

EIGHTH EDITION

FOODS

EXPERIMENTAL PERSPECTIVES



Margaret McWilliams

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Margaret McWilliams

Ph.D., R.D., Professor Emerita
California State University, Los Angeles

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To my food science and dietetic students who made my teaching career such a pleasure and intellectual challenge!

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Brief Contents

Preface	xix
Acknowledgments	xxi
Chapter 1 Today's Food Scene	3
PART I—PHYSICAL PERSPECTIVES	
Chapter 2 Water	27
Chapter 3 Physical Aspects of Food Preparation	39
PART II—CARBOHYDRATES	
Chapter 4 Overview of Carbohydrates	61
Chapter 5 Monosaccharides, Disaccharides, and Sweeteners	73
Chapter 6 Starch	101
Chapter 7 Vegetables and Fruits	125
PART III—LIPIDS	
Chapter 8 Overview of Fats and Oils	167
Chapter 9 Fats and Oils in Food Products	183
PART IV—PROTEINS	
Chapter 10 Overview of Proteins	211
Chapter 11 Milk and Milk Products	223
Chapter 12 Meats, Poultry, and Fish	251
Chapter 13 Eggs	285
Chapter 14 Dimensions of Baking	313
Chapter 15 Baking Applications	343
PART V—FOOD SUPPLY PERSPECTIVES	
Chapter 16 Food Safety Concerns and Controls	375
Chapter 17 Food Preservation	403
Chapter 18 Food Additives	427
PART VI—RESEARCH PERSPECTIVES	
Chapter 19 The Research Process	443
Chapter 20 Sensory Evaluation	461
Chapter 21 Objective Evaluation	485
Appendix: Metrics	501
Glossary	505
Credits	521
Index	523

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Contents

Preface	xix
Acknowledgments	xxi
Chapter 1 Today's Food Scene	3
Objectives	3
Introduction	3
Issues in the Food Supply	4
Production Perspectives	4
Consumer Voices	5
Food for Thought: Ultragrain®	9
Food for Thought: World Farming Challenges and Nonprofits	10
Sustainability	10
The Trip to the Table	13
Security in the Food Supply	13
Food for Thought: Safety with Pressure	14
Challenges to the Food Industry	14
Functional Foods	15
Designer Foods	18
Nanotechnology	18
Careers in Food	20
Summary	23
Study Questions	23
Bibliography	23
PART I—PHYSICAL PERSPECTIVES	25
Chapter 2 Water	27
Objectives	27
A Closer Look at Water	27
States of Water	28
Factors Influencing the Freezing Point	29
Factors Influencing the Boiling Point	31
Bound Water	33
Water Activity	33
Food for Thought: Safe Water for All	35
Water in Food Preparation	35
Hardness of Water	35
Bottled Water	36
Summary	36
Study Questions	37
Bibliography	37

Chapter 3 Physical Aspects of Food Preparation	39
Objectives	39
Introduction	39
Energy and Food	39
Mechanical Energy	39
Radiant Energy	39
Induction	41
Conduction	42
Convection	43
Mass Transfer	45
The State of Matter	45
Solids	45
Liquids	46
Gases	47
Food for Thought: The State Matters	48
Dispersions	49
True Solutions	49
Colloidal Dispersions	50
Coarse Suspensions	56
Summary	56
Study Questions	58
Bibliography	58
PART II—CARBOHYDRATES	59
Chapter 4 Overview of Carbohydrates	61
Objectives	61
Introduction	61
Monosaccharides	62
Pentoses	62
Hexoses	62
Disaccharides	63
Food for Thought: Carbohydrate Paradox	64
Oligosaccharides	65
Glucosidic Polysaccharides	65
Dextrins	65
Dextrans	65
Starch	66
Glycogen	67
Cellulose	68
Food for Thought: Fructans and Biotechnology	68
Non-Glucosidic Polysaccharides	68
Pectic Substances	69
Gums	69
Summary	69
Study Questions	70
Bibliography	70
Chapter 5 Monosaccharides, Disaccharides, and Sweeteners	73
Objectives	73
Introduction	73

