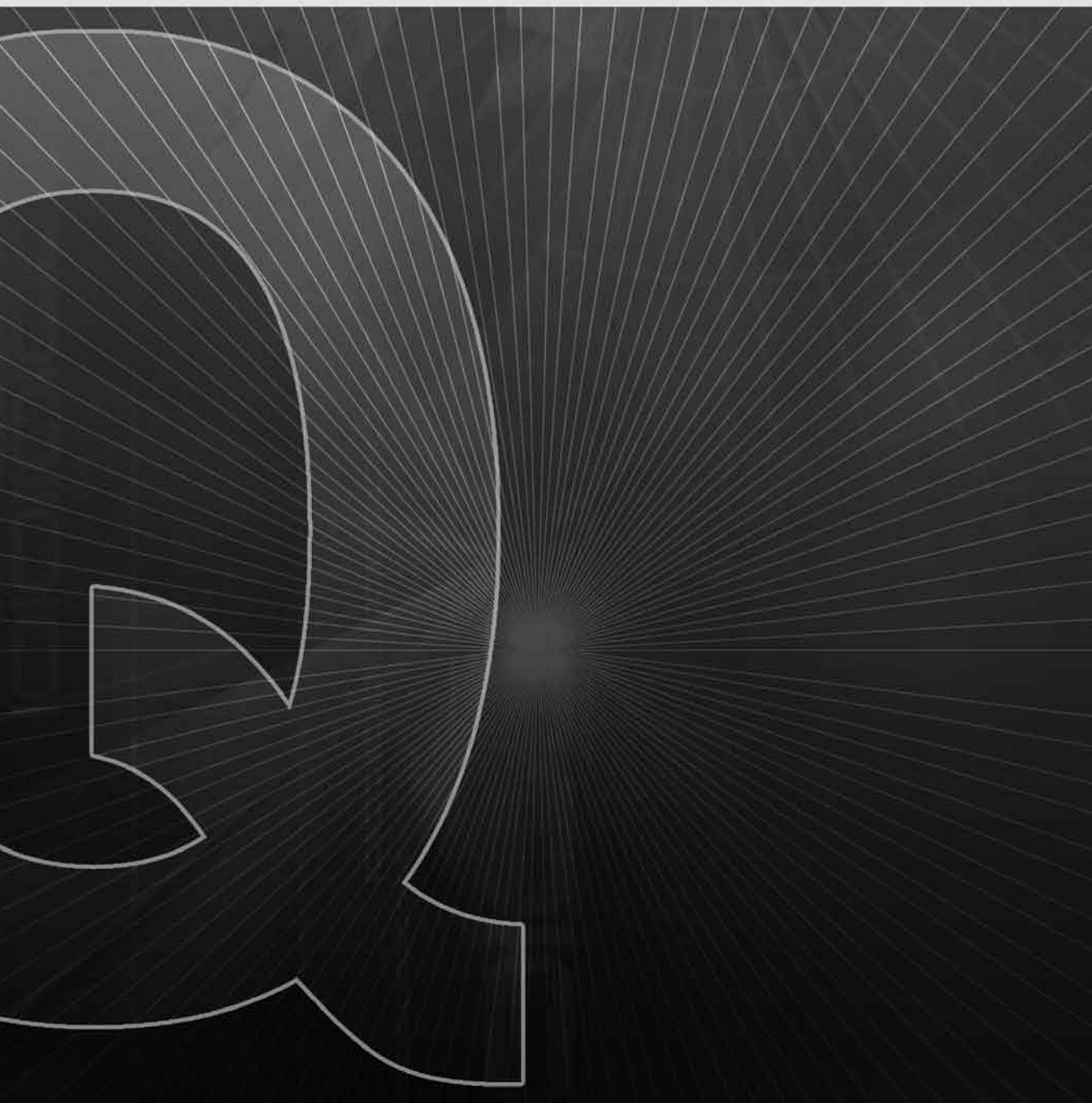


# PROGRAMME STANDARDS : **BIOTECHNOLOGY**



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# FOREWORD

The Malaysian Qualifications Agency (MQA), as the Sole National Higher Education Quality Assurance Organisation, facilitates quality through the development of quality assurance documents. These documents are Malaysian Qualifications Framework (MQF), Codes of Practice, The Guidelines to Good Practices and Programme Standards, all of which must be used as a Reference point in the conduct of a programme of study in Malaysia.

