



Viva Europa, a Land of Excellence in Research and Innovation for Health and Wellbeing

Charles Auffray^a; Michael Sagner^b; Sonia Abdelhak^c; Ian Adcock^d; Alvar Agusti^e; Margarida Amaral^f; Stylianos Antonarakis^g; Ross Arena^h; Françoise Argoulⁱ; Rudi Balling^j; Albert-Laszlo Barabasi^k; Jacques Beckmann^l; Anders Bjartell^m; Niklas Blombergⁿ; Thomas Bourgeron^o; Bertrand Boutron^p; Samir Brahmachari^q; Christian Bréchet^r; Christopher Brightling^s; Marta Cascante^t; Alfredo Cesario^u; Dominique Charron^v; Sai-Juan Chen^w; Zhu Chen^x; Fan Chung^y; Karine Clément^z; Ana Conesa^{aa}; Alain Cozzone^{ab}; Menno de Jong^{ac}; Jean-François Deleuze^{ad}; Jacques Demotes^{ae}; Alberto di Meglio^{af}; Ratko Djukanovic^{ag}; Ugur Dogrusoz^{ah}; Elissa Epel^{ai}; Alain Fischer^{aj}; Andrea Gelemanovic^{ak}; Carole Goble^{al}; Takashi Gojobori^{am}; Michel Goldman^{an}; Herman Goossens^{ao}; François Gros^{ap}; Yi-Ke Guo^{aq}; Pierre Hainaut^{ar}; David Harrison^{as}; Hans Hoffmann^{at}; Leroy Hood^{au}; Peter Hunter^{av}; Yves Jacob^{aw}; Hiroaki Kitano^{ax}; Ursula Klingmüller^{ay}; Bartha Knoppers^{az}; Walter Kolch^{ba}; Marion Koopmans^{bb}; Doron Lancet^{bc}; Martine Laville^{bd}; Jean-Marie Lehn^{be}; Francis Lévi^{bf}; Andrey Lisitsa^{bg}; Vincent Lotteau^{bh}; Antoine Magnan^{bi}; Bongani Mayosi^{bj}; Andres Metspalu^{bk}; Yves Moreau^{bl}; James N'Dow^{bm}; Laurent Nicod^{bn}; Denis Noble^{bo}; Maria Manuela Nogueira^{bp}; Anna Norrby-Teglund^{bq}; Laurent Nottale^{br}; Peter Openshaw^{bs}; Mehmet Oztürk^{bt}; Susanna Palkonen^{bu}; Silvio Parodi^{bv}; Johann Pellet^{bw}; Ozren Polasek^{bx}; Nathan Price^{by}; Christian Pristipino^{bz}; Timothy Radstake^{ca}; Martine Raes^{cb}; Josep Roca^{cc}; Damjana Rozman^{cd}; Philippe Sabatier^{ce}; Shlomo Sasson^{cf}; Bernd Schmeck^{cg}; Ismail Serageldin^{ch}; Anita Simonds^{ci}; Bento Soares^{cj}; Peter Sterk^{ck}; Giulio Superti-Furga^{cl}; David Supple^{cm}; Jesper Tegner^{cn}; Mathias Uhlen^{co}; Sylvie van der Werf^{cp}; Pablo Villoslada^{cq}; Manlio Vinciguerra^{cr}; Vitaly Volpert^{cs}; Steve Webb^{ct}; Emiel Wouters^{cu}; Ferran Sanz^{cv}; Francisco Nobrega^{cw}

