Special Papers

Biotechnology Postgraduate Program in Thailand

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This paper reports the current status of postgraduate programs in biotechnology offered by Thai universities. A comparison of courses offered among universities with respect to their conformation with standard regulations for postgraduate study as established by Ministry of University Affairs (MUA) in 1999 is presented. Each program core and electives courses are grouped and analyzed.

key words : biotechnology, postgraduate program, genetic engineering, bioprocess engineering, fermentation, downstream process, bioethics

Background

The program of study in biotechnology was first established in Thailand in 1980. The first undergraduate program in biotechnology was offered by the Department of Biotechnology, Faculty of Agro-Industry, Kasetsart University (Leelawatcharamas, 1991). Since then, biotechnology programs in both undergraduate and postgraduate levels have sprouted in other Thai universities. This is, perhaps, due to the recognition of the importance of biotechnology and genetic engineering for Thailand. In 1983, the National Center for Genetic Engineering and Biotechnology (BIOTEC, formally NCGEB) was established as a national effort to support the development and application for these technologies. In addition, support for biotechnology was also highlighted by the US -Thai Science and Technology Development Board (STDB) program.

BIOTEC was first set up as a unit in the Ministry of Science, and later, in 1991, incorporated within the STDB program as the National Science and Technology Development Agency (NSTDA). The scope of activities of BIOTEC was also extended to cover implementation of, as well as support for research and development, and training in the field of biotechnology (Yuthavong, 1999).

In 1988, the Thai Society for Biotechnology (TSB) was established by a group of Thai scientists with common interest in the progress and development of research in this field. Since then, the TSB has organized an annual meeting each year. The 11th annual meeting, which was the last meeting of the last millenium, was held in Phuket in November 1999. At that meeting one of the section presentations was on Biotechnology Education in Thailand. This paper is a product of that discussion. However, this paper will discuss only the postgraduate education programs that use the name "Biotechnology". We did not include other related field of studies, such as biochemistry, microbiology nor chemical engineering programs.

Scope of Biotechnology

Biotechnology itself is not a new technology. Microorganisms had been exploited for hundreds, and in some cases thousands of years, by those making bread, cheese, beer and wine. In 1982, the Organization for Economic Co-operation and Development (OECD) published a state-of the-art report on new biotechnology to define what biotechnology is. This definition adopted a broad view, and since then the definition of biotechnology has been widely accepted internationally as "the application of scientific and engineering principles to the

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processing of materials by biological agents to provide goods and services". This definition, clearly elucidates the diversity of biotechnology and emphasizes the way in which biotechnology will influence industry (Antebi and Fishlock, 1986).

Students and scientists today are privileged indeed to be living among the scientific breakthroughs of the genetic engineering world. With this in mind, it is important to emphasize two points: first, biotechnology is not a discipline but rather a field of activity, and second, genetic engineering per se is not biotechnology, but an exciting development which has had and will have an enormous impact on biotechnology.

There are many examples of commercial where applications of genetic manipulation in areas of human health, food, agriculture and horticulture, energy, raw materials, chemicals and environmental management. Hence, the power of biotechnology cannot be underestimated. However, knowledge of genetic engineering is only a component of developing good and valuable products. Active on-going research and development of goods using the field of genetic engineering are leading to spectacular innovations. However, biotechnologists need more than just knowledge of genetic engineering for production. We also need the knowledge of bioprocess engineering, fermentation and the downstream processes to really provide goods and services. As university instructors, we think this is not enough. For graduate students to go out into the real world of business, to work in companies, factories or even to be researchers themselves, we think they need more knowledge in management and in ethics, especially bioethics.

This paper attempts to enumerate the rules and regulations of the Thai Ministry of University Affairs (MUA) and compare all the biotechnology postgraduate programs in Thailand in terms of core and elective courses. Some of our ideas on the terms of standardization of biotechnology graduate program are discussed.

MUA's Degree Structure

To comply with Government rules and regulations concerning standard requirements for postgraduate study in Thailand, every postgraduate programs must conform with standard regulations for postgraduate study as defined in 1990 and 1999 by MUA as given below.

Master's degree

The MUA's 1990 guidelines provide for three types of program structures in order to obtain a master's degree. First is the A (1) type, thesis only program, which requires at least 36 credit hours of thesis. Second, the thesis and course work program which is the A (2) type. This program requires at least 12 credits of thesis and at least 12 credits of course work. However, the total number of credits attained must be at least 36. The third type is the B program, which is a course work only program. So far, none of the biotechnology graduate programs in Thailand makes use of this last program structure.

