SUBJECT BENCHMARK STATEMENT

IN

MICROBIOLOGY

Quality Assurance and Accreditation Council
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CONTENT

FOREWORD

The work in connection with the development of Subject Benchmark Statements was begun in August 2003 as a part of the overall quality assurance framework that supports academic standards and the furtherance and dissemination of good practice in Universities in Sri Lanka.

Subject Benchmark Statements will support and promote quality and standards by:

- Providing universities with a common and explicit reference point for internal and external programme approval and review;

- Guiding and promoting curriculum development, especially in new departments and new universities, and in other institutions of higher education;

- Evolving over time to take account of changes and innovations that reflect subject development and new expectations;

- Providing an authoritative and widely recognized statement of expectations of what is expected of a graduate in a specific (or designated) subject area in a form readily accessible to students, employers and others with a stake in higher education;

- Providing a clear and transparent reference point for External Examiners;

- Assisting international comparison and competitiveness of higher education awards and student achievement.

SUBJECT BENCHMARK STATEMENT

MICROBIOLOGY

1. INTRODUCTION

1.1. Subject Benchmark Statement

- Benchmarking of academic standard is an essential component of quality assurance in the university system. Subject benchmarking statement provides a means for the academic community of a department of study in the university to describe the nature and characteristics of programmes in a specific subject offered in their degree programme.

- They also represent general expectations about the standards for the award of the degree at a given level and indicate the attributes and capabilities of graduates possessing such qualifications.

- Subject benchmark statement provides academic staff and institution with a framework for developing and specifying the intended learning outcomes of the programme and provide external reviewers a source of reference among others, for making judgment about the appropriateness of academic standards within the institution in pursuit of internal quality assurance.

- It also provides professional and statutory bodies potential employers, with academic standards and other performance standards expected of a graduate.

- One of the most important aspects of benchmark statement is that it provide information to the general public at large about the standards of the higher education award.

- This subject benchmark statement refers to the subject Microbiology taught in the Biological science stream of the Faculty of Science at a Bachelors degree level.

- The subject benchmark statement for Microbiology has been undertaken as an activity of the Quality Assurance (QA) project of CVCD/UGC by a subject bench marking team.

1.2. Nature and Extent of the Subject

Microbiology is the study of microorganisms (Archae, bacteria, fungi protozoa, virus, prions), a group of organisms that can only be seen clearly using magnifying equipment. They are by far the largest and most diverse group of organisms on earth and are believed to represent the first inhabitant of earth.

Historically microorganisms first came to public attention as agents of infectious diseases, but it is now known that their impact is much more far reaching. Microorganisms are closely associated with all life forms, animals, humans and

plants throughout their lives and are also indispensable components of earth's ecosystems, nutrient cycling agricultural sustainability and habitat conservation.

Microorganisms have evolved a large variety of diverse metabolic pathways and the study of these aspects at molecular level has provided vital evidence regarding the evolution of life.

The exploitation of biological pathways of diverse metabolic systems of microorganisms underpins the developments of microbial technology (Biotechnology), the basis of food and beverage industry, pharmaceutical/ health care industries industrial biotechnology producing chemicals / biochemical, vaccines etc. Microorganisms play the most important role in genetic engineering technology, which have opened up new areas in health care industries, in agriculture and food industries.

Microbiology is essentially a practical and experiment based subject, therefore appropriate opportunities should be provided to students of Microbiology to develop skills in practical Microbiology - handling a microscope, laboratory cultivation of microorganisms, for conducting independent laboratory investigations/ projects, performing experiments, making observations, interpreting and presenting data.

The bench mark statement in Microbiology as a subject must also take into account the scope and prospects of employability of its graduates. Currently Microbiology graduates may be employed as teachers in schools and universities, technical officers in hospitals, laboratories of research institutes, water and waste management industries, food and drink industries, pharmaceutical industries and in biotechnology and agro-chemical industries. Therefore students following Microbiology should be provided with opportunities to visit industries and also to work in an appropriate industrial environment (internship) during the course of study.

