discovered Vitamins

Rational Thinker • 7:33

<https://www.youtube.com/watch?v=sPRS0vlpAVs>

WHEN TO WATCH

After the story of Eijkman's chickens, before you look at your rice grains.

Note: A small history channel told over old photographs and simple drawings, covering Eijkman's chickens, Casimir Funk and the naming of vitamins. A brief medical diagram of beriberi symptoms appears. Chosen because no major channel tells this story well.

BACKUP VIDEO

What is a Whole Grain?

Oldways • 1:16

<https://www.youtube.com/watch?v=KZqiJoyQh6M>

Before the warm-up, to see the bran, germ and endosperm labeled on one diagram.

KEY TERMS

bran

The tough outer layers of a grain, rich in fiber, B vitamins and minerals.

endosperm

The large starchy center of a grain, the food store for the young plant. White rice and white flour are mostly endosperm.

beriberi

A disease caused by too little thiamine, which weakens the nerves and heart.

germ

The small seed sprout inside a grain, rich in vitamins, minerals and healthy fats.

thiamine

Vitamin B1, which the body needs to turn food into energy for the nerves and heart. It is found in the bran and germ of grains, and in pork, beans and seeds.

enriched

A refined grain food with some B vitamins and iron added back after milling.

CORE IDEAS

The story. In the late 1800s a disease called beriberi was sweeping through the Dutch East Indies (today's Indonesia). Soldiers, sailors and prisoners grew weak, their legs went numb, and their hearts failed; many died. In 1886 the Dutch government sent a team of doctors to the island of Java to find the cause. Most scientists then believed every disease came from a germ, so they looked for a beriberi germ. When the team left, a young army doctor named Christiaan Eijkman stayed behind in Batavia (today's Jakarta) to keep searching.

How he figured it out. In 1890 the chickens kept at Eijkman's laboratory suddenly fell ill with weak, wobbly legs, much like beriberi. Then, just as suddenly, they got better. Eijkman investigated like a detective. He learned that for a while the chickens had been fed leftover polished white rice from the military hospital kitchen. Then a new cook in charge refused to give "military" rice to civilian chickens, and they went back to cheap, unpolished brown rice. Eijkman tested it: chickens fed only white rice became ill; chickens fed brown rice, or white rice with the rice bran added back, stayed well. A colleague, Adolphe Vorderman, checked prisons across Java and found beriberi was far more common where prisoners ate polished rice. At first

Eijkman thought the white rice held something harmful that the bran cured. His successor, Gerrit Grijns, concluded in 1901 that the bran must contain something the body needs. That something, thiamine, was finally isolated in 1926, and Eijkman shared the Nobel Prize in 1929.

The kitchen science. Every whole grain has three parts. The **bran** is the protective outer coat, full of fiber and B vitamins. The **germ** is the tiny sprout. The **endosperm** is the starchy food store that makes up most of the grain. Polishing rice or milling white flour removes the bran and germ, leaving soft, white, quick-cooking endosperm that keeps longer, but losing most of the **thiamine**, fiber and minerals. Today most white rice and white flour in the United States are **enriched**, with thiamine and other B vitamins and iron added back, and beriberi is rare where people eat varied food. Whole grains still keep their fiber, which helps you feel full and keeps digestion healthy. Brown rice takes about 45 minutes to cook instead of 18 because water must work its way through the bran layer before it reaches the starch.

Let's cook. You will make a brown rice pilaf with onion, carrot and peas. A pilaf begins by toasting the grains in a little fat before adding broth, which gives a nutty flavor and helps keep the grains separate. The skill to do well is **simmering with the lid on** and resisting the urge to peek, so the steam stays in and cooks every grain evenly.

PICTURE STUDY



Cleaning Rice, Kusakabe Kimbei, about 1880s–1890s · Hand-colored albumen photograph · Yokohama, Japan

Image: [Wikimedia Commons](#), public domain

Kusakabe Kimbei ran a photography studio in Yokohama, Japan, in the late 1800s. His hand-colored photographs showed daily life and work, including every step of growing and preparing rice. Before machines, rice was cleaned by pounding and winnowing by hand, which removed the husk and some of the bran.

Look closely

- Find the wooden machine. What do you think goes in the top, and what comes out below?
- Find the straw mats on the ground. Why are they spread there?
- How many people are working, and what is each one doing?
- Look at the barn and the bundles of straw. What season might it be?

Talk about it

1. Hand cleaning left some bran on the rice. Steam-powered mills in the 1800s polished rice much whiter. How might that have changed people's health?
2. Eijkman's chickens recovered when they ate unpolished rice. What was in the bran that they needed?

3. Why might people prefer white rice even though brown rice has more fiber and vitamins?

Safety first. An adult is nearby while you use the stove. Lift the lid away from you so steam does not burn your face or hand, and turn pot handles in toward the back of the stove. If you add almonds, check for tree-nut allergies first.

KITCHEN PROJECT

Brown Rice Pilaf and the Two-Rice Test

You will cook a pot of brown rice pilaf for the family and, at the same time, a small test batch of white rice, so you can compare the two grains side by side for cooking time, texture, flavor and how full they keep you.

You will need

- A medium heavy saucepan with a tight lid, and a small saucepan with a lid
- A chef's knife and cutting board
- Measuring cups and spoons, a wooden spoon and a fork
- A magnifying glass (optional) and a timer

BROWN RICE PILAF WITH CARROTS AND PEAS

Serves 6 servings • Prep 15 min • Cook 50 min • Rest 10 min

Ingredients

- 2 tablespoons butter or olive oil
- 1 medium onion, diced small
- 2 carrots, diced small
- 1½ cups (285 g) long-grain brown rice
- 1 clove garlic, minced
- 3 cups (710 mL) chicken or vegetable broth
- ½ teaspoon salt (less if your broth is salty)
- ¾ cup (100 g) frozen peas
- 2 tablespoons chopped parsley
- ⅓ cup (35 g) sliced almonds, toasted (optional)

Method

1. Wash your hands. With an adult nearby, melt the butter in the saucepan over medium heat. Add the onion and carrot and cook, stirring, 5 minutes, until the onion is soft.

2. Add the rice and garlic. Stir 2–3 minutes, until the grains smell toasty and look a little glossy.
3. Pour in the broth (it will sizzle and steam; stand back) and add the salt. Bring to a boil.
4. Cover tightly, turn the heat to low, and simmer 45 minutes without lifting the lid.
5. Turn off the heat. Lift the lid away from you, scatter the peas on top, cover again and let rest 10 minutes. The steam cooks the peas and finishes the rice.
6. Fluff with a fork, stir in the parsley, and top with toasted almonds if using.
7. Clean up: soak the pot, wash everything and wipe the stove when it is cool.

Allergy check: Contains milk if made with butter (use olive oil for milk-free) and tree nuts if you add almonds (leave them out or use toasted sunflower seeds). Some broths contain soy or wheat; check the label. No eggs.

Steps

1. **Look closely.** Draw a grain of brown rice and a grain of white rice, labeling the bran and the place where the germ was.
2. **Two-rice test.** While the pilaf cooks, cook $\frac{1}{2}$ cup white rice in 1 cup water in the small pan (simmer 18 minutes covered). Record the cooking time for each.
3. When both are done, taste a spoonful of each plain. Compare chewiness, flavor and smell on a chart.
4. **Label check.** Read the labels on both bags. Is the white rice enriched? Which vitamins were added? Compare the fiber in one serving of each.
5. **Taste test.** Serve the pilaf with supper. Ask your family to rate it from 1 to 5 and to compare it with plain white rice.
6. **Improve it.** Plan one change: a different vegetable, a spice such as cumin, or a mix of brown rice and lentils.
7. Clean up: wash, dry and put everything away.

Tips

- A tight lid matters. If yours is loose, lay a clean kitchen towel or a piece of foil under it, kept well away from the flame or burner.
- Cooked rice should be cooled and refrigerated within 2 hours. Reheat leftovers to 165 °F.
- Leftover brown rice makes excellent fried rice; cold rice fries better than fresh.

Check your work

- ☐ I can tell how Eijkman's chickens led to the discovery of thiamine.
- ☐ I can name the bran, germ and endosperm and say what each gives.
- ☐ I cooked a brown rice pilaf and compared it with white rice.

COOK'S NOTEBOOK

1. Draw and label a whole grain cut in half: bran, germ and endosperm, with a note of what each contains.
2. Write the story of Eijkman's chickens as a detective's case file: the mystery, the clues, the test and the answer.
3. Make a comparison chart of brown and white rice: cooking time, texture, flavor, fiber and your family's rating.

From history. Eijkman shared the 1929 Nobel Prize in Physiology or Medicine with Frederick Gowland Hopkins of England, who had shown that animals need small "accessory food factors" besides carbohydrate, protein and fat. The word "vitamine" was coined by Casimir Funk in 1912, and the final "e" was later dropped.

COMMON MISTAKES

- Lifting the lid to check the rice. The steam escapes and the rice cooks unevenly; trust the timer.
- Using the white-rice water amount and time for brown rice. Brown rice needs more water and more than twice the time.
- Thinking white rice is "bad." Enriched white rice is a fine food; whole grains simply add fiber and keep more of their natural nutrients.

Make it a game • Chicken and Rice Mystery. Retell the Christiaan Eijkman story as a detective case. Your parent plays a puzzled doctor in the 1890s who asks why the chickens got sick on white rice. You explain polished rice, brown rice and the three parts of a whole grain. Name what enrichment adds back. Switch roles and let your parent be the detective.

2.3 JAMES LIND'S FAIR TEST

OBJECTIVES

- Tell how James Lind tested six remedies for scurvy on twelve sailors aboard HMS *Salisbury* in 1747.
- Explain what makes a test fair (changing only one thing) and run a fair test in the kitchen.
- Explain what vitamin C does in the body and name foods rich in it, then cook orange-glazed chicken with a citrus salad.

Warm-up. Cut an apple into six slices. Put two on a plate with nothing on them, brush two with lemon juice, and brush two with water. Set the plate aside and check it at the end of the lesson. Predict now: which slices will turn brown? Why did you treat two slices the same way each time?

WATCH

Vitamin C and the Limeys

Khan Academy • 7:21

<https://www.youtube.com/watch?v=Mp9II8MmuoA>

WHEN TO WATCH

After the story of Lind's test, before you set up your own fair test.

Note: Khan Academy's Sal Khan talks with a physician about Lind, scurvy and vitamin C over still pictures. Calm and accurate.

KEY TERMS

scurvy

A disease caused by too little vitamin C. It causes weakness, bleeding gums, slow-healing wounds and, if untreated, death.

vitamin C

A vitamin (ascorbic acid) the body needs to make collagen, the protein that holds skin, gums, blood vessels and bones together. People must get it from food.

fair test

An experiment where everything is kept the same except the one thing being tested, so you can tell what caused the result.

variable

Something that can change in an experiment. In a fair test you change only one variable at a time.

control

The part of an experiment that is left untreated, for comparison.

CORE IDEAS

The story. For centuries, scurvy was the terror of long sea voyages. Sailors who ate hard biscuit and salted meat for months grew weak and pale; their gums swelled and bled, old wounds opened, and many died. On some voyages more sailors died of scurvy than of storms and battles together. Doctors offered many cures, but no one knew which, if any, worked. James Lind was a young Scottish naval surgeon aboard the warship HMS *Salisbury*.

How he figured it out. In May 1747, after weeks at sea, Lind chose twelve sailors with scurvy whose cases were as alike as he could find. He kept them in the same part of the ship and gave them all the same basic meals. Then he divided them into six pairs and gave each pair a different remedy, among them vinegar, seawater, a spicy paste, diluted sulfuric acid, and, for one pair, two oranges and a lemon every day. After only six days the two who ate the citrus fruit were by far the best; one was fit for duty and helped nurse the others. Lind published his findings in *A Treatise of the Scurvy* in 1753. His was one of the first controlled trials in medicine. Sadly, it took the British Navy until 1795 to give sailors lemon juice every day, and then scurvy almost disappeared from the fleet.

The kitchen science. We now know scurvy comes from too little **vitamin C**. The body uses vitamin C to build **collagen**, the strong protein that holds together skin, gums, blood vessels and bones. People cannot make vitamin C in their own bodies, so it must come from food, and the body cannot store much of it, so we need some every day. It was finally identified in the early 1930s. Citrus fruits are famous for it, but red bell peppers, strawberries, kiwi, broccoli, tomatoes and potatoes are good sources too; a red bell pepper has more than an orange. Vitamin C dissolves in water and breaks down with long heating and exposure to air, so fresh fruit and lightly cooked

vegetables keep the most. It also slows browning, which is why lemon juice keeps cut apples looking fresh.

Let's cook. You will make orange-glazed chicken thighs and a bright citrus salad, a supper Lind's sailors would have dreamed about. The skill to do well is **zesting and juicing citrus**: grate only the colored outer peel (the white pith underneath is bitter), then roll the fruit firmly on the counter before cutting it so it gives more juice.

PICTURE STUDY



Still Life with Lemons, Oranges and a Rose, Francisco de Zurbarán, 1633 · Oil on canvas · Norton Simon Museum, Pasadena, California

Image: [Wikimedia Commons](#), public domain

Francisco de Zurbarán was a Spanish painter of the 1600s, best known for quiet, devout paintings of monks and saints. He painted only one signed still life, and it is this one. In Spain, oranges and lemons grew in courtyard gardens, and fresh fruit like this was a treasure in winter.

Look closely

- Count the lemons and the oranges. How are they arranged?
- Find the orange blossoms and leaves in the basket. What does that tell you about where these oranges came from?
- Look at the light on the fruit peel. Can you see the tiny dimples where the oils of the zest are?
- Look at the empty space between the three groups. Why do you think the painter left so much space and darkness?

Talk about it

1. If Lind's sailors could have stepped into this painting, which objects would have helped them most? Why?
2. Many people see this painting as an offering of thanks, plain and beautiful. How can a simple bowl of fruit be a reason for thanks?

3. Which other foods would you add to a painting about vitamin C?

Safety first. An adult is nearby while you use the oven. Keep raw chicken on its own board, wash your hands after handling it, and check the thickest thigh at 165 °F (74 °C). Use the zester slowly with your fingers well back from the blades.

KITCHEN PROJECT

A Fair Test and a Citrus Supper

First you will finish the apple-browning fair test from the warm-up and design a second fair test of your own. Then you will cook orange-glazed chicken thighs with a citrus salad, using every part of the oranges you can: zest, juice and segments.

You will need

- A 9 × 13-inch baking dish or rimmed baking sheet
- A small saucepan, a whisk, a zester or fine grater and a citrus juicer
- Two cutting boards (one for raw chicken), a chef's knife and a paring knife
- An instant-read thermometer, oven mitts and a serving bowl

ORANGE-GLAZED CHICKEN THIGHS WITH CITRUS SALAD

Serves 5–6 servings · Prep 25 min · Bake 25 min

Ingredients

- 2 pounds (900 g) boneless, skinless chicken thighs
- ½ teaspoon salt and ¼ teaspoon pepper
- **Glaze:** finely grated zest of 1 orange, ¾ cup (180 mL) fresh orange juice (about 2–3 oranges), 2 tablespoons honey, 2 tablespoons soy sauce, 1 clove garlic, minced, 1 tablespoon cornstarch
- **Citrus salad:** 3 navel oranges, 3 clementines or mandarins, 1 cup (150 g) sliced strawberries or pomegranate seeds, 1 tablespoon lime juice, 1 teaspoon honey, 6 fresh mint leaves, sliced thin

Method

1. Wash your hands. An adult turns the oven to 425 °F (220 °C).
2. Zest one orange onto a small plate, then roll and juice the oranges for the glaze. Whisk the zest, juice, honey, soy sauce, garlic and cornstarch in the saucepan.

3. On the raw board, pat the chicken dry, lay it in the baking dish in one layer, and sprinkle with salt and pepper. Put the board and tongs straight into hot, soapy water and wash your hands.
4. With an adult nearby, bring the glaze to a simmer over medium heat, whisking, until it thickens and turns glossy, about 2 minutes. Brush half of it over the chicken.
5. Bake 20–25 minutes, until the thickest thigh reads 165 °F (74 °C). Brush with the rest of the glaze and let rest 5 minutes.
6. Meanwhile, make the salad: cut the peel and white pith off the navel oranges with a paring knife, slice them into rounds, peel and section the clementines, and arrange with the berries. Drizzle with lime juice and honey and sprinkle with mint.
7. Clean up: wash the baking dish, boards and juicer, and refrigerate leftovers within 2 hours.

Allergy check: Contains soy and wheat (soy sauce). Use tamari labeled gluten-free for wheat-free, or coconut aminos for soy-free. Contains honey: never give honey to a baby under one year old. No milk, eggs or nuts.

Steps

1. **Finish the apple test.** Look at your six apple slices. Record which turned brown and which stayed pale. Which slices were the control? What was the one variable you changed?
2. **Design a fair test.** Write a plan for one more kitchen fair test, such as “Does lime juice slow browning as well as lemon juice?” or “Do avocado slices brown faster in the fridge or on the counter?” Name the one variable you will change and everything you will keep the same. Run it this week.
3. Cook the chicken and salad. Record the temperature of the thickest thigh.
4. **Vitamin C hunt.** Read the produce labels or look up five foods on USDA FoodData Central. Rank them by milligrams of vitamin C per serving. Where does the red bell pepper rank?
5. **Taste test.** Ask your family to rate the chicken and the salad. Was the glaze too sweet, too salty or just right?
6. **Improve it.** Write one change: more zest, a little ginger in the glaze, or lime instead of orange.

7. Clean up: wash, dry and put away everything.

Tips

- Zest the fruit before you juice it. Zesting a squeezed orange is nearly impossible.
- Room-temperature citrus gives more juice than cold fruit. Roll it firmly under your palm first.
- Thighs stay juicier than breasts and are hard to overcook; even so, check every batch with the thermometer.

Check your work

- ☐ I can tell the story of Lind's twelve sailors and why his test was fair.
- ☐ I can explain what vitamin C does and name foods rich in it.
- ☐ I cooked orange-glazed chicken to 165 °F and a fresh citrus salad.

COOK'S NOTEBOOK

1. Draw a chart of Lind's six pairs of sailors, their remedies and what happened, as if you were writing his ship's report.
2. Write up your own fair test: question, prediction, what you changed, what you kept the same, results and conclusion.
3. Copy the chicken recipe in your own words and record the thigh temperature and your family's rating.

From history. British sailors were later nicknamed "limeys" because the navy switched from lemons to West Indian limes in the 1800s. Limes have less vitamin C than lemons, and the juice was often stored in copper pipes, which destroyed more of it, so scurvy crept back on some long expeditions until vitamin C was finally understood.

COMMON MISTAKES

- Changing two things at once in a test. Then you cannot tell which change caused the result.
- Grating the white pith along with the zest. It tastes bitter; take only the colored outer layer.
- Thinking only oranges have vitamin C. Peppers, strawberries, broccoli, kiwi and potatoes are all good sources.

Make it a game • Lind's Fair Test. Design your own fair test with your parent: choose two kinds of apple slices, one with lemon juice and one without, and set them on a plate. Name the variable and the control out loud. Predict which will brown. After thirty minutes, check the results. Then tell how James Lind tested six remedies on twelve sailors in 1747.

2.4 MRS. BEETON PLANS A BALANCED DINNER

OBJECTIVES

- Tell how Isabella Beeton's *Book of Household Management* (1861) helped families plan meals, follow recipes and know their cost.
- Plan a balanced family dinner with all five MyPlate food groups.
- Cook a cottage pie supper with a vegetable side and figure its cost per serving.

Warm-up. Find any cookbook or recipe card in your house. What comes first: the list of ingredients or the instructions? Does it tell you how long the recipe takes, how many people it serves, or what it costs? Which of those facts would help a busy family most? Write your answer.

WATCH

Cottage Pie Recipe | How to Make Classic Cottage Pie

Pinch of Mint • 3:03

<https://www.youtube.com/watch?v=4i-qri6AuYU>

WHEN TO WATCH

Before you cook. Watch the steps for browning the meat and spreading the potato topping, then follow the recipe card in this lesson.

Note: A short, clear cooking demonstration from a home-cooking teacher's channel. His version uses cream in the potatoes; follow this lesson's recipe card for amounts.

KEY TERMS

household management

Running a home well: planning meals, buying food, keeping accounts, caring for the family and welcoming guests.

cost per serving

The total cost of a recipe divided by the number of servings it makes.

cottage pie

A British dish of ground beef and vegetables in gravy, topped with mashed potatoes and baked. Made with lamb, it is called shepherd's pie.

balanced meal

A meal with foods from several food groups, ideally all five, so it gives a variety of nutrients.

CORE IDEAS

The story. In 1861 a young English woman named Isabella Beeton published a book of more than 1,100 pages called *The Book of Household Management*. She was only 25 years old. With her husband Samuel, a publisher, she had been printing it in monthly parts since 1859. It held about 900 recipes, along with advice on shopping, keeping accounts, caring for the sick and running a home. It sold about 60,000 copies in its first year, and editions of “Mrs. Beeton” stayed in British kitchens for more than a hundred years. Isabella Beeton died young, at 28, only a few years after the book appeared.

How she figured it out. Many older cookbooks were written as long paragraphs, with amounts mixed into the instructions and little idea of how long a dish took. Mrs. Beeton gathered recipes from many sources, including other writers and readers, and tested many in her own kitchen. She set each recipe out in the same orderly way: first the **ingredients** with their amounts, then the **mode** (the method), then the **time**, the **average cost**, the number of people it would serve, and when the ingredients were in season. A cook could see at a glance what to buy, how long to allow and what it would cost the household. Most recipes are still written her way today.

The kitchen science. A balanced dinner is easier to plan than it sounds. Start with MyPlate: about half the plate fruits and vegetables, about a quarter grains or starchy foods, about a quarter protein, with dairy on the side or in the dish. A cottage pie covers several groups in one dish: beef for protein and iron, carrots, peas and onions for vegetables, and potatoes for starch. Add a green vegetable and a glass of milk, and the plate is complete. Planning ahead also saves money: when you know your recipe, you can buy exactly what you need, and dividing the total cost by the number of servings shows what each plate costs, just as Mrs. Beeton listed her “average cost.”

Let’s cook. You will make a cottage pie with green beans for the family. The skill to do well is **browning ground beef properly**: spread it in a hot pan, let it sit until a brown crust forms before stirring, break it up, and cook it to 160 °F (71 °C). Browning builds deep flavor for the gravy.

PICTURE STUDY



Isabella Beeton, Maull & Polyblank, about 1860 · Albumen photograph · National Portrait Gallery, London

Image: [Wikimedia Commons](#), public domain

This is one of the few photographs of Isabella Beeton, taken by a London studio around the time she was writing her famous book. Photographs were new and still rare. She looks very young, because she was: she wrote one of the best-known cookbooks in English in her early twenties.

Look closely

- Look at her face and expression. What words would you use to describe her?
- Look at her dress and shawl. Would they have been easy to cook in? How do you think cooks of her time protected their clothes?
- Look at how she rests her chin on her hand. Does she look thoughtful, tired, or confident?
- What does this portrait not show that you would like to know about her?

Talk about it

1. Mrs. Beeton wrote for young wives running a household for the first time, much as you are learning to plan meals now. What advice would you want from her?
2. Why is it helpful to list the ingredients before the method? Give an example from your own cooking.

3. Proverbs 31 praises a woman who looks well to the ways of her household.
How does careful meal planning show love for a family?

Safety first. An adult is nearby while you use the stove and oven. Cook the ground beef to 160 °F (71 °C) and keep raw meat on its own board. Drain potatoes by pouring away from you into a colander in the sink, with an adult close by, because the steam can scald.

KITCHEN PROJECT

A Beeton-Style Recipe Card and a Cottage Pie Supper

You will plan a balanced dinner with MyPlate, write your cottage pie recipe the way Mrs. Beeton would (ingredients, method, time, average cost, servings), cook it for the family, and work out the real cost per serving from your grocery receipt.

You will need

- A large pot, a colander and a potato masher
- A large skillet and a wooden spoon
- A 9 × 13-inch or 3-quart baking dish
- A chef's knife, cutting board, peeler and measuring cups and spoons
- An instant-read thermometer, oven mitts and a calculator
- Your grocery receipt

COTTAGE PIE WITH GREEN BEANS

Serves 6 servings · Prep 30 min · Cook 25 min · Bake 25 min

Ingredients

- **Potato topping:** 2½ pounds (1.1 kg) russet or Yukon Gold potatoes, peeled and cut in 2-inch chunks; ¾ cup (180 mL) milk, warmed; 3 tablespoons butter; ¾ teaspoon salt
- **Filling:** 1 tablespoon vegetable oil; 1½ pounds (680 g) ground beef; 1 medium onion, diced; 2 carrots, diced; 2 stalks celery, diced; 2 cloves garlic, minced; 2 tablespoons tomato paste; 2 tablespoons all-purpose flour; 1½ cups (355 mL) beef broth; 1 teaspoon dried thyme; ½ teaspoon salt; ¼ teaspoon pepper; 1 cup (135 g) frozen peas
- ½ cup (55 g) grated cheddar (optional)
- **Side:** 1 pound (450 g) green beans, trimmed; 1 teaspoon butter or olive oil; a pinch of salt

Method

1. Wash your hands. Put the potatoes in the pot, cover with cold water by an inch, add a big pinch of salt and bring to a boil. Simmer 15–18 minutes, until a fork slides in easily. An adult drains them, or you do it with the adult beside you. Mash with the warm milk, butter and salt.
2. While the potatoes cook, heat the oil in the skillet over medium-high heat. Add the beef, press it flat and let it brown 3–4 minutes without stirring, then break it up and cook until no pink remains and it reads 160 °F (71 °C). Spoon off extra fat into a heat-proof cup (never down the drain).
3. Add the onion, carrots and celery and cook 5–6 minutes, until soft. Stir in the garlic and tomato paste for 1 minute, then sprinkle in the flour and stir 1 minute more.
4. Pour in the broth, add the thyme, salt and pepper, and simmer 8–10 minutes, stirring, until the gravy thickens. Stir in the peas. An adult turns the oven to 400 °F (200 °C).
5. Spread the filling in the baking dish. Spoon the potatoes over it and spread them to the edges, sealing the filling in. Rough up the top with a fork and sprinkle with cheese if using.
6. Bake 20–25 minutes, until bubbling at the edges and golden on top. Let rest 10 minutes before serving.
7. Meanwhile, steam or boil the green beans 5–6 minutes until bright green and tender-crisp; drain and toss with butter and salt.
8. Clean up: soak the potato pot, wash everything, and refrigerate leftovers within 2 hours.

Allergy check: Contains milk (milk, butter, cheese) and wheat (flour). For milk-free, mash potatoes with broth and olive oil and skip the cheese. For wheat-free, thicken with 1 tablespoon cornstarch stirred into a little cold broth. Some broths contain soy; check the label. No eggs or nuts.

Steps

1. **Plan the plate.** Draw a MyPlate and fill in your dinner: cottage pie, green beans and a glass of milk (or another side). Does every food group appear?
2. **Beeton card.** Rewrite the cottage pie recipe on a card in Mrs. Beeton's order: ingredients, mode, time, average cost and sufficient for (servings). Leave the cost blank until after shopping.

3. Cook the supper. Record the temperature of the browned beef and the total time from start to table.
4. **Cost per serving.** From the receipt, add up what you used of each ingredient (for example, if a 5-pound bag of potatoes cost \$4.00 and you used 2½ pounds, that part cost \$2.00). Divide the total by 6. Write it on your Beeton card.
5. **Taste test.** Ask your family to rate the pie and to say whether they would like it again.
6. **Improve it.** Write one change: more vegetables in the filling, a sweet-potato topping, or ground turkey instead of beef.
7. Clean up: wash, dry and put away everything, and wipe the stove and counters.

Tips

- Warm milk mashes into potatoes smoothly; cold milk makes them gluey and cool.
- Seal the potato to the edges of the dish so the gravy does not bubble over.
- Cottage pie freezes well. Make two and freeze one for a busy night.

Check your work

- ☐ I can tell how Mrs. Beeton set out her recipes and why that helped cooks.
- ☐ I planned a balanced dinner with all five food groups.
- ☐ I cooked a cottage pie with beef at 160 °F and figured the cost per serving.

COOK'S NOTEBOOK

1. Glue or copy your finished Beeton-style recipe card, with the real cost per serving.
2. Draw your dinner plate and label each food group.
3. Write three sentences about why planning meals ahead helps a family's time, money and health.

From history. Mrs. Beeton's book was revised again and again after her death, growing to more than 2,000 pages in some editions. Not all of her recipes were her own; like many cookbook writers of her day, she gathered recipes from other books and readers. Her gift was organizing them so that ordinary cooks could follow them.

COMMON MISTAKES

- Stirring ground beef constantly. It turns gray and steamed instead of brown; let it sit first.
- Pouring hot fat down the sink. It hardens and clogs the drain; pour it into a can or heat-proof cup and throw it away when cool.
- Forgetting to divide by the number of servings when figuring cost per serving.

Make it a game • Beeton's Dinner Card. On an index card, write a balanced dinner with all five MyPlate groups and a rough cost per serving, as Mrs. Beeton did. Set a five-minute timer. Your parent checks that every group is present and scores a point for each. Say how her Book of Household Management helped families plan, and what a cottage pie is.

Scripture. “She looketh well to the ways of her household, and eateth not the bread of idleness.” (Proverbs 31:27, KJV)

Planning meals, shopping wisely and cooking for others is good and honorable work, a way of caring well for a household.

UNIT 2

FOOD GROUPS & THE BALANCED MEAL

Food is God's good gift, and He made it wonderfully varied. In this unit you will look inside your food to see what it gives your body. You will meet the three big nutrients that make up most of what we eat, carbohydrate, protein and fat, and learn how scientists first sorted them in the 1820s. Then you will meet two small but mighty nutrients through two great detective stories: Christiaan Eijkman's sick chickens and the brown rice that cured them, and James Lind's fair test of twelve sailors with scurvy aboard HMS *Salisbury* in 1747.

Finally you will meet Isabella Beeton, whose enormous cookbook of 1861 taught British households to plan meals, list ingredients first, and know what a dish would cost. Along the way you will cook a balanced grain bowl, a brown rice pilaf, orange-glazed chicken with a citrus salad, and a cottage pie supper planned with MyPlate. You will use a little arithmetic too: grams, energy, water-to-rice ratios and cost per serving.

PREREQUISITES

- Knows the five MyPlate food groups: fruits, vegetables, grains, protein and dairy (Grade 5)
- Can read a Nutrition Facts label for serving size and grams
- Can use a chef's knife with the claw grip and an adult nearby (Unit 1)
- Checks chicken at 165 °F and ground beef at 160 °F with a thermometer (Unit 1)

MASTERY CHECKLIST

- ☐ I can name the three macronutrients, give foods rich in each, and explain that carbohydrate and protein give about 4 Calories of energy per gram and fat about 9.
- ☐ I can tell how Christiaan Eijkman discovered that polished white rice lacked something found in brown rice, and name the parts of a whole grain.
- ☐ I can tell how James Lind ran a fair test in 1747 and explain what vitamin C does and where to find it.
- ☐ I can plan and cook a balanced family dinner with a MyPlate check and figure its cost per serving, as Mrs. Beeton taught.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **USDA FoodData Central:** Free. The U.S. Department of Agriculture’s searchable database of nutrients in thousands of foods. Use it in Lesson 2.1 to look up grams of carbohydrate, protein and fat.
- ***Dietary Guidelines for Americans*:** Free. The official guidelines behind MyPlate, with sections for children and families. For parents who want to read the source.
- ***The Book of Household Management* by Isabella Beeton (1861), free at Project Gutenberg:** Free to read online. Look at how she lays out a recipe with ingredients, time, cost and servings for Lesson 2.4. Some old recipes use ingredients this course leaves out, so families may want to browse it together.
- **A kitchen scale that reads grams:** Inexpensive. Weigh a serving of rice, beans or cheese and see what “grams” on a label really look like.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

2.1	Macronutrients by the Gram	2 sessions of 50–60 minutes
2.2	Christiaan Eijkman and Brown Rice	2 sessions of 50–60 minutes
2.3	James Lind’s Fair Test	2 sessions of 50–60 minutes
2.4	Mrs. Beeton Plans a Balanced Dinner	2 sessions of 50–60 minutes

UNIT 2 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. 8 pts

Name the three macronutrients and give one food rich in each, and one job each does in the body.

2. 8 pts

Why did William Prout choose milk as his model food in 1827?

3. 10 pts

Calculation: A bowl contains 60 grams of carbohydrate, 20 grams of protein and 15 grams of fat. How many Calories of energy does each supply, and what is the total? (Use 4, 4 and 9.)

4. 8 pts

Name the three parts of a whole grain and what polishing rice removes.

5. 8 pts

What clue led Christiaan Eijkman to suspect the chickens' food, and how did he test his idea?

6. 8 pts

Calculation: Brown rice needs 2 cups of liquid for every 1 cup of rice. How much broth do you need for $1\frac{1}{2}$ cups of rice? For $\frac{3}{4}$ cup?

7. 8 pts

What made James Lind's 1747 test a fair test? Name two things he kept the same and the one thing he changed.

8. 8 pts

What does vitamin C do in the body, and why do we need some every day? Name three foods rich in it.

9. 8 pts

Predict: You leave a bowl of cut apple slices brushed with lemon juice and a bowl of plain slices on the counter for an hour. What will happen, and why?

10. 10 pts

Calculation: A cottage pie used beef (\$7.50), potatoes (\$2.00), vegetables (\$2.40), broth and pantry items (\$1.30) and milk and butter (\$0.80). It serves 6. What is the cost per serving?

11. 8 pts

List the parts of a recipe in the order Mrs. Beeton set them out, and say why the ingredient list comes first.

12. **8 pts**

Short answer: Plan a balanced dinner for your family using MyPlate. Name a food for each of the five groups.

ANSWER KEY

1. Carbohydrate (bread, rice, fruit): main fuel for the body and brain. Protein (beans, eggs, chicken): builds and repairs the body. Fat (olive oil, nuts, avocado): rich energy, carries vitamins A, D, E and K, builds cells. Other correct examples are fine.
2. Milk is meant to keep a baby growing on its own, so it should be complete, and it contains all three classes: milk sugar (carbohydrate), butterfat (fat) and curd (protein).
3. Carbohydrate $60 \times 4 = 240$; protein $20 \times 4 = 80$; fat $15 \times 9 = 135$. Total $240 + 80 + 135 = 455$ Calories.
4. Bran, germ and endosperm. Polishing removes the bran and germ, with most of the fiber, thiamine (vitamin B1) and minerals, leaving the starchy endosperm.
5. The chickens fell ill while eating leftover polished white rice and recovered when a new cook switched them back to brown rice. He fed some chickens only white rice and others brown rice (or white rice with bran added) and compared them: the white-rice chickens became ill.
6. $1\frac{1}{2} \times 2 = 3$ cups of broth. $\frac{3}{4} \times 2 = 1\frac{1}{2}$ cups of broth.
7. He chose sailors with similar scurvy, kept them in the same place and gave them the same basic meals (kept the same); he changed only the remedy each pair received.
8. It helps build collagen, which holds skin, gums, blood vessels and bones together. The body cannot make it and cannot store much, so we need it from food regularly. Examples: oranges, lemons, red bell peppers, strawberries, kiwi, broccoli, tomatoes, potatoes.
9. The plain slices will turn brown; the lemon slices will stay pale much longer, because vitamin C (and the acid) in lemon juice slows the browning reaction with air.
10. $\$7.50 + \$2.00 + \$2.40 + \$1.30 + \$0.80 = \$14.00$. $\$14.00 \div 6 \approx \$2.33$ per serving.
11. Ingredients, mode (method), time, average cost, servings (and when in season). The ingredients come first so the cook can gather and buy everything before starting.
12. Answers vary. Example: baked chicken (protein), brown rice (grain), green beans and salad (vegetables), orange slices (fruit), a glass of milk (dairy).

UNIT CHALLENGE: A BALANCED WEEK OF FAMILY DINNERS

Plan five family dinners for one week, using MyPlate so that each dinner has at least four food groups and the week includes at least two whole-grain dishes and two dinners with a vitamin C-rich vegetable or fruit. Write the plan on a chart with each dinner's food groups checked off.

Cook at least two of the dinners yourself with an adult nearby (one may be a recipe from this unit). Write a Beeton-style recipe card for each, with the cost per serving, and collect your family's ratings. Finish with a paragraph on what you learned about planning balanced meals.

LOOK FOR	WHAT IT MEANS
Balanced plan	Five dinners planned; each has at least four food groups, with whole grains and vitamin C-rich foods included.
Cooking and safety	Two dinners cooked with safe temperatures checked, clean-as-you-go habits and a clean kitchen afterward.
Recipe cards and cost	Two Beeton-style cards with ingredients, method, time, cost per serving (calculated correctly) and servings.
Reflection and improvement	Family ratings recorded and one honest improvement named; a dish that flopped but is recorded and tried again earns full credit.

UNIT 3

TASTE, SMELL & YOUR TASTE BUDS

Why does one person love Brussels sprouts while another can hardly swallow them? Why does food taste flat when you have a cold? Why did your grandfather like coffee-flavored candy that you think is awful? In this unit you will find out. You will meet Arthur Fox, a chemist who discovered by accident in 1931 that a bitter powder tasted bitter to only some people, and learn that your genes help decide how strongly you taste bitterness.

You will discover that much of what you call “taste” is really smell, rising from the back of your mouth into your nose. You will learn how taste changes from babyhood to old age, and interview an older relative to cook a family recipe together. Finally you will study texture, the crunch and creaminess that make food interesting, in a baked macaroni with a crisp golden top. Every taste test in this unit begins with an allergy check and ends with thanks: “O taste and see that the LORD is good.”

PREREQUISITES

- Knows the five basic tastes: sweet, salty, sour, bitter and umami (Grade 5)
- Knows the tongue map is a myth and that every part of the tongue senses every taste (Grade 5)
- Can mince garlic and dice vegetables with a chef’s knife (Unit 1)
- Can roast vegetables in the oven with an adult nearby (Unit 2)

MASTERY CHECKLIST

- ☐ I can tell the story of Arthur Fox and PTC and explain that some people taste bitterness more strongly than others because of their genes.
- ☐ I can explain the difference between smelling through the nose and smelling from the back of the mouth (retronasal smell), and show it with a nose-pinch test.
- ☐ I can describe how taste and smell change from childhood to old age, and why tasting a food many times helps you learn to like it.
- ☐ I can describe food textures with exact words and plan contrasts, like crisp over creamy, in a dish.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **A set of small tasting cups or a muffin tin:** Inexpensive. Handy for the bitter-greens test, the nose-pinch test and the texture tasting in this unit.
- **A blindfold or clean scarf:** For fair blind taste tests in Lessons 3.1–3.4 and the unit challenge.
- **Monell Chemical Senses Center: Science of taste and smell:** Free articles from a research institute in Philadelphia that has studied taste and smell since 1968. For parents and curious students who want to read more about Lessons 3.2 and 3.3.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

3.1 Arthur Fox and the Bitter Taste	2 sessions of 50–60 minutes
3.2 Smelling from the Inside: Retronasal Smell	2 sessions of 50–60 minutes
3.3 Taste Across a Lifetime	2 sessions of 60–90 minutes
3.4 Contrast in Texture	2 sessions of 50–60 minutes

UNIT 3 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**

What happened in Arthur Fox’s laboratory in 1931, and what did he do next?

2. **8 pts**

What did Albert Blakeslee show about tasting PTC, and what was found in 2003?

3. **8 pts**

Name three ways a cook can make bitter greens taste milder.

4. (8 pts)

Explain the difference between orthonasal and retronasal smell, with an example of each.

5. (8 pts)

Predict: You pinch your nose and eat a cinnamon jelly bean. What will you notice? What happens when you let go?

6. (8 pts)

Why do roasted vegetables smell so much stronger and sweeter than raw ones?

7. (8 pts)

What did the 2001 carrot-juice study at the Monell Center show?

8. (8 pts)

Describe how taste changes from childhood to old age.

9. (10 pts)

Calculation: You plan to taste a new vegetable once a week until you have tried it 12 times. You have tasted it 5 times. How many more weeks? If you start on week 1 of March, about which month will you finish? (Use 4 weeks per month.)

10. (10 pts)

Calculation: The macaroni recipe serves 6 and uses $3\frac{1}{2}$ cups of milk. How much milk would you need to make it for 9 people? (Hint: $9 \div 6 = 1\frac{1}{2}$.)

11. (8 pts)

What is a texture profile, and who developed one in 1963?

12. (8 pts)

Short answer: Why does a crisp topping make baked macaroni more interesting, and why does it go soft overnight in the fridge?

ANSWER KEY

1. PTC dust flew into the air; his colleague tasted it as very bitter while Fox tasted nothing. Fox then tested many people and found that some taste PTC and some cannot.
2. That the ability to taste PTC is inherited, passed down in families through genes. In 2003 scientists found the gene, which makes one of the bitter taste receptors.
3. Any three: add fat (olive oil, butter, cheese), salt, acid (lemon juice), a little sweetness, or cook them (sauté or roast).
4. Orthonasal smell is sniffing through the nostrils (smelling bread baking across the room). Retronasal smell is aroma rising from food in the mouth up the back of the throat to the nose while chewing (tasting “strawberry” in a jam).
5. With the nose pinched you notice only sweetness (and maybe a little sourness), not cinnamon. When you let go, aroma reaches the nose and the cinnamon flavor appears.
6. High heat browns sugars and proteins on their surfaces and creates hundreds of new aroma molecules, while some sharp raw compounds break down.
7. Babies whose mothers drank carrot juice during pregnancy or nursing accepted carrot-flavored cereal more happily, showing that flavors from the mother’s food reach the baby and shape early likes.
8. Children prefer sweeter and saltier foods and are more sensitive to bitterness; adults usually come to enjoy more bitter and sour flavors; older adults often lose some smell and some taste, so they may enjoy stronger seasoning.
9. $12 - 5 = 7$ more weeks. 7 weeks is about $1\frac{3}{4}$ months, so you would finish in late April.
10. $3\frac{1}{2} \times 1\frac{1}{2} = 5\frac{1}{4}$ cups of milk.
11. A method for rating food texture on standard scales (such as hardness, chewiness and how it breaks) using reference foods, so tasters can measure texture the same way. Alina Szczesniak and her team at General Foods.
12. The crisp crumbs contrast with the creamy sauce, so each texture stands out and the mouth does not get bored. Overnight, moisture from the sauce and the air moves into the dry crumbs and softens them.

UNIT CHALLENGE: A FAMILY TASTE MAP: THREE GENERATIONS AT THE TABLE

Cook one food three ways for your family, choosing a vegetable at least one person dislikes (for example, Brussels sprouts steamed, roasted, and sautéed with lemon and Parmesan). Run a blind taste test with as many ages as you can gather: children, parents and grandparents or older friends.

Have each taster rate bitterness, flavor, texture and overall liking. Make a chart or graph of the results by age group and by method, and write a one-page report on what you discovered about taste, smell and texture. End with a “try it again” plan for the person who liked the vegetable least.

LOOK FOR	WHAT IT MEANS
Three methods cooked safely	One vegetable cooked three ways with an adult nearby, clean-as-you-go habits and a clean kitchen afterward.
Fair blind test	Same size samples, blindfolds or hidden labels, the same questions for every taster, and an allergy check first.
Chart and analysis	Results organized clearly by age group and method, with at least two honest conclusions tied to lessons in this unit.
Try-again plan and thanks	A kind, practical plan for helping someone learn to like the food; tasters thanked. Surprising or messy results honestly reported earn full credit.

3.1 ARTHUR FOX AND THE BITTER TASTE

OBJECTIVES

- Tell how Arthur Fox discovered in 1931 that some people taste the bitter chemical PTC and others do not.
- Explain bitter taste receptors, and why some people find broccoli, kale and Brussels sprouts much more bitter than others do.
- Run a family bitter-greens taste test and cook sautéed greens, using fat, salt and acid to balance bitterness.

Warm-up. Make a quick family survey: ask everyone at home to rate how much they like broccoli, Brussels sprouts, dark chocolate and grapefruit, from 1 (not at all) to 5 (love it). What do these foods have in common? Do the people in your family agree? Save the chart for the end of the lesson.

WATCH

Do you have the bitter taste gene? | Science-U

[wpsu](#) · 1:33

<https://www.youtube.com/watch?v=fqVSNiWDTQU>

WHEN TO WATCH

After the story of Arthur Fox, before your taste test. Watch how the students sort themselves into tasters and non-tasters.

Note: From Penn State's public-media station (WPSU) Science-U camp. Students test PTC paper, which classrooms use under a teacher's care. At home we taste foods, not chemicals.

KEY TERMS

bitter

One of the five basic tastes, found in foods like coffee, dark chocolate, kale and grapefruit peel.

taste receptor

A tiny protein on the cells of a taste bud that fits certain molecules and sends a signal to the brain when they touch it.

PTC

Phenylthiocarbamide, a chemical that tastes very bitter to most people and has no taste at all to others. It is used only in specially made science test strips, never as food.

gene

A section of DNA that carries instructions for one part of how the body is built or works, passed from parents to children.

supertaster

A person who tastes some flavors, especially bitterness, much more strongly than most people.

