The threshold of biotechnology

E. García Jordá

National Association of Health Reporters [Asociación Nacional de Informadores de la Salud (ANIS)]

“Today, sciences advance fantastically”

This is a sentenced pronounced by Don Hilarión, an amusing pharmacist character in the Spanish light opera «La Verbena de la Paloma» (1894) set to music by Tomás Bretón

Ever since the beginning of mankind, man has looked with amazed eyes at everything around him, his surrounding world. For a long time, anything out of his sight, range of hearing, taste, smell or touch simply did not exist. Comprehension and understanding were subjected to the senses, as if they were vital patterns of reality. As for the rest, man had to invent mythology. This wonderful world comprised the “other” senses, which are more introspective and difficult to explain (time, fear, rage, love, pain, suffering, happiness, etc.); it was an attempt to explain existence in a non-rational way. It was a whole world where imagination helped man, through explanations, to understand those things man’s intellect could not understand.

Undoubtedly, human thinking has been the real motor and the central point for the unfolding of human beings. “Logos” or rational thinking has eventually substituted myths. Inquisitiveness, together with the ability to ask questions and answer them, has marked man’s transformation. On many occasions man has advanced by his own errors, but these have been steps forward nonetheless. It is quite impressive to look back at the last quarter of a century and confirm the huge advances in numerous issues concerning human thought. Particularly, with regard to the advances seen in scientific knowledge that are applied to human health, and where this last holds, a predominant position in the scale of values. For some experts, the threshold to the future has not been yet crossed. It is also true that advances and solutions seen today are the answers to very old questions.

None of this would have happened without the symbiotic union of science and technology. On the one hand, the advance in scientific knowledge has been a relevant issue, and on the other hand the creation of the “tool” and its use for scientific practice has also been crucial. Thus, biotechnology has been the “shining star” of the scientific field in the last 20 years. This may be due to the primary complexities of man’s farming stage, when he began crossing cultures to get determined characteristics. That is to say, genes have been altered and selected for thousand of years. Curiously, beer brewing is for many experts a landmark in the history of biotechnology, as microorganisms were used in the fermentation process. Undoubtedly, the final thrust for this newest science called biotechnology came, among other sources, from the discovery of the structure of DNA in the 1950s, as it marked the beginning of a new era.

Seeing small, thinking big

Experts regard biotechnology as the way nature’s opportunities are exploited on human kind’s behalf; in general terms, it has been defined as the employment of living organisms and the processes that are inherent to them, or part of them, for obtaining goods and/or services; it provides real solutions to the big challenges we face today, in the fields of both health and agriculture.

At present, there is a type of technology used for seeing small, very small – nanotechnology. “Seeing small, thinking big” is a typical sentence heard in scientific research circles when one refers to the expectations surrounding nanotechnology. Though it was once circumscribed to pure fiction, nanotechnology is becoming more and more linked to advances in biotechnology and information technology. Nanotechnology deals with the manipulation of matter; it is not accidental that nanotechnology, computer-based technology and biotechnology have been developed together; they are in fact convergent technologies, and they also complement one another through a complex system of breakthroughs, innovation and better human efficiency.

John Marburger, Director of the Office of Science and Technology Policy at the White House, affirmed: “every advance in seeing things in a smaller scale has revealed new wonders, new models and new behaviors that explain the mysteries of bigger elements. Now we

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can “see” the fundamental atoms that make up matter. Down below this level a huge abyss lies before one can get to the dense cores of atomic nuclei, a hundred thousand times smaller than the smallest atom, where a new world – a beautiful world, but a lifeless one – is being explored by physicists. This huge universe of living organisms not only extends to species, types of organisms and varieties of chemical substances that make it work, but also to life processes. The extraordinary volume that is needed to understand even the simplest forms of life is enormous, and they extend from the numerous systems of chemical reactions, transport of material, flow of information and mechanical support in the smallest scale to the function of organs and the behavior of organisms that belong to the largest scale. Seeing these things is not enough. In order to understand all this, it is necessary to store a huge amount of information, retrieve it adequately and process it in order to test ideas on causes and effects”.

Every day, the prefix “nano” is used more and more often in this incipient and fascinating world of “small things”. Thus, we hear the terms nanobiotechnologists, nanobiostuctures, nanotubes, nanofibre, nanoscales or nanodevices. At present, the so-called nanosensors are being developed from particles 50,000 times smaller than the diameter of a human hair; they are used to detect the protein and the genetic expression of individual cells in a single body; they also permit evaluation of the health of cells in the initial stages of any disease.

The pioneers of biotechnology never predicted the current ability to create disease-resistant plants, animals that synthesise drugs through the milk they produce, and small particles that select and destroy cancerous cells. However, biotechnology is more than engineering alone; it is also a set of instruments that permit the understanding of biological systems.

Cutting, substituting and pasting

In the 1960s, scientists discovered and used a sort of natural “scissors” – some proteins called restriction enzymes – to specifically remove one gene from one type of organism and insert it into another organism, whether it was related or not. Thus, recombinant DNA technology was born; this is what most experts today call “modern biotechnology”. This moved more than a hundred outstanding scientists worldwide to gather at the Asilomar Conference Center in Pacific Grove, California, to discuss the possible risks of genetic engineering. The fear that recombinant DNA technology could transform innocuous microbes into dangerous pathogens for humans prompted scientists to agree on the imposition of a voluntary moratorium to determine tests. All these disastrous predictions were justified. On the other hand, the technique of cutting and splicing genes has lead to numerous revolutions in medicine, including: quick methods for detecting an infection or monitoring the degree of cholesterol in blood, the discovery of new vaccines and new types of therapeutic products, as well as advances made in the comprehension of diseases as diverse as cystic fibrosis and cancer.

Likewise, DNA recombination allowed for the decoding of the human genome sequence and laid the foundations for establishing new fields in bioinformatics, nanomedicine and individualised therapy. Many scientists think the perfection of “focalised therapies” focused on the biological causes of diseases will radically improve the safety and efficiency of drugs in the next 20 years, while the invention of predictive technologies, such as proteomics, could open the door to a new era of disease prevention.

Bill Snyder, editor in chief of scientific issues at the Medical Center of the Vanderbilt University in Nashville, Tennessee, affirmed two years ago: “A lot of impressive advances have been made from those first experiments on gene cutting and splicing techniques; they opened the door to the beginning of the biotechnology industry. New drugs and vaccines, significant and rapid breakthroughs on medication, better means of diagnosis and some other medical applications are proof of it. However, for many scientists the advances obtained so far are a mere first step forward. They believe the perfection of “focalized therapies” focused on the biological causes of diseases should radically improve the safety and efficiency of drugs in a near future, and the advent of predictive technologies could open the door to a new era for the prevention of diseases, particularly in the case of fast developing economies in the world. However, risks cannot be overlooked, since these new events and breakthroughs pose new questions on the genetic therapy fields and on the code of ethics with regard to the research of pluripotential cells and the use of genomic information”.

The first drug derived from bioengineering, a form of recombinant human insulin, was approved by the Food and Drug Administration (FDA) in 1982. The first recombinant vaccine, approved in 1986, was obtained by the introduction of a fragment of the hepatitis B virus gene in yeast. At present there are more than 100 drugs and recombinants. Molecular diagnosis tests and recombinant vaccines may be regarded as of special interest in the fight against traditional diseases in developing countries for their efficiency, innocuousness and relatively low cost.

Biotechnology against cancer

Due to the discovery of the complete sequence of the genome, in 2002 the European Community approved a specific programme called “Integration and