

## CURRICULUM VITAE (January 2012)

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## ONE PAGE BRIEF C.V.

### **Professor Thomas Ming Swi Chang , O.C.,M.D.,C.M.,Ph.D.,FRCP(C), FRS(C)**

Founder and Director of the Artificial Cells & Organs Research Centre, of the Departments of Physiology, Medicine & Biomedical Engineering, Faculty of Medicine, McGill University, Montreal, Quebec, Canada. He is also Honorary Professor, Peking Union Medical College, Beijing, China, Honorary Professor, Blood Transfusion Institute of the Chinese Academy of Medical Sciences and Honorary Professor, Nankai University, Tianjin, China. His other international academic activities include: Honorary President & Editor in Chief, Artificial Cells, Blood Substitutes & Biotechnology; Honorary President International Academy of Nanomedicine; Editor in Chief, Book Series on Regenerative Medicine, Artificial Cells & Nanomedicine.

While an honors B.Sc. undergraduate at McGill, he invented and prepared the first artificial cell (Chang, honors Physiology research report, 1957). He continued this work while in medical school, and then for his Ph.D., in the Department of Chemistry and then Physiology at McGill. During this time, he demonstrated in more detail the potential of artificial cells in biotechnology, nanotechnology and medicine and published the first paper on this topic as the sole author (Chang, **Science**, 1964). After his Ph.D.(1965), he continued on his research and published a number of papers during his early career including Chang & Poznansky, **Nature**, 1968; Chang, **Nature**, 1971, Chang, **Monograph on Artificial Cells** 1972. He now has more than 500 full papers and 20 books. He received career awards from the Medical Research Council of Canada (MRC) first as a MRC scholar (junior career award) (1965-68) and then the prestigious life time award of MRC career investigator (1968-1999 when the program ended as MRC became CIHR). He rose at McGill from assistant professor (1966) to associate professor in 1969 and to full professor in 1972.

Chang has been called the “Father of Artificial Cells”. In 1957, he was the first to use nanotechnology and nanobiotechnology to prepare artificial cells containing biologically active material with 100-200 nanometer membrane thickness polymers, crosslinked proteins or other membranes. Artificial cells can be prepared in the micro, nano or soluble nanodimension complexes. Recent advances in molecular biology, cell biology, biotechnology, nanotechnology, nanobiotechnology, stem cells and other areas have led to rapid developments in the use of artificial cells for nanomedicine, nanobiotechnology, gene therapy, enzyme therapy, cell/stem cell therapy, regenerative medicine, blood substitutes, liver support systems and even in agriculture, aquatic culture, fermentation industry, food industry, nanorobotics and other areas.

Initially, as biotechnology was not yet an area of world interest, Chang used nanotechnology of ultrathin polymeric membrane to developed artificial cells containing adsorbents for hemoperfusion and the effectiveness of his clinical trials in patients resulted in FDA approval. This approach has been a routine treatment for acute poisoning since then, especially in regions where dialysis facilities are not easily available. This has been extended to hemoperfusion using immunosorbents. Many groups have also extended his idea of artificial cells for use in drug delivery systems including the use of microcapsules, microparticles, nanocapsules, nanoparticles, liposomes, etc. The HIV epidemic and concerns over contaminated blood have stimulated a number of groups to develop Chang's earlier idea of blood substitutes, including nanobiotechnology based polyhemoglobin. He is using nanobiotechnology to develop second generation and third-generation blood substitutes to solve problems encountered in Phase III clinical trials. Recent interest and progress in biotechnology, molecular biology and stem cells, has allowed the development of his other earlier basic research. For example, bioencapsulation of cells is being developed around the world for diabetes, liver failure, kidney failure, genetic diseases, endocrine diseases, cancer. More recently, his group has been studying the use of artificial cells containing bone marrow stem cells to successfully allow the regeneration and recovery of rats with only 10% of functioning liver.

He has received a number of awards starting with the 1969 “Inaugurate First Incentive Lecturership” in Sweden (given at Karolinska Institute, Lund Univ and Gothenburg Univ Hospital), followed by others including Clemson Award, Silver Medal Award of Bologna Univ, First Julius Silver Lectureship of Technion, Confederation Medal Award, Queen Elizabeth 25<sup>th</sup> Jubilee Medal, ISBP Annual Award, Virage Award, ISBS Special Award for artificial cells and Blood Substitutes, First “Outstanding Research Award” of the Int Academy of Nanomedicine. He also received the highest Canadian civilian decoration of Order of Canada, for his invention of Artificial Cells. He has been nominated for Nobel Prize in Medicine and Physiology and also for Nobel Prize in Chemistry.

His detailed C.V., publication list and research are available on his McGill website: <http://www.artcell.mcgill.ca>. These include his 1972 monograph on “Artificial Cells” ; [Nature Review Drug Discovery, 4:221-235 \(2005\)](#) and his 2007 Monograph on “ARTIFICIAL CELLS: biotechnology, nanotechnology, blood substitutes, regenerative medicine, bioencapsulation, cell/stem cell therapy”

He was voted as the Greatest McGillian in McGill University’s 190 years history – from a total of 700 nominee and 20 finalists. <http://publications.mcgill.ca/mcgillnews/2011/12/07/the-greatest-of-the-greats/>

張明瑞教授 - 1933 年出生於中國廣東省汕頭市. 在汕頭完成了小學和在香港完成了中學後，就進入了加拿大著名的麥基爾大學進修醫科. 1957 年張明瑞教授仍然是加拿大滿地可市的麥吉爾大學生理學的本科生，他就成功地發明了世界上第一人造細胞』，被譽為『人造細胞之父』『人造細胞』是微米系統和納米系統的原始. 他的發明引致了『人造細胞』在納米醫學、納米生物技術、基因治療、酶療法、細胞/幹細胞治療、癌症治療、再生醫學、血液代用品、和肝臟支持系統上的應用。它甚至產生了對農業，水產文化，發酵工業，食品工業，生物技術，納米機器技術等諸多領域發展的影響

• 以下是張明瑞教授部分的簡歷：

- 1957 年，『人造細胞』的研製成功
- 1957 年，學士學位 (B. Sc., 麥吉爾大學)
- 1961 年，醫學博士學位(MDCM, 麥吉爾大學)
- 1965 年，博士學位(Ph.D, 麥吉爾大學)
- 創辦主任 - 麥吉爾大學『人造細胞及器官研究中心』
- 加拿大皇家醫學院院士 FRCPC
- 加拿大皇家學會院士 FRS(C)
- 名譽教授 - 中國協和醫科大學
- 名譽教授 - 輸血研究所, 中國醫學科學院
- 名譽教授 - 南開大學(中國天津)
- 1991 年- 獲頒發加拿大勳章 O.C.
- 出版：20 多本書及 500 多論文
- 講學：應邀請在世界各地舉行了 500 多個講學。

2011 年被選為『麥基爾大學 190 年历史中最傑出人物』

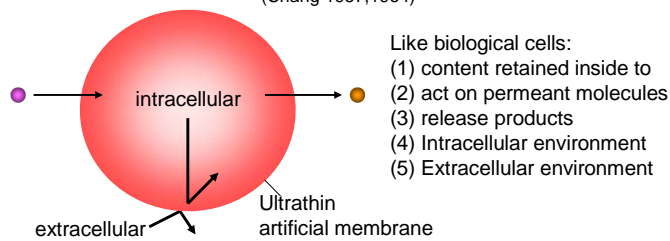
<http://publications.mcgill.ca/mcgillnews/2011/12/07/the-greatest-of-the-greats/>

## ARTIFICIAL CELLS: FROM BASIC RESEARCH TO APPLICATIONS

While an undergraduate at McGill, Chang prepared the first artificial cell (Chang, honors Physiology research report, McGill Medical Library 1957). He continued this work while in medical school, and Ph.D., and showed in more detail the potential of artificial cells and published the first paper on this topic (Chang, **Science**, 1964). After his Ph.D.(1965), he continued on his research (Chang & Poznansky, **Nature**, 1968; Chang, **Nature**, 1971 and Chang, **1972 Monograph on Artificial Cells** 1972). The initial research on artificial cell (Chang, 1957, 1964) forms the basic principle that has been extended for use in many areas by many groups (Chang **Nat.Rev.Drug Disc.** 2005, Chang **2007 Monograph on Artificial Cells**, [www.artcell.mcgill.ca](http://www.artcell.mcgill.ca) 2012).

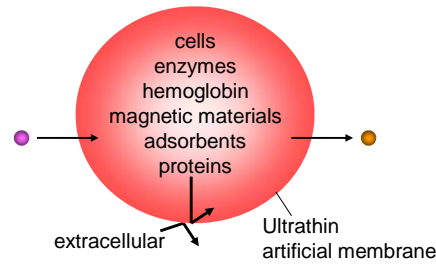
### Basic principle of early Artificial Cells

(Chang 1957,1964)



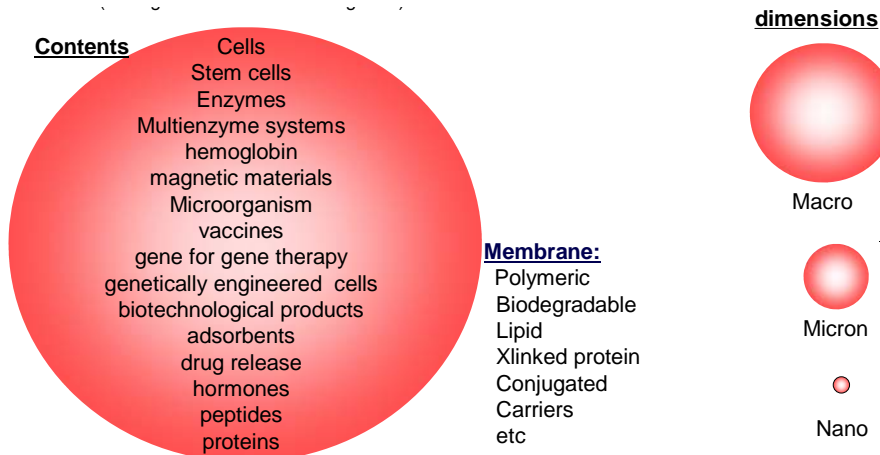
### Types of early Artificial Cells

(Chang 1957 to 1966)



### Present status of Artificial Cells

(Chang 2005 Nature Rev Drug Disc)



### **Basic features of Artificial Cells (as show in above figure):**

- (1) Artificial cells can contain the same biological material as biological cells: including hemoglobin and all red blood cell enzymes, microsomes, cytosol, polymerases, ribosomes and transcription/transolation system. In addition, they are more versatile since adsorbents, magnetic materials, drugs, cells, stem cells, enzymes, multienzyme systems, multi-compartment systems, hemoglobin, microorganism, vaccines, gene for gene therapy, genetically engineered cells, hormones, peptides, and many other materials can also be included separately or in combination.
- (2) In addition to being of cellular dimensions in the micron range, they can also be in the macro range, in the nano range or in the nanobiotechnological range
- (3) Membrane of artificial cell separates its content from the outside, but at the same time the membrane can be prepared to selectively allow different types of molecules to cross. For example, one can prepare artificial cell membranes that selective allow the movement of molecules according to molecular size, lipid solubility, affinity to carrier mechanisms etc.

By selecting the proper membrane material, the permeability can range from membrane that does not allow any molecules to cross to those that allow even very large molecules like proteins to cross. The membrane material includes polymer, biodegradable polymer, lipid, crosslinked protein, lipid-polymer complex, lipid-protein complex and membrane with transport carriers.

- (4) Surface properties of artificial cell membrane can be varied by (1) incorporation of negative or positive charge; (2) incorporation of albumin to increase blood compatibility; (3) incorporation of antigens to bind antibodies or antibodies to bind antigen; (4) incorporation of polysaccharide like heparin or polyethylene glycol (PEG) to increase compatibility or retention time in circulation.
- (5) The artificial cell membranes can be ultrathin and yet strong. There is a large surface area to volume relationship. For example 10 ml of 20  $\mu\text{m}$  diameter artificial cells has a total surface area of 2,500  $\text{cm}^2$  that is the same as that in an artificial kidney machine. Since the artificial cell membrane is also 100 times thinner, permeant molecules can potentially move across 10 ml of 20  $\mu\text{m}$  diameter artificial cells 100 times faster than that across the artificial kidney machine [Chang, 1966]. In addition, the microscopic size of artificial cells allows material to diffuse rapidly inside the artificial cells.

### **Research into the applications of artificial cells**

Initially, as biotechnology was not yet an area of world interest, Chang used the feature in (5) above. This is the use of nanotechnology of ultrathin polymeric membrane to developed artificial cells containing adsorbents for hemoperfusion for the treatment of poisoning. His clinical trials in patients resulted in FDA approval. This has been a routine treatment for acute poisoning, especially in regions where these are much less costly than dialysis. Terman and later Yu and others have extended this to hemoperfusion using immunosorbents.

Many groups have also extended artificial cells for use in drug and gene delivery systems calling these artificial cells by different names of microcapsules, microparticles, nanocapsules, nanoparticles, liposomes, polymersomes, etc. Our use of artificial cells containing magnetic material has also been developed by other groups for drug delivery, biosensors and bioreactor.

The HIV epidemic and concerns over contaminated blood have stimulated a number of groups to develop Chang's earlier idea of blood substitutes, including nanobiotechnology based polyhemoglobin. Others have developed his principle of polyhemoglobin for clinical trials. The high incidence of HIV in South Africa has lead this country to approve the routine clinical use of polyhemoglobin in patients. For more wide spread use in other countries, we and other groups are extending this using nanobiotechnology to develop second generation and third-generation blood substitutes.

His basic research on bioencapsulation of enzymes and cells has been developed by him and others around the world for diabetes, liver failure, kidney failure, genetic diseases, endocrine diseases, cancer. Further research is needed to allow for more than one year of function after implantation. His group has recently shown that only 2 weeks of function is needed, when using artificial cells containing bone marrow stem cells for liver regeneration. This way, one implantation results in the regeneration of liver and recovery of rats with 90% of liver resected. Another recent approach is his group's use of artificial cells containing enzymes or cells for oral administration. This way, each artificial cell works as a microdialyser/bioreactor as it travels down the intestinal tract. We have used this for enzyme replacement therapy. We also study the use of oral administration of artificial cells containing cells to remove unwanted metabolites. Other groups are developing our basic finding for clinical trials in patients.

These and other areas of applications including agriculture, industry, aquatic culture, nanocomputers, nanorobotics being developed by others are summarized in Table I:

## TABLE I: ARTIFICIAL CELL: applications

Chang (2005) Nature Review: Drug Discovery

Chang (2007) Artificial Cell Monograph

Chang (2009) [www.artcell.mcgill.ca](http://www.artcell.mcgill.ca)

Hemoperfusion  
Drug delivery  
Blood Substitutes  
Enzyme & gene therapy  
Cell & Stem Cell Therapy  
Biotechnology & Nanobiotechnology  
Nanomedicine  
Regenerative medicine  
Agriculture, Industry, Aquatic culture  
Nanocomputers and nanorobotics  
Nanosensors etc

### Perspectives:

*“Artificial Cell is not a specific physical entity. It is an idea involving the preparation of artificial structures of cellular dimensions for possible replacement or supplement of deficient cell functions. It is clear that different approaches can be used to demonstrate this idea” (From Chang 1972 Moonography).* Since that time, the idea of artificial cells has progressed way beyond this 1972 prediction. Each major progress in other areas has led to stepwise progress in artificial cells. First there is the coming of age of polymer chemistry and biomaterial. Then there is increasing interest in biotechnology and nanobiotechnology. Then there are ongoing important progress in molecular biology and genomics. Examples of the ongoing development and extension of “artificial cells include nanoparticles, nanotubule, lipid vesicles, liposomes, polymer tethered lipid, polymersome, microcapsules, bioencapsulation, nanocapsules, nanosensor, macroencapsulation, red blood cell mimicks, polyhemoglobin, conjugated hemoglobin, synthetic cells and others. One can expect that there will be other future important progress in developments and extensions.

### Further readings:

This centre’s McGill University Website: [www.artcell.mcgill.ca](http://www.artcell.mcgill.ca) **free complimentary access to** \*Chang 1972 Monograph on Artificial Cells

\*Chang 2007 Monograph on ARTIFICIAL CELLS: biotechnology, nanotechnology, blood substitutes, regenerative medicine, bioencapsulation, cell/stem cell therapy.

\* Review articles, video interview etc

### DEGREES:

1957 B.Sc. (Honours Physiology) McGill University ("invented" artificial cells while an undergraduate student on honours research project). .  
1961 M.D., C.M. Faculty of Medicine, McGill University.  
1965 Ph.D. (on artificial cells including blood substitutes), Departments of Chemistry & Physiology, McGill University.  
1972 F.R.C.P.(C), Medical Sciences, Royal College of Physicians and Surgeons of Canada (based on examination of research and clinical trials on artificial cells).  
2003 F.R.S.[C]. Fellow of the Royal Society of Canada

## APPOINTMENTS AT MCGILL UNIVERSITY

### (1) RESEARCH

- 1962-1965 Medical Research Council of Canada Research Fellow, Department of Chemistry then Department of Physiology
- 1965-1968 Medical Research Council of Canada Scholar (career development award),  
1968- 1999 Medical Research Council of Canada Career Investigator, (laboratory research and clinical trials). Until MRC's Career Investigator Program ended in Dec 1999.
- 1975-1978 Director, Artificial Organs Research Unit, Department of Physiology, McGill University
- 1978-1979 Director, Artificial Organs Research Unit, Faculty of Medicine, McGill University
- 1979-ongoing Director, Artificial Cells and Organs Research Centre, McGill University.  
1985 "Virage" Award of Centre of Excellence in Biotechnology from Quebec Ministry of Science and Education (Chang-principal investigator). Application ranked first among the large number of applicants in the opening round of this award in 1985. The 5-year review of the "Virage" Award in 1990 was successful and it became permanently integrated into the centre as salaries for 4 tenure-track professors for this centre – now integrated into the salary budget of the university (Chang - principal investigator)
- 2002- 2008 Principle investigator, MSSS-FRSQ Research Group on Blood Substitutes in Transfusion Medicine . Maximal length is 6 years. The Quebec Ministry of Health (MSSS) has implemented the Federal Government's Krever Commission Recommendation to improve the safety of blood supply and to increase research and development in related area including the establishment of research groups. The peer review committee of MSSS jointly with the Quebec Medical Research Council (FRSQ) has selected our application as the first research group supported under this effort.

### (2) ACADEMIC APPOINTMENTS AT MCGILL

#### Physiology

- 1965-1966 Lecturer of Physiology, McGill University
- 1966-1969 Assistant Professor of Physiology, McGill University
- 1969-1972 Associate Professor of Physiology, McGill University
- 1972-2007 Professor of Physiology (tenured since 1975), McGill University
- 2007- ongoing Emeritus Professor of Physiology, McGill University

#### Medicine

- 1972-1975 Assistant Professor of Medicine and Clinical Medicine, McGill University and Royal Victoria Hospital (clinical trials)
- 1975-2007 Professor of Medicine (tenured), McGill University and Royal Victoria Hospital (clinical trials)
- 2007-- ongoing Emeritus Professor of Medicine, McGill University & Royal Victoria Hospital

### **Chemical Engineering and Chemistry**

- 1983-2002 Associate of Chemical Engineering, McGill University (Until Biomedical Engineering Department's Ph.D. program was approved. Before this, half of his Ph.D. students graduated from the Department of Chemical Engineering).
- 1985-2000 Associate of Chemistry, McGill University (Until Biomedical Engineering Department's Ph.D. program was approved)

### **Biomedical Engineering** (Department formed in 1990)

- 1990-2007 Professor of Biomedical Engineering (tenured)
- 2007- ongoing Emeritus Professor of Biomedical Engineering.

### **(3) COMMUNITY HOSPITAL: Montreal Chinese Hospital (voluntary free service)**

- 1966-until Medicare well established and staff hired. Voluntary service as Director of Medical Board and Director of Laboratory, until medicare started
- 1968-1981 Consultant
- 1982-1987 Honorary Consultant
- 1987- ongoing Honorary Staff

### **OTHER ACADEMIC APPOINTMENTS**

- 1983- Honorary Professor, Nankai University, Tianjin, China
- 2007- Honorary Professor, Peking Union Medical College, Beijing, China
- 2007- Visiting Professor, Northwest University, Xian, China
- 2008-2010 Guest Professor, Shantou University, Shantou, China

## **PUBLISHED COMMENTS BY OTHERS:**

**Quoted from "Orive et al, Nature Medicine 2003, 9:104-107"** In 1964 (Science 146, 524-525), T.M.S. Chang proposed the idea of using ultrathin polymer membrane microcapsules for the immunoprotection of transplanted cells and introduced the term "artificial cells" to define the concept of bioencapsulation....."

### **From the United Kingdom journal, New Scientist June 3 1989:**

In 1957, Thomas Chang was completing his final year as an undergraduate at McGill University in Montreal. He wondered what would make a good research project..... His answer was both elegantly simple and intellectually ambitious. He would make the first artificial cell..... His undergraduate research project has grown into a dynamic field of biomedical research and development....worldwide. Although the study and use of artificial cells is now a sophisticated marriage of microbiology, chemistry and biotechnology, the concept remains as straightforward as Chang's original notion.

Theoretically, an artificial cell can contain virtually anything: oxygen, drugs, enzymes, antibodies, cell extracts and even cells themselves....Researchers can now create artificial cells with roughly 30 different polymers, as well as several kinds of proteins. ....in 1961(Bangham) also added lipids to the list of construction material for membranes...called "liposomes"

### **From the Journal of the British Royal Society of Chemistry , "Chemistry in Britain" 1989:**

Professor Tom Chang always believed artificial cells would prove as valuable a tool in medicine as ..... but when he started work in the 1950's he was ploughing a lone furrow. In the past five years "designer cells" have become fashionable attracting money for research that has been rewarded with unexpected results.

Chang is credited with inventing microencapsulation, the technique that enables functional biochemistry to be held inside artificial membranes so they can emulate both in vitro and in vivo the behaviour of some natural cells. "Artificial cells" already have many medical applications..... chronic renal failure, drug poisoning, liver failure, enzyme therapy and metabolic function replacement.

He told Chemistry in Britain: "When I first started work it was considered too far-fetched, but by 1966 when I demonstrated the value of artificial cells in hemoperfusion and detoxification there was a surge in interest and curiosity. .... Since 1985 interest in artificial cells and especially modified hemoglobin as a blood substitute has taken off".

### **Quoted from "American Medical News(American Medical Association)" Nov 16, 1998:(by Mark Moran):**

"For nearly 40 years, Dr. Chang has pursued the development of artificial blood, and his work has laid the foundation for products that may be available in coming years. These products, however, are not true red blood cells but modified hemoglobin molecules for short-term transport of oxygen ..... Today, Dr. Chang is working on products that more closely resemble nature's own creation....."

### **Quoted from "Blood Weekly",U.S.A. 1996:**

The conference (VI International Symposium on Blood Substitutes,1996, McGill University) coincides with the 40 year anniversary of Chang's initial efforts back when he was a student at McGill University. This started what might be termed the modern approach of red blood cell substitutes. The year 1996 also is 175th anniversary of McGill University, where Chang and his colleagues have been instrumental in advancing the field of blood substitute research.

### **From Modern Drug Discoveries, ACS Publications, March 2001, Vol. 4 No. 3, pp 45-46:**

The first encapsulated cells were developed as far back as the 1960s, when T.M.S. Chang and colleagues first reported the development of semipermeable aqueous microencapsulation of cells. The vision of using these cells for therapeutic purposes was present from the start..... Several polymeric encapsulation systems have been developed or are currently being tested in clinical trials.... Many research groups are examining the use of biocompatible semipermeable membranes to surround the encapsulated cells,

**From Nature Medicine, “Cell encapsulation: promise and progress” G. Orive et al 2003 9:104-107**

In 1964 Chang (Chang. **Science** 146(3643):524-525) proposed the idea of using ultrathin polymer membrane microcapsules for the immunoprotection of transplanted cells and introduced the term “Artificial Cells” to define the concept of bioencapsulation. Since then ..... bioencapsulation has provided a range of promising therapeutic treatments for diabetes, hemophilia, cancer and renal failure.

**From 50<sup>th</sup> Anniversary Special Gold Edition of the Official Journal of The American Society for Artificial Internal Organs 2003** They selected 25 landmark papers published between 1955-2003 and reproduced these in this Gold edition and one of these is from Chang 1966. The editorial comments (page 43): ....Chang is the originator of “artificial cells”...for medical applications such as related to the artificial kidney, artificial liver, detoxification, enzyme therapy etc... in addition... he is also recognized for his work in the artificial blood field on hemoglobin type products. (Other selected included Kolff, inventor of artificial kidney; Scribner for chronic hemodialysis; Gibbon on heart-lung machine; Cooley first human implant of artificial heart; Kantrowitz on intraaortic balloon pumping; Kolobow on oxygenator)

**EXPERIENCE IN RESEARCH, DEVELOPMENT & CLINICAL TRIALS:**

- ◆ **Invention of artificial cells:** including microencapsulation of biologically active materials and blood substitute while a final year B.Sc. student at McGill University in 1956 – published this as a 1957 research report to McGill available at the McIntyre Medical Library. Parttime independent research on artificial cells during premedical and medical school. Starting winter of 1956 and continued to 1961 then on a full time basis starting in 1992 to present.
- ◆ **First paper in this area in Science, 1964** After medical school and internship, continued with this research in the Chemistry Department and Department of Physiology and obtained a Ph.D. in 1995. This resulted in the first demonstration of the detailed methodology, in vitro feasibility and in vivo feasibility of artificial cell. Published the first paper in the area of artificial cells including blood substitutes (Chang, Science, 1964).
- ◆ It is only in the last 10 years that many of his original ideas on artificial cells are being increasingly applied and extended by him and researchers around the world. This is because many of his original ideas were reported years before the modern era of nanotechnology, regenerative medicine, blood substitutes, biotechnology, gene therapy, stem cell therapy, cell therapy and other areas. The editor of Nature Review Drug Discovery worked out a time line for Chang’s 2005 review on “therapeutic applications of polymeric artificial cells” [www.artcell.mcgill.ca/2005NatureRev.pdf](http://www.artcell.mcgill.ca/2005NatureRev.pdf) and shows that Chang has made 20 of the 23 major discoveries in related areas. This is reflected in his having been nominated twice for the Nobel Prize in the last 10 years and also elected to fellow of the Royal Society of Canada

(FRSC). The official publisher of the Nobel Prize Award Lectures has invited him to prepare a monograph on “Artificial Cells: biotechnology, nanotechnology, blood substitutes, regenerative medicine, bioencapsulation, cell/stem cell therapy” for 2007, the 50<sup>th</sup> anniversary of his invention of artificial cells while an undergraduate in this department at McGill. This will be the first book in a new book series on “Regenerative Medicine, Artificial Cells and Nanomedicine” and he will be the editor-in-chief of this book series.

- ◆ **Nanomedicine and Nanobiotechnology:** Researchers in the academic world of nanomedicine considered his work as the forerunner of nanomedicine and nanobiotechnology and elected him to be the founding president of the International Academy of Nanomedicine (2009) including their first “Outstand Research” Award at their 2009 World Congress.
- ◆ **Hemoperfusion: invention, animal testing, clinical trials and successful transfer of technology** In 1966, he invented the use of artificial cells containing detoxicants for hemoperfusion – perfusion of patient’s blood through a column of artificial cells. He personally carried out scaled up, animal testing and clinical trial in patients. He showed the safety and effectiveness for treating patients with drug poisoning, kidney failure and liver failure. This led to extensions and productions by centres and companies around the world. Despite offers from many major companies outside Canada, he chose to do this in Montreal with a small Canadian start up company. Since he held no stock or interest in this company he was able to test the products in animal and clinical trial in patients. His results led to F.D.A.’s approval for routine use. He assigned the inventor’s income for this to support this research center. This product is more successful than those produced by larger industries (Smith Nephew, Gambro, etc) – as a result, it was bought over by the National Medical Care, New Jersey, U.S.A. (now a subsidiary of Grace Co.). Right from the beginning, he formed an international symposium series rotating around the world including Montreal, UK, China, Germany, Russia, Israel, Japan, Turkey and Mexico, to freely stimulate others to develop this. As a result hemoperfusion devices are produced in China, Russia, Italy, UK, U.S., Sweden, Japan and other countries around the world. This is especially useful in regions where dialysis facilities are not readily available for treating poisoning with sleeping pill and other medications. In a recent visit to China, they have used this to save thousands of accident poisoned patients. The Chinese AIER company has been manufacturing this device for many years. Furthermore it has been extended by researchers in China into hemoperfusion systems in routine clinical uses for immunological diseases like lupus erythematosus etc.
- ◆ **Blood Substitutes:** In the mid 1980’s, worries regarding HIV in donor blood have resulted in extensive development and extensions around the world on blood substitutes. The most successful ones are based on nanotechnology based polymerized hemoglobin, an idea shown by Chang in his 1964 Science paper and also in a later 1972 paper on glutaraldehyde crosslinking. Despite invitation from a major U.S. company, he chose to be one of the scientific advisors for a small Canadian start up company, Hemosol, that then decided to work on another modified hemoglobin. However, his nanobiotechnology based glutaraldehyde polymerized hemoglobin principle is now the most successful one being independently developed and produced by two companies in the U.S. and the only two still in Phase III clinical trial using more than 10 litres in each patient. One of these is the first hemoglobin based blood substitutes approved for routine human use in the world in South Africa for their urgent problem related to HIV. However, further developments are needed to prevent problems related to ischemia-reperfusion injuries in some conditions. More recently his team has developed a second generation nanobiotechnology based polyhemoglobin-superoxide dismutase-catalase (D’Agnillo & Chang, Nature Biotechnology, 1998, Powanda & Chang 2002, Chang, 2008, Gu and Chang, 2009, Chang 2009). His 1957 idea of

microencapsulated hemoglobin is now being developed as a third generation blood substitute. Thus, since 1980 many groups around the world have been developing hemoglobin liposomes. More recently, Chang's group is using a new approach of nanotechnology and biodegradable polymer to form nano artificial rbc that have a circulation time that is more than doubled that of polyhemoglobin (Chang et al 2003). For many years, Chang has been coordinating the international effort in the area of blood substitutes as honorary president and editor in chief of the international network: International Society for Artificial Cells, Blood Substitutes & Immobilization Biotechnology and as chairmen, cochairmen and since 2003 honorary president of the International Symposium Series on Blood Substitutes. The next one will be held in Harvard Medical School with Professor Warren Zapol as the symposium president.

- ◆ **Enzyme therapy:** Chang shows that microencapsulated enzymes can be implanted into animals to treat hereditary enzyme defects, acatalesmia (Chang and Poznansky Nature 1968) and for lymphosarcoma using asparaginase (Chang, Nature 1972). The problem was the need for injection. This has now been solved by his basic research that there is a very extensive recycling of amino acids between the body and the intestine (Chang et al 1989). This way, he showed that microencapsulated enzyme given by mouth can remove unwanted amino acids (e.g. Phenylketonuria – PKU). He has helped to encourage developing this for clinical use and an U.S. company has modified this approach for clinical testing. His new ongoing research includes studies on the use of tyrosinase artificial cells and nanobiotechnology based polyHb-tyrosinase for lowering systemic tyrosine to inhibit the growth of melanoma (BL Yu & Chang 2003, Chang & BL Yu, 2004, Melanoma Research J) in mice.
- ◆ **Encapsulation of living cells including stem cells:** He was the first to prepare artificial cells containing living cells to protect the cells from the immunological rejection system of the body (Chang 1964 Science, 1965, Chang et al 1966, Chang 1972). Despite offer from an U.S. company, he chose to help a Canadian company (Conaught Laboratory, Toronto) where Sun then devoted his whole research career on cell encapsulation. With international interest in biotechnology, Chang's proposal is now being extensively investigated by many groups around the world for encapsulating islets (for diabetes) liver cells (for liver failure), genetically engineered cells (for many conditions) and other cells (Nature Medicine Cell encapsulation: promise and progress" G. Orive et al 2003 9:104-107, Chang: Nature Review: Drug Discovery 2005 March). Chang's ongoing research includes the coencapsulation of hepatocytes with stem cells resulting in increased duration of viability after implantation (Liu and Chang 2002-2005). Most recently, they found that artificial cells containing bone marrow stem cells when implanted into 90% hepatectomized rats increases the long term survival significant to 100% vs 11 to 33% in the control and in free bone marrow stem cells (Liu and Chang, 2007, 2009, in preparation)
- ◆ **Oral administration of encapsulated genetically engineered cells** Research by him with his then graduate student (Prakash & Chang, Nature Medicine 1996, Chang Nature Medicine 1997), showed that encapsulated E.coli DH5 cells can be given orally to kidney failure rats to lower their blood urea level. When given orally, the genetically engineered cells remained at all times inside the artificial cells that travel through the intestine where they can remove the unwanted urea. The artificial cells containing E.coli DH5 and the nitrogen from urea, finally passed out in the stool within one day. This avoids the need to inject genetically engineered materials in gene therapy. This will have applications in many clinical areas since it will avoid the need to inject these into the body. However, FDA is still concerned regarding what happens if some genetic engineered cells should leak out into the intestine. Thus, his group has shown the possibility to use artificial cells containing modified lactobacilli that are used in Yougart (Chow, Liu, Prakash and Chang 2003). His graduate student, Dr. Prakash, now an associate professor is now developing this approach in a start up company in ongoing clinical trials.

- ◆ **Other areas including drug delivery, biotechnology, chemical engineering, aquatic culture agriculture, nanorobotics, food industry, cosmetic industry and other areas.** : His work on microencapsulation of biological material has been extended by many research groups and pharmaceutical companies to produce drug delivery systems for drugs, peptides and other biotechnological products. His use of a biodegradation polymer, polylactic acid, for microencapsulation (Chang, Bioengineering, 1972) is now being extended and developed extensively as a drug delivery system as nanoparticles or nanocapsules. Another extension of his work is the use of lipid by Bangham in the UK to form lipid membrane artificial cells – liposome. This also has wide spread applications as other delivery system. Artificial cell is also being developed in other areas of biotechnology, chemical engineering, aquatic culture and other areas.

**Further information on the above items:** can be obtained from the website:  
[www.artcell.mcgill.ca](http://www.artcell.mcgill.ca)

### **PEER REVIEW SUPPORT OF HIS RESEARCH IN THE LAST 10 YEARS (previous years not included here):**

- (1) He held Medical Research Council of Canada's highly prestigious "career investigator award" since 1968, 3 years after his Ph.D. This has been peer reviewed and renewed every 5 years for a total of 31 years. It normally ends at age 65, but MRC continued this until the end of the MRC Career Investigator Program in December 1999.
- (2) 1985- permanent: "Virage" Award of Centre of Excellence in Biotechnology from Quebec Ministry of Science and Education. Application. (Principal investigator: Chang)  
Ranked first among the large number of applicants in the opening round of this award in 1985. The 5-year review of the "Virage" Award in 1990 was successful and it became permanently integrated into the budget for the centre for 4 professorial positions. This has been integrated into the salary budget of the university
- (3) 1965- 2013: Continuing operating grants from the Medicial Research Council of Canada that is now renamed Canadian Institutes of Health Research.. His recent renewal was ranked first by the grant committee for 5 years for the full amount he has applied (1999-2005) and then again ranked first and renewed for another 5 years for the full amount (2005-2009). This was most recently renewed (2009- 2013) again for the full amount requested. (Principle Investigator: Chang).
- (4) Chang held the Bayer/Canadian Blood Service/HemaQuebec peer review research grant starting in 1996 (Principle Investigator TMS Chang) for research on his 3<sup>rd</sup> generation nanobiotechnology based blood substitute. This award is normally for 2 years, but the peer review committee has continued to support the renewal of this grant for a total of 8 years (1996-2004). Since 2004 Chang has included this project as part of the following larger new grant.
- (5) 2002-2008:In 2001, the Quebec Ministry of Health implemented the report of the federal government Krever commission on Blood Supply in Canada and initiated a special Program on "Hemovigillance and Transfusion Medicine" In the first competition of this program through FRSQ, the review committee only approved one d'equipe award. This is for Chang's research on "Blood Substitutes in Transfusion Medicine" (2002-2008) over 3 years for 2002-2005 and renewed for 3 years for 2005-2008. Maximal support is 6 years (Principle Investigator: TMS Chang)

## **OTHER INTERESTS:**

- ◆ Continuing updating on most recent approaches in management, project control, organization, negotiation, interpersonal relationship, techniques in clear writing and speaking
- ◆ Continuing updating on new approaches in microcomputer especially word processing, database, organization, project control, negotiation, graphics, clear writing, and other areas. Also in mobile communications.
- ◆ Classical music, tennis, table tennis, weight training, physical conditioning, books on history and cultural developments and others.

## **EXAMPLES OF KEY OFFICIAL POSITIONS IN INTERNATIONAL SOCIETIES:**

- ◆ Honorary President, International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology (since 1991).
- ◆ President (1994-1996), President-elect (1992-1994), Immediate-past president (1996-98) International Society for Artificial Organs.
- ◆ Honorary member, International Society for Microencapsulation, since 1995.
- ◆ Senior Member, Society of Biomedical Engineering, since 1989.
- ◆ Honorary presidents, Chairman and co-chairman of I(Montreal), II(Italy), III(Israel), IV(Turkey), V(PR China), VI (Mexico), VII (USSR), VIII(Germany), IX (Japan), X (Italy), International Symposia on Hemoperfusion, Sorbent and Immobilized Bioreactants.
- ◆ Congress President, 7th World Congress, International Society for Artificial Organs and 4th International Symposium on Blood Substitutes, 1991.
- ◆ Honorary Congress President, XI Congress, International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology, organized by MIT with Professor R. Langer as Congress President, Boston, 1994.
- ◆ Honorary Congress President, XII Congress, International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology, Congress president: President of the Chinese Academy of Medical Sciences & Peking Union Medical College; Congress co-president: is President of the Chinese Red Cross Society, Beijing, 1997.
- ◆ Chairmen of III(87,Montreal), IV(91,Montreal), VI (96,Montreal) and Co-Chairman of V(93,San Diego,USA), VII(97,Toyko,). VIII(99, San Diego) International Symposia on Blood Substitutes.
- ◆ Honorary President, 2003 IX International Symposium on Blood Substitutes, Tokyo, Japan 2003
- ◆ Honorary President 2005 X International Symposium on Blood Substitutes, Providence, U.S.A. 2005
- ◆ Honorary President, 2007 XI International Symposium on Blood Substitutes, Beijing, China 2007 organized by the Chinese Academy of Medical Sciences and Union Medical College. The symposium chairman is vice-president of the Chinese Academy of Medical Sciences and President of the Union medical College Hospital.
- ◆ Honorary President, 2009 XII International Symposium on Blood Substitutes, Parma, Italy. Symposium president was Professor Mazarrilli of University of Parma, Parma, Italy.
- ◆ Honorary President, 2011 XIII International Symnposiym on Blood Substitutes, Harvard Medical School, Boston, U.S.A. The symposium chairman is Professor Zapol, Professor of Anesthesia and Crtical Care Medicine, Mass General Hospital, Harvard Medical School.
- ◆ Elected to be the Founding President, International Academy of Nanomedicine (2009)

## EDITORIAL BOARDS:

- ◆ Editor-in-Chief (1989 to present), Artificial Cells, Blood Substitutes and Biotechnology, An International Journal, (in 1986 invited to take over and modernize and reorganize the oldest journal in the field originally “Biomaterials, Medical Devices and Artificial Organs”, An International Journal) Marcel Dekker Publisher, N.Y., merged with Taylor and Francis since 2005.
- ◆ Editor-in-chief of a new book series on “Regenerative Medicine, Artificial Cells and Nanomedicine”, World Scientific Publisher/Imperial College Press, official publisher of Nobel Prize Award Lectures (1921 on).. His 2007 invited monograph on “ARTIFICIAL CELLS: biotechnology, nanomedicine, regenerative medicine, blood substitutes, bioencapsulation, and cell/stem cell therapy” will start this series.
- ◆ Section Editor on Detoxification, International Journal of Artificial Organs, Official Journal of European Society of Artificial Organs. Wichtig Editore Publisher. (1985-present)
- ◆ Section Editor on New Technology then editorial board, TASAIO, Official Journal of the American Society of Artificial Internal Organs. Lippincott Press, U.S.A. (1991-2003)
- ◆ Associate Editor, Biotechnology Annual Rev, Elsevier Science, Netherlands.(1995-present)
- ◆ Honorary Editor. Journal of Hepato-renal and artificial detoxication(2003-present)
- ◆ Editorial Board, Journal of Cell Transplantation. Pergamon Press, USA (1999- 2004)
- ◆ Editorial Board, Journal of Microencapsulation, London, UK.(1990-present)
- ◆ Editorial Board, Journal of the International Academy of Nanomedicine (2010-present)

## EXAMPLES OF HONOURS AND AWARDS:

- ◆ Medical Research Council of Canada (MRC) Research Fellow Award 1962-65
- ◆ MRC Research Scholar Award (career development award) 1965-68
- ◆ Career Investigator Award , Medical Research Council of Canada 1968-1999
- ◆ First Incentive Lecturer. The Annual Incentive Lectures were instituted in Sweden in 1969. The first Incentive Lecturer was "invited to inaugurate these annual lectures". The lecture on "The Clinical Potential of Enzyme Technology" was given at: Karolinska Institute, Stockholm, University of Lund, University of Gothenberg Hospital (1969).
- ◆ Clemson Award for "Basic Research in the Development of the Microcapsule Artificial Kidney", World Congress of International Society for Biomaterials, Vienna, Austria. (1980)
- ◆ Honorary President IVth International Symposium of Hemoperfusion and Artificial Organs, Ankara, Turkey (1982).
- ◆ Honorary President, VIth International Symposium on Hemoperfusion, Mexico (1985).
- ◆ Honorary Professor, Nankai University, Tianjin, PRC. 1983-present
- ◆ Honorary President, 7th International Symposium on Hemoperfusion, Kiev, USSR, sponsored by the USSR Academy of Sciences, (1986)
- ◆ Annual Award of the Education Foundation Federation of Chinese Canadian Professionals, Toronto. (for invention of "Artificial Cells including blood substitutes"), 1986
- ◆ “Ambassador by Appointment” and, AGORA Trophy, Societe du Palais des Congres de Montreal , 1986
- ◆ Honorary President, 8th International Symposium on Hemoperfusion, Sorbents and Immobilized Bioreactants, Germany, 1988.
- ◆ Silver Medal Award for outstanding scientific contribution from Academic Senate of University of Bologna for the 9th Centenary of University of Bologna, 1988
- ◆ Honorary President 9th International Symposium on Hemoperfusion, Sorbents and Immobilized Bioreactants, Tokyo, Japan. , 1989
- ◆ Honorary president 10th International Symposium on Hemoperfusion, Sorbents and

Immobilized Bioreactants, Rome, Italy, 1990

- ◆ Congress President, VIII World Congress, International Society Artificial Organs, 1991
- ◆ Honorary President, International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology (since 1991). (Originally group on Hemoperfusion, Sorbent and Immobilized Bioreactants)
- ◆ Officer of the Order of Canada, for the invention of artificial cells 1992.
- ◆ First Julius Silver Lectureship, Julius Silver Institute of Biomedical Engineering and Israel Society for Biomedical Engineering, 1992.
- ◆ 125th Anniversary of Canadian Confederation Medal Award from Governor General of Canada, 1993
- ◆ Honorary Congress President, XI World Congress, International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology, (Congress president: Professor R.Langer of MIT who organized the congress) Boston, 1994
- ◆ President, International Society for Artificial Organs, 1994-96
- ◆ Honorary member, International Society for Microencapsulation, since 1995
- ◆ Queen Elizabeth 25<sup>th</sup> Jubilee Medal, Governor General of Canada, 2002
- ◆ Honorary Congress President XII World Congress, International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology (Congress President, is the president of the Chinese Academy of Medical Sciences that organizes the congress) co-congress president is the President of the Chinese Red Cross Society, Beijing, 1997
- ◆ 1999 ISBP Annual Award, International Society for Blood Purification (Sir Roy Calne was winner of 1998 Award, other previous winners are Robert Rosenberg,NIH, Charles Dinarello then at Tufts and Colton from MIT)
- ◆ “VIRAGE” AWARD FOR CENTRE OF EXCELLENCE IN BIOTECHNOLOGY, Quebec Ministry of Higher Education, Science and Technology (1985- permanent since 1990 with salaries for 4 professors for the centre now integrated into the faculty salary budget.
- MSSS-FRSQ Research d’equip on Blood Substitutes in Transfusion Medicine (Chang-principal investigator). (2002-2008)
- ◆ Honorary President, IX International Symposium on Blood Substitutes, Tokyo, Japan 2003
- ◆ Fellow of the Royal Society of Canada, FRS(C) 2004
- ◆ Honorary President, X International Symposium on Blood Substitutes, Rhone Island, Providence, U.S.A. 2005
- ◆ Nominated for Nobel Prize in Medicine & Physiology, and also for Nobel Prize in Chemistry
- ◆ Honorary member, International Golden Key Honour Society (2005-)
- ◆ Honorary President, 2007 XI International Sym on Blood Substitutes, Beijing, (President of Symposium, Professor Liu Qian, Vice Minister of Health of China, president of Beijing Union Medical College Hospital and Vice President, Chinese Academic of Medical Sciences)
- ◆ Special Award “For his 50 years Outstanding Contribution on artificial cells and Blood Substitutes” from Professor Liu Qian, Vice Minister of Health of China and President of the 2007 XI International Symposium on Blood Substitutes, Beijing, China
- ◆ Honorary President, 2009 XII International Symposium on Blood Substitutes, Parma, Italy
- ◆ First President, International Academy of Nanomedicine 2009-2010
- ◆ First “Outstanding Research Award of the International Academy of Nanomedicine”, at the First World Congress of the International Academy of Nanomedicine.
- ◆ 2009 Honorary President, 2011 XIII International Symnposiym on Blood Substitutes, Harvard Medical School, Boston, U.S.A. Symposium president, Professor Warren Zapol of Anesthesia and Critical Care Medicine, Mass General Hospital, Harvard Medical School.

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2. Marquis Who's Who in the East (1977,1978)(1995, 1996 Silver anniversary 25th Edition).
3. Marquis Who's Who in America (since 1978).
4. Marquis Who's Who in the World, (since 1984).
5. Canadian Who's Who (since 1983).
6. Marquis Who's Who in Frontier Science and Technology, (since 1984).
7. American Men and Women of Science (ongoing)
8. Marquis Who's Who in Science and Engineering (since 1992)
9. International Who's Who in Medicine (since 1995)
10. American Biographical Institute "Five Hundred Leaders of Influence" (1995)
11. Marquis Who's Who in Medicine and Healthcare (since 1996)
12. Top 100 Scientists, International Biographical Centre, U.K. (2005)

## GRADUATE STUDENTS SUPERVISED:

### Graduate students supervised by T.M.S. Chang (as the sole supervisor):

#### Before 1985 (only one example given):

Ph.D. (Physiology): **Mark Poznanski** was Professor Chang's first Ph.D. graduate in Physiology. He has recently been honoured with the Order of Ontario and Order of Canada. He has been for a number of years the president of University of Western Ontario's "Robart Institute for Medical Research" and has built up the institute to "600+ people with an average of \$600,000+ per investigator" ([www.robarts.ca](http://www.robarts.ca)). He is a founding member and past chair of the Council for Health Research in Canada, a research advocacy group in Ottawa, and also chairs the Scientific Advisory Board of the Canadian Medical Discoveries Fund, and Director of the Ontario Genomics Institute, he also founded London Biotechnology Incubator Inc., in addition to being on many biotechnology-industry related boards. He is now president of a consulting firm.

#### After 1985 (complete list):

- 1986 Ph.D. (Physiology): Peter Keipert ,Senior Director, Blood Substitutes, Alliance Pharmaceutical Co., Calif., USA until 2004, Since 2005 V.P. of Research in Blood Substitutes, Sangart Co. San Diego).
- 1986 M.Eng. (Chem.Eng.): Maurice Cattaneo (continued for Ph.D. with Chang)
- 1986 Ph.D. (Expt. Med.): Zhi Qing Shi, M.D. Research scientist at Amgen Biotechnology Co.in U.S.A. (previously, Assistant Professor in Physiology, University of Toronto)
- 1987 Ph.D. (Physiology): Louis Bourget (completed dentistry at McGill, dental surgeon)
- 1987 Ph.D. (Physiology): Vivek Dixit (Professor and Director, Laboratory of Artificial Liver Support, Department of Medicine,University of California at LA
- 1987 M.Sc. (Physiology): Andrew Budning (completed McGill University M.D., physician)
- 1987 M.Eng. (Chem.Eng.): Flavio Garofalo (continued for Ph.D.with Chang)
- 1987 M.Eng. (Chem.Eng.): David Morley (completed Law at McGill University and Oxford)
- 1989 Ph.D. (Physiology): Soudabeh Aghazaman Kashani, M.D. (now in clinical medicine)
- 1990 Ph.D. (Chem.Eng.): Maurice Cattaneo, (last communication) Director, Technology Development, Cambridge Scientific Inc. Cambridge, MA.Adjunct

- Professor, Northeastern University, Boston. (Previously Research Scientist, NRC, Biotechnology Research Institute, Montreal)
- 1990 Ph.D. (Chem.Eng.): Flavio Garofalo (Research Scientist, in the Biotechnology Co. Microlife Technics in Florida)
- 1990 Ph.D. (Ad Hoc) Kang Fu Gu (Senior scientist in China since 2009. Was senior Scientist, U.S. Biotechnology company "Diveresa" since April 99'. He has been Senior Research Scientist of IBEX Technology, a Montreal biotechnology company for 8 years)
- 1991 Ph.D. (Physiology): Jing Ning, M.D. ( House wife. She was Research Scientist at Hemosol Inc., Etobicoke, Ontario, a blood substitute company)
- 1991 M.Eng. (Chem.Eng.): Vaia Coromili (continued to Ph.D. with Chang)
- 1991 M.Eng. (Chem.Eng.): Maryam Mobed (continued to Ph.D. with Chang)
- 1991 M.Eng. (Chem.Eng.): Daniel Duguay (continued to Ph.D. in Ottawa)
- 1992 Ph.D. (Chem.Eng.): Khaled Alsugair (started as assistant Professor in Saudi Arabia)
- 1993 Ph.D. (Chem.Eng.): Ian Lloyd George (awarded NSERC Research Fellowship at Bureau of Medical Device, Ottawa; now Manager, Research & Development, Polychem Product Ltd., Montreal)
- 1994 Ph.D. (Physiology): Silvia Bruni, M.D. (returned to Italy in clinical practice)
- 1996 M.Eng (Chem.Eng.): Sarah Safos (continued her Ph.D. with Dr. Scriver on use of artificial cells in PKU mice)
- 1996 Ph.D. (Biomed.Eng.): Satya Prakash Was International scholar in Biotechnology from India. (McGill Faculty approves his full professorship, after 3 years as assistant Professor and 4 as associate professor)
- 1996 M.Sc. (Biomed.Eng.): Elizabeth Quebec
- 1997 Ph.D. (Chem.Eng.): Maryam Mobed , Now an assistant professor in university was Research scientist, Bioscience Products Division, Agilent Technologies, a California Biotech company.
- 1997 Ph.D. (Physiology): Felice D'Agnillo Graduated on dean's honours list (was N.I.H. International Forgarty Fellow, Bethesda, USA) , Now promoted to Staff Scientist at FDA-NIH
- 2000 Ph.D. (Chem Eng): Vaia Coromili -.no communication after graduation
- 2002 M.Sc (Physiology): Douglas Powanda (FCAR Scholarship) Continued to compete his Master of Management at Concordia University
- 2004 Ph.D. (Biomed.Eng) Binglan Yu (CIHR studentship) graduated on Dean's honours list with Geddes Award for best graduate student in Biomedical Engineering. Since 2007 was a research fellow with Professor Zapol, previously Chief of Anesthesiology, Mass General Hospital, Harvard Medical School, Boston, now appointed as instructor..
- 2004 M.Sc. (Biomed Eng) Noami Wong (NSERC studentship). Then was a staff engineer, Merck Frosst Co. Montreal. Now home as a new mother
- 2005-2007 M.Sc (Biomed Eng) Caroline Fustier (scholarship student from Paris, France) Now a research scientist in a French Comapny.
- 2006- 2007 M.Sc. (McGill Program on Biotechnology) Jessie Rong. Continued to Medical School at University of Montreal
- 2007- 2008 M.Sc. (McGill Program on Biotechnology) Wei He after graduation continued work in a research lab.
- 2008-2009 M.Sc (McGill Program on Biotechnology) Qianqian DU, completed her M.Sc.and continued as research assistant in this laboratory
- 2010- Ph.D. (Biomedical Engineering) Yuzhul BIAN. M.Sc.Tsinghua University, Beijing.
- 2011- Ph.D. (Biomedical Engineering) Yun WANG M.Sc. Peking Union Medical College of

the Chinese Academy of Medical Sciences.

## OTHER TEACHING AT MCGILL:

Med 1 Physiology 5 hours of lectures (Up to 2008)

Physiology 518a 8 hours of lectures and 4 hours seminar(Ongoing)

Biotechnology 202-505B 3 hours of lectures (up to 2008)

Biomedical Engineering 399-501A 3 hours of lectures (up to 2008)

Biomedical Engineering (Prakash's new course) 2 hours of lectures (up to 2008)

Physiology 518a: Course coordinator: 25 hours (Ongoing)

**518a “Artificial Cells and Biotechnology”** For many years, Professor Chang has organized this course and gives about half the lectures for this course. This is a difficult and highly demanding interdisciplinary advance course, yet he had up to 90 students in one year and had to set a minimal admission cumulative GPA of 3.2 but he still ended up in 2005 with a total of 74 students. The GPA was increased in 2006 to 3.3, but he ended up with 80 students with many with GPA of >3.3 not accepted because of space. This is included in the suggested courses for Physiology, Biomedical Engineering, Biotechnology Diploma, Biotechnology minor and others students came from Experimental Medicine; and anatomy and molecular biology and occasionally from the faculty of engineering.

The student's evaluation of this course is as follows:

**Positive comments:** “I really enjoyed this course” “Great course, really interesting. Worth the trouble of getting into. Excellent diverse topics” “Amazing class full of cutting edge information! This is the most interesting class I've ever taken at McGill. Thank-you” “Overall, great content” “The course is very interesting and challenging” “Very interesting course in general” “One of my favorite courses!” “Subjects are very up-to-date” “Regardless of what specific field I will find myself working under, I will endeavor to incorporate the ideas presented to me in artificial cells to good use” “This was the most inspiring course I have taken at McGill”.

**Negative comments:** “It's a hard class to follow” Some students want all slides and lectures to be given to them and to be responsible only for these for their exam. However, this course is an advance course and we want the students to be able to look up literatures and read articles and books including those posted on [www.artcell.ca](http://www.artcell.ca) and not just being spoon feed by lecture notes.

**Lecturers (only comments related to Professor Chang) L** “Dr. Chang is great!!” “The course is very interesting and challenging, especially Dr. Chang's section” “Dr. Chang is a terrific lecturer. All his lectures were enjoyable. He's very knowledgeable and was able to stimulate my interest.” “Dr. Chang's lectures were very interesting.”

## PUBLICATIONS AND INVITED LECTURESHIPS:

More than 500 papers (abstracts not included) and 26 books and symposium volumes.(details follow). Invited to more than 300 international invited lectureships including opening plenary lectures, special lectureships, keynote lectures, plenary lectures (details follow). He has also assigned 30 patents and patent applications to McGill University (details follow).

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1. CHANG TMS (1957) "Hemoglobin Corpuscles" Report of a research project for Honours Physiology, Medical Library, McGill University. Also reprinted as part of "30 anniversary in Artificial Red Blood Cells Research" J. Biomaterials, Artificial Cells & Artificial Organs 16:1-9, 1988." and also in Chang's 2007 Monograph on 'Artificial Cells'
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11. CHANG TMS (1969) Clinical potential of enzyme technology. (1st Incentive Lecture) *Science Tools* 16(3):33-39.
12. CHANG TMS (1969) Removal of endogenous and exogenous toxins by a microencapsulated absorbent. **Can J Physiol Pharmacol** 47(12):1043-5.
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8. V BONOMINI and CHANG TMS (eds) (1982), "Hemoperfusion" 149 pages, Contributions to Nephrology Series, S. Karger AG, Basel, Switzerland.
9. PISKIN E and CHANG TMS (eds) (1982), "Hemoperfusion and artificial organs" 187 pages, Artificial Organs Society.
10. PISKIN E and CHANG TMS (eds) (1983), Past, present and future of artificial organs 262 pages, Meteksan Publisher Co., Ankara, Turkey.
11. CHANG TMS (ed) (1984), "Microencapsulation and artificial cells" 312 pages, Humana Press, Clifton, New Jersey, USA.
12. CHANG TMS and BL HO (eds) (1985) "Hemoperfusion and artificial organs", 464 pages, China Academic Publishers, Beijing, China.
13. "Hemoperfusion" CHANG TMS and A TREVINO BECERRA (eds) (1986) Special issue Int. J. Artificial Organs, Volume 9:279-368.
14. CHANG TMS and N NICOLAEV (eds) (1987) "Hemoperfusion, sorbent and immobilized bioreactants" Special Issue, Int. J. Biomaterials, Artificial Cells and Artificial Organs 15:1 321, 1987.
15. CHANG TMS and R GEYER (eds) (1989) "Blood substitutes" Marcel Dekker Publisher, U.S.A., 714 pages
16. WINSLOW R and CHANG TMS (eds) (1990) "Red blood cell substitutes" Special issue, Int. J. Biomaterials, Artificial Cells and Artificial Organs 18:133-342, 1990.
17. H KLINKMANN, D FALKENHAGEN, and CHANG TMS (eds) (1990) "Hemoperfusion, sorbent and immobilized bioreactants". Special issue, Int. J. Biomaterials, Artificial Cells and Artificial Organs 18:455-568.
18. CHANG TMS and M ODAKA (eds) 1991. "Hemoperfusion, sorbent and immobilized bioreactants" Special issue, Biomaterials, Artificial Cells and Immobilization Biotechnology, an international journal 19: 1-298, 1991.
19. GURLAND H and CHANG TMS (eds) 1992. "Artificial organs" Special Festschrift issue for W. Kolff's 80th Birthday, J. Artificial Organs, Official Journal of the International Society for Artificial Organs (1992).
20. CHANG TMS (ed) (1992). Blood substitutes and oxygen carriers. Marcel Dekker Publisher, USA, 784 pages. Book Reviews: "...excellent...very useful and easy to read..." "...recommended...an important addition to medical and basic-science libraries." Canadian Medical Association Journal. "The authors of the papers represent a list of "who's who" in the field." Hematologic Pathology
21. CASCIANI C, G. SPLENDIANI AND CHANG TMS (eds) (1993). "Hemoperfusion, sorbent and immobilized bioreactants" Special issue, Biomaterials, Artificial Cells and Immobilization Biotechnology, An International Journal
22. CHANG TMS, J REISS and R WINSLOW (eds) (1994). Blood substitutes: general. Special issue, Artificial Cells, Blood Substitutes and Immobilization Biotechnology, An International Journal, 22:123-360, 1994
23. CHANG TMS and S. WEINSTOCK (eds) (1995). Blood substitutes Special issue, Artificial Cells, Blood Substitutes and Immobilization Biotechnology, An International Journal, 23: 257-459.
24. CHANG TMS, G. GREENBERG and E TSUCHIDA (eds) (1997) Blood substitutes.

- Special issue, Artificial Cells, Blood Substitutes and Immobilization Biotechnology, An International Journal, 25:1-241.
25. CHANG TMS (1997) (monograph) Red blood cell substitutes: Principles, Methods, Products and Clinical Trials Vol I (Monograph) Karger/Landes Systems, Basel, Switzerland (**available for free online viewing at [www.artcell.mcgill.ca](http://www.artcell.mcgill.ca) copyrights in exchange for royalties**)
  26. CHANG TMS (1998) (editor: multiauthors) Red blood cell substitutes: Principles, Methods, Products and Clinical Trials Vol II Karger/Landes Systems, Basel, Switzerland
  27. CHANG TMS (2004) Guest Editor. Special issue on Blood Substitutes: present and future. Artificial Organs Journal.
  28. CHANG TMS (May 2007) Monograph on “ARTIFICIAL CELLS: biotechnology, nanotechnology, blood substitutes, regenerative medicine, bioencapsulation, cell/stem cell therapy” World Scientific Publisher/Imperial College Press 435 pages. (**Since April 2010 has obtained copyright to place this book for noncommercial free online viewing or download on [www.artcell.mcgill.ca](http://www.artcell.mcgill.ca)**  
*Book reviewed by A Gerson Greenburg, MD, PhD, Professor Emeritus of Surgery, Brown University, U.S.A. “This volume is the most comprehensive review of the field of artificial cells and associated fields published to date. It refreshes the knowledge of the experts while informing the naive of the history and promise of the future. Written in a conversational style and very well illustrated for fact and emphasis, it is an easy and informative read. Presented in easily accessible form are the underlying theories and concepts of artificial cells, blood substitutes, nanomedicine, regenerative medicine and stem cell therapy in the context of specific clinical situations ranging from general to very specific diseases. Basic science observations support the tested or proposed clinical applications in an exact manner. This volume contains a near encyclopedia quantity of information, carefully and logically assembled and presented. Future developments in the field will depend on the essential information presented here. An essential read for anyone interested in this field, the vision and foresight of this senior scientist and leading statesman of the field makes the topic accessible and understandable.”*
  29. CHANG, TMS (for 2012) editor, Book on “Selected Topics in Nanomedicine” World Scientific Publisher/Imperial College Press
  30. CHANG TMS (in preparation) 2<sup>nd</sup> edition of Monograph on “ARTIFICIAL CELLS: biotechnology, nanotechnology, blood substitutes, regenerative medicine, bioencapsulation, cell/stem cell therapy” World Scientific Publisher/Imperial College Press

### INVITED LECTURES:

- 1963 Invited speaker, Red Cell Club, NIH, Bethesda, Maryland, USA.
- 1963 Invited lecturer, Dept. of Physiology, University of Pennsylvania, Philadelphia, USA.
- 1964 Invited lecturer, Gordon Research Conference on Medicinal Chemistry, New Hampshire, USA.
- 1964 Invited lecturer, Merck, Sharpe and Dohe, New Jersey, USA.
- 1964 Invited lecturer, Eli Lilly, Indianapolis, Indiana, USA.
- 1965 Invited lecturer, University of Montreal, Montreal, Quebec, Canada.
- 1965 Invited lecturer, New York Blood Center, New York, USA.
- 1965 Invited lecturer, Battelle Memorial Institute, Columbus, Ohio, USA.

- 1966 Invited lecturer, NCR, Dayton, Ohio, USA.
- 1967 Invited lecturer, Dept. of Artificial Organs, Cleveland Clinic, Cleveland, Ohio, USA.
- 1968 Invited lecturer, Microencapsulation Symposium, New Jersey, USA.
- 1968 Guest speaker, Association of Professional Engineers, Ottawa, Ontario, Canada.
- 1968 Guest speaker, Stamford Section, American Chemical Society, Stamford, Connecticut .
- 1968 Invited lecturer, New York Blood Center, New York, USA.
- 1969 First Incentive Lecturer, The Annual Incentive Lectures were instituted in Sweden in 1969 to invite once a year a foreign scientist to give an Incentive Lecture in Stockholm and other Swedish universities. The first Incentive Lecturer was "invited to inaugurate these annual lectures". The lecture on "The Clinical Potential of Enzyme Technology" was given at:
- 1) Karolinska Institute, Stockholm, Sweden.
  - 2) Chemical Centre, University of Lund, Lund, Sweden.
  - 3) University of Gothenberg Hospital, Gothenberg, Sweden.
- 1969 Invited lecturer, Dept. of Physiology, University of Toronto, Toronto, Ontario, Canada.
- 1969 Invited lecturer, Dept. of Pathology, Rhode Island Hospital, Rhode Island, USA.
- 1969 MRC Visiting Professor, Dept. of Biophysics, University of Western Ontario, London, Ontario, Canada.
- 1969 Invited lecturer, Dept. of Artificial Organs, University of Utah, Salt Lake City, Utah,
- 1969 Invited lecturer, Alza Co., Palo Alto, California, USA.
- 1970 Invited lecturer, Cardiovascular Research Institute, San Francisco, California, USA.
- 1970 Invited lecturer, Renal Unit, Sydney Hospital, Sydney, Australia.
- 1970 Invited lecturer, Dept. of Physiology, University of Sydney, Sydney, Australia.
- 1970 Invited lecturer, Renal Unit, Prince Henry Hospital, Sydney, Australia.
- 1970 Invited lecturer, Biomedical Symposium, Australian Academy of Science and Society of Engineers, Sydney, Australia.
- 1970 Invited lecturer, Microencapsulation Symposium, New Jersey, USA.
- 1971 Invited lecturer, Dept. of Chemical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania, USA.
- 1971 Invited lecturer, Gordon Research Conference on Biomaterials, New Hampshire, USA.
- 1971 Enzyme Engineering Conference, New Hampshire, USA.
- 1) Invited lecturer.
  - 2) Invited panel discussant on "Future of Enzyme Engineering".
- 1971 Invited lecturer, Life Science Seminar, Battelle Memorial Institute, Columbus, Ohio,
- 1972 Invited lecturer, National Foundation Symposium on Enzyme Replacement, Sarasota, Florida, USA.
- 1972 Invited lecturer, Chemical Engineering Dept., Princeton University, New Jersey, USA.
- 1972 Invited lecturer, Biomedical Engineering Symposium, MRC Bioengineering Unit, University of Strathclyde, Glasgow, Scotland.

- 1972 Invited lecturer, Renal Unit, Edinburgh Royal Infirmary, Edinburgh Medical School, Scotland.
- 1972 Invited guest speaker, Canadian Kidney Foundation Annual Meeting.
- 1972 Invited lecturer, NIH, General Medical Sciences, Bethesda, Maryland, USA.
- 1972 Invited lecturer, Microencapsulation Symposium, New Jersey, USA.
- 1973 Invited lecturer, First International Microencapsulation Symposium, Athens, Georgia.
- 1973 Chairman, session on "Biomedical Applications" and invited lecturer, International Conference on Insolubilized Enzymes, Milan, Italy.
- 1973 Invited lecturer, Gordon Research Conference on "Separation in Engineering", New Hampshire, USA.
- 1973 Co-chairman, session on "Future Applications of Enzyme Engineering", Enzyme Engineering Conference.
- 1973 Invited lecturer, Enzyme Engineering Conference, Engineering Foundation.
- 1973 Invited lecturer, International Nephrological course, Parma, Italy.
- 1973 Invited lecturer, Microencapsulation Symposium American Chemical Society Annual Meeting, Chicago
- 1973 Invited lecturer, Canadian High Polymer Forum of Membranes, St. John, Quebec.
- 1973 Annual guest speaker, Japanese Society for Artificial Organs, Sandai, Japan.
- 1973 Guest speaker, Japanese Society for Promotion of Renal Transplantation, Tokyo, Japan.
- 1973 Invited lecturer, Tokyo Science University, Tokyo, Japan.
- 1973 Guest discussant, Panel on "Microcapsule Hemoperfusion for Chronic and Renal Failure", Tokyo College of Medicine and Dentistry, Tokyo, Japan.
- 1974 Visiting professor, Medical Engineering Session, Faculty of Medicine, University of Minnesota, Minneapolis, Minnesota, USA.
- 1974 Invited lecturer, Dept. of Anatomy, University of Minnesota, Minneapolis, Minnesota.
- 1974 Invited lecturer, American Chemical Society Symposium on "Polymer Graft in Biochemistry", California, .
- 1974 Invited panelist on "Sorbent for Uremia", American Society for Artificial Internal Organs Annual Meeting, Chicago, Illinois, USA.
- 1974 Invited lecturer, Microencapsulation Workshop, New Jersey, USA.
- 1974 Invited participant and session chairman, Workshop on "Implications of Enzyme Engineering". Organized by International Federation of Institutes for Advanced Studies, Stockholm, Sweden.
- 1974 Invited lecturer, "Immobilization of Enzymes by Microencapsulation", Gordon Research Conference on "Lysozyme", New Hampshire, USA.
- 1974 Invited lecturer and session chairman, 2nd International Microencapsulation Symposium, London, UK.
- 1974 Invited lecturer, International Symposium on "Artificial Support Systems for Acute Hepatic Failure", King's College Hospital Medical School, London, UK.
- 1974 Invited lecturer, International Society of Nephrology sponsored symposium on "Uremic Toxins and New Devices for their Removal", Naples, Italy.
- 1974 Invited discussant, Biomedical Research in Narcotic Abuse Problems, organized by the Non Medical Use of Drugs Directorate, Health & Welfare Canada.

- 1975 Conference on "Sorbents in Uremia and Hepatic Failure", Sponsored by the International Society of Nephrology, NIH Chronic Uremia Program and the Clinical Dialysis and Transplant Forum.  
Invited introductory lecturer on "Microencapsulation and Coating for Adsorbent".  
Invited lecturer on "Microencapsulated Adsorbent for Acute Intoxication, Liver Failure and Uremia".  
Chairman of the session on "Hemoperfusion".  
Panel discussant of second day sessions.
- 1975 Invited speaker, Symposium of the International Pharmacological Congress, Helsinki, Finland.
- 1975 Invited speaker, New York Nephrology Society, New York, USA.
- 1975 Invited speaker, Downstate University of New York, School of Medicine, New York,
- 1975 Invited lecturer, "Microencapsulation Workshop", New Jersey, USA.
- 1975 Invited lecturer, NIH group on "Liver Failure Support", Clinical Center, NIH, Bethesda, Maryland, USA.
- 1975 Invited lecturer, Nephrology Dept., Children's Hospital, National Medical Center, Washington, D.C., USA.
- 1975 Invited speaker, symposium on "Immobilized Enzyme Applications", Chemical Institute of Canada, Toronto, Ontario, Canada.
- 1975 Invited lecturer, Gordon Conference on "Transport Phenomena in Synthetic and Biological Membranes", New Hampshire, USA.
- 1975 Poona International Workshop and Symposium on Enzyme Engineering, Poona, India.  
Main speaker on "Microencapsulated Enzymes".  
Main speaker on "Medical Applications of Immobilized Enzymes".  
Panel discussant on "Technique and Novel Approaches".  
Chairman of session on "Applications of Immobilized enzymes".
- 1975 Invited speaker, University of Poona, Poona, India.
- 1975 Invited participant, Second International Federation of Institutes of Advanced Studies Workshop, Poona, India.
- 1976 Chairman, session on "Biomedical Applications of Microencapsulation" and Invited speaker, 3rd International Symposium on Microencapsulation, Tokyo, Japan.
- 1976 Chairman, "Panel on Adsorbent Hemoperfusion for Uremia, Acute Intoxication and Liver Failure", Annual Meeting, American Society for Artificial Internal Organs, San Francisco, California, USA.
- 1976 Invited lecturer, symposium on "New Technologies of Blood Purification in Uremia", sponsored by NIH, International Society of Nephrology, Weisban, Germany.
- 1976 Chairman and invited lecturer, Session on "Adsorbents in Therapeutic Medicine", Strathclyde Bioengineering Seminar series on "Artificial Organs", Glasgow, Scotland.
- 1976 Consultant and participant, "Drug Delivery Systems Workshop", NIH, Bethesda, Maryland, USA.
- 1976 Invited lecturer, Gordon Research Conference on "Immobilized Enzymes", New Hampshire, USA.
- 1976 Invited speaker, "Lecture Series on Possibilities of Synthetic Biology", Dept. of Life Sciences (James F. Danielli) Worcester Polytechnic Institute, Worcester, Massachusetts, USA.

- 1976 Co-chairman, Session 3 on "Artificial Organs", 11th International Conference on Medical and Biological Engineering, Ottawa, Ontario, Canada.
- 1977 International Enzyme Engineering Conference, Germany. Chairman, session on "New Medical Applications in Immobilized Enzymes". Invited speaker, "New Approaches of Biodegradable Polymer Membranes, Microcapsules and Microencapsulation of Multistep Enzyme Systems."
- 1977 Organizer and program chairman, McGill Artificial Organs Research Unit International Symposium on "Some Novel Approaches in Artificial Kidney, Artificial Liver and Detoxification", McGill University, Montreal, Quebec, Canada.
- 1977 NIH International Conference on "Fulminant Hepatic Failure", Bethesda, Maryland, Chairman, session on "Hemoperfusion Through Sorbents".  
Invited speaker on "Albumin Cellulose Nitrate Coated Charcoal Hemoperfusion in FHF".  
Invited speaker on "Microencapsulation of Multienzyme Systems and Recycling of Cofactors".
- 1977 Guest speaker, "Biomedical Applications of Artificial Cells", Montreal Physiological Society, Montreal, Quebec, Canada.
- 1977 Chairman, panel workshop on "Some Problems Related to Adsorbent Therapy", Annual Meeting, American Society for Artificial Internal Organs, Montreal, Quebec, Canada.
- 1977 Invited speaker, "Biomedical Applications of Enzymes" Symposium on Enzymes, American Chemical Society, Amherst, Massachusetts, USA.
- 1977 Invited speaker on "The Future of Hemodialysis", Dialysis '77 Symposium, Leeds, UK.
- 1977 First International Society of Artificial Organs Meeting, Tokyo, Japan.  
Chairman, session on "Sorbents in Artificial Kidney".  
Invited panelist, "Hepatic Assist Devices".
- 1977 Invited speaker, "Artificial Cells", Dow Cordis Artificial Kidney Division, Concord, California, USA.
- 1977 Invited speaker on "Hemoperfusion", Canadian Conference on Clinical Engineering, Notre Dame Hospital, Montreal, Quebec, Canada.
- 1978 Visiting Professor by invitation of the Chinese Academy of Sciences, lectured at:  
Biophysics Institute, Chinese Academy of Sciences, Peking (12 hrs lectures, plus seminars and demonstrations).  
Capital Hospital (previously Union Medical School), Peking.  
National Symposium, Lang Fang (12 hours of lectures, plus seminars & demonstrations).  
Suchiachung Medical School, Suchiachung.  
Hongchow Medical School, Hongchow.  
Shanghai Medical Association, Shanghai.  
Canton Medical and Scientific group, Canton.
- 1978 International Symposium on "Hemoperfusion, Dialysate and Diafiltrate Purification", Tutzing, Munich, Germany.  
Chairman, session on "Hemoperfusion".  
Invited introductory lecturer on "Hemoperfusion".  
Invited lecturer on "Hemoperfusion in Fulminant Hepatic Failure".  
Invited lecturer on "Conversion of Urea and Ammonia into Amino Acid".
- 1978 Invited speaker in symposium on "Nondialytic Management of Uremia", sponsored by

- NIH, Downstate Medical Center and New York Society of Nephrology, New York, USA.
- 1978 Invited speaker on "Biodegradable Drug Carriers", Gordon Research Conference, Plymouth, New Hampshire, USA.
- 1978 Invited speaker on "Immobilized Enzymes in Therapy", Conference on "Enzyme Economy", Chicago, Illinois, USA.
- 1978 Keynote speaker, Annual meeting of the Biomaterials Society, University of Toronto, Toronto, Ontario, Canada.
- 1978 Chairman, session on "Hemodialysis", International Congress of the International Society of Nephrology, Montreal, Quebec, Canada.
- 1979 International Symposium on Hemoperfusion: Kidney Support, Liver Support and Detoxification", Israel Institute of Technology, Technion, Israel.  
Co-chairman of Symposium.  
Invited speaker on "Present Status and Prospectives of Artificial Cells in Hemoperfusion".  
Chairman, session on "Hemoperfusion".
- 1979 Invited speaker on "Progress in Polymer Encapsulation of Enzymes, Biospecific Adsorbents and Drugs", American Japanese Chemical Societies joint symposium, Honolulu, Hawaii, USA.
- 1979 International Enzyme Engineering Conference, Enzyme Foundation, New Hampshire, USA.  
Invited speaker on "Novel Urea Removal Systems".  
Co-chairman of Workshop on "Biomedical and Analytical Application".
- 1979 Reporteur, Enzyme Therapy in Congenital Diseases Symposium, Hilton Head, North Carolina, USA.
- 1979 Symposium co-chairman and invited speaker, International Workshop on "Hemoperfusion", Haifa, Israel.
- 1979 Invited speaker on "Artificial Liver Support", International Workshop on "Artificial Organs", Sorrento, Italy.
- 1979 Invited speaker, Faculty of Medicine, University of Edmonton, Alberta, Canada.
- 1980 Gordon Research Conference, "Drug Carriers in Biology and Medicine", New Hampshire, USA.  
Co-chairman of Conference.  
Invited speaker on "Artificial Cells".  
Chairman of session on "Artificial Cells".
- 1980 International Symposium on "Artificial Liver Support", Hannover, Germany.  
Invited speaker on "Effects of Artificial Liver Support for Galactosamine Fulminant Hepatic Failure Rats".  
Co-chairman, session on "Hemoperfusion".
- 1980 Invited speaker on "Encapsulated Enzymes and Adsorbent" in replacement therapy. International Symposium on "Therapy in Congenital Diseases", Swiss Academy of Medical Sciences, Interlaken, Switzerland.
- 1980 Annual Meeting, American Society for Artificial Internal Organs, New Orleans, Louisiana, USA.

- Invited plenary speaker on "Artificial Blood Cells" in plenary symposium.  
 Chairman, panel conference on "Adsorbent Hemoperfusion in Blood Purification".  
 Co-chairman, sessions on "Artificial Liver".
- 1980 Recipient "Clemson Award" for "Basic Research in the Development of the Microcapsule Artificial Kidney", World Congress of International Society for Biomaterials, Vienna, Austria.
- 1980 Guest speaker, Mexico Society of Nephrology, Mexico on: Artificial Cells. Hemoperfusion in Chronic Renal Failure. Hemoperfusion in Acute Intoxication and Liver Failure.
- 1981 International Symposium on "Hemoperfusion", Bologna, Italy.  
 Invited speaker on "Hemoperfusion in 1981".  
 Session chairman on "Hemoperfusion General".  
 Guest editor of symposium proceedings.
- 1981 International Symposium on Detoxification Approaches in Chronic Schizophrenia, Berlin, East Germany.  
 Invited speaker on "Endorphin and Middle Molecule Removal in Schizophrenia".  
 Co-chairman on "Detoxification Session".
- 1981 Invited speaker, "Artificial Cells", Science Association, National Research Council of Canada, Ottawa, Ontario, Canada.
- 1981 "Distinguished Honoured Guest", Preview Ceremony, International Center for Artificial Organs and Transplantation, Cleveland, Ohio, USA.
- 1981 Annual Meeting, American Society for Artificial Internal Organs, Anaheim, California.  
 Co-chairman, session on "Plasma Manipulation and Enzyme".  
 Program Committee.
- 1981 Invited plenary lecturer on "Blood Compatible Adsorbent Hemoperfusion in Extracorporeal Blood Treatment", 4th International Symposium on Affinity Chromatography and Related Techniques, Katholieke Universiteit, Nijmegen, The Netherlands. (Unable to attend just before meeting, paper presented as publication in book)
- 1981 Invited speaker on "Present Status of Microencapsulated Adsorbent", Symposium on "Adsorbent in Uremia", Congress of the International Society of Nephrology, Athens, Greece. (Paper read in absence by Dr. E. Espinosa)
- 1981 International Congress of the International Society for Artificial Organs, Paris.  
 Invited speaker on "Hemoperfusion" in opening plenary symposium on "Controversies and Issues in Artificial Organs".  
 Chairman, session on "Hemoperfusion".  
 Keyman of Hemoperfusion, program committee of International Society.
- 1981 Invited speaker, "Artificial Cells Encapsulated Enzymes" in International Symposium on "Therapy of Inborn Errors of Metabolism", London, UK.  
 (Paper read in absence by Dr. M. Poznansky)
- 1981 Invited plenary speaker for plenary lecture on "Biomedical Applications of Immobilized Biologically Active Materials", 6th Biannual International Enzyme Engineering Conference, Kashikojima, Japan.
- 1981 International Symposium of Chemical Engineering, Montreal, Quebec, Canada.  
 Invited speaker plenary lecturer on "The Present Status of Research in Artificial Cells".

- Chairman, session on "Artificial Organs and Implants".
- 1981 Invited speaker, "Microcapsules" in "Colloquium on Microcapsules and Microcarriers in Biotechnology", Massachusetts Institute of Technology, Cambridge, Massachusetts, USA.
- 1981 Invited speaker on "Biotechnology Research on Artificial Cells", McGill Biotechnology Symposium.
- 1981 Invited speaker, Biotechnology Seminars, McGill University, Montreal.
- 1982 Chairman of Gordon Research Conference on "Drug Carriers in Biology and Medicine", New Hampshire, USA (also session chairman and invited speaker on Artificial Cells).
- 1982 IVth International Symposium of Hemoperfusion and Artificial Organs, Ankara, Turkey. Honorary President of symposium.  
Invited speaker on "Past, Present and Future Perspectives of Hemoperfusion".
- 1982 Invited speaker, Canadian Science Writing Association Meeting, Montreal.
- 1982 Invited speaker on "Artificial Cells with Emphasis on Hemoperfusion in Uremia, Liver Failure and Acute Intoxication", Environmental Health Directorate
- 1982 Seminar Series, Bureau of Medical Devices, Health and Welfare Canada, Ottawa, Ontario, Canada.
- 1982 Invited lecturer on "Artificial Cells", Pediatric Travel Club, Montreal Children's Hospital, Montreal, Quebec, Canada.
- 1982 Invited lecturer on "Hepatic Coma", Medical Grand Round, Royal Victoria Hospital, Montreal, Quebec, Canada.
- 1982 Invited lecturer on "Present Status of Research on Artificial Liver Support", St. Luc Hospital, Montreal, Quebec, Canada.
- 1982 Invited speaker on "Artificial Cells: Applications of the biotechnology of microencapsulation and immobilized enzymes and cells", Seminar Program, McGill Chemical Society, Montreal.
- 1983 President, organizer and invited speaker, Fifth International Symposium on "Microencapsulation, including Artificial Cells", Montreal, Canada.
- 1983 Chairman and invited speaker, Symposium on Hemoperfusion, Congress of the European Society for Artificial Organs.
- 1983 4th Congress, International Society for Artificial Organs, Kyoto, Japan.  
Chairman, special graphic symposium on hemoperfusion.  
Invited speaker on "Artificial Liver".  
Program committee, Keyman on Hemoperfusion.
- 1983 Invited speaker on "Artificial Cells", symposium on "Plastics and Artificial Organs", American Chemical Society, Seattle, Washington, USA.
- 1983 Invited panelist on "Liver Support/Transplants and Artificial Organs", Annual meeting of the American Society for Artificial Organs, Toronto, Ontario.
- 1983 Invited speaker on "Clinical Trial on Hemoperfusion" in Workshop on Hemoperfusion organized by Hopital Necker, Paris, France.
- 1983 Invited lecturer on "Basic Principle of Artificial Cells for Blood Substitutes" in symposium on Artificial Blood, Annual Meeting, Canadian Society of Immunohematologists, Ottawa, Ontario, Canada.

- 1983 Invited speaker, Pediatric Research Symposium and Workshop. Faculty of Medicine, University of Alberta, Edmonton, Alberta.
- 1983 Invited speaker on the Composite Artificial Kidney Reviews of indications and applications, Societe Quebecoise de Nephrologie Annual Scientific Meeting, Val David, Quebec.
- 1983 Invited speaker on Artificial Cells in the Newest in Drug Delivery Systems, Pfizer Dialogue, Annual Meeting, Association of Faculties of Pharmacy of Canada.
- 1983 Invited speaker on "Composite Artificial Kidney in Uremic Patients" Symposium on Hemoperfusion, Amsterdam, Holland. (Paper read in absence by Dr. P. Barre)
- 1983 Invited lecturer on "Artificial Cells", 57th Colloid and Surface Science Symposium, Toronto, Ontario.
- 1983 Invited speaker on "Artificial Cells", Symposium, Canadian Society of Cell Biology, CFBS, Ottawa, Ontario.
- 1983 Invited lecturer on "Artificial Cells", International Symposium on Biomaterials in Artificial Organs, Scotland.
- 1983 Invited speaker on Membrane Biotechnology in Artificial Cells in "Membrane Technology Conference", Oregon, USA.
- 1983 Invited speaker on "Artificial Cells", "Hemoperfusion in Uremia", "Hemoperfusion in Poisoning and Fulminant Hepatic Failure", Brazil National Society of Nephrology Congress on Hemodialysis and Transplantation.
- 1983 Session chairman and invited speaker, Vth International Symposium on Hemoperfusion and Artificial Organs, People's Republic of China.
- 1983 Invited speaker, Nankai University, Tianjin, People's Republic of China.
- 1983 Invited speaker, Chongqing Medical College and Chongqing Biomedical Engineering Society, Chongqing, People's Republic of China.
- 1983 Invited speaker, Shanghai First Medical College, Shanghai, People's Republic of China.
- 1983 Invited speaker, Institute of Biochemistry, Shanghai, People's Republic of China.
- 1984 Invited speaker and session chairman, Gordon Research Conference on "Drug Carriers in Biology and Medicine".
- 1984 Invited speaker, Biocatalysis Group, University of Iowa, Iowa, Ill.
- 1984 Guest Faculty, Postgraduate Medicine course on "Life Support Systems in Intensive Care", University of Michigan Medical School, Ann Arbor, Michigan.
- 1984 Invited lecturer, NATO Advanced Study Institute on Biopolymer, Turkey.
- 1984 Guest speaker, "Artificial Cells" Medical Grand Round Montreal General Hospital.
- 1984 Invited speaker in Seminar on "Hemoperfusion in Hemodialysis Patients", NJ, USA.
- 1985 Chairman of session on Immobilized Cells, 8th Biannual International Enzyme Engineering Conference, Denmark.
- 1985 5th Congress of International Society of Artificial Organs, Chicago, USA. Chairman, Program Committee on "Artificial pancreas/artificial liver". Chairman, Workshop on "Artificial Cells".
- 1985 Invited Speaker, Science Council of Canada/Canadian Plastics Institute Meeting on "Emerging Technologies", Toronto.
- 1985 Invited Lecturer, "Artificial Cells", DuPont Co., Wilmington, DE, USA.
- 1985 Invited participant: "Think Tank: The Bowel as a Kidney", Downstate Medical Center,

- Brooklyn, New York.
- 1985 Invited speaker "Artificial Cells in Medicine and Biotechnology", Montreal Physiological Society.
- 1985 Vth International Symposium on Hemoperfusion, Mexico  
Honorary president  
Invited speaker.
- 1985 Invited speaker for special breakfast meeting on "Hemoperfusion in chronic renal failure and aluminum removal", 25th Anniversary of Chronic Dialysis" to honour Professor B. Scribner, Seattle, USA.
- 1985 Invited participant, Science Council Workshop on Medical Devices, Toronto.
- 1985 Opening Plenary Lecturer, State art on "Artificial Blood", Annual Meeting of American Society of Artificial Internal Organs, Atlanta, USA.
- 1986 Invited speaker, International Conference on "Applications of New Technologies in Phospholipid Thin Membranes and Vesicles", US Naval Research Symposium, Tenefrice, Spain.
- 1986 Honorary President of Symposium, Cochairman, Program Committee, and invited speaker, 7th International Symposium on Hemoperfusion, Kiev, USSR, sponsored by the USSR Academy of Sciences, September.
- 1986 Invited speaker, Czechoslovakia Society of Nephrology and Czechoslovakia Academy of Sciences, Prague.
- 1986 Special invited lecturer and session chairman, Annual Meeting of the Controlled Release Society, Virginia, USA.
- 1986 Chairman of two sessions, invited speaker and Program Committee on Artificial Kidney "International Symposium on Biomedical Engineering, Artificial Organs, and Transplantation" to honour Professor W. Kolff, Utah, USA.
- 1986 Invited speaker, Gordon Research Conference on "Bioactive Polymeric Material in Biomedical and Agricultural Application", Oxnard, California.
- 1986 Invited speaker, Workshop on Drug and Enzyme Delivery Systems, Annual Meeting of the American Society of Artificial Internal Organs, U.S.A.
- 1986 Invited speaker on "Artificial Cells" Workshop on Biotechnology, Canadian Society of Biological Sciences, Guelph, Ontario.
- 1987 Chairman of Symposium and Opening Plenary speaker, III International Symposium on Blood Substitutes, Montreal.
- 1987 Chairman, panel on Blood Substitutes, Annual Meeting, American Society of Artificial Internal Organs, New York.
- 1987 Panel Chairman and invited speaker, panel on "Drug Delivery", 6th Congress of the International Society of Artificial Organs.
- 1987 Invited Speaker on "Immobilization of enzymes, liver cell cultures and hemoglobin" in Session on Medical Applications, 9th International Conference on Enzyme Engineering, Santa Barbara, California.
- 1987 Invited speaker and International Scientific Committee, International Symposium on Optimization of Blood Purification, Rostock.
- 1987 Invited plenary lecturer and chairman of session, 7th International Symposium on Microencapsulation, Zegreb, Yugoslavia.

- 1987 Invited speaker, NATO Workshop on Immobilized Enzymes, Italy.
- 1987 Invited panelist, Symposium on "Role of Hemoperfusion in acute liver failure", Georgetown University, Washington.
- 1987 Invited Guest speaker, American Society on Material (Edmonton, Alberta).
- 1987 Invited speaker, Grand Round, Faculty of Medicine, University of Alberta, Edmonton.
- 1987 Invited speaker, Southwestern Research Institute, San Antonio, Texas, USA.
- 1987 Invited Speaker. Conference on Innovations in Protein modifications in therapeutics.
- 1988 Opening Ceremony State Art Lecturer on "Artificial Cells" 1988 Congress of the European Society for Artificial Organs, Prague, Czechoslovakia.
- 1988 Honorary President and Opening Ceremony Festive Lecturer on "Artificial Cells" 8th International Symposium on Hemoperfusion, Adsorbents and Immobilized Bioreactants, Rostock, Germany.
- 1988 Invited Speaker, session on Cell Biotechnology "Artificial Cells and Liposomes", 4th International Congress of Cell Biology, Montreal.
- 1988 Special invited speaker on "Artificial Blood". Symposium, Mexico City, Mexico.
- 1988 Invited lecturer on "Blood Substitutes". Mexican Academy of Surgery, Mexico City.
- 1988 Invited lecturer on "Blood Substitutes". Medical Centre, Mexico City, Mexico.
- 1988 Chairman of session and introductory lecture Gordon Research Conference on "Drug Carriers" New Hampshire, USA.
- 1988 Invited Speaker, Panel on New Trends in Artificial Organs, III World Biomaterials Congress, Kyoto, Japan.
- 1988 Special invited speaker on "Clinical Applications of hemoperfusion in intoxication and hepatic coma". Symposium, Mexico City, Mexico. 1988 Invited Lecture on Artificial Cells, Shiga University, Japan.
- 1988 Invited Speaker International Congress on "New Trends in Nephrology, Dialysis and Transplantation". 9th Centenary, University of Bologna, Bologna, Italy.
- 1988 Session chairman, Artificial liver/pancreas, Annual Meeting of the American Society Artificial Internal Organs, Reno, USA.
- 1988 Invited lecturer in symposium on Mimetic Enzymes. Annual Meeting of the American Chemical Society, Toronto.
- 1988 Invited keynote lecture, Hybrid Artificial Organs Symposium, Bordeaux, France.
- 1989 Honorary president and invited speaker, 9th International Symposium on Hemoperfusion, adsorbents and immobilized bioreactants, Tokyo, Japan.
- 1989 Invited lecturer, Plenary session on "Enzyme Engineering in Medical Field". 10th International Conference on Enzyme Engineering, Kashikojima, Japan.
- 1989 Symposium Co-chairman, Invited lecturer, and Chairman of session, "In vitro and in vivo assessments of cross linked hemoglobin" in International Symposium on Red Blood Cell Substitutes. San Francisco, U.S.A.
- 1989 Invited speaker and chairman of session, International Symposium on Red Blood Cell Substitutes sponsored by the Japanese Red Cross Society.
- 1989 Invited lecturer. "Immunological aspects of modified hemoglobin as blood substitute" Biomedical Engineering Society, Symposium on "Blood Substitutes". Federation of American Biological Sciences, New Orleans, U.S.A.

- 1989 Invited lecturer, "Modified hemoglobin: in vivo studies" American Trauma Society Annual Meeting, Florida, USA.
- 1989 Invited lecturer, Red Blood Cell Substitutes, Waseda University, Tokyo Japan.
- 1989 Invited speaker "Modified Hemoglobin as Blood Substitutes past, present and future", Immunohematology Society, Canadian Red Cross Symposium on "Present Trends in Blood Transfusion", Banff, Alberta.
- 1989 Chairman and speaker, Workshop on Blood Substitutes, European Society of Artificial Organs, Brussels, Belgium.
- 1989 Invited speaker on Blood Substitutes, Montreal Red Cross Society, Montreal.
- 1989 Invited speaker, Biotechnological and Medical applications of Artificial Cells in International Conference on Biotechnology, Salamanca, Spain
- 1989 Invited lecturer, Biotechnology of Artificial Cells, Department of Chemical Engineering, University of Salamanca, Salamanca, Spain
- 1990 Honorary president and invited plenary speaker, X International symposium on Hemoperfusion, absorbent and immobilized bioreactants, Rome, Italy
- 1990 Invited plenary speaker on Biotechnological approach based on artificial cells, Congress of the European Society for Artificial Organs, Bologna, Italy
- 1990 Invited plenary speaker, VI International Symposium on Microencapsulation, Glasgow
- 1990 Invited speaker on Artificial Cells. "International Conference on Membrane," Chicago, IL
- 1990 Invited speaker, symposium, American Chemical Society, Annual Meeting, Washington, DC, USA
- 1991 Invited speaker in panel on Hybrid Artificial Organs, Annual Meeting, American Society of Artificial Internal Organs, Chicago USA.
- 1991 Invited speaker and session chairman on "Blood Substitutes"; Annual Meeting, American Society of Artificial Internal Organs, Chicago, USA.
- 1991 Invited speaker, On "Red Blood Cell Substitutes by Modified Hemoglobin", CPTMQ CSLT Congress, Montreal.
- 1991 Congress President VIII World Congress, International Society of Artificial Organs, Montreal, Canada. Opening ceremony speaker on "35 years of artificial cells"
- 1991 Symposium Chairman and plenary speaker, on "Modified hemoglobin as blood substitutes", IV International Symposium on Blood Substitutes, Montreal, Canada.
- 1991 Invited lecturer on "Modified hemoglobin as blood substitutes", Symposium on "New Concepts in Blood Product Usage", Canadian Society of Hematology and Canadian Red Cross Blood Service, Annual Meeting, Royal College of Physicians of Canada, Quebec City.
- 1992 Chairman of panel on "Blood substitutes", and speaker on "Modified hemoglobin and clinical safety", American Society for Artificial Internal Organs, Annual Meeting, Memphis, USA.
- 1992 Invited plenary speaker on Blood Substitutes., XIX Congress of the European Society for Artificial Organs, Rhode Island, Greece.
- 1992 1st Julius Silver Lectureship, Julius Silver Symposium organized by the Julius Silver Institute of Biomedical Engineering, Technion Institute, Israel and the Israel Society of

- Biomedical Engineering. International
- 1992 Invited speaker, 8th International Symposium on Microencapsulation, Dublin, Ireland,
- 1993 Co-chairman and invited plenary speaker, V International Symposium on Blood Substitutes, San Diego, California, USA.
- 1993 Chairman and opening speaker, IB Conference on Blood Substitutes, Philadelphia, USA.
- 1993 Open plenary lecturer, Inaugurative congress of the founding of the Japanese Society for Blood Substitutes. Tokyo
- 1994 Honorary Congress President and Opening Plenary Speaker, XI Congress of the International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology, with Professor R. Langer of MIT as organizer and congress president, Boston, USA.
- 1994 Conference Chairman and Opening Speaker IBC conference on Blood Substitutes. Washington, D.C.
- 1994 Invited speaker, on Blood Substitutes International Conference on Bioengineering, Krems, Austria.
- 1995 Invited speaker on "Artificial Cells Technologies" Meeting on Cell Transplantation. Technologies Applicable to Cell Therapy, Miami, U.S.A.
- 1995 Invited speaker Symposium on Tissue Engineering using Biomedical Polymers. Kyoto
- 1995 Invited Main Lecturer. (at last minute substituted by my recent Ph.D. graduate because too many invited lectures this year.) International Symposium on Polymer, Institute of Macromolecular Chemistry, Czech Academy of Science, Prague, Czech.
- 1995 Invited Special Lecturer on "Present Status of Modified Hemoglobin as Blood Substitutes" II Congress Japanese Society for Blood Substitute, Tokyo, Japan. This was followed by Invited Lecturer on "Specially designed modified hemoglobins" Waseda University, Tokyo and also Shonan Research Centre, Tokyo.
- 1995 Panel Chairman and opening speaker. Panel on Artificial Blood. Annual Meeting of the American Society for Artificial Internal Organs, Chicago.
- 1995 Chairman, Symposium on Tissue Engineering I: Basic Science and Chairman, Session Tissue and Cellular Engineering, 17th Annual International Conference of the IEEE Engineering in Medicine and Biology society & 21 Canadian Medical and Biological Engineering Conference, Montreal.
- 1995 Presidential address & Key note speaker on "Artificial Cells Biotechnology for Artificial Organs in the 21st Century". X World Congress of the International Society for Artificial Organs, Taipei, Taiwan.
- 1995 Opening speaker on "Present status of modified hemoglobin blood substitutes" International Symposium on the Technology of Blood Substitutes. Taipei, Taiwan.
- 1995 Invited Plenary lecture on "Microcapsule artificial cells containing enzyme, hepatocytes or genetically engineered microorganisms: implications in therapy and biotechnology" in the International Symposium on Microencapsulation, Drug Dynamics Institute, College of Pharmacy, U of T at Austin, Texas, U.S.A.
- 1996 Cochairman and invited speaker Session on "Safety and Efficacy of Artificial Oxygen Carrier" 24th Congress of the International Society of Blood Transfusion, Chiba, Japan.

- 1996 Co-chairman and invited speaker on "Development of bioartificial liver" in Symposium on "Plasmapheresis and/or transplant for fulminant hepatic failure" International Conference for Apheresis. Kyoto, Japan.
- 1996 Co-chairman Session on Blood Substitutes. Annual meeting of the American Society for Artificial Internal Organs, Washington, D.C.
- 1996 Symposium Chairman and opening speaker, VII International Symposium on Blood Substitutes, Montreal
- 1996 Invited opening plenary speaker: Conference on Bioartificial Organs, Science and Technology, Sponsored by the Engineering Foundation, Nashville, Tennessee, USA
- 1997 Honorary congress president and plenary lecturer. XII Congress of the International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology. Organized by the Chinese Academy of Medical Sciences, Beijing, PRC. September.
- 1997 Symposium co-chairman and plenary lecturer of the VIII International Symposium on Blood Substitutes, Tokyo, Japan.
- 1997 Invited speaker and co-chairman of session on Artificial Cells & Blood Substitutes. Congress of the International Society for Artificial Organs. Rhode Island, U.S.A.
- 1997 Invited speaker, Symposium on Blood and Surgery : a Multidisciplinary approach, Winnipeg, Canada.
- 1997 Keynote speaker, "Blood substitutes - present status and future relevance in national blood supply policies" Canadian Society for Transfusion Medicine, Ottawa.
- 1998 Invited opening plenary lecture on "Artificial Cells, Immobilization and Encapsulation", Bioartificial Organs II: Technology, Medicine and Materials, Engineering Foundation Conferences, Banff, Canada.
- 1998 Invited Plenary Lecturer on "Artificial Cells including Blood Substitutes" 8<sup>th</sup> Asian-pacific Congress of Clinical Biochemistry, Kuala Lumpur, Malaysia
- 1998 Invited "State of the art lecture" on hemoglobin-based blood substitutes. XXVth Congress of the Int. Soc of Blood Transfusion. Oslo, Norway,  
Panel speaker on "Polyhemoglobin-catalase-superoxide dismutase: a new blood substitute" Conference on Resuscitation Fluids, Institute of Medicine, National Academy of Science, Washington, D.C.
- 1999 Chairman and opening speaker. Panel on Artificial Blood. Annual Meeting of the American Society for Artificial Internal Organs
- 1999 Invited lecturer on Blood Substitutes in Conference on Biotech Alternatives to Blood & Plasma Products. London, UK
- 1999 Invited lecturer and chairman of panel on "Bioencapsulation" Innovation and Trends in Biotechnology, Laval, Quebec, Canada,
- 1999 Invited lecturer on "Artificial Cells including blood substitutes", Therapeutic Products Program, Continuing Education, Health Canada, Ottawa, Canada
- 1999 Invited speaker in symposium on "The bowel as an artificial kidney" Congress of the International Society for Artificial Organs, Edinburgh, UK.
- 1999 ISBP Award Plenary Lecture, Congress of the International Society for Blood Purification, Prague. (Sir Roy Calne was the winner of the 1998 ISBP Award Lecturer other previous winners have included Robert Rosenberg at the NIH, and Charles

Dinareello then at Tufts)

- 2000 Invited Lecturer on Artificial Cells , Abbott Laboratory, Chicago
- 2000 Invited Lecturer on Blood Substitutes, International Conference on Transfusion Medicine 2001, Cambridge University, United Kingdom
- 2000 Invited Lecturer on Blood Substitutes, European Society for Trauma Surgery, Pisa, Italy
- 2000 Invited Plenary Speaker, Bionics for Human in 3<sup>rd</sup> Millenium, L'Aquila, Italy
- 2000 Chairman, Session on Award Lectures, Congress of the International Society for Blood Purification, Rome, Italy
- 2000 Session Chairman on Clinical Trials and Invited Lecturer on Present Status(1)Blood Substitutes (2) Oral therapy for uremia, IIIrd Bioartificial Organ Conference, Switzland
- 2000 Symposium Co-chairman, session chairman and invited plenary lecturer on New Products in hemoglobin based blood substitutes, VIII International Symposium on Blood Substitutes, San Diego
- 2000 Invited Lecturer, Poly2000, American Chemical Society, Hawaii
  
- 2001 Invited Open Plenary Symposium lecturer on Artificial Cells in the 48<sup>th</sup> Annual Conference, American Society for Artificial Internal Organs, New York City, U.S.A..
- 2001 Invited speaker on "Blood Substitutes" 11<sup>th</sup> European Congress of Anaesthesiology, Florence. Italy.
- 2001 Chairman & Invited Speaker in panel on "Artificial Organs". 6<sup>th</sup> Symposium of World Artificial Organs, Immunology & Transplantation Society, Ottawa, Canada
- 2001 Invited Speaker in panel on "Treatment of Type 1 Diabetes", 6<sup>th</sup> Symposium of World Artificial Organs, Immunology & Transplantation Society, Ottawa, Canada
- 2001 Panelist in public panel on "Ask the Experts". 6<sup>th</sup> Symposium of World Artificial Organs, Immunology & Transplantation Society, Ottawa, Canada
- 2001 13<sup>th</sup> Congress of the International Society for Artificial Organs, Osaka, Japan.  
International Scientific committee, chairman of Panel session on "Genetic Engineering and Biotechnology in Artificial Organs", and invited panel lecturer on "Artificial Cells for genetically engineered cells and modern biology in artificial organs"
- 2001 Invited speaker on Artificial Cells as visiting professor, Chinese Hong Kong University Medical School.
- 2001 Invited specker on Artificial Cells. Capital Medical School Affiliated ChouYaung Hospital, Beijing.
  
- 2002 Invited lecturer on "Artificial Cells in Tissue Engineering with emphasis on oral therapy using artificial cells containing genetically engineered cells". Tissue Engineering Conference, Pittsburg, Penn.
- 2002 Invited plenary speaker on "Future generations of Blood Substitutes" and member of Organizing committee of Conference on Blood Substitute organized by Karolinka Institute, Stockholm, Sweden.
- 2002 Keynote speaker on "Artificial Cells in Biotechnology and Medicine", World Congress. Seoul, South Korea.
- 2002 Invited lecturer on "Blood Substitutes in trauma surgery:". International Congress of Surgery, Taiwan.

- 2002 Invited Keynote speaker on “Artificial Cells in Bioencapsulation: macro, micro, nano and molecular”, Bioencapsulation Conference, Birmingham, U.K.
- 2002 Invited speaker on “Two new blood substitutes: polyhemoglobin-SOD-CAT and biodegradable polymeric Hb nanocapsules”, Minisymposium on Oxygen carrying resuscitation fluid, ATACCC, Florida, U.S.A.
- 2003 Invited Special Plenary speaker on Artificial Oxygen Carriers, International Symposia for Life Science and Medicine, Keio University, Tokyo, Japan (March)
- 2003 Honorary president and invited plenary speaker, 9<sup>th</sup> International Symposium on Blood Substitutes, Tokyo, Japan (March)
- 2003 Invited Speaker, Symosium, Research Fund Bayer/Canadian Blood Service/Hema Quebec
- 2003 Invited speaker on Artificial Cells in Medicine and Biotechnology. CIHR Workshop Regenerative Medicine and Artificial Organs, Toronto, Canada. (March)
- 2003 Chairman and invited speaker, pregress workshop on Blood Substitutes: present and future. Joint congress of International Society for Artificial Organs/American Society for Artificial Internal Organs. Washington D.C., U.S.A. (June)
- 2003 Invited Speaker on “Blood Substitutes & Artificial Cells” 4<sup>th</sup> Regenerative Medicine Conference , Washington, D.C. (November)
- 2003 Visiting Professor, Invited Lecture on Blood Substitutes, Grand Round, Department of Anesthesia and Critical Care, Massachusetta General Hospital, Harvard Medical School, Boston, U.S.A. (December).
- 2003 Invited plenary speaker. TEDA-Waston International Biotechnology Conference, Tianjin , PRC
- 2003 Invited speaker. Life Sciences Faculty, Nankai University, Tianjin, PRC
- 2003 Invited speaker. Chinese Academy of Medical Sciences/ Beijing Union Medical College. Beijing, PRC
- 2003 Invited speaker. Pharmaceutical Sciences and Biotechnology Faculty, Tianjin University, Tainjin, PRC
- 2004 Keynote speaker, Graduate Program Conference, Department of Pharmaceutical Sciences, University of Toronto, Canada.
- 2004 Invited speaker, VIP guest, scientific committee, the 3<sup>rd</sup> TEDA-WATSON International Forum on Biotechnology and Biomedicine, Tianjin, China
- 2004 Invited plenary speaker and Investiture as Visiting Professor Shen Zhen University, National Symposium on Hemoperfusion. ShenZhen, China
- 2004 Keynote speaker, 5<sup>th</sup> International European Molecular Biology Laboratory Ph.D. Students’ Symposium. European Molecular Biology Laboratory (EMBL), Heidelberg, Germany
- 2004 Invited plenary lecturer, International Conference on Chemistry Biology Interface: Synergistic New Frontiers. Delhi, India.
- 2005 Honorary Sympoium President and invited opening plenary speaker on “Evolution of Artificial Cells”, X International Symposium on Blood Substitutes, Rhode Island, Providence, U.S.A.
- 2005 Keynote Speaker on “Artificial Cells in Regenerative Medicine” II World Congress

- Regenerative Medicine, Lipzig, Germany
- 2005 Invited speaker on “Blood Substitutes: molecular biotechnology to nanobiotechnology”  
International Conference on New Technologies in Medicine, Krems, Austria
- 2005 Invited speaker on “Artificial Cells of macro, micro, nano and molecular dimensions”  
Department of Biomedical Engineering Seminar Series , McGill University.
- 2006 Invited speaker on “New Trends in Blood Substitutes: biological and synthetic oxygen carriers”. Joint Conference of the Canadian Society for Transfusion Medicine/Canadian Blood Service/Hema-Quebec, Montreal.
- 2006 Invited Speaker, Biomedical Engineering Department Seminar Series, McGill University.
2006. Opening Plenary lecturer for the 3 days Business Conference section of the 9<sup>th</sup> International Conference on “Gene and Drug Therapy in Molecular Medicine” Crete, Greece. “Therapeutic Application of Polymeric Artificial Cells”
- 2006 Invited opening session lecture on “Therapeutic applications of polymeric artificial blood cells” International visions on blood substitutes. Hemoglobin-based oxygen carriers, from chemistry to clinic” University of Parma, Parma, Italy.
- 2006 Invited speaker: Technology in Liver Regeneration Conference on Stem Cells in Regenerative Medicine, Ankara, Turkey.(cancel because of airline security problem)
- 2006 Invited speaker on nano artificial red blood cell to the Nanoscience Group, University of Duisburg-Essen in Western Germany (Postponed because of airline security problem)
- 2007 Invited Opening keynote lecturer, 2007 Oct XI International Symposium on Blood Substitutes, Organized by Chinese Academy of Medical Sciences and Beijing Union Medical College, Beijing, China
- 2007 Chairman and panelist, Satellite symposium of XI ISBS on Toxicology of Blood Substitutes, Xian, China.
- 2007 Invited Opening keynote lecturer, XI International Symposium on Blood Substitutes, Organized by Chinese Academy of Medical Sciences and Beijing Union Medical College, Beijing, China
- 2007 Co-Chairman and panelist, Satellite symposium of XI ISBS on Toxicology of Blood Substitutes, Xian, China.
- 2007 Invited Speaker, Faculty of Medicine, Shantou University, Shantou, China
- 2007 Visiting Professor and invited speaker, Northwest University in Xian, China
- 2008 Invited lecturer , International Conference on Drug Design and Discovery, Dubai, UAE  
Dubai invited speaker
- 2008 International Drug Discovery Science & Technology Conference (IDDST) Opening keynote session in session on Regenerative Medicine, Beijing, China.
- 2008 Plenary speaker and chair of session, International Academy of Nanomedicine Symposium, WashingtonDC (Potomac MD) USA
- 2008 Guest Professor award ceremony and invited lecture. Shantou University, Shantou, China
- 2008 Plenary Keynote speaker, World Congress on Cancer, Shanghai, China (did not go because of unexpected illness)

