Malaysian Biotechnology
Human Capital Development
Report 2009

Frost & Sullivan
Suite E-08-15, Block E,
Plaza Mont’ Kiara,
2, Jalan Kiara, Mont’ Kiara,

20 April 2009

Prepared for

Malaysian Biotechnology
Corporation Sdn. Bhd. (BiotechCorp)
Level 23 Menara Atlan,
161 Jalan Ampang,
50450 Kuala Lumpur

www.biotechcorp.com.my
www.biomalaysia.com.my
The Honourable Minister of Science, Technology & Innovation  
Datuk Dr. Maximus Johnity Ongkili, JP

The study of human capital development for the Malaysian biotechnology industry contained in this report is both timely and significant.

The Malaysian biotechnology industry is completing its capacity building phase and commencing its science to market commercialization phase by 2011. It is important for all industry participants and stakeholders to review the biotechnology situation to date.

The key drivers of the Malaysian biotech industry are public grants, the competitive labour force, our rich biodiversity and the incentives and privileges we offer – nevertheless, we need to address gaps and constraints in the industry. These include insufficient human capital development, private sector funding and distribution network. We need to address these challenges with focus and commitment.

Specific to human capital development, effective public private sectors initiatives are critical in meeting the requirement for qualified and competent Malaysian talent in biotechnology.

I would like to thank the teams at the Ministry of Science, Technology and Innovation, Malaysian Biotechnology Corporation (BiotechCorp) and Frost & Sullivan in developing this report.

I am confident that the findings in this report will provide a vital framework for public and private sectors participants in the Malaysian biotechnology industry to improve effort for better results.

I look forward to even greater success in enhancing human capital development for the Malaysian biotechnology industry.

Datuk Dr. Maximus Johnity Ongkili, JP
The study of human capital development for the Malaysian biotechnology industry contained in this report is both timely and significant. The Malaysian biotechnology industry is completing its capacity building phase and commencing its science to market commercialization phase by 2011. It is important for all industry participants and stakeholders to review the biotechnology situation to date.

The key drivers of the Malaysian biotech industry are public grants, the competitive labour force, our rich biodiversity and the incentives and privileges we offer – nevertheless, we need to address gaps and constraints in the industry. These include insufficient human capital development, private sector funding and distribution network. We need to address these challenges with focus and commitment.

Specific to human capital development, effective public private sectors initiatives are critical in meeting the requirement for qualified and competent Malaysian talent in biotechnology.

I would like to thank the teams at the Ministry of Science, Technology and Innovation, Malaysian Biotechnology Corporation (BiotechCorp) and Frost & Sullivan in developing this report.

I am confident that the findings in this report will provide a vital framework for public and private sectors participants in the Malaysian biotechnology industry to improve effort for better results.

I look forward to even greater success in enhancing human capital development for the Malaysian biotechnology industry.

Datuk Dr. Maximus Johnity Ongkili, JP

Foreword by CEO

Dato’ Iskandar Mizal Mahmood

Chief Executive Officer

Malaysian Biotechnology Corporation

The strength of Malaysian biotechnology is its people. Whether in boom or challenging times, the capacity and capability of Malaysian talent in biotechnology will determine the growth and progress of this sector. In charting the progress of human capital development thus far, the findings and recommendations in this report affirmed the critical areas that need to be addressed in taking Malaysian biotechnology forward.

Whilst BiotechCorp’s human capital development initiatives such as the Biotechnology Entrepreneurship Development Framework and the Biotechnology Special Training Programme (BeST) for unemployed life science graduates are found to be effective in addressing training gaps – further collaborations with industry partners need to be strengthen to escalate results.

Effective collaborations in human capital development will reinforce the achievement of BioNexus companies which have contributed over 1,467 knowledge workers for the Malaysian biotechnology industry since 2006. Collaborations would also expand the benefits of BiotechCorp’s BioNexus Partner Programme which provides an upskilling component for knowledge workers in public universities and research institutions to provide services for commercial, private sector initiatives. Meanwhile, the technology transfer office initiative for public universities in 2009 under BiotechCorp’s Executive-In-Residence programme is expected to narrow the human capital gap in this area significantly.

In closing, I would like to thank the Honourable Minister of Science, Technology and Innovation (MOSTI), Datuk Dr. Maximus Johnity Ongkili, JP, and the team at MOSTI in supporting this report. I would also like to thank the teams at BiotechCorp and Frost & Sullivan for their work on this report.

Indeed, there is much to be excited about in human capital development even in managing the greater challenge of present global economic uncertainties as we work towards continued progress in Malaysian biotechnology.

Dato’ Iskandar Mizal Mahmood
# Table of Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Content</td>
<td>p.6</td>
</tr>
<tr>
<td>Disclaimer</td>
<td>p.8</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>p.8</td>
</tr>
<tr>
<td>1. Executive Summary</td>
<td>p.9</td>
</tr>
<tr>
<td>2. Engagement Introduction</td>
<td>p.10</td>
</tr>
<tr>
<td>2.1. Project Background &amp; Objectives</td>
<td>p.10</td>
</tr>
<tr>
<td>2.2. Research Scope</td>
<td>p.10</td>
</tr>
<tr>
<td>2.3. Caveats &amp; Limitations</td>
<td>p.11</td>
</tr>
<tr>
<td>3.1. Introduction</td>
<td>p.12</td>
</tr>
<tr>
<td>3.1.1. Definition &amp; Market Segmentation</td>
<td>p.13</td>
</tr>
<tr>
<td>3.1.2. Agricultural Biotechnology</td>
<td>p.14</td>
</tr>
<tr>
<td>3.1.3. Healthcare Biotechnology</td>
<td>p.14</td>
</tr>
<tr>
<td>3.1.4. Industrial Biotechnology</td>
<td>p.14</td>
</tr>
<tr>
<td>3.2. Overview of the Biotech Education Sector</td>
<td>p.17</td>
</tr>
<tr>
<td>3.2.1. Industry Structure</td>
<td>p.17</td>
</tr>
<tr>
<td>3.2.2. Industry Dynamics</td>
<td>p.20</td>
</tr>
<tr>
<td>3.2.3. Existing Regulatory Development &amp; Framework</td>
<td>p.25</td>
</tr>
<tr>
<td>3.3. Situational Analysis of Malaysian Biotech on the Global Roadmap</td>
<td>p.26</td>
</tr>
<tr>
<td>3.3.1. Benchmarking of the International Best Practices within the R&amp;D Spectrum</td>
<td>p.26</td>
</tr>
<tr>
<td>3.3.2. Benchmarking of International Best Practices in R&amp;D Human Capital Development</td>
<td>p.30</td>
</tr>
<tr>
<td>3.3.3. International Best Practices Showcase</td>
<td>p.38</td>
</tr>
<tr>
<td>4. Strategic Analysis of Biotech Human Capital Development in Malaysia</td>
<td>p.50</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>4.2.1.</td>
<td>Malaysian Agricultural Biotechnology Human Capital Forecast</td>
</tr>
<tr>
<td>4.2.2.</td>
<td>Malaysian Healthcare Biotechnology Human Capital Forecast</td>
</tr>
<tr>
<td>4.2.3.</td>
<td>Malaysian Industrial Biotechnology Human Capital Forecast</td>
</tr>
<tr>
<td>5.</td>
<td>Industry’s Sentiments on the Local Biotechnology Workforce</td>
</tr>
<tr>
<td>5.1.</td>
<td>Introduction</td>
</tr>
<tr>
<td>5.2.</td>
<td>Defining the Industry Standards</td>
</tr>
<tr>
<td>5.2.1.</td>
<td>Technical Skill Requirements within the Industry</td>
</tr>
<tr>
<td>5.2.2.</td>
<td>Soft Skill Requirements within the Industry</td>
</tr>
<tr>
<td>5.3.</td>
<td>Demand Gap Analysis</td>
</tr>
<tr>
<td>5.3.1.</td>
<td>Assessment of Manpower Sufficiency within the Biotech Sectors</td>
</tr>
<tr>
<td>5.3.2.</td>
<td>Assessment on the Skill Levels of the Biotech Workforce</td>
</tr>
<tr>
<td>5.4.</td>
<td>Future Expectations from the Industry</td>
</tr>
<tr>
<td>6.</td>
<td>Workforce’s Sentiments on the Biotechnology Employment Market</td>
</tr>
<tr>
<td>6.1.</td>
<td>Introduction</td>
</tr>
<tr>
<td>6.2.</td>
<td>Evaluation of Employment Rate for Biotech Postgraduates</td>
</tr>
<tr>
<td>6.3.</td>
<td>Evaluation of the Key Decision Making Criterion for Biotech Employment</td>
</tr>
<tr>
<td>6.3.1.</td>
<td>The Key Influencers of Career Decisions</td>
</tr>
<tr>
<td>6.4.</td>
<td>Biotech Postgraduates’ Assessments on the Academic Programs</td>
</tr>
<tr>
<td>6.4.1.</td>
<td>Assessment on Satisfaction Levels on the Current Curriculums</td>
</tr>
<tr>
<td>6.5.</td>
<td>Demand Gap Analysis</td>
</tr>
<tr>
<td>6.5.1.</td>
<td>Current Challenges and Future Expectations of the Biotech Workforce</td>
</tr>
<tr>
<td>6.5.2.</td>
<td>Addressing the Key Challenges</td>
</tr>
<tr>
<td>6.5.3.</td>
<td>Bridging the Supply &amp; Demand Gaps</td>
</tr>
<tr>
<td>7.</td>
<td>Conclusion</td>
</tr>
<tr>
<td>7.1.</td>
<td>Key Findings and Interpretations</td>
</tr>
<tr>
<td>7.2.</td>
<td>Key Recommendation</td>
</tr>
</tbody>
</table>
**DISCLAIMER**

Frost & Sullivan takes no responsibility for any incorrect information published by the Ministry of Agriculture, Department of Statistics, Ministry of Higher Education, Malaysian Science and Technology Information Centre and company registrars as well as media press releases in the related countries. Frost & Sullivan has taken care to ensure the figures presented are of the highest accuracy possible.

No part of this report may be given, lent, resold, or disclosed to non-customers without written permission. Furthermore, no part may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the permission of the publisher.

For any queries on this report, please contact:

Mr Keith Lee  
Consultant  
Frost & Sullivan, Asia Pacific Healthcare  
DID: +603 – 6204 5848  
Fax: +603 – 6201 7402  
Email: keith.lee@frost.com

**DEFINITION OF TERMS**

<table>
<thead>
<tr>
<th>TERMS</th>
<th>DEFINITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>APEC</td>
<td>Asia-Pacific Economic Cooperation</td>
</tr>
<tr>
<td>F&amp;S</td>
<td>Frost and Sullivan</td>
</tr>
<tr>
<td>FTE</td>
<td>Full Time Equivalent</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GERD</td>
<td>Gross Expenditure for Research and Development</td>
</tr>
<tr>
<td>HR</td>
<td>Human Resource</td>
</tr>
<tr>
<td>KOL</td>
<td>Key Opinion Leaders</td>
</tr>
<tr>
<td>BiotechCorp</td>
<td>Malaysian Biotechnology Corporation</td>
</tr>
<tr>
<td>MOSTI</td>
<td>Ministry of Science, Technology and Innovation</td>
</tr>
<tr>
<td>NBP</td>
<td>National Biotechnology Policy</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Cooperation and Development</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research &amp; Development</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
The pulling forces of biotechnology for wealth creation have triggered international interests in recent years. Malaysia, a nation striving to remain competitive in the global arena had launched its National Biotechnology Policy in 2005, which was further streamlined through the strong focus and budgetary allocation for the biotechnology sector in the 9th Malaysian Plan.

Four years down the road since the first implementation of the National Biotechnology Policy, the biotechnology industry in Malaysia has shown signs of favourable progression with increasing market capitalization of the biotech players and industry funding. Nonetheless, human capital development still remains as a relatively untapped thrust under the policy. Most significantly is the fast growing rate of unemployed biotech postgraduates in the private sector. In-depth assessments on the industry players and workforce sentiments had generally depicted an overall picture that the private sector growth is unable to cope up with the fast growing workforce production at the academia levels, which had resulted to the emerging trend of workforce seeking employments in the academic sector. Furthermore, general industry sentiment had depicted the need for quality enhancement of the workforce to enhance efficiency and knowledge capabilities.

Emerging regional neighbours, such as Singapore, India, and Taiwan are gradually extending their influence in the international biotech arena and much of the success were accountable to their strong emphasis on their human capital development initiatives. Hence, it is critical for Malaysia to increase its financial support for the biotechnology sector to enhance the quality of this domestic workforce development programs, and vitalize the private sector to improve biotech workforce demand in the country. One such initiative will be foreign expertise collaboration may serve as an effective human capital development strategy to enhance the quality level, which biotech workforce produced and address the “brain-drain” challenge in the country. However, it will be vital for Malaysia to establish its biotech research infrastructure, in order to enhance the confidence and interests of foreign expertise support.

Holding strong advantages of cultural and biodiversity, Malaysia possesses great potential in becoming one of the regional hub for tropically-based biotech research. In order to achieve such objectives, development for both the biotech industry and human capital development must be parallel to equip the nation with competitiveness in the global biotech platform in the future.
ENGAGEMENT
INTRODUCTION

2.1 Project Background & Objectives

Under the strong efforts and initiatives of the Malaysian Biotechnology Corporation (BiotechCorp), the national biotechnology development program is continuing to gain momentum to fulfill its aim in developing biotechnology as one of the key drivers of the Malaysian economy.

While significant strides have been made under the Thrust One of the National Biotechnology Policy - Moving the economy up the value chain, whereby the number of market players and market capitalization of the biotech industry has significantly increased since 2000, the progress in terms of human capital development (Thrust Two) of the National Biotechnology Policy is relatively undefined.

Hence, BiotechCorp has engaged Frost & Sullivan to perform an assessment on the biotechnology human capital market in Malaysia to gain insights on the current employment status and gauge the level of success for the development of biotech workforce through the National Biotechnology Policy. Furthermore, perspectives from various key opinion leaders in the industry are obtained to analyze on the supply and demand gaps in the industry.

2.2 Research Scope

A two-stage study approach was adopted for this study:

Stage 1: Secondary Research:
Secondary research efforts include quantitative data gathering and analysis from:
- Frost & Sullivan Industry Database
- Available printable reports, including company annual report, trade or technical journals and other government publications.
- Online databases from associated bodies or organizations, including the Biotech Industry Organization, APEC, OECD, World Bank, WHO etc.

Stage 2: Primary Research:
Primary research efforts include qualitative and quantitative research through face-to-face or telephonic interviews with major industry players and biotech employers, key opinion leaders and academia leaders and a pool of biotech postgraduate students throughout Malaysia.
A total of 140 respondents had participated and contributed their opinions and perspectives to this study. Segregation of the respondents is presented as the following:

<table>
<thead>
<tr>
<th>Respondent Category</th>
<th>Agricultural</th>
<th>Healthcare</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry players and experts</td>
<td>12</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>KOL’s and Teaching Faculty</td>
<td>8</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Post Graduate Students</td>
<td>20</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>60</strong></td>
<td><strong>40</strong></td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan

2.3 Caveats & Limitations

Limitation in Source of Information:

- In cases where 2007 or 2008 figures are not available from public statistical sources, F&S will use the latest information available or make estimations based on past years’ trend.

- Trade interviews with industry and academic players are conducted to substantiate information in this report, based on a best-efforts basis.

- Frost and Sullivan will not be held responsible for any information gaps where industry players have refused to divulge confidential company data or figures.

- In instances where information is not available, figures based on similar indicators combined with Frost and Sullivan in-house analysis will be deployed to arrive at an estimate.

- Scope of coverage for each biotech segment is based on the definitions of disciplines within the agricultural biotechnology, healthcare biotechnology and industrial biotechnology from MOSTI. In case where the definition differs from overseas practices, the specific definition from foreign countries will be specifically included in the footnotes.

- This report represents a synthesis of biotechnology industry data and observations during a snapshot in time and cannot claim to be a 100 percent accurate representation of the HR landscape for the biotech sector as a whole.

Exchange Rate Conversion:
The exchange rates (as of 31st March 2009) used in this report are as follows:

<table>
<thead>
<tr>
<th></th>
<th>MYR</th>
<th>SGD</th>
<th>EUR</th>
<th>GBP</th>
<th>TWD</th>
<th>JPY</th>
<th>INR</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD 1.00</td>
<td>3.64</td>
<td>1.52</td>
<td>0.76</td>
<td>0.70</td>
<td>33.96</td>
<td>97.35</td>
<td>50.94</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan
3.1 Introduction

In 2005, the National Biotechnology Policy stipulated that one of the main engines of growth for Malaysian economy in our aspiration to reach Vision 2020 is biotechnology. In this, biotechnology has a role in both wealth creation and to provide for the social well-being of Malaysians. Biotechnology has been in existence in Malaysia for a long time. As a country, we are truly blessed with one of the most naturally endowed biodiversity in the world. Being one of the world’s 17 mega diverse countries in marine biodiversity and also one of the 12 world’s hotspots for biodiversity, Malaysia’s potential in developing biotechnology looks brighter than ever. However, in order for a policy to be implemented to its full effectiveness, it requires constant feedback to improve.

Since the introduction of the National Biotechnology Policy, BiotechCorp has developed a total of 97 BioNexus-status biotechnology firms in Malaysia with a total investment of RM1.3 billion. These companies are mainly involved in three areas; 33 are Agricultural Biotechnology companies, 38 are Healthcare Biotechnology companies, 23 are Industrial Biotechnology companies and 3 are Bioinformatics firms. A total of 74 of these 97 firms posted combined revenue of RM100 million in the third quarter of 2008. In 2009, BiotechCorp hopes to roll out another 55 BioNexus-status firms. BioNexus firms have special incentives given by the government to facilitate their starting up. BioNexus firms have freedom of ownership, to source for staff and funds globally, 100 percent income tax exemption for 10 years, tax exemption on dividends distributed, exemption from import duty and sales tax on raw materials, machinery, equipment and components and double deduction on expenditure incurred for research and development.

In Malaysia’s National Biotechnology Policy, there are nine main thrusts. Thrust one is to enhance and transform the value creation of the agricultural sector through biotechnology. Thrust two is to capitalise on the strengths of biodiversity to commercialise discoveries in health-related natural products and bio-generic drugs. Thrust three is to leverage Malaysia’s manufacturing sector by increasing opportunities in bio-processing and bio-manufacturing. The fourth thrust is to establish biotechnology centres of excellence in the country where multi-disciplinary research teams are involved in coordinated initiatives. Thrust five is to build human capital in biotechnology via education and training. The sixth thrust is to apply competitive ‘lab to market’ funding and initiatives to encourage committed participation from academia and private sectors. Thrust seven then moves to improve the country’s innovation system by reviewing the existing legal and regulatory frameworks. The eighth thrust is to establish a global marketing strategy to build recognition for Malaysian biotech and benchmark progress. Finally, the ninth thrust is to establish a dedicated and professional implementation agency overseeing the development of Malaysia’s biotech industry, under the aegis of the Prime Minister and relevant government ministries.
Diagram 3-1
Implementation Phase of National Biotechnology Policy

The implementation of the National Biotechnology Policy encompasses three main phases:

**PHASE I (2005-2010)**
Capacity Building
- Establishment of advisory and implementation Councils
- Establishment of Malaysian Biotech Corporation
- Education and training of knowledge workers
- Development of legal and IP framework
- Business development through Accelerator Programmes
- Build Malaysian branding
- Initial job and industry creation in agricultural biotech, healthcare biotech, industrial biotech and bioinformatics

**PHASE II (2011-2015)**
Science to Business
- Develop expertise in drug discovery and development based on natural resources
- New products development
- Technology acquisition
- Intensify investment promotion
- Intensify spinning-off of companies
- Strengthen branding
- Develop capability in technology licensing
- Knowledge-intensive jobs creation

**PHASE III (2016-2020)**
Global Presence
- Consolidate strengths and capabilities in technology development
- Further develop expertise and strength in drug discovery and development
- Strengthen innovation and technology licensing
- Promote global Malaysian companies

It is intended that by 2020 Malaysia will be a global player in biotechnology and will generate at least 20 global Malaysian companies.

