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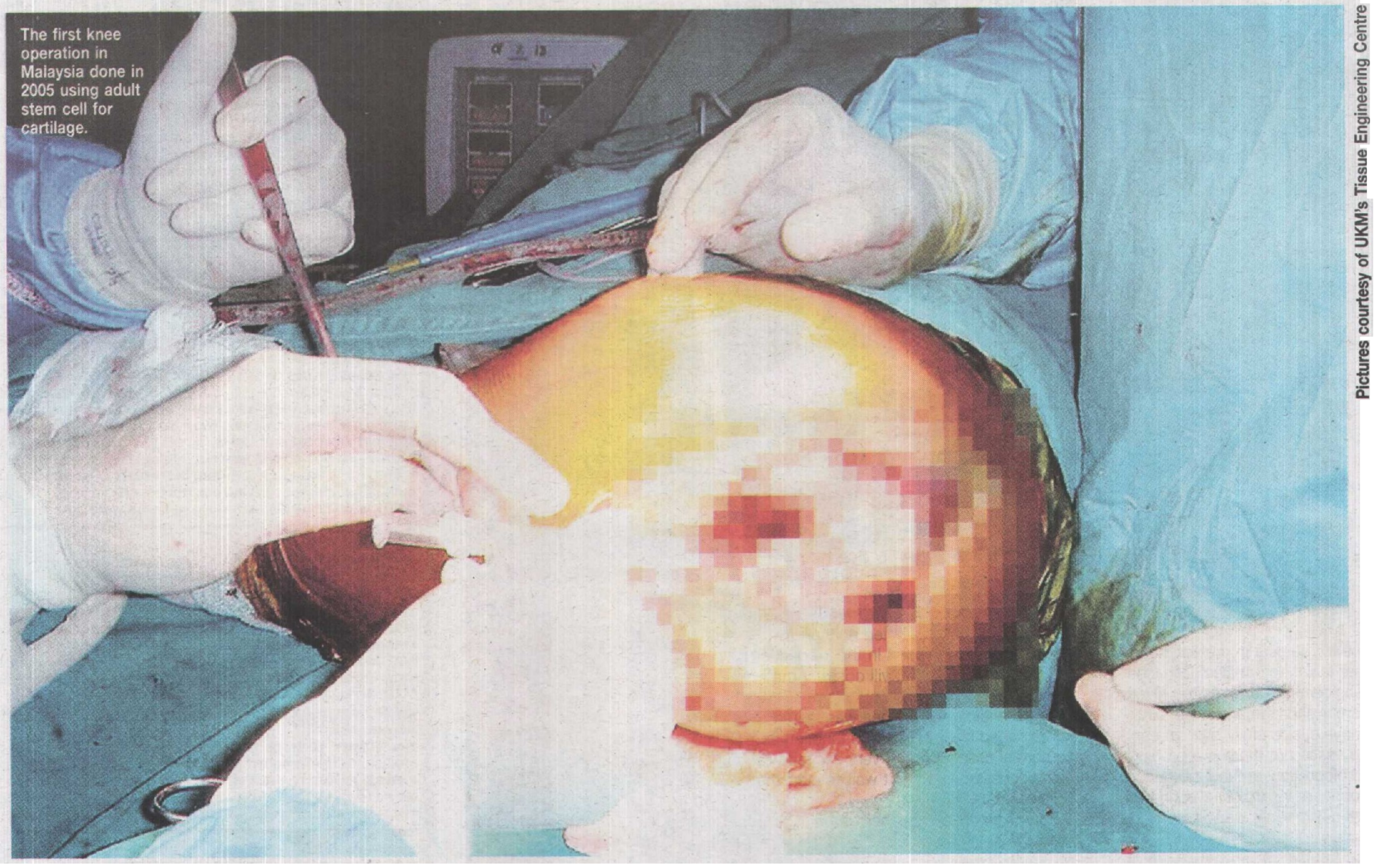
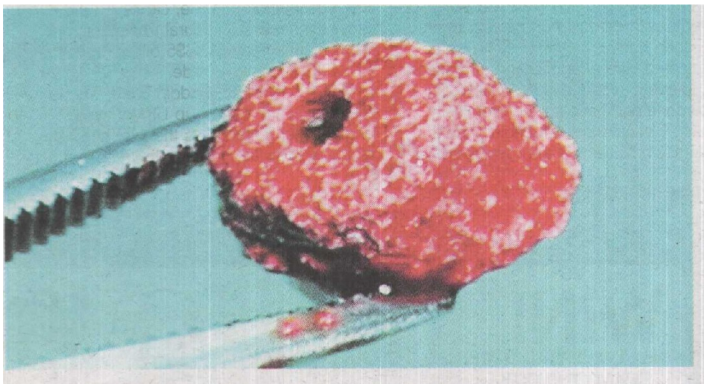


The first knee operation in Malaysia done in 2005 using adult stem cell for cartilage.

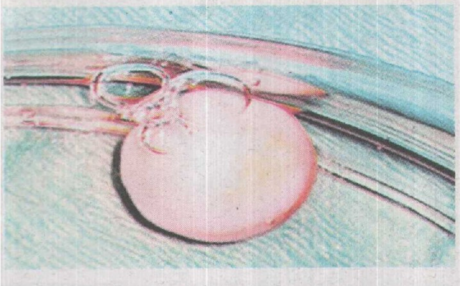
Pictures courtesy of UKM's Tissue Engineering Centre

Issue with tissue

They may be relatively new fields here but the results of stem cell research and tissue engineering have been outstanding, writes **KASMIAH MUSTAPHA.**



Bone formation from bone marrow stem cell via tissue engineering technique.



Knee joint cartilage made through tissue engineering.

The trachea.

SINCE the exploration of stem cell and tissue engineering began years ago, it has created a huge hype in the medical world. Just like any other new findings, scientists all over the world are hoping to come up with a cure for cancer or creating the perfect tissue and organs for humans.

Malaysia is no exception. Though we joined the bandwagon a little late, nevertheless concerted efforts have been out in place — namely by the local universities — to embark on stem cell and tissue engineering research.

Leading the way is Universiti Kebangsaan Malaysia which began its tissue engineering project nine years ago. Others that followed suit were Universiti Putra Malaysia, Universiti Malaya, Universiti Sains Malaysia, International Islamic University of Malaysia and Universiti Teknologi Malaysia. Each of these universities are involved in different aspects of stem cell and tissue engineering research.

While UKM is concentrating its efforts on tissue engineering on cartilage, skin, bone, trachea and cornea, UM is working on cartilage engineering, IIUM on biomaterials and bone engineering, UPM is conducting research on embryonic and cancer stem cell while UTM is using skin cells to test herbal products.

In 2004, local researchers decided to

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pool their resources to avoid duplicating their work and formed the Tissue Engineering Society of Malaysia. The society's objectives include enhancing the science and technology of tissue engineering, bringing together people who are interested in the field and to promote education and research in stem cell and tissue engineering.

Professor Dr Ruszymah Idrus, who is the society's president, says tissue engineering applies the principle of engineering and life sciences in developing biological substitute that restore, maintain or improve tissue or organ function. It has the potential to replace and regenerate damaged tissues and organs.

"Many diseases and defects due to injury will result in either loss or damaged cells in the tissue or organ which will eventually lead to tissue or organ dysfunction. With the tissue engineering technology, damaged tissues or organs can be repaired."

As the co-ordinator of UKM's Tissue Engineering Centre, Professor Ruszymah says since the university began its research on tissue engineering nine years ago, it has successfully engineered several types of tissues from stem cell.

"We have been successful with tissue engineering on cartilage, skin, bone, cornea and trachea. Except for the cornea, the rest have been tested successfully in pre-clinical trials. Once we get the approval and grant, we will proceed to test these on humans."

Research on tissue engineering at the university began with cartilage which is often needed for reconstructive purposes for defects in the ear, nose and other facial deformities. Cartilage tissue engineering done at the university includes ear cartilage and knee joint.

"We have successfully built an ear cartilage tissue but there is a problem with the blood flow around the middle of the lobe, so we are still working on it. Once we get it done, we will start on pre-clinical trials.

"As for the knee joint, we have tested on a sheep and it has shown excellent results. Clinical trials will start soon."

The centre has also developed human skin which could be used to replace skin loss for diabetics, burn victims or those who need a skin graft after an accident.

She says the bi-layered human skin — which is thicker, easier to handle and can be made into various sizes — has been developed. The skin which has been tested on a sheep can produce abundant growth factors and can be used as an alternative to split skin graft especially for patients with chronic non-healing ulcers and deep burns.