Programme Standards are developed to provide specific guidelines to providers in a particular field or course of study so as to fulfil the MQF requirements. These guidelines, if followed closely and wisely, enable the development and sustenance of quality Programmes in Malaysia, consequently improving the quality of graduates and their employability and mobility.

The Programme Standards: Biotechnology is formulated to promote the development of academic programmes in the field of Biotechnology from Diploma to the Doctoral levels. It includes specific guidelines on programme aims and objectives, programme-learning outcomes, programme design (including a proposed programme structure), admission criteria, student assessment, academic staff, educational resources and continuous quality improvement.

The panel of experts involved in the development of this Programme Standards represents various stakeholders including the Government and private agencies, and Higher Education providers. To ensure greater acceptance of the Document, a larger stakeholder workshop was held on 15 November, 2007 where the draft was presented and views consolidated into this final Document.

My deepest gratitude goes to them and the MQA officers who have put forth tremendous effort and generously gave their time in realising the Programme Standards: Biotechnology.

Congratulations.

**Tan Sri Dato' Dr. Mohamed Salleh Mohamed Yasin**

Chairman

Malaysian Qualifications Agency

2010

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The completion of this Document, The Programme Standards: Biotechnology has been largely due to the support of outstanding individuals from the institutions of higher education, industries and government agencies. Coming from different backgrounds, these panel of experts worked meticulously over a period of nine (9) months to produce this final document.

Malaysian Qualifications Agency would like to thank the following experts for their support and contribution towards the production of this Programme Standards.

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Within this Agency, the creative process was assisted by Ms. Mahfiza Mohd. Nasir who may be contacted at mahfiza@mqa.gov.my for further clarification or query.

With our sincere appreciation and gratitude,

Dato' Dr. Syed Ahmad Hussein  
 Chief Executive Officer  
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 2010

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# Programme Standards: Biotechnology

## INTRODUCTION

Biotechnology is the utilisation of living organisms or parts of organisms to produce or enhance products or services for the 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, inclusive of Microbiology, Biochemistry, Genetics, Molecular Biology and Chemistry.

There are great and diversified opportunities in Biotechnology as it combines Science, Engineering and Bioinformatics. Biotechnology can generate economic benefits in several areas and industries including agriculture, medicine, health care, engineering, environmental sciences, manufacturing and services.

The rapid development of the Biotechnology Industry worldwide has created career opportunities for graduates in Biotechnology. The thrust areas as envisioned in the National Biotechnology Policy are indicative of the government's commitment to ensure the healthy development of Biotechnology Industries in Malaysia.

In order to produce graduates qualified in the field of Biotechnology at different levels, the benchmarks leading to the award of individual qualifications are given below.

The qualifications in the field of Biotechnology may be demonstrated by, but not limited to:

- Diploma in Biotechnology
- Bachelor of Science (Biotechnology)
- Bachelor of Biotechnology
- Master of Science
- Doctor of Philosophy

The Programme Standards are subdivided as follows:

1. Aims and Objectives
2. Learning Outcomes
3. Programme Design
4. Student Admission
5. Student Assessment
6. Academic Staff
7. Educational Resources
8. Continuous Improvement
9. Appendices\*

\*The Appendices include an Educational Pathway and a Guide to Biotechnology programme contents at the various levels. This document should be read in conjunction with the following publications and any other related future publications:

1. The Malaysian Qualifications Framework, Malaysian Qualifications Agency, 2007.
2. Code of Practice for Programme Accreditation, Malaysian Qualifications Agency, 2008.
3. Code of Practice for Institutional Audit, Malaysian Qualifications Agency, June 2008.

## AIMS AND 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, taking into account aspects of ethics and social responsibility.

### Diploma

The objectives of the Diploma Programme are to produce graduates who:

1. possess basic understanding of concepts in Biotechnology;
2. are competent in designated practical skills;
3. are aware of biohazard and occupational safety issues;
4. can support and assist in the management of laboratories and related industries; and
5. possess basic communication and interpersonal skills.