CORE IDEAS

The story. One day in 1931 a chemist named Arthur Fox was working at the DuPont company's laboratory in Wilmington, Delaware. He was pouring a fine white powder called phenylthiocarbamide, or PTC, into a bottle when some of the dust flew into the air. His colleague at the next bench, C. R. Noller, complained that the dust tasted terribly bitter. Fox was puzzled. He was even closer to the powder, and he tasted nothing at all.

How he figured it out. Fox did what good scientists do: he tested his surprise. He tasted the crystals himself, still nothing, and then asked many people to taste them, including friends, coworkers and family members. Some found PTC very bitter; others could not taste it at all. He reported his findings in 1931. The next year a scientist named Albert Blakeslee studied families and showed that tasting PTC runs in families: it is inherited, passed from parents to children through their genes. In 2003, scientists finally found the gene, which carries the instructions for one of our bitter taste receptors. About seven in ten people can taste PTC; the rest cannot.

The kitchen science. Your taste buds hold cells covered with **taste receptors**, tiny proteins that work like locks. When a molecule with the right shape fits, the cell signals your brain. People have about 25 different kinds of bitter receptors, so we can notice many kinds of bitter molecules. The gene Fox stumbled upon makes a receptor that also senses bitter compounds in broccoli, kale, cabbage, Brussels sprouts and other vegetables of the cabbage family. That is one reason a strong taster may find Brussels sprouts harsh while a non-taster finds them mild and sweet. Neither person is wrong; they really taste different things. Cooks tame bitterness

with **fat** (olive oil, butter, cheese), **salt** (which partly blocks bitterness on the tongue), **acid** (lemon juice) and gentle sweetness, and by cooking: sautéing or roasting softens many bitter flavors.

Let's cook. You will run a family bitter-greens taste test with raw greens, then cook a skillet of garlicky sautéed greens with lemon and Parmesan. The skill to do well is **sautéing**: a hot pan, a little oil, and greens added in handfuls and turned with tongs until they wilt, bright green, not gray.

PICTURE STUDY



Red Cabbages and Garlic, Vincent van Gogh, 1887 · Oil on canvas · Van Gogh Museum, Amsterdam

Image: [Wikimedia Commons](#), public domain

Vincent van Gogh painted this still life in Paris in 1887, when he was experimenting with bright colors and short, quick brushstrokes. He had grown up in the Dutch countryside and often painted plain foods: potatoes, cabbages, onions, garlic and bread.

Look closely

- Find the cabbages and the garlic. How many of each can you count?
- Look at the colors in the cabbage leaves. Which colors did Van Gogh use besides purple?
- Look at the brushstrokes. Are they smooth or choppy? How do they make the cabbage leaves look crisp?
- Imagine the smell of this table. Which food here would smell strongest?

Talk about it

1. Red cabbage belongs to the same family as broccoli and Brussels sprouts. Would a strong bitter taster enjoy it raw? What could a cook do to make it taste milder?
2. Why do you think a painter chose cabbages and garlic instead of fancy foods?

3. Garlic tastes harsh raw and sweet when roasted. Which kitchen-science idea explains that change?

Safety first. Check every green, the Parmesan and the lemon against your family's allergies before the taste test. Never taste unknown powders or chemicals, even in a science kit, unless an adult has checked that they are made for tasting. An adult is nearby while you sauté; add wet greens slowly and stand back, because water makes hot oil spatter.

KITCHEN PROJECT

The Family Bitterness Test and Sautéed Greens

You will run a fair, blind taste test of bitter greens with your family and chart who tastes bitterness most strongly. Then you will cook the greens and test whether fat, salt and acid really soften bitterness.

You will need

- Small tasting cups or a muffin tin, and a blindfold
- A large skillet and long tongs
- A chef's knife and cutting board
- A salad spinner or clean towels
- A family taste chart and a pencil

GARLICKY SAUTÉED GREENS WITH LEMON AND PARMESAN

Serves 4–5 servings as a side dish • Prep 15 min • Cook 8 min

Ingredients

- 2 large bunches kale or Swiss chard (about 1½ pounds or 680 g)
- 2 tablespoons olive oil
- 3 cloves garlic, sliced thin
- ¼ teaspoon red pepper flakes (optional)
- ½ teaspoon salt
- 1 tablespoon fresh lemon juice
- ¼ cup (20 g) grated Parmesan cheese
- **For the raw taste test:** a few leaves each of romaine, spinach, kale and arugula, and 3 raw broccoli florets

Method

1. Wash your hands and wash the greens well in a big bowl of cold water, lifting them out so grit stays behind. Spin or pat dry.
2. Strip the leaves from the tough stems by pulling along the stem. (For chard, slice the stems thin and cook them first, 2 minutes, before the leaves.) Stack the leaves, roll them, and slice into 1-inch ribbons.

3. With an adult nearby, heat the oil in the skillet over medium heat. Add the garlic and red pepper and stir 30–60 seconds, just until the garlic smells strong and turns pale gold. Do not let it brown, or it turns bitter.
4. Add the greens a big handful at a time, turning with tongs as each handful wilts. Sprinkle with salt. Cook 4–6 minutes in all, until tender and bright green.
5. Turn off the heat. Stir in the lemon juice, taste, and add more salt or lemon if needed. Sprinkle with Parmesan and serve.
6. Clean up: wash the skillet, tongs and board, and compost or throw away the stems you did not use.

Allergy check: Contains milk (Parmesan). Leave out the cheese or use a sprinkle of toasted sunflower seeds for a milk-free version. No eggs, wheat, nuts, soy or fish.

Steps

1. **Blind test.** Put a small piece of each raw green (romaine, spinach, kale, arugula, broccoli) in numbered cups. Blindfold each family member and have them rate bitterness from 0 (none) to 5 (very bitter). Record every score.
2. Chart the results. Who rated bitterness highest overall? Lowest? Compare with the warm-up survey: do the strong tasters dislike the same foods?
3. Cook the sautéed greens. Before adding the lemon and cheese, put a forkful aside.
4. **Balance test.** Have the strongest taster in the family compare the plain cooked greens with the finished greens (oil, salt, lemon and cheese) and rate the bitterness of each. Did fat, salt and acid help?
5. **Taste test.** Ask everyone to rate the finished dish from 1 to 5. Thank each person for trying.
6. **Improve it.** Write one change: a different green, a little honey, or more lemon.
7. Clean up: wash, dry and put everything away.

Tips

- Greens shrink a lot. Two big bunches make only about four servings.
- Garlic burns quickly. Have the greens ready before the garlic goes into the pan.

- If someone is a strong bitter taster, start them on milder greens like spinach or chard before kale.

Check your work

- ☐ I can tell how Arthur Fox discovered that people taste PTC differently.
- ☐ I can explain bitter receptors and why some people taste bitterness more strongly.
- ☐ I ran a fair blind taste test and cooked sautéed greens balanced with fat, salt and acid.

COOK'S NOTEBOOK

1. Make a bar graph of each family member's total bitterness score from the blind test.
2. Draw a taste receptor as a lock and a bitter molecule as a key, and label them.
3. Copy the sautéed greens recipe in your own words and record the balance-test results.

From history. For many years, science classes used PTC strips to teach how traits are inherited. Today many classrooms use a related, safer chemical called PROP, or a simple test with cilantro, which tastes like soap to some people because of differences in their smell receptors.

COMMON MISTAKES

- Thinking someone who dislikes bitter vegetables is just being fussy. Many people really taste them as more bitter.
- Browning or burning garlic. Burnt garlic adds a harsh bitterness to the whole dish.
- Cooking greens until gray. Overcooking makes them mushy and can bring out stronger sulfur smells.

Make it a game • Family Bitter Survey. Ask each family member to taste a tiny sip of unsweetened strong tea or a bite of raw kale. Record each person's rating on a one to five scale. Predict ahead who will find it most bitter. Then explain bitter receptors, a gene, and the PTC story of Arthur Fox in 1931. Compare your prediction to the results.

3.2 SMELLING FROM THE INSIDE: RETRONASAL SMELL

OBJECTIVES

- Explain the difference between orthonasal smell (sniffing through the nose) and retronasal smell (aromas rising from the mouth), as described by Paul Rozin in 1982.
- Show with a nose-pinch test that much of what we call “flavor” is smell.
- Roast a tray of herb-and-garlic vegetables and observe how roasting creates new aromas.

Warm-up. Pinch your nose shut. Put a pinch of cinnamon sugar on your tongue and hold it there. What do you taste? Now let go of your nose. What happens? Write down the two different things you noticed, and guess why letting go made such a difference.

WATCH

How do we smell? - Rose Eveleth

TED-Ed • 4:19

<https://www.youtube.com/watch?v=snJnO6OpjCs>

WHEN TO WATCH

After the kitchen-science paragraph. Pause when the narrator reaches the olfactory receptors and count how many different kinds your nose has.

Note: A TED-Ed animated lesson. One short section mentions that some people cannot smell a sweaty odor; it is brief and scientific.

KEY TERMS

flavor

The whole impression of a food: taste from the tongue, smell from the nose, plus texture, temperature and even sound.

orthonasal smell

Smelling by sniffing air in through the nostrils, such as smelling bread baking from across the room.

retronasal smell

Smelling aromas that rise from food in your mouth up the back of the throat into the nose while you chew and swallow.

aroma

A smell, especially a pleasant smell from food, made of tiny molecules floating in the air.

olfactory receptors

Smell-sensing proteins on nerve cells high inside the nose. People have about 400 kinds.

CORE IDEAS

The story. People have always known that food tastes dull when you have a stuffy nose. But in 1982 a psychologist at the University of Pennsylvania named Paul Rozin asked a sharper question: are smelling with your nose and “smelling” with your mouth really the same sense? He noticed that some foods, like certain strong cheeses, smell unpleasant when you sniff them but taste delicious in your mouth. How could the same molecules give such different messages?

How he figured it out. Rozin and his students ran careful tests. They had people learn to recognize a set of odors by sniffing them, then presented the same odors inside the mouth, and asked them to name what they noticed. People had trouble recognizing an odor in the mouth that they had learned through the nose, and they described it as a “taste.” Rozin published his findings in 1982, calling smell a “dual sense”: one way of smelling looks outward at the world, and the other looks inward at the food in your mouth. Later scientists named these **orthonasal** and **retronasal** smell.

The kitchen science. Your tongue can sense only five basic tastes: sweet, salty, sour, bitter and umami. Yet you can tell strawberry from raspberry, and rosemary from thyme. That difference is smell. As you chew, warm air carries **aroma** molecules from the food up the back of your throat into your nose, where about 400 kinds of **olfactory receptors** sort them out. Your brain blends this smell with taste and feels it as coming from your mouth, so most people never notice that “flavor” is mostly smell. Cooking creates aromas: roasting garlic and vegetables at high heat browns their sugars and proteins and makes hundreds of new aroma molecules. Herbs

release theirs when warmed or chopped. That is why a roasting pan can fill the whole house with a smell that makes everyone hungry.

Let's cook. You will roast a big tray of vegetables with garlic, rosemary and thyme, and then taste them with your nose pinched and unpinched. The skill to do well is **roasting**: cut pieces the same size, coat them lightly in oil, spread them out with space between, and roast at a high heat until the edges brown.

PICTURE STUDY



Kitchen Utensils with Leeks, Fish and Eggs, Jean-Siméon Chardin, about 1734 · Oil on canvas · Cleveland Museum of Art

Image: [Wikimedia Commons](#), public domain

Jean-Siméon Chardin painted the plain tools and foods of a French kitchen with great quiet and care. Here are the makings of a meal: leeks, a fish, eggs and an onion, with a copper pot ready on the ledge and a mortar and pestle for grinding herbs and spices.

Look closely

- Find the leeks and the onion. What would they smell like raw? What would they smell like cooking slowly in butter?
- Find the mortar and pestle. What might a cook grind in it, and why would grinding release more smell?
- Find the copper pot with its lid lifted. What might soon be cooking in it?
- Look at the soft light and colors. Why do you think Chardin chose such plain things to paint?

Talk about it

1. Leeks, onions and garlic release strong aroma molecules when they are cut and heated. Where in your body are those molecules sensed?
2. If you pinched your nose while eating a soup made from these ingredients, what would you still taste? What would you miss?

3. Which plain ingredient in your own kitchen makes the house smell best when it cooks?

Safety first. Check the taste-test foods for allergies first. An adult is nearby while you use the oven at 425 °F (220 °C); use oven mitts, open the oven door and step back so the blast of hot air does not reach your face, and set the hot pan on a trivet.

KITCHEN PROJECT

The Nose Test and a Roasted Vegetable Tray

You will prove to your family that most flavor is smell, using a nose-pinch test with several foods. Then you will roast a tray of vegetables and observe how heat creates aromas, recording the smell of the kitchen every 10 minutes.

You will need

- Two large rimmed baking sheets and parchment paper
- A chef's knife and cutting board
- A large bowl and measuring spoons
- Oven mitts, a spatula and a timer
- Small cups for the nose test, a blindfold

HERB-AND-GARLIC ROASTED VEGETABLE TRAY

Serves 6 servings · Prep 20 min · Roast 35–40 min

Ingredients

- 1½ pounds (680 g) small red or Yukon Gold potatoes, cut in 1-inch pieces
- 3 carrots, peeled and cut in 1-inch pieces
- 1 red onion, cut in wedges
- 1 red bell pepper, cut in 1-inch pieces
- 1 medium zucchini, cut in 1-inch half-moons
- 1 head garlic, cloves separated and peeled (about 10 cloves)
- 3 tablespoons olive oil
- 1 teaspoon salt and ¼ teaspoon black pepper
- 1 tablespoon fresh rosemary and 1 tablespoon fresh thyme leaves, chopped (or 1 teaspoon each dried)
- 1 lemon, cut in wedges, for serving

Method

1. Wash your hands. An adult turns the oven to 425 °F (220 °C). Line the baking sheets with parchment.

2. Cut all the vegetables into pieces about the same size, using the claw grip. Put the potatoes and carrots (which take longest) in the bowl with half the oil, salt and pepper; toss and spread them on one sheet.
3. Roast the potatoes and carrots for 15 minutes.
4. Meanwhile, toss the onion, pepper, zucchini and garlic cloves with the rest of the oil, salt, pepper and the herbs, and spread them on the second sheet.
5. Put the second sheet in the oven. Roast both 20–25 minutes more, turning everything once with a spatula, until the vegetables are tender and browned at the edges and the garlic is soft and golden.
6. Combine on a platter and serve with lemon wedges.
7. Clean up: let the pans cool, throw away the parchment, wash the bowl and tools, and wipe the counters.

Allergy check: No major allergens. Check that your family has no reactions to any of the vegetables or herbs.

Steps

1. **Nose test.** Prepare small pieces of apple, raw potato, a jelly bean or gumdrop, and a little cinnamon sugar. Blindfold a family member and have them pinch their nose, chew each one and guess what it is. Then repeat with the nose open. Record the results.
2. **Smell log.** While the vegetables roast, step into the kitchen every 10 minutes and write one word for what you smell. When did the smell become strongest? When did you first smell garlic?
3. Before the vegetables go in, smell a raw garlic clove. After roasting, smell a roasted clove. Describe the difference.
4. **Taste test.** Taste a roasted carrot with your nose pinched, then unpinched. What changed?
5. Ask your family to rate the tray and name their favorite vegetable.
6. **Improve it.** Plan one change: a different herb, more garlic, or adding chickpeas for protein.
7. Clean up: wash, dry and put away everything.

Tips

- Crowded vegetables steam and stay pale. Use two pans so every piece touches the hot metal.
- Pat the vegetables dry after washing; water on the surface slows browning.
- Roasted garlic cloves become soft and sweet. Spread one on bread and taste the difference from raw.

Check your work

- ☐ I can explain orthonasal and retronasal smell.
- ☐ I showed with a nose-pinch test that flavor is mostly smell.
- ☐ I roasted vegetables evenly and recorded how the aroma changed.

COOK'S NOTEBOOK

1. Draw a side view of a head showing the path of aroma from food in the mouth, up the back of the throat, to the nose. Label orthonasal and retronasal.
2. Make a table of the nose-test results: food, guess with nose pinched, guess with nose open.
3. Copy your smell log from the roasting and write a sentence about which aroma made you hungriest.

From history. Paul Rozin went on to study why people like the foods they do, including how children learn to enjoy hot peppers. He found that liking often grows with repeated tasting, especially when trusted family members enjoy the food too.

COMMON MISTAKES

- Thinking the tongue can taste “strawberry” or “cinnamon.” It senses only five tastes; the rest is smell.
- Cutting vegetables in different sizes. Small pieces burn while big ones stay hard.
- Opening the oven again and again. Each time, the heat escapes and roasting slows down.

Make it a game • Inside Smell Test. Sit with your nose pinched while your parent hands you a spoonful of applesauce, then another of plain yogurt. Name the flavors with your nose closed, then open. Score each guess. Then explain in your own words the difference between orthonasal smell and retronasal smell and why Paul Rozin's idea matters for what we call flavor.

3.3 TASTE ACROSS A LIFETIME

OBJECTIVES

- Describe how taste and smell change from babyhood to childhood, adulthood and old age.
- Explain why tasting a new food many times, often 8 to 15 tries, helps people learn to like it.
- Interview an older relative about a family recipe and cook it together, recording how each generation tastes it.

Warm-up. Think of a food you disliked when you were five but like now, or a food a grown-up in your family loves that you cannot stand. Write it down. Then ask a parent the same question about their own childhood. Why do you think tastes change?

WATCH

Aging and the loss of smell, taste

CBS News • 4:16

https://www.youtube.com/watch?v=A_aevsFwIJA

WHEN TO WATCH

After the story, before you interview your relative.

Note: A CBS News report on how the senses of smell and taste change with age, with a smell test at a university taste-and-smell center.

KEY TERMS

taste bud

A tiny cluster of 50–100 taste cells, mostly on the tongue. Taste cells are replaced about every one to two weeks.

exposure

Being offered a food again and again. Repeated small tastes help people learn to like new foods.

sensitivity

How strongly a person notices a taste or smell. Children are more sensitive to bitterness than most adults.

family recipe

A dish passed down through a family, often cooked from memory and changed a little by each generation.

CORE IDEAS

The story. At the Monell Chemical Senses Center in Philadelphia, a research institute founded in 1968 to study taste and smell, scientist Julie Mennella and her colleagues wanted to know when our food likes begin. In a study published in 2001, they asked a group of mothers to drink carrot juice several times a week during the last months before their babies were born, or while they were nursing. Other mothers drank water instead.

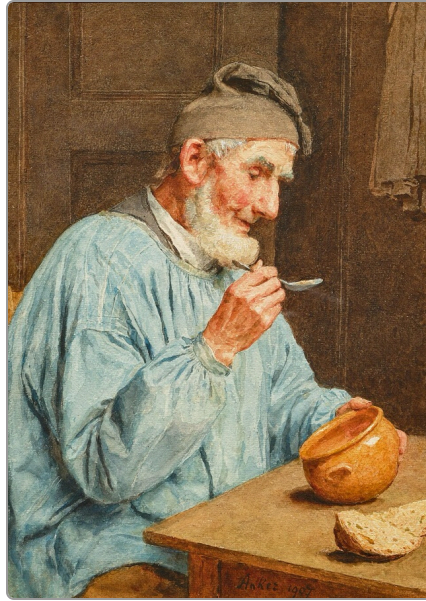
How they figured it out. Months later, when the babies were old enough for cereal, the researchers fed each baby plain cereal and cereal mixed with carrot juice, and filmed the babies' faces. Babies whose mothers had drunk carrot juice made fewer unhappy faces at the carrot-flavored cereal and seemed to enjoy it more. Flavors from the mother's food had already reached them, before birth and through milk. Other studies at Monell found that children prefer much sweeter and saltier foods than adults do, and are more sensitive to bitterness. Tastes really do change as we grow.

The kitchen science. Babies are born liking sweet and disliking bitter. Children taste bitterness more strongly than most adults and prefer sweeter foods, which is one reason many children dislike coffee, dark greens and grapefruit. Through the teen years and adulthood, most people come to enjoy more bitter and sour flavors. Taste cells are replaced about every one to two weeks, and each new taste of a food teaches the brain that it is safe and good, which is why it often takes 8 to 15 tries to learn to like a new food. In older age, many people lose some of their sense of smell, and somewhat less of their sense of taste, so food may seem less flavorful; older adults often enjoy stronger seasonings, more herbs and more salt or sour. A family table where grandparents, parents and children eat together is a table where every age is tasting something a little different.

Let's cook. You will interview a grandparent or another older relative or friend about a recipe from their childhood and cook it together. If your family has no such recipe, use the model recipe, old-fashioned chicken and dumplings. The skill to do well is

listening and recording: old recipes are often “a handful of this, a pinch of that,” so measure what your relative actually does and write it down.

PICTURE STUDY



Farmer Eating Soup, Albert Anker, 1907 · Oil on canvas · Private collection, Switzerland

Image: [Wikimedia Commons](#), public domain

Albert Anker painted the people of his Swiss village, Ins, for more than fifty years. He loved to paint children and old people, often at quiet everyday tasks like reading, knitting or eating. This old farmer is eating a simple bowl of soup with bread, a meal he had probably eaten thousands of times.

Look closely

- Look at the farmer's face and hands. How old do you think he is? What kind of work has he done?
- Find the bowl, the spoon and the bread. Is this a feast or an everyday meal?
- Look at how he holds his spoon and leans toward the bowl. Is he hurrying or eating slowly?
- What is missing from the table that you might find at your own supper?

Talk about it

1. Older people often taste and smell food less strongly. How might a cook season this soup to make it more enjoyable for him?
2. What do you think this farmer ate as a boy? Would it have been very different from his soup?
3. Why is it good for children and grandparents to eat at the same table?

Safety first. An adult or the older relative cooking with you is nearby for all stove work. If your family recipe uses chicken, cook it to 165 °F (74 °C); if it uses uncooked eggs or anything unfamiliar, check the recipe with an adult against today's food-safety rules. Check the dish for allergies before you serve it.

A Family Recipe Across the Generations

You will interview an older relative about food in their childhood, write down a family recipe as they cook or describe it, cook it together, and then run a “taste across the generations” survey at the table. Your interview becomes a page of family history to keep.

You will need

- Your cook’s notebook and a pencil, or a phone to record the interview (with permission)
- Measuring cups and spoons, to measure the “handfuls” and “pinches”
- A large heavy pot or Dutch oven with a lid, for the model recipe
- A large bowl, a fork and a ladle
- An instant-read thermometer

OLD-FASHIONED CHICKEN AND DUMPLINGS (MODEL RECIPE)

Serves 6 servings · Prep 25 min · Cook 50 min

Ingredients

- **Stew:** 2 tablespoons butter; 1 medium onion, diced; 2 carrots, sliced; 2 stalks celery, sliced; $\frac{1}{3}$ cup (40 g) all-purpose flour; 6 cups (1.4 L) chicken broth; $1\frac{1}{2}$ pounds (680 g) boneless, skinless chicken thighs or breasts; 1 teaspoon dried thyme; 1 bay leaf; $\frac{1}{2}$ teaspoon salt; $\frac{1}{4}$ teaspoon pepper; $\frac{1}{2}$ cup (70 g) frozen peas; $\frac{1}{2}$ cup (120 mL) milk
- **Dumplings:** $1\frac{1}{2}$ cups (190 g) all-purpose flour; 2 teaspoons baking powder; $\frac{1}{2}$ teaspoon salt; 1 tablespoon chopped parsley; $\frac{2}{3}$ cup (160 mL) milk; 3 tablespoons butter, melted

Method

1. Wash your hands. In the pot over medium heat, with an adult nearby, melt the butter and cook the onion, carrots and celery 6–7 minutes, until soft. Sprinkle in the flour and stir 1 minute.

2. Slowly whisk in the broth. Add the whole pieces of chicken, thyme, bay leaf, salt and pepper. Bring to a simmer, cover partly and cook 20–25 minutes, until the chicken reads 165 °F (74 °C) in the thickest piece.
3. Lift the chicken onto a clean board, let it cool 5 minutes, and shred it with two forks. Return it to the pot with the peas and milk. Remove the bay leaf.
4. Make the dumplings: in a bowl, stir the flour, baking powder, salt and parsley. Add the milk and melted butter and stir just until a soft, sticky dough forms. Do not overmix, and do not taste the unbaked dough.
5. With the stew at a gentle simmer, drop the dough by heaping tablespoons onto the surface, about 12 dumplings. Cover tightly and simmer 15 minutes without lifting the lid, until the dumplings are puffed and cooked through (a toothpick comes out clean).
6. Ladle into bowls. Clean up: wash the pot, board and bowls, and refrigerate leftovers within 2 hours.

Allergy check: Contains wheat and milk. For milk-free, use olive oil instead of butter and an unsweetened oat milk. Some broths contain soy or wheat; check the label. No eggs or nuts.

Steps

1. **Interview.** Ask your relative at least five questions: What did your family eat for supper when you were my age? What was your favorite food? A food you disliked then but like now? Who taught you to cook? What recipe would you like our family to remember? Write down the answers.
2. **Record the recipe.** Cook the family recipe together (or the model recipe). Each time your relative uses “a handful” or “a pinch,” measure it with cups and spoons before it goes in, and write the measurement.
3. Check the safety of the old recipe with an adult: temperatures for meat, eggs cooked through, and leftovers chilled within 2 hours.
4. **Taste across the generations.** At the table, ask each person to rate the dish for saltiness, flavor strength and overall liking from 1 to 5. Record each person’s age group (child, adult, older adult). Do the ratings differ by age?
5. **Try-again plan.** Pick one food from the interview that you do not like yet. Plan to taste a small amount once a week for the next eight weeks and record

your rating each time.

6. **Improve it.** Write one change you would make next time, and ask your relative whether they approve.

7. Clean up: wash, dry and put away everything, and thank your relative.

Tips

- Keep the lid on while the dumplings cook. Steam cooks their tops; peeking makes them heavy.
- Ask permission before recording a voice or video. A recording of a grandparent telling a recipe is a family treasure.
- Old recipes sometimes use lard, a pinch of baking soda or other old methods. Keep what is safe and note what you changed.

Check your work

- ☐ I can describe how taste changes from babyhood to old age.
- ☐ I can explain why trying a food 8 to 15 times helps.
- ☐ I interviewed an older relative and cooked a family recipe with measured amounts.

COOK'S NOTEBOOK

1. Write up your interview as a page of family history, with a drawing or photo of your relative.
2. Copy the family recipe with your measurements, and title it with the name of the person it came from.
3. Make a chart of the taste-across-the-generations ratings by age group.

From history. Chicken and dumplings is an old American farm dish, especially in the South and Midwest, made to stretch one chicken to feed a large family. Many cultures have their own dumplings in broth, from German *Spätzle* to Chinese wontons to Jewish matzo balls.

COMMON MISTAKES

- Giving up on a food after one or two tastes. It often takes 8 to 15 small tries to learn to like it.
- Assuming old recipes are always safe as written. Check meat temperatures, egg dishes and cooling times with today's rules.

- Stirring the dumpling dough until smooth. Overmixing makes tough dumplings; stir just until combined.

Make it a game • Taste Through the Ages. Make four cards: baby, child, adult, grandparent. Draw one and tell how taste and smell are different at that age. Your parent asks a question like why a toddler refuses broccoli, and you answer. Then count how many tries it takes: tally your tastes of a new food all week. Aim for eight.

Scripture. “O taste and see that the LORD is good: blessed is the man that trusteth in him.” (Psalm 34:8, KJV)

Tasting is how we come to know food, and the psalmist uses it to invite us to know God’s goodness by experience. Every age at the table can give thanks together.

3.4 CONTRAST IN TEXTURE

OBJECTIVES

- Tell how Alina Szczesniak and her team at General Foods created a way to describe food texture in 1963.
- Describe textures with exact words (crisp, crunchy, creamy, chewy, tender, smooth) and explain why contrast makes food interesting.
- Cook a baked macaroni and cheese with a crisp crumb topping, and rate its textures.

Warm-up. Close your eyes while someone hands you a cracker, a slice of banana, a piece of cheese and a grape, one at a time. Describe each texture in at least two words before you name the food. Which words were hardest to find?

WATCH

Baked Macaroni & Cheese with Panko Topping

Jessica Gavin · 6:08

<https://www.youtube.com/watch?v=z7V5PoAgmt0>

WHEN TO WATCH

Before you cook. Watch how the sauce is made and the crumbs are tossed with butter, then follow the recipe card in this lesson.

Note: Jessica Gavin is a food scientist and cook. She explains the roux, the cheese sauce and the panko topping step by step.

KEY TERMS

texture

How a food feels in the mouth and as you bite and chew: hard or soft, crisp or chewy, smooth or lumpy.

mouthfeel

The feeling of a food or drink in the mouth, such as creamy, thin, coating or dry.

crisp

Firm and dry, breaking cleanly with a light, high-pitched sound, like a cracker or a fresh apple.

contrast

Putting different textures or flavors side by side, like crunchy crumbs on a creamy sauce, so each one stands out.

béchamel

A white sauce of milk thickened with a roux of butter and flour, the base of many cheese sauces.

CORE IDEAS

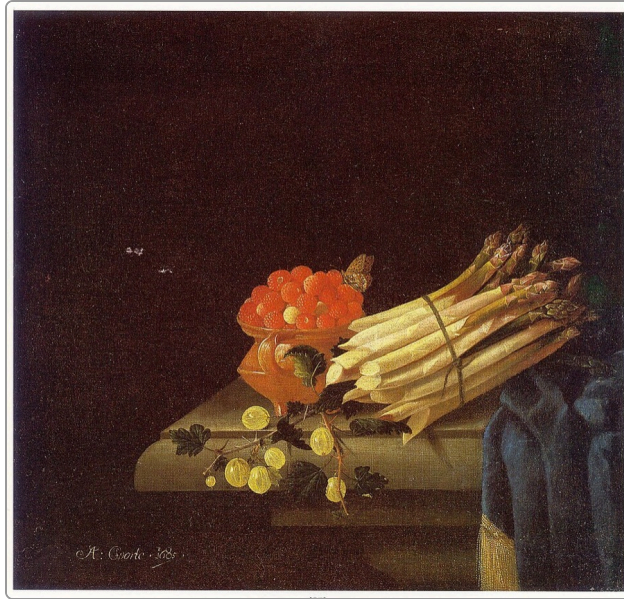
The story. In the 1950s food companies could measure a food's color, sugar and salt, but texture was a mystery. Tasters said a cake was “nice” or a pickle was “off,” without words anyone could measure. Alina Surmacka Szczesniak, a food scientist who had come to America from Poland, led a research team at General Foods in New York to solve this problem.

How they figured it out. Szczesniak's team collected the words ordinary people used to describe how food felt, and sorted them into a few main qualities, such as hardness, chewiness, gumminess and how a food breaks apart. They built scales with reference foods for each quality: for hardness, from something very soft like cream cheese up to something very hard like rock candy. In 1963 they published their “texture profile” method, which trained tasters to rate any food on the same scales. Food scientists still use texture profiles today, and Szczesniak's surveys found that ordinary people mention texture very often when they describe the foods they love or dislike.

The kitchen science. Texture comes from a food's structure: how much water it holds, how its starches, proteins and fats are arranged, and how it breaks. **Crisp** foods are dry and brittle; they break with a sound because tiny air pockets crack one after another. Moisture is the enemy of crispness, which is why crackers go soft in humid air. **Creamy** foods hold fat and water in a smooth, thick mix, like a cheese sauce thickened with a roux. Our mouths quickly get used to one texture, so a bite that is all the same can seem dull. **Contrast** wakes the mouth up: crunchy croutons on soft soup, crisp crumbs on creamy macaroni, a crunchy apple with smooth peanut butter.

Let's cook. You will make a baked macaroni and cheese with a creamy sauce under a golden, crunchy topping of buttered crumbs. The skill to do well is a **smooth cheese sauce**: cook the roux, whisk in the milk slowly, let the sauce thicken, then take it off the heat before you stir in the cheese so it melts smoothly instead of turning grainy.

PICTURE STUDY



Strawberries, Asparagus and Gooseberries, Adriaen Coorte, 1680s · Oil on paper mounted on panel · Private collection

Image: [Wikimedia Commons](#), public domain

Adriaen Coorte was a Dutch painter from Middelburg who painted small, quiet pictures of a few fresh foods on a stone ledge: strawberries, asparagus, gooseberries, shells. Each texture is painted so truly that you can almost feel it.

Look closely

- Find the strawberries. How did Coorte show that they are soft, juicy and bumpy?
- Find the asparagus. Which words describe its texture: crisp, smooth, firm, stringy?
- Find the gooseberries. How are they different from the strawberries in texture?
- Find the small butterfly. Why do you think the painter added it?

Talk about it

1. If you ate a bite of crisp asparagus and then a soft strawberry, which textures would contrast?
2. Use three exact texture words from this lesson to describe the foods in this painting.

3. Coorte painted only a few ordinary foods. What ordinary food in your kitchen would you choose to paint, and why?

Safety first. An adult is nearby while you use the stove and oven. Hot cheese sauce and boiling pasta water can burn: stir with a long spoon, drain pasta into a colander in the sink away from you, and keep pot handles turned in. Use oven mitts for the baking dish.

Texture Contrast: Crisp-Topped Baked Macaroni

You will make a baked macaroni and cheese and bake half of it with a buttered crumb topping and half without. Then your family will rate both halves with a simple texture profile, the way Szczesniak's tasters did.

You will need

- A large pot and a colander
- A medium heavy saucepan and a whisk
- A 9 × 13-inch baking dish
- A small bowl for the topping, a box grater
- Measuring cups and spoons, oven mitts and a timer

BAKED MACARONI AND CHEESE WITH CRISP CRUMB TOPPING

Serves 6–8 servings · Prep 20 min · Cook 15 min · Bake 20 min

Ingredients

- 1 pound (450 g) elbow macaroni or shells
- 4 tablespoons (57 g) butter
- ¼ cup (32 g) all-purpose flour
- 3½ cups (830 mL) milk
- 1 teaspoon salt, ¼ teaspoon pepper, ½ teaspoon dry mustard or paprika
- 3 cups (340 g) grated sharp cheddar cheese
- 1 cup (115 g) grated Monterey Jack or mozzarella cheese
- **Topping:** 1 cup (50 g) panko or coarse dry bread crumbs, 2 tablespoons butter, melted, ¼ cup (20 g) grated Parmesan

Method

1. Wash your hands. An adult turns the oven to 375 °F (190 °C). Butter the baking dish.
2. Cook the pasta in a big pot of salted boiling water for 2 minutes less than the package says (it will finish in the oven). Drain in the colander.

3. Meanwhile, melt the butter in the saucepan over medium heat. Whisk in the flour and cook, whisking, 1–2 minutes, until bubbly and smelling like toast. This is the roux.
4. Slowly pour in the milk, about ½ cup at a time, whisking well after each addition. Add salt, pepper and mustard. Cook, whisking, 5–7 minutes, until the sauce bubbles gently and coats a spoon.
5. Take the pan off the heat. Stir in the cheddar and Jack a handful at a time until smooth. Stir in the pasta and spread it in the baking dish.
6. Toss the crumbs with the melted butter and Parmesan. Sprinkle over *half* the dish only (for the texture test), or over all of it after this first time.
7. Bake 18–20 minutes, until bubbly at the edges and the crumbs are golden. Let rest 5 minutes before serving.
8. Clean up: soak the sauce pan right away, wash everything, and refrigerate leftovers within 2 hours.

Allergy check: Contains wheat and milk. For wheat-free, use gluten-free pasta, thicken with 2 tablespoons cornstarch whisked into cold milk instead of a roux, and use gluten-free crumbs. No eggs, nuts or soy.

Steps

1. **Predict.** Before baking, write which half you think your family will prefer and why.
2. Make and bake the macaroni with crumbs on one half only.
3. **Texture profile.** Make a chart with four scales from 1 to 5: crispness, creaminess, chewiness and overall interest. Have each family member rate a bite from each half.
4. **Listen:** bite a forkful from each half with your eyes closed. Which one makes a sound?
5. **Moisture test.** Put a spoonful of the topped macaroni in a covered container in the fridge overnight. The next day, taste it cold or reheated (to 165 °F). What happened to the crispness, and why?
6. **Improve it.** Write one change: a different crunchy topping (crushed crackers, toasted nuts), roasted broccoli stirred in, or a different cheese.
7. Clean up: wash, dry and put away everything.

Tips

- Warm milk whisks into the roux more smoothly than cold milk, but cold milk works too if you add it slowly.
- Shred your own cheese if you can. Pre-grated cheese is coated to keep it from sticking, which can make the sauce a little grainy.
- For an even crunchier top, an adult can run the dish under the broiler for 1–2 minutes at the end. Watch it every second.

Check your work

- ☐ I can describe textures with exact words and explain why contrast matters.
- ☐ I made a smooth cheese sauce from a roux.
- ☐ I ran a texture profile comparing topped and plain macaroni.

COOK'S NOTEBOOK

1. Draw a cross-section of your baked macaroni and label each layer with its texture words.
2. Copy your family's texture-profile chart and write which half won and why.
3. Make a list of five favorite food pairs that use texture contrast, and invent one new pair.

From history. Recipes for macaroni baked with cheese appear in English cookbooks of the 1700s and in Mary Randolph's *The Virginia House-Wife* (1824). Boxed macaroni and cheese was introduced in 1937 and became a pantry staple during the years of rationing that followed.

COMMON MISTAKES

- Adding cheese to a sauce that is boiling. High heat can make cheese grainy and oily; take the pan off the heat first.
- Cooking the pasta fully before baking. It turns mushy in the oven; undercook it by 2 minutes.
- Covering a crisp topping while it is still hot. Trapped steam makes it soggy.

Make it a game • Szczesniak's Texture Words. Gather ten foods and take turns choosing one without telling the other person which. Give three texture clues using exact words such as crisp, chewy and smooth. The other player guesses the food. Fewer clues needed means more points. Then explain why contrast makes a meal interesting and who Alina Szczesniak was.

UNIT 3

TASTE, SMELL & YOUR TASTE BUDS

Why does one person love Brussels sprouts while another can hardly swallow them? Why does food taste flat when you have a cold? Why did your grandfather like coffee-flavored candy that you think is awful? In this unit you will find out. You will meet Arthur Fox, a chemist who discovered by accident in 1931 that a bitter powder tasted bitter to only some people, and learn that your genes help decide how strongly you taste bitterness.

You will discover that much of what you call “taste” is really smell, rising from the back of your mouth into your nose. You will learn how taste changes from babyhood to old age, and interview an older relative to cook a family recipe together. Finally you will study texture, the crunch and creaminess that make food interesting, in a baked macaroni with a crisp golden top. Every taste test in this unit begins with an allergy check and ends with thanks: “O taste and see that the LORD is good.”

PREREQUISITES

- Knows the five basic tastes: sweet, salty, sour, bitter and umami (Grade 5)
- Knows the tongue map is a myth and that every part of the tongue senses every taste (Grade 5)
- Can mince garlic and dice vegetables with a chef’s knife (Unit 1)
- Can roast vegetables in the oven with an adult nearby (Unit 2)

MASTERY CHECKLIST

- ☐ I can tell the story of Arthur Fox and PTC and explain that some people taste bitterness more strongly than others because of their genes.
- ☐ I can explain the difference between smelling through the nose and smelling from the back of the mouth (retronasal smell), and show it with a nose-pinch test.
- ☐ I can describe how taste and smell change from childhood to old age, and why tasting a food many times helps you learn to like it.
- ☐ I can describe food textures with exact words and plan contrasts, like crisp over creamy, in a dish.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **A set of small tasting cups or a muffin tin:** Inexpensive. Handy for the bitter-greens test, the nose-pinch test and the texture tasting in this unit.
- **A blindfold or clean scarf:** For fair blind taste tests in Lessons 3.1–3.4 and the unit challenge.
- **Monell Chemical Senses Center: Science of taste and smell:** Free articles from a research institute in Philadelphia that has studied taste and smell since 1968. For parents and curious students who want to read more about Lessons 3.2 and 3.3.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

3.1 Arthur Fox and the Bitter Taste	2 sessions of 50–60 minutes
3.2 Smelling from the Inside: Retronasal Smell	2 sessions of 50–60 minutes
3.3 Taste Across a Lifetime	2 sessions of 60–90 minutes
3.4 Contrast in Texture	2 sessions of 50–60 minutes

UNIT 3 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**

What happened in Arthur Fox’s laboratory in 1931, and what did he do next?

2. **8 pts**

What did Albert Blakeslee show about tasting PTC, and what was found in 2003?

3. **8 pts**

Name three ways a cook can make bitter greens taste milder.

4. (8 pts)

Explain the difference between orthonasal and retronasal smell, with an example of each.

5. (8 pts)

Predict: You pinch your nose and eat a cinnamon jelly bean. What will you notice? What happens when you let go?

6. (8 pts)

Why do roasted vegetables smell so much stronger and sweeter than raw ones?

7. (8 pts)

What did the 2001 carrot-juice study at the Monell Center show?

8. (8 pts)

Describe how taste changes from childhood to old age.

9. (10 pts)

Calculation: You plan to taste a new vegetable once a week until you have tried it 12 times. You have tasted it 5 times. How many more weeks? If you start on week 1 of March, about which month will you finish? (Use 4 weeks per month.)

10. (10 pts)

Calculation: The macaroni recipe serves 6 and uses $3\frac{1}{2}$ cups of milk. How much milk would you need to make it for 9 people? (Hint: $9 \div 6 = 1\frac{1}{2}$.)

11. (8 pts)

What is a texture profile, and who developed one in 1963?

12. (8 pts)

Short answer: Why does a crisp topping make baked macaroni more interesting, and why does it go soft overnight in the fridge?

ANSWER KEY

1. PTC dust flew into the air; his colleague tasted it as very bitter while Fox tasted nothing. Fox then tested many people and found that some taste PTC and some cannot.
2. That the ability to taste PTC is inherited, passed down in families through genes. In 2003 scientists found the gene, which makes one of the bitter taste receptors.
3. Any three: add fat (olive oil, butter, cheese), salt, acid (lemon juice), a little sweetness, or cook them (sauté or roast).
4. Orthonasal smell is sniffing through the nostrils (smelling bread baking across the room). Retronasal smell is aroma rising from food in the mouth up the back of the throat to the nose while chewing (tasting “strawberry” in a jam).
5. With the nose pinched you notice only sweetness (and maybe a little sourness), not cinnamon. When you let go, aroma reaches the nose and the cinnamon flavor appears.
6. High heat browns sugars and proteins on their surfaces and creates hundreds of new aroma molecules, while some sharp raw compounds break down.
7. Babies whose mothers drank carrot juice during pregnancy or nursing accepted carrot-flavored cereal more happily, showing that flavors from the mother’s food reach the baby and shape early likes.
8. Children prefer sweeter and saltier foods and are more sensitive to bitterness; adults usually come to enjoy more bitter and sour flavors; older adults often lose some smell and some taste, so they may enjoy stronger seasoning.
9. $12 - 5 = 7$ more weeks. 7 weeks is about $1\frac{3}{4}$ months, so you would finish in late April.
10. $3\frac{1}{2} \times 1\frac{1}{2} = 5\frac{1}{4}$ cups of milk.
11. A method for rating food texture on standard scales (such as hardness, chewiness and how it breaks) using reference foods, so tasters can measure texture the same way. Alina Szczesniak and her team at General Foods.
12. The crisp crumbs contrast with the creamy sauce, so each texture stands out and the mouth does not get bored. Overnight, moisture from the sauce and the air moves into the dry crumbs and softens them.

UNIT CHALLENGE: A FAMILY TASTE MAP: THREE GENERATIONS AT THE TABLE

Cook one food three ways for your family, choosing a vegetable at least one person dislikes (for example, Brussels sprouts steamed, roasted, and sautéed with lemon and Parmesan). Run a blind taste test with as many ages as you can gather: children, parents and grandparents or older friends.

Have each taster rate bitterness, flavor, texture and overall liking. Make a chart or graph of the results by age group and by method, and write a one-page report on what you discovered about taste, smell and texture. End with a “try it again” plan for the person who liked the vegetable least.

LOOK FOR	WHAT IT MEANS
Three methods cooked safely	One vegetable cooked three ways with an adult nearby, clean-as-you-go habits and a clean kitchen afterward.
Fair blind test	Same size samples, blindfolds or hidden labels, the same questions for every taster, and an allergy check first.
Chart and analysis	Results organized clearly by age group and method, with at least two honest conclusions tied to lessons in this unit.
Try-again plan and thanks	A kind, practical plan for helping someone learn to like the food; tasters thanked. Surprising or messy results honestly reported earn full credit.

UNIT 4

HEAT & COLD

Cooking is the art of moving heat into food, and keeping food is often the art of moving heat out. In this unit you will learn the three ways heat travels, conduction, convection and radiation, and watch all three at work in one hot oven on a sheet-pan supper. You will meet Percy Spencer, the self-taught engineer who discovered in 1945 that invisible microwaves could cook food, and you will compare a microwave and a stovetop side by side.

Then you will turn to cold and keeping. Nicolas Appert won a prize from Napoleon's government in 1810 for sealing food in jars, years before anyone knew why it worked. Clarence Birdseye learned from Inuit fishermen in Labrador that fast freezing keeps food tasting fresh. You will make quick refrigerator pickles and test their acidity with a homemade indicator, and you will cook a big batch of meatballs and freeze them the way Birdseye taught the world to freeze food.