Physical Properties of Sugars	73
Sweetness	73
Hygroscopicity	74
Solubility	74
Chemical Reactions	76
Hydrolysis	76
Degradation	76
Caramelization	76
The Maillard Reaction	77
Functional Properties of Sugars	79
Food Applications	79
Crystalline Candies	79
Amorphous Candies	84
Syrups, Sauces, Jams, and Jellies	86
Baked Products	86
Choosing Sweeteners	87
Types	87
Food for Thought: Brown Sugar Options	88
Alternative Sweeteners	90
Substituting Sweeteners	95
Summary	96
Study Questions	98
Bibliography	98
Chapter 6 Starch	101
Objectives	101
Introduction	101
Structure	101
Amylose	101
Amylopectin	102
Starch Granule	103
Functional Properties of Starch	104
Gelatinization and Pasting	104
Gelation	109
Retrogradation	112
Dextrinization	112
Examining Starches	112
Sources	112
Native Starches	114
Modified Starches	115
Uses	117
Food For Thought: Resistant Starch	118
Criteria for Selecting A Starch	119
Rice and Its Starch	121
Summary	122
Study Questions	122
Bibliography	123
Chapter 7 Vegetables and Fruits	125
Objectives	125
Introduction	125

Structure of Fruits and Vegetables	126
Tissue Systems	127
Parenchyma Cells	127
Collenchyma Tissue	129
Sclerenchyma Cells	129
Carbohydrate Structural Constituents	131
Cellulose	131
Hemicelluloses	131
Pectic Substances	131
Lignin	135
Changes during Maturation	135
Postharvest Changes and Storage	135
Textural Changes during Preparation	138
Nutrients	139
Classification	140
Pigments and Phytochemicals	140
Chlorophyll	140
Carotenoids	143
Flavonoids	146
Coloring Agents in Food Products	153
Flavor	154
Fiber	157
Categories of Fiber	157
Bran in Food Products	157
Food for Thought: Reducing Waste	157
Gums	158
Functions	159
Sources	159
Food for Thought: Inulin, Ingredient in Functional Foods	159
Chemical Composition	160
Food for Thought: Textural Polysaccharides	161
Applications	162
Summary	163
Study Questions	164
Bibliography	164

PART III—LIPIDS **165**

Chapter 8 Overview of Fats and Oils **167**

Objectives	167
Chemistry	167
Glycerol	167
Fatty Acids	168
Structures of Fats In Foods	171
Crystallinity of Solid Fats	172
Chemical Degradation	173
Rancidity	173

Food for Thought: Sunlight and Olive Oils	175
Reversion	176
Effects of Heat	176
Summary	179
Study Questions	180
Bibliography	180
Chapter 9 Fats and Oils in Food Products	183
Objectives	183
Introduction	183
Steps in Manufacturing Food Fats	183
Extraction	183
Refining	184
Food for Thought: Olive Oil Quality	185
Fractionation	186
Food for Thought: Refining and Smoke Point	186
Crystallization of Fats	187
Quality Determinations	188
Chemical Modifications	188
Hydrogenation	188
Food for Thought: Fat Facts	189
Inter- and Intraesterification	191
Fats and Oils in the Marketplace	191
Fats and Today's Health Challenges	191
Sources	191
Food for Thought: Profiting from Grape Seeds?	194
Products	195
Functional Roles of Fats	198
Color	198
Flavor	198
Texture	198
Tenderness	199
Emulsification	202
Cooking Medium	203
Fat Replacements	204
Protein-Based Replacements	205
Carbohydrate-Based Replacements	205
Fat-Based Replacements	206
Summary	207
Study Questions	207
Bibliography	207
PART IV—PROTEINS	209
Chapter 10 Overview of Proteins	211
Objectives	211
Introduction	211
Composition	211
Types of Proteins	216

Electrical Charges	216
Hydrolysis	217
Denaturation and Coagulation	217
Functional Roles	219
Foam Formation	219
Thickening Agent	219
Food for Thought: The Clot Thickens	220
Structural Component	220
Summary	220
Study Questions	221
Bibliography	221
Chapter 11 Milk and Milk Products	223
Objectives	223
Components	223
Lipids	223
Carbohydrate	225
Proteins	225
Food for Thought: Encasing with Casein	227
Vitamins and Minerals	227
Flavor Components	228
Food for Thought: Cloning and Casein	228
Processing	228
Pasteurization	228
Homogenization	229
Evaporation	230
Drying	231
Fermentation	231
Products	232
Milk	232
Butter	234
Creams	235
Cheeses	235
Food for Thought: Burrata	237
Whey	240
Ice Cream and Frozen Desserts	240
Physical and Chemical Effects on Milk Products	243
Heat	243
Enzyme Action	244
Acid	245
Salts	245
Effects of Heat on Cheese Products	245
Foams	246
Milk Foams	246
Cream Foams	246
Ingredients from Dairy Foods	247
Summary	247
Study Questions	248
Bibliography	249

