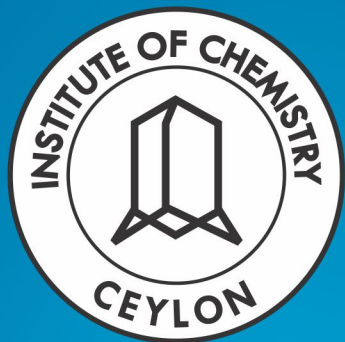


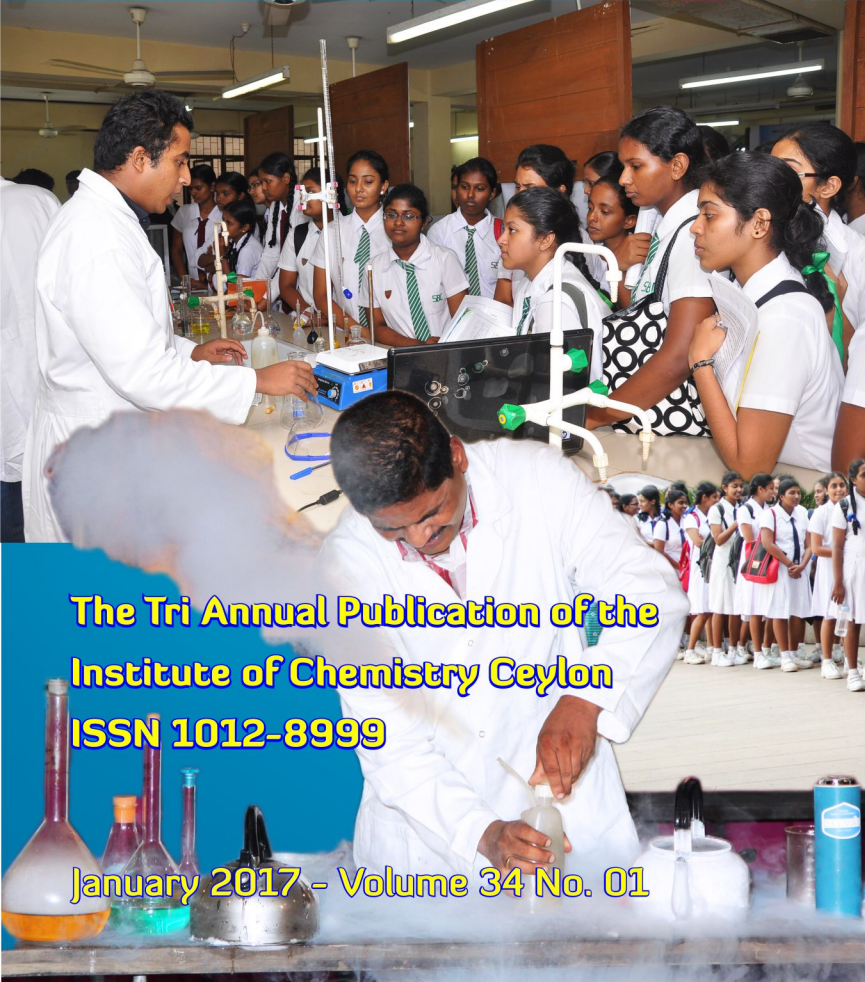
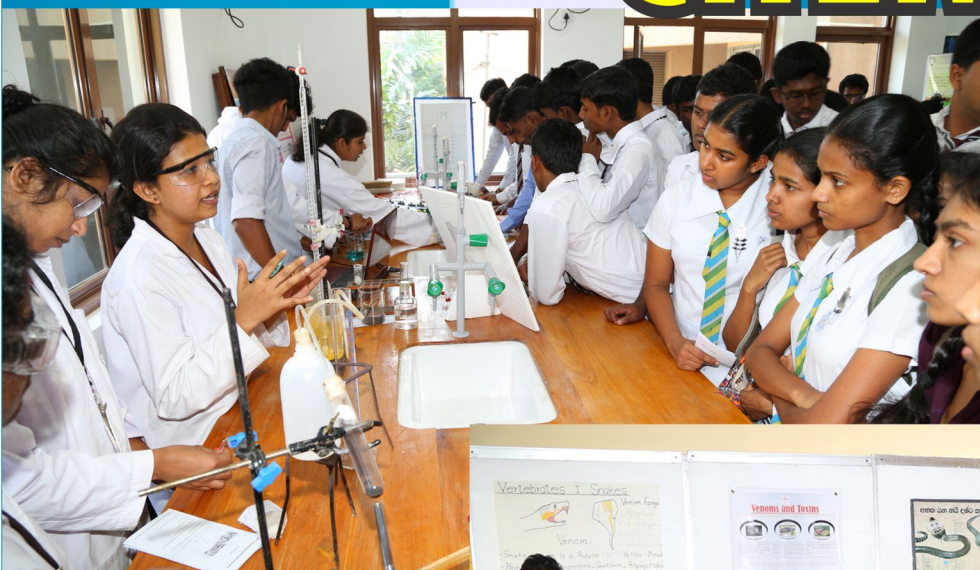


CHEMEX



CHEMISTRY

IN SRI LANKA



The Tri Annual Publication of the
Institute of Chemistry Ceylon
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Ninth Inaugural Professorial Lecture and Unveiling of Photographs of Two Distinguished Service Awardees 28th October 2016 at Adamantane House

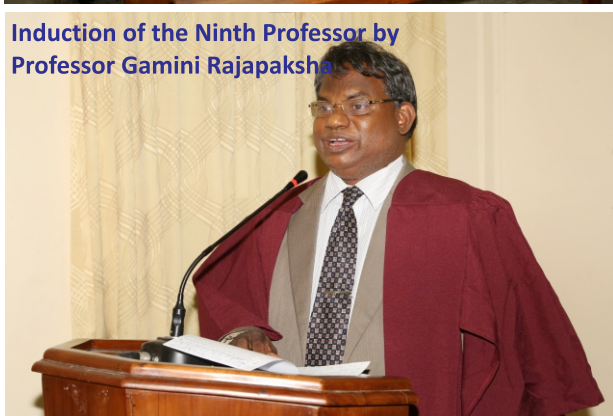


Head Table

**Welcome address by Hony. Rector,
Professor S P Deraniyagala**



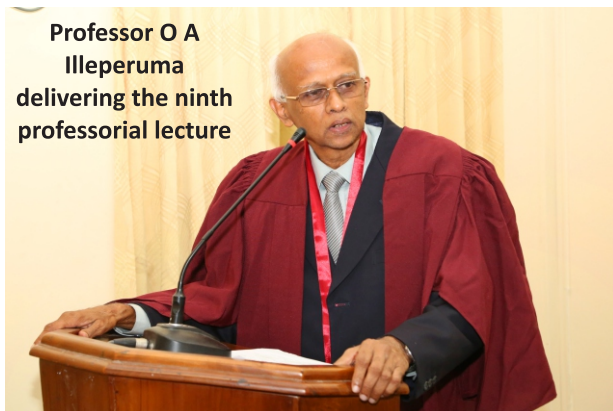
**Induction of the Ninth Professor by
Professor Gamini Rajapaksa**



**Mr. M R M Haniffa congratulates the Orator after
investing him with the Oration Medal**



**Professor O A
Illeperuma
delivering the ninth
professorial lecture**



**Concluding Remarks by Dean,
Professor P A Paranagama**



Distinguished Service Awardees - 2016



**Profssor
Tuley de Silva**

**Professor Upali
Samarajeewa**



Chemistry in Sri Lanka

ISSN 1012 - 8999

The Tri-Annual Publication of the Institute of Chemistry Ceylon

Founded in 1971, Incorporated by Act of Parliament No. 15 of 1972

Successor to the Chemical Society of Ceylon, founded on 25th January 1941

Vol. 34 No. 1

January 2017

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Theme for the year -

Role of Chemists for a Better Tomorrow

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Outline of our Institute

The Institute of Chemistry Ceylon is a professional body and a learned society founded in 1971 and incorporated by act of Parliament No. 15 of 1972. It is the successor to the Chemical Society of Ceylon which was founded in 1941. Over 50 years of existence in Sri Lanka makes it the oldest scientific body in the country.

The Institute has been established for the general advancement of the science and practice of Chemistry and for the enhancement of the status of the profession of Chemistry in Sri Lanka. The Institute represents all branches of the profession and its membership is accepted by the government of Sri Lanka (by establishment circular 234 of 9-3-77) for purposes of recruitment and promotion of chemists.

Corporate Membership

Full membership is referred to as corporate membership and consists of two grades: **Fellow (F.I.Chem.C.)** and **Member (M.I.Chem.C.)**

Application for non-corporate membership is entertained for four grades: **Associate (former Graduate) (A.I.Chem.C.)**, **Licentiate (L.I.Chem.C.)**, **Technician (Tech.I.Chem.C.)** and **Affiliate Member**.

Revision of Membership Regulation

All Special Degree Chemists can now apply directly to obtain **Associate (Graduate) Membership**. Three year B. Sc. Graduates (with an acceptable standard of Chemistry) can

- directly become **Licentiate**
- obtain corporate membership in a lesser number of years.

Tech.I.Chem.C.

Those who have passed the DLTC examination or LTCC examination or have obtained equivalent qualification and are engaged in the practice of Chemistry (or chemical sciences) acceptable to the Council are entitled to the designation **Tech.I.Chem.C.**

Members/Fellows are entitled to the designation of **Chartered Chemist (C.Chem.)** on establishment of a high level of competence and professionalism in the practice of chemistry and showing their commitment to maintain their expertise.

All corporate members (Members / Fellows) are entitled to vote and become Council/ Committee members whether Chartered Chemists or not.

Membership Applications

Any application for admission to the appropriate class of membership or for transfer should be made on the prescribed form available from the Institute Office.

Current Subscription Rates

Fees should be paid on 1st of July every year and will be in respect of the year commencing from 1st July to 30th June

Fellow	Rs. 1500
Member	Rs. 1500
Associate	Rs. 1200
Licentiate	Rs. 1000
Technician	Rs. 500
Affiliate	Rs. 1000
Membership for Life	Rs. 15000

Entrance Fee

All the grades	Rs. 1000
Processing Fees*	Rs. 500
Processing Fee for Chartered Chemist designation	Rs. 1000
Institutional Members	Rs. 2500

*per application for admission/transfer to any grade

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CHEMISTRY IN SRI LANKA

Chemistry in Sri Lanka is a tri-annual publication of the Institute of Chemistry Ceylon and is published in January, May and September of each year. It is circulated among the members of the Institute of Chemistry and students of the Graduateship/DLTC course and libraries. The publication has a wide circulation and more than 1000 copies are published. Award winning lectures, abstracts of communications to be presented at the annual sessions, review papers, activities of the institute, membership news are some of the items included in the magazine.

The editor invites from the membership the following items for publication in the next issue of the Chemistry in Sri Lanka which is due to be released in May 2017.

- Personal news of the members
 - Brief articles of topical interests
 - Forthcoming conferences, seminars and workshops
 - Latest text books and monographs of interest to chemists
- All publications will be subjected to approval of the 'Editorial and Publicity Committee' and the Council of the Institute of Chemistry Ceylon.*

Further, prospective career opportunities for chemists, could be advertised in Chemistry in Sri Lanka at a nominal payment. The editor welcomes from the members suggestions for improvement of the publication.

Provision of clean water towards a better tomorrow

Professor Hema M K K Pathirana, *C.Chem., F.I.Chem.C.*

Professor of Chemistry, Department of Chemistry, University of Ruhuna, Matara

“Water, water, everywhere; but how do we know what's in it” is the title of a lecture delivered by Dermot Diamond at an invited public lecture organized by the Royal Society of Chemistry in April 2014 in UK. This phrase is appropriate for the present status of water resources in Sri Lanka and therefore I decided to highlight our duty and the responsibility as chemists to develop chemistry based innovative technologies for conservation and management of water, targeting the availability of clean water in sufficient quantities to every citizen.

Sri Lanka is blessed with many water resources, but they are not evenly distributed across the country. Currently we are experiencing unusual long spells of droughts, heavy rain falls within short periods resulting destructive flash floods and contamination of certain fresh water systems due to sea water intrusion, and all these could be due to climate change. Extended droughts as well as flash floods affect water quality which can affect aquatic life as well as human health. Pollution of water sources due to anthropogenic activities such as release of untreated industrial waste, domestic sewage, excess usage of agrochemicals and high level of ground water abstraction are also reported frequently. Natural phenomena such as geological factors also have caused water pollution. Some of the water quality problems that have created serious controversy in Sri Lanka recently are industrial pollution in Kelani River, high levels of fluoride in ground water in Rajarata area and acidity of ground water at Rathupaswala.

Monitoring of quality of water in important water bodies in a regular basis and displaying the water quality data in the same manner the air quality data are displayed in certain cities in the country are important. This will educate general public and encourage relevant authorities to enforce environmental laws. Many rural communities use surface, ground or rain-water for drinking as it is or after boiling. Chemists can help these communities by developing cost-effective, user-friendly methods/test-kits to detect pollutant levels in such water. Development of water purification methods such as membrane technology or adsorbents, if possible by using locally available materials is also important. Roof top rain water harvesting and storm water capturing are currently practiced in the country as water conservation methods. It is necessary to introduce

affordable methods to monitor and improve the quality of such water.

Pollution of water due to agricultural runoff can be controlled by minimising excess usage of agrochemicals. To achieve this, it is essential to introduce the practice of application of fertilizers considering a comprehensive analytical report on nutrients already exists in the soil. Preparation of a zonal plan considering the nutrient levels of soil in agricultural land is important. Application of pesticides should be monitored in an effective manner. Pollution due to industrial effluents can be minimized by introducing recovery and reuse methods for nutrients and metal ions. Ancient wisdom in Sri Lanka has successfully used natural filtration processes such as bio-filtration and filtration through soils and sediments especially in cascade systems, probably using unwritten science they gathered from nature. Therefore, it is necessary to identify the chemical processes behind those natural processes and improve awareness on importance of implementing such traditional wisdom. For example, biofilters can be introduced to minimise contamination of water canals, cascade systems *etc.* due to run-off and also as a controlling method for contamination of fresh water due to sea water intrusion. This kind of natural purification systems would reduce the necessity for usage of intensive chemical treatments, which may later cause unforeseen problems.