PREREQUISITES

- Knows the danger zone (40–140 °F) and safe internal temperatures (Unit 1)
- Uses the oven and stove with an adult nearby and oven mitts (Units 1–3)
- Can cut vegetables into even pieces with a chef's knife (Unit 1)
- Knows that heat makes molecules move faster (science)

MASTERY CHECKLIST

- ☐ I can explain conduction, convection and radiation and point to each one in an oven or on a stove.
- ☐ I can tell how Percy Spencer discovered microwave cooking and explain how microwaves heat the water in food.
- ☐ I can tell how Nicolas Appert preserved food in sealed jars and explain why acid and heat keep pickles safe.
- ☐ I can explain why fast freezing keeps food better than slow freezing, and freeze and thaw food safely.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **National Center for Home Food Preservation**: Free. The University of Georgia’s tested guide to pickling, canning, freezing and drying at home. If your family ever wants to can food for the shelf, use only tested recipes like these, with an adult.
- **FoodSafety.gov: Cold Food Storage Chart**: Free. How long foods keep in the refrigerator and freezer. Useful for Lesson 4.4 and for labeling your freezer meals. Search “FoodSafety.gov cold food storage chart.”
- **An oven thermometer**: Inexpensive. Hang it in the oven to see whether your oven really heats to the temperature on the dial (Lesson 4.1).

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

4.1 Conduction, Convection and Radiation in the Kitchen	2 sessions of 50–60 minutes
4.2 Percy Spencer and the Microwave Oven	2 sessions of 50–60 minutes
4.3 Napoleon’s Prize and Appert’s Jars	2 sessions of 50–60 minutes
4.4 Clarence Birdseye and Fast Freezing	2 sessions of 60–90 minutes

UNIT 4 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**

Name the three ways heat travels, and give a kitchen example of each.

2. **8 pts**

Predict: You roast one pan of potatoes spread out and one pan piled up. Which will be crispier, and why?

3. **8 pts**

What did Joseph Fourier discover about how heat moves?

4. (8 pts)

How did Percy Spencer discover microwave cooking, and what were his first two tests?

5. (8 pts)

Explain how a microwave oven heats food, and why you should stir food and let it stand.

6. (8 pts)

Calculation: A recipe says to microwave 1 bowl of vegetables for 4 minutes. If doubling the amount takes about 1.6 times as long, how long should you microwave a double batch? Round to the nearest half minute.

7. (8 pts)

What did Nicolas Appert do to preserve food, and what did Louis Pasteur later explain about why it worked?

8. (8 pts)

Why must low-acid foods like green beans be canned in a pressure canner, not a pot of boiling water?

9. (10 pts)

Calculation: Your pickle brine uses 1 cup vinegar, 1 cup water, 1 tablespoon sugar and 2 teaspoons salt for 2 jars. How much of each do you need for 5 jars?

10. (10 pts)

Calculation: Convert the freezer temperature 0 °F and the pressure-canner temperature 240 °F to Celsius using $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5 \div 9$. Round to the nearest degree.

11. (8 pts)

Why does fast freezing keep food better than slow freezing?

12. (8 pts)

Short answer: Name three safe ways to thaw frozen meatballs and one unsafe way, and explain why it is unsafe.

ANSWER KEY

1. Conduction (a hot pan browning the bottom of a potato; a metal spoon getting hot in soup), convection (hot air circling in the oven; boiling water rolling), radiation (heat from a broiler, oven element or campfire).
2. The spread-out potatoes will be crispier, because hot air reaches every surface and steam escapes; piled-up potatoes trap steam and steam instead of browning.
3. Heat always flows from hotter to cooler places, and faster when the temperature difference is larger and the material conducts better. He wrote this as a mathematical law in 1822.
4. In 1945 he noticed a candy bar in his pocket melted while he stood near a working magnetron. He tested popcorn kernels, which popped, and an egg, which cooked so fast it burst.
5. Microwaves make water molecules twist back and forth, and their motion and bumping make heat. The waves reach only about an inch in and are uneven, so stirring and standing time let heat spread evenly by conduction and remove hot spots.
6. $4 \times 1.6 = 6.4$ minutes, about $6\frac{1}{2}$ minutes. (Check for doneness and stir halfway.)
7. He sealed food in glass jars or bottles with corks and boiled the jars. Pasteur showed that heat kills the microorganisms that cause spoilage and the seal keeps new microorganisms out.
8. Spores of *Clostridium botulinum* survive boiling water (212°F). In a sealed, low-acid jar they can make a deadly toxin. A pressure canner reaches 240°F , which destroys them.
9. $5 \div 2 = 2\frac{1}{2}$ times. Vinegar $2\frac{1}{2}$ cups; water $2\frac{1}{2}$ cups; sugar $2\frac{1}{2}$ tablespoons; salt 5 teaspoons (1 tablespoon + 2 teaspoons).
10. 0°F : $(0 - 32) \times 5 \div 9 = -160 \div 9 \approx -18^{\circ}\text{C}$. 240°F : $(240 - 32) \times 5 \div 9 = 1040 \div 9 \approx 116^{\circ}\text{C}$.
11. Fast freezing forms many tiny ice crystals that do little damage to cells. Slow freezing forms large crystals that break cell walls, so the food leaks water and turns mushy when thawed.
12. Safe: in the refrigerator, in cold water changed every 30 minutes, in the microwave (then cook right away), or straight into simmering sauce until 165°F . Unsafe: on the counter, because the outside sits in the danger zone ($40\text{--}140^{\circ}\text{F}$) where bacteria grow while the inside thaws.

UNIT CHALLENGE: FREEZER MEAL PLAN: COOK ONCE, EAT THREE TIMES

Plan and cook a big batch of one freezer-friendly food (the meatballs from Lesson 4.4, a soup, a chili or a casserole) with an adult nearby. Serve it once fresh, and freeze the rest in labeled, dated portions after cooling it safely.

Write a plan for two future meals using the frozen portions: a safe thaw method, the reheating temperature (165 °F) and what you will serve with each. Cook at least one of them within the unit, and record how the frozen food compared with the fresh: texture, flavor and your family's rating. Include a sketch of your labeled freezer bags and a one-paragraph explanation of the science of fast freezing.

LOOK FOR	WHAT IT MEANS
Safe cooking and cooling	Food cooked to the right temperature, cooled within 2 hours, and frozen spread out or in shallow portions.
Labels and plan	Every portion labeled with name and date; a clear, safe thaw and reheat plan for two meals.
Fresh vs. frozen comparison	An honest comparison of texture, flavor and family rating, with the science explained correctly.
Cleanup and improvement	Kitchen left clean; one improvement named for next time. A meal that did not freeze well but is recorded honestly earns full credit.

4.1 CONDUCTION, CONVECTION AND RADIATION IN THE KITCHEN

OBJECTIVES

- Explain conduction, convection and radiation, and identify each in an oven, on a stovetop and over a fire.
- Tell how Joseph Fourier described the flow of heat in 1822.
- Cook a sheet-pan chicken dinner and test how pan color, rack position and spacing change browning.

Warm-up. With an adult, set a metal spoon, a wooden spoon and a plastic spatula in a mug of hot tap water (not boiling). Wait two minutes, then carefully touch the handle of each. Which handle got warm? Why do you think pot handles are often made of wood or plastic?

WATCH

Heat Transfer: Conduction, Convection, and Radiation

Wisc-Online (Part of WisTech Open) · 3:04

<https://www.youtube.com/watch?v=lvyCe0UaqJY>

WHEN TO WATCH

After the kitchen-science paragraph. Pause after each kind of heat transfer and name one place you see it in your own kitchen.

Note: A short animated lesson from Wisc-Online, an educational service of Wisconsin's technical colleges, using a campfire, a kettle and a swimming pool to show the three kinds of heat transfer.

KEY TERMS

conduction

Heat moving through direct contact, from a hot pan into the food touching it, or along a metal spoon.

convection

Heat carried by moving air or liquid, like hot air circling in an oven or water rolling in a boiling pot.

radiation

Heat traveling as invisible infrared rays, like the warmth you feel from a fire, a broiler or the glowing element in an oven.

conductor

A material heat moves through easily, such as copper, aluminum and steel.

insulator

A material heat moves through slowly, such as wood, plastic, air and oven mitts.

CORE IDEAS

The story. Joseph Fourier was the son of a tailor in Auxerre, France, orphaned as a boy and educated by monks. He grew up to be a brilliant mathematician and went with Napoleon's expedition to Egypt in 1798. When he came home he became governor of a region of France, and in his spare time he studied a question no one had answered: exactly how does heat move through a solid object, like an iron bar heated at one end?

How he figured it out. Fourier heated metal rings and bars and measured the temperatures along them over time. He saw that heat always flows from hotter places to cooler places, and that it flows faster when the difference in temperature is bigger and when the material is a better conductor. He wrote the rule as a mathematical equation and published it in 1822 in *The Analytical Theory of Heat*. Engineers still use Fourier's law of heat conduction to design everything from engines to oven mitts.

The kitchen science. Heat reaches food in three ways. **Conduction** is heat passing by touch: the hot sheet pan browns the bottom of the potatoes, and heat then conducts slowly inward through the food itself. Metals are good **conductors**; wood, plastic and air are **insulators**. **Convection** is heat carried by moving air or liquid: hot air rises and circles inside the oven, and a "convection" setting uses a fan to move it faster. **Radiation** is heat traveling as infrared rays from anything very hot, such as the glowing element, a broiler or a campfire; it travels in straight lines and browns the surfaces it "sees." A sheet-pan dinner uses all three. Dark pans absorb more radiant heat than shiny ones and brown food faster. Food packed tightly together blocks the moving air and gives off steam, so it steams instead of browning.

Let's cook. You will roast a whole dinner on sheet pans: chicken thighs, potatoes and green beans with garlic and lemon. The skill to do well is **arranging the pan**: give every piece room so hot air can reach it, put slower-cooking foods on first, and use the oven's racks wisely.

PICTURE STUDY



Interior with a Woman by the Hearth, Leopold Löwenstam, after Jozef Israëls, second half of the 1800s ·

Etching · Rijksmuseum, Amsterdam

Image: [Wikimedia Commons](#), public domain

Jozef Israëls was a Dutch painter who often showed poor fishermen's and farmers' families in their simple cottages. This etching, made after one of his paintings, shows a kitchen like the ones where most families cooked for centuries before stoves: an open fire on a hearth, a pot hung above it, and a chimney to carry the smoke away.

Look closely

- Find the fire. Where would you feel the most heat if you stood in this room?
- Find the pot hanging over the fire. How does the heat get from the flames into the food inside?
- Look at the smoke and the chimney. Which way is the hot air moving?
- Find the woman's long stick. Why does she need it?

Talk about it

1. Name the three kinds of heat transfer in this picture and point to where each one happens.
2. How is cooking on an open hearth harder or more dangerous than cooking on your stove?

3. What would this woman think of a sheet-pan supper in a modern oven?

Safety first. An adult is nearby while you use the oven at 425 °F (220 °C). Use dry oven mitts (wet mitts conduct heat and steam straight to your hand), pull the rack out rather than reaching into the oven, and set hot pans on a trivet. Keep raw chicken on its own board and check the thickest piece at 165 °F (74 °C).

KITCHEN PROJECT

Three Kinds of Heat on a Sheet Pan

You will cook a sheet-pan chicken dinner and, alongside it, run a small heat experiment with potato slices to see conduction, convection and radiation at work: one tray of crowded slices and one spread out, or one tray on the top rack and one on the bottom.

You will need

- Two large rimmed baking sheets (one dark and one shiny, if you have them)
- A small extra pan or pie plate for the potato test
- Two cutting boards, a chef's knife and a large bowl
- An instant-read thermometer and an oven thermometer (optional)
- Oven mitts, tongs and a timer

SHEET-PAN LEMON-GARLIC CHICKEN WITH POTATOES AND GREEN BEANS

Serves 5–6 servings · Prep 20 min · Roast 35–40 min

Ingredients

- 2 pounds (900 g) boneless, skinless chicken thighs (about 8)
- 1½ pounds (680 g) small potatoes, cut in 1-inch pieces
- 12 ounces (340 g) green beans, trimmed
- 4 tablespoons olive oil, divided
- 4 cloves garlic, minced
- Zest and juice of 1 lemon
- 1½ teaspoons dried oregano or Italian seasoning
- 1¼ teaspoons salt and ½ teaspoon black pepper, divided

Method

1. Wash your hands. An adult turns the oven to 425 °F (220 °C) with racks in the upper and lower thirds.

2. Toss the potatoes with 2 tablespoons oil, $\frac{1}{2}$ teaspoon salt and $\frac{1}{4}$ teaspoon pepper and spread them on one sheet. Roast on the lower rack for 15 minutes.
3. Meanwhile, whisk the remaining 2 tablespoons oil, garlic, lemon zest and juice, oregano, $\frac{1}{2}$ teaspoon salt and $\frac{1}{4}$ teaspoon pepper in the bowl. On the raw board, pat the chicken dry, add it to the bowl and turn to coat. Wash the board, tongs and your hands.
4. Take the potato pan out (stand back from the steam), turn the potatoes, and push them to the edges. Lay the chicken in the middle with space between pieces. Toss the green beans with the last $\frac{1}{4}$ teaspoon salt and a drizzle of oil and spread them on the second sheet.
5. Roast both pans 20–25 minutes, switching racks halfway, until the chicken reads 165 °F (74 °C) in the thickest piece and the potatoes are browned.
6. Rest the chicken 5 minutes, spoon the pan juices over everything and serve.
7. Clean up: let the pans cool, soak and scrub them, and refrigerate leftovers within 2 hours.

Allergy check: No major allergens. Check spice blends for added ingredients if your family has allergies.

Steps

1. **Potato test.** Slice one extra potato into thin rounds. Crowd half of them, overlapping, in the small pan, and spread the other half apart on the edge of a sheet. Predict which will brown more, then check after cooking.
2. **Rack test.** If you have an oven thermometer, record the temperature on the top rack and the bottom rack. Which pan browned faster on the bottom? On top? Why?
3. Cook the dinner. Record the chicken temperature and the time it took.
4. Label a sketch of your oven with arrows for conduction (pan to food), convection (moving hot air) and radiation (from the heating element).
5. **Taste test.** Ask your family to rate the crispness of the potatoes and the juiciness of the chicken.

6. **Improve it.** Write one change: a dark pan for crispier potatoes, a different vegetable, or a different spice.

7. Clean up: wash, dry and put away everything.

Tips

- Dry food browns; wet food steams. Pat chicken and potatoes dry before oiling.
- Lining a pan with foil or parchment makes cleanup easier, but foil on a dark pan reflects heat and slows browning a little.
- If your oven runs hot or cold, the oven thermometer will tell you. Adjust the dial to match.

Check your work

- ☐ I can explain conduction, convection and radiation with kitchen examples.
- ☐ I can tell what Joseph Fourier discovered about heat flow.
- ☐ I cooked a sheet-pan dinner with chicken at 165 °F and tested spacing and rack position.

COOK'S NOTEBOOK

1. Draw your oven from the side with arrows showing all three kinds of heat transfer.
2. Record the potato and rack tests in a table: setup, prediction, result and explanation.
3. Copy the sheet-pan recipe in your own words, and note the order foods went in and why.

From history. Fourier is also remembered for showing that complicated waves can be built from simple ones, an idea now used in music, radio and medical scans. His name is one of the 72 engraved on the Eiffel Tower in honor of great French scientists and engineers.

COMMON MISTAKES

- Crowding the pan. Food steams instead of browning when hot air cannot reach it.
- Using a damp oven mitt or towel. Water conducts heat quickly and can scald your hand.

- Putting all vegetables in at the same time. Dense potatoes need a head start over green beans.

Make it a game • Heat in Three Rooms. Walk through the kitchen with your parent and find an example of conduction, convection and radiation in each: oven, stovetop and a campfire or toaster. Name them in sixty seconds. Your parent hides a sneaky wrong example, such as calling a hot pan handle radiation. Spot it. Then say what Joseph Fourier did in 1822.

Scripture. “And he looked, and, behold, there was a cake baked on the coals, and a cruse of water at his head. And he did eat and drink, and laid him down again.” (1 Kings 19:6, KJV)

God provided Elijah a simple cake baked on hot coals, cooked by the radiant heat of the fire. Plain, warm food is a gift and a strength in a hard time.

4.2 PERCY SPENCER AND THE MICROWAVE OVEN

OBJECTIVES

- Tell how Percy Spencer discovered microwave cooking at Raytheon in 1945.
- Explain how microwaves heat the water molecules in food, and why microwaved food heats unevenly.
- Steam vegetables in the microwave and on the stovetop, and compare time, color, texture and taste.

Warm-up. With an adult, heat a cup of water in the microwave for 1 minute. Stir it, then dip a thermometer at the top and at the bottom. Next, heat a dry, empty microwave-safe plate for 15 seconds (no longer) and touch it. Which got hot: the water or the plate? Write your guess about why.

WATCH

A Brief History of Microwave Ovens | The Henry Ford's Innovation Nation

The Henry Ford • 3:52

<https://www.youtube.com/watch?v=Fuo6bw5wyf8>

WHEN TO WATCH

After the story of Percy Spencer, before your microwave experiment.

Note: From The Henry Ford museum's Innovation Nation series. It shows an early Radarange and the magnetron Spencer worked with.

BACKUP VIDEO

Why can't you put metal in a microwave? - Aaron Slepko

TED-Ed • 5:49

<https://www.youtube.com/watch?v=ZExGV6jSuBw>

After the experiment, to learn why metal sparks in a microwave and how the waves heat water.

KEY TERMS

microwaves

Invisible waves of energy, like radio waves but shorter. Kitchen microwave ovens use waves that make water molecules jiggle.

magnetron

The tube inside a microwave oven (and in radar sets) that produces microwaves.

standing time

The minutes after microwaving when heat keeps spreading from hot spots to cold spots by conduction.

steaming

Cooking food with hot water vapor instead of in water, which keeps more color, vitamins and crunch.

hot spot

A part of the food that heats much faster than the rest.

CORE IDEAS

The story. Percy Spencer was born in Maine in 1894 and lost his father as a baby. He left school after grammar school to work in a mill. He taught himself electricity, learned radio in the Navy, and became one of the best engineers at the Raytheon company in Massachusetts. During World War II, Raytheon built magnetrons, the tubes that make the microwaves used in radar, and Spencer found a way to make them much faster.

How he figured it out. One day in 1945, standing near a working magnetron, Spencer noticed that a candy bar in his pocket had melted. Other people had felt warmth near magnetrons, but Spencer was curious enough to test it. He held a bag of popcorn kernels near the tube, and they popped all over the lab. He tried an egg in a kettle, and it cooked so fast it burst. Spencer built a metal box to hold the microwaves in, and Raytheon applied for a patent that year. The first microwave oven, the Radarange of 1947, was nearly six feet tall and was used in restaurants, ships and railroad cars. Small countertop microwave ovens for homes became popular in the late 1960s and 1970s.

The kitchen science. Water molecules have a slightly positive end and a slightly negative end. A microwave oven fills its metal box with microwaves whose electric field flips back and forth billions of times each second. The water molecules twist

back and forth to follow it, bumping into their neighbors, and that motion becomes heat. Dry things like an empty plate barely warm. Microwaves reach only about an inch into food, so the inside of a big piece heats by conduction from the outside. Because the waves bounce around the box, some spots get more energy than others; that is why food has **hot spots** and cold spots, why ovens have turntables, and why you stir and let food stand. Microwaves do not make food radioactive; when the oven turns off, the waves are gone. Steam builds up fast, so covered dishes must be vented and opened away from your face.

Let's cook. You will steam broccoli and carrots two ways, in the microwave and on the stovetop, and compare them. The skill to do well is **judging doneness**: vegetables are done when they are bright in color and “crisp-tender,” meaning a fork goes in with a little resistance.

PICTURE STUDY



Astronaut Owen Garriott Eats a Meal aboard Skylab, NASA, 1973 · Photograph · Skylab space station, in orbit around the Earth

Image: [Wikimedia Commons](#), public domain

In 1973 three astronauts lived for 59 days aboard Skylab, America's first space station. Their galley had a food tray with built-in warmers that heated cans of food by conduction, along with a freezer and a water supply. Cooking in space showed how much thinking goes into heating food safely without open flames.

Look closely

- Find the food tray. How are the containers held so they do not float away?
- Look at the food package in his hands. Why would space food be sealed in packages?
- Which kind of heat transfer warmed the containers in the tray?
- Look at the lockers behind him. What do you think is stored in them?

Talk about it

1. Why would an open flame be dangerous in a space station? What safer ways to heat food would engineers choose?
2. Microwave ovens work by heating water in food. Why might that be useful on a spaceship or ship?
3. If you had to plan a week of meals in space, what foods would you bring?

Safety first. Use the microwave with an adult nearby. Use only microwave-safe dishes, never metal or foil, and never heat eggs in their shells or sealed containers. Vent covers, and lift lids and plastic wrap away from your face, because steam from the microwave burns. Stir food and let it stand before tasting, since hot spots can be much hotter than the rest.

Microwave vs. Stovetop: The Steamed Vegetable Test

You will steam the same amount of broccoli and carrots in the microwave and on the stovetop, timing each, and compare color, texture, flavor and how much water each used. You will also map the hot spots in your microwave.

You will need

- A large microwave-safe bowl with a microwave-safe plate or vented lid
- A medium saucepan with a lid and a steamer basket
- A chef's knife and cutting board
- An instant-read thermometer and a timer
- A microwave-safe plate and a slice of cheese or a piece of bread with butter for the hot-spot map

TWO-WAY STEAMED BROCCOLI AND CARROTS WITH LEMON BUTTER

Serves 6 servings (3 from each method) • Prep 15 min • Cook 5–10 min

Ingredients

- 2 large heads broccoli (about 2 pounds or 900 g), cut in 1½-inch florets
- 4 carrots, peeled and sliced ¼ inch thick on a slant
- 4 tablespoons water, for the microwave batch
- 1 cup (240 mL) water, for the stovetop batch
- **Lemon butter:** 2 tablespoons butter, 1 teaspoon lemon zest, 1 tablespoon lemon juice, ¼ teaspoon salt

Method

1. Wash your hands and the vegetables. Cut the broccoli into even florets and the carrots into even slices. Divide them into two equal piles.
2. **Microwave batch:** Put one pile in the microwave-safe bowl with 3 tablespoons water. Cover with a plate or vented lid. Microwave on high 3 minutes, stir, then 1–2 minutes more, until crisp-tender. Let stand 1 minute, then uncover away from your face.

3. **Stovetop batch:** Put the steamer basket in the saucepan with 1 cup water (the water should not touch the basket). With an adult nearby, bring to a boil, add the carrots first, cover, and steam 2 minutes; add the broccoli, cover, and steam 4–5 minutes more, until crisp-tender.
4. Melt the butter with the lemon zest in a small cup in the microwave (20–30 seconds). Stir in the lemon juice and salt.
5. Taste one piece from each batch plain. Then drizzle lemon butter over both and serve.
6. Clean up: wash the bowl, saucepan and steamer basket, and wipe the inside of the microwave.

Allergy check: Contains milk (butter). Use olive oil instead for a milk-free version. No other major allergens.

Steps

1. **Predict.** Write which method you think will be faster, which will be greener, and which your family will prefer.
2. Cook both batches. Record the time each took from start to crisp-tender, and the temperature of a broccoli stem from each.
3. **Compare.** Line up one floret from each batch. Rate color, crunch and flavor from 1 to 5. Note how much water each method used.
4. **Hot-spot map.** With the turntable turned off if your microwave allows (or the plate set at the edge), heat a slice of cheese on a plate for 30–60 seconds and watch where it melts first. Draw the pattern.
5. **Taste test.** Ask your family to taste both blind and choose a favorite.
6. **Improve it.** Write one change: a shorter time, a different vegetable, or a different seasoning.
7. Clean up: wash, dry and put away everything.

Tips

- Cut pieces the same size so they finish together, in either method.
- Vegetables keep cooking after they come out. Stop a little early.
- Steaming and microwaving keep more water-soluble vitamins, like vitamin C, than boiling in lots of water.

Check your work

- ☐ I can tell how Percy Spencer discovered microwave cooking.
- ☐ I can explain how microwaves heat food and why hot spots form.
- ☐ I steamed vegetables two ways and compared them fairly.

COOK'S NOTEBOOK

1. Draw a water molecule twisting back and forth in a microwave and write two sentences explaining how that makes heat.
2. Draw your microwave hot-spot map.
3. Make a comparison chart of the two steaming methods: time, water used, color, crunch, flavor and family favorite.

From history. Percy Spencer received about 150 patents in his life, though he never finished high school. Raytheon paid him only a small bonus for the microwave oven patent, as was the custom for company engineers. He later received an honorary doctorate and was inducted into the National Inventors Hall of Fame in 1999.

COMMON MISTAKES

- Thinking microwaves cook food “from the inside out.” They heat the outer inch; the center heats by conduction.
- Lifting plastic wrap toward your face. Steam rushes out and can burn; peel it away from you.
- Tasting right away without stirring. Hot spots can burn your mouth even when other parts are cool.

Make it a game • Hot Spot Map. Spread a layer of cooked rice or mashed potato on a plate, and have an adult heat it briefly in the microwave. Draw a map of where it is hot or cool, using a thermometer. Compare your map to your prediction. Then tell how Percy Spencer discovered microwave cooking at Raytheon and why standing time helps.

4.3 NAPOLEON'S PRIZE AND APPERT'S JARS

OBJECTIVES

- Tell how Nicolas Appert preserved food in sealed glass jars and won a prize from the French government in 1810.
- Explain how heat, sealing and acid keep preserved food safe, and why home canning must follow tested recipes.
- Make quick refrigerator pickles and test the acidity of the brine with a red-cabbage indicator.

Warm-up. Look in your pantry and refrigerator for foods that are preserved: canned, pickled, dried, salted, sugared or frozen. List as many as you can find in five minutes. Which preserving method appears most often in your kitchen?

WATCH

The Chemistry of Pickles

NBC News Learn • 6:24

<https://www.youtube.com/watch?v=9FW4pUJfmgU>

WHEN TO WATCH

After the story of Appert, before you make your brine.

Note: From NBC Learn's Chemistry Now series with the National Science Foundation. It explains brine, acid, fermentation and the pH scale; the word "alcohols" appears only as a chemistry term.

BACKUP VIDEO

The Father of Canned Food: Nicholas Appert - Hidden Genius

Stuff of Genius - HowStuffWorks • 1:37

<https://www.youtube.com/watch?v=z7ZCD8ZSB9U>

After the story, for a quick animated retelling of Appert and Napoleon's prize.

KEY TERMS

preserve

To keep food from spoiling so it can be eaten later.

canning

Sealing food in jars or cans and heating it to kill microorganisms, so it keeps on the shelf.

pickling

Preserving food in an acid, such as vinegar, or by fermentation.

acidity

How sour or acidic something is, measured on the pH scale. Lower pH means more acidic.

indicator

A substance that changes color in an acid or a base, such as the purple juice of red cabbage.

CORE IDEAS

The story. In the 1790s France was at war, and its armies and navy needed food that would not rot on long marches and voyages. Soldiers lived on hard biscuit and salted meat, and many fell sick from poor food. The French government offered a reward for a better way to preserve food. Nicolas Appert, a confectioner and cook in Paris, had been wondering for years why food spoiled and whether it could be stopped.

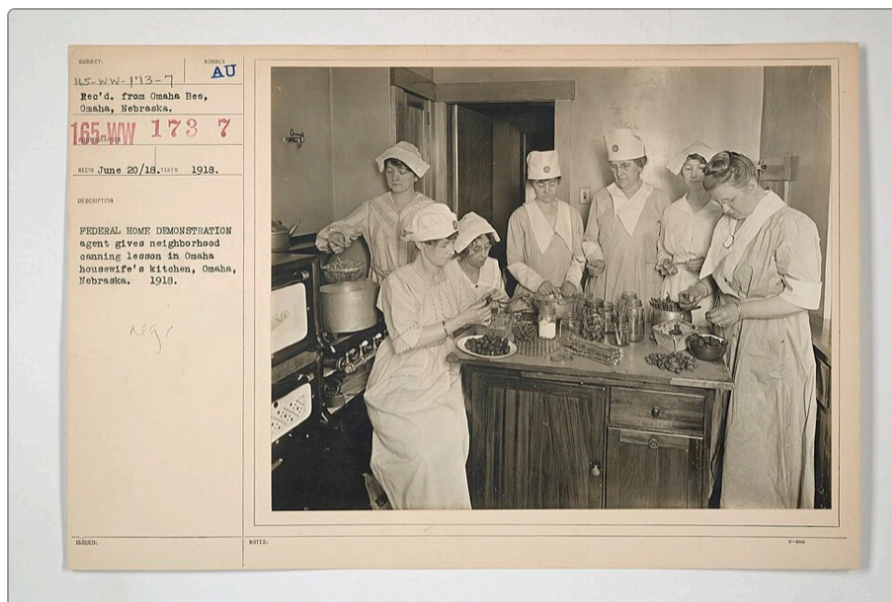
How he figured it out. Appert tried something simple and patient. He packed food (soups, meats, vegetables, fruits, milk) into thick glass bottles and jars, corked them tightly, wired the corks down, and then boiled the sealed jars in a big pot of water for different lengths of time. He opened them weeks and months later to see which had kept. By 1803 he was sending preserved foods to the French navy, and they arrived in good condition after months at sea. In 1810 the government of Napoleon awarded him 12,000 francs on the condition that he publish his method for everyone, and he did, in a book called *The Art of Preserving All Kinds of Animal and Vegetable Substances for Several Years*. Appert did not know why it worked. Fifty years later, Louis Pasteur showed that heat kills the microorganisms that spoil food, and the seal keeps new ones out.

The kitchen science. Spoilage microorganisms need moisture, warmth, food and the right **acidity**. Canning beats them with heat and a seal. But one dangerous bacterium, *Clostridium botulinum*, forms tough spores that survive boiling water, and in a sealed, airless, low-acid jar they can make a deadly toxin. That is why low-acid foods like green beans, corn and meat must be canned in a pressure canner, which reaches 240 °F (116 °C), and why home canning must follow tested recipes exactly. Acid is a second defense: spoilage bacteria grow poorly in acidic food (pH 4.6 or

below). Pickles are preserved by vinegar's acid. Quick refrigerator pickles use acid and cold together, and are kept in the refrigerator, not on the shelf.

Let's cook. You will make a jar or two of quick pickled carrots, cucumbers and red onions, and test your brine's acidity with red-cabbage juice, a natural indicator that turns pink in acid. The skill to do well is **making a balanced brine**: vinegar, water, salt and a little sugar, heated just until dissolved.

PICTURE STUDY



A Neighborhood Canning Lesson in Omaha, Photographer for the *Omaha Bee*, for the U.S. Food Administration, 1918 · Photograph · National Archives, Washington, D.C.

Image: [Wikimedia Commons](#), public domain

During World War I, the U.S. Food Administration urged families not to waste food and to preserve their garden harvest. Home demonstration agents, trained teachers sent by the government and state colleges, went into neighborhoods to teach safe canning. This lesson took place in an ordinary family kitchen in Omaha in 1918.

Look closely

- Find the canning jars. Are they full or empty? What might be inside?
- Find the teacher. How can you tell who is leading the lesson?
- Look at the stove and pots. Where would the jars be heated?
- Look at the women watching. Why do you think neighbors learned together?

Talk about it

1. These women canned food so nothing from their gardens would be wasted. How is that like Appert's goal?
2. Why was it important to have a trained teacher show the safe method instead of guessing?
3. Which foods in your family could be preserved so nothing goes to waste?

Safety first. An adult is nearby while you heat the brine; pour hot brine slowly with a funnel or ladle, away from your body. Quick pickles are refrigerator pickles only: keep them cold and eat them within about a month. Do not try shelf canning without an adult and a tested recipe from a source such as the National Center for Home Food Preservation.

Quick Pickles and the Red-Cabbage Acid Test

You will make a purple indicator from red cabbage, test the acidity of vinegar, water, baking soda and your brine, and then pickle vegetables. Over a week, you will taste and record how the pickles change.

You will need

- Two clean pint (16-ounce) glass jars with lids
- A small saucepan, a funnel or ladle, measuring cups and spoons
- A chef's knife, cutting board and vegetable peeler
- For the indicator: $\frac{1}{4}$ head red cabbage, a pot, a strainer, 5 clear cups or glasses
- Masking tape and a marker for labels

QUICK REFRIGERATOR PICKLED VEGETABLES

Serves 2 pint jars (about 16 servings) · Prep 20 min · Cook 5 min · Chill at least 24 hr

Ingredients

- 2 carrots, peeled and cut in thin sticks
- 1 English cucumber, sliced into $\frac{1}{4}$ -inch rounds or spears
- $\frac{1}{2}$ red onion, sliced thin
- 4 sprigs fresh dill (or 1 teaspoon dried dill)
- 2 cloves garlic, peeled and halved
- 1 teaspoon whole black peppercorns or mustard seeds
- **Brine:** 1 cup (240 mL) white or apple cider vinegar (5% acidity), 1 cup (240 mL) water, 1 tablespoon sugar, 2 teaspoons salt (canning or kosher salt)

Method

1. Wash your hands, the jars and the vegetables. Cut the vegetables, keeping pieces about the same thickness.
2. Divide the dill, garlic and peppercorns between the jars. Pack the vegetables in tightly, leaving $\frac{1}{2}$ inch of space at the top.

3. With an adult nearby, heat the vinegar, water, sugar and salt in the saucepan over medium heat, stirring, just until the sugar and salt dissolve and the brine steams, 2–3 minutes. Do not boil it hard (boiling vinegar fumes sting your eyes).
4. Using a funnel or ladle, pour the hot brine over the vegetables until covered. Tap the jars gently to release air bubbles.
5. Let cool to room temperature (no more than 2 hours), close the lids, label with the date, and refrigerate at least 24 hours before eating. Keep refrigerated and eat within about a month.
6. Clean up: rinse the saucepan, wash the knife and board, and wipe the counter.

Allergy check: No major allergens (mustard seed, if used, is an allergen for some people). The brine contains sugar and salt.

Steps

1. **Make the indicator.** With an adult, chop the red cabbage, cover it with water in a pot and simmer 10 minutes. Strain and cool the purple juice.
2. **Acid test.** Pour a little indicator into five cups. Add a spoonful of: plain water, vinegar, lemon juice, baking soda dissolved in water, and your pickle brine. Record each color. Which were acids (pink or red)? Which was a base (green or blue)?
3. Make the pickles. Then add a few drops of indicator to a spoonful of leftover brine and compare its color with the plain vinegar cup.
4. **Pickle log.** Taste a pickle on day 1, day 3 and day 7. Rate sourness, crunch and flavor each time.
5. **Taste test.** Serve the pickles with a meal and ask your family to rate them.
6. **Improve it.** Write one change: more or less sugar, a different vegetable (green beans, radishes), or a spice such as a pinch of red pepper.
7. Clean up: wash, dry and put away everything; the cabbage pulp can go in the compost.

Tips

- Use vinegar labeled 5% acidity. Weaker homemade or flavored vinegars may not be acidic enough.

- Thin slices pickle faster than thick spears.
- The red cabbage indicator stains. Wear an apron and wipe spills right away.

Check your work

- ☐ I can tell how Nicolas Appert preserved food and what Pasteur later explained.
- ☐ I can explain why acid, heat and sealing keep food safe and why canning needs tested recipes.
- ☐ I made quick refrigerator pickles and tested acidity with a red-cabbage indicator.

COOK'S NOTEBOOK

1. Draw your five indicator cups in color and label each as acid, neutral or base.
2. Draw Appert's process as a four-step comic: pack, cork, boil, store.
3. Record your pickle log for days 1, 3 and 7 and write which day you liked best.

From history. In 1810, the same year Appert published his book, an Englishman named Peter Durand received a patent for preserving food in tin cans, which did not break like glass. Tin cans fed armies and explorers for the next century, though the can opener was not invented until decades later; early cans were opened with a hammer and chisel.

COMMON MISTAKES

- Storing quick pickles on the shelf. They are not canned; keep them in the refrigerator.
- Inventing your own canning recipe. Home canning must follow tested times and methods to be safe.
- Using less vinegar than the recipe calls for. The acid is what keeps the pickles safe.

Make it a game • Napoleon's Prize Pitch. Pretend you are Nicolas Appert asking for a prize from the French government. Give a pitch of one minute on why sealed jars kept food. Your parent plays Napoleon's judge and asks a question about heat, sealing or acid. Answer without notes. Then say why home canning must follow tested recipes. Switch roles.

4.4 CLARENCE BIRDSEYE AND FAST FREEZING

OBJECTIVES

- Tell how Clarence Birdseye learned fast freezing from Inuit fishermen in Labrador and brought frozen food to American stores in 1930.
- Explain why fast freezing makes small ice crystals and keeps food better than slow freezing, and how to freeze and thaw food safely.
- Cook a big batch of baked meatballs to 160 °F and freeze them for later meals.

Warm-up. Open your freezer with an adult. Read the temperature if there is a thermometer (it should be 0 °F, or –18 °C). Make a list of what is inside. How many foods have dates on them? Find any food with dry, white, frosty patches. What do you think caused them?

WATCH

How flash-freezing preserves food quality

Adam Ragusea · 13:40

https://www.youtube.com/watch?v=U_PMnCpaJiQ

WHEN TO WATCH

After the story, before you make your meatballs.

Note: From Adam Ragusea, a cooking teacher and former journalism professor, with a Penn State food scientist. He shows how ice crystals form and why fast freezing keeps food better. It opens with a short sponsor message for a website company; skip past it.

BACKUP VIDEO

Instant Ice Crystals - The Secret Life of Ice - BBC

BBC · 2:28

<https://www.youtube.com/watch?v=3Qasw7lb2UM>

After the strawberry test, to watch ice crystals grow in an instant.

KEY TERMS

fast freezing

Freezing food very quickly at very low temperatures, which forms many tiny ice crystals.

ice crystal

A tiny piece of frozen water. Large crystals poke through food cells and make thawed food mushy and wet.

flash freezing

Freezing pieces of food spread apart on a tray before bagging them, so they freeze fast and do not stick together.

freezer burn

Dry, tough, discolored patches where air has dried out frozen food. It is safe but tastes poor.

thaw

To let frozen food become unfrozen. Safe thawing is in the refrigerator, in cold water or in the microwave, never on the counter.

CORE IDEAS

The story. Clarence Birdseye was a young naturalist from New York who loved the outdoors. From about 1912 to 1915 he lived in Labrador, in far northeastern Canada, trading furs. The winters were brutally cold, often 30 or 40 degrees below zero. He watched Inuit fishermen catch fish through holes in the ice. The moment the fish came out of the water, they froze stiff in the bitter wind.

How he figured it out. Birdseye noticed something surprising: when those fish were thawed and cooked months later, they tasted almost fresh. Frozen food sold in American cities at that time was usually frozen slowly and tasted mushy and dull. Birdseye reasoned that speed made the difference. Back home, he experimented with fish and vegetables pressed between very cold metal plates, and he designed machines to freeze packaged food fast. He started a company in 1924 in Gloucester, Massachusetts. In 1929 a large food company bought his business and patents, and on March 6, 1930, the first Birds Eye frozen foods went on sale in grocery stores in Springfield, Massachusetts.

The kitchen science. Food is mostly water held in tiny cells. When food freezes slowly, water molecules have time to gather into a few **large ice crystals**, which grow like sharp spikes and break the cell walls. When it thaws, the water leaks out, and

the food is limp and wet. When food freezes fast, the water forms **many tiny crystals** that do little damage, so the food keeps its texture. Freezing does not kill most bacteria; it stops them from growing. Food kept at 0 °F (−18 °C) stays safe indefinitely, though quality slowly declines, so label and date everything. Air dries frozen food and causes **freezer burn**, so press air out of bags. Thaw food in the refrigerator, in cold water changed every 30 minutes, or in the microwave, and never on the counter, where the outside can sit in the danger zone while the inside thaws.

Let's cook. You will bake a big batch of meatballs, eat some for supper, and **flash-freeze** the rest, spread on a tray so they freeze fast and separately, just as Birdseye's machines froze food in thin packages. The skill to do well is **shaping even meatballs**, all the same size so they cook through at the same time, and checking that they reach 160 °F (71 °C).

PICTURE STUDY



Clarence Birdseye, Unknown photographer, 1930 · Photograph, published in *Air Conditioning, Heating & Refrigeration News* · Published in the United States

Image: [Wikimedia Commons](#), public domain

This photograph of Clarence Birdseye appeared in a trade magazine for the refrigeration business in March 1930, the very month his frozen foods first went on sale. He was 43 years old and had already spent years experimenting in his own kitchen and laboratory.

Look closely

- Look at his face and expression. What kind of person do you think he was: careful, cheerful, stubborn, curious?
- Look at his clothes. He had once lived as a fur trader in the Arctic. Does he look like an explorer here, or a businessman?
- What would you add to this picture to show what he invented?
- This photo was printed in a magazine about refrigeration. Why would that magazine want to show him?

Talk about it

1. Birdseye learned from the Inuit fishermen by watching closely. What is one thing you have learned by watching an older cook?
2. Why did fish frozen in the Labrador wind taste better than fish frozen slowly in a city warehouse?

3. How has frozen food changed the way your family plans and cooks meals?

Safety first. An adult is nearby while you use the oven. Keep raw ground meat on its own board and in its own bowl, wash your hands well after shaping the meatballs, and never taste the raw mixture. Bake the meatballs to 160 °F (71 °C), cool them no more than 2 hours, and thaw frozen meatballs in the refrigerator, never on the counter. Reheat leftovers to 165 °F (74 °C).

KITCHEN PROJECT

Fast Freeze, Slow Freeze: Meatballs for Later

You will bake a big batch of meatballs for tonight's supper and for the freezer. You will also run Birdseye's experiment with strawberries, freezing some fast and some slowly, and compare them when they thaw.

You will need

- Two rimmed baking sheets lined with parchment, plus a small tray or plate that fits in the freezer
- A large mixing bowl and a fork
- A 1½-tablespoon scoop or a tablespoon measure
- An instant-read thermometer and oven mitts
- Freezer bags, a marker and masking tape
- For the strawberry test: 10 strawberries, a metal pan and a deep plastic container

FREEZER-FRIENDLY BAKED MEATBALLS

Serves About 48 meatballs (8 servings) · Prep 30 min · Bake 18–20 min

Ingredients

- 2 pounds (900 g) ground beef (85% lean), or 1 pound beef and 1 pound ground pork
- 2 large eggs
- ⅔ cup (70 g) plain dry bread crumbs
- ½ cup (120 mL) milk
- ½ cup (45 g) grated Parmesan cheese
- 1 small onion, grated or very finely minced
- 2 cloves garlic, minced
- 3 tablespoons chopped parsley
- 1½ teaspoons salt, ½ teaspoon pepper, 1 teaspoon dried oregano

Method

1. Wash your hands. An adult turns the oven to 400 °F (200 °C).

2. In the large bowl, stir the bread crumbs and milk together and let them soak 5 minutes. Add the eggs, Parmesan, onion, garlic, parsley, salt, pepper and oregano, and mix well.
3. Add the meat and mix gently with your clean hands just until combined. Overmixing makes tough meatballs.
4. Scoop and roll the mixture into 1½-inch balls (about 1½ tablespoons each). Set them on the lined baking sheets, not touching. Wash your hands well.
5. Bake 18–20 minutes, until browned and a meatball in the center of the pan reads 160 °F (71 °C).
6. Serve some for supper (with pasta and sauce, in sandwiches, or with rice). Cool the rest on the pan for 20–30 minutes.
7. **Flash freeze:** Put the pan of cooled meatballs in the freezer for 1–2 hours until hard, then move them to labeled freezer bags, pressing out the air. Write the date. Use within 3–4 months for best quality.
8. **Clean up:** wash the bowl, scoop and boards in hot, soapy water, wipe the counters, and wash your hands.

Allergy check: Contains eggs, milk (milk and Parmesan) and wheat (bread crumbs). For egg-free, use 3 tablespoons extra milk. For milk-free, use broth instead of milk and leave out the cheese. Use gluten-free crumbs or quick oats for wheat-free.

Steps

1. **Strawberry test.** Spread 5 strawberries apart on a cold metal pan and put them in the coldest part of the freezer (fast freeze). Pile 5 strawberries in a deep plastic container, cover, and put them in the door (slow freeze). After 24 hours, thaw both in the refrigerator on separate plates. Compare the juice on each plate and the firmness of the berries.
2. Make, bake and flash-freeze the meatballs. Record the temperature of the center meatball.
3. **Freeze log.** Record the time the meatballs went into the freezer and when they were frozen hard.
4. **Thaw plan.** Write a plan for a future meal using the frozen meatballs: when to move them to the refrigerator to thaw, how to reheat them to 165 °F, and

what to serve with them.

5. **Taste test.** Ask your family to rate tonight's meatballs for tenderness and flavor.
6. **Improve it.** Write one change: a turkey version, more vegetables (finely grated zucchini), or a different herb.
7. Clean up: wash, dry and put away everything.

Tips

- Wet your hands lightly with cold water so the mixture does not stick while you roll.
- A small scoop makes every meatball the same size, so they all cook in the same time.
- Frozen meatballs can go straight into simmering sauce; simmer until they reach 165 °F in the center.

Check your work

- ☐ I can tell how Clarence Birdseye learned fast freezing in Labrador.
- ☐ I can explain why fast freezing makes small ice crystals and keeps food better.
- ☐ I baked meatballs to 160 °F, flash-froze them, and wrote a safe thaw plan.

