CHAPTER 6

BASIC PRINCIPLES OF COOKING AND FOOD SCIENCE
No written recipe can be 100 percent accurate.

The judgment of the cook is still the most important factor!

A cook’s judgment is based on experience and understanding of:

– Raw materials available
– Basic cooking principles
– Food science
• Ever since Carême, professional cooking has been based on procedures and methods rather than only on recipes.

• By the twenty-first century, chefs have improved their knowledge not just of cooking theory but also of the science behind it.
Basic Concepts in Food Science

What Is Heat?

- **Heat** is a form of energy associated with the motion of atoms or molecules.

- When a substance absorbs heat, its molecules move faster.
  - In liquids and gases, the molecules move more quickly from place to place and bounce off each other more frequently.
  - In solids, the molecules stay mostly in place, but they vibrate with more energy.
• **Temperature**: Temperature can be defined as a measure of this molecular activity. The higher the temperature, the faster the molecules are moving.

• How foods heat up:
  – Fast-moving molecules in hot substances come in contact with slower molecules in cold substances.
  – The fast molecules bump into the slower ones and transfer some of their energy.
  – This action makes the slower molecules move faster, or heat up.
Foods are composed of:
- Proteins
- Fats
- Carbohydrates
- Water

Foods are composed of small amounts of other compounds such as:
- Minerals (including salt)
- Vitamins
- Pigments (coloring agents)
- Flavor elements
Carbohydrates: Starches and sugars are carbohydrates; both of these compounds are present in foods in many forms and can be found in:

- Fruits
- Vegetables
- Grains
- Beans
- Nuts
- Meats and fish contain a small amount of carbohydrate
Carbohydrates (cont’d)

- Caramelization and gelatinization are the two most important changes in carbohydrates caused by heat.
  - Caramelization: the browning of sugars.
  - Gelatinization: occurs when starches absorb water and swell.
    - Acids inhibit gelatinization.
Fruit and Vegetable Fiber

- **Fiber**: a group of complex substances that give structure and firmness to plants.
  - Fiber cannot be digested.
  - The softening of fruits and vegetables in cooking is, in part, the breaking down of fiber.
  - Acids and sugar make fiber firmer.
  - Baking soda (and other alkalis) makes fiber softer.
Effects of Heat on Foods (cont’d)

Proteins

- Protein is a major component of:
  - Meats
  - Poultry
  - Fish
  - Eggs
  - Milk and milk products

- It is present in smaller amounts in nuts, beans, and grains.
Proteins (cont’d)

• Coagulation
  – Protein coils unwind, become attracted to each other, and form bonds.
  – Coagulated proteins form solid network of bonds and become firm.
  – Excessive heat toughens proteins and makes them dry.
  – Most proteins complete coagulation or are cooked at 160º–185ºF (71º–85ºC).
Proteins (cont’d)

- **Maillard reaction**
  - Occurs when proteins are heated to about 310°F (154°C).
  - The amino acids in the protein chains react with the carbohydrate molecules and undergo a complex chemical reaction.
  - The result is that they turn brown and develop richer flavors.
  - Takes place only on the dry surface of the food.
Proteins *(cont’d)*

- **Connective tissues**
  - Special proteins that are present in meats.
  - Some connective tissues are dissolved when cooked slowly with moisture.

- **Acids, such as lemon juice, vinegar, and tomato products, have two effects on proteins:**
  - They speed coagulation.
  - They help dissolve some connective tissues.
Fats

- Fats are present in:
  - Meats, Poultry, Fish, Eggs, Milk and milk products, Nuts and whole grains, Fruits and vegetables (to a lesser extent
- Fats are also important as cooking mediums, as for frying.
- Can be either solid or liquid at room temperature.
- Liquid fats are called oils.
- When solid fats are heated, they melt, changing from solid to liquid.
- The melting point of solid fats varies.
Fats (cont’d)

- When fats are heated, they begin to break down.
- **Smoke point**: The temperature at which fats deteriorate rapidly and begin to smoke.
  - Smoke point varies by type of fat.
Basic Concepts in Food Science

Effects of Heat on Foods (cont’d)

Minerals, Vitamins, Pigments, and Flavor Components

• Important to:
  – The nutritional quality of the food
  – Food’s appearance and taste
  – Select cooking methods that preserve, as much as possible, a food’s nutrients, taste, and appearance.
Water

- Nearly all foods contain water.