Doctoral degree

Two categories of incoming students for the Ph.D. program exist. First, the incoming students are those who have already obtained a master degree; second are students with a bachelor degree who enter the Ph.D. program directly. In the past most students entering a Ph.D. program are students with a master degree in a related field. However, the recent Royal Golden Jubilee scholarships offered by the Thailand Research Fund (TRF) provide funds for students with bachelor degrees to do their Ph.D. directly. Therefore, the number of Ph.D. students holding bachelor degree is increasing. The number of credits requires for Ph.D. for students entering with a bachelor's degree will be shown in parenthesis in all the following text.

Under MUA's 1990 regulations two plans for Ph.D. programs are offered. Plan 1 requires at least 48 (72) credit hours of thesis work. This is a thesis work only program. Plan 2 requires at least 12 (24) credits of course work and 36 (48) credits of thesis. The credit requirements for achieving master and Ph.D. degrees are summarized in Table 1.

In addition to the number of credit hours for the thesis and the requirement for course work for achieving each degree, there are also more detail guidelines to be follow, such as comprehensive and preliminary examination for master and doctoral degree students respectively, thesis proposal examination, and qualification by examiner committees, which will not be mentioned in this paper.

Current status of postgraduate program in biotechnology

Presently, there are eight universities that offer postgraduate programs in biotechnology. All eight offer both master's and Ph.D. degrees. Some of these programs are national programs that teach in Thai; some

Table 1 Number of credits required by MUA to obtain the appropriate degree. Number in parentheses are the credit required to obtain a Ph.D. degree for a student entering Ph.D. program holding only bachelor degree.

Plan	Total	Credits	Thesis	Course
Master	A 1	36	36	-
	A 2	36	>12	>12
	B	36	-	36
Ph.D.	1	48 (72)	48 (72)	-
	2	48 (72)	36 (48)	12 (24)

are international programs that teach in English and some (unofficially) are bilingual programs.

Most of these universities offer common course work for both master and doctoral students. Course titles show that most of them offer a variety of courses. Less choice is likely to be provided in core courses, when compared to elective course offerings. The variety of elective courses reflects the specialization of each program and the available staff. However, all of the programs require at least two credits of seminar courses. Details for Master's and Ph.D. courses are presented in table 2 and table 3, respectively.

Analysis of each individual programs

In order to directly analyze each program, we need to start with the entrance qualification requirements of candidates to the programs. Most programs do not have specific requirements for candidates; having a bachelor's degree in a related field of science or engineering is sufficient. However, some programs require background studies in a more specific field. Table 4 provides details of qualification requirements by each university.

At the 2nd meeting on biotechnology curriculum development organized by TSB at Suranaree University of Technology in October 1999, it was proposed to divide course work offerings into six groups according to relevant disciplines. The groups established in order to clearly and simply characterize the programs are as follows: biochemistry, bioprocess (biochemical engineering), biotechnology, microbiology, molecular biology and others. Table 5 gives details and the number of credits of the proposed grouping of each individual program. The graph in figure 1 reveals a distribution of course discipline for core courses in each, and among, universities. Similarly, figure 2 compares the number of credits of elective courses distribution in each, and among, universities.

