Chapter 1
Introduction to Industrial Biotechnology

Outlines:

1.1 Biotechnology

1.2 Applications of biotechnology

1.3 Industrial Biotechnology

1.4 Career prospects

1.5 Important skills required in biotechnology

Learning outcomes:

- Define “biotechnology”.
- List main categories of biotechnology.
- Recognize the applications of biotechnology.
- Identify career categories and opportunities in biotechnology
- Aware of important skills and training required to be part of biotechnology workforce

1.1 Biotechnology

- Bio ?
  living organisms or tissue.

- Technology ?
  is a scientific method of achieving a practical purpose.

1.1 Biotechnology

- The U.S. government defines biotechnology as "**any technique that uses living organisms or parts of living organisms to**:
- **make or modify products,**
- **improve plants or animals, or**
- **develop microorganisms for specific uses.**

1.1 Biotechnology

- Ancient biotechnology:
  - Early examples: domestication of animals, planting of crops and the use of microorganisms to make cheese, yoghurt, bread, beer and wine.






1.1 Biotechnology

- Main categories of biotech:
- **Industrial Biotechnology (White)**
- **Agricultural Biotechnology (Green)**
- **Healthcare Biotechnology (Red)**
- Aquatic Biotechnology (Blue)

1.1 Biotechnology

Table 1-2: Malaysian Biotechnology Industry Overview

Sector	Number of Companies*	Revenue		Investment	
		USD million	RM million	USD million	RM million
Agricultural Biotechnology	143	57.9	202.7	287.5	1,006.3
Healthcare Biotechnology	134	47.4	165.8	235.1	822.8
Industrial Biotechnology	72	44.8	156.9	297.6	1,041.6
Total	349	150.1	525.4	820.2	2,870.7

Source:
(1) BiotechCorp (as at 30 September 2009)
(2) SSM (as at 31 December 2008 or latest financial reports available)
** as at 30 September 2009*

1.2 Applications of Biotechnology

Fuel the World

- Biotech uses biological processes such as fermentation and harnesses biocatalysts such as enzymes, yeast, and other microbes to become microscopic manufacturing plants. Biotech is helping to fuel the world by:
  - Streamlining the steps in chemical manufacturing processes by 80% or more;

1.2 Applications of Biotechnology

- Lowering the temperature for cleaning clothes and potentially saving $4.1 billion annually;
- Improving manufacturing process efficiency to save 50% or more on operating costs;
- Reducing use of and reliance on petrochemicals;

1.2 Applications of Biotechnology

- Using biofuels to cut greenhouse gas emissions by 52% or more;
- Decreasing water usage and waste generation; and
- Tapping into the full potential of traditional biomass waste products.

1.2 Applications of Biotechnology

Feed the World

- Biotech improves crop insect resistance, enhances crop herbicide tolerance and facilitates the use of more environmentally sustainable farming practices. Biotech is helping to feed the world by:
  - Generating higher crop yields with fewer inputs;
  - Lowering volumes of agricultural chemicals required by crops-limiting the run-off of these products into the environment;

1.2 Applications of Biotechnology

- Using biotech crops that need fewer applications of pesticides and that a farmers to reduce tilling farmland;
- Developing crops with enhanced nutrition profiles that solve vitamin and nutrient deficiencies;
- Producing foods free of allergens and toxins such as mycotoxin; and
- Improving food and crop oil content to help improve cardiovascular health.

1.2 Applications of Biotechnology

Heal the World

- Biotech is helping to heal the world by harnessing nature's own toolbox and using our own genetic makeup to heal and guide lines of research by:
  - Reducing rates of infectious disease;
  - Saving millions of children's lives;
  - Changing the odds of serious, life-threatening conditions affecting millions around the world;

1.2 Applications of Biotechnology

- Tailoring treatments to individuals to minimize health risks and side effects;
- Creating more precise tools for disease detection; and
- Combating serious illnesses and everyday threats confronting the developing world.

1.3 Industrial Biotechnology

- Industrial biotechnology uses biological systems for the production of chemicals, materials, and energy.
- This technology is mainly based in biocatalysis (the use of enzymes to catalyze chemical reactions) and in fermentation technology (directed use of microorganisms),in combination with breakthroughs in molecular genetics, directed evolutions, and enzyme engineering and metabolic engineering of microorganisms and cells.