Chapter 12 Meats, Poultry, and Fish	251
Objectives	251
Classification	251
Food for Thought: Fish and the Environment	251
Structure	253
Muscle Tissue	253
Connective Tissue	253
Fat	256
Pigments	257
Myoglobin and Related Compounds	257
Changes Effected by Heating	258
Changes Effected by Curing	259
Meat Quality	260
Factors Affecting Quality	260
Inspection and Grading	261
Identifying Meat Cuts	261
Marketing	262
Fresh/Frozen	262
Food for Thought: Kosher/Halal	264
Domestic/Foreign	264
Carcass/Case-Ready	265
Food for Thought: Shrimp Ahoy	266
Preparation	266
Changes Effected by Heat	266
Effects of Altering pH	271
Effect of Salt	271
Meat Tenderizers	272
Meat Tenderizers	272
Modified Meat Products	272
Reduced-Fat Meats	272
Restructured Meats	273
Comminuted Meats	273
Structured Seafood Products	273
Soy Protein	274
Products	274
Using Textured Soy Proteins	276
Quorn™	277
Food for Thought: Petri Burgers?	277
Gelatin	277
Composition	277
Properties	277
Summary	280
Study Questions	281
Bibliography	282
Chapter 13 Eggs	285
Objectives	285
Formation	285
Structure	285
Composition	287

Proteins	288
Albumen	288
Yolk	289
Eggs by Design	289
Egg Quality	290
Egg Safety	294
Preservation	294
Pasteurization	294
Drying	295
Freezing	295
Food for Thought: Thousand-Year Eggs	296
Functional Properties and Applications	296
Coloring Agent	297
Emulsifying Agent	297
Thickening Agent	297
Foams	302
Egg Substitutes/Replacers	308
Summary	309
Study Questions	310
Bibliography	311
Chapter 14 Dimensions of Baking	313
Objectives	313
Introduction	313
Wheat Flour	313
Milling	313
Types of Milled Wheat Flour	314
Modifying Wheat Flour	316
Food for Thought: Innovative Wheat Flour	317
Composition of Wheat Flours	317
Gluten	319
Flours from Other Sources	323
Roles of Ingredients	327
Wheat and Other Flours	327
Liquid	327
Eggs	329
Fats	329
Sugar	329
Salt	330
Leavening Agents	330
Commercial Baking Challenges	330
Leavening	330
Air	330
Steam	331
Biological Agents	332
Chemical Agents	335
Baking Powders	336
Baking Ammonia	338
Summary	338
Study Questions	340
Bibliography	340

Chapter 15 Baking Applications	343
Objectives	343
Introduction	343
Quick Breads	343
Types	343
Ingredients	344
Mixing Methods	345
Selected Examples of Quick Breads	346
Yeast Breads	349
Ingredients	349
Dynamics in Mixing and Kneading	351
Changes	352
Changes during Baking	352
Flour Options	353
Staling	353
Foam Cakes	354
Angel Food Cake	355
Sponge Cake	356
Chiffon Cake	357
Shortened Cakes	357
Ingredients	357
Food for Thought: Chocolate in the Spotlight	360
Methods of Mixing	361
Food for Thought: A “Prime” Ingredient	363
Baking	363
Causes of Variations	364
Altitude Adjustments	365
Pastry	366
Ingredients	366
Causes of Variations	366
Puff Pastry	367
Cookies	368
Summary	369
Study Questions	371
Bibliography	371
PART V—FOOD SUPPLY PERSPECTIVES	373
Chapter 16 Food Safety Concerns and Controls	375
Objectives	375
Defining The Problem	375
Microbiological Hazards	376
Bacteria	376
Food for Thought: Preamble to Safety	381
Food for Thought: Activated Lactoferrin	384
Viruses	386
Molds	388
Microalgae	388
Food for Thought: Something Fishy!	389
Parasites	390

