COURSE OUTLINE

1 GENERAL

SCHOOL	School of Applied Biology and Biotechnology		
ACADEMIC UNIT	Department of Biotechnology		
LEVEL OF STUDIES	Postgraduate (Level 7)		
COURSE CODE	(To be assigned)	**SEMESTER**	1st
COURSE TITLE	Human Microbiome in Health and Disease		
INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, state the weekly teaching hours and the total credits*		**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures & Guided Study (Virtual & Pre-recorded)		3	
Case-study seminars / discussions / Group Projects		1	
TOTAL		4	6 ECTS
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail in section (4).			
COURSE TYPE *general background, special background, specialization, general education, skills development*	Specialization / Special Background		
PREREQUISITE COURSES	Cell Biology and Genetics or equivalent background in Biology/Biotechnology.		
LANGUAGE OF INSTRUCTION AND OF ASSESSMENT	English		
MODE OF TEACHING *in-person (%) synchronous distance learning (%) asynchronous distance learning (%) (In the case of synchronous distance learning, the total weekly duration of teaching is recorded)*	Synchronous distance learning (75%) Asynchronous distance learning (25%)		
AVAILABILITY TO ERASMUS STUDENTS	No		
COURSE WEBSITE (URL)	https://purdue.brightspace.com/d2l/home/456410		

2 LEARNING OUTCOMES

Learning Outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Brief Guide for drafting Learning Outcomes*

Upon successful completion of the course, students will be able to:

- Define and distinguish the terms microbiota and microbiome within the context of human biology.
- Describe the overall structure, composition, and diversity of the human

microbiome across various body sites as distinct microbial habitats.

- Explain the expanded metabolic capacity of the host provided by microbial enzymes, specifically regarding the transformation of polysaccharides, proteins, bile acids, and plant secondary metabolites into bioactive products like short-chain fatty acids (SCFAs).
- Analyze the role of the microbiome in maintaining human homeostasis and its contribution to pathological states, including intestinal inflammation, infections, and metabolic or neurological disorders.
- Distinguish between traditional cultivation-based microbiology and modern, high-throughput molecular analysis techniques, including targeted amplicon and shotgun metagenomic sequencing.
- Critically evaluate primary microbiome research studies, emphasizing the integration of multi-omics data (metatranscriptomics, metaproteomics, and metabolomics) to move from correlation to causation.
- Apply computational and machine learning protocols to integrate complex microbiome datasets, generate predictions, and interpret multi-omics biological insights.
- Synthesize scientific findings into a manuscript-style final report, demonstrating effective scientific communication and the ability to build mechanism chains connecting microbiome perturbations to clinical outcomes.
- Evaluate current and emerging microbiome-targeted therapies, such as fecal microbiota transplantation (FMT), probiotics, prebiotics, and bacteriophage therapy, including their risks and clinical administration.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and are stated below), at which of the following does the course aim?

Search, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adaptability to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Other…*
	…….

- Search for, analysis and synthesis of data and information, with the use of the necessary technology (through weekly literature-based quizzes and the final manuscript report).
- Working independently (during the completion of individual quizzes and the final research report).
- Teamwork (through the collaborative oral group presentation focusing on critical evaluation of primary research).
- Working in an international environment (as part of a dual-degree MS program with international faculty and student cohorts).
- Criticism and self-criticism (developed via the critical evaluation of microbiome research studies and peer-to-peer discussions).
- Production of free, creative and inductive thinking (evidenced by the design and completion of an original microbiome project).

