Artificially developed cells that are injected into the body and who monitor and wipe out all disease. That is the dream of the American researcher Ian Akyildiz.

- The artificial cells may circulate in the blood system and be an addition to the red and white blood cells. They will be programmed to detect viruses, bacteria, and tumors and attacking all diseases, such as Alzheimer's disease, diabetes, cancer and influenza, Akyildiz says.

He is Professor of Electrical and Computer Engineering at the Georgia Institute of Technology Atlanta, USA, and one of the key note speakers at the VERDIKT conference 2013. About ten years ago he became interested in nano networks when he began to wonder how nanoscale devices could be used for transmitting and receiving information.

Most components in nanoscale devices available today are millions of times smaller than an ant and primitive with limited options.

- However, if the different machines begin to communicate, they can collaborate and share information. Thus the uses powerful, Akyildiz says.

Bacteria show the way

While researchers are actively working on the development of artificial cells, which are made of artificial nanomaterials and mimic the way cells work and interact with each other in the nature, an alternative viable way to realize the aforementioned objectives is to genetically program biological cells to perform specific functions.

On the one hand, the development of artificial cells faces numerious challenges: How to get the artificial cells to communicate? How to get them to understand when they encounter a problem that must be solved? And not least - how to get the body to accept the artificial cells? On the other hand, the use of genetically programmed biological cells takes advantage of the solutions that nature already provided to most of these issues.

Scientists worlwide are today trying to develop nanomaterial-based components suitable for artificial cells, but Akyildiz is aware that the process will take a long time, perhaps 20 years or longer. At the same time, recent advancements of the research on genetically programmed biological cells have increased the belief that the realization of the aforementioned goals is not just science fiction. Akyildiz and his collaborators are also actively involved in this latter research direction, and in particular they focus on the engineering of communication pathways between genetically engineered bacteria.

Bacteria are among the simplest cellular organisms, and since the techniques to realize their genetic programming are quite well established, they are easier to study.

- The research on communication among genetically engineered bacteria has been a great success. During the first three years of the MoNaCo (Fundamentals of Molecular Nano-Communication Networks) project, supported by the US National Science Foundation (NSF), has been going on so far, they have learned a lot about how genetically engineered bacteria can share information and form networks to coordinate their behavior. These natural solutions can probably be used to develop communication models for different nanonetworks, as for instance the future artificial cells, Akyildiz says.

More targeted drug delivery

The communication technique used by bacteria is called molecular communication, where bacteria exchange information-bearing molecules between each other. While Akyildiz and his collaborators are building tools to realize network of bacteria based on this communication technique, they also apply these same tools to study targeted drug delivery systems within a project supported by the Samsung Advanced Institute of Technology (SAIT).

The goal is to help medicine direct drug particles to the exact spot where it is needed, while minimizing the effects on other healthy parts of the body - and make sure that the medication has the correct concentration when it arrives at the targeted spot.

There are for instance great differences in how individuals react to drugs. These differences can have dramatic effects on the impact of specific doses subministered to each individual.

- More targeted drug delivery may lead to fewer deaths from adverse drug use, and more effective treatment of the disease, Akyildiz says.

To get there, researchers must understand how the drug particles, which can have a nanoscale size, are dissolved and distributed in the body over time. These are among the questions Akyildiz and his colleagues address through the study of molecular communication, by drawing an analogy between how bacteria communicate and how drug particles are propagated and absorbed in a human body.

- Targeted drug delivery and artificial blood cells are just two of the many areas within medicine and health where nanotechnology could prove to be very useful. At best we can contribute to a medical revolution, Akyildiz says.