

BIOMEDICAL MICROBIAL PRODUCTS - 2024/5

Module code: BMS3060

Module Overview

The module provides a description and demonstration of how the application of the principles of microbial and biochemical sciences, studied elsewhere in the programme, can be used in the discovery, production, and manufacture of commercially important products for the pharmaceutical, food, and chemical industries, with examples and case studies and an intensive experimental section. The principles of genetic and physiological deregulation and overexpression of metabolic products that are discussed in the module build upon the analysis of metabolic pathways (studied in L4 and L5 Biochemistry modules) and the study of microbial diversity, metabolism and function (studied in L4 and L5 Microbiology modules), and complement concepts covered in the Level 6 modules BMS3092 Advanced Technologies in Gene Expression and BMS3070 Systems Biology: Genes in Action. The principles of biomedical and bioveterinary microbial product discovery, over-production and applications are compared to those of other microbial products (food, bioenergy, and (bio)chemical industries).

Module provider

School of Biosciences

Module Leader

AVIGNONE ROSSA Claudio (Biosciences)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 6

Module cap (Maximum number of students): N/A

Overall student workload

Independent Learning Hours: 75

Tutorial Hours: 10

Laboratory Hours: 25

Guided Learning: 15

Module Availability

Semester 1

Prerequisites / Co-requisites

N/A

Module content

Indicative content includes:

Lectures and captured content: The lectures will present and discuss a range of biomedical products, with emphasis on the products of secondary metabolism (e.g. antibiotics).

- Discovery of new bioproducts for application in medicine and veterinary.
- Case study: Penicillin and other antibiotics. Analyse why and how microbes make antibiotics and other bioactive molecules. How this information can be used for improving the quality of the bioactive molecules and the titres obtained.
- The dynamics of microbial growth and its link to product formation
- Physiological and genetic control of metabolism
- Other biochemicals and biopharmaceuticals of interest: Enzymes and inhibitors.
- Biocommodities, precursors, and food additives: Bioethanol, Biosolvents, Organic acids, Amino acids
- Different systems for cultivation of microorganisms
- Metabolic Engineering and Synthetic Biology for production of recombinant compounds
- Medical product economics
- Introduction to Biotechnology operations and processes

Practical lab content: The experimental aspect of the course is a 10-class long experiment directed to the screening and isolation of soil microorganisms based on their capability to produce compounds with antimicrobial activity.

- Isolation of antibiotic and enzyme-producing micro-organisms
- DNA extraction from soil microbial communities
- Preparation of seed flask liquid cultures for subculture of isolates
- Purity checks, re-isolation, and subculture of selected strains

- Droplet culture assay for medicinal activity
- Completion of bioactivity assessment
- Selection of isolates for physiological study
- Liquid culture of bioactive products
- Liquid culture assay for medicinal activity
- Analysis of sequencing data and calculation of species abundance and diversity
- Data analysis tutorial and supervised results write-up

Assessment pattern

Assessment type	Unit of assessment	Weighting
Online Scheduled Summative Class Test	Multi-Selection Test (extended MCQ) (30 min within a 4 hr window)	30
Coursework	Coursework - Practical Report Write-Up	70

Alternative Assessment

N/A

Assessment Strategy

The **summative assessment** for this module consists of:

- Analysis of data and lab report (4 weeks after end of course to deadline) 70% - addresses Learning Outcomes 1, 2, 3, and 4
- Multi-selection test (half-way through the module) 30% - addresses Learning outcomes 5 and 6

The assessment strategy is designed to provide students with the opportunity to hone their laboratory skills, and to demonstrate ability to process large amounts of data using graphical and statistical approaches (practical write-up), and the application of generic principles and strategies (e.g. sample selection, screening criteria -by function or by structure- , use of native strains or selection of microbial chassis, design and application of mutation programmes or development of metabolic engineering strategies, criteria for large scale production, criteria for testing, registering and approval of novel pharmaceuticals, etc) through the analysis of a collection of scientific publications (MST)

The **formative assessment and feedback** involves the discussion of past reports and essays to enable students to develop their own approach for the write-up. (1h x 3 sessions per semester). Feedback for student work will be provided in writing (where applicable) and in verbal form during practical classes and tutorials. The students will have opportunities to reflect and analyse their performance during ad-hoc tutorials, where they will be given feed-back on drafts and improved versions of essays and reports, through discussion of ideas and concepts.

Together with the L&T methods and approaches, these assessment activities have a direct impact on employability, as they will provide the students with skills for excellence in report writing, large-data analysis, use of state-of-the-art (bio)informatic tools, etc. Also, the experimental report involves the use of up-to-date scientific literature and database searches and analysis. The introduction of a thorough metataxonomic analysis in the practical would give the students access to modern techniques

for microbiome analysis, of utmost relevance for health, academic research, and industry.

