Department of Higher Education
Ministry of Higher Education Malaysia
Level 4, No.2 Tower 2
Street P5/6, Precint 5
62200 W.P Putrajaya, Malaysia

UNIVERSITI TEKNOLOGI MARA
University Publication Centre

WINNER of the Prime Minister's Quality Award 2008

ISBN 978-967-363-340-1

Future Direction of Biomedical Science Programme in Malaysia, 2011

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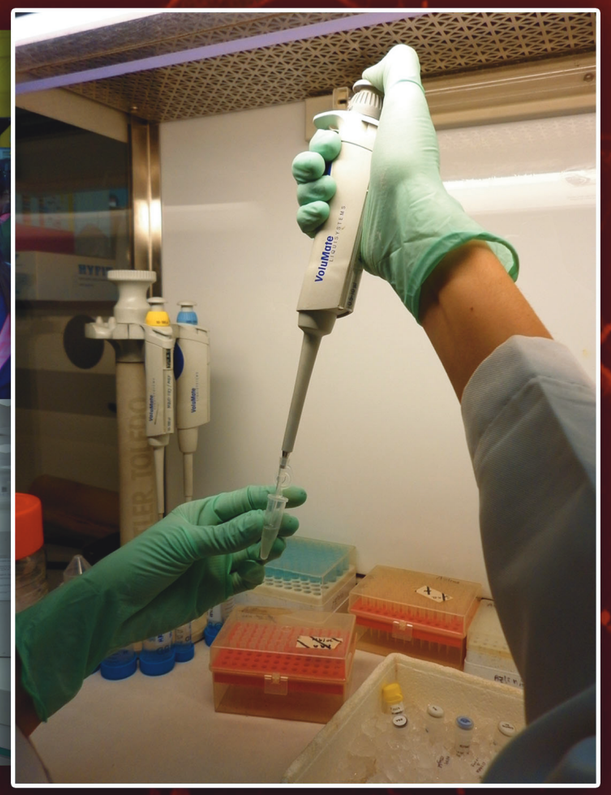

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Universiti Teknologi MARA • SHAH ALAM

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Future direction of biomedical science programme in Malaysia, 2011.
Bibliography: p. 57
ISBN 978-967-363-340-1
1. Biomedical engineering--Study and teaching (Higher)--Malaysia.
2. Medical technology--Study and teaching (Higher)--Malaysia.
610.28

Cover design : Siti Suhaini Mazlan
Typesetting : Univision Press Sdn. Bhd.
Typeface : Helvetica/Times
Typesize : 10/12

Printed in Malaysia by : Univision Press Sdn. Bhd.
Lot 46, 47 & 48 SR 1/9, Seksyen 9,
Jalan Serdang Raya, Taman Serdang Raya,
43300 Seri Kembangan, Selangor
e-mail: univisionpress@gmail.com

CONTENT

PREFACE

This book on the future directions of Biomedical Science Programmes and Education in Malaysia is the joint contribution of numerous personnel, institutes and entities. I greatly appreciate the move by the Ministry of Higher Education in initiating this project. It is evident that the Ministry is committed to producing quality, world-class Biomedical Science graduates. One of the main reasons for the need to look into the future directions of Biomedical Science is the lack of standardization in the level and quality of graduates produced by various Malaysian institutes, particularly some private institutes.

It is hoped that this book would serve as a guide to improve and standardize the existing Biomedical Science curriculum and to determine the level of practical training that is absolutely necessary in order to produce professional and competent graduates in this field. The implementation of these suggestions and recommendations will hopefully take the Malaysian Education of Biomedical Science to World Class levels, and lead to Malaysia achieving Biomedical Science Education Hub status in South East Asia.

On behalf of the committee, I would like to thank the Department of Higher Education, Ministry of Higher Education for entrusting us with this task. We have done our level best to conduct numerous surveys, dialogue sessions and academic visits to accumulate data and provide recommendations for further improvement.

My hope is that this task will be fruitful in contributing towards our National Education Goal, in line with the National Economic Policy.

Professor Dr. Umah Rani Kuppusamy
Chairperson
Biomedical Science Programme
Ministry of Higher Education
(Department of Molecular Medicine)
Faculty of Medicine
University of Malaya)

ACKNOWLEDGEMENT

The task force committee members of the Future Direction of Biomedical Science, Malaysia Project, wish to thank everyone who contributed to the commencement and preparation of this book.

First and foremost the committee expresses our deepest gratitude to the Department of Higher Education, Ministry of Higher Education for mooting the idea of looking into the future for Biomedical Science Programmes in Malaysia and the National Institute of Higher Education Research for providing us with the funding for this research; Professor Emeritus Chowdery, president of the HUBMS, United Kingdom who gave us insight into the current requirement for recognition by the Institute of Biomedical Science (IBMS) international accreditation body; the staff of Mahidol University, Chulalangkorn University and Khon Kaen University who were enthusiastic hosts and shared with us their experiences on running similar programmes and their trials and tribulations as they worked to achieve professional status for their respective university Biomedical Science Programmes. We are grateful to Encik Azli for his efficient administration and advice on procedures, and we thank all those who participated in our surveys and provided valuable input and ideas, and Dr. Suzita Mohd Noor for her painstaking effort in proof-reading this report.

Last but not the least, the committee wishes to express our appreciation to the Project research assistant, Cik Nor Syuhada binti Ahmad Basha for her commitment and tireless effort in helping to complete this Project.

CHAPTER 1

INTRODUCTION

DEFINITION OF BIOMEDICAL SCIENCE

Biomedical Science is the application of Biological Sciences to medical use particularly in research, diagnosis, and health monitoring or treatment. With the current global increasing trend in sophisticated healthcare, the demand has increased for highly skilled biomedical scientists who are capable of performing and analysing technical procedures in the healthcare system.

A biomedical professional who works in a hospital laboratory can expect to be tasked with the analysis of body tissues, blood, or other body fluids so as to enable accurate diagnoses of pathological conditions. Common analyses may include determination of metabolic disorders; identification of infectious diseases caused by microorganisms viz. bacteria, viruses, or parasites; typing of blood during transfusion emergencies; assessment of immuno-compatibility; performing genetic tests; and confirmation of abnormal pathology during surgical resections. Thus, the biomedical scientist must possess sound understanding of medical biochemistry, microbiology, clinical and medicinal chemistry, pharmacology, cell and molecular biology, immunology, anatomy, physiology, pathology and/or cytology.

DEVELOPMENT OF BIOMEDICAL SCIENCE EDUCATION

1.1.1 Worldwide

The Biomedical Science degree programme is relatively new in Malaysia compared to those in other parts of the world. In the United Kingdom, the structured degree programme started in 1976, at Bradford University and Portsmouth Polytechnic. By 1987 the number of Institutions offering the degree programme had increased to 14, with others following suit. In the United States, the American Society for Clinical Pathology (ASCP) was founded 1922 and by 1928, 350 Medical Technologists (MTs) (analogous to the Biomedical Scientists) were registered by the ASCP Board of Registry (BOR). The American Society for Medical Technologists (ASMT), now known as American Society for Clinical Laboratory Science (1993), was originally formed as a sub-group of the ASCP. In the late 1950's, MTs sought governmental recognition for their educational qualifications through personnel licensure laws and positions in the civil service and armed forces. In Canada, the Canadian Society for Medical Laboratory Science (CSMLS) is the national certifying body for medical laboratory technologists and medical laboratory assistants. The national professional society for Canada's medical laboratory professionals, incorporated in 1937, now has over 14,000 members. Closer to home, the Association of Medical Technologists of Thailand (AMMT) was officially established in 1963. There, the profession was placed under the 'Act

of the Art of Healing Practice' and subsequent to that, the Medical Technology Council (MTC) was legally established according to the Medical Technology Act in 2005.

1.1.2 In Malaysia

In Malaysia, the Biomedical Science degree programme is closely linked with Medical Laboratory Technology diploma courses. Prior to 1995, Medical Laboratory services were solely performed by Medical Laboratory Technologists who had certificate or diploma level qualifications. Their career path, particularly in the public sector, was limited. In line with developments in the rest of the world, where personnel providing medical laboratory services had degree level qualifications, a degree level medical laboratory based programme was proposed by the University of Malaya, UKM and UPM. The Ministry of Education approved the commencement of the programme at the three universities in 1992. UKM and UPM proceeded with their first intake of students in 1992 while UM's Biomedical Science Programmed commenced in 1993 ('super-fresh' STPM and Asasi Sains Hayat candidates as well as Diploma in MLT holders). The three universities produced their first batches of Biomedical Science graduates in 1996. This was followed by USM with its first intake in 2000, IIUM in 2002 and UiTM (degree in Medical Laboratory Technology) in 2003.

Meanwhile, private universities and university colleges that also offer this programme have been mushrooming at an alarming level. This has led to various problems and issues; for instance, the hotchpotch approach to the name of the degree (Table 2.1).

Unlike in other countries, the Biomedical Science Degree in Malaysia has yet to be recognized as a professional degree. Neither are there professional bodies or councils to control or monitor the Programme, as with other degree programmes such as Medicine or Pharmacy. Recently, the Biomedical Science degree was listed as an Allied Health profession and the Ministry of Health has finally moved to professionalize all the Allied Health degrees. The enactment of Allied Health Profession Act has been initiated and is expected to be in place by next year.

ISSUES AND PROBLEMS FACED

Due to the demand for Biomedical Science degrees and the establishment of new universities and university colleges that offer degree programmes related to medical laboratory sciences but with different degree names and varied duration of study ranging from 3-4 years, the Ministry of Higher Education (MOHE) is now in the process of monitoring not only the quality of graduates in this field but also their employability in the specialised areas in which they have been trained.

Another major MOHE concern is whether the increased number of graduates from local universities and abroad are in parallel with our market needs.

Critical issues and problems that have been identified:

1. Lack of standardization for syllabi and the curricula.
2. Different names used for the degrees, causing confusion at the employment level. Graduates with the wrong qualifications have wound up being employed in medical laboratories, leading to unnecessary complaints and problems.
3. Over-production of Biomedical Science graduates, particularly by the private institutions.
4. Flawed graduates: Poor/No practical training provided by some of the institutions, resulting in graduates who are incompetent in practical skills.
5. Lack of appropriately trained academic staff.
6. Lack of appropriate infrastructure especially for practical training.
7. Absence of a council to vigilantly monitor the issues stated above.
8. The degree is not recognized as the professional degree as is warranted.

FUTURE DIRECTION OF BIOMEDICAL SCIENCE PROGRAMME IN MALAYSIA

In order to facilitate monitoring and to address persisting issues and problems, a task force committee was formed by MOHE to look into the future direction and study the prospects for the Biomedical Science Programmes at our local institutes of higher learning. The Committee comprises one or two lecturers representing each of the public academic institutions that offer Biomedical Science degree programmes, notably the University of Malaya (UM), Universiti Kebangsaan Malaysia (UKM), Universiti Putra Malaysia (UPM), University Sains Malaysia (USM), International Islamic University Malaysia (IIUM) and Universiti Teknologi MARA (UiTM)-MLT degree programme.

1.1.3 Task Force Committee Members

Prof. Dr. Umah Rani Kuppusamy - Chairperson
Coordinator of Biomedical Science Programme
Department of Molecular Medicine
Faculty of Medicine
University of Malaya (UM)

Assoc. Prof. Dr. Sabrina binti Sukardi - Secretary
Head of Department
Department of Biomedical Science
Faculty of Medicine and Allied Health Science
Universiti Putra Malaysia (UPM)

Assoc. Prof. Dr. Nor Fadilah Rajab
Head of Biomedical Science Programme
School of Diagnostic and Applied Health Sciences
Faculty of Health Science
Universiti Kebangsaan Malaysia (UKM)

Assoc. Prof. Pim Chau Dam
Deputy Dean (Academic and Student Affairs)
School of Health Sciences
Universiti Sains Malaysia (USM)

Assoc. Prof. Madya Dr. Mohd Aziz bin Dollah
Programme Coordinator
Department of Biomedical Science
Faculty of Medicine and Allied Health Science
Universiti Putra Malaysia (UPM)

Dr. Mohd Arifin bin Kaderi
Deputy Dean (Research and Postgraduate Studies)
Kulliyyah of Allied Health Sciences
International Islamic University Malaysia (IIUM)

Dr. Lim Boon Huat
Chairman of Biomedicine Programme
School of Health Sciences
Universiti Sains Malaysia (USM)

Dr. Ong Kien Chai
Senior Lecturer
Department of Molecular Medicine
Faculty of Medicine
University of Malaya (UM)

Front row, from the left:

A/Prof. Dr. Nor Fadilah Rajab, Prof. Dr. Umah Rani Kuppusamy (Chairperson), A/ Prof. Dr. Sabrina binti Sukardi (Secretary), Nor Syuhada Ahmad Basha (R.A)

Back row, from the left:

A/ Prof. Madya Dr. Mohd Aziz bin Dollah, Dr. Mohd Arifin bin Kaderi, Dr. Ong Kien Chai, Dr. Lim Boon Huat, A/ Prof. Pim Chau Dam

1.1.4 Objectives

To study the present trends/modes in offering the Biomedical Science Degree Programme by public universities in Malaysia.

To produce a working paper to be used as a guideline/reference standard by the Ministry of Higher Education for Biomedical Science programmes.