Contaminants and Natural Toxicants in Foods	392
Contaminants	392
Natural Toxicants	393
Allergens	393
Controlling Food Safety	394
Personal Responsibilities	394
Federal Regulators	395
Federal and Industrial Cooperative Efforts	396
International Food Safety and Control Efforts	397
Some Commercial Approaches to Extend Shelf Life	397
Use of Antimicrobial Agents	397
Energy	397
Summary	398
Study Questions	399
Bibliography	400
Chapter 17 Food Preservation	403
Objectives	403
Methods of Preservation (Commercial and Home)	403
Food for Thought: Kimchi in Today's World	404
Freezing	405
Produce	405
Food for Thought: Current Crisis	407
Protein Foods	407
Other Foods	408
Commercial Methods	409
Canning	411
Methods	412
Potential Problems	415
Drying	415
Preserving with Sugar	418
Freeze-Drying	419
Non-Thermal Commercial Methods	420
Irradiation	420
High-Pressure Processing	420
Pulsed Electric Field Processing	422
Shelf Life and Food Waste	422
Summary	423
Study Questions	424
Bibliography	424
Chapter 18 Food Additives	427
Objectives	427
Overview	427
Rationale	428
Food for Thought: Translating "EAFUS"	431
Additives	431
Accidental Additives	431
Intentional Additives	432
Manufacturing Applications	433
Safety	434

Using Herbs and Spices	436
Food for Thought: Truffles Treasures	438
Dietary Supplements	440
Summary	441
Study Questions	441
Bibliography	441
PART VI—RESEARCH PERSPECTIVES	443
Chapter 19 The Research Process	445
Objectives	445
Introduction	445
Defining the Purpose	446
Reviewing the Literature	447
Food for Thought: Agricola	448
Designing the Experiment	448
Method	449
Evaluation	450
Data Recording	451
Conducting the Experiment	451
Interpreting and Reporting Results	452
A Look at Statistics	453
Overview of the Report	455
Summary	457
Study Questions	458
Bibliography	458
Chapter 20 Sensory Evaluation	461
Objectives	461
Introduction	461
Food for Thought: Designing for Flavor	462
Physiological Bases of Sensory Evaluation	462
Olfactory Receptor Neurons	462
Taste Receptors	463
Other Oral Sensations	465
Visual Receptors	466
Sensory Characteristics of Food	467
Appearance	468
Aroma	468
Flavor	469
Texture	469
Food for Thought: Crispy or Crunchy?	470
Sensory Panels	471
Selecting Panel Members	471
Training Panelists	471
Environment for Sensory Evaluation	472
Sample Preparation and Presentation	472

Types of Sensory Tests	473
Single Sample	473
Descriptive Testing	473
Affective Testing	474
Difference Testing	474
Scorecards	475
Summary	481
Study Questions	482
Bibliography	482
Chapter 21 Objective Evaluation	485
Objectives	485
Introduction	485
General Guidelines	485
Physical Methods	486
Volume	486
Specific Gravity	488
Moisture	488
Texture	489
Food for Thought: Accessories after the Facts	490
Rheology	493
Color	495
Cell Structure	495
Chemical Methods	495
Nutrient Analysis	495
pH	495
Sugar Concentration	496
Saltiness	496
Aroma	497
Flavor	497
Electronic Tongue	497
Proximate Analysis	497
Summary	498
Study Questions	499
Bibliography	499
Appendix: Metrics	501
Glossary	505
Credits	521
Index	523

Preface

The world has never focused more on the food scene than is true today. Fascination, pleasures, and concerns include unusual and exotic foods, genetic modifications, and healthy eating. Farmers and fishermen are challenged to produce enough food to feed the world despite an ever-increasing population and severe detrimental weather. Voices are raised loudly on both sides of arguments about such topics as labeling, food safety, GMOs, organic, and animal rights. Careers in food and food science are right in the middle of the scene. It is a great time to be studying to gain knowledge of the underlying science as well as the philosophical and practical aspects of food.

Careers in this realm require a depth of understanding far beyond what can be seen on television. This book is designed to help readers broaden and strengthen their scientific knowledge of food and its safe preparation. Chapter 1 introduces some food topics of particular concern to consumers, surveys government involvement, and explores opportunities in food-related careers. Part I explains the role of water in food and the physical aspects of food preparation. Parts II, III, and IV discuss carbohydrates (sugars, starch, vegetables, and fruits), lipids, and proteins (meat, eggs, milk, and baked products). Part V includes food safety, preservation, and additives. Part VI examines research basics, including sensory and objective evaluation. Laboratory experiments to augment your study are presented in my *Experimental Foods Laboratory Manual*, which also is published by Pearson.

