GOURMET LAB

The Scientific Principles Behind Your Favorite Foods

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EDUCATION

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INTRODUCTION

Are you hungry for science? Gourmet Lab: The Scientific Principles Behind Your Favorite Foods takes that phrase to a whole new level as students have the opportunity to discover science concepts and learn experimental design skills through interactions with everyday foods. This collection of hands-on experiments challenges students' take on the role of both scientist and chef, as students boil, bake, and toast their way into a better understanding of science concepts from chemistry, biology, and physics. Based on cooking edible food items such as pancakes and butterscotch, students have the opportunity to learn about physical changes, states of matter, acids and bases, biochemistry, and molecular structure. Rather than recipes, students are presented with laboratory explorations that use lab equipment such as Bunsen burners, beakers, and tongs, and work with chemicals such as sodium chloride and sucrose to experience science through cooking. This collection of lab activities brings science to life through an engaging exploration of cooking that will enhance any classroom experience.

The creation of Gourmet Lab stems from the general definition of science as "the study of the world around you." Often this connection to the real world eludes teachers and students who rely on textbooks to illustrate concepts through labs that attempt to support content with activities that are contrived and narrow in their scope. As a teacher, I found that the experiments in this book encourage students to investigate science phenomena through materials that they can connect to their daily experiences in the kitchen. This connection allows students to actively engage in the science concepts, making for an enhanced learning experience that is both meaningful and memorable.

The labs are designed for secondary science instruction, targeting students in grades 7–10. The labs can be used to illustrate individual concepts such as physical and chemical changes, or used in a series to teach a more complete picture of science concepts including molecular structure, biochemistry, and acids and bases. These topics are identified by the National Science Education Standards as integral to the education of middle school and high school students when studying chemistry, biology, physics, and more. These standards state, "The program of study in science for all students should be developmentally appropriate, interesting, and relevant to the student's lives; emphasize student understanding through inquiry; and be connected with other school subjects" (NRC 1996, p. 212). Each experiment in this book has been correlated to both content and skill standards in the National Science Education Standards, which are outlined in the table following this introduction.

Each lab is presented with both a student section and a teacher section. The student section of the lab is designed so that it can be handed out directly to students for easy implementation. Each lab begins with background information about the food and science concepts covered in the lab, and then offers a structured approach for investigating a question while building science skills. The investigations conclude with an analysis of data and with connection questions that encourage students to apply concepts from the lab to life experiences beyond the kitchen. Teachers are encouraged to remove elements of the labs such as the Data Analysis, Procedure, or Hypothesis sections to allow students the opportunity to experience the concepts through an inquiry-based model. All the elements provided allow the teacher to decide what information to use to excite students' curiosity and scaffold their investigation of each topic.

The teacher section of each experiment presents a detailed description of how to prepare for each lab, including safety highlights, a materials list that has been decoded for the grocery store, and prelab preparations for a successful experiment. This section goes on to detail demonstrations and

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activities to engage students, a detailed outline describing implementation of the lab, and answer keys for the students' data analysis and conclusion and connections questions. To enhance the overall learning experience, each teacher section concludes with cross-curricular suggestions for math and literacy (and technology in some cases), and suggests optional extension activities that highlight ways to make the activities engaging for middle school and high school students. The teacher sections are designed to provide teachers with a detailed approach to presenting the activity that allows you to implement it in your class the following day.

Whether you choose to implement a few of the experiments or all of them, Gourmet Lab is designed to improve student understanding, skills, and enthusiasm for physics, biology, and chemistry. So put on your apron, safety goggles, and chef hat and help your students start cooking up science!

REFERENCE

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academies Press.