1.1.5 Terms of Reference of the Task Force Committee

Prepare a report on the current mode of implementation of the Biomedical Science Degree Programme in local institutes of higher learning;

Study and propose a curriculum restructuring for Biomedical Science programmes at local institutes of higher learning – to meet the employment market requirements;

Recommend ways to improve training/skills and suggest the minimum appropriate infrastructure required for conducting Biomedical Science Degree programme in local institutes of higher learning;

Develop a database on human resource and expertise that is appropriate to the relevant fields of Biomedical Science;

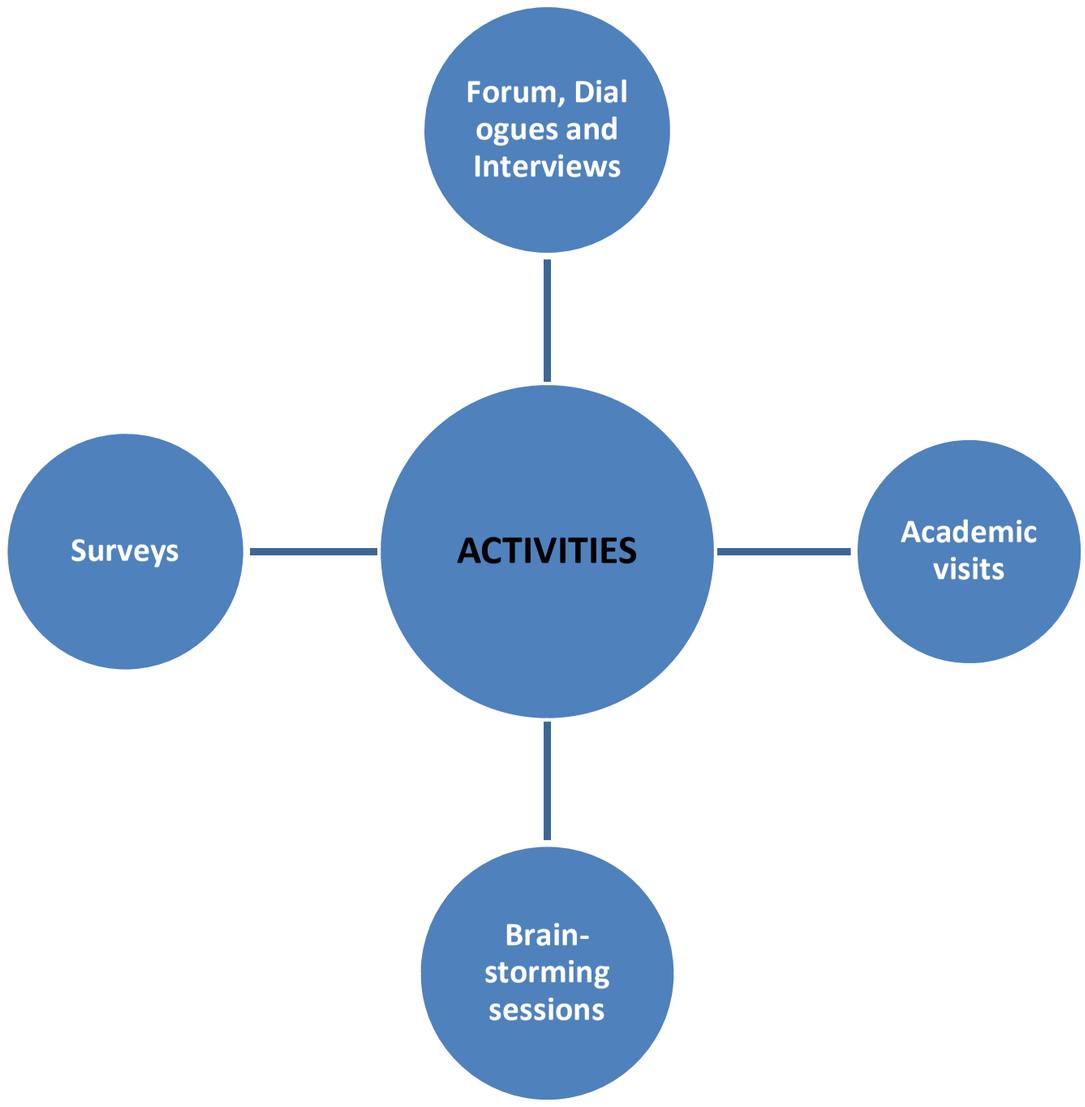
Recommend an academic development plan for human resource in the field of Biomedical Science and recommend an action plan to enhance the Biomedical Science profession in this country;

Suggest/recommend a mode of cooperative relationship between Institutes of Higher Learning with government agencies/industries, especially in R & D and industrial training in the fields of Biomedical Science;

Various approaches were utilised by the committee to accomplish this task. The general outline of the methods used is depicted in Scheme 1.

The calendar of activities is depicted in Appendix 1.

SCHEME 1


Forum, Dial ogues and Interviews
Surveys
ACTIVITIES
Academic visits
Brain- storming sessions

CHAPTER 2

BIOMEDICAL SCIENCE EDUCATION IN MALAYSIA

This chapter addresses the issues on syllabi, curricula, the varied names of degrees, entry requirement for students, academic staff qualifications, and infrastructure and training.

PUBLIC UNIVERSITIES AND PRIVATE UNIVERSITIES AND UNIVERSITY COLLEGES THAT OFFER BIOMEDICAL SCIENCE OR SIMILAR PROGRAMMES

2.1.1 Public universities

Public universities in Malaysia that offer Bachelor degree programmes in Biomedical Science or Biomedicine include the University of Malaya, Universiti Kebangsaan Malaysia, Universiti Putra Malaysia, Universiti Sains Malaysia and International Islamic University Malaysia. Universiti Technology MARA offers a similar programme viz. degree in Laboratory Technology.

2.1.2 Private universities and university colleges

The demand for clinical laboratory professional will continue to grow as more sub-specialties such as molecular diagnostics, flow cytometry, and genetic testing emerge. Moreover, the advent of wellness and preventive medicine has created the need for the laboratory professionals who would be available for consultation and disease screening.

Due to a high demand for qualified medical laboratory professionals at the decision-making level at both the public and private sectors, many private institutions are now competing to offer degrees in Biomedical Sciences. Interestingly, the curricula of some degrees are similar to that of the Biomedical Sciences, but registered under different programme names (Table 2.1).

Table 2.1 Different names used for the Biomedical Science degree programme

Institute of Higher Learning	Programme Name
Public Universities	
University of Malaya	Bachelor of Biomedical Science (BBMedSc) Honours
Universiti Kebangsaan Malaysia	Bachelor of Biomedical Science (Honours)

Institute of Higher Learning	Programme Name
Public Universities	
Universiti Putra Malaysia	Bachelor of Science (Biomedical Science) Honours
Universiti Sains Malaysia	Bachelor of Health Science (Biomedicine) Honours
International Islamic University Malaysia	Bachelor of Biomedical Science (BSBM) Honours
University Technology MARA	Bachelor of Medical Technology
University of Malaya	Bachelor of Biomedical Science (BBMedSc) Honours
Universiti Kebangsaan Malaysia	Bachelor of Biomedical Science (Honours)
Universiti Putra Malaysia	Bachelor of Science (Biomedical Science) Honours
Universiti Sains Malaysia	Bachelor of Health Science (Biomedicine) Honours
Private Universities/University Colleges	
International Medical University (IMU)	Bachelor of Science (Hons) Biomedical Science (IMU) or Biomedical Science degree from Partner Universities (Credit transfer options to the University of Newcastle, Australia, University of Otago, New Zealand and University of Strathclyde, Scotland)
Masterskill College of Nursing and Health	Bachelor of Biomedical Science (Hons)
Management and Science University (MSU)	Bachelor of Biomedical Science (Hons)
MAHSA University College	Bachelor of Science (Honours) Biomedical Sciences in collaboration with the University of Northumbria, UK
Universiti Tunku Abdul Rahman (UTAR)	Bachelor of Science (Hons) Biomedical Science
Universiti Industri Selangor (UNISEL)	Bachelor of Medical Sciences Laboratory (Hons);
Institute of Medical Science Technology (UniKL MESTECH)	Bachelor of Clinical Laboratory Science (Honours);
INTI International University Malaysia	INTI Australian Degree Transfer Programme (Science) in Biomedical Science

LACK OF STANDARDIZED PROGRAMME STRUCTURE AND CURRICULA

When the programme was first commenced in 1992-1993 at UM, UKM and UPM there were differences in terms of the programme structure, student enrolment, infrastructure, and academic staff: student ratio (Table 2.2). Nonetheless these three pioneering universities were successful in obtaining the IBMS, UK accreditation in 1996. Problem arose when the Ministry of Education introduced a 3-year programme policy for all basic degree programmes in 1998. In order to maintain the quality of the Biomedical Science programme and ensure continued recognition from IBMS, UK, the three public universities struggled to squeeze their respective 4-year syllabi into the 3-year programme structure. The notional credit hours in each university were not the same. For example, a 110 credit at UM was in essence on par with 125 credits at UKM and 120 at UPM. Subsequently, the UKM and UPM revised their programme structure again to the 4-year study period, with total credit hours of 125 and 132 respectively in 2005, whereas UM retained with their 110-credit hour programme until 2009. Meanwhile, USM and IIUM commenced their respective Biomedical Science programmes in 2000 and 2002, with required 120 credits in 3 years (USM) and 135 credits in 4 years (IIUM). USM subsequently shifted to the 4-year structure in 2002 with a 124 credit programme.

About a decade ago, private universities and university colleges began offering Biomedical Science degrees as well. Initially a limited number of private institutions offered the Biomedical Science degree programme; the numbers have since increased drastically. The academic staff: student ratio is unacceptable in most instances, resulting in greatly compromised quality and training.

Table: 2.2 Programme Structure and number of students per intake

Institution / Year programme commenced	Study period	Total credits	Average intake of students per year	Academic staff : student ratio
UM / 1993	1993-1997 (4 years) 1998-2009 (3 years) 2010 onwards (4 years)	120 110 136	29	1:3
UKM / 1992	1992-1997 (4 years) 1998-2004 (3 years) 2005 onwards (4 years)	120 125 145	100	1:20
UPM / 1992	1992-1997 (4 years) 1998-2004 (3 years) 2005-2010 (4 years) 2011 onwards	120 120 132 145	60	1: 22
USM / 2000	2000-2003 (3 years) 2004 onwards (4 years)	120 124	30	1:4
IIUM / 2002	2002 onwards (4 years)	135	60	1:12

TOWARDS A STANDARDIZED PROGRAMME CONTENT AND STRUCTURE

Currently, all local universities have structured their programme content based on the proposed guideline introduced by the Malaysian Qualifications Agency (MQA) Programme Standards for Medical and Health Sciences (http://www.mqa.gov.my/garispanduan/Medical and Health Sciences.pdf). However, only continuous monitoring via audits, student/alumni feedback, and

stakeholder surveys would be able to reveal whether current restructured programmes match the stipulated requirements.

Table 2.3 Programme Structure in line with MQA requirement

Institution	Study period (years)	Commencement year	Total credits	Student intake	Academic staff : student ratio
UM	4	2010	136	40	1:5
UKM	4	2010	145	45	1:14
UPM	4	2011	145	50	1: 15
USM	4	2012 (expected)	140	35	1:4
IIUM	4	2012 (expected)	145	60	1:9

All public universities offering the Biomedical Science Degree Programme run approximately similar programmes, structured with learning outcomes that are in line with the MQA requirement. Biomedical Science education has moved towards outcome-based learning, where the credit hours are based on student learning time (SLT).

Private universities and university colleges that offer similar programmes also appear to have structured their programmes in line with the MQA requirement.

2.1.3 Programme Aims and Learning Outcomes

The following aims and learning outcomes of the Biomedical Science Programme were developed in line with MOHE aspirations. A Bachelor of Biomedical Science degree prepares graduates for general employment, entry into postgraduate programmes and research, as well as opportunities for highly skilled careers. Individuals are capable of pairing responsibility, with its required autonomy, with 'professional' decision-making.

The Bachelor's degree should aim to:

- prepare knowledgeable individuals who are safe and competent practitioners in medical and health sciences;
- produce graduates who can contribute effectively for the community;
- generate graduates who are creative, innovative, sensitive, and responsive towards the community, culture and environment;
- inculcate professional attitudes, ethical conduct, and social responsibilities;
- develop graduates with leadership, teamwork, and communication skills;
- equip graduates with technical, problem-solving, and scientific skills;

- generate graduates who can conduct research under supervision;
- equip graduates with ICT, managerial, and entrepreneurial skills; and
- instil lifelong learning skills in graduates.

LEARNING OUTCOMES

At the end of the programme, graduates should be able to:

- apply their fundamental and advanced knowledge in medical sciences;
- perform medical laboratory procedures;
- validate and present information and findings coherently;
- plan, manage and execute quality management systems and Good Laboratory Practices (GLP);
- evaluate and implement new medical laboratory methodologies and instrumentations;
- demonstrate the ability to seek, adapt and provide solutions to address challenges in medical laboratory practices;
- coordinate the daily activities of a medical laboratory practice;
- adhere to biological, chemical and radiation safety requirements and regulations;
- demonstrate sensitivities and responsibilities towards the community, culture and environment;
- adhere to legal, ethical principles and the professional code of conduct in medical laboratory;
- communicate effectively in verbal and written forms with their Biomedical peers and with healthcare professionals, patients, patients' families/caregivers, and the stakeholders at large;
- demonstrate leadership, and interpersonal and social skills;
- utilise relevant techniques and identify problems and solutions based on critical and lateral thinking;
- conduct research related to medical sciences;
- utilise ICT and information management system to enhance their medical laboratory practice;
- apply the skills and principles of lifelong learning for academic and career development; and
- apply broad business and real world perspectives in the workplace and for everyday activities.

