

Introduction

Food Biochemistry stands as a pivotal discipline at the intersection of nutritional science, chemistry, and food technology. It moves beyond the foundational principles of general biochemistry to focus specifically on the composition, properties, and transformations of the biological molecules that constitute our food. This module is designed to provide a comprehensive understanding of the major constituents in food—water, proteins, lipids, and carbohydrates—and their critical roles in determining the nutritional value, sensory quality, safety, and shelf-life of food products.



Food Biochemistry represents the cornerstone of modern food science, providing the fundamental principles to understand the complex interplay between the molecular composition of food and its macroscopic properties, technological functionality, and nutritional impact. This advanced module delves beyond the static composition of food to dynamically investigate the biochemical metamorphosis that constituents undergo during processing, storage, and digestion. In an era of global challenges, including the need for sustainable food systems and the rise of precision nutrition, a deep biochemical understanding is paramount for innovation in food design, waste reduction, and enhancing food security (McClements, 2019).

The course is structured to systematically deconstruct food into its primary molecular components, beginning with **water**, the most ubiquitous yet critical component. We will explore its molecular structure and colligative properties, with a focused analysis on **water activity (aw)** and **moisture sorption isotherms** as predictive tools for controlling microbial growth, enzymatic activity, and non-enzymatic browning, which are essential for shelf-life prediction and packaging design (Rahman, 2009).

The module then progresses to **proteins**, the versatile workhorses of food systems. The curriculum moves past basic classification to a detailed examination of structure-function relationships. This includes the extraction and modification techniques for plant and alternative proteins, the gelation and foaming mechanics of egg albumin, and the nuanced functional and

bioactive properties of milk caseins and whey proteins, such as their role in creating emulsion-based delivery systems (Damodaran, 2017; Tömösközi et al., 2022).

The study of **lipids** addresses both their nutritional essence and their role as textural and flavor mediators. It covers recent advances in understanding lipid oxidation pathways and the development of natural antioxidants, as well as the enzymatic interesterification processes used to structure fats without generating *trans*-fatty acids, aligning with global health initiatives (Gunstone, 2021).

A significant focus is placed on **carbohydrates**, the most diverse class of food biopolymers. The module details the molecular architecture of starch and its role in gelatinization and retrogradation, which govern texture in products from baked goods to sauces. It explores the strategic use of **amylolytic enzymes** in syrups and brewing, and the multifaceted role of **dietary fibers**, not just for health but as critical techno-functional ingredients for viscosity, gelation, and as prebiotics (Bertoft, 2017).

Finally, the course integrates this knowledge by analyzing holistic **Food Systems**, comparing the cellular biochemistry of plant-based tissues with the connective tissue and protein networks of animal-based foods. A critical look at **Non-Conventional Food Systems (N.C.F.S.)**, such as insect protein or cultured meat, highlights the application of biochemical principles to future food challenges. The module culminates by linking the biochemical properties of these constituents to the mechanisms of **food spoilage and deterioration**, empowering students to devise scientifically-grounded preservation strategies.

This theoretical mastery is cemented through applied **Practical Work**, including quantitative protein and lipid analysis, and enzymatic assays for quality control (e.g., alkaline phosphatase for milk pasteurization verification), ensuring graduates possess the rigorous biochemical foundation required to lead in food industry research, development, and quality assurance.