

## Microbial bioactive metabolites,

5 ECTS

### General information

Language: English

Winter Semester

ECTS: 5

### Learning outcomes

The course Microbial bioactive metabolite is created to acquaint students with the principles of basic microbiology from culture isolation from environment, cultivation and identification of microorganisms (bacteria, fungi, algae) in laboratory to the principles of application of microorganisms in industrial and environmental microbiology (bioremediation). Use of microorganisms in biotechnology can offer solutions to the problems of various industries such as food colorant or agriculture – living microbiom as biofertilizers that enhance plant nutrition. The course will provide students with the general features of biology of microbes as the most important producers of natural bioactive compounds (pigments:  $\beta$ -carotene, lycopene, vitamins,  $\beta$ -beta glucans etc.) that can be used further in biotechnology by using existing microbiological culture techniques. The special attention will be given to understanding of metabolic pathways (primary and secondary metabolism) for production of bioactive metabolites that plays a crucial role in modern healthcare as frontline treatments for many diseases. Since diverse bio-activities of microbial metabolites: antibiotic, anticancer, antiproliferative, immunosuppressive, probiotic have been detected until now: their activity will be specifically related to the microbial product structure (structure activity relation). Bioactive microbial metabolites play an important role in expanding the market of antibiotics, food, and agriculture but also offer eco-friendly, safer, and profitable solutions to respective industries. Special attention will be given to the problems of safe use of microbial products in humans and their impact on the environment with respect to their biodegradability. Content is divided into three sections: 1. Introduction to the diversity of microorganisms and microbial physiology 2. diversity of metabolic activities and thier primary and secondary products 3. application of microorganisms in industry and the main concept of technological processes for large-scale cultivation - production of metabolites (antibiotics, Vitamins B2 (riboflavin) which have application in textile and food industries. . Microalgae are used as sources of natural food colorants (astaxanthin, phycocyanin,  $\beta$ -carotene and other carotenoids). Students will search out specific features and discusses future research of microbial metabolites with a wide perspective.

The lectures will demonstrate the latest scientific results connected with the phenomena of application of microorganisms in the interdisciplinary frame where the aspects of microbiology, physiology and biotechnology will meet the innovative approaches to the subject from the field of microbial products and their bioactivities (antioxidative, antimicrobial – antibacterial, antifungal and antiviral, immunomodulators etc).

The activities are divided into three categories:

1. lectures
2. interactive discussion with participants
3. practical exercises in the application of previously presented skills

The participants will learn and practice understanding of secondary metabolic products of microbial origin (antibiotics, pigments, growth hormones, chelating compounds, antitumour agents, toxins) together with developing skills for conducting simple biotechnological processes of production of biologically active compounds of microorganisms.

Understanding principles of microbial metabolites and their application will facilitate the mastery of the participants in creating suitable presentation (Ppt or Prezi).

*Theory.* Students get acquainted with the contemporary concept of understanding microbial secondary metabolism and effect of environmental and ecological factors on microbial metabolism, as the basis for microbial bioactive compounds production; bacterial, algal and fungal/lichen bioactive metabolites, Microbial bioactive agents in medicine and pharmacy (antibiotics, antitumor agents, antiviral agents), as biopesticides, biofertilizers, biosynthetic plastics etc. Microbial metabolites in treating insomnia, cholesterolemia, as coagulants and anticoagulants, as tonics, angiotensins, cardiacs and aphrodisiacs, as sexual attractants and in cosmetics, as immunomodulators (immunoactivators and immunosuppressors), as the sources of healthy and organic food (vitamins, minerals, essential aminoacids), Microbial toxins (bacterial, cyanobacterial, algal, and fungal toxins); Mycetismus.

Emphasis will be placed on research of microbial bioactive compounds, what should enable students to understand contemporary tendencies of use of microorganisms in different biotechnology fields, as well as to understand the microbial role and problems related to biologically active substances in the environment. Principles of isolation, identification, separation and purification of fermentation and products. This course will provide clear and better understanding of metabolic pathways for bioactive metabolites production by using many schemes: illustrations, figures, and tables so students can easily grasp key concepts.

*Practice* Developing competence in experimental work: inoculation on culture media and cultivation procedure. Developing skills in methods applied for culture cultivation, conservation of pure cultures and procedures for maintenance of microbial strains in culture collections. Cultivation of isolated strains and cultures from stock collections on specific media with an aim

to optimize microbial growth in different experimental conditions during submerged cultivation by shifting from primary to secondary metabolism. Through the practice, students get acquainted with the cultural and physiological properties of isolated strains with high potential in biotechnology. Antibiotics production and antibiogram experiments. Some attention will be given to the identification and structure elucidation of novel microbial metabolites and uncovering extended functions of microbial metabolites.

Upon completion of the course, participants should have enhanced their ability in understanding of microbial metabolites and their products and have a working knowledge of their individual skills in laboratory work with different microorganisms. An additional focus of the training is to familiarize participants with the knowledge of possible use of microbial metabolites in treating insomnia, cholesterolemia, as coagulants and anticoagulants, as tonics, angiotensins, cardiacs and aphrodisiacs, sexual attractants and in cosmetics, as immunomodulators (immunoactivators and immunosuppressors). A special lecture will be devoted to the toxins originated from microorganisms and intoxication they cause in humans - harm effects on humans health.

