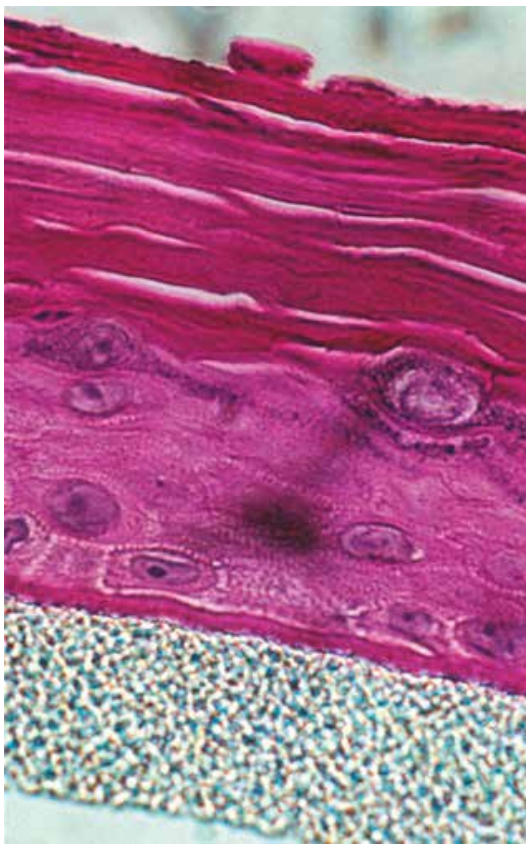
THE IAEA WORKS TO IMPROVE MEMBER STATES' CAPABILITIES IN TISSUE ENGINEERING

"TISSUE noun \'ti-(,)shü, chiefly British 'tis-(,)yü\ : an aggregate of cells usually of a particular kind together with their intercellular substance that form one of the structural materials of a plant or an animal."

Loss of tissue is one of the most debilitating results of medical conditions such as burns, cancer, cardiovascular disease, and traumatic accidents involving the loss of whole or partial body parts.

Regrowing the lost tissue using either natural or synthetic building blocks is currently the most promising treatment.

The IAEA is helping Member States develop and use tissue engineering technology, a relatively new area focused on the development of new tissue created either from stem cells or synthetically produced biomaterials (including polymers originating from natural materials).



Artificial upper layer of skin, the epidermis, which can be used to treat conditions such as burns.
(Photo: MatTek)

Building Blocks

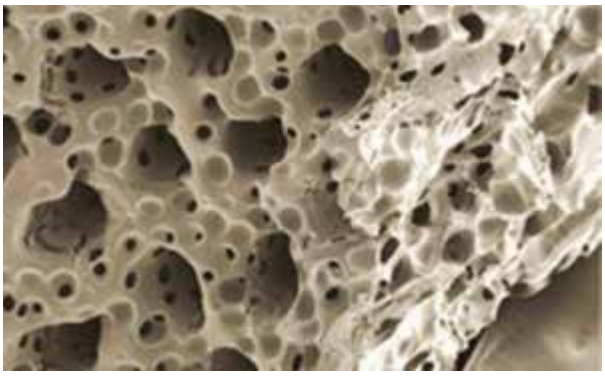
Many thousands of people suffer from tissue loss every year because of illness or injury. Most countries have developed tissue banks where donated tissue (from cadavers or other sources) is treated and stored. But there is a worldwide shortage of donor tissue in these banks because, for religious, cultural or social reasons, most people do not donate their organs, or the organs of relatives, to medicine after death. Also, there may be no national donor registration programmes to facilitate tissue donation or harvesting.

Therefore, countries now see artificial/engineered tissue as the best solution to the persistent medical problem of tissue loss.