### Bachelor's Degree

The objectives of the Bachelor's Degree Programme are to produce graduates who:

1. have a comprehensive understanding of Biotechnology and their applications;
2. are competent in wide ranging practical skills;
3. are aware of biohazard and occupational safety issues;
4. are competent in communication and interpersonal skills;
5. possess innovative thinking, analytical skills and problem solving abilities; and
6. are aware of current issues and technological advancement in Biotechnology taking into account of commercial, ethical, social and legal issues.

### Master's Degree

The objectives of the Master's Degree Programme are to produce graduates who:

1. have enhanced knowledge of relevant areas in Biotechnology;

2. are competent in developing protocols and procedures;
3. are aware of biohazard and occupational safety issues;
4. are competent in communication and interpersonal skills;
5. have the ability to carry out guided research;
6. keep abreast of current issues and technological advancement in Biotechnology taking into account relevant commercial, ethical, social and legal issues; and
7. are innovative, creative, and possess analytical and problem-solving abilities.

### **Doctoral Degree**

The objectives of the Doctoral Degree Programme are to produce graduates who:

1. have specialised knowledge in relevant areas of Biotechnology;
2. are competent in developing protocols and procedures;
3. are competent in biohazards and occupational safety;
4. are competent in communication and interpersonal skills;
5. have the ability to carry out independent research;
6. can contribute to the understanding of current issues and technological advancement in Biotechnology taking into account relevant commercial, ethical, social and legal issues; and
7. are innovative, creative, and possess analytical and problem-solving abilities.

## **LEARNING OUTCOMES**

### **Diploma**

At the end of the Diploma Programme, graduates should be able to:

1. demonstrate an understanding of basic concepts in Biotechnology;
2. apply theoretical knowledge and practical skills in relevant areas of Biotechnology;
3. communicate effectively with peers and others;
4. collect experimental data under supervision and generate a simple report;
5. perform basic technical activities;
6. execute basic biohazard and occupational safety procedures;

7. use basic computer applications; and
8. recognise and practise the concept of lifelong learning.

### **Bachelor's Degree**

At the end of the Bachelor's Degree Programme, graduates should be able to:

1. demonstrate a comprehensive understanding of Biotechnology;
2. operate and maintain basic Biotechnology equipment;
3. analyse, synthesise, and integrate knowledge and information;
4. apply theoretical knowledge and practical skills;
5. conduct basic-guided research;
6. demonstrate the ability to seek, adapt, and provide solutions to address challenges and concerns in Biotechnology;
7. recognise and practise the concept of lifelong learning;
8. demonstrate an understanding and awareness of basic commercial, ethical, legal and social issues related to Biotechnology; and
9. communicate and demonstrate interpersonal skills.

### **Master's Degree**

At the end of the Master's Degree Programme, graduates should be able to:

1. demonstrate enhanced knowledge of relevant areas in Biotechnology;
2. access, evaluate and analyse Biotechnology information from a variety of sources and to communicate the principles both orally and in writing;
3. evaluate and analyse current information from relevant sources for incorporation into Biotechnology research with minimal guidance;
4. demonstrate the ability to seek, adapt and provide solutions to address challenges and concerns in Biotechnology;
5. recognise and practise the concept of lifelong learning;
6. demonstrate an understanding and awareness of basic commercial, ethical, legal and social issues related to biotechnology;
7. perform managerial or supervisory roles in laboratories and related industries; and
8. communicate and demonstrate interpersonal skills.

## Doctoral Degree

At the end of the Doctoral Degree Programme, graduates should be able to:

1. generate knowledge and understanding through independent research;
2. contribute to a specific area in Biotechnology;
3. create and interpret knowledge towards the advancement of Biotechnology;
4. apply specialised techniques and knowledge at the frontiers of Biotechnology development;
5. demonstrate the ability to seek, adapt and provide solutions to address challenges and concerns in Biotechnology;
6. contribute towards the understanding of current issues and technological advancement in Biotechnology, taking into account relevant commercial, ethical, social and legal issues;
7. provide leadership and contribute to research and refereed publication, and
8. be involved in academic discourse with peers and experts in related Disciplines.