- Water exists in three states: solid (ice), liquid, and gas (water vapor or steam).

- At sea level, pure liquid water becomes solid, or freezes, at 32°F (0°C) and turns to steam at 212°F (100°C).
An emulsion is a uniform mixture of two substances that are normally unmixable. Two types are temporary and permanent:

- Examples are:
  - Mayonnaise
  - Hollandaise
  - Vinaigrette

- In an emulsion of two liquids, one of the liquids is said to be in suspension in the other.
Heat must be transferred from a heat source to and all throughout the food in order for it to be cooked.

– Heat is transferred in three ways:
  • Conduction
  • Convection
  • Radiation
Conduction

- **Conduction**: Occurs in two ways:
  - When heat moves directly from one item to something touching it.
  - When heat moves from one part of something to an adjacent part of the same item.
Convection

- **Convection**: Occurs when heat is spread by the movement of air, steam, or liquid (including hot fat). Convection is the process that carries the heat from the heat source to the food.

- There are two kinds of convection:
  - **Natural**: Hot liquids and gases rise, while cooler ones sink.
  - **Mechanical**: In convection ovens and convection steamers, fans speed the circulation of heat.
Radiation

– Radiation occurs when energy is transferred by waves from a source to the food.

– These waves are changed into heat energy when they strike the food being cooked.
Radiation (cont’d)

- Infrared
  - Broiling is the most familiar example of infrared cooking.
- Microwave
  - The radiation generated by the oven penetrates partway into the food where it agitates the molecules of water.
  - The friction this agitation causes creates heat, which cooks the food.
Doneness and Cooking Times

- We say a food is “done” when two things have happened:
  - The interior temperature has risen to the desired degree.
  - The desired changes have taken place in the food
- The time it takes to achieve doneness is affected by three factors:
  - Cooking temperature
  - The speed of heat transfer
  - Size, temperature, and individual characteristics of the food
Cooking methods are classified as moist heat or dry heat.

**Moist-heat methods:** Those in which the heat is conducted to the food product by water or water-based liquids.

**Dry-heat methods:** Those in which the heat is conducted by hot air, hot metal, radiation, or hot fat.
Dry-Heat Methods

- Bake or roast: to cook foods by surrounding them with hot, dry air, usually in an oven.
- The term *baking* usually applies to breads, pastries, vegetables, and fish.
- The term *roasting* usually applies to meats and poultry.
- Cooking on a spit in front of an open fire may also be considered roasting.
Dry-Heat Methods (*cont’d*)

- **Barbecue**: to cook with dry heat created by the burning of hardwood or by the hot coals of this wood.
- **Pan smoking**: a procedure done in a closed container, using wood chips to make smoke.
Dry-Heat Methods (cont’d)

- **Broiling**: to cook with radiant heat from above.
- **Grilling**: done on an open grid over a heat source, which may be charcoal, an electric element, or a gas-heated element.
- **Griddling**: done on a solid cooking surface called a griddle, with or without small amounts of fat to prevent sticking.
- **Pan-broiling**: like griddling except it is done in a sauté pan or skillet instead of on a griddle surface.
Dry-Heat Methods Using Fat

• **Sauté:** to cook quickly in a small amount of fat.

• **Pan-frey:** to cook in a moderate amount of fat in a pan over moderate heat.

• **Deep-frey:** to cook a food submerged in hot fat.
• Moist-Heat Methods
  – **Boil**: to cook in a liquid that is bubbling rapidly and greatly agitated.
  – Water boils at 212°F (100°C) at sea level.
  – **Simmer**: to cook in a liquid that is bubbling gently at a temperature of about 185°F to 205°F (85° to 96°C).
CONVENTIONAL COOKING METHODS \textit{cont’d}

- **Moist-Heat Methods \textit{(cont’d)}**
  - **Poach:** to cook in a liquid, usually a small amount, that is hot but not actually bubbling.
    - Temperature is 160º-180ºF (71º-82ºC).
  - **Blanch:** to cook an item partially and briefly, usually in water.
    - Sometimes by other methods (as when French fries are blanched in deep fat).
• Moist-Heat Methods (cont’d)
  – Steam: to cook foods by exposing them directly to steam.
    • Cooking en papillote: refers to cooking an item tightly wrapped in parchment paper.
    • The item cooks in the steam formed by its own moisture.
**Moist-Heat Methods (cont’d)**

