UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Food Microbiology

**2526-1-F0602Q118**

## Aims

*Knowledge and understanding*
Students will acquire knowledge regarding:

- The roles, both positive and negative, of microorganisms in food and the basic principles of microbial contamination;
- Factors influencing microbial growth in food, methodologies for their study, and strategies for their containment in the context of food safety;
- The main microorganisms characterizing different types of food, both fermented and non-fermented;
- Principles of icrobial ecology applied to the study of food systems and human microbiomes;
- Principles regulating the role of the human microbiome in modulating the health effects of food.

*Ability to apply Knowledge and understanding*
Students will develop the necessary competence to understand the role that a specific microorganism can play in a particular food. Additionally, they will acquire the ability to conduct a microbiological risk assessment associated with specific foods. Furthermore, students will develop the competence to interpret scientific publications involving metataxonomy and metagenomics data related to human-associated microbial ecosystems.

*Autonomy of judgment*
Students will gain autonomy of judgment to predict which microorganisms may be present in a particular food and establish the most suitable analytical strategy for their study. The ability to thoroughly examine the ecological characteristics of human-associated microbial ecosystems will allow them to distinguish situations where the microbiome plays a crucial role from those where it is less relevant.

*Communicative skills*
Students will be able to describe with appropriate language the characteristics and roles of microorganisms associated with food and human-associated microbial ecosystems. Moreover, they will be able to clearly describe the potential microbiological risk associated with a specific food and the potential impact of the human microbiome on the effects of food components on human health.

*Learning ability*
At the end of the course, students will be able to continue learning through consulting the latest literature and regulations in the field of food microbiology and microbiological risk associated with food consumption. Knowledge of the terminology and methodologies used in scientific research will enable students to integrate the knowledge acquired on the microbiome with that of other disciplines.

## Contents

- The relationship between microorganisms and food: basic concepts
- Strategies for managing microorganisms in food
- The main groups of microorganisms of food interest
- Foodborne diseases
- Microbiology of non-fermented foods
- Food fermentations
- Study of microbial ecosystems
- Ecology of the human microbiota
- The diet-microbiota-human health relationship: basic concepts
- The diet-microbiota-human health relationship: analysis of different case studies

## Detailed program

- *The relationship between microorganisms and food: basic concepts*
  Microbial contamination of food. The role of microorganisms in food: protechnological, spoilage, and pathogenic microorganisms. Factors influencing microbial growth in food. Isolation, identification, and quantification of microorganisms in food.

*- Strategies for managing microorganisms in food*
Principles of microbial control. Biological risk. Prevention of contamination. Control of microbial growth in food (acidification, water activity, natural and artificial preservatives, temperature, packaging, physical treatments). Overview of food safety management in the food industry.

*- The main groups of microorganisms of food interest*
Biology and ecology of lactic acid bacteria, acetic acid bacteria, spore-forming bacteria, enterobacteria, coagulase-negative cocci, yeasts, and filamentous fungi.

*- Foodborne diseases*
Meaning of infection, intoxication, and toxoinfection. Food contamination by pathogenic microorganisms. Epidemiology of foodborne diseases. Foodborne pathogens causing infections (Arcobacter, Campylobacter, Cronobacter, Escherichia coli, Listeria monocytogenes, Salmonella, Shigella, Vibrio, Yersinia) and intoxications (Bacillus cereus, Clostridium botulinum, Clostridium perfringens, Staphylococcus aureus). Foodborne viruses.

*- Microbiology of non-fermented foods*
Milk. Meat. Fish products. Eggs and egg products. Fruits and vegetables. Vegetable juices. Food preserves. Water and ice for consumption. Survival of microorganisms in alcoholic beverages and soft drinks.

*- Food fermentations*
General concepts. Spontaneous fermentations and fermentations with inocula. Microbiology of major fermented foods (yogurt and milk-based fermented beverages, cheeses and butter, fermented raw sausages, fermented fish products, bread and other baked leavened products, fermented plant-based products, cocoa and coffee, wine,

beer, vinegar). Distinguishing between fermented foods and probiotic foods.