## PROGRAMME DESIGN

The specific requirements for each level are as indicated below. As a general guide, the following should be considered:

- the minimum credits for Diploma and Bachelor's Degree Programmes are 90 and 120, respectively; and
- the minimum duration of study for Diploma and Bachelor's Degree Programmes are two and a half (2.5) years and three (3) years respectively.

### Diploma

Modes of delivery:

- Concept and theory by lecture and tutorial;
- Skill development through laboratory hands-on and student placement; and
- Table (1a) provides programme design components and percentage breakdown recommended for this Level.

## **Bachelor's Degree**

Modes of Delivery:

- Lectures, practicals, tutorials, research projects, seminars, presentations, e-learning, problem-based learning, industrial visits and student placements;
- Biotechnology Programmes must focus on presentation, discussion and practical work that enable students to demonstrate an understanding of theories and possess analytical skills, ability to communicate, plan and manage;
- Programmes should encourage the development of teamwork and leadership skills;
- Student placement is compulsory; and
- Table (1b) provides programme design components and percentage breakdown recommended for this Level.

## **Master's Degree**

Structure:

- Structure A – Research only;
- Structure B – Coursework (18 - 24 credits) and Research; and
- Structure C – Coursework only (40 credits inclusive of a Project-paper).

Note:

1. Minimum duration is of one (1) year full-time or two (2) years part-time for all Structures.
2. Research Methodology as a compulsory subject is recommended.

## **Doctoral Degree**

Structures:

- Structure A – Research only; and
- Structure B – Research and Coursework.

Note:

1. Minimum duration is of two (2) years full-time or four (4) years part-time for all Structures.
2. Research Methodology as a compulsory subject is recommended.

## STUDENT ADMISSION

The specific requirements for each Level are as indicated below. As a general guide, the following should be considered in the selection process:

- the requirements given below are the minimum entry qualifications; and
- any exemptions provided for entry into a higher Level are subjected to existing policies.

### Diploma

- Pass Sijil Pelajaran Malaysia (SPM) with three Credits in related Field or equivalent; OR
- Certificate in a related Field.

### Bachelor's Degree

Pass Sijil Pelajaran Malaysia (SPM) or equivalent, AND

- Sijil Tinggi Persekolahan Malaysia (STPM) with two Principals or equivalent; OR
- Diploma in a related Field; OR
- Foundation, Matriculation, Pre-university programme in a related Stream or equivalent.

### Master's Degree

A Bachelor's Degree or equivalent from related Disciplines.

### Doctoral Degree

- A Bachelor's Degree in Biotechnology or related Disciplines and a Master's Degree; OR
- A Bachelor's Degree with distinction from a related Discipline and a Postgraduate Certificate or a Diploma in a related Field.

Note: A Candidate registered for a Master's Degree may opt to convert his Registration after a year to a Doctoral Degree subject to fulfilment of the specified criteria.

## STUDENT ASSESSMENT

The specific requirements for each Level are as indicated below. However, as a general guide, the following items should be considered:

- Each Level, depending on the requirements of individual subjects/modules, should incorporate both summative and formative assessments; and
- Higher Education Providers (HEPs) are encouraged to use a variety of methods and tools appropriate to the learning outcomes and competencies. The types of assessments shown below are examples.

### Diploma

Assessments are as follows:

- Open/Closed Book Examinations
  - ▶ Multiple choice questions
  - ▶ Short answer questions
  - ▶ Mixed essay questions
  - ▶ Problem-based essay questions
- Continuous Assessments
  - ▶ Presentations
  - ▶ Class participation
  - ▶ Report-writing
  - ▶ Laboratory skills
  - ▶ Assignment/Mini project

### Bachelor's Degree

Assessments are as follows:

- Open/Closed Book Examinations
  - ▶ Multiple choice questions
  - ▶ Short answer questions
  - ▶ Mixed essay questions
  - ▶ Problem-based essay questions
- Continuous Assessments
  - ▶ Critical review of published articles
  - ▶ Presentation

- ▶ Class Participation
- ▶ Report-writing
- ▶ Laboratory skills
- ▶ Assignment/Mini project
- Research Project with Project Report/Dissertation/Viva Voce

### **Master's Degree**

Assessments may be as follows:

- Open/Closed Book Examinations
  - ▶ Short answer questions
  - ▶ Mixed essay questions
  - ▶ Problem-based essay questions
- Continuous Assessments
  - ▶ Critical review of published articles
  - ▶ Presentation
  - ▶ Class participation
  - ▶ Report-writing
  - ▶ Laboratory skill
  - ▶ Assignment
- Research project with Project Report/Dissertation/Thesis/Viva Voce

### **Doctoral Degree**

Assessments are as follows:

- Research Project, Thesis and Viva Voce.

