TWO PAGE EXECUTIVE SUMMARY (July 18 2024)

Professor Thomas Ming Swi Chang, O.C., M.D., C.M., Ph.D., D.Sc.,FRCPC, FRS[C], FCAHS

Degrees

- 1957 B.Sc. Honours Physiology McGill University (invented artificial Cells)
- 1961 M.D.,C.M. Faculty of Medicine, McGill University
- 1965 Ph.D. (on artificial cells) McGill University
- 2023 D.Sc.honorary, University of British Columbia
- F.R.C.P.C. Fellow of the Royal College of Canada (Medical Sciences)
- F.R.S.C. Fellow of the Royal Society of Canada
- F.C.A.H.S. Fellow of the Canadian Academy of Health Sciences
- D.Sc. (honorary from University British Columnia

Academic positions

Promoted at 3-year intervals from assistant professor to associate professor to full professor of the departments of Physiology, Medicine and Biomedical Engineering, Faculty of Medicine & Health Sciences, McGill University, Montreal, Quebec, Canada

McGill onlu allows full professors to have a limited amount of time for activities outside the university. I requested to be appointed emeritus professor so that I can fulfill the following activities:

Director, Artificial Cells & Organs Research Centre, an international centre www.medicine.mcgill.ca/centrechart.pdf

Elected Honorary President and coordinator, Artificial Cells, Blood Substitutes & Biotechnology (an international network) www.medicine.mcgill.ca/ISAB.pdf

Editor in Chief 1980-2020, Emeritus Editor 2020- Artificial Cells, Nanomedicine & Biotechnology, an international Journal, (Taylor and Frances Publisher)

Editor in Chief 2006- Book series on Regenerative Medicine, Artificial Cells & Nanomedicine, World Science Publisher/Imperial College Press,

Editor in Chief 2024 International Journal Cell/tissue Engineering, Artificial Cell & Regenerative Medicine

Director, " Father of Artificial Cell TMS Chang Academician Specialist Research Station" First Hospital of the Shantou University Medical School.(Shantou is my home town.

Honorary Professor, Peking Union Medical College, Chinese Academy of Medical Sciences, China

Honorary Professor and chief consultant, Blood Transfusion Institute, Chinese Academy Medical Sciences, China

Honorary Professor, Nankai University

Publications www.medicine.mcgill.ca/changPub.pdf

He has published more than 586 full papers and chapters

More than 500 invited lectures and plenary lectures

30 books and special issues

Other recognitions for his research

He was awarded Officer of the Order of Canada for his invention of artificial cells

A worldwide poll voted him the “Greatest McGillian” out of 700 nominees from McGill’s 190 years history http://www.medicine.mcgill.ca/artcell/voting%20result.pdf

Virage Centre of Excellence in high Technology (Permanent), Other awards www.medicine.mcgill.ca/changpub.pdf

He is known as the “Father of Artificial Cells”. He proposed and prepared the first artificial cells (Chang 1957 McGill, Science 1964) and continued this research for his research career. **In his Invited Monograph on Artificial Cells (Chang 1972)** (Charles C Thomas Publisher). he stated that:“Artificial Cell is not a specific physical entity. It is an idea involving the preparation of artificial structures……. for possible replacement or supplement of deficient cell functions different approaches can be used to demonstrate this idea.” This area has now progressed well beyond his 1972 predictions. His 2019 review https://www.tandfonline.com/doi/full/10.1080/21691401.2019.1577885 Titled “**ARTIFICIAL CELL evolved into** nanomedicine, biotherapeutics, blood substitutes, drug delivery, enzyme/gene therapy, cancer therapy, cell/stem cell therapy, nanoparticles, liposomes, bioencapsulation, synthetic cells, cell encapsulation/scaffold, biosorbent/immunosorbent hemoperfusion/plasmapheresis, regenerative medicine, encapsulated microbe, nanobiotechnology, nanotechnology”. The potential of artificial cells in biomedical research and clinical application is only limited by one’s imagination.

Further details: www.medicine.mcgill.ca/artcell free papers, reviews, videos, Monographs and books

COMMENTS BY HIS PEERS

Greatest McGillian in the university's 190 years history *A 2011 world wide poll voted the inventor of artificial cells, Chang, as the "Greatest McGillian" out of 20 finalists from 700 nominee in McGill University's 190 years history. http://www.medicine.mcgill.ca/artcell/votingresult.pdf*

The Canadian Academy of Health Sciences "Dr. Chang's original ideas were years ahead of the modern era of nanotechnology, regenerative medicine, gene therapy, stem cell/cell therapy and blood substitutes.Evidence of his stature within the international scientific community was confirmed by 2 nominations for the Nobel Prize".

United Kingdom journal, New Scientist: In 1957, Thomas Chang was completing his final year as an undergraduate at McGill University in Montreal. … He would make the first artificial cell . It has grown into a dynamic field.... worldwide 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….. 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 …."liposomes"

Journal of the British Royal Society of Chemistry , "Chemistry in Britain": Professor Tom Chang when he started work in the 1950's he was ploughing a lone furrow. Chang is credited with inventing microencapsulation,…….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. … interest in artificial cells has taken off".

"American Medical News(American Medical Association)" (Mark Moran):
"….. 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 ....."

"Blood Weekly",U.S.A.: "The conference (VI International Symposium on Blood Substitutes) coincides with the 40 year anniversary of Chang's initial efforts back when he was a student at McGill University. This started … the modern approach of red blood cell substitutes…McGill University, where Chang and his colleagues have been instrumental in advancing the field of blood substitute"

The role of artificial cells in the fight against COVID-19: deliver COVID vaccine, hemoperfusion removes toxic cytokines, nanobiotherapeutics lower free radicals and pCO2 and replenish blood supply (Chang 2022) (Artificial Cells, Nanomedlicine & Biotechnology). 50:1, 240-251, Open access at DOI: 10.1080/21691401.2022.2126491

Modern Drug Discoveries, ACS Publications: "The first encapsulated cells were developed as far back as the 1960s, when T.M.S. Chang and colleagues first reported the 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 …. are examining the use of biocompatible .. membranes to surround the encapsulated cells"

Nature Medicine, "Cell encapsulation: promise and progress" G. Orive et al
"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 50th Anniversary Special Gold Edition of the Official Journal of The American Society for Artificial Internal Organs The 1966 paper by Chang is one of the 25 landmark papers selected for this Gold edition. The editorial "…Chang is the originator of artificial cells (Others included Kolff, inventor of artificial kidney; Scribner for chronic hemodialysis; Gibbon heart-lung machine; Cooley artificial heart; Kantrowitz intra-aortic balloon pumping; Kolobow oxygenator)

DETAILED C.V. FOLLOWS

DETAILS

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.
2023. D.Sc.Honorary. University of British Columbia
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).
F.R.S.C. Fellow of the Royal Society of Canada
F.C.A.H.S. Fellow of the Canadian Academy of Health Sciences

ACADEMIC APPOINTMENTS

(1) RESEARCH APPOINTMENTS AT McGILL

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.

(2) ACADEMIC APPOINTMENTS AT McGILL

Physiology

1965 Lecturer of Physiology, McGill University
1966 Assistant Professor of Physiology, McGill University
1969 Associate Professor of Physiology, McGill University
1972 Professor of Physiology (tenured since l975), McGill University
2007- Emeritus Professor. Professors have no age limit at McGill but are only allowed very limited time for activities outside the university. I requested McGill to appoint me as emeritus professor – at that time it was an honour since the faculty only appointed 2 emeritus professors each year. I remain as director of the Artificial Cells and Organs Research Center.

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
2007—ongoing: I requested McGill to appoint me as Emeritus Professor of Medicine, McGill University – please see above

Biomedical Engineering (Department formed in 1990)

1990-2007 Professor of Biomedical Engineering (tenured)
2007- ongoing. I requested McGill to appoint me as Emeritus Professor. Please see above

Chemical Engineering and Chemistry

1983-2002 Associate of Chemical Engineering, McGill University
1985-2000 Associate of Chemistry, McGill University
(Until Biomedical Engineering's Ph.D. was approved, this allowed me to train a number of Chemical Engineering PhD graduate students)

(3) HONORARY ACADEMIC APPOINTMENTS OUTSIDE McGill University

1983- ongoing Honorary Professor, Nankai University, Tianjin, China
2007- ongoing Honorary Professor, Peking Union Medical College, Beijing, China
2011-ongoing Honorary Professor and key consultant on blood substitutes, Blood Transfusion Institute of the Chinese Academy of Medical Sciences,
2013- 2018 Honorary Professor, Shantou University Medical College
2019-ongoing. Director, "Academician TMS Chang Research station" and Clinical Research Centre, Shantou University Medical School.

(4) VOLUNTRY SERVICE AT COMMUNITY

Montreal Chinese Hospital

1966-1967 Director of Medical Board and Director of Laboratory, until Medicare started
1968-1981 Consultant
1982-1987 Honorary Consultant
1987- ongoing Honorary Staff

CheoChoa (Shantou his hometown) Association

2016-ongoing Honorary President, Province of Quebec Branch of the

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 IV International Symposium of Hemoperfusion and Artificial Organs, Ankara, Turkey (1982).
- Honorary President, VI International Symposium on Hemoperfusion, Mexico (1985).
- Honorary Professor, Nankai University, Tianjin, PRC. 1983-present
- Honorary President, VII 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 deMontreal , 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). (formed by originally group on Hemoperfusion, Sorbent and Immobilized Bioreactants)l

- **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 25th 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 from NIH, Charles Dinarello then at Tufts and Colton from MIT)
- **"VIRAGE" AWARD FOR CENTRE OF EXCELLENCE IN BIOTECHNOLOGY**,

QuebecMinistry of Higher Education, Science and Technology (1985- permanent since 1990 sarted with infrastructure and with salaries. Renewed permenantly as 4 professors salaries for the centre integrated into the faculty salary budget.

- **MSSS-FRSQ group on Blood Substitutes** in Transfusion Medicine (2002-2008)
- Honorary President, IX International Symposium on Blood Substitutes, Tokyo, Japan 2003
- **Fellow of the Royal Society of Canada, FRSC 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 "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
- **Founding President, International Academy of Nanomedicine** 2009-2010
- **First "Outstanding Research Award of the International Academy of Nanomedicine**", atthe First World Congress of the International Academy of Nanomedicine.
- Honorary President, 2011 XIII International Symposium on Blood Substitutes, Harvard Medical School, Boston, U.S.A. Symposium president, Professor Warren Zapol, Emeritus Chief of Anesthesia and Critical Care Medicine, Mass General Hospital, Harvard Medical School. http://www.medicine.mcgill.ca/artcell/536.pdf
- **2011 Voted as the Greatest McGillian in McGill University's 190 years history**.(Out of 700 nominee and 20 finalists that included Rutherford, Penfield, Osler, James McGill, Cohen and others) http://www.medicine.mcgill.ca/artcell/voting%20result.pdf
- **Honorary President, International Academy of Nanomedicine, since 2012** then continue when it was reorganized into the **International Society for Nanomedical**

Sciences.

- **Honorary President, International Society for Nanomedical Sciences, since 2013**
- **Honorary President. 2013 XIV ISBS** International Symposium on Blood Substitutes, Institute of Blood Transfusion, Chinese Academy of Medical School, President will be vice president of the Chinese Academy of Medical Sciences.
- Queen Elizabeth Diamond Jubilee Medal 2013
- **Honorary President. 2015 XIV ISBS** International Symposium on Blood Substitutes, Lund, Sweden. President Professor Leif Bulow
- **Chinese Canadian Legend 2015**
- **Honorary President, 2017 XV ISBS** International Symposium on Blood Substitutes, Montreal
- **Honorary President, 2017 V ISNS** World Conference on Nanomedicine, Montreal
- **Honorary President, 2018 V ISNS** World Conference on Nanomedicine, Delhi, India
- **Honorary President, 2019 XVI ISBS** International Symposium on Blood Substitutes, Japan
- **Father of Artificial Cells Academian Chang Ming Swi Specialist Workstation, Clinical Research Centre,** Faculty of Medicine, Santou University, Shantou (home town) China
- **Honorary President, 2022 XV ISBS** International Symposium on Blood Substitutes(Cancelled)
- **Honorary Doctor of Science,** University of British Columbia, Canada
- **Honorary President, 2024 XVI ISBS** International Symposium on Blood Substitutes, (U.S.A)

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, website management, organization, project control, negotiation, graphics, clear writing, and other areas. Also in mobile communications.

- □ Classical music, tennis, badminton, table tennis, weight training, physical conditioning, martial arts, books on history and cultural developments and others.

ARTIFICIAL CELLS:
INVENTION, INNOVATION & TRANSLATION.

Abstract:

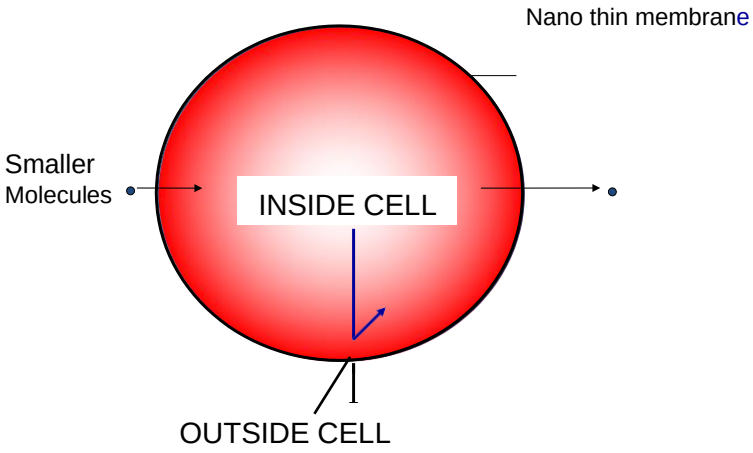
Artificial Cell invented by Chang (Chang, McGill 1957, Science 1964)and developed by Chang's group has led to development by his group and other groups around the world resulting in approval for routine clinical uses in a number of areas: For example:

- For use in COVID_19 vaccines.
- Hemoperfusion for COVID-19 cytokine storm also for treating poisoning, partial support of liver and renal failure, and for some immunological diseases.
- For use as first-generation blood substitute (Biopure) in countries with HIV contaminated donor blood. A murine HBOC (Zal) is approved in the EU for pre-transplantation organ preservation.
- As a number of drug delivery systems.
- PEG-asparaginase for use in leukemia treatment.
- Recently approved as PEG-Phenylalanine ammonia lyase for the treatment of adult Phenylketonuria PKU

This is just the beginning of the routine clinical use of artificial cells since the principle of artificial cell is just beginning to be actively explored into other areas of nanomedcine, biotherapeutics, blood substitutes, targeted drug delivery, enzyme/gene therapy, cancer therapy, cell/stem cell therapy, nanoparticles, liposomes, bioencapsulation, replicating synthetic cells, cell encapsulation, biosorbent/immunosorbent hemoperfusion/plasmapheresis, regenerative medicine, encapsulated microbe, nanobiotechnology, nanotechnology and other areas. More futuristic research includes nanorobot, nanocomputer, multimodal locomotion delivery robot.

