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The Revolution of Personalized Medicine: Are We Going to Cure all Diseases and at what Price?

Many important drugs such as penicillin and aspirin were discovered by serendipity. Other major drugs like the cholesterol-reducing statins were discovered using more advanced technologies, such as screening of large libraries of synthetic or natural compounds. In all these cases, the mechanism of action of the drug was largely unknown at the time of their discovery, and was unraveled only later. With the realization that patients with apparently similar diseases – breast or prostate cancer, for example - respond differently to similar treatments and their disease course is vastly different, we have begun to understand that the molecular mechanistic base of what we assumed to be the same disease entity, are different. Thus, breast or prostate cancers appear to be sub-divided to smaller distinct classes according to their molecular characteristics and the causing underlying mechanisms/mutations. As a result, we are exiting now the era where the treatment of many diseases is “one size fits all”, and enter a new era of “personalized medicine” where the treatment is tailored according to the patient’s molecular/mutational profile. Here, the understanding of the mechanism will drive the development of new drugs. This era will be characterized initially by the development of technologies to sequence individual genomes, transcriptomes, proteomes and metabolomes, followed by identification and characterization of new disease-specific molecular markers and drug targets, and by design of novel, mechanism-based drugs to these targets. The era will be also accompanied by complex bioethical problems, from high pricing and limited accessibility of large fractions of needy population to the achievements of biomedical research, but also to an era where genetic information of large populations will become available, and protection of privacy will become an important, yet a fragile issue. The introduction of gene editing technology to the armamentarium of novel therapeutic modalities, will add yet another layer of bioethical complexity to the one imposed by access to generic information and the ability to predict the future of health course of patients.

Biography

Aaron Ciechanover is a Distinguished Research Professor in the Technion - Israel Institute of Technology in Haifa. He received his M.Sc. (1971) and M.D. (1973) from the Hebrew University in Jerusalem. He then completed his national service (1973-1976) as military physician, and continued his studies to obtain a doctorate in biological sciences in the Faculty of Medicine in the Technion (D.Sc.; 1982). There, as a graduate student with Dr. Avram Hershko and in collaboration with Dr. Irwin A. Rose from the Fox Chase Cancer Center in Philadelphia, USA, they discovered that covalent attachment of ubiquitin to a target protein signals it for degradation. They deciphered the mechanism of conjugation, described the general proteolytic functions of the system, and proposed a model according to which this modification serves as a recognition signal for a specific downstream protease. As a postdoctoral fellow with Dr. Harvey Lodish at the M.I.T., he continued his studies on the ubiquitin system and made additional important discoveries. Along the years it has become clear that ubiquitin-mediated proteolysis plays major roles in numerous cellular processes, and aberrations in the system underlie the pathogenetic mechanisms of many diseases, among them certain malignancies and neurodegenerative disorders. Consequently, the system has become an important platform for drug development.

Among the numerous prizes Ciechanover received are the 2000 Albert Lasker Award, the 2003 Israel Prize, and the 2004 Nobel Prize (Chemistry; shared with Drs. Hershko and Rose). Among many academies, Ciechanover is member of the Israeli National Academy of Sciences and Humanities, The European Molecular Biology Organization (EMBO), the American Academy of Arts and Sciences (Foreign Fellow), the American Philosophical Society, the National Academies of Sciences (NAS) and Medicine (NAM) of the USA (Foreign Associate), the Pontifical Academy of Sciences at the Vatican, the Chinese Academy of Sciences (CAS; Foreign Member), and the Russian Academy of Sciences (Foreign Member).