COOK'S NOTEBOOK

1. Draw two food cells: one with small ice crystals from fast freezing and one with large crystals breaking the cell walls.
2. Record the strawberry test with a sketch of each plate after thawing.
3. Copy the meatball recipe and your thaw plan, and make a freezer label design you can use all year.

From history. Birdseye held nearly 300 patents, for everything from freezing machines to a harpoon for marking whales for study and a better light bulb for store windows. He also helped invent refrigerated display cases, because grocers had nowhere to keep frozen food when it first appeared.

COMMON MISTAKES

- Thawing meat on the counter. The outside sits in the danger zone for hours; thaw in the refrigerator, in cold water or in the microwave.

- Freezing hot food in a big pile. It freezes slowly and can warm the foods around it; cool it, spread it out, then freeze.
- Leaving air in freezer bags. Air causes freezer burn; press it out before sealing.

Make it a game · Small Crystal, Big Crystal. Predict which freezes better, a small bowl of berries frozen fast on a metal pan or a big clump frozen slowly in a bowl. Freeze both and compare the next day, thawing safely in the refrigerator. Draw the ice crystals you expect to see. Tell the Clarence Birdseye story and name two safe ways to thaw food.

Scripture. “Go to the ant, thou sluggard; consider her ways, and be wise: Which having no guide, overseer, or ruler, Provideth her meat in the summer, and gathereth her food in the harvest.” (Proverbs 6:6-8, KJV)

The ant stores food in a time of plenty for a time of need. Preserving and freezing food is wise planning, so that nothing good is wasted.

UNIT 4

HEAT & COLD

Cooking is the art of moving heat into food, and keeping food is often the art of moving heat out. In this unit you will learn the three ways heat travels, conduction, convection and radiation, and watch all three at work in one hot oven on a sheet-pan supper. You will meet Percy Spencer, the self-taught engineer who discovered in 1945 that invisible microwaves could cook food, and you will compare a microwave and a stovetop side by side.

Then you will turn to cold and keeping. Nicolas Appert won a prize from Napoleon's government in 1810 for sealing food in jars, years before anyone knew why it worked. Clarence Birdseye learned from Inuit fishermen in Labrador that fast freezing keeps food tasting fresh. You will make quick refrigerator pickles and test their acidity with a homemade indicator, and you will cook a big batch of meatballs and freeze them the way Birdseye taught the world to freeze food.

PREREQUISITES

- Knows the danger zone (40–140 °F) and safe internal temperatures (Unit 1)
- Uses the oven and stove with an adult nearby and oven mitts (Units 1–3)
- Can cut vegetables into even pieces with a chef's knife (Unit 1)
- Knows that heat makes molecules move faster (science)

MASTERY CHECKLIST

- ☐ I can explain conduction, convection and radiation and point to each one in an oven or on a stove.
- ☐ I can tell how Percy Spencer discovered microwave cooking and explain how microwaves heat the water in food.
- ☐ I can tell how Nicolas Appert preserved food in sealed jars and explain why acid and heat keep pickles safe.
- ☐ I can explain why fast freezing keeps food better than slow freezing, and freeze and thaw food safely.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **National Center for Home Food Preservation**: Free. The University of Georgia’s tested guide to pickling, canning, freezing and drying at home. If your family ever wants to can food for the shelf, use only tested recipes like these, with an adult.
- **FoodSafety.gov: Cold Food Storage Chart**: Free. How long foods keep in the refrigerator and freezer. Useful for Lesson 4.4 and for labeling your freezer meals. Search “FoodSafety.gov cold food storage chart.”
- **An oven thermometer**: Inexpensive. Hang it in the oven to see whether your oven really heats to the temperature on the dial (Lesson 4.1).

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

4.1 Conduction, Convection and Radiation in the Kitchen	2 sessions of 50–60 minutes
4.2 Percy Spencer and the Microwave Oven	2 sessions of 50–60 minutes
4.3 Napoleon’s Prize and Appert’s Jars	2 sessions of 50–60 minutes
4.4 Clarence Birdseye and Fast Freezing	2 sessions of 60–90 minutes

UNIT 4 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**

Name the three ways heat travels, and give a kitchen example of each.

2. **8 pts**

Predict: You roast one pan of potatoes spread out and one pan piled up. Which will be crispier, and why?

3. **8 pts**

What did Joseph Fourier discover about how heat moves?

4. (8 pts)

How did Percy Spencer discover microwave cooking, and what were his first two tests?

5. (8 pts)

Explain how a microwave oven heats food, and why you should stir food and let it stand.

6. (8 pts)

Calculation: A recipe says to microwave 1 bowl of vegetables for 4 minutes. If doubling the amount takes about 1.6 times as long, how long should you microwave a double batch? Round to the nearest half minute.

7. (8 pts)

What did Nicolas Appert do to preserve food, and what did Louis Pasteur later explain about why it worked?

8. (8 pts)

Why must low-acid foods like green beans be canned in a pressure canner, not a pot of boiling water?

9. (10 pts)

Calculation: Your pickle brine uses 1 cup vinegar, 1 cup water, 1 tablespoon sugar and 2 teaspoons salt for 2 jars. How much of each do you need for 5 jars?

10. (10 pts)

Calculation: Convert the freezer temperature 0 °F and the pressure-canner temperature 240 °F to Celsius using $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5 \div 9$. Round to the nearest degree.

11. (8 pts)

Why does fast freezing keep food better than slow freezing?

12. (8 pts)

Short answer: Name three safe ways to thaw frozen meatballs and one unsafe way, and explain why it is unsafe.

ANSWER KEY

1. Conduction (a hot pan browning the bottom of a potato; a metal spoon getting hot in soup), convection (hot air circling in the oven; boiling water rolling), radiation (heat from a broiler, oven element or campfire).
2. The spread-out potatoes will be crispier, because hot air reaches every surface and steam escapes; piled-up potatoes trap steam and steam instead of browning.
3. Heat always flows from hotter to cooler places, and faster when the temperature difference is larger and the material conducts better. He wrote this as a mathematical law in 1822.
4. In 1945 he noticed a candy bar in his pocket melted while he stood near a working magnetron. He tested popcorn kernels, which popped, and an egg, which cooked so fast it burst.
5. Microwaves make water molecules twist back and forth, and their motion and bumping make heat. The waves reach only about an inch in and are uneven, so stirring and standing time let heat spread evenly by conduction and remove hot spots.
6. $4 \times 1.6 = 6.4$ minutes, about $6\frac{1}{2}$ minutes. (Check for doneness and stir halfway.)
7. He sealed food in glass jars or bottles with corks and boiled the jars. Pasteur showed that heat kills the microorganisms that cause spoilage and the seal keeps new microorganisms out.
8. Spores of *Clostridium botulinum* survive boiling water (212°F). In a sealed, low-acid jar they can make a deadly toxin. A pressure canner reaches 240°F , which destroys them.
9. $5 \div 2 = 2\frac{1}{2}$ times. Vinegar $2\frac{1}{2}$ cups; water $2\frac{1}{2}$ cups; sugar $2\frac{1}{2}$ tablespoons; salt 5 teaspoons (1 tablespoon + 2 teaspoons).
10. 0°F : $(0 - 32) \times 5 \div 9 = -160 \div 9 \approx -18^{\circ}\text{C}$. 240°F : $(240 - 32) \times 5 \div 9 = 1040 \div 9 \approx 116^{\circ}\text{C}$.
11. Fast freezing forms many tiny ice crystals that do little damage to cells. Slow freezing forms large crystals that break cell walls, so the food leaks water and turns mushy when thawed.
12. Safe: in the refrigerator, in cold water changed every 30 minutes, in the microwave (then cook right away), or straight into simmering sauce until 165°F . Unsafe: on the counter, because the outside sits in the danger zone ($40\text{--}140^{\circ}\text{F}$) where bacteria grow while the inside thaws.

UNIT CHALLENGE: FREEZER MEAL PLAN: COOK ONCE, EAT THREE TIMES

Plan and cook a big batch of one freezer-friendly food (the meatballs from Lesson 4.4, a soup, a chili or a casserole) with an adult nearby. Serve it once fresh, and freeze the rest in labeled, dated portions after cooling it safely.

Write a plan for two future meals using the frozen portions: a safe thaw method, the reheating temperature (165 °F) and what you will serve with each. Cook at least one of them within the unit, and record how the frozen food compared with the fresh: texture, flavor and your family's rating. Include a sketch of your labeled freezer bags and a one-paragraph explanation of the science of fast freezing.

LOOK FOR	WHAT IT MEANS
Safe cooking and cooling	Food cooked to the right temperature, cooled within 2 hours, and frozen spread out or in shallow portions.
Labels and plan	Every portion labeled with name and date; a clear, safe thaw and reheat plan for two meals.
Fresh vs. frozen comparison	An honest comparison of texture, flavor and family rating, with the science explained correctly.
Cleanup and improvement	Kitchen left clean; one improvement named for next time. A meal that did not freeze well but is recorded honestly earns full credit.

UNIT 5

FOOD CHEMISTRY

Every recipe is a set of chemistry instructions, and this unit teaches you to read them. You will study the five ingredients that do the most work in a kitchen: **starch**, which swells and thickens; **fats and oils**, which carry flavor and can be coaxed into mixing with water; **protein**, which stretches into gluten and sets into custard; **moisture**, which evaporates, steams and softens; and **yeast**, the living fungus that fills dough with gas.

Your guides are a retired Italian silk merchant who tested every recipe in his famous cookbook of 1891, a French duke's cook who, legend says, invented mayonnaise in 1756, a scientist in Bologna who washed a ball of dough in water until only gluten was left, and a chemist in Birmingham, England, who made an eggless custard for his wife in 1837. You will cook a creamy risotto-style rice, an egg-free Caesar dressing, hand-stretched yeast flatbreads and two custards, and you will explain the chemistry of each.

PREREQUISITES

- Knows that starch thickens when heated in water, and how to make a slurry and a roux (Grade 5 and Lesson 3.4)
- Knows that egg dishes are cooked to 160 °F and that unbaked dough and batter are never tasted (Unit 1)
- Can use the stove with an adult nearby and stir steadily over medium heat
- Has made a shaken vinaigrette (Lesson 1.2)

MASTERY CHECKLIST

- ☐ I can explain starch gelatinization and how stirring and slow additions of broth make creamy rice, and I can describe evaporation in the pot.
- ☐ I can explain what an emulsion is and how emulsifiers like mustard and Parmesan hold oil and water together, and I can make an emulsified dressing without uncooked egg.
- ☐ I can tell how Jacopo Beccari discovered gluten, explain how kneading and resting change dough, and explain how yeast and steam puff a flatbread.
- ☐ I can explain how egg proteins set a custard and how starch thickens an eggless one, and cook a custard to a safe temperature without curdling it.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **King Arthur Baking: Learn to bake guides**: Free illustrated guides from the King Arthur Baking Company about yeast, gluten and kneading. Helpful for Lesson 5.3.
- **American Chemical Society: Reactions videos**: Free short chemistry videos from the American Chemical Society, many about the chemistry of food. For curious students and parents.
- **A digital kitchen scale**: Inexpensive. Weighing flour in grams makes dough come out the same every time, and lets you weigh your gluten ball in Lesson 5.3.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

5.1 Starch at Work: Artusi's Creamy Rice

2 sessions of 50–60 minutes

5.2 Emulsions and the Mayonnaise Legend

2 sessions of 50–60 minutes

5.3 Gluten and Yeast: Hand-Stretched Flatbread

2 sessions of 60–90 minutes

5.4 Alfred Bird's Eggless Custard

2 sessions of 50–60 minutes

UNIT 5 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. 8 pts

What is gelatinization? Use it to explain why risotto-style rice becomes creamy.

2. 8 pts

Why does Arborio rice make a creamier dish than long-grain rice?

3. 8 pts

Calculation: You added 11 ladles of broth, each $\frac{1}{2}$ cup. Rice absorbs about 3 cups. About how much broth evaporated?

4. 8 pts

What is an emulsion, and how does an emulsifier work?

5. 8 pts

Tell the mayonnaise legend and give one reason historians doubt it.

6. 8 pts

Predict: You dump all the oil into the dressing base at once instead of drizzling it. What will happen, and how could you fix it?

7. 8 pts

Describe Beccari's 1728 experiment and what he discovered.

8. (8 pts)

Why does dough spring back right after kneading, and why does resting help?

9. (10 pts)

Calculation: The flatbread recipe makes 8 flatbreads with 3 cups (375 g) flour. How many grams of flour are in each flatbread? How much flour would you need for 12 flatbreads?

10. (8 pts)

Explain what happens to egg proteins as a custard cooks, and why it curdles if overheated.

11. (10 pts)

Calculation: Convert 160 °F and 180 °F to Celsius using $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5 \div 9$. Round to the nearest degree.

12. (8 pts)

Short answer: Why did Alfred Bird invent custard powder, and what thickens it?

ANSWER KEY

1. Starch granules absorb hot liquid, swell and release starch chains that thicken the liquid. Stirring short-grain rice with broth added a little at a time rubs swollen starch off the grains into the liquid, making a creamy sauce.
2. Arborio is short-grain rice with more amylopectin, a branched starch that becomes sticky and creamy; long-grain rice has more amylose, which keeps grains separate.
3. $11 \times \frac{1}{2} = 5\frac{1}{2}$ cups added. $5\frac{1}{2} - 3 = 2\frac{1}{2}$ cups evaporated (approximately).
4. A mixture of liquids that normally do not mix, like oil and water, with droplets of one spread through the other. An emulsifier has a water-loving end and an oil-loving end; it coats the droplets and keeps them from joining back together.
5. The Duke of Richelieu's cook supposedly invented the sauce after capturing Port Mahón in 1756, naming it "mahonnaise." But the word first appears in cookbooks around 1806, and other origins (Bayonne, the old word moyeu for yolk) are possible.
6. The dressing will stay thin or break into an oily mess, because the emulsifier cannot coat all the droplets at once. Fix it by whisking the broken dressing slowly into a little fresh mustard.
7. He washed a ball of wheat dough in water until the starch washed away, leaving a sticky, stretchy mass: gluten. He showed wheat contains a protein much like substances in animals.
8. Kneading links glutenin and gliadin into a tight, springy gluten network. Resting lets the gluten relax, so the dough stretches without shrinking back.
9. $375 \div 8 \approx 47$ g of flour per flatbread. For 12: $375 \times 12 \div 8 = 562.5$ g (about $4\frac{1}{2}$ cups).
10. Heat denatures the folded proteins so they unfold; they then coagulate into a net that traps milk and thickens the custard. If overheated, the net squeezes too tight into lumps and pushes out watery liquid.
11. $160^\circ\text{F}: 128 \times 5 \div 9 \approx 71^\circ\text{C}$. $180^\circ\text{F}: 148 \times 5 \div 9 \approx 82^\circ\text{C}$.
12. His wife could not eat eggs, so in 1837 he made an eggless custard. It is thickened by cornflour (cornstarch), whose granules gelatinize in hot milk.

UNIT CHALLENGE: THE KITCHEN CHEMISTRY SUPPER

Plan and cook a supper for your family that shows all five kitchen ingredients-in-action from this unit: **starch** (creamy rice or a starch-thickened sauce), **fat and emulsion** (a dressing), **protein** (custard, meatballs or eggs cooked to a safe temperature), **moisture** (evaporation, steam or browning), and **yeast and gluten** (flatbreads or rolls).

Before serving, write a menu card. After the meal, write a one-page “lab report” that names the chemistry at work in each dish, includes at least two measurements you took (temperatures, times, volumes or weights), and records your family’s ratings and one improvement for next time.

LOOK FOR	WHAT IT MEANS
Five ingredients shown	Each of the five (starch, fat/emulsion, protein, moisture, yeast/gluten) appears in the meal and is identified correctly.
Safe cooking	Eggs and meat cooked to safe temperatures, no unbaked dough or uncooked eggs tasted, adult nearby for stove and oven, clean kitchen afterward.
Lab report	Clear explanations in the student’s own words, with at least two real measurements.
Hospitality and improvement	Menu card, a set table, thanks given, and one honest improvement named. A dish that flopped but is recorded and explained earns full credit.

5.1 STARCH AT WORK: ARTUSI’S CREAMY RICE

OBJECTIVES

- Tell how Pellegrino Artusi tested and published the recipes of his 1891 cookbook, *Science in the Kitchen and the Art of Eating Well*.
- Explain how starch granules gelatinize as they absorb hot liquid, and how stirring and evaporation make risotto-style rice creamy.
- Cook a creamy Parmesan rice, adding broth a ladle at a time, and record how much liquid the rice absorbs.

Warm-up. Put a tablespoon of short-grain (Arborio) rice in one glass of cold water and a tablespoon of long-grain rice in another. Swish each with a spoon for 30 seconds. Which water turns cloudier? What do you think the cloudiness is?

WATCH

What is Starch Gelatinization? | Knead to Know Basis | BAKERpedia

BAKERpedia · 4:38

<https://www.youtube.com/watch?v=BMOgr-Buiag>

WHEN TO WATCH

After the kitchen-science paragraph, before you start the rice.

Note: From BAKERpedia, a baking-science teaching site. It shows starch granules swelling under the microscope and the temperatures at which they gelatinize.

KEY TERMS

gelatinization

When starch granules absorb hot water, swell and release starch chains that thicken the liquid. Most starches begin between about 140 and 160 °F (60–70 °C).

amylopectin

A branched kind of starch molecule that makes food sticky and creamy. Short-grain rice like Arborio has a lot of it.

amylose

A long, straight kind of starch molecule that helps cooked grains stay separate and firm. Long-grain rice has more of it.

evaporation

Liquid water turning into vapor and leaving the pot, which concentrates flavors and thickens sauces.

risotto

An Italian rice dish made by adding hot broth a little at a time and stirring, so the rice releases starch and becomes creamy.

CORE IDEAS

The story. Pellegrino Artusi was born in 1820 in the small Italian town of Forlimpopoli. He became a successful silk merchant in Florence, never married, and in his retirement turned to his favorite hobby: cooking good food and writing down exactly how to make it. When he finished his cookbook, publishers turned it down, so in 1891 he paid to print 1,000 copies himself. He called it *La scienza in cucina e l'arte di mangiar bene: Science in the Kitchen and the Art of Eating Well*.

How he figured it out. Artusi treated his kitchen like a laboratory. With his cook, Marietta Sabatini, he tested each recipe again and again, changing one thing at a time, and he wrote in a friendly, joking voice so ordinary families could follow along. Readers from all over Italy sent him letters with their own recipes and suggestions, and he tested those too and added the best to each new edition. By the time he died in 1911 the book had grown to 790 recipes and had become one of the most beloved cookbooks in Italy, including several for rice cooked in broth, the dish we call risotto.

The kitchen science. Rice grains are packed with starch. Short-grain rice such as Arborio has lots of **amylopectin**, a bushy, branched starch that turns sticky and creamy, while long-grain rice has more **amylose**, a straight starch that keeps grains separate and fluffy. When hot broth surrounds the grains, the starch granules absorb water and swell (**gelatinization**), beginning around 140–160 °F (60–70 °C). Adding broth a little at a time and stirring rubs starch off the outside of each grain into the liquid, where it thickens into a creamy sauce while the center of the grain stays slightly firm. Meanwhile some of the broth **evaporates**, carrying away water and

leaving the flavor more concentrated. Butter and Parmesan stirred in at the end add fat and savory umami. Because starch keeps swelling as it sits, creamy rice thickens on the plate; serve it right away.

Let's cook. You will make a creamy Parmesan rice with peas, risotto-style. The skill to do well is **patient stirring**: add one ladle of hot broth, stir until it is nearly absorbed, then add the next, for about 18–22 minutes, tasting the grains as you go.

PICTURE STUDY



Pellegrino Artusi, Unknown photographer, about 1890s–1900s · Photograph · Casa Artusi, Forlimpopoli, Italy (collection)

Image: [Wikimedia Commons](#), public domain

This is Pellegrino Artusi in his later years, when his cookbook was being printed in edition after edition. He liked to call himself an amateur, cooking for pleasure, but he was a careful tester. Today his hometown of Forlimpopoli holds a cooking school and festival in his name.

Look closely

- Look at his face. Does he look like a serious scientist, a cheerful host, or both?
- Look at his clothes. What do they tell you about his life as a merchant in Florence?
- How old do you think he is here? He wrote his cookbook in his seventies.
- If you could add one object to this photograph to show his love of cooking, what would it be?

Talk about it

1. Artusi tested each recipe many times, changing one thing at a time. Which lesson from this year used the same kind of fair testing?
2. Why do you think he wrote “science” in the title of a cookbook?

3. Artusi began his great project after he retired. What does that teach about learning at any age?

Safety first. An adult is nearby while you cook. Keep the broth at a gentle simmer on a back burner with the handle turned in, and ladle it carefully. Bubbling rice can spatter; stir with a long wooden spoon and keep your face back.

Creamy Rice and the Broth Count

You will cook risotto-style rice and count exactly how much broth the rice absorbs and how much evaporates. You will also compare the texture of short-grain and long-grain rice cooked the same way in a small side test.

You will need

- A wide, heavy saucepan or deep skillet, and a medium saucepan for the broth
- A ladle and a wooden spoon
- A liquid measuring cup
- A chef's knife, cutting board and box grater
- A small saucepan and $\frac{1}{4}$ cup long-grain rice for the side test

CREAMY PARMESAN RICE WITH PEAS (RISOTTO-STYLE)

Serves 5–6 servings · Prep 10 min · Cook 30 min

Ingredients

- 6 cups (1.4 L) low-sodium chicken or vegetable broth
- 2 tablespoons butter and 1 tablespoon olive oil
- 1 medium onion, diced small
- $1\frac{1}{2}$ cups (300 g) Arborio or other short-grain rice
- 1 cup (135 g) frozen peas
- $\frac{3}{4}$ cup (60 g) finely grated Parmesan cheese, plus extra to serve
- 1 teaspoon lemon zest
- Salt and pepper to taste

Method

1. Wash your hands. With an adult nearby, heat the broth in the medium saucepan until steaming, then turn it to low and keep it hot on a back burner.
2. In the wide pan, melt 1 tablespoon butter with the oil over medium heat. Cook the onion 4–5 minutes, until soft and clear.

3. Add the rice and stir 2 minutes, until the edges of the grains look see-through and the rice smells toasty.
4. Add 1 ladle (about $\frac{1}{2}$ cup) hot broth and stir until most of it is absorbed. Keep adding broth one ladle at a time, stirring often, waiting until each is nearly absorbed. Keep the mixture at a lively simmer.
5. After about 18 minutes, taste a grain. It should be tender with a tiny bit of firmness in the center, and the rice should flow slowly when you tilt the pan. Add the peas with the last ladle of broth.
6. Turn off the heat. Stir in the last tablespoon of butter, the Parmesan and lemon zest. Taste and add salt and pepper. Let it sit 1 minute and serve right away.
7. Clean up: soak the pan right away (starch dries like glue), and wash everything.

Allergy check: Contains milk (butter, Parmesan). For milk-free, use olive oil and 2 tablespoons nutritional yeast or a milk-free cheese. Some broths contain soy or wheat; check the label. No eggs or nuts.

Steps

1. **Broth count.** Keep a tally of how many $\frac{1}{2}$ -cup ladles of broth you add. When the rice is done, measure the broth left over. How many cups went into the rice?
2. **Evaporation estimate.** Measure the finished rice in cups. $1\frac{1}{2}$ cups of dry rice absorbs about 3 cups of liquid when fully cooked. Compare with the broth you added: about how much evaporated?
3. **Side test.** In the small saucepan, cook $\frac{1}{4}$ cup long-grain rice the same way with hot broth, ladle by ladle. Compare its texture with the Arborio. Which is creamier? Why?
4. Watch a spoonful of creamy rice on a plate for 5 minutes. Does it spread or set? Write what you see and explain it with the word “starch.”
5. **Taste test.** Ask your family to rate creaminess, flavor and firmness of the grains.
6. **Improve it.** Write one change: mushrooms, roasted squash, a different cheese, or less stirring to see what happens.
7. Clean up: wash, dry and put away everything.

Tips

- Hot broth keeps the pot simmering. Cold broth stops the cooking each time you add it.
- You may not need all the broth, or you may need a little hot water at the end. Let the rice, not the measuring cup, decide.
- Leftover risotto-style rice thickens in the refrigerator. An adult can help you shape it into patties and pan-fry them for lunch, reheated to 165 °F.

Check your work

- ☐ I can tell how Artusi tested and published his recipes.
- ☐ I can explain gelatinization, amylopectin and evaporation in a pot of creamy rice.
- ☐ I cooked risotto-style rice ladle by ladle and measured the broth it used.

COOK'S NOTEBOOK

1. Draw a rice grain before cooking, halfway, and done, showing starch swelling and rubbing off into the sauce.
2. Record your broth count, finished volume and evaporation estimate with your arithmetic shown.
3. Copy the recipe in Artusi's friendly style, as if writing to a reader who sent you a letter.

From history. Artusi's book was the first popular cookbook to gather recipes from many regions of the newly united Italy into one volume, helping Italians share each other's dishes. It has been translated into English, French, German, Spanish and other languages.

COMMON MISTAKES

- Rinsing short-grain rice for risotto. It washes off the surface starch that makes the dish creamy.
- Adding all the broth at once. The rice boils instead of rubbing out its starch, and turns out soupy.
- Cooking until mushy. The center of each grain should stay a little firm, "to the tooth."

Make it a game • Artusi Recipe Test. Tell your parent how Pellegrino Artusi tested and published his recipes, then play the stirring game: stir a pot of water with a spoon at a slow, steady pace for one minute as a timer runs, and explain starch gelatinization out loud while you stir. Name amylose and amylopectin from memory, then say why stirring and evaporation make risotto-style rice creamy.

5.2 EMULSIONS AND THE MAYONNAISE LEGEND

OBJECTIVES

- Tell the legend of mayonnaise and the 1756 siege of Port Mahón, and explain why historians are not sure it is true.
- Explain what an emulsion is, and how emulsifiers like mustard, egg yolk and Parmesan hold oil droplets in water.
- Make an egg-free Caesar-style dressing by whisking oil in slowly, and test how long different dressings stay emulsified.

Warm-up. Pour 2 tablespoons of oil and 2 tablespoons of water into a clear jar. Shake hard for 10 seconds and set it down. Time how long it takes to separate. Then add ½ teaspoon of mustard, shake again and time it. What did the mustard change?

WATCH

The Science of Food: Emulsions

Houston Museum of Natural Science · 4:19

<https://www.youtube.com/watch?v=cuPpVQ14320>

WHEN TO WATCH

After the story, before you make your dressing.

Note: From the Houston Museum of Natural Science. A chef and a museum educator whisk a vinaigrette and explain emulsions.

BACKUP VIDEO

Easy Homemade Caesar Dressing: No Raw Eggs, Anchovies Optional!

Natashas Kitchen · 4:04

<https://www.youtube.com/watch?v=tkdr4jt1Qvs>

For another egg-free Caesar dressing, after you make your own.

KEY TERMS

emulsion

A mixture of two liquids that normally do not mix, such as oil and water, with tiny droplets of one spread through the other.

temporary emulsion

An emulsion that separates soon after mixing, like a shaken vinaigrette without an emulsifier.

lecithin

An emulsifying molecule found in egg yolks, soybeans and other foods.

emulsifier

A substance with one end that attracts water and one end that attracts oil, which coats droplets and keeps them apart. Lecithin in egg yolk is one.

stable emulsion

An emulsion that stays mixed for days or longer, like mayonnaise.

CORE IDEAS

The story. In 1756 a French fleet and army under the Duke of Richelieu captured the British-held fortress of Port Mahón on the island of Minorca, in the Mediterranean Sea. A favorite legend says that the duke’s cook, preparing a victory dinner, found no cream for his sauce. He whisked olive oil, drop by drop, into egg yolks instead, and created a thick, shining sauce that was named “mahonnaise” after the town. Over time the name became “mayonnaise.”

How they figured it out. Food historians have checked old cookbooks and letters, and the legend may not be true. The word “mayonnaise” first appears in French cookbooks around 1806, fifty years after the battle. Other historians think the name came from the town of Bayonne, or from an old French word for egg yolk, *moyeu*. And cooks around the Mediterranean had long made a similar sauce of garlic pounded with olive oil, now called *aioli*. What cooks certainly did learn by trying is the secret of the method: oil must be added very slowly at first, while whisking hard, or the sauce “breaks” into a greasy puddle.

The kitchen science. Water molecules cling tightly to each other; oil molecules do not fit among them, so oil and water push apart and the lighter oil floats. Shaking breaks the oil into droplets, but they soon bump together and rejoin. An **emulsifier** stops this. Its molecules have a water-loving end and an oil-loving end, so they line

up around each droplet like a coat, keeping droplets from merging. Egg yolk contains **lecithin**; mustard and finely grated cheese also help hold an emulsion, and thick ingredients like yogurt slow droplets down. Adding oil slowly at first lets the emulsifier coat each new droplet. Mayonnaise is a **stable emulsion** of mostly oil held in a little water and yolk. Homemade mayonnaise with uncooked yolks is not safe for us, because uncooked eggs can carry *Salmonella*; store-bought mayonnaise is made with pasteurized eggs, and today's dressing uses no egg at all.

Let's cook. You will make a Caesar-style salad with an egg-free creamy dressing held together by mustard, Parmesan and yogurt, and crunchy homemade croutons. The skill to do well is **whisking in a thin stream**: pour the oil a few drops at a time at first, whisking constantly, then in a thin stream once the dressing thickens.

PICTURE STUDY



Still Life with Oysters, Garlic, Eggs and a Pot, Luis Egidio Meléndez, 1770s · Oil on canvas · Museo Nacional del Prado, Madrid

Image: [Wikimedia Commons](#), public domain

Luis Meléndez painted dozens of still lifes of Spanish food for the royal family's natural history collection, showing the foods of each season. Here he gathered oysters, garlic and eggs: ingredients a Spanish cook might use for a meal, and two of the ingredients of the old Mediterranean sauces of garlic, oil and egg.

Look closely

- Find the eggs. How many are there? How did Meléndez make their shells look smooth and round?
- Find the garlic bulbs. Can you see the papery skins?
- Look at the brass basin and the jug. What might a cook make with these ingredients?
- Notice where the light comes from. Which object shines the most?

Talk about it

1. Egg yolk and garlic both help make Mediterranean emulsified sauces. Why is the yolk so useful in an emulsion?
2. Why do we not use uncooked egg yolks in our own dressing today?

3. These foods were painted on a plain wooden ledge. What feeling does that give the painting?

Safety first. Never make dressings or sauces with raw or undercooked eggs; this recipe uses none. An adult is nearby while you toast croutons in the oven; use oven mitts. The optional Worcestershire sauce and anchovies contain fish, and the dressing contains milk, so check for allergies.

The Emulsion Test and an Egg-Free Caesar Salad

You will compare three dressings to see which emulsifiers hold oil and water together longest, then make a Caesar-style salad with a creamy, egg-free dressing and homemade croutons for the family.

You will need

- Three small clear jars with lids, a timer
- A medium bowl and a whisk, a damp towel to hold the bowl steady
- A liquid measuring cup with a spout
- A rimmed baking sheet, a serrated knife and cutting board
- A large salad bowl and tongs

CAESAR-STYLE SALAD WITH EGG-FREE CREAMY DRESSING AND HOMEMADE CROUTONS

Serves 6 servings · Prep 25 min · Bake 12 min

Ingredients

- **Croutons:** 4 cups (about 150 g) day-old crusty bread in $\frac{3}{4}$ -inch cubes, 2 tablespoons olive oil, $\frac{1}{4}$ teaspoon garlic powder, $\frac{1}{4}$ teaspoon salt
- **Dressing:** $\frac{1}{4}$ cup (60 g) plain Greek yogurt, 1 tablespoon prepared mustard, 2 tablespoons fresh lemon juice, 1 small clove garlic, finely grated, 1 teaspoon Worcestershire sauce or $\frac{1}{2}$ teaspoon anchovy paste (optional), $\frac{1}{2}$ cup (40 g) finely grated Parmesan, $\frac{1}{3}$ cup (80 mL) olive oil, $\frac{1}{4}$ teaspoon salt, $\frac{1}{4}$ teaspoon black pepper, 1–2 tablespoons water to thin
- 2 large heads romaine lettuce (about $1\frac{1}{2}$ pounds or 680 g), washed, dried and torn
- Extra Parmesan for shaving or grating

Method

1. Wash your hands. An adult turns the oven to 375 °F (190 °C). Toss the bread cubes with the oil, garlic powder and salt on the baking sheet and bake 10–12 minutes, stirring once, until golden and crisp. Cool.

2. Set the medium bowl on a damp towel so it will not spin. Whisk the yogurt, mustard, lemon juice, garlic, Worcestershire (if using), Parmesan, salt and pepper until smooth.
3. Whisking constantly, add the olive oil a few drops at a time for the first 2 tablespoons, then in a thin, steady stream. The dressing should turn thick and creamy. Whisk in water a spoonful at a time until it pours like heavy cream.
4. Taste. Add more lemon, salt or pepper if needed.
5. In the salad bowl, toss the romaine with about half the dressing. Add the croutons and toss again with more dressing to taste. Top with Parmesan and serve right away.
6. Clean up: wash the bowls, whisk and baking sheet, and refrigerate leftover dressing (it keeps 4–5 days).

Allergy check: Contains milk (yogurt, Parmesan) and wheat (bread). Worcestershire sauce and anchovy paste contain fish; leave them out for a fish-free dressing. Use gluten-free bread for wheat-free croutons. Mustard seed is an allergen for some. No eggs or nuts.

Steps

1. **Three-jar test.** In each jar put 2 tablespoons oil and 1 tablespoon lemon juice. Add nothing to jar A, $\frac{1}{2}$ teaspoon mustard to jar B, and $\frac{1}{2}$ teaspoon mustard plus 1 tablespoon yogurt to jar C. Shake each 15 seconds. Time how long until each separates (check every 2 minutes for 20 minutes).
2. **Fast vs. slow.** In a small cup, quickly dump 2 tablespoons oil onto 1 tablespoon of your dressing base (yogurt, mustard and lemon) and whisk. Compare with your slowly whisked dressing. Which is thicker and smoother?
3. Make the salad and dressing. Look at a drop of dressing on a dark plate with a magnifying glass. Can you see droplets?
4. **Taste test.** Ask your family to rate the dressing for creaminess, tang and saltiness, and the croutons for crunch.
5. **Improve it.** Write one change: more garlic, a little honey, or a dairy-free version with tahini (sesame) for families without sesame allergies.
6. Clean up: wash, dry and put away everything.

Tips

- If the dressing breaks and looks oily, put 1 teaspoon mustard in a clean bowl and slowly whisk the broken dressing into it.
- Dry the lettuce well. Water on the leaves thins the dressing and keeps it from clinging.
- Dress the salad just before serving so the croutons stay crisp (remember the texture lesson).

Check your work

- ☐ I can tell the Port Mahón legend and why historians doubt it.
- ☐ I can explain how an emulsifier keeps oil and water mixed.
- ☐ I made an egg-free emulsified dressing and tested three emulsions.

COOK'S NOTEBOOK

1. Draw an oil droplet surrounded by emulsifier molecules, with water-loving heads facing out and oil-loving tails facing in.
2. Make a bar graph of how many minutes each jar in the three-jar test stayed mixed.
3. Copy the dressing recipe and underline each ingredient that helps hold the emulsion.

From history. Caesar salad is said to have been created in 1924 by Caesar Cardini, an Italian-born restaurant owner in Tijuana, Mexico, who tossed romaine, croutons, Parmesan and a coddled-egg dressing at the table for his guests. Like the mayonnaise story, the details vary depending on who tells it.

COMMON MISTAKES

- Pouring the oil in all at once. The emulsifier cannot coat the droplets fast enough and the dressing stays thin or breaks.
- Making homemade mayonnaise or Caesar dressing with uncooked egg yolks. Uncooked eggs can carry Salmonella.
- Adding croutons too early. They soak up dressing and turn soggy.

Make it a game • Mayonnaise Legend Debate. Debate the legend of mayonnaise and the siege of Port Mahón. One of you argues it is true, the other argues historians are unsure, giving reasons. Then whisk a spoon of oil into a little mustard and vinegar in a bowl, adding drops slowly, and name each emulsifier at work: mustard, egg yolk, Parmesan.

5.3 GLUTEN AND YEAST: HAND-STRETCHED FLATBREAD

OBJECTIVES

- Tell how Jacopo Beccari of Bologna discovered gluten in 1728 by washing a ball of dough in water.
- Explain how kneading builds a gluten network, how resting relaxes it, and how yeast and steam make dough puff.
- Make yeast flatbreads, wash out a gluten ball, and stretch dough before and after resting.

Warm-up. Stir 2 tablespoons of flour and 1 tablespoon of water into a small ball of dough. Stretch it right away: does it tear or stretch? Knead it in your fingers for 2 minutes and stretch again. What changed? (Do not taste it.)

WATCH

Science: What is Gluten? Here's How to See and Feel Gluten

America's Test Kitchen • 3:24

<https://www.youtube.com/watch?v=zDEcvSc2UKA>

WHEN TO WATCH

After the story of Beccari, before you wash out your own gluten ball.

Note: From America's Test Kitchen's Science of Good Cooking. Dan Souza washes a ball of dough under water until only gluten is left, just as Beccari did in 1728.

BACKUP VIDEO

The Only Video You'll Ever Need to Watch About Gluten

Reactions • 3:30

<https://www.youtube.com/watch?v=-JVO62Vzhqc>

After you cook, for animations of glutenin and gliadin linking into gluten.

KEY TERMS

gluten

A stretchy network of proteins formed when wheat flour is mixed with water and kneaded. It traps gas and gives bread its chew.

knead

To push, fold and turn dough over and over, lining up and linking gluten proteins.

yeast

A living one-celled fungus that eats sugars in dough and gives off carbon dioxide gas, making dough rise.

glutenin and gliadin

The two kinds of wheat proteins that join to make gluten: glutenin gives strength and spring; gliadin gives stretch.

rest

To leave dough alone for a while so the gluten relaxes and the dough stops springing back.

CORE IDEAS

The story. Jacopo Bartolomeo Beccari was a doctor and professor in Bologna, Italy, one of the oldest university cities in Europe. Scientists of his day believed that plant foods and animal foods were made of completely different stuff. Beccari wanted to know what wheat, the most important grain in Europe, was really made of. In 1728 he presented his findings to the Academy of Sciences in Bologna.

How he figured it out. Beccari made a ball of dough from wheat flour and water and then washed it, again and again, in clean water, squeezing and kneading it as the water ran off milky white. The white cloudiness was starch, washing away. What was left in his hands was a small, sticky, stretchy, grayish mass that would not wash away. He called it the “glutinous” part of the wheat. When he tested it further, it behaved much more like substances found in animals, such as meat, than like the starch of plants. He had discovered **gluten**, and shown that wheat contains protein, a nourishing part of bread.

The kitchen science. Wheat flour holds two proteins, **glutenin** and **gliadin**. When water is added and the dough is **kneaded**, they link into long, tangled chains: **gluten**. Glutenin gives the dough strength and springiness; gliadin lets it stretch. Freshly kneaded dough springs back when you stretch it; after the dough **rests** 10–20

minutes, the gluten relaxes and the dough stretches easily. **Yeast**, a living fungus, eats sugars in the dough and breathes out carbon dioxide, which gluten traps in thousands of bubbles. In a very hot skillet, the **moisture** in a thin flatbread flashes to steam, puffing it like a balloon, while the Maillard reaction browns the spots that touch the pan. Some people have celiac disease, in which gluten harms the body; they must avoid wheat, barley and rye, and their meals are planned with their family and doctor.

Let's cook. You will make a batch of soft yeast flatbreads, stretched by hand and cooked in a dry, hot skillet. The skill to do well is **kneading** until the dough is smooth and springy, and then **stretching** rested dough into thin rounds without tearing them.

PICTURE STUDY



Woman Baking Bread, Jean-François Millet, 1854 · Oil on canvas · Kröller-Müller Museum, Otterlo, Netherlands

Image: [Wikimedia Commons](#), public domain

Jean-François Millet grew up on a farm in Normandy and spent his life painting the work of country people. Here a farm woman bakes the household's bread in a brick oven built into the wall. Families like hers baked a big batch once a week or so, and the bread had to last until the next baking day.

Look closely

- Find the glowing mouth of the brick oven. Where is the fire, and how can you tell it is very hot?
- Follow the long wooden paddle, called a peel. Why does she need such a long handle?
- Find the round straw baskets. Shaped dough rested and puffed up in baskets like these before baking.
- Look at how she leans forward. Is baking bread for a whole household light work or hard work?

Talk about it

1. What made her dough puff up before it went into the oven?
2. What happens to the outside of the loaf in the hot oven, and why does it turn brown?

3. Why do you think Millet chose to paint a farm woman baking bread?

Safety first. Never taste unbaked dough: uncooked flour can carry germs. An adult is nearby while you heat the skillet to a high temperature; use a dry pan with no oil, turn flatbreads with tongs, and keep your face back when they puff, because the steam inside is very hot.

Beccari's Gluten Ball and Skillet Flatbreads

You will repeat Beccari's experiment, washing a ball of dough until only gluten is left. Then you will make yeast flatbreads, test how resting changes stretchiness, and watch them puff with steam in a hot skillet.

You will need

- A large bowl, a wooden spoon and a clean towel or plastic wrap
- A kitchen scale (optional) and measuring cups and spoons
- An instant-read thermometer for the water
- A large cast-iron or heavy skillet and long tongs
- A small bowl and a fine strainer for the gluten ball
- A pastry brush and a clean towel to keep finished flatbreads warm

SOFT YEAST FLATBREADS

Serves 8 flatbreads · Prep 25 min · Rise 1 hr · Cook 20 min

Ingredients

- 1 cup (240 mL) warm water, 105–110 °F (40–43 °C)
- 2¼ teaspoons (1 packet) instant or active dry yeast
- 1 teaspoon sugar
- 3 cups (375 g) all-purpose flour, plus a little for shaping
- 1¼ teaspoons salt
- 2 tablespoons olive oil, plus 1 teaspoon for the bowl
- **Topping (optional):** 2 tablespoons melted butter or olive oil with 1 clove garlic, minced, and 1 tablespoon chopped parsley

Method

1. Wash your hands. Check the water with the thermometer: 105–110 °F, like a warm bath. In the large bowl, stir the water, yeast and sugar and let stand 5 minutes until foamy.
2. Add the flour, salt and 2 tablespoons oil. Stir into a shaggy dough.

3. Turn the dough onto a lightly floured counter and knead 6–8 minutes, until smooth and springy. Add flour a spoonful at a time only if it sticks badly.
4. Oil the bowl, add the dough, turn it to coat, cover, and let rise in a warm place until doubled, about 1 hour.
5. Divide the dough into 8 equal pieces (about 80 g each). Roll each into a ball, cover with a towel and let rest 10–15 minutes.
6. With an adult nearby, heat the dry skillet over medium-high heat for 3–4 minutes. Stretch or roll one ball into a thin round about 7–8 inches (18–20 cm) across.
7. Lay it in the hot skillet. Cook 1–2 minutes, until bubbles form and the bottom has brown spots. Turn with tongs and cook 1 minute more. It may puff up with steam. Move it to a towel and brush with garlic butter. Repeat with the rest.
8. Clean up: scrape dough off the counter with a bench scraper or spatula before washing (wet dough turns to glue), and let the skillet cool before wiping it.

Allergy check: Contains wheat (gluten) and milk if brushed with butter (use olive oil for milk-free). No eggs, nuts or soy. This recipe cannot be made gluten-free by a simple swap; families avoiding gluten should use a tested gluten-free flatbread recipe.

Steps

1. **Beccari's experiment.** Mix $\frac{1}{2}$ cup (65 g) flour with about $\frac{1}{4}$ cup water into a firm dough and let it rest 15 minutes. Then hold it over a strainer in a bowl and knead it under a thin stream of cool water. Keep going until the water runs nearly clear (5–10 minutes). Weigh or measure what is left. What happened to the starch? (Do not taste it.)
2. With an adult, bake your gluten ball on a small piece of foil at 425 °F for 15–20 minutes. What happens to it, and why? (Hint: water turns to steam.)
3. **Rest test.** When you divide your flatbread dough, try to stretch one ball right away. Then stretch another after 15 minutes of rest. Which stretched more easily and why?
4. Cook the flatbreads. Count how many puffed up fully. What do you think made some puff more than others?

5. **Taste test.** Serve the flatbreads with a meal, such as soup, hummus or grilled vegetables, and ask your family to rate softness and flavor.
6. **Improve it.** Write one change: thinner rounds, a hotter or cooler pan, half whole-wheat flour, or a sprinkle of herbs in the dough.
7. Clean up: wash, dry and put away everything, and wipe flour from the counter and floor.

Tips

- If the dough keeps shrinking back as you stretch it, cover it and let it rest 5 more minutes. The gluten needs to relax.
- Stack finished flatbreads in a clean towel. Their own steam keeps them soft.
- Leftover flatbreads freeze well. Reheat them in a dry skillet for 30 seconds a side.

Check your work

- ☐ I can tell how Beccari discovered gluten.
- ☐ I can explain how kneading, resting, yeast and steam change dough.
- ☐ I washed out a gluten ball and cooked yeast flatbreads that puffed.

COOK'S NOTEBOOK

1. Draw gluten as tangled chains before kneading and lined-up chains after kneading, with gas bubbles trapped inside.
2. Record the Beccari experiment: amount of flour, what washed away, what was left, and what happened when it baked.
3. Copy the flatbread recipe and note your rise time and how many flatbreads puffed.