1.3 Industrial Biotechnology

Table 3-12: Overview of the Malaysian Industrial Biotechnology Sector (31 December 2008)

Type of Companies	Number of Companies	Total Revenue		Total Investment	
		USD million	RM million	USD million	RM million
BioNexus Status Companies	20	37.9	132.6	137.2	480.4
Non-BioNexus Status Companies	52	6.9	24.3	160.3	561.2
Total	72	44.8	156.9	297.6	1,041.6

Source:
(1) BiotechCorp
(2) SSM (31 December 2008 or latest financial reports available)

1.3 Industrial Biotechnology

Table 3-13: Overview of BioNexus Status Companies in the Malaysian Industrial Biotechnology Sector (30 September 2009)

Focus Areas	Number of Companies	Total 9 Months Revenue (USD '000)	Total Approved Investment (USD million)	Projected Total R&D Expenses (USD million)	Projected Number of Knowledge Workers
Biofuel	1	0	48,218.4	0	20
Bioremediation	7	1,164.8	11,171.9	1,838.8	64
Biomaterial / Biopolymer	3	0	12,338.7	51.9	39
Biocatalyst	4	853.1	3,782.8	0	36
Fine and Specialty Chemicals	4	45,224.0	61,094.1	72.3	193
Others	1	502.1	638.2	166.6	31
Total	20	47,744.0	137,244.1	2,129.6	383

** Actual R&D expenses for 12 months ending 30 September 2009 was USD 1 million (RM 3.4 million)*
*** Actual number of knowledge workers as at 30 September 2009 was 162*
Source: BiotechCorp (based on the latest information available)

1.3 Industrial Biotechnology

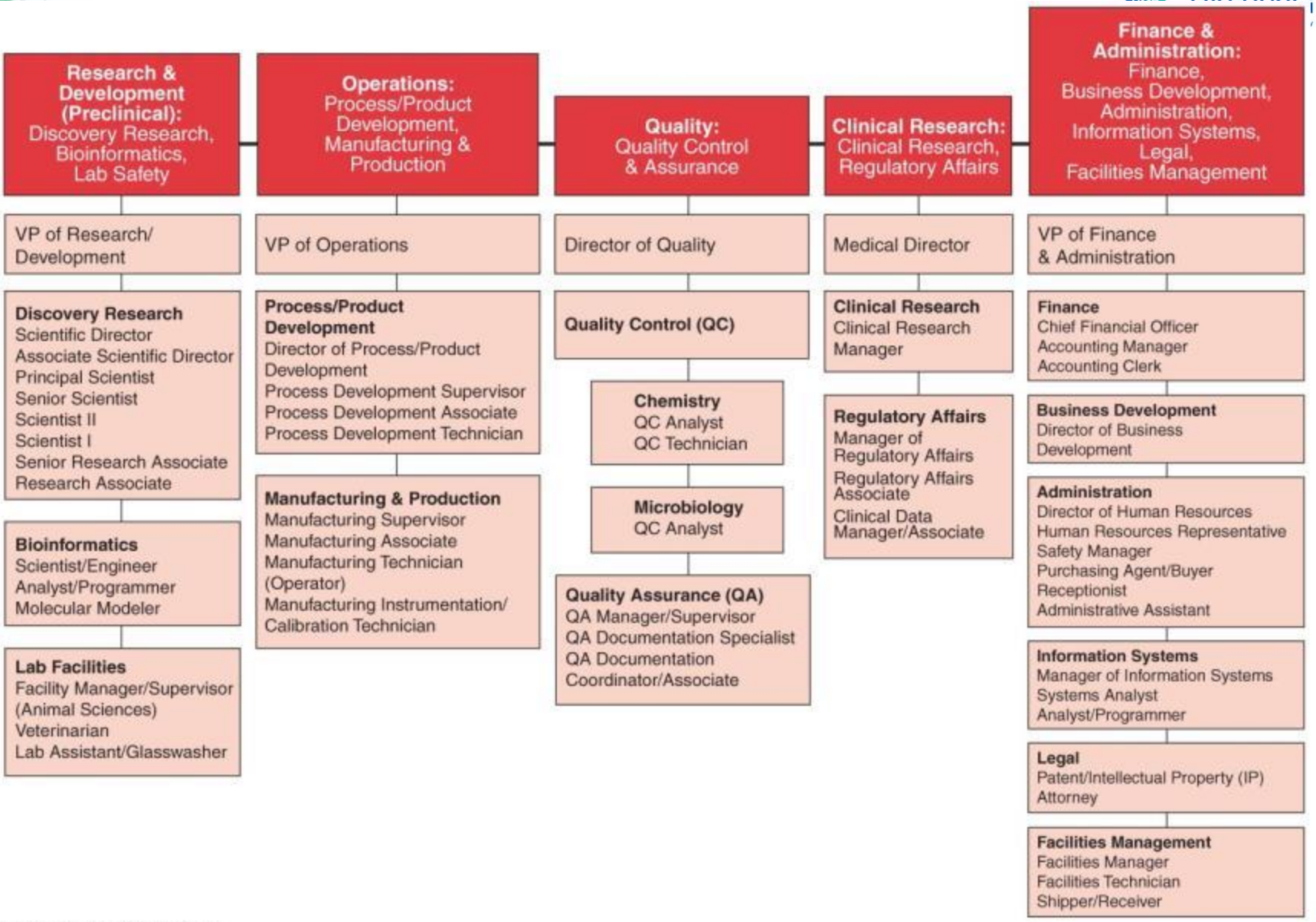
- Focus areas in Malaysia.