Module aims

- Familiarise students with the metabolic and biosynthetic characteristics of a wide range of bioactive microbial products and obtain a working knowledge of the biotechnological approaches involved in their production
- Study in detail the physiology of metabolite over-production and its exploitation for production of compounds of interest
- Teach and provide training on practical skills relevant to the isolation, recognition, and cultivation of microorganisms able to produce compounds of pharmaceutical and biotechnological interest
- Demonstrate a semi-automated approach to handling large numbers of microorganisms
- Provide practical experience of biotechnological issues arising from the subjects discussed in lectures
- Introduce novel approaches and strategies for the rational design of microorganisms with novel or improved metabolic function

Learning outcomes

		Attributes Developed
003	Distinguish between screening approaches that rely on positive selection and neutral selection for bioproduct-synthesising cultures and identify and describe methods for high-throughput analysis and strains	CT
004	Understand and apply bioinformatic and computational tools for the analysis of genomic and metagenomic data	KCPT
005	Develop and apply methods of report preparation, data reduction, data presentation, and literature searching suitable for scientific publications, demonstrating critical analysis and scientific reasoning skills	CPT
006	Analyse, evaluate and assess current scientific literature and critically discuss and contrast experimental results with those obtained in the experimental work	CPT
001	Distinguish and identify the physiological events responsible for inducing the synthesis of diverse products of primary and secondary metabolism	KC
002	Identify research strategies for the development of new strains and bioproducts	KC

Attributes Developed

- C - Cognitive/analytical
- K - Subject knowledge
- T - Transferable skills
- P - Professional/Practical skills

Methods of Teaching / Learning

The learning and teaching strategy is designed to encourage and assist students to integrate the subjects discussed in the module across a range of different parts of the course. The use of case studies will help to highlight the themes under discussion. The interlink between theory and experimental work, with specific milestones and deliverables throughout the course, is designed to ensure the students reach the learning outcomes and develop competencies adjusted to the current framework, such as employability, sustainability, digital competency, and resilience and resourcefulness.

The learning and teaching methods include:

- Demonstration, hands-on experience, and data analysis in the laboratory sessions
- Use of work-books in all the sessions to encourage and facilitate questions and other forms of interaction between students, and between students and lecturer and teaching and technical staff

Scheduled and non-scheduled tutorials to enable students to test their understanding and comprehension of the course content and data analysis, and to facilitate the write up of the report and the essay. Three scheduled sessions per semester, non-scheduled sessions on-demand, where the students present their work and discuss the issues and doubts with regards to the experimental work and the production of reports and essays. These activities are aimed at improving the understanding and comprehension of the problems under study, and help to consolidate the analysis of experimental data

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

<https://readinglists.surrey.ac.uk>

Upon accessing the reading list, please search for the module using the module code: **BMS3060**

Other information

The module will contribute with the 5 pillars as follows

Digital capabilities: Apart from the use of standard software and digital tools, a substantial part of the module includes the use of highly specialized bioinformatics and modelling tools for the analysis of composition of microbial communities and their metabolic capabilities. In future years, we expect to introduce machine learning approaches into the screening process.

The students are encouraged to make use of diverse platforms for communication, discussion groups, databases relevant to biological processes, use of statistical and graphical tools on-line, etc.

Sustainability: The module not only familiarizes the students with biotechnological approaches to obtain bioproducts that may replace fossil fuel derivatives, but also with the use of microbial communities for bioremediation and depollution. In this sense, the chapter dedicated to the application of biotech approaches in industry will promote the engagement and interest of the students in

the UN’s Sustainable Development Goals. Furthermore, the academic and technical staff endeavors to minimize the use of disposable material and consumables, and streamline the experimental activities in order to demonstrate and inculcate the need for sustainable and environmentally friendly approach to the learning experience.

Resourcefulness and resilience: The practical activities involved in the module are labour- and time-consuming for all the actors involved, from the Technical Team to the students. The students develop an understanding of the need for organization and planning necessary in a real-life laboratory.

Global and cultural capabilities: The module normally receives students from various different programmes, and as such they are immerse in a multi-background (and multi-cultural) environment. Examples of different approaches to environmental issues are discussed, highlighting the differences that exist between central countries and the so-called global South. The publications suggested as reading material contain a large number of articles from authors from Low and Middle Income Countries, which gives the students a broad view of the problems and solutions achievable in different parts of the world.

Employability: The subjects and approaches taught and developed in the module provide the students with background, knowledge and skills, such as modern approaches to drug discovery, genomic and metagenomic analysis (experimental and computational), advanced microbial processes for the pharmaceutical, biotechnology, and environmental fields, as well as excellence in soft skills such as report writing, data analysis, scientific presentation, and team work. All of them are attractive to various different employers, including the pharmaceutical and biotechnology industries but also clinical and veterinary environments

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Biological Sciences (Infection and Immunity) BSc (Hons).	1	Optional	A weighted aggregate mark of 40% is required to pass the module
Biological Sciences BSc (Hons).	1	Optional	A weighted aggregate mark of 40% is required to pass the module
Biomedical Science BSc (Hons).	1	Optional	A weighted aggregate mark of 40% is required to pass the module
Biomedical Science MSci (Hons).	1	Optional	A weighted aggregate mark of 40% is required to pass the module
Microbiology BSc (Hons).	1	Optional	A weighted aggregate mark of 40% is required to pass the module
Veterinary Biosciences BSc (Hons).	1	Optional	A weighted aggregate mark of 40% is required to pass the module

Please note that the information detailed within this record is accurate at the time of publishing and may be subject to change. This record contains information for the most up to date version of the programme / module for the 2024/5 academic year.