“Food for Thought” and other boxes highlighting unique ingredients are features of this new edition that broaden this look at the world of food. Numerous color pictures, objectives, margin notes and definitions, summary charts, and study questions are designed to enhance learning.

This revision has been updated to include new information pertinent to each chapter, ranging from the food scene and marketplace to the spectrum of foods and the science that forms the basis for their handling and preparation. Particularly extensive revisions occur in Chapters 1, 12, and 16. The sequence of chapters has been altered significantly, with the research chapters being placed following the parts discussing the science of food.

Space limitations make it impossible to include background information that usually is included in an introductory class. You will find this material in my book *Food Fundamentals*, 10th edition, also published by Pearson.

You have chosen an important field. I hope that you will enjoy your study of food and that it will serve you well as you proceed in your career.

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Acknowledgments

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Margaret McWilliams

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Other Prentice Hall Books by Margaret McWilliams

Experimental Foods Laboratory Manual (9th edition), 2016.

Food Fundamentals (10th edition), 2013.

Illustrated Guide to Food Preparation (11th edition), 2013.

Fundamentals of Meal Management (6th edition), 2008.

Food around the World (4th edition), 2014.



Farms are the key source of much of the nation's food supply.

1

Today's Food Scene

CHAPTER OUTLINE

Objectives
Introduction
Issues in the Food Supply
 Production Perspectives
 • Consumer Voices
Food for Thought: Ultragrain®
Food for Thought: World Farming Challenges and Nonprofits
 Sustainability
The Trip to the Table
Security in the Food Supply
Food for Thought: Safety with Pressure
Challenges to the Food Industry
 Functional Foods • Designer Foods • Nanotechnology
Careers in Food
Summary
Study Questions
Bibliography

OBJECTIVES

After studying this chapter, you will be able to:

1. Discuss genetically modified organisms from the perspectives of both food producers and consumers.
2. Describe some of the problems farmers have to deal with in their profession.
3. Outline the issues fishermen and people running fish farms face. Discuss the significance of functional foods for consumers.
4. Discuss the roles of some federal agencies involved in the nation's food supply.
5. Describe various professional career opportunities that are centered on diverse aspects of the food industry.

INTRODUCTION

Today's professionals working in the many aspects of food, ranging from farm to table, are confronted with unique challenges as consumers increasingly focus their attention on what they are eating. Never before has there been so much media attention and public engagement in cooking and eating. The joys of fine dining have drawn many to savor their food, but negative aspects such as the obesity epidemic, the rise in diabetes, and other food-related health issues have brought sharply critical attention. **Genetically modified organisms (GMOs)**, "natural" foods, and animal rights are among leading topics that have fostered public concern and heated discussions. The publicity has caused people to be more aware of what they are eating; it has not only increased dining pleasure for many but also caused considerable anxiety about food safety and nutritional deficiencies.

The public has heeded the information and misinformation that is being fed to them via the Internet, television, radio, and print media. Unfortunately, the accuracy of the information and the qualifications of the source are often ignored, creating enthusiastic messengers clamoring for changes that may not be necessary and can actually be costly and harmful.

In contrast, the U.S. Department of Agriculture (USDA) has provided accurate information on food groups and recommendations for healthy eating to the public for many

Genetically modified organism (GMO)

Plant or animal food developed by genetic manipulation to alter nutrient levels or other characteristics; also designated as GM.

