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Malaysian Qualifications Agency

PROGRAMME STANDARDS:
BIOTECHNOLOGY

2nd Edition

Programme Standards: Biotechnology
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Malaysian Qualifications Agency
Bangunan Mercu MQA
No. 3539, Jalan Teknokrat 7
Cyber 5
63000 Cyberjaya
Selangor Darul Ehsan

Tel +603- 8688 1900
Fax +603- 8688 1911
Email akreditasi@mqa.gov.my
Website www.mqa.gov.my

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FOREWORD

The Malaysian Qualifications Agency (MQA) has published numerous quality assurance documents such as the Malaysian Qualifications Framework (MQF), Code of Practice for Programme Accreditation (COPPA), Code of Practice for Institutional Audit (COPIA), Standards, Programme Standards (PS) and Guidelines to Good Practices (GGP). This is to ensure that the programmes offered by Higher Education Providers (HEPs) in Malaysia meet an acceptable level of quality. It is imperative that these documents be read together with this PS document for the development and delivery of Biotechnology programmes in Malaysia.

The PS for Biotechnology was first enforced by the MQA in 2009 (MQA, 2009). Since then, more than 90 programmes (www2.mqa.gov.my/mqr/) of different levels within the field of biotechnology have been accredited by the MQA and registered in the Malaysian Qualifications Register (MQR). As a recognised accrediting agency in Malaysia, the MQA is required to conduct a comprehensive review of its standards on a periodic basis, and does so every 5 years. The current review and revision process was undertaken to ensure its relevance to current academic requirements and industry good practices.

This document represents the significant contribution from panel members (as listed in **Appendix 1**) from both public and private HEPs and industry, in consultation with various HEPs, relevant government and statutory agencies, professional bodies, industry, alumni and students (as listed in **Appendix 2**) through stakeholders' workshops and online feedback. Hence, the standards developed reflect national and international best practices to ensure Biotechnology graduates from Malaysian HEPs are globally accepted.

The MQA would like to express appreciation to all the panel members, various stakeholders for their valuable input and all the MQA officers who have contributed to the development of this PS for Biotechnology. It is hoped that this PS document is beneficial to the various stakeholders for the development of the competencies required in our students, for their job and higher education prospects.

Thank you.

Dato' Dr. Rahmah Mohamed
Chief Executive Officer
Malaysian Qualifications Agency
January 2019

ABBREVIATIONS

COPIA	Code of Practice for Institutional Audit
COPPA	Code of Practice of Programme Accreditation
GGP	Guidelines to Good Practices
GP	Grade Point
HEPs	Higher Education Providers
IELTS	International English Language Testing System
MQA	Malaysian Qualifications Agency
MQF	Malaysian Qualifications Framework
MUET	Malaysian University English Test
SKM	*Sijil Kemahiran Malaysia*
SPM	*Sijil Pelajaran Malaysia*
STAM	*Sijil Tinggi Agama Malaysia*
STPM	*Sijil Tinggi Persekolahan Malaysia*

1. INTRODUCTION

Biotechnology is the utilisation of living organisms or parts of organisms through the application of science and technology to produce or enhance products or services, contributing towards the improvement of mankind's well-being and quality of life. Biotechnology can be viewed as a multi-sectoral and multi-disciplinary field involving the integration of knowledge and skills drawn from various disciplines in fundamental and applied aspects of life sciences, engineering, mathematics and technology. Biotechnology can be used as a tool to contribute to the achievement of a number of the United Nations Sustainable Development Goals (United Nations, 2015) in the areas of food security, healthcare, economic growth and environment as well as being one of the key drivers of Industry Revolution 4.0. The thrust areas as envisioned in the National Biotechnology Policy (MOSTI, 2005) are indicative of the government's commitment to ensure the healthy development of the biotechnology industry in Malaysia. This policy and other relevant science, technology and innovation (STI) policies are regularly reviewed and assessed to stay abreast of the rapid development in the field of biotechnology. The rapid development of the biotechnology industry worldwide has created career opportunities for graduates with a diploma, bachelor's, master's and doctoral degree including academicians, researchers, biotechnology executives, science communicators, science officers, product specialists, consultants and entrepreneurs, just to name a few.

The **three (3) main disciplines** of biotechnology, i.e. **agricultural, medical and industrial** were identified as the key engine of economic growth for Malaysia. In addition, biotechnology applications are widely used in the areas of **environment, food and marine**. In recent years, their applications, impacts and market demands have gained comparable prominence. There are also other areas, namely **bioinformatics and nanobiotechnology**, that are interdisciplinary in nature and these areas cut across all the main disciplines of biotechnology.

Table 1 provides the description of the three main disciplines which may have common and overlapping areas/tools/products/services. There are also essential tools such as genetic modification, gene editing, gene drive, synthetic biology and biosensor technology as well as regulatory frameworks/guidelines including intellectual property rights, biosafety and bioethics that have overarching applications in all disciplines of biotechnology.

Table 1: Description of Main Biotechnology Disciplines

Disciplines	Definition	Examples of Areas/ Tools/Products/Services
Agricultural Biotechnology	Agricultural biotechnology is a set of tools and techniques used to improve plants, animals and microorganisms to increase agricultural productivity. Modern agricultural biotechnology may involve the use of genetic engineering and/or gene editing technologies to permanently alter the genetic makeup of living organisms.	• Animal breeding • Aquaculture and fisheries • Biocontrol agents • Biofertilisers • Biopharming • Environmental security • Food security • Metagenomics of plant and animal • Molecular diagnostics • Molecular markers • Mushroom biotechnology • Plant breeding • Seaweeds and algae • Tissue culture • Vaccines • Waste management
Medical Biotechnology	Medical biotechnology is defined as the application of biotechnological tools for producing pharmaceuticals, nutraceuticals and therapeutics that involves cells and genes, and medical products that can be used for the diagnosis, prevention, and treatment of diseases.	• Diagnostic and monitoring tools • DNA fingerprinting • Innovative therapies • Nanobiotechnology • Nanodrug delivery • Natural products • Nutriceuticals, nutraceuticals and whole food nutrients • Stem cell culture for regenerative cells and drug production • Tissue engineering • Vaccines and drug development • Pharmacogenomics
Industrial Biotechnology	Industrial biotechnology is a set of practices that use terrestrial and marine living cells (such as bacteria, yeast, fungi and algae) or component of cells like enzymes to generate industrial bioproducts, biomolecules and bioprocesses.	• Biocatalysts • Biomanufacturing • Biomaterials (creating new products from waste) • Enzymes • Fermentation and bioproducts • Fine chemicals • Metagenomics of biocompost

Disciplines	Definition	Examples of Areas/ Tools/Products/Services
		• Modify and develop new industrial processes • Nanocellulose from lignocellulose biomass • Natural products • Nutriceuticals, nutraceuticals and whole food nutrients • Reduce the environmental impact of manufacturing • Replace petroleum-based feedstocks by processing biomass in biorefineries

Since 2009, the MQA's 'Programme Standards: Biotechnology' has been a reference for higher education providers in developing and offering Biotechnology programmes. A revision to this programme standards is timely and inevitable to remain relevant to national priorities and global trends; to incorporate emerging disciplines, technologies and tools; and to fulfil stakeholders' needs. The revision also aligns to the Malaysian Qualifications Framework (MQF) 2nd Edition and Code of Practice for Programme Accreditation (COPPA) 2nd Edition as well as incorporating relevant stakeholders' feedback obtained from an impact study (MQA, 2013b) and stakeholders' workshop (Stakeholders' Workshop for Review of Programme Standards: Biotechnology, 1 and 2 August 2018, MQA Cyberjaya). Strategic directions of Malaysia Education Blueprint 2015-2025 (Higher Education) and Malaysia Higher Education 4.0 were also taken into consideration.