Source: Ministry of Science, Technology & Innovation

3.1.1 Market Segmentation & Definition

In the spectrum of biotechnology, there are many definitions derived from the several branches of biotechnology. Most definitions are classifying biotechnology into fields of subjectresearches. There are bioinformatics, blue biotechnology, green biotechnology, red biotechnology and white biotechnology. In this study, we will be looking at green biotechnology - agricultural biotechnology, red biotechnology is also called healthcare biotechnology and white biotechnology or industrial biotechnology, which are included in Malaysia’s National Biotechnology Policy.
3.1.2 Agricultural Biotechnology

Agricultural Biotechnology is also known as green biotechnology. This classification takes into account all biotechnology used in relation to plants whether it is crops or ornamental plants. Agricultural Biotechnology primarily focuses on using biotechnology to increase the yield of crops, reduce the plant’s vulnerability to environmental stress and to improve nutritional quality and quantity of crops. Besides that, green biotechnology also improves the taste, texture and appearance of food. It also helps to reduce dependence on fertilizers, pesticides and agrochemicals which may harm our health in the long run and has been credited with production of novel substances in crop plants.

3.1.3 Healthcare Biotechnology

Healthcare Biotechnology or red biotechnology focuses on fields of biotechnology which is related to healthcare. This field has been in existence in Asia for a long while with various communities throughout Asia using herbal concoctions to treat illnesses. In modern biotechnology, red biotechnology focuses on treatment of illnesses and diagnosis of diseases through novel methods such pharmagenomics, genetic testing, gene therapy, cloning, creating new pharmaceutical products and the Human Genome Project.

3.1.4 Industrial Biotechnology

Industrial Biotechnology is also known as white biotechnology. This field of biotechnology involves applying biotechnology to industrial processes. Usage of white biotechnology in industrial processes are lauded as environmentally friendly as it is said to consume less resources when producing a chemical and can also be used to bio remediate the environment when used to destroy hazardous and polluting chemicals. The forefronts of this field of biotechnology are in the fields of carbon foot print management and environmental protection. This field also deals with sustainability issues of industry and its impact to the environment. Another example is the use of microbes in waste treatment and management.

3.1.5 Changing Trends in Biotechnology Industry

Politically, there is a concern that the Malaysian government may reduce its focus on biotechnology given the deteriorating global economic situation and realign the government’s focus to coping with the coming economic recession. This is a major concern as during recession, almost all other sectors will be constantly lobbying for the government’s
attention and the government’s resources will be stretched thin. Another political issue is the political instability in Malaysia has created a level of uncertainty amongst investors both local and foreign.

There is also the impact deriving from socio-economic factors such as the coming economic recession. There is a belief that with the global economic recession seeing no signs of improving within the year, there is going to be a reduction in investments in biotechnology. There is also a possible reduction in spending amongst consumers, which will reduce biotech sales revenue for biotech companies.

Technologically, there is also the rapid change of technology in biotechnology, which may render the entire technological infrastructure in Malaysia obsolete and wasting all the efforts by the Malaysian government to encourage biotechnology in Malaysia by upgrading Malaysia’s research infrastructure.

### Table 3-1
Changing trends in the biotechnology industry by market forces

<table>
<thead>
<tr>
<th>Changing trends in the biotechnology industry:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Political:</strong></td>
</tr>
<tr>
<td>• Government may reduce focus on biotech to cope with recession.</td>
</tr>
<tr>
<td>• Political stability of Malaysia is a concern</td>
</tr>
<tr>
<td><strong>Socio- economical:</strong></td>
</tr>
<tr>
<td>• Recession may reduce investments in biotech.</td>
</tr>
<tr>
<td>• Consumer spending may be reduced during recession, thereby reducing sales revenue for companies.</td>
</tr>
<tr>
<td><strong>Technological:</strong></td>
</tr>
<tr>
<td>• Rapidly changing technology may render present equipment obsolete.</td>
</tr>
<tr>
<td><strong>Environmental:</strong></td>
</tr>
<tr>
<td>• Increasing pressure on using biotechnology to assist in coping with climate change and also other environmental issues.</td>
</tr>
<tr>
<td>• Increasing awareness on the harm of agricultural biotechnology on the environment of naturally grown crops.</td>
</tr>
<tr>
<td><strong>Legal:</strong></td>
</tr>
<tr>
<td>• Some parties have voiced concern on the need for more rules and regulations related to ethics and environmental protection in biotechnology.</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan
Environmentally, there is an increasing pressure and demand to use biotechnology to cope with climate change and other environmental pressure. A move in this direction is the genetic modification of genetics of microbes to allow them to use the fuel spilt by oil tankers into the sea as nutrition for their metabolism. This is a push into the direction to use biotechnology to address environmental concerns. However, on the opposite side, there is also a growing awareness of how crops modified by biotech are posing a challenge to naturally grown crops. The environmentalists are bringing attention to the possible extinction of crops which are unable to cope with the strong survivability of biotech modified plants.

Legally, some parties have called on the need for more rules and regulations related to ethics and environmental protection in biotechnology. They have called attention on both ethical issues on the conduct of research and sale of biotech products to Malaysians. There is also a health concern on the implications on using biotech goods whether from agricultural biotechnology or healthcare biotechnology.

Both the above political factors impact the biotech industry by reducing governmental support for the sector and also creates a climate of wariness and cautiousness amongst investors. Whether the government support is by funding or by general policy friendly to the sector, the biotech industry in Malaysia is in a nascent stage and needs all the policies and help needed for it to mature to be able to stand on its own. Any reduction or withdrawal of governmental support will affect the sector’s ability to climb to a higher level of business development.

The socio-economic factors in play in Malaysia are consistent around the world. The Malaysian government’s budget unveiled on March 10th 2009, stipulated that there will be a continued governmental investment in the biotechnology cluster in the Iskandar Malaysia, which will dispel some of these uncertainties. However, though investment spending in biotechnology may remain, there is no avoiding a reduction of consumer spending in this economic climate. Consumers will likely spend less on luxury goods such as cosmetics, spa and facial products. However, essential items such as foodstuff and healthcare products will remain in the consumer’s budgets. Therefore, the impact of socio-economic factors on biotechnology in Malaysia appears to be quite favourable in the near future.

Technologically, there is no stopping the rapid change of technology in biotechnology. Though the risk exists of the pace of technological change rendering the research infrastructure in Malaysia obsolete, Malaysia as a country, cannot change this and therefore, we consider this factor to be neutral as other countries in the region also face the same problem.
Environmental factors affecting the usage of biotech can lead to a boom or bust in the biotech sector. The favourable awareness of biotech usage to cope with environmental issues will likely spur the advancement of biotech into sectors such as waste management and bio remediation of the environment. These factors can be looked at as being good in boosting the growth of the biotech sector.

The legal factors concerning the biotech usage are relatively new to Malaysia. There is currently only the Ministry of Science, Technology and Innovation who is involved in biotechnology and the other relevant ministries such as Ministry of Health which supervises the clinical trials and approval of new drugs and the Ministry of Agriculture which supervises plants grown for the market. These three ministries are at the forefront of any ethical issues with regard to biotechnology in Malaysia from research ethics to the sale of biotech products to Malaysians. We recognise that there is a lack of rules and regulations in Malaysia with regards to this but as the sector develops and more biotech products enters the market, the Malaysian government would be prompted to enact new laws governing these areas. Therefore, we view the legal factors affecting biotech as neutral.

3.2 Overview of the Biotech Education Sector

3.2.1 Industry Structure

In Malaysia, biotech education is provided by both public and private institutions. Public educational institutions providing biotech education consists of public universities such as Malaya University, National University of Malaysia, Science University of Malaysia, Putra University of Malaysia, Islamic Science University of Malaysia, Sarawak Malaysian University, Sabah Malaysian University, Malaysia University of Science and Technology and Asian Institute Of Medicine, Science & Technology. These public institutions are funded by the Government of Malaysia and a majority of them are called ‘Research Universities’ heavily participating in research and development and offering post graduate studies in Biotechnology as they are able to tap into governmental research grants and funds. The minimal requirements for PhDs in these universities are usually a Master’s degree in the relevant field from a reputable university whether local or foreign whilst the admission requirements for a Master’s degree is an Upper Second or First Class degree in the relevant field from a reputable university.

There are institutions offering Master’s degrees in Biotechnology but none of these private educational institutions offer PhDs in biotechnology.
Diagram 3-2
Local educational institutions offering degree in Biotechnology

**PUBLIC INSTITUTIONS**
- Malaya University (UM)
- National University of Malaysia (UKM)
- Science University of Malaysia (USM)
- Putra University of Malaysia (UPM)
- Islamic Science University of Malaysia (UISM)
- Sarawak Malaysian University (UNIMAS)
- Sabah Malaysian University (UMS)
- International Islamic University (UIA)
- Malaysia University of Science and Technology (MUST)
- Asian Institute Of Medicine, Science & Technology (AIMST)

**PRIVATE INSTITUTIONS**
- Technology Park Malaysia College
- Monash University Malaysia
- Nottingham University Malaysia
- UCSI University
- Tunku Abdul Rahman University
- Selangor Industrial University

Source: Frost & Sullivan

Diagram 3-3
Local educational institutions offering Master’s Degree in Biotechnology

**PUBLIC INSTITUTIONS**
- Malaya University (UM)
- National University of Malaysia (UKM)
- Science University of Malaysia (USM)
- Putra University of Malaysia (UPM)
- Islamic Science University of Malaysia (UISM)
- Sarawak Malaysian University (UNIMAS)
- Sabah Malaysian University (UMS)
- International Islamic University (UIA)
- Malaysia University of Science and Technology (MUST)
- Asian Institute Of Medicine, Science & Technology (AIMST)

**PRIVATE INSTITUTIONS**
- Monash University Malaysia
- Nottingham University Malaysia
- Tunku Abdul Rahman University

Source: Frost & Sullivan
Diagram 3-4
Local educational institutions offering PhD in Biotechnology

Biotech Education Sector in Malaysia (INSTITUTIONS OFFERING PhD LEVEL STUDIES)

PUBLIC INSTITUTIONS
Malaya University (UM)
National University of Malaysia (UKM)
Science University of Malaysia (USM)
Putra University of Malaysia (UPM)
Islamic Science University of Malaysia (UISM)
Sarawak Malaysian University (UNIMAS)
Sabah Malaysian University (UMS)
International Islamic University (UIA)
Malaysia University of Science and Technology (MUST)
Asian Institute of Medicine, Science & Technology (AIMST)

PRIVATE INSTITUTIONS
Nil

Source: Frost & Sullivan
3.2.2 Industry Dynamics  
(Drivers, Restraints, Opportunities, and Challenges)

Table 3-2  
Market Drivers for Biotechnology in Malaysia

<table>
<thead>
<tr>
<th>No</th>
<th>Top Drivers of Biotech Industry in Malaysia</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Research grants and funding</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Ample cheap labour</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Rich biodiversity</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Better profit margins in Malaysia</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Market demand as more people looks to biotech for cures</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Good infrastructure</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>National Biotechnology Policy</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>BioNexus Status</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan

Participants in the biotech sector felt that the above reasons were the top drivers of biotechnology in Malaysia. The top driver in their list was the availability of research grants and funding. The easiness and speed of the grant disbursement along with the amount of it, has prompted many industry players to consider this as imperative to the growth of Research and Development based biotechnology in Malaysia. Research grants are very important to the biotechnology sector as these companies are often conducting research using the latest technologies and these technologies are often very expensive. Hence, the Malaysian government’s decision to provide research grants and funding to aid in the development of biotechnology in Malaysia has done much to aid these start up companies. However, the industry is also seeking the government to increase funding and also to risk manage the usage of these funds. They would like the government to audit the allocation of these funds as well to ensure there is no misuse.

The second most important driver of biotechnology in Malaysia is the ample supply of cheap labour. Despite the relatively more expensive price of labour in Malaysia as compared to Vietnam, China and India, most companies still feel that Malaysia can provide cheap labour with adequate skills and another plus point is that the Malaysian workforce is highly trainable.
The third most important driver of biotechnology in Malaysia is that Malaysia has one of the richest biodiversity in the world. As one of the world’s 17 mega diverse countries in marine biodiversity and also one of the 12 world’s hotspots for biodiversity, Malaysia offers a potpourri of potential raw material for research. This is evident as almost all respondents replied that Malaysia’s biodiversity allows them to carry out a vast variety of research.

Respondents view the ability of attaining a higher profit margin in Malaysia as the fourth most important driver for Malaysia’s biotechnology scene. Despite the rising costs of doing business in Malaysia relative to other places, companies still view that they can achieve better profit margins in Malaysia. They have stated that they plan to expand from Malaysia into other markets in South-East Asia, using Malaysia as their hub. In fact, this expansion has already been undertaken by a few slightly more advanced Malaysian biotech companies.

The historical and cultural background of Malaysian and South East Asian countries in general; who favours herbal and traditional cures from natural resources is also a market driver for biotechnology in Malaysia. This makes it easier in two ways for companies; the sourcing of raw materials needed for research is easier as the information is easily attainable from traditional folk medicine practitioners or even laymen and also the awareness of traditional plant remedies makes Malaysian biotech firms’ products easily marketable in Malaysia and the region. This market driver helps increase the demand for biotech products and helps increase the sales volume of biotech companies.

Besides that, efforts by the Malaysian government to provide research infrastructure has also paid off. The respondents have indicated that the government policies in place have increased the technological level of research equipment and infrastructure to be on par with international standards. Respondents have indicated that the research infrastructure in Malaysia has allowed them to pursue cutting-edge research previously not available in Malaysia. This helps them reduce the time-to-market for their products and assist in the commercialisation phase of their research findings.

The second last driver for biotechnology in Malaysia is the National Biotechnology Policy unveiled by the Malaysian government. Most companies interviewed have cited that the Policy has created an awareness not found amongst Malaysians before on biotechnology. The surveyed respondents were satisfied with the promotional and training programs organized by BiotechCorp, as they found them to be useful. They have also indicated that with the policy in place and if the implementation and business environment is favourable, they have no doubts that they can expand their businesses in the near future.
The last driver for biotechnology in Malaysia is the BioNexus Status. The granting of this status to Malaysian biotech firms has helped them in freeing them from the burden of red tape and bureaucracy. This allows their business leaders to focus on growing their businesses instead of being occupied with the nitty-gritty issues such as import of technology, etc. This driver reduces the non-productive time spent by business leaders and helps free them up to expand their business.

**Table 3-3**

*Market restraints of biotechnology in Malaysia*

<table>
<thead>
<tr>
<th>No</th>
<th>Top restraints of biotech industry in Malaysia</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Human resource</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Insufficient funding</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Lack of distribution network</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Structural and background as manufacturing country</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Lack of financial loans from financial institutions</td>
<td>5</td>
</tr>
</tbody>
</table>

*Source: Frost & Sullivan*

The above table highlights the market restraints of biotechnology in Malaysia as opined by the biotech industry participants in Malaysia. As predicted, the main restraint to their business is human resource, particularly in a knowledge-based biotech industry. The industry players have indicated that due to the scarcity of high quality workforce, most were required to retrain their local staff on-the-job. Furthermore, the surveyed companies are compelled to hire foreign expatriates from India, China, the United States and European Union. However, due to the complexity of foreign employee’s visa application, most respondents would prefer to hire the local workforce if their skill-set standards are improved.

The second most common mentioned market restraint relates to the insufficient funding for biotech in the country. Although the Malaysian government has provided funding for biotech research grants, the companies feel that in order to push their companies to greater heights, the funds granted by the government has to be increased. One vividly drawn example is Singapore, whose research grants and commercialisation funding has attracted top notch researchers from the Western countries. Therefore, although the Malaysian biotech business leaders are grateful over the research grants provided by the Malaysian government thus far, most expect more funding and grants in the future to continue propelling the sector forward.
The lack of distribution networks is currently impeding the progress of some biotechnology companies in Malaysia, particularly for companies that are in the commercialisation phase of their products. Some of the earlier biotech companies have already established their own distribution network and would not allow their distributors and retailers to distribute other products. This ensures that their products are exclusive to established distributors and consists of the first mover advantage of the more advanced firms.

Although exclusive dealership is a part of a company’s corporate strategy, it will impede the progress of other companies and will stop competition. Therefore, the lack of distribution networks for biotech companies in Malaysia is unhealthy and stops the active competition which is good for biotech in Malaysia. And this is a major market restraint.

Besides that, there is also a structural issue which is constraining the progress of the biotechnology sector. Malaysia, as a country, has been developed as a manufacturing hub for electronics and electrical parts. There is a lack of understanding on the needs of a biotech sector. This lack of understanding stems from the success of Malaysia as an industrial country and is prevalent amongst governmental agencies, academia, financial institutions and the public. Therefore, this lack of awareness on the biotech scene will eventually result in the lack of domestic and foreign investments on biotech in Malaysia.

The final market restraint is the lack of financial loans and support from the Malaysian financial institutions. This also stems from the above structural issue. The lack of awareness on biotechnology among the financial institution circles has caused them to not provide loans to biotech companies. This lack of financial products to biotech companies increased the dependency of the companies to rely on the government for grants and funding. Moving forward, the industry players are expecting more viable options of funding, such as bank loans and venture capitals.

**Opportunities to biotechnology in Malaysia**

There are various opportunities for biotechnology in Malaysia. Amongst the most obvious opportunities are improvements to the agricultural sector. Fundamentally, Malaysia has established its inherent capability in the agricultural field. Whether it is cash crops or food crops, Malaysia has been a country with an active agricultural sector. Therefore, it is only natural for Malaysia to play to its competitive advantage by focusing on biotechnology to improve the quantity and quality of its agricultural yield. The agricultural sector in Malaysia already has several world renowned research institutes such as Malaysian Agricultural Research and Development Institute (MARDI), Palm Oil Research Institute of Malaysia (PORIM), Forest Research Institute of Malaysia (FRIM) and Rubber Research Institute of Malaysia (RRIM).
Therefore, it is important for Malaysia to expand its research capabilities in these institutes and use biotechnology to harness its richness in biodiversity to create an agricultural sector that is competitive on the global platform.

Another opportunity of biotechnology in Malaysia lies in exporting to various countries. Malaysia is the 17th largest trading nation in the world and therefore, there is an enormous potential for Malaysia to export its products to the world. The ‘Made-in-Malaysia’ brand is trusted and is considered a stamp of confidence in the country’s products. Therefore, any biotech products made in Malaysia can be the country’s export to the world.

There is also the opportunity for biotech in this country to pursue a niche market. As mentioned above, there is already a brand awareness of Malaysian products and there is also relative competitive advantage in agriculture in Malaysia. Therefore if Malaysian biotech companies pursue this niche market and the appropriate policies and efforts are made to pursue this, there is an enormous potential to grow and capture a niche market in biotech in the world.

Malaysia also has the potential to be a centre for contract research and manufacturing for Asia. Malaysia’s background as a heavily industrialised country allows Malaysia to leverage its manufacturing capabilities and highly skilled factory workforce to produce medical devices. The relatively cheap price of researchers in Malaysia also makes it an attractive contract research hub. The existence of multiple races in Malaysia makes it an excellent choice for clinical research as treatment results on the various ethnicities in Malaysia can be used for the existence of multiple races in Malaysia makes it an excellent choice for clinical research as treatment results on the various ethnicities in Malaysia can be used for the various ethnicities in Malaysia can be used for China, India and the South-East Asia region, given that in Malaysia hosts a huge communities of Chinese, Indian and Malays.