2.1.4 Programme Content

Based on the programme aims and learning outcomes, the programme content should integrate basic biomedical knowledge with clinical subjects in order to gain understanding of laboratory diagnosis, disease prevention and research in the fields of biomedical science. Hence, the content must include three subject areas, namely:

(a) Basic Biomedical Science courses,
(b) Core Biomedical Science courses,
(c) Practical Training in Biomedical Science.

The programme must at least include the types of courses listed under each subject area as shown below; however the suggested names of the courses listed are not intended to imply course titles.

Basic Biomedical Science

Human Anatomy and Physiology

Human anatomy and physiology is the study of the structure, function and control of the human body.

Biochemistry

Biochemistry refers to the application of chemistry in the study of biological processes at the cellular and molecular level.

Genetics

Genetics focuses on the structure and function of genes and inheritance.

Biostatistics

Biostatistics deals with the use of statistical analysis in the study of human biology.

Core Biomedical Science

Clinical Biochemistry

Clinical biochemistry refers to the use of biochemical tests for diagnosis and treatment.

Molecular Biology

Molecular biology is the study of the molecular basis of human biological activity.

Immunology

Immunology is the study of the human immune system.

Pathology

Pathology refers to the science of human disease cause and effect.

Haematology

Haematology deals with human diseases of the blood and blood-forming organs.

Transfusion Science

Transfusion science refers to identification of blood group antigens and antibodies for the safe supply of blood and/or blood components.

Basic Microbiology

Basic microbiology focuses on the characteristic features of harmful bacteria, viruses, fungi and parasites; and also on the application of routine microbiological techniques.

Medical Microbiology

Medical microbiology deals with the study of microorganisms including bacteria, viruses and fungi, which are capable of causing diseases in human beings.

Medical Parasitology

Medical parasitology deals with the study of helminths and protozoa, which are capable of causing diseases in human beings.

Research Methodology

Research methodology encompasses the principles and application of both qualitative and quantitative research methods.

Practical Training In Biomedical Science

Industrial training / Biomedical practicum/ Laboratory posting in a hospital
Industrial training enables student to gain experiences in either a research laboratory (which includes medical biotechnology-based research), a diagnostic laboratory in a hospital, or a healthcare-based laboratory.

Laboratory Management

Laboratory management refers to the understanding of basic management procedures like quality control, good laboratory practice (GLP), quality management, safety, and ethical issues.

Final year research project

The final year research project requires students to carry out a research project in order to broaden their knowledge and skills in critical analysis and to acquire skills in scientific aspects for the testing of hypotheses in biomedical science topics.

A sample of the academic structure of a typical Biomedical Science programme is shown in Appendix 2.

The current implemented course structure is approved by MOHE and is based on both MQA and IBMS requirements. This is in line with similar programmes offered in neighbouring Thailand (Table 2.4), where the programme structure

is comparable to that in the US, while countries such as Singapore, Canada, Australia and Hong Kong are in line with IBMS UK.

Table 2.5: Bachelor of Medical Technology (MT) Programme structure in Thailand

Level	Course/Subject	Khon Kaen	Chulalong-korn	Mahidol
A	General Education	30	30	30
B	Specific Subject	105	102 (Core)	103
B1	- Basic Professional	38	40 (Basic)	43
B2	- Professional	61	62 (Major)	60
B3	- Professional Elective	6	-	
C	Elective (Free)	6	6	6
	TOTAL	**141**	**138**	**139**

The academic structure of the Bachelor of Medical Technology (MT) in Thailand is similar to the Biomedical Science Programme in Malaysia (public universities).

QUALIFICATION REQUIREMENT: STUDENT AND ACADEMIC STAFF

2.1.5 Entry requirements for students

It is important to ensure that students enrolled into the Biomedical Science Degree Programme have the appropriate basic qualifications. The current minimum entry requirement is listed in Table 2.4. This may need to be revised to a higher level of entry-requirement.

A persisting issue pertaining to student intake is students being offered degree programmes which were not in their original list of degree choices. Students who meet the criteria for acceptance into the Biomedical Science Programme at one university that has no vacancy, who are instead offered degree programmes which they had never selected for, should be allowed to transfer to another university which may still have a vacancy. The UPU should allow a certain amount of flexibility in the transfer process. Currently, such flexibility in the transfer mechanism is lacking and thus detrimental to a student's ambitions and future plans.

More Diploma level students with excellent qualifications and experience ought to be given the opportunity to pursue the Biomedical Science Degree

Programme. However, the qualification levels of the Diploma in MLT candidates produced by the various schools or colleges are inconsistent; some are even questionable. Diploma level MLT programmes in Malaysia have mushroomed, with little control over academic quality, infrastructure and training. As an example, a diploma candidate with a lower cGPA from a MOH-endorsed school may be far more competent than a person with an "excellent cGPA" from a private institution. One way to overcome this problem is to have a standard entrance examination to screen for deserving candidates. A committee comprising personnel with various expertises in medical and laboratory sciences may be set up to determine the type and level of assessment for the entrance examination.

Table 2.6: Current minimum entry requirement

i. Local students
STPM or Matriculation Minimum of Grade B (cGPA 3.00) in two subjects and C in one subject in the following subjects: Biology Chemistry Mathematics and at least three credits at SPM level in the following subjects Biology Chemistry and Mathematics
Diploma in MLT CGPA >3.00
ii. International students Qualifications equivalent to and recognised by the Malaysian Government, and approved by University senates.

2.1.6 Qualification Requirement: Academic Staff.

It is imperative that only academics with the appropriate qualifications and the necessary competency level (Table 2.5) be allowed to teach the courses in this Programme. The Academic staff to student ratio must be maintained at a satisfactory level (see Table 2.3) in order to guarantee an efficient teaching and learning environment. The recommended academic qualifications required for the respective areas in Biomedical Science are listed in Table 2.5.

Table 2.7: Recommended Qualification Requirement of Academic Staff

Number	Fields	PhD in the specific field with either a Science, Biomedical Sciences or Veterinary Medicine based first degree)	MBBS/MD/BDS with MMed/M.Sc/PhD
1	Anatomy/histology	Yes	Yes
2	Biochemistry	Yes	No
3	Biotechnology	Yes	No
4	Biostatistics/Bioinformatics/ Research Methods	Yes	No
5	Clinical Chemistry/Chemical Pathology/Clinical Biochemistry	Yes	Yes
6	Epidemiology	Yes	No
7	Genetics, inclusive of cytogenetics	Yes	No
8	Haematology, inclusive of phlebotomy	Yes	Yes
9	Immunology	Yes	No
10	Laboratory Animal Husbandry/Management	Yes	No
11	Laboratory Management	Yes	No
12	Laboratory Science and Instrumentation	Yes	No
13	Microbiology	Yes	No
14	Molecular Biology	Yes	No

Number	Fields	PhD in the specific field with either a Science, Biomedical Sciences or Veterinary Medicine based first degree)	MBBS/MD/BDS with MMed/M.Sc/PhD
15	Pathology/histopathology	Yes	Yes
16	Parasitology inclusive of entomology	Yes	No
17	Physiology	Yes	No
18	Radiobiology/Nuclear Medicine	Yes	No
19	Transfusion Science and Blood Banking	Yes	Yes
20	Toxicology	Yes	No

2.1.7 Human Resource Development and Academic Training

Existing academics who do not fulfill the basic academic qualification requirement should be encouraged to upgrade their qualification levels. Alternatively, their continued tenure within the institution may be made contingent on their successful advancement to a higher degree. They may pursue their further studies in established universities locally or abroad. At present, this is already standard practice for public universities in Malaysia. Amongst the private institutes, a notably select few show care and concern over academic development and continuous training; while the majority are neglecting this issue of human resource development. Institutes that ignore this crucial aspect should not be allowed to continue offering this degree programme.

2.1.8 Infrastructure

The lack of appropriate infrastructure, particularly well-equipped and well-maintained laboratories, is another factor affecting the quality of graduates. Some institutes have the laboratory premises, but such facilities may not be sufficiently equipped. Available equipment may be poorly maintained. Laboratory design and safety could also be poor. The minimum requirement

for running and maintatining a Biomedical Science Degree Programme is shown in Appendix 3.

Institutes that do not provide appropriate laboratory facilities and other forms of infrastructure should not be allowed to continue to run the programme.

2.1.9 Practical training

Several private institutes do not allocate sufficient funding for research projects. In addition, such institutes suffer from a of lack research facilities, and do not have competent personnel to supervise quality projects. The students are expected to seek projects and supervisors “elsewhere” to complete their research project module. The quality and standard of these projects are often greatly compromised.

Biomedical Science students should be provided with the adequate amount of practical training. This should include individual subject-based class practicals, hospital-based diagnostic laboratory training, industrial training and research project. A wider choice of laboratory/industrial training options may be encouraged so as to give the students a broad exposure to the current development and employment requirement. The kind of training obtained may also help with the choice of a future career-path. For an example, a student on a laboratory posting placement at a biotechnology (industrial research) based laboratory may be a likely professional candidate in the future for a Biotechnology-based company. On the other hand, a student trained at a diagnostic laboratory in a particular speciality such as haematology and blood banking may find suitable opportunities at a similar department in a diagnostic laboratory.

2.1.10 Conclusion

To succeed in producing quality graduates, one does not only depend on a programme structure and idealistic requirements that have been proposed on paper, but also on how well and to what extent they are implemented.

Problems with regards to non-uniform curricula can hopefully be resolved by vigilant enforcement of standardization and benchmarking by the MOHE and MQA. Meanwhile, issues pertaining to poor academic qualification, infrastructure, and the type and level of practical training may be resolved with vigilant implementation of the recommendations made here and with enforcement of these requirements by MOHE. The existing problems are undeniably “mistakes” of the past, and positive moves made currently would ensure a more standardized, high quality Programme that would produce highly competent Biomedical Science graduates, regardless of the institution.

CHAPTER 3

CAREER-PATH AND EMPLOYABILITY OF BIOMEDICAL SCIENCE GRADUATES

This chapter evaluates the employability of Biomedical Science graduates and the satisfaction level expressed by employers in terms of the quality of the graduates. Issues pertaining to career paths and demands by stakeholders are also addressed in this chapter.

The annual alumni surveys carried out by 5 public universities revealed that Biomedical Science graduates were engaged in careers in the fields listed in Table 3.1. A more current alumni survey was also conducted by the task force members. The data obtained is shown in subsequent sections of this chapter. Relevant agencies and companies (both public and private) were approached for feedback on Biomedical Science Graduates' competency levels and employers' satisfaction.

The alumni and employer survey forms used are attached in Appendix 4.

Table 3.1 Career paths for Biomedical graduates

Field	Specific Career
Education	• School teachers • Private tuition teachers • Teachers at Matriculation Colleges • Teachers at Foundation Colleges • Tutors at Public and Private Universities/Colleges • Tutors at Colleges under the MOH, IMR • Lecturers at Public and Private Universities/Colleges
Research	• Research Officers attached to MARDI, IMR, VRI, SIRIM, FRIM, PORIM, FELDA, FELCRA BioTech Corp among others • Researchers attached to Universities both locally and abroad
Service	• Biomedical Science Officers in Hematology, Molecular Biology and Clinical Chemistry Laboratories in Government Hospitals • Biomedical Science Officers in medical-related departments in Universities • Medical Laboratory Technologists in private hospitals and private diagnostic laboratories eg Pathlab, Gribbles Lab, BP Lab etc
Others	• Insurance Underwriters for Prudential Insurance, Great Eastern, AMLife, etc. • Medical Sales Representative or Technical Sales Representatives for Companies dealing with laboratory equipment and products • Nutrition Specialists for Slimming Sanctuary • Self-employed entrepreneurs

EMPLOYER SURVEY

3.1.1 Introduction

This survey was conducted to obtain feedback on the performance of Biomedical Sciences graduates who had undergone the three to four year programme in their respective universities.

The survey was comprised of three parts; Part A: Employers' basic information; Part B: Programme objective – being the attained targets for graduates during their course of study, of which nine objectives were outlined for the Bachelor of Biomedical Science Programme (see below); and Part C: Graduates' attributes. Pertaining to the qualities and skills that the students were expected to develop during their course of study. For Parts B and C, the scale range used was from 'strongly disagree', not 'sure/irrelevant', 'agree', to 'strongly agree', with 'not applicable' available as an option.

3.1.2 Survey Purpose

The purpose of the survey was to:

i. measure employers' level of satisfaction with the performance and quality of Biomedical Science graduates
ii. measure the achivement of the Programme objectives and the attributes of Biomedical Science graduateassess Biomedical Science graduates' employability

3.1.3 Methodology

The survey was fielded online through a website (http://umesurvey.um.edu.my/community/survey.php?sid=246). Fielding was conducted between 26th April 2011 and 30th June 2011. Employers were notified of the survey in advance by ordinary mail notification from the committee.

3.1.4 Response Rate

The overall response rate was 15.3% (only 69 employers participated in the survey despite a total of 450 employers/agencies/companies being notified/invited to participate in this survey). Nevertheless, there was a good mix of various agencies and fields of employment among the participants.