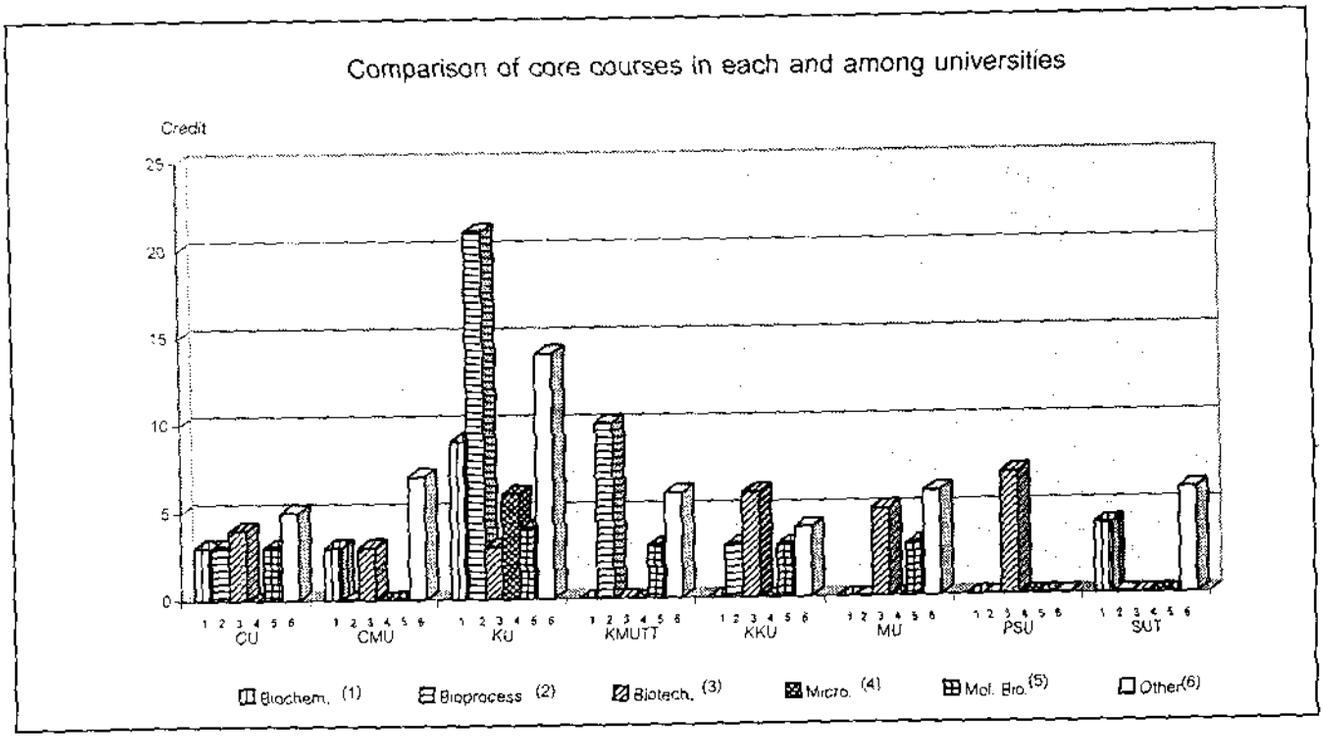

Fig. 1 Comparison of core courses in each and among universities

Future prospects

This paper has provided an initial report of the current status of each course program while emphasizing course structures and course analyses. With regard to core courses, there are many differences in the core courses offered among universities. The definition of biotechnology indicates that a biotechnologist should be capable of applying both scientific and engineering principles to obtain the most benefit out of biological agents. In this respect, the core courses must reflect some of these skills for future biotechnologists. Is this not enough reason for us to reconsider our course curriculum and revise it, if needed? Table 5 and Figure 1 indicate that several biotechnology programs do not require any bioprocess course. Some programs do not require courses in neither genetic engineering nor molecular biology. However, some programs provide one or two courses with the title of "biotechnology", which if considered in detail, include both genetic engineering and bioprocess.

In order to achieve a degree in biotechnology from Thailand, should we recognize a need to standardize the core courses and allow the elective courses to reflect the specialization of each university or should we leave the curriculum as it is, because biotechnology is far too broad to consider narrowing it? The TSB could and should play a role in guiding existing program owners in revising their courses. For programs being developed, this guidance would be very useful. The anticipated guidelines for postgraduate programs in biotechnology prepared by the TSB, have, in fact, no official compulsory effect. Existing program owners should voluntarily cooperate in order to standardize their programs. The MUA, however, is fully authorized to call for program revisions and to set standards for new program developers. Therefore, it is essential that we realize that it is time for changes for the betterment of our programs and for the sake of our students.

Another important component which describes the nature of postgraduate studies is thesis-related research. It is not the intention of this paper to describe much of this component due to difficulty in gathering information and inadequate information. However, research publications in biosciences and biotechnology make the greatest contributions, by far, to international scientific publications from Thailand, as measured by number and citations (Ruenwangsa and Ponijpan, 1996).

At present collaboration among institutions is essential, since Thailand has a serious shortage both of expertise in different field of specialization of biotechnology and in number of staff. Sharing of the expertise of persons scattered among different universities is very

