Life sciences and the quality of life

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Science satisfies our curiosity, provides knowledge to make wise decisions, is at the foundation of innovation that lead to economic growth, but above all science should also contribute to the improvement of the quality of life. Concerned by ethical principles molecular biologists have voluntarily decided to restrict freedom of research, signing in 1975 the Asilomar agreement. Experiments that were prohibited under the Asilomar guidelines may be useful only to bioterrorists. Wise science policy should help to solve social problems rather than to create more serious ones. Thinking about life sciences we should remember about broader issues, not only about creation of new biotech companies that introduce products to the market. We should most of all care for the optimal development and happiness of people. Europe has the best social systems in the world, but it is still far from warranting optimal human development, from infancy through school period to mature adulthood and healthy old age. The goal of life sciences should be to contribute to European social policy at many levels, not just to the economic development. The best use of human resources is an important goal, but the policy to create best conditions for human development, from natural conception and infancy to participation of wise citizens in the society, is a far greater goal of the European policy. Life sciences will play a critical role in reaching such a goal.

First, what is meant by life sciences? Between 1990 and 2000 the number of books that referred to this term grew up seven times and is still growing rapidly. Traditionally life sciences include various branches of biology and medicine, but the divisions between branches of science melt quickly, and other scientific areas become a part of life sciences. Advances in natural sciences (chemistry, physics), informatics, and technical sciences (nanotechnology, electronics, metrology) are the key to the progress in medicine and biotechnology. On the biological side basic and applied life sciences encompass a large number of specialized scientific disciplines, from genetics, molecular biology, structural and synthetic biology, to cellular, tissue, organs and subsystem levels, to the integrative biology, populations of organisms, sociobiology, ethology, ecology and evolutionary biology. Agriculture, microbiology, biopathology have direct influence on food production and safety. The complexity of living cells and microorganisms is enormous. The list of life science disciplines jointly referred to as "omics" group includes genomics, transcriptomics, proteomics, metabolomics, epigenomics, exposomics, interactomics, nutrigenomics, foodomics, connectomics, and about 400 other "omics" (see omic.org). Complexity of biological organisms can be handled only using computational methods, creating huge ontologies and databases that collect information about genomic, pathway and metabolic processes for thousands of organisms. Databases in the BioCyc repository are used to predict the metabolic pathways and genes that code for missing enzymes. Without algorithms and tools provided by bioinformatics creation and analysis of such databases would not be possible. Great discoveries and innovative therapeutic approaches require deep understanding of basic life sciences, new equipment for making experiments, and new computational tools.

On the medical side many classical branches of medicine are now expanding using results of basic research, joined by new interdisciplinary branches of science. Personalized medicine will slowly become reality thanks to pharmacogenomics, understanding how individual organism will respond to a given drug. Foodomics, defined in 2009 as scientific discipline that studies in a comprehensive way how to optimize nutrition to improve health and well-being, will lead to a personalized approach to food consumption. The widespread introduction of such personalized approaches requires development of fast and cheap DNA sequencing techniques, such as the high speed nanopore technologies. Small portable devices will be used in the near future to do genome-wide studies. Analysis of bacteria, the subject of metagenomics and microbiomics, will also help to create therapies that apply the right drug at the right dose. Antibiotic resistance is a big problem that may cause a public health crisis, but new methods to grow bacteria cultures that could not previously be grown in the laboratory has opened in 2014 a way to create many new effective antibiotics. One example is teixobactin – it works in a different way than the current generation of antibiotics. It is quite likely that bacteria will not be able to develop resistance to such new antibiotics.

According to the European Brain Council the total costs of brain disorders in Europe reached 800 billion euro in 2010, about one fourth of all direct medical costs, and has been growing fast. Research on stem cells and glia cells brought new opportunities for rehabilitation of stroke patients and spine cord injury patients. In 2014 extraordinary progress of restoring functions after spinal injury was reported, using epidural electrical stimulation at the University of Louisville, USA, and through olfactory ensheathing cell transplantation from the brain of paralyzed patient to his spinal cord in Wroclaw, Poland. Research on prevention of mental disorders is also promising. Large scale programs aimed at understanding human brain, such as the FET Flagship Human Brain Program (HBP), are aimed at multi-level understanding of the brain, from genes to behaviour. This 10-year long program is focused on realistic computational simulations of neural processes. It should integrate multilevel clinical data to develop a map of neurological and psychiatric diseases, leading to personalised medicine in this area. HBP approach links life sciences with brain-inspired Information and Communications Technologies

(ICT), and may lead to neurocognitive computational technologies, with broad applications to robotics and autonomous systems control. Development of brain imaging techniques based on functional magnetic resonance (fMRI), positron emission tomography (PET) and many other techniques invented by physicists play key role in experimental investigation of the Human Connectome (USA, started in 2009), and the Developing Human Connectome Project (UK, started in 2013), mapping the brain development in the early infancy. Computational medicine is making a big impact in all areas of medicine and health care.

In 2014 the Max Planck Institute for Brain Research celebrated its 100 years anniversary. The Network of 14 major European Neuroscience Institutes (ENINET) was established in 2005, promoting work of young investigators. Although the level of scientific research at European neuroscience institutes is excellent ultimately understanding the brain and its diseases will require broader perspective. Integration of information at all levels is necessary, from the impact of environment on genetic and epigenetics mechanisms, formation of proteins, cellular systems and signalling pathways, development of neurons and neural systems, formation of cognitive phenotypes, manifestation of symptoms and syndromes, even influence of culture and milieu. In 2008 the Consortium for Neuropsychiatric Phenomics (CNP) has been formed in the USA to focus on diagnostic and therapeutic methods in various mental disease. Understanding the influence of environment on genetic, epigenetic, metabolic processes, signalling pathways, functioning of cells and tissues, neurons and their networks is a great challenge, but there is simply no alternative. In the long run describing and linking phenotypes (observable characteristics of organism), from genetic to behavioural levels, should be beneficial not only for medicine, but also learning sciences, unfolding full human potential and improving quality of life. Such comprehensive research program, focusing on all aspects of human development across life span, at all levels, does not exist yet.

Life sciences are also connected to rapidly growing electronic gadgets designed for fitness, wellness and health improvement. Great progress in sensor technology, combined with portable computing devices and software applications, led to creation of the WeArable TeChnology in Healthcare (WATCH) Society, an international group of physicians who adopt wearable technology in healthcare. Smart shirts, called also E-textiles, measure vital signs such as heart and respiration rate, temperature, activity, and soon will analyse sweat and blood glucose levels from tears, as shown by Google in their smart contact lenses project. Already in 2015 self-monitoring health devices will account for most of wireless medical devices. Bio, nano and info technologies are going to be the new “horn of plenty”, based on results of scientific research and technological developments.

Applications for smart phones may play important role in preventive medicine. Such phones and other portable devices are already so complex that the average user is able to use only a very small fraction of functions that these devices provide. The need for cognitive systems that interact with humans in a natural way becomes quite acute. Human-centred computing or anthropocentric technologies require understanding of cognitive capabilities and limitations of humans and thus rely on artificial intelligence and cognitive science. This is another broad area where science and technology will change our life, form mobile devices to cognitive robotics.

There is much more to life sciences than traditional pharmaceutical and health industries. In the rush to commercialize scientific innovations we should remember that basic research must come first and the most important goal is the improvement of the quality of life.