- 2008 Invited Keynote speaker, Joint meeting of the 15<sup>th</sup> Japanese Society for Blood Substitutes and 6<sup>th</sup> Current Issues in Blood Substitutes, Keio University, Tokyo, Japan (did not go because of unexpected illness)
- 2009 Honorary President, opening speaker, invited speaker and panelist, XII International Symposium on Blood Substitutes, Parma, Italy.
- 2009 Opening plenary lecturer, First World Congress of the International Academy of Nanomedicine, Hainan, China
- 2009 Special invited speaker, Chinese Research Group on Blood Substitutes, Beijing China, Chinese Academy of Sciences.
- 2009 Invited plenary lecturer, 2<sup>nd</sup> Science Conclave of Nobel Laureates, Allahabad, India.
- 2010 Opening Keynote plenary lecturer, 2<sup>nd</sup> World Congress of the International Academy of Nanomedicine, Antalya, Turkey
- 2010 Opening Keynote plenary lecturer. International Congress on Nanotechnology, Ottawa
- 2010 Opening Keynote plenary lecture BIOMED2010, Istanbul
- 2010 Opening Keynote plenary lecturer BIT 3<sup>rd</sup> Congress on Regenerative Medicine and Stem Cells, Shanghai, China.
- 2010 Opening Keynote plenary lecturer BIT 1<sup>st</sup> Congress on Nanomedicine, Beijing, China
- 2010 Invited Lecture, Tsinghua University, Beijing, China
- 2010 Invited Lecture, Peking University Health Sciences, Beijing, China
- 2010 Invited Lecture, Polytech University, Hong Kong, China
- 2010 Invited Lecture, Transfusion Institute, Beijing, China
- 2011 Kjeldgaard Lecturer, Department of Molecular Biology, Aarhus University, Denmark
- 2011 Honorary president and opening lecture, XIII International Symposium of Blood Substitutes, Mass General Hospital, Harvard Medical School, Boston,
- 2011 Opening Keynote Speaker, Conference on Micro and Nano Systems, Chongqing, China
- 2011 Invited Speaker, Blood Transfusion Institute of the Chinese Academy of Medical Sciences.
- 2011 Invited Speaker, Ordos Blood Substitute Congress, Ordos, Inner Mongolia, China

### **COMMITTEES AND BOARDS:**

1. Diocesan Boys' School, Hong Kong:
  - Head Prefect of Boarding School.
  - Captain, Featherstone House (sports).
  - Pianist, General Assembly and Chapel services.
2. McGill University Undergraduate:
  - Social Convenor and Student Council, Douglas Hall of Residence, McGill.
  - McGill Intercollegiate Wrestling Team (Letter award).
  - Sunday School Teacher, Christ Church Cathedral, Montreal.
3. Free voluntary community service in Montreal Chinese Hospital:
  - First of the annually rotating chairmen, Medical Board, newly built Montreal Chinese Hospital (free voluntary service) (1966-1967).
  - Attending staff and chief of laboratory (free voluntary service) (1966 until

- Medicare in Quebec);  
 Consultant – free voluntary service (since Medicare started until 1982);  
 Honorary Consultant (1982-1987);  
 Honorary Staff (1987-present).
4. Board of Directors, Preville Presbyterian Church (1967-1968).
  5. Advisory Board, Biannual International Enzyme Engineering Conference (1971).
  6. Committee on the Standardization of Nomenclature in Enzyme Technology, (consisting of E Katchalski, Y Levin & A Patchornik from Israel; J Porath & K Mosbach from Sweden; MD Lilly from the UK; G Manecke from Germany; PV Sundarum from India; NO Kaplan, VH Edwards, AE Humphrey, EK Pye, HH Weetall & LB Wingard, Jr. from the USA; & TMS Chang from Canada (1971 +1973).
  7. Canadian National Committee, National Research Council of Canada, International Union of Pure and Applied Biophysics (1971-1975).
  8. Isotope Committee, McIntyre Building, McGill University (1967-1976).
  9. Ad Hoc Committee on Contracts from Drug Systems, National Institute of Child Health and Human Development, National Institutes of Health, Washington, DC (1972).
  10. Postgraduate Awards Committee, Faculty of Medicine, McGill University(1972-79).
  11. Advisory Board, Biannual International Enzyme Engineering Conference (1973).
  12. Project Site Visit and Special Study Section, National Institutes of Health (USA) (1974).
  13. Project Site Visit and Special Study Section, National Institutes of Health (USA) (1975).
  14. Advisory Board, Biannual International Enzyme Conference (1975)
  15. National Institute of Child Health and Human Development, National Institutes of Health, Washington, DC  
 Consultant (1975-1977).
  16. Promotion, Reappointment and Tenure Committee, Dept of Physiology, McGill University (1975-1977).
  17. Statutory Committee for Professors in Medicine, McGill University (1975).
  18. Statutory Committee for Professors in Biochemistry, McGill University (1977).
  19. Advisory Board, Biannual International Enzyme Engineering Conference (1977).
  20. Chairman and Organizer, International Symposium on "Some Novel Approaches in Artificial Kidney, Artificial Liver and Detoxification", (1st International Symposium on Hemoperfusion) Montreal (1977).
  21. Canadian Standard Association Subcommittee on Kidney Dialysis (1977-1987).
  22. International Council Member, International Society for Artificial Organs (1977  
 1 982).
  23. Scientific Film Comm., American Society for Artificial Internal Organs(1977).
  24. Video Committee, American Society for Artificial Internal Organs (1977).
  25. Program Committee, American Society for Artificial Internal Organs(1978-81).
  26. Project Site Visit and Special Study Section, National Institutes of Health (USA) (1978).
  27. Search Committee for Physiology Chairman, McGill University (1978).
  28. McGill University Patent Policy Review Committee (1979).
  29. McGill University Ad Hoc Committee on visiting scholars, fellows and students from China (1979).
  30. Cochairman, 2nd International Symposium on Hemoperfusion, Israel Institute of Technology, Technion, Israel (1979).
  31. Organizer and initiator, Canadian Society for Artificial Organs, Artificial Organs,

- Artificial Cells and Medical Devices (1979).
32. Member of International Program Committee, Symposium on Control Aspects of Artificial Organs. International Federation of Automatic Control and International Society for Artificial Organs, Warsaw, Poland (1979-1980).
  33. Co-chairman, Gordon Research Conference on "Drug Carriers in Biology and Medicine", New Hampshire, USA (1980).
  34. Admissions Committee, Faculty of Medicine, McGill University (1979-1982).
  35. Departmental Policy Committee, Dept. of Physiology, McGill Univ. (1979-1986).
  36. Advisory Board, Biannual International Enzyme Engineering Conference, Japan (1981).
  37. Founding President, Canadian Society for Artificial Organs, Artificial Cells and Medical Devices (1980-1982).
  38. Standing Committee on Biotechnology, McGill University (1980-1981).
  39. Biotechnology Research Group, Faculty of Graduate Studies and Research, McGill University (1981-1984).
  40. Keyman on Hemoperfusion, Program Committee, International Congress of the International Society for Artificial Organs, Paris, France (1981).
  41. Chairman, Gordon Research Conference on "Drug Carriers in Biology and Medicine", New Hampshire, USA (1982).
  42. Honorary President, 4th International Symposium on "Hemoperfusion", Turkey and member of International Organizing Committee (1982).
  43. Member, McGill University Regional Advisory Group of International Development Research Centre of Canada (IDRC) on People's Republic of China (1982-present).
  44. Board of Trustees, International Society for Artificial Organs (1982-1986).
  45. Symposium President and Chairman of Organizing Committee, Fifth International Symposium on "Microencapsulation, Including Artificial Cells", Montreal, Canada (1983).
  46. Fifth International Symposium on "Hemoperfusion and Artificial Organs", People's Republic of China, International Scientific Committee (1983). Co sponsored by the Chinese Biomedical Engineering Society and the International Society of Artificial Organs.
  47. Advisory Committee, VII International Conference on Enzyme Engineering, Engineering Foundation for 1983.
  48. Organizing Committee and chairman of program committee on Hemoperfusion", 4th International Congress of the International Society of Artificial Organs, Kyoto, Japan (1983).
  49. International Scientific Committee, International Symposium on Hemodetoxifications in Nonuremic patients, Italy (1983).
  50. Chairman, International Committee of past symposium presidents, International Symposium on Hemoperfusion, sorbents and immobilised bioreactants series (1983 to present)
  51. Consultant, Dialaid International Ltd. (1981-1984), which became Biomicroencapsulation Technology Ltd., Montreal (1984 to 1986), which became Carbomed, Co. (1986 1990).
  52. Scientific Advisory Board, Karyon Technology Co., Boston, Mass, USA (1983 to 1986).
  53. Honorary president, 6th International Symposium on Hemoperfusion (1985), and member of International Scientific Committee, Mexico. Co

- sponsored by the Mexican Society of Nephrology and the International Society of Artificial Organs.
54. Organizing Committee (past chairmen), Gordon Research Conference on "Drug Carriers in Biology and Medicine", New Hampshire, USA (1984).
  55. International Committee, NATO Advanced Study Institute on Biopolymer, Turkey (1984).
  56. Advisory Committee, Biotechnology, McGill University (1984 to 1993).
  57. 5th Congress of the International Society of Artificial Organs, Chicago, U.S.A. (1985) Chairman, Program Committee on "Artificial pancreas/artificial liver". Chairman, workshop on "Artificial Cells"; Specialty Chairman on "Plasmapheresis Blood Manipulation Field".
  58. Chairman, Search Committee for Cardiovascular Physiologist, Dept. of Physiology, McGill University (1986).
  59. Chairman, Advisory Committee Meeting on "Particulate Contamination in Medical Devices", Bureau of Medical Devices, Department of Health and Welfare, Government of Canada, Feb. 1986, Ottawa.
  60. Honorary President, 7th International Symposium on Hemoperfusion, Kiev, USSR (1986). Sponsored by the USSR Academy of Sciences.
  61. President, 3rd International Symposium on Blood Substitutes, Montreal, PQ, Canada (1987).
  62. Committee on Appointment, Tenure and reappointment, Physiology, McGill (1983-85)
  63. International Program Committee for the Joint World Congress of International Society of Artificial Organs and European Society of Artificial Organs, Munich, Germany, 1987.
  64. International Program Committee: International Symposium on "Optimization of Blood Purification", Rostock GDR, 1987.
  65. Program committee on Artificial Cells and Hemoperfusion. 1988 Congress of the European Society of Artificial Organs, Prague, Czechoslovakia.
  66. Program Committee, Annual Meetings of the American Society of Artificial Internal Organs (1986 to 1992).
  67. Program Committee, 7th International Symposium on Microencapsulation, 1987.
  68. Scientific Advisory Board, Hemosol Co., Toronto, Canada.(1988-1998)
  69. Member of Chairman's Advisory Committee, Department of Physiology, McGill University (1988-present)
  70. Honorary President, 8th International Symposium on Hemoperfusion, Sorbent and Immobilised Bioreactants, Germany, 1988.
  71. Cochairman, 1989 International Symposium on Red Blood Cell Substitutes: Design and Clinical Application, San Francisco, U.S.A.
  72. Honorary President, 9th International Symposium on Hemoperfusion, Sorbent and Immobilised Bioreactants, Tokyo, Japan, 1989.
  73. Program Committee, 1989 Congress of the International Society of Artificial Organs, Sapporo, Japan.
  74. Honorary President, 10th International Symposium on Hemoperfusion, Sorbent and Immobilised Bioreactants, Rome, Italy, 1990.
  75. International Scientific Advisory Committee member, 7th International Symposium on Microencapsulation, Glasgow, Scotland, 1990.
  76. Congress President, 8th World Congress of the International Society of Artificial

- Organs, in conjunction with the 4th International Symposium of Blood Substitutes, Montreal, 1991.
77. International Scientific Advisory Committee, 8th International Symposium on Microencapsulation, Ireland, 1992.
  78. Member, McGill Biotechnology Committee (1984 to present).
  79. Member, Subcommittee on Research Centers, Faculty of Graduate Studies (1991).
  80. Board of Trustee, International Society of Artificial Organs. Reappointed for 1989-1993.
  81. Honorary President, International Society for Artificial Cells and Immobilization Biotechnology (1991-present).
  82. President-elect, International Society for Artificial Organs (1992-1994).
  83. President, International Society for Artificial Organs (1994-1996).
  84. International Scientific Advisory Committee, 9th International Symposium on Microencapsulation, Turkey, 1993.
  85. Honorary congress president, XI Congress of the International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology. (Congress president Professor R.Langer of MIT which organized this), Boston, 1994.
  86. Conference Chairman IBC Conference on Blood Substitutes, Washington D.C. 1994
  87. International Scientific Advisory Committee, 9th International Symposium on Microencapsulation, USA, 1993.
  88. Program Chairman, International Organizing Committee, Xth World Congress of the International Society for Artificial Organs, Taipei, Taiwan (1995).
  89. Chairman, VI International Symposium on Blood Substitutes. Montreal 1996.
  90. Organizing Committee, Congress of the International Society for Artificial Organs, Rhode Island, U.S.A.
  91. Cochairman, VI International Symposium on Blood Substitutes Tokyo, Japan 1997
  494. Honorary congress president, XII Congress of the International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology. Organized by the Chinese Academy of Medical Science with president of academy as congress president) Beijing, PRC, 1997
  495. Cochairman and member of organizing committee, VIII International Symposium on Blood Substitutes, San Diego, 2000
  496. Honorary Chairman, International Society for Artificial Cells, Blood Substitutes & Immobilization Biotechnology XIV Conference on "Artificial Cells & Cells in Novel Medical Application" Istanbul, Turkey
  497. Member of MRC and CIHR "Pharmaceutical Sciences" Grants Review committee. (1999-2001)
  498. FRSQ & MSSS (Quebec Ministry of Health) Member of Working group on Research Priority in Transfusion Medicine (2000-2001).
  499. Member, International Scientific Committee of the 13<sup>th</sup> Congress of the International Society for Artificial Organs, Osaka, Japan, 2001
  500. Member, Organizing committee of Conference in Blood Substitute organized by Karolinka Institute, Stockholm, Sweden. 2002 June
  501. Member, International Scientific Committee of the 13<sup>th</sup> Congress of the International Society for Artificial Organs, Washington, D.C. 2003 June
  502. Chairman and Organizer, pre-congress workshop on Blood Substitutes: present and future. Joint congress of International Society for Artificial Organs/American Society for

- Artificial Internal Organs. Washington D.C., 2003 June
503. Honorary President and Member of International Advisory Committee, IX International Symposium on Blood Substitutes, Tokyo, Japan 2003 March
  504. Scientific committee and VIP guest, III International Symposium on Biotechnology and Biomedicine, Tianjin, PRC. 2004
  505. Honorary President and Member of International Advisory Committee, X International Symposium on Blood Substitutes, Providence, Rhode Island 2005, June
  506. Member, Scientific Board, 2<sup>nd</sup> World Congress on Regenerative Medicine, Germany
  507. 2004 Olympic Summer Games, Athen. Expert consultant (blood substitutes) for the ad hoc Court of Arbitration for Sport(CAS) on doping related matters (e.g. blood substitutes).
  508. 2006 XX Olympic Winter Games, Turin. Expert consultant for the ad hoc Court of Arbitration for Sport(CAS) on doping related matters (e.g. blood substitutes).
  509. 2006 March XVIII Commonwealth Games, Melbourne. Expert consultant for the ad hoc Court of Arbitration for Sport (CAS) doping related matters (e.g. blood substitutes).
  510. Honorary President and Member of International Advisory Committee, XI International Symposium on Blood Substitutes, Beijing, China 2007
  511. International Scientific Board, Congress of ESAO 2007 Austria
  512. Founding member, International Academy of Nanomedicine 2008-
  513. NATO co-director of workshop on Advance Institute of Science 2008
  514. Honorary President and Member of International Advisory Committee, XII International Symposium on Blood Substitutes, Parma, Italy. 2009
  515. President and member of the board, International Academy of Nanomedicine, 2009-2010
  516. Honorary President, International Scientific Advisory Committee XII International Symposium on Blood Substitutes, Parma, Italy
  517. International Scientific Advisory Committee First World Congress of the International Academy of Nanomedicine, Hainan, China
  518. International Scientific Advisory Committee 2<sup>nd</sup> World Congress of the International Academy of Nanomedicine, Antalya, Turkey
  519. International Scientific Advisory Committee. 2010 International Congress on Nanotechnology, Ottawa
  520. International Scientific Advisory Committee 2010 BIT 3<sup>rd</sup> Congress on Regenerative Medicine and Stem Cells, Shanghai, China.
  521. International Scientific Advisory Committee BIT 1<sup>st</sup> Congress on Nanomedicine, Beijing, China, 2010