The key changes made to the Programme Standards (PS) are as follows:

i. The new format presented in the seven quality assurance areas of the standards is aligned with the COPPA 2nd Edition.
ii. Statements for programme educational objectives and learning outcomes for each level of qualification are aligned with the MQF 2nd Edition.
iii. The PS is aligned with the Standards: Master's and Doctoral Degree.
iv. An expanded list of suggested courses for each level of study (body of knowledge) is presented.
v. A percentage range is suggested for the continuous and final assessments are suggested to give more flexibility for the overall assessment.
vi. Minimum entry requirements of students for each level of study are revised.
vii. Minimum qualifications of academic staff for each level of study are revised.

viii. Teaching facilities and educational resources are updated to reflect current industry practices.
ix. Examples of programme nomenclature complying with the Policy on Nomenclature of Malaysian Higher Education Programme are provided.

To produce graduates qualified in the field of biotechnology at different levels, the benchmarks leading to the award of individual qualifications are given in these sections:

i. Programme Educational Objectives
ii. Learning Outcomes
iii. Curriculum Design and Delivery
iv. Assessment of Student Learning
v. Student Selection
vi. Academic Staff
vii. Educational Resources
viii. Programme Management
ix. Programme Monitoring, Review and Continual Quality Improvement

This document should be viewed as a benchmark statement and not as a syllabus and no form of prescription is intended for the amount of time devoted to each area or the order in which the materials are delivered. HEPs are encouraged to go beyond the basic minimum where they should be innovative in terms of customising, organising, teaching and assessing their programmes and specific subject matters to meet the current and future national and global needs of the industry and society. Hence, HEPs must take cognisance of the rapidly evolving subject matter and introduce effective and sustainable programme improvements.

As the purpose of this document is to provide guidelines pertaining to the development and conduct of different levels of Biotechnology programmes within the main disciplines described, it is paramount that this document is read with other quality assurance documents and policies issued by the MQA and other related agencies, which include, but are not limited to the following:

i. The Malaysian Qualifications Framework 2nd Edition (2017).
ii. The Code of Practice for Programme Accreditation 2nd Edition (2016).
iii. The Code of Practice for Institutional Audit (2008).
iv. Relevant Standards.
v. Relevant Guidelines to Good Practices.

2. PROGRAMME DEVELOPMENT AND DELIVERY

The programme educational objectives (PEO) are broad statements that describe the career and professional accomplishments that the programme is preparing the graduates to achieve after they graduated.

"A programme is designed and delivered to facilitate the attainment of a set of desired learning outcomes. It starts with a clear definition of the intended outcomes that students are to achieve by the end of the programme and supported by appropriate instructional approaches and assessment mechanisms" (*COPPA 2nd Edition*, 2017).

2.1 PROGRAMME EDUCATIONAL OBJECTIVES

General Objectives

The main objective of a Biotechnology programme is to produce graduates who are knowledgeable, skilful and able to integrate knowledge drawn from biological sciences and related technologies to design, develop and provide solutions in the development of products/processes/technologies/services, taking into account the aspects of critical thinking, communication, entrepreneurship, ethics and social responsibility.

A more detailed description of the PEO is provided for each level of study, from diploma to doctoral level. It should be noted that the PEO provided describes the minimum requirements, and the HEPs may provide additional objectives where appropriate. The PEO for each level of qualification is outlined below.

DIPLOMA (Level 4, MQF)

The programme aims to provide candidates with basic broad-based knowledge, practical and theoretical training in various fields of biotechnology to perform effectively and ethically in the industry. Candidates should be able to work collaboratively with guidance to comprehend a given task and conduct experiments as well as analyse, report and communicate the outcomes. Candidates should possess the ability to pursue lifelong learning for continuous professional development throughout their career.

BACHELOR'S DEGREE (Level 6, MQF)

The programme aims to provide candidates with fundamental and applied inter-disciplinary knowledge, practical and analytical skills, and critical thinking in biotechnology, as well as the agility to adapt to the rapid advancements in this field and its related fields such as policies, regulations, business, legal, ethics and the socioeconomic aspects. The candidates should be able to develop the capacity to pursue lifelong learning, to undertake research, to demonstrate professionalism and explore entrepreneurial opportunities from the programme. Candidates should be able to work cooperatively with minimal guidance to comprehend a given project, lead and conduct research as well as analyse, report and communicate the outcomes, thus contributing to the current needs and future developments in the industry.

MASTER'S DEGREE BY COURSEWORK (Level 7, MQF)

The programme aims to provide candidates with comprehensive knowledge and transferable skills in biotechnology to prepare candidates for a career in the government, industry and academia. This programme would also enable candidates to acquire comprehensive knowledge on the latest developments in biotechnology and its related socioeconomic fields as well as to pursue lifelong learning and adapt effectively, professionally and ethically in an increasingly challenging and continually changing global bioindustry environment. In addition, candidates should be able to work cooperatively with limited guidance to comprehend a given project, lead and conduct research as well as analyse, report and communicate the outcomes, thus contributing to the current needs and future developments in the industry.

MASTER'S DEGREE BY MIXED MODE (Level 7, MQF)

The programme aims to provide candidates with advanced knowledge and transferable skills in biotechnology to contribute to the developments in the industry and to serve in a broad range of capacity in research, consultancy, academia and public administration. This programme would also enable candidates to pursue lifelong learning and to adapt effectively, professionally and ethically in an increasingly challenging and continually changing global bioindustry environment. In addition, candidates should be able to work independently to comprehend a given project, design and conduct research as well as analyse, report and communicate the outcomes. Candidates should be able to demonstrate leadership qualities through effective collaboration with peers and stakeholders, thus contributing to the current needs and future developments in the industry and research environment.

MASTER'S DEGREE BY RESEARCH (Level 7, MQF)

The programme aims to provide candidates with advanced and in-depth knowledge and transferable skills in biotechnology to contribute to the development of processes, products, technologies and services. This programme would also enable candidates to pursue lifelong learning and adapt effectively, professionally and ethically in an increasingly challenging and continually changing global bioindustry environment. In addition, candidates should be able to work independently and systematically to comprehend a project, design and conduct research as well as analyse and communicate the outcomes effectively. Candidates should be able to demonstrate leadership qualities through effective collaboration with peers and stakeholders, thus contributing to the body of knowledge relevant to the current needs and future developments in the industry and research environment.

DOCTORAL DEGREE BY RESEARCH (Level 8, MQF)

The programme aims to provide candidates with advanced and in-depth knowledge and transferable skills in biotechnology to innovate and create new knowledge to solve problems. This programme would also enable candidates to pursue lifelong learning and adapt effectively, professionally and ethically in an increasingly challenging and continually changing global bioindustry environment. Importantly, candidates should have a deep understanding of the philosophy of science and methodological designs to undertake independent research and projects as well as communicate the outcomes of the project effectively to peers and stakeholders. Candidates should also be able to contribute in fields pertinent to biotechnology research, development and commercialisation; policies and regulations; ethics; and socioeconomics. Candidates should be able to demonstrate leadership qualities through effective collaboration with peers and stakeholders, thus contributing to the current needs and future developments in the industry and research environment.

2.2 LEARNING OUTCOMES

Learning outcomes are detailed statements describing in explicit terms the achievement of candidates and that they are to be assessed upon completion of a period of study.

“The quality of a programme is ultimately assessed by the ability of its graduates to carry out their expected roles and responsibilities in society. This requires the programme to have a clear statement of the competencies that is the practical, intellectual and soft skills that are expected to be achieved by the students at the end of the programme" (*COPPA 2nd Edition*, 2017).

The learning outcomes in biotechnology field should **cumulatively reflect the five clusters of learning outcomes** (*MQF 2nd Edition*, 2018, para 44), which are meant to develop well-balanced individuals with a holistic set of competencies.

The five clusters of learning outcomes are:

i. Knowledge and understanding
ii. Cognitive skills
iii. Functional work skills with focus on:
    a. Practical skills
    b. Interpersonal and communication skills
    c. Digital and numeracy skills
    d. Leadership, autonomy and responsibility
iv. Personal and entrepreneurial skills
v. Ethics and professionalism.