From history. Flatbreads are among the oldest breads in the world, baked on hot stones, in clay ovens and on griddles: pita, naan, tortillas, lavash and chapati. When Jesus taught His disciples to pray for daily bread, the bread of their homes was a simple loaf or flatbread baked fresh each day.

COMMON MISTAKES

- Using water that is too hot. Water above about 130 °F (54 °C) can kill yeast; use a thermometer.
- Fighting dough that keeps shrinking. Let it rest instead; the gluten will relax.

- Adding oil to the skillet for these flatbreads. A dry, hot pan gives the brown spots and the puff.

Make it a game • Gluten Ball Wash. Knead a small dough ball for two minutes, then rest it for ten and notice the difference. Predict how it will change, then check by stretching. Retell how Jacopo Beccari washed a ball of dough in 1728 and found gluten. Explain the roles of kneading, resting, yeast and steam in the puff.

Scripture. “Give us this day our daily bread.” (Matthew 6:11, KJV)

Bread is the plainest of daily foods, and Jesus taught us to ask God for it each day. Every batch of bread is a reminder that our food comes from His hand.

5.4 ALFRED BIRD'S EGGLESS CUSTARD

OBJECTIVES

- Tell how Alfred Bird invented eggless custard powder in 1837 for his wife, who could not eat eggs.
- Explain how egg proteins thicken a custard as they set, why custards curdle, and how starch thickens an eggless custard.
- Cook a vanilla egg custard to at least 160 °F without curdling, and an eggless cornstarch custard, and compare them.

Warm-up. Crack one egg into a small bowl (wash your hands afterward). Look at the white and the yolk. With an adult, put a spoonful of the white into a cup of very hot tap water and watch for one minute. What happens? Now predict: what will happen to egg proteins in hot milk?

WATCH

How to Temper Eggs

Serious Eats · 3:18

<https://www.youtube.com/watch?v=0Z7-AblywIY>

WHEN TO WATCH

Before you cook the egg custard. Watch closely how the hot milk is added to the eggs a little at a time.

Note: From Serious Eats. Clear close-ups and animations of egg proteins unfolding, setting and overcooking.

BACKUP VIDEO

How to Make Classic Vanilla Pastry Cream

Oh Yum with Anna Olson · 3:25

<https://www.youtube.com/watch?v=-NlGom53TsM>

To watch a professional pastry chef make a vanilla pastry cream, a custard thickened with eggs and starch.

KEY TERMS

custard

A mixture of milk and eggs (or a starch) cooked gently until it thickens, served as a sauce, a pudding or a filling.

coagulate

When unfolded proteins link into a network that traps liquid, so a runny egg mixture sets or thickens.

tempering

Slowly whisking a little hot liquid into eggs to warm them gently so they do not scramble.

denature

When heat unfolds a protein's tightly folded shape so it can link with other proteins.

curdle

When a custard is overheated and its proteins squeeze together into lumps, leaving watery liquid behind.

CORE IDEAS

The story. Alfred Bird was a chemist who ran a pharmacy in Birmingham, England. His wife, Elizabeth, loved custard, but she could not eat eggs, and eggs were what made custard thick. In 1837 Bird set out to make a custard she could enjoy.

How he figured it out. Bird knew that starch thickens hot liquids. He experimented with cornflour (what Americans call cornstarch), adding flavoring and a little yellow coloring so it would look like egg custard. When the powder was stirred into hot milk with sugar, it thickened into a smooth, creamy sauce. The story goes that it was served to dinner guests by mistake one evening, and they liked it so much that Bird began to sell it. Bird's Custard Powder became a favorite across Britain and is still made today. Elizabeth could not eat yeast either, so a few years later, in 1843, Bird also developed a yeast-free baking powder to make her bread rise.

The kitchen science. In a true custard, egg proteins do the thickening. In an uncooked egg, the proteins are folded into tight balls. As the custard heats, they **denature**, unfolding into long strands, and then **coagulate**, linking into a loose net that traps the milk. A stirred custard thickens as it reaches about 160–180 °F (71–82 °C). If it gets too hot, the net squeezes tight and the custard **curdles** into sweet scrambled eggs and watery milk. **Tempering** and steady stirring over medium-low heat prevent this. Adding a little cornstarch protects the eggs, because the swelling

starch gets in the way of the proteins clumping, so a custard with starch can be brought to a gentle bubble safely. Bird's eggless custard uses only starch: the granules swell and gelatinize, just like the rice in Lesson 5.1. Egg custards must reach at least 160 °F (71 °C) to be safe.

Let's cook. You will make a vanilla custard with egg yolks and a little cornstarch, and a small batch of eggless custard in Bird's style, and compare them. The skill to do well is **tempering**: whisking the eggs constantly while pouring in the hot milk in a thin stream.

PICTURE STUDY



A Woman Preparing Bread and Butter for a Boy, Pieter de Hooch, about 1660–1663 · Oil on canvas · J. Paul Getty Museum, Los Angeles

Image: [Wikimedia Commons](#), public domain

Pieter de Hooch painted calm, orderly Dutch homes full of light. A mother is spreading butter on bread for her son, who is about to go off to school. Milk, butter and eggs from nearby farms were everyday foods in Dutch homes, and mothers made puddings, custards and porridges from them.

Look closely

- Find the bread and butter. What tool is the mother using?
- Look at the boy. What is he holding, and where do you think he is going?
- Look through the doorway. What can you see outside?
- Find the light. How does it fall on the mother's hands and the food?

Talk about it

1. Butter is a fat made from cream. Which ingredients from a Dutch dairy would you need to make a custard?
2. Alfred Bird made custard for someone who could not eat eggs. How is preparing food for someone else an act of love, as in this painting?
3. What simple food does someone prepare for you before you start your day?

Safety first. An adult is nearby while you cook. Egg custard must reach at least 160 °F (71 °C); check with a thermometer. Wash your hands after cracking eggs. Hot custard spatters and sticks to skin, so stir with a long spatula and keep your face back. Never taste the uncooked egg mixture.

KITCHEN PROJECT

Two Custards: Egg and Eggless

You will cook a classic vanilla custard thickened mainly by egg yolks, and a small eggless custard thickened only by cornstarch, as Alfred Bird did. Then you will compare their color, texture, flavor and the temperatures at which each thickened.

You will need

- A medium heavy saucepan and a small saucepan
- Two mixing bowls, a whisk and a heat-proof spatula
- A ladle or measuring cup with a spout
- An instant-read thermometer
- A fine strainer, small serving bowls and plastic wrap
- A small container for the leftover egg whites

VANILLA CUSTARD (WITH AN EGGLESS BIRD-STYLE BATCH)

Serves 6 servings of egg custard plus 2 of eggless · Prep 10 min · Cook 15 min · Chill 2 hr

Ingredients

- **Egg custard:** 2½ cups (590 mL) milk; 4 large egg yolks; ½ cup (100 g) sugar; 2 tablespoons cornstarch; ⅛ teaspoon salt; 1 tablespoon butter; 2 teaspoons vanilla extract
- **Eggless Bird-style custard:** 1 cup (240 mL) milk; 1½ tablespoons cornstarch; 1½ tablespoons sugar; a tiny pinch of ground turmeric for color (optional); ½ teaspoon vanilla extract
- Fresh berries or sliced bananas, for serving

Method

1. Wash your hands. Heat 2 cups of the milk in the medium saucepan over medium heat, with an adult nearby, until steaming and tiny bubbles form at the edge (do not boil).
2. Meanwhile, separate the eggs (save the whites in a covered container in the refrigerator). In a bowl, whisk the yolks, sugar, cornstarch, salt and

the remaining $\frac{1}{2}$ cup cold milk until smooth and pale. Wash your hands.

3. **Temper:** Whisking the yolks constantly, slowly pour in about 1 cup of the hot milk in a thin stream. Then pour the warmed yolk mixture back into the saucepan, whisking.
4. Cook over medium-low heat, stirring constantly with the spatula and scraping the bottom, until the custard thickens and begins to bubble gently, 3–5 minutes. Check that it has reached at least 160 °F (71 °C); with the cornstarch it can safely reach a gentle bubble. Stir 1 minute more.
5. Remove from the heat. Stir in the butter and vanilla. Pour through the strainer into a clean bowl to catch any lumps. Spoon into serving bowls and press plastic wrap onto the surface.
6. **Eggless batch:** In the small saucepan, whisk the cornstarch, sugar and turmeric into the cold milk until no lumps remain. Cook over medium heat, stirring constantly, until it thickens and bubbles, about 4 minutes. Stir in the vanilla and pour into two small bowls.
7. Chill both custards at least 2 hours. Serve with fruit.
8. Clean up: soak the pans right away, wash everything, and use the egg whites within 2 days (for example, in scrambled eggs or an omelet cooked until firm).

Allergy check: The egg custard contains eggs and milk. The eggless custard contains milk but no eggs. For milk-free, use unsweetened soy or oat milk (soy is a major allergen) and leave out the butter; it will be a little softer. No wheat or nuts.

Steps

1. **Predict.** Write which custard you think will be thicker, yellower and richer.
2. **Temperature log.** While cooking the egg custard, take its temperature every minute after tempering and note when it first coats the spatula. Do the same for the eggless custard.
3. **Curdle check.** With an adult, heat 2 tablespoons of the leftover egg custard in a small cup in the microwave in 10-second bursts until it bubbles hard and goes past smooth. What happens? (Do not eat curdled custard that has cooled; this is only for looking.)

4. **Compare.** After chilling, compare the two custards for color, texture (smooth, firm, wobbly), flavor and how cleanly a spoon cuts them.
5. **Taste test.** Ask your family to taste both without knowing which is which and choose a favorite.
6. **Improve it.** Write one change: chocolate custard, less sugar, or a custard sauce poured over a fruit crisp.
7. Clean up: wash, dry and put away everything.

Tips

- A heavy pan and medium-low heat give you time to stop before the eggs overcook.
- If a few lumps form, pour the custard through a strainer. If it curdles badly, start again; curdled egg cannot be un-scrambled.
- Custard keeps covered in the refrigerator for 3 days.

Check your work

- ☐ I can tell how Alfred Bird invented eggless custard powder.
- ☐ I can explain how egg proteins and starch each thicken custard, and why custard curdles.
- ☐ I tempered eggs and cooked a custard to at least 160 °F, and compared it with an eggless one.

COOK'S NOTEBOOK

1. Draw three stages of egg protein: folded (raw), unfolded (denatured), and linked in a net (coagulated). Add a fourth picture of a curdled, squeezed net.
2. Make a table of your temperature log for both custards.
3. Write a short letter as if from Alfred Bird to Elizabeth, explaining how his custard works.

From history. In Britain, “custard” poured hot over puddings and pies is a beloved part of school dinners and family meals, and much of it is still made from custard powder. Alfred Bird’s son, also named Alfred, grew the business and also became a member of Parliament.

COMMON MISTAKES

- Pouring hot milk into eggs all at once. The eggs scramble; temper them slowly while whisking.
- Turning up the heat to hurry. High heat curdles egg custard.
- Taking an egg custard off the heat before 160 °F. It may be thin and not safe.

Make it a game • Curdle or Not. Make two cards, egg custard and eggless custard. Your parent names a kitchen mistake, such as heating too fast or skipping tempering, and you say which custard it affects and why. Score a point per correct answer. Then retell how Alfred Bird invented his custard powder for his wife in 1837.

UNIT 5

FOOD CHEMISTRY

Every recipe is a set of chemistry instructions, and this unit teaches you to read them. You will study the five ingredients that do the most work in a kitchen: **starch**, which swells and thickens; **fats and oils**, which carry flavor and can be coaxed into mixing with water; **protein**, which stretches into gluten and sets into custard; **moisture**, which evaporates, steams and softens; and **yeast**, the living fungus that fills dough with gas.

Your guides are a retired Italian silk merchant who tested every recipe in his famous cookbook of 1891, a French duke's cook who, legend says, invented mayonnaise in 1756, a scientist in Bologna who washed a ball of dough in water until only gluten was left, and a chemist in Birmingham, England, who made an eggless custard for his wife in 1837. You will cook a creamy risotto-style rice, an egg-free Caesar dressing, hand-stretched yeast flatbreads and two custards, and you will explain the chemistry of each.

PREREQUISITES

- Knows that starch thickens when heated in water, and how to make a slurry and a roux (Grade 5 and Lesson 3.4)
- Knows that egg dishes are cooked to 160 °F and that unbaked dough and batter are never tasted (Unit 1)
- Can use the stove with an adult nearby and stir steadily over medium heat
- Has made a shaken vinaigrette (Lesson 1.2)

MASTERY CHECKLIST

- ☐ I can explain starch gelatinization and how stirring and slow additions of broth make creamy rice, and I can describe evaporation in the pot.
- ☐ I can explain what an emulsion is and how emulsifiers like mustard and Parmesan hold oil and water together, and I can make an emulsified dressing without uncooked egg.
- ☐ I can tell how Jacopo Beccari discovered gluten, explain how kneading and resting change dough, and explain how yeast and steam puff a flatbread.
- ☐ I can explain how egg proteins set a custard and how starch thickens an eggless one, and cook a custard to a safe temperature without curdling it.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **King Arthur Baking: Learn to bake guides**: Free illustrated guides from the King Arthur Baking Company about yeast, gluten and kneading. Helpful for Lesson 5.3.
- **American Chemical Society: Reactions videos**: Free short chemistry videos from the American Chemical Society, many about the chemistry of food. For curious students and parents.
- **A digital kitchen scale**: Inexpensive. Weighing flour in grams makes dough come out the same every time, and lets you weigh your gluten ball in Lesson 5.3.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

5.1 Starch at Work: Artusi's Creamy Rice

2 sessions of 50–60 minutes

5.2 Emulsions and the Mayonnaise Legend

2 sessions of 50–60 minutes

5.3 Gluten and Yeast: Hand-Stretched Flatbread

2 sessions of 60–90 minutes

5.4 Alfred Bird's Eggless Custard

2 sessions of 50–60 minutes

UNIT 5 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. 8 pts

What is gelatinization? Use it to explain why risotto-style rice becomes creamy.

2. 8 pts

Why does Arborio rice make a creamier dish than long-grain rice?

3. 8 pts

Calculation: You added 11 ladles of broth, each $\frac{1}{2}$ cup. Rice absorbs about 3 cups. About how much broth evaporated?

4. 8 pts

What is an emulsion, and how does an emulsifier work?

5. 8 pts

Tell the mayonnaise legend and give one reason historians doubt it.

6. 8 pts

Predict: You dump all the oil into the dressing base at once instead of drizzling it. What will happen, and how could you fix it?

7. 8 pts

Describe Beccari's 1728 experiment and what he discovered.

8. (8 pts)

Why does dough spring back right after kneading, and why does resting help?

9. (10 pts)

Calculation: The flatbread recipe makes 8 flatbreads with 3 cups (375 g) flour. How many grams of flour are in each flatbread? How much flour would you need for 12 flatbreads?

10. (8 pts)

Explain what happens to egg proteins as a custard cooks, and why it curdles if overheated.

11. (10 pts)

Calculation: Convert 160 °F and 180 °F to Celsius using $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5 \div 9$. Round to the nearest degree.

12. (8 pts)

Short answer: Why did Alfred Bird invent custard powder, and what thickens it?

ANSWER KEY

1. Starch granules absorb hot liquid, swell and release starch chains that thicken the liquid. Stirring short-grain rice with broth added a little at a time rubs swollen starch off the grains into the liquid, making a creamy sauce.
2. Arborio is short-grain rice with more amylopectin, a branched starch that becomes sticky and creamy; long-grain rice has more amylose, which keeps grains separate.
3. $11 \times \frac{1}{2} = 5\frac{1}{2}$ cups added. $5\frac{1}{2} - 3 = 2\frac{1}{2}$ cups evaporated (approximately).
4. A mixture of liquids that normally do not mix, like oil and water, with droplets of one spread through the other. An emulsifier has a water-loving end and an oil-loving end; it coats the droplets and keeps them from joining back together.
5. The Duke of Richelieu's cook supposedly invented the sauce after capturing Port Mahón in 1756, naming it "mahonnaise." But the word first appears in cookbooks around 1806, and other origins (Bayonne, the old word moyeu for yolk) are possible.
6. The dressing will stay thin or break into an oily mess, because the emulsifier cannot coat all the droplets at once. Fix it by whisking the broken dressing slowly into a little fresh mustard.
7. He washed a ball of wheat dough in water until the starch washed away, leaving a sticky, stretchy mass: gluten. He showed wheat contains a protein much like substances in animals.
8. Kneading links glutenin and gliadin into a tight, springy gluten network. Resting lets the gluten relax, so the dough stretches without shrinking back.
9. $375 \div 8 \approx 47$ g of flour per flatbread. For 12: $375 \times 12 \div 8 = 562.5$ g (about $4\frac{1}{2}$ cups).
10. Heat denatures the folded proteins so they unfold; they then coagulate into a net that traps milk and thickens the custard. If overheated, the net squeezes too tight into lumps and pushes out watery liquid.
11. $160^\circ\text{F}: 128 \times 5 \div 9 \approx 71^\circ\text{C}$. $180^\circ\text{F}: 148 \times 5 \div 9 \approx 82^\circ\text{C}$.
12. His wife could not eat eggs, so in 1837 he made an eggless custard. It is thickened by cornflour (cornstarch), whose granules gelatinize in hot milk.

UNIT CHALLENGE: THE KITCHEN CHEMISTRY SUPPER

Plan and cook a supper for your family that shows all five kitchen ingredients-in-action from this unit: **starch** (creamy rice or a starch-thickened sauce), **fat and emulsion** (a dressing), **protein** (custard, meatballs or eggs cooked to a safe temperature), **moisture** (evaporation, steam or browning), and **yeast and gluten** (flatbreads or rolls).

Before serving, write a menu card. After the meal, write a one-page “lab report” that names the chemistry at work in each dish, includes at least two measurements you took (temperatures, times, volumes or weights), and records your family’s ratings and one improvement for next time.

LOOK FOR	WHAT IT MEANS
Five ingredients shown	Each of the five (starch, fat/emulsion, protein, moisture, yeast/gluten) appears in the meal and is identified correctly.
Safe cooking	Eggs and meat cooked to safe temperatures, no unbaked dough or uncooked eggs tasted, adult nearby for stove and oven, clean kitchen afterward.
Lab report	Clear explanations in the student’s own words, with at least two real measurements.
Hospitality and improvement	Menu card, a set table, thanks given, and one honest improvement named. A dish that flopped but is recorded and explained earns full credit.

CRAVINGS, REWARD & A BALANCED DIET

Why do you suddenly want a snack when you walk past a bakery, or at the same time every afternoon? Why is it easy to keep eating chips long after you are full, but hard to eat a second bowl of plain oatmeal? This unit looks honestly at how God made our bodies and brains to want food, how those wants are learned, and how good habits and self-control help us enjoy food in its place.

You will meet Ivan Pavlov, whose dogs learned to expect dinner at the sound of a signal; Walter Mischel and the children of the marshmallow test; and Susanna Holt, who measured which foods keep people satisfied longest. You will learn to read the Added Sugars line on a Nutrition Facts label. Along the way you will make crunchy roasted chickpeas, a portioned fruit crisp, a hearty vegetable-bean soup and homemade granola, and you will keep a habit log. This unit is about wisdom and thankfulness, not about bodies: treats and feasts are good gifts, and nutrient-dense foods are good gifts too.

PREREQUISITES

- Knows the three macronutrients and that Calories measure food energy (Unit 2)
- Can read a Nutrition Facts label for serving size and grams (Unit 2)
- Can roast and simmer with an adult nearby (Units 3–4)
- Knows that tastes change with repeated tasting (Unit 3)

MASTERY CHECKLIST

- ☐ I can tell how Ivan Pavlov discovered that the body learns to expect food, and explain cues, cravings and habits in my own life.
- ☐ I can explain dopamine as a messenger linked to wanting and learning, and why foods that combine sugar, salt and fat are easy to keep eating.
- ☐ I can describe the marshmallow test honestly, including what later studies found, and name strategies that help with self-control.
- ☐ I can explain what helps us feel satisfied (protein, fiber, water, volume and about 20 minutes of time) and read the Added Sugars line on a label, converting grams to teaspoons.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **FDA: Added Sugars on the Nutrition Facts Label**: Free. The U.S. Food and Drug Administration explains the Added Sugars line and the Daily Value. Useful for Lesson 6.4.
- **KidsHealth (Nemours): Food and nutrition articles for kids and teens**: Free, reliable articles from a children's health system, written for young readers, about hunger, fullness, snacks and labels.
- **A set of small bowls or ramekins**: Inexpensive. Handy for portioning snacks and desserts in Lessons 6.1–6.2.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

6.1	Ivan Pavlov and Learning to Expect Food	2 sessions of 50–60 minutes
6.2	The Marshmallow Test and Self-Control	2 sessions of 50–60 minutes
6.3	Satiety: Fiber, Protein, Water and Time	2 sessions of 50–60 minutes
6.4	Labels and Added Sugar	2 sessions of 50–60 minutes

UNIT 6 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**
What did Ivan Pavlov notice about his laboratory dogs, and how did he test it?
2. **8 pts**
Describe dopamine accurately. What is it, and what does it do?
3. **8 pts**
Name three food cues from everyday life and one way to retrain a cue-driven habit.

4. 8 pts

What did the marshmallow test measure, and what did the 2018 study and the 2012 study add?

5. 8 pts

List three strategies that make it easier to wait or to enjoy treats in their place.

6. 8 pts

What did Susanna Holt's 1995 study find about which foods keep people satisfied?

7. 8 pts

Name four things that help a meal keep us satisfied.

8. 10 pts

Calculation: A cereal has 16 grams of added sugars per serving, and you eat $1\frac{1}{2}$ servings. How many grams and how many teaspoons of added sugar is that?

9. 10 pts

Calculation: The Daily Value for added sugars is 50 grams. What %DV is a drink with 39 grams of added sugars? About how many teaspoons is it?

10. 8 pts

Calculation: Your granola has $\frac{1}{3}$ cup honey (about 90 grams of sugar) and makes 12 servings. How many grams of added sugar per serving, and about how many teaspoons?

11. 8 pts

Predict: A family cuts back on sweetened drinks and desserts for three weeks. What will probably happen to how sweet foods taste to them?

12. 8 pts

Short answer: Explain in two or three sentences how a Christian can enjoy treats and feasts while practicing self-control.

ANSWER KEY

1. The dogs began to drool before food arrived, at the sight of the dish or the sound of footsteps. He sounded a signal (such as a metronome or buzzer) before each feeding until the dogs drooled at the signal alone: a conditioned reflex.
2. A messenger chemical in the brain released when we expect or get something good. It is tied to wanting, motivation and learning what is rewarding, not simply to pleasure.
3. Examples: the smell of a bakery, a commercial, a certain time of day, a screen, a chip bag crinkling. Retrain: notice the cue, pause and drink water, ask whether you are hungry, plan a satisfying snack, or move treats out of sight.
4. Whether young children could wait for a bigger reward and how they did it. The 2018 study found the link with later success was smaller than first thought and partly explained by home life; the 2012 study found children waited longer when the adult had kept an earlier promise.
5. Any three: look away or keep treats out of sight, keep busy, sing or think of something else, serve a planned portion in a small bowl, eat slowly at the table, enjoy treats after a balanced meal, plan when treats fit in the week.
6. Boiled potatoes scored highest (more than three times white bread); fish, oatmeal, oranges, apples, beans and lean meat also scored high; croissants, cake, doughnuts and candy scored low.
7. Protein, fiber, water and volume, plus time (eating slowly so fullness signals can arrive in about 20 minutes).
8. $16 \times 1\frac{1}{2} = 24$ grams. $24 \div 4 = 6$ teaspoons.
9. $39 \div 50 = 0.78$, or 78% DV. $39 \div 4 \approx 9\frac{3}{4}$ teaspoons, about 10 teaspoons.
10. $90 \div 12 = 7.5$ grams per serving. $7.5 \div 4 \approx 1.9$, about 2 teaspoons.
11. Their taste buds will adjust, so lightly sweetened foods and fruit will taste sweeter and very sugary foods may taste too sweet.
12. Answers vary. Example: Treats and feasts are good gifts from God to enjoy with thanks. Self-control, a fruit of the Spirit, helps us enjoy them at the right time and in the right amount, so that food serves us and our family rather than ruling us.

UNIT CHALLENGE: A TWO-WEEK SNACK AND DRINK SWAP

For two weeks, keep a daily log of your snacks and drinks. In the first few days, notice your cues and your hunger ratings. Then choose two swaps (for example, water or milk instead of a sweet drink at lunch, and a planned homemade snack such as roasted chickpeas, fruit with cheese, or yogurt with granola after school).

Make at least two homemade snacks during the two weeks. At the end, write a one-page reflection: which cues you noticed, which swaps were easy or hard, how your taste buds changed, and which treats you enjoyed in their place. Include one chart from your log.

LOOK FOR	WHAT IT MEANS
Honest daily log	Snacks, drinks, cues and hunger ratings recorded on most days, with no judgment of anyone’s body.
Swaps and homemade snacks	Two clear swaps tried, and at least two homemade snacks made safely and cleaned up after.
Chart and reflection	One clear chart and a thoughtful reflection about cues, satisfaction and taste-bud changes.
Thankfulness and improvement	Names one habit to keep and one to improve; days that did not go as planned, honestly recorded, still earn full credit.

6.1 IVAN PAVLOV AND LEARNING TO EXPECT FOOD

OBJECTIVES

- Tell how Ivan Pavlov discovered in the 1890s and 1900s that the body learns to expect food from signals.
- Explain cues, cravings and habits, and describe dopamine accurately as a messenger tied to wanting and learning.
- Make crunchy roasted chickpeas as a planned snack and keep a three-day habit log.

Warm-up. Close your eyes while an adult opens a jar of peanut butter, a bag of popcorn or a lemon near you (check allergies). Before you see or taste anything, notice: does your mouth start to water? Do you suddenly feel hungrier? Write down what happened in your body, and when.

WATCH

Pavlov's Classical Conditioning

Sprouts • 4:42

<https://www.youtube.com/watch?v=jd7Jdug5SRc>

WHEN TO WATCH

After the story of Pavlov, before you start your habit log.

Note: An animated lesson from Sprouts. It shows Pavlov's dogs connected to saliva-measuring tubes in simple drawings, without any surgery shown.

KEY TERMS

conditioning

Learning to connect a signal with something that follows it, so the body responds to the signal alone.

cue

A signal that triggers a want or a habit: a smell, a time of day, a place, a package or a picture.

craving

A strong want for a particular food, often set off by a cue rather than by true hunger.

dopamine

A messenger chemical in the brain tied to wanting and motivation. It is released when we expect or receive something good, and it helps us learn what to seek again.

habit

Something we do so often in the same situation that we do it almost without thinking.

CORE IDEAS

The story. Ivan Pavlov was the son of a village priest in Ryazan, Russia, and he first studied for the priesthood before turning to science. In St. Petersburg he became one of the world's great experts on digestion, studying how the stomach and glands prepare to digest food. In 1904 he received the Nobel Prize for this work. But along the way, something kept spoiling his measurements.

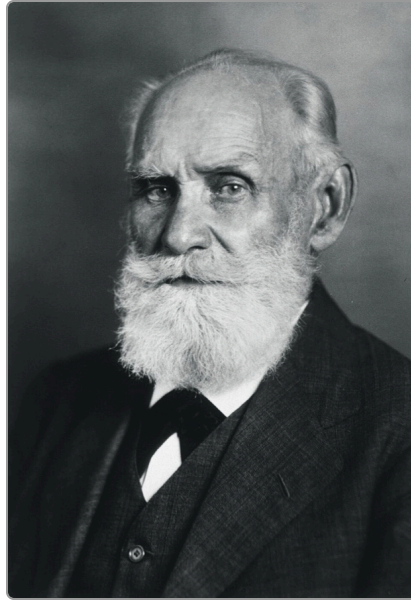
How he figured it out. Pavlov and his assistants measured how much saliva their laboratory dogs produced when food was placed in their mouths. They noticed that the dogs began to drool before the food arrived: at the sight of the food dish, or even at the sound of the assistant's footsteps. Instead of ignoring this, Pavlov studied it. His team sounded a signal, such as a metronome or a buzzer, just before feeding the dogs, again and again. Soon the dogs drooled at the sound alone. The body had **learned** to expect food from a signal. Pavlov called this a conditioned reflex, and it became one of the most famous discoveries in psychology.

The kitchen science. People learn the same way. The smell of a bakery, the crinkle of a chip bag, a commercial, the clock striking three, or sitting down in front of a screen can become **cues** that make us want food even when we are not hungry. In the brain, a messenger chemical called **dopamine** is released when we expect or receive something good. Dopamine is less about pleasure itself than about **wanting** and learning: it helps the brain remember what was rewarding and push us to seek it again. God made us able to enjoy food and to want what nourishes us, and that is good. But cues can build **habits**, like grabbing a snack every time we walk into the kitchen after school. The good news is that habits can be retrained. Noticing the cue,

asking “Am I hungry, or just reminded?”, and planning a satisfying snack ahead of time puts you back in charge.

Let’s cook. You will make a batch of crunchy oven-roasted chickpeas in two flavors, a planned snack with protein and fiber. The skill to do well is **drying the chickpeas thoroughly** before roasting, so they turn crisp instead of chewy.

PICTURE STUDY



Ivan Pavlov, Unknown photographer, about 1930 · Photograph · National Library of Medicine, Bethesda, Maryland

Image: [Wikimedia Commons](#), public domain

This photograph shows Ivan Pavlov late in his long life, when he was about eighty and still working in his laboratory. He was famous for his hard work and strict, careful habits: he arrived at his laboratory at the same time each day, ate his meals at the same times, and expected the same exactness from his students.

Look closely

- Look at his face and eyes. What words describe him: patient, stern, curious, kind?
- Look at his beard and clothing. About how old do you think he is?
- What would you expect to see in his laboratory if the photographer had stepped back?
- Does he look like a man who noticed small details? Why?

Talk about it

1. Pavlov noticed something that “spoiled” his experiment and made it a new discovery. Why is it important to notice surprises?
2. Pavlov kept very regular mealtimes. How might regular mealtimes help a family avoid snacking at every cue?

3. What cue in your own day most often makes you want a snack?

Safety first. An adult is nearby while you use the oven. Roasting chickpeas can pop and spit; stir them with a long spoon and use oven mitts. Check the seasonings and the warm-up foods against your family's allergies.

KITCHEN PROJECT

Roasted Chickpeas and the Three-Day Habit Log

You will make a planned snack and then become a scientist of your own habits. For three days, you will log every time you want a snack: what the cue was, whether you were truly hungry, and what you chose.

You will need

- A rimmed baking sheet and parchment
- A colander and clean kitchen towels
- Two small bowls for seasoning, measuring spoons
- Oven mitts and a long spoon
- Your cook's notebook for the habit log

CRUNCHY OVEN-ROASTED CHICKPEAS, TWO WAYS

Serves 4–6 snack servings • Prep 15 min • Roast 30–40 min

Ingredients

- 2 cans (15 oz or 425 g each) chickpeas, drained and rinsed
- 2 tablespoons olive oil, divided
- ½ teaspoon salt, divided
- **Savory:** ½ teaspoon smoked paprika, ¼ teaspoon garlic powder, ¼ teaspoon cumin
- **Sweet-spiced:** ½ teaspoon cinnamon and 1 teaspoon brown sugar, tossed on after roasting

Method

1. Wash your hands. An adult turns the oven to 400 °F (200 °C).
2. Spread the chickpeas on a clean towel and rub gently with another towel until very dry. Pick off any loose skins.
3. Toss the chickpeas with 1½ tablespoons oil and ¼ teaspoon salt. Spread them in one layer on the parchment-lined sheet.
4. Roast 30–40 minutes, shaking the pan every 10 minutes, until golden and crunchy all the way through (cool one for a minute and bite it to

test).

5. Divide the hot chickpeas between two bowls. Toss one half with the remaining oil, salt and savory spices; toss the other with the cinnamon and brown sugar.
6. Cool completely. Store in an open bowl for the first day (a sealed jar traps moisture and softens them).
7. Clean up: throw away the parchment, wash the bowls and wipe the counter.

Allergy check: No major allergens in the chickpeas and spices. Chickpeas are legumes; people with peanut allergy are usually fine with them, but check with your family. No milk, eggs, wheat, nuts or soy.

Steps

1. **Habit log.** For three days, every time you want a snack, write: the time, where you were, the cue (smell, boredom, screen, time of day, seeing food), your hunger from 1 (not hungry) to 5 (very hungry), and what you chose.
2. Make the roasted chickpeas, and portion them into small snack bowls or bags for the three days.
3. **Pause test.** Once a day, when a craving comes, wait 10 minutes and drink a glass of water first. Record whether the craving was still there after 10 minutes.
4. **Find the pattern.** At the end of three days, circle the cue that showed up most. Was most of your snacking from true hunger or from cues?
5. **Plan.** Write one change for next week: a planned after-school snack, eating at the table instead of in front of a screen, or moving the cookie jar out of sight.
6. **Taste test.** Ask your family to rate both chickpea flavors.
7. Clean up: wash, dry and put away everything.

Tips

- The drier the chickpeas, the crunchier the result. An extra 5 minutes of drying makes a big difference.
- Chickpeas crisp more as they cool. If they are still chewy when cool, roast 5–10 minutes more.
- Be honest in your log. The goal is to learn, not to get a perfect score.

Check your work

- ☐ I can tell how Pavlov discovered conditioned reflexes.
- ☐ I can explain cues, cravings, habits and dopamine as a “wanting” messenger.
- ☐ I made a planned snack and kept a three-day habit log.

COOK’S NOTEBOOK

1. Draw Pavlov’s experiment as three panels: signal plus food, signal plus food again, signal alone.
2. Draw your own “habit loop” as a circle: cue, routine (what you did), reward, and one way to change it.
3. Copy your habit log neatly with your pattern circled and your plan for next week.

From history. Pavlov worked into his eighties and remained outspoken and independent all his life. Many of his students became leading scientists, and his laboratory near St. Petersburg trained researchers from around the world.

COMMON MISTAKES

- Calling dopamine the “pleasure chemical.” It is more about wanting, motivation and learning what to seek.
- Thinking every craving means you are hungry. Many cravings come from cues; a pause and a glass of water help you tell the difference.
- Feeling guilty about wanting food. Wanting food is good and God-given; wisdom is about how we answer the want.

Make it a game • Cue and Craving Chain. Think of a cue, like a smell of bread or a bell sound, and tell a story chain of how it triggers expecting food, as in Pavlov's dogs. You and your parent add one sentence each. Include the words conditioning, cue, craving, habit and dopamine. Whoever can add a new fact last wins a point.

6.2 THE MARSHMALLOW TEST AND SELF-CONTROL

OBJECTIVES

- Tell the story of Walter Mischel's marshmallow test at Stanford University and what later studies added.
- Name practical strategies that make waiting and self-control easier, and connect self-control to the fruit of the Spirit.
- Bake an apple-berry crisp, portion it, and practice “waiting for it” while it cools.

Warm-up. Imagine someone offers you one cookie now, or two cookies if you can wait 15 minutes alone in a room with the one cookie in front of you. Write what you would do and exactly how you would pass the time. Then ask a younger child and an adult the same question and compare answers.

WATCH

The Marshmallow Test | Igniter Media | Church Video

Igniter Media · 3:28

https://www.youtube.com/watch?v=QX_oy9614HQ

WHEN TO WATCH

After the story, before you bake. Watch the children's strategies and write down two you could use.

Note: A short film of children taking a version of the marshmallow test, with no narration; watch their strategies.

BACKUP VIDEO

How to Make the Easiest Apple Crumble with Julia Collin Davison

America's Test Kitchen · 8:49

<https://www.youtube.com/watch?v=bNCPY6XlsN0>

Before you bake, to see an expert make a fruit crumble topping by hand.

KEY TERMS

self-control

Choosing what is good and wise instead of what is tempting right now. Scripture calls it temperance, a fruit of the Spirit.

delayed reward

A bigger or better reward that comes later, if you wait.

strategy

A plan or trick that helps you succeed, such as looking away, singing or keeping busy.

portion

The amount of food served to one person at one time.

replication

Repeating an experiment, often with more people, to see if the results hold up.

CORE IDEAS

The story. In the late 1960s and early 1970s, a psychologist named Walter Mischel and his students ran a simple test at the Bing Nursery School on the campus of Stanford University in California. A child of about four or five sat at a table with a treat, often a marshmallow or a pretzel stick. The researcher said: “You can eat this one now, or, if you wait until I come back, you can have two.” Then the researcher left the room, sometimes for as long as 15 or 20 minutes.

How they figured it out. Some children ate the treat right away. Others waited the whole time. The researchers watched how the waiting children did it. They covered their eyes, turned their chairs around, sang songs, kicked the table, or imagined the marshmallow as a fluffy cloud instead of something sweet. When children were taught these tricks, many more of them could wait. Years later, Mischel checked on some of the children as teenagers and found that the waiters tended to do better in school. In 2018 a much larger study repeated the test and found that the link with later success was smaller than first thought, and was partly explained by children’s home lives. Another study in 2012 found that children waited much longer when the adult had kept an earlier promise. Waiting is easier when we trust that the promise is real.

The kitchen science. Self-control is not about never enjoying a treat. It is about choosing the best time and amount, and it is a skill that grows with practice and with good **strategies**. Keeping treats out of sight, serving a planned **portion** in a small bowl instead of eating from the pan, eating slowly at the table, and waiting until after a balanced meal all help. The fruit crisp you make today teaches a kitchen kind of waiting: it must cool for 20–30 minutes so the bubbling juices thicken (the starch sets as it cools) and so no one burns a tongue. Scripture lists temperance, or self-control, as a fruit of the Spirit (Galatians 5:22-23): something God grows in us, not just something we force.

Let's cook. You will bake an apple-berry crisp with an oat topping, made with less sugar than many recipes because ripe fruit is already sweet. The skill to do well is **rubbing butter into the topping** with your fingertips until it forms clumps, so it bakes crisp.

PICTURE STUDY



Still Life with Apples and Pears, Paul Cézanne, about 1891–1892 · Oil on canvas · Metropolitan Museum of Art, New York

Image: [Wikimedia Commons](#), public domain

Paul Cézanne painted apples again and again for most of his life, sometimes the same fruit for days, until it began to soften. He was patient: he wanted to show how solid and round each apple was, and how the colors of the fruit and the cloth affected each other.

Look closely

- Count the apples and pears. Which look ripest?
- Look at the white cloth. Is it flat and neat, or folded and rumpled?
- Find a piece of fruit that looks as if it might roll off the table. How did Cézanne make it look that way?
- Look at the colors on one apple. How many colors can you find on it?

Talk about it

1. Cézanne waited patiently, painting the same fruit for days. How is patience part of good cooking, too?
2. Ripe apples and pears are naturally sweet. How does that help a fruit crisp need less added sugar?

3. If you could arrange a still life of fruit for a family dessert, what would you choose?

Safety first. An adult is nearby while you use the oven. The filling bubbles at well above the boiling point of water and can burn badly, so let the crisp cool at least 20 minutes before serving. Use oven mitts and set the hot dish on a rack or trivet.

Wait for It: A Portioned Fruit Crisp

You will bake an apple-berry crisp for the family and practice the “wait for it” strategy while it cools. You will also portion it into servings before anyone eats, and make a plan for when treats fit best in your family’s week.

You will need

- An 8 × 8-inch or 9-inch baking dish
- Two mixing bowls, a vegetable peeler, a paring knife and a cutting board
- Measuring cups and spoons, a timer
- Oven mitts and a cooling rack
- Small bowls or ramekins for portions

APPLE-BERRY CRISP WITH OAT TOPPING

Serves 8 servings · Prep 25 min · Bake 40–45 min · Cool 20–30 min

Ingredients

- **Filling:** 5 medium apples (about 2 pounds or 900 g), peeled and sliced $\frac{1}{4}$ inch thick; $1\frac{1}{2}$ cups (about 200 g) berries, fresh or frozen; 2 tablespoons sugar; 1 tablespoon cornstarch; 1 tablespoon lemon juice; 1 teaspoon cinnamon
- **Topping:** $\frac{3}{4}$ cup (70 g) old-fashioned rolled oats; $\frac{1}{2}$ cup (65 g) all-purpose flour; $\frac{1}{3}$ cup (70 g) packed brown sugar; $\frac{1}{2}$ teaspoon cinnamon; $\frac{1}{4}$ teaspoon salt; 6 tablespoons (85 g) cold butter, cut in small cubes

Method

1. Wash your hands. An adult turns the oven to 375 °F (190 °C).
2. Peel, core and slice the apples using the claw grip. In a bowl, toss the apples and berries with the sugar, cornstarch, lemon juice and cinnamon. Spread in the baking dish.
3. In the second bowl, stir the oats, flour, brown sugar, cinnamon and salt. Add the butter cubes and rub them in with your fingertips until the mixture forms pea-size clumps.

4. Sprinkle the topping evenly over the fruit.
5. Bake 40–45 minutes, until the topping is golden and the juices bubble thickly around the edges. (Put a baking sheet on the rack below to catch drips.)
6. Cool on a rack at least 20–30 minutes, so the juices thicken. Cut or scoop into 8 portions.
7. Clean up: wash the bowls and tools, and wipe the counter of apple peels and flour (peels can go in the compost).

Allergy check: Contains wheat and milk. For wheat-free, use a 1-to-1 gluten-free flour and oats labeled gluten-free. For milk-free, use a plant-based butter or $\frac{1}{4}$ cup coconut oil. No eggs, nuts or soy (some families add chopped nuts; check allergies first).

Steps

1. **Waiting plan.** Before the crisp comes out, write three strategies you will use to wait 20–30 minutes (for example: set the table, wash the dishes, read a chapter). Use them.
2. Bake the crisp. Take a photo or draw it right out of the oven and again after cooling. How did the juices change?
3. **Portion it.** Cut the crisp into 8 equal portions before serving. Serve each portion in a small bowl at the table after dinner.
4. **Sugar math.** Add up the sugar in the recipe (2 tablespoons granulated plus $\frac{1}{3}$ cup brown sugar, about $7\frac{1}{3}$ tablespoons, or about 22 teaspoons). Divide by 8. About how many teaspoons of added sugar are in each portion?
5. **Taste test.** Ask your family whether the crisp is sweet enough with the fruit doing most of the work. Rate it from 1 to 5.
6. **Treats in their place.** With your family, plan when desserts fit best in your week (for example, Sunday dinner and a birthday), and write the plan in your notebook.
7. Clean up: wash, dry and put away everything.

Tips

- Use a mix of tart and sweet apples, such as Granny Smith and Gala, for the best flavor and texture.
- Frozen berries can go in frozen; add 5 minutes to the baking time.

- Leftover crisp keeps covered in the refrigerator for 3 days. It also makes a good breakfast with plain yogurt.

Check your work

- ☐ I can tell the story of the marshmallow test and what later studies found.
- ☐ I can name three strategies that make waiting easier.
- ☐ I baked a fruit crisp, waited for it to cool, and portioned it.

COOK'S NOTEBOOK

1. Draw a comic strip of a child using three different strategies to wait in the marshmallow test.
2. Record your sugar math for one portion of crisp.
3. Write your family's "treats in their place" plan for the week.

From history. Walter Mischel was born in Vienna, Austria, in 1930, and his family fled to the United States when he was a boy. He spent his life studying self-control and wrote a book about it, *The Marshmallow Test*, in 2014, in which he stressed that self-control can be learned.

COMMON MISTAKES

- Thinking self-control means never having treats. It means enjoying them at a good time, in a good amount, with thanks.
- Serving a crisp right out of the oven. The filling is dangerously hot and still runny; wait.
- Eating straight from the pan. A served portion helps you notice and enjoy what you eat.

Make it a game • Marshmallow Strategy Cards. Write five waiting strategies on slips, such as distracting yourself or covering the treat. Place one cracker in front of you with a two-minute timer and try each strategy in turn. Rate each from one to five. Retell Walter Mischel's study and tell what later studies added. Connect self-control to the fruit of the Spirit.

Scripture. “But the fruit of the Spirit is love, joy, peace, longsuffering, gentleness, goodness, faith, Meekness, temperance: against such there is no law.” (Galatians 5:22-23, KJV)

Temperance means self-control. Like fruit on a tree, it grows over time; God grows it in us as we walk with Him and practice it in small daily choices.

6.3 SATIETY: FIBER, PROTEIN, WATER AND TIME

OBJECTIVES

- Tell how Susanna Holt and her team measured the “satiety index” of 38 foods in 1995.
- Explain how protein, fiber, water, food volume and about 20 minutes of time help us feel satisfied.
- Cook a hearty vegetable-bean soup and record hunger and fullness before and after a meal.

Warm-up. Rate how hungry you are right now from 1 (not hungry at all) to 5 (very hungry). Then list three meals that kept you feeling full and steady for a long time, and three foods that left you hungry again soon. What do the long-lasting ones have in common?

WATCH

How does your body know you're full? - Hilary Coller

TED-Ed • 4:33

<https://www.youtube.com/watch?v=YVfyYrEmzgM>

WHEN TO WATCH

After the kitchen-science paragraph, before you cook the soup.

Note: A TED-Ed animation of how the stomach, gut and brain signal fullness, ending with how water, fiber and protein help. (The Grade 5 course also uses it; it is the clearest short video on this topic.)

