Biology becomes digital

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“Biology becomes digital,” says prof.dr.ir. Menno Prins, part-time professor at TU/e and Research Fellow at Philips. It is a statement derived from his work in the field of biosensing. His aim is to create technologies to measure the presence and behaviour of molecules within complex biological environments. Methods and instruments are being developed that will enable ‘on-the-spot decision making’ in medical diagnostics. The new devices will have to be fast, affordable, reliable and easy to use, by professional caregivers and later also by patients themselves. Prins: “This requires the development of novel principles and novel architectures, focused on integration rather than separation”.
In health care we see a clear tendency towards decentralisation. This development has arisen because care in hospitals is extremely expensive. Prins: “Every bit of care that doesn’t require the high education level of medical specialists should no longer take place in the hospital.” Technology is an important enabler in this field. A large part of the input for diagnoses is gathered by in vitro analysis of blood, cell or tissue samples. The analysis of such samples is mostly carried out by specialised laboratories using advanced robotic equipment.

With the trend of decentralisation, an era is arriving where testing should become widely available, providing caregivers with relevant information for making on-the-spot decisions in a single patient interaction. Prins: “A good example is the monitoring of patients taking anti-coagulants. The first tests could only be done in a hospital with a well-equipped lab. For a number of years, there are devices available for use outside hospitals and even at home. These devices improve the lives of patients and cut costs on the side of professional care.”

**The biosensor roadmap**
However, developing in vitro diagnostic equipment for use further down the chain involves exploring new principles and developing new architectures. Traditional testing in centralized labs is based on series of separate fluid handling steps suited for automation by robotic equipment. Different concepts are needed for small, fast, reliable and affordable handheld devices.

Prins: “We work on measurement methods to detect the presence of molecules within complex environments, such as blood. The challenge is to detect few specific molecules in an environment with many other molecules that are present at high concentrations. To be able to crack this problem we use micro- or nanoparticles that can bind the targeted molecules thus making them visible for our optical sensing systems. We use biofunctionalized magnetic particles that can be actuated by magnetic fields, and we also study plasmonic particles that exhibit optical resonances. We cannot directly see the targeted molecules, but we can detect and monitor the particles and thereby detect and study the targeted molecules.”

A concrete application based on magnetic nanoparticles is Minicare, a handheld testing platform for near-patient testing, e.g. to determine whether a patient is suffering from acute myocardial infarction, which...
is currently being developed at Philips. Prins: “A point-of-care device like this can help a physician to come to a proper diagnosis in minutes instead of one hour. That can be life-saving.”

Unravel the human body
Prins: “In the bigger picture, our research is part of the quest to quantify biological processes, unravel biological principles, and understand how the human body works. In our research work at TU/e, we aim for concepts that have single molecule resolution. Biology is digital: it consists of digital units: molecules. Therefore, biological analysis methods are also becoming digital, based on counting and following single molecules, in real time, directly within complex biological environments. We divide the research problem into smaller pieces in order to make it manageable. You cannot ask a student to try to investigate three new aspects at the same time. You make sure just one of the aspects is brand new and that the rest is available from experts in the environment. For example, one can investigate new measurement methodologies using existing biomaterials, or new biomaterials with existing measurement methods. Such research can flourish when students have access to high-level scientific knowledge from multiple disciplines, in an atmosphere of open communication. That is the power of the ICMS.”

It is all about function
Prins: “I like to combine science with engineering. I think science is great, trying to really understand the principles behind phenomena. But for me it becomes even more interesting if what you discover can help to make something with a function. Something that can propagate into society, something that other people can use. Deep down I am more like an applied scientist. This resonates well with my work at TU/e and Philips. Both environments are working toward functionality. And the fun part is, as soon as you start talking about function, you invariably have to involve different scientific disciplines. This multidisciplinary approach to science is very challenging and very motivating. Every week I learn new things, each other, and that brings people together from different backgrounds. Crossing disciplines is difficult and it is critically looked at from the traditional scientific angles. However in industrial environments it is encouraged enormously.

I think that with a solid scientific background one should not be afraid to advance into new directions. Keep on learning, develop a vision, collaborate around this vision, and the chance that you will discover and leverage new things and really contribute to society is much larger.”