

APDTI Annual Report 1999/2000

*Pilot Plant Development and Training Institute
King Mongkut's University of Technology Thonburi*



Research & Development Cluster at Bangkhuntien

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Director's Message



Asot. Prof. Dr. Suvit Tia

During the 1999-2000 period, our group undertook a number of significant initiatives and activities, some of which are highlighted below:

- We moved to new research buildings, complete with high standard laboratory equipment, at Bangkhuntien campus. This represents a major step and provides the opportunity for our group to create and build a “**Research Heaven**” within KMUTT.
- The promotion of synergy between the Pilot Plant Development and Training Institute (PDTI) and the School of Bioresources and Technology (SBT), to create the first KMUTT research and development (R&D) cluster - the integration without walls of R&D laboratories, education programs and services, based on a multidisciplinary concept - has been fully implemented.

- The proposal of increase our services to small and medium enterprises (SMEs) over the next five years, commencing in 2001, has been approved by Cabinet. Of the total budget of around Baht 300 million, our R&D cluster is committed to finding at least one third from external sources, including the private sector and research granting agencies, which will be the matching funds for the government grant.
- The first incubator unit - natural dyeing of textile products for export - has been successfully established.
- The policy for supporting new entrepreneurs has been initiated within our R&D cluster.
- We have successfully commercialized some of the technologies developed by our research work, such as biogas and fluidized bed combustion.

Details of these initiatives, as well as other useful and interesting information concerning our R&D cluster can be found in this bi-annual report. Achieving these milestones required much effort from all our staff and the cooperation and good working spirit of our colleagues. Fortunately, despite very unfavorable prevailing economic conditions, our group still managed to secure a gradual increase in our annual budget. Of this, about one-third came directly from the Budget Bureau and the remaining portion was outsource funding obtained from R&D and service projects. However, we still have a long way to go to make our dream - “Research Heaven” - real and sustainable, and of course need even greater efforts from all involved. In the longer term, we expect that our R&D cluster will be effectively developed to increase quality, reduce cost, and to generate innovation, as well as achieving our ultimate endeavor to become a learning organization, nurturing the next generation of researchers by providing the ideal environment and career structure. This will enable us to better perform our mandate - bridging the gap between university and industry - under the global environment of high competitiveness, e-everything and volatile technology.

Finally, on behalf of the R&D cluster, I would like to thank the university's top management team, especially our president Dr. Krissanapong Kirtikara and advisors: Prof. Morakot Tanticharoen, Dr. Sakarindr Bhumiratana and Dr. Solot Suwanayuen for their generous support and guidance; and to all of our staff and colleagues for their efforts and cooperation; and to the team that prepared this report.

Executive Summary

Pilot Plant Development and Training Institute (PDTI) was established in 1990 as an autonomous unit within King Mongkut's University of Technology Thonburi (KMUTT). KMUTT is an engineering university in Thailand which has traditionally strong links to many industries. Therefore, PDTI is assigned to serve as a bridge between academic research and industrial needs. The major activities of PDTI are contract research, process development, consultancy services and technology transfer. KMUTT's Industrial Park Center also collaborates with PDTI to provide incubation units and a pilot plant for the private sectors to develop new commercial products and entrepreneurs.

Goals

PDTI's aims are to develop and transfer advanced technologies to private as well as government sectors.

Objectives

- ◆ Research, design and develop industrial processes based on industrial needs.
- ◆ Develop pilot plants for studying the feasibility of industrial scale.
- ◆ Facilitate personnel in designing, fabrication, installation, operation and the maintenance of industrial plants.
- ◆ Provide access to the current technical and economic information from international resources.

Activities

- ◆ Pilot plant operation services
- ◆ Hands-on training
- ◆ Technical research
- ◆ Consultancy services

Areas of Expertise

- ◆ Microbial bioprocessing
- ◆ Engineering properties of food materials
- ◆ Thermal and aseptic processing
- ◆ Cell culture and genetic modified organism fermentation
- ◆ *Spirulina* mass cultivation and biochemicals
- ◆ Waste utilization, management and cleaner production
- ◆ Computer application, modeling and simulation
- ◆ Environmental biotechnology
- ◆ Energy conservation and clean energy technology
- ◆ Fluidized bed combustion

PDTI's Highlights in 1999-2000

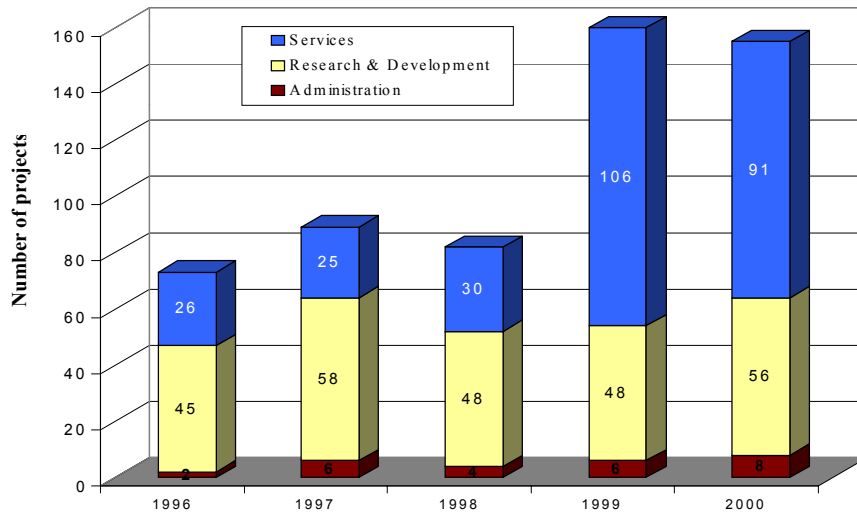
- ◆ Research & Development Cluster
- ◆ Industrial Park Center

Overview of 1996-2000 Performance

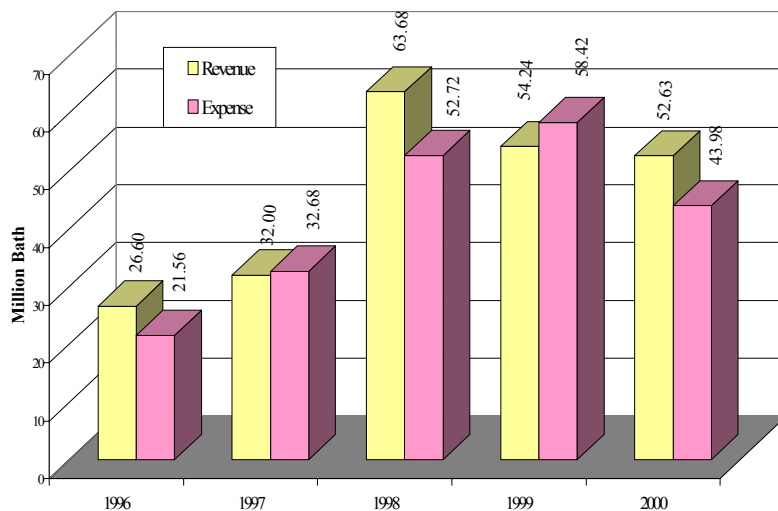
PDTI's Plans and Outcomes in 1996-2000

	1996 (%)	1997 (%)	1998 (%)	1999(%)	2000(%)
<i>Total</i>	73(125)	89 (130)	82 (102.5)	160(129)	147(112)
<i>Administration</i>	2 (100)	6 (200)	4 (100)	6(100)	8(133)
<i>Research & Development</i>	45 (94)	58 (118)	48 (109)	48(82.7)	56(57)
<i>Services</i>	26(325)	25 (156)	30 (120)	106(176.6)	91(113.7)

Note: (%) = Percentage of actual outcomes per plans

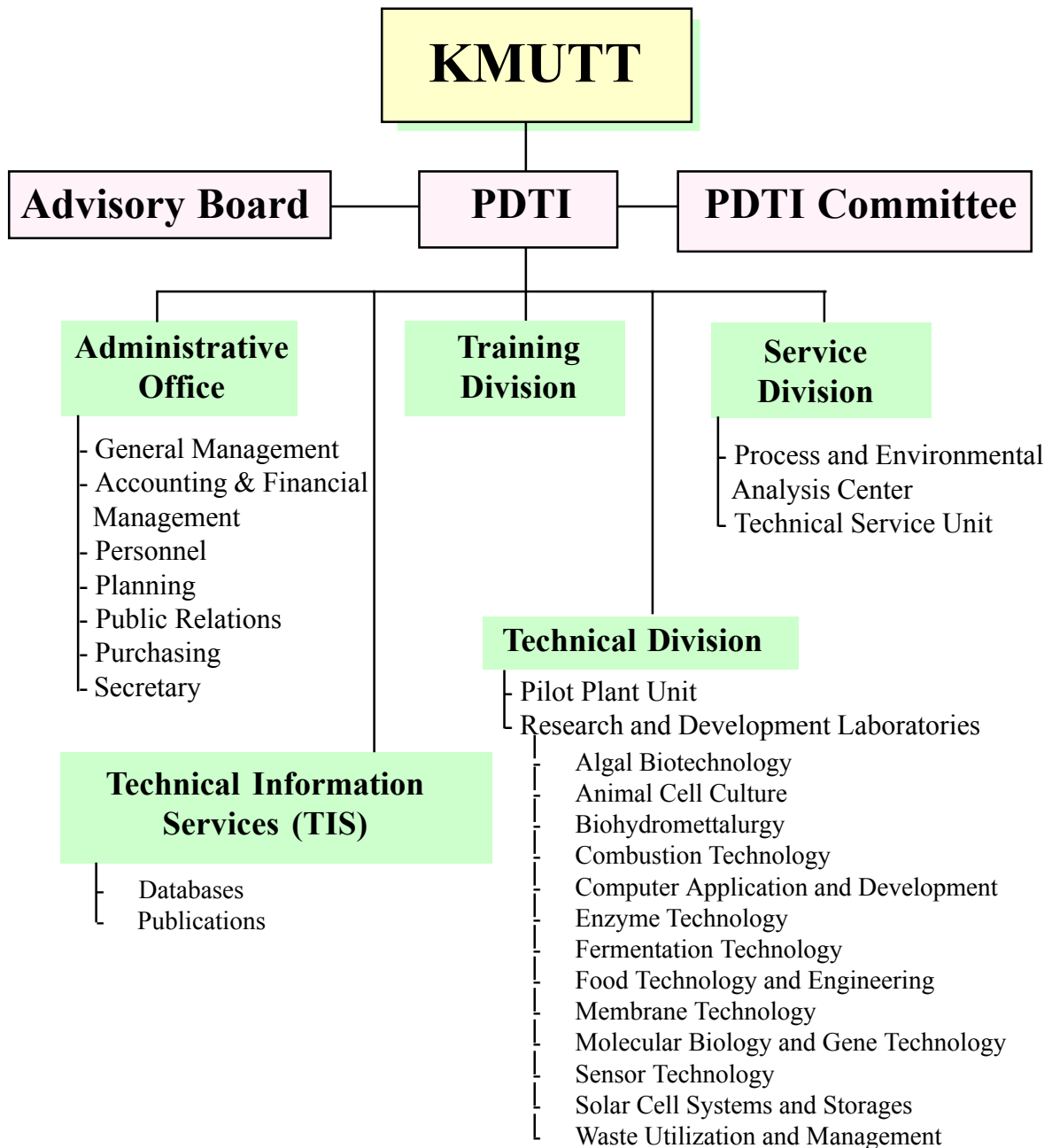


Number of Projects in 1996-2000



Comparison between Revenues and Expenses in 1996-2000

Organization Chart



PDTI Committee 1999

Advisory Board

1. Dr. Krissanapong Kirtikara President of KMUTT
2. Assoc. Prof. Dr. Sakarindr Bhumiratana Director of BIOTEC
3. Assoc. Prof. Dr. Morakot Tanticharoen Deputy Director of BIOTEC