Certain changes in attitudes of general public towards environment are essential in protecting this natural resource. I believe that only way to achieve this is by education. Curricula should be modified in order to disseminate knowledge in Green Chemistry, Cleaner Production, Chemistry related to natural purification processes, and chemistry for sustainability of ecosystems, *etc.* at secondary and tertiary levels of education. Such reforms in curricula would help to develop the minds of younger generation to take steps to minimise pollution during industry, agriculture and household activities.

Provision of clean water is important for good health. As responsible chemists of Sri Lanka, let us get together to achieve the important goal of making clean water equally accessible to every citizen of our motherland.

Role of Chemists for a Better Tomorrow

Dr. Poshitha Premarathne

President-Elect, Institute of Chemistry Ceylon

The world we live in faces serious unprecedented changes continually. These changes impact on the rising population world over and are compounded by realities of climate changes, our fragile environment and our ever depleting natural resources.

This in mind therefore there is a vital role that the chemical sciences will have to play over the coming decades in addressing the global challenges faced by our human society and other terrestrial and marine fauna and flora.

It would be the profound duty of an enthusiastic, innovative and motivated scientific community to undertake these challenges to face the future. Thus emerges the all important role the chemical scientists have to strive towards bringing a better tomorrow for us all.

A large amount of observations and views have been gathered from scientific findings over decades and the following text is an attempt, though not exclusive, to highlight a few key areas of enormous challenges that lay ahead for the scientific fraternity to solve. Challenges relating to and opportunities for chemical scientists are in sectors such as,

- Water – ensuring the drinking quality and sustainable management of water and pollutant control.
- Air – monitoring and improving air quality and its impact on climate changes and on contaminants and their management.
- Soil – enriching soil conditions, water retention /drainage improvement
- Energy – creating a sustainable environmentally friendly energy supply. Other areas such as biofuels, biopower, nuclear, hydrogen, solar, wind and water.
- Food – to create a secure, safe and environmentally friendly, diverse and affordable food supply
- Human health and medicines – improving and maintaining accessible health, disease prevention, hygiene and infection, diagnostics, drugs and therapies, prosthetics, personalized medicines, traditional medication, targeted drug delivery systems.
- Raw material and feedstocks – to create a sustainable feedstock from e-waste and landfills, biomass feedstock, recovered feedstock.

- Lifestyle and recreation – to create a comfortable, richer and varied lifestyle. Sporting technology, creative industries
- Buildings, towns and cities – green architecture, designing and building material, advance electronics, solar heating and lighting for domestic and municipal applications.

WATER

With population growth there is a greater demand on water supply. Be it for domestic use, agriculture or industry. Poor quality drinking water damages human health. Chemical sciences alongside engineering should play a role in sustainable management and distribution of clean, good quality water as a priority. This could be achieved from many avenues, such as adopting, principles of green chemistry, integrated pollution prevention and controlling industrial manufacture, in order to reduce waste, energy and water usage.

Household products and appliances must be designed to work effectively and efficiently with minimal usage of water and energy and possibly made of material that can be recycled subsequently. Efficient low maintenance protocols should be developed for industry and for agriculture systems with a view to the economized usage of water; its recycling and reuse capability.

Chemical sciences can develop energy efficient (possibly solar) desalination processes.

Develop low cost portable analyzers and treatment units for testing contaminated water.

Develop energy efficient point of used water purification and disinfection units using novel micro filtration membranes and other technologies e.g. novel synthetic ion exchange material, such as functionalized polystyrene beads conjugated with different groups for different ions, UV irradiation, catalytic and photochemical processes, ultra filtration, reverse osmosis *etc.*

Rain / gray water can be harvested and with appropriate localized treatment it can be used for secondary use.

Sewers collect billions of waste water daily. These sources have a wide range of contaminants, removal of which currently is energy intensive. The challenge for

chemical scientists is to make waste water treatment energy neutral as far as possible and to generate beneficial by-products including grades of re-usable water. Chemical sciences should also be aware of the impact of climate changes such as global warming have on the fate and behavior of contaminants and find solutions for them.

AIR QUALITY AND CLIMATE CHANGE

Increasing anthropogenic emissions, mainly due to human activities are affecting air quality and are contributing to climate change and human health. Chemical science has an important role to play in understanding the chemistry of the atmosphere and the impact of these emissions and devise methodologies to prevent further changes. According to climatology experts, in order to achieve this chemical sciences will need to,

- develop novel techniques to study reactive chemicals that occur in ultra-low concentrations in the atmosphere that affect air quality through there chemical changes, such as sub-micron particles; how aerosols form and change in the atmosphere.
- develop new low cost chemical sensors that could be deployed widespread for monitoring atmospheric gases
- engage geo-engineering solutions to modify earth's climate in response to rising greenhouse gas levels.
- develop new modelling methodologies to study and to treat any complex chemicals in atmosphere, both at regional and at much larger global levels.

ENERGY

A secure, sustainable energy supply is as essential (as is good quality water), for almost every aspect of our lives and it has to be achieved without causing adverse environmental impact. It has been forecast that global emissions would reach double the pre-industrial levels by 2050, with a consequent impact on our climate. At the same time the demand globally continues to rise with increasing population and expanding economies. Concomitantly there would be a rise in greenhouse emissions.

Potential opportunities are seen for chemical sciences to address these issues and some of these are presented in point form.

- Development in material chemistry for products suitable for superconductivity and for high temperature tolerance.
- Development of cheaper, better insulation material

from perhaps recyclables.

- Use of nano and other technologies including smart polymers to make components and structural material with enhanced strength to weight ratio.
- Develop more efficient lighting.
- Improve fuel economy with high performance catalysts and next generation fuels in energy conversion and storage sector
- Improve power and energy density.
- Decrease battery cycle times.
- Develop enzymatic synthesis of nanomaterials.
- Improve safety of devices – e.g. problems associated with overheating.
- Develop strategies for material re-cycling.
- Replace strategic material to ensure security of supply.

Fossil fuels – Current fossil fuel usage in the petroleum industry suggests that it is unsustainable and is associated with the production of greenhouse gases, which deplete the protective ozone layer. More efficient use of fossil fuels and their by-products is needed, however not at the expense of tarnishing the atmosphere.

- Continuous R&D in the extraction of and processing of crude oil.
- R&D for the option of converting CO₂ (as a feedstock) to useful chemicals.
- Further research into carbon capture and storage (CCS) technologies
- Improved catalysts for conversion and separation in the production of ultra-low sulfur fuels.
- Through physical chemistry applications, study and enhance oil recovery from oil-water-porous rock systems.
- Further R&D of clean coal tar technologies.
- Further R&D of natural gas processing.
- Develop improved gas purification processes.

Nuclear Energy - From fission and fusion technologies –This is a medium term solution for the energy crisis. There are technical challenges associated with safety, storage disposal and re-use of nuclear waste. Both technologies are nuclear reactions that produce heat energy, of which fission technology can be controlled in nuclear power reactors, whereas fusion technology, though less harmful and cleaner than the former, produces higher thermal energy than in fission type, but it is not easily controllable. If fusion energy can be harnessed, that would be a challenge for

the chemists. With that aim in view much research is focused on material science to develop material and strategies that could tolerate the extremely hot plasma temperatures created during nuclear fusion.

Alongside the generation of nuclear energy there are challenges and opportunities for chemists in,

- the study of physico-chemical effects of radiation on corrosion of polymers, latex products and on material fatigue in nuclear power generation stations.
- the study of aging properties of cement/concrete structures due to radiation effects and to develop enhanced materials to withstand such hazards, especially in intermediate storage facilities of nuclear waste.
- for nuclear power generation the use of lanthanide and actinides from a study of their chemical and nuclear properties.
- improved methods in separation technology of spent nuclear fuels i.e. of uranium, plutonium and other fission products.
- improved methods of decommissioning of nuclear plants and post operational clearing and cleaning of these said facilities.
- development of structural and engineering (building) materials to sustain extreme thermal and radiation effects in reactors.
- development of medium and long term storage of nuclear waste.
- the study of environmental chemistry in and around nuclear plants i.e. soil, water and air quality and research in to the development of any remedial protocols where needed.
- the development of improved detectors and hazard markers to monitor all aspects of our exposed environment and for nuclear power plants.

Solar energy – As imparted by the Sun has been seen to provide the earth with over 100,000 TW of energy, which is abundantly more than the global annual fossil fuel consumption rate. Harnessing this free sustainable clean energy for heating and electricity generation is an area for development and application for chemical sciences. Already there are many technologies that have been developed in harnessing solar energy, such as photo voltaic (PV), passive water heating and day lighting. Chemical sciences have a role to play in improving 'first', the 'Second' and 'Third' generation photo voltaic cells. A breakthrough is required in,

- silicon refining for lower cost and higher energy

PV systems.

- improved deposition on transparent conducting and other flexible substrates.
- dye sensitized solar cells.
- development of high efficiency concentrator photovoltaics (CPV).
- improved solar power plants to produce both solar power and hydrogen as a fuel for electricity generation.
- developing the next generation technologies using biological methods of generating and storing energy from light-mimicking photosynthesis. Artificial photosynthesis routes, if developed give sustainable supply of hydrogen (usable as a fuel) through electrolysis of water and develop a process to potentially reduce CO₂ from the atmosphere, which in turn can be transformed in to useful products.
- developing other photosynthetic organisms (algae and cyanobacteria) in the use of photo bioreactors for hydrogen production or for processing to biofuels and Biopower.
- improving the energy conversion and storage technologies, such as batteries, accumulators *etc.*

This list is by no means exhaustive or exclusive as there are many main stream and spin- off areas where R&D is active already, but still more can be done through chemical sciences.

AGRICULTURE AND FOOD

At a time when the world population is on the rise there will be a concomitant rise in demand for food and potable water. Limited land for agriculture and water availability is a constraint facing food production for a growing population. Therefore a sustainable increase in agricultural productivity has to be practiced. Various sub sections of agriculture, such as soil science, plant science, pest and weed control, irrigation, aquaculture, livestock management, effective farming *etc* are challenging areas, thus creating opportunities for chemical sciences.

1. In soil science an understanding of its structural properties, chemical and microbiological composition and its interaction with the various cultivars and with the environment is necessary.

- Mechanical properties of soil and mobility of water and nutrients within the soil. Study of soil, water, gases (methane, nitrous oxide), roots and other soil components should be monitored.
- Understanding the biochemistry of soil

ecosystems

- Developing methane fixing technologies (methane oxidation by bacteria-methanotrophs).
- Develop fertilizer formulations capable of effective nitrogen retention in soil and uptake into plants.
- Use of machinery and chemicals to compensate for the decline of farm workers and high cost of labour, both for land and soil preparation at pre and post harvesting phases.

2. Understanding plant science to increase crop yields

- Improved plant growth regulators.
- Develop secondary metabolites for food and industries (pharmaceutical, nutraceuticals, enzymes *etc.*).
- Nitrogen and water usage improvement.
- Using modern biotechnology, improve better components for biofuels.
- Crop defense technology and devising hazard warning biomarkers.

3. Pest and weed control- Agriculture faces losses in excess of 35% of productivity due to emerging resistant strains of pests and weeds.

- Formulations to improve existing actives and new high-potency more targeted agrochemicals with new modes of action (they have to be environmentally benign), ensuring a consistent, effective dose application at the right time and an effective quantity.
- Alternative pest control using pheromones, GM pesticides and weedicides, allelochemical and semiochemicals.
- Hydroponics.
- Reduce crop protection chemicals through GM strains of crops

4. Irrigation- Primarily be guided by the FAO “Irrigation Water Quality” document and venture into,

- develop simple analytical devices to check ‘at field’ water quality.
- using grey water in agriculture
- rain water harvesting and storage for agriculture.
- drip irrigation technology (targeted economized use of water).
- research into collecting spent water, fortifying with the used-up chemicals and pumping back for re-irrigation, thereby conserving good irrigation quality water. This has to be done within a closed loop of localized tank systems.

5. Aquaculture and livestock management

- Using algae and other media, develop aquaculture for food and industrial use.
- Develop new veterinary medicines and vaccines to treat old, new and emerging diseases, both in livestock and farmed fish and other food based marine organisms.
- Use of genetic engineering techniques.

6. Effective farming - In agronomy in general, to minimize inputs and maximize outputs.

- Develop in situ biosensors and systems to monitor soil and irrigation water quality, nutrient deficiencies *etc.*
- Optimizing crop ripening techniques
- Methods to improve quality and yields of crops
- Climate change parameter analysis for greenhouse emissions, sea water salinity *etc*
- Develop predictive models based on data analysis, for identifying changing conditions for agronomy, especially useful for planting new crops and crop protection.
- Developing effective engineering tools for farm practices e.g. grain drying, seed treatment and crop handling and its protection.

HEALTHY FOOD

To provide a secure, nutritious, safe and affordable food supply.

- Develop functionalized foods fortified with micro nutrients for specific health benefits.
- Develop new formulation technology for controlled release of macro- and micro nutrients and remove unhealthy contents in food.
- Develop diets for infants, adolescents and the develop formulations to increase nutritional content of food for sensory benefit and the use of pro-and prebiotics for health benefit.
- Using the glycaemic index understands the role of nutrition and in particular the role of glucose to formulate foods for type 2 diabetics.
- Target food composition for immune health.
- Through nutrigenomics and nutrigenetics develop specific foods for individual genotypes, bearing in mind their individual dietary needs and for protection against diseases and other medical conditions.
- Research into naturally occurring carcinogens like acrylamide and mutagenic compounds formed during cooking and the link between diet and cancer.

- Irradiation of foods to prevent food spoilage and to eradicate bacterial pathogens.
- To combat obesity and diabetes produce sugar replacements with natural low-calorie nutritious sweeteners.
- Study the prolonged exposure to food ingredients.
- Develop micro sensors for food packaging industry to detect and measure food quality and other parameters that would help in determining its shelf life.
- Using analytical chemistry, microanalytical techniques and advanced detection methods to screen for food allergens, chemicals, toxins, growth hormones, microbial contaminants and veterinary drug residues both in food and in packaging material.
- Development of natural food additives, natural colorants, preservatives and antioxidants for the food industry.

Much energy and other resources are required for food manufacturing processes, storage and distribution. Chemical sciences can contribute to the efficient management in optimizing these inputs, thus saving time and money spent on them. There are opportunities for chemical sciences to,

- improve process control to raise production standards and minimize variability, scale down and combine process steps (for energy saving strategies and minimizing production waste).
- replace existing refrigeration methods with super chilling and fast freezing technology.
- develop ambient storage technology for fresh produce.
- develop routes for making use of by-products of manufacture to reduce waste and recover value.
- develop new surface coatings for food processing work surfaces to minimize fouling and save on existing cleaning operations (which is time and energy consuming).
- extract valuable ingredients from food waste e.g. phytochemicals, enzymes, chitin, cellulose etc.
- polymer chemistry to develop new biodegradable, recyclable, microwavable and multifunctional packaging material e.g. (made from epoxides and CO₂), packaging thin films using e.g. corn starch, polylactic acid or cellulose feedstock which is able to withstand chilling, consumer handling, storage etc.

Whatever R&D is attempted in Sri Lanka, it is imperative to adhere strictly to food safety guidelines

as stipulated by the Food Act No 26 with its amendments, which formulates the legal framework for food safety in Sri Lanka.

HUMAN HEALTH

Towards a better tomorrow, chemical sciences can and will play a leading role, in Improving and maintaining accessible health, disease prevention, hygiene and infection, diagnostics, drugs and therapies, prosthetics, personalized medicines, traditional medication, targeted drug delivery systems *etc.* Some opportunities for development for the chemical scientists would be to,

- develop cost effective diagnostics, biomarkers, contrast agents and analytical tools for non-invasive diagnosis to be used in regular health checks.
- develop combined diagnostic and therapeutic devices to detect infection and respond appropriately (e.g. bacterial infections)
- focus on chemical genetics and develop treatment methodologies targeted at specific genotypes rather than on mass phenotypes (study an individual's genetic profile for diagnosis and design personalized treatment protocols)
- drug toxicity testing at cellular level employing toxicogenomics.
- prevent/control chronic diseases such as CKD, cancer, diabetes, obesity, arthritis, cardiovascular defects *etc.*
- design and develop drugs for common diseases (such as stated above) with less or no long term side effects and toxicity issues.
- through a study of chemical-physiology devise methods to modulate neural activity (neuron conduction) for treatment of brain degeneration diseases such as Alzheimer's, Parkinson's *etc.*
- bio-responsive drug delivery devices for cardiovascular, diabetics, asthma *etc.*
- develop methods for regenerative medicine through tissue engineering techniques, stem cell research and synthetic biology.
- develop smart polymers, nano-composites and other biocompatible material for implants, prosthetics, artificial tissues/organs, eye lenses, surgical equipment *etc.*
- development of new generation of clinically safe, sterilisable surface coatings, e.g. polymers, thermo-setting powder paints *etc.*
- improved pace makers.
- receptor binding studies and computational

modelling studies will help in understanding drug design and development.

There are other spheres of interest in addressing global challenges and innovations that is not included in this report. However it is worth mentioning few other areas of challenge with opportunities for chemical sciences such as, in the development of future cities and towns, ceramics and other construction materials, Mobility and public transport, public safety and security, household care products, sporting technology, sustainable electronics and textiles.

A renowned pharmacologist - Sir James Black once stated that, "Science is a gradual progression that requires building on the work of others".

This is an ongoing process and there are many scientists and technologists already engaged in development work in keeping with the theme "Role of Chemist for a better tomorrow". As new challenges are emerging, so are the opportunities created for Chemists.

~

Effects of major Micropollutants in Aquatic Ecosystem

Dr. Nishantha K. Kalutharage

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Introduction

Micropollutants are compounds which are found in the $\mu\text{g L}^{-1}$ or ng L^{-1} concentration range in the aquatic environment. They are considered to be potential threats to environmental ecosystems. Pesticides, PCBs, PAHs, flame retardants, perfluorinated compounds, pharmaceuticals, surfactants and personal care products are the major group of chemical compounds considered as micro-pollutants. The major routes to enter these compounds to the environments are runoff, wastewater discharge, sludge disposal and accidental spills.

Their bioavailability in environment will be determined by the processes such as distribution between different phases, biological and abiotic degradation. Role of these processes in micropollutants' fate depends on the physico-chemical properties of these compounds and the type of the environment (groundwater, surface water, sediment, etc.). As a result, different transformation reactions can take place, producing metabolites that often differ in their environmental behaviour and ecotoxicological properties from the parent compounds. Several effects of these compounds on aquatic organisms are known such as acute and chronic toxicity, endocrine disruption, bioaccumulation and biomagnifications.

The major categories of micropollutants are pesticides, pharmaceuticals, steroid hormones, perfluorinated compounds, surfactants and personal care products (PCP)) due to the great interest that has recently arisen for their occurrence in the environment.

Pesticides

Many different classes of pesticides are used, including chlorinated hydrocarbons, organophosphoric compounds, substituted ureas and triazines. The extensive use of these compounds resulted in serious environmental contamination problems worldwide and deleterious effects on humans and ecosystems (Table 1).

Pharmaceuticals

Pharmaceuticals are complex molecules with molecular weights ranging from 200-500/1000 Da with specific biological activity. A great number of pharmaceutical compounds are discharged to the environment after human and veterinary usage.

Among pharmaceuticals, non-steroidal anti-inflammatory drugs (NSAIDs), anticonvulsants, lipid regulators and antibiotics are often detected in the aquatic environment and they are considered as a potential group of environmental contaminants. Typical examples for this category are ibuprofen (IBF) and diclofenac (DCF) (Figure 1). Anticonvulsants are used in the treatment of epileptic seizures, such as carbamazepine (CBZ) which estimated to be consumed 1000 tons CBZ worldwide. Antibiotics are characterized by the great variety of substances such as penicillins, tetracyclines, sulfonamides and fluoroquinolones. Erythromycin is a macrolide antibiotic used as human and veterinary medicine, as well as in aquacultures.

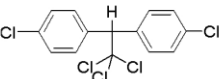
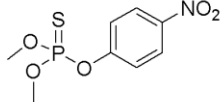
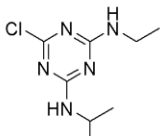
Pharmaceuticals are not completely metabolized by the human/animal body. As a result, they are excreted via urine and faeces as unchanged parent

compound and as metabolites or conjugates. Only 5% of erythromycin is excreted unchanged, while its major metabolite is Erythromycin-H₂O.

Municipal wastewater is the main source for the introduction of human pharmaceuticals and their metabolites in the environment. Hospital wastewater, wastewater from industries and landfill leachates may contain significant concentrations of these compounds.

Regarding veterinary drugs, they can directly or indirectly be released to the environment. Removal rates are variable between different Waster Water Treatment Systems (WWTSS) and different compounds, indicating that they depend on the chemical properties of the compound as well as the treatment process applied.

Table 1: Group of pesticides and their effects on environment

Insecticide Group	Example	Fate	Effect
Organochlorine Insecticides	 DDT	$t_{1/2}$ (up to 15 years). very slow elimination by most living organisms.	moderately toxic to mammals with LD ₅₀ values 113- 118 mg kg ⁻¹ . 0.6 mg kg ⁻¹ , cause egg shell thinning for the black duck.
Organophosphorous insecticides	 methyl parathion	short life (3 days). low water solubility. Can be degraded by oxidation, photodegradation, hydrolysis and adsorption. Biotic degradation can also be occurred.	Highly toxic to aquatic organisms. Can be transformed to more toxic and persistent metabolites. Methyl paraoxon, a photodegradation product of methyl parathion, found to be at least 10 times more toxic than the parent compound, regarding the inhibition on acetylcholinesterase activity.
Triazine Herbicides	 Atrazine	Persistent organic pollutant, $t_{1/2}$ 30-100 day. The biotic and abiotic transformations lead to the formation of metabolites by several mechanisms such as dehalogenation, dezalkylation and deamination.	Has been classified by WHO (2004) as a compound unlikely to present acute hazard in normal use. Slightly toxic to fish and other aquatic organisms and practically nontoxic to birds.

The main mechanisms affecting pharmaceuticals' removal in WWTSS are sorption and biodegradation. NSAIDs occurs as ions at neutral pH and they have little tendency of adsorption to the suspended solids in WWTSS. As a result, they remain in the dissolved phase and they disposed to the environment via the treated wastewater. On the other hand, basic pharmaceuticals (e.g. fluoroquinolone antibiotics) can be adsorbed to suspended solids and accumulated to the sludge. Regarding the role of biodegradation in WWTSS, this seems to be significant for some compounds (e.g. DCF), while it is of minor importance for others (e.g. CBZ).

Due to the partial removal of pharmaceuticals during WWTSS, significant concentrations of these

compounds are often detected in effluent wastewater, while lower concentrations are detected in surface water and groundwater. There are limited data for pharmaceuticals biodegradation in the aquatic environment.

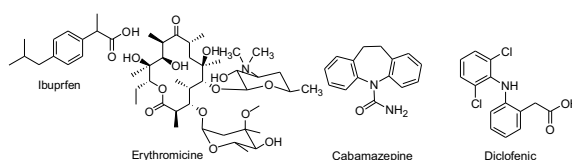


Figure 1: Chemical structures of selected pharmaceuticals.

Experiments with single compounds have shown that acute effects have been observed at much higher

concentrations (100–1000 times) than those usually determined in the aquatic environment. Ecotoxicity tests with antibiotics showed that combined toxicity of two antibiotics can lead to either synergistic, antagonistic, or additive effects.

On the other hand, chronic toxicity of pharmaceuticals is a matter of great interest, as several aquatic species are exposed to these compounds for their entire life cycle. Fewer data are available regarding the long-term effects of pharmaceuticals to aquatic organisms. Some of the pharmaceuticals seem to bioconcentrate and transport through food chain in other species.

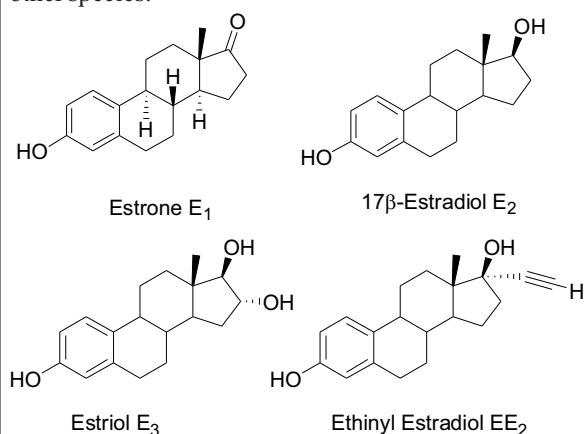


Figure 2: Molecular formula of estrogens: estrone (E₁), 17β-estradiol (E₂), estriol (E₃) and ethinylestradiol (EE₂).

Steroid Hormones

Steroid hormones are a group of compounds controlling endocrine and immune system. The major classes of natural hormones are estrogens (e.g. estradiol, estrone, estriol), androgens (e.g. progesterone, androstenedione), progestagens (e.g. progesterone) and corticoids (e.g. cortisol). Several synthetic hormones such as ethinylestradiol, mestranol, dexamethanose have also been produced apart from the aforementioned endogenous hormones.

Among these compounds, estrone (E₁), 17β-estradiol (E₂), estriol (E₃) and ethinylestradiol (EE₂) (Figure 2) have received more scientific attention since they consider to be the most important contributors to estrogenicity of treated wastewaters and surface waters. These compounds end up in the environment through wastewater effluents, untreated discharges, runoff of manure and sewage sludge reuse. Aquaculture is another important source of estrogens in the environment. Fish food additives containing hormones are directly added into the water. Therefore, these compounds can end up in the aquatic environment due

to overfeeding or loss of appetite of fish (a phenomenon normally observed in sick organisms).

Steroid hormones are excreted by humans. Estrogenic compounds have been detected in WWTSS and surface waters. Biodegradation of estrogens can be occurred in natural environments. The behaviour of E₂ and EE₂ in surface waters has been studied. Furthermore, bioaccumulation of these compounds by several organisms has been reported.

Steroid hormones are mainly known for their estrogenic action. These compounds present higher endocrine disrupting activity compared with other chemicals. They cause effects such as feminization of male fish and induction of vitellogenesis. Even at concentrations close to detection limits, steroids can cause deleterious effects. Few ng L⁻¹ of estradiols also led to induction of vitellogenin in juvenile rainbow trout. Steroids can cause adverse effects not only in fish but also in other organisms such as amphibians, reptiles or invertebrate. Humans are also affected by steroids. EE₂ has been linked with prostate cancer development. E₂ has also been related with diseases like breast cancer and endometriosis.

Surfactants and Personal Care Products

Surfactants are a group of synthetic organic compounds consisting of a polar head group and a nonpolar hydrocarbon tail. They are widely used in detergents, textiles, polymer, paper industries and their major classes are anionic (e.g. linear alkylbenzene sulphonates), cationic (e.g. quaternary ammonium compounds) and non-ionic surfactants (e.g. alkylphenol ethoxylates).

Among them, alkylphenoethoxylates (APEs) constitute a large portion of the surfactant market (production equal to 500.000 t in 1997). Significant scientific attention has been given during the last decade to nonylphenol ethoxylates (NPE) which represent almost 80% of the worldwide production of APEs. The microbial breakdown of NPEs results to the formation of nonylphenol (NP) (Figure 3) which is much more toxic than the parent compounds and induces estrogenic effects in several aquatic organisms.

Personal care products contain significant concentrations of synthetic organic chemicals such as antimicrobial disinfectants (e.g. triclosan, triclocarban), preservatives (e.g. methylparaben; ethylparaben, butylparaben, propylparaben) and sunscreen agents (e.g. benzophenone-3, octyl methoxycinnamate) which are introduced to the aquatic environment during regular use. Among them,

triclosan (TCS) and parabens (Figure 3) seem to be compounds of significant research and practical interest due to their wide use and toxicological properties. Parabens are used in more than 22000 cosmetic products, while approximately 350 tons of TCS are produced annually in Europe for commercial applications. The major source of all these compounds in the environment is the discharge of wastewater. The partial elimination of some of these substances (e.g. nonylphenol) during wastewater treatment or/and the disposal of untreated wastewater in the environment result to frequent detection of these compounds in surface waters.

NP is considered as an endocrine disruptor, effects of NP are very diverse and they are depended on the test organism (species, stage of development) and the characteristics of the environment.

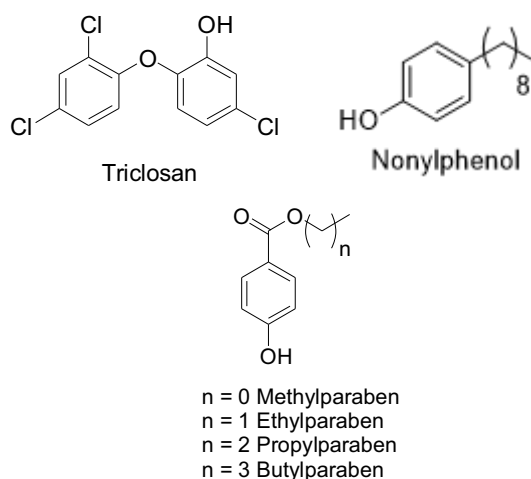


Figure 3: Chemical structures of selected surfactants and personal care products.

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Cover Page

The IChemC with the CCS, proudly organizes CHEMEX - 4 under this year's theme "Role of Chemists for a better tomorrow", which will be held from 26th to 28th January 2017 at the Sri Lanka Exhibition and Convention Centre (SLECC).

CHEMEX educational exhibitions (1,2,3) held during past years attracted a large crowd, including school children, university students & the general public.

(refer pages 23-28)

Use of metal ions in diagnostic imaging

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Imaging techniques play an important role in diagnostic medicine. Diagnostic medicine is part of clinics and medical research, which aid with the detection of diseases as well as the monitoring of disease progression and treatment. These imaging modalities include single photon emission computed tomography, positron emission tomography, ultrasound, magnetic resonance imaging (MRI), photoacoustic tomography, and fluorescence imaging. Some of these techniques can produce two dimensional images with sufficient spatial resolution and signal to noise ratio, while the development of computer technology allows some imaging modalities to produce three dimensional images. Highly sensitive imaging techniques are preferred to visualize targets present in very low concentrations for better understanding and treatment of disease. Imaging agents play a vital role in diagnostic imaging to improve the image quality by enhancing the sensitivity and contrast. Among different types of imaging agents, metal ions containing imaging agents occupy a great interest.

Metal ions have been known to play vital roles in various cellular processes. Therapeutic value of certain metal ions and their complexes is well known and has been practiced since ancient time. Such metals include mercury, arsenic, and iron. The introduction of metal chelates in biological systems for therapeutic or diagnostic purpose is an important field in bioinorganic chemistry. Diagnostic metallopharmaceuticals are powerful tools in the diagnosis of various disease conditions including malignant conditions, cardiologic disorders, kidney infections, liver problems, and neurological disorders. The quality of imaging and imaging agents have improved over the decades and it is now possible to do targeted imaging to visualize particular cell, tissue or organ. The main function of the imaging agent is to improve the contrast between healthy tissues and diseased tissues, which allows a physician or a scientist to easily differentiate them from each other based on the visual imaging impression; hence, they are often termed as contrast agents. This letter will discuss the use of various metal ions in different diagnostic imaging techniques.

The selection of a metal ion or a metal complex as an imaging agent depends on the compatibility of metal ion properties with requirements of imaging modality.

The properties of metal ions important for imaging include magnetic, photophysical properties of metals and decay properties of radioisotopes. Further, the biological half-life and radiation half-life properties of the metal or metal complexes are important when administering these agents for imaging. Biological half-life tells how long these foreign materials circulate or retain in the body and elimination of these agents as soon as the imaging is performed is preferred because that will reduce the toxicity. Elimination often takes place via renal or fecal excretion. Radiation half-life is related to radionuclides and tells the time taken for radiation dose to reduce into half of the original value. Longer radiation half-life results in extended exposure of tissues to a high dose of radiation and it is not desirable. Often metal chelates are preferred as imaging agents than free metal ions or metal salts because of the toxicity of free metal ions to biological systems. Many of these metal ions are heavy metals and if they are in free or easily ionizable form, they can interfere with biological processes and sometimes these interferences are irreversible.

The following sections discuss the different diagnostic imaging techniques and the use of metal-containing imaging agents in these techniques.

X-ray imaging

X-ray imaging is the oldest technique of imaging that found in diagnostic medicine. Here, the image is produced by passing a high-energy radiation (X-rays) through a sample (a body part of an animal/human). According to the thickness and density of the tissue, amount of X-ray that penetrate through the tissue vary. This variation is due to the degree of absorption of X-ray by tissue masses. Image is produced on a photographic paper or screen when this penetrating radiation hit on it, giving dark and light regions. In the image, lighter regions represent denser tissue masses such as bones while darker regions represent thin tissue masses. In today's clinics various types of X-ray imaging techniques can be found including X-ray computed tomography (CT), mammography, angiography, and fluoroscopy, other than the conventional plain X-ray imaging. In the X-ray imaging techniques - specifically in angiography, CT, and fluoroscopy - contrast agents are used to enhance the contrast of the image. These contrast agents are

composed of heavy elements and they will absorb more radiation than normal tissues. Therefore, when these elements are present in a particular tissue or organ (arteries, veins, genitourinary tract or gastro-intestinal tract) that tissue or organ appears whiter than surrounding tissues highlighting anatomical boundaries clearly and giving required contrast enhancement to the image.

Barium sulfate (BaSO_4) is one of the contrast agents used in X-ray imaging. It is mainly used to visualize the gastrointestinal tract with X-ray imaging. Because barium absorb radiation more than a normal tissue, regions in the gastrointestinal tract that contain Ba^{II} appear more whiter in the image giving good contrast enhancement to identify anatomical features and abnormalities properly.

Although a non-metal, iodine is also used as a contrast agent in X-ray imaging. It is mainly used in angiography and administered as ionic or non-ionic organic iodinated compounds that highlight the anatomical boundaries of arteries and veins enabling to identify blockages easily.

Nuclear imaging techniques

Nuclear imaging techniques produce the image by monitoring the radiation emitted by a radioactive material. Thus the radioactive material is the imaging agent. Positron emission tomography (PET) and single photon emission computed tomography (SPECT) are two widely used nuclear imaging techniques in clinics. In both these imaging techniques radioisotopes are used as the imaging agents. Radioisotopes are atoms that have an unstable nucleus and in a state with too much energy. By undergoing decay, the nuclei arrive in a less energetic state, which is more stable. The energy released during the decay process is used in the imaging.

In PET, radionuclides which emit positrons (β^+) are used. In β^+ decay, a nuclide transforms one of its core protons (p) into a neutron (n) and emits a positron, which is a positively charged electron, and a neutrino (ν) a form of energy as shown in eq 1.

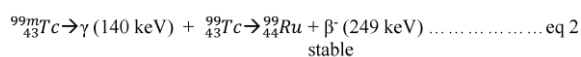


The positron is annihilated with an electron in the body giving out gamma photons. Two gamma photons occur simultaneously in opposite direction is then used for the generation of the image. PET allows both anatomical and functional imaging; however, the spatial resolution of the image is poor than X-ray

image. There are several non-metal and metal radionuclides used as imaging agents in PET. Requirements of these radioisotopes are that they need to emit positrons thus usually proton rich, should possess short radiation half-life that match with the duration of imaging procedure, and the energy of the emitted positron and gamma photons should be in the PET detector window. Having a short radiation half-life is important since these high energy radiation is harmful to the living cells. Hence, long term exposure of living cell to these radiation is not good. Generally, these radioisotopes are produced in cyclotrons or in generators/reactors. Several metal radioisotopes that used in PET includes gallium-68, copper-60 and 64, zirconium-89, and Rubidium-82. The radiation half-life of ^{68}Ga is 67 min, ^{60}Cu is 23.7 min, ^{64}Cu is 12.7 h, ^{89}Zr is 78.5 h, and ^{82}Rb is 1.27 min.

These metal radioisotopes are injected in their chelated form to avoid toxicity. Chelating ligand can be functionalized to attain target specificity; hence, a tissue or organ of interest can be detected with low signal to noise ratio.

In SPECT, radioisotopes that emit gamma radiation are used to produce the image. The generation of radioisotopes is similar to PET where cyclotron or generator is used. Radioisotopes with short radiation half-life are preferred similar to PET. The most popular metal radioisotope used in SPECT is meta-stable technetium-99. The isotope ^{99m}Tc is produced by the decay of ^{99}Mo isotope. The half-life of ^{99m}Tc is about six hours, while the half-life of ^{99}Mo is 2.75 days. Hence, the precursor isotope ^{99}Mo can be easily transport from place to place where active radioisotope ^{99m}Tc is produced just before the imaging experiment. Decay of ^{99m}Tc gives gamma radiation with 140 keV energy and ultimately converts into a stable ruthenium species (eq 2).



The isotope ^{99m}Tc is then complexed with a chelating ligand to administer it into the body. Based on the functionality of the ligand the metal chelate retain in different parts of the body allowing specific imaging. For example the ^{99m}Tc chelate known as Tc-99m medronate is used for imaging bone, Tc-99m pentetate is used for imaging brain and kidney, and Tc-99m sestamibi is used for imaging myocardium and breast (Figure 1). Other than ^{99m}Tc , there are few other metal radioisotopes that used in SPECTS including ^{67}Ga , ^{111}In , and ^{201}Tl .

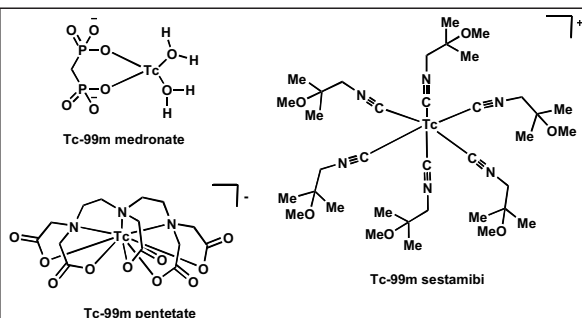


Figure 1: Imaging agents containing ^{99m}Tc radioisotope and different chelating ligands.

Magnetic resonance imaging

Magnetic resonance imaging (MRI) is a powerful and widely used imaging technique, and which is non-invasive and does not use harmful radiation. Images with better spatial resolution than PET or SPECT can be obtained with MRI. Conventional MR images are produced by mapping the relaxation rates or densities of the nuclear spins of water protons in a magnetic field excited with radio frequency. Differences in relaxation rates are due in part to the chemical composition of the surrounding environment. The inherent differences in relaxation rates are often not sufficient to produce satisfactory contrast; hence, chemicals known as contrast agents are used in MRI to catalytically accelerate the relaxation of water protons. Thereby to improve the contrast of the image where the contrast agents are found. In X-ray and nuclear imaging, it is the imaging/contrast agent that the instrument looks at because the agent itself either absorb or emit radiation. However, in MRI the instrument looks at the water protons relaxation and not the contrast agent. It acts as a mere catalyst to improve the relaxation of water protons. Two common classes of contrast agents are paramagnetic complexes and superparamagnetic particles. Paramagnets including Gd^{III} and Mn^{II} are referred to as “ T_1 agents” because of their influence on longitudinal (T_1) relaxation rates. Whereas superparamagnetic iron oxide (SPIO) particles are referred to as “ T_2 agents” because of their influence on transverse (T_2) relaxation rates of water protons. T_1 agents tend to lead to brighter images, and T_2 agents tend to darken images; consequently, these agents are often referred to as positive and negative contrast agents, respectively. In current clinical MRI, Gd^{III} -based complexes are the most commonly used contrast agents and they are used in ~35% of clinical scans. The reason is Gd^{III} having seven unpaired electrons (spin 7/2) shows high magnetic moments. Therefore, its efficiency as a catalyst to accelerate water proton

relaxation is high. Most of the Gd^{III} -based complexes are formed using macrocyclic ligand 1,4,7,10-tetraazacyclododecane- N,N',N'',N''' -tetraacetic acid (DOTA) or polydentate chelating ligand diethylenetriaminetetraacetic acid (DTPA) (Figure 2).

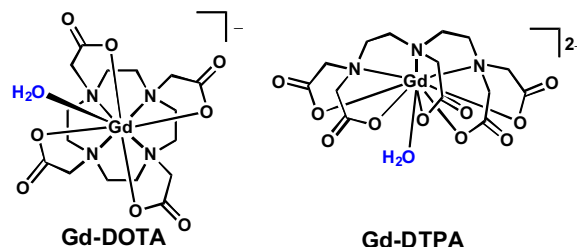


Figure 2: Clinically approved Gd^{III} -based contrast agents for MRI

Gadolinium, which is a lanthanide, is a hard Lewis acid and has a coordination number of nine. DOTA and DTPA are polyaminopolycarboxylate ligands, thus form stable eight coordinated complexes with Gd^{III} . The ninth coordination site interacts with a water molecule, which helps to transfer catalytic process to the surrounding bulk water in tissues. Kinetic stability of these complexes is important and Gd^{III} should not leach out from the chelate while inside the body. Free Gd^{III} is toxic and it can irreversibly replace functions of calcium in living systems due to size similarity. These ligands also allow the functionalization of their backbone; hence, these chelates can be attached to antibodies, dendrimers, proteins, and nanoparticles to achieve target specificity (Figure 3).

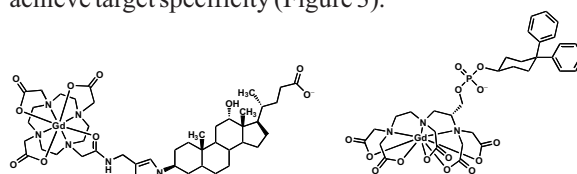


Figure 3: Functionalized Gd^{III} complexes for target specific imaging

Mn^{II} (spin 5/2) has a lower efficiency in catalyzing water proton relaxation than Gd^{III} (spin 7/2); however, nanosystems with large Mn^{II} loadings can be used to produce contrast enhancement of targets.

Superparamagnetic iron oxide (SPIO) nanoparticles coated with polymers are another class of contrast agents for MRI. SPIOs have a good biocompatibility and aid in T_2 relaxation of water protons. Increase in T_2 relaxation of water protons decrease the signal intensity and, consequently, enhance the contrast of images by darkening the target relative to surrounding tissues.

Luminescence imaging

Photophysical properties of several d-block and f-block metal ions have enabled the use of metal ions in luminescence imaging of biological systems. Metal lumophores have advantages over organic fluorophores in terms of less photobleaching and high photostability, good quantum yield, long excited state life times, and ease of emission tunability. From d-block, complexes of ruthenium (Ru^{II}), rhenium (Re^{I}), iridium (Ir^{III}) have been reported in luminescent imaging.

From f-block europium (Eu^{III}), and terbium (Tb^{III}) have been reported to use as luminescent imaging probes that emit in visible region while neodymium (Nd^{III}), erbium (Er^{III}), and ytterbium (Yb^{III}) have shown near IR emission. Long luminescence life times of lanthanides including europium and terbium enables the time-gated imaging thus eliminating the interferences from background autofluorescence. These metal complexes are often chelated with a ligand that contains a organic chromophore, which act as an antenna that efficiently excite the metal ion by energy transfer.

Summary

Various metal ions are used in different imaging modalities as imaging probes to generate the image (nuclear and luminescent imaging techniques) and to improve the image contrast (X-ray and MRI). The spectrum of metal ions that can be used as imaging

agents expands day by day with the advancement of nanotechnology; however, this article is limited to discuss only the metals that currently in use and they are mostly found as either salts or coordination complexes.

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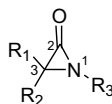
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## Chemistry of Aziridinones ( $\alpha$ -lactams)

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Small-ring heterocycles have been recognized as useful synthetic targets and as building blocks in the synthesis of complex structures. Strained heterocycles, such as epoxides and aziridines, serve as the important intermediates in reactions developed recently in organic chemistry. Aziridinones ( $\alpha$ -lactams) contribute to another class of strained heterocycles that were first proposed as reactive intermediates by Sheehan and coworkers in 1949. These compounds are three-membered rings consisting of the amide function (Figure 1).



**Figure 1:** Structure of  $\alpha$ -lactam

## Synthesis of $\alpha$ -lactams

Currently, there are two practical methods used to synthesize  $\alpha$ -lactams.

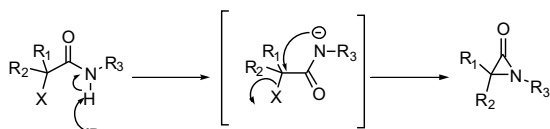
(1) *Cyclization by dehydrohalogenation of  $\alpha$ -haloamides*

The most common approach to the synthesis of  $\alpha$ -lactam is the base-induced cyclization of  $\alpha$ -haloamides by bases like *t*-BuOK, *t*-BuONa, KOH and NaH. The corresponding  $\alpha$ -lactams are formed by an abstraction of the acidic hydrogen from the nitrogen of  $\alpha$ -haloamide and subsequent removing of  $\alpha$ -halide (Scheme 1).

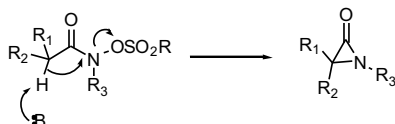
(2) *Cycloelimination of N-sulfonyloxy substituted amides*

In this method, *N*-sulfonyloxyamides are

converted to the corresponding  $\alpha$ -lactam by base promoted 1,3 elimination (Scheme 2).



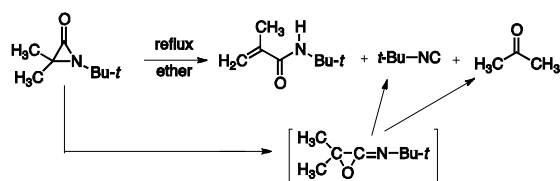
**Scheme 1:** The base induced cyclization of  $\alpha$ -haloamides



**Scheme 2:** Base promoted 1,3 elimination of *N*-sulfonyloxamide

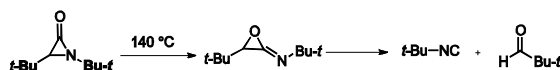
### Stability of $\alpha$ -lactams

The carbonyl group of  $\alpha$ -lactams adds additional strain to the  $\alpha$ -lactam ring as compared to aziridines and epoxides, making them highly reactive. Most of the known  $\alpha$ -lactams have been stabilized by bulky groups such as *tert*-butyl or 1-adamantyl on nitrogen atom and C-3 position. The enhanced stability may be due to the steric hindrance at the usual reaction sites. The higher the steric hindrance of the substituent group on both the nitrogen atom and  $\alpha$ -carbon atom, the greater the thermal stability of  $\alpha$ -lactam. However, the ease of thermal decomposition does not only depend on steric effect but also on the presence or absence of at least one  $\beta$ -hydrogen in the alkyl group at the C-3 position.  $\alpha$ -lactams with at least one  $\beta$ -hydrogen such as 1-*tert*-butyl-3,3-dimethylaziridinone decompose quickly in refluxing ether, producing  $\alpha$ - $\beta$  unsaturated amides via  $\beta$ -hydrogen elimination (Scheme 3).



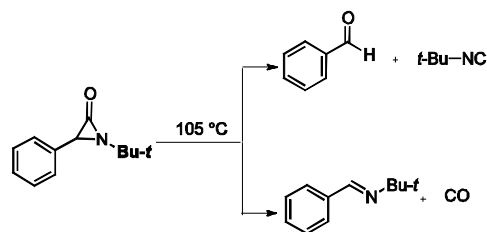
**Scheme 3:** Thermal decomposition of 1-*tert*-butyl-3,3-dimethylaziridinone

In contrast, 1,3-di-*tert*-butylaziridinone that does not have any  $\beta$ -hydrogen atoms further stabilized by two bulky *tert*-butyl groups, starts decomposing at ca. 140 °C (Scheme 4).



**Scheme 4:** Thermal decomposition of 1,3-di-*tert*-butylaziridinone

Moreover, *N*-*tert*-butyl-phenylaziridinone starts to decompose at 105 °C and produces benzaldehyde, *tert*-butyl isocyanide and trace amounts of *N*-benzylidene-*tert*-butylamine and carbon monoxide (Scheme 5).

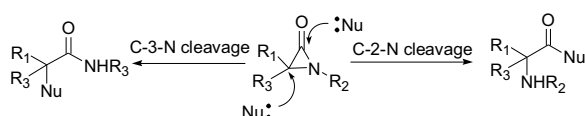


**Scheme 5:** Thermal decomposition of *N*-*tert*-butyl-phenylaziridinone

Some  $\alpha$ -lactams which contain a phenyl group at the C-3 position are less stable and nonisolable. Nonetheless, many  $\alpha$ -lactams can be generated *in situ* and reacted without the need for isolation.

### Nucleophilic ring opening reactions of $\alpha$ -lactams

Among the reported reactions of  $\alpha$ -lactams, nucleophilic ring opening reactions with various nucleophiles containing N, O, and S heteroatoms have been studied extensively. Nucleophile can attack  $\alpha$ -lactams either on the  $sp^3$  hybridized carbon (C-3) to give secondary amide as a product or on the acyl carbon (C-2) to give 2-amino acid derivatives (Scheme 6). In particular, various generalizations were stated for the regioselectivity of a nucleophilic ring opening reactions of  $\alpha$ -lactams.



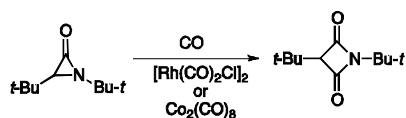
**Scheme 6:** Two paths of nucleophilic ring opening of  $\alpha$ -lactams

Sheehan and coworkers reported that selectivity of the ring opening mainly depends on the nature of the incoming nucleophile. Reactions with neutral protic nucleophiles such as water, alcohols, thiols, amines and mineral acids formed amides resulting from the alkyl-nitrogen (C-3-N) bond cleavage. On the other hand, anionic aprotic nucleophiles cause a rupture of the acyl-nitrogen (C-2-N) bond to give amino acid derivatives as the major product. However, Yusoff and coworkers reported that the steric factor also plays a significant role in the regioselectivity of the nucleophilic ring opening of  $\alpha$ -lactams. Strong, unhindered nitrogen nucleophiles tend to rupture the C-2-N bond, whereas sterically hindered, weaker nucleophiles favor a

scission of the C-3-N bond. However, aprotic nucleophiles containing O and S exhibit considerable variation in regioselectivity. In addition, hardness/softness of the nucleophile also effects the regioselectivity of the ring opening reactions. Soft nucleophiles like iodide ion attack the soft alkyl carbon of  $\alpha$ -lactam and hard nucleophiles such as alkoxide prefer to attack the harder acyl carbon. Clearly, the generalization was not established for the regioselective ring opening of  $\alpha$ -lactams.

### Transition metal catalyzed reactions of $\alpha$ -lactams

To the best of our knowledge, there are two examples in the literature for the transition metal catalyzed reactions of  $\alpha$ -lactams. Roberto and co-workers reported that 1,3-di-*tert*-butylaziridinone was converted to azetidine-2,4-dione using Rh(I) and Co(0) complexes (Scheme 7). Ring expansion of 1,3-di-*tert*-butylaziridinone with Rh(I) was catalytic and with Co(0) stoichiometric. The treatment of 1,3-di-*tert*-butylaziridinone with CO in the presence of catalytic amount of  $[\text{Rh}(\text{CO})_2\text{Cl}]_2$  in dry benzene afforded azetidine-2,4-dione in quantitative yield. Furthermore, when 1,3-di-*tert*-butylaziridinone treated with an equimolar amount of  $\text{Co}_2(\text{CO})_8$  in benzene overnight at 65 °C under nitrogen afforded azetidine-2,4-dione in 90% yield.

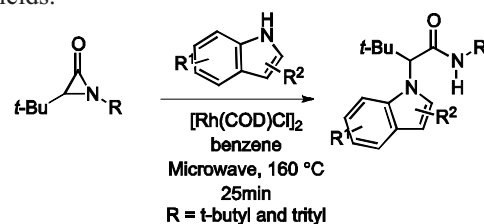


**Scheme 7:** Ring expansion of 1,3-di-*tert*-butylaziridinone

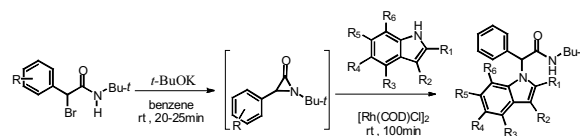
Nitrogen-containing heterocyclic compounds are extremely important due to their abundance in natural products and synthetic organic compounds that show biological activities. Moreover, construction of the C-N bond containing aromatic compounds is particularly important in areas of biologically active compounds. Box and co-workers reported a methodology for rhodium-catalyzed regioselective coupling of highly stable 1,3-di-*tert*-butylaziridinone and 3-(*tert*-butyl)-1-tritylaziridinone with indole derivatives to construct the new class of compounds which possessed C-N bond and the amino amide function (Scheme 8).

In addition, the scope of above reaction was extended by the development of a method for the *in situ* generation of less stable phenyl-substituted  $\alpha$ -lactams (Scheme 9). All the phenyl-substituted  $\alpha$ -lactams were generated *in situ* and subsequently reacted with the

indoles in the presence of rhodium catalyst. The developed method provided an atom-economical approach for the formation of C-N bond containing substituted  $\alpha$ -amino amides with good to excellent yields.



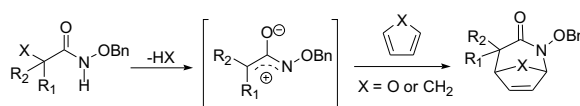
**Scheme 8:** Rhodium catalyzed coupling of  $\alpha$ -lactams with indoles



**Scheme 9:** Rhodium catalyzed coupling of *in situ* generated phenyl substituted  $\alpha$ -lactams

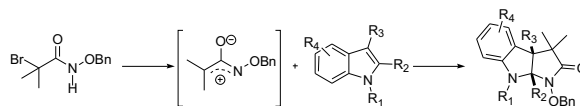
### Ring expansions of aza-oxyallyl cation

In addition to the metal catalyzed ring expansion of  $\alpha$ -lactams, ring expansion of aza-oxyallyl cation was also reported. Aza-oxyallyl cation is one of the proposed intermediates in  $\alpha$ -lactam chemistry. Jeffery and co-workers reported the first example of [4+3] cycloaddition of aza-oxyallyl cation with cyclic dienes (Scheme 10).



**Scheme 10:** [4+3] cycloaddition of aza-oxyallyl cation

Most recently DiPoto and co-workers reported indole (3+2) dearomative annulation reactions involving aza-oxyallyl cation (Scheme 11).



**Scheme 11:** (3+2) dearomative annulation of aza-oxyallyl cation

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Synopsis of the lecture delivered at the College of Chemical Sciences, Institute of Chemistry Ceylon and National Institute of Fundamental Studies, Kandy in November 2016 by Professor S. Sotheeswaran.

Pharmaceuticals from Marine Organisms

Professor S. Sotheeswaran

Emeritus Professor of the University of the South Pacific, Fiji.

For many years, traditional Western pharmacognosy focused on the investigation and identification of medically important plants and animals in the terrestrial environment. However, many marine organisms have been used in traditional Chinese medicine. In the recent past, some chemists started looking for new medicines in marine organisms. 70% of the earth's surface is covered by water and the marine environment contains over 80% of world's plant and animal species. Thus marine organisms are a vast resource for new medicines to combat major diseases such as cancer, AIDS and malaria. Research typically focuses on sessile marine organisms or slow moving animals because of their inherent need for chemical defenses. Standard research involves an extraction of constituents in a suitable solvent followed by either an assay of this crude extract for a particular disease target or a rationally guided isolation of new chemical compounds using standard chromatography techniques.

In recent years, many bioactive compounds have been extracted from various marine organisms like tunicates, sponges, soft corals, sea hares, nudibranchs, bryozoans and sea slugs.

Ara-C (Arabinofuranosyl cytidine) (Cytarabine)

The anticancer drug, Ara-C (Figure 1), is used to treat acute myelocytic leukemia and non-Hodgkin's lymphoma. It kills cancer cells by interfering with DNA synthesis. Ara C is on the World Health Organization's List of Essential Medicines, a list of the most important medications needed in a basic health system.

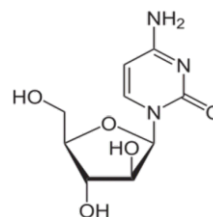


Figure 1: Structure of Ara-C

Ara-A (Arabinofuranosyladenine) (Vidarabine)

The anti-viral activity of Ara-A (Figure 2) was first described by M. Privat de Garilhe and J. De Rudder in 1964. It was the first nucleoside analog antiviral to be given systemically and was the first agent to be licensed for the treatment of herpes virus infection in humans. It was at the University of Alabama in Birmingham that Dr. Richard Whitley, researcher and physician, realized the clinical effectiveness of this compound in 1976, and subsequently it was used in the treatment of many viral diseases.

Both Ara-C and Ara-A are derived from nucleosides isolated from a shallow-water marine sponge collected off the coast of Florida, USA.

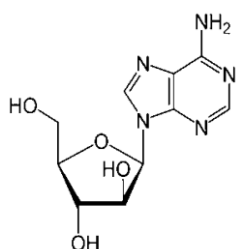


Figure 2: Structure of Ara-A

Bryostatin

Bryostatin (Figure 3), isolated from the bryozoan *Bugula neritina*, is a polyketide with both anticancer and immune modulating activity. Its mechanism of action is through the activation of protein kinase C mediation of cell signal transduction pathways. This compound is currently in Phase II clinical trials for non-Hodgkin's lymphoma, chronic lymphocyte leukemia, and multiple myeloma through a Cooperative Research and Development Agreement (CRADA) between the National Cancer Institute (NCI) and Bristol-Myers Squibb.

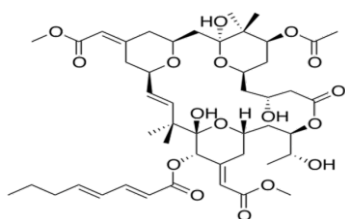


Figure 3: Structure of Bryostatin

Discodermolide

(+)-Discodermolide (Figure 4) is a polyketide natural product.

It was isolated by Gunasekera and his co-workers from the deep-sea sponge *Discodermia dissoluta* in 1990. Gunasekera was a Ph.D. graduate of the University of Peradeniya's Chemistry Department.

Discodermolide is a potent immunosuppressive

and anticancer agent which inhibits the proliferation of cells by interfering with the cell's microtubule network. This compound may be effective against breast and other types of cancer that have become resistant to other microtubule disrupting drugs. Discodermolide has been licensed by Harbor Branch Oceanographic Institution (Fort Pierce, FL) to Novartis Pharmaceutical Corporation, and is in advanced preclinical trials.

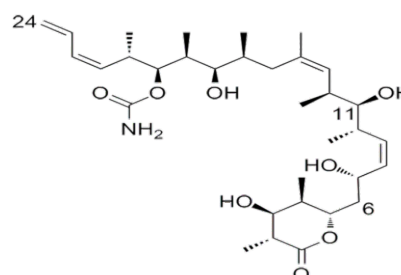


Figure 4: Structure of Discodermolide

A large number of efforts toward the total synthesis of (+)-discodermolide were directed by its interesting biological activities and extreme scarcity of natural sources (0.002% w/w from frozen marine sponge). The compound supply necessary for complete clinical trials cannot be met by harvesting, isolation, and purification. As of 2005, attempts at synthesis or semi-synthesis by fermentation have proven unsuccessful. As a result, all discodermolide used in preclinical studies and clinical trials has come from large-scale total synthesis.

Pseudopterosins

Despite the emphasis on identifying new anticancer compounds, marine natural products have also been found to have other biological activities, including intervention in the inflammatory response. Pseudopterosins (Figure 5) have anti-inflammatory and analgesic activity, with a mechanism of action different from the common Non-Steroidal Anti-inflammatory Agents (NSAIDs). The pseudopterosins are glycosides derived from the Caribbean soft coral *Pseudoptero-gorgia elisabethae*.

Pseudopterosin A is a diterpene glycoside isolated from the gorgian sea whip *Pseudoptero-gorgia elisabethae*, found in the Bahamas and Florida Keys. Pseudopterosins A-D, which differ in the degree of acetylation at the sugar ring, were first isolated and reported in 1986. There are at least 25 unique diterpenes isolated from this species of marine animal. Samples of *P. elisabethae* from the Bahamas are found

to have higher concentrations of pseudopterosins than populations from the Florida Keys, which have a greater diversity in diterpene structures. Pseudopterosins have anti-inflammatory and analgesic activity, with a mechanism of action different from the common non-steroidal anti-inflammatory drugs, NSAID. Commercially, pseudopterosins are found in skin creams as topical anti-inflammatory agents.

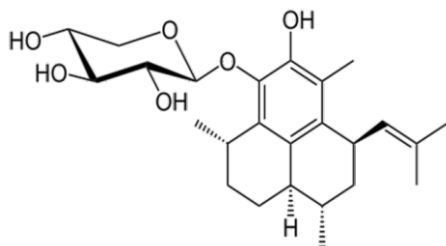


Figure 5: structure of Pseudopterosin A

Ziconotide

Ziconotide is a peptide with the amino acid sequence H-Cys-Lys-Gly-Lys-Gly-Ala-Lys-Cys-Ser-Arg-Leu-Met-Tyr-Asp-Cys-Cys-Thr-Gly-Ser-Cys-Arg-Ser-Gly-Lys-Cys-NH₂.

Ziconotide is an atypical analgesic agent for the amelioration of severe and chronic pain. Derived from *Conus magus*, a cone snail, it is the synthetic form of an ω -conotoxin peptide. In December 2004 the Food and Drug Administration approved ziconotide when delivered as an infusion into the cerebrospinal fluid using an intrathecal pump system.

Yondelis (Trabectedin) also known as ecteinascidin 743 or ET-743

It is sold by Zeltia and Johnson and Johnson under the brand name Yondelis (Figure 6). It is approved for use in Europe, Russia and South Korea for the treatment of advanced soft tissue sarcoma. It is also undergoing clinical trials for the treatment of breast, prostate, and paediatric sarcomas. The European Commission and the U.S. Food and Drug Administration (FDA) have granted drug status to yondelis for soft tissue sarcomas and ovarian cancer.

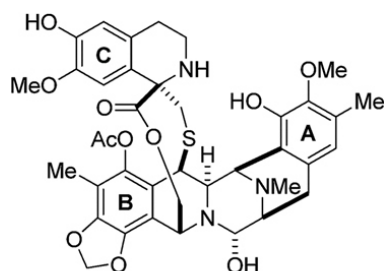


Figure 6: Structure of Yondelis

Supply

In each of these cases of marine derived pharmaceuticals, bulk supply of the chemicals for continued clinical use is a problem. It is often neither economically nor ecologically feasible to rely on large-scale collections of the source organisms from their natural habitats to derive marine drugs. Whether a drug company decides to support the clinical development of a new drug is dependent on identifying an adequate supply of the source material. This could be through the culture of the organism. The drug could also be obtained through synthesis of the compound using an economically feasible, industrial-scale process.

Research is in progress on options for biological supply (e.g., aquaculture, cell culture, microbial fermentation, and genetic engineering) to address this critical issue in the development of chemicals from natural sources.

Unfortunately, neither the National Institute of Health (NIH) in the USA nor most drug companies are prepared to invest funds in basic research to develop general models for biological supply of marine natural products with therapeutic potential.

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From coordination chemistry to semiconductor photochemistry and solar energy conversion: A voyage through four decades of research

Professor O A Ileperuma

Visiting Senior Professor in Chemistry, Institute of Chemistry Ceylon, Rajagiriya

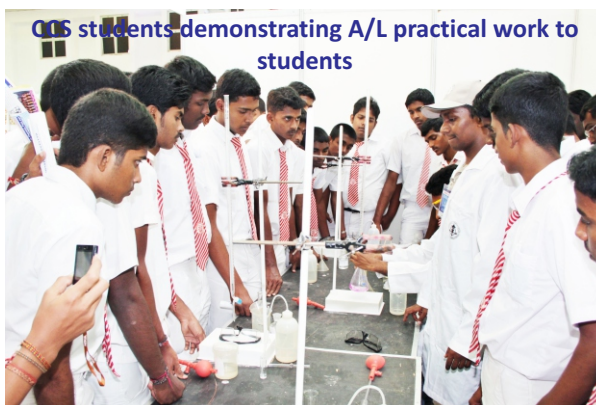
Semiconductor photocatalysis is important owing to the global energy crisis and using solar energy to carry out important reactions such as water splitting, degradation of pollutants, nitrogen fixation and solar cells has distinct advantages. Water splitting reaction on ferric oxide was first discovered during this work on irradiated nanoparticles. It was found that compared to crystalline iron oxide, band gap increases by 0.28 eV for 40 nm particles for nano ferric oxide taking it above the redox level for hydrogen reduction. In addition, oxidative nitrogen fixation to nitrate on irradiated TiO_2 and hydrous ferric oxide was also discovered. More recently, water splitting on an infra-red active novel nanocomposite photocatalyst comprised of $\text{Ag}_2\text{O}/\text{TiO}_2$ was discovered. This observation can be attributed to the presence of sub-energy levels due to Ag_2O within the band gap of TiO_2 .

Dye-sensitised solar cells are being extensively studied as a substitute to the more expensive and technologically complex silicon solar cells. However, the use of an organic liquid as the electrolyte severely limits its large scale applications. In order to overcome this problem, polymer based gel electrolytes have been developed which showed slightly lower efficiencies (~7.5%) but with considerable stability suitable for large area solar cells. Polyacrylonitrile along with plasticisers ethylene carbonate and propylene carbonate can be easily converted to a gel which can then be hot pressed between the two electrodes of a solar cell. The use of such gel electrolytes has been extended to TiO_2 sensitised with organic dyes such as indoline D-149. The I/I_3 ratio for optimal activity was found to be 1.50 M:0.05 M compared to 0.50 M:0.05 M for the liquid electrolyte. Higher concentrations of I may promote Grotthus type of mechanism through triiodide ion chains. Pore filling using the standard liquid electrolyte prior to hot pressing the gel electrolytes enhanced the efficiency from 5.2% to 8.4% which is quite close to the 9.8% efficiency obtained for the standard liquid electrolyte. More recently, a polymer free gel electrolyte was prepared using fumed silica as the gelling agent. This had an efficiency of 7.5% and represents a more stable form suitable for long term applications of this type of solar cell.

Research carried out on the air quality of Kandy indicated that pollutant levels are 2-3 times more than the corresponding values of Colombo. Criteria pollutants in Kandy exceeded the air quality standards on about 40% of the occasions. Monthly variation of pollutants indicated that the pollutant levels are higher during the North-East monsoon owing to transboundary air pollution. Monitoring of acid rain in seven provinces except the North and the East indicate that acid rain occurs in the hill country and also in the Anuradhapura district, particularly during the North-East monsoonal period. Computer modeling of future acidic depositions indicate that the highest acidic depositions will occur in Kandy followed by Jaffna again due to transboundary air pollution.

Chronic kidney disease of unknown etiology (CKDu) in the North-Central and Uva provinces has received considerable attention recently and studies carried out on the geographic distribution of this disease show that it is positively correlated to the fluoride distribution. Fluoride is a nephrotoxic element and its intake is further enhanced by the formation of aluminofluoride complexes when high fluoride water is stored or used for cooking in sub-standard aluminium utensils. It was also found that skeletal fluorosis patients all have CKDu. Providing purified water to such patients reverses the adverse effects of skeletal fluorosis with a concomitant improvement of kidney function.

Flashback - CHEMEX - 1, 27th to 30th January 2011 at BMICH



Flashback - CHEMEX 2 , 24 - 26 November 2011 at Adamantane House

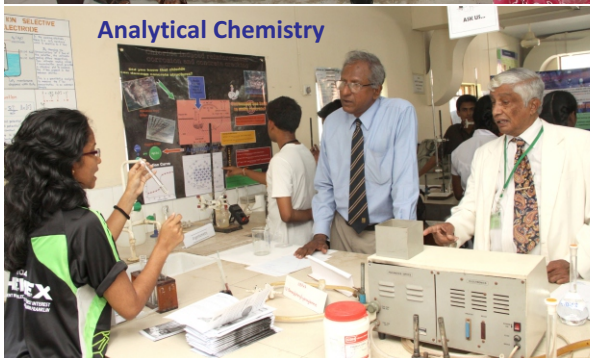


Flashback - CHEMEX - 3, 22nd to 24th January 2014 at Adamantane House

Opening of CHEMEX 3 on 22nd January



Chief Guest
Mr. Mevan Pieris



Analytical Chemistry



Practical Demonstration for A/L Students



Practical Demonstration for A/L Students



INORGANIC
CHEMISTRY



Practical Demonstration for A/L Students



Orchestra

Institute of Chemistry Ceylon Ready for its Unique Chemical Education Exhibition and Trade Fair– “CHEMEX - 4”

A.M. Jayasekara

*Additional Registrar, College of Chemical Sciences, Institute of Chemistry, Rajagiriya
Secretary, Organizing Committee CHEMEX - 4*

The Institute of Chemistry Ceylon, the largest producer of Graduate Chemists and Laboratory Technicians in Sri Lanka proudly celebrates its 75th Anniversary in 2016. As part of its Anniversary Celebrations, the Institute has planned to conduct “CHEMEX - 4” Educational Exhibition and Trade Fair from 26th to 28th January 2017 at the Sri Lanka Exhibition and Convention Centre (SLECC).

The Institute conducted its most successful Mega Exhibition and Trade Fair “CHEMEX - 1” in 2011 under the theme “*Chemistry Our Life- Our Future*” as part of the UN International Year of Chemistry at BMICH. The Sri Lanka National Secretariat for UNESCO, several Ministries and relevant Government Agencies, private sector industrialists, universities and media organizations contributed to the success of the exhibition. The Ministry of Education extended its fullest cooperation by facilitating the participation of thousands of school students from all parts of the country.

The feedback received from those who visited previous exhibitions such as “CHEMEX - 1”, held at BMICH and “CHEMEX - 2” and “CHEMEX - 3” held at the Institute of Chemistry Ceylon, expressed their satisfaction as the visits had been very useful for them.

“It was not only a mere exhibition” one student from Akkaraipattu who visited “CHEMEX - 1” said, “it was a place for obtaining wealth of information. I acquired much knowledge and experience by listening to the lectures given at the seminars and workshops and observing the chemical processes. Pros and cons of using various chemicals in our day to day life were well explained and I enjoyed chemical magic shows, entertainment activities such as dances and musical programmes, all conducted by the students of College of Chemical Sciences and the Universities.”

Another student from Badulla who participated at “CHEMEX - 2” said “It was a great experience as such a variety of things to see and learn Chemistry. It was a great service especially to the young generation and even for the teachers. I thank the Institute for arranging an exhibition of this nature”.

Another Student from Jaffna said “I had the opportunity to visit two of the “CHEMEX” exhibitions. I could get a lot of information and a good knowledge

on A/Level Chemistry practical. The students of the College of Chemical Sciences and the staff were very kind and they never hesitated to explain everything that we wanted to know.”

“It was indeed very useful for me. It enhanced my knowledge in Chemistry. Every student should visit “CHEMEX” exhibitions. It is a very rare opportunity” said a second year science student from the University of Ruhuna, commenting on his experience.

An enthusiastic young entrepreneur from Galle said that he will never miss the forth coming “CHEMEX - 4”. “Now being employed in a private sector firm as a Chemist, I want to see the stalls maintained by the Chemical industries. One day I wish to have my own industry. That is my ambition. My dream. It will definitely come true.”

In view of its success and the increasing demand for such type of exhibitions the Institute conducted “CHEMEX - 2” in November 2011 and “CHEMEX - 3” in January 2014 and now planning for “CHEMEX - 4”.

This year's theme of the Institute is “*Role of Chemists for a Better Tomorrow*”. A large number of fascinating well organized stalls that are to be set up by the industrial sector will depict various aspects of chemistry and chemical industrial products. University students and the students of the College of Chemical Sciences will demonstrate “*wonders of chemistry*” through chemical products and chemical reactions of educational and industrial value. The students of the College of Chemical Sciences with the guidance of its academic staff are enthusiastically working for its success and are positive that they can offer maximum benefits to the visitors by demonstrating chemical processes and products of day to day use through their especially created exhibition stalls.

The Exhibition is expected to attract a good cross section of the society of around 200,000 people consisting of school children, university students, businessmen, industrialists, academics and the general public from all over the country. The Ministry of Education, as in the previous exhibitions has informed all the Provincial Education Departments to inform all the school principals in their respective areas to instruct the students / teachers to participate in the “CHEMEX -

4" exhibition and witness the rare opportunity in view of its importance in chemical education. This exhibition is unique in that, it will consist of multifarious activities such as seminars, debates, chemistry magic shows, dramas and chemistry demonstrations, as well as kiddies play, musical programmes, dances and many other entertainments. It is indeed very much more than a conventional exhibition.

The type of stalls would consist of industries directly related to Chemistry, such as pharmaceuticals and medical, food processing, paint production, cement production, plastic and rubber production industries, laboratories, chemistry related educational institutes, agricultural institutes, energy conservation agencies, hazardous chemical control agencies *etc.* The Institute is well geared to accomplish its task by inviting many leading companies, small and medium scale producers of chemicals, chemical industrial products and marketing agencies to open their stalls. Print and, Electronic Media have been invited for sponsorship. With the wide publicity given to their products and services, the chemical industrialists will be benefitted

tremendously through participating in "CHEMEX - 4". The industrial sector stall holders at "CHEMEX - 4" Educational Exhibition and Trade Fair will have the opportunity for maximum exposure of their products to a large cross section of the society.

The visitors including school children will also have the opportunity to develop their enthusiasm and interest in chemistry and chemical sciences while they will be able to witness '*wonders of chemistry*' demonstrated by the College of Chemical Sciences and the Universities. They have the opportunity to witness how chemistry is involved in their day to day life. The students will have an additional benefit of participating at the debates and seminars which will be conducted by the academics and professionals in chemistry and chemical sciences and listen to key note addresses and guest speeches delivered by eminent chemists and industrialists in Sri Lanka. The theme of the year "*Role of Chemists for a Better Tomorrow*" will no doubt deeply penetrate into the minds of younger generation, policy makers and general public through the exhibition.

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CHEMEX - 4 to mark the 75th anniversary of Ceylon Chemical Society

Dr. Udaya K. Jayasundara

Senior Lecturer in Chemistry, Institute of Chemistry Ceylon, Rajagiriya

The Institute of Chemistry Ceylon (ICChemC), the only professional body of Sri Lankan Chemists, proudly organizes its' biannual social event, Chemex -4 in January 2017 to mark the diamond jubilee of the Ceylon Chemical Society incepted in 1941. Armed with academics, renowned scientists, and industrialists the event itself quenches the thirst of chemistry lovers in various disciplines.

With unprecedented support and untried collaborative well-wishers, the enthusiastic students at the College of Chemical Sciences (CCS), the educational arm of the ICChemC, work hard to deliver the best to the public from January 26 to 28 at the Sri Lanka Exhibition and Conventional Center (SLECC) to celebrate the seventy-five years of undisturbed service.

Having felt exhilarated by the experience in the past, the ICChemC has come up with a new theme to inculcate the chemistry of chemistry to the eagerly waiting community as well as to the uninterested in terms of magic shows, debates, exhibits, stalls and other goose bumping experiments.

By keeping the unbroken relationship with the state universities and the research institutes, the ICChemC invites the schoolchildren, teachers, educators, industrialists and the public to take the benefits of this once in a blue moon event, which would be an unforgettable experience to life.

Over hundred of exhibition stalls form various generous sponsors, the participants will surely find the answer to the question "why". The participants would get to know the daily chemistry they are using from morning to evening, which might be in their foods, cosmetics, and clothing. Therefore, the organizing committee kindly requests the head of schools to encourage the respective students to pay a visit to SLECC to grab the maximum out of this effort. The organizers will ensure that all exhibits are elucidated to facilitate the participants' learning process.

The glamorous magic shows available at a nominal fee, which raise your eyebrows, will demonstrate the power of chemistry. Hardly seen, but never experienced colorful chemistry practical will definitely take you to the hidden areas of the life from

microscopic world to the macroscopic world. The participant will never regret for the time and energy put on to visit this grand exhibition. Therefore, we request

you to mark your calendar and visit the CHEMEX - 4 with your kith and kin in the dawn of the year 2017.

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## **CHEMEX - 4 at SLECC**

Dr. Chandani Udawatte

*Senior Lecturer in Chemistry, Institute of Chemistry Ceylon, Rajagiriya*

The Institute of Chemistry Ceylon and its educational arm, College of Chemical Sciences will be conducting their fourth public exhibition, CHEMEX - 4, from 26<sup>th</sup> to 28<sup>th</sup> January 2017 at the Sri Lanka Exhibition and Convention Centre (SLECC) in Colombo. The theme of this exhibition will be "Role of Chemists for a better tomorrow". These series of exhibitions have been conducted by the Institute of Chemistry to increase awareness about the role of chemists in society, and to popularize chemistry among the general public. The first such exhibition, CHEMEX - 1, was conducted in 2011 to felicitate the International Year of Chemistry, IYC. There have been two more exhibitions conducted since then, CHEMEX - 2 in November 2011 and CHEMEX - 3 in January 2014.

CHEMEX - 4 exhibition has something for everybody. It will feature many items that are of interest

to school children, young adults, and senior citizens. There will be stalls run by universities, trade stalls, magic shows, debates, laboratory practicals for A' Level students and many interesting exhibits depicting the role of chemists in different spheres.

The **Toxicology** stall will feature toxins that we encounter regularly in our daily lives, and methods of detecting common toxins. The use of analytical instruments will be demonstrated by staff and students of the College of Chemical Sciences. User friendly detection methods will be carried out and explained virtually.

This exhibition is for all age groups, from school goers to adults, and it is a family affair!!!

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"CHEMEX" from a Student's Perspective

Samadhi Nawalage

Student, College of Chemical Sciences, Institute of Chemistry Ceylon, Rajagiriya

Everything has its hidden mysteries and science too is still in the process of being unraveled. In the process of its revelation we bring to you "CHEMEX", an initiative of the Institute of Chemistry Ceylon. "CHEMEX" Educational exhibition and Trade fair is happening for the fourth time on the 26th, 27th and 28th of January 2017 at the SLECC (Sri Lanka Exhibition and Convention Center). Under the theme "Role of Chemists for a better future", the institute is planning on reaching out to a vast audience comprising mostly students, with the goal of enriching and enlightening them on the many different branches of chemistry and its applications. It also focuses on empowering the young minds to explore the chemist within and to instill the spark and passion towards its further study.

The stalls would be based on narcotics, toxicology and pharmaceuticals, physical and computational chemistry, laboratory testing and research, analytical chemistry, cosmetics, food industry, polymer

chemistry, natural products etc. Advanced level chemistry practical stalls would be conducted along with magic shows which would make the walk through the stalls all the more fascinating.

With the aid of various state agencies and media sponsors along with many eminent figures in the field of science, CHEMEX - 4 is coming...this time bigger and better....



New Honorary Rector of College of Chemical Sciences

Professor Sujatha Hewage, retired Professor in Chemistry at the Department of Chemistry, University of Colombo was appointed as the third Honorary Rector of the College of Chemical Sciences by the Council of the Institute on the recommendation of the Academic Board with effective from 1st November 2016. Professor Hewage has been a Member of the Institute of Chemistry Ceylon since early 1970's and a Fellow of the Institute from 1993 onwards. She has held many positions at the Institute and served as the President in 2005/2006.

Call for Nominations for Institute of Chemistry Gold Medal 2017 by 31st March *(Under Revised Rules)*

This Gold Medal was the very first of such awards to be donated to the Institute and was made possible through a generous donation made by **Mascons Ltd** in memory of their founder, **Mr A Subramaniam** in 1978/79. It recognised contributions made to National Development through research and development involving Chemical Sciences. The Gold Medal Fund was supplemented recently through a further contribution from Mascons Ltd. This criteria governing the award were changed in 2011 since there were no applicants since 2007 in order to enable the award to be made to a mid-career Chemist in recognition of honorary services to the Institute.

Nominations are now being invited for the 2017 Award from amongst **Corporate Members** of the Institute who have fulfilled the following minimum criteria;

- Nominees should be not more than 55 years of age and should have been Corporate members of the Institute for at least 10 years on 1st of June 2017
- Nominees should have made significant contributions towards the activities of the Institute through yeoman services in an honorary capacity during the period of membership. These activities could include holding office, membership in committees, coordination of events such as workshops, social events etc.

Nominations could be made by any **corporate member** of the Institute and should include the consent of the nominee and details of the contributions made by the nominee in accordance with the above guidelines. The Award will be presented at the 46th Annual Sessions. **Nominations should be forwarded to reach the Hony. Secretary, Institute of Chemistry Ceylon not later than 31st March 2017.**

Graduate Chemists Welfare Fund

This fund has been established with effect from 1-1-2012. The principal benefits towards CCS Graduate Chemists would be,

- I. To provide partial assistance towards international travel of those proceeding abroad for PG degrees (once a life time). Assistance for

| | |
|---------------------------------------|---------------------------------------|
| Active Graduate Chemists : Rs. 60,000 | Passive Graduate Chemists: Rs. 30,000 |
|---------------------------------------|---------------------------------------|
- ii. To provide partial assistance towards registration fees in respect of IChemC /CCS events such as international Conferences.
- iii. To provide assistance towards registration fees for IChemC /CCS training seminars etc.
- iv. To provide partial assistance towards activities of the Alumni Association.

Note : Depending on the demand, Graduate Chemists who maintain positive contact and participate in IChemC/Alumni activities will get preference for the above mentioned assistance scheme.

An appreciation

Late Dr. N.R. De Silva, FRSC (UK); F. I.Chem.C.; C. Chem.

I was deeply saddened to learn about the passing away of one of my close associates, Dr N R De Silva in early October 2016. He was a Past President of the Institute of the Chemistry Ceylon.

Dr De Silva obtained his Master of Philosophy (M.Phil.) in Analytical Chemistry from the University of Bristol. Dr De Silva was a Fellow of the Royal Society of Chemistry (UK & Ireland), a Fellow and a Chartered Chemist of the Institute of Chemistry Ceylon (ICChemC), and a Fellow of the Sri Lanka Association of Quality Control.

He was a visiting Lecturer / Examiner for the M.Sc. Analytical Chemistry programme at the University of Colombo and served as a member of the Faculty Boards of the Faculties of Science at the Universities of Colombo and Kelaniya, and as a Council Member of the Open University of Sri Lanka and the University of Colombo. He was also a nominee of H. E. the President on the Research Council and of the Institute of Fundamental Studies in Sri Lanka (IFS).

He began his career as a Biochemist at the Department of Health Services. He held positions as a Senior Chemist at the Geological Survey Department and was appointed Director General and later as the acting Chairman of the Sri Lanka Standards Institution and Chairman of the Industrial Technology Institute (formerly Ceylon Institute of Scientific & Industrial Research). He had also served on the Governing Board of the IFS, Sri Lanka. Dr De Silva was a recipient of the National honour "Vidya Jothi" bestowed on him, by H.E. the President of Sri Lanka.

He was the President of the Institute of Chemistry in 1989. What N R was planning for the Institute was not the training and teaching programmes as done at that time, but he felt that the Institute should divert more

of its efforts to chemistry in industry and standards and quality control.

By the mid ninety nineties N R was appointed Director General (CEO) of the Sri Lanka Standards Institute (SLSI). He had many major accomplishments there including moving the Institute to a new building in Elvitigala Mawatha which was equipped with up to date laboratory facilities. He also had to bring together senior staff who had diverse opinions. He had added responsibilities as he had been elected as the President elect of the ICChemC in 1988 and became the President of the ICChemC in 1989. Unfortunately things did not go right externally in SLSI and he decided to resign his post at that Institution. Feeling that being the President of ICChemC would have a negative effect on ICChemC, he resigned from the post of President too at the end of 1989. As far as I know N R did not participate in any activity of ICChemC thereafter. However he contributed to many other organizations.

The unfortunate demise of Dr N R De Silva leaves a void. Many chemists who know him well will feel that his knowledge has not been best used for the benefit of Sri Lanka.

Professor E R Jansz, *F.I.Chem.C, C.Chem.PhD, DSc.*

Benevolent Fund Benefits for Members

i. Long life benefits:

Amount provided will be as follows:

- a. Over 70 yrs : Rs. 12,000 b. Over 75 yrs : Rs.18,000 c. Over 80 yrs : Rs. 25,000.

ii. Critical illness benefits: up to Rs. 60,000

iii. International travel for conferences (with presentation of a paper):

- a. Passive members : Rs. 30,000 (international travel only)
b. Active members : Rs. 60,000 (international travel and/or accommodation).

Any member who has paid membership fees for life (after 3years of such payment) is entitled for these benefits. All members are advised to pay the membership fee for life and become beneficiaries.