3 COURSE SYLLABUS

The course provides a comprehensive exploration of the microbial communities inhabiting the human body and their critical roles in health and pathophysiology. The content is organized into the following thematic modules:

- Foundations of Microbiome Science: Introduction to key terminology (microbiota vs. microbiome), historical perspectives, and the ecological principles governing microbial habitats in the human body.
- Microbial Habitats and Diversity: Comparative analysis of distinct microbial ecosystems (gut, skin, oral, vaginal) and the factors influencing their composition and diversity.
- Host-Microbe Interactions and Homeostasis: Mechanistic insights into how the microbiome communicates with the host immune and nervous systems to maintain physiological balance.
- Metabolic and Functional Capacity: Exploration of microbial enzyme systems and their role in nutrient processing, including the production of Short-Chain Fatty Acids (SCFAs), bile acid transformation, and the metabolism of plant secondary metabolites.
- Microbiome in Disease (Dysbiosis): Analysis of the microbiome's involvement in specific pathological states, such as Inflammatory Bowel Disease (IBD), obesity, metabolic syndrome, and the gut-brain axis in neurological disorders.
- Advanced Analytical Methodologies: Transitioning from cultivation-based microbiology to molecular techniques, including 16S rRNA targeted amplicon sequencing and shotgun metagenomics.
- Multi-Omics Integration: The application of metatranscriptomics, metaproteomics, and metabolomics to move beyond "who is there" to "what they are doing" (functional profiling).
- Computational Microbiome Science: Introduction to bioinformatics pipelines, data normalization, and the use of Machine Learning protocols for predictive modeling in microbiome research.
- Clinical Applications and Microbiome-Targeted Therapies: Evaluating the efficacy and safety of Fecal Microbiota Transplantation (FMT), next-generation probiotics, prebiotics, and bacteriophage therapy.
- Regulatory and Future Perspectives: Discussion on the current regulatory landscape for microbiome-based products and emerging trends in precision medicine.

4 TEACHING AND LEARNING METHODS - ASSESSMENT

MODE OF TEACHING *Face-to-face, distance learning, etc.*	Distance Learning • Synchronous distance learning: 75% • Asynchronous distance learning: 25%

MODE AND FREQUENCY OF COMMUNICATION WITH THE STUDENTS	Weekly Synchronous Sessions: A 4-hour live lecture is held every week. These sessions allow for real-time interaction, clarification of complex concepts, and immediate feedback. LMS Announcements: Official course updates, reminders for weekly quizzes, and technical instructions are communicated at least twice a week through the "Announcements" tool of the Brightspace Learning Management System. Discussion Boards: Faculty and Teaching Assistants (TAs) monitor the course discussion forums daily (Monday–Friday). Students receive responses to their academic queries within 24–48 hours. Virtual Office Hours: Instructors hold weekly "Virtual Office Hours" by appointment, providing one-on-one academic advising and guidance, especially during the development of the final manuscript report. Feedback on Assignments: Detailed, individualized feedback is provided on all major assessments (Group Presentations, Manuscript Reports) within two weeks of submission. Automated feedback is provided immediately upon completion of the weekly online quizzes. Email Communication: For personal or administrative matters, students can contact the instructional team via university email, with a guaranteed response time of 24 hours during the work week.
ENSURING THE MODE OF COMMUNICATION AMONG STUDENTS *Team assignments and discussions, collaborative learning platforms with the use of AI, video conference, QA sessions, κ.α.*	Student interaction and collaborative learning are facilitated through several integrated academic and technological strategies: • Collaborative Group Projects: A significant portion of the course assessment (30%) is derived from a group oral presentation. This activity requires students to work together to critically evaluate primary research and demonstrate effective scientific communication.

	• Structured Class Discussions: 10% of the final grade is dedicated to class participation and discussion. Weekly lectures provide a regular environment for students to engage with microbial community concepts and host-microbe interactions. • Collaborative Learning Platforms: Students utilize the Brightspace Learning Management System (LMS) as the central hub for course hosting and communication. For group-based tasks, students are expected to use Microsoft PowerPoint to co-develop their scientific presentations. • Integration of AI Tools: Students are permitted to use AI tools, such as ChatGPT, for collaborative brainstorming and editing, provided they obtain instructor approval and properly cite and acknowledge the AI's contribution to their work. This allows for modern, technology-enhanced collaborative workflows while upholding academic integrity. • Peer-to-Peer Feedback: The oral group presentations, scheduled for the final weeks of the semester, serve as a forum for students to present findings to their peers, fostering a broader academic dialogue within the student cohort.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, in laboratory training, in the communication with students*	The course extensively utilizes modern Information and Communication Technologies (ICT) to facilitate high-quality distance learning and training and communication with Students: • Learning Management System (LMS): The course is hosted on the Brightspace platform, which serves as the central hub for all instructional materials, including digitized lectures, course modules, and reading resources. • Synchronous Video Conferencing is used for real-time, interactive lectures, guest speaker presentations, and synchronous student-faculty workshops.