Committee

1. Asst. Prof. Dr. Solot Suwanayuen PDTI Director, Chairman
2. Assoc. Prof. Dr. Suvit Tia Deputy Director in Techniques, Information and Services, Vice Chairman
3. Asst. Prof. Dr. Supapon Cheevadhanarak Deputy Director in Research, Foreign Relations and Public Relations, Vice Chairman
4. Asst. Prof. Dr. Supatpong Damrongrat Dean, Faculty of Science, Senior member
5. Assoc. Prof. Bosaya Bunnag Dean, School of Bioresources and Technology, Senior Member
6. Asst. Prof. Dr. Yuwapin Lertwerawat School of Bioresources and Technology, Senior Member
7. Asst. Prof. Dr. Tipaporn Yoovidchaya Head, Department of Food Engineering, Senior Member
8. Ms. Duchanee Buranasiri Office of Director, Manager
9. Ms. Navaporn Punyasak Technical Information Services, Manager
10. Ms. Sopida Boonanaksub Training Division Manager
11. Mr. Tawatchai Suwanakum Service Division Manager
12. Mr. Tanong Chayawattana Technical Division Manager

PDTI Committee 2000

Advisory Board



Prof. Dr. Morakot Tanticharoen
Director of BIOTEC



Dr. Krissanapong Kirtikara
President of KMUTT



Assoc. Prof. Dr. Sakarindr Bhumiratana
Senior Vice President for Administrative
Affairs of KMUTT



Asst. Prof. Dr. Solot Suwanayuen
Vice President in charge of Bangkhuntien and
Rajaburi Campus of KMUTT

Committee



Asst. Prof. Dr. Veera Loha
Deputy Director for Technique,
Information and Services



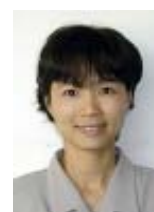
Assoc. Prof. Dr. Suvit Tia
PDTI Director



Asst. Prof. Dr. Supapon Cheevadhanarak
Deputy Director for Research Foreign Relations
and Public Relations



Dr. Annop Nopharatana
Assistant Director for Technique,
Information and Services



Dr. Phenjun Mekvichitsaeng
Assistant Director for Research Foreign
Relations and Public Relations



Prof. Dr. Somchai Chucheeepsakul
Vice President for Research and Information of KMUTT,
Senior Member



Assoc. Prof. Busaya Bunnag
Dean, School of Bioresources
and Technology, Senior member



Asst. Prof. Dr. Tipaporn Yoovidhaya
Department of Food Engineering,
Senior Member



Asst. Prof. Dr. Supatpong Damrongrat
Faculty of Science,
Senior Member



Ms. Duchanee Buranasiri
Office Director Manager



Ms. Navaporn Punyasak
TIS Manager



Ms. Sopida Boonanaksub
Training Division Manager



Mr. Tawatchai Suwanakum
Service Division Manager



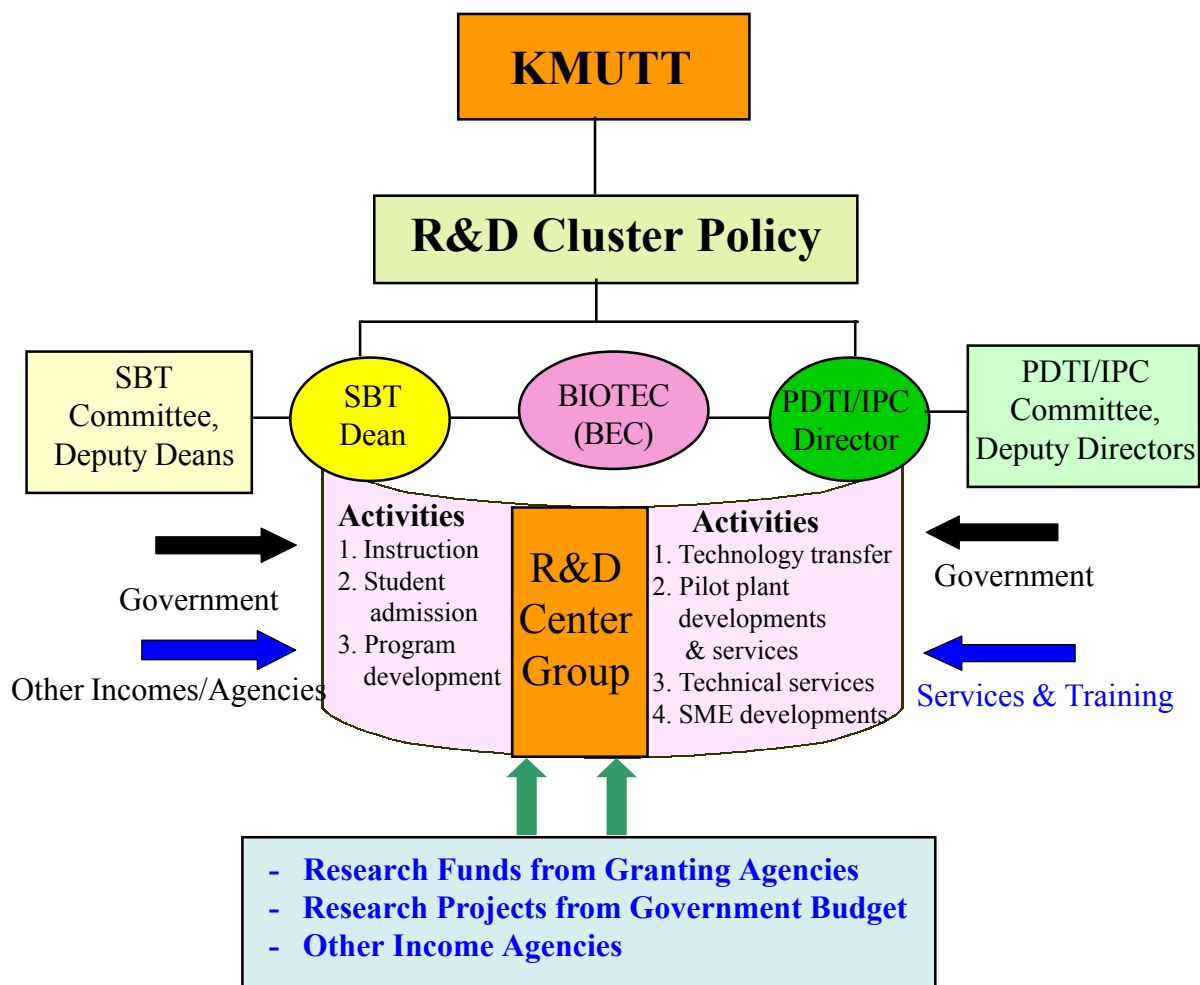
Mr. Tanong Chayawattana
Technical Division Manager

R&D Cluster Management

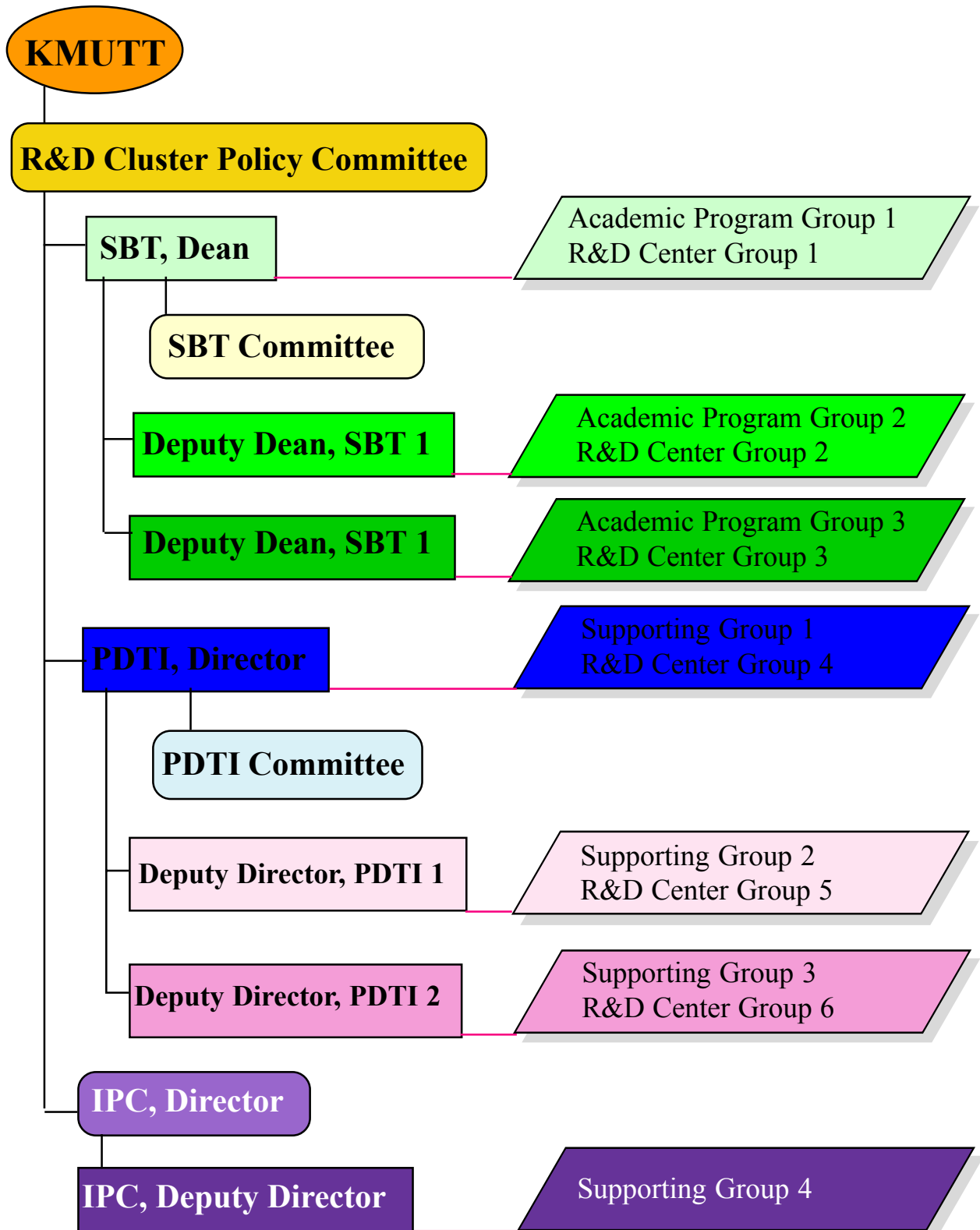
Objectives

1. Develop, manage and conduct a research based mode.
2. Develop the PPBS system to meet the international university standard.
3. Provide a conducive atmosphere for research and idea exchange.
4. Support education and research through learning ,teaching and researching
5. Provide a center for supporting of satellite research groups engaging in resource sharing for efficiency and quality.
6. Provide quality post-graduate capabilities , skills and excellence in all research fields with and the ability to distribute knowledge to society.