From the ^aEuropean Institute for Systems Biology and Medicine, Lyon, France; ^bUniversity of Illinois, Chicago, Ill.; ^cInstitut Pasteur, Tunis, Tunisia; ^dImperial College, London, United Kingdom; ^eHospital Clinic, Barcelona, Spain; ^fUniversidade de Lisboa, Portugal; ^gUniversité de Genève, Switzerland; ^hUniversity of Illinois, Chicago, Ill.; ⁱUniversité de Bordeaux, France; ^jCenter for Systems Biomedicine, Luxembourg, Belgium; ^kCentral European University, Budapest, Hungary; ^lUniversité de Lausanne, Switzerland; ^mUniversity of Lund, Sweden; ⁿCORBEL, ELIXIR, Hinxton, United Kingdom; ^oInstitut Pasteur, Paris, France; ^pLe Geste Réactif, Paris, France; ^qInstitute of Genomics and Integrative Biology, New Delhi, India; ^rInstitut Pasteur, Paris, France; ^sUniversity of Leicester, United Kingdom; ^tUniversidad de Barcelona, Spain; ^uPoliclino Gemelli, Rome, Italy; ^vHôpital Saint Louis, Paris, France; ^wJiao-Tong University, Shanghai, China; ^xJiao-Tong University, Shanghai, China; ^yImperial College, London, United Kingdom; ^zHôpital Pitié-Salpêtrière, Paris, France; ^{aa}Centro de Investigacion Principe Felipe, Valencia, Spain; ^{ab}Université Claude Bernard, Lyon, France; ^{ac}Medical Center, Amsterdam, The Netherlands; ^{ad}CNG, Evry and CEPH Fondation Jean Dausset, Paris, France; ^{ae}European Clinical Research Infrastructure Network, Paris, France; ^{af}CERN, Geneva, Switzerland; ^{ag}University of Southampton, United Kingdom; ^{ah}Bilkent University, Ankara, Turkey; ^{ai}University of California, San Francisco, Calif.; ^{aj}Hôpital Necker & Collège de France, Paris, France; ^{ak}University of Split, Croatia; ^{al}University of Manchester, United Kingdom; ^{am}National Institute of Genetics, Mishima, Japan; ^{an}Université Libre de Bruxelles, Belgium; ^{ao}University of Antwerp, Belgium; ^{ap}Académie des Sciences, Paris, France; ^{aq}Data Science Institute, Imperial College, London, United Kingdom; ^{ar}Institut pour l'Avancée des Biosciences, Grenoble, France; ^{as}University of St Andrews, United Kingdom; ^{at}CERN, Geneva, Switzerland; ^{au}Institute for Systems Biology, Seattle, Wash.; ^{av}University of Auckland, New Zealand; ^{aw}Institut Pasteur, Paris, France; ^{ax}Systems Biology Institute, Tokyo, Japan; ^{ay}DKFZ, Heidelberg, Germany; ^{az}Université de Montréal, Canada; ^{ba}University College Dublin, Ireland; ^{bb}Erasmus Medical Centre, Rotterdam, The Netherlands; ^{bc}Weizmann Institute of Science, Rehovot, Israel; ^{bd}Hospices Civils de Lyon, France; ^{be}Université de Strasbourg, France; ^{bf}University of Warwick, United Kingdom; ^{bg}Orekhovich Institute of Biomedical Chemistry, Moscow, Russia; ^{bh}Centre International de Recherche en Infectiologie, Lyon, France; ^{bi}Centre Hospitalier Universitaire, Nantes, France; ^{bj}Groote Schuur Hospital, Cape Town, South Africa; ^{bk}University of Tartu, Estonia (AndM); ^{bl}Université Catholique de Louvain, Belgium; ^{bm}University of Aberdeen, UK; ^{bn}Centre Hospitalier Universitaire, Lausanne, Switzerland; ^{bo}University of Oxford, United Kingdom; ^{bp}European Institute for Systems Biology and Medicine, Lyon, France; ^{bq}Karolinska Institutet, Stockholm, Sweden; ^{br}Observatoire de Paris-Meudon, France; ^{bs}Imperial College, London, United Kingdom; ^{bt}Dokuz Eylul University, Izmir, Turkey; ^{bu}European Patient Forum, Brussels, Belgium; ^{bv}Università di Genova, Italy; ^{bw}European Institute for Systems Biology and Medicine, Lyon, France; ^{bx}University of Split, Croatia; ^{by}Institute for Systems Biology, Seattle, Wash.; ^{bz}San Filippo Neri Hospital, Rome, Italy; ^{ca}Medical Center, Utrecht, The Netherlands; ^{cb}Université de Namur, Belgium; ^{cc}Hospital Clinic, Barcelona, Spain; ^{cd}University of Ljubljana, Slovenia; ^{ce}European Scientific Institute, Archamps, France; ^{cf}Hebrew University, Jerusalem, Israel; ^{cg}Philipps University of Marburg, Germany; ^{ch}Bibliotheca Alexandrina, Alexandria, Egypt; ^{ci}Royal Brompton Hospital, London, United Kingdom; ^{cj}University of Illinois, Peoria, Ill.; ^{ck}Medical Center, Amsterdam, The Netherlands; ^{cl}Center for Molecular Medicine, Vienna, Austria; ^{cm}Asthma UK, London, United Kingdom; ^{cn}Karolinska Institutet, Stockholm, Sweden; ^{co}Royal Institute of Technology, Stockholm, Sweden; ^{cp}Institut Pasteur, Paris, France; ^{cq}Universidad de Barcelona, Spain; ^{cr}St Anne's Hospital, Brno, Czech Republic; ^{cs}Institut Camille Jordan, Lyon, France; ^{ct}University of Western Australia, Crawley, Australia; ^{cu}University of Maastricht, The Netherlands; ^{cv}Hospital del Mar, Barcelona, Spain; and ^{cw}Universidade de São Paulo, São Paulo, Brasil.

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Charles Auffray, PhD



Michael Sagner, MD

Our colleague Herman Goossens pointed out that “millions of Europeans are questioning what the European Union does for them” and invited the community to “shout about the European Union’s successes” (Nature 542:273). A short answer was given by the Nobel Committee in 2012 when it awarded the Nobel Peace Prize to the European Union that “for over 6 decades contributed to the advancement of peace and reconciliation, democracy and human rights in Europe.” As a matter of fact, great contributions to science and society have been made in Europe, for example, by CERN through advances in particle physics and the development of the World Wide Web, the Groupe Spécial Mobile, to develop the GSM telecommunication standard, the combination of which enabled the widespread use of the Internet and mobile telephones, by Ariane with rockets for the exploration of space, or Airbus with aircrafts for airline transportation, to name only a few.

In turn, Carlos Moedas, the European Union Commissioner for Research, Science and Innovation, stated “As a paradigm of excellence, the European Research Council should act as a model in other areas” on the occasion of the 10th anniversary of the ERC supporting basic research conducted by outstanding investigators (Nature 543:465). Complementarily, in recent years, the Innovative Medicines Initiative, the world’s largest public–private partnership supported by the European Union and the European Federation of Pharmaceutical Industry Associations has started to tackle the big challenges and hurdles faced in developing safer and more efficacious drugs for the many disorders that affect human health globally.^[1] Europe is thus in an ideal position to take a leading role in the formation of a World Alliance for Health and Wellbeing.

Indeed, we live a historical moment, witnessing a true metamorphosis from a reactive to a proactive practice of medicine: for the first time, humanity has the ability to follow proactively the health of the entire population by combining Participatory Prevention and Personalized Prediction (P4 Medicine) of disorders across the entire health spectrum.^[2,3] We cannot afford to continue reacting too late, once symptoms have appeared and diseases have manifested themselves, since the poorly efficient and increasingly costly management of diseases is the source of growing inequalities leading to impoverishment of the vulnerable populations and crashing of health-care systems.

To implement the systemic approach underlying this proactive practice of medicine, the time has come to focus on the scientific definition of wellbeing.^[4] Indeed, it is essential for each individual to know her/his state and trajectory of wellbeing to enable the prevention and the management of chronic diseases (cardiometabolic, neurologic, respiratory, cancers, and so on) as well as infectious diseases (bacterial, parasitic, viral, and so on). This requires the collection, analysis, and understanding of the processes occurring in the human body on time scales ranging from fractions of a second to many years, with the active participation of each person.

For this purpose, we can now use the methods of “advanced intelligence”^[5]: the cross-disciplinary integration of human expertise with the technological innovations of artificial intelligence and complexity sciences within an European Union action plan.^[6–9] This enables us to make sense of the vast amounts of functional information on the human body extracted from data collected in biological and clinical assays and in real time through mobile and connected devices for the monitoring of environmental and lifestyle exposures (nutrition, exercise, sleep, stress). These technologies should produce major discoveries, trigger the development of more effective medicines, and empower drastic reduction of health-care costs with the active participation of citizens through social networks.

In the short term, the goal is to develop a prototype of an innovative Systems P4 Medicine center, grouping under the same roof all necessary medical, paramedical, scientific, societal, and technological competences to allow the monitoring and follow-up of 1,000 proactively involved participants, generating actionable recommendations, providing new opportunities for each person to manage her/his health and wellbeing. This will provide the basis for the much-needed transformation of training curricula of a new generation of scientists, engineers, coaches, healthcare, social, and wellbeing professionals.

In the middle term, each hospital center should include an Institute of Systems P4 Medicine, making it possible to monitor and follow-up tens of thousands of individuals and to renovate the local and regional health-care system, providing individuals with the means to take active control of their health and wellbeing while ensuring and preserving their privacy and intimacy.^[10]

In the long term, the global deployment of Systems P4 Medicine on the planet would take place under the aegis of a World Alliance for Health and Wellbeing. To be successful, this Alliance will have to promote and be the custodian of a universal standard for communication of health data similar to the GSM standard that enabled the widespread use of mobile phones. This will trigger the creation of a whole industry for the production of thousands to millions of functional units and their installation in the field, in close proximity of the end users.

This Alliance will need to involve all stakeholders concerned through international forums in developing and developed countries: foundations, governments, and the relevant organizations of the United Nations such as UNESCO and WHO, non-governmental organizations, civil society, and patient organizations, cooperating closely with economic and industrial actors in various sectors, including biotechnology, health care, insurance, logistics, nutrition, pharmacy, sport, telecommunication, and wellbeing.

The challenges are considerable and the outcomes will not be minimal either. What is at stake is to better manage trillions of Euros of annual expenditures dedicated to health, our common good, unequally throughout the world, and to a large extent in a wasteful manner. The full implementation of proactive medicine will allow similarly large savings and their reuse in the prevention for maintenance of wellbeing of each human being.

Let us all become together the promoters and actors of this major transformation for the future generations!

References

- [1] Goldman M. The innovative medicines initiative: a European response to the innovation challenge. *Clin Pharmacol Ther.* 2012;91:418–425.
- [2] Hood L, Balling R, Auffray C. Revolutionizing medicine in the 21st century through systems approaches. *Biotechnol J.* 2012;7:992–1001.
- [3] Sagner M, McNeil A, Puska P, et al. The P4 health spectrum. A predictive, preventive, personalized and participatory continuum for promoting healthspan. *Prog Cardiovasc Dis.* 2017;59:506–521.
- [4] Hood L, Price ND. Demystifying disease, democratizing health care. *Sci Transl Med.* 2014;6:225.
- [5] Kitano H. Artificial intelligence to win the Nobel Prize and beyond: creating the engine for scientific discovery. *AI Magazine;* 2016. pp. 39–49.
- [6] Auffray C, Balling R, Barroso I, et al. Making sense of big data in health research: towards an EU action plan. *Genome Med.* 2016;8:71.
- [7] Barabasi AL, Gulbahce N, Loscalzo J. Network medicine: a network-based approach to human disease. *Nat Rev Genet.* 2011;12:56–68.
- [8] Lehn JM. Perspectives in chemistry—steps towards complex matter. *Angew Chem Int Ed Engl.* 2013;52:2836–2850.
- [9] Noble D. A theory of biological relativity: no privileged level of causation. *Interface Focus.* 2012;2:55–64.
- [10] Hood L, Auffray C. Participatory medicine: a driving force for revolutionizing healthcare. *Genome Med.* 2013;5:110.