	• Integrated LMS Tools: Continuous communication through Brightspace Announcements and moderated Discussion Boards for academic queries and peer-to-peer dialogue. • Digital Assessment & Feedback: All assessments (weekly quizzes, reports, and presentations) are submitted and graded digitally, with individualized electronic feedback provided to students. • Virtual Office Hours: Synchronous one-on-one or group online meetings for personalized academic support and advising.
TECHNOLOGICAL EQUIPMENT REQUIREMENTS	To successfully participate in this distance-learning course, students are required to have access to the following technological equipment and infrastructure: • Personal Computer / Laptop: A modern computer with sufficient processing power and memory (RAM) to handle data-intensive tasks, such as microbiome data visualization and bioinformatics analysis. • High-Speed Internet Connection: Reliable broadband access (DSL, Fiber, or equivalent) to support high-definition synchronous video conferencing and the streaming of archived lecture content. • Peripherals: A functional webcam and a high-quality microphone/headset to facilitate active participation in live Q&A sessions and the delivery of group oral presentations. Software & Tools: • LMS Access: Standard web browser (Chrome, Firefox, or Edge) for accessing the Brightspace platform. • Installation of Zoom client or other approved teleconference platform to support synchronous video conferencing. • Data Analysis Software: Access to Microsoft Excel and a local installation of Python (or access to web-based environments like

	Google Colab) for computational assignments. • Productivity Suite: Software for creating scientific reports and presentations (e.g., Microsoft Office, Google Workspace). • Institutional Infrastructure: Students are provided with institutional accounts for the University's Learning Management System (LMS) and access to digital library resources for primary literature research.
PLAGIARISM POLICY/ PLAGIARISM DETECTION TOOLS	The program maintains a zero-tolerance policy towards academic dishonesty and plagiarism, ensuring that all submitted work reflects the student's original research and critical thinking. • Plagiarism Policy: Plagiarism is defined as using the words, ideas, results, or images of others without proper attribution, as well as self-plagiarism (resubmitting prior work). • Students are required to follow the Purdue Honor Pledge ("As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. I will neither give nor receive aid unless the instructor authorizes it"). • In alignment with the Agricultural University of Athens (AUA) regulations, all postgraduate assignments and the final thesis must comply with the institutional standards for originality. Plagiarism Detection Tools: • Turnitin: All written assignments (Manuscript Reports, Discussion Board posts, and the final Thesis) are systematically screened through the Turnitin plagiarism detection software. • Originality Reports: Instructors review detailed similarity reports generated by Turnitin to identify improperly cited content or excessive overlap with existing literature.

	• AI Writing Detection: The program utilizes Turnitin's AI writing detection feature to identify instances where generative AI tools may have been used outside the permitted guidelines. • Consequences: Instances of academic dishonesty are handled according to the procedures of the Office of Student Rights and Responsibilities (OSRR) at Purdue and the Assembly of the Department of Biotechnology at AUA. Sanctions may range from failure of the assignment to dismissal from the dual-degree program.
ARTIFICIAL INTELLIGENCE POLICY *(1) The use of Artificial Intelligence is prohibited in all circumstances* *(2) The use of Artificial Intelligence is allowed only with the permission of the instructor* *(3) The use of Artificial Intelligence is allowed only with an explicit reference to the literature* *(4) Students are free to use Artificial Intelligence*	(2) The use of Artificial Intelligence is allowed only with the permission of the instructor (3) The use of Artificial Intelligence is allowed only with an explicit reference to the literature Description & Implementation: In this course, a constructive but regulated approach to Generative AI (e.g., ChatGPT, Gemini) is adopted: • Permitted Use: Students are allowed to use AI tools primarily as "collaborative partners" for brainstorming, structuring outlines, or refining the linguistic clarity of their written reports (e.g., the final manuscript report). • Instructor Approval: Use of AI for specific assignments must be discussed with and approved by the instructor during the initial stages of the project. • Mandatory Disclosure: If AI tools are used, students must include a dedicated "AI Disclosure Statement" in their work, explicitly describing which tool was used and for which part of the assignment. • Academic Integrity: Students remain 100% responsible for the accuracy and scientific validity of the final output. AI-generated text must be critically verified against primary peer-reviewed literature. • Prohibited Use: Using AI to generate entire assignments, perform primary data analysis without disclosure, or bypass critical thinking

