(1) WHEN, WHERE, WHO ?

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

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

Quoted from feature article on "Going Cellular", Modern Drug Discovery, ACS Publication by Mark S. Lesney 2002
"As can be expected, research into various capsular materials is almost as important as studying the requirements and kinds of cells that can be appropriately transplanted. The first encapsulated cells were developed as far back as the 1960s, when T.M.S. Chang and colleagues first reported the development of semipermeable aqueous microencapsulation of cells. The vision of using these cells for therapeutic purposes was present from the start".

Quoated from "American Medical News(American Medical Association)" Nov 16, 1998:(by Mark Moran)
"For nearly 40 years, Dr. Chang has pursued the development of artificial blood, and his work has laid the foundation for products that may be available in coming years. These products, however, are not true red blood cells but modified hemoglobin molecules for short-term transport of oxygen ..... Today, Dr. Chang is working on products that more closely resemble nature's own creation....."

International Academy of Nanomedicine
Researchers in nanomedicine recognized Chang's invention as the forerunner of nanomedicine by electing him the founding president of the new International Academy of Nanomedicine in 2009 and their first "Outstanding Research Award".

(2) WHAT, HOW ?

Quoted from the United Kingdom journal, New Scientist (by Leigh Dayton):

In 1957, Thomas Chang was completing his final year as an undergraduate at McGill University in Montreal. He wondered what would make a good research

project, a project that would demonstrate his growing interest in medicine and biotechnology. His answer was both elegantly simple and intellectually ambitious. He would make the first artificial cell..... He "built" cells, about a millimetre in diameter, that contained hemoglobin wrapped in a thin plastic membrane.

His undergraduate research project has grown into a dynamic field of biomedical research and development ..... Although the study and use of artificial cells is now a sophisticated marriage of microbiology, chemistry and biotechnology, the concept remains as straightforward as Chang's original notion. "…. we are not trying to make models of biological cells. Rather, we are trying to make artificial cells for application in medicine and biotechnology".

Because the artificial cell is an attempt to mimic some of the biological processes of a real cell, it may ultimately prove most useful as a partial substitute for human cells and organs. For example, artificial cells may one day produce insulin for diabetics, replace human blood in transfusions, or serve as building blocks for artificial livers and kidneys. Researchers can now create artificial cells with roughly 30 different polymers, as well as several kinds of proteins.

Theoretically, an artificial cell can contain virtually anything: oxygen, drugs, enzymes, antibodies, cell extracts and even cells themselves....Charcoal (in artificial cells) can detoxify the blood of people suffering from some forms of drug poisoning. The procedure, called "hemoperfusion" was pioneered at the McGill Artificial Cells & Organs Research Centre in the late 1960s.

Chang's group is working with artificial cells filled with enzymes. …. convert waste products such as ammonia and urea into the essntial amino acids valine, leucine and isoleucine.....also hold promise as a treatment of enzyme-deficiency diseases such as phenylketonuria (PKU).... could process the damaging phenylalanine and remove it from the system.

.....artificial cells carrying insulin-secreting cells from animals could free millions of people with diabetes...Anthony Sun.has been working on transplanting such insulin-secreting cells... into the abdominal cavities of diabetic rats, he has been able to stabilize the levels of glucose in their blood for as long as a year after one injection.

Injectable artificial cells have also been the "vehicle of choice" for ....deliverying drugs to their targets in the body....[.in 1961(Bangham) also added lipids to the list of construction material for membranes...called "liposomes"]..scientists have used liposomes, in particular, to protect medication from degradation and to deliver it to target tissues and organs.

Another.....is a substitute for red blood cells....concern about the safety of blood supplies....has focused ….on …. developing a stable, universally compatible alternative..... the short-term answer is … chemically tying together, or linking,

the hemoglobin molecules, ... in the very long run, may be the microencapsulation of hemoglobin..... to make artificial cells .

But what are the prospects for artificial cells in the long term? will synthetic cells fly in space with astronuats, coverting their body wastes into useful amino acids and proteins? Will miniaturised surgical robots travel in microcapsules to sites in the body that are inaccessible to human surgeons? Will artificial cells and organs one day outperform their biological counterparts? If Thomas Chang and his colleagues have their way, this science fiction may one day be science fact.

(update - not part of the above report: His group has been working on regenerative medicine (e.g. liver regeneration for many years). More recently *Chang and his colleague, Dr. Zunchang Liu showed that implantation of artificial cells containing bone marrow stem cells increase the survival of rats that have only 10% of the original liver). Chang and his colleague Satya Prakash has showed that artificial cells containing a genetically engineered cells can be given orally to rats to remove urea.*

Quoted from the Journal of the British Royal Society of Chemistry , Chemistry in Britain:

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

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

The quest for a successful artificial red blood cell system has occupied Thomas Chang's life since he was an undergraduate more than 30 years ago. His early work concentrated on the design and synthesis of artificial cell membranes from various polymer, protein-lipid and polymer-lipid combinations. Now...realizing the full..potential of his revolutionary ideas..... Chang's team looked at polyhemoglobin.

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

blood substitute has taken off". He could be on his way to a bloodless coup in the search for an alternative to blood transfusion.

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