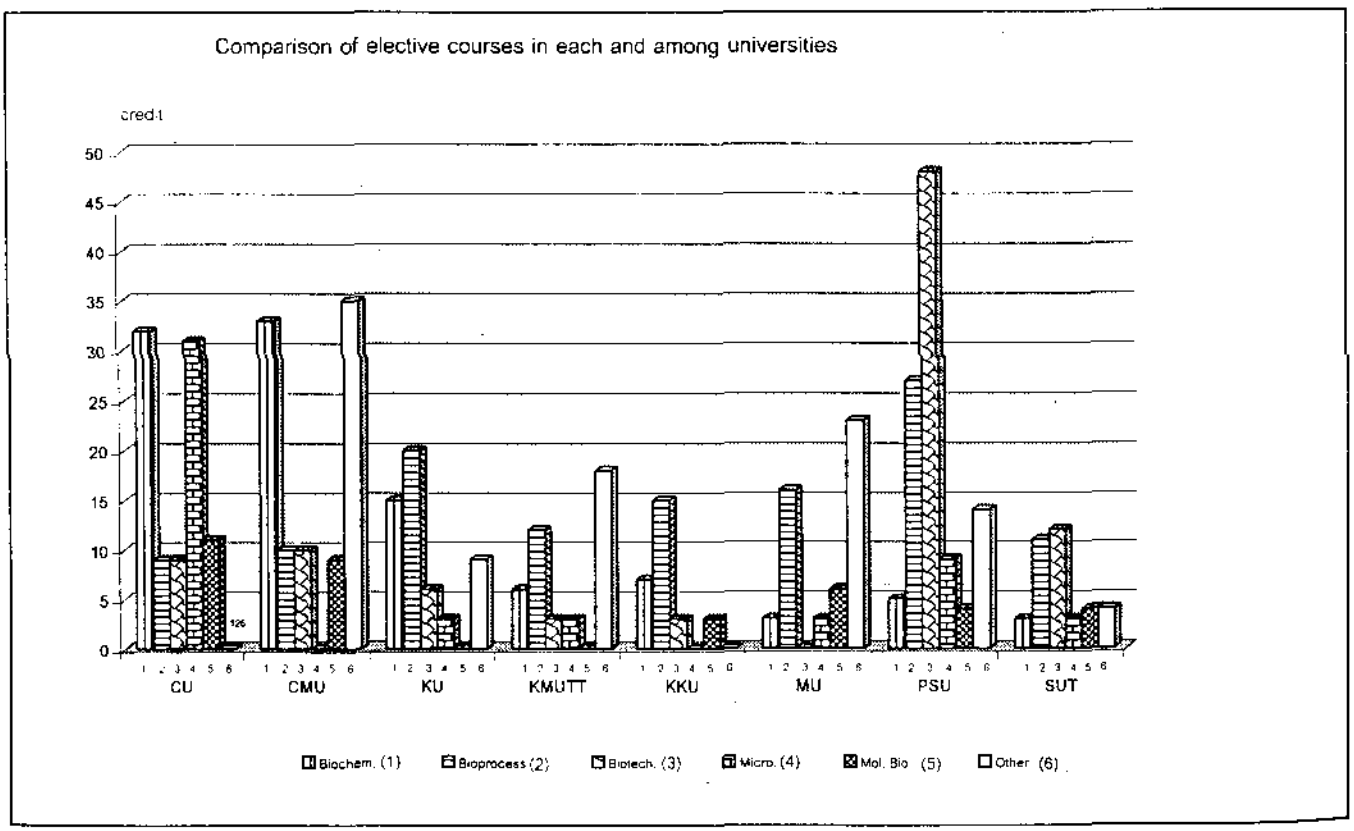

Fig. 2 Comparison of elective courses in each and among universities

Table 2 Detail of master programs in Biotechnology offered by 8 Thai universities.