Management System



R&D Cluster : Organization and Management Structure



R&D Groups

1. Algal biotechnology
2. Microbial bioprocess developments
 - ❖ Animal cell culture
 - ❖ Fermentation technology
 - ❖ Fungal Biotechnology
3. Biohydrometallurgy
4. Biodiversity
5. Food technology and engineering
6. Enzyme technology
7. Bio-and Chemical sensor
8. Waste utilization and management
9. Clean energy system
10. Combustion technology
11. Pilot plant engineering service
12. Analytical laboratory
13. Technology information services

Supporting Groups

1. Academic services
2. Cash/credit management
3. Document preparation/publishing
4. Executive secretary
5. Financial & cost accounting
6. Internal audits (finance/performance / management)
7. Office clerical work
8. Personnel management & HRD
9. Planning & MIS/computer strategy
10. Procurement & inventory
11. Public relation
12. Quality system management

Academic Programs

- | | |
|-----------------------------------|-----------------|
| 1. Biotechnology | (M.Sc. & Ph.D.) |
| 2. Biochemical Technology | (M.Sc. & Ph.D.) |
| 3. Natural Resource Management | (M.Sc.) |
| 4. Chemical Engineering Practices | (M.Eng.) |
| 5. Post Harvest Technology | (M.Sc.) |

Industrial Park Center (IPC)

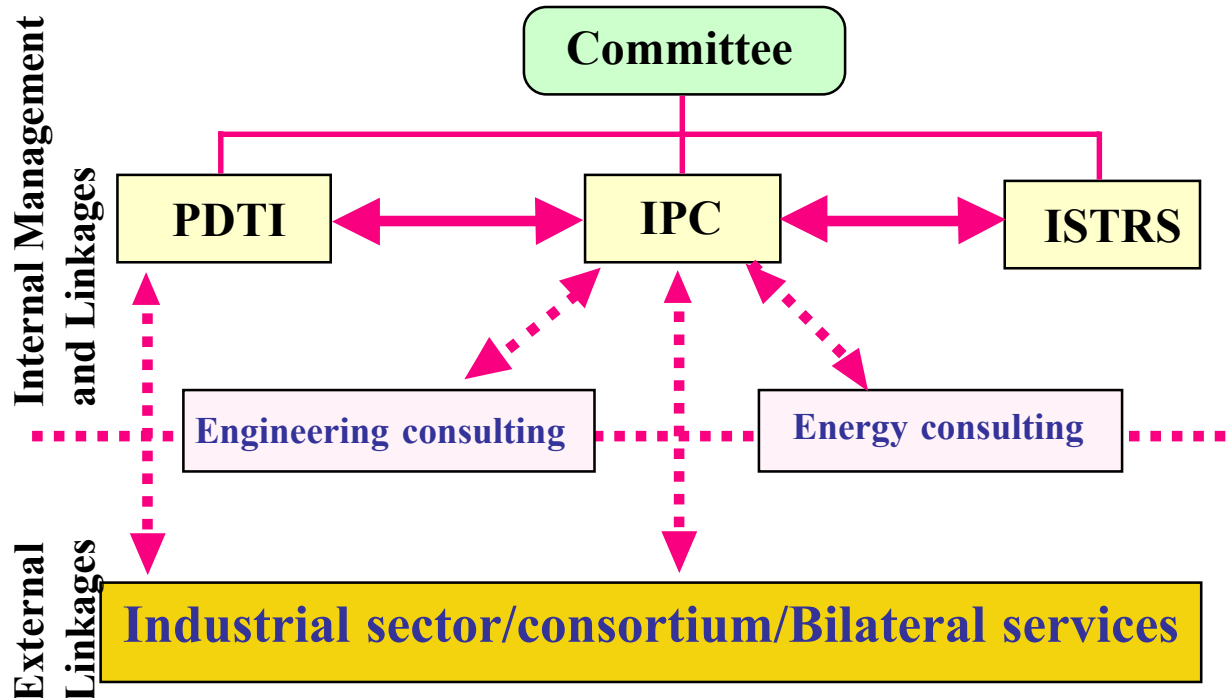
Function and Structure

Industrial Park Center (IPC) is the managing office for KMUTT's industrial park. The functions of IPC are to enhance government and the private sector to develop indigenous technology. IPC is also a matching center between KMUTT's expertise and industrial needs, especially the small and medium enterprises (SMEs). Both incubation units and pilot plants are provided for SMEs to create novel commercial products and strengthen new entrepreneurs.

Operating Targets

- ❖ Transfer science and technology to SMEs to enhance their competitive potential in world wide marketing
- ❖ Increase the number of SMEs who can develop their own technologies or effectively select and improve imported technologies.

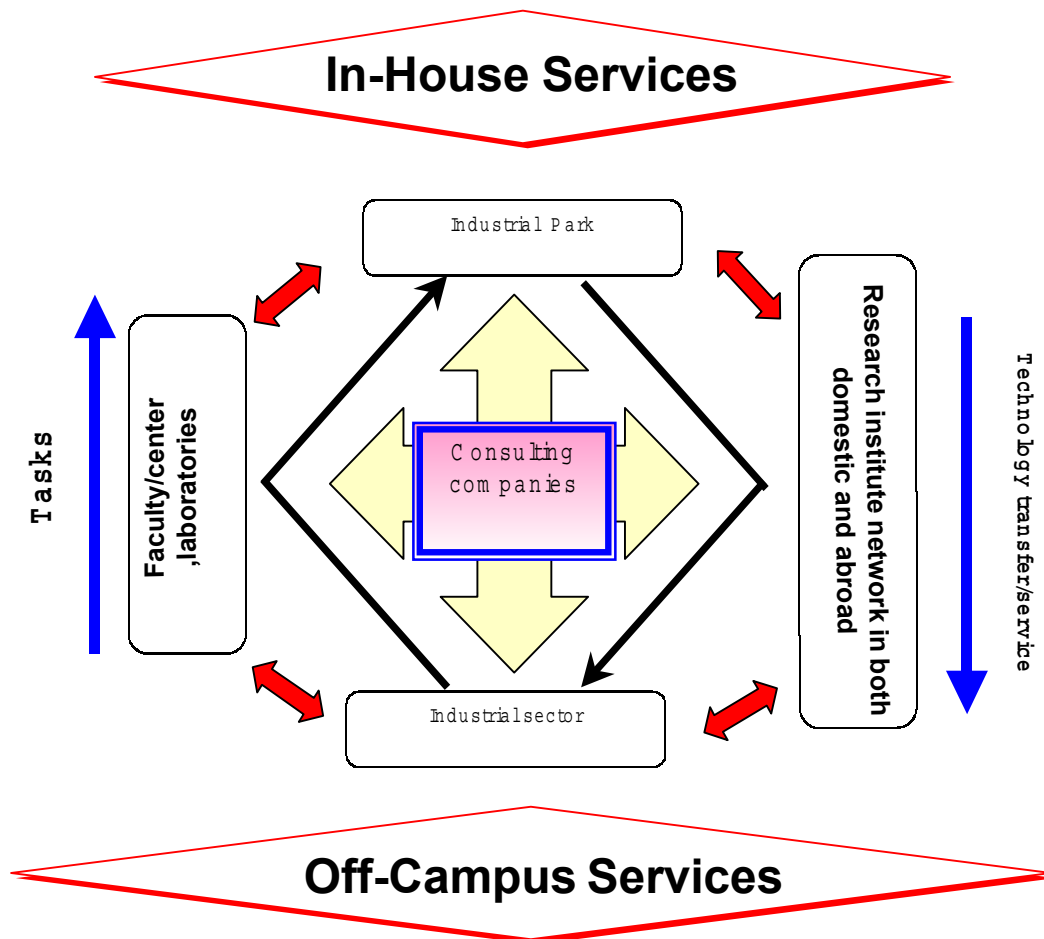
Organization structure and relationship of the industrial park management



Working Strategy for Success

- ❖ Set up a collaborative mechanism between the private sector and the university.
- ❖ Support the management and technology skills of SMEs.
- ❖ Train and develop human resources in SMEs.
- ❖ Develop new technology and/or modify imported technology for the nation's use.
- ❖ Incubate potential SMEs to strengthen their capabilities in both technology and management.
- ❖ Transfer the developed in-house technology to SMEs.

Co-ordination, the configuration and the research network of the Industrial Park



Industrial Services

In 1999-2000, PDTI provided numerous successful technology transfers to the industrial sectors by means of designing and developing processes, conducting workshops and training courses. Services included wastewater treatment, tapioca starch processing, fruit juice processing, environmental management, information technology and biotechnology, information management.

The following list are companies which benefited from PDTI's technological transfer:

1. Asia Aquaculture Co.,Ltd.
2. Dhepadungporn Coconut Jelly Co.,Ltd.
3. Thai Special Starch Co.,Ltd.
4. Department of Industrial Works.
5. Pollution Control Department.
6. Safety Invention Co.,Ltd.
7. Rung-Aroon Farm.
8. BioMac Food,Co.,Ltd.
9. Chumporn Palm Oil Industry,PCL.
10. Siam Steel Siligate,Co.,Ltd.
11. Ajinomoto Co.,Ltd.
12. Thai Power Supply Co.,Ltd.
13. Thai Health Foundation
14. National Starch Chemical Co.,Ltd.
15. Sahatharawatana Co.,Ltd.
16. Sunyang Food Industry Co.,Ltd.
17. IPS International Co.,Ltd.
18. Thaidheparot Food Product Co.,Ltd.
19. Longtex Rubber Industry Co.,Ltd.
20. Department of Energy Development and Promotion.



Consultancy Services

Projects	Customers
<ul style="list-style-type: none"> • A prototype of kai jor wrapping machine 	<ul style="list-style-type: none"> • Star Marketing Co., Ltd.
<ul style="list-style-type: none"> • The improvement of food processing in Thai fast food restaurant 	<ul style="list-style-type: none"> • Star Marketing Co., Ltd.
<ul style="list-style-type: none"> • Problem in inadequate ventilation and fog in a fried chicken processing plant. 	<ul style="list-style-type: none"> • CP. Food Products Co.,Ltd. + ChEPS
<ul style="list-style-type: none"> • GMP and HACCP training 	<ul style="list-style-type: none"> • Frito-Lay Thailand Co.,Ltd.
<ul style="list-style-type: none"> • Energy index of Frito-Lay products 	<ul style="list-style-type: none"> • Frito-Lay Thailand Co.,Ltd
<ul style="list-style-type: none"> • Improvement of maintenance and management system 	<ul style="list-style-type: none"> • Frito-Lay Thailand Co.,Ltd.
<ul style="list-style-type: none"> • Time and motion study 	<ul style="list-style-type: none"> • Frito-Lay Thailand Co.,Ltd.
<ul style="list-style-type: none"> • The effectiveness of the inline oil filter at a fluid chicken processing line in terms of acid value improvements of the oil 	<ul style="list-style-type: none"> • CP Food Group + Food Engineering
<ul style="list-style-type: none"> • The effect of different food additives on the acid value of cooking oil used in fried chicken processing 	<ul style="list-style-type: none"> • CP Food Group + Food Engineering
<ul style="list-style-type: none"> • Modeling of adsorption-desorption process for mixed solvents 	<ul style="list-style-type: none"> • T.T. Consulting and Interade Co., Ltd + ChEPS
<ul style="list-style-type: none"> • A design of toluene recovery unit in a PU artificial leather manufacturing plant 	<ul style="list-style-type: none"> • Thai Urethane Plastic Co.,Ltd.
<ul style="list-style-type: none"> • A design of solvent recovery unit in a PVC manufacturing plant. 	<ul style="list-style-type: none"> • CPPC – Decorative Products Co., Ltd.
<ul style="list-style-type: none"> • A design of used paint recovery unit 	<ul style="list-style-type: none"> • CPPC-Decorative Products Co.,Ltd.
<ul style="list-style-type: none"> • A prototype of mixed solvents recovery unit from a PVC manufacturing plant 	<ul style="list-style-type: none"> • Apex Plastics Co., Ltd.

Incubation Unit

KMUTT at Bangkuntein provides research centers, technical services and rental facilities for industrial incubation. The purpose of the incubation unit is to promote SMEs to develop their own technologies with the support in research and technology transfer from KMUTT.

Green Care Co., Ltd was the first industrial firm using this facility in 1999. The objectives of the company are to produce a sample dying fabric for marketing and develop a dying process using natural dyes. The first rental period of this contract for incubation is for 3 years.



Training Courses and Workshops

PDTI realizes that training courses and workshops are the most important mechanism for technology transfer to the private sector. PDTI's staff and researchers deliver the internal training courses regularly. Overseas experts and specialists were also invited to give seminars for industries or to be co-instructors. Currently, the training courses were well attended by both private and government sectors, as well as international attendees from Southeast Asian countries. The following lists of workshops and training courses were conducted in 1999-2000 :

23-25 February, 1999	AAECP Phase III: Wastewater Treatment Technology Transfer and Cleaner Production Demonstration Project.
11 August 1999	Technical Training of Wastewater Treatment from the Pilot Scale of Metal Surface Coating Process.
24-26 August 1999	Technical and Quality Analysis Method of <i>Spirulina</i> Culture and Biochemical Composition.
10 Sept., 12 November 1999	Technical Training of a Royal Project.
1-2 November 1999	Management of Chemical and Hazardous Waste from Laboratory
2-3 December 1999	Workshop: Principles of Modified Electrode.
21 March., 1999 and Septmper 2000	Meeting in Fuel Cell # 1 & 2.
18 May 2000	Commercialization Workshops in ASEAN : Fluidized Bed Combustion Technology and Co-generation.
7-9 June 2000	Technology Training of Royal Project



Research, Development and Engineering Laboratories

Presently, PDTI is comprised of 14 research, development and engineering laboratories conducting research, design and development of new technologies for commercial applications. Many PDTI talented researchers, engineers and scientists have proven track records successfully turning their research to new inventions of commercial products.