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PART ONE: CHANGES IN MATTER

The activities in this section are designed to help introduce and reinforce the idea of changes in matter. Experiment 1: Butter Battle highlights the differences between physical and chemical changes in the creation of butter. Experiment 2: Exploding Corn highlights how water can change state from liquid to gas in the popping of corn. These changes are measured by mass and volume, and the experiment highlights the differences in these measurements. Experiment 3: "Melting" Apples pushes students' understanding of phase changes further to show that these changes are a result of thermal energy changes in molecules. Students use graphing skills to see how temperature relates to the phases of matter. Experiment 4: Cold Milk highlights how temperature change can come from places other than Bunsen burners, and introduces students to the concepts of endothermic reactions and exothermic reactions. Finally, Experiment 5: Gummy Invertebrates challenges students to look at how phase changes can be initiated by the introduction of new chemical elements such as gelatin. The experiment also introduces the concept of independent variables, and how changing a variable in a recipe can impact the final outcome. These activities are designed to introduce students to basic concepts in changes in matter with a progression that starts with basic concepts and builds to a discussion of molecular energy and chemical interactions. Each activity highlights different fundamental science skills in measurement, graphing, and experimental design.

PART TWO: ACIDS AND BASES

This section of experiments highlights how acidity plays a vital role in the creation of some everyday foods. Experiment 6: Acidic Milk uses lemon juice to prompt the creation of basic soft cheese. The experiment introduces students to the concepts of acid and base, and how they can be measured by pH. Experiment 7: Berries and Bacteria explores how acids can be used to prevent the growth of microorganisms in the creation of jam. This experiment shows students how acids can change the environment enough to preserve foods and stop them from spoiling, while teaching students about growing cultures of bacteria. Experiment 8: American Mozzarella asks students to make mozzarella cheese using a biological compound to change the pH of milk rather than a direct application of acid. The rate of the pH change is measured so students can compare and contrast the reaction rate that occurs in the complicated creation of mozzarella cheese with that of the cheese created in Experiment 6. The experiments in this section introduce students to skills such as measuring pH, growing bacteria cultures, and measuring chemical reaction rates.

PART THREE: BIOCHEMISTRY

This section highlights how the organism yeast is able to impact the creation of foods such as pretzels and pancakes, as well as liquids such as mint ginger soda. Experiment 9: Ballpark Pretzels introduces yeast and how it uses sugar in a process of fermentation to create carbon dioxide. Students have the opportunity to look at the yeast under the microscope, learning how to create a wet mount slide to observe yeast and fermentation. Experiment 10: Cinnamon Rolls builds on the understanding of fermentation to look at how the process directly affects the creation of cinnamon rolls. This experiment highlights the role of a control set in experimental design. Experiment 11: Growing a Pancake builds on the understanding of fermentation and looks at how yeast growth and processes can be affected by environmental factors such as heat and access to resources in the creation of a sourdough starter. Experiment 12: Under Pressure moves students from looking at fermentation in baked goods to looking at yeast as a source of soda carbonization. Students create mint ginger soda while analyzing the mathematical relationship that occurs in the fermentation of sugar. Experiment 13: Regular or Diet Soda? asks students to use their understanding of yeast to design a procedure that tests the impact of sugar substitutes on the fermentation process. While creating diet and regular soda, students learn about writing a procedure as a part of experimental design. The experiments in this section yield delicious results while teaching about yeast, biological processes, environmental limiting factors, and reaction rates.

PART FOUR: MOLECULAR STRUCTURE

This final section highlights how the molecular structure of chemicals and compounds can affect the physical characteristics of food. These relationships are highlighted in the creation of sugar-based candies. In Experiment 14: Crystal Carbohydrates, students are introduced to the structure of sugar molecules and how these molecules can be arranged into chains to create crystallized sugar. Students create crystallized sugar and compare its physical qualities to qualities of sugar where crystallization is impeded by the type of sugar and acid. Students design a data table to highlight the importance of qualitative data organization. Experiment 15: Strong Sugar Science asks students to use the experimental design skills introduced in the 14 previous experiments to create an experiment that finds a relationship between temperature and sugar structure. This experiment is the culmination of the book and allows students to direct the inquiry into the molecular structure of sugar.