3.1.5 Results and Analysis

PART A: Respondent Information

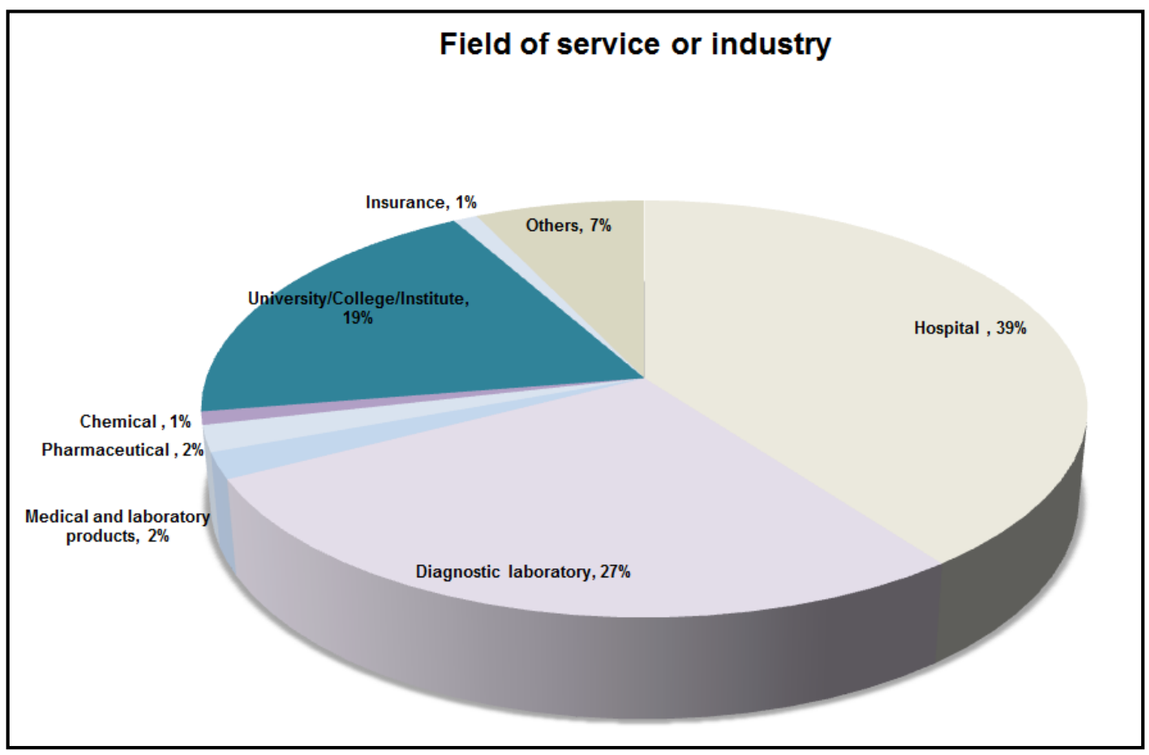


Figure 3.1a

Note: 'Others' refers to biotechnology, bioinformatics, stem cell processing, or clinical research.

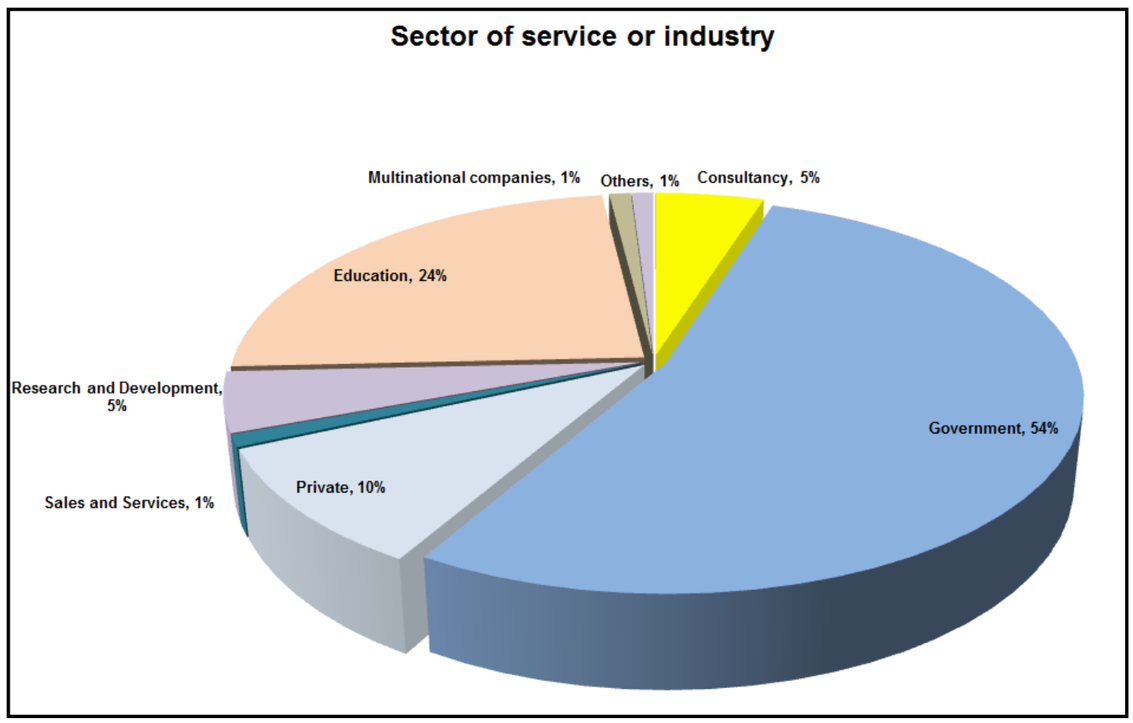


Figure 3.1b

The majority of the employers who responded were from the Government sector.

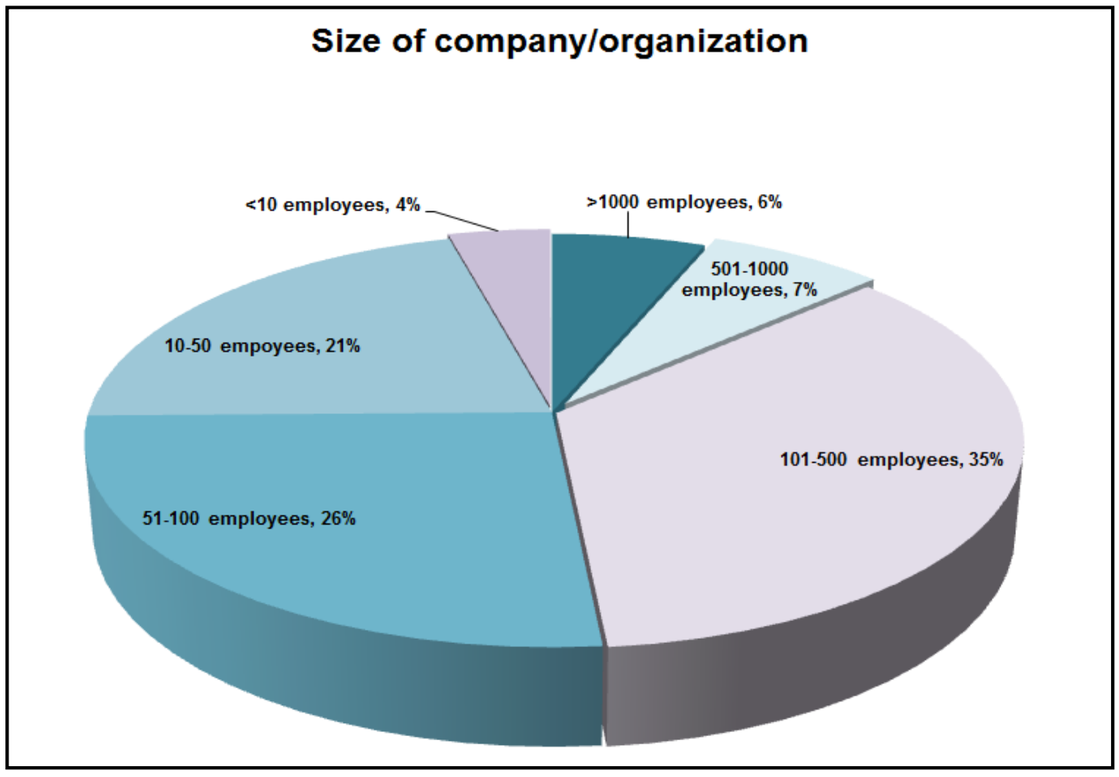


Figure 3.1c

The majority of the respondents were from relatively large organizations, agencies/companies

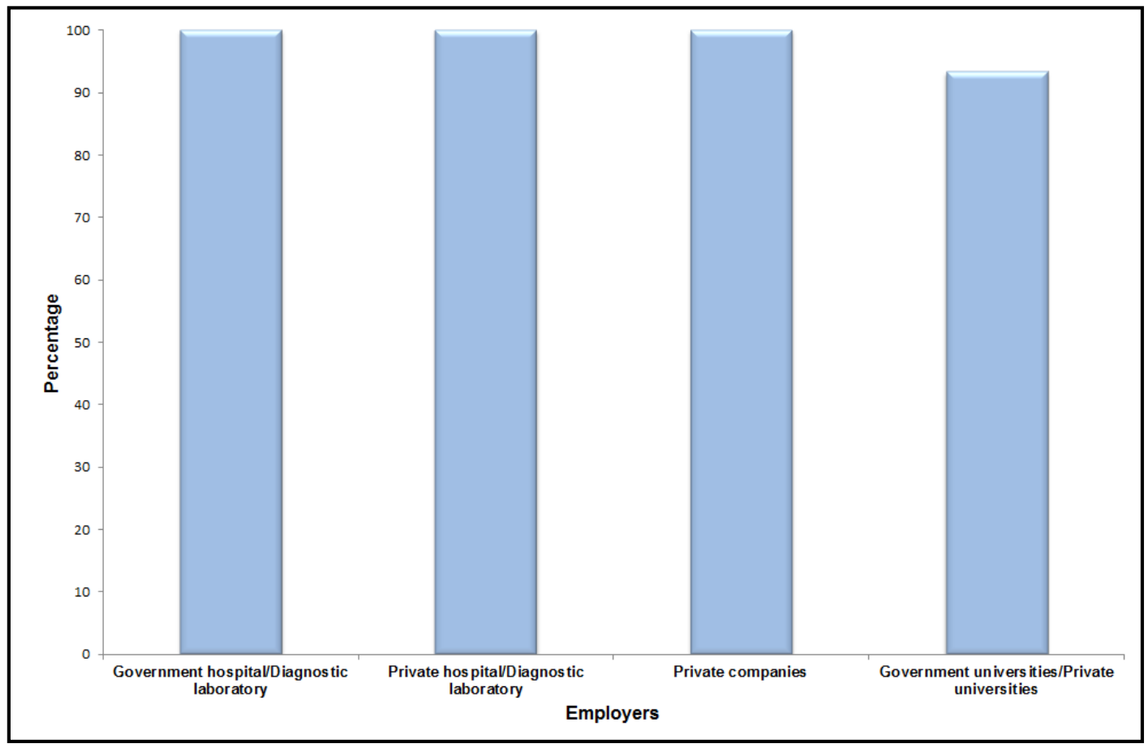


Figure 3.1d Preference of Biomedical Science graduates

Over 90% of respondents were satisfied and stated a preference for Biomedical Science graduates to work in their organizations.

Some of the reasons given for the preference for Biomedical Science graduates are as follows:

i. "Biomedical Sciences include a wide range of medical and laboratory science, so it is good to have an all-rounder to work in the organization," (respondent from the Ministry of Heath).
ii. "A Biomedical Science graduate would be most likely to have balanced exposure to subject areas, which would be a requirement for a career in a diagnostic healthcare laboratory," (respondent from Ministry of Heath, Sarawak).
iii. "Comparatively, Biomedical Science graduates can supervise Medical Laboratory staff better. Their comprehensive training in all areas enables them to identify and rectify technical and administrative problems. Biomedical Science graduates seem to be well-versed in all areas, compared to pure science graduates who only concentrate in their specific major," (respondent from Ministry of Health, Pahang).
iv. "More knowledgeable about research in medical sciences," (respondent from Universiti Kebangsaan Malaysia Medical Centre).
v. "We have departments that actively hire Biomedical Science graduates as we need their knowledge to carry out the operations in the organization," (responded from Prudential Assurance Bhd).

vi. "Biomedical Science graduates can help in managing hospital services and facilities," (respondent from Ministry of Health, Sarawak).

vii. "Have some biomedical knowledge. Good as research officers," (respondent from Clinical Research Council, Ministry of Heath).

viii. "Wide knowledge in many fields. They can teach many different subjects," (respondent from City University College).

ix. "Have wide knowledge in subjects ranging from Pathology to Parasitology," (respondent from Masterskill University).

x. "They are adaptable, have good communications skills, strong research skills and are hardworking," (respondent from Universiti Putra Malaysia).

PART B: Programme Objectives

More than 70% of the respondents agreed that the Biomedical Science graduates working in their organizations have achieved all the listed objectives during the course of their study. The keys: 'Strongly disagree'; 'Disagree'; 'Not sure/irrelevant'; 'Agree'; 'Strongly agree'; and 'Not applicable' are presented in the figure below as the percentage of the total number of respondents.