Basic Principle of Artificial Cells

(Chang 1957 McGill, 1964 Science)

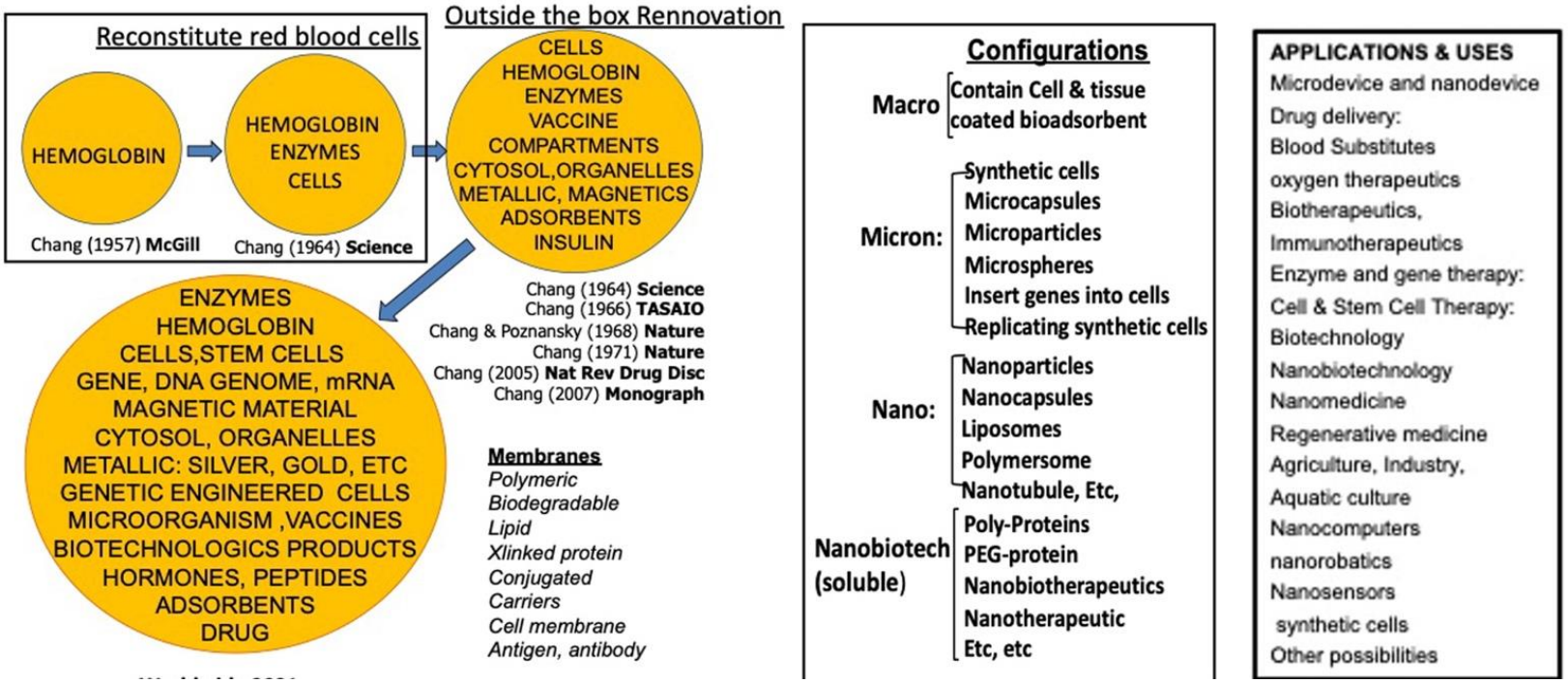


The very first humble “artificial cells” reported by Chang in 1957 (Chang McGill 1957, Science 1964) is not to reproduce biological cells, but to use available basic knowledge to prepare very simple system for possible uses in medicine and other areas (Fig. 1). Chang predicted in his 1972 monograph on Artificial Cells that *“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 only in the last 20 years that many of the original ideas on artificial cells are being increasingly applied and extended by researchers around the world. This is because many of the original ideas were report**e**d years before the modern era of nanotechnology regenerative medicine, blood substitutes, biotechnology, gene therapy, stem cell therapy, cell therapy and other areas. Thus, following his 2005 review on “therapeutic applications of polymeric artificial cells” in Nature Review Drug Discovery (Chang 2005), a timeline prepared by the editor shows that Chang and his group has made 20 of the 23 major discoveries in related areas up to that time.

However, since that time, other groups are making rapid and exiting progress and numerous discoveries. 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 the recognition of the importance and developments in biotechnology. Then there is the progress in molecular biology and genomics. All these has contributed to a quantum leap in the area of artificial cells. One can expect that there will be important future progress in other areas, for example, artificial intelligence and nanorobots, that will contribute to unlimited progress by increasing number of groups world-wide in the area of artificial cells. We have only touched the surface the potential of the extension, innovations and uses of artificial cells (Fig. 1-2). Space only allows for a general overview follows by some examples of the different configurations and their applications.

HIGHLIGHTS OF THE PRESENT INTERNATIONAL STATUS OF ARTIFICIAL CELLS



HIGHLIGHTS OF THE PRESENT INTERNATIONAL STATUS OF ARTIFICIAL CELLS

Artificial cell is a McGill Invention (Chang 1958 BSc. Chang 1964 Science). The first artificial cell was in the form of artificial red blood cells (rbc). RBCs are one of the most important cells since we, our organs, tissues and cells need it for survival. By going outside the box (Chang 1964-2005) (Fig 1), we were able to extend this to prepare artificial cells of unlimited configurations and contents resulting in large areas of applications (Fig 1). Although published in Science and Nature (Chang 1964 Science, Chang and Poznanski summer student, Nature, Chang, Nature 1971), other laboratories were initially curious and interested but did not carry out serious research in this area. Thus, for more than 10 years since 1964 my laboratory has carried out most of the original invention in this area (Fig 1). It was after our clinical trial showing the effectiveness in the use of artificial cell for hemoperfusion (Chang et al 1973) and also the publication of the first monograph on Artificial Cells (Chang 1972) that other laboratories started to seriously carry out research in this area, resulting in explosive developments around the world (Fig 1). Indeed, nearly all researchers in therapy or diagnosis are using different configurations of artificial cells (Fig 1) perhaps even without knowing it.

Some examples of the clinical uses of artificial cells

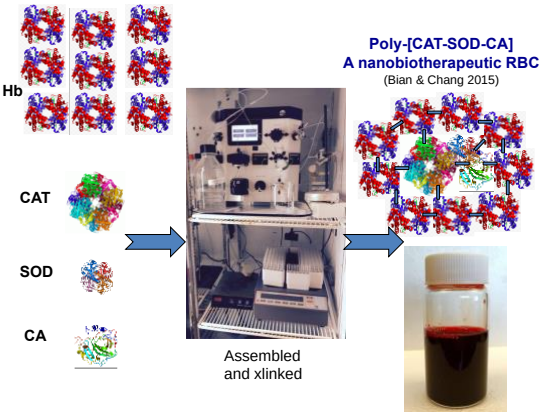
Artificial cells can now be prepared with extensive variations in terms of their contents, membranes, dimensions, and configurations. This allows for an array of promising and innovative medical applications. Notable developments in Artificial red blood cells. include hemoglobin-based oxygen carriers and oxygen carriers with antioxidant properties or those with CO2 transport and antioxidant properties. Brief discussion of other notable innovative applications of artificial cells encompasses hemoperfusion, delivery systems, COVID-19 vaccines, cancer therapy, hereditary enzyme defects, cell/stem cell therapy, microbes and nanorobotics. The possibilities extend beyond these, as listed in figure 1 , encompassing nanomedicine, biotherapeutics, gene therapy, regenerative medicine, agricultural applications, aquatic culture, and the field of nanorobotics.

(1) Artificial red blood cells as nanobiotherapeutic based blood substitutes Open access details available at
2021 Chang ,editor in chief; coeditors Bulow, Jahr, Sakai, Yang: 1004 pages Book on Nanobiotherapeutic based Blood Substitutes Open access Nanobiotherapeutic Based Blood Substitutes

Research on artificial red blood cells started at McGill well back in 1957 (Chang, McGill 1957, Science 1964). There was no interest until 1989 with HIV contaminated blood, and countries around the world belatedly carried out catch up R&D.. Despite invitation from the U.S. Chang decided to help a Canadian start-up Hemasol, but it then decided to develop its own blood substitute. Biopure and Northfield in the US developed Chang's 1971 published Nanobiotechnology Glutaldehyde polyhemoglobin method resulting in a 1st generation blood substitute, polyhemoglobin oxygen carrier approved for use in South Africa and Russia to avoid the use of HIV contaminated donor blood.. Multicenter clinical trial in the U.S showed that this can be given on the spot in the ambulance without crossmatching. This was more effective that the control group. but there was cardiac side effect in 3% of the patients compared to the control group with 0.6%.

Thus, my laboratory developed a second generation one that that has 2 of the three red blood cell functions: carries oxygen and remove oxygen radicals (D'Agnillo PhD student & Chang 1987 Nature Biotech). Biopure wanted to develop this. I opted to help a new start up Canadian Co, but after one year they were not able to obtain the needed funding.

) In the meantime, my laboratory persisted to explore this into the 3rd generation that has all 3 red blood cell functions: it can carry oxygen, remove oxygen radicals and remove carbon dioxide. The ability to remove carbon dioxide finally solves the cardiac side effects of the earlier generation ones (Bian & Chang 2015, Chang 2017, Gao & Chang 2018, Chang et al 2021 Bian & Chang 2023). China officially contacted Canadian External Affair to collaborate with me on this. Canada Global.Affairs encouraged me to go ahead and to seek Canadian support for the collaboration. Canadian Blood Service and CIHR were not interested. The VP of Beijing University's Technology Transfer division has a Venture Capital group and has successfully started 3 biotechnology companies in China. He wanted to start a new company to help develop this for use by patients in both China and Canada using nongovernment private funds.



McGill has earlier transferred the rights to the inventors (Chang & Bian). We therefore followed McGill's Technology Transfer procedure with this company. McGill has approved the agreement that follows the usual technology transfer agreement with income to McGill and the inventors. Instead of financial gain for myself, they agreed to an unrestricted donation of one million Canadian dollars to my laboratory through McGill Advancement that McGill has already received. In addition, starting in 2024 they plan to start a $800,000 TMS Chang Scholarhsip and research Fund for Chang's laboratory plus donations and scholarships to Chinese institutes or workstations related to Chang. The company only seeks private Venture Capital funding in order to develop this for both Canada and China. The world-wide post pandemic financial situation of private funds will delay the other donations

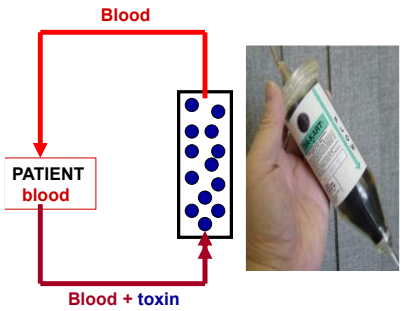
My position in the company. They offer me the positions of (1) honorary chairman of the board, (2) Chief Scientist and (3) Chairman of Scientific Advisory board with shares of the company and a large salary that is nearly 3x my present McGill pension. I did not accept their offer because of potential conflict of interest with my present position as director of research centre, international leader, coordinator of international network and editor in chief of journals on artificial cells. Furthermore. I always prefer to let my PhDs or postdocs to work with companies. They have hired an associate professor from the Blood Transfusion institute of the Chinese Academy of Medical Sciences who was a postdoc in my lab.. They have appointed a full time representative for the company in Canada. She is an MD who has obtained her PhD with me and has recently retired from the Health Canada Regulatory division. Unfortunately, the two PhDs from my lab who have each spent 4 years of their PhD in the 3rd generation blood substitutes did not accept the condition of their recruitment and only join as consultant.

) Use of synthetic enzymes rather than natural enzymes for the nanobiotherapeutic based 3rd generation Blood Substitutes. The concentration of my laboratory is to always look forward to innovative areas. I asked my PhD student, Hoq, to carry research on the use of a solution of chemically prepared small chemical molecules of synthetic enzymes: catalase, superoxide dismutase, and carbonic anhydrase (CAT, SOD, and CA). We carried out a study to see if these synthetic enzymes can replace the natural enzymes (CAT, SOD, and CA). Since they are simple chemicals and not immunogenic it can avoid the need for the complicated cross-linking of natural enzymes to PolyHb to form PolyHb-CAT-SOD-CA. Furthermore, they are much more stable than natural enzymes with hardly any change in enzyme activities over 260 days, compared to a decrease to at least 30% within days for the natural ones. We compared the effect a solution of these three synthetic enzymes has on the viability of warm-ischemic hepatocytes that were exposed to nitrogen for 1 h at 37°C. PolyHb significantly increased the viability. The three synthetic enzymes themselves also significantly increased the viability. The use of both PolyHb and the three synthetic enzymes resulted in an additive effect in the recovery of viability. Increasing the concentration of the synthetic enzymes resulted in further increase in the effect due to the synthetic enzymes. Other Implications: For blood transfusion, in addition to PolyHb, there are a number of other HBOC oxygen carriers. Regulatory agencies may require HBOCs to have antioxidant and CO_2 transport properties in order to prevent side effects. All that is needed is to add or inject the solution of synthetic enzymes as a separate component. (Hoq & Chang 2023) Open Acess: Preliminary feasibility study using a solution of synthetic enzymes to replace the natural enzymes in Polyhemoglobin-catalase-superoxide dismutasecarbonic anhydrase: effect on warm ischemic hepatocyte cell culture We have sent in a ROI to McGill, then obtained a US provisional patent (Chang & Hoq 2023)

(2) **Artificial Cells for Hemoperfusion:** 2017 Opening Chapter in Book on Hemoperfusion
www.medicine.mcgill.ca/artcell/hpbk_ch1.pdf

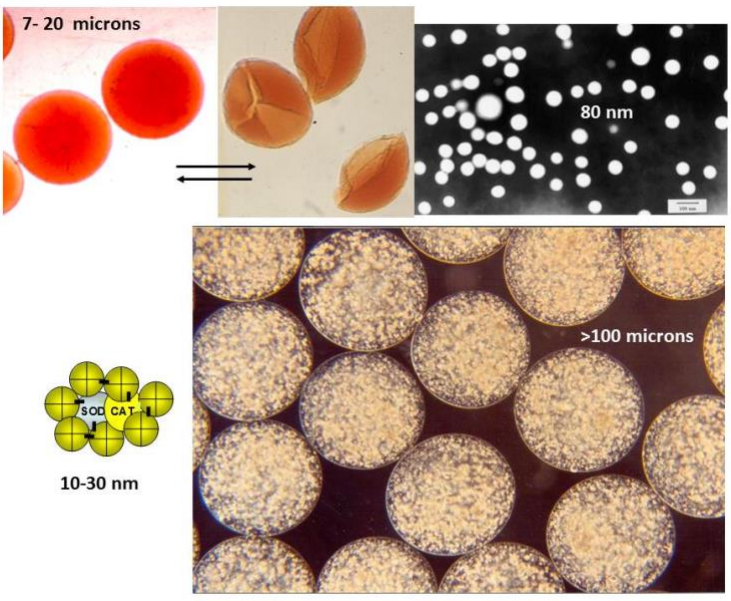
1.