**Threats to biotechnology in Malaysia**

The first and foremost threat to the biotechnology sector in Malaysia is the lack of human resource. This shortage of suitable and ample human resource needed for biotechnology to grow in Malaysia can be considered a major threat. Not only are there a major shortage of human resource in Malaysia, there is also a major brain drain from Malaysia to other countries aspiring to be the biotech centres of the world like Singapore, China and India.

The second major threat to the biotechnology sector in Malaysia is the competition from other countries in the region with the same aspiration as Malaysia. Singapore, India and China have all established special economic zones to attract investments on biotechnology and to grow their very own local biotech companies. This creates a hypercompetitive atmosphere in the region as all these newly apportioned areas are all in Asia and these countries have all revealed almost similar schemes to attract investment. These countries also share almost the same climate and are considered to be major users of folk medicines. Hence, competition from these countries is considered a major threat to the biotech sector in Malaysia.
### 3.2.3 Existing Regulatory Development and Framework

The biotechnology sector in Malaysia is led by BiotechCorp. BiotechCorp was created to identify value propositions in both R&D and commerce and support these ventures via financial assistance and developmental services. In short, BiotechCorp is the lead agency for biotech companies in Malaysia. The direction of the biotechnology sector’s development was charted by the National Biotechnology Policy, unveiled in 2005. Besides the Ministry of Science, Technology and Innovation, the Ministry of Agriculture is also involved with Agricultural Biotechnology and the Ministry of Health is involved with Healthcare Biotechnology.

In terms of trials leading to approval of healthcare biotechnology products, units involved from the Ministry of Health, Malaysia are the National Pharmaceutical Control Bureau for pharmaceutical products and the Medical Devices Control Unit. Though, both these units are skilled and experienced to approve products, they may have issues understanding the nature of biotech products. Unlike traditional medical devices and drugs, healthcare biotechnology products may have other side effects as the way these products are produced are novel to Malaysia. Therefore, the standard regime of testing on these products may not be adequate for biotech products. As biotech products are produced via advanced technique such as gene sequencing, gene manipulation and various other cutting-edge procedures, the effects of these products used in patients in the long run needs to be investigated and analysed. Both the units may face challenges in this area. There is a need for new rules and regulations for the approval of new Healthcare Biotechnology products.

Agricultural biotechnology products also face the same issues as healthcare biotechnology products. This is further proven by the refusal of the European Union to approve Genetically Modified Foods produced from the United States of America though these foods have been eaten in the United States for many years. This example should raise concern on the regulatory authorities within Malaysia’s Ministry of Agriculture and the Ministry of Health whose role are approving new agricultural products for the market. The principal food approval process in Malaysia is governed by the Food Act 1983 and the Food Regulations 1985, which are developed and amended by the Food Safety and Quality Division (FSQD) of the Malaysian Ministry of Health (MOH). Hence, both ministries are responsible for Agricultural Biotechnology products. The need of much more stringent regulations and rules for new food types is more urgent than ever. There is also the issue of food security that is on the mind of the government after a food shortage in Malaysia last year. Certain food-drug interface products, however, are regulated by the MOH National Pharmaceutical Control Authority Board (NPCB).
The higher education sector in Malaysia is governed by the Ministry of Higher Education in Malaysia. The ministry oversees all higher educational institutions in Malaysia. It has created the Malaysian Qualifications Agency to accredit all local educational programmes from both public and private institutions of higher learning. This body is responsible to ensure the courses run by all educational institutions in Malaysia is of a high quality and students are given adequate training to ensure their employability in the workplace. Besides that, this body will also accredit the foreign degrees pursued by Malaysians overseas. As you can see, the role of the MQA plays a huge part in the development of biotech education in Malaysia.

3.3 Situational Analysis of Malaysian Biotech on the Global Roadmap

In recognition of biotechnology as a new engine of growth for the country, Malaysian had embarked on a journey that developed nations had taken decades before. Nonetheless, the key objective shared in common was to generate alternative revenue sources and remain competitive in the regional or global economy. While Malaysia possesses various advantages, such as its rich biodiversity and ethnicity, cost-competitive skilled labour, good transportation and ICT infrastructure, and strong governmental support, it is still considered as an early developer within the global biotech industry.

The following sections showcase the various early adopting countries for biotechnology, such as the United States, EU, Japan, and also the fast emerging countries in the APAC region to assess on the industrial growth trend and regulatory policy development in each country. Subsequently, assessments on the biotech human capital development system in each respective country will be conducted to explain on the fundamental knowledge background.

Finally, Malaysia will be put on the global biotechnology roadmap to assess on the relative strengths and weaknesses against the global best practices, thereby identifying the key considerations to enhance Malaysia’s competitiveness on the global biotech platform.

3.3.1 Benchmarking of International Best Practices within the R&D Spectrum

The assessment criteria biotech industry performance was based on several parameters that will reflect (a) the development status of the biotech industry (b) the efficiency of the R&D operations and (c) the sufficiency of funding for the biotech sectors, for each specific country.
The higher education sector in Malaysia is governed by the Ministry of Higher Education in Malaysia. The ministry oversees all higher educational institutions in Malaysia. It has created the Malaysian Qualifications Agency to accredit all local educational programmes from both public and private institutions of higher learning. This body is responsible to ensure the courses run by all educational institutions in Malaysia is of a high quality and students are given adequate training to ensure their employability in the workplace. Besides that, this body will also accredit the foreign degrees pursued by Malaysians overseas. As you can see, the role of the MQA plays a huge part in the development of biotech education in Malaysia.

3.3  Situational Analysis of Malaysian Biotech on the Global Roadmap

In recognition of biotechnology as a new engine of growth for the country, Malaysian had embarked on a journey that developed nations had taken decades before. Nonetheless, the key objective shared in common was to generate alternative revenue sources and remain competitive in the regional or global economy. While Malaysia possesses various advantages, such as its rich biodiversity and ethnicity, cost-competitive skilled labour, good transportation and ICT infrastructure, and strong governmental support, it is still considered as an early developer within the global biotech industry.

The following sections showcase the various early adopting countries for biotechnology, such as the United States, EU, Japan, and also the fast emerging countries in the APAC region to assess on the industrial growth trend and regulatory policy development in each country. Subsequently, assessments on the biotech human capital development system in each respective country will be conducted to explain on the fundamental knowledge background. Finally, Malaysia will be put on the global biotechnology roadmap to assess on the relative strengths and weaknesses against the global best practices, thereby identifying the key considerations to enhance Malaysia’s competitiveness on the global biotech platform.

3.3.1  Benchmarking of International Best Practices within the R&D Spectrum

The assessment criteria biotech industry performance was based on several parameters that will reflect (a) the development status of the biotech industry (b) the efficiency of the R&D operations and (c) the sufficiency of funding for the biotech sectors, for each specific country.

The Gross Expenditure for Research and Development (GERD) in Malaysia has been on the upward trend since 1996. With the increasing governmental focus, evident in the significantly increased funding in its 9th National Plan, and the simultaneous growth of its private sector, the increased GERD to GDP ratio signals the growth of R&D industry. In 2006, the GERD in Malaysia accounted to about 0.64 percent of the country’s GDP, up from 0.37 percent in 1992. Nonetheless, despite the increasing efforts from the R&D industry, Malaysia still remains as a relatively small player on the global basis.

On the global roadmap, Japan leads the world with 3.4 percent of its GDP spent on R&D activities, and is expected to continue its upward trend with the implementation of the 3rd Japanese Science & Technology Basic Plan. Spearheaded by its Council for Science and Technology Policy (CSTP), the Japanese Government had planned to fund approximately RM946.4 billion from 2006 to 2010 through the plan.

South Korea was the ranked the second highest spender in R&D in relation to its GDP at 3.2 percent. Despite the high proportion of spending of R&D, majority of the spending, according to Korea’s Standardized Classification of Science and Technology, were allocated for electric and electronics, machinery, and telecommunications. In 2004, the three major sectors accounted for approximately 52.1 percent of the GERD, while R&D expenditure on life science and earth science were relatively small.

R&D Expenditure as Percentage of GDP

.Chart 3-1
GERD to GDP Expenditure by Country

<table>
<thead>
<tr>
<th>Country</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>0.1%</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.3%</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.6%</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>1.1%</td>
</tr>
<tr>
<td>China</td>
<td>1.4%</td>
</tr>
<tr>
<td>Australia</td>
<td>1.8%</td>
</tr>
<tr>
<td>Canada</td>
<td>1.9%</td>
</tr>
<tr>
<td>Singapore</td>
<td>2.3%</td>
</tr>
<tr>
<td>Taiwan</td>
<td>2.6%</td>
</tr>
<tr>
<td>EU / UK</td>
<td>2.6%</td>
</tr>
<tr>
<td>USA</td>
<td>2.6%</td>
</tr>
<tr>
<td>Korea</td>
<td>3.2%</td>
</tr>
<tr>
<td>Japan</td>
<td>3.4%</td>
</tr>
</tbody>
</table>

Source: APEC Industrial Science & Technology Internationalization Database
United States garnered the third spot with approximately 2.6 percent of its GDP. While being the most significant market share holder in the global biotech market by revenue (75 percent in 2006), the GERD to GDP ratio of United States remained relatively unchanged since 2002.

Within the South East Asian region, Singapore was the most significant market player with 2.3 percent of its GDP allocated for R&D funding. Similar to South Korea, the main share of GERD (65 percent) in Singapore was spent on the fields of engineering and technology, while 27 percent were spent on biotech-related fields, including as biomedical and related sciences (17 percent), natural sciences (9 percent), and agricultural & food sciences (1 percent). Further analysis on the spending pattern within each field reveals that approximately 60 to 70 percent of the spending in the biotech related sector were most dedicated to the early development stages of basic research and applied research, while the engineering and technology field, majority of the funds spent (68 percent) were utilized for the more advanced stage of experimental development.

**Allocation of R&D Funding by Sectors**

*Chart 3-2*

**Distribution of R&D Expenditure on Performing Sectors by Country**

Source: National Science Foundation: Science & Engineering Indicators 2008
On comparison with the leading global economic nations, the R&D performance pattern of Malaysia is relatively similar, on which the industrial sector accounted approximately 65 percent of the GERD recipient. South Korea and Japan were reported to achieve the highest performance in the industrial sector with more than 77 percent and 75 percent of the GERD spent.

The portion of GERD spending on the higher education sector, in contrast, had depicted a different picture, whereby all the G-8 Nations, except The Russian Federation, had prioritized the higher education sector as the second most important fund recipient. Canada, in particular, had allocated the highest proportion (38 percent) of its GERD on R&D activities in the higher education sector. Whereas most of the major Asian countries (except Japan) had dedicated more funds for the R&D activities in the government sector.

In Singapore, a significant 14 percent of R&D expenditure was spent on the other publicly funded research institutes, which includes funding for its local institutes and investments on foreign based biotech entities. Predominant funding by the Singapore government in this segment suggests that the nation is gradually expanding its focus on community based and technological break through research activities extended beyond its national border. It is recently announced in March 2009 that a UK-based biotech spin-off had recently received RM19.6 million funding from the Singapore government to develop chemical detection technology to identify the presence of airborne bird flu.
Comparison of the research density of FTE researchers of Malaysia against some of the leading developed or developing nations shows a significant discrepancy in terms of skilled and employed R&D workforce, with merely 9.1 FTE researchers out of every ten thousand of the total workforces in the country in 2006. Despite the growth of its research density from 5.8 in 1994, the ratio is considerably low for a nation in plan to boost its science and technology industry. Furthermore, the research density in Malaysia had experienced a slight decline from its peak FTE researcher to workforce ratio of 12.4 in 2004, suggesting the possible discharge of trained researchers to overseas or shift of profession due to the lack of job opportunities in the R&D sector.

Japan leads the global platform with about 118.1 FTE researchers in every ten thousand workforce, followed by Singapore at 91.1 based on equivalent scale. The strong output of R&D workforce in Singapore is attributable to the greater emphasis on sciences and technology in tertiary education. Already in 2002, approximately 75 percent of the courses in polytechnics and 62 percent of the university courses in the country were science and technology based.

The further analysis on the proportion of FTE researchers to the total headcount in each country had further illustrate the level of employability for Science & Technology related employments in each country. In Singapore and Korea for example, the FTE researchers to the total researcher headcount ratio was 85 percent and 74 percent respectively in 2005, illustrating the high level of full time employment of qualified R&D knowledge workers in their industries. Malaysia, in comparison, is estimated to achieve a ratio of 51 percent, which signals the need for more job creations in the industry.

Another key observation is the allocation of FTE R&D workers by sector for Malaysia was predominantly concentrated in the higher education sector, unlike the remaining best practices countries, in which majority of the workforce are absorbed by the private industry sector. This again signals the lack of working opportunities for researchers in the private sector, thus resulting to a larger research workforce population in the government and higher education sector.

In terms of the funding source for R&D expenditure, Malaysia is following a similar pattern with most of the nations (except The Russian Federation), on which almost 50 percent or the majority portion of the funding were provided through the private sector. Japan and Korea, in particular, had the strongest dependency on private sector funding. The shift of private players focus from the down-turning IT sector to bio businesses and the consistent growth of biotech venture capitals are likely factors driving the growth of private funding in Japan, while Korea was mainly boosted by the strong growth of its small number of large scale conglomerates and the SME sector.

Government funding was the second most prominent source of R&D funding in majority of the countries, except for The Russian Federation, whereby government funding is the key source with 62 percent. Within the spectrum of government funding for biotechnology, Malaysia is estimated to have allocated, through its 9th Malaysian Plan, RM4.3 billion throughout 2006 to 2010 to boost its biotech industry. The level of governmental funding in Malaysia is comparable to a country like India, in which about RM4.4 billion had been allocated for biotech industry development in the nation’s 10th Five-Year Plan. Furthermore, the estimated budget of RM575 million allocated for biotech human resource development in Malaysia had edged out the spending of RM400 million by the Indian government.

Nonetheless, despite the increasing government funding support in Malaysia, the nation is still trailing behind by a significant distance from its strongest regional competitor – Singapore. In 2006, the Singaporean government announced that approximately RM35 billion will be invested in biotech and R&D industry during the second phase of its Biomedical Sciences Initiative from 2006 to 2010, nearly 8-fold of the total governmental biotech funding in Malaysia. Life science research development alone had already accounted for about RM12.4 billion of the total budget.

3.3.2 Benchmarking of International Best Practices in R&D Human Capital Development

R&D Manpower Resources

Chart 3-4
Full Time Equivalent (FTE) Researchers per ten thousand Populations / Workforce by Country

Source:
(1) APEC Industrial Science & Technology Internationalization Database

Notes: Malaysia: 2006 data; Singapore, Taiwan: 2005 data; the remaining countries are based on 2004 data.
Comparison of the research density of FTE researchers of Malaysia against some of the leading developed or developing nations shows a significant discrepancy in terms of skilled and employed R&D workforce, with merely 9.1 FTE researchers out of every ten thousand of the total workforces in the country in 2006. Despite the growth of its research density from 5.8 in 1994, the ratio is considerably low for a nation in plan to boost its science and technology industry. Furthermore, the research density in Malaysia had experienced a slight decline from its peak FTE researcher to workforce ratio of 12.4 in 2004, suggesting the possible discharge of trained researchers to overseas or shift of profession due to the lack of job opportunities in the R&D sector.

Japan leads the global platform with about 118.1 FTE researchers in every ten thousand workforce, followed by Singapore at 91.1 based on equivalent scale. The strong output of R&D workforce in Singapore is attributable to the greater emphasis on sciences and technology in tertiary education. Already in 2002, approximately 75 percent of the courses in polytechnics and 62 percent of the university courses in the country were science and technology based.

The further analysis on the proportion of FTE researchers to the total headcount in each country had further illustrate the level of employability for Science & Technology related employments in each country. In Singapore and Korea for example, the FTE researchers to the total researcher headcount ratio was 85 percent and 74 percent respectively in 2005, illustrating the high level of full time employment of qualified R&D knowledge workers in their industries. Malaysia, in comparison, is estimated to achieve a ratio of 51 percent, which signals the need for more job creations in the industry.

Another key observation is the allocation of FTE R&D workers by sector for Malaysia was predominantly concentrated in the higher education sector, unlike the remaining best practices countries, in which majority of the workforce are absorbed by the private industry sector. This again signals the lack of working opportunities for researchers in the private sector, thus resulting to a larger research workforce population in the government and higher education sector.
As a result of the significantly lower researcher per population ratio, the scientific productivity of Malaysia is considerably lower as compared to the other regional counterparts. While achieving a better research publication to thousand population ratio than several Asian countries like China and Indonesia, the gap between the 0.073 ratio of Malaysia with its neighbouring nation, Singapore, which is ranked first globally at 1.41 research paper out of a thousand of its population, is noteworthy.

Nonetheless, the efficiency level of the R&D researcher in Malaysia has depicted a more favourable picture when compared according to the output per researcher.

While strong emphasis from the government in boosting the biotech industry through increasing funding, infrastructure establishments and other financial and non-financial incentives, manpower development remains as the key cornerstone for Malaysia to develop itself as a centre of excellence for biotechnology. Comparison at an international level and given the significant shortfall in terms of research density indicates that intense focus would be required for the nation to expedite its human capital development initiatives, which would require joint efforts from the government and private sector participants to build up the infrastructure and create the demand of biotech researchers in the industry.

While strong emphasis from the government in boosting the biotech industry through increasing funding, infrastructure establishments and other financial and non-financial incentives, manpower development remains as the key cornerstone for Malaysia to develop itself as a centre of excellence for biotechnology. Comparison at an international level and given the significant shortfall in terms of research density indicates that intense focus would be required for the nation to expedite its human capital development initiatives, which would require joint efforts from the government and private sector participants to build up the infrastructure and create the demand of biotech researchers in the industry.
R&D Output

As a result of the significantly lower researcher per population ratio, the scientific productivity of Malaysia is considerably lower as compared to the other regional counterparts. While achieving a better research publication to thousand population ratio than several Asian countries like China and Indonesia, the gap between the 0.073 ratio of Malaysia with its neighbouring nation, Singapore, which is ranked first globally at 1.41 research paper out of a thousand of its population, is noteworthy.

Nonetheless, the efficiency level of the R&D researcher in Malaysia has depicted a more favourable picture when compared according to the output per researcher.
Within the context of human capital development for biotech and life-science, the tertiary education sector serves as the fundamental source of production. Furthermore, the academia sector is the key body to impart the knowledge and skills required by the workforce in the country.

Comparisons on the international rankings of the top universities in biomedicine and life science specialization in 2008 clearly exemplify the strength of the scientific research academia in the North American and European regions. Among the top twenty ranks of universities, 11 were based in the United States, while Canada and the United Kingdoms each occupied 3 spots. Japan (University of Tokyo), Singapore (National University of Singapore), and China (Peking University) garnered the fifteenth, seventeenth, and nineteenth spot respectively and were the top representative institutions in the Asian region.

In Malaysia, Universiti Sains Malaysia was the highest ranked school at 123rd, followed by Universiti Malaya (127th) and University Kebangsaan Malaysia (144th). With the consistent up-rise of traditionally trailing schools, such as Universitas Gadjah Mada, Indonesia (106th), and Chulalongkorn University, Thailand (108th). It is critical for prompt improvements on the education system of biomedicine and life science in Malaysia.

Apart from the leading Western nations, Malaysia was only behind Singapore as the highest R&D output nation in Asia, with 0.19 research publication per research in the country. The favourable result shows that despite the lower overall research output in the country due to low population of research manpower, the efficiency level of Malaysian researchers are on par with some of the leading R&D nations worldwide, and ahead of the Asian powerhouses like Japan, South Korea and China.
Academia

Within the context of human capital development for biotech and life-science, the tertiary education sector serves as the fundamental source of production. Furthermore, the academia sector is the key body to impart the knowledge and skills required by the workforce in the country.