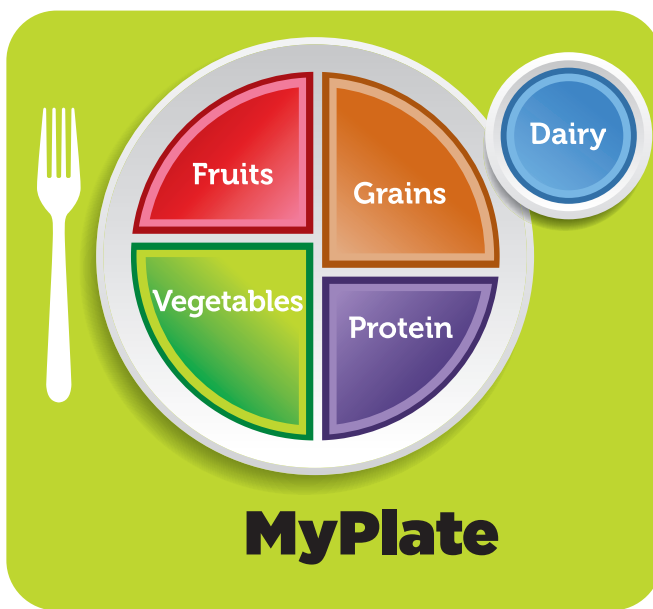


Figure 1.1 MyPlate is the logo for the USDA's current dietary guidelines. (Courtesy of USDA.)

years. The USDA's Food Guide Pyramid was the icon in 1992 and was replaced with MyPyramid in 2005. The most recent format for guiding eating is "MyPlate," which was introduced in 2011. MyPlate features five food groups: fruit, vegetable, grains, protein foods, and dairy (Figure 1.1). Detailed guidance for using MyPlate is available at <http://www.choosemyplate.gov/>.

What people choose to eat is defined jointly by consumers and the food industry. Changes have come to the marketplace as the public's voice has increasingly been heard. A trip through a supermarket today immediately reveals that the food world is flat; that is, it has become international. Ingredients are imported from around the world, and cultural food specialties are stocked. Labels shout claims about health benefits, and fresh produce often is identified as locally grown and/or organic. Although gourmet cooking at home is a hobby pursued by some, delicatessen sections are gaining more space in supermarkets as people cope with the challenges of lack of time and healthy eating.

ISSUES IN THE FOOD SUPPLY

Production Perspectives

The food for sale in markets is available via a chain of workers, beginning with farmers or fishermen. Some farmers are operating on a family farm, and they make decisions on such critical matters as when and what to plant, how to cultivate, and when to harvest and market their crops. The trend for decades has been consolidation as family farms have been sold and merged into megafarms. These large-scale operations are operated often under distant management and with less involvement in local communities.

Big farming operations face the same issues as small farmers, but the operating decisions that are made can have a significant impact on the immediate environment. For example, the problem of safe waste removal from a single milk cow for a family is of very limited consequence, whereas waste from a herd of 1,000 cattle has to be managed carefully to avoid carrying microbiological contamination into soil when heavy rains flood and run off into neighboring fields. Operators of large-scale livestock and poultry farms need to constantly monitor sanitation to maintain healthy animals and to minimize the environmental impact of their farm on the air quality (an aroma that can quickly draw complaints) in the neighborhood.

Animal rights have garnered news stories as some activists have recorded documentaries (usually surreptitiously obtained) showing how some farmers are housing and treating their livestock and poultry. Reports of crowded conditions led to calls for allowing poultry to roam outdoors, and “free range” chicken entered the marketplace. The American Humane Association and other organizations are dedicating their efforts to improving the quality of life for livestock and even providing their own certification when producers meet the guidelines established by the certifying organization. Federal agencies are not involved in these unofficial certification programs.

Small, family-owned farms are disappearing gradually as a consequence of economic challenges. Large-scale farming requires relatively less human labor because big operators are tilling enough land to justify the high cost of giant farm equipment. However, some small-farm operators help each other and may share special equipment during threshing and harvesting. Gradually, many small towns scattered across the farm belt have shrunk or even disappeared as family farms have been acquired by corporations.

Regardless of the size of the farm, weather introduces a major factor into the size of the crop and the income it brings in. Seed or livestock must be purchased at the beginning of the season, and additional expenditures for plant fertilizers and pesticides or for animal feed and antibiotics and other healthcare have to be paid during the growing season regardless of flood or drought conditions. A storm at the wrong time can suddenly cause huge losses for farmers. The severe droughts of the past few years have caused many small farmers in the affected regions to lose their farms.

Consumer Voices

Among the words consumers speak frequently and with authority and enthusiasm are *natural*, *fresh*, and *locally grown*. USDA regulations allow food labels to include the word **natural** if no ingredients have been added and if little or minimal processing has been done. Alice Waters and other famous chefs and restaurateurs created the demand for produce straight from the garden or local farm to the table. Gradually these terms have become part of table talk in many settings. They also have helped to promote shopping at local farmers markets. Unlike *organic*, *fresh*, and *locally grown* have not been given legal definitions and are dropped liberally into table talk about food, but with little attention to accuracy.