	System	Programme	Degree	Weeks /term	Academic years	No Plan	Course work/ Cumulative credits	Core	Selective Core	Seminar	Elective		Thesis	Modules	Remark
MUA						A(1) A(2)	A(1) & A(2) >36 A(2) not< 12						A(1) at least 36 A(2) at least 12		
CU	Semester	National	M Sc (Biotechnology)	15	2 (not>4)	1	24/42	12 Adv Biochem Lab (3) Biotech (4) Expt Design & Data Anal (3) Individual Study I (1) Individual Study II (1)	3 Gen Unit Operation(3) Molecular Biology (3)	2	>98 items		18	No	
CMU	Semester	National	M S (Biotechnology)	18	2 (not>5)	A(1) A(2)	21/36	8 3 *Biochem &Biochemical Tech* - Enz Tech. (3) - Research Methods (4) *or* Plant Biotech - Cell Biol (3) - Plant Biotech (3)		2	9 10 *Biochem &Biochemical Tech (9)* Adv Ferment Tech. (3) Biochem Aspect of Nutrition (3) Biochem of Nucleic Acid and - Gen Eng (3) Biochem Membrane (3) Biosensor and Appl (3) Downstream Process (4) Enzyme Cat. In Organic Syn (4) Flavor and Aroma Tech (3) Immobilized Biocat Tech (4) Plant Biochem &App (3) Protein Chem.(3) Protein Eng (3) Recombinant DNA Tech. (3) Selected Topics in Biochem & - Biochemical Tech (1) *Plant Biotech (10)* Adv Plant Breeding (3) Adv Plant Pathology (3) Biol Nitrogen Fixation (3) Cytogen. In Agri (3) Gen Host-parasite Inter (3) Germplasm Collection and Preservation (3) Instrumentation (4) Integrated Genetics (3) Mutation Breeding (3) Plant Molec. Biol (3) Quantitative Gen In Plant Breeding (3) Selected Topics in Plant - Biotech (1)	15	2 Biochem & Biochemical tech Plant Biotech	plan A(1) Thesis (36) Co-Faculties involved - Fac Agriculture - Fac Agro-industry - Fac Pharmacy - Fac Science
KU	Semester	National	M Sc (Biotechnology)	15	2 (not >5)	A(2)	36/45	13 Adv Biochem Eng I (3) Gene Tech (4) Selected Topics in Biotech (3) Sp Problems (3)	>9	2	>9 Adv Biochem Eng II (3) Adv Ind Ferment Process (3) Alcoholic Beverage Tech (2) Biodegrad. & Biodeterior (3) Biotech. Design (3) Biotech. III (3) Control & Instru. (3) Enzyme Tech. (3)	>9 Ferment Process (3) Imm. Bio-eat (3) Ind Ferment (3) Ind Waste Supp & Waste Treast (3) Sugar Tech. (3) Tech Vegetable Oil Ext (3) Waste Treat. Sys. (3) Waste Utiliz. (3)	9	No	
KMUT	Semester	National	M Sc (Biotechnology) M Eng. (Biotechnology)	15	2 (not >5)	A(2)	30/42	9 Biochem. Instrumentation (3) Biochem. Reactor Design (3) Intro. Gene Tech (3) Mathematics for Scientist (3) Tech. Ferment. Process (4) Transport Phenomena -In Biol. Process (3)	>9	2	>9 Adsorption Separation (3) Adv. Biotech. (3) Biochem. Engineering (3) Biodegrad. & Biodeterior (3) Bio-Energy Conversion (3) Energy System Design (3) Enzyme Tech. (3)	>9 Food Eng. I (3) Food Eng. II (3) Lipid Tech. (3) Marine Biotech. (3) Methanne Tech. (3) Separation & Purification (3) Treat & Utiliz. of Biol. Waste (3)	12	No	
KKU	Semester	National	M Sc (Biotechnology)	15	2 (not >5)	A(2)	9/36	>7 Aspects of Biotech (3) Biochem. Eng. I (3) Biol Product Innovation (2) Biotech. Management (3) Inst. For Chem. Anal. Biotech (2) Molec. & Cell Biol. (3)		2	>9 Animal Biotech. (3) Biochem. Eng. II (3) Biomass Energy Tech. (3) Environmental Biotech. (3) Enz. & Cell Tech. (3) Gene Tech. (2)	Gene Tech. Lab (1) Plant Biotech. (3) Selected Topics in Biotech I (3) Selected Topics in Biotech II (3) Transport Phenomena in Biotech Process (3)	18	No	
MU	Semester	International	M Sc (Biotechnology)	15	2 (not >5)	A(2)	16/>25	14 Sp. Topics in Biotech I (1) Sp. Topics in Biotech II (1) Techniques in Biotech (3) Adv. Industrial Biotech (3) Molecular Bioscience (3) Biostatistics & Research Method. (3)		2	>12 Adv. Bioprocess Eng. Lab (3) Adv. Bioprocess Eng. Lecture (3)* Adv. Food Tech. (3)* Adv. Food Tech. Lab (2) Adv. Mycology (3) Adv. Plant & Animal Cell Tech. (3) Bioprocess Eng. Lab (1) Current Topics in Bioprocess Eng. (3) Downstream Processing in Biotech. (3)	Fermentation Tech. (3) Food & Agri. Product Marketing (3) Food Enzymes (3) Food Hygiene & Sanitation (3) Food Product & Process Develop. (3) Food Science & Tech. (3) Food Tech. (3) Gene Regulation (3)* Recomb. DNA Tech (3)* ** for each module*	12	5 Biochemical Eng. (BE) Food Biotech. (FB) Genetic Engineering (GE) Plant Biotech. (PB) Industrial Microbiology (IM)	
PSU	Semester	National	M Sc (Biotechnology)	15	2 (not >5)	A(1) A(2)	9/36	7 Biotech I (3) Biotech II (4)		2	12 Biotech (17 items) Bioprocess (5 items) Food Tech. (1 item) Agro-ind (2 items)	Microbiol (3 items) Biochem. (3 items) Biol (2 items) Chem. Eng. (3 items)	13	No	*plan A(1) Thesis (36) **need subjects in Biotech and/or Bioprocess at least 6 credits
SUT	Trimester	International	M Sc (Biotechnology)	13	2 (not >4)	A(1) A(2)	>20/>48 (15/36) Semester Credit	10 Graduate Biochemistry (4) Biotechnological Instrumentation (3) Selected research Techniques (3)		>5	>7 Adv. Bioprocess Engineering (4) Agricultural Biotech. (3) Animal Biotech. (3) Animal Biotech. Research (1) Applied Microbiology (3) Bioprocess Engineering (4) Bioprocess Tech. for Waste treatment (3)	Cell Biology (4) Current Issues in Biotech (1) Immunobiochemistry (3) Mol. Biol. & Recomb. DNA Tech (4) Plant Biotech. (3) Plant Biotech. Research (1)	>20	No	