1. Algal Biotechnology laboratory

- Develop mass cultivation technology of *Spirulina*
- Extraction of value-added compounds from *Spirulina* such as phycocyanin and gamma-linolenic acid (GLA)

Laboratory director : Assoc.Prof. Boosaya Bunnag
E-mail : boosya.bun@kmutt.ac.th

2. Animal cell culture laboratory

- Insect cell culture
- Produce high value bio-active compounds such as recombinant proteins

Laboratory director : Dr. Kanokwan Poomputsa
E-mail : kanokwan.poo@kmutt.ac.th



Bioleaching of copper from low-grade copper sulphide ores by Thiobacillus ferrooxidans in a column leaching

3. Biohydrometallurgy laboratory

- Recover precious metals from industrial waste and soil
- Study the mechanism of Zinc extraction from mining waste

Laboratory director : Dr.Paithip Theeravetyan
E-mail : paithip.the@kmutt.ac.th

4. Combustion technology laboratory

- Coal and biomass combustion
- Fluidized bed combustion technique
- Improve LPG cooking stove

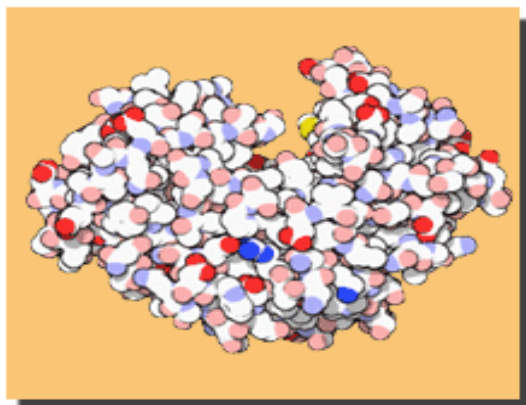
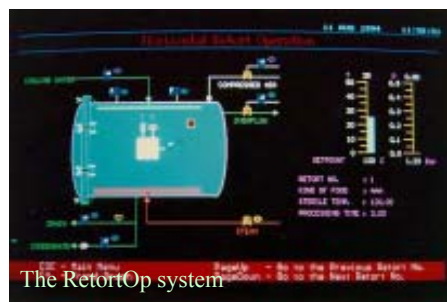
Laboratory director : Assoc.Prof.Dr.Suvit Tia
E-mail : suvit.tia@kmutt.ac.th



5. Computer application and development laboratory

- On-line computer control of retort in food processing
- Simulation and automatic control

Laboratory director : Mr.Worasit Ratanabonkorn
E-mail : worasit@pdti.kmutt.ac.th



6. Enzyme technology laboratory

- Hydrolytic enzyme such as alkaline amylase, cellulase-free xylanase and mannanase
- High value products from low value carbon sources such as cellulose

Laboratory director :
Assoc. Prof. Dr. Khanok Ratanakhanokchai
E-mail : khanok.rat@kmutt.ac.th

7. Fermentation technology laboratory

- Investigate the strategy for maximizing the trehalose production in *Saccharomyces cerevisiae*
- Study effect of temperature on fatty acid profiles and growth in *Mucor rouxii*
- Cultivate and characterize fungus

Laboratory director :
Asst.Prof.Dr.Yuwapin Dandusitapunth
E-mail : yuwapin.dan@kmutt.ac.th

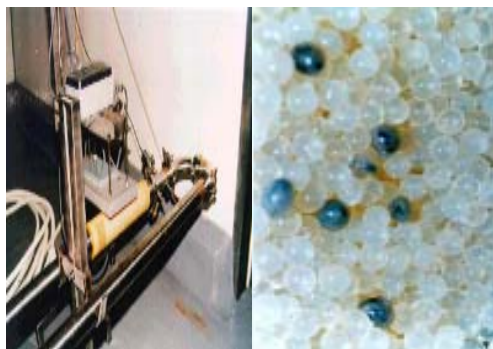


1,500 Litre Fermentor in PDTI 's Pilot Plant

8. Food technology and engineering laboratory

- Thermal processing technology in food industries
- Develop electronic identification techniques in a continuous bioprocess
- Food dehydration

Laboratory director :
Asst.Prof.Dr.Tipaporn Yoovidhaya
E-mail : tipaporn.yoo@kmutt.ac.th



Electronic Identification Device

9. Membrane technology laboratory

- Preparation of synthetic membrane
- Fundamentals of membrane transport mechanism and fouling
- Application of membrane process

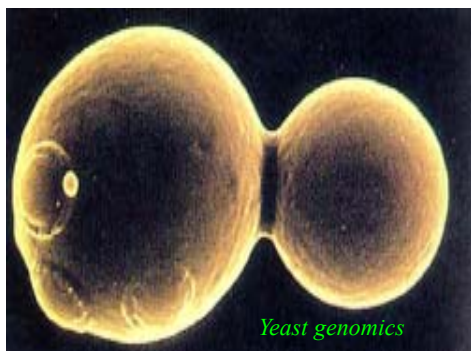
Laboratory director :

Assoc.Prof.Dr.Ratana Jiraratananon

E-mail : ratana.jir@kmutt.ac.th



Ceramic Membrane Ultrafiltration



Yeast genomics

10. Gene manipulation in filamentous fungi Gene manipulation in cyanobacteria Metabolic engineering and functional genomics of filamentous fungi technology laboratory

- Develop new techniques in gene technology of *Spirulina patensis*, *Mucor rouxii* and *Aspergillus oryzae*

Laboratory director :

Asst.Prof.Dr.Supapon Cheevadhanark

E-mail : supapon.che@kmutt.ac.th

11. Sensor technology laboratory

- Develop biosensors of sucrose and glucose
- Microbial BOD biosensor
- Oxidase based biosensor
- Modified electrodes for electroanalysis

Laboratory director : Dr.Werasak Surareungchai

E-mail : werasak.sur@kmutt.ac.th



Prototype of Sucrose Measurement



PV Hybrid System

12. Solar cell systems and storage research and development laboratory

- Develop and commercialize modules and prototypes of BOS
- Develop solar to AC (STAC) converter
- Develop generator-battery prototype for clean energy

Laboratory director : Mr.Tawatchai Suwankum

E-mail : tawatchai@pdti.kmutt.ac.th

13. Waste utilization and management laboratory

- Research and develop process to treat and utilize industrial wastes
- Provide technology know-how and economic data for potential users
- Design and implement a novel high rate anaerobic system
- Provide consultancy services



Laboratory director : Dr.Pawinee Chaiprasert
E-mail : pawinee.cha@.kmutt.ac.th



14. Process and Environmental Analysis Center

- Provide services in chemical, physical and microbiological analysis
- Water and waste water analysis
- Consultation in laboratory analysis techniques

Laboratory director : Mrs.Suchada Chaisawadi
E-mail : suchada@pdti.kmutt.ac.th

Note:

Many laboratories achieved significant progress in research and innovation in the past 2 years. However, only a few highlights and successes from research laboratories are presented in this report.

Research Grants and Project Funds

In 1999/2000, PDTI conducted 53 research projects from 11 granting agencies, totalling funds was of Baht 48.178 million.

PDTI & SBT Funds

1. Effects of storage condition and processing methods on lime juice quality
(Head: Mrs. Suchada Chaisawadi)
2. Heat and power integration sugar-cane factory (Head: Chirapun Nuengchanin)
3. Prototype of PV grid-connected system phase I
(Head: Mr. Tawachai Suwannakum)
4. Waste water characterization on electroplating industry
(Head: Mrs. Suchada Chaisawadi)
5. Cloning and characterization of the core-membrane linker phycobilitrotein gene from *Spirulina platensis* (Head: Asst. Prof. Dr. Supapon Cheevadhanarak)
6. Development of a transformation system for *Mucor rouxii* ATCC 2490
(Head: Asst. Prof. Dr. Supapon Cheevadhanarak)
7. Using concentration of inorganic phosphate for controlling expression of gene for envelope protein of danger virus from *Saccharomyces cerevisiae*
(Head: Dr. Chulee Yamapakdee)
8. Life cycle analysis (Head: Asst. Prof. Dr. Suvit Tia)
9. Starch extraction from cassava root (Head: Mrs. Sopida Boonakesup)
10. Electrical conductivity property of food materials for ohmic heating application
(Head: Asst. Prof. Dr. Suvit Tia)
11. Development of pilot-scale heat pump dryer for food dehydration
(Head: Asst. Prof. Dr. Tipaporn Yoovidhaya)
12. The study on polysaccharide production from *Spirulina*
(Head Ms. Wipawan Siangdung)
13. The use of copper electrodes in electrocatalysis
(Head: Dr. Weerasak Surareungchai)
14. Molecular cloning and characterization of $\Delta 6$ desaturase from *Mucor rouxii* ATCC24905
(Head: Dr. Kopkul Laoteng)
15. The molecular study of the biosynthetic origin of cytochalasin from *Xylaria* sp. BCC1067 (Head: Asst. Prof. Dr. Supapon Cheevadhanarak)
16. Effect of Propionic acid on methanogenesis in mesophilic pineapple peel digester
(Head: Ms. Pornpun Phanitnumsin)

National Research Council of Thailand (NRCT)

1. Biological treatment of chlorinated organic compound in wastewater from printing paper industry. (Head : Asst. Prof. Dr. Solot Suwannayuen)
2. Acceleration of biofilm development during start-up process in an anaerobic flat bed reactor. (Head : Asst. Prof. Dr. Suvit Tia)
3. Biological removal of nitrogen in wastewater from shrimp farm. (Head : Dr. Sunun Siriraksophon)
4. The lignocellulolytic microorganism in anaerobic digestion of pineapple peel. (Head : Dr. Yuwadee Nakapadungrat)
5. Application of xylanolytic enzymes in pulp prebleaching process. (Head : Assoc. Prof. Dr. Khanok Ratanakhanokchai)

National Center of Genetic Engineering and Biotechnology (BIOTEC)

1. Mutagenesis and selection of mutants in fatty acid desaturation in *S. platensis*. (Head Dr. Marasri Rungjitchatchawalya)
2. Cloning, expression and sequencing of phycocyanin and allophycocyanin genes of *S. platensis* C1. (Head Asst. Prof. Dr. Supapon Cheevadhanarak)
3. Database programming on processing technology in agro and food industries. (Head: Dr. Monthira Nopharatana)
4. Water minimization in tapioca starch factory. (Head : Mrs. Sopida Boonanaksub)
5. Waste water characterization in tapioca starch production process. (Head : Mrs. Sopida Boonanaksub)
6. Multienzyme complexes from aerobic cellulolytic and xylanolytic bacteria. (Head : Dr. Khin Lay Kyu)

Biochemical Engineering and Pilot Plant Research and Development Unit (BEC)

1. Food standards research program. (Head : Dr. Ampawan Tunsakun)
2. Glucose sensor by screen printing. (Head : Dr. Pawadee Chaiprasert)
3. Performance of a hybrid reactor combining an upflow sludge bed and a fixed bed in treating and producing biogas from tapioca starch waste water. (Head : Dr. Pawinee Chaiprasert)
4. Development of electrode sensor for the determination of tetracyclines in meat. (Head: Dr. Weerasak Surareungchai)
5. Population dynamics study of bacterial communities in an anaerobic hybrid reactor using 16S-rRNA fluorescent in situ hybridization. (Head : Dr. Somkiet Techakarnjanaruk)
6. A study of molecular mechanism that controls the synthesis of desaturase and its gene expression in *S. platensis*. (Head : Dr. Patcharaporn Deshnum)

National Metal and Material Technology Center (MTEC)

1. Synthesis of redox-active biocompatible membrane use for biosensor.
(Head: Dr. Weerasak Surareungchai)

The Thailand Research Fund (TRF)

1. Industry - university cooperation research center for environmental and hazardous water management Phase I : management of environmental problems and hazardous waste in KMUTT. (Head: Assist Prof. Dr. Solot Suwannayuen)
2. A literature survey for water minization on Mae Klong water shed.
(Head : Mrs. Sopida Boonanaksub)
3. Production of activated carbon from bagass.
(Head : Mrs. Sopida Boonanaksub)

National Energy Policy Office (NEPO)