A related issue is identification of products on the basis of point of origin. As the market for upscale food products has increased, careful control of products by their source has become significant for marketing. Examples of producers protecting their “point of origin” names include Champagne and Roquefort cheese in France, Parma hams, and Parmigiano-Reggiano cheese (Figure 1.2) from Parma in northern Italy, and Wensleydale and Stilton cheese from Leicestershire, Nottinghamshire, and Derbyshire, England. To avoid having competitors from other places invade their carefully cultivated customers, some authentic producers are gradually establishing legal ownership of their “point of origin,” thus making it necessary for imitation products to stop using the original name; a different name must be stated on the label.

Organic Concerns Gradually during the decades since the 1960s, consumers have become more aware of what they eat and where it comes from. In some cases, this has added considerable emotion to the dialog about food. Perhaps the most obvious change such voices have generated is **organic foods**.

Some consumers say they want organic or natural foods as though they were synonymous terms, but they are not the same legally. When used in reference to foods, *natural* generally mean that original food ingredients have been used and that no artificial or chemical additives have been included. Using beet pigments rather than a red chemical dye to color a food product is one example of using a natural coloring agent.

The legal definition to label a food *organic* is that the plant or animal food has been produced without using growth hormones, antibiotics, or petroleum-based or sewage sludge-based fertilizers. Designation as organic does not mean that the food is higher in

Natural

USDA allows this term on labels if the product contains no artificial ingredient or added color and is only minimally processed. Minimal processing means that the product was processed in a manner that does not fundamentally alter the product. The label must include a statement explaining the meaning of the term *natural* (e.g., “no artificial ingredients, minimally processed”).

Organic foods

Foods raised to meet the legal requirements blocking use of fertilizers, pesticides, ionizing radiation, and bio-engineering.



Figure 1.2 Parmigiano-Reggiano cheese is identified clearly by its point of origin to distinguish it as the authentic Parmesan cheese from Parma in northern Italy. (Courtesy of Barbara Boyer.)

nutrients than the same type of food that has not been produced according to organic requirements. Nevertheless, many consumers often are willing to pay more for organic produce because they think they are buying more nourishing food.

The first federal legislation regarding producing and marketing organic foods was the **Organic Food Production Act of 1990**. However, the impact of this act was not evident until passage of legislation in 2002 that implemented the earlier act. The **National Organic Program**, administered by the Agricultural Marketing Service of the USDA, went into effect in late 2002 (Figure 1.3).

Plant and animal foods marketed as organic may carry the USDA Organic seal if they meet the following requirements:

- To be eligible for the designation of organic or 95 percent organic, at least 95 percent of produce (by weight) must not have been treated with sewage sludge-based or petroleum-based fertilizers, conventional pesticides, ionizing radiation, or bioengineering.
- Food mixtures in packages may be labeled “made with organic ingredients” if 70 percent of the ingredients (by weight) meet the requirements for being designated organic.

Today many markets have a large display of organic foods in the produce department, and many packaged foods display organic labels. Despite the fact that organic

Organic Food Production Act of 1990
Federal legislation that regulates production and marketing of organic foods.

National Organic Program
Federal legislation passed in 2002 to implement the Organic Food Production Act of 1990.



Figure 1.3 This USDA official seal can only be used to identify foods that meet organic standards. (Courtesy of USDA.)

foods often cost more, they frequently are the choice of shoppers who feel that their health is in jeopardy if they do not buy organic foods. While these are safe food choices, they often are no better for one's health than foods that are not identified as organic. Vegetables and fruits clearly are essential in the diet, but today's farming practices yield high-quality produce regardless of their labeling. The important thing is to eat a variety of them.

Biotechnology Plants have been modified for centuries by crossbreeding to develop strains with improved characteristics. These hybrids have been an established part of farming for many decades, and their safety as food has not been a concern. However, when scientists were experimenting with rice and some other basic crops after World War II, some research was directed toward altering plants genetically. The goal was to develop strains with improved characteristics so that crop harvests would be large enough to feed the expanding world population. The "Green Revolution" was under way and is continuing today.