The mapping of learning outcomes of the biotechnology field against the five MQF clusters of learning outcomes is shown in **Table 2**. **The flexibility in describing the learning outcomes remains with the Higher Education Providers (HEPs) as long as they are sufficiently covered.**

Table 2: Mapping of learning outcomes (LO) of the biotechnology field against five Malaysian Qualifications Framework (MQF) clusters of LOs

LO / MQF Level	Knowledge and Understanding	Cognitive Skills	Functional Work Skills				Personal and Entrepreneurial Skills	Ethics and Professionalism
			Practical Skills	Interpersonal and Communication Skills	Digital and Numeracy Skills	Leadership, Autonomy and Responsibility		
Diploma	Demonstrate an understanding of the basic concepts in biotechnology	Apply theoretical and practical knowledge in decision making and problem solving	Perform basic experiments, generate reliable data and report individually or in a group	Communicate clearly, both orally and in writing with peers and others	Analyse and interpret data using basic digital skills	Demonstrate problem solving skills individually or in a group with guidance	Demonstrate initiative for self-improvement and possibilities for entrepreneurial and managerial skills in biotechnology	Execute basic biohazard and occupational safety procedures
Bachelor	Demonstrate a comprehensive understanding of the concepts in biotechnology	Analyse and interpret data of related knowledge and information in order to suggest solutions related to biotechnology	Perform experiments based on guided manuals and conduct basic guided research to generate reliable data for scientific report, individually or in a group	Communicate effectively, both orally and in writing with peers and others	Analyse, interpret and present data using digital skills	Demonstrate problem solving skills in the context of specialisation by working collaboratively as a group member or a leader in a group to solve problems using scientific approaches	Demonstrate self-directed lifelong learning, awareness of business opportunities and entrepreneurship	Demonstrate an understanding and awareness of biosafety, ethical, legal, commercial and social issues related to biotechnology

LO / MQF Level	Knowledge and Understanding	Cognitive Skills	Functional Work Skills				Personal and Entrepreneurial Skills	Ethics and Professionalism
			Practical Skills	Interpersonal and Communication Skills	Digital and Numeracy Skills	Leadership, Autonomy and Responsibility		
Master's by Course-work	Demonstrate comprehensive knowledge and understanding across related disciplines in biotechnology	Access, evaluate and integrate current information from relevant sources for incorporation into biotechnology related fields	Perform experiments with limited guidance and generate reliable data for scientific report individually or in a group	Communicate effectively, both orally and in writing with peers and other relevant communities	Compute, analyse, interpret and present data using a broad range of information, media and technological applications	Demonstrate independence, leadership, and interpersonal skills in planning, resource management and problem solving within the group in scholastic activities	Engage in self-directed lifelong learning, professional pathways and entrepreneurship	Demonstrate understanding, awareness and adherence to biosafety, ethical, professional and legal norms as well as awareness of commercial and social issues related to biotechnology
Master's by Mixed Mode	Demonstrate advanced knowledge and understanding of concepts and the dynamic global perspectives across related disciplines in biotechnology	Analyse critically and integrate current information independently from relevant sources for incorporation into biotechnology related fields	Conduct specialised research methodologies independently using basic and specific biotechnology equipment to generate reliable and valid data	Communicate effectively, both orally and in writing with peers and other relevant communities	Compute, analyse, interpret and present data using a broad range of information, media and technological applications	Demonstrate independence, leadership and interpersonal skills in planning, resource management and problem solving within the group in scholastic activities	Engage in self-directed lifelong learning, professional pathways and entrepreneurship	Demonstrate understanding, awareness and adherence to biosafety, ethical, professional and legal norms as well as awareness of commercial and social issues related to biotechnology

LO / MQF Level	Knowledge and Understanding	Cognitive Skills	Functional Work Skills				Personal and Entrepreneurial Skills	Ethics and Professionalism
			Practical Skills	Interpersonal and Communication Skills	Digital and Numeracy Skills	Leadership, Autonomy and Responsibility		
Master's by Research	Demonstrate advanced and in-depth knowledge and understanding of concepts and the dynamic global perspectives across related disciplines in biotechnology	Analyse critically and integrate current information independently from relevant sources to provide solutions for biotechnology research and industry	Plan and conduct specialised research methodologies to generate reliable and valid data using basic and specific biotechnology equipment	Communicate research findings effectively, both orally and in writing with peers and other relevant communities as well as publish in a peer-reviewed journal or present a conference paper	Compute, analyse, interpret and present data from research findings using a broad range of information, media and technological applications	Demonstrate independence, leadership, and interpersonal skills in planning, resource management and problem solving within the group in scholastic activities	Engage in self-directed lifelong learning, professional pathways and entrepreneurship	Demonstrate understanding, awareness and adherence to biosafety, ethical, professional and legal norms as well as awareness of commercial and social issues related to biotechnology
Doctoral Degree by Research	Generate knowledge and innovation through independent research and contribute to the frontiers of knowledge across related disciplines in biotechnology	Analyse critically, integrate and synthesise knowledge in biotechnology as well as contribute new scientific findings for biotechnology research and industry	Plan, design and conduct independent research using specific and advanced biotechnology equipment with limited guidance to generate reliable and valid data	Communicate research findings effectively, both orally and in writing with peers, experts, research community /network and publish research findings in a peer-reviewed journal or present a conference paper	Compute, analyse, interpret and present secondary data and derive inferences from research findings using a broad range of information, media and technological applications	Demonstrate independence, leadership, and interpersonal skills in planning, resource management and problem solving within the group in scholastic activities	Integrate knowledge for lifelong learning, professional pathways and entrepreneurship with development of innovative ideas/solutions	Demonstrate understanding, awareness and adherence to biosafety, ethical, professional and legal norms as well as awareness of commercial and social issues related to biotechnology

2.3 CURRICULUM DESIGN AND DELIVERY

For the purpose of the Programme Standards, reference is made to the Code of Practice for Programme Accreditation (COPPA) 2nd Edition and in particular, the section on Area 1: Programme Development and Delivery.

The term “programme development and delivery” is used interchangeably with the term ‘curriculum design and delivery’. This area is best read together with the Guidelines to Good Practices: Curriculum Design and Delivery (*COPPA 2nd Edition*, 2017).

This document also contains the matrices for graduating credits and percentage of components for all levels of qualifications. Specific requirements as to the body of knowledge of the core areas and various disciplines of biotechnology are provided in **Appendix 3**. **Higher Education Providers (HEPs) are given the flexibility to design their own programmes; however, they are expected to cover the body of knowledge indicated in this document.**

In addition, HEPs are encouraged to develop their programmes to reflect the current best practices and to achieve higher standards. The Biotechnology programmes offered may vary in their nomenclature; however, the programme nomenclature must reflect the content of the programme as mentioned in the Policy on Nomenclature of Malaysian Higher Education Programme (2018). Examples are provided in **Appendix 4**.

HEPs must provide guideline to the industry specifying the requirements and responsibilities of the host industry for students to achieve the learning outcomes of the industrial training.

DIPLOMA Graduating Credit - 90			
Component		**Percentage (%)**	**Credits**
Compulsory Courses (General* and HEPs Courses)		9 – 20	8 – 18
Core	Fundamental and Biological Sciences**	35 – 40	32 – 36
	Discipline Core	30 – 40	27 – 36
	Industrial Training***	7 – 10	6 – 9
Elective	Electives related to Discipline Core	0 – 5	0 – 5
Total		**100**	**90**

* 8-11 credits as prescribed by the Ministry of Higher Education (refer to *Garis Panduan Mata Pelajaran Pengajian Umum (MPU) Edisi Kedua*). The minimum credit requirement is set as such because some HEPs do not have HEP compulsory courses and in this case, only the MPU requirement is considered.

** Core courses for Fundamental and Biological Sciences components may be integrated or embedded within the Discipline Core.

*** Industrial training should be in a related industry/research institution/centre of excellence and is allocated according to the formula of 1 credit = 2 weeks of training (refer to The Guidelines on Criteria and Standards for PHEI Course of Study).