Artificial cells containing bioactive material for hemoperfusion (Chang TASAIO 1966) was developed by Chang's group (Chang 1969) and tested in clinical trial in McGill teaching hospitals showing its effectiveness for acute drug poisoning, liver failure and kidney failure (Chang et al 1970, 1973 1975). A large multinational in Europe flew Chang to its board of director meeting and offered him large personal gain if he signs an agreement to develop this with them. Chang says to al potential companies that he would do this if they start a company in Montreal and instead of personal gain, for them to give an annual donation to the centre. A Dialysis company from Paris sold their company and moved to Montreal to concentrate on hemoperfusion. They signed an agreement for an annual donation to our McGill centre. They worked hard with Chang who carried out clinical trial with their products (Chang et al 1985) resulting in the best hemoperfusion device at that time and approved by the FDA. A large US dialysis company approach this new company to buy it over against my objection. They offered the stock holders something that they could not refuse. I have no vote since I did not want to hold any stock since I was doing the clinical trial. To be fair, the company was not able to obtain the needed fund from Canadian sources. As I have expected, the Dialysis company pulled the hemoperfusion device off the market to prevent it from competing against their expensive dialysis machine. Fortunately, all my methods and results were published in details and a visiting scholar from China, Prof YT Yu. came to my lab for 2 years. On returning to China, he helped a start-up company 10 years ago to use my ultrathin collodion polymer membrane coating method resulting in the best artificial cell hemoperfusion device. This company is now one of the largest medical device company in China. They have found this to be useful for treating cytokine storm and more recent they have used this successfully for the treatment of severe COVID-19[23]. Canadian Health Regulatory Agency has approved this for emergency use in Canada for COVID-19. They have also developed a novel hemoperfusion system for the treatment immunological disease like LUPUS as reported in 2023 in The development of immunosorbent for the treatment of systemic lupus erythematosus by hemoperfusion



(3)Artificial Cells in the fight against COVID[26-28]

The use of artificial cells as carrier for vaccine has been reported many years ago (Chang1976). Artificial cells prevent mRNA from inactivation by body enzymes and allow it to carry out its function as COVID-19 vaccine. Back in 1976 Chang has already used artificial cells for vaccine (Chang1976 Bioengineering, Chang 1975 chapter in book by Prof Heden from Karolinska). As mentioned above Artificial cells based hemoperfusion has also been used recently to lower the elevated toxic level of cytokines in patients with severe COVID-19. More details available at open access: 2022 Chang: The role of artificial cells in the fight against COVID-19: deliver vaccine, hemoperfusion removes toxic cytokines, nanobiotherapeutics lower free radicals and pCO2 and replenish blood supply" https://doi.org/10.1080/21691401.2022.2126491 .



. **(4)Artificial Cells Delivery system** Artificial cells in different configurations have used successfully as delivery systems for drugs, biologics, cell/stem cells. therapeutics, microbes etc.. These are in the different configurations of artificial cells (Chang 1964, 1971, 1972, 2002 , 2923, etc), bioencapsulation, nanoparticles, liposomes, lipid vesicles, pegulation, nanorobotics, nanobiotheraspetics, and different carriers of macro, micro and nano dimensions, synthetic cells, and others.) Nearly all researchers in areas related to therapy or diagnosis are using one of these configurations, perhaps even knowing that they are using artificial cells. Open access details from 2019 Chang: review on Artificial Cells: https://doi.org/10.1080/21691401.2019.1577885 Chang (2023) from Frontier Medical Technology "https://www.frontiersin.org/articles/10.3389/fmedt.2023.1306419

(5)Artificial cells for Hereditary enzyme deficiency

We first show that catalase artificial cells can replace the deficient enzyme in hereditary catalase deficient mice (Chang & Posnanasky. Nature)[29]. Use in patients only became possible when stable simple enzymes became available for artificial cells. This allowed us to treat a patient with Lesch Nyhan disease using artificial cells contain xanthine oxidase (Chang 1985. Palmer ,,,Chang, Lancet 1985) We also use artificial cells containing Phenylalanine ammonia lyase (PAL) to treat rats with Phenylketonuria (Bourget and Chang 19 86). Ibex Co from Montreal licenced our patent with McGill and collaborated with us to prepared less expensive human recombinant PAL with the help of my PhD graduate, Dr KF Gu. This company then collaborate with which an U.S. company to prepare PEG-PAL that has been approved by FDA for acute use by injection in adult PKU patients (.*FDA approves a new treatment for PKU, a rare and serious genetic disease*(2018). Available at: https://www.fda.gov/news-events/press-announcements/fda-approves-new-treatment-pku-rare-and-serious-genetic-disease

)[33] For the more large scale use in children our oral administration is needed and a suitable industrial oral formulation needs to be developed

(6)Artificial Cells for Cancer therapy

We first reported the use of artificial cells containing asparaginase for the suppression of lymphosarcoma in mice (Chang 1971 Nature)[35]. This is now being used in patients in the form of PEG-asparaginase. We are using artificial cell containing polyHb-tyrosinase in mice with melanoma (Wang & Chang 2021)[37,38.] Zhao, a PhD student with Chang shows the use of artificial cells for the suppression for other 4 types of tumours and an ROI for this has been sent to McGill.

(7)Artificial cells containing cell/stem cell in therapy and regenerative medicine[39-43],

We have shown the effectiveness of artificial cells bioencapsulated rat bone marrow stem cells for the recovery of rats with 90% liver removed (Liu & Chang 2006,2012). For use in human, we need to use human source of stem cells. In collaboration with Professor Sun (at my TMS Chang Academian Work station at Shantou University in my home town), we are carrying out research on artificial cells bioencapsulated human source of stem cells with the first major paper published in CELLS.

(8)Artificial Cells containing Microbes

One of my earlier projects is on the use of artificial cells containing microorganisms for the removal of cholesterol and other waste metabolites. When Prakash came as my PhD student, he was assigned the study of encapsulated genetic engineered microbe for oral administration (Prakash & Chang 1996 Nature Medicine). Later also shown to be effective for the removal of other waste metabolites. However, FDA does not look kindly on the use of genetical engineered microbes. My suggestion to use artificial cell containing Lactobicilus (use for Yogurt) resulted in a publication in this approach by Chow, Liu, Prakash and Chang (2003). An US company and a Canadian company wanted to develop this and I opted for the Canadian Company, Again, after one year they were not able to obtain the needed funds. In the meantime, the US company has already come out with products for use in kidney failure patients. Fortunately, as I usually do for my PhD grduates,, I asked Professor Prakash to independently take over the research and commercial development of artificial cell microbe project. He has done well having established himself in this area and started a number of companies

(9)Artificial cells as micro and nanorobotic delivery systems

Artificial cells containing magnetically active material can be control by external magnetic forces was first reported from McGill (Chang 1966, ASAIO). This has recently become an ultramodern and explosive area as shown in recent reviews including a review (Wang Tao, postdoc fellow and Chang 2023) on 'Supramagnetic artificial cells in cancer therapy' on the present world wide research on nanorobotic drug delivery for cancer. https://www.mdpi.com/2072-6694/15/24/5807

(10)The possible uses extend beyond the above examples as listed in figure 1, encompassing nanomedicine, biotherapeutics, gene therapy, regenerative medicine, cell and stem cell therapies, agricultural applications, aquatic culture, and the field of nanorobotics.industry, agriculture, aquatic culture[4,5,50], synthetic cells[47] and others (Fig.1)[4,5,49]

This is now a very large area, and the above summary is just a brief overview.. Some references are cited here, but for a complete reference of his group's research please see the Publication section of this C.V. Some typical recent reviews are as

(1) 2019 Chang: review on Artificial Cells: https://doi.org/10.1080/21691401.2019.1577885

(3) 2017 Opening Chapter in Book on Hemoperfusion www.medicine.mcgill.ca/artcell/hpbk_ch1.pdf

(4) 2021 Chang ,editor in chief; coeditors Bulow, Jahr, Sakai, Yang: 1004 pages Book on Nanobiotherapeutic based Blood Substitutes
Open access Nanobiotherapeutic Based Blood Substitutes

(5)MONOGRAPH 2007 by Chang ARTIFICIALCELLS: biotechnology, nanotechnology,regenerative medicine, blood substitutes bioencapsulation and cell/stem cell
www.medicine.mcgill.ca/artcell/2007%20ebook%20artcell%20web.pdf

(6) 2022 Chang: The role of artificial cells in the fight against COVID-19: deliver vaccine, hemoperfusion removes toxic cytokines, nanobiotherapeutics lower free radicals and pCO2 and replenish blood supply" https://doi.org/10.1080/21691401.2022.2126491 .

(7) Chang (2023) editorial. Frontier Medical Technology series on "Innovative Medical Technology based on artificial cells"https://www.frontiersin.org/articles/10.3389/fmedt.2023.1306419

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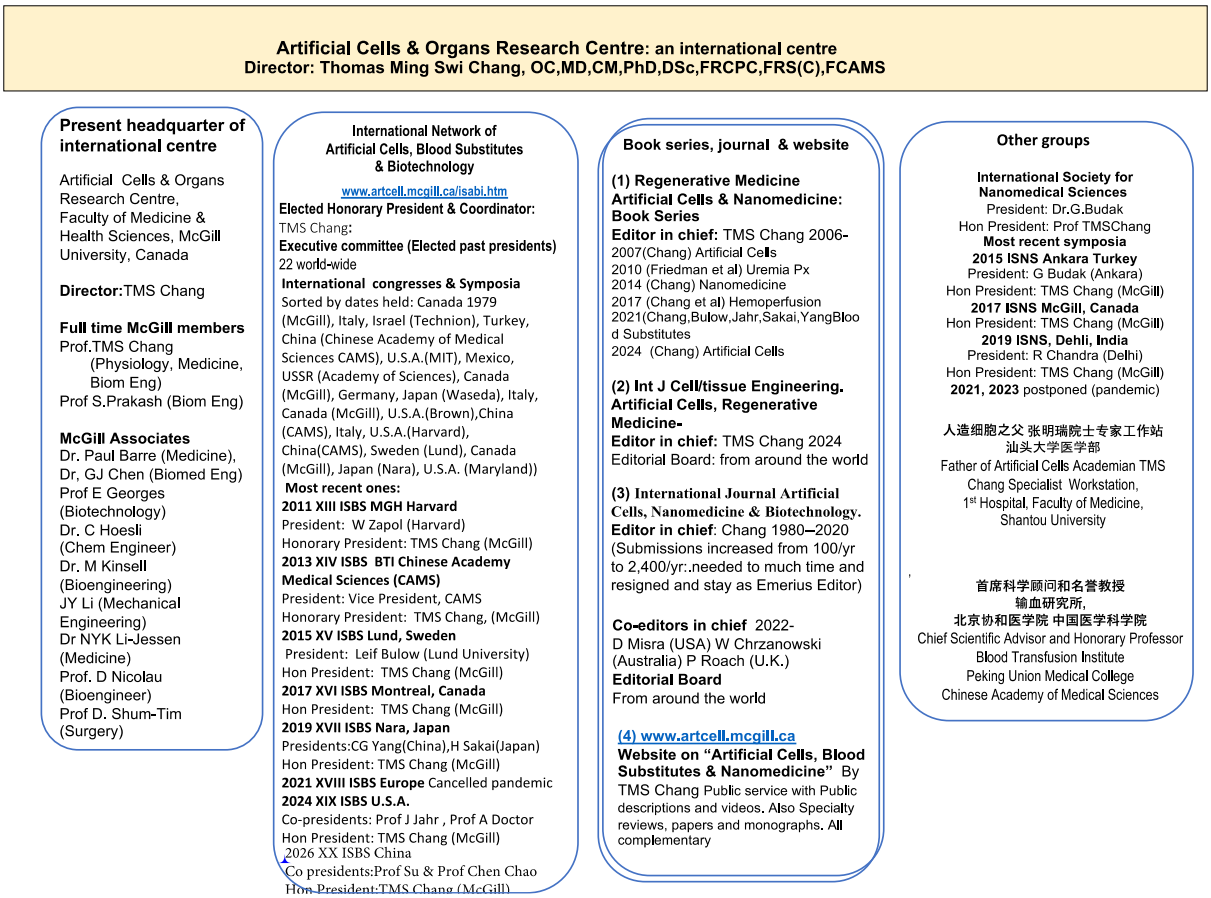
ORGNAIZATION OF INTERNATIONAL CENTRE

Artificial cell was invented at McGill by Chang (Chang McGill 1957, Science 1964). Right from the beginning realizes that this is such a large area that it will not be possible or ethical for one laboratory, one center, one university or even one country to do everything. As a physician researcher with the aim to do what is best for the patients, my plan has been to continue to do frontier innovative research of the future and at the same time to encourage others around the world to develop his ideas for patient use. This is by publishing all the reproducible details and methods; by encouraging and helping others to do this research; by sending researchers to help others to start research in this area; by organizing international network, international meetings, international journals, books and a public service website containing complementary papers, books and videos for free access by all www.artcell.mcgill.ca

VIRAGE AWARD FOR CENTRE OF EXCELLENCE IN BIOTECHNOLOGY,
Quebec Ministry of Higher Education, Science and Technology (1985- permanent since 1990 sarted with infrastructure and with salaries. Renewed permenantly in 1990 as salaries for 4 professors for the centre integrated into the faculty salary budget



1. AT McGILL

Placed our emphasis on innovative ideas that depends on original ideas of individuals rather than extensive staff or facilities. This way, we have been more than competitive with the much larger international centers. Most of the original ideas in this area come from the director's laboratory.

Associate members from McGill:

They come from departments of Physiology, Biomedical Engineering, Experimental Medicine, Medicine and Surgery. Others come from the departments of Bioengineering , Chemical Engineering and Mechanical Engineering and also McGill's Biotechnology program .

