General information	
Academic subject	General microbiology
Degree course	Biology
Academic Year	3rd
European Credit Transfer and Accumulation System (ECTS)	9
Language	Italian
Academic calendar (starting and ending date)	2nd semester
Attendance	Compulsory attendance

Professor/ Lecturer	
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Virtual headquarters	Teams group: 02falyb
Tutoring (time and day)	Tuesday 11.00-13.00 by appointment to be agreed upon e-mail

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Syllabus	
Learning Objectives	Acquiring a general knowledge of microbiology
Course prerequisites	Basic knowledge of maths, chemistry, physics, genetics, molecular biology and biochemistry
Contents	**The foundations of microbiology.** Cell structure and evolutionary history. Diversity of microorganisms. Microscopy and the origin of microbiology. L. Pasteur and Spontaneous Generation. R. Koch, Infectious Diseases, and Pure Cultures. M.W. Beijerinck e S. Winogradsky. C. Woese and the first phylogenetic trees. Microscopy: Light Microscopy. The Gram stain. Phase-contrast microscopy. Fluorescence microscopy. Electron microscopy. **Size and shape of microorganisms.** **Cell structure.** The cytoplasmic membrane: composition and fluidity; transport of solutes, proteins, cellular communication and energy production. Cell wall: structure in Gram-positive and Gram-negative bacteria; The thecoic acids. The external membrane of Gram negative. Lipopolysaccharide. The yeast wall. Internal structures: Cell inclusions. Gas vesicles. The spore: structure; sporulation and germination processes. Appendices and external structures: Fimbriae and pili. Capsule and mucous layer. Flagella, motility and chemotaxis: structure; flagellar rotation. Eukaryotic cell: Nucleus, mitochondria, hydrogenosomes, chloroplasts and other eukaryotic cell structures. **Microbial metabolism and metabolic diversity**. Nutrients and nutrient transport. Bioenergetics principles. Autotrophy and heterotrophy. Catabolism: fermentation and respiration. Phototrophy (oxygenic and anoxygenic photosynthesis). Nitrogen fixation. Respiration processes. Fermentation. Hydrocarbon metabolism. **Molecular information flow and protein processing.** Replication. Transcription. Translation. Protein processing. Protein transport systems. **Microbial growth.** Quantitative aspects of microbial growth. Culturing microbes. Measuring microbial growth (viable count, total count and turbidimetric measures). Culture media. Colony morphology. Selective, differential and enriched media. Environmental effects on growth: Temperature; pH; osmolarity; oxygen. Controlling microbial growth: sterilization, disinfection and pasteurization. Physical

	and chemical agents. Antimicrobial agents. Assaying antimicrobial activity (minimum inhibitory concentration). **Microbial regulatory systems**. DNA binding proteins and transcriptional regulation. Sensing and signal transduction: two-component systems, regulation of chemotaxis, quorum sensing, stringent response. RNA-based regulation. Feedback inhibition. Post-translational regulation. **Molecular biology of microbial growth.** Bacterial genome and cell division: Segregation (Par system). Plasmid segregation systems. Cell division and Fts proteins. Min system and nucleoid occlusion. MreB and cell morphology. Regulation of development in model bacteria: Endospore formation; Differentiation in *Caulobacter crescentus*; Heterocyst formation in *Anabaena*; Biofilm formation. Antibiotics and antibiotic resistance **Virus.** Virus classification. Double and single-stranded DNA viruses; double and single-stranded RNA viruses; retroviruses. Virus replication. Counting viruses. Structure of the virion: the capsid; the coating; complex virions. Replication of bacteriophages T4. Temperate bacteriophage and lysogeny The viral genome and its evolution. Virus ecology. Subviral agents: viroids and prions. **Microbial systems biology.** Genome size and gene content. Evolution of genomes. Functional omics. The utility of systems biology. **Genetics of Bacteria and Archaea.** Mutation. Genetic transfer: transformation, transduction and conjugation. Genetic transfer in the Archaea. **Biotechnology and synthetic biology.** Biotechnology: commercial applications of genetically modified organisms. Synthetic biology and genome editing. **Microbial evolution and systematics.** Origin and evolution of microorganisms. Endosymbiotic origin of Eukaryotes. Microbial phylogeny and evolutionary clocks. The species concept in microbiology. **Functional diversity of microorganisms.** Diversity of phototrophic Bacteria. Microbial diversity in the sulfur cycle. Microbial diversity in the nitrogen cycle. Other functional groups of microorganisms (dissimilative iron-reducers, dissimilative iron-oxidizers, microbial predators, etc.). Morphologically diverse bacteria. **Diversity of microorganisms.** Bacteria; Archaea; Eukarya. **Microbial ecology and environmental microbiology.** Taking the measure of microbial systems. Microbial habitats. Nutrient cycles (Carbon, Sulfur, Nitrogen, Iron). Anthropic disturbances and bioremediation. Symbiosis with animals and plants. **Interactions between microorganisms and humans**. The human microbiome. Microbial infections and pathogenesis. Epidemiology. **Laboratory.** Microbiome analysis
Books and bibliography	- Brock. Biologia dei microrganismi Microbiologia Generale, Ambientale e industriale Madigan MT et al. 16/Ed Pearson - Biologia dei microrganismi. Deho G e Galli E. Terza edizione. Casa Editrice Ambrosiana
Additional materials	Study of reference texts should be supplemented with lecture notes and articles and/or reviews provided during the course. Multimedia presentations used during the course will be made available in pdf format. These should not be considered as handouts but only as support for studying on texts and notes.