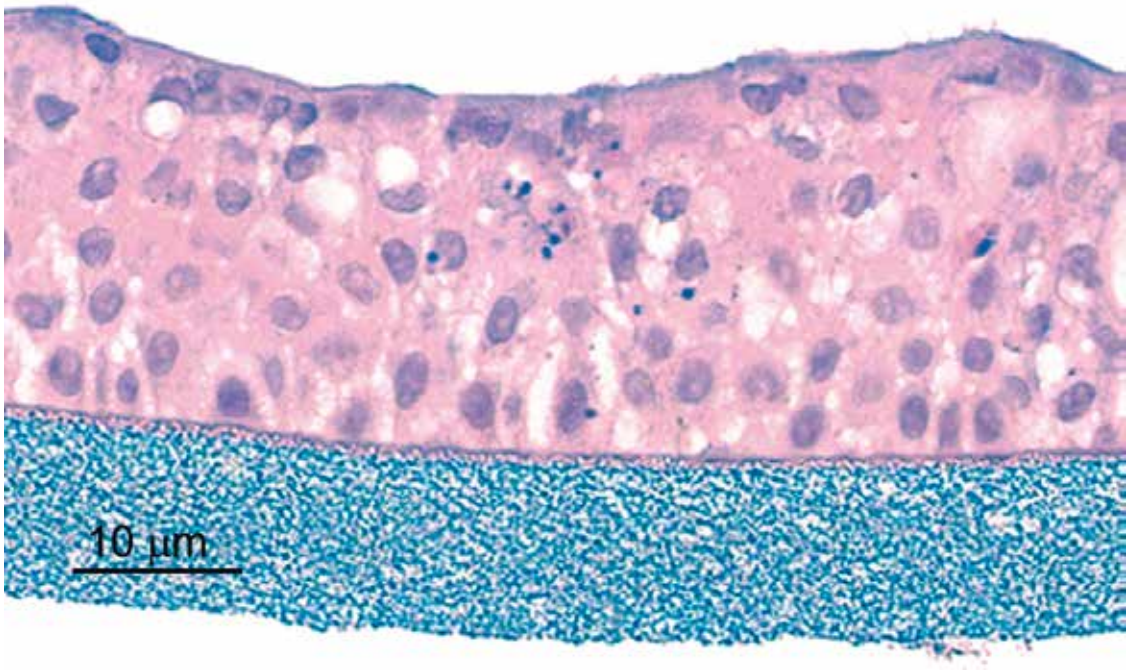
Making tissue scaffolds is one of the first steps in tissue regrowth. Scaffolds are structures with uneven surfaces that promote cell growth (cells won't grow on smooth surfaces) and cell migration (like people, cells like to move around and interact with other cells).

"Give cells the right conditions and the right information and they will make just about anything — a new heart, a new bone, a few feet of new intestine, or part of a liver," says Oleg Belyakov, Radiation Biologist in the IAEA's Applied Radiation Biology and Radiotherapy Section.

"The right conditions for cell growth mean scaffolds, temperature, microenvironments and microarchitecture. The right information can be nudges in the right direction. For example, stem cells used in tissue engineering need growth signals from other cells to let them know what they should become, how they should differentiate," says Agnes Safrany, Radiation Chemist in the IAEA's Radioisotope Products and Radiation Technology Section.



Three-Dimensional heart tissue scaffold with holes of different sizes to promote the growth of nerves, blood vessels, etc. Artificial/engineered heart tissue can be used to replace portions of the heart that have become necrotic.
(Photo: CRPs F23030 and E31007)



Artificial tracheal/bronchial epithelial human tissue system.
(Photo: MatTek)

Scaffolds provide the framework for cells to build the necessary structures — whether blood vessels, valves, skin, nerves, cartilage, etc. If the tissue scaffold isn't 'just right', the cells will not make the right connections and the engineered tissue will die.

Being 'just right' can mean scaffolding with holes large enough for cell migration during the initial stages of tissue creation, and then holes that are much smaller when the time comes for nerves and blood vessels to be created.

Changing the shape and structure of scaffolding like this can be done quickly and effectively using radiation, which causes no damage to the growing tissue within the scaffold.

Radiation technologies are also instrumental in other areas of tissue engineering, such as surface grafting, killing cells to form a 'feeder layer' for other tissues, and in sterilization.

Tissue engineering, whether combined with traditional tissue banking techniques or not, has the possibility of improving the outcome of medical treatment and decreasing the need for sterilized donor material in the future.

Research and Development

The IAEA's coordinated research project (CRP) on instructive surfaces and scaffolds for tissue engineering using radiation technology began this year and is slated to end in 2018. It is being implemented by both the Division of Human Health and the Division of Physical and Chemical Sciences.

Of the 14 Member States involved, Argentina, Bangladesh, Brazil, Egypt, Malaysia, Mexico, Portugal, Slovakia, Turkey and Uruguay all have limited capabilities in this area, while China, Poland, the UK and USA have advanced knowledge and infrastructure in tissue engineering.

"The CRP is organized in this way so we, and by extension developing Member States, can draw on the expertise of those countries who are leaders in the field," says Belyakov, who is in charge of the project. "Our aim is to provide a forum for knowledge and technology transfer among participating institutions, and facilitate the formation of a network between diverse disciplines (such as chemists, biologists, physicists, medical engineers and material science specialists), as well as promote the early involvement of low and middle income Member States in this quickly developing field."

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