Table 3 Detail of Ph.D. programs in Biotechnology offered by 8 Thai Universities

	System	Programme	Degree	Weeks /term	Academic years	No. Plan	Plan 1 Cumulative credits	Plan 2 Cumulative credits	1.Course work	Core	Seminar	Elective	2. Thesis	ublication Need	Prelim Exam.	Last Update Issue	Remark
MUA						2	47 [72]	48 [72]	12 (24)				36 (48)				
CU	Semester	International	Ph D (Biotechnology)	15	not > 5	1		48 [72]	No credit	12 Adv. Biochem Lab (3) Biotech (4) Expt Design & Data Anal (3) Individual Study I (1) Individual Study II (1)	4		48 need thesis defense pass	at least 1	Yes	1998	
CMU	Semester	National	Ph D (Biotechnology)	18	not >5 [not >8]	2	48 [73]	50 [73]	14 (25)	- (6-7) Similar to Master Degree and more	2 (4)	9 (11-12) Similar to Master Degree and more	36 (48)			1997	Co-Faculties among -Fac Agriculture -Fac Agro-industry -Fac Pharmacy -Fac Science
KU	Semester	International	Ph D (Biotechnology)	15	2, not >5 [3, not >8]	2	48 (international students)	42 Thai students	12	>6 Adv. Biochem Eng II (3)	2	>6 Similar to Master Degree and more	16 need thesis defense pass		Yes	1995	
KMUT	Semester	National	Ph D (Biotechnology)	15	2, not >5 [3, not >8]	1		48 [76]	12 (28)	1 (1) Selective Topics (1)	2 (3)	9 (24) Similar to Master Degree and more	36 (48) need thesis defense pass			1998	
KKU	Semester	National	Ph D (Biotechnology)	15	not >5 [not >8]	2	48	48 [72]	12 (24)	3 (12)	4(4)	5 (8) Similar to Master Degree and more	36 (48) need proposal defense pass need thesis defense pass	at least 1	S or U	1999	
MU	Semester	International	Ph D (Biotechnology)	15	not >5 [not >8]	1		48 [78]	12 (30)	6 (15) Similar to Master Degree	3 (3)	3 (12) Similar to Master Degree and more	36 (48) need proposal defense pass need thesis defense pass	at least 1	Yes	1999	
PSU	Semester	National	Ph D (Biotechnology)	15	3, not >5 [4, not >8] 4 (not >8) for cont. B Sc Degree	2	47 [72]	48 [72]		3 (10) Special Topics in Biotech I (1) Special Topics in Biotech II (1) Special Topics in Biotech III(1) Biotech I (3) *for cont. B. Sc.* Biotech II (4) *for cont. B. Sc.*	3 (3)	6 (11) Similar to Master Degree and more	36 (48) need proposal defense pass need thesis defense pass	at least 1	No	1996	
SUT	Trimester	International	Ph D (Biotechnology)	12	3, not >5 [5, not >8]	2	64 [96]	64 [96]	16 (32)	- (10) Similar to Master Degree	6 (9)	10 (13) Similar to Master Degree	48 (64) need thesis defense pass		S or U	1999	