At present, Microbiology is taught as a subject for the BSc degree programme only in the University of Kelaniya. This benchmark is developed on the basis of our experience of teaching this subject for the last 15 years. Microbiology is taught at two levels in this University,. i.e. a 03 year general degree programme and a 4 year special degree programme.

2. SUBJECT AIMS

The major aims of a degree programme in Microbiology or including Microbiology as a subject in a degree programme are;

- To provide knowledge and understanding of the principles of Microbiology and current developments of Microbiology and its applications in an organized manner appropriate to the type of degree, general degree or special degree.

- To stimulate and cultivate among students, an interest in learning the biology of this unique group of organisms, leading them to appreciate the role of microorganisms in

everyday life of mankind, and in environments and its management, and the diverse beneficial application of microorganisms in agriculture and medicine.

- To provide students a range of transferable skills through practical experience, group work, industrial exposure required by professional practitioners of Microbiology, that will be of value in employment and self employment.

3. SUBJECT KNOWLEDGE AND UNDERSTANDING

To achieve the aims of a degree programme in Microbiology/ teaching Microbiology as a subject for a degree programme, it should comprise of the following subject areas.

- Introductory Microbiology course to include history and development and scope of Microbiology, nature of the microbial world and basic laboratory techniques in Microbiology.
- Microbial physiology and biochemistry and control of microbial growth.
- Microbial taxonomy.
- Microbial genetics and its application.
- Microbial ecology, environmental microbiology and its application.
- Food Microbiology, quality assurance and food standards.
- Industrial Microbiology (Biotechnology) and microbial technology.
- Microorganisms and diseases.

The above areas constitute the broad base core covering the major elements of the subject, which provides the essential knowledge and understanding, technical skills and professional approaches required by any graduate in Microbiology who intend to make Microbiology as a career.

However, it is anticipated that graduates in Microbiology are given opportunities for training in other supportive areas such as in elements of management, communication and computer skills in keeping with the global/ local requirements for their career development.

The programmes should also include;

- Specialization (in depth of study) of certain areas required by those who want to be professionals in that area. They should be provided with opportunities, to follow such courses in the final year of the degree programme.

- Current developments and applications of Microbiology and related fields and awareness of philosophical and ethical issues involved in relation to sustainability of human life.

- The guidelines to indicate how this knowledge and understanding of the subject forms the basis for informed concern about the quality of life and its benefits for the welfare of the mankind.

- A substantial part of courses to deliver the knowledge and experience in microbiological laboratory techniques related to all major disciplines of Microbiology covered in this programme, awareness of fundamentals, major concepts and principles and terminology associated with the subject.

- Methods of collecting information and data and processing them with critical analysis and assessment, enabling comprehensive understanding of the subject.

- Guidelines wherever possible for the applicability of Microbiology to professional and career development of students.

4. SKILLS AND ATTITUDES

There is a range of skills and attitudes which graduate students in Microbiology will acquire during the programme of study. These are;

4.1. Generic Skills

Generic standards that are expected are sub divided into following headings

- Intellectual skills
- Communication and information technology skills
- Interpersonal and team work skills
- Self management and professional skills

- ***Intellectual Skills***

  Students pursuing Microbiology as a subject should be able to;

  a. recognize the application of subject specific concepts, principles ex: role of microorganisms in nature, in disease, in industrial biotechnology, in genetic engineering.

  b. analyze and synthesize, summarize information critically including published research reports.

  c. apply subject knowledge and understanding to address appropriately and solve familiar and unfamiliar problems related to Microbiology eg: oil contamination in a river, food poisoning.

- ***Communication, Presentation and Information Technology Skills***.