1. Prototype of PV-hybrid systems for national park and wildlife sanctuaries in Thailand.
(Head : Asst. Prof. Dr. Suvit Tia)
2. Feasibility study of clean energy demonstation in the royal development study centers.
(Head: Mr. Tawachai Suwannakum)
3. Technical, economic and social evaluation of photovoltaic battery charging systems.
(Head: Mr. Sirichai Thepa)
4. Feasibility study of a pilot project to repair PV water pumping systems in northeast Thailand. (Head: Mr. Sumate Tanchareon)
5. Investigation of electric generation using molten carbonate fuel cell.
(Head: Dr. Apichai Therdtianwong)
6. PV standards project (Head: Dr. Veeraphol Monyakul)
7. Solar to AC Equipment (STAC) testing project (Head: Mr. Dhirayut Chenvidhaya)
8. Solar car (Head: Mr. Rungroj Songprakob)
9. Feasibility study on establishment of industrial park : energy technology and it's management.
(Head : Mr. Surain Thapanangkun)
10. Consulting project for the evaluation of promoting production from animal manure as an alternative energy and to improve environment conditions.
(Head : Mr. Wuthipong Sritongkam)

US-Israel Cooperative Development Research Program (CDRP)

1. Development of a transformation system in *S. platensis* C1.
(Head : Asst. Prof. Dr. Supapon Cheevadhanarak)

KMUTT Research Fund

1. Solar reverse osmosis system. (Head: Mr. Tawachai Suwannakum)
2. PV stand-alone for remove village electrification (Na Heaw).
(Head: Mr.Tawachai Suwannakum)

Pollution Control Department, Ministry of Science, Technology and Environment

1. The development of pilot-scale for air and waste water treatment from metal-coating. (Head : Mrs.Chareamraj Wangtawin)

ASEAN

1. Energy from Biomass Residues Project.
(Head: Asoc. Prof. Dr.Suvit Tia)
2. Waste water treatment technology transfer and cleaner production demonstration project. (WWTTT&CPDP) (Head : Dr. Pawinee Chairasert)

Selected Reports and Publications

In 1999/2000, PDTI produced 29 reports and 68 publications, as follows:

Selected Reports

1. Molecular genetic study on the production of γ -linolenic acid of *Mucor rouxii* 24905: cloning and characterization of $\Delta 9$ and $\Delta 12$ desaturase genes, the genes involved in the production of γ -linolenic acid. (Head : Asst. Prof. Dr. Supapon Cheevadhanarak)
2. Expression of gene for envelope protein of dengue virus and characterization of its products in *Sacharomeyces cerevisiae*. (Head: Dr. Chulee Yompakdee)
3. Techno-economic evaluation and social impacts assessment of photovoltaic water pumping installations in northeast Thailand. (Head: Dr. Sirichai Thepa)
4. Cellulosome structure of thermophilic cellulolytic and alkaliphilic xylanolytic microorganisms. (Head: Assoc. Prof. Dr. Kanok Ratanakanokchai)
5. The development of bio-film coating on piezoelectric crystal by electrochemical polymerization technique for biosensor application. (Head: Mrs. Pornpimol Sritongkam)
6. The investigation for elimination interference of electrocatalyst microparticle for glucose oxidase (Head: Mrs. Pornpimol Sritongkam)
7. The development of piezoelectric crystal biosensor for the determination of organophosphorus pesticides (phase II) (Head: Mrs. Pornpimol Sritongkam)
8. Amperometric enzyme electrode for the determination of glutamate using flow injection analysis (phase II) (Head: Asst. Prof. Boosya Bunnag)
9. Production of baculovirus in insect cell culture for biopesticide (Head: Dr. Phenjun Mekvichitsaeng)
10. Production of recombinant dengue viral proteins using baculovirus expression insect cell system. (Head: Dr. Kanokwan Poomputsa)
11. Software developemnt for retort operation control (Phase 2) (Head: Asst. Prof. Dr. Pakorn Nuchnoi)
12. Feasibility study on establishment of industrial park: Energy technology and it's management. (Head : Mr. Surain Thapanangkun)
13. Wastewater characterization on tapioca starch production process (Head : Mrs. Sopida Boonanaksub)
14. Water minimization in tapioca starch factory (Head : Mrs. Sopida Boonanaksub)
15. The development of pilot-scale for air and waste water treatment from metal-coating. (Head : Dr. Chareamraj Wangtawin)
16. Production of activated carbon from bagasses (Head : Mrs. Sopida Boonanaksub)
17. A study of starch extraction from cassava root (Head : Mrs. Sopida Boonanaksub)

18. A study on wastewater characterization in electroplating plant.
(Head : Mrs. Sopida Boonanaksub)
19. Wastewater survey from tapioca starch industries.
(Head : Assoc. Prof. Dr.Suvit Tia)
20. Development of a transformation system in *Spirulina platensis* C1
(Head : Asst. Prof. Dr. Supapon Cheevadhanarak)
21. Molecular cloning and characterization of glutaminase gene from *Aspergillus oryzae*
(Head : Asst. Prof. Dr. Supapon Cheevadhanarak)
22. The testing of STAC of premier global corporation project
(Head : Mr. Rungroj Songpakorb)
23. Feasibility study on establishment of industrial park : Energy technology and it's management.
(Head : Mr. Surain Thapaungkun)
24. Feasibility study on the minimization and recovery of VOC emission
(Head : Asst. Prof. Dr. Wittaya Teppaitoon)
25. Database programming on processing technology in agro and food industries
(Head : Dr. Monthira Nopharatana)

Publications

Algal Technology Laboratory

- Nomsawai, P., Tandeau. de Marsac, N., Claude Thomas, J., Tanticharoen, M. and Cheevadhanarak, S. 1999. "Light regulation of phycobilisome structure and gene expression in *Spirulina platensis* C1 (*Arthrospira* sp. PCC9438)." *Plant Cell Physiol.* 40(12): 1194-1202.
- Deshnium, P., Paitoonrangsarid, K., Suphatrakul, A. and Cheevadhanarak, S. 1999. "Effect of temperature on the expression of desaturase gene in cyanobacterium, *Spirulina platensis* C1." *Biotech week '99*, March 22-26, NSTDA building, Bangkok, Thailand.
- Chaiklahan, R., Ruengjitchachawalya, M., Chanpen, R. and Tanticharoen, M. 1999. "Inhibitory effect of berberines on growth and fatty acid desaturation in *Spirulina platensis*." Poster presentation at 5th Asia- Pacific Biochemical Engineering Conference 1999 and The 11th Annual Meeting of the Thai Society for Biotechnology "New Era of Biochemical Engineering and Biotechnology", November 15-18,1999, Phuket, Thailand.
- Chirasuwan, N., Chaiklahan, R., Ruengjitchachawalya, M., Bunnag, B., Deshnium, P. and Tanticharoen, M.1999. "Characterization of *Spirulina platensis* mutant defective in photosynthesis." The 5th Asia- Pacific Biochemical Engineering Conference 1999 and The 11th Annual Meeting of the Thai Society for Biotechnology "New Era of Biochemical Engineering and Biotechnology", November, 15-18, Phuket, Thailand.
- Hongsthong, A., Deshnium, P., Paitoonrangsarid, K., Phapugrangkul, P., Tanticharoen, M. and Cheevadhanarak, S., 2000. "Effect of temperature on the desaturase gene translation in *Spirulina platensis* strain C1." Poster presentation at the 4th Asia-Pacific Conference on

Algal Biotechnology, July, 3-6. Hong Kong.

- Hongsthong, A., Deshniem, P., Paitoonrangsarid, K., Phapugrangkul, P., Tanticharoen, M. and Cheevadhanarak, S. 2000. "Differences in the regulation of fatty acid desaturation in two types of membranes, plasma and thylakoid, of *Spirulina platensis* strain C1." Poster presentation at the 12th annual meeting of the Thai Society for Biotechnology, November, 1-3, Kanchanaburi, Thailand.
- Paitoonrangsarid, K., Phapugrangkul, P., Hongsthong, A., Deshniem, P., Tanticharoen, M. and Cheevadhanarak, S. 2000. "Production of $\Delta 9$ and $\Delta 12$ acyl-lipid desaturases of *Spirulina platensis* in *Escherichia coli*." Poster presentation at the 12th annual meeting of the Thai Society for Biotechnology, November, 1-3, Kanchanaburi, Thailand.
- Deshniem, P., Paitoonrangsarid, K., Hongsthong, A., Phapugrangkul, P., Tanticharoen, M. and Cheevadhanarak, S. 2000. "Alteration of GLA content in *Spirulina platensis* strain C1 upon the change of temperature is controlled by the up- and down-expression of the *desD* gene for $\Delta 6$ desaturase." Poster presentation at the 12th Annual Meeting of the Thai Society for Biotechnology, November, 1-3, Kanchanaburi, Thailand.
- Naranong, S., Deshniem, P., Mungpakdee, S. and Cheevadhanarak, S. 2000. "Secondary structure and role of repetitive palindromic sequences at 3' end of the *desA* gene from *Spirulina platensis* C1." Poster presentation at the 12th Annual Meeting of the Thai Society for Biotechnology, November, 1-3, Kanchanaburi, Thailand.
- Phapugrangkul, P., Paitoonrangsarid, K., Hongsthong, A., Deshniem, P., Tanticharoen, M. and Cheevadhanarak, S. 2000. "Overexpression of $\Delta 6$ acyl-lipid desaturase of *Spirulina platensis* in *Escherichia coli*." Poster presentation at the 12th Annual Meeting of the Thai Society for Biotechnology, November, 1-3. Kanchanaburi, Thailand.
- Pongakarakun, S., Tanyongmaskul, C., Meechai, A., Deshniem, P., Cheevadhanarak, S. And Bhumiratana, S. 2000. "Metabolic flux analysis for GLA synthetic pathways in *Spirulina platensis*." Poster presentation at the 12th Annual Meeting of the Thai Society for Biotechnology, November, 1-3. Kanchanaburi, Thailand.
- Choothai, R., Bunnag, B., Hongsthong, A., Cheevadhanarak, S., Ruengjitchawalaya, M. and Tanticharoen, M. 2000. "Response of *Spirulina platensis* to high temperature." Poster presentation at the 12th annual meeting of the Thai Society for Biotechnology, November, 1-3, Kanchanaburi, Thailand.

Animal cell culture

- Pittayakhajornwut D., Poomputsa K. and Ponglikitmongkol M. 1999. "Screening for anti-ras and anti-mitotic activities from extracts of plant and microorganisms in Thailand." Poster presented at The 5th Asia-Pacific biochemical engineering conference and the 11th annual meeting of the Thai Society for Biotechnology, 5-18 November. Phuket Arcadia Hotel & Resort, Phuket, Thailand.
- Puewkoaw K., Punsod I., Poomputsa K., Malasit P. and Mekvichitsaeng P. 1999. "Production of recombinant dengue E and NS1 proteins using baculovirus-insect cell expression system." Poster presented at the 5th Asia-Pacific biochemical engineering Conference and the 11th Annual Meeting of the Thai Society for Biotechnology, 5-18 November. Phuket Arcadia Hotel & Resort, Phuket, Thailand.
- Poomputsa K., 1999. "Protein expression in baculovirus system," Oral presented at workshop on heterologous protein expression in prokaryote system, 17-21 Aug, 1999., National Center for Genetic engineering and Biotechnology, Bangkok. Effect of temperature on Baculovirus production in insect cell culture, Poster presented at the 12th Annual meeting of the Thai Society for Biotechnology, 1-3 Nov, 2000, Felix hotel, Kanchanaburi, Thailand.
- Puewkoaw, K., Poomputsa, K. and Mekvichitsaeng, P. 2000, "Purification and characterization of recombinant dengue viral NS1 protein from baculovirus expression vector system (BEVS)." Poster presented at the 12th Annual Meeting of the Thai Society for Biotechnology, 1-3 November, Felix Hotel, Kanchanaburi, Thailand.