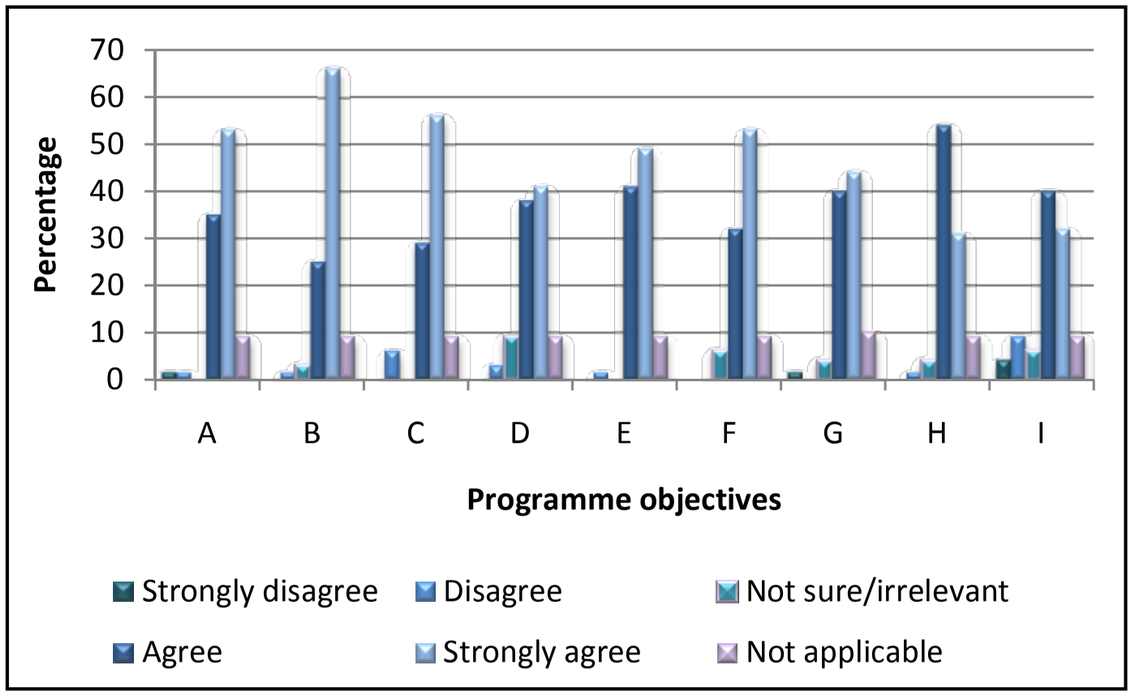


Figure 3.2

A: Basic theory; B: Knowledgeable in current concepts; C: Practical skills; D: Awareness of legal and ethical issues; E: ICT skills; F: Use of quantitative and qualitatative methods; G: Relevance to industry/market; H:Duration of study; and I: Industrial attachment (6-10 weeks).

PART C: ATTRIBUTES OF GRADUATES

Respondents were asked about their opinions on the attributes of Bachelor of Biomedical Science graduates. More than 80% of the respondents agreed that the Biomedical Science graduates working in their organizations have achieved all the listed attributes during the course of their study. The keys: 'Strongly disagree'; 'Disagree'; 'Not sure/irrelevant'; 'Agree'; 'Strongly agree'; and 'Not applicable' are presented as the percentage of the total number of respondents.

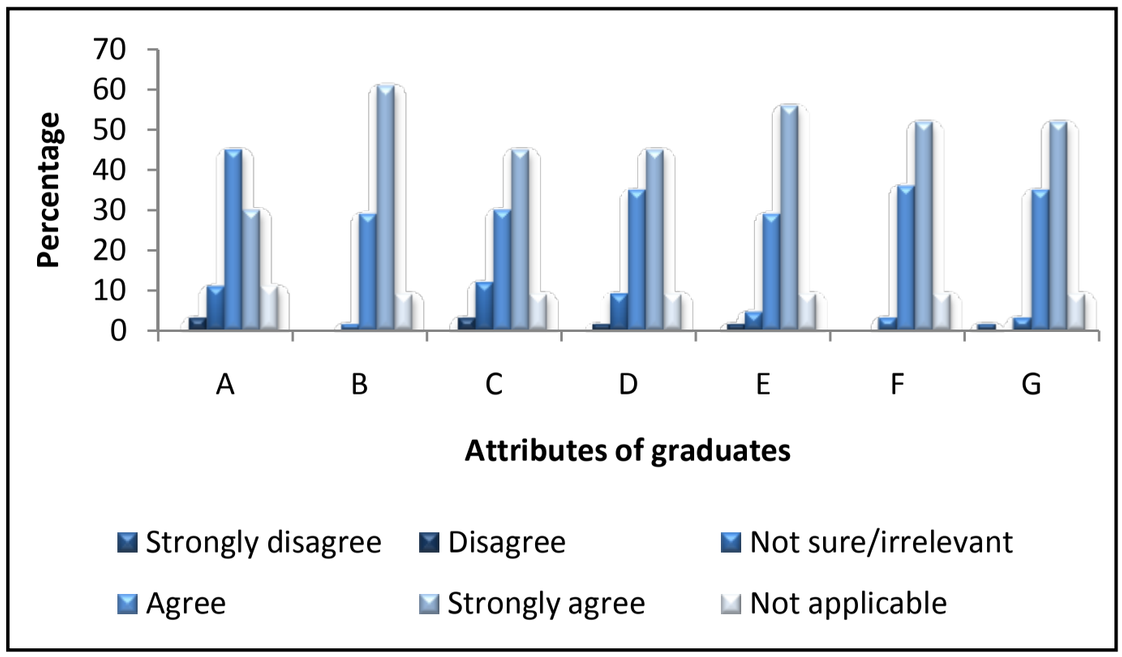


Figure 3.3 Distribution of the graduate attributes

Note
A: Ability to design a system, component or process to meet the design requirement; B: Ability to function effectively as an individual in a group; C: Ability to function as a leader or manager; D: Ability to identify, formulate and provide creative/innovative/effective solutions to a problem; E: Ability to communicate effectively with health professionals, other professionals, and the community at large; F: Recognition of the need for and the ability to engage in lifelong learning; and G: Ability to meet challenges in job-related tasks.

3.1.6 Conclusion

Based on the overall employers' survey results and analyses, we can conclude that the majority of the Biomedical Science graduates were able to achieve most of the programme objectives and attributes set by the universities during the course of their study.

Nearly 100% of the respondents (from various fields and sectors of service) were satisfied with our graduates' levels of competency/performance.

Over 90% of the respondents (employers) who completed the survey preferred to have Biomedical Science graduates in their organizations.

The major conclusion from the survey is that respondents (employers) had a positive impression of Biomedical Science graduates produced by local public universities. It appears that the programme has largely succeeded in achieving the main goals set.

Alumni survey

3.1.7 Introduction

This survey was conducted to obtain feedback from alumni who graduated from local public universities, namely UM, UKM, UPM, and USM, on their career development. (data on IIUM alumni was not available).

The survey comprised of; Part A: Basic information; Part B: Professional and career details; and Part C: Current employment.

3.1.8 Purpose of the Survey

i. to gather alumni information on employment status
ii. to track the career development of Biomedical Science graduates

3.1.9 Methodology for Conducting the Survey

The survey was fielded online through a website (http://umesurvey.um.edu.my/community/survey.php?sid=248). Fielding was conducted between 30th April 2011 and 30th June 2011. Alumni were notified of the survey in advance by e-mail or through Facebook.

3.1.10 Results and Analysis

PART A: Respondent Information

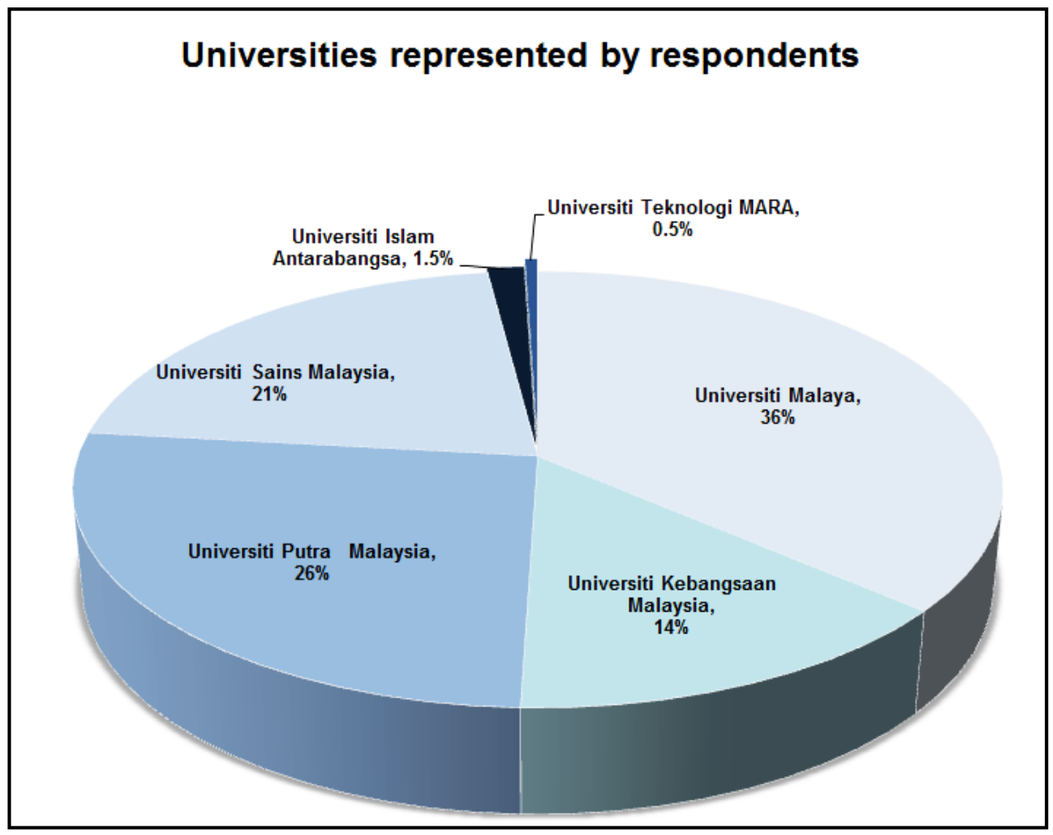


Figure 3.4

Note: Respondents' admission to the public universities ranged from 1992-2007. 70% of the respondents were female and 30% were male.

PART B: Professional and Career Details

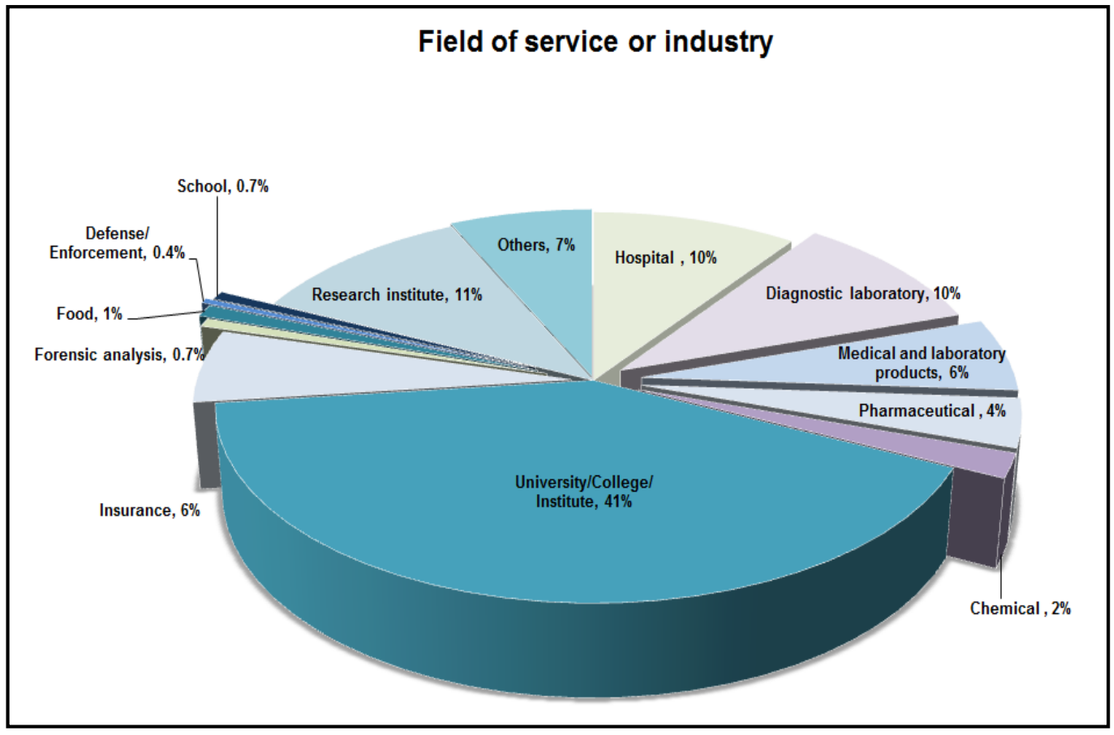


Figure 3.5a

The majority of the respondents were affiliated with a University or College

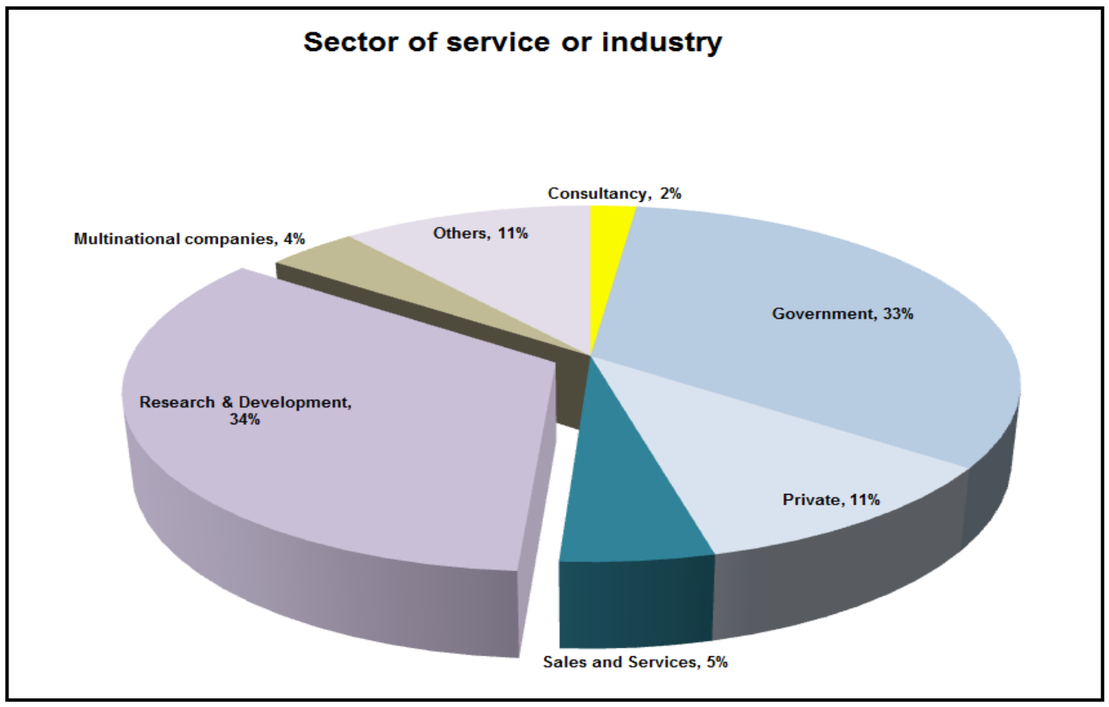


Figure 3.5b

Note: The majority of respondents working in service or in the industrial sector were involved were from research & development sector.