Collaborate with other universities:

The director holds a number of non-salary voluntary positions as honorary professor of Nankai University, China; Honorary Professor of Peking Union Medical College of the Chinese Academy of Medical Sciences (CAMS), Honorary Professor and key consultant of the Blood Transfusion Institute of the Chinese Academy Medical Sciences; and honorary professor of the Shantou University Medical College in his hometown. In 2019 his hometown Shantou university formed the "Father of Artificial Cells: Chang Ming Swi Academia Specialist Research Station" for their newly built Clinical Research Centre building.

Some examples of Chang helping other groups:

- Way back in 1964, the late Harvard Professor Folkman of angiogenesis fame phoned me for the detail procedure of my 1964 Science paper for his PhD student, the now well-known Professor Robert Langer of MIT. For many years Langer has interacted with me in organizing meetings and was a member of editorial board of our journal

- Connaught Laboratory: I helped the director of Connaught start a research project on artificial cells containing islet. His research associate there, Professor A Sun did some excellent research.

- The late Professor Sam Sideman, Chair of Biomedical Engineering, Israel Institute of Technology, Technion, has collaborated in hemoperfusion and blood substitutes and coeditor with me 2 books.

- Help Professor Neufeld of McGill's Chemical Engineering and his postdoc Dr Poncelet start their research in this area. Prof Neufeld later become Chairman of Chemical Engineering at Queens and works full time in this area. They have organized annual meetings on Bioencapsulation, especially in Europe.

- Help Professor Mason of Chemistry at McGill and his postdoc Dr Kondo start a program on AC

- Help a Professor in Polymer chemistry at McGill to start research on AC
- Help Professor Charles Scriver at McGill to start a research project on the use of AC for PKU
- Help Dr Paul Barre establish the Hemoperfusion procedure in McGill teaching hospital. He becomes the director of dialysis at McGill
- Professor C Yang, has collaborated in blood substitutes for many years – was director and now emeritus director of the Blood Transfusion Institute of Peking Union Medical College and Chinese Academy of Medical Sciences
- In 1968, Muller and Rudin reported that they used the method from Chang Science 1964, to prepare lipid membrane artificial cells. I "brain washed" a McGill Biochemistry PhD graduate, Gregoriadis, to study lipid membrane artificial cell for drug delivery for his postdoc in England with Bangham using their onion like multilaminar lipid microspheres. This has resulted in liposomes now used commonly for drug delivery.
- D'Agnillo, (PhD with me in Physiology) to help Dr Alayash head of division of FDA/NIH to start a research program on blood substitutes. (He is now a senior staff there)
- BL Yu (PhD with me in Biomed Eng) to help the late Dr. Zapol, Chief Anesthesiology, MGH Harvard start a research program on blood substitute (She is now an assistant Professor there)
- Keipert (PhD with me in Physiology) to help start the blood substitute program for the late Professor Winslow at Letterman Institute and UC San Diego, he then become VP of Winslow's company on blood substitutes
- Prakash (PhD with me in Physiology) now professor at McGill Biomedical Engineering with his companies.
- Poznanski (My first PhD graduate, Physiology) is director emeritus of Robert Research Institute.
- Chawla, Daka & Ning join as staff at Health Canada Regulatory division.
- Piskins both return to Turkey as professors.
- YT Yu helps to start a successful hemoperfusion company in China.
- KF Gu (PhD with me Chemical Enginering) helps Montreal IBEX Co on recombinant enzyme production.
- The late Vivek Dixit (PhD with me in Physiology) professor and head of the artificial liver unit at UCLA
- Wang (PhD with me in Expt Med) now associate Professor and director of a program at the 3rd affiliated hospital of Beijing University Medical School.
- Bian (PhD with me in Biomedical Engineering and coinventor with me), is now senior administrator of the 3rd Generation Blood Substitute Co, Proheme in China. CHEN Gang (postdoc with me) is their manager. Jing (PhD with me in Physiology) is their representative in Canada. Guo (PhD with me in Expt Medicine) and Gu (PhD with me in Chemical Engineering) are their consultants.
- others include those from Saudi Arabia, Israel (Technion & Wiseman Institute), Japan (Tabata) and others.

INTERNATIONAL NETWORK FOR ARTIFICIAL CELLS, BLOOD SUBSTITUTES & BIOTECHNOLOGY (ISABB)

Aims

This international network was formed in 1976 to encourage research, development and clinical applications in artificial cells, blood substitutes, nanomedicine, regenerative medicine, tissue engineering, cell/stem cell therapy, immunotherapy, hemoperfusion, bioencapsulation, and related areas.

We have avoided a tight and restrictive organizational structure. Instead responsibilities are widely distributed to committees and organizers of congresses and symposia. This allows this society to benefit from fresh ideas and novel approaches and to move with the frontier of research. This, plus the enthusiastic participation and voluntary contribution of members of the society, has allowed us to continue this international network for more than 40 years without charging membership fees – this allows for world-wide participation with no restrictions related to nationality, age, experience, financial status. This also avoid any one group or groups from controlling the network or preventing it from moving in the frontier of research.

Officers

Elected Honorary President & coordinator : T.M.S.Chang (McGill, Canada)

Elected executive committee (Elected Past-Presidents of ISABI congresses and/or symposia): V.Bonamini (Italy)1978; L.Bulow (Sweden), 2015; C.U.Casciani(Italy)1990; T.M.S.Chang(Canada)1976, 1987,1991,1996, 2017 ; K. Kobayashi (Japan) 2003; R.Langer (USA) 1994; Qin Liu (China) 2007; A. Mozzarelli (Italy) 2009;. Nikolaev(USSR) 1986; E.Piskin (Turkey)1982,2001; H. Sakai (Japan) 2019, A.Trevinoemorials Becerra(Mexico)1985, C.M.Yang(China), 1997, 2019;: Zheng/Yang/Liu (China) 2013[

Memorials:Late Prof D. Falkenhagen (Austria); Late Prof. AG.Greenburg (USA) ;Late Prof M.Odaka (Japan); Late Prof S.Sideman(Israel); Late Prof E.Tsuchida (Japan); Late Prof R.Winslow (USA)]: Late Professor Y.T.Yu(China); Late Prof WM Zapol (USA)

Subcommittee of ISABB: International Committee on Blood Substitutes:ISBS

Elected executive board members ISBS (past elected ISBS presidents or their representatives):

1987: Chang (1987, 1991,1996)
1993: Keipert (for late Winslow 1993, 1999)
1997: Yang/Yu YT (1997)
1997: Sakai (for late Tsuchida 1997)
2003: Kobayashi (2003)
2005: Greenberg (2005)
2007: Liu/Xiu (2007)
2009: Mozzarelli (2009)
2011: Zapol (2011)
2013: Zheng/Liu/Yang (2013)
2015: Leif Bülow (2015)
2017: Chang (2017)
2019: CM Yang, H Sakai (2017)
2023: Leif Bulow (2023

Scientific Advisory Board ISBS

Alayash A, Abuchowski A. H Beumler, Bian Y,Biro B, Bucci E, Bülow L, Burhop K, Chan G, Chang TMS, Chen C, Cooper C, D'Agnillo F, Estep T, Feola M, Gould S, Han JQ, Hong Z, Intaglietta M, Jahr S, Keipert P,Kim HW, Kluger R, Kobayashi K, Krafft MP, Liu Q, Liu JX, Ma L, Meßmer K, Mozzarelli A, Palmer A, Privalle C, Pugach I, Rausch C, Riess JG, Sakai H, Simoni, Selivanov E, Su ZG, Tsai AG, Wei G, Wong B, Wong JT, Xiu RJ, Yang CM, Yu BL,

Conferences

The emphasis is to concentrate on 1 or 2 areas that need extensive effort towards routine clinical uses. Once the area is in routine clinical use, the area is left to other groups to look after and we then concentrate on another 1 to 2 areas that needs major effort. Each congress or symposium president in consultation with his local organizing committee, makes the final decision and has the final responsibilities including financial responsibilities. After each congress or symposium, the president or appointed representative becomes a member of the executive committee of the ISABI.

1976 ISABI (I HPS) President: TMS Chang (McGill, Canada)
1978 ISABI (II HPS) President: V Bonamini (Bologna U, Italy) co-chair TMS Chang (McGill Canada)
1980 ISABI (III HPS) President: S. Sideman (Technion, Israel) co-chair TMS Chang (McGill Canada)
1982 ISABI (IV HPS) President: E. Piskin (Ankara U, Turkey) Honorary President: TMS Chang(Canada)
1983 ISABI (V HPS) President: C Z Huang (President, Chinese Academy of Medical Sciences), co-chair TMS Chang (McGill Canada)
1985 ISABI (VI HPS) President: A. Trevino Becerra (Mexico). Honorary President: TMS Chang (Canada) VII 1986 ISABI (VII HPS) President: V.Nikolaev(USSR Academy of Sci), Honorary President: TMS Chang VIII 1987 ISABI (III ISBS) President: TMS Chang (McGill, Canada), Cochair: R.Geyer (Harvard) 1987
1988 ISABI (VIII HPS) President: D.Falkenhagen & Klinkmann(Germany) Honorary President:TMS Chang
1989 ISABI (VIV HPS) President: M.Odaka(Chiba U, Japan), Honorary President: TMS Chang
1990 ISABI (X HPS): President: C.U.Casciani(Rome U, Italy), Cochiar: G Splendiani (Rome U, Italy) Honorary President TMS Chang (McGill, Canada)
1991 ISABI (IV ISBS) President: T.M.S.Chang(McGill, Canada) Cochair R.Geyer (Harvard, USA)
1993 ISABI (V ISBS) President: R.Winslow(Letterman, USA) Cochairs: TMS Chang (McGill, Canada) & R.Riess (France), 1993
1994 ISABI Congress President: R. Langer (MIT, U.S.A.), Honorary president: TMS Chag (McGill)
1996 ISABI (VI ISBS) President: TMS Chang (McGill, Canada) Cochairs: A.G.Greenberg (Brown U, U.S.A) & E.Tsuchica (Waseda U, Japan)
1997 ISABI Congress President: Denian Ba (President,Academy of Med Sci, China) & C.M. Yang (CAMS, China), Honorary President TMS Chang (McGill, Canada)
1997 ISABI (VII ISBS) President: E.Tsuchida (Waseda U, Japan) Cochairs: S.Sekiguchi (Red Cross, Japan) & TMS Chang (McGill, Canada)
1999 ISABI (VIII ISBS) President: R.Winslow (UC at San Diego, U.S.A.) Cochairs: TMS Chang (McGill, Canada), M.Intaglietta(UC at San Diego, U.S.A.) & E.Tsuchida (Waseda U, Japan)
2001 ISABI Congress President: E. Piskin (Ankara U, Turkey) Honorary President: TMSChang (McGill)
2003 ISABI (IX ISBS) President: K. Kobayashi (Keio U, Japan), Cochair: E.Tsuchida (Waseda U, Japan), Honorary President: TMS Chang (McGill, Canada)
2005 ISABI (X ISBS) President: G. Greenberg (Brown U, U.S.A.) HonoraryPresident: TMS Chang
2007 ISABI (XI ISBS) President: Q. Liu (Vice-president, Chineswe Academyof Medical Sci., China) Executive President: R Xiu (Academy of Medical Sci, China), Honorary President: TMS Chang (McGill)
2009 ISABI (XII ISBS) President: A. Mozzarelli (University of Parma, Italy), Vice Presidents Professor

Enrico Bucci (University of Maryland) and Professor Clara Fronticelli (Johns Hopkins University, U.S.A.), Honorary President: Professor TMS Chang (McGill University, Canada)
2011 ISABI (XIII ISBS) President: Professor W Zapol (Harvard Medical School, U.S.A.) Honorary President: Professor TMS Chang (McGill University, Canada)
2013 ISABI (XIV ISBS) President: Professor Zheng (BTI China), Vice presidents Professor Liu (BTI China) & Professor Yang (BIT China), Honorary President, Professor Chang (McGill, Canada)
2015 ISABI (XV ISBS) President: Professor L Bulow (Lund, Sweden), Honorary President, Prof TMS Chang
2017 ISABI Congress (XVI ISBS, V ISNS) Professor TMS Chang, 60th anniversary Conference on Artificial Cells in conjunction with XVI ISBS and V ISNS (McGill, Canada)
2019 ISABI (XV ISBS) China/Japan: Presidents Prof CM Yang/Prof H Sakai; Hon President: TMS Chang
2022(cancelled because of pandemic) ISABI (XVI ISBS) Berlin, Germany President:Prof H Beumler, Hon President Prof TMS Chang
2023 ISABI (XVI ISBS) President:Prof Leif Bulow, Lund. Sweden Honorary President:TMS Chang
2024 ISABI (XV ISBS) Presidents: Prof Jahr, Prof Doctor, U.S.A, Hon President TMS Chang

JOURNALS AND BOOKS

ARTIFICIAL CELLS, NANOMEDICINE AND BIOTECHNOLOGY, an international journal (IF 6.355 2021) Publisher: Frances & Taylor,

This is a peer review journal that is the oldest journal in the field having started in 1972 "Biomaterial, Medical Devices & Artificial Organs, an international journal".
1979: Chang became the editor in chief and allows the name of the journal to change with time to reflect the frontier of research in the area. Before 2003 this journal was "Artificial Cells, Blood Substitutes and Immobilization Biotechnology").
2003: Starting in 2003 it was "Artificial Cells Blood Substitutes and Biotechnology.
2012 it became Artificial Cells, Nanomedicine and Biotechnology. Its demand is such that in 2016 the publisher has increased the issues from 6/year to 8/year with corresponding increase in the total pages. In 2019 the submission increased to 2,400 that required too much time for the editor in chief. He thus becomes emeritus editor to be free from day-to-day functions and looking after major matters.
Editor in chief 1980-2020 Emeritus Editor 2020- TMS Chang (McGill, Canada);
2020- Two coeditors in chief and 1 review editor

BOOK SERIES ON REGENERATIVE MEDICINE, ARTIFICIAL CELLS AND NANOMEDICINE http://www.medicine.mcgill.ca/artcell/1%20book%20series.pdf

(World Science Publisher/Imperial College Press)
Editor in chief: TMS Chang (McGill,Canada)
Volume 1: Monograph “ARTIFICIAL CELLS: Biotechnology, Nanomedicine, Regenerative Medicine, Blood Substitutes, Bioencapsulation and Cell-Stem Cell Therapy” Chang 2007 454 pages with full text now available free on http://www.medicine.mcgill.ca/artcell/2007%20ebook%20artcell%20web.pdf
Volume 2: Present and future Therapies for End-Stage Renal Failure. Editors: Eli Friedman & MC Mallappallil (2010)
Volume 3: Selected Topics in Nanomedicine. Editor: TMS Chang (2013)
Volume 4: Hemoperfusion and plasma-perfusion: general, selective, immune and leucocyte adsorbents. Editors: TMS Chang, Y Endo, VG Nikolaev, T Tani, YT Yu and WH Zheng (2017)
Volume 5: Nanobiotherapeutic Blood Substitutes: Editor in chief: TMS Chang, Co-editors: Bulow, Jahr , Sakai and Yang 2021
Volume 6: TMS Chang: 3rd edition of Monograph “ARTIFICIAL CELLS” Chang for 2023:

International Journal of Cell/tissue Engineering, Artificial Cells & Regenerative Medicine

The official publisher of Nobel prize lectures has started a new journal on “International Journal of Cell/tissue Engineering, Artificial Cells & Regenerative Medicine” They invited the director of our centre to be the editor in chief with 46 editorial board members. Please click link and follow “about this journal”
https://www.worldscientific.com/worldscinet/ijcteacrm

WEBSITE

The Web Site of this international

network: www.medicine.mcgill.ca/artcell or www.artcell.mcgill.ca or www.artificialcell.info or www.artificialcell.org

Chang's KEY OFFICIAL POSITIONS

- Honorary President, International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology (1991- ongoing).
- Honorary President, International Society of Nanomedical Sciences (2012-ongoing)
- President (1994-1996), President-elect (1992-1994), Immediate-past president (1996-98) International Society for Artificial Organs.
- Honorary member, International Society for Microencapsulation, (1995-ongoing).
- Senior Member, Society of Biomedical Engineering, since 1989.
- Honorary presidents, Chairman and co-chairman of International Symposia on Hemoperfusion, Sorbent and Immobilized Bioreactants. I (Montreal), II(Italy), III(Israel), IV(Turkey), V(PR China), VI (Mexico), VII (USSR), VIII(Germany), IX (Japan), X (Italy),
- Congress President, 7th World Congress, International Society for Artificial Organs and 4th International Symposium on Blood Substitutes, Montreal, 1991.
- Honorary Congress President, XI Congress, International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology, organized by MIT with Professor R. Langeras 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, Brown University, Providence, U.S.A.
- 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 was Professor Liu Qin vice-president of the Chinese Academy of Medical Sciences and President of the Union medical College Hospital – now vice premier of Health of China.
- 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 Symposium on Blood Substitutes, Harvard Medical School, Boston, U.S.A. The symposium chairman was Professor Zapol, Professor and Chief of Anesthesia and Critical Care Medicine, Mass General Hospital, Harvard Medical School. http://www.medicine.mcgill.ca/artcell/536.pdf
- Honorary President, 2012 III Congress of the International Academy of Nanomedicine, Ankara, Turkey
- Honorary President. 2013 XIV International Symposium on Blood Substitutes, Institute of Blood Transfusion, Chinese Academy of Medical School, President was the Director of the Institute.
- Honorary President. 2015 XV International Symposium on Blood Substitutes, President Professor Leif Bulow, University of Lund, Lund, Sweden

- Honorary President 2015 IV ISNS World Nanomedicine Congress, Turkey.
- Honorary President 2017 V ISNS World Nanomedicine Congress, Montreal
- Honorary President. 2017 XVl International Symposium on Blood Substitutes, Montreal
- Honorary President 2018 V ISNS World Nanomedicine Congress, Delhi, India
- Honorary President. 2019 XVIl International Symposium on Blood Substitutes, Nara, Japan
- Honorary President. 2023 XVIIl International Symposium on Blood Substitutes, Lund, Sweden (cancelled)

Honorary President, 2024 XIX 2024 International Symposium on Blood Substitutes. Maryland, U.S.A.

EDITORIAL BOARDS:

Editor-in-Chief (1986 - 2020), **Emeritus Editor** (2020-) Artificial Cells, Nanomedicine and Biotechnology, An International Journal, Informa Publisher now Tayor & Francis, UK.
(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. In order to keep rate, annual issues increased from 4 issues in 2015 to 6 issues in 2016 and 8 issues in 2017 and 8 issues with 3 supplementary issues in 2018. As a result, starting in 2019 it has become an Open Access journal in order to accommodate the increasing number of papers. 2019 Reuter Impact Factor: 4.462. With an increase in submissions >2,400 in 2019, It became more than a full-time position. With his many other research related responsibilities, Chang resigned but was asked to continue as emeritus editor in May 2020.

Editor in chief (2023-): International Journal of Cell/tissue engineering. Artificial cells & Regenerative dicine
2023, World Science Publisher (Official publisher of all the Nobel Prize Lectures since the inning) started this new journal with hybrid Open Access so authors can decide whether they want ay a fee for their papers to be open access. They invited me to be editor in chief of this new journal ccepted this because it is important not to restrict those who cannot afford the high open access). I am already the editor in chief for their book series on REGENERATIVE MEDICINE, ARTIFICIAL LLS AND NANOMEDICINE since 2006 and know them well

Editor-in-chief of a book series on "Regenerative Medicine, Artificial Cells and Nanomedicine", World Scientific Publisher/Imperial College Press (official publisher of Nobel Prize Award Lectures since1921)..

(1) TMS Chang 2007 monograph "ARTIFICIAL CELLS: biotechnology, nanomedicine, regenerative medicine, blood substitutes, bioencapsulation, and cell/stem cell therapy" started this series. Now available for free access by all on his McGill University public service site: http://www.medicine.mcgill.ca/artcell/2007%20ebook%20artcell%20web.pdf
(2) Second in this series is the 2011 book on Novel Therapies in Terminal Renal Failure edited by Professor Eli Friedman's group
(3) Third in this series is the 2013 book on Selected Topics in Nanomedicine edited by Chang
(4) Fourth in this series is a 2017 book on "Hemoperfusion and Plasma-perfusion and other Clinical Uses of General ,Biospecific, immune and leucocyte Adsorbents" Editors: Chang, Endo, Nicolaev, Tani and Zheng Total 1004 pages www.medicine.mcgill.ca/artcell/HPBk_Ch1.pdf
(5) Nanobiotherapeutic based Blood Substitutes (Editor: Chang, Associate editors: Bulow. Jahr. Saki and Yang (in press for 2021)
(6) 6th in this series will be the 2nd edition of the monograph by Chang 2017 on "ARTIFICIAL CELLS: biotechnology, nanomedicine, regenerative medicine, blood substitutes, bioencapsulation, and cell/stem cell therapy" 650 pages

- **Editorial Board**, Journal of Microencapsulation, London, UK.(1990-)
- **Editorial board**. International Journal on Theoretical and Applied Nanotechnology (IJTAN) ofThe International Academy of Science, Engineering and Technology (2012-)
- **Honorary Editor**. Journal of Hepato-renal and artificial detoxication(2003-)
- **Associate editor**, Nanomedicine Journal (2014-)

- **Editorial Board**, Journal Biotherapy (2014-)
- **Editorial Board** ,J Biotechnology Bioengineering (2014-)
- **Associated editor**, Nanomedicine Research J (2014-)

Previous editorial boards

- Section Editor on Detoxification, International Journal of Artificial Organs, Official Journal of European Society of Artificial Organs. Wichtig Editore Publisher. (1985-2005)
- 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.(1995-2011)
- Editorial Board, Journal of Cell Transplantation. Pergamon Press, USA (1999-2011)
- **Editorial Board**, New Biotechnology. 1990-2021

BIBILOGRAPHIES:

1. Who's Who in Artificial Organs , International Society for Artificial Organs 1977
2. Marquis Who's Who in the East (1977,1978)(1995, 1996 Silver aniversary 25th 2014
3. Marquis Who's Who in America (1978 - ongoing).
4. Marquis Who's Who in the World, (1984 - ongoing).
5. Canadian Who's Who (1983 - ongoing).
6. Marquis Who's Who in Frontier Science and Technology, (1984 - ongoing).
7. American Men and Women of Science (ongoing)
8. Marquis Who's Who in Science and Engineering (1992 - ongoing)
9. International Who's Who in Medicine (1995 - ongoing)
10. American Biographical Institute "Five Hundred Leaders of Influence" (1995)
11. Marquis Who's Who in Medicine and Healthcare (1996 -ongoing)
12. Top 100 Scientists, International Biographical Centre, U.K. (2005)

GRADUATE STUDENTS SUPERVISED by CHANG

Before 1985 (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). 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 his own consulting firm.

After 1985 (complete list):

1986 Ph.D. (Physiology): **Peter Keipert** , was Senior Director, Blood Substitutes, Alliance Pharmaceutical Co., Calif., USA until 2004; 2005-2013 V.P. of Research in Blood Substitutes, Sangart Co. San Diego). Now part owner of the renewed Sangart Co.
1986 M.Eng. (Chem.Eng.): **Maurice Cattaneo** (continued for Ph.D. with Chang)
1986 Ph.D. (Expt. Med.): **Zhi Qing Shi**, M.D. Vice President REMD Biotherapeutics Inc,

CA, USA. Was Medical Director, Genzyme Co, US, and Research scientist at Amgen Biotechnology Co.in U.S.A. after Assistant Professor in Physiology, University of Toronto
1987 Ph.D. (Physiology): **Louis Bourget** (then dentistry at McGill, now a dental surgeon)
1987 Ph.D. (Physiology): **Vivek Dixit** (retired 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**, Consultant (Previously 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** retired Senior scientist of a Biotechnology Company in China (Was senior Scientist, U.S. Biotechnology before this he was Senior Research Scientist of IBEX Technology, a Montreal biotechnology company)
1991 Ph.D. (Physiology): **Jing Ning**, M.D. (She was Research Scientist at Hemosol Inc., Etobicoke, Ontario, a blood substitute company. Retired from Health Canada Regulatory division)
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** Manager, Research & Development, Polychem Product Ltd., Montreal (awarded NSERC Research Fellowship at Bureau of Medical Device, Ottawa)
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** now a Full Professor of Biomedical Engineering, McGill (Came to me as International scholar in Biotechnology from India)
1996 M.Sc. (Biomed.Eng.): **Elizabeth Quebec**
1997 Ph.D. (Chem.Eng.): **Maryam Mobed** , was Endowed Chair in Bioengineering, Davidson College of Engineering, U.S. (previously 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 Senior Staff Scientist at FDA-NIH
2000 Ph.D. (Chem Eng): **Vaia Coromili** - no communication after graduation
2002 M.Sc (Physiology): **Douglas Powanda** (FCAR Scholarship) Continuned to compete his Master of Management at Concordia University
2004 Ph.D. (Biomed.Eng) **Binglan Yu** graduated on Dean's honours list with Geddes Award for best graduate student in Biomedical Engineering. Research fellow with Professor Zapol, previously Chief of Anesthesiology, Mass General Hospital, Harvard Medical School, then instructor, and now assistant professor.
2004 M.Sc. (Biomed Eng) **Noami Wong** (NSERC studentship). Then was a staff engineer, Merck Frosst Co. Montreal. Now home as house wife
2005-2007 M.Sc (Biomed Eng) **Caroline Fustier** (scholarship student from Paris, France) Now a research scientist in a French Company.
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 for 1 year
2010-2014 Ph.D. (Biomedical Engineering) **Yuzhul BIAN**. Came with M.Sc. from Tsinghua University, Beijing. Graduated in June 2014. Now staff in a consulting company in Beijing, China.
2011- Feb 2015 Ph.D. (Experimental Medicine) **Yun WANG** came with M.Sc. from Peking Union

Medical College of the Chinese Academy of Medical Sciences. With a China Scholarship Council Scholarship. Now research staff at the 3rd Hospital of Peking University Medical School.
2011-2012 Ph.D. Trainee (Physiology) **Wei** came with China Scholarship Council Scholarship. Was Assistant Professor then associate professor, Xian University, PRC
2014 M.Sc. (McGill Program on Biotechnology) **Chen Guo**, continued to PhD heee.
2015 M.Sc (McGill Program on Biotechnology) **Shou Ma**
2015 M.Sc (McGill Program on Biotechnology) **Christoher Lee**
2015- 2018 Ph.D. (Experimental Medicine) **Chen Guo**. PhD in 2018 now research staff in a Chinese company 2017 M.Sc (McGill Program on Biotechnology) **Amir Shahein**
2018 M.Sc (McGill Program on Biotechnology) **Petko Komsalov**
2019. M.Sc. (McGill Program on Biotechnology) **J. Zhang**
2020 M.Sc. (McGill Program on Biotechnology) M. **Hoq**
2021- Ph.D. (Experimental Medicine) **Hoq**
2021- MSc (Experimental Medicine) **Zhao**
2022- Ph.D. (Experimental Medicine) **Zhao**

OTHER TEACHING AT McGILL:

Physiology 518a: Course coordinator: 25 hours (1972 - Ongoing) Physiology

518a 6 hours of lectures and 6 hours seminar(1972-Ongoing)

Biomedical Engineering 399-501A 2.5 hours of lectures (onging)

Biomedical Engineering (Prof Prakash's new course) 2 hours of lectures (ongoing)

Med 1 Physiology 5 hours of lectures (1972 to 2008)

Biotechnology 202-505B 3 hours of lectures

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. 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.

Publications

Books

Invited lectures

Patents

Publications full papers and book chapters

1. CHANG TMS (1969) Removal of endogenous and exogenous toxins by a microencapsulated absorbent. **Can J Physiol Pharmacol** 47(12):1043-5.
2. CHANG TMS (1969) Artificial cells made to order. New Scientist 4:18-19.
3. CHANG TMS, N MALAVE (1970) The development and first clinical use of semipermeable microcapsules (artificial cells) as a compact artificial kidney. Trans Am Soc Artif Intern Organs 16:141-148.
4. CHANG TMS (1971) A new concept in artificial kidneys using semipermeable microcapsules. "Chemeca '70", Butterworths of Australia (Publisher), pp 48-54.
5. CHANG TMS, A GONDA, JH DIRKS, N MALAVE (1971) Clinical evaluation of chronic, intermittent, and short term hemoperfusions in patients with chronic renal failure using semipermeable microcapsules (artificial cells) formed from membrane-coated activated charcoal. Trans Am Soc Artif Intern Organs 17:246-252.
6. CHANG TMS (1971) The in vivo effects of semipermeable microcapsules containing L-asparaginase on 6C3HED lymphosarcoma. **Nature** 229(528):117-118.
7. CHANG TMS (1971) Stabilisation of enzymes by microencapsulation with a concentrated protein solution or by microencapsulation followed by cross-linking with glutaraldehyde. **Biochem Biophys Res Common** 44(6):1531-1536.
8. CHANG TMS (1972) In vitro and in vivo kinetics of enzymes immobilized by microencapsulation. **Biotechnol & Bioeng** 14:520-525 (Symp.Vol 3:395-399).

9. CHANG TMS, A GONDA, JH DIRKS, JF COFFEY, T LEE-BURNS (1972) ACAC microcapsule artificial kidney for the long term and short-term management of eleven patients with chronic renal failure. Trans Am Soc Artif Intern Organs 18:465-472.
10. SUNDARUM PV, EK PYE, TMS CHANG, VH EDWARDS, AE HUMPHREY, NO KAPLAN, E KATCHALSKI, Y LEVIN, MD LILLY, G MANECKE, K MOSBACH, A PATCHORNIK, J PORATH, HH WEETALL, LB WINGARD, Jr. (1972) Recommendations for standardization of nomenclature in enzyme technology. **Biotechnology & Bioengineering** 14:15-18 (Symp. Vol 3:15-18).
11. CHANG TMS (1972) A new approach to separation using semipermeable microcapsules (artificial cells): combined dialysis, catalysis, and absorption. **"Recent Developments in Separation Science"** (N LI, ed.) Chemical Rubber Co. Press, Cleveland, OH, USA pp 203-216.
12. CHANG TMS (1972) Haemoperfusions over microencapsulated adsorbent in a patient with hepatic coma**. Lancet** ii:1371-1372.
13. CHANG TMS (1972) Microcapsule artificial kidney and medium molecular weight clearance. **Proc Eur Dial Transplant Assoc** 9:568-574.
14. CHANG TMS (1972) Effects of local applications of microencapsulated catalase on the response of oral lesions to hydrogen peroxide in acatalasemia. J Dental Res 51(2):319-321.
15. CHANG TMS, JF COFFEY, P BARRE, A GONDA, JH DIRKS, M LEVY, C LISTER (1973) Microcapsule artificial kidney: treatment of patients with acute drug intoxication. **Can Med Assoc J** 108:429-433.
16. CHANG TMS (1973) Immobilization of enzymes, adsorbents, or both within semipermeable microcapsules (artificial cells) for clinical and experimental treatment of metabolite-related disorders**. "Enzyme Therapy for Congenital Diseases"** D BERGSMA, ed. Birth Defects: Original Article Series, Vol IX, No 2), Williams & Wilkins Co., Baltimore, MD, pp 66-76.
17. CHANG TMS (1973) Recent trends in biocompatible materials and microcapsular absorbents for kidney function replacement**. "Perspectives in Biomedical Engineering"** (RM KENEDI, ed.) University Park Press (MacMillan), Baltimore, MD, pp 39-44.
18. CHANG TMS, JF COFFEY, C LISTER, E TAROY, A STARK (1973) Methaqualone, methyprylon, and glutethimide clearance by the ACAC microcapsule artificial kidney: in vitro and in patients with acute intoxication. Trans Am Soc Artif Intern Organs 19:87-91.
19. CHANG TMS, M MIGCHELSEN (1973) Characterization of possible "toxic" metabolites in uremia and hepatic coma based on the clearance spectrum for larger molecules by the ACAC microcapsule artificial kidney. Trans Am Soc Artif Intern Organs 19:314-319.
20. CHANG TMS (1973) L-Asparaginase immobilized within semipermeable microcapsules: in vitro and in vivo stability. **Enzyme** 14(2):95-104.

21. CHANG TMS (1973) Biomedical applications of artificial cells. **Biomedical Engineering** 8(8):334-339.
22. CHANG TMS (1973) The use of semipermeable microcapsules (artificial cells) as Microsystems for separation. **Am Chem Soc** 33:581-583.
23. CHAWLA, AS, CHANG TMS (1973) Nonthrombogenic polymeric membraneprepared by gamma-radiation grafting of heparin. **Am Chem Soc** 33:379-385.
24. SIU-CHONG, CHANG TMS (1974) In vivo effects of intraperitoneally injected L-asparaginase solution and L-asparaginase immobilized within semipermeable nylon microcapsules with emphasis on blood L-asparaginase, 'body' L-asparaginase, and plasma L-asparagine levels. **Enzyme** 18:218-239.
25. CHANG TMS (1974) Enzymes immobilized by microencapsulation: preparation and biomedical applications. **"Insolubilized Enzymes"** (M SALMONA, C SARONIO, S GARATTINI, eds.) Raven Press, New York, pp 15-27.
26. POZNANSKY MJ, CHANG TMS (1974) Comparison of the enzyme kinetics and immunological properties of catalase immobilized by microencapsulation and catalase in free solution for enzyme replacement. **Biochim Biophys Acta** 334:103-115.
27. CHANG TMS (1974) Effects of different routes of in vivo administration of microencapsulated enzymes. **Enzyme Engineering** 2:419-424.
28. CHANG TMS (1974) Platelet-surface interaction: effect of albumin coating orheparin complexing on thrombogenic surfaces. **Can J Physiol Pharmacol** 52(2):275-285.
29. CHANG TMS (1974) A spherical ultrathin polymeric membrane systemcontaining enzymes. Polymer Preprints, American Chemical Society 15:381-382.
30. CHANG TMS (1974) Performance characteristics of the microcapsule artificial kidney. in **"Renal Dialysis"** (D WHELPTON, ed.) Sector Publisher, London, pp 135-147.
31. CHANG TMS (1974) Future prospective: pediatric hemodialysis based on artificial cells. Clin Proc Children's Hospital National Medical Center, Washington, DC,30(10):304-311.
32. CHANG TMS, M MIGCHELSEN, JF COFFEY, A STARK (1974) Serum middle molecule levels in uremia during long term intermittent hemoperfusions with the ACAC (coated charcoal) microcapsule artificial kidney. Trans Am Soc Artif Intern Organs 20:364-371.
33. CHANG TMS (1974) Artificial cells and microcapsules: Comparison of structuraland functional differences. **"Microencapsulation: Processes and Applications"** (JEVANDAGAER, ed.) Plenum Press, New York, pp 95- 102.
34. CHANG TMS (1974) A comparison of semipermeable microcapsules and standard dialysers for use in separation. **J Separation & Purification Methods** 3(2):245-262.
35. CHAWLA AS, CHANG TMS (1974) Nonthrombogenic surface by radiation graftingof heparin: preparation, in-vitro and in-vivo studies. **Int J Biomaterial Medical Devices & Artif Organs** 2(2):157-169.
36. CHANG TMS (1975) Rationale for the use of the ACAC microcapsule artificialkidney for the treatment of patients with chronic renal failure. L'Ateneo Parmense**, Acta Bio-Medica** 46:35368.
37. CHANG TMS (1975) Artificial cells. **Chem Tech** 5:80-85.
38. CHANG TMS (1975) Artificial kidney and artificial liver**. Lancet** iv:1451-1452.
39. CHANG TMS (1975) Microencapsulated adsorbent hemoperfusion for uremia, intoxication and hepatic failure. **Kidney Int** 7:S387-S392.
40. CHAWLA AS, CHANG TMS (1975) A new method for the preparation of nonthrombogenic surface by radiation grafting of heparin: Preparation and in-vitro studies. in **"Biomedical Applications of Polymers"** (HP GREGOR, ed.) Plenum Press, New York, pp 147-157.
41. CHANG TMS (1975) Biocompatible microencapsulated (coated) charcoal for haemoperfusions in patients. **"Artificial Support Systems for Acute Hepatic Failure"** (R WILLIAMS, ed.) Whitefriars Press, Ltd., London, UK, pp 94-103.
42. CHANG TMS (1975) Experience with the treatment of acute liver failure patientsby haemoperfusion over biocompatible microencapsulated (coated) charcoal. in "Artificial Support Systems for Acute Hepatic Failure" (R WILLIAMS, ed.) Whitefriars Press, Ltd., London, UK, pp 229-233.
43. CHANG TMS (1975) Immobilized enzymes and their biomedical applications. in **"Immobilized Enzymes, Antigens, Antibodies, and Peptides"** (HH WEETALL, ed.)

Marcel Dekker, Inc., New York, pp 245-292.
44. CHAWLA AS, CHANG TMS (1975) Use of solubility parameters for the preparationof hemodialysis membranes**. J Applied Polymer Sci** 19:1723-1730.
45. CHANG TMS (1975) Biomedical research for the treatment of drug abuse and related problems. "Biomedical Research in Narcotic Abuse Problems" (MO MAYKUT, ed.) Health and Welfare Canada, pp 69-78.
46. CHANG TMS (1975) The one-shot vaccine. in "Socio-Economic and Ethical Implications of Enzyme Engineering" (C-G HEDEN, ed.) International Federation of Institutes for Advanced Studies, Stockholm, Sweden, pp 17-18.
47. CAMPBELL J, CHANG TMS (1975) Enzymatic recycling of coenzymes by amultienzyme system immobilized within semipermeable collodion microcapsules. **Biochim Biophys Acta** 397:101-109.
48. CHANG TMS, CHIRITO E, P BARRE, C COLE, M HEWISH (1975) Clinical performance characteristics of a new combined system for simultaneous hemoperfusionhemodialysis-ultrafiltration in series. Trans Am Soc Artif Intern Organs 21:502-508.
49. CHANG TMS (1975) Artificial cells as carriers for biologically active materialsin therapy. in "Clinical Pharmacology" (MJ MATTILA, ed.) Proc 6th International Congress of Pharmacology, Finland, Vol 5, pp 81-90.
50. CHANG TMS (1975). A microcapsule artificial kidney: a step toward miniaturization J **Dial Transplant** 4:23-25.
51. WATSON WJ, CHANG TMS (1975) Platelet-surface interaction: effects of dextran 70 on platelet retention in extracorporeal surfaces. Int J Biomaterial, Medical Devices & Artificial Organs 3(4):489-502.
52. CHANG TMS (1976) Semipermeable microcapsules as artificial cells: clinical applications and perspectives. **"Microencapsulation"** (J NIXON, ed.) Marcel Dekker, Inc., New York, pp 57-65.
53. CAMPBELL J, CHANG TMS (1976) The recycling of NAD+ (free and immobilized) within semipermeable aqueous microcapsules containing a multi-enzyme system. **Biochem Biophys Res Commun** 69(2):562-569.
54. CHANG TMS (1976) Microcapsule artificial kidney: including updatedpreparative procedures and properties. **Kidney Int** 10:S218-S224.
55. CHANG TMS (1976) Hemoperfusion alone and in series with ultrafiltration ordialysis for uremia, poisoning and liver failure. **Kidney Int** 10:S305-S311.
56. CHANG TMS (1976) Enzymes immobilized by microencapsulation within spherical ultra-thin polymeric membranes. **J Macromol Sci Chem** A10(1_):245-258.
57. CHANG TMS (1976) Methods for the therapeutic applications of immobilized enzymes. **Methods in Enzymology** XLIV: 676-698.
58. CHANG TMS (1976) Microencapsulation of enzymes and biologicals**. Methods in Enzymology** XLIV: 201-217.
59. CHANG TMS (1976) Biodegradable semipermeable microcapsules containingenzymes, hormones, vaccines, and other biologicals. **J Bioengineering** 1:25-32. www.artcell.mcgill.ca/1976ChangBiodegr.pdf
60. CHANG TMS (1977) Enzyme immobilized within spherical ultrathin polymeric membranes. "Polymer Grafts in Biochemistry-Bioactive Material".Preprint, American-Japanese Chemical Societies Joint Meeting, Hawaii.
61. CHANG TMS, CHIRITO E, P BARRE, C COLE, C LISTER, E RESURRECCION (1977) Clinical evaluation of the clearance profiles of a portable, compact, dialysate-free system incorporating microencapsulated charcoal hemoperfusion for blood purification with ultrafiltration for fluid removal. **J Dialysis** 1(3):239-259.
62. PRICHARD S, CHIRITO E, CHANG TMS, AD SNIDERMAN (1977) ell.mcgMicroencapsulated charcoal hemoperfusion: A possible therapeutic adjunct in digoxin toxicity**. J Dialysis** 1(4):367-377.
63. CHANG TMS (1977) Introduction. Introductory Chapter in "Biomedical Applicationsof Immobilized Enzymes and Proteins" Vol 1 (CHANG TMS, ed.) Plenum Press, New York, pp 1-4.
64. CHANG TMS (1977) Encapsulation of enzymes, cell contents, cells, vaccines,antigens, antiserum, cofactors, hormones, and proteins. in "Biomedical Applications Immobilized Enzymes and Proteins" Vol 1 (CHANG TMS, ed.) Plenum Press, New York, pp 69-90.
65. CHANG TMS (1977) Rationale and strategies for the therapeutic applications of

immobilized enzymes. in "Biomedical Applications of Immobilized Enzymes and Proteins" Vol 1 (CHANG TMS, ed.) Plenum Press, New York, pp 93-104.
66. SIU-CHONG ED, CHANG TMS (1977) L-Asparaginase as a model for enzyme therapy of substrate- dependent tumors. in "Biomedical Applications of Immobilized Enzymes and Proteins" Vol 1 (TMS CHANG, ed.) Plenum Press, New York, pp 105-120.
67. CHANG TMS (1977) Experimental therapy using semipermeable microcapsules containing enzymes and other biologically active material. in "BiomedicalApplications of Immobilized Enzymes and Proteins" Vol 1 (CHANG TMS, ed.) Plenum Press, New York, pp 147-162.
68. CHANG TMS (1977) Artificial kidney, artificial liver, and detoxifiers based on artificial cells, immobilized proteins, and immobilized enzymes in "Biomedical Applications of Immobilized Enzymes and Proteins" Vol 1 (CHANG TMS, ed.) Plenum Press, New York, pp 281-295.
69. CAMPBELL J, CHANG TMS (1977) Immobilized multienzyme systems and coenzyme requirements: Perspectives in biomedical applications. in "Biomedical Applications of Immobilized Enzymes and Proteins" Vol 2 (CHANG TMS, ed.) Plenum Press, New York, pp 281-302.
70. CHANG TMS (1977) Criteria, evaluation, and perspectives of various microencapsulated charcoal hemoperfusion systems**. J Dial Transplant** 6:50-53.
71. CHIRITO E, B REITER, C LISTER, CHANG TMS(1977) Artificial liver: The effect of ACAC microencapsulated charcoal hemoperfusion on fulminant hepatic failure. **Artif Organs** 1(1):76-83.
72. CAMPBELL J, CHAWLA AS, CHANG TMS (1977) The use of immobilized enzyme-membrane sandwich reactors in automated analysis. **Analytical Biochem** 83:330-335.
73. CHANG TMS (1977) Protective effects of microencapsulation (coating) on platelet depletion and particulate embolism in the clinical applications of charcoal haemoperfusion. "**Artificial Organs**" (RM KENEDI, JM COURTNEY, JDS GAYLOR,T GILCHRIST, eds.) MacMillan Press Ltd., London, UK, pp 164-177.
74. GRUNWALD & CHANG (1977) Formation of amino acid from urea and ammonia by sequential enzyme reaction using a microencapsulated multi-enzyme system. **Biochem Biophys Res Commun** 79(1):24-3l.
75. CHANG TMS (1977) Novel approaches in artificial kidney, artificial liver, and detoxification. **J Dialysis & Transplant** 8:20-26.
76. CHANG TMS (1978) Artificial cells in 1977. **Int J Artif Organs** 1(1):35-43.
77. CHANG TMS (1978) Biomedical applications of microencapsulation. in "Microencapsulation" (T KONDO, ed.) Tokyo, Japan, pp 369-376.
78. CHANG TMS (1978) Biomedical application of microencapsulated enzyme. Hind Antibiot Bull 2-:5-9.
79. CHANG TMS (1978) Artificial cells and charcoal hemoperfusion**. Int J Artif Organs** 1:111-112.
80. CHANG TMS (1978) Introductory chapter. in Artificial Kidney, Artificial Liver and Artificial Cells" (CHANG TMS, ed.) Plenum Press, New York, pp 3-8.
81. CHANG TMS (1978) Artificial cells for artificial kidney, artificial liver and detoxification. "Artificial Kidney, Artificial Liver and Artificial Cells" (CHANGTMS, ed.) Plenum Press, New York, pp 57-77.
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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 Immbolization Biotechnology, An International Jounral, 22:123-360, 1994

23. CHANG TMS and S. WEINSTOCK (eds) (1995). Blood substitutes Special issue, Artificial Cells, Blood Substitutes and Immbolization Biotechnology, An International Jounral, 23:

257-459.

24. CHANG TMS, G. GREENBERG and E TSUCHIDA (eds) (1997)Blood substitutes. Special issue, Artificial Cells, Blood Substitutes and Immbolization Biotechnology, An International Journal, 25:1-241.

25. CHANG TMS (1998) (editor: multiauthors) **Red blood cell substitutes: Principles, Methods, Products and Clinical Trials** Vol II Karger/Landes Systems, Basel, Switzerland

26. CHANG TMS (2004) Guest Editor. Special issue on Blood Substitutes:present and future. Artificial Organs Journal.

27. **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 wonline viewing or download on:**
http://www.medicine.mcgill.ca/artcell/2007%20ebook%20artcell%20web.pdf *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."*

28. CHANG, TMS (2013) editor, Book on **"Selected Topics in Nanomedicine**" World Scientific Publisher/Imperial College Press pp590
http://www.medicine.mcgill.ca/artcell/NanoBk_Ch1.pdf

29. Chang, Endo, Nicolaev, Tani and Zheng (editors) (2017) editors, Book on "**Hemoperfusion and Plasma-perfusion and other Clinical Uses of General ,Biospecific, immune and leucocyte Adsorbents"** World Scientific Publisher/Imperial College Press 1004 pages www.medicine.mcgill.ca/artcell/HPBk_Ch1.pdf

30. Editor in Chief Chang , coeditors:Bulow, Jahr,Sakai & Yang (for 2021) A multiauthor book on "**Nanobiotheraeutic basis for blood substitutes**, World Scientific Publisher/Imperial College >1000 pages (2021) https://www.worldscientific.com/worldscibooks/10.1142/12054#t=toc (Being Translated into Chinese)

30. CHANG TMS (for 2024) 3rd edition of Monograph on "ARTIFICIAL CELLS: biotechnology, nanotechnology, blood substitutes, synthetic cells, 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., Pala 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

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", llth 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:
i. Biophysics Institute, Chinese Academy of Sciences, Peking (12 hrs lectures, plus seminars and demonstrations).

ii. Capital Hospital (previously Union Medical School), Peking.
iii. National Symposium, Lang Fang (12 hours of lectures, plus seminars & demonstrations).
iv. Suchiachung Medical School, Suchiachung.
v. Hongchow Medical School, Hongchow.
vi. Shanghai Medical Association, Shanghai.
vii. 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 Prospective 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, Kyota, 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, V 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

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 VIth International Symposium on Hemoperfusion, Mexico
Honora ry 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. 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, Bordeau, 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, Slamanca, Spain

1990 Honorary president and invited plenary speaker, X International symposium on Hemoperfusion, absorbent and immobilzed bioreactants, Rome, Italy
1990 Invited plenary speaker on Biotechnoligcal apporach 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 Soceity, Annual Meeting, Washington, DC, USA

1991 Invited speaker in panel on Hydribd 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 Conferenc 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 conferenece 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 desig ned 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 Annula 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 "Deveopment 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 Hononary 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 Substitues, 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" 8th 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,

1998. 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 lecturere 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, Edingburgh, 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 Dinarello 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 3rd 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, III 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 48th Annual Conference, American Society for Artificial Internal Organs, New York City, U.S.A..

2001 Invited speaker on "Blood Substitutes" 11th European Congress of Anaesthesiology, Florence. Italy.

2001 Chairman & Invited Speaker in panel on "Artificial Organs". 6th Symposium of World Artificial Organs, Immunology & Transplantation Society, Ottawa, Canada

2001 Invited Speaker in panel on "Treatment of Type 1 Diabetes", 6th Symposium of World Artificial Organs, Immunology & Transplantation Society, Ottawa, Canada

2001 Panelist in public panel on "Ask the Experts". 6th Symposium of World Artificial Organs, Immunology & Transplantation Society, Ottawa, Canada

2001 13th 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 speaker 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", Mini symposium 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, 9th International Symposium on Blood Substitutes, Tokyo, Japan (March)

2003 Invited Speaker, Symposium, 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, precongress 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" 4th Regenerative Medicine Conference , Washington, D.C. (November)

2003 Visiting Professor, Invited Lecture on Blood Substitutes, Grand Round, Department of Anesthesia and Critical Care, Massachusetts 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 3rd 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, 5th 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 Unversity.

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 9th 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 Designand Discovery, Dubai, UAE Dubais invited speaker

2008 International Drug Discovery Science & Technology Conference (IDDST) Opening keynote session in seesion on Regnerative Medicine, Beijing, Chinag.

2008 Plenary specker and chair of session, International Academy of Nanomedicine Symposium, Washington DC (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 15th Japanese Soceity for Blood Substitutes and 6th 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.

2010 Opening Keynote plenary lecturer, 2nd World Congress of the International Academy of Nanomedicine, Antelya, Turkey
2010 Opening Keynote plenary lecturer. International Congress on Nanotechnoloy, Ottawa
2010 Opening Keynote plenary lecture BIOMED2010, Istanbul
2010 Opening Keynote plenary lecturer BIT 3rd Congress on Regenerative Medicine and Stem Cells, Shanghai, China.
2010 Opening Keynote plenary lecturer BIT 1st 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 Hong, China
2010 Invited Lecture, Transfusion Institute, Beijing, China

2011 Acceptance speech for being voted the “Greatest McGillian” in McGill University’s 190 years history. Result of a worldwide poll to vote on 700 nominee and 20 finalists to celebrate the 190th anniversary of McGill University.
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, Symposium president is Professor W Zapol, previously chief of Critical Care and Anesthesiology at at Mass General Hospital of Harvard Medical School. http://www.medicine.mcgill.ca/artcell/536.pdf
2011 Opening Keynote Speaker, Conference on Micro and Nano Systems, Chongqin, China 2011 Invited Speaker, Blood Transfusion Institute of the Chinese Academy of Medical Sciences and Peking Union Medical College.
2011 Invited Speaker, Ordos Blood Substitute Congress, Ordos, Inner Mongolia, China

2012 Opening Keynote lecturer on Frontier in Transfusion Medicine based on nanobiotechnological blood subsitutes, BIT International Congress on Hematology, Beijing, China.
2012 Invited lecturer, Microcirculation Institute of the Chinese Academy of Medical Sciences, Beijing, China
2012 Invited lecturer, Beijing Transfusion Institute, Beijing, China
2012 Opening Keynote Lecturer and honorary president , III International Academy of Nanomedicine Congress, Ankara, Turkey.
2012 Invited Speaker, XX Conference on Bioencapsulation, Ontario, Canada

2013 Opening Plenary lecturer and Honorary Symposium President of the XIV International Symposium on Blood Substitutes and Oxygen Therapeutics. at the Blood Transfusion Institute of the Chinese Academy of Medical Sciences, China. Symposium president is the president of the Chinese Academy of Medical Sciences and the other honorary symposium president is the vice minister of health of China.
2013 “Fronteir in Medicine” lecture series, Shantou University Medical School. Title of lecture “Blood substitutes in transfusion medicine: present clinical status and future perspectives”
2013 “Distinguished speaker lecture series” title of lecture “Artificial Cells” Calgary University Biomedical Engineering group

2014 Opening Plenary Lecturer 3rd Congress of the International Society for Nanomedical Science (postpored because of unsettle condition in region)

2015 Honorary President and invited speaker on *Nanobiotherapeutics with enhanaced rbc functions*, 4th Congress of the International Society for Nanomedical Sciences, Turkey
2015 Honorary Presdient and invited speaker on Red blood cell replacement or Nanobiotherapeutics with enhanaced rbc functions?, XIV International Symposium on Blood Substitutes, Lund, Sweden
2015 Invited lecturer on Blood substitutes and nanobiotherapeutic Blood Transfusion Institute of the Chinese Academy of Medical Sciences
2015 Invited lecturer on Blood substitutes: Present status and future perspectives Tianjin International Biotherapeutic Research Institute, Tianjin, China.

2016 Invited "Eminent researchers" round table for Canada's Science Review, Toronto, Canada
2016 Chinese Canadian Legend Award and address, Toronto, Canada

2017 Opening plenary speaker:**)**
60th Anniversary of the Invention of Artificial Cells in conjunction with of XVI International Symposium on Blood Substitutes and V ISNS Nanomedicine Conference,
Evolution of Artificial Cells to Nanobiotherapeutic, blood substitutes, Bioencapsulation, Hemoperfusion, Nanomedicine, etc. *www.medicine.mcgill.ca/artcell/60AC.m4v*

2017 Keynote lecture
60th Anniversary of the Invention of Artificial Cells in conjunction with of XVI International Symposium on Blood Substitutes and V ISNS Nanomedicine Conference,
Individual Roles of (1) Oxygen carriers, (2) Oxygen carries with antioxidant and (3) Oxygen carries with antioxidant and CO2 transport.

2018. Opening Plenary Speaker on 3rd general blood substitute. Chinese Society Symposium on Blood Substitute, Chengdu, China
2018. Lecture on design of clinical trial, Chinese Society Symposium on Blood Substitute, Chengdu, China
2018. Closing remarks, Chinese Society Symposium on Blood Substitute, Chengdu, China 2018 Invited speaker, International workshop on Bioencapsulation and Industry, Montreal 2018 Invited speaker, Biomedical Symposium, University of Quebec at Montreal

2019. Invited plenary speaker and Honorary President, 2018 V ISNS World Conference on Nanomedicine, Delhi, India
2019. Plenary Lecturer 13th Asian Science Camp (ASC 2019) Shantou, China
2019. Honorary President and opening presidential lecture, XVII International Symposium on Blood Substitutes, Nara, Japan
2019 Plenary Lecture Pacific-Asia Society of Blood Purification Nephrology Subdivision, Shenzhen, China.
2019 A number of smaller invited talks during a visit to China for the planning of the "Chang Artificial Cell Research Centre"
2019 Invited Speaker, Shantou University First Affiliated Hospital, Shantou, China., (invited speaker).

2020-2023 **COVID pandemic did not participate in meetings**
Placed my plenary lecture for all to view at **www.artcell.mcgill.ca**

2021 Opening Address. Chinese meeting on Blood Substitutes (online)

2021 Opening Address and Opening Plenary Lecture, South China Conference on Renal Immunology and blood purification (online)

2024. Honorary ISBS president opening lecture
Chair and lecture in panel on "Cardiac toxicity of blood substitutes: fact or misinformation?"
2024 XIX International Symposium on Blood Substitutes. Maryland, U.S.A.

PATENTS and PATENT APPLICATIONS:

1. T.M.S. Chang (1970) "Nonthrombogenic Microcapsules": U.S. Patent, 3, 522, 346
2. T.M.S. Chang, F.C. MacIntosh and S.G. Mason (1971) "Encapsulated hydrophilic compositions and Methods of Making them" Canadian Patent, 873, 815
3. T.M.S. Chang (1971) "Nonthrombogenic microcapsules" Canadian Patent, 876,100
4. T.M.S. Chang (1973) "Blood compatible microcapsules containing detoxicants" U.S. Patent, 3, 725, 113
5. T.M.S. Chang (1976) "Blood compatible microcapsules containing detoxicants" Canadian Patent, 982, 941
6. T.M.S. Chang and J. Daka (1990) "A novel method for bilirubin removal" Canadian Patent granted.
7. T.M.S. Chang, L. Bourget and C. Lister (1991) Novel method of amino acid removal by immobilized bioreactant based on new findings of enterorecirculation of amino acids USA Patent No. 5,147,641, Issued Sept. 15, 1992
8. T.M.S. Chang, L. Bourget and C. Lister (1989) Patent as above, Canada
9. T.M.S. Chang and H. Wong (1992) A novel method for cell encapsulation in artificial cells. USA Patent No. 5,084,350, Issued Jan. 28, 1992
10. T.M.S. Chang and C. Lister (1993) Screening test for modified hemoglobin blood substitute before use in human. U.S. Patent No. 5,200,323, Issued April 6, 1993
11. T.M.S. Chang and W.P. Yu (1992). Biodegradable polymer membrane containing hemoglobin as potential blood substitutes. British Provisional Patent No. 9219426.5, Issued September 14, 1992.
12. T.M.S. Chang and W.P. Yu (1997). Biodegradable polymer membrane containing hemoglobin for blood substitutes. U.S.A. Patent 5670173 September, 23, 1997
13. D'Agnillo F & TMS. Chang (1997) Modified hemoglobin blood substitute from Cross-linked hemoglobin-superoxide dismutase-catalase.US patent 5,606,025, Feb,1997
14. D'Agnillo F & T.M.S.Chang Hemoglobin-enzyme complexes. Canadian Patent 2,135,739
15. Satya Prakash & T.M.S.Chang (1996) Microencapsulated genetically engineered microorganisms for clinical application. British Priority Patent No 9601333-9, January 23, 1996
16 T.M.S.Chang & Satya Prakash(1998) Microencapsulated genetically engineered microorganisms for clinical application. International PTC application for Europe, Japan, U.S.A.& Canada.(removal of urea and ammonia)
17 Satya Prakash & T.M.S.Chang (April, 28,1999). Microencapsulated genetically engineered E. Coli DH5 cells for the removal of undesired electrolytes and/or metabolites. U.S.A. Provisional Application. Serial Number 60/131,468
18 Satya Prakash & TMS Chang (April27, 2000) Artificial Cells Microencapsulated Genetically Engineered E. Coli DH5 Cells for the Removal of Undersired electrolytes and/or metabolites. International Application No:PCT/CA00/00482
19 TMS Chang & Satya Prakash (2001) Microencapsulated geneticallyengineered microorganisms for clinical application. U.S. Patent 6,217,859 April 17 2001.
20 TMS Chang & Satya Prakash (2001) Microencapsulated genetically engineered microorganisms for clinical application. Japanese Patent 3228941 (September 7 2001).
21 TMS Chang, & WP Yu (2001) Biodegradable Polymeric Nanocapsules and uses thereof. U.S. Provisional Patent Application. No 60/316,001 (August 31, 2001)
22 TMS Chang, D.Powanda & WP Yu (2002) Biodegradable Polymeric Nanocapsules and uses thereof. International Patent Application No. PCT/CA02/01331- August 2002. WO 03/017989 A1 (2003)
23 TMS Chang, D.Powanda & WP Yu (2002) Biodegradable Polymeric Nanocapsules and uses thereof. Chinese Patent Application 2004
24 TMS Chang & Binglan Yu (2002) Composition for inhibiting tumour growth and methods thereof. US Provisional Patent Application 60/364,581 (March 18, 2002)
25 TMS Chang & Binglan Yu (2003) Composition for inhibiting tumour growth and methods thereof. US Patent Application (March 2003)
26 T.M.S. Chang and C. Lister (2003). Screening test for modified hemoglobin blood substitute before use in human. Canadian Patent (awarded)
27 TMS Chang, D.Powanda & WP Yu (2004) Biodegradable Polymeric Nanocapsules and uses thereof. U.S. Patent Application February 27 2004
28 TMS Chang, D.Powanda & WP Yu (2007) Biodegradable Polymeric Nanocapsules and uses thereof. Chinese Patent awarded
29 TMS Chang & Wong, N (2007) A novel blood substitute. U.S. Provisional

Patent.60/968720 August 29, 2007

30 TMS Chang, & WP Yu (2008) Biodegradable Polymeric Nanocapsules and uses thereof. U.S. Patent Awarded Nov 2008

31 TMS Chang, & WP Yu (2008) Biodegradable Polymeric Nanocapsules and uses thereof. Chinese Patent Awarded 2008

32 TMS Chang & YZ Bian (2011) Novel Blood Substitute with complete red blood cell functions. U.S. Provisional Patent US 61/490.304

33 TMS Chang & YZ Bian (2021) Novel Blood Substitute with complete red blood cell functions. Canadian Patent approved

34 TMS Chang & M Hoq.(2023) Artificial blood substitutes. US Provisional Patent

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,free voluntary service (1982-1987);
   Honorary Staff, free voluntary service (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. Consultant, National Institute of Child Health and Human Development, National Institutes of Health, Washington, DC (1975-1977).
15. Promotion, Reappointment and Tenure Committee, Dept of Physiology, McGill University (1975-1977).
16. Statutory Committee for Professors in Medicine, McGill University (1975).
17. Statutory Committee for Professors in Biochemistry, McGill University (1977).
18. Advisory Board, Biannual International Enzyme Engineering Conference (1977).
19. Chairman and Organizer, International Symposium on "Some Novel Approaches in Artificial Kidney, Artificial Liver and Detoxification", (1st International Symposium on Hemoperfusion) Montreal (1977).
20. Canadian Standard Association Subcommittee on Kidney Dialysis (1977-1987).
21. International Council Member, International Society for Artificial Organs (1977 982).

22. Scientific Film Comm., American Society for Artificial Internal Organs (1977).
23. Video Committee, American Society for Artificial Internal Organs (1977).
24. Program Committee, American Society for Artificial Internal Organs (1978-81).
25. Project Site Visit and Special Study Section, National Institutes of Health (USA) (1978).
26. Search Committee for Physiology Chairman, McGill University (1978).
27. McGill University Patent Policy Review Committee (1979).
28. McGill University Ad Hoc Committee on visiting scholars, fellows and students from China (1979).
29. Cochairman, 2nd International Symposium on Hemoperfusion, Israel Institute of Technology, Technion, Israel (1979).
30. Organizer and initiator, Canadian Society for Artificial Organs, Artificial Organs, Artificial Cells and Medical Devices (1979).
31. 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).
32. Co-chairman, Gordon Research Conference on "Drug Carriers in Biology and Medicine", New Hampshire, USA (1980).
33. Admissions Committee, Faculty of Medicine, McGill University (1979-1982).
34. Departmental Policy Committee, Dept. of Physiology, McGill Univ. (1979-1986).
35. Advisory Board, Biannual International Enzyme Engineering Conference, Japan (1981).
36. Founding President, Canadian Society for Artificial Organs, Artificial Cells and Medical Devices (1980-1982).
37. Standing Committee on Biotechnology, McGill University (1980-1981).
38. Biotechnology Research Group, Faculty of Graduate Studies and Research, McGill University (1981-1984).
39. Keyman on Hemoperfusion, Program Committee, International Congress ofthe International Society for Artificial Organs, Paris, France (1981).
40. Chairman, Gordon Research Conference on "Drug Carriers in Biology and Medicine", New Hampshire, USA (1982).
41. Honorary President, 4th International Symposium on "Hemoperfusion", Turkey and member of International Organizing Committee (1982).
42. Member, McGill University Regional Advisory Group of International Development Research Centre of Canada (IDRC) on People's Republic of China (1982-present).
43. Board of Trustees, International Society for Artificial Organs (1982-1986).
44. Symposium President and Chairman of Organizing Committee, Fifth International Symposium on "Microencapsulation, Including Artificial Cells", Montreal, Canada (1983).
45. 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.
46. Advisory Committee, VII International Conference on Enzyme Engineering, Engineering Foundation for 1983.
47. Organizing Committee and chairman of program committee on Hemoperfusion", 4th International Congress of the International Society of Artificial Organs, Kyoto, Japan (1983).
48. International Scientific Committee, International Symposium on Hemodetoxifications in Nonuremic patients, Italy (1983).

    Hemoperfusion, sorbents and immobilized bioreactants series (1983 to present)
49. Consultant, Dialaid International Ltd. (1981-1984), whichbecame Biomicroencapsulation Technology Ltd., Montreal (1984 to 1986), which became Carbomed, Co. (19861990).
50. Scientific Advisory Board, Karyon Technology Co., Boston, Mass, USA (1983 to 1986).
51. 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.
52. Organizing Committee (past chairmen), Gordon Research Conference on "Drug Carriers in Biology and Medicine", New Hampshire, USA (1984).
53. International Committee, NATO Advanced Study Institute on Biopolymer, Turkey (1984).
54. Advisory Committee, Biotechnology, McGill University (1984 to 1993).
55. 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".

56. Chairman, Search Committee for Cardiovascular Physiologist, Dept. ofPhysiology, McGill University (1986).
57. Chairman, Advisory Committee Meeting on "Particulate Contamination in Medical Devices", Bureau of Medical Devices, Department ofHealth and Welfare, Government of Canada, Feb. 1986, Ottawa.
58. Honorary President, 7th International Symposium on Hemoperfusion, Kiev,USSR (1986). Sponsored by the USSR Academy of Sciences.
59. President, 3rd International Symposium on Blood Substitutes, Montreal, PQ, Canada (1987).
60. Committee on Appointment, Tenure and reappointment, Physiology, McGill (1983-85)
61. International Program Committee for the Joint World Congress of International Society of Artificial Organs and European Society of Artificial Organs, Munich, Germany,1987.
62. International Program Committee: International Symposium on "Optimization of Blood Purification", Rostock GDR, 1987.
63. Program committee on Artificial Cells and Hemoperfusion. 1988 Congress of the European Society of Artificial Organs, Prague, Czechoslovakia.
64. Program Committee, Annual Meetings of the American Society of ArtificialInternal Organs (1986 to 1992).
65. Program Committee, 7th International Symposium on Microencapsulation, 1987.
66. Scientific Advisory Board, Hemosol Co., Toronto, Canada.(1988-1998)
67. Member of Chairman"s Advisory Committee, Department of Physiology,McGill University (1988-present)
68. Honorary President, 8th International Symposium on Hemoperfusion, Sorbent and Immobilized Bioreactants, Germany, 1988.
69. Cochairman, 1989 International Symposium on Red Blood Cell Substitutes: Design and Clinical Application, San Francisco, U.S.A.
70. Honorary President, 9th International Symposium on Hemoperfusion, Sorbent and Immobilized Bioreactants, Tokyo, Japan, 1989.
71. Program Committee, 1989 Congress of the International Society of ArtificialOrgans, Sapporo, Japan.
72. Honorary President, 10th International Symposium on Hemoperfusion, Sorbent and Immobilized Bioreactants, Rome, Italy, 1990.
73. International Scientific Advisory Committee member,7th International Symposium on Microencapsulation, Glasgow, Scotland, 1990.
74. Congress President, 8th World Congress of the International Society of Artificial Organs, in conjunction with the 4th International Symposium of Blood Substitutes, Montreal, 1991.
75. International Scientific Advisory Committee, 8th International Symposium on Microencapsulation, Ireland, 1992.
76. Member, McGill Biotechnology Committee (1984 to present).
77. Member, Subcommittee on Research Centers, Faculty of Graduate Studies (1991).
78. Board of Trustee, International Society of Artificial Organs. Reappointed for 1989 1993.
79. Honorary President, International Society for Artificial Cells and Immobilization Biotechnology (1991-present).
80. President, International Society for Artificial Organs (1994-1996).
81. International Scientific Advisory Committee, 9th International Symposium on Microencapsulation, Turkey,1993.
82. Honorary congress president, XI Congressof the International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology. (Congress president Professor R.Langer of MIT which organized this), Boston,1994.
83. Conference Chairman IBC Conference on Blood Substitutes, Washington D.C. 1994
84. International Scientific Advisory Committee, 9th International Symposium on Microencapsulation, USA ,1993.
85. Program Chairman, International Organizing Committee, Xth World Congress ofthe International Society for Artificial Organs, Taipei, Taiwan (1995).
86. Chairman, VI International Symposium on Blood Substitutes. Montreal 1996.
87. Organizing Committee, Congress of the International Society for Artificial Organs, Rhode Island, U.S.A.
88. Cochairman, VI International Symposium on Blood Substitutes Tokyo, Japan 1997

89. Honorary congress president, XII Congress of the International Society for Artificial Cells, Blood Substitutes and Immobilization Biotechnology. Organized by theChinese Academy of Medical Science with president of academy as congress president) Beijing,PRC,1997
90. Cochairman and member of organizing committee, VIII International Symposiumon Blood Substitutes, San Diego, 2000
91. Honorary Chairman, International Society for Artificial Cells, Blood Subsitutes & Immobilization Biotechnology XIV Conference on "Artificial Cells & Cells inNovel Medical Application" Istanbul, Turkey
92. Member of MRC and CIHR "Pharmaceutical Sciences" Grants Reviewcommittee. (1999-2001)
93. FRSQ & MSSS (Quebec Ministry of Health) Member of Working group on Research Priority in Transfusion Medicine (2000-2001).
94. Member, International Scientific Committee of the 13th Congress of the International Society for Artificail Organs, Osaka, Japan, 2001
95. Member, Organizing committee of Conference in Blood Substitute organized by Karolinka Institute, Stockholm, Sweden. 2002 June
96. Member, International Scientific Committee of the 13th Congress of the International Society for Artificail Organs, Washington, D.C. 2003 .June
97. Chairman and Organizer, precongress 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
98. Honorary President and Member of International Advisory Committee, IX International Symposium on Blood Substitutes, Tokyo, Japan 2003 March
99. Scientific committee and VIP guest, III International Symposium on Biotechnologyand Biomedicine, Tianjin, PRC. 2004
100. Honorary President and Member of International Advisory Committee, XInternational Symposium on Blood Substitutes, Providence, Rhode Island 2005, June
101. Member, Scientific Board, 2nd World Congress on Regenerative Medicine, Germany
102. 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).
103. 2006 XX Olympic Winter Games, Turin. Expert consultant for the ad hoc Courtof Arbitration for Sport(CAS) on doping related matters (e.g.blood substitutes).

104. 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).
105. Honorary President and Member of International Advisory Committee, XI International Symposium on Blood Substitutes, Beijing, China 2007
106. International Scientific Board, Congress of ESAO 2007 Austria
107. Founding member, International Academy of Nanomedicine 2008-
108. NATO co-director of workshop on Advance Institute of Science 2008
109. Honorary President and Member of International Advisory Committee, XII International Symposium on Blood Substitutes, Parma, Italy. 2009
110. President and member of the board, International Academy of Nanomedicine, 2009- 2010
111. International Scientific Advisory Committee 2nd World Congress of the International Academy of Nanomedicine, Antelya, Turkey
112. International Scientific Advisory Committee. 2010 International Congress on Nanotechnology, Ottawa
113. International Scientific Advisory Committee 2010 BIT 3rd Congress on Regenerative Medicine and Stem Cells, Shanghai, China.
114. International Scientific Advisory Committee BIT 1st Congress on Nanomedicine, Beijing, China, 2010
115. Honorary President and member, International Scientific Advisory Committee, 2011 XIII International Symposium on Blood Substitutes and Oxygen Carriers, Mass General, Harvard, Boston
116. International Scientific Advisory Committee 2012 3rd World Congress ofthe International Academy of Nanomedicine, Ankara, Turkey
117. Honorary President, International Scientific Advisory Committee 2013 XIV International Symposium on Blood Substitutes, Institute of Blood Transfusion, Chinese Academy of Medical Sciences, China

118. Honorary President and International Scientific Advisory Committee 2015XV International Symposium on Blood Substitutes, Lund, Sweden
119. Honorary President, 60th Anniversary of Artificial Cells in conjunction with 2017 XVI International Symposium on Blood Substitutes and V Congress of Nanomedical Sciences.
120. 2017, Honorary President, Quebec Branch of the Chiu Chow Association (Hometown of Shantou)
121. Chinese government's Overseas Chinese Expert Advisory Committee on Trade, Science and Technology 2017-2021
122. Honorary President, VI ISNS World Nanomedicine Conference, Delhi, India.
123. Honorary President and International Scientific Advisory Committee 2019 XVII International Symposium on Blood Substitutes, Nara, Japan
124. Key consultant, Chinese Research Alliance on Innovation, and Industrial developmentof Blood Engineered Products 2018-
125. 2019 Honorary President, 30th Anniversary of the Quebec Branch of the Chiu Chow Association (Hometown of Shantou)
126. 2022 Honorary President and International Scientific Advisory Committee XVIII International Symposium on Blood Substitutes, Berlin, Germany (Cancelled due to pandemic)
127. 2024 Honorary president and International Scientific Advisory Committee XIX International Symposium on Blood Substitutes, U.S.A.