John A. Rogers: "We can carry a permanent diagnostic laboratory in our organism "

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Dr. John A. Rogers gave a seminar at CNIC called “Soft, Bio-integrated Electronic Systems for Cardiovascular Research”*, invited by Jorge Alegre Cebollada*

Dr. John A. Rogers, from the University of Illinois (USA), has spent years applying his knowledge of bioengineering on health. His group tries to understand and exploit interesting characteristics of “soft” materials, like polymers, liquid crystals and biological tissues, as well as hybrid combinations of these with other unusual types of micro/nano materials, in the form of tapes, wires, membranes, tubes or the like. Some of his contributions are related to the field of portable electronics and biosensors, a technical development that could be the next revolution of the digital era.

Rogers’ group has recently published a study in the magazine «Science Translational Medicine» on a skin patch, which is very small in size and thickness, and has the capacity to analyze in real time four biomarkers found in sweat that are essential to check our state of health. A very cheap, single-use device that can be put on the arm or on the back and that can send the results of the analysis to

our mobile phone and warn us of the measures that we should take in case our health is at risk. Rogers trusts that these systems, which can also use other fluids like tears, will be used in the future to diagnose a number of diseases. Dr. Rogers gave a seminar at CNIC called "**Soft, Bio-integrated Electronic Systems for Cardiovascular Research**", invited by Jorge Alegre Cebollada.

- **What is the current situation on the investigation of these bio-integrated electronic systems in the field of cardiology?**

At the moment we are working with these platforms on the heart, the brain and the skin. But we think they will have many more applications. We are trying to develop, for example, batteries which are compatible so that in this way, we can integrate the devices inside the organism and not only use them externally. We don't want to stop at the heart, brain and skin. Our intention is to generate platforms for the pancreas, kidneys, etc. This is just the first step.

- **What would the applications of these platforms be?**

The brain is a very sophisticated organ. Many times we do not know how it works, how some diseases develop, etc. That's why if we can get more in-depth knowledge on it through these devices we will start to get some answers to the fundamental questions in neuroscience. This is just one example of how these new tools will allow us to go more in depth in neuroscience research. But in addition to researching, these technological platforms have a diagnostic application. Actually, they have two very defined uses: research, to make new biological discoveries and clinical, as a diagnostic tool.

- **In your opinion, are these devices ready to use in the clinic on a routine basis?**

We are already working with and trying on our prototypes on people. I'm referring to the devices that are put on the skin, like the one I have on right now and that provide us with information about certain physiological parameters related to our health. This type of platforms are unique because they adapt to our skin and, depending on the specific area of our body where they are located, they can measure a series of physiological parameters that can usually only be done in hospitals. Thus, if for example they are placed on the chest, they will measure the heartbeats without the need for an electrocardiogram, with a greater clinical fidelity than an electro, since the measurement is done in a continuous way over time. Other devices can evaluate the level of oxygen in the blood, the pulse, the body temperature, etc. The number of applications of the "external" devices on the skin is very extensive. Furthermore, we continue to work on the internal devices, those that can be integrated inside the organism, especially in the brain or the heart, although at the moment we have only worked on animal models, and we hope to start testing on humans next year.

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- **Do they also have therapeutic applications?**

Although our work is focusing on diagnosis, these devices also have a therapeutic application. For example, the devices integrated in the brain or the heart could generate small stimuli that would control the heart rate, like a sophisticated type of pacemakers, but they can also be combined with optogenetic systems in order to perform optical stimulation, etc. And in the future we hope to work together with microfluidic research and integrate drugs that are released at the right time and place.

- **In the future, will we all have a doctor incorporated into our body?**

Something like that. With these devices we can carry a permanent laboratory of diagnosis on our bodies which controls the main physiological health parameters. But the idea is not to take on the work of medical professionals, if not to provide them with more precise and high-quality information in real time.

- **What is the biggest challenge that these devices pose?**

In my opinion, the biggest challenge that all of these bioelectronic devices pose is the safety in clinical practice and its subsequent approval by the health regulatory authorities that will allow their production on a larger scale for use in health. Furthermore, another of the challenges that we will be faced with in the future, as bioelectronics becomes increasingly more sophisticated, is related to batteries. That is to say, their size must be reduced, but mainly to obtain batteries that, for example, can be charged inside our own body through movement. New and revolutionary ideas are greatly needed in this field.

- **Why did you decide to focus on the health applications of your research?**

I have been in the field of materials engineering for years, and from the beginning I have been working on the design of flexible electronic devices. We discovered that all of our work could be of interest to the neuroscientists, although we had never actually thought it would be of any interest to health. But, thanks to clinicians and biologists we have found ourselves in this exciting career, and also thanks to the students, who are very enthusiastic in this field.

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- **What advice can you give to people who begin their career in scientific research?**

Throughout the years, I have worked with many young researchers in my laboratory. I try to instill in them some values, like being generous, and try to make them understand the importance of getting really good training. But in the last years I have realized that they have to begin contemplating their career from a multidisciplinary point of view. They should know how to collaborate with researchers from other areas that have a lot of experience in other fields. In summary, generous, good collaborators, and with an interdisciplinary mindset. For me, these are key.

- **How important is a mentor in a scientific career?**

It is possible that at this moment this is the most important task that I currently perform. I do it with real pleasure and it gives me great satisfaction to see how some of my students have a very important scientific career. I believe it’s not just researching, but rather that mentoring is a way to educate the future mentors to do the same thing that many of us are doing.

- **What is the current situation regarding the funding of research in the USA?**

Funding is always a big headache. In our case, the way that we do science which combines research, engineering and health, allows us to receive multiple funding from agencies in different areas. Furthermore, since health is an area that is of interest to many of us, we have multiple sponsors that support our work. In spite of this, it is still a challenge, and many laboratory directors, like myself, invest a lot of our time in searching for potential financial backers. On the other hand, we also work on the commercial side of our developments; that is to say that our research has a repercussion on society and we work on this field.

- **It is your first visit to CNIC. What possibilities for collaboration have you seen?**

Of course, it would be very interesting to collaborate with a center like CNIC in the future. We have many areas of research in common in the cardiovascular field; and this center, apart from its facilities, also has incredible experience. I believe that after some of the meetings we have had during my stay in Madrid, we will most likely find ways to work together.

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