Recommended delivery methods:

i. Lecture
ii. Tutorial
iii. Practical
iv. Field Work
v. Task-Based / Problem-Based / Project-Based Learning
vi. Blended Learning
vii. Interactive Learning

BACHELOR'S DEGREE Graduating Credit - 120			
Component		**Percentage (%)**	**Credits**
Compulsory Courses (General* and HEPs Courses)		8 – 17	10 – 20
Core	Fundamental Sciences**	10 – 13	12 – 16
	Discipline Core	40 – 48	48 – 58
	Final Year Project	5 – 10	6 – 12
	Industrial Training***	5 – 10	6 – 12
Elective	Electives related to Discipline Core	8 – 15	10 – 18
	Free Electives****	2 – 5	2 – 6
Total		**100**	**120**

* 10-14 credits as prescribed by the Ministry of Higher Education (Refer to *Garis Panduan Mata Pelajaran Pengajian Umum (MPU) Edisi Kedua*). The minimum credit requirement is set as such because some HEPs do not have HEP compulsory courses and in this case, only MPU requirement is considered.

** Core courses for Fundamental Sciences components may be integrated or embedded within the Discipline Core.

*** Industrial training should be in a related industry/research institution/centre of excellence and is allocated according to the formula of 1 credit = 2 weeks of training.
(refer to The Guidelines on Criteria and Standards for PHEI Course of Study).

**** Free electives are from non-Biotechnology courses (such as courses from humanities, liberal arts, etc).

Recommended delivery methods:

i. Lecture
ii. Tutorial
iii. Practical
iv. Research Project
v. Seminar
vi. Task-Based / Problem-Based / Project-Based Learning
vii. Blended Learning

viii. Industrial Visit
ix. Interactive Learning
x. Flipped Learning

MASTER'S DEGREE BY COURSEWORK Graduating Credit - 40			
Component		**Percentage (%)**	**Credits**
Core	Core	63 – 83	25 – 33
	Research Project	15 – 25	6 – 10
Elective	Electives related to Discipline Core*	15 – 23	6 – 9
Total		**100**	**40**

* Core can be inclusive of Electives.

Note:

i. Coursework components must include research methodology.
(Refer to Standards: Master's and Doctoral Degree).

Recommended delivery methods:

i. Lecture/Tutorial
ii. Practical
iii. Seminar
iv. Task-Based / Problem-Based / Project-Based Learning
v. Blended Learning
vi. Interactive Learning
vii. Flipped learning

MASTER'S DEGREE BY MIXED MODE Graduating Credit - 40			
Component		**Percentage (%)**	**Credits**
Core	Core	23 – 53	9 – 21
	Dissertation	50 – 70	20 – 28
Elective	Electives related to Discipline Core*	8 – 23	3 – 9
Total		**100**	**40**

* Core can be inclusive of Electives.

Notes:

i. Coursework components must include research methodology.

ii. Ratio of coursework to dissertation is within the range of 50:50 or 40:60 or 30:70. (Refer to Standards: Master's and Doctoral Degree).

Recommended delivery methods:

i. Lecture / Tutorial
ii. Practical
iii. Seminar
iv. Task-Based / Problem-Based / Project-Based Learning
v. Blended Learning
vi. Interactive Learning
vii. Flipped Learning

MASTER'S DEGREE BY RESEARCH		
Component	**Percentage (%)**	**Credits**
Dissertation	100	No given credit value

Notes:

i. Students are required to undertake research in a related field of study and submit a dissertation.
ii. The programme must include appropriate training in research methodology.
iii. The HEP must have a set of procedures and guidelines pertaining to:
    a) Minimum and maximum periods of study.
    b) Format of the dissertation.

    (Refer to the Standards: Master's and Doctoral Degree).

Recommended delivery methods:

i. Lecture
ii. Face to face supervision
iii. Seminar / Workshop

DOCTORAL DEGREE BY RESEARCH		
Component	**Percentage (%)**	**Credits**
Thesis	100	No given credit value

Notes:

i. Students are required to undertake research in a related field of study and submit a thesis.
ii. The programme must include appropriate training in research methodology.
iii. The HEP must have a set of procedures and guidelines pertaining to:
    a) Minimum and maximum periods of study.
    b) Format of the thesis.

(Refer to the Standards: Master's and Doctoral Degree).

Recommended delivery methods:

i. Lecture
ii. Face to face supervision
iii. Seminar / Workshop
iv. Training attachment

3. ASSESSMENT OF STUDENT LEARNING

"Assessment of student learning is a key aspect of quality assurance and it is one of the most important measures to show the achievement of learning outcomes. Hence, it is crucial that an appropriate assessment method and mechanism is in place. Qualifications are awarded based on the results of the assessment. The methods of student assessment must be clear, consistent, effective, reliable and in line with current practices. They must clearly measure the achievement of the intended learning outcomes" (*COPPA 2nd Edition*, 2017).

The method of assessment depends on the specific requirements of each course. However, as a general guide, the following are to be considered:

i. Assessment for learning (formative assessment);
ii. Assessment as learning (formative assessment);
iii. Assessment of learning (summative assessment);
iv. A combination of various methods of assessment to measure the achievement of learning outcomes should be used.
v. Assessments should comprise continuous and final assessments.
vi. Assessment must include written and/or oral modes.

Table 3 illustrate the different types of assessments that can be applied for **each course**. Higher Education Providers (HEPs) are encouraged to use a variety of appropriate methods and tools to meet the learning outcomes and achieve the intended competencies.

Table 3: Percentages of continuous and final assessments for each MQF level

Qualification	Continuous Assessment (%)	Final Assessment* (%)	Bloom's Taxonomy - Level of Difficulty	Suggested Forms of Assessment
Diploma	50 – 100	0 – 50	i. Cognitive: C3 ii. Psychomotor: P4 iii. Affective: A3	<u>Continuous Assessments</u> i. Test/Quiz ii. Presentation iii. Class participation iv. Report-writing v. Laboratory skills vi. Assignment / Mini project <u>Open/Closed Book Examinations</u> i. Multiple choice questions ii. Short answer questions iii. Mixed essay questions iv. Problem-based essay questions
Bachelor's Degree	40 – 100	0 – 60	i. Cognitive: C4 ii. Psychomotor: P5 iii. Affective: A4	<u>Continuous Assessments</u> i. Test/Quiz ii. Critical review of published articles iii. Presentation iv. Class participation v. Report-writing vi. Laboratory skills vii. Assignment / Mini project <u>Open/Closed Book Examinations</u> i. Multiple choice questions

Qualification	Continuous Assessment (%)	Final Assessment* (%)	Bloom's Taxonomy - Level of Difficulty	Suggested Forms of Assessment
				ii. Short answer questions iii. Mixed essay questions iv. Problem-based essay questions Research project with Project report / Viva voce
Master's Degree by Coursework	50 – 100	0 – 50	i. Cognitive: C6 ii. Psychomotor: P6 iii. Affective: A5	<u>Open/Closed Book Examinations</u> i. Short answer questions ii. Mixed essay questions iii. Problem-based essay questions <u>Continuous Assessments</u> i. Test/Quiz ii. Critical review of published articles iii. Presentation iv. Class participation v. Report-writing vi. Laboratory skill vii. Assignment Research project with Project report / Dissertation
Master's Degree by Mixed Mode Coursework Dissertation	50 – 100 0	0 – 50 100	i. Cognitive: C6 ii. Psychomotor: P6 iii. Affective: A5	
Master's Degree by Research Dissertation	0	100	i. Cognitive: C6 ii. Psychomotor: P6 iii. Affective: A5	Dissertation and viva voce**. Note: Publication in a peer-reviewed journal or presentation of a conference paper is encouraged.

Qualification	Continuous Assessment (%)	Final Assessment* (%)	Bloom's Taxonomy - Level of Difficulty	Suggested Forms of Assessment
Doctoral Degree by Research Thesis	0	100	i. Cognitive: C6 ii. Psychomotor: P7 iii. Affective: A5	Thesis and viva voce**. Note: Publication in a peer-reviewed journal or presentation of a conference paper is encouraged.

* For Diploma level, at least 50% of the total courses in the programme must have final examination in the Final Assessment, for Bachelor's Degree level, at least 70% of the total courses in the programme must have final examination in the Final Assessment, and for Master's Degree by Coursework/Mixed Mode, at least 50% of the total courses in the programme must have final examination in the Final Assessment.