Table 4 Qualifications of students entering post graduate Biotechnology programs in Thai universities

	M.Sc. Degree					
	from Bachelor's Degree	GPA (not less than)	from Bachelor's Degree		from Master's Degree	
[redacted]						
[redacted]	Science or related	N.S.	N.S.	N.S.	Engineering, Science or related	3.25
CMU	Biotech., Science, Agri., Food, Med. Tech. or related	N.S.	Biotech.,Science,Agri.,Food Med. Tech. or related	N.S.	Biotech., Science, Agri., Food, Med. Tech. or related	N.S.
[redacted]	Science, Agro. ind or related	2.50 or 2.00 (with GPA of related Master course >3.00) or 2.00 (with >3 years work)	N.S.	N.S.	related	good expertise
KMIT (Thonburi)	Science or related	N.S.	Engineering, Science or related	3.50	Engineering, Science or related	3.50
[redacted]	Biotech., Engineering, Science or related	2.50	Biotech.	3.25	Biotech., Engineering, Science or related	3.50
[redacted]	Science, Chem Engineering or related	2.50	Biotech. or related	3.50	Biotech. or related	3.50
PSU	plan1 Biotech., Food, Agro-In plan2 Science, Engineering	plan1,3.00 or 2.75(with good expertise) plan2,2.50 or <2.50(with >1 year work)	Science, Engineering or last year of Biotech Master course	3.25	Science, Biotech., Engineering or related	plan1, 3.25 with good expertise plan2, <3.25 (with good expertise or > 1 year research work)
[redacted]	Science, Engineering or relate	2.50 or 2.00 (with GPA of related Master course >2.75) or 2.00 (with > 2 years work experience)	related	3.25	related	3.25

N.S. = not specified

Table 5 Course grouping of master program in Biotechnology.

	MUA	CU	CMU	KU	KMUT	KKU	MU	PSU	SUT*
Cumulative crdits		42	36	45	42	36	>25	36	>48
1. Course work	36	24	21	36	30	9	16	9	>20
			Biochem. or Plant						
- Core	12	12	6-7	13	19	>7	14	7	>10
Biochem.	-	3	3 -	-	-	-	-	-	4
Bioprocess	-	-	- -	3	10	3	-	-	-
Biotechnology	-	4	- 3	3	-	6	5	7	-
Microbiol.	-	-	- -	-	-	-	-	-	-
Molec. Biol.	-	-	- -	4	3	3	3	-	-
Other	-	5	4 3	3	6	4	6	-	6
- Selective Core	-	3		>9	-	-	-	-	-
Biochem.	-	-	- -	9	-	-	-	-	-
Bioprocess	-	3	- -	18	-	-	-	-	-
Biotechnology	-	-	- -	-	-	-	-	-	-
Microbiol.	-	-	- -	6	-	-	-	-	-
Molec. Biol.	-	3	- -	-	-	-	-	-	-
Other	-	-	- -	11	-	-	-	-	-
- Seminar	-	2	2	2	2	2	2	2	>3
- Elective	-	7	9-10	>9	>9	>9	>12	12	>7
Biochem.	-	32	33 -	15	6	7	3	5	3
Bioprocess	-	9	10 -	20	12	15	16	27	11
Biotechnology	-	9	- 10	6	3	3	-	48	12
Microbiol.	-	31	- -	3	3	-	3	9	3
Molec. Biol.	-	11	6 3	-	-	3	6	4	4
Other	-	168	3 32	9	18	-	23	14	4
2. Thesis	12	18	15	9	12	18	12	15	20

Biochem. : Biocatalysis, Biochemistry, Enyzme, Immobilization, Lipid, Sugar Tech., Vegetable Oil Tech. and related
Bioprocess : Biochemical Engineering, Fermentation, Separation, Unit Operation, Waste treatmnet and related
Biotechnology: Animal/Marine/Plant Biotechnology, Biotechnological, Biotechnology, Management, Special Topics in Biotechnology and related
Microbiol. : Biodegradation & Biodeterioration, Food Microbiol, Industrial Microbiol., Microbiology, Yeast Tech. and related
Molec. Biol. : Gene Tech., Genetic Engineering, Molec. Genetics, Plant Molec. Genetics, Protein Engineering and related
Other : Design, Breeding, Cell Biology, Chemistry, Energy Resource, Experimental design, Food, Individual study, Innovation, Instrumentation/Technique, Marine, Membrane Presentation and related.