The passing grade of the course will be awarded to the students that have:

1. The knowledge and understanding of
  - ✓ Microbial sources in the environment
  - ✓ Diverse products of microbial metabolism
  - ✓ Bioactivity of microbial metabolites that can be use in a humans diet or as a additional therapy for enhancing humans health
  
2. Competence and skills
  - ✓ To isolate microorganisms from the environment
  - ✓ To cultivate and control conditions of microorganisms growth in laboratory
  - ✓ To detect anti-oxidative activity and antimicrobial activity of microbial extracts /isolated compounds
  - ✓ Developing competence in experimental work
  - ✓ Developing skills in results recording
  
3. Judgement and approach
  - ✓ To be able to suggest the possible use of microorganisms in a real life for improving humans' health (diet, dietary supplement)

- ✓ To be able to use adequate research testing of bioactivity of the specific organism/extract/compound

## Course content

### Lectures:

1. Bacterial - cyanobacterial and algal bioactive metabolites – distribution and classification
2. Fungi and lichens and their bioactive metabolites
3. Microbial bioactive metabolites in medicine and pharmacy (antibiotics, antitumor agents from terrestrial and marine environment, antiviral agents)
4. Microbial metabolites in treating insomnia, neuroprotection and treating metabolic syndrome (diabetes, obesity, cholesterolemia)
5. Microbial metabolites in treating cardiovascular system: angiotensins, cardiacs, and as coagulants and anticoagulants
6. Microbial metabolites as tonics, sexual attractants and aphrodisiacs
7. Microbial metabolites as immuno-modulators (-activators, -suppressors)
8. Microorganisms as the sources of a nutritive agents and healthy and organic food (vitamins, minerals, essential amino acids) and their use in cosmetics,
9. Microbial toxins (bacterial, cyanobacterial, algal and fungal toxins) with harm effects on humans' health; Mycetismus.

### Exercises:

1. Isolation of microorganism from different environment and detection based on classical and molecular methods
2. Inoculation on media and cultivation procedure, conservation and procedures for culture maintenance
3. Cultivation and optimization of microbial growth in submerged cultivation with different conditions shifting from primary to secondary metabolism
4. Cultural and physiological properties of isolated strains of microorganisms
5. Research in production of antibiotics and antibiogram experiments
6. Research in antioxidative assays regarding microbial products

### Team Work:

1. Analyzing the Seminar work defense on line (PPT presentation in groups of 2 students or alone based on their specific interest in the field)
2. Resolving quick tests for first recognition of microbial product with health potential in humans
3. Making a video clip about cultivation of specific group of microbes to improve secondary metabolites production

## **Course design**

The online modules consist of theoretical parts, discussion parts, and practice parts.

1. The theoretical parts are delivered through lectures. The discussion parts are delivered through questions that encourage reflection. The practice parts consist of experimental work in laboratory to manipulate with microorganism in sterile environment alone or in teams. Teacher-led online introduction and facilitation will be provided. The teams will be formed of the members that do not know each other in order to foster the communication and experimental surrounding in microbiological laboratory between strangers.
2. Supervision will be provided for all the exercises and the process of team work.
3. All the learning materials, handouts, Ppt presentation will be posted on TRELLO platform

## **Assessment**

Students pass the course when they have completed the online attendance of the lectures, exercises and team projects.

Grades Marking scale:

Fail (5), E (6), D (7), C (8), B (9), A (10).

Grade (Definition) Points or % out of maximum points.

Characteristic.

A (Excellent, 10) 85-100. A distinguished result that is excellent with regard to theoretical depth, practical relevance, analytical ability and independent thought.

B (Very good, 9) 75-84. A very good result with regard to theoretical depth, practical relevance, analytical ability and independent thought.

C (Good, 8) 65-74. The result is of a good standard with regard to theoretical depth, practical relevance, analytical ability and independent thought and lives up to expectations.

D (Satisfactory, 7) 55-64. The result is of a satisfactory standard with regard to theoretical depth, practical relevance, analytical ability and independent thought.

E (Sufficient, 6) 50-54. The result satisfies the minimum requirements with regard to theoretical depth, practical relevance, analytical ability and independent thought, but not more.

F (U) (Fail, 5) 0-49. The result does not meet the minimum requirements with regard to theoretical depth, practical relevance, analytical ability and independent thought. Some occasional examination elements of the course may have the grading scale pass

Plagiarism is considered to be a very serious academic offence. The University will take disciplinary actions against any kind of attempted malpractice in examinations and assessments. The penalty that may be imposed for this, and other improper practices, includes suspension from the University for a specific

period of time. (This is a translation of the course syllabus approved in Swedish in examinations or assessments from the Lund Univ.)

## Entry requirements

To be student of Master level of the universities partners in the EUGLOH projects.

## Further Information

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## Required Reading:

1. Waites Michael J. , Morgan Neil L., Rockey John S. , Higton Gary (2009) Industrial Microbiology. An Introduction Wiley, pp. 304. ISBN:9781444311587
2. Bioactive Microbial Metabolites. Scope and Challenges (2024) Ed Elsevier Science. ISBN:9780443185694, p:350
3. G. Lancini, R. Lorenzetti. Bioactive Microbial Metabolites. (1993) MMDRI—Lepetit Biotechnology of Antibiotics Springer Science and Buissines Media. New York. p. 227.
4. Svirčev Z (2005): Microalgae and Cyanobacteria in Biotechnology. Faculty of Sciences, University of N. Sad, (In Serbian).