Comparisons on the international rankings of the top universities in biomedicine and life science specialization in 2008 clearly exemplify the strength of the scientific research academia in the North American and European regions. Among the top twenty ranks of universities, 11 were based in the United States, while Canada and the United Kingdoms each occupied 3 spots. Japan (University of Tokyo), Singapore (National University of Singapore), and China (Peking University) garnered the fifteenth, seventeenth, and nineteenth spot respectively and were the top representative institutions in the Asian region.

In Malaysia, Universiti Sains Malaysia was the highest ranked school at 123rd, followed by Universiti Malaya (127th) and University Kebangsaan Malaysia (144th). With the consistent up-rise of traditionally trailing schools, such as Universitas Gadjah Mada, Indonesia (106th), and Chulalongkorn University, Thailand (108th). It is critical for prompt improvements on the education system of biomedicine and life science in Malaysia.
The benchmarking on the faculty to postgraduate research student ratio in the Malaysian universities to the foreign universities does not illustrate significant discrepancy. On average, the teaching faculty to postgraduate student ratios in the science and biotech technology faculties in Malaysia ranged from 1.25 to 4.43, as compared to the average 1.6 ratio in the National University of Singapore. Furthermore, most of the university research centres in the top four universities for biomedicine and life sciences in Malaysia are estimated to be attaining their research supervisor to postgraduate research student ratio of 1.28, which is comparable to international standards. Hence, the teaching manpower sufficiency at the universities is considered to be adequate.

However, comparison on the research output at university level had shown greater discrepancies. Based on the statistics reported by Time Higher Education Survey (THES), the research paper and citations per faculty ratio in the Malaysian universities are considerably lower, averaging out 0.68 research paper and 2.45 research citations per faculty. In the National University of Singapore, approximately 4.68 research papers and 18.81 citations are produced per faculty on average. Likewise for the National University of Taiwan, 5.69 research papers and 16.18 citations per faculty. Seoul National University, Korea and University of Tokyo, Japan set the benchmark in the Asian region in terms of research productivity at university level with an average of 6.45 research paper and 40.39 citations per faculty. One of the key factors for the discrepancy in research output may be attributable to the level of funding and facilities available in the Malaysian universities, as compared to the top ranked biomedicine and life science schools abroad. In the United States for example, Harvard University had recently announced an investment of RM728 million to fund the creation of its Centre for Genomics & Proteomics, and a Centre for Imaging and Mesoscale Structures. Yale University had also recently announced a RM1820 initiative to boost the university’s science and engineering program. In the United Kingdoms, the UK Biotechnology and Biological Research Council had also awarded a grant of more than RM182 million to launch three new centres of integrative systems biology at the universities of Edinburgh, Nottingham, and Oxford. In Singapore, the funding of the higher education for the biotechnology and life science was approximately RM677 million out of the RM1.45 billion overall R&D funding of higher education sector in 2007. Furthermore, a dedicated Academic Research Fund of RM2.5 billion had been provided by the Singapore government over a five-year period to facilitate basic and applied research at the universities. In Malaysia, however, while funding for the higher education sector is consistently increasing, its fund size of RM513 million for the overall R&D activities in the higher education sector in 2006 is still considerably lower than its regional counterparts.

### Table 3-4

**QS Top Universities Ranking of Life Science & Biomedicine Schools:**

<table>
<thead>
<tr>
<th>Country</th>
<th>Institution</th>
<th>QS Ranking (2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>Harvard University</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>John Hopkins University</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>University of California, Berkeley</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>McGill University, Canada</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>University of Toronto, Canada</td>
<td>13</td>
</tr>
<tr>
<td>UK / EU</td>
<td>University of Cambridge</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>University of Oxford</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Karolinska Institute, Sweden</td>
<td>23</td>
</tr>
<tr>
<td>Japan</td>
<td>University of Tokyo</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Kyoto University</td>
<td>24</td>
</tr>
<tr>
<td>China</td>
<td>Peking University</td>
<td>19</td>
</tr>
<tr>
<td>Singapore</td>
<td>National University of Singapore</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Nanyang Technology University of Singapore</td>
<td>78</td>
</tr>
<tr>
<td>Australia</td>
<td>The University of Melbourne</td>
<td>26</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>University of Hong Kong</td>
<td>39</td>
</tr>
<tr>
<td>South Korea</td>
<td>Seoul National University</td>
<td>40</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Universitas Gadjah Mada</td>
<td>106</td>
</tr>
<tr>
<td>Thailand</td>
<td>Chulalongkorn University</td>
<td>108</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Universiti Sains Malaysia</td>
<td>123</td>
</tr>
<tr>
<td></td>
<td>Universiti Malaya</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td>Universiti Kebangsaan Malaysia</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>Universiti Putra Malaysia</td>
<td>213</td>
</tr>
</tbody>
</table>

Source: QS Top Universities Rankings 2008: Life Sciences & Biomedicine
The benchmarking on the faculty to postgraduate research student ratio in the Malaysian universities to the foreign universities does not illustrate significant discrepancy. On average, the teaching faculty to postgraduate student ratios in the science and biotech technology faculties in Malaysia ranged from 1.25 to 4.43, as compared to the average 1.6 ratio in the National University of Singapore. Furthermore, most of the university research centres in the top four universities for biomedicine and life sciences in Malaysia are estimated to be attaining their research supervisor to post graduate research student ratio of 1.28, which is comparable to international standards. Hence, the teaching manpower sufficiency at the universities is considered to be adequate.

However, comparison on the research output at university level had shown greater discrepancies. Based on the statistics reported by Time Higher Education Survey (THES), the research paper and citations per faculty ratio in the Malaysian universities are considerably lower, averaging out 0.68 research paper and 2.45 research citations per faculty. In the National University of Singapore, approximately 4.68 research papers and 18.81 citations are produced per faculty on average. Likewise for the National University of Taiwan, 5.69 research papers and 16.18 citations per faculty. Seoul National University, Korea and University of Tokyo, Japan set the benchmark in the Asian region in terms of research productivity at university level with an average of 6.45 research paper and 40.39 citations per faculty.

One of the key factors for the discrepancy in research output may be attributable to the level of funding and facilities available in the Malaysian universities, as compared to the top ranked biomedicine and life science schools abroad. In the United States for example, Harvard University had recently announced an investment of RM728 million to fund the creation of its Centre for Genomics & Proteomics, and a Centre for Imaging and Mesoscale Structures.

Yale University had also recently announced a RM1820 initiative to boost the university’s science and engineering program. In the United Kingdoms, the UK Biotechnology and Biological Research Council had also awarded a grant of more than RM182 million to launch three new centres of integrative systems biology at the universities of Edinburgh, Nottingham, and Oxford. In Singapore, the funding of the higher education for the biotechnology and life science was approximately RM677 million out of the RM1.45 billion overall R&D funding of higher education sector in 2007. Furthermore, a dedicated Academic Research Fund of RM2.5 billion had been provided by the Singapore government over a five-year period to facilitate basic and applied research at the universities. In Malaysia, however, while funding for the higher education sector is consistently increasing, its fund size of RM513 million for the overall R&D activities in the higher education sector in 2006 is still considerably lower than its regional counterparts.
The policy making process in the United States is mainly channelled through the budget process driven by the National Science & Technology Council (NSTC). The NSTC, which is chaired by the President of the United States, receives advice from the Office of Science and Technology Policy (OSTP), an independent government department responsible for the co-ordination of all science and technology issues and industrial demands.

The President will therefore submit the request to the Congress for policy setting, and approved policies will subsequently be implemented by the executive branches of the government, such as the Food & Drug Administration (FDA), National Institute of Health (NIH), Department of Agriculture (USDA), and Environmental Protection Agency (EPA).

The federal funded non-profit organizations, such as the National Academies, the American Association for the Advancement of Science (AAAS) and the State Science and Technology Institute keep track of the industry trends, provide advice to the federal government, and disseminate information relating to scientific and technological fields.

3.3.3 International Best Practices Showcase

Developed Nation: The United States

Governance & Key Policies:

Being one of the first nations to recognize the potential of biotechnology R&D since its emergence in the 1970s, and currently the worldwide benchmark nation for research and development, the United States have evolved through multiple reforms. The tradition of its R&D governance of the United States, which is still widely being practised in the developing countries today, was centralized at the Federal government in terms of funding and policy making.

Today, the R&D industry in United States has shifted towards the state of independence, whereby apart from the contribution of the federal government, the state governments are developing new R&D programs to enhance the capabilities of their local universities. Likewise, more universities are expanding towards applied research roles and are increasing investing in technology transfer through licensing offices, incubators, and joint programs with the industry.

Source: Data Source: QS Top Universities Ranking 2008, Frost & Sullivan Analysis
The policy making process in the United States is mainly channelled through the budget process driven by the National Science & Technology Council (NSTC). The NSTC, which is chaired by the President of the United States, receives advice from the Office of Science and Technology Policy (OSTP), an independent government department responsible for the co-ordination of all science and technology issues and industrial demands.

The President will therefore submit the request to the Congress for policy setting, and approved policies will subsequently be implemented by the executive branches of the government, such as the Food & Drug Administration (FDA), National Institute of Health (NIH), Department of Agriculture (USDA), and Environmental Protection Agency (EPA).

The federal funded non-profit organizations, such as the National Academies, the American Association for the Advancement of Science (AAAS) and the State Science and Technology Institute keep track of the industry trends, provide advice to the federal government, and disseminate information relating to scientific and technological fields.

*Diagram 3-5*

**Regulatory Structure of the US research system**

Source: European Union and International Best Practice in Research & Development (2007)
Within the biotech spectrum, the Biotechnology Industry Organization (BIO) is the key non-profit organization in the country for biotech advocacy. In the most recent efforts, the BIO has earmarked several key initiatives to tackle emerging issues on biotech intellectual property protection, bioethics, enhancement of funding in government and academic research, and fostering of emerging biotech company growth.

**Industry Structure & Infrastructure:**

The United States biotech market is by far the market leader global in terms of market share. In 2006, it is estimated that public companies had generate total revenue worth RM214 billion, equivalent to more than 75 percent of the global market share and posted a growth of 13.4 percent from 2005. While only accounting for 336 (23 percent) of the 1,452 biotech companies in the country, public companies are the predominant revenue earner with RM202 billion.

In total, the 1,452 biotech companies are estimated to recruit about 180,800 employees. The public companies employed the majority 72.2 percent of the biotech workforce in the country.

Apart from holding a lion share of the biotech market revenue, the United States is also the nation with the highest number of scientific publications, and holds the highest number of biotechnology patents (43.3 percent) globally.

Within the U.S. academic system, there are approximately 625 universities and colleges conducting R&D. Majority of the universities are supervised at state authorities. It is also estimated that the nation hosts approximately 600 major federally owned laboratories throughout the country.

**Research Funding:**

The total R&D expenditure spent in the United States was approximately RM12.37 trillion in 2006. The private sector was the most heavily funded industry, which accounted for 71.8 percent of the expenditure, followed by the higher education sector at approximately 14 percent.

Within the context of bio-science funding, the fund allocation for the private industry and academic sectors have increased significantly from 2001. The industry is estimated to have been funded up to RM74 billion of R&D expenditure, up 64 percent from 2001. Predominantly, 54.2 percent were funded through own funds from the private sector, 25.1 percent through venture funding, and 20.7 percent through public offerings.
The bio-science related academic sector was reported to have received a total funding of RM107 billion in 2006, of which majority of the funding were derived from the federal and state governments. The medical science discipline was the highest recipient with 54 percent of the funds allocated.

**Chart 3-9**

*U.S. Academic Bio Science R&D Expenditures by Discipline, 2006*

![Chart showing U.S. Academic Bio Science R&D Expenditures by Discipline, 2006](chart)


**Human Capital Development:**

The total bioscience occupational employment in 2006 is estimated to be 588,520 workers. More than half (52 percent) were employed as medical and clinical laboratory technicians, with an additional 35 percent employed as biological scientists and technicians (with medical scientists accounting for more than 78,000 workers in this field).
In the 2006 academic year, the U.S. higher education institutions had granted bio-science related degrees to more than 143,000 students. Apart from the category of other life science clinical / technical fields, which were mainly made up by associate degree holders, majority of the other biotechnology workforce categories held bachelor degree qualifications. Based on the surveyed result, biological science is tracked to be the most commonly pursued discipline.

While standing firm as the global leader in the field of biotechnology, the United States has not halted its progress for human capital development, particularly with the growing competition from the European and Asian regions.
In 2006, the U.S. higher education institutions granted bio-science related degrees to more than 143,000 students. Apart from the category of other life science clinical/technical fields, which were mainly made up of associate degree holders, the majority of the other biotechnology workforce categories held bachelor degree qualifications. Based on the surveyed result, biological science is tracked to be the most commonly pursued discipline.

While standing firm as the global leader in the field of biotechnology, the United States has not halted its progress for human capital development, particularly with the growing competition from the European and Asian regions.

In 2004, the National Biotechnology Worker Training Initiative was embarked by the U.S. Labour office. With a funding amount of RM63 million, the initiative aims to provide the funding support in national region where a short-fall of skills or workforce in the life science sector is identified.

In order to nurture the next generation of skilled, educated and science-savvy Americans, the Obama administration has recently launched the Science, Technology, Engineering, and Mathematics (STEM) education program to support the development of students from the early elementary stages.
Key Success Factors:

- Early-adopter of biotechnology, thus capitalizing on its expertise and large funding capabilities to streamline the current industry functions.
- Strong R&D funding, which accounted for about 2.6 percent of the nation's GDP.
- Mature private industry and academic sectors, which are able to fund research programs, and advocate industry enhancement initiatives independently. Furthermore, most of the well-established universities have fostered a strong relationship with the industry for technology transfers, and are highly capable for research commercialization.
- Possesses a large pool of highly-skilled biotech workforce.
- Dedicated federally funded non-profit organization for each biotech thrust to keep track of industry development and needs and provide recommendations for policy formation.
- Joint participation between the government, industry players, academic bodies, and non-profit organizations in the formulation of biotech policies.
- Policy making and funding at state levels, which more appropriately addresses the needs of the local biotech industries.

Emerging Nation: Singapore

Governance & Key Policies:

The R&D and innovation in Singapore is under the custody of the Ministry of Trade & Industry, which have established two key statutory boards, namely Agency of Science, Technology & Research (A*STAR), and Economic Development Board (EDB), to champion the biotech and R&D activities in the country.

Planning and implementation of innovation strategies are primarily driven by three key agencies comprising of A*STAR, EDB’s Biomedical Science Group and Bio*One. In 2000, the three agencies jointly developed and launched the Singapore Biomedical Sciences Initiative. Developed on a two-phase approach, the first phase of the initiative focuses on the foundation building of basic biomedical research in Singapore, from 2000 to 2005. Throughout 2006 to 2010, the nation has been embarking on its second phase of development to strengthen the industry’s basic and translational research capabilities.

A*STAR comprises of the Biomedical Research Council (BMRC) and Science & Engineering Research Council (SERC), which promote, provide funding support, and oversee the public R&D research activities in Singapore. Exploit Technologies is responsible for the management of intellectual property created within the agency’s institutes, and facilitate technology transfer and commercialization to the industry, while the A*STAR Graduate Academy (A*GA) supports the agency’s key thrust of human capital development.
Key Success Factors:

- Early-adopter of biotechnology, thus capitalizing on its expertise and large funding capabilities to streamline the current industry functions.
- Strong R&D funding, which accounted for about 2.6 percent of the nation’s GDP.
- Mature private industry and academic sectors, which are able to fund research programs, and advocate industry enhancement initiatives independently. Furthermore, most of the well-established universities have fostered a strong relationship with the industry for technology transfers, and are highly capable for research commercialization.
- Possesses a large pool of highly-skilled biotech workforce.
- Dedicated federally funded non-profit organization for each biotech thrust to keep track of industry development and needs and provide recommendations for policy formation.
- Joint participation between the government, industry players, academic bodies, and non-profit organizations in the formulation of biotech policies.
- Policy making and funding at state levels, which more appropriately addresses the needs of the local biotech industries.

Emerging Nation: Singapore

Governance & Key Policies:
The R&D and innovation in Singapore is under the custody of the Ministry of Trade & Industry, which have established two key statutory boards, namely Agency of Science, Technology & Research (A*STAR), and Economic Development Board (EDB), to champion the biotech and R&D activities in the country.

Planning and implementation of innovation strategies are primarily driven by three key agencies comprising of A*STAR, EDB’s Biomedical Science Group and Bio*One. In 2000, the three agencies jointly developed and launched the Singapore Biomedical Sciences Initiative.

Developed on a two-phase approach, the first phase of the initiative focuses on the foundation building of basic biomedical research in Singapore, from 2000 to 2005. Throughout 2006 to 2010, the nation has been embarking on its second phase of development to strengthen the industry’s basic and translational research capabilities.

A*STAR comprises of the Biomedical Research Council (BMRC) and Science & Engineering Research Council (SERC), which promote, provide funding support, and oversee the public R&D research activities in Singapore. Exploit Technologies is responsible for the management of intellectual property created within the agency’s institutes, and facilitate technology transfer and commercialization to the industry, while the A*STAR Graduate Academy (A*GA) supports the agency’s key thrust of human capital development.

The two agencies from EDB, on the contrary, are responsible for the policy implementation within the private sector, whereby the Bioscience Group is responsible for development of the private biomedical science industry, while the Bio*One Capital is primarily set up to facilitate technological acquisition and investments in promising private R&D companies.

The Research, Innovation and Enterprise Council (RIEC) is an independent body chaired by the Prime Minister of Singapore to oversee the National Research Foundation, which is responsible for the implementation of policies formulated by the RIEC.

*Diagram 3-6*

*Biotechnology Institutional Framework in Singapore*
Research Funding:

The Singapore government had budgeted approximately RM35.3 billion for its phase-two development plan of its Biomedical Science Initiative from 2006 to 2010, in which approximately RM15 billion was allocated for life-sciences research alone.

A*STAR was a top fund recipient through the plan at RM13.1 billion, followed by the National Research Foundation at RM12 billion. The EDB-Biomedical Science Group and Bio*One Capital were allocated RM4.7 billion and RM2.9 billion respectively for the development of the private biotech sector. The remaining RM2.54 billion of government funds was allocated as Academic Research Fund for the Ministry of Education to cover the basic research activities at the universities.

Similar to the patterns of most OECD countries, the private sector funding constitute the majority of R&D funding in Singapore at 61 percent (RM9.5 billion), followed by 32 percent (RM5.1 billion) from the government in 2007. Foreign funding accounted for 4 percent (RM659 million).

Human Capital Development:

Since the late 1980s, the recognition of biotechnology of as one of the major economic driver had lead to the establishment of various human development programs in the country to build up skilled manpower in the sector.

From the local perspective, human capital development initiatives are primarily driven through the A*STAR Graduate Academy (A*GA), providing scholarships and fellowships through the National Science Scholarship (NSS) and A*STAR Graduate Scholarship (AGS). More than 250 of post graduate and post doctoral candidates had already benefited through the programs for trainings at the leading local and top ranked foreign partner universities and institutions, such as Imperial College of London, University of Illinois, John Hopkins University, and Karolinska Institute.

Being a considerably late adopter of biotechnology as compared to the developed nations in the Western regions, the strategy of international recruitment had swiftly established a strong management framework of the public research institutes. With the strong efforts from the government, Singapore is continuing to recruit prominent international scientific luminaries to form the management or scientific board members for majority of the institutes. Some of the most prominent recruits include Prof Sir David Lane, heading the BMRC, Prof Edison Liu for GIS, and Sir George Radda, Deputy Chairman of the SBIC.
Research Funding:
The Singapore government had budgeted approximately RM35.3 billion for its phase-two development plan of its Biomedical Science Initiative from 2006 to 2010, in which approximately RM15 billion was allocated for life-sciences research alone. A*STAR was a top fund recipient through the plan at RM13.1 billion, followed by the National Research Foundation at RM12 billion. The EDB-Biomedical Science Group and Bio*One Capital were allocated RM4.7 billion and RM2.9 billion respectively for the development of the private biotech sector. The remaining RM2.54 billion of government funds was allocated as Academic Research Fund for the Ministry of Education to cover the basic research activities at the universities.