** Requirement for viva voce is as prescribed in the Standards: Master's and Doctoral Degree

Notes:

i. Compositions of the dissertation/thesis examiners in reference to the Standards: Master's and Doctoral Degree is as follows:
   a. Master's Degree by Mixed Mode
      The dissertation must be examined by at least two examiners.
   b. Master's Degree by Research
      The dissertation must be examined by at least two examiners, one of whom is an external examiner.
   c. Doctoral Degree by Research
      The thesis must be examined by at least three examiners, two of whom are external examiners.

ii. The examiners should be from the related field of studies.

iii. The HEPs should have a clear policy on the appointment of external and internal examiners.

4. STUDENT SELECTION

This section of the Programme Standards concerns the recruitment of candidates into the individual programme of study.

"In general, admission to a programme needs to comply with the prevailing policies of the Ministry of Education. There are varying views on the best method of student selection. Whatever the method used, the Higher Education Provider (HEP) must be able to defend the consistency of the method it utilises. The number of students to be admitted to a programme is determined by the capacity of the HEP and the number of qualified applicants. HEP admission and retention policies must not be compromised for the sole purpose of maintaining a desired enrolment. If an HEP operates in geographically separated campuses or if the programme is a collaborative one, the selection and assignment of all students must be consistent with national policies" (*COPPA 2nd Edition*, 2017).

The standards for the recruitment of students are formulated keeping in mind the generic National Higher Education policies pertaining to the minimum student entry requirements. The HEPs must take cognisance of any specific policies that may apply to their individual institution. The minimum requirements are as stated in **Table 4**.

Table 4: Student's entry requirements for each MQF level

MQF Level	Entry Requirement	English Competency Requirement (International Student)
Diploma	i. Possess *Sijil Pelajaran Malaysia* (SPM) with three (3) credits in Mathematics, one science subject and one any other subject, or its equivalent; **OR** ii. Pass *Sijil Tinggi Persekolahan Malaysia* (STPM) with a minimum of Grade C (GP 2.00) in any subject, or its equivalent; and possess SPM with three (3) credits in Mathematics, one science subject and one any other subject, or its equivalent; **OR** iii. Pass *Sijil Tinggi Agama Malaysia* (STAM) with a minimum grade of *Maqbul*, or its equivalent; and possess SPM with three (3) credits in Mathematics, one science subject and one any other subject, or its equivalent; **OR** iv. Pass *Sijil Kemahiran Malaysia* (SKM) (Level 3, MQF) in a related field and possess SPM with one (1) credit; **OR** v. A Certificate (Level 3, MQF) in a related field with a minimum CGPA of 2.00, or its equivalent. Note: The credit requirement at SPM level for candidate in categories (ii) and (iii) can be waived should the grades obtained at the STPM / STAM level are equivalent/higher.	International students are required to achieve a **minimum** score of 5.0 in International English Language Testing System (IELTS) **OR** Band 3 in Malaysian University English Test (MUET) **OR** its equivalent.
Bachelor's Degree	i. Pass STPM with a minimum of Grade C (GPA 2.00) in any two (2) subjects, or its equivalent; and possess SPM with three (3) credits in Mathematics, one science subject and one any other subject, or its equivalent;	International students are required to achieve a **minimum** score of 5.0 in IELTS **OR** Band 3 in MUET **OR** its equivalent.

MQF Level	Entry Requirement	English Competency Requirement (International Student)
	OR ii. Pass STAM with a minimum grade of *Jayyid*, or its equivalent; and possess SPM with three (3) credits in Mathematics, one science subject and one any other subject, or its equivalent; **OR** iii. Matriculation/Foundation with a minimum CGPA of 2.00, or its equivalent, and possess SPM with three (3) credits in Mathematics, one science subject and one any other subject, or its equivalent; **OR** iv. A Diploma (Level 4, MQF) in a related field with a minimum CGPA of 2.00, or its equivalent. Note: The credit requirement at SPM level for candidate in categories (i), (ii) and (iii) can be waived should the grades obtained at the STPM / STAM / Diploma / Matriculation / Foundation level are equivalent/higher.	
Master's Degree by Coursework, Mixed Mode and Research	i. A Bachelor's degree (Level 6, MQF) in a related field with a minimum CGPA of 2.75, or its equivalent, as accepted by the HEP Senate; **OR** ii. A Bachelor's degree (Level 6, MQF) in a related field with at least CGPA of 2.50 and has not achieved CGPA 2.75, or its equivalent can be accepted subject to a rigorous internal assessment; **OR** iii. A Bachelor's degree (Level 6, MQF) in related field but has not achieved CGPA of 2.50, or its equivalent can be accepted subject to a minimum of 5 years' working experience in the relevant field.	International students are required to achieve a **minimum** score of 5.5 in IELTS **OR** Band 3 in MUET **OR** its equivalent.

MQF Level	Entry Requirement	English Competency Requirement (International Student)
Doctoral Degree by Research	A Master's degree (Level 7, MQF) in a related field, as accepted by the HEP Senate.	International students are required to achieve a **minimum** score of 5.5 in IELTS **OR** Band 3 in MUET **OR** its equivalent.

Note:

For Doctoral Degree by Research as stated in the Standards: Master's and Doctoral Degree:

i. There shall be no direct entry from bachelor's degree level to doctoral degree level.
ii. However, candidates with bachelor's degree qualification, who have registered for a master's degree by research programme may apply to convert their candidacy to a doctoral degree programmes.
iii. Application for conversion must be made within one year after the candidate has registered for a master's degree programme.
iv. Application approval is subject to:
    a. the candidate having shown competency and capability in conducting research at doctoral degree level;
    b. rigorous internal assessment by the HEP; and
    c. approval by the HEP Senate.

5. ACADEMIC STAFF

"As the quality of the academic staff is one of the most important components in assuring the quality of higher education, an HEP is expected to search for and appoint the best-suited candidates to serve its programmes in an open, transparent and fair manner. To achieve this, HEPs are expected to design and implement an academic staff search and recruitment practice that is as efficient as it is effective to achieve the desired results. It is important that every programme has appropriately qualified and sufficient number of academic staff, working in a conducive environment that attracts talented individuals. The numbers recruited have to be adequate for, and appropriate to, the needs of the programmes. The role of the academic staff in various activities has to be clarified in order to reflect a fair distribution of responsibilities. It is important for the HEP to provide a continuous staff development programme for its academic staff, for them to be current in their knowledge and skills, both in their chosen discipline as well as in their pedagogical skills" (*COPPA 2nd Edition*, 2017).

The Higher Education Providers (HEPs) must ensure that the academic qualifications of their academics are accredited by the relevant accreditation bodies. **It is also the responsibility of the HEPs to ensure appropriate qualification is considered for the recruitment of staff in relation to the courses offered.** It would also be advantageous to the HEPs to hire those with a certain number of years of working experience due to greater versatility. As a general guide, it is important to note that the academic staff should have the relevant expertise or training in the courses taught. HEPs should also strive towards maintaining a balance between senior and junior academic staff. The specific recruitment criteria of academic staff for each level are as indicated in **Table 5**.

Table 5: Recruitment criteria of academic staff for each MQF level

MQF Level	Recruitment Criteria	Composition of Academic Staff
Diploma	A minimum of a Bachelor's degree (Level 6, MQF) in a related field.	<u>Academic staff ratio</u> i. In addition to observing staff to student ratio, the programme must consist of academic staff with expertise or background contributing to the related discipline core offered. ii. At least 60% of the academic staff are full-timers. iii. Part-time staff may consist of industry practitioners or from the academia.

