**Educational Objectives Organized According to Core Competencies**

(By the completion of the program, the student will be able to...)

## 1. Food Chemistry

A. Know the chemical composition of foods

1. define the major categories of nutrients and other compounds in foods
2. describe the organic and inorganic molecules in foods

B. Describe the properties and reactions of food components

1. describe the major reaction mechanisms in foods: e.g., Maillard Browning, lipid oxidation, protein denaturation, etc.
2. relate the main reactions in foods to changes in quality (including nutrition, acceptance and safety) during processing and storage
3. control major reactions in foods by adjusting formulation and processing
4. describe a kinetically controlled and a thermodynamically controlled reaction in food
5. calculate the rate constant of a reaction and its dependence on temperature
6. determine the most important reaction for chemical degradation in a specific food
7. understand the effects of moisture, temperature, and oxygen on shelf life
8. understand the basis of action of chemical preservatives
9. describe the biochemical changes in post harvest/post-mortem plant/animal tissues
10. understand the basis of physical functionality in food macromolecules and food ingredients
11. understand the concept of glass transition in foods
12. understand important chemical reactions pertinent to food toxins (eg, nitrosamines, acrylamide, xenobiotic compounds)
13. evaluate the chemical safety of a food product/process, including consumer behavior post purchase

C. Know the principles, methods, and techniques of food analysis

1. perform chemical analyses, including gross composition and specific constituents
2. perform physical analyses
3. work safely in the laboratory
4. gather and summarize data
5. interpret data using appropriate statistical inference
6. identify likely contributions to sources of error, considering both accuracy and precision
7. understand the principles behind analytical techniques associated with food
8. understand the advantages and disadvantages of an analytical technique for a specific problem
9. understand how an analytical method is validated

## 2. Food Microbiology

A. Classify and characterize microorganisms; know the beneficial, pathogenic, and spoilage microorganisms in foods

1. select appropriate cultural, biochemical or molecular methodology to isolate, characterize, and identify microorganisms of relevance in food(s)
2. perform various cultural methods to isolate microorganisms in foods
3. perform both cultural and molecular methods to characterize and identify microorganisms in foods.
4. understand advantages and disadvantages of conventional and rapid molecular methods (including sensor-based methods) of microbial detection
5. perform conventional and rapid molecular methods of detection
6. integrate detection, tracking and control of microorganisms in foods
7. differentiate among spoilage, pathogenic, and beneficial microorganisms
8. define and distinguish between selective and differential media
9. apply the concept of microbial injury to recover injured cells
10. differentiate endospores and vegetative cells
11. enumerate microorganisms in culture, in food, or on a surface

B. Use the principles of microbial growth, injury & death to control growth of microorganisms in foods to solve applied food microbiology problems.

1. understand intrinsic and extrinsic factors and describe their effects on the microbial ecology of foods
2. apply the principles of microbial ecology (including intrinsic and extrinsic factors, as well as the nature of cells) to control the growth and survival of microorganisms in foods
3. describe microbial growth and death kinetics mathematically, including D,z and F values
4. know how to use a predictive modeling program to predict the growth and death of spoilage microorganisms and pathogens in foods
5. identify the conditions, including sanitation practices, under which pathogenic and spoilage microorganisms are killed, injured or made harmless in foods
6. determine appropriate strategies to control microbial growth including the use of preservatives and/or antimicrobials in foods
7. understand the importance of indicator organisms
8. develop a protocol for and execute a microbial shelf life study
9. determine the effects of processing on the growth and survival of microorganisms
10. define and differentiate among pasteurization, commercial sterilization, and complete sterilization
11. understand the microbial basis of fermentation processes
12. differentiate among infectious, toxigenic, toxico-infectious pathogens
13. explain proper food handling practices to ensure food safety
14. know the origin and major routes of contamination for food borne pathogens
15. describe the characteristic symptoms associated with different foodborne diseases
16. retrieve current information from the appropriate websites or other sources regarding foodborne illness outbreaks

## 3. Food Engineering

A. Know the fundamental engineering principles

1. define the terms : heat, mass, flux, etc.
2. define diffusion and mass transfer
3. be able to use mass and energy balances for a given food process.
4. understand the principles of fluid flow and their practical applications
5. understand ways to measure and describe the rheological characteristics of foods
6. understand transport processes and unit operations in food processing as demonstrated both conceptually and in practical laboratory settings
7. use concepts in mass transfer, heat transfer to explain/speculate changes in food during processing and storage
8. define the difference between convection, conduction, and radiant heat transfer
9. apply knowledge of thermodynamics to foods
10. calculate reaction rates and predict shelf life
11. calculate changes in local concentration (or temperature) in a point in a food product under steady or unsteady state conditions
12. analyze heat penetration data
13. calculate thermal processes for sterilization and pasteurization
14. design, conduct and verify a thermal process to manufacture a shelf-stable food