Similar to the patterns of most OECD countries, the private sector funding constitute the majority of R&D funding in Singapore at 61 percent (RM9.5 billion), followed by 32 percent (RM5.1 billion) from the government in 2007. Foreign funding accounted for 4 percent (RM659 million).

Human Capital Development:
Since the late 1980s, the recognition of biotechnology as one of the major economic driver had lead to the establishment of various human development programs in the country to build up skilled manpower in the sector.

From the local perspective, human capital development initiatives are primarily driven through the A*STAR Graduate Academy (A*GA), providing scholarships and fellowships through the National Science Scholarship (NSS) and A*STAR Graduate Scholarship (AGS). More than 250 of post graduate and post doctoral candidates had already benefited through the programs for trainings at the leading local and top ranked foreign partner universities and institutions, such as Imperial College of London, University of Illinois, John Hopkins University, and Karolinska Institute.

Being a considerably late adopter of biotechnology as compared to the developed nations in the Western regions, the strategy of international recruitment had swiftly established a strong management framework of the public research institutes. With the strong efforts from the government, Singapore is continuing to recruit prominent international scientific luminaries to form the management or scientific board members for majority of the institutes. Some of the most prominent recruits include Prof Sir David Lane, heading the BMRC, Prof Edison Liu for GIS, and Sir George Radda, Deputy Chairman of the SBIC.

Through its strong international networking with leading research institutions globally, Singapore is also able to leverage on the advisory support from its partners through the formation of the International Advisory Council (IAC), and the Distinguish Visitor Programme, which to date, had hosted more than 55 international scientific luminaries and Nobel Laureates to foster stronger ties between the local research community and world-renowned scientists.

Apart from focusing on the quantitative and knowledge development within the biotech spectrum, the formation of the universal Singapore HR Accreditation Framework aims to enhance the employment advantage in the country. Being the first Singapore HR competency model, the framework is introduced by the Singapore Human Resources Institute (SHRI) after rigorous effort to study and put together best worldwide HR practices while taking into account local needs. By streamlining the competency levels of the HR professionals in the country, the new framework serve to address the compensation and remuneration needs of the industry that coincides with international standards. In 2006, a postdoctoral fellow in Singapore is estimated to earn up to $3,210 a month, nearly five times the salary that is paid in Malaysia.

The strong market drivers have rapidly increased the biotech workforce in the country. According to A*STAR, the total R&D researcher headcount had grown by 9 percent to 27,301 in 2007. The private sector is the largest recruiter with 59 percent of the workforce employed. Furthermore, new PhD researcher hire has also increased by 21 percent in the private sector from 957 in 2006 to 1,159 in 2007, compared to the public sector’s 14 percent year-on-year increase.

Within the segments of biotech and life science, there were 1,784 doctorate and 981 master degree conferred FTE researchers in 2007. The public research institute segment is the highest recruiter of PhD researchers with 712 recruits (40 percent, followed by the private sector at 422 (24 percent). The private sector is also the highest recruiter of master holder researchers by hiring 42 percent of the workforce in this category.
Chart 3-12
Distribution of FTE Biotech & Life Science Postgraduate Researchers by sector

<table>
<thead>
<tr>
<th>Specialization</th>
<th>PhD 2007</th>
<th>MSc 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Sector</td>
<td>451</td>
<td>444</td>
</tr>
<tr>
<td>Higher Education Sector</td>
<td>523</td>
<td>243</td>
</tr>
<tr>
<td>Government Sector</td>
<td>131</td>
<td>183</td>
</tr>
<tr>
<td>Public Research Institutes</td>
<td>723</td>
<td>159</td>
</tr>
</tbody>
</table>

Notes: Calculation based on A*STAR’s workforce classifications of Agricultural & Food Sciences, Biomedical & Related Sciences, Biomedical Engineering, Material Sciences & Chemical Engineering, Marine Engineering, and Earth & Related Environmental Sciences

On average, the FTE rate of postgraduate biotech researchers is considerably high. Approximately 77.6 percent of the biotech and life science postgraduate researchers were hired on a full time basis. The public research institutes are found to have the highest FTE rate for postgraduate research at 91.1 percent, followed by the private sector at 89.3 percent.

Within the biotech and life science specializations, 63 percent majority of the postgraduate researchers were specialized in the field of biomedical & related sciences, signifying the stimulated outcome of strong governmental focus in this specialization area. Material Sciences and Chemical Engineering is the second most common field with 23 percent.

Agricultural and Environmental related sciences, and engineering fields in marine and biomedicine accounted for the remaining 14 percent.
Distribution of FTE Biotech & Life Science Postgraduate Researchers by specialization

- Biomedical & Related Sciences: 63%
- Material Science & Chemical Engineering: 23%
- Earth & Related Environmental Sciences: 3%
- Agricultural & Food Sciences: 4%
- Biomedical Engineering: 4%
- Marine Engineering: 3%
- Biomedical & Related Sciences: 4%

Key Success Factors:

- Successful implementation for the phase-one of Biomedical Sciences Initiatives, including the establishment of Bio-polis cluster equipped with world-class facilities.
- GERD to GDP ratio of 2.3 percent puts Singapore up in the ranks as one of the highest R&D intense country in the region.
- Ability to lure top foreign scientific talents with its favourable research environment and attractive remuneration incentives.
- Strong international networking with active knowledge transfers from the leading research institutes and scientists allows continuous capability enhancement of the local research community.
4.1 Biotechnology Workforce and Growth Trend in Malaysia (2008)

Skilled human capital is an essential factor in the development of the biotechnology industry. Without the availability of capable scientific personnel and researchers the industry will not be able to generate sufficient volume of intellectual output to be commercialised. The implementation of prototypes and concepts into fully commercialised products will also suffer as there will be shortage of adequately skilled workforce to carry out these activities.

The government of Malaysia has duly recognised the importance of human capital in their strategic planning for the biotechnology industry and laid out the necessary policy and regulatory framework to promote the development of skilled human resources. However, grooming such workforce require time and infrastructure. To offset the initial lack of human capital “intellectual brain gain” policy has been established to pull in foreign intellectuals and scientists to Malaysia in the first thrust of industry expansion. The acquisition of foreign IPR will become the basis for further development of local researchers and scientists.

According to Malaysian Ministry of Science, Technology, and Innovation (MOSTI), the employment capacity target of 40,000 employees (scientific and non-scientific) in the biotechnology sector has been set for the year 2010. By the year 2015 the industry is expected to reach 80,000 employees.

Targets for GDP contribution have also been set as the nation is hoping to move away from other industry sectors, within which the country is placed at the bottom of the value chain and therefore can experience higher competition from emerging SEA nations such as Vietnam, Thailand, Indonesia, and China.
4.1 Biotechnology Workforce and Growth Trend in Malaysia (2008)

Skilled human capital is an essential factor in the development of the biotechnology industry. Without the availability of capable scientific personnel and researchers the industry will not be able to generate sufficient volume of intellectual output to be commercialised. The implementation of prototypes and concepts into fully commercialised products will also suffer as there will be shortage of adequately skilled workforce to carry out these activities.

The government of Malaysia has duly recognised the importance of human capital in their strategic planning for the biotechnology industry and laid out the necessary policy and regulatory framework to promote the development of skilled human resources. However, grooming such workforce require time and infrastructure. To offset the initial lack of human capital "intellectual brain gain" policy has been established to pull in foreign intellectuals and scientists to Malaysia in the first thrust of industry expansion. The acquisition of foreign IPR will become the basis for further development of local researchers and scientists.

According to Malaysian Ministry of Science, Technology, and Innovation (MOSTI), the employment capacity target of 40,000 employees (scientific and non-scientific) in the biotechnology sector has been set for the year 2010. By the year 2015 the industry is expected to reach 80,000 employees.

Targets for GDP contribution have also been set as the nation is hoping to move away from other industry sectors, within which the country is placed at the bottom of the value chain and therefore can experience higher competition from emerging SEA nations such as Vietnam, Thailand, Indonesia, and China.

In 2008, the entire workforce within the biotechnology sector was estimated at 36,000 with 18,000 (~50%) being classified as knowledge workers (Frost & Sullivan). The knowledge based classification includes researchers, scientists and industry employees having degree (BSc) or higher (MSc and PhD).

The exact number is difficult to establish as many companies, especially in the agricultural and healthcare biotechnology sectors, dedicate only part of its workforce to biotech related products and services.

---

**Figure 4-1**

*Strategic Targets in the Master Development Plan for the Biotechnology Industry in Malaysia*

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Phase I 2005 to 2010 “Capacity Building”</th>
<th>Phase II 2011 to 2015 “Science to Business”</th>
<th>Phase III 2016 to 2020 “Global Business”</th>
<th>Total Phase I to III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment by Private Sector and Government</td>
<td>RM 6b</td>
<td>RM 9b</td>
<td>RM 15b</td>
<td>RM 30b</td>
</tr>
<tr>
<td>Employment</td>
<td>40,000</td>
<td>80,000</td>
<td>160,000</td>
<td>280,000</td>
</tr>
<tr>
<td>No. of Companies</td>
<td>25</td>
<td>25</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Total Revenue</td>
<td>RM 20b</td>
<td>RM 80b</td>
<td>RM 170b</td>
<td>RM 270b</td>
</tr>
<tr>
<td>Contribution to GDP</td>
<td>2.5%</td>
<td>4%</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Source: Malaysian Ministry of Science, Technology, and Innovation (MOSTI) and Malaysian Biotechnology Corporation (BiotechCorp)
The estimated industry size in 2008 was RM20 Billion, with industrial biotechnology contributing 50 percent, healthcare biotechnology 40 percent, and agricultural biotechnology 10 percent. The future trends will see a shift towards healthcare and agriculture as these sectors are experiencing the highest growth in Malaysia and the region due to increased demand for biological, molecular diagnostics, personalised treatments, bio-fuels and modified crops.

At the same time the graduation output from local public and private colleges and higher education institutions in the field of biotechnology related sciences was estimated at 5,170 and included BSc, MSc, and PhD. Frost & Sullivan estimates that the number graduate output will grow in the next 5 years at the rate of approximately 25 percent per year.
The estimated industry size in 2008 was RM20 Billion, with industrial biotechnology contributing 50 percent, healthcare biotechnology 40 percent, and agricultural biotechnology 10 percent. The future trends will see a shift towards healthcare and agriculture as these sectors are experiencing the highest growth in Malaysia and the region due to increased demand for biological, molecular diagnostics, personalised treatments, bio-fuels and modified crops.
Frost & Sullivan predicts that the biotechnology industry in Malaysia will grow by revenue at an average rate of 15 percent per year (CAGR). Healthcare revenue will experience the highest growth with CAGR of 20 percent, followed by agriculture 15 percent and industrial 10 percent. By the year 2013 the industry is expected to generate RM45 Billion in revenue. However, worsening economic recession could have negative impact on the industry growth, which might drop below 10 percent.
Frost & Sullivan predicts that the biotechnology industry in Malaysia will grow by revenue at an average rate of 15 percent per year (CAGR). Healthcare revenue will experience the highest growth with CAGR of 20 percent, followed by agriculture 15 percent and industrial 10 percent. By the year 2013 the industry is expected to generate RM45 Billion in revenue. However, worsening economic recession could have negative impact on the industry growth, which might drop below 10 percent.

There is lack of information on the total number of workforce engaged in biotechnology industry in Malaysia. The information available from BiotechCorp, and being used in this document as reference for assumptions, represents employment statistics from within BioNexus network of companies, which accounts for about 5 – 10 percent of the total biotechnology industry.

Based on the statistical modelling and simulation of available information, Frost & Sullivan established close correlation (70 percent) between industry growth and the demand for knowledge workers. Using this relationship trends of future demand and supply where plotted to assess the knowledge gap.

According to the findings the total industry demand - supply gap will be increasing to gross 22 thousand by the year 2013. This is caused by the industry demand outpacing the education system supply as demonstrated in the Chart 4-3.

*Chart 4-3*

*Malaysian Biotechnology Human Capital Trends: Supply - Demand Gap*

![Human Capital Trends: Total Biotechnology Supply - Demand Gap](source: frost & Sullivan)
4.2.1 Malaysian Agricultural Biotechnology Human Capital Forecast

The Agriculture sector will experience rapid growth in the next 5 years as a result of the Malaysian government emphasis on its natural resources as the basis for the industry expansion. There are number of initiatives in the country to promote bio-herbal, bio-fuels, and bio-food industries. The most important is the East Coast Economic Region initiative to coordinate the development of herbal and agro-biotech clusters.

The education system is well prepared to service the increased demand for agro-biotech knowledge workers. The graduate outputs are the highest compared with other biotechnology sciences. As a result the gap in supply and demand will be shrinking. By the year 2013 the unfulfilled needs in regards to human capital are estimated to be at the range of 2,500. This number could still be higher as the absorption rate into industry is around 70 percent.

Chart 4-4
Agricultural Biotechnology human capital trends

Human Capital Trends: Agricultural Biotechnology Supply - Demand Gap

Source: Frost & Sullivan
4.2.2 Malaysian Healthcare Biotechnology Human Capital Forecast

The healthcare biotechnology sector is the most dynamic and represents the highest growth trends. This is directly linked to the trends in healthcare industry and the demand for biotechnology therapeuticals (medicines, vaccines) and diagnostics.

Therefore, it will experience the highest shortage of knowledge workers as the education system will not be able to increase its output at the rate the industry is developing. Frost & Sullivan estimates that by the year 2013 the gap could be as high as 14,000.

*Chart 4-5*

*Healthcare Biotechnology human capital trends:*

[Graph showing human capital trends: Healthcare Biotechnology Supply - Demand Gap]
4.2.3 Malaysian Industrial Biotechnology Human Capital Forecast

The demand for biofuels, processing, and materials will be growing at the rate of around 15 percent. This will require an estimated 8,500 knowledge workers by the year 2013. The education system output will provide slightly more than 3,000 fresh graduates by this time with the unfulfilled needs of about 5,000 knowledge workers.

*Chart 4-5*

*Industrial biotechnology human capital trends*

*Chart 4-6*

*Human Capital Trends: Industrial Biotechnology Supply - Demand Gap*

![Graph showing the supply and demand for industrial biotechnology knowledge workers from 2008 to 2013. The graph illustrates the growing gap between supply and demand, with a significant shortage expected by 2013.](source: Frost & Sullivan)
INDUSTRY’S SENTIMENTS ON THE LOCAL BIOTECHNOLOGY WORKFORCE

5.1 Introduction

Efforts by BiotechCorp to stimulate growth in biotechnology have created a group of BioNexus companies which form the core of biotechnology industry in Malaysia. These industry players employ the majority of the biotech workforce in the private sector. Given that these players form the crux of the Malaysian biotechnology scene, we interviewed a sampling of them from the three biotech sector; biotech-agriculture, biotech-healthcare and biotech-industrial. Their opinions were analysed to provide us with the industry sentiments on our local biotech workforce.

A total 42 biotech companies were interviewed with 12 coming from Agricultural Biotechnology, 18 companies from Healthcare Biotechnology and 12 from Industrial Biotechnology sector to gather their opinions on the current local biotech workforce and their current and future expectations on the biotech human resource and their requirements for employees.

Chart 5-1
Sample of Biotech Industry Players interviewed by sectors:

Agriculture, 28%
Healthcare, 42%
Industrial, 28%

Source: Frost & Sullivan
5.2 Defining the Industry Standards

All the industry players have indicated that there is not a staffing shortage in the industry but there is a huge skills shortage. Staffing shortage is defined as a lack of sufficient manpower in the market to supply the industry in numbers adequate for the industry to grow. A skills shortage occurs when current employees do not have the full repertoire of skills their company requires and thus is different from staffing shortage, which pertains to the need to fill vacant positions. All the employers in the biotech sector in Malaysia agree that there is a lack of adequate manpower with sufficient hard and soft skills to spur their businesses to greater heights. Hard skills here are defined as technical, hands-on and lab skills. Soft skills refer mainly to skills relating to the management of people. There is also an urgent need for key senior personnel and project leads in the industry.

Many of them have cited that they have to bring in foreign expatriates to help in addressing the human resource needs of their companies as the local talent pool could not fill it. Some of them have also cited issues with working visas on bringing in foreign talent. There is also one incident which required the approval of the Chief Minister in order to facilitate the visa approval of an expatriate with a PhD’s entry into Malaysia. The pressing human resource needs of the biotech industry are now being seen as an Achilles’ heel in Malaysia’s biotech plans. Many industry players have indicated that the industry will not be able to catch up with the developed nations if there is no concerted effort being done to address this issue.

5.2.1 Technical Skill Requirement within the Industry

Technical skills are considered hard skills needed in the industry. These skills are related to the key aspect of biotechnology work such as lab work, lab equipment expertise, instrumentation and analysis, project management, job knowledge, self learning and commercialisation skills. These are skills relating to the job at hand, whether it is in the laboratory or in the office whilst planning the project. Needless to say, in today’s biotechnology field, these skills are considered rudimentary and should be seen in biotech staff.

The respondents have generally categorised these technical skills into four broad categories: Practical skills, job knowledge, commercialisation skills and project management skills. The players were unanimous in stating that there needs to be a marked technical skills improvement in Malaysia’s workforce in order for the biotech sector to grow.
As to the reasons why the employers feel that the present graduates lack the necessary hard and soft skills, 75 percent of the employers feel that the reason for the skills shortage is because of the lack of funding. They felt that the graduates lack the necessary funds needed to learn the latest techniques in the universities. Therefore, they come out without knowing these hard skills. 70 percent of the respondents felt that the graduates did not learn these skills because there is a lack of necessary equipment in the universities. Therefore, they did not have the opportunity to learn the skills as the universities do not come equipped with the latest apparatus compared to the equipment used in the industry. 55 percent of the respondents felt that the students lack the proper mentoring and the university syllabus is inadequate for the teaching of post graduate students needed by the industry. They felt that the lecturers do not know the latest technologies and techniques used in the workplace and therefore, fail to impart the necessary knowledge to their students. The employers also opined that there is a need for a syllabus change to allow the students to remain relevant for the industry. Only 30 percent of the respondents view that there is a lack of interest amongst the students in pursuing the necessary skills.
A total of 12 Agricultural Biotechnology companies were interviewed to get their view on the technical skills requirement of the industry.

According to the 80 percent of the Agricultural Biotechnology industry players, the major technical skills lacking amongst their employees are practical skills which are laboratory skills, on-the-bench tips and hands-on practise that is used in the lab. These skills are mostly related to research and development techniques and procedures. They have found that their employees lack the most up-to-date methods needed in the biotech field and though, most of them have heard about the methods, few have actually done them. The graduates are also at a big disadvantage when it comes to on-the-bench tips that can reduce time and is needed heavily in the research and development environment of biotechnology. Therefore, they have to retrain their employees before allowing them to start work. This increases their cost of retraining, compounded by the search cost for suitable candidates for hiring.
Not only that, in today’s fast paced biotech research field, the non-availability of the trainer and the employee to do research may cost them a competitive edge as their rivals in the industry may have progress one more day in advance of them while they spend time training their new staff. Hence, employers have indicated that these practical skills are highly prized by the industry and employees who have these skills are quick to find employment with biotech firms who are usually more than willing to pay a premium on their salary. According to 50 percent of the companies interviewed, this lack of practical skills is more prevalent amongst graduates of Master’s degree by coursework compared to PhD graduates as they only handle lab assignments during their final year of study, compared to PhD students who have to handle lab work in their research.