PART C: Current Employment

The majority of the respondents were in the RM2000-RM3000 income bracket. However, it is noteworthy that about 15% of the graduates were earning more than RM5000/month.

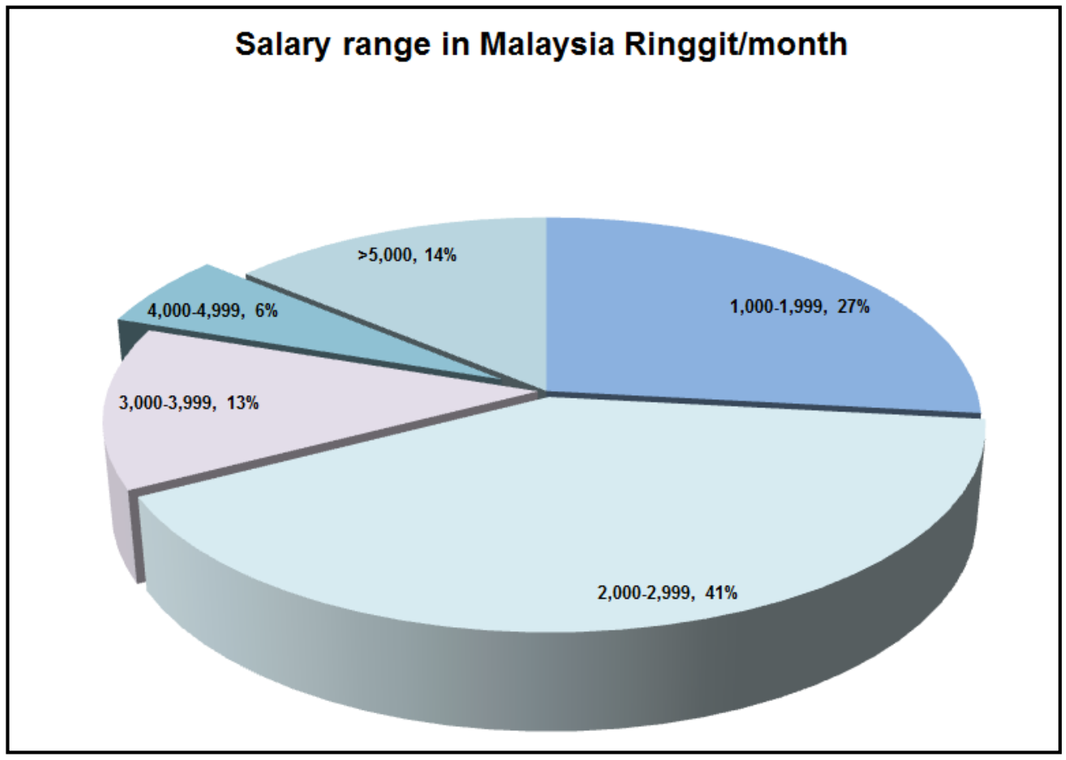


Figure 3.6a

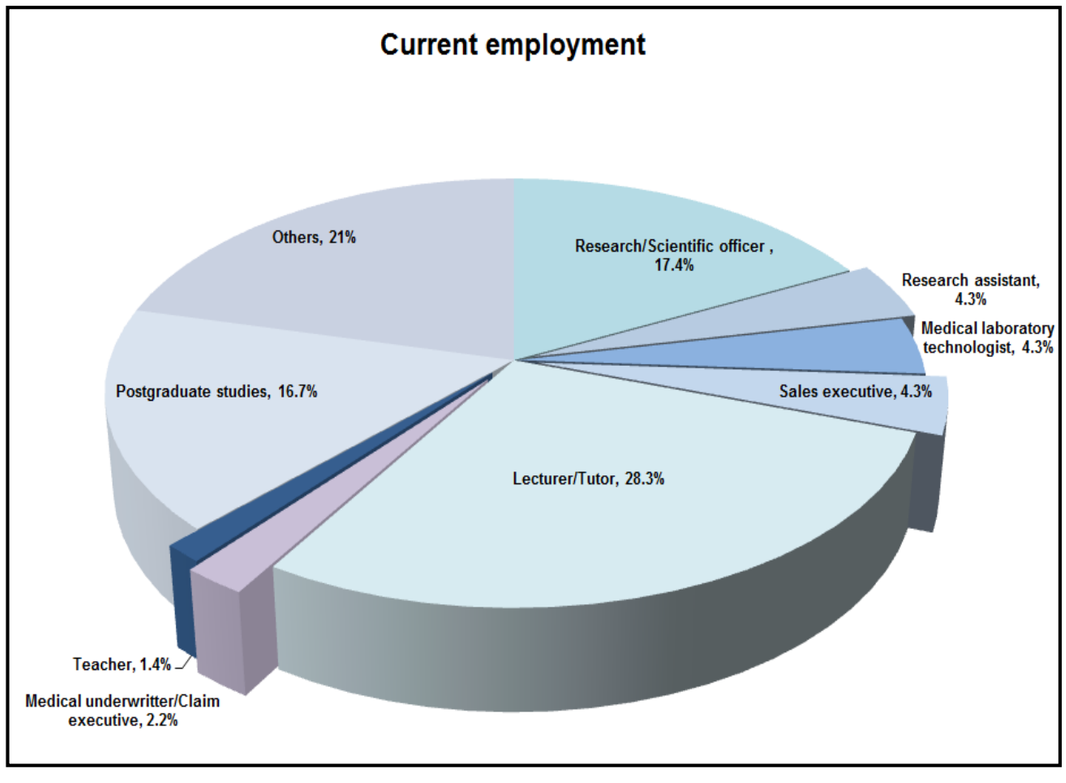


Figure 3.6b

Note: About 60% of the alumni's current jobs are directly related to their degree. Most are working as lecturers or tutors in universities and colleges, with Masters or PhD qualifications (28.3%). Approximately 21% of respondents reported that their current jobs could not be classified into any of the 9 categories listed. These would include jobs as administrative executives, executives, wealth advisers, etc.

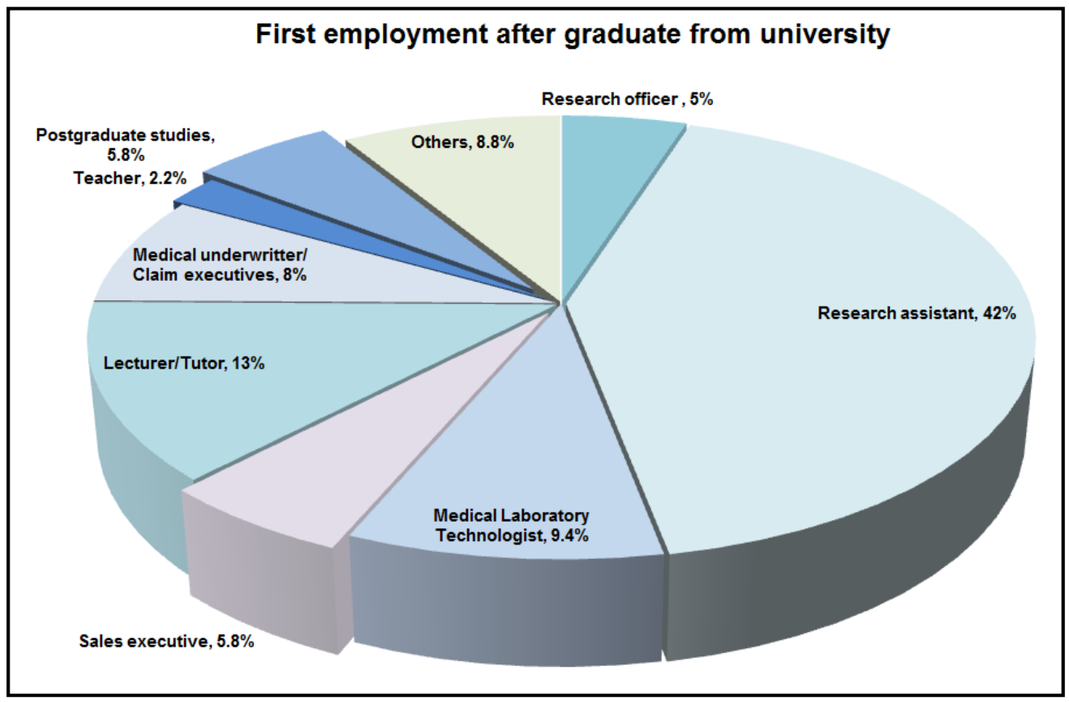


Figure 3.6c

Note:
Approximately 78% of the alumni reported that they were firstly employed in positions that were related to their fields of study. The majority of the respondents worked as research assistants while pursuing their post-graduate studies (42%).

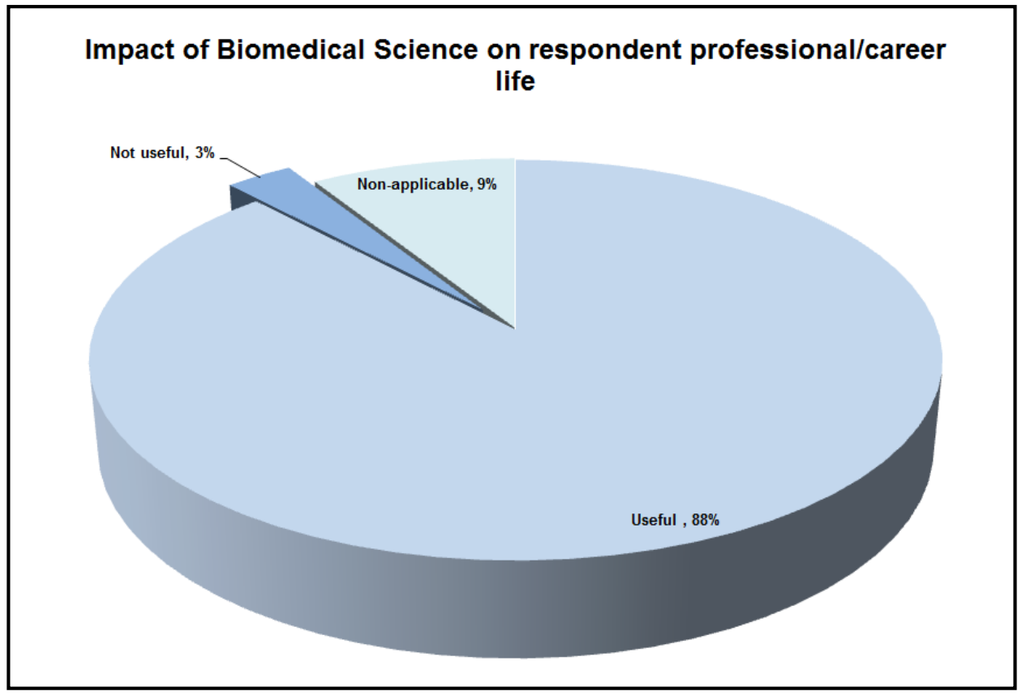


Figure 3.6d

Note: More than 80% of the respondents opined that their Biomedical Science degree qualification was useful in their professional careers, while 12% of the respondents were of the opinion that the degree was neither useful nor applicable to their professional lives.

3.1.11 Conclusion

The vast majority of alumni are currently employed in fields related to their degree. A significant number of doctoral alumni worked in either education or research and development fields. Among alumni holding a basic degree, career paths were more varied, but was observed to be concentrated in hospitals, diagnostic laboratories, and research and development sectors. Over 80% of the respondents felt that the degree that they obtained was useful in their professional/career development.