- *Study of microbial ecosystems*
Description: Principles of ecology applied to microbial ecosystems (definition of microbiota and microbiome). Culture-independent techniques for studying microbial communities in foods: metataxonomy through 16S rRNA gene profiling and shotgun metagenomics. Study of biodiversity in a microbial ecosystem: concepts of richness, evenness, and relative abundance. Indices and models for describing biodiversity in a microbial ecosystem.

- *Ecology of the human microbiota*
Description: The concept of holobiont. General characteristics of human microbiomes (concepts of functional redundancy, functional stability, ecosystem service, disturbance, resistance, and resilience, dysbiosis). Biogeography of human microbial ecosystems. The main functions of the intestinal microbiota (competitive exclusion, vitamin production, interaction with the host immune system).

- *The relationship between diet, microbiota, and human health: basic concepts*
Description: Dietary carbohydrates and their relationship with the intestinal microbiota (concepts of fiber, carbohydrates accessible to the microbiota, and prebiotics). Carbohydrates as drivers of microbiota-host coevolution. Short-chain fatty acids produced in the intestine and their role in health. Foodborne bacteria, alterations of the human microbiome, and non-communicable diseases in the industrialized world (biome depletion theory).

- *The relationship between diet, microbiota, and human health: analysis of different case studies*
[i] High-fat diet and liver cancer. [ii] Salt and hypertension; [iii] Dietary fiber, intestinal polyps, and liver cancer; [iv] Carnitine/choline and atherosclerosis; [v] Milk fats and colitis; [vi] Health effects of food additives.

## Prerequisites

Knowledge acquired in the courses of Microbiology and Biochemistry is required.
Basic knowledge of Immunology is necessary.

## Teaching form

LECTURES. Lectures of 2 hours each, consisting of:

- A section of delivered didactics (Didattica erogativa, DE) focused on the presentation of scientific and technical contents by the lecturer.
- A section of interactive teaching (Didattica Interattiva, DI) including supplementary didactic interventions, brief presentations by the students, and additional demonstrations of practical applications of the content covered in the lecture-based part. Specifically, at the end of each major topic of the course, the use of Audience Engagement platforms will allow students to answer questions designed to apply the acquired knowledge to real-world issues in the context of food microbiology and human microbiome science. The collected responses will serve as a basis for a debate, which the teacher will moderate and enrich by showing scientific publications, popular articles, case studies, and media news.
- Workload: 35 hours of lectures + 10 hours of practical exercises.

All activities are delivered in person (no remote teaching hours are scheduled, except in case of unforeseen circumstances).

The course is taught in English.

## Textbook and teaching resource

The teaching material (slides) and supplementary material (scientific publications and videos) are available on the e-learning page of the course. The video recording of each lecture (*didattica erogativa*) will be made available at the end of each lesson.

Suggested text: Microbiologia alimentare applicata, CEA - Casa Editrice Ambrosiana.

## Semester

First semester.

## Assessment method

- Written examination: The assessment consists of a single 90-minute written test comprising 8–10 open-ended questions. Each question is awarded 2-4 points; the total score determines the final mark (a minimum of 18/30 is required to pass). Each answer is evaluated for:

- accuracy and completeness of content, with correct specialist terminology;
- theoretical mastery and ability to apply knowledge in practice;
- relevance and methodological rigour of the proposed solutions;
- logical coherence of the argumentation;
- clarity of expression and appropriate technical language.

- Optional oral examination: At the student's or instructor's request, an oral interview may be held to complete the overall assessment and verify communication skills. If no oral is taken, these skills are inferred from the discursive sections of the written test.

- No mid-term tests are scheduled. Sample questions will be provided during the lectures.

## Office hours

On appointment (in person or via video chat), upon prior request by email (simone.guglielmetti@unimib.it) or in classroom.

## Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION