Chulabhorn Research Institute

INTERNATIONAL CENTRE FOR ENVIRONMENTAL AND INDUSTRIAL TOXICOLOGY (ICEIT)

CRI/ICEIT NEWSLETTER

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CRI's ICEIT has been designated as a "UNEP Centre of Excellence for Environmental and Industrial Toxicology".

Effects of Ethanol on the Developing Human Brain

Exposure of the human fetus to ethanol causes a neurotoxic syndrome termed fetal alcohol effects (FAE) or fetal alcohol syndrome (FAS). The most disabling features of FAE/FAS are neurobehavioral disturbances ranging from hyperactivity and learning disabilities to depression and psychosis. It is thought that the brain is particularly sensitive to the neurotoxic effects of ethanol during the period of synaptogenesis, also known as the brain growth spurt period, which occurs postnatally in rats but prenatally (during the last trimester of gestation) in humans. Thus, ethanol treatment of neonatal rats causes reproducible effects relevant to FAE/FAS, including a generalized loss of brain mass and a specific loss of cerebellar and hippocampal neurons. However, these circumscribed losses cannot account for the overall loss of brain mass, and mechanism(s) underlying ethanol's injurious effects on the developing brain remain a mystery.

Results of recent research show that exposure of the developing rat brain to ethanol for a period of hours during a specific developmental stage (synaptogenesis) predictably induces an apoptotic neurodegenerative reaction that deletes large numbers of neurons from several major regions of the developing brain. Of ethanol's many actions in the brain, it appears that two – its blocking action at *N*-methyl-D-aspartate (NMDA) glutamate receptors and its positive modulatory action at gamma-aminobutyric acid ($GABA_A$) receptors – are primarily responsible for its proapoptotic effects. In addition, the developmental period during which the immature brain is vulnerable to the proapoptotic action of NMDA antagonists, GABAergic agents, and ethanol is the same. For all three, it coincides with the synaptogenesis period.

In humans, as noted above, the period of synaptogenesis occurs prenatally, during the last 3 months of gestation. If a pregnant mother imbibes ethanolic beverages for several hours in a single drinking episode, she could expose her third-trimester fetus to blood ethanol levels equivalent to those required to trigger apoptotic neurodegeneration in the immature rat brain (200mg/dl lasting 4 hours or more).

From a clinical perspective, it is important to recognize that both NMDA antagonists and $GABA_A$ agonists are frequently used as sedatives, tranquilizers, anticonvulsants, or anesthetics in pediatric and/or obstetric medicine. These agents also are drugs of abuse. Because the human brain growth spurt spans not only the last trimester of pregnancy but several years after birth, the developing human brain may be exposed to these agents by medical professionals or by drug-abusing pregnant mothers.

Source: Science Vol. 287 No. 5455 February 2000.

Counting the Economic Cost of Illness Arising from Allergies

Allergies affect about 30 per cent of the population in the developed world. In Europe, hay fever afflicts between 10 and 20 per cent of the population and eczema between 10 and 12 per cent. Of the children who develop eczema, up to one in five will develop asthma in later life. In Britain, asthma affects between 10 and 15 per cent of children under 15, and about 5 per cent of adults – differences that partly reflect changes in the immune system throughout life. Disturbingly, the number of people with allergies has been increasing over the past 20 years.

This is well illustrated by the figures for asthma in Britain. In 1993, almost four times as many children (aged 5-14) were diagnosed with asthma as had been in 1979. For infants (aged 0-4), the increase was closer to fivefold.

Many factors have been implicated. The development of allergic disease depends on two things: genetics and the environment. Allergy tends to run in families – if both parents have allergies, the risk to their children is 75 per cent, but if just one parent suffers, the risk is 50 per cent. The genetic predisposition to allergic reactions is called **atopy**, and the activity of atopy genes is governed by the environment – which helps to explain why identical twins do not always share the same allergies. Numerous candidates for atopy genes are under investigation, with those for the most economically important allergic disease of all, asthma (estimated by the National Asthma Campaign to cost Britain £1 billion a year), receiving the most attention.

The environment and genes interact in complex ways to produce the symptoms of allergic disease. There are large differences worldwide in the prevalence of particular allergies, with the highest reports in Britain, Australia, New Zealand and Ireland, and the lowest in several eastern European countries, China and India. These patterns suggest that environmental factors related to Western living conditions are important. There is even tantalising evidence that exposure to pathogens in dirt during childhood may **train** the immune system and reduce the incidence of allergy in later life, which suggests that the Western obsession with hygiene may distort the immune response.

Nearly all allergic reactions are the result of an immune response called **type I immediate hypersensitivity**. Like the response to infection by pathogens, type I immediate hypersensitivity has two stages: **sensitisation**, when an allergen is first encountered, and **provocation**, which may follow weeks or even years later, when the allergen next appears.

Once past the epithelium, allergens are ingested by **antigen-presenting cells**. These cells process the allergen and present a fragment of it (an antigen) on their cell membranes. They do this by binding the allergen to the **class II major histocompatibility complex molecule, MHC II** for short. Another class of MHC molecule, **MHC I**, presents antigens that originate from within the cell, for instance fragments of a virus that has infected it.

The antigen-MHC II complex is recognised by a member of the next group of cells in the immune response, the lymphocytes. There are two types of lymphocyte: **B-cells** and **T-cells**. B-cells make **antibodies (immunoglobulins)**, which are responsible for immune responses targeted at specific antigens. But they can't mount this response until they have communicated with T helper cells (**TH** cells). There are two types of TH cell: **TH2** cells help to tackle infection by bacteria or parasitic worms and are central to the regulation of the allergic response, and **TH1** cells are more often involved with cell-mediated immunity – immune reactions particularly suited to dealing with cells infected with viruses.

The outcome of the interaction between antigen-presenting cells and T-cells dictates the subsequent course of events. At this point, in a non-allergic individual, no further action would be taken by the immune system. However, in the allergic individual, TH2 cells then instruct B-cells to produce immunoglobulins. There are five classes of immunoglobulin: **IgA, IgD, IgE, IgG** and **IgM**. Each is suited to different roles. IgE, for example, is produced in response to parasitic infection, but came to the attention of biologists in 1966 because of its role in allergy.

An area of growing interest is fetal and infant programming of immunity. The importance of the environment in the development of allergies has long been acknowledged, but the environment before birth has only recently been addressed. Following birth, the immune system continues to develop and the symptoms of allergy vary with age.

Since the fall of the Berlin Wall in 1989, the inhabitants of East Germany have seen a dramatic swing towards Western living conditions. This has been accompanied by a rise in the incidence of allergic diseases, but in a very age-dependent fashion. Studies have been carried out on children who lived in the former socialist system until they were three years old. Between 1991-92 and 1995-96 there was a significant increase in the prevalence of hay fever in these children, but there was no corresponding increase in the number of children with asthma. This suggests that there are important differences in the development of childhood asthma compared with hay fever.

There is mounting pressure to tackle the rising incidence of allergies. In 1997, the direct and indirect costs of allergies in Europe were estimated to be 35 billion dollars per year, and a pan-European response to the problem was initiated. The International Study of Asthma and Allergies in Childhood is investigating patterns of disease across Europe and the extent to which they relate to allergens, other environmental agents and factors such as previous infections and immunisations. The WHO has announced plans to halve the number of asthma-related deaths worldwide within five years (each year there are about 25,000 avoidable deaths from asthma).

At a time when the prevalence of allergic disorders is increasing everywhere, the hope is that further understanding of the complex interactions involved in their development will reveal new opportunities for prevention and treatment.

Source: New Scientist: Inside Science Vol. 165 No. 2222 January 2000.

Developments in the Treatment of Organophosphate Poisoning

Organophosphates (OPs) represent a class of highly toxic compounds that includes nerve agents, insecticides and pesticides. The biological effects of OPs are exerted by reversible or irreversible inhibition of acetylcholinesterase (AChE), which results in attenuation of the catalysed hydrolysis of acetylcholine (ACh) and excessive accumulation of extracellular ACh. The ensuing hyperactivation of ACh receptors results in various toxic effects including hypersecretions, convulsions, respiratory distress, coma and ultimately death.

The greatest concern of OP poisoning is the convulsive activity that is produced in susceptible brain areas as a result of elevated ACh levels. convulsive activity develops almost immediately after exposure to the OP and progresses rapidly to *status epilepticus,* causing profound neuronal damage.

A drug-induced decrease in the (evoked) release of ACh and glutamate shortly after acute OP poisoning could prevent or counteract convulsions and the occurrence of neuronal damage.

Recently, it was shown that the amount of ACh released from the neuromuscular junction after crotylsarin (*trans*-2-butenylmethyl-phosphonofluoridate) poisoning was decreased significantly by the oxime HI-6, a compound designed to reactivate OP-inhibited AChE. This effect was associated with recovery of neuromuscular transmission, whereas the AChE activity before and after HI-6 treatment did not differ and was -6% of control values. In soman (*O*-pinacolyl-methylphosphonylfluoridate)- or tabun-poisoned rhesus monkeys and soman-poisoned marmoset monkeys, which were all treated with HI-6, atropine and diazepam, survival of the animals was not associated with a significant recovery of AChE activity. In the latter experiments, survival might have been as a result of HI-6-induced reduction of ACh release, although protection could also have been caused by a reduction in the release of glutamate, or both ACh and glutamate. Various NMDA receptor channel blockers can attenuate or prevent convulsions; however, they also appear to possess lethal interactions with respiratory function in OP-poisoned animals. The latter phenomenon could be bypassed by inhibiting the release of glutamate, as an alternative approach to prevent overstimulation of NMDA receptors.

Thus, early inhibition of both ACh and glutamate release after OP poisoning could be very effective. Of the different drugs currently available (e.g. adenosine A_1 receptor agonists, choline uptake inhibitors, presynaptic muscarinic M_2 ACh receptor agonists, opioid receptor agonists and histamine H_3 receptor agonists) that can inhibit at least ACh release, adenosine A_1 receptor agonists are among the most promising candidates.

Source: TiPS Vol. 20 November 1999.

Ammonium Fertilization and Methanotroph Growth in Rice-paddy Ecosystems

Most of the methane in the Earth's atmosphere comes from biological processes, and rice paddies are one of the main sources. A large fraction of the methane produced in rice soils is consumed, however, being oxidized to carbon dioxide by methane-oxidizing bacteria (methanotrophs) in the soil, and so never makes it to the atmosphere. In upland soils, ammonium, which is formed naturally but is also a major constituent of nitrogen fertilizers, can inhibit methane oxidation and methanotroph growth. It has been a common assumption that this should occur in other ecosystems as well.

However, recent research has found that, in rice-paddy soils, ammonium actually stimulates methane oxidation and methanotroph growth. This phenomenon may dominate the overall response of methane cycling to fertilization in rice-paddy ecosystems.

In a rice paddy, the interactions of nitrogen fertilizer and the methane cycle are complex, with different effects occurring at different levels of organization. At the ecosystem and biochemical levels, fertilization would lead to increased methane emissions. However, at the level of the microbial community, fertilization can stimulate methane consumption and reduce its efflux from the paddy. Which set of effects dominates the overall methane efflux may vary between systems, but responses at the level of the microbial community have generally not been considered.

The new research highlights the importance of understanding ecological processes at the microbial-community level, a level of organization that previously has been little studied.

Source: Nature Vol. 403 January 2000.

A New Process to Check Carbon Emissions

Researchers at the Southern Illinois University in Carbondale have invented a process that effectively reverses the chemistry of burning. This process uses an enzyme that breaks down alcohol in the liver, producing methanol.

To make methanol, the liver enzyme and two bacterial enzymes are embedded in a sponge-like, glassy material, which is placed in water. When CO_2 is bubbled through the water, one of the bacterial enzymes, formate dehydrogenase, converts CO_2 into formic acid. Then another, formaldehyde dehydrogenase, transforms the formic acid into formaldehyde. Finally, alcohol dehydrogenase, which normally helps the liver to detoxify alcohol, completes the reaction by turning the formaldehyde into methanol.

Each of the enzyme reactions is reversible, so to drive the process in the right direction, the Illinois team adds a fourth, electron-donating ingredient called nicotinamide adenine dinucleotide (NADH).

The spongy glass, a substance called a silica sol-gel, is the key to the reaction's success. It contains millions of microscopic pores that act as mini-reactors. By mixing the enzymes with the liquid gel, they are successfully locked into the structure; when it solidifies, the enzymes get trapped. The enzymes can't get in or out, but the small reactants can. So CO_2 and NADH can get in, and methanol can diffuse out.

To make the process practical, the NADH will have to be recycled by constantly replenishing the electrons it feeds to the enzymes. This might be possible if the sol-gel is made from materials which conduct electricity and feed electrons back into the system.

The new process promises to be a highly efficient way to produce a fuel that can be used to power cars. Perhaps even more importantly, it could be used to recycle carbon and thus reduce the amount of the greenhouse gas carbon dioxide in the atmosphere.

Source: New Scientist Vol. 165 No. 2223 January 2000.

Widespread Opposition to Genetically Modified Products

In the last year, opposition to marketing of products made with or containing genetically modified organisms (GMOs) for food and feed uses has increased exponentially in Europe. Broad segments of the general public appear convinced that genetic engineering of these products is dangerous to health and to the environment. There has been much more indifference to the use of GMOs in the United States; however, the resistance in Europe appears to be spreading. Although the risks to health and the environment are far from certain, reports in the popular press regarding potential toxic effects of crops expressing proteins of *Bacillus thuringiensis* (Bt) on nontarget insects such as butterflies, increased induction of resistance in pests, as well as possible pleiotropic effects on gene expression have raised public anxiety. Increasing caution of scientific organizations like the British Medical Association, efficient networking of environmental groups, and public distrust have resulted in substantial rejection of agricultural products of the new technology.

This significant public opposition to the use of GMOs in many regions of the world clearly indicates that only by addressing environmental concerns and consumer demands with improved risk management (specifically monitoring) and appropriate labeling will it be possible for the industry to introduce GMOs into worldwide markets without significant resistance.

This makes it important for the biotechnology industry to accept the challenge of developing and regulating products that take into account diverse regional needs and concerns of consumers and environmental differences.

Source: Science Vol. 287 No. 5452 January 2000.

Beneficial Activities of Oestrogen

The steroid hormone oestrogen is now recognized to possess many actions. Oestrogen is sexually dimorphic; it is not restricted to the female as the male sex hormone testosterone, and other steroids that contain a 19-carbon atom structure (C-19 steroids), and can be converted locally to oestradiol in various tissues, including the brain, by an aromatase cytochrome P450 enzyme. The ovaries remain the main source of oestrogen; however, the existence of multiple sites of activity, including the brain, demonstrate that the activity of oestrogen extends far beyond the modulation of sex differentiation and sex function. Oestrogens might also act in a hormone-receptor-independent (non-genomic) manner.

Among the multiple neuromodulatory roles of oestrogen, the neuroprotective effects have raised increasing interest. This has been partly as a result of the beneficial effects of oestrogen replacement therapy in the prevention and treatment of age-related physiological changes, in general, and in neurodegenerative diseases, in particular. Yet, it is not proven which particular function of oestrogens (receptor-dependent versus receptor-independent) is mediating their neuroprotective effects in various disease states and in normal brain functions. The data accumulated so far clearly show that oestrogen might have neuroprotective functions at various cellular levels: the membrane (e.g. by modulating neurotransmission), the cytoplasm (e.g. by acting as a free-radical scavenger and by cross-talking with intracellular signalling), and the nucleus (via the activation of nuclear oestrogen receptors). Although many neuromodulatory and neuroprotective effects of oestrogen have already been described, much work is still necessary to unravel the full picture of oestrogen's beneficial activities in the nervous system.

Source: TiPS Vol. 20 November 1999.

WASTE MANAGEMENT IN THE NUCLEAR AGE

The nuclear age has brought significant improvements in medicine and in electricity generation, but it has also led to some difficult waste-management problems. Indeed, one of the biggest challenges for science and engineering is to find a long-term solution to the problem posed by radioactive wastes, some of which are potentially hazardous for thousands of years.

At present, the method of choice in most countries for dealing with long-lived radioactive wastes is deep geological disposal in multibarrier containment systems. This method employs physical barriers, both man-made and natural, to contain the waste.

Essentially the waste is immobilised in steel or concrete drums, to produce waste packages, which in turn are held in a disposal vault excavated at depth at a suitable location. The waste packages will contain the radionuclides for a long time, but they are unlikely to remain intact for the timescales involved with some very long-lived radionuclides. This means that the engineered barriers must also limit the migration of radionuclides away from the repository when the waste package eventually degrades.

Engineered barriers are provided by the wasteform itself, the containers and any overpacks (additional packaging that is physically attached to the containers), the 'backfill' materials used to fill the excavated spaces of a repository, and by the construction features of the repository.

The natural barrier is provided by rocks and other geological formations that lie between the repository and the human environment. The geological formations can be grouped into three categories: hard basement rock, salt deposits and sedimentary deposits such as clay. Natural barriers must ensure a combination of sufficiently low flows of groundwater through the repository and, where necessary, sufficient retardation and ultimate dilution of any radionuclides that escape. Altogether, the containment system holds the waste long enough so that radioactive decay removes many of the radionuclides, and reduces substantially the concentrations of others reaching the surface.

Programs to support disposal in deep geological repositories are well advanced in a number of countries, including Canada, Finland, France, Sweden, Switzerland, Belgium, Spain, Germany, Japan and the U.S.

The United Kingdom has significant quantities of radioactive waste and the waste management policy established in 1995 is currently under review. This review will determine whether geological disposal will be pursued in the United Kingdom.

The former Soviet Union had an extensive nuclear program and a different strategy to those of Western powers for disposing of nuclear wastes was developed. Since the 1950s, liquid reprocessing wastes have been injected into deep confined aquifers in sedimentary strata at depths of 400-1500m. A number of repository concepts for the disposal of solid high-level waste and spent fuel are still being considered in Russia. These include disposal in granite, salt, clays and permafrost.

In addition to the major international effort to establish deep geological disposal facilities and, in some countries such as France, to research long-term storage at or near the surface, another approach to waste management is being investigated. This involves "partitioning and transmutation" of the radioactive materials in the wastes. Here, the individual radionuclides are separated out of wastes and then transmuted, by exposure to high-energy nuclear particles, into isotopes of elements that are either non-radioactive or have shorter decay half-lives than the original radionuclide.

Current thinking is that partitioning and transmutation should be seen as complementary to a long-term management option such as geological disposal, with potential for reducing the quantities of some problematic radionuclides when these are concentrated in small volumes of relatively homogeneous wastes.

With much nuclear waste currently being stored in sites around the world pending a long-term solution, deep geological disposal is set to play an important role. Placing wastes in a stable underground excavation meets the modern requirements of sustainability and intergenerational equity. In other words, the responsible management of the wastes is a matter for those who have benefited from their production and not a problem that should be passed on to future generations.

Source: Chemistry & Industry 15 November 1999.

The Effect of Pesticide Exposure and Fertilization Rates in Males – an in vitro Study

Pesticides are widely used throughout the world and there is growing concern that certain of these chemicals can adversely affect male reproductive function. However, regulation of new pesticides is based mainly on animal models since data from human studies is extremely limited.

Recently, a study was carried out in the Netherlands investigating the effect of paternal pesticide exposure on the fertilizing ability among 836 couples who sought *in-vitro* fertilization treatment between 1991 and 1998. Of the total population of the study, 652 completed a questionnaire on occupational and life style factors over the treatment period, and 184 participated in an ongoing case-control study on occupational exposures and semen quality before enrolling on the *in vitro* fertilization program. A detailed assessment was made for exposure to organic solvents, metal dust or fumes, welding fumes, and pesticides. The 20 males potentially exposed to pesticides were asked to provide additional information concerning the source of exposure. Of these, 7 individuals were classified as moderately exposed and 7 as highly exposed to pesticides.

The study found that fertilization rates were significantly decreased for couples with male partners occupationally exposed to pesticides. Additional adjustment for paternal or maternal smoking habits, caffeine use, alcohol consumption, or other occupational exposures had little effect on the observed associations.

The results suggest that paternal pesticide exposure decreases the sperm fertilizing ability *in vitro*.

Source: The Lancet Vol. 354 August 7, 1999.