STUDY LIMITATION

No research is without limitations; these survey studies are no exception. The most obvious limitations:

i. Low response rate from stakeholders and alumni. We might postulate that one reason for this is that e-mail addresses have changed over the years, and our requests for participation might not have reached the intended audience,

ii. The bias towards alumni who graduated from local public universities, as graduates from private colleges/universities were not surveyed.

ISSUES PERTAINING TO A CAREER IN DIAGNOSTIC LABORATORY: THE MINISTRY OF HEALTH AS A STAKEHOLDER

A very pertinent issue is the over-production of graduates, especially by several private institutions, creating an inevitable “glut”. The MOHE should be vigilant in limiting the number of graduates produced by each institute of higher learning. Commencement of any new Biomedical Science or similar programmes should be put on hold for the time being.

Naturally, there remains a tendency for stakeholders/potential employers to employ graduates who can be paid the minimum salary with maximum workload. We have been made aware of private diagnostic laboratories that have employed Biomedical Science graduates on salary scales that do not commensurate with their expertise or workload.

The situation at MOH diagnostic laboratories is not very favourable either. Although the first batch of Biomedical Science students graduated in 1996, positions for Biomedical Scientists were only created in 2009. Currently there are only 65 such posts at the MOH and the remuneration scale is similar to the Basic Science graduates who have been employed at said diagnostic laboratories. The limited availability of diagnostic posts means it is not feasible to customize the curricula and industrial training to suit employment in diagnostic laboratories only. Despite Biomedical Science degree being, in essence, a professional degree, Malaysian Biomedical Scientists have yet to receive due recognition as professionals.

On the other hand, diploma level MLT posts are among the largest in terms of numbers at MOH diagnostic laboratories. It is recommended these personnel with diploma qualification gradually make way for degree-holders; this can be achieved by replacing the vacancies that arise due to retirement with graduate degree holders, and by providing genuine opportunities for diploma holders to obtain their degrees in Biomedical Science and subsequently be absorbed back into the system on an improved remuneration scale. This method was adopted by Thailand as a way to have degree-level MLTs transitioning into the posts previously held by certificate and diploma-level MLT. The Thailand effort took 40 years, but they have now reached their target staffing of 100% degree holders (Medical Technologist/Biomedical Scientist) in all diagnostic laboratories.

In Malaysia, under the current system, it would be more feasible to target at least 60% of the workforce to eventually be filled by Biomedical Science or similar degree holders.

RESEARCH AS AN IMPORTANT CAREER PATH

It is noteworthy that a significant number of our local graduates have pursued postgraduate studies in various areas of Biomedical Science. In aspiring to achieve fully developed nation status by the year 2020, Malaysia faces nine central strategic developmental challenges. The sixth developmental challenge is “to estalish a scientific and a progressive society that is innovative and forward-looking, one that is not only a consumer of technology, but also a contributor to the scientific and technological civilisation of the future”. Currently, scientists account for 0.3% of the Malaysian population, which is an improvement over 0.18% in 2004. In line with this challenge, it is hoped that by 2020, scientists would represent 0.6% of the country’s population. Sadly, this figure would pale in comparison with the 15-18% representation by scientists in France, while Japanese and US scientists account for 28-30% of their respective populations.

There is a need to train intelligent and well-balanced graduates to become successful research scientists. Biomedical science undergraduates would be the most prepared and available cohort of future scientists who can be trained to earn PhDs in medical research. They will be at the frontline of endeavours to meet the current medical challenges endemic in this geographical region. These would include, but would not be limited to, blazing through new frontiers in medical knowledge related to tropical diseases, development of improved diagnostic tools for endemic diseases, and exploration of the rich potential of existing natural health products originating from Malaysia’s diverse ecosystem.

CHAPTER 4

RECOGNITION AS A PROFESSIONAL DEGREE

In countries such as the UK, Australia, Thailand, Canada and the US (to name a few), Biomedical Science graduates would be the predominant practitioners in diagnostic service laboratories. In contrast, in Malaysia, only a very small percentage of Biomedical Science graduates seek employment in service laboratories. This raises a pertinent issue that must be addressed. At present there is an absence of a professional status and an appalling shortage of allocated positions in hospital diagnostic laboratories under the Ministry of Health. Whatever positions that are available are taken up by Bachelor of Science graduates with majors in Biochemistry, Microbiology, Genetics, etc. It is worth the reminder that under current programme curicula, basic science undergraduates are neither exposed to diagnostic laboratory services nor trained in the core areas of diagnostic laboratory sciences.

Despite worldwide recognition of the Biomedical Science degree as a professional degree, Biomedical Science in Malaysia was commenced as non-professional degree programmes. As a consequence, Biomedical Science graduates are identified as non-professional degree-holders, which adversely affects their career outlook and denies them a clearly defined career path. In other countries (especially those mentioned above) only graduates with a Biomedical Science or similar degrees (eg. Medical Technology, Biomedicine, Laboratory Medicine) are allowed to practice in a diagnostic laboratory. The lack of communication and moderation between the stakeholders (for example, the Ministry of Health) and the Ministry of Education (Ministry of Higher Education, from 2004 onwards) was a likely factor in this persisting neglect of giving these graduates their due recognition.

An important and significant move has now been made by the Ministry of Health to include Biomedical Science as one of the Allied Health Professions. An enactment of Allied Health Profession Act has already been initiated and our earnest hope is that with the existence of this Act, Biomedical Science will be rightfully identified as a professional degree in the near future. In the meantime, discussions are still on-going between the Ministry of Health and local Universities on issues pertaining to laboratory posting.

NEED FOR A PROFESSIONAL (BIOMEDICAL SCIENCE) BODY/COUNCIL

The establishment of a professional body/council is an essential move towards professionalization. This council would play an important role in monitoring curricula and in accreditating the Programme at each institution; set the terms of reference for Biomedical Scientists/graduates; function to promote and

conduct courses that are important to the profession, akin to Post Basic or Continuous Professional Development (CPD).

Personnel working in a diagnostic laboratory must have adequate knowledge on handling clinical and biohazard specimens. Enforcement of “License to practice in a diagnostic laboratory” would eliminate the problems and issues associated with poorly qualified or incompetent personnel being employed at such critical service oriented premises. Issues pertaining to licensing would be handled by this council.

FORMATION OF A NATIONAL BIOMEDICAL SCIENCE SOCIETY

The Society will build a database to track, compile and update the career progression of Biomedical Science graduates. The Society would also be responsible for providing updates on the profession, as aligned to national and international requirements. This Society should include membership of all Biomedical Science graduates, regardless of their current professions, so as to serve as a platform for discussing issues and arising problems, while charting the future development of the Biomedical Science profession.

CHAPTER 5

RECOMMENDATIONS: CONCISE SUMMARY

This chapter summarizes the pertinent issues raised in earlier chapters (chapters 2, 3 and 4) and the committee's recommendations on approaches and methods to resolve the issues. The quality of graduates and of the Programme itself, and the setting up of professional bodies are issues that require immediate attention. Now that the committee has compiled this information, it is up to the policy makers to respond with the enforcement of the relevant acts and regulations that would contribute to the standardization and recognition of the Biomedical Science profession in Malaysia.

ISSUES	SUGGESTIONS/ RECOMMENDATIONS	NOTES
Too many graduates	• Limit student intake (especially at Private Institutions) • MOHE has to play a vigilant role in control and regulation	• Unlimited intake and the lack of infrastructure , such as teaching and research laboratories, as well as the sparcity of qualified academic staff has adversely affected the quality of graduates
Quality of Programme	• Allow only institutions with university status, which are equipped with adequate facilities to conduct this programme • Regular auditing of each institution to ensure that the intake numbers do not exceed the capacity and capability of the institution • University must have the research facilities that would enable students to conduct research, as this is part of their training requirement, and is indeed the acknowledged, important part of the curiculum that makes the Biomedical Science graduate stand out amongst all Science graduates	• Teaching staff must have appropriate qualification • Institutions must have sufficiently equipped facilities for practicals / research

ISSUES	SUGGESTIONS/ RECOMMENDATIONS	NOTES
Absence of a Professional Body	• Professionalization of the Biomedical Science degree • Formation of a professional (Biomedical Science) Body/Council: - To monitor curricula and accreditate the Programme at each institution - For licensing of qualified Biomedical Science professionals - Terms of Reference for Biomedical Scientists - Function to promote and conduct courses that are important to the profession , akin to Post Basic or Continuous Professional Development (CPD)	• Currently in progress under the AHP Bill/Act • Professional bodies have long been established in the United Kingdom (the Institute for Biomedical Sciences, IBMS) and in Thailand (Medical Technology Council, MTC) • Ideally: - A national Biomedical Scientist Board & Council should be set up by 2013-2015
Absence of Licensing	• Enforcement of a License to practice in a diagnostic laboratory • Personnel working in a diagnostic laboratory must have adequate knowledge on handling clinical and biohazard specimens	• Recent advances might resolve the issue to a certain extent, with the enactment of the Health Act
Formation of a National Biomedical Science Society	• A national Biomedical Science society should be formed • The society should build a database to track, compile and update career progression of Biomedical Science graduates • Would also be responsible for providing updates on the profession, as aligned to national and international requirements.	• This society should cover all Biomedical Sciences graduates, regardless of their current professions. • This could serve as a platform to discuss issues and arising problems, as well as the future development of the Biomedical Science profession

ISSUES	SUGGESTIONS/ RECOMMENDATIONS	NOTES
Clinical laboratory placement for undergraduate student Current system for gaining access to facilities at Ministry of Health (MOH) establishment is not optimum for the undergraduate student placement	• MOHE needs to communicate and coordinate with the MOH at the ministry level on the mechanisms for handling students' clinical laboratory placements. • Students may be allowed to opt for research laboratory posting (including Biotechnology research laboratory).	• MOH should not show disparity between private and public institutions • (giving preference to those who offer an honorarium) • Practical/posting at public hospitals should take into consideration the minimum requirement for undergraduate training
Salary scale	• The profession needs to be recognized as a clinical /medical laboratory profession • Special allowance such as clinical and critical allowance should be provided	• Should be categorized under the medical scheme (U scheme).
Classification of diagnostic services as professional services	• Diagnostic laboratories offering diagnostic services should employ only qualified personnel with biomedical science or similar disciplines • Licensing for practicing should be made compulsory • Professional bodies may be appointed for monitoring and moderating Biomedical Service	• 60% of the providers of diagnostic services should hold a basic degree in Biomedical Science. • Majority of the workforce in the diagnostic laboratory comprises MLT diploma holders. They may be gradually replaced by Biomedical Science degree holders via mechanisms recommended in chapter 3. • Worldwide, Biomedical Science is recognized as a professional service and Biomedical Scientists are identifed as

ISSUES	SUGGESTIONS/ RECOMMENDATIONS	NOTES
		professionals; • it is high time for Malaysia to do so
Autonomy on diagnostic results	• Biomedical Science graduate practicing in the diagnostic laboratory should be allowed to issue (sign) the results for tests performed within their area of expertise • Revision / amendment of any act that does not allow this is recommended • Create a niche for these high-skilled graduates in the diagnostic laboratory to make full use of their potential.	• Essential element for profession al status ; independent and not controlled by other professions • With licensing and a special professional exam this is possible • Refer to practices in the UK, Thailand and other countries • Association and Alumni form a strong lobby.

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APPENDICES

Appendix 1 Flow of Activities

JANUARY 2011	FEBRUARY 2011	MARCH 2011
Brainstorming sessions	Produce survey forms - Alumni Survey - Employer Survey	Forum – Biomedical Science Symposium
MARCH- JULY 2011	**APRIL 2011**	**JUNE 2011**
Distribution of alumni and employer surveys via hard copy and online: - Mail - E-mail - Facebook	Briefing on IBMS accreditation by Professor Dr. Chowdery, President HUBMS	Academic Visit to: Khon Kaen University Chulalongkorn University Mahidol University
JULY 2011	**AUGUST 2011**	**OCTOBER 2011**
Analysis of results Compilation and interpretation of data	Preparation of final report (draft)	Submission of final report

Appendix 2 A sample academic structure of a typical Biomedical Science programme

Levels	Target Credit	Total Credit	Subject	Notional Credit	Theory credit	Practical credit
Basic Sciences	(60-70%)	80	Anatomy & Physiology (I & II)	6	4	2
(Theory & Concepts)			Biochemistry and Basic Genetics	4	3	1
	(57)		Psychology and Behavioral Science	3	3	0
			Fundamentals of Health Informatics	3	3	0
			Biostatistics	3	3	0
			Human Biochemistry	3	2	1
			SUB TOTAL	(22)	(18)	(4)
Core			Laboratory Science	3	2	1
(Professional)			Epidemiology	3	3	0

APPENDICES

Levels	Target Credit	Total Credit	Subject	Notional Credit	Theory credit	Practical credit
			Basic Immunology	2	2	0
			Molecular Biology Techniques	3	2	1
			Human Genetics	2	2	0
			Basic Microbiology	3	2	1
			Basic Haematology	3	2	1
			Basic Pharmacology	3	2	1
			Basic Pathology	3	2	1
			Clinical Biochemistry	4	3	1
			Medical Microbiology	4	3	1
			Medical Parasitology	3	2	1
			Research Methodology	2	2	0
			Systemic Pathology & Cytology	4	3	1
			Transfusion Science & Blood Banking	3	2	1
			Advanced Haematology	3	2	1
			Advanced Immunology	2	1.5	0.5
			Advanced Health Informatics	3	3	0
			Principles of Lab. Animal Sciences	2	1.5	0.5
			Special topics in Biomedical Sciences	3	3	0

Levels	Target Credit	Total Credit	Subject	Notional Credit	Theory credit	Practical credit
			SUB TOTAL	(58)	(45)	(13)
			TOTAL	80	63	17
Practical Training		22	Laboratory Management	2	0	2
(Throughout the course)			Final Year Research Project	8	0	8
			Biomedical Practicum	8	0	8
			Industrial Training	4	0	4
			TOTAL	22	0	22
Electives Free choice: Maximum of 15	11%	16	Gender Perspectives in Health	2	2	0
			Ethics and Law for Health Professionals	2	2	0
			Basic Chemistry	2	1.5	0.5
			Tissue Banking	2	1.5	0.5
			Oral Health	2	2	0
			Biodiversity	2	1.5	0.5
			Public Health Entomology	2	1.5	0.5
			Principles of Forensic	2	1.5	0.5
			Health Economy	2	2	0
			Health Communication & Education	2	2	0
			Principles of Health Management	2	2	0
			Communication & Self Development	2	2	0
			Environmental Microbiology	2	1.5	0.5
			Advanced Pharmacology	2	1.5	0.5
			Toxicology	3	2	1

APPENDICES

Levels	Target Credit	Total Credit	Subject	Notional Credit	Theory credit	Practical credit
University Courses (Compul-sory)	16%	22	Bahasa Malaysia IV	2		
			Academic English	2		
			Scientific and Medical English	2		
			TITAS (Islamic and Asian Civilization)	2		
			Ethnics Relation	2		
			Entrepreneurship	2		
			Thinking Techniques	2		
			Foreign (Third) Languages	(2)		
			Co-curriculum (Sports/Cultural PALAPES/SUKSIS/PBSM)	(6)		
Total Units (Core, Electives and University)	136	140				

Appendix 3: List of laboratory equipment necessary to manage a Biomedical Science degree programme

The equipment listed are 'benchmarked resources' (must have), which are estimated based on an average of 50 students per intake per year.