B. Know the principles of food processing unit operations as related to preservation, packaging, and cleaning and sanitation

1. predict spoilage and deterioration in foods and relate to methods to control deterioration and spoilage
2. understand the principles that make a food product safe for consumption
3. differentiate various thermal and non-thermal processes for destruction of microorganisms
4. know the principles of aseptic processing and packaging
5. experimentally determine D, z, and F to calculate process lethality (under the settings of canning methods and aseptic processing)
6. recognize how process changes can enhance or be detrimental to food safety
7. understand the unit operations required to produce a given food product.
8. understand the principles and current practices of processing techniques and the effects of processing parameters on product quality
9. design a separation/purification process for a food ingredient
10. understand the properties, efficiencies, and uses of different types of heat exchangers (plate, tubular)
11. understand principles of microwave heating of foods
12. describe how a HTST pasteurizer works
13. identify new and novel (non-thermal) technologies that can improve the safety and quality of foods
14. understand the properties and uses of various packaging materials.
15. food packaging including the proper choice of materials and methods for product safety, shelf life extension, and waste minimization
16. investigate various packaging methods and assess impact on safety and quality of foods
17. understand the basic principles and practices of cleaning and sanitation in food processing operations
18. understand the importance of equipment design to efficiency of process and ability to clean and sanitize
19. describe the difference between cleaning and sanitizing

20. understand the requirements for water utilization and waste management in food and food processing
21. understand waste and wastewater treatment
22. discuss the relationship between the food composition and processing methods (i.e., types of heating, pumping) on properties of the finished foods
23. select the best processing method for a particular product
24. conduct an economic analysis of a food manufacturing process
25. design a simple food processing plant (including all unit operations) from raw ingredients to finished product
26. design a basic food processing line, dairy operation, etc
27. size food processing equipment (pumps, heat exchanger etc.)

**4. Integration and Application of Scientific Disciplines: Food Processing and Manufacturing**

A. Apply the principles of food science to practical situations and problems for selected foods

1. describe the steps from agricultural production to consumption for a specific food
2. analyze and measure the effects of processing, packaging, distribution, and storage on a specific food
3. evaluate microbial and chemical stability for a specific food or ingredient
4. identify methods of increasing efficiency of a specific process
5. understand how the choice of ingredients influences the physical, chemical and microbiological properties of a specific food
6. identify and measure quality parameters for a variety of products
7. determine the likely causes of specific quality defects
8. design and conduct an experiment to evaluate the effect of changes in ingredients or processes on the quality of a food
9. apply statistical process control to maintain product quality
10. predict effect of processing methods and storage conditions on product characteristics
11. select an appropriate packaging system for a specific food
12. predict and determine shelf-life of food products
13. develop and evaluate a HACCP plan
14. write specifications for a food ingredient

B. Understand the commercial context for food processing and manufacturing

1. describe the economic constraints and drivers for development of a new food product
2. understand the idea of production efficiency with respect to use of a particular raw material or ingredient
3. understand the idea of production efficiency with respect to environmental effects and energy use
4. reverse engineer a product that is on the market

C. Demonstrate practical skills in the pilot plant

1. use pilot-scale processing equipment to manufacture an edible food product
2. understand and practice GMPs, suggesting corrective action when appropriate
3. clean and sanitize food process equipment

D. Design a new food product and/or a new manufacturing process

1. formulate a new food product to meet specified design criteria
2. design a process to manufacture a food to meet specified criteria

## 5. The Human/Food Interface

A. Assess sensory attributes of food

1. understand the basic principles of sensory science
2. select appropriate sensory tests to answer analytical and hedonic questions
3. perform a sensory test using accepted techniques
4. apply appropriate statistical techniques to the analysis of sensory data
5. understand the biology/psychology of perception