Note: Publication in peer-reviewed journal or presentation of a conference paper is encouraged.

## **ACADEMIC STAFF**

The specific requirements for each Level are as indicated below. As a general guide, it is important to note that:

- the academic leadership of the school/faculty/department must be a person with a Doctoral Degree or a Master's Degree with at least ten (10) years work experience in related Field;

- sufficient support staff such as lab technicians and administrators should be provided; and
- the Higher Education Providers (HEPs) should strive towards maintaining a balance between senior and junior academic staff.

Note: However, where the lecturer lacks post-graduate qualifications, industrial experience may be taken into account in the recruitment of staff.

### **Diploma**

- Minimum qualification of academic staff: Bachelor's Degree in a related Field.
- Academic staff-student ratio: 1:25.
- Percentage of full-time and part-time academic staff is 60% and 40% respectively.

### **Bachelor's Degree**

- Minimum qualification of academic staff: Masters degree.
- Academic staff-student ratio: 1:20.
- Percentage of full-time and part time academic staff is 60% and 40% respectively.

### **Master's Degree**

- Minimum qualification of academic staff: Doctoral Degree or Master's Degree with minimum five (5) years working experience in a related Field.
- Academic staff-student ratio: 1:10.
- Percentage of full-time and part-time academic staff is 60% and 40% respectively.

### **Doctoral Degree**

- Minimum qualification of academic staff: Doctoral Degree with three (3) years working experience.
- Academic staff-student ratio: 1:5.
- Percentage of full-time and part time academic staff is 60% and 40% respectively.

## EDUCATIONAL RESOURCES

### For All Levels

For the Field of Biotechnology, Higher Education Providers (HEPs) must also comply with the provisions of safety and health as prescribed under the Occupational Safety and Health Act, 1994.

- **Basic Facilities**

A typical laboratory should be equipped to carry out basic Biotechnology experiments and should have equipment such as microscopes, incubators, pH meters, water baths, centrifuges, electrophoresis apparatus, spectrophotometers (ultraviolet-visible), incubator shakers, autoclaves, balances, freezers/chillers, fumehoods as well as computers with Internet connection and relevant software.

- **Specialised Facilities**

- **Molecular Biology facilities:** Polymerase Chain Reaction (PCR) machines, electrophoresis apparatus and gel documentation system;
- **Protein/enzyme technology facilities:** protein-extraction and chromatographic apparatus;
- **Culture facilities:** incubators, laminar flow cabinets and growth chambers; and
- **Bioprocessing equipment suitable for upstream and downstream processing.**

Note:

Where high-end facilities are not available in-house, the Higher Education Providers (HEPs) should make arrangement with other Institutions for access.

- **Library**

- Higher Education Providers (HEPs) must provide adequate library facilities including e-library; and
- The library must have adequate collection of up-to-date reference material required to support the needs of each Programme and Research amongst staff and students.

- **Non-Academic Resources**
  - o These fall under a wide umbrella of facilities and resources not directly academic but necessary for supporting the teaching-learning activities of the Higher Education Providers (HEPs);
  - o Higher Education Providers (HEPs) are required to provide among others resources to support students' extra curricular activities, such as recreational and community-based activities;
  - o Student lounges with Internet facilities are necessary for student relaxation and must be adequately provided;
  - o Higher Education Providers (HEPs) must also provide sick-bay and counselling room where specific needs of their students can be met; and
  - o Non-academic resources also refer to sufficient and appropriate physical facilities for the physically-challenged.