Diploma in Laboratory Technology in Chemistry (DLTC), 42nd Batch (2014/16)

Clinical Laboratory Technology (CLT)

Honours Pass (10)

Mr. M R A Rameez, Ms. F Z Shamil, Ms. L O Senarathne, Ms. P A C K Pasyala, Ms. B G K Jagathsiri, Ms. S Sandra, Ms. A S F Sahara Samad, Mr. D G S Ruwan Kumara, Ms. V Printha, Mr. M D T Maragala

Merit Pass (38)

Ms. A F Sahani, Ms. J Rajunisa, Mr. M J Z Bazeera, Mr. P W D S Ranasinghe, Mr. B G C M Ranasinghe, Ms. B M H Kanaththage, Ms. M F F Asma, Mr. U B S Dissanayake, Ms. A Azra, Ms. H F Narshana, Ms. M V O Peries, Ms. U P P P C J Dharmasena, Ms. B S A J P Brahmanayake, Mr. M M F Basheema, Ms. H L T De Silva, Mrs. P K Kaushalya, Mr. W W M P Senadheera, Ms. S Jayasekara, Mr. A A C B Amarasinghe, Ms. K K M Malindi, Mr. M G C C Preemal, Ms. M N F N Shadhany, Mr. H W N Gunathilaka, Mr. A S M Fahim, Mr. S M C K Samarasinghe, Ms. G D I K Priyanthi, Mr. G M D D S Jayasinghe, Mr. H M D N Herath, Ms. A T H Jayaweera, Mr. K Pranavan, Ms. R D A M C Ivanthika, Ms. D J G B M Dissanayake, Ms. H P G R Dilrukshi, Ms. H F Arshika, Mr. M S M Safwan, Mr. L M Asmath, Mrs. K N R Wijayasinghe, Mr. M J F S Shakaaf

Ordinary Pass (37)

Ms. M I S Fajeela, Ms. M A F Afka, Mr. G D Senadeera, Ms. R R Jayawardana, Mr. K R C S Perera, Ms. E A K P Edirisinghe, Ms. R T V Diwamini, Mr. B Y Halgaswithana, Mr. M J M L Munasinghe, Mr. K K K Munasinghe, Ms. G H Ahirtha, Ms. H M R C Herath, Mr. M T Nihmathullah, Ms. M C K Jayaratne, Mr. G A I G Gajasinghe, Mr. M N M Thisan, Mr. T N B Illeperuma Arachchige, Ms. A M S Begam, Ms. R Aksharah, Mr. W M A T Rangajeewa, Mr. J W S N D Siriwardhana, Mr. K D W Senevirathne, Ms. T J Abeywardhana, Ms. M F F Sameeha, Ms. D P P Samaranayake, Mr. M A M Anfas, Mr. P D K Magodage, Mr. I G G T Amararathne, Mr. G J Palliyaguruge, Mr. M R M Fazil, Mr. A J Siyan, Mr. C Wattegedara, Ms. S T N Kuruppu, Mr. J A S Dinusha, Mr. K D G S Dharshana, Ms. S Sathyabama, Mr. B K C K Bandara

Industrial & Food Chemistry (IFC)

Honours Pass (4)

Ms. H G J Chandima, Ms. B W K I Wickramanayake, Mr. S N Abeysingha, Ms. H M N P Herath

Merit Pass (4)

Ms. H P T Sulakshani, Ms. H P I S Pathirathne, Ms. D A T Poornima, Mr. R M C M Rathnayake

Ordinary Pass (2)

Mr. M A Liyana arachchi, Ms. D M D Hansani

DLTC Overall Prize List-2016

| | | |
|------------------------|---|-----------------------------|
| First in batch | - G C N Jayasuriya Award | - Ms. H G J Chandima |
| Second in batch | - Dr. Shentheshanmuganathan Appreciation Award | - Mr. M R A Rameez |
| Third in batch | - CCS Award | - Ms. F Z Shamil |

| | |
|---|-----------------------------|
| Rohan K Fernando Prize for the Best Performance in Industrial and Food Chemistry | - Ms. H G J Chandima |
| P. D. Luckmal De Zoysa Prize for the Best Performance in Clinical Lab Technology | - Mr. M R A Rameez |

Diploma in Laboratory Technology in Chemistry Award for Overall outstanding performance in 2016

- Ms. P A C K Pasyala

46th Annual Sessions of the Institute of Chemistry Ceylon 2017

Theme:
Role of Chemists for a Better Tomorrow

Date: June, 2017

CALL FOR ABSTRACTS AND EXTENDED ABSTRACTS

Last Date for receiving abstracts and extended abstracts is 31st January 2017

AWARDS 2017

The following awards will be presented at the Annual Sessions 2017 of the Institute of Chemistry Ceylon.

- **Dr. C L de Silva Gold Medal Award**

Awarded for an outstanding research contribution in any branch of Chemical Sciences and/ or the use of such research for National Development during the last five (5) years in Sri Lanka. Credit will be given for the utilization of local raw materials, and where the contribution has already resulted in (i) a publication in a Citation Indexed Journal or (ii) Registering a Patent or (iii) where the contribution has already resulted in a positive impact in the development and innovation in the industry.

- **INSTITUTE OF CHEMISTRY SILVER MEDALS**

Devanathan Memorial Award

Awarded for an exceptional research contribution of an original nature in the field of Physical Chemistry and/or related areas, such as Physical-Inorganic, Physical-Organic and Biophysical Chemistry.

Chandrasena Memorial Award

Awarded for an exceptional research contribution of an original nature in the field of Organic Chemistry and/or related areas such as Biochemistry, Pharmacognosy, Molecular Biology and Bioactivity studies.

Ramakrishna Memorial Award

Awarded for an exceptional research contribution of an original nature in the field of Inorganic and/or Analytical Chemistry and/or related areas such as Bio-inorganic Chemistry or Bio-analytical Chemistry.

- **INSTITUTE OF CHEMISTRY BRONZE MEDALS**

Kandiah Memorial Awards

Awarded for the best research contribution in Chemistry carried out by a postgraduate student registered for a postgraduate degree by either course work or/ and research at a Higher Educational Institute in Sri Lanka and for work carried out in Sri Lanka, with the exception of special analysis that cannot be done in the country. Such results should be less than 20% of the findings from the work. Sandwich programs carried out partially abroad do not qualify for the award.

Kandiah Award for Basic Chemistry

For research predominately in basic Chemistry (Organic, Inorganic, Physical, and Analytical).

Kandiah Award for Applied Chemistry

For research in Chemistry related areas such as polymer, food, biochemistry, biotechnology, where interdisciplinary research is involved and provided that chemistry has a central role and comprises at least 50% of the content.

Kandiah Memorial Graduateship Award

For the best piece of research in the Chemical Sciences carried out by a Graduate Chemist of the College of Chemical Sciences/Institute Chemistry Ceylon registered with a Higher Education Institute for a Post Graduate Degree.

- **Professor M. U. S. Sultanbawa Award for Research in Chemistry**

Awarded for the best research paper presented at the Annual Sessions of the Institute of Chemistry Ceylon, for work carried out and completed in Sri Lanka.

Closing date for receiving applications/nominations for the above awards: 28th February 2017

Further information could be obtained from the Registrar, Institute of Chemistry Ceylon or www.ichemc.edu.lk

PUBLICATIONS OF THE INSTITUTE OF CHEMISTRY CEYLON

| Monograph | Title | Author | Price |
|-----------|---|---|-------------------|
| 01 | Textile Fibers | Mr T Rajasekeram | Rs.50/- |
| 02 | Principles of Food Preservation | Prof U Samarajeewa | Rs.75/- |
| 03 | Biotechnology | Prof C P D W Mathew | Rs.75/- |
| 04 | Recombinant DNA Technology | Prof J Welihinda | Rs.75/- |
| 05 | *Natural Toxins in Foodstuffs | Prof E R Jansz & Ms A S Perera | Rs.50/- |
| 06 | Fat Soluble Vitamins | Prof E R Jansz & Ms S Malavidana | Rs.50/- |
| 07 | Nucleic Acid and Protein Synthesis | Prof J Welihinda | Rs.75/- |
| 08 | Extraction of Energy from Food | Prof J Welihinda | Rs.50/- |
| 09 | Corrosion of Materials | Dr A M M Amirudeen | Rs.75/- |
| 10 | Vitamin C-Have all its mysteries been Unravalled ? | Prof E R Jansz & Ms S T C Mahavithanage | Rs.75/- |
| 11 | *Environmental Organic Chemistry | Prof S Sotheeswaran | Rs.150/- (US \$3) |
| 12 | Enzyme Kinetics and Catalysis | Prof (Mrs) S A Deraniyagala | Rs.100/- |
| 13 | Insecticides | Prof (Mrs) Sukumal Wimalasena | Rs.95/- |
| 14 | Organotransition Metal Catalysts | Prof S P Deraniyagala & Prof M D P De Costa | Rs.75/- |
| 15 | Some Important Aspects of Polymer Characterization | Prof L Karunanayake | Rs.75/- |
| 16 | *Hard & Soft Acids & Bases | Prof (Mrs) Janitha A Liyanage | Rs.65/- |
| 17 | Chemistry of Metallocenes | Prof Sarath D Perera | Rs.65/- |
| 18 | Lasers | Prof P P M Jayaweera | Rs.65/- |
| 19 | *Life and Metals | Prof (Mrs) Janitha A Liyanage | Rs.75/- |
| 21 | *Silicones | Prof Sudantha Liyanage | Rs.65/- |
| 22 | *Pericyclic Reactions: Theory and Applications | Dr M D P De Costa | Rs.65/- |
| 23 | Inorganic NMR Spectroscopy | Prof K S D Perera | Rs.65/- |
| 24 | Industrial Polymers | Prof L Karunanayake | Rs.75/- |
| 25 | *NMR Spectroscopy | Dr (Mrs) D T U Abeyunga | Rs.65/- |
| 26 | Mosquito Coils and Consumer | Ms D K Galpoththage | Rs.100/- |
| 27 | *Atomic Absorption Spectrometry | Prof K A S Pathiratne | Rs.100/- |
| 28 | Iron Management on Biological Systems | Prof (Ms) R D Wijesekera | Rs.100/- |
| 29 | Nutritional Antioxidants | Prof. (Mrs) Sukumal Wimalasena | Rs.100/- |
| 30 | *f-Block Elements | Prof Sudantha Liyanage | Rs.65/- |
| 31 | *Scientific Measurements and Calculations | Prof (Mrs) S A Deraniyagala | Rs. 80/- |
| 32 | Applications of Organometallic compounds in Organic Synthesis | Dr. Chayanika Padumadasa | Rs. 60/- |
| 33 | Organosulfur Compounds in Nature | Prof. S Sotheeswaran | Rs. 200/- |

* - Second Edition /new print published on popular demand

CCS Publications

| | | | |
|----|---|---|-----------|
| 01 | Functional Group Analysis in Organic Chemistry | Prof AAL Gunatilake & Prof S Sotheeswaran | Rs. 175/- |
| 02 | Zinc Metalloproteins | Prof (Ms) R D Wijesekera | Rs. 175/- |
| 03 | Conformational Analysis and Reactivity of Organic Molecules | Prof S Sotheeswaran & Dr. (Ms) H I C de Silva | Rs. 175/- |
| 04 | Marine Organic Chemistry | Prof S Sotheeswaran | Rs. 175 |



General Publications

- ★ Historical Accounts of the Educational Activities (1972 - 2004) (Rs.350/-)
- ★ Polymer Industries of Sri Lanka (Rs. 200/-)
- ★ Industry & Environment (Rs. 200/-)
- ★ Herbal Medicine Phytopharmaceuticals and Other Natural Products: Trends and Advances (Rs. 500/-)
- ★ Chemistry in Sri Lanka (Rs. 150/-)



RSC NEWS

THE ROYAL SOCIETY OF CHEMISTRY SRI LANKA SECTION

1. Membership

According to the records sent to us from the parent body, a breakdown of the membership is as follows:-

| Category | Number |
|---|------------------|
| CChem, FRSC | 08 |
| FRSC | 02 |
| Chem, MRSC | 08 |
| MRSC | 26 |
| AMRSC | 12 |
| Affiliate /Under Graduate. | <u>10</u> |
| Total Membership as at July 2016 | <u>66</u> |

2. Committee of Management

The following were elected to the Committee at the 55th Annual General Meeting held in July 2016.

Hony. Chairman - Mr S Perasiriyana
Hony. Secretary - Dr W G Piyal Ariyananda
Hony. Treasurer - Mr. I M S Herath

Committee Members -

Mr. R M G B Rajanayake
 Prof. Sudantha Liyanage
 Dr. Poshitha Premarathne
 Dr. M Sirimuthu
 Dr. P Iyngaran
 Mr. Sulith Liyanage
 Mr. Wasantha Samarakoon
 Mr. Viraj Jayalath

Co opted Members

Dr. M.K. Deeyamulla
 Prof. W S Fernando
 Mr. T M Kumara

3 Activities

3.1 Contributions to Activities of the Institute of Chemistry Ceylon

- (a) Full page advertisement of "Chemistry in Sri Lanka".
- (b) Contribution for the Interschool Chemistry Quiz
- (c) Award for the Best Performance at the Graduateship Examination in Chemistry Levels 3/4 Theory Examination
- (d) Have an exhibition stall in CHEMEX 2017 – Chemistry Exhibition Planned to be held in January 2017

3.2 All - Island Inter School Chemistry Essay Competition.

3.3 Inter University Chemistry Essay Competition

3.4 Book donation programme

3.5 A/L Teacher training workshop

3.6 Advanced Level Chemistry Seminar

3.7 Industrial Visit for B.Sc. Special degree students, M.Sc. students and RSC Members

3.8 Collaboration with SLAAS E-2 workshop and seminars

3.9 Supporting Chemical Societies of Universities in Sri Lanka

Dr Piyal Ariyananda
Hony Secretary

CCS Analytical and Consultancy Services

We are happy to announce that the following services are provided by the College of Chemical Sciences (CCS), the educational arm of **Institute of Chemistry Ceylon**.

The H D Gunawardhana Instruments Center of the College is equipped with the following advanced instruments.

Gas Chromatograph
(GL sciences 4000, Japan)



Atomic Absorption Spectrometer with flame
and Graphite furnace
(Hitachi ZA 3000)



Fluorescence Spectrophotometer
(Hitachi, F 2700)



FT-IR spectrophotometer
(ABB MB 3000)



UV- Visible Spectrophotometer
(Hitachi U 2910)



TOTP- H 50 ml High Temperature-
High Pressure Reactor

For the Industry

- Consultancy Services
- Method Development
- R&D services

Analytical Services Offered

- Water Quality Parameters (DOD, BOD, COD, pH, Conductivity, Hardness, turbidity, Nitrate, Nitrite, and Total Nitrogen etc).
- Food and Nutrient Analysis.
- Analysis of specific chemicals in various samples.
- Analysis of heavy metals
- Analysis of paint, textile dyes, pigments etc

Contact any of the following officials for your requirements of Analytical/ Consultancy Services

The Management Committee on Analytical and Consultancy Services

Prof. MDP De Costa, Senior Professor, (Academic laboratory and Analytical / Consultancy Services Coordinator)

Dr. USK Welivegamage, Senior Lecturer

Dr. C Udawatte, Senior Lecturer

Dr. U K Jayasundara, Senior Lecturer

Tel: 011 2861231, 2861653, 4015230