- Hayeeawama, J., Poomputsa, K. and Mekvichitsaeng, P. 2000. "Effect of temperature on baculovirus production in insect cell culture," Poster presented at the 12th annual meeting of the Thai Society for Biotechnology, 1-3 November. Felix hotel, Kanchanaburi, Thailand.
- Owatworakit, A., Poomputsa, K. and Mekvichitsaeng, P. 2000. "Expression of recombinant dengue envelope protein in *Bombyx mori* cell." Poster presented at the 12th annual meeting of the Thai Society for Biotechnology, 1-3 November, Felix hotel, Kanchanaburi, Thailand.
- Sotasan, S., Poomputsa, K. and Mekvichitsaeng, P. 2000. "Optimization of recombinant dengue envelope protein production in insect cell culture." Poster presented at the 12th Annual meeting of the Thai Society for Biotechnology, 1-3 November, Felix hotel, Kanchanaburi, Thailand.
- Lertwattanavanlee, L., Pimsmarn, J. and Mekvichitsaeng, P. 2000. "Kinetic and scale up of *Acetobacter xylinum* in batch process." Poster presented at the 12th Annual Meeting of the Thai Society for Biotechnology, 1-3 Nov., Felix Hotel, Kanchanaburi, Thailand.
- Posayapisit, N., Poomputsa, K., Mekvichitsaeng, P. and Techkarnjnaruk, S., 2000. "Identification and characterization of a chitinase gene in the Thai- isolated *Helicoverpa armigera Nucleopolyhedrovirus*," Poster presented at the 12th annual meeting of the Thai Society for Biotechnology, 1-3 November., Felix Hotel, Kanchanaburi, Thailand.

Enzyme Technology Laboratory

- Ratanakhanokchai, K., Poonpium, P. and Kyu, K. L., 1999. "A cellulosome- type enzyme from anaerobic thermophilic *Bacteroides* sp. P-1. I. isolation and cultivation of microorganism and some properties of enzyme." In: Ohmiya, K., Sakka, K., Karita, S., Hayashi, K., Kobayashi, Y. and Kimura, T. (eds.) Genetics, biochemistry and ecology of cellulose degradation. UNI publishers Co., Ltd, Japan. p. 521-530.
- Ratanakhanokchai, K., Piyatheerawong, W. and Kyu, K. L. 2000., "Production and location of xylanolytic enzymes in alkaliphilic *Bacillus* sp. K-1." In: Yoshida, T., Seki, T., Matangkasombut, P., Ebor, R. V., Sukara, E., Karim, M. I. A. (eds.), Biotechnology for sustainable utilization of biological resources in the tropics. Proceeding of JSPS-NRCT/DOST/LIPI/VCC Joint Seminar, 22-24 November, 1999 at Penang, Malaysia. International Center for Biotechnology, Osaka University, Japan. Vol. 14, pp. 283-292.

Fermentation Technology Laboratory

- Isaka, M., Punya, J., Lertwerawat, Y., Tanticharoen, M., and Thebtaranonth, Y. 1999, "Antimalarial activity of macrocyclic trichothecenes isolated from the fungus *Myrothecium verrucaria*." Journal of Natural Products, 62(2), 329-331.
- Kittakoop, P., Punya, J., Lertwerawat, Y., Tanticharoen, M., and Thebtaranonth, Y. 1999. "Bioactive naphthoquinones from *Cordyceps unilateralis*." Phytochemistry, 52, 453-457.
- Lertwerawat, Y., Plaingam, N., Pongphanumaporn, P., Jaturapat, A., Tanticharoen, M. and Hywel Jones, N. 2000. "The physiological differences between *C. pseudomilitaris* and *C. militaris*." Journal of the National Research Council of Thailand, vol. 32(2).
- Isaka, M., Jaturapat, A., Kladwang, W., Punya, J., Lertwerawat, Y., Tanticharoen, M. and Thebtaranonth, Y. 2000. "Antiplasmodial compounds from the wood-decayed fungus *Xylaria* sp. BCC 1067." Planta Medica 66, 473-475.
- Plaingam, N., Au, D.W.T., Jones, E.B.G. and Dandusitapunth, Y. 2000. "Ultrastructure of conidial appendage ontogeny of the coelomyces *Chaetospermum camelliae*." Poster presentation at Symposium Tropical Mycology. Liverpool Johns Moores University, UK, 25-29 April.

- Plaingam, N., Jones, E.B.G. and Dandusitapunth, Y. 2000. "Ultrastructure of conidial appendage ontogeny of the 2 Coelomycetes *Chaetospermum camelliae* and *Pestalotiopsis sp.*" Poster presentation at Asian Mycological Congress 2000 (AMC 2000) in incorporating 2nd Asia-Pacific Mycological Conference on Biodiversity and Biotechnology., at The University of Hong Kong, Hong Kong, 9-13 July.
- Srikitikulchai, P., Jones, E.B.G. and Dandusitapunth, Y., Tanticharoen, M. 2000. "Qualitative estimation of lignocellulose breakdown by selected tropical xylariaceous." Poster presentation at "Asian Mycological Congress 2000 (AMC 2000) in incorporating 2nd Asia-Pacific Mycological Conference on Biodiversity and Biotechnology" at The University of Hong Kong, Hong Kong, 9-13 July.
- Luttisungneon, P. Hywel-Jones, N.L., Dandusitapunth, Y. and Tanticharoen, M. 2000. "A study of the morphology, physiology and fatty acid profiles of *Aschersonia* for the identification of closely related fungal taxa." Poster presentation at Asian Mycological Congress 2000 (AMC 2000) in incorporating 2nd Asia-Pacific Mycological Conference on Biodiversity and Biotechnology at The University of Hong Kong, Hong Kong, 9-13 July.
- Wittayaanumas, S., Dandusitapunth, Y., Pongtanya, P. and Tanticharoen M. 2000. "Increase biomass of *Aspergillus oryzae* U1521 in submerged fermentation for higher alkaline protease production." Poster presentation at The 12th Annual Meeting of the Thai Society of Biotechnology, Biotechnology : Impacts and Trends in Biotechnology, 1-3 November, Felix Hotel, Kancharaburi, Thailand.
- Jirawatthanapong, S., Dandusitapunth, Y., and Tanticharoen, M. 2000 "The effect of inducer on alkaline protease production in *Aspergillus oryzae* U1521." Poster presentation at The 12th Annual Meeting of the Thai Society of Biotechnology, Biotechnology : Impacts and Trends in Biotechnology, 1-3 November, Felix Hotel, Kancharaburi, Thailand.
- Limpocharoenchai, S., Dandusitapunth, Y., Poomputsa, K. and Tanticharoen, M. 2000 "Effect of alkaline protease on lysis phenomenon in *Aspergillus oryzae* U1521." Poster presentation at The 12th Annual Meeting of the Thai Society for Biotechnology, Biotechnology: Impacts and Trends in Biotechnology, Meeting of the Thai Society of Biotechnology, Biotechnology: Impacts and Trends in Biotechnology, 1-3 November, Felix Hotel, Kancharaburi, Thailand.
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Molecular Biology and Gene Technology Laboratory

- Laoteng, K., Anjard, C., Rachadawong, S., Tanticharoen, M., Maresca, B. and Cheevadhanarak, S. 1999. "*Mucor rouxii* $\Delta 9$ desaturase gene is transcriptionally regulated during cell growth and by low temperature." Mol. Cell Biol. Res. Commun.1: 36-43
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- Rueksomtawin, K., Pongchuachidthai, R., Tanticharoen, M. and Cheevadhanarak, S. 2000. "Isolation and characterization of mutants affecting expression of the fatty acid desaturase genes in *Mucor rouxii* ATCC24905." Poster presented at the 5th European conference on fungal genetics, March 25-29, Arcachon, France.
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- Tachaleat, A., Rueksomtawin, K., Techakarnjanaruk, S., and Cheevadhanark S., 2000. "Is your fungus is glowing green? Expression of GEP in *Aspergillus oryzae*." Poster presented at the 12th annual meeting of the Thai Society of Biotechnology, Biotechnology: impacts and trends, November 1-3, Felix Hotel, Kanchanaburi, Thailand.

Sensor Technology Laboratory

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- Sritongkam, P., Bunnak, B., Tantichareon, M. and Kirtikara, K. 2000. "Electrode for the detection of glutamate." Meeting at NECTEC.

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- Suriyawattanakul, L., Sritongkam, P., Surareungchai, W., Tanticharoen, M., and Kirtikara, K. 2000. “Measurement of BOD using a microbial sensor based on mixed microorganisms immobilized oxygen electrode: optimization and characterization” the 12th annual meeting of the Thai Society for Biotechnology, 1-3 November Kanchanaburi, Thailand.
- Phanthong, C., Worasing, S., Tasakorn, P., Surareungchai, W., and Somasundrum, M. 2000. “Synthesis of novel redox-active biocompatible polymer membranes for use in clinical biosensors” 12th annual meeting of the Thai Society for Biotechnology, 1-3 November, Kanchanaburi, Thailand.
- Thongnimit, N., Sritongkam, P., Surareungchai, W. Tanticharoen, M., and Kirtikara, K. 2000. “The production screen printed biosensor for use in biomedical application.” 12th annual meeting of the Thai Society for Biotechnology, 1-3 November, Kanchanaburi, Thailand.

Solar Cell System and Energy Storage Research and Development Laboratory

- Kirtikara, K., Suwannakum, T., Pongchawee, D., Boonbumrung, U., Kumsri, S. 1999 “Exhibition on the occasion of his majesty the king 12nd cycle and 30 year project-encyclopedia: Solar reverse osmosis system.”, September 11-12, 1999 Mahisol convention hall, Thai Commercial Bank head office, Rachayotin junction, Ratchadapiset road.
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- Thepa, S., Tunmeesuk., D. 2000. “Performance analysis of a furnace for metal heating. “*Proceedings of the Research and Development Journal of The Engineering Institute of Thailand*, Volume 11, No.1, p67-79.

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- Nopharatana, A., Tanticharoen, M., Bhumiratana, S., and Chaiprasert, P. 1999. "Recent development of anaerobic digestion in Thailand agro-industry." New era of biochemical engineering and biotechnology (APBioChEC'99), The 5th Asia-Pacific biochemical engineering conference 1999 and The 11th annual meeting of the Thai society for biotechnology, 15-18 November, Thailand.
- Panichnumsin, P., Payungwong, C., Chaiprasert, P., Tanticharoen, M. and Bhumiratana, S. 1999. "Interaction of organic acid bacteria in biogas production: A modeling of synergism and/or competition." New era of biochemical engineering and biotechnology (APBioChEC'99), The 5th Asia-Pacific biochemical engineering conference 1999 and The 11th annual meeting of the Thai society for biotechnology, 15-18 November, Thailand.
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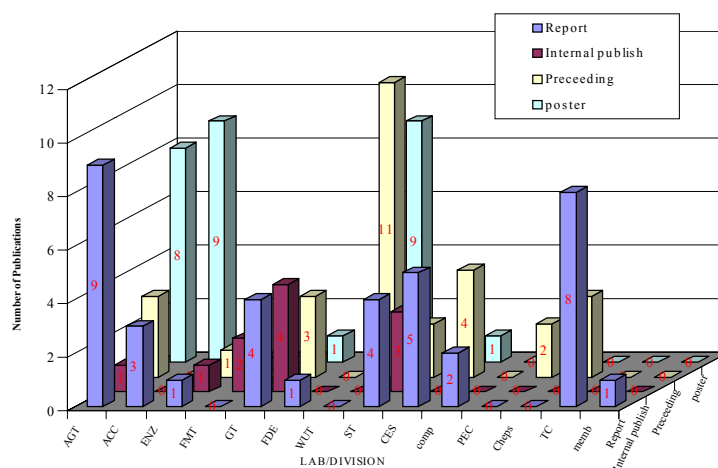
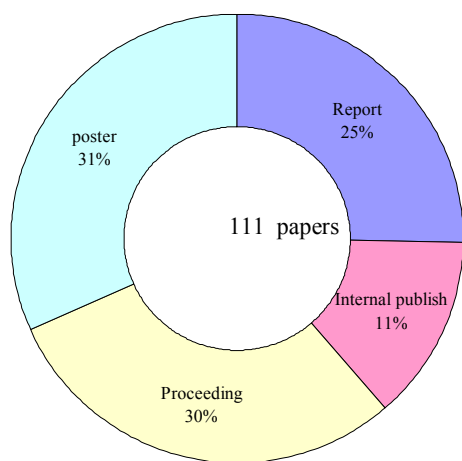
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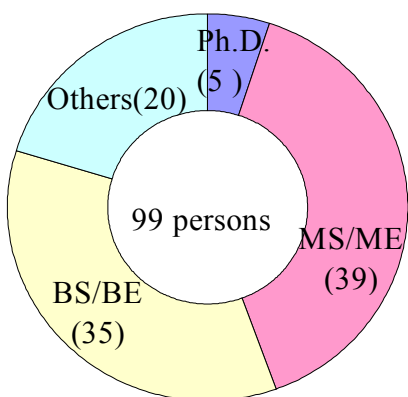
PDTI's reports and Publications in 1999/2000