However, 50 percent more indicated that both Masters and PhD graduates lack these skills. Although the complaints on PhD graduates are that they are not proficient in the latest methods and lab techniques, this could have been caused by the lack of funding in the universities where they are doing their lab work. This finding has been confirmed by the academic respondents who stated that though some of them have the latest equipment, the funds needed to maintain and use the equipment is lacking.

47 percent of the Agricultural Biotechnology employers also found their employees lack the job knowledge and self-learning skills, even if they have a Master’s degree or PhD. They have found that their employees are very academic in nature and are unable to apply their knowledge while on the job. This is a frustration amongst the employers as their employees are often at a loss while in discussion with their supervisors.

In the field of research, discussions are often the catalyst of thoughts as results of experiments are talked over during discussions and findings are explained and understood by all. Therefore, they find it a hindrance as they have to spend additional time correcting the thinking and concepts needed to allow their research to be productive at work. The employees do not do enough self study to research the topic and also to pursue self knowledge. This leads to them committing the same mistakes in the work. The employers have cited the learning culture of ‘spoon-feeding the students’ in the Malaysian education system to be the source of this. They have said that the students expected to be told what to read and given information related to their work instead of actively pursuing the knowledge by their own initiatives. Both the lack of job knowledge and lack of learning skills are prevalent among the local Masters and PhD graduates.

Healthcare Biotechnology

Out of the total of 18 Healthcare Biotechnology companies interviewed, the technical skills required by them consist of three categories: practical skills, job knowledge and self-learning skills and project management skills. Unlike Agricultural Biotechnology companies, they did not feel that the present employees lack commercialisation skills. This could be due to the nature of the healthcare field which approach the problem from the curative and treatment of disease point of view.
The graduates also lack skills needed to commercialise new found results into commercial products as claimed by 33 percent of the Agricultural Biotechnology industry players. This is evident in the PhD project topics which they research in as the projects were mostly repetitive and were not innovative ideas which can be commercialised. According to the industry players, although some of the local researchers have collaborated with them to commercialise products, many of the PhD projects are not creative and lack commercialisation values. Graduates who are employed also lack skills required to commercialise products. They lack the marketing knowledge needed in a business environment to foresee market demand for products. This lack of commercialisation skills does not bode well for the companies as they are not able to transform research findings into sellable products. This will cause most biotech firms to go under. Hence, there is an urgent need to address this shortage of skills.

There is also a lack of project management skills amongst graduates. Employees in the biotech industry are expected to be able to manage their project and prioritise their work in order to maximize productivity and results of their projects. However, according to 27 percent of the Agricultural Biotechnology industry players, this skill set is evidently lacking in our present pool of workforce as they do not seem to be able to plan and execute their projects properly on time and within budget. Employers have said that the lack of project management skills have led them to look for foreign expatriates who can function as project leads in order to ensure the smooth running of their research and development.

**Healthcare Biotechnology**

Out of the total of 18 Healthcare Biotechnology companies interviewed, the technical skills required by them consist of three categories: practical skills, job knowledge and self-learning skills and project management skills. Unlike Agricultural Biotechnology companies, they did not feel that the present employees lack commercialisation skills. This could be due to the nature of the healthcare field which approach the problem from the curative and treatment of disease point of view.
64 percent of the respondents feel that the present workforce available in the local biotech scene needs retraining as their practical skills are inadequate to be used in their research and development laboratories. Even if they are trained, the lab skills required by the industry usually uses cutting edge technology, not available in the local universities, thus the candidates have never used these new equipment in the commercial laboratories before.

45 percent of the companies felt that the second most important technical skills missing from their local employees are job knowledge and self-learning skills.

As mentioned above, it is imperative that in a scientific field, employees must have the ability to learn, relearn and unlearn to allow them to maximise their learning opportunities while at work. Sadly, this is missing amongst the local talent pool.

Lastly, 9 percent of the companies felt that the project management skills of their local employees leave much to be desired. The inability of the local workforce to lead and champion their project especially when contesting for company funding for their research have caused the employers great grief. This leads them to invest in the wrong projects and some have also complaint of cost overruns in their projects due to bad project management.
**Industrial Biotechnology**

A total of 12 Industrial Biotechnology companies were surveyed. They have cited that their technical skills requirements were the same as Agricultural Biotechnology. They needed practical skills, job knowledge and self-learning skills, commercialisation skills and project management skills.

**Chart 5-5**

*Technical skills lacking from local employees in the Industrial Biotechnology sector:*

![Chart showing the percentage of respondents lacking technical skills in various categories]

Among the 12 Industrial Biotechnology companies surveyed, a total of 60 percent of them complained of the inadequacies in practical skills among their local employees. They were forced to retrain their employees regardless of whether their employees have Masters or PhD. However, for the employers in this field, and as their field is relatively new in Malaysia, they do understand that this cannot be avoided and seem conciliatory towards the local universities.

60 percent of them also opined that the job knowledge and self-learning skills which are missing from local employees impede their growth. This is especially so for the Industrial Biotechnology sector as it is relatively new and employees need to quickly learn new skills and acquire new knowledge which are missing from their syllabus in order to keep abreast of the market.
A total of 20 percent of the biotech companies opined that their employees lack commercialisation skills needed to convert their findings into commercial products while another 20 percent opined that project management skills are inadequate. The project management skills in biotech industry is very important as this field is very much into building industrial plants and cost overruns will risk their deliverables which are the plants themselves.

### 5.2.2 Soft Skill Requirements within the Industry

Soft skills refer to skills related to the management of people and self. This skill will bring out the extra edge in the graduates. Among the soft skills are presentation skills, communication skills, language skills and etiquette and ethics.

#### Table 5-1

**Soft Skill shortfall by sectors:**

<table>
<thead>
<tr>
<th>No</th>
<th>Soft Skills Lacking Amongst Graduates</th>
<th>Agricultural Biotechnology</th>
<th>Healthcare Biotechnology</th>
<th>Industrial Biotechnology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Presentation skills</td>
<td>67%</td>
<td>55%</td>
<td>57%</td>
</tr>
<tr>
<td>2</td>
<td>Communication skills</td>
<td>67%</td>
<td>45%</td>
<td>43%</td>
</tr>
<tr>
<td>3</td>
<td>English Language skills</td>
<td>53%</td>
<td>45%</td>
<td>72%</td>
</tr>
<tr>
<td>4</td>
<td>Etiquette and ethics</td>
<td>27%</td>
<td>45%</td>
<td>14%</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan
According to the employers, there is a sharp lack of presentation skills amongst graduates. These remarks were voiced by 67 percent of Agricultural Biotechnology companies, 55 percent of Healthcare Biotechnology companies and 57 percent of Industrial Biotechnology companies surveyed. This is evident in the local workforce as they are expected to have these skills upon the completion of the post-graduate studies. This is in part due to the expectations that during their post graduate studies, they have been exposed to proposal presentation and defending their research findings in front of fellow researchers. The opposite is evidenced in the local graduates.

The inability of the employees to present their projects correctly in a commercial environment is damaging especially when they need to convince their supervisors and managers to choose between their research projects compared to others. This is also very damaging when the staff do presentations in front of customers and to raise project funding. Hence, employers view the lack of presentation skills amongst the top soft skills required.
67 percent of the Agricultural Biotechnology companies surveyed, 45 percent Healthcare Biotechnology companies and 43 percent of the Industrial Biotechnology companies surveyed found that the communication skills are foundering among the present graduates. This skill involves using the appropriate formal and informal method of communicating amongst researcher and towards superior, email writing skills and the proper way to address others. There is also a need in the business world to present proposals and project updates and also to chair meetings amongst their peers. These skills are also imperative in project leaders in Research and Development projects. Hence, communication skills are important as one has to communicate in order to network with others to discuss, criticise and share the research findings in a biotechnology firm.

The absence of language skills especially the English Language is another major weakness in the graduates as evidenced by the opinions of 53 percent of the Agricultural Biotechnology employers, 45 percent of the Healthcare Biotechnology employers and 72 percent Industrial Biotechnology employers. The English Language is the lingua franca of the biotech world and the mastery of it or the lack of mastery of this language will reflect on the individual’s ability to attain and exchange knowledge with his or her peers.

Many employers also find the language skills of their employees as a limiting factor when they choose to send them overseas for retraining. They have found that those with better English Language skills are able to adapt faster to a foreign environment and also learn faster. Hence, they are able to come back to Malaysia and train others. Therefore, they view English Language skills as a major criterion in their selection of staff. The lack of mastery of the English Language could have been caused by the heavy usage of Malay Language in the academia. Students have been using the Malay Language since their primary school as a medium of learning and communicating and some even used it to write their PhD projects. This could have led to the English Language being underutilized by the graduates even after their post graduate studies. The lack of English Language writing skills also contributes to the lack of scientific research publications in the international arena as these research outputs are usually done in English. The lack of mastery in this language leads to researchers publishing in local scientific journals using the Malay language.

Graduates also lack basic etiquette and ethics. Traits such as discipline, punctuality, honesty, sincerity and integrity are missing in the local workforce. Etiquette and ethics complaints were voiced by 27 percent of Agricultural Biotechnology employers, 45 percent of Healthcare Biotechnology employers and 14 percent of Industrial Biotechnology employers. One such example, as informed by the employer respondent, relates to the use of inappropriate email address for job application. This incident illustrates the lack of professional etiquette amongst the local graduates. Discipline and punctuality are also lacking in the present workforce.
Discipline and punctuality are important because in a lab environment, the discipline needed to be punctual, to perform test at the right time and place, drives the research and development environment in biotechnology. The ability of the employees to do this affect the performance of the whole company as the probability of good results from experiments and findings out of it rests on doing things efficiently and effectively.

Besides the above, some employers have also cited that honesty, sincerity and integrity is lacking. The need for biotech staff to be honest, sincere and having integrity comes from the fact that biotech is a knowledge based industry and the need for transparency and forthrightness is highly needed. The lack of it amongst their employees has created issues in the industry and has prompted companies to check their staff strictly. This issue is not new as other industries also highly prize this skill. Therefore, it is not surprising that some opinion exists that given the ethical issue related to biotechnology such as harvesting of stem cells, genetic engineering and cloning still fresh in their minds, etiquette and ethics will remain featured in the requirements of biotech industry players as an important must-have in their employees.

5.3 Demand Gap Analysis

There is an obvious demand gap between the supply of biotech human capital and the demand of biotech human resource needs in qualitative terms. Most industry players have indicated that there is sufficient manpower in Malaysia, just not those with good quality hence, the term skills shortage. According to the industry players, they have no preference for PhD graduates but would prefer graduates to have some working experience in R&D regardless of their qualifications.

5.3.1 Assessment of Manpower Sufficiency within the Biotech Sector

All the respondents in all areas have agreed that there is sufficient numbers of Masters and PhD candidates in all three sectors. However, they wish to convey that the quality of graduates is more important than the quantity of it at this moment. They felt that the number of staff in Malaysia is more than enough for the industry as it is still in a nascent stage.

They expect that in future, the number of researchers will increase in due course but they are more concerned about the quality of these researchers in the long run.
5.3.2 Assessment on the Skill Level of the Biotech Workforce
The sentiments described by the industry players of all three biotech sectors indicate that the skill levels of local workforce are inadequate without retraining. The skills acquired by the graduates in the universities during their post graduate studies are not transferable wholly to the commercial research centres.

5.4 Future Expectations from the Industry
The industry players have requested that some changes be made in the near future in order for Malaysian post graduate students to remain competitive in the marketplace. Realising that biotechnology requires the suitable human capital to allow Malaysia to continue to attract investments, the industry players have recommended the following:

All respondents from the biotech industry regardless of biotech sectors would like access to training grants and other types of training funds in order to retrain their local workforce to ensure their business growth. To them, this is imperative as their efforts on their business are currently being impeded by their staff’s lack of hard and soft skills. However, they do not have access to these funds, they would prefer that the government can either be their guarantor for commercial loans or the government provide them with soft loans for training their staff. If this is not possible, the industry participants would like the government to allow the training expenses for their staff to be tax-free and deductible from their profits. This will allow them to utilise their cash to retrain their staff without exerting stress on their company. This is important as the retraining of their staff is viewed as urgently needed if they were to progress further.

The industry players also recommended that the syllabus being taught in the local institutions of higher learning to be changed to suit the industry needs. The employers have also ascertained that the curriculum of what is being taught in the universities must remain relevant to the industry in order for the graduates to be employable.

The biotech industry players have also volunteered to have more industrial attachments to the local universities in order to allow the graduates to update themselves on the research being done now. They are more than willing to allow graduates to be attached to them for a longer period as some of them felt the current attachments are too short for the graduates to learn much.
In terms of trends in biotechnology, there may be an increase in Contract Manufacturing, Contract Research to Malaysia and on the opposite end; there will be some outsourcing of certain functions to other companies in Malaysia. In terms of Contract Manufacturing, there is a high potential in Malaysia being a site for future contract manufacturing in view that Malaysia is a suitable site for major manufacturing given the country’s base as a manufacturing country.

For contract research, Malaysia has several competitive advantages such as cheap wages, a diverse community, relatively developed accompanying economic sectors in agriculture, healthcare and industry and flexible clinical trials legislation. These factors are the major drivers for contract research in Malaysia and almost 55 percent of the biotech companies in Malaysia are receptive to this type of contract research being carried out in their firms.

The biotech companies in Malaysia are also open to outsourcing certain functions to vendors outside the country. This is in view of the slow but sure rising wages in Malaysia and being an open economy, up to 45 percent of Malaysian employers mentioned that in future, there will likely be outsourcing of some functions from their companies to other companies in Malaysia or outside Malaysia.
6.1 Introduction

Stimulated by the ongoing growth of the Malaysian biotechnology industry, increasing efforts have been contributed by the Government and various biotechnology agencies from the public sector to build the necessary infrastructure and prepare for the goal of attaining a developed nation status by year 2020.

In line with the development trend of the biotechnology industry, the establishment of a well equipped biotech workforce still remain as the critical component that serves as the pillar of the entire biotechnology sector in the future.

In this section, 70 biotech postgraduate respondents were surveyed throughout the public and private institutions in Malaysia to gather their perspectives on the current employment prospects and their current and future expectations on the biotech curriculums and job opportunities available in the market. Towards the end of the section, analytical studies will also be conducted to assess the demand and supply gap between the expectations of the biotech workforce and the level of support provided from the Malaysian Government, biotech employers, and the training institutions.

6.2 Evaluation of Employment Rate for Biotech Postgraduates

Out of the 70 biotechnology graduates surveyed, 42 percent were recruited from the healthcare biotechnology discipline, while 29 percent specialized in the agricultural biotechnology and industrial biotechnology disciplines respectively. Each biotech discipline comprised of 3 Doctorate holders, while the remaining respondents were either holders, or pursuers of Master degrees for their field of study.
6.1 Introduction

Stimulated by the ongoing growth of the Malaysian biotechnology industry, increasing efforts have been contributed by the Government and various biotechnology agencies from the public sector to build the necessary infrastructure and prepare for the goal of attaining a developed nation status by year 2020.

In line with the development trend of the biotechnology industry, the establishment of a well-equipped biotech workforce still remains as the critical component that serves as the pillar of the entire biotechnology sector in the future.

In this section, 70 biotech postgraduate respondents were surveyed throughout the public and private institutions in Malaysia to gather their perspectives on the current employment prospects and their current and future expectations on the biotech curriculums and job opportunities available in the market. Towards the end of the section, analytical studies will also be conducted to assess the demand and supply gap between the expectations of the biotech workforce and the level of support provided from the Malaysian Government, biotech employers, and the training institutions.

6.2 Evaluation of Employment Rate for Biotech Postgraduates

Out of the 70 biotechnology graduates surveyed, 42 percent were recruited from the healthcare biotechnology discipline, while 29 percent specialized in the agricultural biotechnology and industrial biotechnology disciplines respectively. Each biotech discipline comprised of 3 Doctorate holders, while the remaining respondents were either holders, or pursuers of Master degrees for their field of study.

**Chart 6-1**

*Biotech Graduate Employment Rate by Curriculum Segments*

![Chart showing employment rates for different biotechnology disciplines](image)

**Agricultural Biotechnology**

44.4 percent of the postgraduate respondents from the public universities were informed to have secured employment. 12.5 percent of the employed respondents were employed by the private institution and the remaining 87.5 percent continued pursuing their career in the public sector. It is also interesting to note that 100 percent of the employed biotech agricultural postgraduate in the public sectors obtained their employment with the universities they were studying in.

**Table 6-1**

*Agricultural Biotechnology: Occupation Categorization of Postgraduate Respondents*

<table>
<thead>
<tr>
<th>Sector</th>
<th>Employment Rate</th>
<th>Employed Segment</th>
<th>Occupation</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public University</td>
<td>44.4%</td>
<td>University (Public)</td>
<td>Lecturer / Tutor</td>
<td>42.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lab Assistant</td>
<td>28.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Research Assistant</td>
<td>28.6%</td>
</tr>
<tr>
<td>Private University</td>
<td>50.0%</td>
<td>Horticulture (Private)</td>
<td>Landscaping Horticulturist</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan
All the respondents, who pursue their careers as educators informed that they are satisfied with the career they are pursuing, which enabled them to further their interests in the research topics, and at the same time, being exposed to more extensive research environment, which was not achievable from the employments in the private commercial sectors. Some of the respondents also informed that they are more inclined to the public tertiary environment as it offers time flexibility and they will only be required to focus on research rather than in the commercial sector, where they may be attached to other administrative duties or rigid and routine job functions in the laboratory environment. Job security was also one of the main factors for their consideration to seek employment in the university campus, as the commercial sector is perceived to be underdeveloped at the moment and will not be able to offer the benefits and job opportunities that are comparable to the public sector.

As for the respondents who are pursuing their careers as laboratory or research assistants, 75 percent viewed this as an opportunity to hone their research foundations for more advanced employments in the future within the field of biotechnology agriculture, while 25 percent were informed to be dissatisfied with the current employment, as the career that they are undertaking does not build the foundation for entrepreneurship in the future.

Healthcare Biotechnology

83.3 percent of the employed post graduates from the public universities surveyed secured their employments in their respective universities, whereas 16.7 percent of the respondents were employed in the government departments as administrative assistants. In the group of private Healthcare Biotechnology postgraduates, 80 percent followed their career paths within the universities, in which majority of the postgraduate chose to become academic lecturers and tutors. About 20 percent of the private postgraduates secured a job outside the university as pharmacists.

According to the respondents who selected the academic careers, the most common career objective was to become lecturers or trainers in their field of expertise. Apart from being able to build their skills and experience in a supervisory capacity, and cultivate the career path as advanced researchers, the respondents also felt that the limited job opportunity in the sector was also the main rationale for their decisions to remain as university employees. According to one of the respondent from a private university, job opportunities for non-bumiputra citizens in the national research institutions, such as the Malaysia Genome Institute and Malaysia Institute of Pharmaceuticals and Neutraceuticals are scarce. In the private commercial sector, on the contrary, job availability for professional researchers is
also limited due to the diminutive number of players in the market. Furthermore, most corporate players are still in the early development stage; thereby mostly do not require high numbers of scientists in their R&D divisions. Hence, employment in the tertiary education sector will offer the best career option for the graduates in the current environment.

The seemingly popular trend of graduates seeking employments as educators is also reflected in the public sector, in which several graduates from foreign origins also felt that most job opportunities are provided in the universities and not the commercial sector. For the local citizen graduates, the majority either prefer the working environment of the universities, or were using the university career as opportunities to enhance their knowledge and skills, and be prepared when the market demand for biotech professionals flourishes in the future.

