

Mimicking the function of kidney, lung, liver or pancreas

Artificial organs with natural intelligence

Before entering national service in Greece, in 1985 Dimitrios Stamatialis, who was 27 at the time, travelled to Twente to take up a postdoc fellowship in membrane technology at the UT. After the turn of the century, he returned here to resume his academic career. Since 2013, Stamatialis has been Professor of Biomeical Membranes and (bio)artificial organs at the UT.

Development of bioartificial organs is how Stamatialis describes his research at the UT. He has also been teaching Physical Chemistry to students of Biomedical Engineering for years:

'I teach Bachelor students how to apply the principles of physics and chemistry to understanding life. With Master students, those principles are applied more specifically to my research into bioartificial organs that can mimic the function of a dysfunctional kidney, lung, liver or pancreas.'

Difficult

There is an urgent need to improve the mechanics of artificial kidneys, according to Stamatialis. End stage renal disease (ESRD) is an increasing global health problem with an annual growth rate of 7-8%. Worldwide there are around 2.5 million patients. The majority of them, approximately 80%, are treated by hemodialysis, which is mainly performed in specialised dialysis centers. In the Netherlands, there are approximately 40,000 kidney patients from whom around 12,000 patients require renal replacement therapy and 6,500 patients are dialyzed. Dialysis is not a cure, but is a strenuous, expensive treatment (it costs approximately 90,000 euros per patient per year), while it can achieve only 15-20% of the removal function of the kidneys.

Bearable

The accumulation of toxins significantly increases the risk of cardiovascular disease, Stamatialis knows. His research focuses on improving the most commonly used form of dialysis, hemodialysis. 'All of a patient's blood is pumped several times through a filter (artificial kidney),

which transfers the waste substances from the blood into 120 litres of dialysis liquid flowing through the filter in the opposite direction. We are in the process of developing a better filter with an extra layer of activated carbon that removes more toxic substances from the blood. At the same time, we are looking for ways of making the dialysis system more compact by recycling the dialysis liquid so that hemodialysis can be performed at home.'

"There is an urgent need to improve the mechanics of artificial kidneys"

Automatic release

In addition to the research into a new filter and a more compact system, Stamatialis' group is also studying the possibility of adding living kidney cells to the filter: 'Our new filter removes more toxins from the blood than the traditional filter, but living kidney cells could remove even more. They are intelligent: they know which toxins they should remove and do it more effectively than an artificial kidney.

Going even further, Stamatialis is studying the possibilities of a bioartificial implant for people with Type I diabetes: 'the implant with pancreatic cells is placed in contact with the blood stream. These pancreatic cells measure the glucose level and administer insulin if needed.'

A better life

Taking a blood sample and injecting insulin two or three times a day is something that people can do in the course of a 'normal' lifestyle, but dialysis for four hours in a hospital three or four times a week is scarcely possible any longer. The solutions that Stamatialis is studying will not only greatly reduce that burden, but more importantly improve the average condition of patients: 'Healthy organs work well around the clock. If that only happens periodically, large fluctuations occur that affect the patient's condition. If insulin can be automatically administered whenever necessary through an implant or if patients can have a more continuous dialysis treatment at home during the night, they will have a better quality of life.'

Multi-stage process

Stamatialis knows there is a long way to go before his ultimate solutions reach the clinic. The path of replacing existing extracorporeal artificial organs into implantable bioartificial organs for humans will therefore be a multi-stage process: 'We are currently improving the function and performance of extra-corporeal artificial organs and investigating the viability of cells, immune reactions and the scalability of implantable devices. These future developments are already in sight, but in the short term medical practice will benefit most from improving existing methods.

It is a very urgent issue, because people are still dying every day due to a shortage of donor organs. I promise that we will not have to wait much longer for a better and more compact dialysis system.'