The challenge of providing food security for the burgeoning population of the world (expected to reach 9 billion by 2050) is the impetus to create new strains with higher yields, more resistance to insects, and greater drought tolerance (of importance as nations deal with global warming and extreme weather conditions). Plants that have increased resistance to insects can be raised using less pesticide protection, which is a bonus for both farmers and consumers. Scientists have been striving to develop plants with these beneficial characteristics through **genetic engineering** (also referred to as biotechnology).

Genetic engineering
Another term for
biotechnology.

A gene is a segment of DNA that encodes enough information to synthesize a protein. By identifying specific genes that provide the codes for making proteins that impart desirable traits, researchers have then been able to transfer the desired genes to other organisms to develop plants or animals that continue to replicate the desired gene(s) in succeeding generations (Figure 1.4). These food crops are designated as GMOs, sometimes simply referred to as GM. Corn and soybeans are major crops that have been the object of efforts to create plants that can effectively resist infections from insects, viruses, and/or fungi. Roundup-Ready® is one brand of genetically modified crops (e.g., soybeans) already being grown in the United States. Biotechnology also has led to the development of sunflower, peanut, and other oilseed plants with reduced levels of *trans* fatty acids and higher smoke points (see Chapter 8).



Figure 1.4 Bottom: Parent variety of rice with normal phytic acid. Middle: The new low-phytic-acid variety. Top: The new variety given a gene for golden hull color to help identify it. (Courtesy of USDA.)

Continuing research projects to develop a range of crops with modified nutrient value and health benefits include:

- Altering oil composition of oilseed rape and soybeans
- Using soybean protein for use as meat substitutes
- Reducing discoloration of potatoes from bruising during commercial storage; lowering moisture content (to reduce oil absorption during cooking)
- Increasing vitamin A levels in rice (Golden Rice™) to aid in preventing blindness in Southeast Asia
- Increasing the antioxidant content in some vegetables

Other research in biotechnology is aimed toward improving flavor, color, and/or texture of tomatoes (e.g., FlavrSavr® tomato), corn, and squash. Additional research is being directed toward creating plants that are drought resistant, heat resistant, and/or able to survive increased salinity.

In many countries in various parts of the world, particularly in Europe, concerns were raised regarding the growing and marketing of food resulting from biotechnology. Nevertheless, farmers in many parts of Asia, South America, and the United States have been raising GMO crops for more than a decade. In 2013, 174 million hectares around the world were planted in GMO crops, and these crops were raised by 18 million farmers. Soybeans, maize, cotton, and rapeseed were the leading GMO crops planted.

Resistance to insect attack on corn and a few other crops is being incorporated by inserting a gene from *Bacillus thuringiensis* (a soil bacterium), resulting ultimately in the formation of a toxin that serves as an insecticide in the plant. Crops that incorporate this gene are designated as Bt. **Bt maize** is being grown in Europe despite the fact that France has banned it. Ongoing research and monitoring are being done to detect possible negative consequences of Bt crops. On the positive side is a significant decrease in worldwide fertilizer use (estimated to be almost 30 percent during the decade from 1996 to 2006) because of Bt maize and cotton.

Governmental regulatory agencies are involved in approving and regulating the products of biotechnology. In the United States, the FDA is responsible for food products of plant biotechnology. Agricultural products are under the purview of the USDA, primarily its Animal and Plant Health Inspection Service (APHIS). Herbicides and pesticides are under the aegis of the U.S. Environmental Protection Agency (EPA). These agencies are all involved in the regulation and oversight of some products of biotechnology.

The possibilities for improved food products as the result of biotechnology (specifically by techniques of genetic engineering) are diverse and multiplying. Examples include increased essential amino acid content in corn and soybeans, naturally decaffeinated coffee, plant oils with modified fatty acid content, potatoes and tomatoes with higher solids content (to decrease energy needed to remove water during processing), and controlled ripening of fruits and vegetables that are difficult to ship to markets in satisfactory condition.

Bt maize

Corn that has been modified genetically by inserting a gene from *Bacillus thuringiensis*.

FOOD FOR THOUGHT

Ultragrain®

The conflict that some people face when choosing bread that is good for them (whole grains) and the one they prefer (soft, white) has been addressed by ConAgra. This food company spent more than eight years developing a new strain of wheat and a modified milling process to produce a flour for people who want whole grain nutrition benefits and soft white bread. The new strain of wheat is grown in the Midwest, the part of the country where the hard wheat traditionally used for bread making is grown. New milling

(Continued)