*SUT Trimester system, therefore credit at SUT time 3/4 will convert to the normal credit of semester system

important not only for relief of serious shortages of staff in some universities but also for exchange of research ideas and collaboration between universities.

Research funding and postgraduate scholarships are other barriers to the development of biotechnology in Thailand. Government is, by far, a major supporter for most of the funding. Does the government spend enough money wisely in this field? Does the Private sector play a sufficient role here, since they are the main employers of the graduates? Is the Private sector in Thailand giving enough assistance both in cash and in kind to support graduate schools? Or is the research in our universities not compatible with their interests? What should we do to match our mutual interests to ensure they really help the development of the country?

These are some of the important challenges for the future prospects of biotechnology and bioscience in Thailand,with respect to postgraduate studies in these exciting fields.

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7. คณะเกษตรศาสตร์ คณะเภสัชศาสตร์ คณะวิทยาศาสตร์ คณะอุตสาหกรรมเกษตร และบัณฑิตวิทยาลัย มหาวิทยาลัยเชียงใหม่ หลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ หลักสูตรปรับปรุง พ.ศ. 2540
8. บัณฑิตวิทยาลัย มหาวิทยาลัยเกษตรศาสตร์ หลักสูตรวิทยาศาสตรดุษฎีบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ โครงการปริญญาเอกกาญจนาภิเษก หลักสูตรปรับปรุง พ.ศ. 2541
9. บัณฑิตวิทยาลัย มหาวิทยาลัยเกษตรศาสตร์ หลักสูตรวิทยาศาสตรดุษฎีบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ (หลักสูตรนานาชาติ) หลักสูตรใหม่ ปี พ.ศ. 2539
10. บัณฑิตวิทยาลัย มหาวิทยาลัยเกษตรศาสตร์ หลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ (หลักสูตรนานาชาติ) หลักสูตรปรับปรุง พ.ศ. 2542
11. ภาควิชาเทคโนโลยีชีวภาพ คณะเทคโนโลยีและบัณฑิตวิทยาลัย มหาวิทยาลัยขอนแก่น หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ หลักสูตรใหม่ พ.ศ. 2542
12. ภาควิชาเทคโนโลยีชีวภาพ คณะเทคโนโลยีและบัณฑิตวิทยาลัย มหาวิทยาลัยขอนแก่น หลักสูตรวิทยาศาสตร์มหาบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ หลักสูตรใหม่ พ.ศ. 2539
13. ภาควิชาเทคโนโลยีชีวภาพ คณะวิทยาศาสตร์และบัณฑิตวิทยาลัย มหาวิทยาลัยมหิดล หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ (หลักสูตรนานาชาติ) หลักสูตรปรับปรุง พ.ศ. 2542
14. ภาควิชาเทคโนโลยีชีวภาพ คณะวิทยาศาสตร์และบัณฑิตวิทยาลัย มหาวิทยาลัยมหิดล หลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ (หลักสูตรนานาชาติ) หลักสูตรปรับปรุง พ.ศ. 2542
15. ภาควิชาเทคโนโลยีชีวภาพอุตสาหกรรม คณะอุตสาหกรรมเกษตรและบัณฑิตวิทยาลัย มหาวิทยาลัยสงขลานครินทร์ วิทยาเขตหาดใหญ่ หลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ หลักสูตรปรับปรุง พ.ศ. 2538
16. ภาควิชาเทคโนโลยีชีวภาพอุตสาหกรรม คณะอุตสาหกรรมเกษตรและบัณฑิตวิทยาลัย มหาวิทยาลัยสงขลานครินทร์ หลักสูตรวิทยาศาสตรดุษฎีบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ หลักสูตรใหม่ พ.ศ. 2539
17. สาขาวิชาเทคโนโลยีชีวภาพ คณะทรัพยากรชีวภาพและเทคโนโลยี มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ หลักสูตรปรับ ปรุงใหม่ พ.ศ. 2541
18. สาขาวิชาเทคโนโลยีชีวภาพ คณะทรัพยากรชีวภาพและเทคโนโลยี สถาบันเทคโนโลยีพระจอมเกล้าธนบุรี หลักสูตรวิศวกรรมศาสตรมหาบัณฑิต หลักสูตรวิทยาศาสตรมหาบัณฑิต หลักสูตรปรับปรุง พ.ศ. 2539
19. สาขาวิชาเทคโนโลยีชีวภาพ คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย หลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาวิชาเทคโนโลยีชีวภาพ หลักสูตรปรับปรุง พ.ศ. 2541