



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Microbiologia degli Alimenti

2627-1-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 microbial 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 food-microbiota-human health relationship: basic concepts
- The food-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

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

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 food, microbiota, and human health: basic concepts

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 food, 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

The course includes 35 hours of in-person lectures and 10 hours of in-person tutorial/practical activities.

Lectures are delivered mainly as expository teaching (DE) and are dedicated to the presentation of the scientific and technical contents of the course. Lectures also include moments of interactive teaching (DI), aimed at promoting the active involvement of students through application-oriented questions, guided discussion of case studies, analysis of examples from the scientific literature, and discussion of real-world issues in the fields of food microbiology and human microbiome science.

Tutorial/practical activities are delivered as interactive teaching (DI) and are dedicated to the application of the acquired knowledge to concrete problems, also through the use of audience engagement platforms and debate-based activities. Students' answers will be used as a basis for classroom discussion, moderated by the lecturer.

All teaching activities are delivered in person. No remote teaching hours are planned, except in the case of extraordinary circumstances.

The course is delivered in Italian. Teaching materials and supplementary resources are predominantly provided 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.

Lecture recordings, for the part delivered in expository teaching mode, will be made available after each class.

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

Semester

First semester.

Assessment method

The assessment consists of an individual written examination, lasting approximately 60-90 minutes, aimed at verifying the achievement of the expected learning outcomes.

The written examination includes 6–10 open-ended questions covering the topics addressed during the course. Questions may require the description of theoretical concepts, the interpretation of microbiological phenomena in foods, the application of food microbiology principles to concrete cases, the analysis of issues related to food microbiological safety, and the discussion of the relationship between foods, microorganisms and the human microbiome.

Each question is assigned a score ranging indicatively from 2 to 6 points, depending on its complexity. The sum of the scores determines the final grade, expressed on a 30-point scale. The examination is passed with a minimum grade of 18/30.

The assessment is based on the following criteria:

- accuracy, completeness and up-to-date knowledge of the contents;
- correct use of specialist terminology;
- ability to apply theoretical knowledge to concrete problems in food microbiology;
- ability to interpret the microbiological risk associated with foods;
- ability to connect the different topics of the course, including aspects related to food microbial ecosystems and the human microbiome;
- relevance, methodological rigour and logical coherence of the argumentation;
- clarity of exposition and appropriate use of technical language.

The written examination therefore assesses knowledge and understanding of the course contents, the ability to apply such knowledge to specific cases, independent judgement in the interpretation of microbiological issues, and communication skills through the formulation of structured and technically accurate written answers.

An **optional oral examination** may be held at the request of the student or the lecturer. The oral examination consists of a discussion of the course topics and/or of the written examination and allows the overall assessment to be completed, with particular reference to the ability to argue critically, connect the different topics of the course and use appropriate technical language. The oral examination may modify the grade obtained in the written examination, either upwards or downwards, based on the outcome of the discussion.

No mid-term examinations are planned. Examples of questions or mock examination materials may be made available during lectures and/or on the course e-learning page.

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 | RESPONSIBLE CONSUMPTION AND PRODUCTION