KEY TERMS

satiety

The feeling of being satisfied after eating, which keeps us from feeling hungry again for a while. Say it “suh-TY-uh-tee.”

satiety index

A ranking of foods by how satisfied people felt for two hours after eating equal amounts of energy from each.

fiber

The part of plant foods the body cannot digest. It adds bulk, slows digestion and helps us feel full.

volume

How much space food takes up. Foods with lots of water and fiber, like soup and vegetables, have high volume.

fullness signals

Messages from the stomach and intestines to the brain, by nerves and hormones, that say “enough.” They take about 20 minutes to build.

CORE IDEAS

The story. In the early 1990s, a young nutrition scientist named Susanna Holt at the University of Sydney in Australia wanted to answer a question every cook and parent wonders about: which foods keep people satisfied longest? Many people had opinions, but almost no one had measured it carefully.

How she figured it out. Holt and her team chose 38 common foods, from fruit and fish to cake and candy. They served volunteers equal-energy portions of one food at a time, each portion giving 240 Calories. Every 15 minutes for two hours, the volunteers rated how full or hungry they felt. Then they were allowed to eat what they liked from a buffet, and the researchers measured how much they ate. White bread was given a score of 100, and every other food was compared with it. Plain boiled potatoes scored highest, more than three times higher than white bread. Fish, oatmeal, oranges, apples, beans and lean meat also scored high. A croissant scored lowest, with cake, doughnuts and candy bars near the bottom. The study was published in 1995.

The kitchen science. Foods that kept people satisfied had a few things in common.

Protein (fish, meat, eggs, beans) is digested slowly and sends strong fullness signals.

Fiber (beans, oats, vegetables, fruit with its skin) adds bulk and slows digestion.

Water and volume fill the stomach: a bowl of soup takes up much more room than the same energy in a cookie. Foods that combine lots of sugar and fat in a small, soft package tend to be eaten quickly and leave people hungry sooner. Fullness signals from the stomach and intestines take about **20 minutes** to reach the brain, so eating slowly, at a table, with conversation, lets the body catch up. This is not about eating

less; growing bodies need plenty of food. It is about eating in a way that gives steady energy and real satisfaction.

Let's cook. You will make a big pot of minestrone-style vegetable-bean soup with pasta, full of protein, fiber and water. The skill to do well is **layering a soup**: soften the onions, carrots and celery first, then add tomatoes and broth, then the slower-cooking vegetables, then beans and pasta at the end so nothing turns mushy.

PICTURE STUDY



Girl Eating Soup, Albert Anker, 1898 · Oil on canvas · Private collection, Switzerland

Image: [Wikimedia Commons](#), public domain

Albert Anker painted the children of his Swiss village with great tenderness. Soup with bread was the everyday supper of many farm families: warm, filling and inexpensive. This girl eats slowly and carefully, her whole attention on her bowl.

Look closely

- Find the bowl and spoon. How full is the bowl?
- Find the bread. Why do you think bread was served with soup?
- Look at the girl's face. Is she hurrying or eating slowly?
- Look at the room and table. Is this a rich home or a simple one?

Talk about it

1. Why does a bowl of vegetable soup with bread keep a person satisfied for a long time?
2. Proverbs says a dinner of herbs where love is beats a feast where there is hatred. What makes a simple meal feel rich?
3. How does eating slowly help your body's fullness signals?

Safety first. An adult is nearby while you cook. Keep pot handles turned in, ladle hot soup away from your body, and let it cool a few minutes before tasting. Cool leftovers quickly by dividing them into shallow containers and refrigerate within 2 hours; reheat to 165 °F (74 °C).

KITCHEN PROJECT

A Satisfying Soup and the Fullness Log

You will cook a big pot of vegetable-bean soup for supper and keep a family fullness log: everyone rates hunger before the meal, right after, and two hours later. You will also try eating the first bowl slowly, setting your spoon down between bites.

You will need

- A large heavy pot (6-quart) with a lid
- A chef's knife, cutting board and vegetable peeler
- A can opener, colander, ladle and wooden spoon
- Measuring cups and spoons, a timer
- A family fullness chart

HEARTY MINISTRONE (VEGETABLE-BEAN SOUP WITH PASTA)

Serves 8 servings (about 1½ cups each) • Prep 25 min • Cook 40 min

Ingredients

- 2 tablespoons olive oil
- 1 large onion, diced
- 2 carrots, diced
- 2 stalks celery, diced
- 3 cloves garlic, minced
- 1 can (28 oz or 794 g) diced tomatoes
- 8 cups (1.9 L) low-sodium vegetable or chicken broth
- 1 teaspoon dried oregano, 1 teaspoon dried basil, 1 bay leaf
- 2 medium potatoes (about 12 oz or 340 g), diced
- 1 medium zucchini, diced
- 2 cans (15 oz or 425 g each) cannellini or kidney beans, drained and rinsed
- 1 cup (100 g) small pasta, such as ditalini or small shells

- 3 cups (90 g) fresh spinach or chopped kale
- 1 teaspoon salt (adjust to taste), ½ teaspoon pepper
- Grated Parmesan, for serving (optional)

Method

1. Wash your hands. With an adult nearby, heat the oil in the pot over medium heat. Add the onion, carrots and celery and cook 6–8 minutes, until soft. Add the garlic for 1 minute.
2. Add the tomatoes, broth, oregano, basil and bay leaf. Bring to a boil, then lower to a simmer.
3. Add the potatoes and simmer 10 minutes. Add the zucchini and beans and simmer 5 minutes more.
4. Add the pasta and simmer 8–10 minutes, stirring now and then, until the pasta is tender.
5. Stir in the spinach until wilted, about 1 minute. Remove the bay leaf. Taste and add salt and pepper.
6. Serve in bowls with Parmesan and bread if you like.
7. Clean up: wash the pot and tools; divide leftovers into shallow containers and refrigerate within 2 hours (the pasta will soak up broth; add a little water when reheating).

Allergy check: Contains wheat (pasta). Use a gluten-free pasta or ½ cup rice for wheat-free. Parmesan (optional) contains milk. Some broths contain soy or wheat; check the label. No eggs or nuts.

Steps

1. **Fullness log.** Before supper, have each family member rate hunger from 1 to 5. Rate again right after the meal and two hours later. Record everything in a chart.
2. Cook the soup. Count how many different plant foods went in.
3. **Slow first bowl.** Eat your first bowl slowly, setting your spoon down between bites and talking with your family. Note the time you started and finished. Then wait a few minutes before deciding on seconds.
4. **Compare.** On another day, rate your fullness two hours after a snack of the same energy that is mostly sugar (for example, a small pastry). Which kept

you satisfied longer?

5. **Taste test.** Ask your family to rate the soup and name the ingredient they liked best.
6. **Improve it.** Write one change: different beans, a parmesan rind simmered in the broth, or a swirl of pesto.
7. Clean up: wash, dry and put away everything.

Tips

- Cut the vegetables about the same size as the beans so every spoonful has a little of everything.
- If you plan to freeze soup, freeze it without pasta and cook fresh pasta when you reheat.
- A big pot of soup is a gift to a sick neighbor or a new family. Make extra to share.

Check your work

- ☐ I can describe Susanna Holt's satiety-index study and its results.
- ☐ I can explain how protein, fiber, water, volume and time help us feel satisfied.
- ☐ I cooked a hearty soup and kept a family fullness log.

COOK'S NOTEBOOK

1. Make a bar chart of six foods from Holt's study, from the highest score (potatoes) to the lowest (croissant), with a sentence explaining the pattern.
2. Record your family fullness log as a line graph: hunger before, right after, and two hours after.
3. Copy the soup recipe and circle each ingredient that brings protein, fiber or water.

From history. Minestrone, Italian for "big soup," has no single recipe. Italian families made it from whatever vegetables, beans and pasta or rice were in season and in the pantry, so no two pots were quite the same.

COMMON MISTAKES

- Eating so fast that the body's fullness signals cannot keep up. Slow down and give it about 20 minutes.

- Thinking a food that is “light” must be satisfying. Satisfaction comes from protein, fiber, water and volume.
- Adding the pasta too early. It turns mushy and soaks up all the broth.

Make it a game · Satiety Ranking. Write ten foods on slips, including potatoes, oatmeal, a donut, fish and apples. Rank them from most to least filling. Then tell why with the words fiber, protein, water, volume and time. Your parent challenges two of your choices. Compare your list with Susanna Holt's 1995 satiety index of 38 foods.

Scripture. “Better is a dinner of herbs where love is, than a stalled ox and hatred therewith.” (Proverbs 15:17, KJV)

A simple meal shared with love satisfies more than a rich feast in an unhappy home. Satisfaction is about the table as well as the food.

6.4 LABELS AND ADDED SUGAR

OBJECTIVES

- Tell how the Nutrition Facts label began in 1990–1994 and gained an Added Sugars line in 2016.
- Read the Added Sugars line, convert grams to teaspoons (4 grams $\approx$ 1 teaspoon), and compare products.
- Make homemade granola, calculate its added sugar per serving, and compare it with a store-bought cereal or granola.

Warm-up. Find three breakfast foods in your kitchen with Nutrition Facts labels (cereal, yogurt, granola bars, juice). For each, find the serving size and the line that says “Includes __ g Added Sugars.” Guess which has the most added sugar per serving before you look.

WATCH

Nemours: How to Read a Nutrition Facts Label

Nemours • 9:38

<https://www.youtube.com/watch?v=RGrsNP5KZCo>

WHEN TO WATCH

Before you read the labels in your kitchen. Pause on the picture of the label and point to each part on a real package.

Note: From Nemours Children’s Health, with a registered dietitian. It was made before the 2016 label update, so it shows the older label without the Added Sugars line; everything else it teaches still applies.

BACKUP VIDEO

Alton Brown Makes Granola | Good Eats | Food Network

Food Network • 1:57

<https://www.youtube.com/watch?v=PFw8pJiQToA>

For a second way to make granola, after you have done your own sugar math.

KEY TERMS

Nutrition Facts label

The panel on packaged food, required by U.S. law since 1994, that lists serving size, energy and nutrients.

added sugars

Sugars and syrups put into foods during cooking or processing, such as table sugar, honey, maple syrup and corn syrup, as opposed to sugars naturally found in fruit and milk.

Daily Value (%DV)

How much of a day's recommended amount of a nutrient one serving provides, as a percent.

serving size

The amount of food all the label numbers are based on. Your actual portion may be more or less.

nutrient-dense

Describes foods that give lots of vitamins, minerals, fiber or protein for their energy, like fruits, vegetables, whole grains, beans, eggs and milk.

CORE IDEAS

The story. Before 1990, many packaged foods in the United States had no nutrition information at all, and others used confusing labels that made comparing foods nearly impossible. In 1990 Congress passed the Nutrition Labeling and Education Act, and by 1994 almost every packaged food carried the same black-and-white “Nutrition Facts” box, designed so that anyone could compare two products at a glance. In 2016 the Food and Drug Administration updated the label: bigger, bolder serving sizes and Calories, serving sizes closer to what people really eat, and a new line, “Includes __ g Added Sugars.” Large companies had to use the new label by 2020.

How they figured it out. Designers tested many label layouts with ordinary shoppers to see which ones people could read quickly and correctly, and settled on the simple box with bold lines that you see today. When scientists writing the *Dietary Guidelines for Americans* studied what Americans were eating, they found that many people, especially children and teens, were getting much of their added sugar from sweet drinks, desserts and snacks without realizing it. Because the old label lumped

natural and added sugars together, the new line was added so families could see the difference. The Dietary Guidelines advise that, from age 2 on, less than 10 percent of daily food energy should come from added sugars.

The kitchen science. Sugar is a good gift; God made us able to enjoy sweet foods, and the natural sugars in fruit and milk come packaged with fiber, vitamins and protein. Added sugars bring sweetness and energy but few other nutrients. Here is how to use the label: find the **serving size**; find “Includes __ g Added Sugars”; divide the grams by 4 to get teaspoons, since 4 grams of sugar is about 1 teaspoon. A cereal with 12 grams of added sugar per serving holds about 3 teaspoons. The %DV for added sugars is based on 50 grams a day (about 12 teaspoons) for a 2,000-Calorie eating pattern. Taste buds adjust: when people eat less added sugar for a few weeks, lightly sweetened foods begin to taste sweet enough.

Let’s cook. You will make a batch of homemade granola, sweetened with a measured amount of honey or maple syrup, and calculate exactly how much added sugar is in each serving. The skill to do well is **baking low and slow** and stirring, so the oats toast evenly to golden without burning.

PICTURE STUDY



The Harvest, Jules Breton, 19th century · Oil on canvas · The Mesdag Collection, The Hague

Image: [Wikimedia Commons](#), public domain

Jules Breton grew up in a farming village in northern France and spent his life painting the people who worked its fields. Here the grain harvest is under way. Grains like wheat and oats, harvested by hard work, became the bread and porridge that fed families through the year.

Look closely

- Find the woman. What is she gathering?
- Find the man. What is he doing with his scythe, and why?
- Look at the color of the field. How can you tell the grain is ripe?
- Find the sky and the light. What time of day might it be?

Talk about it

1. Oats and other grains are the base of granola. What has to happen between this field and a bowl of granola?
2. These workers ate plain, nourishing food to fuel a long day. Which foods would give them steady energy?
3. Why is it good to remember the work behind our food when we give thanks?

Safety first. An adult is nearby while you use the oven. Use oven mitts to stir the hot granola, and let it cool on the pan. If you use honey and your family has a baby, never give honey to a baby under one year old. Check nuts and seeds against your family's allergies.

KITCHEN PROJECT

Label Detective and Homemade Granola

You will read the labels of five foods in your kitchen and turn grams of added sugar into teaspoons. Then you will make homemade granola, calculate its added sugar per serving, and compare it with a store-bought granola or cereal.

You will need

- A large rimmed baking sheet and parchment
- A large bowl and a small saucepan or microwave-safe cup
- Measuring cups and spoons, a kitchen scale (optional)
- A calculator and the labels of five packaged foods
- A glass jar for storage

HOMEMADE HONEY-OAT GRANOLA

Serves About 12 servings (½ cup each) · Prep 10 min · Bake 30–35 min · Cool 30 min

Ingredients

- 4 cups (360 g) old-fashioned rolled oats
- 1 cup (about 130 g) mixed seeds or chopped nuts (sunflower and pumpkin seeds, or almonds and pecans)
- ½ cup (40 g) unsweetened flaked coconut (optional)
- 1 teaspoon cinnamon and ½ teaspoon salt
- ⅓ cup (80 mL) honey or maple syrup
- ⅓ cup (80 mL) vegetable oil or melted coconut oil
- 1 teaspoon vanilla extract
- ½ cup (75 g) raisins or other dried fruit, added after baking

Method

1. Wash your hands. An adult turns the oven to 325 °F (165 °C). Line the baking sheet with parchment.
2. In the large bowl, stir the oats, seeds or nuts, coconut, cinnamon and salt.

3. Warm the honey and oil together for 20–30 seconds in the microwave (or in a small pan) until runny. Stir in the vanilla.
4. Pour the honey mixture over the oats and stir until every oat is coated. Spread evenly on the baking sheet and press down lightly.
5. Bake 30–35 minutes, stirring every 10 minutes with a spatula (oven mitts on), until golden and fragrant. Watch the edges; they brown first.
6. Cool completely on the pan without stirring, so it forms crunchy clusters. Then stir in the raisins.
7. Store in an airtight jar for up to 2 weeks. Clean up: wash the bowl and tools and wipe the counter.

Allergy check: Contains tree nuts if you use almonds or pecans, and coconut, to which some people are allergic. For a nut-free granola, use sunflower and pumpkin seeds and leave out the coconut. Oats may be processed with wheat; buy oats labeled gluten-free if needed. No milk or eggs. Honey: never for babies under one.

Steps

1. **Label detective.** Make a table of five packaged foods: name, serving size, grams of added sugars, teaspoons (grams $\div$ 4), and %DV. Rank them from most to least added sugar per serving.
2. **Drinks check.** If your family has any sweetened drink, find its added sugars per container (not per serving) and convert to teaspoons. Measure that many teaspoons of sugar into a clear glass to see it.
3. Make the granola.
4. **Granola math.** $\frac{1}{3}$ cup of honey has about 90 grams of sugar ($\frac{1}{3}$ cup of maple syrup has about 60). Divide by 12 servings. How many grams of added sugar per serving? How many teaspoons? Compare with the label of a store-bought granola or cereal per the same size serving.
5. **Taste test.** Ask your family to rate your granola with plain yogurt and fruit. Was it sweet enough?
6. **Improve it.** Next batch, try $\frac{1}{4}$ cup honey instead of $\frac{1}{3}$ cup. Recalculate and compare the taste.
7. Clean up: wash, dry and put away everything.

Tips

- Do not stir the granola while it cools if you want big clusters.
- Add dried fruit after baking; in the oven it turns hard and bitter.
- Serve granola as a topping on plain yogurt with fruit: crunchy, creamy and lightly sweet.

Check your work

- ☐ I can tell how the Nutrition Facts label and the Added Sugars line came to be.
- ☐ I can convert grams of added sugar to teaspoons and compare products.
- ☐ I made granola and calculated its added sugar per serving.

COOK'S NOTEBOOK

1. Draw a Nutrition Facts label from memory and label the serving size, Calories, and the Added Sugars line.
2. Copy your label-detective table and your granola math with the work shown.
3. Write a short paragraph about how your family will enjoy sweet foods wisely this month.

From history. Granola began in 1863, when Dr. James Caleb Jackson of Dansville, New York, baked whole-grain dough into sheets, broke it up and baked it again, and called it “Granula.” It was so hard it had to be soaked overnight. Oat-based granola like today’s became popular in the 1960s and 1970s.

COMMON MISTAKES

- Reading the numbers without checking the serving size. A bottle or package may hold two or more servings.
- Counting the natural sugar in plain milk or fruit as added sugar. The Added Sugars line shows only sugars that were added.
- Thinking a food is a treat or not just by its sugar. Look at the whole label, including fiber and protein.

Make it a game • Label Speed Round. Take two similar products, such as two cereals or yogurts. Race to find the added sugars line, convert grams to teaspoons by dividing by four, and name the winner with the lower amount. Then tell the history of the label from 1990 to 2016. Explain what Daily Value percent means.

Scripture. “My son, eat thou honey, because it is good; and the honeycomb, which is sweet to thy taste:” (Proverbs 24:13, KJV)

Scripture calls honey good and sweet. Sweet things are gifts to enjoy; wisdom is enjoying them in their place, with thanks.

CRAVINGS, REWARD & A BALANCED DIET

Why do you suddenly want a snack when you walk past a bakery, or at the same time every afternoon? Why is it easy to keep eating chips long after you are full, but hard to eat a second bowl of plain oatmeal? This unit looks honestly at how God made our bodies and brains to want food, how those wants are learned, and how good habits and self-control help us enjoy food in its place.

You will meet Ivan Pavlov, whose dogs learned to expect dinner at the sound of a signal; Walter Mischel and the children of the marshmallow test; and Susanna Holt, who measured which foods keep people satisfied longest. You will learn to read the Added Sugars line on a Nutrition Facts label. Along the way you will make crunchy roasted chickpeas, a portioned fruit crisp, a hearty vegetable-bean soup and homemade granola, and you will keep a habit log. This unit is about wisdom and thankfulness, not about bodies: treats and feasts are good gifts, and nutrient-dense foods are good gifts too.

PREREQUISITES

- Knows the three macronutrients and that Calories measure food energy (Unit 2)
- Can read a Nutrition Facts label for serving size and grams (Unit 2)
- Can roast and simmer with an adult nearby (Units 3–4)
- Knows that tastes change with repeated tasting (Unit 3)

MASTERY CHECKLIST

- ☐ I can tell how Ivan Pavlov discovered that the body learns to expect food, and explain cues, cravings and habits in my own life.
- ☐ I can explain dopamine as a messenger linked to wanting and learning, and why foods that combine sugar, salt and fat are easy to keep eating.
- ☐ I can describe the marshmallow test honestly, including what later studies found, and name strategies that help with self-control.
- ☐ I can explain what helps us feel satisfied (protein, fiber, water, volume and about 20 minutes of time) and read the Added Sugars line on a label, converting grams to teaspoons.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **FDA: Added Sugars on the Nutrition Facts Label**: Free. The U.S. Food and Drug Administration explains the Added Sugars line and the Daily Value. Useful for Lesson 6.4.
- **KidsHealth (Nemours): Food and nutrition articles for kids and teens**: Free, reliable articles from a children's health system, written for young readers, about hunger, fullness, snacks and labels.
- **A set of small bowls or ramekins**: Inexpensive. Handy for portioning snacks and desserts in Lessons 6.1–6.2.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

6.1	Ivan Pavlov and Learning to Expect Food	2 sessions of 50–60 minutes
6.2	The Marshmallow Test and Self-Control	2 sessions of 50–60 minutes
6.3	Satiety: Fiber, Protein, Water and Time	2 sessions of 50–60 minutes
6.4	Labels and Added Sugar	2 sessions of 50–60 minutes

UNIT 6 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**
What did Ivan Pavlov notice about his laboratory dogs, and how did he test it?
2. **8 pts**
Describe dopamine accurately. What is it, and what does it do?
3. **8 pts**
Name three food cues from everyday life and one way to retrain a cue-driven habit.

4. **8 pts**

What did the marshmallow test measure, and what did the 2018 study and the 2012 study add?

5. **8 pts**

List three strategies that make it easier to wait or to enjoy treats in their place.

6. **8 pts**

What did Susanna Holt's 1995 study find about which foods keep people satisfied?

7. **8 pts**

Name four things that help a meal keep us satisfied.

8. **10 pts**

Calculation: A cereal has 16 grams of added sugars per serving, and you eat $1\frac{1}{2}$ servings. How many grams and how many teaspoons of added sugar is that?

9. **10 pts**

Calculation: The Daily Value for added sugars is 50 grams. What %DV is a drink with 39 grams of added sugars? About how many teaspoons is it?

10. **8 pts**

Calculation: Your granola has $\frac{1}{3}$ cup honey (about 90 grams of sugar) and makes 12 servings. How many grams of added sugar per serving, and about how many teaspoons?

11. **8 pts**

Predict: A family cuts back on sweetened drinks and desserts for three weeks. What will probably happen to how sweet foods taste to them?

12. **8 pts**

Short answer: Explain in two or three sentences how a Christian can enjoy treats and feasts while practicing self-control.

ANSWER KEY

1. The dogs began to drool before food arrived, at the sight of the dish or the sound of footsteps. He sounded a signal (such as a metronome or buzzer) before each feeding until the dogs drooled at the signal alone: a conditioned reflex.
2. A messenger chemical in the brain released when we expect or get something good. It is tied to wanting, motivation and learning what is rewarding, not simply to pleasure.
3. Examples: the smell of a bakery, a commercial, a certain time of day, a screen, a chip bag crinkling. Retrain: notice the cue, pause and drink water, ask whether you are hungry, plan a satisfying snack, or move treats out of sight.
4. Whether young children could wait for a bigger reward and how they did it. The 2018 study found the link with later success was smaller than first thought and partly explained by home life; the 2012 study found children waited longer when the adult had kept an earlier promise.
5. Any three: look away or keep treats out of sight, keep busy, sing or think of something else, serve a planned portion in a small bowl, eat slowly at the table, enjoy treats after a balanced meal, plan when treats fit in the week.
6. Boiled potatoes scored highest (more than three times white bread); fish, oatmeal, oranges, apples, beans and lean meat also scored high; croissants, cake, doughnuts and candy scored low.
7. Protein, fiber, water and volume, plus time (eating slowly so fullness signals can arrive in about 20 minutes).
8. $16 \times 1\frac{1}{2} = 24$ grams. $24 \div 4 = 6$ teaspoons.
9. $39 \div 50 = 0.78$, or 78% DV. $39 \div 4 \approx 9\frac{3}{4}$ teaspoons, about 10 teaspoons.
10. $90 \div 12 = 7.5$ grams per serving. $7.5 \div 4 \approx 1.9$, about 2 teaspoons.
11. Their taste buds will adjust, so lightly sweetened foods and fruit will taste sweeter and very sugary foods may taste too sweet.
12. Answers vary. Example: Treats and feasts are good gifts from God to enjoy with thanks. Self-control, a fruit of the Spirit, helps us enjoy them at the right time and in the right amount, so that food serves us and our family rather than ruling us.

UNIT CHALLENGE: A TWO-WEEK SNACK AND DRINK SWAP

For two weeks, keep a daily log of your snacks and drinks. In the first few days, notice your cues and your hunger ratings. Then choose two swaps (for example, water or milk instead of a sweet drink at lunch, and a planned homemade snack such as roasted chickpeas, fruit with cheese, or yogurt with granola after school).

Make at least two homemade snacks during the two weeks. At the end, write a one-page reflection: which cues you noticed, which swaps were easy or hard, how your taste buds changed, and which treats you enjoyed in their place. Include one chart from your log.

LOOK FOR	WHAT IT MEANS
Honest daily log	Snacks, drinks, cues and hunger ratings recorded on most days, with no judgment of anyone's body.
Swaps and homemade snacks	Two clear swaps tried, and at least two homemade snacks made safely and cleaned up after.
Chart and reflection	One clear chart and a thoughtful reflection about cues, satisfaction and taste-bud changes.
Thankfulness and improvement	Names one habit to keep and one to improve; days that did not go as planned, honestly recorded, still earn full credit.

UNIT 7

FIRE, THE GRILL & SPICE

This is the fun unit, and also the one that asks the most care. This year you move from watching the grill to cooking on it yourself, with an adult beside you. You will learn the grill's rules first: an adult always lights it, no one uses lighter fluid, long tongs instead of forks, and a lid ready for flare-ups. Then you will meet Henry Ford, who turned the wood scraps from his car factory into charcoal briquettes and helped start America's love of backyard cooking.

You will also explore heat of another kind: the burn of chili peppers, measured by the pharmacist Wilbur Scoville in 1912. You will learn to build a two-zone fire for cooking over direct and indirect heat, a method as old as the wooden barbecue frames early Spanish writers saw in the Caribbean. And you will learn the cook's four great tools for balancing a dish, salt, acid, fat and heat, using a Spanish friar's careful records of the foods of old Mexico as your guide. Every grill recipe has an indoor version for families without a grill.

PREREQUISITES

- Knows the fire triangle and kitchen fire safety (Lesson 1.4)
- Can check meat at safe internal temperatures with a thermometer (Units 1–4)
- Can use a chef's knife with the claw and bridge grips (Unit 1)
- Knows conduction, convection and radiation (Lesson 4.1)

MASTERY CHECKLIST

- ☐ I can state the grill safety rules and explain how a chimney starter, vents and the lid control the fire triangle.
- ☐ I can tell how Henry Ford's factory made charcoal briquettes and grill burgers to 160 °F with an adult beside me.
- ☐ I can tell how Wilbur Scoville measured pepper heat, explain what capsaicin does, and handle hot peppers safely.
- ☐ I can set up a two-zone fire, explain direct and indirect heat, and balance a dish using salt, acid, fat and heat.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **NFPA: Grilling safety:** Free. Grilling safety tips and a printable tip sheet from the National Fire Protection Association. Read it together before Lesson 7.1.
- **For the adult griller: a chimney starter, long-handled tongs and a fire extinguisher:** A chimney starter lights charcoal with crumpled newspaper and no lighter fluid. Keep a fire extinguisher or garden hose within reach whenever the grill is lit.
- **Disposable kitchen gloves:** Inexpensive. For cutting hot peppers in Lessons 7.2 and 7.4, so the capsaicin does not get on your hands and into your eyes.
- **A stovetop grill pan:** Optional. The indoor alternative to the outdoor grill for every recipe in this unit, used with an adult and the kitchen fan on.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

7.1	Henry Ford and the Charcoal Briquette	2 sessions of 50–60 minutes
7.2	Wilbur Scoville and the Heat of Peppers	2 sessions of 50–60 minutes
7.3	Direct and Indirect Heat	2 sessions of 60–90 minutes
7.4	Balance a Dish: Salt, Acid, Fat and Heat	2 sessions of 50–60 minutes

UNIT 7 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. 8 pts

List five grill safety rules from this unit.

2. 8 pts

How did Henry Ford's company make charcoal briquettes, and why?

3. 8 pts

Use the fire triangle to explain how a chimney starter lights coals and how closing the grill lid stops a flare-up.

4. 8 pts

Calculation: Six burger patties use 2 pounds of beef. How many ounces is each patty? (1 pound = 16 ounces.) How much beef would you need for 15 patties of the same size?

5. 8 pts

How did Wilbur Scoville measure pepper heat in 1912?

6. 8 pts

Why does milk cool a chili burn better than water? Where is most of a pepper's capsaicin?

7. 8 pts

Calculation: A jalapeño is about 5,000 Scoville units and a habanero about 250,000. How many times hotter is the habanero?

8. 8 pts

Explain direct and indirect heat, and why thick chicken thighs are cooked with both.

9. 8 pts

Where does the word "barbecue" come from?

10. 10 pts

Calculation: Convert 165 °F and 175 °F to Celsius using $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5 \div 9$. Round to the nearest degree.

11. 10 pts

Predict and fix: Your salsa tastes flat. Your crema is too sour. Your taco filling is too spicy. What would you add to each?

12. 8 pts

Short answer: How did Bernardino de Sahagún gather and check his information about the foods of the Mexica?

ANSWER KEY

1. Any five: grills outdoors only on flat ground away from the house, railings, overhangs and leaves; only adults light the grill; no lighter fluid; long tongs, never a fork to flip; close the lid to smother a flare-up; hose or extinguisher nearby; never leave a lit grill alone; let coals cool 24–48 hours before an adult disposes of them in a metal can.
2. It heated wood scraps from its car-parts factory with very little air to make charcoal, crushed it, mixed it with a starch binder and pressed it into briquettes. Ford hated waste and turned scraps into a product.
3. The starter supplies heat (burning newspaper) to the fuel (charcoal), and rising hot air draws in oxygen through the bottom (convection). Closing the lid cuts off oxygen, so the flames die down.
4. $2 \times 16 = 32$ ounces; $32 \div 6 \approx 5\frac{1}{3}$ ounces each. For 15: $15 \times 5\frac{1}{3} = 80$ ounces = 5 pounds.
5. He diluted a pepper extract with sugar water again and again and gave it to a panel of five tasters until most could no longer feel the heat. The number of dilutions became the Scoville Heat Units.
6. Capsaicin dissolves in fat, not water; the fat and protein in milk carry it away, while water just spreads it. Most capsaicin is in the pale pith (ribs) and around the seeds.
7. $250,000 \div 5,000 = 50$ times hotter.
8. Direct heat is right over the coals (radiation and conduction), hot and fast for searing. Indirect heat is beside the coals with the lid closed (convection), gentle like an oven. Thighs are seared over direct heat for color, then finished over indirect heat so the inside reaches 165 °F before the outside burns.
9. From barbacoa, the Taíno word for a wooden frame used to cook over a fire, recorded by Spanish writers such as Gonzalo Fernández de Oviedo in 1526.
10. 165 °F: $133 \times 5 \div 9 \approx 74$ °C. 175 °F: $143 \times 5 \div 9 \approx 79$ °C.
11. Flat salsa: a pinch of salt, then a little lime. Too-sour crema: more sour cream or yogurt (fat), or a pinch of sugar. Too-spicy filling: something fatty and cool, such as crema, avocado or cheese, or a little sweetness.
12. He learned Nahuatl, interviewed Nahua elders, had trained Nahua students write down their answers, and checked them with other groups of elders, recording it all in Nahuatl and Spanish with pictures in the Florentine Codex.

UNIT CHALLENGE: A FAMILY GRILLED DINNER WITH A HOMEMADE SPICE RUB

Plan and cook a grilled (or broiled) dinner for your family with an adult beside you: a main dish cooked to a safe temperature, a grilled vegetable, and a fresh salsa or sauce. Create your own spice rub from at least four spices, record the recipe in teaspoons, and smell-test it before using it.

Write the grill safety checklist and check it off before the adult lights the grill. During the meal, collect your family's ratings, and afterward make a flavor-balance chart for each dish showing its salt, acid, fat, heat, sweet and bitter. Families without a grill may use the broiler and a grill pan.

LOOK FOR	WHAT IT MEANS
Safety checklist	Checklist completed before lighting; adult lights the grill; no lighter fluid; long tools; lid used for flare-ups; safe temperatures checked and recorded.
Spice rub	An original rub with at least four spices, measured and recorded, and a short note on why the spices go together.
Balanced menu	Main dish, vegetable and sauce that use salt, acid, fat and heat thoughtfully; flavor-balance chart completed.
Cleanup and improvement	Grill area and kitchen cleaned, coals left to cool safely, and one honest improvement named. A dish that burned but is recorded and improved earns full credit.

7.1 HENRY FORD AND THE CHARCOAL BRIQUETTE

OBJECTIVES

- Tell how Henry Ford’s company turned wood scraps into charcoal briquettes in the 1920s.
- State the grill safety rules and explain how a chimney starter, vents and the lid use the fire triangle.
- Grill hamburgers to 160 °F (71 °C) with an adult beside you, or broil them indoors.

Warm-up. With an adult, look at a bag of charcoal briquettes (or a picture of one). Pick one up and look at its shape. What do you think it is made of? Why do you think it is shaped like a little pillow? Then list everything a fire needs, from Lesson 1.4.

WATCH

How Henry Ford Repurposed Wood Waste into Charcoal | The Henry Ford’s Innovation Nation

The Henry Ford • 3:26

<https://www.youtube.com/watch?v=457zpUczRRY>

WHEN TO WATCH

After the story of Henry Ford, before your grill-safety walk-through.

Note: From The Henry Ford museum’s Innovation Nation series, with old photographs of Ford’s Iron Mountain mill, Edward Kingsford and the first bags of Ford charcoal briquets.

KEY TERMS

charcoal

Wood that has been heated with very little air, driving off water and gases and leaving nearly pure carbon that burns hot and steady.

briquette

A small, pillow-shaped block of crushed charcoal pressed together with a binder such as starch, so it burns evenly.

chimney starter

A metal cylinder with a handle that lights charcoal using crumpled newspaper underneath, with no lighter fluid.

vent

An opening on a grill that lets in air. More air means a hotter fire; less air cools it.

flare-up

A sudden burst of flame when fat drips onto hot coals. Closing the lid cuts off oxygen and calms it.

CORE IDEAS

The story. In the early 1900s, Henry Ford's Model T cars used a surprising amount of wood for their frames, floorboards and wheels. Ford bought huge forests in Michigan's Upper Peninsula and built a sawmill and parts plant at Iron Mountain. With help from a relative by marriage, a local businessman named Edward G. Kingsford, who helped Ford find the land, the operation grew so large that a whole town grew up around it, named Kingsford.

How they figured it out. Ford hated waste. His mills produced mountains of wood scraps, sawdust and branches. In the 1920s his engineers built a plant that heated the scraps with very little air, turning them into charcoal, crushed the charcoal, mixed it with a starch binder and pressed it into small pillow-shaped briquettes. (The idea of pressed charcoal briquettes had been patented earlier, in 1897, by Ellsworth Zwoyer of Pennsylvania.) Ford sold the briquettes through his car dealers and advertised picnic kits so families could cook outdoors on trips. In 1951 a group of businessmen bought the charcoal plant and named the company Kingsford, which became the best-known charcoal in America.

The kitchen science. A charcoal grill is the fire triangle you can control. **Fuel** is the charcoal, which burns hotter and with less smoke than raw wood because its water and gases were driven off when it was made. **Heat** starts it: a **chimney starter** lights coals with a few sheets of crumpled newspaper underneath; as hot air rises up the chimney (convection), the coals catch in 15–20 minutes, with no lighter fluid at all. **Oxygen** comes through the **vents**: open vents make a hotter fire; closed vents cool it. The **lid** cuts off oxygen, which is why closing it calms a **flare-up**. Grill rules: grills are used outdoors only, on a flat surface, well away from the house, railings, overhangs

and dry leaves; only adults light a grill; no one uses lighter fluid; use long tongs, never a fork to flip; keep a hose or extinguisher nearby; never leave a lit grill alone; and let coals cool 24–48 hours before an adult empties them into a metal can.

Let's cook. You will grill hamburgers for the family, cooking them yourself with an adult beside you, after the adult has lit the grill. The skill to do well is **shaping and grilling patties**: make them even, press a shallow dimple in the center so they stay flat, flip only once with a long spatula, and check that the center reaches 160 °F (71 °C).

PICTURE STUDY



The Charcoal Burners, Rosa Bonheur, 1853 · Oil on canvas · Aberdeen Art Gallery, Scotland

Image: [Wikimedia Commons](#), public domain

Rosa Bonheur was one of the most famous painters of the 1800s, known for her careful studies of animals and country work. Before factories like Ford's, charcoal was made by “charcoal burners” who lived in the forests, stacking wood into mounds, covering them with earth and letting them smolder slowly for days. Here a load of finished charcoal is being hauled away.

Look closely

- Find the cart. What is it loaded with?
- Look at the smoke drifting through the trees. Where is it coming from?
- Find the workers and the oxen. What job is each one doing?
- Look at the forest. Where did the fuel for this charcoal come from?

Talk about it

1. Charcoal burners covered their wood mounds with earth to keep most of the air out. Using the fire triangle, explain why that turns wood into charcoal instead of ashes.
2. How was Henry Ford's charcoal plant like these forest workers, and how was it different?

3. Ford hated wasting his wood scraps. What is one thing in your kitchen that could be used instead of wasted?

Safety first. An adult always lights the grill with a chimney starter or gas igniter; students never handle lighter fluid. You may cook on the grill with an adult beside you, using long tongs or a long spatula, standing to the side, with the grill outdoors on flat ground away from the house, railings, overhangs and dry leaves, and a hose or extinguisher nearby. Close the lid to smother a flare-up. Cook burgers to 160 °F (71 °C).

Grill Safety Walk-Through and Family Burgers

Before you cook, you and an adult will walk through the grill safety checklist together. Then you will grill hamburgers for the family while the adult stands beside you, and you will check every burger with a thermometer. Families without a grill will broil the burgers indoors with an adult.

You will need

- A charcoal or gas grill, set up by an adult (or the oven broiler and a broiler pan indoors)
- A chimney starter and newspaper, for the adult (charcoal grills)
- Long-handled tongs and a long, wide spatula
- An instant-read thermometer
- A clean platter for cooked burgers and a separate plate for raw patties
- A fire extinguisher or garden hose within reach

CLASSIC GRILLED HAMBURGERS

Serves 6 burgers · Prep 15 min · Grill 10–12 min (after the adult lights the grill, about 20 min)

Ingredients

- 2 pounds (900 g) ground beef (80–85% lean)
- 1 teaspoon salt and ½ teaspoon black pepper
- 1 teaspoon Worcestershire sauce (optional)
- 6 hamburger buns
- 6 slices cheese (optional)
- Toppings: lettuce leaves, sliced tomatoes, sliced onion, pickles, ketchup and mustard

Method

1. Wash your hands. An adult lights the grill (a chimney of charcoal, or a gas grill on medium-high) and sets the grate. While it heats, slice the tomatoes and onions and wash the lettuce.

2. Gently mix the beef with salt, pepper and Worcestershire. Divide into 6 equal portions and shape each into a patty about $\frac{3}{4}$ inch thick and a little wider than the bun. Press a shallow dimple in the center of each with your thumb. Wash your hands.
3. With the adult beside you, place the patties on the hot grate using the long spatula. Close the lid if your grill has one. Cook 4–5 minutes, until they release easily and have grill marks.
4. Flip once. Cook 3–5 minutes more. Add cheese in the last minute if using.
5. Check each burger in the center from the side: it must read 160 °F (71 °C). Move cooked burgers to the clean platter, never the plate that held the raw patties.
6. Toast the buns cut side down for 30–60 seconds. Build the burgers and serve.
7. Clean up: an adult shuts the vents or turns off the gas. Wash the raw-meat plate, tools and your hands. Charcoal must cool 24–48 hours before an adult empties it into a metal can.
8. **Indoor version:** An adult sets an oven rack 4 inches below the broiler. Broil the patties on a broiler pan 4–5 minutes per side, with an adult beside you, until 160 °F.

Allergy check: Contains wheat (buns), and milk if you add cheese. Worcestershire sauce contains fish (anchovies); leave it out for a fish-free burger. Some buns contain sesame, eggs, milk or soy; check the label. Use gluten-free buns or lettuce wraps for wheat-free.

Steps

1. **Safety walk-through.** With the adult, check off: grill outdoors on flat ground, at least 10 feet from the house, away from railings, overhangs and leaves; extinguisher or hose ready; long tools; no lighter fluid anywhere; a plan for flare-ups (close the lid); and who will stay with the grill the whole time.
2. Watch the adult light the chimney starter. Time how long until the top coals are covered in gray ash. Draw the chimney and label the fuel, heat and oxygen.
3. Grill the burgers. Record the temperature of each burger and how many minutes it took.

4. **Dimple test.** Make one patty without a dimple. After cooking, compare its shape with the others. Why did the dimple help?
5. **Taste test.** Ask your family to rate juiciness and flavor.
6. **Improve it.** Write one change: a turkey burger (cooked to 165 °F), grilled onions, or a homemade spice blend.
7. **Clean up:** wash, dry and put away everything, and write the time so the adult knows when the coals will be cool.

Tips

- Handle the meat gently and briefly. Overworked burgers turn tough.
- Do not press burgers with the spatula. It squeezes out the juices and causes flare-ups.
- Ground meat is mixed all the way through, so germs from the surface can be inside. That is why burgers must reach 160 °F in the center, not just look brown.

Check your work

- ☐ I can tell how Henry Ford's company made charcoal briquettes.
- ☐ I can state the grill safety rules and explain them with the fire triangle.
- ☐ I grilled (or broiled) burgers to 160 °F with an adult beside me.

COOK'S NOTEBOOK

1. Draw a chimney starter with the newspaper and coals, labeling where fuel, heat and oxygen enter.
2. Write your grill safety checklist neatly and keep it in your notebook for the rest of the unit.
3. Record each burger's temperature and cooking time in a table.

From history. Henry Ford's friend Thomas Edison is sometimes said to have designed the charcoal plant, but historians have found little evidence for it. What is certain is that Ford's factories were famous for using nearly everything, turning scraps into products instead of waste.

COMMON MISTAKES

- Using lighter fluid. It is dangerous and none of our recipes need it; an adult uses a chimney starter or a gas grill.

- Flipping with a fork. It pierces the meat and lets juices drip onto the coals, causing flare-ups.
- Judging burgers by color. A burger can look brown before it is safe; check for 160 °F.

Make it a game • Grill Rules Quiz Show. Host a quiz show with your parent. Take turns asking grill safety questions, such as where the chimney starter goes and when vents should open. Answer in complete sentences. A wrong or missing rule earns a buzzer sound. Then explain how the fire triangle shapes the vents and lid, and how Henry Ford made briquettes.

7.2 WILBUR SCOVILLE AND THE HEAT OF PEPPERS

OBJECTIVES

- Tell how Wilbur Scoville measured the heat of chili peppers in 1912.
- Explain that capsaicin triggers the body’s heat-and-pain sensors rather than taste buds, and how cooks control and cool a pepper’s heat.
- Make a fresh salsa, handling hot peppers safely, and run a mild-to-hot pepper tasting ladder.

Warm-up. Look at three peppers side by side: a bell pepper, a poblano (or Anaheim) and a jalapeño. Without tasting, rank them from mildest to hottest. What clues did you use: size, color, shape? Write your guesses.

WATCH

The science of spiciness - Rose Eveleth

TED-Ed · 3:54

https://www.youtube.com/watch?v=qD0_yWgifDM

WHEN TO WATCH

After the story of Wilbur Scoville, before you cut any peppers.

Note: A TED-Ed animated lesson on how capsaicin, menthol and other compounds trigger our sensors, with the Scoville scale.

KEY TERMS

capsaicin

The chemical in chili peppers that makes them feel hot. Say it “cap-SAY-uh-sin.”

heat receptor

A sensor on nerve endings that signals “hot” to the brain. Capsaicin triggers it even though nothing is actually hot.

Scoville Heat Units (SHU)

A scale of pepper heat: how many times a pepper’s extract must be diluted before tasters can no longer feel any heat.

pith

The pale inner ribs of a pepper, where most of the capsaicin is made and stored.

salsa

Spanish for “sauce.” A fresh salsa is a raw mixture of chopped tomatoes, onion, peppers, herbs and lime.

CORE IDEAS

The story. In 1912 Wilbur Scoville was a pharmacist working for the Parke-Davis drug company in Detroit, Michigan. The company used capsaicin, the hot chemical in chili peppers, in a warming ointment for sore muscles. Scoville needed a way to tell how hot each batch of peppers was, so the medicine would come out the same every time. But there was no machine that could measure “hot.”

How he figured it out. Scoville used the best measuring instrument he had: the human tongue. He soaked ground peppers to draw out their heat compounds, then diluted a measured amount with sugar water, and gave it to a panel of five tasters. If they could still feel the burn, he diluted it more, again and again, until most of the panel could no longer feel any heat. The number of times he had to dilute it became the pepper’s score, now called **Scoville Heat Units**. A bell pepper scores 0. A jalapeño scores about 2,500 to 8,000. A cayenne scores about 30,000 to 50,000, and a habanero about 100,000 to 350,000. Today laboratories measure capsaicin with machines, but they still report the results in Scoville units.