MQF Level	Recruitment Criteria	Composition of Academic Staff
		iv. The minimum number of academic staff in the related field for each programme– 6* <u>Staff-student ratio</u> i. Programme – 1:25 ii. Practical – 1:30 iii. Tutorial – 1:20
Bachelor's Degree	A minimum of a Master's degree (Level 7, MQF) in a related field; **AND** A Bachelor's degree (Level 6, MQF) in a related field.	<u>Academic staff ratio</u> i. In addition to observing staff to student ratio, the programme must consist of academic staff with expertise or background contributing to the related discipline core offered. ii. At least 60% of the academic staff are full-timers. iii. Part-time staff may consist of industry practitioners or from the academia. iv. The minimum number of academic staff in the related field for each programme– 10* <u>Staff-student ratio</u> i. Programme – 1:20 ii. Practical – 1:30 iii. Tutorial – 1:20
Master's Degree by Coursework, Mixed Mode and Research	i. A Doctoral degree (Level 8, MQF) in a related field; **OR** ii. A Master's degree in a related field with a minimum of five (5) years' working experience in a related field a. in teaching and research; **or** b. as a co-supervisor for postgraduate programme; **or** c. in industry. **AND** A Bachelor's degree (Level 6, MQF) in a related field.	<u>Academic staff ratio</u> i. In addition to observing staff to student ratio, the programme must consist of academic staff with expertise or background contributing to the related discipline core offered. ii. At least 60% of the academic staff are full-timers. iii. Part-time staff may consist of industry practitioners or from the academia. iv. The minimum number of academic staff in the related field for each programme– 5* <u>Staff-student ratio (coursework and mixed mode)</u> Programme – 1:10

MQF Level	Recruitment Criteria	Composition of Academic Staff
Doctoral Degree by Research	i. A Doctoral degree (Level 8, MQF) with three (3) years' working experience a. in teaching and research; **or** b. as a co-supervisor for postgraduate programme; **or** c. in industry. **AND** A Bachelor's degree (Level 6, MQF) in a related field.	Academic staff ratio i. In addition to observing staff to student ratio, the programme must consist of academic staff with expertise or background contributing to the related discipline core offered. ii. At least 60% of the academic staff are full-timers. iii. Part-time staff may consist of industry practitioners or from the academia.

*Refer to *Surat Makluman MQA Bil. 7/2014 – Garis Panduan Beban Staf Akademik*.

A candidate without a Bachelor's degree and with a Master's degree through Accreditation of Prior Experiential Learning, APEL(A) route, may be accepted as an academic staff considering the related industry experience gained.

For the supervision of a Master's Degree by Mixed Mode and Research, and a Doctoral Degree by Research:

i. If there is only one supervisor, the supervisor must be a full-time staff of the conferring HEP.
ii. If there is more than one supervisors, the principal supervisor must be a full-time staff of the conferring HEP.
iii. On a case-by-case basis, co-supervisors may be appointed amongst industry experts, subject to the approval of the HEP Senate.

The principal supervisor can ideally have a maximum of 10 supervisees at a time. This is inclusive of the master's and doctoral degree students. This requirement does not apply to the supervision of project paper with 6 or less credit hours.

Academic Staff Development

To deliver quality programmes, to produce graduates who are marketable and to keep up with the rapid advancement in the fields of biotechnology, quality academic staff would need to be employed and provided with continuous trainings. HEPs should provide the following development programmes, amongst others:

i. Academic staff exchange and participation in national and international partner institutions as well as industry attachment should be highly advocated by the HEPs in ensuring that their academics get acquainted with different work settings. This will allow mentoring junior scholars and researchers and working with colleagues within the same, similar or even different research disciplines, consequently building stronger and wider professional networks. Additionally, this may lead to the broadening of the multi-disciplinary horizons at the HEPs.

ii. The academics need to be provided with professional development opportunities to support their expertise and skills in contemporary teaching, learning, assessment and research practices*.

iii. The academics should strongly be encouraged to pursue higher academic degree or professional certifications.

*Note: Although HEPs may plan custom training sessions for their staff based on demand, it is expected that the academics engage in the Continuous Professional Development (CPD) according to the specialisation needs with at least 40 hours of relevant training per year or participation in their respective field of expertise inclusive of research, consultation and community service. Part-time and/or contract staff should also be considered for the professional development programmes.

6. EDUCATIONAL RESOURCES

"Adequate educational resources are necessary to support the learning and teaching activities of a programme. These include all the required physical facilities, information and communication technologies, research facilities, and finance" (*COPPA 2nd Edition*, 2017).

Higher Education Providers (HEPs) are required to provide sufficient resources to support learning and teaching in the various areas of biotechnology at various qualification levels. HEPs must ensure that relevant educational resources and training facilities are in good working conditions and are available to support the learning and teaching activities as required by the respective areas of study. In addition, the HEPs must comply with the provisions of safety and health as prescribed under the Occupational Safety and Health Act, 1994 and any other regulations/guidelines as stipulated by the relevant ministries/agencies such as the Ethics Committee and Institutional Biosafety Committee (IBC).

Educational resources recommended for Biotechnology programmes include:

i. Basic Facilities

A typical laboratory should be equipped to carry out basic biotechnology experiments and should have equipment such as microscopes, micropipettes, drying oven, steriliser oven, incubators, pH meters, water bath, centrifuge, electrophoresis apparatus, spectrophotometers (ultraviolet-visible), water distiller, incubator shaker, autoclave, balances, freezer/chiller/refrigerator, fume hood, biosafety cabinet, emergency shower, eye wash as well as computers with an internet connection and relevant software.

ii. Specialised Facilities

a. Molecular biology facilities: Polymerase Chain Reaction (PCR) machine, electrophoresis apparatus, gel documentation system and microcentrifuge;
b. Protein/enzyme technology and natural product facilities: high speed refrigerated centrifuge, rotary evaporator, extraction and chromatographic apparatus; and
c. Bioprocessing equipment suitable for upstream and downstream processing.

Note:
Where high-end facilities are not available in-house, the HEPs must make arrangements with other institutions for access and must provide evidence (agreement letter) of the arrangement.

iii. Library

a. The HEPs must provide adequate library facilities including e-library; and
b. The library must have an adequate collection of up-to-date reference materials required to support the needs of each programme and research amongst staff and students.

iv. Non-Academic Resources

a. These fall under a wide umbrella of facilities and resources not directly academic but necessary for supporting the teaching-learning activities of the HEPs;
b. The HEPs are required to provide among others resources to support students' extra-curricular activities, such as recreational and community-based activities;
c. Student lounges with internet facilities, which are necessary for student relaxation, must be adequately provided;
d. HEPs must also provide sick-bay/accessible medical attention and counselling room where specific needs of their students can be met; and
e. Non-academic resources also refer to sufficient and appropriate physical facilities for the physically-challenged.

v. Support and Technical Staff

a. The technical staff in a Biotechnology programme include laboratory assistants and/or science officers;
b. The HEP determines the allocation of support staff to assist in the delivery of the programme; and
c. The HEP should also facilitate continuous professional development opportunities for the technical staff to support their expertise and skills.

7. PROGRAMME MANAGEMENT

"There are many ways of administering an educational institution and the methods of management differ between Higher Education Providers (HEPs). Nevertheless, governance that reflects the collective leadership of an academic organisation must emphasise on excellence and scholarship. At the departmental level, it is crucial that the leadership provides clear guidelines and directions, builds relationships amongst the different constituents based on collegiality and transparency, manages finances and other resources with accountability, forges partnerships with significant stakeholders in educational delivery, research and consultancy, and dedicates itself to academic and scholarly endeavours. Whilst formalised arrangements can protect these relationships, they are best developed by a culture of reciprocity, mutuality and open communication" (*COPPA 2nd Edition*, 2017).

This document will not raise issues pertaining to governance and administration as these are at the institutional rather than at the programme level. In this programme standards document, academic leadership is largely focused on suitably qualified persons in the biotechnology field to lead the programme. The leaders of the programme should demonstrate knowledge of the field and the attributes of good ethical values in work practices.

The leadership requirement of this document is complementary to Area 6 in the COPPA 2nd Edition (2017) document. Thus, the selection of programme leadership positions (e.g. Dean, Head of Department, Head of Programme, Student Advisor or Programme Coordinator) offered at different levels in the HEPs should fulfil the qualifications and experience as stated in **Table 6**.

Table 6: Criteria for selection of programme leader

MQF Level	Selection Criteria
Diploma	A Bachelor's degree in a related field with a minimum of 5 years' of relevant academic experience; **OR** A Master's degree in a related field.
Bachelor's Degree	A Master's degree in a related field with a minimum of 5 years' of relevant academic experience **OR**

MQF Level	Selection Criteria
	A Doctoral Degree in a related field.
Master's Degree	i. A Doctoral degree in a related field with a minimum of 5 years' of relevant academic or industrial experience; **OR** ii. A Master's degree in a related field with a minimum of 7 years' of relevant academic or industrial experience.
Doctoral Degree	A Doctoral degree in a related field with a minimum of 5 years' of relevant academic or industrial experience.