No.	Facility/ Equipment	Total Number	Ratio per Student
BASIC BIOMEDICAL SCIENCE			
HUMAN ANATOMY AND PHYSIOLOGY			
1.	Blood pressure meter/stethoscope	25	1:2
2.	Electrocardiography (ECG) machine	5	1:10
3.	Anatomical models (all organs systems) - 2 sets/system	5	1:10
4.	Anatomical & physiological charts - 2 sets/system	5	1:10
5.	Histology slides (all organ systems - 50-60 slides/box)	10	1:5
6.	Spirometer	5	1:10
7.	Physiograph	2	1:25
8.	Microscope (under general equipment)	-	-
BIOCHEMISTRY			
1.	Centrifuge bench top	10	1:5
2.	Analytical balance	2	1:25
3.	Fume hood	5	1:10
4.	pH meter	5	1:10
5.	Waterbath	5	1:10
6.	Microscope	50	1:25
7.	Electrophoresis (agarose)	2	1:25
8.	Electrophoresis (SDS)	2	1:25
9.	Elisa reader	2	1:25
10.	Spectrophotometer	2	1:25
GENETICS			
1.	Centrifuge bench top	2	1:25
2.	Analytical balance	2	1:25
3.	Fume hood	2	1:25

No.	Facility/ Equipment	Total Number	Ratio per Student
4.	pH meter	2	1:25
5.	PCR machine/thermo cycler	5	1:10
6.	Electrophoresis (SDS)	2	1:25
7.	Incubator	2	1:25
BIOSTATISTICS			
	(No equipment required)		
CORE BIOMEDICAL SCIENCE			
	(Under general equipment)		
CLINICAL BIOCHEMISTRY			
	(Under general equipment)		
MOLECULAR BIOLOGY			
1.	Autoclave	2	1:25
2.	Microwave oven	2	1:25
3.	Microcentrifuge	2	1:25
4.	UV illuminator	2	1:25
5.	PCR machine/thermocycler	5	1:10
IMMUNOLOGY			
1.	Centrifuge (bench top)	2	1:25
2.	ELISA reader/ELISA test kit/	2	1:25
3.	Fume hood	2	1:25
4.	pH meter	2	1:25
PATHOLOGY & CYTOLOGY			
1.	Histopathology Slides – 50-60slides/box	25	1:2
2.	Microtome	2	1:25
3.	Cryostat	2	1:25
4.	Microscope (under general equipment)	-	-
5.	Automated tissue processor	2	1:25
6.	Tissue embedding Machine	2	1:25
7.	Tissue floatation bath	2	1:25
8.	Cyto centrifuge	5	1:10
HAEMATOLOGY			

No.	Facility/ Equipment	Total Number	Ratio per Student
1.	Hemocytometer	25	1:2
2.	Haemoglobinometer	2	1:25
3.	Spectrophotometer	2	1:25
4.	Haematology analyser	2	1:25
5.	Coagulation analyser	2	1:25
6.	Electrophoresis syatem	2	1:25
7.	Centrifuge bench top	2	1:25
8.	Waterbath	2	1:25
9.	Incubator	2	1:25
10.	Microhematocrit centrifuge	5	1:10
11.	Microscope research model	5	1:10
TRANSFUSION SCIENCE			
1.	Centrifuge bench top	2	1:25
2.	Immunohaematology gel card system	5	1:10
3.	Serofuge	10	1:5
4.	Blood refrigerator	2	1:25
5.	Deep freezer -20°C	2	1:25
6.	Waterbath	2	1:25
7.	Incubator	2	1:25
BASIC & MEDICAL MICROBIOLOGY			
1.	Biosafety cabinet	5	1:10
2.	Microscope (under general equipment)	-	-
3.	Incubator	2	1:25
4.	Waterbath	2	1:25
5.	Inverted microscope	1	1:50
MEDICAL PARASITOLOGY			
1.	Specimen entomology/parasitology related	5	10
2.	Microscope (under general equipment)	-	-
3.	Stereo zoom microscope	5	1:10
GENERAL LABORATORY EQUIPMENT (CENTRALISED)			
1.	Microscope (student)	50	1:1

APPENDICES

No.	Facility/ Equipment	Total Number	Ratio per Student
2.	Autoclave (Mid range)	2	1:25
3.	Bench top centrifuge	2	1:25
4.	Blood mixer	2	1:25
5.	Colorimeter	5	1:10
6.	Deep freezer (-20°C)	2	1:25
7.	Electronic balance	2	1:25
8.	Hazardous chemical cabinet	2	1:25
9.	Incubator (37°C)	2	1:25
10.	Laminar flow hood (Clean bench)	2	1:25
11.	Analytical balance	2	1:25
12.	Water purification system	1	1:50
13.	Oven (Hot air)	2	1:25
14.	Platform shaker	2	1:25
15.	Safety cabinet Class 3	2	1:25
16.	Water bath	2	1:25
17.	Automatic pipette (Various volumes)		
	Automatic pipette (Various volumes)		
	Pipette - adjustable vol. (0.2-2.0µl)	50	1:1
	Pipette- adjustable vol. (1-10µl)	50	1:1
	Pipette - adjustable vol. (2-20µl)	50	1:1
	Pipette - adjustable vol. (20-100ul)	50	1:1
	Pipette - adjustable vol. (50-200µl)	50	1:1
	Pipette - adjustable vol. (200-1000µl)	50	1:1
	Pipette - adjustable vol. (1ml -5ml)	50	1:1
	Pipette - fixed volume (1µl)	10	1:5
	Pipette - fixed volume (2µl)	10	1:5
	Pipette - fixed volume (5µl)	10	1:5
	Pipette - fixed volume (10µl)	10	1:5
	Pipette - fixed volume (20µl)	10	1:5
	Pipette - fixed volume (25µl)	10	1:5

No.	Facility/ Equipment	Total Number	Ratio per Student
	Pipette - fixed volume (50µl)	10	1:5
	Pipette - fixed volume (100µl)	10	1:5
	Pipette - fixed volume (200µl)	10	1:5
	Pipette - fixed volume (250µl)	10	1:5
	Pipette - fixed volume (500µl)	10	1:5
	Pipette - fixed volume (1000µl)	10	1:5
PRACTICAL TRAINING / FINAL YEAR PROJECT SPECIALISED LABORATORY IN BIOMEDICAL SCIENCE			
1.	Analytical balance	2	1:25
2.	Bench top centrifuge	5	1:10
3.	Dark room facilities	1	1:50
4.	Deep freezer (-20°C)	2	1:25
5.	Deep freezer (-70°C)	2	1:25
6.	DNA analysis system	1	1:50
7.	DNA sequencer system	1	1:50
8.	Dry heating block	1	1:50
9.	Electronic balance	2	1:25
10.	ELISA reader and washer system	1	1:50
11.	Fume Hood	2	1:25
12.	Gel dryer	1	1:50
13.	Hazardous chemical cabinet	2	1:25
14.	High speed centrifuge	1	1:50
15.	Hybridization oven	2	1:25
16.	Image analysis system	2	1:25
17.	Incubator	2	1:25
18.	Laminar flow hood (clean bench)	2	1:25
19.	Light box	10	1:5
20.	Liquid nitrogen preservation tank	1	1:50

No.	Facility/ Equipment	Total Number	Ratio per Student
21.	Magnetic stirrers	5	1:10
22.	Microfuge	2	1:25
23.	Microwave oven	1	1:50
24.	Microarray system	1	1:50
25.	pH Meter	5	1:10
26.	Platform incubator shaker	2	1:25
27.	Platform shaker	2	1:25
28.	Protein analysis system	1	1:50
29.	Refrigerated benchtop centrifuge	2	1:25
30.	Refrigerated microfuge	5	1:10
31.	Refrigerator (4°C)	2	1:25
32.	Sonicator	1	1:50
33.	Spectrophotometer	5	1:10
34.	Thermal cycler	5	1:10
35.	Water bath	2	1:25
36.	Water purification system (Ultrapure)	1	1:50

Appendix 4: Survey forms

ALUMNI STUDY
BIOMEDICAL SCIENCE PROGRAM

PART A: RESPONDENT INFORMATION

A1: PERSONAL DETAILS

1. Nationality:

   ☐ Malaysian ☐ Others, please specify:

2. Name of Institution:
3. Date of birth:
4. Sex: ☐ Male ☐ Female
5. Marital Status: ☐ Single ☐ Married
6. Year/Session Admission:
7. Admission Qualification:

   ☐ Matriculation
   ☐ STPM
   ☐ Diploma: _____
   (Please state field/ Institution)

   ☐ Foundation Science
   ☐ Ministry of Education
   ☐ Others, Please specify:
   _____

8. Residential Address:

9. Corresspondence Address: (If different from the residential address)

   Home Tel. No:
   Handphone No:
   Latest E-mail Address:

A2: PROFESSIONAL/CAREER DETAILS

1. Field of Service or Industry

Please tick in the appropriate box (You may tick more than one option)

☐ Hospital	☐ Pharmaceutical	☐ School
☐ Diagnostic Laboratory	☐ Chemical	☐ University/college/institute
☐ Forensic Analysis	☐ Food	☐ Insurance
☐ Medical & Laboratory Products	☐ Defense/Enforcement (Military/Police/Fire Department/Prison, etc.)	☐ Research Institute

☐ Others: _____
(please specify)

2. Sector of Service or Industry

Please tick in the appropriate box (You may tick more than one option)

☐ Consultancy	☐ Sales and services	☐ Government
☐ R&D	☐ Private	☐ Multinational Companies
☐ Others, _____ (please specify)		

3. Work Experience: Years: ☐ Months: ☐

A3: CURRENT POSITION:

1. Employer's name and address:

	Office tel no:
	Office fax no:

2. Level of Position

*Please tick in the appropriate box (Tick **ONE** option only)*

☐ Top Management ☐ Middle management ☐ Others, please specify; _____

3. Name of position:

4. Job status (Please state status; i.e. contract / permanent / probation / temporary):

5. Salary in MYR:

☐ 1,000-1,999	☐ 2,000-2,999	☐ 3,000-3,999
☐ 4,000-4,999	☐ 5,000- 9,999	☐ >10,000

6. What was your first job after you graduated from university?
Please state:

7. Reason(s) for seeking current employment:

8. Please state your current level of education:

☐ Master,please specify: _____ ☐ PhD
☐ Others, Please specify:_____

9. Do you take any additional degree after graduate from Biomedical science Programme?

☐ Yes (Ongoing), please specify:_____ ☐ No
☐ Yes (Completed), please specify: _____

10. If you are currently pursuing your postgraduate studies, please complete the following questions:

a. Current status of postgraduate studies:

☐ Ongoing ☐ Waiting for graduation ☐ Completed

b. Current status of postgraduate studies:

☐ Ongoing ☐ Waiting for graduation ☐ Completed

c. Field of research:

11. Comment on impact of “Biomedical Science Program” to your professional/career life?

☐ Useful ☐ Not useful ☐ Not applicable

Other comments, (Please state):

_____
_____
_____
_____

Signature: _____

Date: _____

END

We wish to thank you for your time and effort. If you have any question, please write to:

kajianhalatuju@gmail.com, or call: 603-79674900

Kindly return this survey to the following address :

Prof. Dr. Umah Rani Kuppusamy
Chairman,
Kajian Hala Tuju Program Pengajian Sains Bioperubatan,
Program Sains Bioperubatan
Jabatan Perubatan Molekul
Fakulti Perubatan
Universiti Malaya
50603 Kuala Lumpur
Fax: 603-79676600
or through e-mail:
kajianhalatuju@gmail.com