- **Braise:** to cook covered in a small amount of liquid, usually after preliminary browning.
  - Braising also refers to cooking some vegetables at low temperature in a small amount of liquid without first browning in fat.
  - Braised meats are usually browned first using a dry-heat method, then finished with a moist-heat method.
  - A braise consists of large pieces of food, at least portion-size, cooked by the braising method.
Moist-Heat Methods (cont’d)

- *Stew* consists of:
  - Small pieces of food, bite-sized or slightly larger.
  - Cooked either by the braising method (first dry heat, then moist heat) or by the simmering method (moist heat only).
COOKING METHODS

COOKING SOUS VIDE

• French for “under vacuum”
• The term is applied to cooking foods that have been vacuum-sealed in plastic bags.
• The heart of sous vide cooking is the precise temperature control it permits.
COOKING METHODS

COOKING SOUS VIDE (CONT’D)

• Critical safety factors for sous vide cooking:
  – Know the rules established by your local health department.
  – Use only the freshest, most wholesome foods from reputable purveyors.
  – Chill all food thoroughly before vacuum packing. If you sear a food, chill it after searing and before packing.
  – After packing food, immediately cook, refrigerate, or freeze it.
  – After cooking, serve the food immediately, or chill it as quickly as possible.
  – Thaw cooked food frozen in its package in the refrigerator.
• The manipulation of food ingredients in new ways by the use of technology.
• A better name might be **avant-garde cuisine**.
• Today avant-garde is used to describe any group that pushes the boundaries of a discipline beyond what is considered normal.
• In this style of cooking, using the best ingredients is necessary.
A second definition of molecular gastronomy:

– The selective use of technology and nonstandard ingredients to help enhance the flavors, aromas, appearance, and textures of natural foods.

– Because the techniques are used to focus attention on flavors, colors, textures, and aromas, only the freshest foods have the quality to work in these dishes.
Building Flavor Profiles

• The harmony of ingredient flavors and aromas the cook creates by skillfully combining ingredients.

• Primary flavor: The most important flavors of a given preparation are those of its main ingredients.

• Supporting flavors: Support and enhance the primary flavors of the main ingredients.
General Concepts in Flavor Building

• Every ingredient should have a purpose.
• Start with the main ingredients, and then think about what will work with them.
• Ingredients can work together by harmonizing or by contrasting.
• When two ingredients contrast, be sure they balance.
• Consider not only the components of the single recipe but also the other items that will be served with it on the plate.
BUILDING FLAVOR

Simplicity and Complexity

• Simpler is usually better.
• The more flavors you combine, the harder you have to work to balance them all.
• The more competing flavors you have, the more you have to take care that the primary flavors of the main ingredients are not lost.
Classic Flavor Profiles

- The best place to start is to study traditional recipes from around the world.
- Also to study the classical cuisine passed down to us through Escoffier.

Courtesy of Adjointe à la Conservation du Musée Escoffier de l'Art Culinaire
Building Flavor

Seasoning and Flavor Ingredients

- **Seasoning**: enhancing the natural flavor of a food without significantly changing its flavor.
  - The most important time for seasoning liquid foods is at the end of the cooking process.

- **Flavoring**: adding a new flavor to a food, thus changing or modifying the original flavor. Flavoring ingredients can be added at the beginning, middle, or end, depending on:
  - The cooking time
  - The cooking process
  - The flavoring ingredient
Flavoring

- Most flavorings need heat to release their flavors and time for the flavors to blend.
- Too much cooking results in loss of flavor.
- Most flavors are volatile, which means they evaporate when heated.
Flavoring (cont’d)

- Herbs and spices should cook with the foods long enough to release their flavors.
- Do not cook so long that their flavors are lost.
- If cooking times are long, it is better to add herbs and spices in the middle or toward the end of cooking time.
BUILDING FLAVOR

USING HERBS AND SPICES

- **Herbs:** the leaves of certain plants that usually grow in temperate climates.
- **Spices:** the buds, fruits, flowers, bark, seeds, and roots of plants and trees, many of which grow in tropical climates.