  Students of the Microbiology degree programme should be able to

  a. communicate about the subject appropriately to a variety of audience, general public, school children, media personal, professionals university students and university teachers using a wide range of formats and approaches and technology using appropriate scientific language.

b. write scientific reports using and citing specific scientific reference work with proper acknowledgement.

c. use internet and other electronic sources critically as a means of communication and sources of information.

- ***Interpersonal and Team work Skills***

  Students of the Microbiology degree programme should be able to;

  a. work in groups recognizing their own individual responsibility and respecting the views and opinions of the team members and also develop some skills in negotiation.

  b. develop an appreciation of the interdisciplinary nature of Microbiology and of the validity of different points of view.

- ***Self Management and Professional Development Skills***

  Students of Microbiology degree programme should be able to;

  a. develop the skills needed for self managed and lifelong learning (e.g. working independently, time management, organization, enterprise and knowledge transfer skills appropriate to the area of work.)

  b. develop entrepreneurial skills related to microbiological industries.

  c. recognize the need to work towards targets for personal, academic and career development

4.2. Subject Specific Skills

These are qualities of mind that have to be developed among learners, appropriate to Microbiology and include;

a. appreciation of the complexity, diversity of microbial world, the cellular physiological evolutionary interrelationship with the environment.

b. awareness of the depth and scope of Microbiology in the light of current developments.

c. appreciation of the role of microorganisms in our day to day life, and environment and its impact on mankind.

d. the ability to read and use appropriate literature and recognize Microbiology related issues/ problems, critically evaluate and interpret data, the ability to design plan and conduct appropriate laboratory experiments/ field experiments and preparing scientific reports.

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4.3. Attitudes

Students of Microbiology degree programme;

a. should recognize the moral and ethical issues of investigations related to Microbiology

b. appreciate the need for ethical standards and professional codes of conduct.

5. TEACHING AND LEARNING STRATEGIES

A diversity of teaching, learning and assessment strategies must be employed to realize the main objectives of the programme of study.

The students graduating from the course of study should be competent in a range of knowledge and skills relevant to the major areas of Microbiology.

The teaching learning methodology should be designed to encourage and progressive acquisition of subject knowledge and skills through conventional means or also through independent and self directed study.

A balanced selection of the following teaching and learning methods can be used.

- Lecture and audiovisual presentations
- Laboratory classes/ field work (including visits to industry or institutions) computer simulation / use of bio-informatics tools.
- Seminars, workshops, tutorials
- Assignments / projects / problem based learning
- Industrial / professional placement to obtain work experience
- Distance learning materials, electronic multimedia videos / internet based resources.

Lectures convey subject knowledge, provide core themes and explanation of difficult concepts and make way for students to work independently. Lectures should encourage and enable students to develop **skills in listening and comprehension, selective note taking, to appreciate how information is structured and presented.**

Laboratory classes play the most important role in learning a practical subject like Microbiology and should form a substantial part of the programme. The laboratory exercises should be designed to provide opportunities **for acquisition of subject specific technical and transferable skills, recoding and interpreting experiments and results**, re-enforcing what is taught in the curriculum. The overall objective should be to develop competencies required in their chosen field with relevant hands on experience.

Seminars, workshops tutorials and oral presentations provide opportunities for interactive learning and allow students to explore the current development of the subject in depth. They also provide opportunities for development of interpersonal skills such as retrieval of information, problem solving, communication and team working.

A significant proportion of student study time should be set for independent study, assignments and self directed study, individually or within groups. This will give them

training as information gathering, use of learning resources available in electronic or other format, report writing and problem solving.

Industrial placement / internship / professional placement play a vital role for students in Microbiology and enables them to acquire a variety of skills needed for their career development in Microbiology related industries or profession

6. ASSESSMENT STRATEGIES

A variety of assessment technique may be employed to test subject knowledge and skill acquisition. They also provide valuable information to the general public and employers about the performances and quality of the candidates and the award.