Post Graduate Education in
ENVIRONMENTAL TOXICOLOGY TECHNOLOGY AND MANAGEMENT

Joint Program Between

Chulabhorn Research Institute
Mahidol University and
Asian Institute of Technology

Chulabhorn Research Institute (CRI)

The Chulabhorn Research Institute is an autonomous, multidisciplinary institute which receives major financial support from the Royal Thai Government through the Ministry of University Affairs. The Council of Ministers approved the establishment of CRI on December 1, 1987. CRI focuses its activities on four major areas namely, research; education and training; scientific exchange; and special activities. Priority research areas are:-

- Natural Products, Medicinal Chemistry and Organic Synthesis
- Environmental Toxicology
- Biomedical Research
- Biotechnology

CRI has a strong research program as well as educational and training programs that include both short-term and post graduate training in Environmental and Industrial Toxicology. The institute has been designated a UNEP Center of Excellence for Environmental and Industrial Toxicology.

Mahidol University (MU)

Mahidol University originated from Siriraj Hospital which was founded by King Rama V in 1889 as the first teaching hospital in Thailand. The University itself was established in 1943 under the name University of Medical Sciences. It integrated several existing medical institutions, including Siriraj Hospital, into a single academic body to better serve the needs of the country. In 1969, the University was again reorganized, awarded a new charter and renamed Mahidol University. At present, the University has three campuses, and thirteen faculties. It provides programs leading to bachelor's degrees and certificates in basic health sciences, and to M.Sc. and Ph.D. degrees in basic and health sciences, in the humanities and in the social sciences.

Asian Institute of Technology (AIT)

The Asian Institute of Technology is an autonomous non-profit, international and co-educational post graduate institute located in Pathumthani Province, 40 km north of Bangkok. The Institute originated in 1959 to help meet the growing need for advanced engineering education in Asia. Its programs of study lead to the academic degrees of Diploma, Master or Doctor, or to the award of the Institute's Certificate. The Institute's regular academic and professional education is offered by its four units namely, the School of Advanced Technology; the School of Civil Engineering; the School of Environment, Resources and Development, and the School of Management. AIT seeks the integration of technology, planning and management, with constant attention to environmental and socio-economic considerations.

This post graduate program on Environmental Toxicology, Technology and Management which has been designed by CRI together with faculty members of AIT and a team of international experts was launched in January 1999. The design of the program is based on the recognition that in developing countries there is a severe shortage of qualified and trained personnel in both government and industry needed for policy/decision making, management and research focused on toxic chemicals and hazardous waste treatment, so as to cope with rapid industrialization. It is also evident that effective management of toxic chemicals in developing countries requires technical and management personnel with a broad background knowledge in both health science and environmental engineering and management.

This innovative, multi-disciplinary inter-university program is a combination of toxicology and other related toxicology health sciences, biotechnology and environmental engineering designed to train human resources capable of dealing with toxic chemicals with international perspectives as well as conducting research and development in the areas of environmental/industrial toxicology, hazardous waste treatment and environmental management.

Graduates of this professional degree program will have the opportunity to familiarize themselves with global and international issues associated with chemicals and hazardous wastes and the current strategies to manage and solve problems through the teaching of international experts from North America, European Union, Asia and international organizations who will join the program as visiting professors.

Master's Degree Program: January is the normal term of admission and entry annually to the five-term (20 months) Master's degree program. Students can either complete a program of coursework of 55 credits, including an independent research study of 12 credits, or a program of coursework of a minimum of 30 credits, and a research thesis.

Doctoral Program: Doctoral degree students are given flexible entry timing and are required to complete a minimum of 18 credits of coursework, of which not more than 6 credits are earned from special studies. Students must have taken their advancement to candidacy not later than the end of their third term of study, and completed all the requirements for the Doctor's degree within five years of advancement.

Curriculum

The curriculum consists of three types of courses: prerequisite, core and elective.

Prerequisite courses: These are courses designed for those students who may need additional background in environmental science. They are:

- Integrated Life Science
- Biochemistry
- Statistics
- Biology or Life Sciences

Core courses: These are fundamental courses which provide students a common background in environmental toxicology, technology and management. All Master's students should complete these courses. They include:

- Principles of Toxicology
- Principles of Environmental Management
- Environmental Toxicology
- Environmental Health Risk Assessment and Management
- Sampling Design
- Industrial Pollution Abatement and Management
- Health, Development and Environment
- Hazardous Waste Technology and Management
- Environmental Economics and Legislation