8. PROGRAMME MONITORING, REVIEW AND CONTINUAL QUALITY IMPROVEMENT

"Quality enhancement calls for programmes to be regularly monitored, reviewed and evaluated. These include the responsibility of the department to monitor, review and evaluate the structures and processes, curriculum components as well as student progress, employability and performance.

Feedback from multiple sources -- students, alumni, academic staff, employers, professional bodies and informed citizens -- assists in enhancing the quality of the programme. Feedback can also be obtained from an analysis of student performance and from longitudinal studies.

Measures of student performance would include the average study duration, assessment scores, passing rate at examinations, success and dropout rates, students' and alumni' reports about their learning experience, as well as time spent by students in areas of special interest. Evaluation of student performance in examinations can reveal very useful information. For example, if student selection has been correctly done, a high failure rate in a programme indicates something amiss in the curriculum content, teaching-learning activities or assessment system. The programme committees need to monitor the performance rate in each course and investigate if the rate is too high or too low.

Student feedback, for example through questionnaires and representation in programme committees, is useful for identifying specific problems and for continual improvement of the programme.

One method to evaluate programme effectiveness is longitudinal study of the graduates. The department should have mechanisms for monitoring the performance of its graduates and for obtaining the perceptions of society and employers on the strengths and weaknesses of the graduates, and to respond appropriately" (*COPPA 2nd Edition*, 2017).

Higher Education Providers (HEPs) are also advised to refer to the Guidelines to Good Practices: Monitoring, Reviewing and Continually Improving Institutional Quality.

"Comprehensive monitoring and review of the programme for its improvement is to be carried out with a proper mechanism, considering feedback from various parties. The committee responsible for this should be granted adequate autonomy to carry out its responsibility

effectively. It is desirable that the departments work in association with the HEP's central Quality Assurance Unit to ensure objectivity" (*COPPA 2nd Edition*, 2017).

The HEPs are expected to provide evidence of their ability to keep pace with changes in the field of biotechnology and the requirements of the stakeholders. The HEPs **must**

i. conduct a comprehensive curriculum review at least once in every three (3) to five (5) years;
ii. appoint external advisor(s) who are qualified in the related fields to provide assurance of quality for bachelor's degree (Level 6, MQF) and above as well as to ensure continual benchmarking against top universities at national and international levels; and
iii. engage with industry practitioners through appointment (official appointment letter) as a member of Board of Studies or by establishing an industry advisory panel.

In addition, these **may be** demonstrated by, but are not limited to, the following:

i. Continuous review of industrial attachment practices and records;
ii. Dialogue sessions with stakeholders at least once in every three (3) years;
iii. Active participation of the academic staff at relevant conferences, seminars, workshops and short courses;
iv. Presentations by invited speakers, national or international; and
v. Organising conferences, seminars and workshops.

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APPENDIX 1

LIST OF PANEL MEMBERS

No.	Name	Organisation
1.	Vikineswary Sabaratnam (Prof. Dr.) *- Chairman -*	Universiti Malaya
2.	Alan Ong Han Kiat (Prof. Dr.)	Universiti Tunku Abdul Rahman
3.	Arbakariya Ariff (Prof. Dr.)	Universiti Putra Malaysia
4.	Madihah Md Salleh (Assoc. Prof. Dr.)	Universiti Teknologi Malaysia
5.	Mahaletchumy Arujanan (Dr.)	Malaysian Biotechnology Information Centre

Miss Fairouz Jahaan Mohd Aanifah assisted in the development process and can be contacted for further information or query via email: fairouz.jahaan@mqa.gov.my.

APPENDIX 2

LIST OF STAKEHOLDERS

A. Related Ministry, Agencies and Industry

1. Ministry of Human Resource
2. Majlis Amanah Rakyat (MARA)
3. TalentCorp Malaysia
4. Johor Biotechnology & Biodiversity Corporation (JBiotech)
5. Academy of Sciences Malaysia
6. Felda Global Ventures
7. Forest Research Institute Malaysia (FRIM)
8. Sabah Biodiversity Centre
9. BioMolecular Industries Sdn. Bhd.
10. Meluha Life Sciences Sdn. Bhd.
11. Pharmaniaga
12. CryoCord
13. Malaysia Genome Institute
14. CCM Duopharma Biotech Berhad
15. Inno Biologics Sdn. Bhd.
16. Malaysian Agricultural Research and Development Institute (MARDI)
17. Agro-Biotechnology Institute Malaysia (ABI)
18. Malaysian Palm Oil Board (MPOB)
19. Sime Darby Plantation Berhad
20. Oncode Scientific Sdn. Bhd.

B. Higher Education Providers

1. Universiti Malaya
2. Universiti Kebangsaan Malaysia
3. Universiti Malaysia Perlis
4. Universiti Malaysia Sarawak
5. Universiti Malaysia Terengganu
6. Universiti Sains Malaysia
7. Universiti Sultan Zainal Abidin (Kampus Besut)
8. Universiti Teknologi MARA (Cawangan Melaka)
9. Universiti Malaysia Pahang
10. Universiti Pendidikan Sultan Idris

11. International Islamic University Malaysia
12. Kolej Universiti Islam Melaka
13. Universiti Tunku Abdul Rahman (Kampar)
14. AIMST University
15. International Medical University
16. INTI International University (Nilai)
17. UCSI University
18. Xiamen University Malaysia
19. Perdana University
20. Sunway University
21. Swinburne University of Technology Sarawak Campus
22. Manipal International University
23. Monash University Malaysia
24. Quest International University Perak
25. Lincoln University College
26. Geomatika University College
27. Nilai Polytechnic
28. Taylor's University

C. Alumni

1. Universiti Kebangsaan Malaysia
2. International Islamic University Malaysia
3. Geomatika Universiti College

D. MQA Panel of Assessors

E. MQA Officers

APPENDIX 3

BODY OF KNOWLEDGE

A. CORE COURSES

DIPLOMA

No.	Component	Body of Knowledge
1.	Core Fundamental Sciences and Biological Sciences **Note:** i. The topics covered under each proposed course must collectively provide a strong foundation for the students to understand the basic components relevant to **biotechnology in the discipline core**. ii. Courses may be integrated or embedded within the discipline core.	Biochemistry
		Biology
		Biostatistics
		Cell Biology
		Chemistry
		Genetics
		Mathematics
		Microbiology
		Molecular Biology
		Physics
		Physiology
2.	Discipline Core	Animal Biotechnology
		Animal Cell and Tissue Culture

No.	Component	Body of Knowledge
	Note: i. The topics covered under each course must collectively provide a strong foundation for the students to understand the basic components relevant to the **respective biotechnology areas**. ii. Courses may be integrated or embedded within the discipline core.	Bioethics and Biosafety
		Bioinformatics
		Bioprocess Technology
		Current Topics in Biotechnology
		Instrumentation in Biotechnology
		Introduction to Biotechnology
		Medical Biotechnology
		Microbial Technology
		Plant Biotechnology
		Plant Cell and Tissue Culture
		Principles of DNA Technology

Note: For Electives related to Discipline Core (page 18), refer to Part B: Suggested Courses for Areas of Biotechnology.