The kitchen science. Capsaicin is not a taste at all. It fits into a **heat receptor** on nerve endings in the mouth and skin, the same sensor that tells you a cup of cocoa is too hot. That is why peppers “burn” though they are not warm, and why capsaicin on your fingers can sting your eyes hours later. Most of the capsaicin is in the pale **pith** (the ribs) and around the seeds, so removing them makes a pepper much milder. Capsaicin dissolves in fat, not water, so a drink of water spreads it around, while milk, yogurt or a bite of bread and cheese soothes the burn. People who eat peppers often grow used to them, so the same salsa feels milder over time. Heat is a seasoning to be balanced, never a contest.

Let’s cook. You will make a fresh tomato salsa in two heat levels, mild and medium, and run a pepper tasting ladder from bell pepper upward, as far as each taster wishes to go. The skill to do well is **handling hot peppers safely**: wear gloves, cut out the pith and seeds with a spoon or paring knife, wash the board and knife right away, and keep your hands away from your face.

PICTURE STUDY



Stringing Chili, Milton E. Porter, 1907 · Gelatin silver photograph · Library of Congress, Washington, D.C.

Image: [Wikimedia Commons](#), public domain

In New Mexico and the American Southwest, families have long dried their red chilies by tying them into long strings called *ristras* and hanging them in the sun on porches and walls. Dried this way, the peppers kept all winter for cooking. This photograph was taken in 1907.

Look closely

- Find the heap of chili peppers. About how many do you think there are?
- Look at her hands. How is she tying the chilies together?
- Look at the room. Where would the finished strings hang to dry, and what would the sun do to the peppers?
- What clues tell you this photograph is more than a hundred years old?

Talk about it

1. Drying is a way of preserving food, as you learned in Unit 4. Why does drying keep peppers from spoiling?
2. Would the heat of the chilies be stronger or weaker after drying? Why do you think so?
3. Stringing a whole harvest takes many hours. Why do you think families shared this work?

Safety first. Wear disposable gloves to cut hot peppers, never touch your eyes or face, and wash your hands, the knife and the board with soap right away. An adult may cut the hottest peppers. Taste only tiny pieces in the tasting ladder, stop whenever you like, and keep milk or yogurt nearby; this is never a contest. Check every ingredient for allergies first.

A Pepper Heat Ladder and Fresh Salsa

You will rank peppers by heat with a family tasting ladder, using tiny pieces and a cooling glass of milk. Then you will make two bowls of fresh salsa, one mild and one medium, and see how removing the pith and seeds changes the heat.

You will need

- Disposable gloves
- A chef's knife, a paring knife, a small spoon and a cutting board used only for peppers
- Two medium bowls and a small bowl
- A citrus juicer, measuring cups and spoons
- Small cups of milk or yogurt for the tasting ladder

FRESH TOMATO SALSA, MILD AND MEDIUM

Serves About 3 cups (8 servings) · Prep 25 min · Rest 15 min

Ingredients

- 6 ripe Roma tomatoes (about 1½ pounds or 680 g), diced small
- ½ medium white or red onion, diced small
- ½ cup (10 g) chopped fresh cilantro (or parsley)
- 1 small green bell pepper, diced small (for the mild bowl)
- 1 jalapeño, seeds and pith removed, minced (for the medium bowl)
- 2 tablespoons fresh lime juice (about 1 lime)
- ¾ teaspoon salt, divided
- Tortilla chips, or vegetable sticks, for serving

Method

1. Wash your hands and all the vegetables. Put on gloves before you touch the jalapeño.
2. Dice the tomatoes and onion small. Chop the cilantro. Divide the tomatoes, onion and cilantro evenly between the two bowls.

3. **Mild bowl:** add the diced bell pepper.
4. **Medium bowl:** cut the jalapeño in half lengthwise. Scrape out the seeds and white pith with a small spoon. Mince the green flesh and add it.
5. Add 1 tablespoon lime juice and a generous $\frac{1}{3}$ teaspoon salt to each bowl. Stir, taste (with a chip, not a finger), and adjust.
6. Let the salsas rest 15 minutes so the flavors blend. Serve with chips or vegetable sticks.
7. Clean up: wash the pepper board, knife and spoon with hot, soapy water right away. Remove gloves by turning them inside out, then wash your hands.

Allergy check: No major allergens in the salsa itself. Tortilla chips are usually made from corn but may be fried in oils or made in plants with wheat or other allergens; check the label. Some people react to cilantro (it tastes like soap to some people).

Steps

1. **Heat ladder.** Cut a tiny sliver (the size of a pencil eraser) of each pepper: bell, poblano or Anaheim, and jalapeño (an adult cuts this one). Each taster tries them in order from mild to hot, rating heat from 0 to 5, and may stop at any step. Keep milk nearby.
2. Compare your family's ladder with the Scoville ranges in the lesson. Did your ratings follow the same order?
3. **Pith test.** Taste a tiny piece of jalapeño flesh from the outer wall and a tiny piece of the pith (only if you wish). Which is hotter?
4. **Cooling test.** After a hot bite, try water for one taster and milk for another. Which cooled the burn faster? Explain with the word "fat."
5. Make both salsas and serve them with a meal. Ask your family which they prefer.
6. **Improve it.** Write one change: add corn and black beans, use pineapple or mango, or grill the tomatoes first for a smoky salsa.
7. Clean up: wash, dry and put away everything.

Tips

- Taste the jalapeño before you add it all. Two jalapeños from the same plant can have very different heat.

- Salt draws juice out of tomatoes. Drain a little liquid before serving if the salsa gets watery.
- Fresh salsa keeps covered in the refrigerator for 2–3 days.

Check your work

- ☐ I can tell how Wilbur Scoville measured pepper heat.
- ☐ I can explain how capsaicin works and how to cool the burn.
- ☐ I handled hot peppers safely and made two salsas.

COOK'S NOTEBOOK

1. Draw a Scoville scale as a thermometer with bell pepper, poblano, jalapeño, cayenne and habanero marked at their heat levels.
2. Draw a jalapeño cut in half and label the flesh, pith and seeds, shading where the heat is strongest.
3. Record your family heat-ladder ratings in a chart.

From history. Chili peppers come from the Americas and had been grown in Mexico for thousands of years. After Columbus's voyages in the 1490s, Spanish and Portuguese ships carried them around the world, and within a century they had become central to the cooking of India, Thailand, Korea, Hungary and many other lands.

COMMON MISTAKES

- Cutting hot peppers bare-handed and then rubbing your eyes. Wear gloves and wash up right away.
- Drinking water to cool a pepper burn. Capsaicin dissolves in fat; milk, yogurt or bread work better.
- Turning pepper tasting into a dare. Heat is a seasoning to enjoy, and everyone may stop whenever they like.

Make it a game • Scoville Scale Sort. Write six peppers on slips, such as bell, jalapeno, serrano, cayenne, habanero and ghost pepper. Sort them from mild to hot from memory. Look up the order with your parent in a book. Then explain capsaicin, why it fools heat receptors, and why removing the pith lowers the heat. Retell how Wilbur Scoville measured it.

7.3 DIRECT AND INDIRECT HEAT

OBJECTIVES

- Tell how early Spanish writers described the wooden “barbacoa” frames used for cooking over fire in the Caribbean.
- Explain direct and indirect heat and how a two-zone fire uses both.
- Grill marinated chicken thighs on a two-zone fire to 165 °F (74 °C) with an adult beside you, or use the indoor sear-and-roast method.

Warm-up. Hold your hand (carefully, with an adult) about 6 inches to the side of a toaster or stovetop burner that is on, and then about a foot above a pot of simmering water. Which do you feel more: the heat coming straight at you or the warm air rising? Now guess: why might a cook want two different kinds of heat on one grill?

WATCH

How to Make the Best Grilled Chicken Thighs with Mustard and Tarragon

America's Test Kitchen · 7:51

https://www.youtube.com/watch?v=_Q9X0n00goQ

WHEN TO WATCH

After the kitchen-science paragraph. Watch how the coals are arranged, then draw the setup before you cook.

Note: From America’s Test Kitchen. The cooks sear chicken thighs over the hot side of a gas grill and finish them on the cooler side. Their marinade differs from ours; follow the recipe card.

BACKUP VIDEO

Setting Up a Two-Zone Charcoal Fire | Weber Grills

Weber Grills · 1:26

<https://www.youtube.com/watch?v=V-21tnf6tHk>

For the adult who will light the grill: how to use a chimney starter and spread the coals for a two-zone fire.

KEY TERMS

direct heat

Cooking food right over the fire, mostly by radiation and conduction. Fast and hot, for searing and thin foods.

indirect heat

Cooking food beside the fire with the lid closed, mostly by convection. Slower and gentler, for thick foods.

two-zone fire

A grill set up with coals (or burners) on one side and none on the other, giving a hot zone and a cool zone.

sear

To brown the surface of food quickly over high heat.

barbacoa

A word recorded by Spanish writers in the 1500s for a wooden frame used by the Taíno people of the Caribbean to cook food over a fire. Our word “barbecue” comes from it.

CORE IDEAS

The story. When Spanish explorers reached the islands of the Caribbean in the 1490s and early 1500s, they met the Taíno people, who cooked fish and meat on raised frames of green sticks set over a fire. A Spanish official and historian named Gonzalo Fernández de Oviedo, who lived on the island of Hispaniola, described these frames in his writings in 1526 and recorded the Taíno word for them: *barbacoa*. Our word “barbecue” grew from it.

How they figured it out. Cooks who used the barbacoa learned by experience what grill cooks still learn. Food set low, right over the flames, browned fast and could burn on the outside while staying raw inside. Food raised higher, or set to the side of the fire, cooked slowly and evenly in the warm smoke and air, and stayed tender. Over the centuries, cooks around the world learned to use both: a hot place to brown, and a gentler place to cook through. Today’s grill cooks call this a **two-zone fire**.

The kitchen science. Over the coals, food gets **direct heat**: intense infrared radiation from below plus conduction from the hot grate, perfect for **searing** a crust and for thin foods like burgers and vegetables. Beside the coals with the lid closed, food gets

indirect heat: hot air circulates around it (convection), cooking thick pieces evenly, like an oven. Thick, bone-in chicken thighs are the perfect example: sear them over the coals for color and flavor (the Maillard reaction), then move them to the cool side to finish cooking through without burning. Fat dripping on coals causes flare-ups; the cool side is a safe place to move food when that happens. Indoors, a cook can do the same thing by searing chicken in a skillet and finishing it in the oven.

Let's cook. You will grill yogurt-marinated chicken thighs on a two-zone fire, cooking them yourself with an adult beside you. The skill to do well is **moving food between the zones:** sear, move to indirect heat, close the lid, and check the thickest piece near (but not touching) the bone for 165 °F (74 °C).

PICTURE STUDY



Serving Up the Barbeque at the Pie Town, New Mexico, Fair, Russell Lee, for the Farm Security Administration, 1940 · Color slide photograph · Library of Congress, Washington, D.C.

Image: [Wikimedia Commons](#), public domain

Pie Town was a small community of homesteading families in the New Mexico high desert. In 1940 the government photographer Russell Lee visited and photographed their fall fair, where the whole town shared a free barbecue dinner. Meat for a crowd was cooked slowly for hours over coals in a pit, a form of low, indirect heat.

Look closely

- Find the meat being served. How is it being cut and passed out?
- Look at the people in line. How many families do you think came?
- Look for the plates, pots and serving tools. Were they fancy or simple?
- What does the landscape behind tell you about the place?

Talk about it

1. Meat for a crowd is often cooked “low and slow.” Is that direct or indirect heat? Why does it work well for big, tough cuts?
2. Why would a community barbecue be important to families living far apart in a dry, hard land?
3. How is serving a meal to your neighbors a kind of hospitality?

Safety first. An adult lights the grill and stays beside you the whole time you cook on it; no lighter fluid is used. Use long tongs, keep raw-chicken tools and plates separate from cooked ones, close the lid to smother flare-ups, and check every thigh for 165 °F (74 °C). Never leave a lit grill alone.

Two-Zone Grilled Chicken Thighs

With an adult, you will set up a two-zone fire, sear chicken over direct heat and finish it over indirect heat. You will log the temperatures as the chicken cooks, and compare one thigh cooked only over direct heat.

You will need

- A charcoal grill with a lid and a chimney starter (for the adult), or a gas grill with one side turned off
- Long-handled tongs and an instant-read thermometer
- A large bowl or zip-top bag for marinating
- A plate for raw chicken and a clean platter for cooked chicken
- A fire extinguisher or hose nearby
- Indoor version: a large oven-safe skillet and oven mitts

YOGURT-LEMON GRILLED CHICKEN THIGHS

Serves 5–6 servings · Marinate 1–8 hr · Prep 15 min · Grill 30–40 min

Ingredients

- 3 pounds (1.4 kg) bone-in, skin-on chicken thighs (about 8)
- **Marinade:** 1 cup (240 g) plain yogurt; zest and juice of 1 lemon; 3 cloves garlic, minced; 1 tablespoon olive oil; 2 teaspoons paprika; 1 teaspoon ground cumin; 1½ teaspoons salt; ½ teaspoon black pepper
- Chopped parsley and lemon wedges, for serving

Method

1. Wash your hands. Whisk the marinade in a bowl. Add the chicken, turn to coat, cover and refrigerate 1–8 hours. Wash your hands and the bowl.
2. An adult lights a chimney of charcoal and pours the coals onto one side of the grill (or lights a gas grill and turns one side off). Put the grate on, close the lid and let it heat 10 minutes.
3. Lift the chicken from the marinade, letting extra drip off. Throw the used marinade away (never use it as a sauce).

4. With the adult beside you, place the thighs skin side down over the hot side. Sear 3–5 minutes, until browned, moving any piece that flares up to the cool side and closing the lid.
5. Turn the thighs skin side up and move them all to the cool side. Close the lid (vents half open). Cook 20–30 minutes, until the thickest thigh reads 165 °F (74 °C) near the bone. Many cooks like thighs best at 175 °F, when they are very tender.
6. Move to the clean platter, rest 5 minutes, and serve with parsley and lemon.
7. Clean up: wash the raw-chicken plate, tongs and bowl in hot, soapy water. The adult closes the vents; coals must cool 24–48 hours before an adult empties them into a metal can.
8. **Indoor version:** An adult heats the oven to 425 °F (220 °C). Sear the thighs skin side down in a lightly oiled skillet over medium-high heat, with the adult beside you, 5–6 minutes. Turn them, move the skillet to the oven with oven mitts, and roast 20–25 minutes to 165 °F.

Allergy check: Contains milk (yogurt). For milk-free, use a marinade of ¼ cup olive oil, lemon juice, garlic and the same spices. No eggs, wheat, nuts, soy or fish.

Steps

1. **Draw the setup.** Before the grill is lit, draw your two-zone plan: where the coals go, where you will sear, where the chicken will finish, and where the vents are.
2. **Temperature log.** Every 5 minutes after moving the chicken to the cool side, check one thigh and record the temperature. Make a line graph after supper.
3. **Direct-only test.** Cook one thigh over direct heat the whole time, turning often. Compare its outside and inside with the two-zone thighs.
4. If a flare-up happens, practice the calm response: move the food to the cool side and close the lid. Write what happened.
5. **Taste test.** Ask your family to rate the skin, juiciness and flavor.
6. **Improve it.** Write one change: a different spice, a longer marinade, or grilled vegetables on the hot side while the chicken finishes.
7. Clean up: wash, dry and put away everything.

Tips

- Yogurt marinades tenderize and help browning, but sugar-free marinades like this one burn less than sweet sauces.
- If you want a sauce, brush it on only in the last 5 minutes on the cool side, so the sugar does not burn.
- Thighs are forgiving. They stay juicy even a little past 165 °F, which makes them perfect for learning to grill.

Check your work

- ☐ I can tell where the word “barbecue” comes from.
- ☐ I can explain direct and indirect heat and set up a two-zone fire.
- ☐ I grilled chicken thighs to 165 °F with an adult beside me and logged the temperatures.

COOK’S NOTEBOOK

1. Draw your two-zone grill from above and from the side, with arrows showing radiation over the coals and convection on the cool side.
2. Make a line graph of your temperature log.
3. Copy the chicken recipe and add a note on how you would cook it indoors.

From history. Oviedo also described the Taíno people’s hammocks, another word that entered English from their language. Cooking over fire on a raised frame is found in many parts of the world, from Caribbean barbacoa to the open-fire cooking of shepherds, fishermen and cowboys.

COMMON MISTAKES

- Cooking thick chicken only over direct heat. The outside burns before the inside reaches 165 °F.
- Reusing raw-chicken marinade as a sauce. Throw it away, or set some aside before it touches raw meat.
- Opening the lid again and again during indirect cooking. The heat escapes and cooking takes much longer.

Make it a game • Two-Zone Map. Draw a grill from above and shade the direct zone and the indirect zone. Your parent calls out foods, such as steak, thick chicken thighs and corn, and you point to where each should begin and why. Say what searing does. Then explain what barbacoa meant to early Spanish writers in the Caribbean.

Scripture. “As soon then as they were come to land, they saw a fire of coals there, and fish laid thereon, and bread.” (John 21:9, KJV)

After His resurrection, Jesus Himself cooked breakfast on a fire of coals for His tired disciples. Cooking for others over a fire is an old and honorable act of love.

7.4 BALANCE A DISH: SALT, ACID, FAT AND HEAT

OBJECTIVES

- Tell how the friar Bernardino de Sahagún recorded the foods and sauces of the Mexica (Aztec) people in the 1500s.
- Explain how salt, acid, fat and heat (with sweetness and bitterness) balance one another in a dish, and how to taste and adjust.
- Grill vegetables for tacos with a lime crema, adjusting the balance by tasting, with an adult beside you or using a grill pan indoors.

Warm-up. Taste a plain tortilla chip, then one with a squeeze of lime, then one with a pinch of salt, then one with both. Describe each in one word. Which tasted most “complete”? Why do you think lime and salt work so well together?

WATCH

Grilled Mexican Corn with Chile Lime Sauce

Cowboy Kent Rollins • 8:06

https://www.youtube.com/watch?v=QP7LM_sZn1k

WHEN TO WATCH

After the kitchen-science paragraph, before you taste and adjust your crema.

Note: Cowboy Kent Rollins and his wife Shannon grill corn and balance it with a creamy, tangy chile-lime sauce: salt, acid, fat and heat in one dish. Also used in the Grade 5 course; no better short video on balancing flavors passed our review.

KEY TERMS

balance

The way the flavors in a dish work together so that no single one overpowers the rest.

complementary flavors

Flavors that make each other better, like salt and sweet, acid and fat, or spicy heat and a cool, creamy sauce.

acid

Sour ingredients like lime, lemon, vinegar, tomatoes and yogurt. Acid brightens food and cuts richness.

crema

A thick, slightly tangy cream used in Mexican cooking; here made with sour cream or yogurt and lime.

season to taste

To taste a dish and adjust it, usually with salt, acid or heat, until it is balanced.

CORE IDEAS

The story. Bernardino de Sahagún was a Spanish Franciscan friar who came to Mexico in 1529, only a few years after the Spanish conquest of the Mexica (Aztec) capital. He learned the Nahuatl language and spent much of his long life recording the customs, knowledge and daily life of the Mexica people, working with Nahua elders and students. His great work, finished in the 1570s and now called the *Florentine Codex*, filled twelve books with text in Nahuatl and Spanish and more than 2,000 pictures.

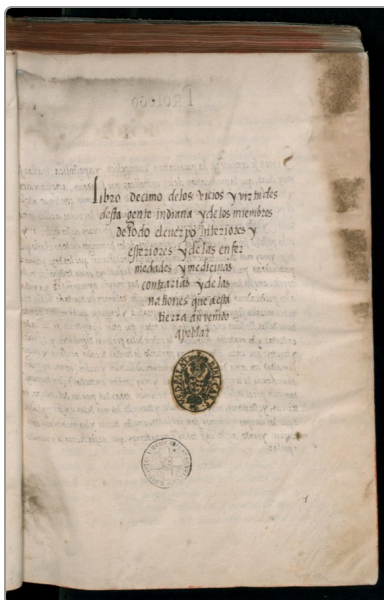
How he figured it out. Sahagún did not guess; he asked. He interviewed elders, had his trained Nahua students write down their answers, and checked them with other groups of elders. In the book about the people and their work, the elders described the sellers in the great markets: tortilla makers, sellers of tamales, and sellers of many kinds of chilies, tomatoes and sauces. Their sauces combined chilies, tomatoes, ground squash seeds and salt, the same ideas of heat, sourness, richness and salt that cooks still balance today. Corn tortillas, chilies and tomatoes, all native to Mexico, have fed people there for thousands of years.

The kitchen science. Good cooks taste and adjust. **Salt** makes flavors stronger and quiets bitterness (remember Lesson 3.1). **Acid** (lime, lemon, vinegar) brightens a dish and cuts through richness, so a squeeze of lime wakes up grilled vegetables. **Fat** (avocado, sour cream, cheese, oil) carries flavors and softens sharp ones; it is why a cool, creamy crema tames chili **heat**. A little **sweetness**, like charred corn, balances sourness and spice, and a little **bitterness**, like the char from the grill, adds depth. These pairs are **complementary flavors**: salt + sweet, acid + fat, heat + cool, herb + citrus. When a dish tastes flat, it usually needs salt or acid. When it is too sour, a little fat or sweetness helps. When it is too spicy, add fat and something cool. Taste after every change.

Let's cook. You will grill vegetables (zucchini, peppers, onion and corn) and serve them in warm tortillas with black beans, avocado, cheese and a lime crema. The skill

to do well is **seasoning to taste**: adjust the crema and the vegetables a little at a time, tasting with a clean spoon after each change.

PICTURE STUDY



Title Page of Book X of the Florentine Codex, Bernardino de Sahagún and Nahua artists and scribes,
about 1575–1577 · Ink and paint on paper · Biblioteca Medicea Laurenziana, Florence, Italy

Image: Wikimedia Commons, public domain

This is the opening page of Book X of the *Florentine Codex*, the book about the people of Mexico, their work and their character. Its title, in old Spanish, begins “Libro décimo,” the tenth book. Inside, Nahua scribes wrote the text in Nahuatl and Spanish side by side, and Nahua artists painted small pictures of people at their trades, including the food sellers of the markets. The manuscript is kept today in a library in Florence, Italy, which is how it got its name.

Look closely

- Find the title in the center. Can you find the words for “tenth book” (Libro décimo)?
- Look at the handwriting. How is it different from writing today?
- Look at the edges of the page. What tells you the book is more than four hundred years old?
- Find the stamp. Why might a library stamp its books?

Talk about it

1. Sahagún learned by asking elders and checking their answers. How did you do something similar in Lesson 3.3?

2. Chilies, tomatoes and corn came from Mexico. Which foods on your table today have roots there?
3. Why is it important to record how people cook and eat before that knowledge is forgotten?

Safety first. An adult lights the grill and stays beside you while you cook; no lighter fluid is used. Use long tongs and a grill basket or large pieces so vegetables do not fall through. Wear gloves if you cut hot peppers. Indoors, use a grill pan or the broiler with an adult. Check toppings for allergies.

KITCHEN PROJECT

Grilled Vegetable Tacos and the Balance Test

You will grill vegetables for a taco supper and make a lime crema, then run a balance test: taste a plain grilled vegetable, then adjust it step by step with salt, acid, fat and heat, recording how each one changes the flavor.

You will need

- A grill (lit by an adult) or a stovetop grill pan
- Long tongs and a grill basket (optional)
- A chef's knife, cutting board and large bowl
- A small bowl and whisk for the crema
- Clean tasting spoons and a kitchen towel to keep tortillas warm

GRILLED VEGETABLE TACOS WITH LIME CREMA

Serves 6 servings (2–3 tacos each) · Prep 25 min · Grill 15–20 min

Ingredients

- 2 medium zucchini, cut lengthwise in ½-inch planks
- 2 bell peppers (red and yellow), cut in wide flat pieces
- 1 large red onion, cut in ½-inch rounds (keep the rings together)
- 2 ears corn, husked
- 3 tablespoons olive oil, 1 teaspoon chili powder, 1 teaspoon ground cumin, ¾ teaspoon salt
- 1 can (15 oz or 425 g) black beans, drained, rinsed and warmed
- 12–16 small corn or flour tortillas
- 1 avocado, sliced, and ½ cup (60 g) crumbled cotija or feta cheese
- **Lime crema:** ¾ cup (180 g) sour cream or plain Greek yogurt, zest of 1 lime and 1–2 tablespoons lime juice, ¼ teaspoon salt, 1–2 teaspoons water to thin
- Lime wedges and chopped cilantro, for serving

Method

1. Wash your hands and the vegetables. An adult lights the grill to medium-high (or heat a grill pan over medium-high heat indoors, with an adult beside you).
2. Brush the vegetables and corn with olive oil and sprinkle with chili powder, cumin and salt.
3. Whisk the crema ingredients. Taste it and adjust: more lime if it tastes flat, more salt if it tastes dull, a little water if it is too thick.
4. With the adult beside you, grill the vegetables over direct heat with long tongs: peppers and onions 4–5 minutes per side, zucchini 3–4 minutes per side, corn 8–10 minutes, turning, until tender with grill marks.
5. Warm the tortillas on the grill 15–20 seconds per side and wrap them in a towel.
6. Cut the vegetables into strips and the corn off the cob. Fill each tortilla with beans, vegetables, avocado and cheese, then add crema, cilantro and a squeeze of lime.
7. Clean up: an adult shuts down the grill. Wash the tools and bowls, and refrigerate leftovers within 2 hours.

Allergy check: Contains milk (sour cream or yogurt, cheese) and wheat if you use flour tortillas. Use corn tortillas for wheat-free; for milk-free, make the crema from mashed avocado, lime and water, and skip the cheese. No eggs or nuts.

Steps

1. **Balance test.** Set aside a few plain grilled zucchini strips (no seasoning, if you can grill a plain piece). Taste one. Then taste one with a pinch of salt, one with salt and lime, one with salt, lime and a dab of crema, and one with all of those plus a pinch of chili. Rate each from 1 to 5 and describe it in one word.
2. Grill the vegetables and assemble the tacos.
3. **Fix-it practice.** Make a tiny bowl of crema that is too sour (extra lime). Fix it by adding a little more sour cream or a pinch of sugar. Make another that is too salty, and fix it with more sour cream and lime. Record what worked.
4. **Taste test.** Ask each family member to build a taco and tell you which topping made it taste most balanced.

5. **Improve it.** Write one change: grilled pineapple, a smoky chipotle crema, or a squeeze of orange with the lime.

6. Clean up: wash, dry and put away everything.

Tips

- Cut vegetables into large, flat pieces for grilling, then slice them after. Small pieces fall through the grate.
- Corn tortillas stay softer if warmed just before eating and kept wrapped in a towel.
- When a dish tastes “missing something,” try salt first, then acid.

Check your work

- ☐ I can tell how Sahagún recorded the foods and sauces of the Mexica.
- ☐ I can explain how salt, acid, fat and heat balance each other.
- ☐ I grilled vegetables for tacos and seasoned the crema to taste.

COOK'S NOTEBOOK

1. Draw a “balance wheel” with salt, acid, fat, heat, sweet and bitter around a circle, and write one ingredient for each.
2. Record your balance-test ratings and the one-word descriptions.
3. Write three complementary flavor pairs you have tasted this year and the dish each came from.

From history. The word “taco” is much younger than the food. Mexicans have folded tortillas around fillings for centuries, but the word taco for this dish appears in print only in the late 1800s. Tacos spread across the United States in the 1900s.

COMMON MISTAKES

- Adding lots of salt or lime at once. Add a little, taste, and add more if needed.
- Tasting with the same spoon you stir with. Use a clean spoon each time.
- Fixing too much spice with water. Add fat, something cool or a little sweetness instead.

Make it a game • Taste and Adjust. Make a bowl of plain tomato soup. Your parent calls out a problem, like flat, sharp, bitter or greasy, and you decide whether to add salt, acid, fat or sweetness. Taste with a clean spoon each time. Then tell how Bernardino de Sahagun recorded the foods of the Mexica people in the 1500s.

Scripture. “Let your speech be alway with grace, seasoned with salt, that ye may know how ye ought to answer every man.” (Colossians 4:6, KJV)

Paul compares good words to well-seasoned food: not bland, not harsh, but balanced and gracious. A cook who balances a dish can remember to balance words, too.

UNIT 7

FIRE, THE GRILL & SPICE

This is the fun unit, and also the one that asks the most care. This year you move from watching the grill to cooking on it yourself, with an adult beside you. You will learn the grill's rules first: an adult always lights it, no one uses lighter fluid, long tongs instead of forks, and a lid ready for flare-ups. Then you will meet Henry Ford, who turned the wood scraps from his car factory into charcoal briquettes and helped start America's love of backyard cooking.

You will also explore heat of another kind: the burn of chili peppers, measured by the pharmacist Wilbur Scoville in 1912. You will learn to build a two-zone fire for cooking over direct and indirect heat, a method as old as the wooden barbecue frames early Spanish writers saw in the Caribbean. And you will learn the cook's four great tools for balancing a dish, salt, acid, fat and heat, using a Spanish friar's careful records of the foods of old Mexico as your guide. Every grill recipe has an indoor version for families without a grill.

PREREQUISITES

- Knows the fire triangle and kitchen fire safety (Lesson 1.4)
- Can check meat at safe internal temperatures with a thermometer (Units 1–4)
- Can use a chef's knife with the claw and bridge grips (Unit 1)
- Knows conduction, convection and radiation (Lesson 4.1)

MASTERY CHECKLIST

- ☐ I can state the grill safety rules and explain how a chimney starter, vents and the lid control the fire triangle.
- ☐ I can tell how Henry Ford's factory made charcoal briquettes and grill burgers to 160 °F with an adult beside me.
- ☐ I can tell how Wilbur Scoville measured pepper heat, explain what capsaicin does, and handle hot peppers safely.
- ☐ I can set up a two-zone fire, explain direct and indirect heat, and balance a dish using salt, acid, fat and heat.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **NFPA: Grilling safety:** Free. Grilling safety tips and a printable tip sheet from the National Fire Protection Association. Read it together before Lesson 7.1.
- **For the adult griller: a chimney starter, long-handled tongs and a fire extinguisher:** A chimney starter lights charcoal with crumpled newspaper and no lighter fluid. Keep a fire extinguisher or garden hose within reach whenever the grill is lit.
- **Disposable kitchen gloves:** Inexpensive. For cutting hot peppers in Lessons 7.2 and 7.4, so the capsaicin does not get on your hands and into your eyes.
- **A stovetop grill pan:** Optional. The indoor alternative to the outdoor grill for every recipe in this unit, used with an adult and the kitchen fan on.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

7.1	Henry Ford and the Charcoal Briquette	2 sessions of 50–60 minutes
7.2	Wilbur Scoville and the Heat of Peppers	2 sessions of 50–60 minutes
7.3	Direct and Indirect Heat	2 sessions of 60–90 minutes
7.4	Balance a Dish: Salt, Acid, Fat and Heat	2 sessions of 50–60 minutes

UNIT 7 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. 8 pts

List five grill safety rules from this unit.

2. 8 pts

How did Henry Ford's company make charcoal briquettes, and why?

3. 8 pts

Use the fire triangle to explain how a chimney starter lights coals and how closing the grill lid stops a flare-up.

4. 8 pts

Calculation: Six burger patties use 2 pounds of beef. How many ounces is each patty? (1 pound = 16 ounces.) How much beef would you need for 15 patties of the same size?

5. 8 pts

How did Wilbur Scoville measure pepper heat in 1912?

6. 8 pts

Why does milk cool a chili burn better than water? Where is most of a pepper's capsaicin?

7. 8 pts

Calculation: A jalapeño is about 5,000 Scoville units and a habanero about 250,000. How many times hotter is the habanero?

8. 8 pts

Explain direct and indirect heat, and why thick chicken thighs are cooked with both.

9. 8 pts

Where does the word "barbecue" come from?

10. 10 pts

Calculation: Convert 165 °F and 175 °F to Celsius using $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5 \div 9$. Round to the nearest degree.

11. 10 pts

Predict and fix: Your salsa tastes flat. Your crema is too sour. Your taco filling is too spicy. What would you add to each?

12. 8 pts

Short answer: How did Bernardino de Sahagún gather and check his information about the foods of the Mexica?

ANSWER KEY

1. Any five: grills outdoors only on flat ground away from the house, railings, overhangs and leaves; only adults light the grill; no lighter fluid; long tongs, never a fork to flip; close the lid to smother a flare-up; hose or extinguisher nearby; never leave a lit grill alone; let coals cool 24–48 hours before an adult disposes of them in a metal can.
2. It heated wood scraps from its car-parts factory with very little air to make charcoal, crushed it, mixed it with a starch binder and pressed it into briquettes. Ford hated waste and turned scraps into a product.
3. The starter supplies heat (burning newspaper) to the fuel (charcoal), and rising hot air draws in oxygen through the bottom (convection). Closing the lid cuts off oxygen, so the flames die down.
4. $2 \times 16 = 32$ ounces; $32 \div 6 \approx 5\frac{1}{3}$ ounces each. For 15: $15 \times 5\frac{1}{3} = 80$ ounces = 5 pounds.
5. He diluted a pepper extract with sugar water again and again and gave it to a panel of five tasters until most could no longer feel the heat. The number of dilutions became the Scoville Heat Units.
6. Capsaicin dissolves in fat, not water; the fat and protein in milk carry it away, while water just spreads it. Most capsaicin is in the pale pith (ribs) and around the seeds.
7. $250,000 \div 5,000 = 50$ times hotter.
8. Direct heat is right over the coals (radiation and conduction), hot and fast for searing. Indirect heat is beside the coals with the lid closed (convection), gentle like an oven. Thighs are seared over direct heat for color, then finished over indirect heat so the inside reaches 165 °F before the outside burns.
9. From barbacoa, the Taíno word for a wooden frame used to cook over a fire, recorded by Spanish writers such as Gonzalo Fernández de Oviedo in 1526.
10. 165 °F: $133 \times 5 \div 9 \approx 74$ °C. 175 °F: $143 \times 5 \div 9 \approx 79$ °C.
11. Flat salsa: a pinch of salt, then a little lime. Too-sour crema: more sour cream or yogurt (fat), or a pinch of sugar. Too-spicy filling: something fatty and cool, such as crema, avocado or cheese, or a little sweetness.
12. He learned Nahuatl, interviewed Nahua elders, had trained Nahua students write down their answers, and checked them with other groups of elders, recording it all in Nahuatl and Spanish with pictures in the Florentine Codex.

UNIT CHALLENGE: A FAMILY GRILLED DINNER WITH A HOMEMADE SPICE RUB

Plan and cook a grilled (or broiled) dinner for your family with an adult beside you: a main dish cooked to a safe temperature, a grilled vegetable, and a fresh salsa or sauce. Create your own spice rub from at least four spices, record the recipe in teaspoons, and smell-test it before using it.

Write the grill safety checklist and check it off before the adult lights the grill. During the meal, collect your family's ratings, and afterward make a flavor-balance chart for each dish showing its salt, acid, fat, heat, sweet and bitter. Families without a grill may use the broiler and a grill pan.

LOOK FOR	WHAT IT MEANS
Safety checklist	Checklist completed before lighting; adult lights the grill; no lighter fluid; long tools; lid used for flare-ups; safe temperatures checked and recorded.
Spice rub	An original rub with at least four spices, measured and recorded, and a short note on why the spices go together.
Balanced menu	Main dish, vegetable and sauce that use salt, acid, fat and heat thoughtfully; flavor-balance chart completed.
Cleanup and improvement	Grill area and kitchen cleaned, coals left to cool safely, and one honest improvement named. A dish that burned but is recorded and improved earns full credit.

UNIT 8

MEAL PLANNING & THE FAMILY TABLE

All year you have learned to cook safely, balance a meal, understand taste and heat, and read the chemistry of a recipe. In this last unit you will learn to plan: to shop wisely, to cook within a budget, to make one cooking session feed a family twice, and finally to plan, shop for and cook a three-course feast. You will meet Sylvan Goldman, an Oklahoma grocer who invented the shopping cart in 1937, and the families of the World War II home front who planted victory gardens and cooked with ration books.

You will also study the capable woman of Proverbs 31, who rises early to provide food for her household, and the slow cooker invented by Irving Naxon, who remembered a stew that cooked slowly overnight in his mother's village. You will cook rice and bean burritos with a cost per serving, a ration-style carrot cake, a slow-cooker pot roast that becomes two dinners, and your own family feast. "Gather up the fragments that remain, that nothing be lost" (John 6:12): good planning honors God's gifts by wasting nothing.

PREREQUISITES

- Can figure cost per serving (Lesson 2.4) and scale a recipe up or down (Units 3–5)
- Can plan a balanced meal with MyPlate (Unit 2)
- Knows safe temperatures, cooling within 2 hours and reheating to 165 °F (Units 1 and 4)
- Has cooked at least one recipe from each unit this year

MASTERY CHECKLIST

- ☐ I can find and compare unit prices, write a shopping list from a menu, and figure cost per serving.
- ☐ I can tell how families on the World War II home front planned meals with ration books and victory gardens, and I can plan around limits.
- ☐ I can plan a cook-once, eat-twice meal and store and reheat leftovers safely.
- ☐ I can plan, budget, schedule, cook and serve a three-course family feast with an adult present, set the table, and give thanks.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **MyPlate Kitchen (USDA):** Free. The USDA’s collection of budget-friendly recipes with cost and nutrition information, and tools for meal planning and shopping lists. Useful for Lessons 8.1–8.4. Search “MyPlate Kitchen.”
- **FoodSafety.gov: Leftovers and food safety:** Free. How long cooked foods keep in the refrigerator and freezer, for the leftover plans in Lessons 8.2–8.3. Search “FoodSafety.gov cold food storage chart.”
- **A slow cooker:** Optional. Lesson 8.3 gives an oven method in a heavy covered pot for families without one.
- **A calculator and a notebook folder for receipts:** For unit prices, cost per serving and the feast budget.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

8.1	Sylvan Goldman’s Shopping Cart and the Unit Price	2 sessions of 50–60 minutes
8.2	Victory Gardens and the Ration Book	2 sessions of 60–90 minutes
8.3	Proverbs 31: Planning Ahead with the Slow Cooker	2 sessions of 50–60 minutes
8.4	The Family Feast	2 sessions of 60–90 minutes

UNIT 8 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**

What problem did Sylvan Goldman notice in his stores, and how did he solve it?

2. **10 pts**

Calculation: A 2-pound bag of rice costs \$3.00. A 5-pound bag costs \$6.50. Which is the better buy per pound?

3. **10 pts**

Calculation: Your burritos cost \$11.20 in all and made 8 burritos. What is the cost per burrito? If you made 12 burritos with the same cost per burrito, what would the total be?

4. **8 pts**

Why did the United States ration food during World War II? Name the first food rationed and two later ones.

5. **8 pts**

What was a victory garden, and why did it matter?

6. **10 pts**

Calculation: A family has 64 red points for three days. Butter is 8 points per $\frac{1}{4}$ pound, cheese 6 points per $\frac{1}{2}$ pound, and ground beef 7 points per pound. If they buy $\frac{1}{2}$ pound butter, $\frac{1}{2}$ pound cheese and 3 pounds of ground beef, how many points are left?

7. **8 pts**

Name two ways home-front cooks made cakes with less sugar and butter, and explain why oil makes a moist cake.

8. **8 pts**

What inspired Irving Naxon's slow cooker, and what was it later named?

9. **8 pts**

Why does a tough chuck roast become tender after many hours of slow, moist cooking?

10. **8 pts**

List three rules for safe leftovers.

11. **6 pts**

Calculation: Dinner is at 6:00 p.m. The chicken needs 1 hour 20 minutes to roast and 15 minutes to rest, and you need 25 minutes to prepare it before roasting.

What time must you start preparing the chicken?

12. **8 pts**

Short answer: Name three things that make a family meal a true feast, using ideas from this unit and the year.

ANSWER KEY

1. Shoppers stopped buying when their hand baskets got full and heavy. In 1937 he introduced a folding metal cart on wheels holding two baskets, and hired people to push carts around the store until shoppers accepted them.
2. 2-pound bag: $\$3.00 \div 2 = \$1.50$ per pound. 5-pound bag: $\$6.50 \div 5 = \$1.30$ per pound. The 5-pound bag is the better buy (if you will use it).
3. $\$11.20 \div 8 = \$1.40$ per burrito. $12 \times \$1.40 = \$16.80$.
4. Food was needed for the armed forces and allies, and shipping was needed for the war, so supplies were limited and rationing shared them fairly. Sugar was first (1942); later coffee, meat, butter, fats, cheese and canned and processed foods.
5. A home or community vegetable garden planted during the war. Families grew their own vegetables, saving money and ration points and leaving more commercial food for the troops; by some estimates they grew about 40 percent of the fresh vegetables Americans ate.
6. Butter: $\frac{1}{2}$ pound = $2 \times 8 = 16$. Cheese: 6. Beef: $3 \times 7 = 21$. Total $16 + 6 + 21 = 43$. $64 - 43 = 21$ points left.
7. Any two: used grated carrots, raisins, applesauce or honey for sweetness; added spices and vanilla; used oil instead of butter. Oil stays liquid and coats the flour, limiting gluten and keeping the cake tender and moist.
8. His mother's stories of cholent, a Sabbath stew left to cook slowly overnight in the village baker's oven in Lithuania. Rival bought it in 1970 and named it the Crock-Pot in 1971.
9. Its collagen, a tough connective protein, slowly melts into gelatin in long, moist heat, so the meat falls apart easily and the liquid becomes rich.
10. Refrigerate within 2 hours (1 hour above 90°F); cool in shallow containers; label and use cooked leftovers within 3–4 days; reheat to 165°F ; thaw frozen meat before slow cooking.
11. $25 + 80 + 15 = 120$ minutes = 2 hours. Start at 4:00 p.m.
12. Answers vary. Examples: careful planning and cooking; balanced, delicious food served safely; a set table and a warm welcome (hospitality); giving thanks together; giving to others and wasting nothing.

UNIT CHALLENGE: THE FAMILY FEAST

The family feast from Lesson 8.4 is the unit challenge. Hand in your complete feast plan: the menu card, the shopping list with unit prices and the budget (with the total spent and the cost per person), and the timeline you posted in the kitchen.

Add a photograph or drawing of the set table and the finished dishes, the temperature you recorded for the main dish, your family's favorite-dish votes, a written grace or thank-you note to your family, and your one-page reflection on the year in the kitchen.

LOOK FOR	WHAT IT MEANS
Planning	A balanced three-course menu, a shopping list priced with unit prices, a budget met (or honestly explained), and a timeline worked backward from dinnertime.
Safe, skilled cooking	Adult present; clean-as-you-go habits; raw and cooked foods kept apart; safe temperatures checked and recorded; leftovers refrigerated within 2 hours.
Hospitality	Table set properly, family welcomed warmly, grace or thanks given, cleanup shared.
Reflection	A thoughtful one-page reflection on the year: skills learned, thankfulness, and plans for future cooking.
Improvement	Names what went well and what to change next time. A dish that did not turn out but is honestly recorded earns full credit.

8.1 SYLVAN GOLDMAN'S SHOPPING CART AND THE UNIT PRICE

OBJECTIVES

- Tell how Sylvan Goldman invented the shopping cart in 1937 and how it changed grocery shopping.
- Read a shelf tag's unit price and compare products by price per ounce or per pound.
- Plan, shop for and cook rice and bean burritos for the family, and figure the cost per serving.

Warm-up. Look at two sizes of the same food in your pantry, such as a small and a large jar of peanut butter or a small and large bag of rice. Write each price (from a receipt or the store's website) and its weight. Which do you think is the better buy? How could you prove it?

WATCH

Unit pricing helps you save money at the grocery store | Consumer Reports

Consumer Reports • 1:48

<https://www.youtube.com/watch?v=KMe85qahPbk>

WHEN TO WATCH

After the story of Sylvan Goldman, before your shopping trip.

Note: A short Consumer Reports segment showing real shelf tags and how to read the unit price.

BACKUP VIDEO

Shopping Carts: Invented in 1937, But Nobody Wanted to Use It

History of Simple Things • 8:29

<https://www.youtube.com/watch?v=IPaQkwrrqvU>

After the story, for more photographs of Goldman's first carts in his Humpty Dumpty stores.

KEY TERMS

unit price

The cost for one unit of measure, such as per ounce or per pound. It lets you compare packages of different sizes.

budget

A plan for how much money to spend.

cost per serving

The total cost of a recipe divided by the number of servings.

store brand

A product sold under the grocery store's own name, often cheaper than a well-known brand and similar in quality.

staple

A basic food a household keeps on hand and uses often, such as rice, beans, flour, oats and oil.

CORE IDEAS

The story. Sylvan Goldman owned a chain of grocery stores called Humpty Dumpty in Oklahoma City in the 1930s. His stores were self-service, so shoppers carried wire or wooden hand baskets. Goldman noticed something: when a basket grew full and heavy, shoppers stopped picking things up and went to the checkout. They were buying only as much as they could carry.

How he figured it out. One night in 1936, Goldman looked at two folding wooden chairs in his office and imagined putting wheels on the legs and a basket on the seat. With a mechanic named Fred Young, he built a folding metal frame on wheels that held two baskets, one above the other. The carts appeared in his stores in June 1937, with newspaper ads inviting shoppers to try them. At first almost no one did; people were used to baskets and did not want to look odd. So Goldman hired people of all ages to push carts around the store, filling them with groceries, and before long everyone was using them. His folding carts spread across the country, and the shopping cart made the big American supermarket possible.

