Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2020 Volume II: Chemistry of Food and Cooking

Introduction

In this volume, we use our everyday experiences of food and cooking in teaching science in grade-school classrooms. We view cooking as running chemical reactions by considering ingredients as reactants and final dishes as products. We aim to understand how molecules in food transform during the cooking process that leads to new chemical compositions and how changes in the chemical compositions give favors and texture of dishes.

In March-July 2020, we discussed in our seminars the basic concept of atomic and molecular structures. Using this basic concept as a foundation, we covered the chemical and physical properties of three important molecules in food: carbohydrates, fat, and protein. Subsequently, we went through the principles of rate of chemical reaction and energy exchange. This fundamental knowledge enables us to answer many questions related to chemistry of food and cooking. For examples, why do we need to cook beef stew for 2 hours on a stove but only 15 minutes in a high-pressure cooker? Why do almost all recipes call for a baking temperature higher than 285°F? How can ramen noodles taste so good? Why do you need to wait for a bread dough to rise when you use yeast as a leavening agent but not baking powder? How can we mix oil and vinegar when making salad dressing?

Conducting the seminar in 2020 has been challenging due to the COVID-19 pandemic. However, five Fellows have successfully completed the seminar. Each of them contributes a teaching unit to this volume. These units cover a wide range of topics.

The first unit is by Somi Akella. This unit teaches chemical structures and biological functions of biomolecules, including protein, carbohydrate, and lipid. Somi has linked the basic knowledge of biochemistry to nutrition and energy in food. Her goal is to use the content to help students understand the importance of balanced diets. The unit is expected to have lasting impact in students' dietary choices and help them establish a healthy living style.

The second unit is by Nick Farrell. It discusses energy that is stored in food and energy that can be dissipated by doing exercise. Based on the first law of thermodynamics, the unit requires students to practice quantitative skills. They will calculate amounts of energy in various forms, such as potential energy and kinetic energy. The unit also includes experiments, in which students can measure thermal diffusion constant of food. These experiments are highly feasible and can be readily implemented in a high-school classroom setting.

Third, Michael Petrescu has written a unit covering general and organic chemistry. It discusses molecules in food and uses them as examples to distinguish chemical and physical processes. The unit also systematically introduces functional groups, a basic topic in organic chemistry. The goal is to prepare students for general

and organic chemistry courses that they will take after entering college. Indeed, many college students feel that organic chemistry is exceedingly difficult and thus decide not to take advanced courses in chemistry. This unit is designed to help them succeed in science classes upon entering college.

The fourth unit by Lianne Samalot is on electromagnetic waves. The unit uses microwave ovens and conventional ovens to demonstrate how electromagnetic waves are applied in our daily life. Lianne has derived some innovative methods in teaching advanced concepts in molecular dynamics and statistical thermodynamics. For example, she will provide students with Styrofoam balls and pipe cleaners to make a model of water molecule. The students will then use the models to illustrate different molecular motions, including translation, rotation, and vibration. This type of class activities will be effective to instill the abstract concept that relates temperature and thermal energy at the molecular level.

Finally, Jason Ward's unit is to explore with his second-graders the best recipe for making playdough. In introducing the major ingredients in the recipes, Jason will discuss the concepts of atoms and molecules. He will also implement hands-on experiments and thereby engage his students in learning chemistry behind making playdough. The unit also requires his students to play the role of an engineer. They will use organized methods and systematic approaches to record notes and observations. While teaching and learning science and engineering, Jason and his second-graders will certainly enjoy every minute of the class!

I am sure that these units will be a good starting point to engage students in learning various topics in science. I hope that the students will appreciate our Fellows' time and effort in developing the units and other grade-school teachers will find the units useful in their own classrooms.

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