BACHELOR'S DEGREE

No.	Component	Body of Knowledge
1.	Fundamental Sciences **Note:** i. The topics covered under each course must collectively provide a strong foundation for the students to understand the basic components relevant to **biotechnology in the discipline core**. ii. Courses may be integrated or embedded within the discipline core.	Biology Chemistry Mathematics and/or Statistics Physics
2.	Discipline Core **Note**: i. The topics covered under each course must collectively provide a strong foundation for the students to understand the basic components relevant to the **respective biotechnology areas**. ii. Courses may be integrated or embedded. * May be offered under MPU.	**Core Sciences** Biochemistry Bioinformatics Cell Biology and Immunology Genetics Introduction to Biotechnology Microbiology Molecular Biology Physiology **Applied Sciences** Bioethics, Biosafety and Legal

No.	Component	Body of Knowledge
		Bioproduct Business and Supply Chain
		Cell and Tissue Culture
		Current Topics in Biotechnology
		Enzyme Technology
		Fermentation
		Fundamentals of Bioprocess Engineering
		Genetics Engineering / Recombinant DNA Technology
		Genomics and post-Genomics
		Plant and Animal Breeding
		Research and Commercialisation in Biotechnology
		Research Methodologies
		Science Communication*

Note: For Electives related to Discipline Core (page 19), refer to Part B: Suggested Courses for Areas of Biotechnology

B. SUGGESTED COURSES FOR AREAS OF BIOTECHNOLOGY

No.	Areas of Biotechnology	Body of Knowledge
1.	Agriculture Biotechnology	Animal / Plant Breeding
		Aquaculture Biotechnology
		Biofertilisers
		Biological Markers
		Environmental Security
		Food Security
		Genetic Engineering
		Genomics and post-Genomics
		Molecular Biopharming
		Molecular Diagnostic
		Mushroom Biotechnology
		New Breeding Technologies
		Nutraceutical and Functional Food
		Post-harvest Technology
		Protection / Biocontrol Agents

No.	Areas of Biotechnology	Body of Knowledge
		Protein Engineering
		Recent Advances in Agriculture Biotechnology
		Seaweeds and Algae
		Vaccines and Probiotics
2.	Industrial Biotechnology	Biomaterials
		Biomass Utilization Technology
		Biomanufacturing
		Food and Feed Ingredients
		Strain Improvement and Preservation
		Biocatalysts
		Bioenergy
		Bioprocessing Standard, Regulation and Certification
		Biosensor Technology
		Metabolic engineering
		Nanobiotechnology and Nanomaterials
		Natural Products

No.	Areas of Biotechnology	Body of Knowledge
		Nutriceuticals, Nutraceuticals and Whole Food Nutrients
		Primary and Secondary Metabolites
		Protein Engineering
		Recent Advances in Industrial Biotechnology
		Waste Treatment
3.	Medical Biotechnology	Anatomy and Physiology
		Cell and Tissue Engineering
		Design and Execution of Clinical Trials
		DNA Forensics
		Drug Design and Development
		Good Clinical Practice
		Human Genetics
		Immunology and Virology
		Medical Biochemistry
		Medical Informatics
		Medical Microbiology

No.	Areas of Biotechnology	Body of Knowledge
		Molecular Diagnostics
		Molecular Pharming
		Pharmaceutical Biotechnology
		Pharmacology and Toxicology
		Protein Engineering
		Recent Advances in Medical Biotechnology
		Safety Assessment of Drugs
		Stem Cell Biotechnology
4.	Environmental Biotechnology	Analytical Techniques
		Biological Control and Environment Conservation
		Biomass and Biorefineries
		Bioremediation and Biodegradation
		Biosensor Technology
		Environmental Biochemistry
		Environmental Biology
		Environmental Monitoring and Biodeterioration

No.	Areas of Biotechnology	Body of Knowledge
		Environmental Pollution
		Environmental Security
		Environmental Toxicology
		IPR and Biosafety
		Natural Resources
		Recent Advances in Environmental Biotechnology
		Waste Management and Utilization
5.	Food Biotechnology	Regulation of Biotechnology Foods
		Bioprocesses in Food Production
		Biosensor Technology
		Fermented Food
		Food Chemistry / Food Analysis
		Food Ingredient, Nutrition and Flavour
		Food Laws and Quality Assurance
		Food Microbiology and Biochemistry
		Food Toxicology

No.	Areas of Biotechnology	Body of Knowledge
		Genetically Modified Food and Detection of GMOs
		Genetically Modified Organisms for Food Production
		Halal Food Ingredient
		Microbial / Plant-based Food
		Nutritional Food / Nutraceuticals / Functional Food / Novel Food
		Preparation and Packaging Materials
		Recent Advances in Food Biotechnology
		Starter Cultures
6.	Marine Biotechnology	Aquaculture Biotechnology
		Aquatic Animal Nutrition
		Bioactive Marine Natural Products
		Biochemistry and Molecular Biology
		Bioinformatics
		Breeding
		Disease Prevention and Management
		Feed Ingredients and Nutrition

No.	Areas of Biotechnology	Body of Knowledge
		Genetic Engineering
		Immunology of Aquatic Animals
		Mariculture
		Marine Animal Physiology
		Marine Biological Resources and Utilization
		Marine Ecology, Environment and Conservation
		Genomics and post-Genomics
		Marine Microbiology
		Marine Pharmaceuticals and Bioactives
		Nutritional Food / Nutraceuticals / Functional Food / Novel Food
		Recent Advances in Marine Biotechnology
		Seaweed and Algae

Notes:

i. The courses suggested are for specialisation or electives. The list of body of knowledge provided is not exhaustive and the suggestions are for consideration.

ii. For any programme that encompasses two programme standards, the HEPs are to refer to the Body of Knowledge of both the programme standards. In terms of the other components of the standards, the HEPs are to adopt whichever is higher.

APPENDIX 4

PROGRAMME NOMENCLATURE

The programmes in the field of biotechnology may be offered as indicated below, but not limited to:

Programme Structure	Explanation	Example
Major	A programme containing only one main area.	i. Diploma in Biotechnology ii. Diploma in Marine Biotechnology iii. Bachelor of Science in Biotechnology iv. Bachelor in Biotechnology v. Bachelor in Food Biotechnology vi. Master of Science in Biotechnology vii. Master in Environmental Biotechnology viii. PhD
Major with Specialisation	A programme that has a **specialised field** that covers 25-30%* of the body of knowledge **for the area of specialisation**. This specialisation is indicated in **brackets**. The programme structure for **Certificate** and **Diploma** programmes **shall not** include specialisation.	i. Bachelor in Biotechnology (Food Biotechnology) ii. Master in Biotechnology (Environmental Biotechnology)
Major - Minor	A programme with a **minor** that includes 25-30%* of the body of knowledge **in another discipline**. The conjunction **'with'** is used in naming this type of programme where the major and minor disciplines are mentioned. The programme structure for **Certificate** and **Diploma** programmes **shall not** include a minor in another discipline.	i. Bachelor in Food Biotechnology with Management ii. Master in Biotechnology with Entrepreneurship

Note: Refer to the Policy on Nomenclature of Malaysian Higher Education Programme for further reference.

GLOSSARY

1) Continuous Assessment	The assessment of student progress throughout a course using a series of methods which may include, but are not limited to, essays, quizzes, test(s), oral presentations and individual/group assignments/projects.
2) External Examiner	External examiner refers to qualified person(s) who evaluate(s) the dissertation/thesis. The external examiner is appointed by the HEP, but is not affiliated with the HEP. The external examiner may be requested to be a member of the Dissertation/Thesis Examination Committee.
3) Final Assessment	The assessment of student progress at the end of a course in the form of a formal examination, dissertation/thesis, projects or industrial training report.
4) Formative Assessment	Formative assessment is the assessment of student progress throughout a course, in which the feedback from the learning activities is used to improve student attainment of knowledge in the subject matter.
5) Summative Assessment	Summative assessment is the assessment of learning, which summarises the progress of the learner at a particular time and is used to assign the learner with a course grade.
6) Final Examination	An examination or test scheduled within an official examination period held at the end of an academic term. It serves as the final evaluation of a course or courses of study which contributes to the overall academic performance of students.
7) Assessment for Learning	Assessment for learning is also known as formative assessment. It is an approach that enables teachers and learners to decide where the learners are in their learning and the information can be used in deciding what strategies to use in teaching and learning respectively.
8) Assessment as Learning	Assessment as learning is the student learning process where they monitor their own learning and become aware of how they learn.
9) Assessment of Learning	Assessment of learning is sometimes referred to as ‘summative assessment', typically administered at the end of a unit or grading period and may be used to rank or grade students.

10) Interactive Learning	Interactive learning is a two-way pedagogical approach which involves hands-on and work-based processes of delivering information to students.
11) Flipped Learning	Flipped learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic and interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.