Selected clinical application on patients with diabetic ulcers and burn lesions were done and have shown promising results. Clinical trials will begin once the university receives the approval, says Professor Ruszymah.

Another success story for the centre is tissue engineering for tracheal epithelium. According to Professor Ruszymah, the most common complication after surgical procedure is the disrupted epithelium continuity which results in the production of fibrous tissues that will obstruct the airway.

"The engineered trachea was tested on a sheep and was able to function as a normal tissue. We are very excited with the success and cannot wait to start the clinical trials."

She says the researchers are also working on tissue engineering for the cornea, which may provide a valuable alternative to overcome the conventional corneal transplantation since there is always shortage of donors.

"Though tissue engineering and regenerative medicine may be relatively new here but the work done by the researchers is outstanding. Once we have done the clinical trials, we can have the products commercialised. We can use it locally or even sell it to other countries."

It is reported that the estimated market for tissue engineered products including the regeneration of bone, cartilage, and other connective structural treatments are worth approximately US$5 billion (about RM16.5 billion) worldwide.

Meanwhile, Dr Aminuddin Saim, who is responsible for setting up UKM's tissue engineering centre, says the joint effort by all universities as well as other research groups is needed to ensure stem cell and tissue engineering field in Malaysia can advance further.

Though researchers have made much progress in stem cell and tissue engineering studies, too many red tapes have hampered their plans to start on clinical trials. One way to overcome this problem is to set-up a good manufacturing practice (GMP) laboratory before clinical trials can begin.

"We have limited funds as the cost of a GMP lab is RM30 million. This has created a bottleneck as we can't implement research findings which have been successfully tested in pre-clinical trials."

It is said that UKM is expected to have the GMP lab ready within the next two years. It will be the first lab in the country for clinical trials in stem cell and tissue engineering research.

Another issue raised by Dr Aminuddin is the funding for stem cell and tissue engineering research. With more research expected to be done on stem cell and tissue engineering, costs will become one of the major problems.

"We are getting funds from the Government. Perhaps the Government should encourage foreign pharmaceutical companies which are selling their products here to assist in providing grants for the research."

■ kasmiah@nst.com.my

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Allow for clinical trials soon, says Dr Aminuddin.

Results from research have been outstanding, says Ruszymah.

Ear cartilage tested on a lab rat.

How cells are engineered

WHAT are stem cells?

STEM cells are the progenitors of all cells in the human body. Stem cells are found in a variety of sources including adult tissue, umbilical cord blood, placental tissue and human embryos.

Stem cell has the ability to restore damaged organs and tissues. Currently, the only way to treat a damaged organ or tissue is by getting a donor which is often difficult.

Stem cells can be used to treat numerous diseases including Parkinson's and Alzheimer's diseases, spinal cord injuries, stroke, burn injuries, heart disease, diabetes and arthritis.

Using stem cells, scientists have embarked on tissue engineering or regenerative medicine that are closely associated with applications that repair or replace portions of or whole tissues such as bone, cartilage and other organs.

What is regenerative medicine?

Clinical procedures that aim to repair damaged tissue or organs, most often by using tissue engineered scaffolds and stem cells to replace cells and tissues damaged by aging or disease. In some cases, medical devices are part of the therapeutic procedure.

What is tissue engineering?

Coined in 1987, the term "tissue engineering" combines engineering principles and the life sciences in a bold attempt to use the body's own biological materials to repair, regenerate, and ultimately replace damaged organs and tissues, including bone and cartilage.

Tissue engineering would eliminate the need for bone grafts and avoid problems associated with artificial replacement of joints, such as donor site defects, immuno-rejection, abnormal wear and tear, and transmission of pathogens.

Tissue engineering may involve the design and production of scaffolds or matrices, the harvesting of cells from a suitable source, the culture of these cells within the scaffolds under the conditions imposed by a bio reactor with both molecular and mechanical signalling, and the subsequent regeneration of tissue, and the transposition of the resulting tissue into the host.

In addition to having a therapeutic application, where the tissue is either grown in a patient or outside the patient and transplanted, tissue engineering can have diagnostic applications where the tissue is made in vitro and used for testing drug metabolism and uptake, toxicity, and pathogenicity.

Sources:
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