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
225	68	6	151
ECTS			
9	8.5	0.5	

Teaching strategy	Blended learning
	Lectures with visual help of slides
Expected learning outcomes	
Knowledge and understanding on:	Acquisition of knowledge concerning the biology of prokaryotic and eukaryotic microorganisms and viruses. At the end of the course the student will know: ○ The structure and function of microbial cells and the differences between eukaryotic and prokaryotic cells ○ The main features of microbial metabolism and the metabolic differences between different microorganisms - The main aspects of microbial growth and its control ○ Regulation control in microorganisms (quorum sensing, chemotaxis, biofilm formation, etc.) ○ The mechanisms underlying cell division and cell differentiation ○ The characteristics of the viruses and the different virus replication strategies ○ The evolution of microorganisms and their genomes ○ Eukaryotic and prokaryotic microorganism's systematics ○ The main interactions among microorganisms and between microorganisms and eukaryotic organisms ○ The habitats of microorganisms and how microorganisms interact with the surrounding environment
Applying knowledge and understanding on:	At the end of the course the student should be able to: ○ Progress the knowledge acquired and connect it to what has been learned in previous courses (biochemistry, genetics, molecular biology)
Soft skills	• *Making informed judgments and choices* At the end of the course the student should be able to: ○ Understand the importance of microorganisms as simplified models for the study of more complex organisms. ○ Ability to evaluate the influence of microorganisms on other organisms and respect to the surrounding environment. • *Communicating knowledge and understanding* ○ Students will be able to discuss about what they learned during the course in appropriate scientific written and oral language • *Capacities to continue learning* ○ Students will acquire skills to deepen the microbiology knowledge autonomously and learn the most recent advancements in this field thanks to the use of databases, bibliographic material and other information available on the web.

Assessment and feedback	
Methods of assessment	Oral exam
Evaluation criteria	• *Knowledge and understanding* o Oral exam, consisting of 4-6 questions on the main contents of the course, is aimed at verifying the knowledge of: o - Cell structure and metabolism of microorganisms o - Regulation systems and growth of microorganisms o - Genomics and genetics of microorganisms o - Diversity and evolution of microorganisms o - Microbial ecology and environmental microbiology o - Interactions between microorganisms and humans o During the oral exam will be also assessed skills in linking different aspects of microbiology and making connections with other courses previously attended (e.g., molecular biology, genetics) • *Applying knowledge and understanding* o the student will demonstrate its skill in planning experiments and analysing data. • *Autonomy of judgment* o The achievement of autonomy will surely be evaluated thanks to discussions during lessons, tutoring meetings and the oral exam. • *Communicating knowledge and understanding* o The ability to argue and use the correct scientific language related to microbiology will be assessed thanks to class discussions during lessons and oral exam. • • *Communication skills* o Argumentation skills and verification of correct scientific vocabulary related to microbiology will be assessed through in-class discussions during class and during the oral profit exam • *Capacities to continue learning* o On the basis of class discussions and the oral exam, it will be possible to evaluate the student's ability to deepen independently the different topics covered during the course
Criteria for assessment and attribution of the final mark	The final grade is awarded out of thirty and the exam is passed with a grade greater than or equal to 18. Final judgment formulation will be mainly based on the results obtained in the oral interview. The commitment and the degree of autonomy shown by the student in the classroom and in the laboratory will also be positively judged. In order to obtain a high evaluation, the student must have developed autonomy of judgment, the capability to link different aspects of microbiology among them and with other disciplines and good skills for argumentation and presentation.
Additional information	