Table 6-2
Healthcare Biotechnology: Occupation Categorization of Postgraduate Respondents

<table>
<thead>
<tr>
<th>Sector</th>
<th>Employment Rate</th>
<th>Employed Segment</th>
<th>Occupation</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public University</td>
<td>31.8%</td>
<td>University (Public)</td>
<td>Lecturer / Tutor</td>
<td>28.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lab Assistant</td>
<td>42.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Research Assistant</td>
<td>14.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government Department</td>
<td>Admin Assistant</td>
<td>14.3%</td>
</tr>
<tr>
<td>Private University</td>
<td>62.5%</td>
<td>University (Private)</td>
<td>Lecturer / Tutor</td>
<td>60.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Research Assistant</td>
<td>20.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pharmaceutical</td>
<td>Pharmacist</td>
<td>20.0%</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan
Industrial Biotechnology

Due to the absence of program from the private academic sectors on Industrial Biotechnology related curriculums, all respondents surveyed for this segment were recruited from the public universities.

In comparison with the other 2 segments, the employment rate in the Industrial Biotechnology sector is relatively lower, which is likely to be caused by the niche nature of the specialization, which subsequently resulted in the scarcity of job opportunities in the country.

Of the postgraduates surveyed, 31.8 percent have been employed, of which the private to public employment ratio is approximately 1:1.5. Similar to the trends from the Healthcare Biotechnology, 60 percent of the respondents remained employed within the universities as lecturers or research assistants, while the remaining 40 percent obtained engineering employments within the private commercial sectors.

Table 6-3
Industrial Biotechnology: Occupation Categorization of Postgraduate Respondents

<table>
<thead>
<tr>
<th>Sector</th>
<th>Employment Rate</th>
<th>Employed Segment</th>
<th>Occupation</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public University</td>
<td>31.8%</td>
<td>University (Public)</td>
<td>Lecturer</td>
<td>20.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Research Assistant</td>
<td>40.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chemical Engineering (Private)</td>
<td>Chemical Engineer</td>
<td>20.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waste Water Treatment (Private)</td>
<td>Engineer</td>
<td>20.0%</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan

Further probing on the satisfaction level of the current employment revealed that 80 percent of the respondents had chosen their desired career path mainly due to the vast exposure on research functions and relevance to the field of study.

Furthermore, the respondents working as research assistants had viewed the career as skill enhancement platforms for them to further their research career or PhD curriculums in the future.
6.3 Evaluation of the Key Decision-making Criterion for Biotech Employment

In the following exercise, the biotech postgraduates were subsequently requested to mention five main assessment criteria for their career path selection without assisted prompting from the interviewers. While the respondents from different biotech specialization had provided slightly different inputs, it is noticeable personal interest was the most commonly mentioned criteria when it relates to selecting a biotech career.

42.9 percent of the respondents informed that by selecting a biotech career which is relevant to their interests, it helps create motivation, while 29.2 percent felt that by not selecting the field of interest, it will lead to deteriorated work performance. Furthermore, 16.7 percent informed that they will not be retained in the biotech job if it was irrelevant to their area of interest.
According to the respondents from the agricultural biotechnology and industrial biotechnology fields, selecting a biotech career that is the most relevant to their field of study was the second most commonly mentioned criteria. Overall, 54 percent of the respondents that selected the criteria informed that the ability to utilize the knowledge and skill adopted from the time and effort spent in the biotech program creates more value. Furthermore, with the fundamental knowledge and skill sets acquired from the academic program, it would also allow smoother transition for fresh graduates to more easily adapt to the new working environment in relevant field. Within the same pool of respondents, 16 percent of respondents expressed that they have already identified their desired career options and will be targeting to practice in a relevant field that will fulfil their career objectives, while 12 percent viewed practicing in a relevant field as an opportunity to further advance their existing skills and knowledge.

Workforce demand from the specific industry was ranked the third highest top mentioned career seeking criteria by the postgraduates from the agricultural biotechnology and industrial biotechnology segments. The respondents with prioritized selection of this criteria believed that strong industry performance will indicate the growth of the industrial players thus creating more job opportunities and career advancement prospects. Furthermore, 11 percent of the respondents indicate that they would be able to command for higher remuneration packages if they select employments from strong performing sectors. The favourable selection of the workforce demand criteria is an indication that is consistent with the findings in the previous sections where majority of the students select or would like to select the teaching sector as their desired career. Weak perception on the robustness, job availability, and remuneration levels of the commercial research sector is the possible reason for post graduates to select alternative career options, such as tertiary teaching, which currently offers more career opportunities and incentives.

In contrast to the response from the agricultural biotechnology and industrial biotechnology postgraduates, remuneration was ranked the third highest selection for the respondents from the healthcare biotechnology segment. 95 percent of the respondents from the segments regarded remuneration as the key motivational factor for them to select employment and must be provided at an appropriate level that corresponds to their professional status, while the remaining 5 percent of respondents regarded remuneration with high importance as it is viewed as the key personal funding source for qualification advancement.

The remaining criteria, such as foreign exposure, university referral, and location were the least prioritized selection during the survey process, which illustrate a trend that majority of the postgraduate are focusing more on the fundamental requirements of engaging in professional careers.
According to the respondents from the agricultural biotechnology and industrial biotechnology fields, selecting a biotech career that is the most relevant to their field of study was the second most commonly mentioned criteria. Overall, 54 percent of the respondents that selected the criteria informed that the ability to utilize the knowledge and skill adopted from the time and effort spent in the biotech program creates more value. Furthermore, with the fundamental knowledge and skill sets acquired from the academic program, it would also allow smoother transition for fresh graduates to more easily adapt to the new working environment in relevant field. Within the same pool of respondents, 16 percent of respondents expressed that they have already identified their desired career options and will be targeting to practice in a relevant field that will fulfil their career objectives, while 12 percent viewed practicing in a relevant field as an opportunity to further advance their existing skills and knowledge.

Workforce demand from the specific industry was ranked the third highest top mentioned career seeking criteria by the postgraduates from the agricultural biotechnology and industrial biotechnology segments. The respondents with prioritized selection of this criteria believed that strong industry performance will indicate the growth of the industrial players thus creating more job opportunities and career advancement prospects. Furthermore, 11 percent of the respondents indicate that they would be able to command for higher remuneration packages if they select employments from strong performing sectors. The favourable selection of the workforce demand criteria is an indication that is consistent with the findings in the previous sections where majority of the students select or would like to select the teaching sector as their desired career. Weak perception on the robustness, job availability, and remuneration levels of the commercial research sector is the possible reason for post graduates to select alternative career options, such as tertiary teaching, which currently offers more career opportunities and incentives.

In contrast to the response from the agricultural biotechnology and industrial biotechnology postgraduates, remuneration was ranked the third highest selection for the respondents from the healthcare biotechnology segment. 95 percent of the respondents from the segments regarded remuneration as the key motivational factor for them to select employment and must be provided at an appropriate level that corresponds to their professional status, while the remaining 5 percent of respondents regarded remuneration with high importance as it is viewed as the key personal funding source for qualification advancement.

The remaining criteria, such as foreign exposure, university referral, and location were the least prioritized selection during the survey process, which illustrate a trend that majority of the postgraduate are focusing more on the fundamental requirements of engaging in professional careers. Strong self-opined expectations, such as personal interests, relevance to studies suggest that the internal influencing factors play the most significant roles in deciding their career directions, which thereby correlates to some opinions from the industry players that the interest in biotechnology curriculums and topics should be created from an early elementary stage. Such initiative will likely be creating a new generation of workforce with a high retention rate.

On the contrary, remuneration and industry demand were also some of the key external factors scrutinized by the postgraduates and is reflected on the current development status of the biotech industry in Malaysia. Perceived low job opportunities and remuneration packages in the commercial sector has resulted in the increasing volume of students relying on university employments. However, in the long term, the job opportunities and capabilities in the universities will likely reach its recruitment threshold. Hence, nurtured growth of the commercial segments within the biotech industry will be critical in the near future to neutralize the deposition of biotech manpower within the public and private sectors.
The key influencer on the career decision of the biotech postgraduates revealed that the industry players received the highest votes for the most influential stakeholder group. 46 percent of the respondents informed that the industry players represent the most significant influence on the career decision. According to the respondents, the successful development of the biotech players in the market, especially the BioNexus status companies, will significantly enhance their confidence to seek employments in the commercial sector. The other 30 percent of respondents informed that their career decisions are most strongly influenced by their family and friends, while the remaining 23 percent regarded the academic faculties play the most important role in affirming their career decisions.

6.4 Biotech Postgraduates' Assessments on the Academic Programs

In this section, the biotech graduate respondents were requested to provide their top 5 assessment criteria before they embark on the biotech courses that they are undertaking. Subsequently, the respondents were also required to rate the importance of their selected criteria, based on a scale of 1 (least significant) to 10 (most significant), in order to identify the most important considerations that will influence their academic decisions. The other objective of this exercise is also to understand the respondents' perspectives on how the current industrial environment will affect their training development.

Consistent to the findings in Part 1 of the exercise, personal interest, relevance to the field of study, remuneration, and industrial demand were the four highest rate criteria.

Subsequently in a similar exercise, the postgraduate respondents were invited to rate the importance of the 5 career selection criteria based on a scale of 1 (least significant) to 10 (most significant).

Consistent to the findings in Part 1 of the exercise, personal interest, relevance to the field of study, remuneration, and industrial demand were the four highest rate criteria.
6.3.1 The Key Influencers of Career Decisions

Assessment on the key influencer on the career decision of the biotech postgraduates revealed that the industry players received the highest votes for the most influential stakeholder group. 46 percent of the respondents informed that the industry players represent the most significant influence on the career decision. According to the respondents, the successful development of the biotech players in the market, especially the BioNexus status companies, will significantly enhance their confidence to seek employments in the commercial sector. The other 30 percent of respondents informed that their career decisions are most strongly influenced by their family and friends, while the remaining 23 percent regarded the academic faculties play the most important role in affirming their career decisions.

6.4 Biotech Postgraduates’ Assessments on the Academic Programs

In this section, the biotech graduate respondents were requested to provide their top 5 assessment criteria before they embark on the biotech courses that they are undertaking. Subsequently, the respondents were also required to rate the importance of their selected criteria, based on a scale of 1 (least significant) to 10 (most significant), in order to identify the most important considerations that will influence their academic decisions. The other objective of this exercise is also to understand the respondents’ perspectives on how the current industrial environment will affect their training development.
Agricultural Biotechnology

Employment prospect was the highest criteria voted by the spectrum of biotech agricultural postgraduate respondents. 40 percent of the respondents felt that the biotech programs that they are selecting should cater for the current or future industrial demand. According to some of the respondents within the specialization, the job prospects within the agro-industry in Malaysia is perceived to be significantly higher as compared to the other two thrusts of Healthcare Biotechnology and Industrial Biotechnology, due to the establishments of various government bodies, such as MARDI, FRIM, MCB, FRI and RRIM. The strong reliance of agricultural outputs of the country for crops, such as rubber and oil palm has also created additional job opportunities for the postgraduates from both the public and private sectors. Hence, in the respondents’ opinions, they are provided with more selection choices for the university courses and the courses acquired are likely to be consistent with the industry demand.

Subsequent to the career prospects criteria, the assessment on the teaching faculty formed the second most important selection criteria with 23 percent of the votes. Within the group of respondents that voted for the criteria, 31.8 percent believed that an experienced faculty will be able to design more advanced courses, which can thereafter enable them to further their qualifications. Apart from the courses offered by the faculties, most students will also assess the credentials of the lecturers, past research journals and experimental results from the faculties.

Facilities of the universities obtained the third highest vote from the biotech agricultural postgraduates at 12 percent. Majority of the respondents selecting the facilities criteria felt that the university they are selecting must at least possess the basic research facilities, equipment, and sufficient lab space to facilitate the smooth operations of their program syllabus. A marginal number of respondents further informed that if given an opportunity, they would also hope that more advanced or modernized equipments are provided in the university to enable students to be exposed to the latest technologies, which will also improve the quality and accuracy of their research results. The significance of agricultural biotech students selecting the facilities criteria proved to be correlated to the comments from some educator respondents of the public biotech agricultural schools that the facilities provided in their institutions should be improved. According to the educator respondents, most of the equipments are currently shared with the other biotech departments, which limited the efficiency of the research operations. Hence, they would hope for more funding support from the government in the future to create dedicated research space for specific biotech departments.

The ranking, accreditation, availability of student exchange programs, curriculum, and partnerships of the university with other renowned institutions form the other remaining criteria from the biotech agricultural postgraduate respondents, each garnering 5 percent of the votes.
Based on the surveyed respondents, plant science specialization was the most commonly acquired program in the public university with 67 percent enrolment rate, followed by food science with 28 percent, and animal biotechnology at 6 percent. In the private sector, on the contrary, the type of postgraduate programs offered within the field of “green” biotech is relatively lower with 54 percent of the respondents specializing in plant or crop science, while the remaining 46 percent specializing in food science or chemistry.
The teaching faculty was the third highest assessed criteria, out of which 13 percent of the respondents had confirmed that an experienced faculty will be able to provide high quality teaching staff to provide the best form of guidance for this skill and knowledge development. According to 31 percent of respondents that selected the teaching faculty criteria, an experienced faculty will possess the capability to design more advanced and innovative academic programs that will be relevant to industrial demands. Before embarking on the academic programs, the postgraduate will assess on the research track record and journal publications of the particular faculty. Testimonials and awards conferred to the particular faculty or alumni members will also significantly enhance the respondents’ selection preference.

Accreditation or recognition of the university was reported to be the fourth most important criteria, constituting 10 percent of votes from the respondents. Majority of the respondents felt that certifications from accredited or reputable universities will gain more recognition in the employment market, thus amplifying their employment prospects, while 18.2 percent from this criteria selection groups perceived that the postgraduate programs offered in the accredited universities will be of better quality.

Healthcare Biotechnology

Within the spectrum of Healthcare Biotechnology, the availability of research grants was the criteria that most postgraduate respondents regarded as the key to their selection of biotech programs.

Out of the 23 percent that mentioned the research grant criteria, 92.3 percent felt that the funding from the government or private corporate bodies are vital to sustain the practical components and research works in their university programs, and also provide the opportunities for the students to expand their R&D scope. Furthermore, universities or research programs with sufficient grant support will increase the confidence of the students during their program selection process. The postgraduates from the private education sector, in particular, informed that the level of research grant support is insufficient, which impeded their ability to expand the scale of their research.

The career prospects of a particular program offered by the university was the second highest voted criteria by 20 percent of the respondents. Within the pool of respondents supporting such criteria, majority informed that factors, such as industry demand, availability of market players, and future industrial outlooks were some of the factors considered by the postgraduates before they finalized their academic decisions. It was broadly perceived by the respondents in this criteria group that their opportunity of securing employment and career advancement prospect will be significantly higher if the related market segment is believed to be in strong economic growth.
The teaching faculty was the third highest assessed criteria, out of which 13 percent of the respondents had confirmed that an experienced faculty will be able to provide high quality teaching staff to provide the best form of guidance for this skill and knowledge development. According to 31 percent of respondents that selected the teaching faculty criteria, an experienced faculty will possess the capability to design more advanced and innovative academic programs that will be relevant to industrial demands. Before embarking on the academic programs, the postgraduate will assess on the research track record and journal publications of the particular faculty. Testimonials and awards conferred to the particular faculty or alumni members will also significantly enhance the respondents’ selection preference.

Accreditation or recognition of the university was reported to be the fourth most important criteria, constituting 10 percent of votes from the respondents. Majority of the respondents felt that certifications from accredited or reputable universities will gain more recognition in the employment market, thus amplifying their employment prospects, while 18.2 percent from this criteria selection groups perceived that the postgraduate programs offered in the accredited universities will be of better quality.
Research facilities, tuition fees or availability of scholarships and curriculum components within the biotech programs will be the next most important criteria, each garnering 7 percent of the respondents’ votes, while other criteria like university ranking and opportunity for student exchange programs garnered meagre votes of 3 percent.

Based on the surveyed respondent population of Healthcare Biotechnology postgraduates, it is observed that the courses undertaken by the respondents in the public university sector were significantly more homogeneous as compared to the respondents from the private university sector. 95.2 percent of the respondents from the public universities were specializing in microbiology and molecular biology majors and only a minority 4.8 percent of respondents adopted specializations in biomedical science and virology, whereas in the private sectors, apart from exposure to the conventional courses of microbiology and molecular biology, respondents were also exposed to broader scope of specializations, such as immunology, biomedical science, infectious disease, bioinformatics and pharmacogenetics.

Nonetheless, in comparison with the syllabus offered in best practices countries in APAC and other regions, USA, and UK, the students abroad are exposed to extended biotech courses, such as bio-nanotechnology research, therapeutic pharmaceuticals, neurobiology, bioethics, and stem cell research. Furthermore, several universities in the other regions, such as the University of Hyderabad (the top ranked biotech school in India) have also incorporated the IPR and Entrepreneurship skills components into their syllabus to broaden the skill sets of their post graduates on patent writing, business market planning, presentation skills, and theme building. The disparity of available courses between the biotech schools in Malaysia and the foreign counterparts illustrate the vast development potential and benchmarks for the public and private universities to pull alongside in the future.

**Industrial Biotechnology**

Similar to the response from the “green biotech” postgraduates, the career prospects offered by a particular biotech program was also the top mentioned criteria by the industrial biotechnology postgraduate at 23 percent. According to the respondents, the ability to secure employment upon completion of their programs studied will be the first priority when they finalize their programme selection.

The establishment history of the faculty and the curriculum or syllabus of the programmes offered were two of the next most important criteria, as mentioned by 14 percent of the respondents respectively. Among the respondents that selected the faculty criteria, 71.4 percent informed that the experience and credentials of the lecturers or supervisors will be the most important factor to ensure that the quality and uniqueness of the program,
while 28.6 percent also believed that the availability of past successes attained by the faculties, such as published research papers, awards, and testimonials received by the faculty members or the graduate alumni will provide confidence to their selections.

From the curriculum criteria perspective, the respondents informed that they will normally compare the syllabus offered by various universities and select the programs that coincide with their interests, career objectives and are up-to-date with the current market trends and demand. About one third of the respondents also informed that they will also prefer postgraduate programs that are mirrored to the UK-based syllabus structure, instead of the American-based syllabus structure, as the UK-based structure was perceived to provide stronger focus on practical research activities.

The research facilities, level of tuition fees or availability of scholarships, and collaborative programs with other renowned universities by the assessed universities were the next most important selection criteria, with 9 percent of the votes each, while research grant, location, and accreditation of the universities each garnered 5 percent of the votes.

*Chart 6-8*

*Industrial Biotechnology: First mentioned postgraduate program selection criteria*

Source: Frost & Sullivan
Further analysis of the programs undertaken by the respondents in this category revealed that a majority 50 percent were attached to the bioprocess engineering specialization, while environmental biotech involving bioremediation was the next most popular course, covering 27 percent of the respondents.

The stimulating growth of the bio-industrial sectors in Malaysia, such as bio-waste management and bio fuel development through utilization of palm oil resources, and the increasing political and socio-economic focus on environmental conservation is likely to create demand for skilled professionals in the “white biotech” industry. Hence, these factors are likely to drive the demand of the Industrial Biotechnology programs in the universities. Despite most of the related programs are currently offered in the public institutions, the private institutions are likely to recognize the potential market demand and incorporate the Industrial Biotechnology courses into their umbrella of science programs in the future.

**Chart 6-9**
Distribution of Specializations for Surveyed Industrial Biotechnology Postgraduates

The Overall Ratings

In part two of the exercise, where respondents had rated their selected criteria based on a scale of 1 (least significant) to 10 (most significant), the concluding results of the ratings are proven to be consistent with the findings in part one of this exercise.