Assessment method should be designed to test the learning outcomes of the subject/ courses and may include some or all of the following modes;

- Close book examination
- Practical examination
- Laboratory and field work reports
- Project reports
- Work experience reports/ internship reports/ professional placement reports.
- *Viva–voce* examination

A combination of continuous assessment and end course assessment may be employed.

7. MAINTAINING STANDARDS

It is anticipated that programme designers monitor the progress of the programme and student performance, to achieve the goals set for standards of achievements, by taking following measures.

- Involvement of external examiners
- Periodic subject review
- Interaction between course teachers and professional bodies and employers.

8. STUDENTS ATTAINMENT AND BENCHMARK LEVEL (STANDARD)

The standards required for the subject bench mark describes the transferable and core skills and subject specific expected skills of graduates in Microbiology.

The standards required by students have been divided into two groups in accordance with the nature of the degree programme conducted in Sri Lankan Universities.

The threshold level describes the minimum standard of acceptable knowledge and the level of skills to be attained by anyone following Microbiology as a subject for the Bachelors degree programme.

Good honours level students are expected to show excellent performances with achievement of a range of competencies and skills including subject specific skills at **an enhanced level, in addition to those indicated for threshold level**.

(a) Threshold level

On graduating with Microbiology as a subject for the Bachelors degree the students should be able to;

- access Microbiology information relevant to the subject from a variety of sources and communicate the principles in a manner appropriate to the programme of study.

- identify the contributions made by scientists to the development of Microbiology.

- describe the basic cytological, nutritional, physiological and reproduction characteristics of microorganisms.

- demonstrate the understanding of principles of taxonomy of microorganisms and the use of basic biochemical and physiological characteristics of microorganisms in classification and identification.

- demonstrate the understanding of fundamental and advanced concepts in microbial genetics.
- demonstrate the knowledge and understanding of the role of microorganisms in nature /nature cycles, soil fertility in diseases of agricultural crops

- explain the principles of re-combinant DNA technology and its applications in agricultural, medical, environmental and industrials activities.

- demonstrate the knowledge and understanding of Microbiology related to food spoilage, food hygiene and safety, quality assurance of food and food preservation.
- demonstrate the knowledge and understanding of microbiological aspects of drinking water and solid and liquid waste treatment.

- demonstrate the knowledge and understanding of the role of microorganisms in human diseases

- describe the basic features of human body defense systems against infection, non-specific and specific immune systems and practical applications of immunology

- demonstrate the knowledge and understanding of the microbiological processes involved in microbial technology, microbial process development, production of industrial chemicals, and health care products.

(b) Good Honors Level

On graduating with a good honors level degree in Microbiology, students **in addition to achieving all aspects indicated for threshold level** should;

- be able to access and evaluate information related to Microbiology including current developments from a variety of sources and must be able to communicate **with authority and confidence** the principles, advanced aspects of Microbiology both orally and in writing (essays and reports) in an organized manner.

- have the ability in a broad range of appropriate practical techniques and skills relevant to Microbiology. This will include the ability to recognize problems related to Microbiology in nature, industry or agriculture and design appropriate experiments to investigate and suggest possible remedial measures.

- be able to construct reasoned arguments to support their positions on ethical and social impacts of advances in Microbiology and related technology (eg: genetic engineering)

- should have the knowledge and understanding of advanced methods (molecular methods) of classification and identification of microorganisms

- be able to apply basic principles of bio-informatics to study microbial gene sequences, microbial products of industrial importance.

- apply microbial growth kinetics and principles of biochemical engineering in microbial product formulation.

- apply microbial technology to design waste treatment plants to a variety of industries and to control environmental pollution.

9. ANNEX1. MEMBERSHIP OF THE BENCHMARK GROUP

Prof. G. S. Vidanapathirana	University of Kelaniya
Dr. D. L. Jayaratne	University of Kelaniya
Prof. C. P. Kodikara	University of Kelaniya
Dr. Anoma Perera	University of Peradeniya
Dr. N. S. Kottearachchi	Wayamba University of Sri Lanka