The kitchen science. A cart makes it easy to buy more; a plan makes it easy to buy wisely. Start with a menu, then write a shopping list grouped by store section, and check the pantry first. On the shelf, compare **unit prices**: the small tag under each

product shows its price per ounce, per pound or per count. To find it yourself, divide the price by the amount: a 2-pound bag of rice for \$3.00 costs \$1.50 per pound, and a 5-pound bag for \$6.00 costs \$1.20 per pound. Bigger is often cheaper per unit, but not always, and it is only a bargain if you will use it before it spoils. **Staples** such as rice, dried or canned beans, oats, flour and seasonal vegetables give the most nourishment for the money. Finally, figure **cost per serving** so you know what a meal truly costs.

Let's cook. You will shop for and cook rice and bean burritos for the family, a satisfying, balanced, low-cost meal. The skill to do well is **rolling a burrito**: warm the tortilla so it bends, put the filling in a line just below the center, fold the bottom up over it, fold in the sides, and roll it tight.

PICTURE STUDY



Canned Goods in a Company Store, Gary, West Virginia, Russell Lee, for the U.S. Department of the Interior, 1946 · Photograph · National Archives, College Park, Maryland

Image: [Wikimedia Commons](#), public domain

In 1946 the photographer Russell Lee traveled through America's coal-mining towns, photographing the homes, schools and stores of miners' families. In many of these towns the coal company owned the store. Here, shelves of canned goods stand ready for shoppers, row on row, the same kind of canned food Nicolas Appert made possible in Unit 4.

Look closely

- Look at the cans. How many different kinds of food can you name from their labels?
- Find cans of different sizes. Which would be the better buy? What would you need to know to decide?
- Look at how the shelves are arranged. How do stores group foods to help shoppers?
- Look at the counter. How did shoppers in this store get their groceries: by serving themselves or by asking a clerk?

Talk about it

1. A miner's family had a limited budget. How could unit prices and a shopping list help them?

2. Why would canned foods have been so important to a family in a mining town in 1946?
3. How is shopping wisely a way of caring for your family?

Safety first. An adult is nearby while you use the stove. Warm tortillas in a dry skillet or the microwave and handle them with tongs or a towel. Keep the meal's leftovers in the refrigerator within 2 hours and reheat burritos to 165 °F (74 °C). Check the tortillas and cheese labels for allergens.

The Shopping Trip and Budget Burritos

You will plan a burrito supper, write a shopping list, go to the store with a parent, compare unit prices for at least three items, and stay within a budget your parent sets. Then you will cook the burritos and figure the real cost per serving.

You will need

- A shopping list and a calculator (and a parent-set budget)
- A medium saucepan with a lid for rice, a large skillet
- A chef's knife, cutting board, can opener and potato masher or fork
- Measuring cups and spoons, tongs, a box grater
- Your grocery receipt

RICE AND BEAN BURRITOS

Serves 8 burritos • Prep 20 min • Cook 25 min

Ingredients

- **Seasoned rice:** 1 cup (200 g) long-grain rice, 1 tablespoon oil, $\frac{1}{4}$ cup tomato sauce, $1\frac{3}{4}$ cups (415 mL) water or broth, $\frac{1}{2}$ teaspoon salt
- **Beans:** 1 tablespoon oil, 1 small onion, diced, 2 cloves garlic, minced, 2 cans (15 oz or 425 g each) pinto or black beans, drained and rinsed, 1 teaspoon ground cumin, 1 teaspoon chili powder, $\frac{1}{2}$ teaspoon salt, $\frac{1}{2}$ cup (120 mL) water
- 8 large (10-inch) flour tortillas
- $1\frac{1}{2}$ cups (170 g) grated cheddar or Monterey Jack cheese
- **Toppings:** chopped lettuce, diced tomatoes, salsa (from Lesson 7.2), sour cream or plain yogurt

Method

1. Wash your hands. **Rice:** with an adult nearby, heat the oil in the saucepan, add the rice and stir 2 minutes until lightly toasted. Add the

tomato sauce, water and salt, bring to a boil, cover, turn to low and simmer 18 minutes. Rest 5 minutes, then fluff.

2. **Beans:** heat the oil in the skillet over medium heat. Cook the onion 5 minutes, add the garlic for 1 minute, then the beans, spices, salt and water. Simmer 5 minutes, mashing about half the beans with a fork or masher, until thick.
3. Warm the tortillas one at a time in a dry skillet, 15–20 seconds per side, or wrapped in a damp towel in the microwave for 30–45 seconds.
4. Lay a tortilla flat. Spoon a line of rice, beans and cheese just below the center. Fold the bottom edge up over the filling, fold in both sides, and roll away from you tightly. Place seam side down.
5. Serve with toppings. For crisp burritos, an adult can help you brown them seam side down in the skillet 1–2 minutes per side.
6. Clean up: wash the pans and tools, and wrap leftover burritos in foil or plastic and refrigerate within 2 hours (or freeze for up to 2 months).

Allergy check: Contains wheat (flour tortillas) and milk (cheese, sour cream or yogurt). Use corn tortillas (and fold them as soft tacos) for wheat-free; skip the cheese and sour cream for milk-free. Some broths and tortillas contain soy; check labels. No eggs or nuts.

Steps

1. **Plan.** Write the menu and a shopping list grouped by store section (produce, canned goods, dairy, bread). Check the pantry first and cross off what you already have.
2. **Unit-price hunt.** At the store, compare the unit prices of at least three items in two sizes or two brands each (for example: rice, canned beans, cheese). Record the price, the amount and the unit price, and circle the better buy.
3. Stay within the budget your parent set. Keep the receipt.
4. Cook the burritos for supper.
5. **Cost per serving.** Using the receipt, figure the cost of the amount of each ingredient you used, add them, and divide by 8. Compare it with the price of a burrito at a restaurant.
6. **Taste test and improve.** Ask your family to rate the burritos, and write one change: brown rice, added corn and peppers, or a different bean.

7. Clean up: wash, dry and put away everything, and file the receipt in your notebook folder.

Tips

- Warm tortillas bend; cold ones crack. Do not skip the warming step.
- Do not overfill. About $\frac{1}{3}$ cup rice, $\frac{1}{3}$ cup beans and a small handful of cheese fits a 10-inch tortilla.
- Dried beans cost even less than canned. Ask an adult to help you cook a pot from scratch one weekend and compare the cost.

Check your work

- ☐ I can tell how Sylvan Goldman invented the shopping cart.
- ☐ I can find and compare unit prices.
- ☐ I shopped within a budget, cooked burritos and figured the cost per serving.

COOK'S NOTEBOOK

1. Copy your unit-price table with the better buy circled for each item, and show one division problem.
2. Write your shopping list, budget, total spent and cost per serving.
3. Draw a burrito-rolling diagram in four steps.

From history. Goldman later improved his cart so that carts could nest inside each other to save space, an idea patented by an inventor named Orla Watson, who applied for his patent in 1946. Goldman became a wealthy businessman and gave generously to his city of Oklahoma City.

COMMON MISTAKES

- Assuming the biggest package is always the best buy. Check the unit price, and buy only what you will use.
- Shopping without a list. It is easy to forget items and to buy extra things you do not need.
- Forgetting to count pantry staples (oil, spices) in the cost per serving. Estimate a small amount for them.

Make it a game • Price per Ounce. Take two boxes of the same kind of food in different sizes. Race to divide the price by ounces and decide which has the lower unit price. Round to the nearest cent. Then say what a store brand and a staple are, and tell how Sylvan Goldman's shopping cart changed grocery shopping in 1937.

Scripture. “For which of you, intending to build a tower, sitteth not down first, and counteth the cost, whether he have sufficient to finish it?” (Luke 14:28, KJV)

Jesus said a wise builder counts the cost before he begins. A wise cook does the same before shopping for a meal.

8.2 VICTORY GARDENS AND THE RATION BOOK

OBJECTIVES

- Tell how American families on the World War II home front planned meals with ration books and grew victory gardens (1942–1945).
- Plan meals within a limit, using ration-style points, and explain how cooks substituted ingredients when sugar, butter and meat were scarce.
- Bake a ration-style carrot spice cake and compare its sugar with a modern carrot cake.

Warm-up. Imagine the store could sell your family only a little sugar each week, and the butter and meat for the whole week had to fit inside a small budget of “points.” Write down three foods you would miss most and one way you could still make a good supper.

WATCH

Clip- Victory Gardens

The National WWII Museum · 4:02

<https://www.youtube.com/watch?v=NTjwK3Ldrzg>

WHEN TO WATCH

After the story, before you plan your ration-style menu.

Note: From The National WWII Museum’s student series. A student reporter visits the museum’s victory garden with a volunteer who grew a garden as a boy during the war, with ration stamps and posters.

KEY TERMS

rationing

A government system that limits how much of a scarce food or product each person may buy, so everyone gets a fair share.

ration book

A booklet of stamps given to each person during World War II. Shoppers had to hand over stamps, as well as money, to buy rationed foods.

points

In the World War II system, the stamp value each rationed food cost, such as so many points for a pound of butter or a can of peaches.

victory garden

A home or community vegetable garden planted during the world wars so families could grow their own food.

substitute

To use one ingredient in place of another, such as oil for butter or honey for some of the sugar.

CORE IDEAS

The story. After the United States entered World War II in December 1941, huge amounts of food were needed for soldiers and sailors and for allies overseas, and ships that once brought sugar and coffee were needed for the war. In the spring of 1942 sugar became the first food rationed in America. Coffee followed that fall, and in 1943 meats, butter, cheese, fats and canned and processed foods were rationed too. Every man, woman and child received ration books full of stamps.

How they figured it out. Families learned to plan meals with two budgets: money and points. Red stamps were for meat, butter, fats and cheese; blue stamps were for canned and processed foods. Each food had a point value, set by the government and printed in newspapers, and the values changed with supply. Cooks shared recipes for cakes with less sugar, sweetened with honey, corn syrup or grated carrots and raisins; they saved bacon grease, stretched meat with beans and bread crumbs, and wasted almost nothing. The government also urged families to plant **victory gardens** in backyards, schoolyards, rooftops and city lots. Millions did, and by some government estimates, victory gardens grew around 40 percent of the fresh vegetables Americans ate during the war. Rationing of most foods ended in 1945, and sugar in 1947.

The kitchen science. Planning within limits is a skill. When sugar is short, cooks can let naturally sweet ingredients like carrots, apples, raisins and spices such as cinnamon and nutmeg carry the flavor; cinnamon and vanilla make food taste sweeter than it is. When butter is short, oil can replace it in many cakes and muffins (about $\frac{3}{4}$ cup oil for 1 cup butter), giving a moist, tender crumb because oil stays liquid and coats the flour, limiting gluten. When meat is short, beans, eggs, cheese

and grains supply protein. Fresh garden vegetables, picked at their best, need little added to taste good. These same habits help any family stretch a budget today.

Let's cook. You will bake a ration-style carrot spice cake, sweetened with less sugar plus carrots, raisins and applesauce, and made with oil instead of butter. The skill to do well is **finely grating carrots** on a box grater, with your fingers well back and a carrot stub left over for snacking, and **folding** them into the batter gently.

PICTURE STUDY



Your Victory Garden Counts More Than Ever!, Hubert Morley, for the U.S. War Food Administration, 1945
· Poster · National Archives, College Park, Maryland
Image: [Wikimedia Commons](#), public domain

During World War II, the U.S. government printed posters to encourage families to grow and preserve their own food. This one, from 1945, the last year of the war, reminded families that their gardens still mattered. Posters like it hung in post offices, schools and stores across the country.

Look closely

- Name every vegetable you can find in the basket.
- Which of these vegetables could be eaten fresh, and which could be canned, dried or stored for winter?
- Look at the colors and lettering. How did the artist make you want to garden?
- Is anything in the basket something you could grow in a pot or a small yard?

Talk about it

1. How would a garden like this help a family with ration points and a tight budget?
2. Joseph stored grain in good years for the hard years ahead (Genesis 41). How were victory gardeners doing something similar?

3. What one vegetable would you like to grow, and what would you cook with it?

Safety first. An adult is nearby while you use the oven. Grate carrots slowly with your fingers well back from the grater and stop when the piece gets short. Never taste the unbaked batter, which contains uncooked eggs and flour. Use oven mitts and let the cake cool on a rack.

KITCHEN PROJECT

A Ration-Week Menu and a Carrot Spice Cake

You will plan three days of family suppers using a ration-style points budget, and bake a carrot spice cake from the home-front playbook: less sugar, no butter, and naturally sweet carrots and raisins.

You will need

- An 8- or 9-inch square baking pan, greased and lined with parchment
- Two mixing bowls, a whisk, a rubber spatula
- A box grater and a vegetable peeler
- Measuring cups and spoons, oven mitts, a cooling rack and a toothpick
- Your notebook for the ration-points menu

RATION-STYLE CARROT SPICE CAKE

Serves 9 squares · Prep 25 min · Bake 35–40 min · Cool 1 hr

Ingredients

- 1½ cups (190 g) all-purpose flour
- 1 teaspoon baking soda and ½ teaspoon baking powder
- 1½ teaspoons cinnamon, ¼ teaspoon nutmeg, ½ teaspoon salt
- 2 large eggs
- ½ cup (100 g) packed brown sugar
- ⅓ cup (80 mL) vegetable oil
- ½ cup (120 g) unsweetened applesauce
- 1 teaspoon vanilla extract
- 2 cups (about 4 medium or 220 g) finely grated carrots
- ½ cup (75 g) raisins

Method

1. Wash your hands. An adult turns the oven to 350 °F (175 °C).
2. In one bowl, whisk the flour, baking soda, baking powder, cinnamon, nutmeg and salt.

3. In the other bowl, whisk the eggs and brown sugar until smooth, then whisk in the oil, applesauce and vanilla. Wash your hands after cracking the eggs.
4. Stir the grated carrots and raisins into the wet mixture. Add the dry ingredients and fold gently with the spatula just until no flour streaks remain. Do not taste the raw batter.
5. Spread the batter in the pan. Bake 35–40 minutes, until the top springs back when lightly pressed and a toothpick in the center comes out clean.
6. Cool in the pan on a rack for 15 minutes, then lift out by the parchment and cool completely. Cut into 9 squares.
7. Clean up: wash the bowls, grater and tools (soak the grater first), and wipe the counter.

Allergy check: Contains wheat and eggs. For egg-free, use $\frac{1}{2}$ cup more applesauce instead of the eggs (the cake will be denser). For wheat-free, use a 1-to-1 gluten-free baking flour. No milk or nuts (some families add chopped walnuts; check allergies first).

Steps

1. **Ration menu.** Your family has 64 “red points” for three days. Use this point list: butter 8 points per $\frac{1}{4}$ pound, cheese 6 points per $\frac{1}{2}$ pound, ground beef 7 points per pound, a chicken 5 points per pound, eggs and beans 0 points. Plan three balanced suppers that fit, and show your point math.
2. Bake the carrot spice cake.
3. **Sugar comparison.** Many modern carrot cake recipes use about $1\frac{1}{2}$ cups of sugar for a 9×13 pan, plus a frosting. Our cake uses $\frac{1}{2}$ cup brown sugar for an 8×8 pan. A 9×13 pan is about 1.8 times as big. How much sugar would our recipe use if scaled up to a 9×13 pan? Compare.
4. **Taste test.** Ask your family to rate the cake for sweetness, moistness and spice. Did anyone miss the frosting?
5. **Waste check.** Make a list of every food scrap from this lesson (carrot peels, stubs) and how it could be used (stock, compost, a snack).
6. **Improve it.** Write one change: whole-wheat flour for half, chopped apple, or a light dusting of cinnamon sugar on top.

7. Clean up: wash, dry and put away everything.

Tips

- Grate carrots on the fine side of the grater; fine shreds melt into the cake.
- Oil cakes stay moist for days. Store covered at room temperature for 2 days or in the refrigerator for up to 5.
- Leftover cake squares freeze well for lunch boxes.

Check your work

- ☐ I can describe rationing and victory gardens on the World War II home front.
- ☐ I planned three suppers within a points budget.
- ☐ I baked a lower-sugar carrot spice cake and compared its sugar.

COOK'S NOTEBOOK

1. Copy your three-day ration menu with the point math shown.
2. Draw a ration book page with stamps, and label which stamps were for meat and which for canned foods.
3. Write a short diary entry as a sixth grader in 1943 helping your family cook and garden.

From history. Britain rationed food even longer than America, from 1940 until 1954. The British Ministry of Food promoted carrots so strongly, in cakes, puddings and even “carrot fudge,” that cartoon characters named Doctor Carrot and Potato Pete appeared in its posters and leaflets.

COMMON MISTAKES

- Overmixing the batter after adding flour. The cake turns tough; fold just until combined.
- Grating carrots down to your fingertips. Stop when the piece is short and eat the stub.
- Thinking less sugar means less flavor. Spices, vanilla and sweet vegetables carry the taste.

Make it a game • Ration Book Dinner. Give yourself twenty paper points to plan a dinner. Each food costs points: meat five, butter four, sugar three, vegetables one. Plan a balanced meal within your limit, then try again with substitutions for scarce items. Retell how families on the home front used ration books and victory gardens from 1942 to 1945.

Scripture. “When they were filled, he said unto his disciples, Gather up the fragments that remain, that nothing be lost.” (John 6:12, KJV)

After feeding the five thousand, Jesus told His disciples to gather the leftovers. Home-front families lived out this lesson, and wise cooks still waste nothing that can be used.

8.3 PROVERBS 31: PLANNING AHEAD WITH THE SLOW COOKER

OBJECTIVES

- Tell how Irving Naxon invented an electric slow cooker, inspired by a Sabbath stew from his mother's village, and how it became the Crock-Pot.
- Explain how long, low, moist heat turns tough cuts of meat tender, and how to use a slow cooker and leftovers safely.
- Cook a pot roast that becomes two different family dinners, and plan the second night.

Warm-up. Ask a parent: what is the busiest evening of your family's week? What do you usually eat that night? Write down one meal that could be cooked earlier in the day, or the day before, so supper is ready when everyone comes home.

WATCH

How Do Slow Cookers Work?

History of Simple Things • 8:07

<https://www.youtube.com/watch?v=BC9gwSTmqql>

WHEN TO WATCH

After the story of Irving Naxon, before you load your slow cooker.

Note: Explains how a slow cooker heats food gently and safely, with pictures of Irving Naxon's Beanery and the first Crock-Pot.

KEY TERMS

slow cooker

An electric pot that cooks food at a low, steady temperature for many hours with the lid on.

collagen

A tough protein in the connective tissue of meat. Long, moist heat melts it into gelatin, making meat tender.

braise

To cook food slowly in a covered pot with a small amount of liquid.

planned-over

Leftovers planned on purpose, cooked once and turned into a different meal later.

chuck roast

An inexpensive cut of beef from the shoulder, full of collagen, that becomes very tender when braised.

CORE IDEAS

The story. Irving Naxon was an inventor in Chicago who loved to tinker. His mother had grown up in a Jewish village in Lithuania, and she told him about *cholent*, a stew of beans, barley and meat. Because no cooking was done on the Sabbath, families prepared the stew on Friday afternoon and carried their pots to the town baker, whose great oven cooled slowly overnight. On Saturday the stew came home hot and tender.

How he figured it out. Naxon wanted to recreate that slow, gentle oven in a single pot. He designed a heating element that wrapped around the sides of a crock, warming it evenly at a low temperature, and received a patent for his cooking apparatus in 1940. He sold it as the Naxon Beanery, for cooking beans. In 1970 the Rival company bought his invention, and in 1971 renamed it the Crock-Pot, sold with a little cookbook. Families with busy days discovered they could load the pot in the morning and come home to supper, and millions were sold.

The kitchen science. Cheap cuts of meat, like a **chuck roast**, come from hard-working muscles full of **collagen**, a tough connective protein. Quick, hot cooking leaves them chewy. But held in moist heat for hours, collagen slowly melts into gelatin, which makes the meat fall-apart tender and the cooking liquid rich and silky. A slow cooker on low brings its contents to roughly the simmering point over several hours, hot enough to be safe when used correctly: start with thawed meat, fill it one-half to two-thirds full, keep the lid on, and cook until done. Cool leftovers within 2 hours in shallow containers and reheat them to 165 °F (74 °C). Cooking once for two nights saves time, money and energy. The capable woman of Proverbs 31 “riseth also while it is yet night, and giveth meat to her household”: planning ahead is a form of love.

Let's cook. You will make a slow-cooker pot roast with potatoes and carrots for Night 1, and plan and cook a different dinner from the leftovers for Night 2. The skill to do well is **planning the second meal:** setting aside the right amount of meat and broth before the first dinner is served.

PICTURE STUDY



A Woman Peeling Apples, Pieter de Hooch, about 1663 · Oil on canvas · The Wallace Collection, London

Image: [Wikimedia Commons](#), public domain

Pieter de Hooch painted Dutch mothers at work in their homes with quiet respect. Here a woman peels apples, perhaps for a pie, a sauce or to dry for winter, while her little child watches and learns. It is an ordinary task that feeds a family.

Look closely

- Find the apples and the bowl. How is she peeling them?
- Look at the child. What is the child holding and watching?
- Find the fireplace. How might the apples be cooked later?
- Look at the light and the room. What feeling does this home have?

Talk about it

1. Proverbs 31 describes a woman who works willingly with her hands and plans ahead for her household. Which parts of this painting remind you of that?
2. How does a child learn to cook by watching and helping, as this child does?
3. What could this family make from the apple peels so that nothing is wasted?

Safety first. An adult is nearby when you brown the meat and when you lift the heavy, hot slow-cooker insert; use oven mitts. Use only thawed meat in the slow cooker, keep the lid on while it cooks, and check that the roast is fork-tender and at least 145 °F (63 °C) (it will be much higher when tender). Refrigerate leftovers within 2 hours in shallow containers and reheat them to 165 °F (74 °C).

One Roast, Two Dinners

You will cook a pot roast in the slow cooker (or the oven) for the first night, set aside planned-overs safely, and turn them into a second, different dinner later in the week, such as beef and vegetable soup, pot roast sandwiches or a skillet hash.

You will need

- A 5- to 7-quart slow cooker (or a heavy Dutch oven with a lid for the oven method)
- A large skillet and long tongs
- A chef's knife, cutting board and vegetable peeler
- An instant-read thermometer, oven mitts
- Shallow storage containers with lids and masking tape for labels

SLOW-COOKER POT ROAST WITH POTATOES AND CARROTS

Serves 6 servings for Night 1, plus planned-overs for Night 2 · Prep 25 min · Cook 8–9 hr on low (or 3–3½ hr in the oven)

Ingredients

- 1 boneless beef chuck roast (3½–4 pounds or 1.6–1.8 kg)
- 1½ teaspoons salt and ½ teaspoon pepper
- 1 tablespoon vegetable oil
- 2 pounds (900 g) small potatoes, halved
- 1 pound (450 g) carrots, peeled and cut in 2-inch pieces
- 1 large onion, cut in wedges
- 3 cloves garlic, smashed
- 1½ cups (355 mL) low-sodium beef broth
- 2 tablespoons tomato paste and 1 tablespoon Worcestershire sauce
- 1 teaspoon dried thyme and 1 bay leaf
- **To thicken the gravy (optional):** 2 tablespoons cornstarch stirred into 3 tablespoons cold water

Method

1. Wash your hands. Put the potatoes, carrots, onion and garlic in the bottom of the slow cooker.
2. Pat the roast dry and season it all over with salt and pepper. With an adult beside you, heat the oil in the skillet over medium-high heat and brown the roast 3–4 minutes per side, using long tongs. (This step adds flavor through the Maillard reaction; you may skip it if you are short of time.)
3. Set the roast on top of the vegetables. Whisk the broth, tomato paste and Worcestershire and pour it over. Add the thyme and bay leaf.
4. Cover and cook on low 8–9 hours (or high 5–6 hours), without lifting the lid, until the meat pulls apart easily with a fork.
5. With oven mitts, an adult lifts out the roast and vegetables. For gravy, pour the liquid into a saucepan, bring to a boil, stir in the cornstarch slurry and simmer 1 minute until thick.
6. **Before serving**, set aside about one-third of the meat and 1 cup of the liquid for Night 2. Serve the rest with the vegetables and gravy.
7. Cool the planned-overs and leftovers in shallow containers and refrigerate within 2 hours; label and use within 3–4 days. Clean up: wash the insert (once cool), skillet and tools.
8. **Oven method:** In a heavy Dutch oven, brown the roast, add the liquid, cover, and cook at 300 °F (150 °C) for 3–3½ hours, adding the vegetables for the last 1½ hours.

Allergy check: Worcestershire sauce contains fish (anchovies); leave it out for a fish-free roast. Some broths contain soy or wheat; check the label. No milk, eggs, nuts or wheat in the recipe itself (cornstarch is wheat-free).

Steps

1. **Plan Night 2.** Before you cook, choose your second dinner: beef and vegetable soup (planned-over beef and liquid plus broth, carrots, celery, potatoes and barley or pasta), pot roast sandwiches with gravy, or a skillet hash with an egg cooked until firm. Write its recipe and shopping list.
2. Load the slow cooker in the morning. Write the time on a note on the counter. Check the time you came home and how supper smelled.

3. Serve Night 1. Record how much meat you set aside and what the family thought.
4. **Night 2.** Within 3–4 days, cook your planned-over dinner with an adult nearby, reheating everything to 165 °F (74 °C).
5. **Cost and time.** Divide the roast's cost by the total number of servings across both nights. Estimate how much cooking time Night 2 saved.
6. **Improve it.** Write one change: a different vegetable, a sweet potato, or a new Night 2 idea.
7. Clean up: wash, dry and put away everything.

Tips

- Root vegetables go on the bottom, where it is hottest; the meat sits on top.
- Every time you lift the lid, a slow cooker loses heat and needs about 20 more minutes. Resist peeking.
- Chill the cooking liquid overnight and the fat will rise and harden on top, so it is easy to lift off before you use the liquid for soup.

Check your work

- ☐ I can tell how Irving Naxon invented the slow cooker.
- ☐ I can explain how collagen turns into gelatin with long, moist heat.
- ☐ I cooked one roast for two different dinners and handled leftovers safely.

COOK'S NOTEBOOK

1. Draw a cut of chuck roast before and after braising, showing collagen turning to gelatin.
2. Write a two-night plan with recipes, a timeline and a leftovers label.
3. Record the cost per serving across both nights.

From history. Slow, overnight cooking is very old. Besides cholent, there are French cassoulet, Boston baked beans (often slow-baked overnight in a bean pot on Saturday), and many other dishes made to cook gently while families rested or worshiped.

COMMON MISTAKES

- Putting frozen meat in a slow cooker. It stays too long in the danger zone; always thaw it first in the refrigerator.

- Leaving leftovers in the warm slow cooker for hours after supper. Cool them in shallow containers and refrigerate within 2 hours.
- Using a lean, tender cut like sirloin for pot roast. It dries out; tough, collagen-rich chuck is the right choice.

Make it a game · Slow Cooker Story. Act out the Proverbs 31 woman planning ahead, and show how a slow cooker lets you start dinner early. Explain how long, low, moist heat melts collagen in tough cuts of meat. Then name three safety rules for slow cookers and leftovers. Tell how Irving Naxon was inspired by his mother's Sabbath stew.

Scripture. “She riseth also while it is yet night, and giveth meat to her household, and a portion to her maidens.” (Proverbs 31:15, KJV)

The capable woman of Proverbs plans ahead so her household is fed. Loading a slow cooker in the morning is a small modern way to do the same.

8.4 THE FAMILY FEAST

OBJECTIVES

- Plan a balanced three-course family feast with a menu, a shopping list, a budget and a cooking timeline.
- Cook the feast with an adult present, using dishes and skills from across the year, and serve every dish at a safe temperature.
- Set the table, welcome the family, give thanks, and reflect on the year in the kitchen.

Warm-up. Look back through your cook's notebook. List your three favorite dishes from the year, one dish your family loved most, and one skill you are proudest of. Which of them belong in your feast?

WATCH

How to Roast a Whole Chicken That's Juicy Every Time | Allrecipes

Allrecipes • 3:12

<https://www.youtube.com/watch?v=W2AS0MPgPIA>

WHEN TO WATCH

Before you write your timeline. Watch how the cook plans the order of steps, then build your own schedule backward from the time you want to eat.

Note: From Allrecipes. She pats the chicken dry (she does not rinse it), seasons it with butter, herbs and lemon, and roasts it; follow this lesson's card for temperatures.

KEY TERMS

course

One part of a meal served at a time, such as a starter, a main course and a dessert.

timeline

A schedule that lists every cooking step and when it must start so all the dishes finish on time.

work backward

To plan a timeline starting from the time you want to eat and subtracting each step's time.

hospitality

Welcoming others warmly and caring for them, especially by offering food and a place at the table.

grace

A prayer of thanks to God before (or after) a meal.

CORE IDEAS

The story. In the autumn of 1940, the homesteading families of Pie Town, New Mexico, a tiny farming community in the high desert, held their yearly fair. They had little money, and life was hard, but they shared what they had: a free barbecue dinner for everyone, with pinto beans, bread and tables of homemade pies and cakes. Before they ate, they bowed their heads and gave thanks together. A government photographer, Russell Lee, captured the moment in color.

How they figured it out. A feast for many does not happen by accident. The families of Pie Town planned who would bring what, who would cook the meat over the pit through the night, and who would bake the pies. Feasts in Scripture were planned too: Nehemiah sent the people to “eat the fat” and share portions with those who had nothing prepared, and the early church “did eat their meat with gladness and singleness of heart.” Good hosts throughout history have done the same three things: planned carefully, cooked with care, and welcomed their guests with joy.

The kitchen science. A feast brings together everything you learned this year. Safety: clean as you go, keep raw and cooked apart, check temperatures (165 °F for poultry), and keep hot foods hot and cold foods cold. Balance: a menu with vegetables, a whole grain or starch, a protein and a fruit-based dessert. Chemistry: browning, emulsions, gluten, starch. Planning: a shopping list, a budget, unit prices and a **timeline**. To build a timeline, **work backward** from the time you want to eat. If dinner is at 6:00 and the chicken needs 1 hour 15 minutes to roast plus 15 minutes to rest, it goes in the oven at 4:30; dishes that can be made ahead, like dessert or bread, are made earlier in the day.

Let's cook. You will plan and cook a three-course feast for your family, with an adult present the whole time. A model menu is below: a starter, a herb-roasted chicken

with vegetables as the main course, flatbreads, and a fruit crisp for dessert. You may swap in any dishes from the year. The skill to do well is **following your timeline** calmly, and asking for help when you need it.

PICTURE STUDY



Saying Grace before the Barbeque Dinner at the Pie Town, New Mexico, Fair, Russell Lee, for the Farm Security Administration, 1940 · Color slide photograph · Library of Congress, Washington, D.C.

Image: [Wikimedia Commons](#), public domain

This is one of the early color photographs of everyday American life, taken on new color slide film. Russell Lee took it in 1940 at the fair in Pie Town, New Mexico. Men, women and children have gathered at long tables, and before anyone eats, they bow their heads to give thanks.

Look closely

- Find the men holding their hats. Why did men take off their hats to pray?
- Look at the children. What are they doing during the prayer?
- Look at the people's clothing. What does it tell you about their work and their lives?
- Look at the field and the cars. Is this a fancy hall or a simple outdoor gathering?

Talk about it

1. These families had little money but shared a feast with their whole town. What makes a meal a feast?
2. Why do you think they gave thanks before eating, even in hard times?
3. Who would you like to invite to your own family feast, and why?

Safety first. An adult is present in the kitchen for the whole feast, especially for the oven, stove and carving. Follow your timeline so nothing is rushed, keep raw chicken and its tools separate, check the chicken at 165 °F (74 °C) in the thickest part of the thigh and breast, and refrigerate leftovers within 2 hours. Check every dish against your family's and guests' allergies.

KITCHEN PROJECT

Plan, Cook and Serve the Family Feast

This is your final kitchen project of the year. You will plan a three-course feast for your family (and a guest, if your family agrees), write a menu card, a shopping list with a budget, and a timeline worked backward from dinnertime. You will cook with an adult present, set the table, welcome everyone, and lead or join in grace.

You will need

- Your cook's notebook, a calculator and the store flyer or website
- A large roasting pan or two rimmed baking sheets, an instant-read thermometer, oven mitts
- The equipment for each dish on your menu
- A tablecloth or place mats, dishes, glasses, cutlery and napkins
- Card stock or paper for a menu card and place cards

MODEL FEAST MAIN COURSE: HERB-ROASTED CHICKEN WITH ROOT VEGETABLES

Serves 6 servings • Prep 25 min • Roast 1 hr 15 min–1 hr 30 min • Rest 15 min

Ingredients

- 1 whole chicken (4½–5 pounds or 2–2.3 kg), giblets removed
- 2 tablespoons softened butter or olive oil
- 1 tablespoon chopped fresh rosemary, 1 tablespoon fresh thyme leaves (or 1 teaspoon each dried)
- 2 cloves garlic, minced, and zest of 1 lemon (save the lemon)
- 1½ teaspoons salt and ½ teaspoon pepper
- 1½ pounds (680 g) small potatoes, halved; 4 carrots, cut in 2-inch pieces; 1 red onion, cut in wedges; 1 tablespoon olive oil and ½ teaspoon salt for the vegetables

- **Rest of the model menu:** starter, the Caesar-style salad (Lesson 5.2) or minestrone (Lesson 6.3); bread, soft yeast flatbreads (Lesson 5.3); dessert, apple-berry crisp (Lesson 6.2) with vanilla custard sauce (Lesson 5.4)

Method

1. Wash your hands. An adult turns the oven to 425 °F (220 °C). Toss the vegetables with oil and salt and spread them in the roasting pan.
2. On a separate raw-chicken board or tray, pat the chicken dry with paper towels (do not rinse it). Mix the butter, herbs, garlic, lemon zest, salt and pepper. Rub it all over the chicken and a little under the breast skin. Put the halved lemon inside. Throw away the paper towels and wash your hands, the board and any tools.
3. Set the chicken breast side up on top of the vegetables. Tuck the wing tips under.
4. Roast 1 hour 15 minutes to 1 hour 30 minutes, until the thickest part of the thigh (not touching bone) and the thickest part of the breast both read at least 165 °F (74 °C), and the juices run clear. Stir the vegetables once halfway, with oven mitts.
5. With an adult, lift the chicken onto a clean cutting board and let it rest 15 minutes. Keep the vegetables warm in the turned-off oven.
6. An adult carves the chicken (or you carve with the adult beside you): legs and thighs first, then wings, then slice the breast. Arrange on a platter with the vegetables.
7. Clean up as you go throughout the feast, and wash the roasting pan, boards and knives after the meal. Refrigerate leftovers within 2 hours; the carcass can become soup stock.

Allergy check: Contains milk if you use butter (use olive oil for milk-free). No eggs, wheat, nuts, soy or fish in the main course. Check every other dish on your menu against your family's and guests' allergies, using the allergen notes from each lesson.

Steps

1. **Menu.** Choose three courses (starter, main with vegetables and bread, dessert) using dishes from the year. Check the menu with MyPlate and with an adult. Make a menu card.

2. **Budget and list.** Write a shopping list grouped by store section. Price each item using unit prices and stay within the budget your parent sets (for example, \$40 for 6 people). Figure the cost per person.
3. **Timeline.** Write a timeline working backward from dinnertime: what you will make the day before (dessert, flatbread dough), and each step on feast day with its start time. Post it in the kitchen.
4. Cook the feast with an adult present, following your timeline and cleaning as you go. Record the chicken's temperature.
5. **Set the table and welcome.** Set each place properly (fork on the left, knife and spoon on the right, glass above the knife, napkin), add place cards, and welcome your family. Lead or join in grace.
6. **Reflect.** After the meal, ask each person to name their favorite dish. Then write a one-page reflection on your year in the kitchen: what you learned, what you are thankful for, and what you want to cook next.
7. Clean up: wash, dry and put away everything, with the family helping, and thank them.

Tips

- Choose at least one dish you can make entirely the day before. It makes feast day much calmer.
- Build 15 minutes of “cushion” into your timeline. Something always takes longer than planned.
- Ask a younger brother or sister to help set the table or make place cards. A feast is better shared.

Check your work

- ☐ I planned a balanced three-course menu with a budget and a timeline.
- ☐ I cooked a feast with an adult present, checked temperatures and cleaned as I went.
- ☐ I set the table, welcomed my family and gave thanks.

COOK'S NOTEBOOK

1. Copy your menu card, shopping list with costs, and the cost per person.
2. Copy your feast timeline and mark what happened on time and what ran late.

3. Write your one-page reflection on the year in the kitchen, and draw the feast table.

From history. Russell Lee took hundreds of photographs in Pie Town in 1940, including some of the early color photographs of everyday American life. They are kept at the Library of Congress and show a whole community at work, at worship and at the table.

COMMON MISTAKES

- Planning too many new or complicated dishes. Choose mostly dishes you have already cooked this year.
- Forgetting the chicken's resting time in the timeline. Resting keeps it juicy and frees the oven for other dishes.
- Leaving the cleanup until the very end. Clean as you go so the kitchen is ready for each next step.

Make it a game • Work Backward Challenge. Pick a feast time, such as six o'clock. Plan a three-course menu and write a timeline working backward, step by step. Your parent adds a surprise, such as a late guest or an oven that is full. Rework your plan within three minutes. Then say how hospitality and grace belong at the family table.

Scripture. "And they, continuing daily with one accord in the temple, and breaking bread from house to house, did eat their meat with gladness and singleness of heart," (Acts 2:46, KJV)

The first Christians shared meals in their homes with gladness. A family feast, prepared with care and eaten with thanks, is part of that same joyful tradition.

UNIT 8

MEAL PLANNING & THE FAMILY TABLE

All year you have learned to cook safely, balance a meal, understand taste and heat, and read the chemistry of a recipe. In this last unit you will learn to plan: to shop wisely, to cook within a budget, to make one cooking session feed a family twice, and finally to plan, shop for and cook a three-course feast. You will meet Sylvan Goldman, an Oklahoma grocer who invented the shopping cart in 1937, and the families of the World War II home front who planted victory gardens and cooked with ration books.

You will also study the capable woman of Proverbs 31, who rises early to provide food for her household, and the slow cooker invented by Irving Naxon, who remembered a stew that cooked slowly overnight in his mother's village. You will cook rice and bean burritos with a cost per serving, a ration-style carrot cake, a slow-cooker pot roast that becomes two dinners, and your own family feast. "Gather up the fragments that remain, that nothing be lost" (John 6:12): good planning honors God's gifts by wasting nothing.

PREREQUISITES

- Can figure cost per serving (Lesson 2.4) and scale a recipe up or down (Units 3–5)
- Can plan a balanced meal with MyPlate (Unit 2)
- Knows safe temperatures, cooling within 2 hours and reheating to 165 °F (Units 1 and 4)
- Has cooked at least one recipe from each unit this year

MASTERY CHECKLIST

- ☐ I can find and compare unit prices, write a shopping list from a menu, and figure cost per serving.
- ☐ I can tell how families on the World War II home front planned meals with ration books and victory gardens, and I can plan around limits.
- ☐ I can plan a cook-once, eat-twice meal and store and reheat leftovers safely.
- ☐ I can plan, budget, schedule, cook and serve a three-course family feast with an adult present, set the table, and give thanks.

OPTIONAL BOOKS AND TOOLS FOR THIS UNIT

- **MyPlate Kitchen (USDA):** Free. The USDA’s collection of budget-friendly recipes with cost and nutrition information, and tools for meal planning and shopping lists. Useful for Lessons 8.1–8.4. Search “MyPlate Kitchen.”
- **FoodSafety.gov: Leftovers and food safety:** Free. How long cooked foods keep in the refrigerator and freezer, for the leftover plans in Lessons 8.2–8.3. Search “FoodSafety.gov cold food storage chart.”
- **A slow cooker:** Optional. Lesson 8.3 gives an oven method in a heavy covered pot for families without one.
- **A calculator and a notebook folder for receipts:** For unit prices, cost per serving and the feast budget.

Not required. Every recipe in this unit works in an ordinary home kitchen.

School Launch has no ties to these authors, publishers or companies.

LESSONS IN THIS UNIT

8.1	Sylvan Goldman’s Shopping Cart and the Unit Price	2 sessions of 50–60 minutes
8.2	Victory Gardens and the Ration Book	2 sessions of 60–90 minutes
8.3	Proverbs 31: Planning Ahead with the Slow Cooker	2 sessions of 50–60 minutes
8.4	The Family Feast	2 sessions of 60–90 minutes

UNIT 8 REVIEW

Answer each question. Show your work on calculations. Use complete sentences for explanations. The review is worth 100 points.

1. **8 pts**

What problem did Sylvan Goldman notice in his stores, and how did he solve it?

2. **10 pts**

Calculation: A 2-pound bag of rice costs \$3.00. A 5-pound bag costs \$6.50. Which is the better buy per pound?

3. (10 pts)

Calculation: Your burritos cost \$11.20 in all and made 8 burritos. What is the cost per burrito? If you made 12 burritos with the same cost per burrito, what would the total be?

4. (8 pts)

Why did the United States ration food during World War II? Name the first food rationed and two later ones.

5. (8 pts)

What was a victory garden, and why did it matter?

6. (10 pts)

Calculation: A family has 64 red points for three days. Butter is 8 points per $\frac{1}{4}$ pound, cheese 6 points per $\frac{1}{2}$ pound, and ground beef 7 points per pound. If they buy $\frac{1}{2}$ pound butter, $\frac{1}{2}$ pound cheese and 3 pounds of ground beef, how many points are left?

7. (8 pts)

Name two ways home-front cooks made cakes with less sugar and butter, and explain why oil makes a moist cake.

8. (8 pts)

What inspired Irving Naxon's slow cooker, and what was it later named?

9. (8 pts)

Why does a tough chuck roast become tender after many hours of slow, moist cooking?

10. (8 pts)

List three rules for safe leftovers.

11. (6 pts)

Calculation: Dinner is at 6:00 p.m. The chicken needs 1 hour 20 minutes to roast and 15 minutes to rest, and you need 25 minutes to prepare it before roasting.

What time must you start preparing the chicken?

12. **8 pts**

Short answer: Name three things that make a family meal a true feast, using ideas from this unit and the year.

ANSWER KEY

1. Shoppers stopped buying when their hand baskets got full and heavy. In 1937 he introduced a folding metal cart on wheels holding two baskets, and hired people to push carts around the store until shoppers accepted them.
2. 2-pound bag: $\$3.00 \div 2 = \$1.50$ per pound. 5-pound bag: $\$6.50 \div 5 = \$1.30$ per pound. The 5-pound bag is the better buy (if you will use it).
3. $\$11.20 \div 8 = \$1.40$ per burrito. $12 \times \$1.40 = \$16.80$.
4. Food was needed for the armed forces and allies, and shipping was needed for the war, so supplies were limited and rationing shared them fairly. Sugar was first (1942); later coffee, meat, butter, fats, cheese and canned and processed foods.
5. A home or community vegetable garden planted during the war. Families grew their own vegetables, saving money and ration points and leaving more commercial food for the troops; by some estimates they grew about 40 percent of the fresh vegetables Americans ate.
6. Butter: $\frac{1}{2}$ pound = $2 \times 8 = 16$. Cheese: 6. Beef: $3 \times 7 = 21$. Total $16 + 6 + 21 = 43$. $64 - 43 = 21$ points left.
7. Any two: used grated carrots, raisins, applesauce or honey for sweetness; added spices and vanilla; used oil instead of butter. Oil stays liquid and coats the flour, limiting gluten and keeping the cake tender and moist.
8. His mother's stories of cholent, a Sabbath stew left to cook slowly overnight in the village baker's oven in Lithuania. Rival bought it in 1970 and named it the Crock-Pot in 1971.
9. Its collagen, a tough connective protein, slowly melts into gelatin in long, moist heat, so the meat falls apart easily and the liquid becomes rich.
10. Refrigerate within 2 hours (1 hour above 90°F); cool in shallow containers; label and use cooked leftovers within 3–4 days; reheat to 165°F ; thaw frozen meat before slow cooking.
11. $25 + 80 + 15 = 120$ minutes = 2 hours. Start at 4:00 p.m.
12. Answers vary. Examples: careful planning and cooking; balanced, delicious food served safely; a set table and a warm welcome (hospitality); giving thanks together; giving to others and wasting nothing.

UNIT CHALLENGE: THE FAMILY FEAST

The family feast from Lesson 8.4 is the unit challenge. Hand in your complete feast plan: the menu card, the shopping list with unit prices and the budget (with the total spent and the cost per person), and the timeline you posted in the kitchen.

Add a photograph or drawing of the set table and the finished dishes, the temperature you recorded for the main dish, your family's favorite-dish votes, a written grace or thank-you note to your family, and your one-page reflection on the year in the kitchen.

LOOK FOR	WHAT IT MEANS
Planning	A balanced three-course menu, a shopping list priced with unit prices, a budget met (or honestly explained), and a timeline worked backward from dinnertime.
Safe, skilled cooking	Adult present; clean-as-you-go habits; raw and cooked foods kept apart; safe temperatures checked and recorded; leftovers refrigerated within 2 hours.
Hospitality	Table set properly, family welcomed warmly, grace or thanks given, cleanup shared.
Reflection	A thoughtful one-page reflection on the year: skills learned, thankfulness, and plans for future cooking.
Improvement	Names what went well and what to change next time. A dish that did not turn out but is honestly recorded earns full credit.