The faculty criteria (8.68), career prospects (8.67), availability of research grant (8.63), and the program curriculum or syllabus (8.39) were rated four most important criteria for the respondents on the selection of biotech programs.
Further analysis of the programs undertaken by the respondents in this category revealed that a majority 50 percent were attached to the bioprocess engineering specialization, while environmental biotech involving bioremediation was the next most popular course, covering 27 percent of the respondents. The stimulating growth of the bio-industrial sectors in Malaysia, such as bio-waste management and bio-fuel development through utilization of palm oil resources, and the increasing political and socio-economic focus on environmental conservation is likely to create demand for skilled professionals in the “white biotech” industry. Hence, these factors are likely to drive the demand of the Industrial Biotechnology programs in the universities. Despite most of the related programs are currently offered in the public institutions, the private institutions are likely to recognize the potential market demand and incorporate the Industrial Biotechnology courses into their umbrella of science programs in the future.

6.4.1 Assessment on Satisfaction Levels on the Current Curriculums

Agricultural Biotechnology

Within the spectrum of agro-biotech, a majority 83 percent of the respondents also informed that they were generally satisfied with the biotech program that were undertaken, mainly due to the extensive practical research trainings outlined in the program syllabus. Furthermore, they were also satisfied with the level and quality of supervisory support from the respective faculties.

On the contrary, 17 percent of the respondents felt that the programs that they were undertaking were too focused on academic theory, and thus lacked sufficient coverage on the practical research functions. Concerns were also raised in anticipation that the lack of practical research experience will thereby adversely affect their ability to handle the “real-time” research programs in the employment markets.
Healthcare Biotechnology

Based on the assessments of the satisfaction levels of the postgraduate respondents, 80 percent were satisfied with the biotech programs that they were involved in. Majority of the respondents informed that the predominant focus on practical research work in their studied syllabus was key factor for their preference. Furthermore, the respondents from the private institutions were provided with high levels of research duties, which they believe will effectively develop their foundation for their future academic or career advancements.

However, 17 percent of the respondents had also suggested that more improvements in the biotech programs are required in the future. Within this pool of respondents, 80 percent felt that the research duration required by the program was too extensive, and their foundation for basic knowledge still remained relatively inadequate to effectively facilitate their research works. Some of the respondents also felt that they will be required to devote additional efforts subsequent to their completion of the programs to hone their basic applied science knowledge. The remaining 20 percent of respondents informed that due to the limited facilities in the private institution that they were studying, they were facing restraints to gain sufficient exposure in practical research activities.
Healthcare Biotechnology

Based on the assessments of the satisfaction levels of the postgraduate respondents, 80 percent were satisfied with the biotech programs that they were involved in. Majority of the respondents informed that the predominant focus on practical research work in their studied syllabus was key factor for their preference. Furthermore, the respondents from the private institutions were provided with high levels of research duties, which they believe will effectively develop their foundation for their future academic or career advancements. However, 17 percent of the respondents had also suggested that more improvements in the biotech programs are required in the future. Within this pool of respondents, 80 percent felt that the research duration required by the program was too extensive, and their foundation for basic knowledge still remained relatively inadequate to effectively facilitate their research works. Some of the respondents also felt that they will be required to devote additional efforts subsequent to their completion of the programs to hone their basic applied science knowledge. The remaining 20 percent of respondents informed that due to the limited facilities in the private institution that they were studying, they were facing restraints to gain sufficient exposure in practical research activities.

Industrial Biotechnology

The satisfaction level on the biotech program undertaken by the pool of industrial biotechnology postgraduates was relatively less favourable, as compared to the other two biotech spectrums. Nonetheless, the satisfied respondents still formed the 68 percent of the population. Majority of the respondents believed that the program syllabus designed were well balanced in terms of theoretical knowledge impartation and practical research skill enhancement.

Within the 23 percent of unsatisfied respondents, 84 percent felt that the practical component in their biotech programs was insufficient. They have further informed that the limited lab space, supervisors, and equipments were the key determinants, which restricted the adequacy of research activities conducted.
6.5 Demand Gap Analysis

In the final section of the postgraduate survey, respondents were requested to identify three main challenges that they are currently facing or foresee in their future career development. Based on the challenges highlighted, they were also required to provide their comments on the improvements, which they believe will effectively mitigate the issues raised.

Source: Frost & Sullivan
### 6.5.1 Current Challenges and Future Expectations of the Biotech Workforce

**Table 6-4**

*List of Challenges and Expectations*

<table>
<thead>
<tr>
<th>Biotech Sectors</th>
<th>Challenges</th>
<th>Future Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agricultural</strong></td>
<td>• Competitive Job Market; Lack of job opportunities (59%)</td>
<td>• Increase number of public and private research institutions (39%)</td>
</tr>
<tr>
<td></td>
<td>• Lack of Working Experience &amp; Field Knowledge; Lack Commercialization Skills (27%)</td>
<td>• Increase Government Funding &amp; Research Grants (23%)</td>
</tr>
<tr>
<td></td>
<td>• Low Remuneration Packages (9%)</td>
<td>• Increase promotions and awareness of job prospects in the Healthcare Biotechnology sector (12%)</td>
</tr>
<tr>
<td></td>
<td>• Lack of Facilities in Training Institutions (3%)</td>
<td>• Creation of new job descriptions outside the scope of researchers and lecturers (8%)</td>
</tr>
<tr>
<td></td>
<td>• Increase number of public and private research institutions (39%)</td>
<td>• Increase foreign expertise (8%)</td>
</tr>
<tr>
<td><strong>Healthcare</strong></td>
<td>• Competitive Job Market; Lack of job opportunities (43%)</td>
<td>• Increase Government Funding &amp; Research Grants (32%)</td>
</tr>
<tr>
<td></td>
<td>• Lack of Working Experience &amp; Field Knowledge; Lack of Commercialization Skills (32%)</td>
<td>• Increase number of public and private research institutions (32%)</td>
</tr>
<tr>
<td></td>
<td>• Low Remuneration Packages (13%)</td>
<td>• More initiatives from Government to encourage researchers to commercialize (12%)</td>
</tr>
<tr>
<td></td>
<td>• Lack of Understanding in biotech employment market (6%)</td>
<td>• Government and Private sector collaboration to provide more professional trainings (8%)</td>
</tr>
<tr>
<td></td>
<td>• Lack variety of biotech research units in government and private sector (4%)</td>
<td>• Increase promotions and awareness of job prospects in the Healthcare Biotechnology sector (8%)</td>
</tr>
<tr>
<td></td>
<td>• Increase Government Funding &amp; Research Grants (32%)</td>
<td>• Increase foreign expertise (8%)</td>
</tr>
<tr>
<td></td>
<td>• Increase number of public and private research institutions (32%)</td>
<td>• More initiatives from Government to encourage researchers to commercialize (7%)</td>
</tr>
<tr>
<td><strong>Industrial</strong></td>
<td>• Competitive Job Market; Lack of job opportunities (43%)</td>
<td>• Increase Government Funding &amp; Research Grants (22%)</td>
</tr>
<tr>
<td></td>
<td>• Lack of Working Experience &amp; Field Knowledge; Lack of Commercialization Skills (28%)</td>
<td>• Increase number of public and private research institutions (19%)</td>
</tr>
<tr>
<td></td>
<td>• Low Remuneration Packages (18%)</td>
<td>• Government and Private sector collaboration to provide more professional trainings (19%)</td>
</tr>
<tr>
<td></td>
<td>• Lack of Understanding in biotech employment market (8%)</td>
<td>• Increase promotions and awareness of job prospects in the Healthcare Biotechnology sector (11%)</td>
</tr>
<tr>
<td></td>
<td>• More initiatives from Government to encourage researchers to commercialize (7%)</td>
<td>• Increase foreign expertise (8%)</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan
The overall assessment showed 47 percent of the respondents viewed the lack of job opportunities in the biotech sector as the main obstacle for their career developments in the country. Most respondents felt that industrial growth and job demand does not coincide with the increasing supply of biotech graduates. As general undergraduate degrees holders begin to saturate the biotech employment market, most students begin to recognize the need for differentiation and decided to further their academic advancement for postgraduate or specialized biotech programs. Several overseas originated respondents who are currently studying in the public institutions also informed that in consideration of the scarce job opportunities for the local graduates, they do not foresee attractive job opportunities to be allocated for foreigners upon their graduation. Hence, the possibility of retention of these foreign national postgraduate will be relatively low. The lack of diversity in the various research specialities were further considered by the additional 2 percent of respondents, who felt that deficiency had led to most researchers forced to adopt job functions that are unrelated to their field of expertise and further aggravate the low employment situation in the industry.

6.5.2 Addressing the Key Challenges

**Chart 6-14**
Assessment of Key Challenges Faced by Biotech Postgraduates

<table>
<thead>
<tr>
<th>Factor</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scarcity of Job Opportunity</td>
<td>47%</td>
</tr>
<tr>
<td>Lack of Diversity in Biotech Careers</td>
<td>2%</td>
</tr>
<tr>
<td>Lack Understanding of Employment Market</td>
<td>6%</td>
</tr>
<tr>
<td>Lack of Commercialization Knowledge</td>
<td>4%</td>
</tr>
<tr>
<td>Lack of Field Knowledge or Work Experience</td>
<td>25%</td>
</tr>
<tr>
<td>Low Remuneration / Funding</td>
<td>13%</td>
</tr>
<tr>
<td>Economic Recession</td>
<td>2%</td>
</tr>
<tr>
<td>Lack of Facilities</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan

The overall assessment showed 47 percent of the respondents viewed the lack of job opportunities in the biotech sector as the main obstacle for their career developments in the country. Most respondents felt that industrial growth and job demand does not coincide with the increasing supply of biotech graduates. As general undergraduate degrees holders begin to saturate the biotech employment market, most students begin to recognize the need for differentiation and decided to further their academic advancement for postgraduate or specialized biotech programs. Several overseas originated respondents who are currently studying in the public institutions also informed that in consideration of the scarce job opportunities for the local graduates, they do not foresee attractive job opportunities to be allocated for foreigners upon their graduation. Hence, the possibility of retention of these foreign national postgraduate will be relatively low. The lack of diversity in the various research specialities were further considered by the additional 2 percent of respondents, who felt that deficiency had led to most researchers forced to adopt job functions that are unrelated to their field of expertise and further aggravate the low employment situation in the industry.
25 percent of the respondents showed their lack of confidence to enter the commercial market for employment and thus decided to remain employed in the universities. Acknowledging the limited job opportunities in the market, most surveyed respondents felt that it will be difficult for the fresh graduates, who lacked the field knowledge and experience, to remain competitive in the job market that is already saturated with more experienced professionals. With the understanding on the limited job prospect in the sector and their shortfall in terms of field experience, most newly graduated respondents had already lowered job expectations to seek for basic biotech job positions, such as lab or research assistants in the universities that they are studying to firstly, continue building their research experience, while secondly, further advance their qualifications by undertaking the postgraduate or PhD programs.

In conjunction with the respondents commenting about the lack of field experience for the fresh graduates, an additional 4 percent of the respondents also felt that most researchers trained were over specializing in conducting research operations and lacked knowledge on commercializing their research work. Under such environment, the career advancement prospects of the researchers will therefore, being confined, and will not be unable to fully utilize their research findings for momentous purposes.

The unsatisfactory remuneration package offered to researchers was the third most challenging factor in the biotech employment market, according to 13 percent of the respondents. Drawing comparisons with a neighbouring country like Singapore, several respondents highlighted the significant disparity of remuneration packages offered to the biotech researchers in Malaysia, whereby the salary offered to some of their peers seeking employment in Singapore doubled the salary scale offered in Malaysia. Despite expressing their desire to remain in Malaysia for their career development, about 60 percent of the respondents informed that remuneration may eventually be the driving factor for them to seek employments in foreign countries.

The lack of understanding in the employment market was raised by 6 percent of the respondents, who felt that there is absence of connectivity between the government and private research institutes with the universities that they are studying. Hence, they believe that graduating student will therefore be unfamiliar with the industrial development trend, functionality and the types of jobs that are available in the public and private employment market, and subsequently they will not be able to determine their appropriate career paths upon graduation.

The remaining factors, such as economic downturn, the lack of facilities in the teaching institutions combined to a meagre portion of 3 percent among the surveyed comments.
A majority 30 percent of respondents felt that the most critical improvement in the current biotech employment market is to create more biotech research units to expand the job prospects in the country. 92 percent of the respondents within this respondent pool expressed that the government should be the principal body to drive such initiatives. The increase of public-private partnerships research institutions and program are believed to be able to expedite the development process. Apart from build on the numbers, 6 percent of the respondents also felt that research units created should be more diverse, and each unit should specify within its individual field of expertise, to eliminate the issues of a multi-tasked research workforce.

**6.5.3 Bridging the Supply and Demand Gaps**

*Chart 6-15*

*Key Future Expectations from Biotech Postgraduates*

- Establish more research Units: 31%
- Professional Training for Freshgraduates: 10%
- Encourage Commercialization: 8%
- More Promotion & Awareness: 10%
- Regulations for researchers remuneration: 3%
- Limit University Intake: 3%
- Increase foreign expertise: 4%
- Create More Job Functions: 6%
- Increase Govt. Funding: 26%

Source: Frost & Sullivan
In order to fuel the development initiatives of creating more research units and job opportunities, 26 percent of the respondents felt that increased government funding will be the vital mechanism. The increased funding could first be used to facilitate and sustain the operations of both the private and public research units, which thereby nurture the growth of the industry, and ultimately, create jobs with better prospects and remunerations. Furthermore, the additional funds could also be used to improve the quality and sufficiency of facilities at the teaching institutions and resolve the capacity constraint problems for the research operations.

Addressing the difficulties of fresh biotech graduates faced during the transition period of job searching, which were predominantly due to lack of understanding of the employment market, and insufficient professional experience, most respondents felt that more interactive career development programs should be formulated. On-the-job training, in their opinion, are either limited, due to the poor employment rate in the market or inopportune, as the requirements of the working environment requires the pool of workforce to quickly adapt to specific job functions. Hence, 10 percent of the respondents suggested that more promotional activities should be targeted at teaching institutions to increase the awareness and provide innovative guidelines on the job opportunities available in the market. Exhibitions, career fairs or road shows organized by the public or private bodies at the university sites, for example, should be effective methods to increase interactions between the students, teaching community and the industry players, thus allowing the formation of mutual understanding and expectations among the stakeholder groups.

Promotional initiatives will also serve as effective tools to boost the confidence and interests of the university students towards the employment opportunities in the commercial sector.

In order to better prepare the fresh graduates for future employment in the commercial sector, 10 percent of respondents informed that the government and private players should embark on more professional training programs while an additional 8 percent of respondents felt that professional training to develop the entrepreneurship capabilities and intellectual property management skills of the researchers should be broadly promoted. When being probed to provide some of the professional training programs or institutions that provide relevant professional trainings, 64 percent of the respondents mentioned the Malaysian BiotechCorp as the key government body currently providing value added training programs, such as the Entrepreneurship Development, and Biotechnology Special Training Programme for Unemployed Life Science Graduates (BeST) training programs.

Some other suggestions provided by minority of the surveyed respondents included the encouragement of more foreign expertise imports (4 percent), the intervention of government on the researchers’ employment benefits provided by the commercial players (3 percent), and limiting the student intake in the public teaching institutions and focus more on quality teaching through improved supervisor to student ratio (3 percent).

<table>
<thead>
<tr>
<th>Suggestion</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish more research Units</td>
<td>31%</td>
</tr>
<tr>
<td>Limit University Intake</td>
<td>3%</td>
</tr>
<tr>
<td>Regulations for researchers</td>
<td>3%</td>
</tr>
<tr>
<td>Remuneration</td>
<td>3%</td>
</tr>
<tr>
<td>More Promotion &amp; Awareness</td>
<td>10%</td>
</tr>
<tr>
<td>Limit University Intake</td>
<td>3%</td>
</tr>
<tr>
<td>Regulations for researchers</td>
<td>3%</td>
</tr>
<tr>
<td>Remuneration</td>
<td>3%</td>
</tr>
<tr>
<td>More Promotion &amp; Awareness</td>
<td>10%</td>
</tr>
<tr>
<td>Encourage Commercialization</td>
<td>8%</td>
</tr>
<tr>
<td>Professional Training for Freshgraduates</td>
<td>10%</td>
</tr>
<tr>
<td>Increase foreign expertise</td>
<td>4%</td>
</tr>
<tr>
<td>Create More Job Functions</td>
<td>6%</td>
</tr>
<tr>
<td>Increase Govt. Funding</td>
<td>26%</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan
7.1 Key findings and Interpretations

At present, there is a substantial gap between the demand and supply of skilled human capital in the biotechnology sector in Malaysia. The gap is a result of multiple factors including: insufficient graduate output from local teaching institutions, skills shortages, and low industry absorption. The skills shortage in the Malaysian biotechnology sector consists of both hard and soft skills. In the next 5 years the shortage of biotechnology human capital will increase to negatively impact the growth of the industry in Malaysia.

7.2 Key Recommendations

i. Quick or auto approval of working visas for foreign expatriates

The entry of foreign expatriates can be useful to speed up the transfer of skills to the local workforce in Malaysia and also help alleviate the immediate skills shortage in the market.

ii. Change of syllabus – more up-to-date curriculum, more lab skill trainings

The present syllabus being taught to post graduate students in the local universities could be improved by including more practical training as well as introducing aspects of commercialization know-how. This will improve their marketability and the absorption into industry.

iii. Co-supervisor when public universities sponsor students for PhDs overseas

One of the local universities in Malaysia has developed an innovative method to allow local researchers to network internationally. The university has insisted that for post-graduate students sponsored to study overseas, the student must have two supervisors, one abroad and one in the local university. This allows the university to build its international network and the local supervisor may also learn new techniques being used abroad that will increase both the publications and the lab skills in Malaysia.

iv. Increase mastery of English Language skills

There has to be more emphasis on English Language skills in the education system in Malaysia. It takes a fairly long time to master this language in all aspects; speech, writing, listening and comprehension. Thus, in order for students to master this language, there has to be a greater emphasis in the education system.
v. Include commercialisation knowledge into syllabus

There must be inclusion of commercialisation knowledge into the post graduate syllabus in order for the students to become not only scientists but also entrepreneurs in biotechnology.

vi. Upfront grants – Special Purpose Financial Vehicle to allow quick funding.

There is also a need to develop Special Purpose Financial Vehicles to allow the quick funding of biotech loans. There is currently a very huge lack of funding options available for biotech companies. The government can also guarantee some of the commercial loans to allow the companies to borrow money needed for business financing.

vii. Updating of the National Biotechnology Policy

There is also a need to constantly update the National Biotechnology Policy as for the policy to function properly, it has to be a living document to allow the progress of the biotechnology sector to be updated and the most suitable policy to spur the progress of the sector is implemented.

viii. Single approval system for products – e.g.: FDA for USA and CT for EU.

Presently, there is a need for ASEAN countries to adopt a single, common approval system for biotech products. This standard would be similar to the FDA approval in the United States of America. The certification of this standard will allow biotech products to be sold in all ASEAN countries. This will be of much help much in growing the biotech sector in Malaysia.

ix. Nurture interests in Biotech at elementary levels

Interactive components should be in place to foster a group of young students with instilled interest in the various fields of biotechnology. Increased practical interaction on the functioning of biotech research would likely promote the growth of interested biotech workforce in the future.
Malaysian Biotechnology Corporation (BiotechCorp) is a central contact point for biotechnology and life science companies in Malaysia. BiotechCorp is the industry’s one-stop-centre providing support, facilitation and advisory services.

MALAYSIAN BIOTECHNOLOGY CORPORATION SDN BHD
(BIOTECHCORP)
Level 23, Menara Astra,
161, Jalan Ampang, 50450 Kuala Lumpur, Malaysia

T: +6 03 2116 8585   F: +6 03 2116 5528
E-mail: info@biotechcorp.com.my