components of the course is strictly prohibited and constitutes academic dishonesty.

ORGANISATION OF TEACHING

The mode and methods of teaching are described in detail.
Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, work placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artworks, etc.

The student's study hours for each learning activity are stated, as well as the hours of independent study, according to the principles of the ECTS.

Activity	***Semester workload***
Lectures (Synchronous distance learning - 3h/week)	39
Case-study seminars / Q&A (Synchronous distance learning - 1h/week)	13
Interactive teaching (Discussion Boards & Asynchronous modules)	10
Study and analysis of bibliography (Independent study)	38
Preparation and completion of Weekly Quizzes	15
Preparation of Group Oral Presentation	15
Preparation of Final Manuscript Report	20
Course total	**150**

STUDENT ASSESSMENT

Description of the assessment method

Language of assessment, methods of assessment, formative or summative assessment, multiple choice questions test, short answer questions, essay questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory assignment, clinical examination of patient, art interpretation, other

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.

Language of assessment: English

Methods of assessment: The assessment is summative and comprises multiple components designed to evaluate both theoretical knowledge and practical analytical skills:

- Weekly Online Quizzes (30%): Consisting of multiple-choice and short-answer questions. These are conducted via the Brightspace LMS to assess the understanding of the weekly lectures and assigned primary literature.

- Oral Group Presentation (30%): A public (within the class) virtual presentation where students, working in teams, critically analyze a primary research paper. This evaluates

	scientific communication and collaborative skills. • Final Manuscript Report (30%): A comprehensive written report (essay/report) formatted as a scientific manuscript. Students analyze microbiome data or literature to build a "mechanism chain" connecting microbial activity to human health outcomes. • Class Participation and Discussions (10%): Evaluated through synchronous Q&A sessions and contributions to the asynchronous Discussion Boards. Evaluation Criteria: • Specifically defined criteria: Detailed rubrics are provided for the Oral Presentation and the Final Manuscript Report. These rubrics outline expectations for scientific accuracy, depth of analysis, clarity of communication, and proper use of citations. • Accessibility: All evaluation criteria, rubrics, and the weighted grading scale are explicitly stated in the Course Syllabus and are permanently accessible to students through the Brightspace LMS from the first day of the semester. • Feedback: Formative feedback is provided weekly through quiz results, while detailed qualitative feedback is provided electronically for the presentation and the final report to guide student improvement.

5 RECOMMENDED BIBLIOGRAPHY

- Required Textbook: The Gut Microbiome in Health and Disease. Dirk Haller, Springer Nature 2018. The electronic version is freely accessible through the Purdue Library.

- Additional Readings: - Selected papers from scientific journals such as Nature, Nature Microbiology, Cell, and Cell Host & Microbe (posted on Brightspace). A list of papers includes:

1. Chen, L., Wang, D., Garmaeva, S., Kurilshikov, A., Vila, A.V., Gacesa, R., Sinha, T., Segal, E., Weersma, R.K., Wijmenga, C. and Zhernakova, A., 2021. The long-term genetic stability and individual specificity of the human gut microbiome. Cell, 184(9), pp.2302-2315.
2. Hou, K., Wu, Z.X., Chen, X.Y., Wang, J.Q., Zhang, D., Xiao, C., Zhu, D., Koya, J.B., Wei, L., Li, J.and Chen, Z.S., 2022. Microbiota in health and diseases. Signal transduction and targeted therapy, 7(1), p.135.
3. Chen, L., Zhernakova, D.V., Kurilshikov, A., Andreu-Sánchez, S., Wang, D., Augustijn, H.E., Vich Vila, A., Lifelines Cohort Study, Weersma, R.K., Medema, M.H. and Netea, M.G., 2022. Influence of the microbiome, diet and genetics on inter-individual variation in the human plasma metabolome. Nature medicine, 28(11), pp.2333-2343.
4. Claesson, M.J., Clooney, A.G. and O'toole, P.W., 2017. A clinician's guide to microbiome analysis. Nature Reviews Gastroenterology & Hepatology, 14(10), pp.585-595.
5. Dominguez-Bello, M.G., Costello, E.K., Contreras, M., Magris, M., Hidalgo, G., Fierer, N. and Knight, R., 2010. Delivery mode shapes the acquisition and structure of the initial microbiota across multiple body habitats in newborns. Proceedings of the National Academy of Sciences, 107(26), pp.11971-11975.
6. Zeevi, D., Korem, T., Zmora, N., Israeli, D., Rothschild, D., Weinberger, A., Ben-Yacov, O., Lador, D., Avnit-Sagi, T., Lotan-Pompan, M. and Suez, J., 2015. Personalized nutrition by prediction of glycemic responses. Cell, 163(5), pp.1079-1094.
7. Andreu-Sánchez, S., Bourgonje, A.R., Vogl, T., Kurilshikov, A., Leviatan, S., Ruiz-Moreno, A.J., Hu, S., Sinha, T., Vila, A.V., Klompus, S. and Kalka, I.N., 2023. Phage display sequencing reveals that genetic, environmental, and intrinsic factors influence variation of human antibody epitope repertoire. Immunity, 56(6), pp.1376-1392.
8. Vujkovic-Cvijin, I., Welles, H.C., Ha, C.W., Huq, L., Mistry, S., Brenchley, J.M., Trinchieri, G., Devkota, S. and Belkaid, Y., 2022. The systemic anti-microbiota IgG repertoire can identify gut bacteria that translocate across gut barrier surfaces. Science translational medicine, 14(658), p.eabl3927.
9. Levan, S.R., Stamnes, K.A., Lin, D.L., Panzer, A.R., Fukui, E., McCauley, K., Fujimura, K.E., McKean, M., Ownby, D.R., Zoratti, E.M. and Boushey, H.A., 2019. Elevated faecal 12, 13 diHOME concentration in neonates at high risk for asthma is produced by gut bacteria and impedes immune tolerance. Nature microbiology, 4(11), pp.1851-1861.
10. Turnbaugh, P.J., Ley, R.E., Mahowald, M.A., Magrini, V., Mardis, E.R. and Gordon, J.I., 2006. An obesity-associated gut microbiome with increased capacity for energy harvest. nature, 444(7122), pp.1027-1031.
11. Sharon, G., Cruz, N.J., Kang, D.W., Gandal, M.J., Wang, B., Kim, Y.M., Zink, E.M., Casey, C.P., Taylor, B.C., Lane, C.J. and Bramer, L.M., 2019. Human gut microbiota from autism spectrum disorder promote behavioral symptoms in mice. Cell, 177(6), pp.1600-1618.
12. Wang, T., Holscher, H.D., Maslov, S., Hu, F.B., Weiss, S.T. and Liu, Y.Y., 2025. Predicting metabolite response to dietary intervention using deep learning. Nature communications, 16(1), p.815.
13. Franzosa, E.A., Sirota-Madi, A., Avila-Pacheco, J., Fornelos, N., Haiser, H.J., Reinker, S., Vatanen, T., Hall, A.B., Mallick, H., McIver, L.J. and Sauk, J.S., 2019. Gut microbiome structure and metabolic activity in inflammatory bowel disease. Nature microbiology, 4(2), pp.293-305.

- Purdue Library resources accessible via Brightspace Reading List