## CONTINUOUS QUALITY IMPROVEMENT

The Higher Education Providers (HEPs) are expected to provide evidence of ability to keep pace with changes in the Field and requirements of stakeholders. These may be demonstrated by, but not limited to:

1. curriculum review, conducted at least once every three (3) years;
2. appointment of external Reviewer for quality assessment processes;
3. linkages with industry;
4. continuous review of industrial attachment practices and records;
5. dialogue sessions with stakeholders at least once every 2 years;
6. active participation of academic staff at relevant conferences, seminars, workshops and short courses;
7. presentations by invited speakers, local or international; and
8. organisation of conferences, seminars and workshops.

**Table (1a): The Design Components for Diploma in the Field of Biotechnology**

<b>Content</b>
<b>Core Fundamental Sciences and Biological Sciences (35-40%)</b>  Fundamental Sciences (Mathematics, Physics, Chemistry and Biology) Basic Biological Sciences (Biochemistry, Microbiology, Cell and Molecular Biology and Genetics)
<b>Core Major (30-40%)</b>  Applied Subjects in Biotechnology Disciplines such as Principles of DNA Technology, Cell and Tissue Culture, Plant and Animal Breeding, Fermentation and Enzymes Technology, Bioprocess Engineering and Instrumentation in Biotechnology.
<b>Electives in Major (0-5%)</b>  Elective courses may be taken from selected areas such as Marine & Aquaculture Biotechnology, Plant Biotechnology, Animal Biotechnology, Agribiotechnology, Pharmaceutical Biotechnology, Environmental Biotechnology, Food Biotechnology, Nutraceutical and Functional Food, Fermentation/Bioprocessing, Industrial Biotechnology and Protein Engineering.
<b>Industrial Training (5-10%)</b>
<b>Generic Skills, Humanities &amp; Liberal Arts (15-20%)*</b>  May consist of selected Disciplines in Communication Skills, ICT, Management, Entrepreneurship, Intellectual Property Rights, Bioethics & Biosafety, Legal, Social Issues, Bahasa Malaysia, Malaysian Studies and Islamic/Moral Studies

\* Note: May be integrated in core components

**Table (1b): The Design Components for Bachelor's Degree in the Field of Biotechnology**

<b>Content</b>
<b>Fundamental Sciences (10-20%)</b>
(Biology, Chemistry, Physics and Mathematics in particular Statistics) Note: Courses for Fundamental Science components may be integrated or embedded within the core Sciences and Applied Science courses.
<b>Core Component (Core Sciences and Applied Courses) (40-48%)</b>
<ul style="list-style-type: none"><li>• Core Sciences (Biochemistry, Microbiology, Genetics, Cell and Molecular Biology)</li><li>• Applied Courses such as Genetics Engineering/Recombinant DNA Technology, Molecular Diagnostics, Cell and Tissue Culture, Plant &amp; Animal Breeding, Fermentation, Bioprocessing, Biopharming, Bioinformatics, Genomics and Proteomics,</li></ul>
<b>Specialisation Electives (15-20%)</b>
Elective Courses may be taken from selected areas such as Marine & Aquaculture Biotechnology, Plant Biotechnology, Animal Biotechnology, Agribiotechnology, Pharmaceutical, Environmental Biotechnology, Food Biotechnology, Nutraceuticals, Medical Biotechnology, Fermentation/Bioprocessing, Industrial Biotechnology and Protein Engineering.
<b>Final Year Project (5-10%)</b>
<b>Industrial Training or Internships (2-5%)</b>

### **Generic Skills, Humanities & Liberal Arts: (10-15%)\***

Consisting of Communication Skills, ICT, Management, Entrepreneurship, Intellectual Property Rights, Bioethics & Biosafety, Legal, Social Issues Bahasa Malaysia, Malaysian Studies and Islamic/Moral Studies

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\*Note: The Subject-components for Generic-skills may be integrated or embedded into the core or elective components.

**Table 2: Distribution Percentage (%) Programme Design According to Theoretical / Concepts and Skills in Programme of Studies**

Components	% by Qualification Level	
	Diploma	Bachelor's Degree
Concept and Theory	30-35	40-45
Skills	45-55	40-50
Generic Skills, Humanities and Liberal Arts	15-20	10-15

Note: Concepts and Theories are normally acquired through Lectures, Tutorials and Readings. Skills are normally acquired through hands-on work/exposure (Laboratory-work, Projects, Industrial-training) and enhanced through supervised and effective assessment.

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