B. Understand the contribution of food and food processing to nutrition, health, and wellness

1. understand basic nutritional concepts, such as essential nutrients, digestion, absorption, and metabolism
2. describe how food processing, storage, distribution, and preparation enhance or diminish nutritional quality
3. understand Dietary Guidelines for Americans, DRIs and RDAs, and FDA-approved health claims
4. evaluate the evidence for links between diet and disease, and for the possible effects of specific foods
5. understand the distinction between nutrients as individual food components as compared to how they act within a whole food matrix
6. evaluate the beneficial and detrimental aspects of bioactive components in food products
7. understand how consumer behavior post purchase can alter the chemical and microbiological safety of food.
8. explain how food ingredients are evaluated for use in foods
9. distinguish between food allergies and food intolerances

C. Identify and apply pertinent food laws and regulations.

1. identify the role of different governmental agencies (state and federal) responsible for regulating food
2. describe the key US legislation governing foods and food additives
3. understand government regulations required for the manufacture and sale of food products.
4. evaluate a food label for health messages with reference to NLEA and DSHEA
5. create a nutrition label for a specific food product.
6. be aware of the CFR and Codex Alimentarius and their applicability
7. be aware of other regulatory schemas, based on religious or ethical considerations (eg, Kosher, Halal and Fair Trade)

D. Understand the business perspective of the food industry

1. understand the role of the food scientist within the context of the corporation
2. understand the consumer-driven nature of the food system
3. understand what factors influence acceptance or rejection of food
4. understand how a food scientist contributes to the process of product development
5. understand how consumer perception of risks or of benefits can influence product availability or purchase behavior

E. Understand the Context of Food Science in Society

1. understand the nature of the food system, its scope and interdependence with all other parts of society
2. understand the idea of food in the context of different cultures
3. describe how consumers perceive food safety risks, including the importance of "outrage factors"

4. be aware of global issues relevant to the availability and consumption of foods and food choices
5. be aware of issues of food and the environment, including sustainability (eg carbon footprint, packaging)
6. understand consumer concerns about added ingredients in foods
7. understand consumer trends related to "natural" and organic foods
8. be aware of alternative food regimens including the raw food movement, and multiple forms of vegetarianism
9. be able to provide a scientific perspective on current food issues in the media and society
10. be aware of the history of food technology
11. be able to critically evaluate the positive contributions, as well as the concerns, related to the application of food science and technology
12. be aware of the susceptibility of the food system to intentional disruption
13. understand how the food system differs in developing countries

**6. Professional Skills**

A. Professional ethics

1. distinguish between legal and ethical issues faced by the food scientist
2. be aware of ethical issues in production, processing, manufacturing and marketing of food
3. recognize the need to be profitable which may conflict with other societal goods

B. problem solving skills (creativity, resourcefulness, scientific reasoning, analytical thinking)

1. identify and define a problem, identify potential causes and possible solutions, and make thoughtful recommendations
2. locate and utilize relevant information in the analysis of specific problems
3. formulate approaches to solving problems
4. design experiments, with positive and negative controls as needed, to address a problem

C. Computer skills

1. use computer software to collect and analyze data, and to control processes
2. use a predictive modeling program

D. Quantitative Skills

1. apply mathematical thinking to problems throughout the curriculum
2. understand basic statistical principles, including the distinction between descriptive statistics and inferential statistics
3. apply inferential statistics to food science problems
4. make decisions in the face of uncertainty, and understand risk-benefit concepts
5. use basic calculus
6. convert units
7. conduct a dimensional analysis on an equation

E. Information acquisition skills

1. ability to read primary literature in the field from a critical perspective
2. locate and evaluate scientific and nonscientific information of interest to food professionals

F. Technical Communication

1. write a coherent lab report
2. communicate technical information in a broader context to a non-specialist audience

**7. Life Skills**

A. Communication skills

1. demonstrate proficiency in oral and written communication skills, including formal and informal presentations.
2. speak effectively and listen actively
3. read with understanding and write with clarity

B. Critical thinking skills

1. identify relevant assumptions
2. evaluate information from different sources
3. adopt an objective stance
4. distinguish data and inferences from judgments
5. identify relevant information and ambiguous information
6. detect bias and consider information accordingly
7. determine the strength of a claim; detect logical fallacies and inconsistencies

C. Cultural Awareness

1. interact effectively with individuals from diverse cultures
2. recognize different cultural expectations among cultures or on different occasions within a culture

D. Life-long learning

1. continually educate herself or himself, with the skills and inclination to do so

E. Interpersonal interaction skills

1. function effectively as a member and as the leader in a team based activity
2. work effectively with others to achieve goals
3. serve effectively as a leader in both formal and informal situations
4. serve effectively as a member of a group in both formal and informal situations
5. resolve individual and/or group conflict

F. Organizational skills

1. handle multiple tasks and pressures
2. manage time effectively