Elective courses: Students can choose from the following elective courses either as listed below or from other fields of study in AIT. Elective courses under the ETT&M field of study are:

- Environmental Microbiology (+ laboratory)
- Advanced Microbial Technology (+ laboratory)
- Molecular Biology of Environmental Stress
- Seminar in Toxicology
- Environmental Chemistry
- Environmental Health and Sanitation
- Bioengineering and Environmental Health (Joint Massachusetts Institute of Technology-ETTM program course)

A wide range of more specialized course relevant to ETT&M students are offered by various academic programs such as:

- Agricultural and Aquatic System Program
- Bioprocess Technology Program
- Environmental Engineering Program
- Energy Technology Program
- Water Supply, Drainage and Sewage Engineering Program
- Urban Environmental Management Program

Support Facilities for Teaching and Research

Students enrolled in the CRI/MU/AIT inter-university program will get the opportunity to make use of the many well equipped and up-to-date laboratories, facilities and research stations. Examples of such facilities are listed below:

At CRI:

Research activities are organized into 10 laboratories e.g. specializing in chemistry, biomedical science, environmental toxicology and biotechnology.

At MU:

- Pilot Plant for Biotechnology
- Multidisciplinary Laboratories

At AIT:

- Environmental Engineering Laboratory
- Biotechnology Laboratory

Admission Requirements

To be eligible for admission to the Master's Degree Program a candidate must hold a bachelor degree (normally from a four-year program) or its equivalent preferably in Biological Sciences, Chemistry, Engineering, Natural Sciences, Medical Sciences, Agriculture or in a related field.

Candidates to the Doctoral Degree Program should hold a master's degree or its equivalent from an institution of good standing and should normally have a GPA of 3.50 at the master's level.

Financial Assistance

AIT offers some scholarships as supported by donor governments, foundations, and other international organizations including private firms and state enterprises. However, the number of such scholarships is quite limited and selection of awardees follows a highly competitive process.

Further Information

Please send your requests for further information and application forms to:

Office of Scientific Affairs
Chulabhorn Research Institute
Vibhavadee-Rangsit Highway, Bangkok 10210, Thailand
Tel: (66-2) 574-0622-33 ext. 1610 or (66-2) 574-0615
Fax: (66-2) 574-0616
CRI Homepage: <http//www.cri.or.th>

or

Toxicology Graduate Program
Office of the Dean
Faculty of Science
Mahidol University
Rama 6 Road, Bangkok 10400
Tel & Fax: 245-8387
MU Homepage:
<http//www.mahidol.ac.th>

or

The Dean, School of Environment, Resources and Development
Asian Institute of Technology
P.O. Box 4, Khlong Luang, Pathumthani 12120, Thailand
Tel: (66-2) 524-6069
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ANNOUNCEMENT

Chulabhorn Research Institute Training Workshop

Environmental & Health Risk Assessment and Risk Management of Toxic Chemicals

20-29 November 2000, Bangkok, Thailand

This course will be taught by a team of international experts as part of the Institute's UNDP supported program on Capacity Building in Environmental Toxicology and Technology and Management to Promote Sustainable Development in Asia and the Pacific.

Transfer of knowledge and explanation of techniques will be by means of plenary sessions and discussion followed by small group participation in selected case studies under the guidance of the team of experts.

The topic of *Health Risk Assessment* will focus on:

1. Concept and Process of Health Risk Assessment
2. Hazard Identification
3. Dose-Response Assessment
4. Exposure Assessment
5. Risk Characterisation
6. Environmental Guidelines/Standards
7. Risk Management and Reduction
8. Risk Perception and Communication
9. Examples of Application Fields: air pollution, waste incineration, and agricultural pesticides

With regard to the principles and practice of Environmental Risk Assessment, the following topics will be covered:

1. The Relationship between Risk Assessment and Decisions on Optimal Environmental Strategies
2. The Use of Evidence in Reasoning within Risk Assessment
3. Exposure Assessment in Complex Environments
4. Exposure-Response Assessment
5. Risk Characterization

Registration Fee US$650

Further information can be obtained from:

Office of Academic Affairs
Vibhavadee-Rangsit Highway,
Bangkok 10210, Thailand
Tel: (66-2) 574-0622-33 ext. 1610
Fax: (66-2) 574-0616, 247-1222

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