Sector Strengths	Biofuels	Bio- Catalyst	Fine & Specialty Chemicals
Vast natural resources	✓	✓	✓
Abundant supply of biomass	✓		
Advanced commodity sector	✓		
Strength in oleochemical and specialty chemical manufacturing		✓	✓
Cost competitive skilled labour	✓	✓	✓
Heavy concentration of oil palm plantations	✓		
Palm oil refineries and ready supply of feedstock	✓		
Absence of moratorium on genetically modified crops	✓		
Globally recognised halal certification	✓	✓	✓

1.3 Industrial Biotechnology

- Industrial microbiology
- Industrial cell biology
- Industrial biomaterials
- Omics Technology

Organisation structure of a medium-size biotechnology



1.4 Career prospects

- Lab assistant
- Research associates
- Scientist
- Associate Scientist Director
- Scientific Director
- Project Manager and Technical Service Manager
- Quality Control Workers
- Clinical Researchers
- Regulatory Affairs
- Manufacturing
- Marketing and Sales

1.4 Career prospects

- Customer service representative
- Technical services representative
- Manufacturing and Production
- Process development engineer
- Production planner/scheduler
- Manufacturing technician
- Packaging/distribution handler
- Manufacturing associate
- Instrument/calibration technician
- Process development associate

1.5 Important skills required in biotechnology

Table 1 Core Basic Skill Requirements for Biotechnology Occupations

Basic Skill Requirements	Occupations Applicable To
Ability to understand and follow instructions Math skills Written and verbal communication	Animal Technician Bioassay Associate Bioinformatics Programmer/Analyst Biostatistician Calibration Technician Clinical Lab Associate Manufacturing Technician Regulatory Affairs Specialist Research Associate

1.5 Important skills required in biotechnology

Table 2 Core Personal Skill Requirements for Biotechnology Occupations

Personal Skill Requirements	Occupations Applicable To
Ability to work in a team Ability to work independently Attention to detail	Animal Technician Bioinformatics Programmer/Analyst Biostatistician Calibration Technician Clinical Lab Associate Manufacturing Technician QA/QC Specialist Regulatory Affairs Specialist Research Associate
Organizational skills	Animal Technician Bioinformatics Programmer/Analyst Biostatistician Clinical Lab Associate QA/QC Specialist Regulatory Affairs Specialist Research Associate

1.5 Important skills required in biotechnology

- Technical skills
- Ability to analyze/evaluate technical data
- Biotechnology lab techniques/skills
- Computer skills
- Knowledge of life sciences
- Manufacturing skills
- Problem solving/critical thinking
- Technical writing skills

Video…

- http://www.youtube.com/watch?v=SHb8K2Uo9sU
- http://www.youtube.com/watch?v=R2noqvlBxZk

Extra reading…

- http://www.thisisbiotechnology.com
- http://www.bio.org/node/517
- http://cse.edc.org/products/biomfgskills/introduction.asp#how
- http://www.genengnews.com/insight-and-intelligenceand153/top-ten-biotech-jobs-most-in-demand-over-the-next-decade/77899666/

Extra reading…

- http://www.niacreative.com/clients/w2f/LMI_Documents/work2future_Biotech_Report_10%5B1%5D.04.06.pdf
- http://www.youtube.com/watch?v=nElhiCyXJZA
- http://www.youtube.com/watch?v=fqcKQiQuT0M
- http://www.youtube.com/watch?v=sU-eeaLwKCc
- http://www.youtube.com/watch?v=8amT40qAlXc&feature=related

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