PDTI's publication in 1999/2000

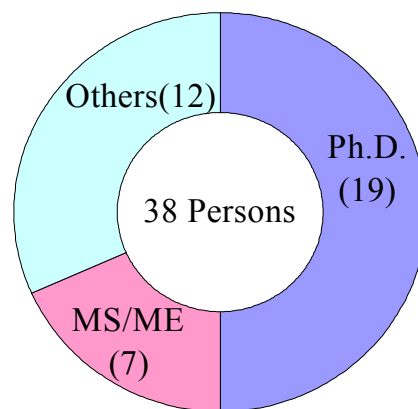
Staff

R&D Cluster has 137 staff including PDTI and SBT (School of Bioresource and Technology) which can be divided by educational qualification as follows :

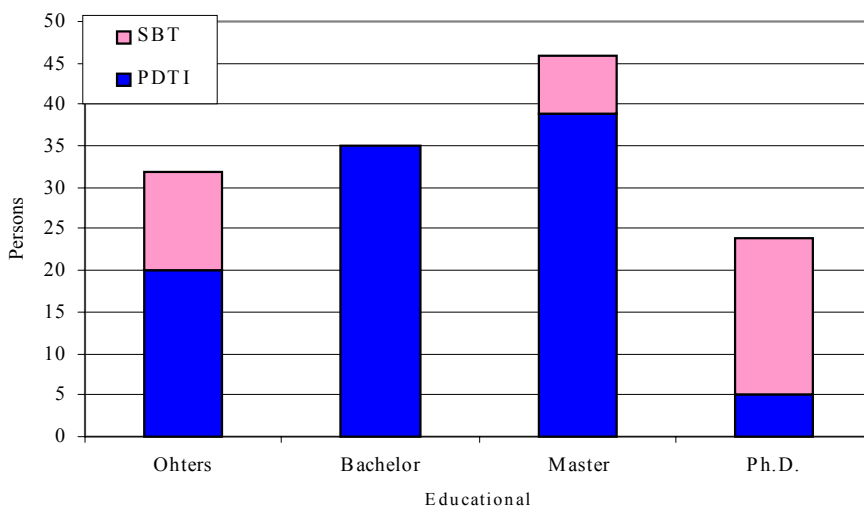
- ❖ Ph.D. in science/engineering 24 persons
- ❖ Master degree in science/engineering 46 persons
- ❖ Bachelor degree in science/engineering 35 persons
- ❖ Undergraduate (Others) 32 persons



PDTI's Staff



SBT's Staff



R&D Cluster staff in 1999/2000

Financial Statement and Data

Statement of Revenues and Expenses September 30, 1999 and 2000

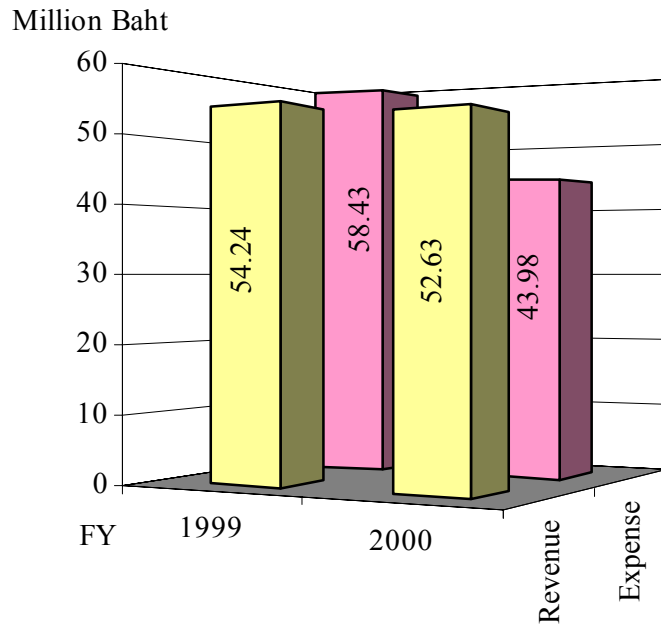
	1999	2000
REVENUES		
R&D	24,378,034.78	23,800,562.03
SERVICE	16,200,481.74	9,615,385.20
INTEREST INCOME	225,207.91	49,458.03
OTHERS	13,432,742.69	19,166,181.80
TOTAL REVENUES	54,236,467.12	52,631,587.06
LESS EXPENSES		
HONORARIUM/SALARY	28,016,965.41	24,583,340.67
MATERIALS	8,869,600.14	6,574,816.47
SUPPLIES	1,466,536.02	2,327,191.89
TRAVELLING	2,310,636.76	1,947,665.47
MAINTENANCE	535,218.53	340,487.15
PHOTOCOPYING	754,820.54	547,341.41
TRAINING	527,303.27	551,638.71
UTILITIES		8,650.00
POSTAGE	668,810.70	593,896.00
COMMUNICATION	71,918.01	95,889.77
INTERNET	11,312.10	26,611.79
ELECTRICITY/WATER	55,906.00	31,753.00
OTHER COST	1,845,120.66	1,482,676.67
SOCIAL REFUND	75,795.00	126,047.00
OVERHEAD AT KMUTT	1,194,283.27	680,013.92
TOTAL EXPENSES	46,404,226.41	39,918,019.92
EXCESS OF REVENUES OVER(UNDER)EXPENSES FOR THE YEAR	7,832,240.71	12,713,567.14
LESS DEPRECIATION	651,013.27	717,173.31
COMMULATIVE EXCESS OF REVENUES OVER (UNDER)EXPENSES END OF YEAR	7,181,227.44	11,996,393.83

Statement of Assets, Liabilities and Fund Balance

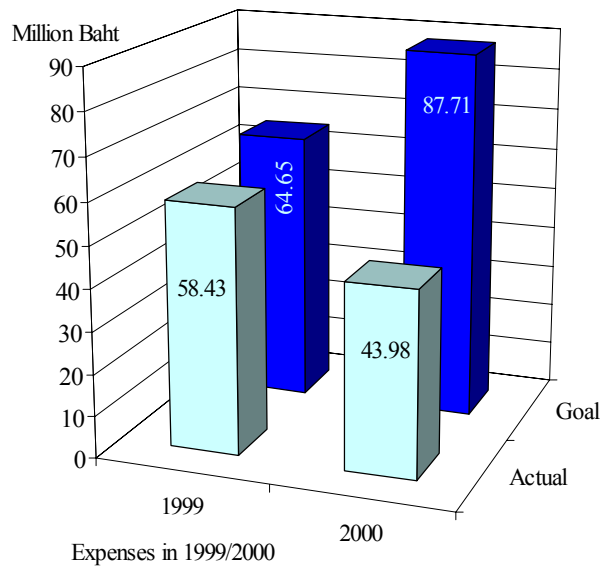
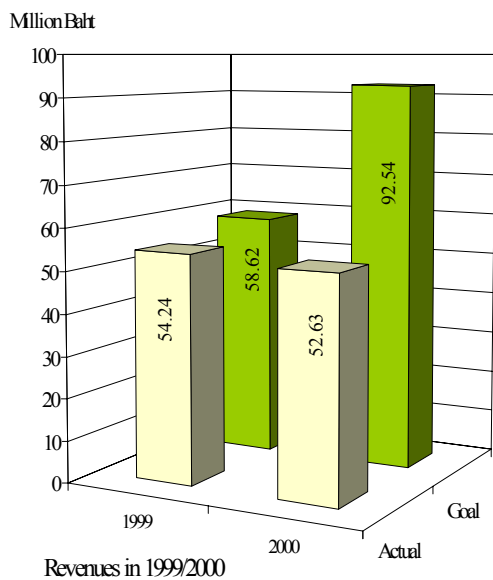
as of September 30, 1999 and 2000

	1999	2000
CURRENT ASSETS		
Cash at Bank - Current account	(1,052,002.23)	395,330.97
Cash at Bank - Saving account	11,733,134.95	15,862,280.07
Cash at Bank - Fixed account	641,023.81	674,215.83
Cash Other	5,857,531.38	6,467,260.09
Advance	2,501,662.54	4,157,847.24
Accrued Account Receivable	190,199.78	256,145.11
Prepaid Account	100,689.00	173,192.16
TOTAL CURRENT ASSETS	19,972,239.23	27,986,271.47
FIXED ASSETS		
Equipment	63,343,928.92	71,898,782.32
INTERNAL TRANSFER	3,310,282.37	6,382,419.62
TOTAL ASSETS (Baht)	86,626,450.52	106,267,473.41
LIABILITIES AND FUND BALANCE		
CURRENT LIABILITIES		
Post date cheques	-	2,413,628.25
Deferred Interest Income	1,204,931.89	1,305,690.88
Social Refund and Income Tax Payable	139,539.69	148,365.56
Accrued Expense	676,261.28	-
Deferred other	351,646.46	339,500.01
Credit other	1,421,528.87	(247,412.55)
Account Payable	344,429.25	9,271.92
TOTAL CURRENT LIABILITIES	4,138,337.44	3,969,044.07
INTERNAL TRANSFER	3,222,142.37	5,825,753.65
FUND BALANCE		
Fund Balance Foreward	43,973,849.48	51,113,561.92
Fund Balance - Equipment	28,110,893.79	33,362,719.94
Fund Carried Forward	7,181,227.44	11,996,393.83
TOTAL LIABILITIES AND FUND BALANCE (Baht)	86,626,450.52	106,267,473.41

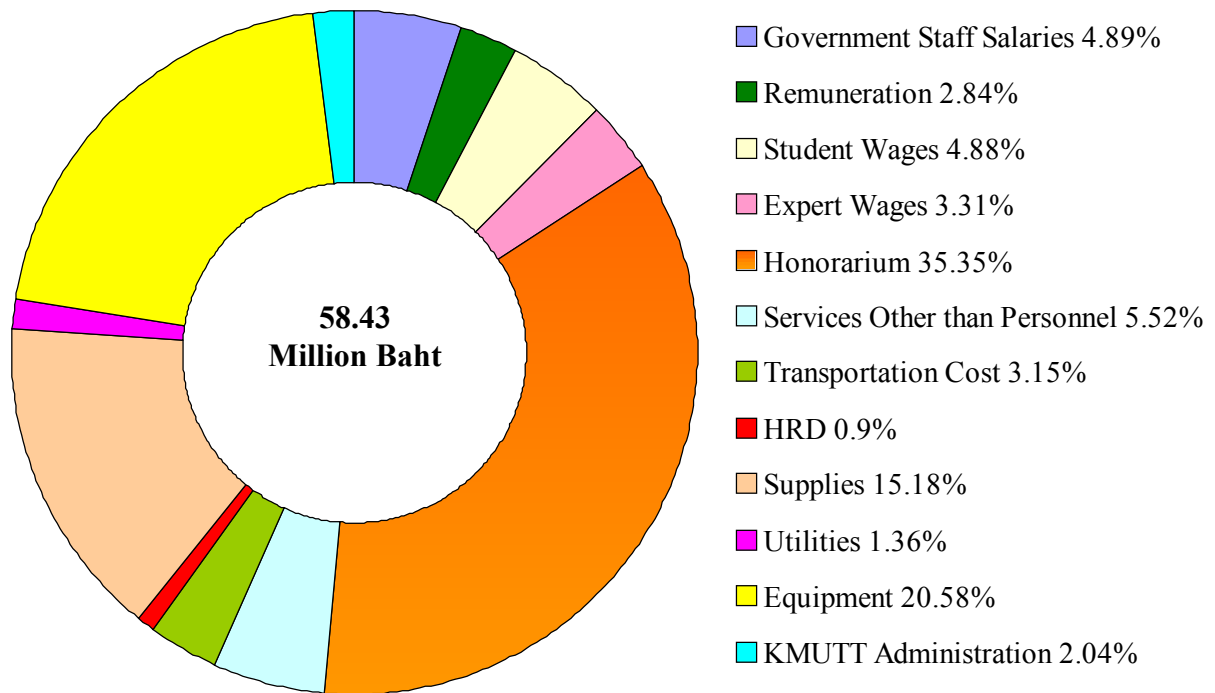
In 1999 and 2000, PDTI had a balance of revenues and expenses which are compared below:



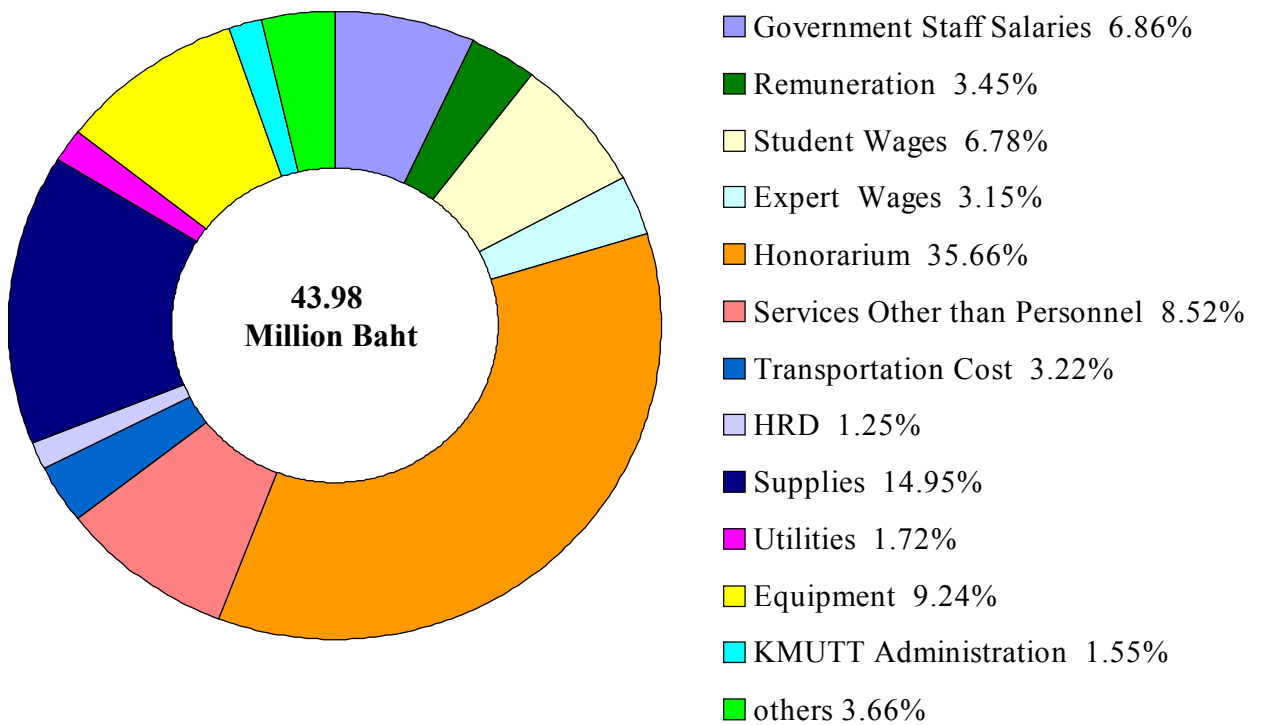
PDTI revenues and expenses in 1999/2000



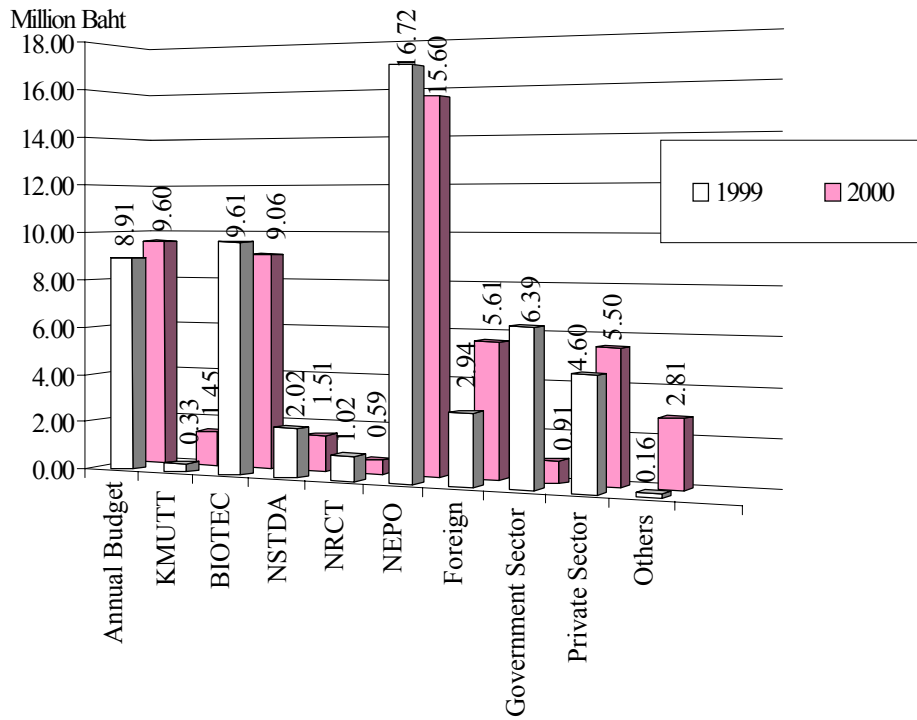
Remark : The expenses included assets and fund balances of 12.03 M฿ and 4.06 M฿ in 1999 and 2000, respectively.



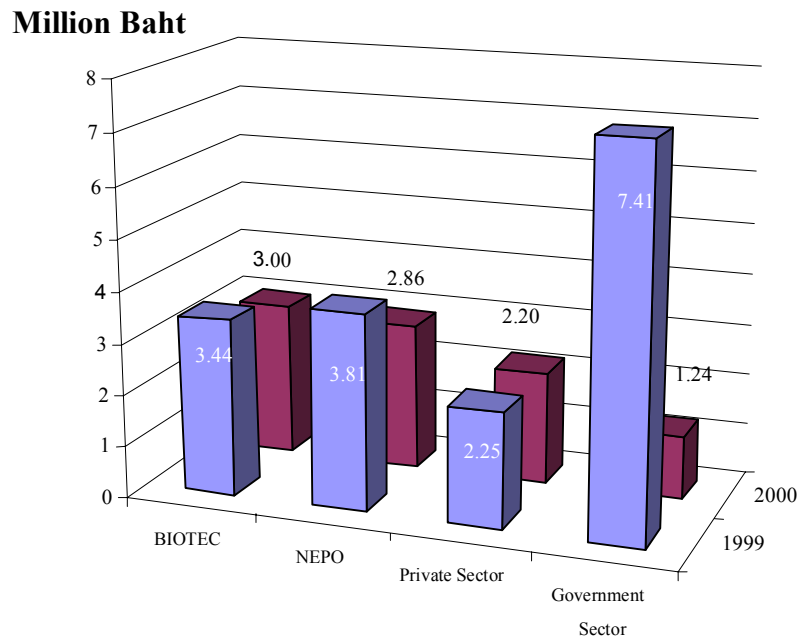
PDTI's Expenditure in 1999



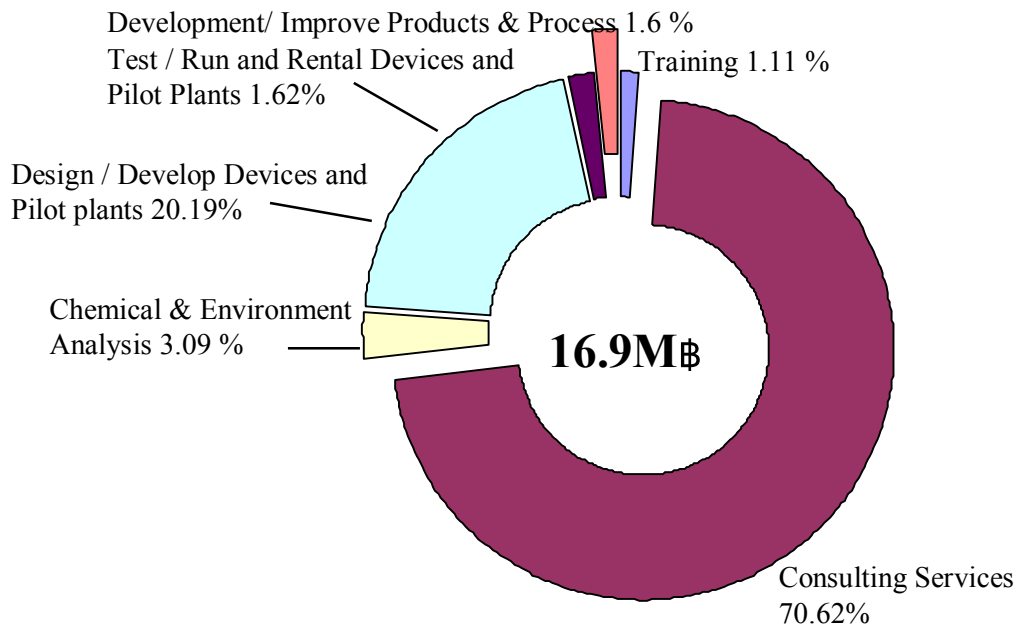
PDTI's Expenditure in 2000



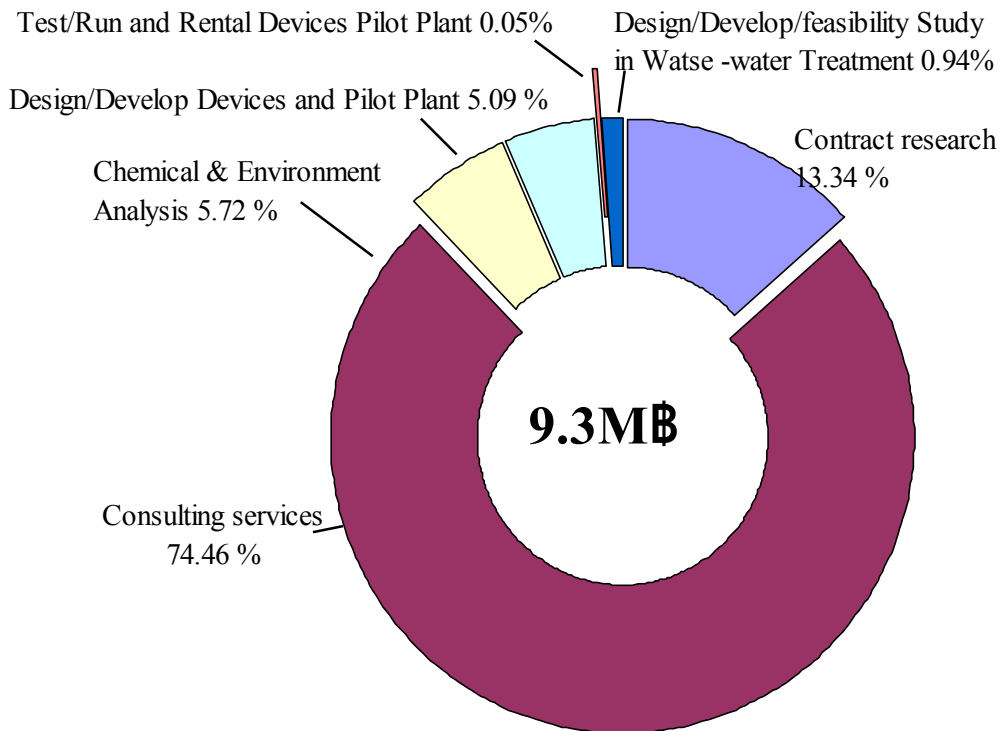
Granted Sources for PDTI's Research Projects in 1999/2000



Granted Sources for PDTI's Technology Services in 1999/2000



Type of PDTI's Services in 1999



Type of PDTI's Services in 2000