Biological and Medical Sciences Research Infrastructures and the future of medicine: global cooperation.

Presentation to the United Nations Commission on Science and Technology for Development

Manila, 13 December 2011
Problem

1. Medicine typically treats patients based on statistical information generated on large, heterogeneous groups, not as individuals: *avoidable suffering and death*

2. Health care costs continue to rise, strangling most advanced economies: *increasing health care costs*

3. Citizens get older, but have to stop working early due to ill health: *increased load on the pension system*

4. Pharma development costs are skyrocketing, endangering an entire industry: *job losses in pharma industry*

5. ICT developments have been predominantly driven by physics and astronomy, not by medicine: *lack of an important driver of IT developments and markets*
Biobanks and Biomolecular Resources

• Most of our current knowledge on diseases as well as available diagnostic assays and drugs are based on systematic investigation of human biological samples and medical data
“NEW YORK, Dec. 8, 2010 /PRNewswire/ -- Spending on healthcare among the OECD countries and BRIC nations of Brazil, Russia, India and China will grow by 51 percent between 2010 and 2020, amounting to a cumulative total of more than $71 trillion, according to estimates from PwC's Health Research Institute. Health spending in these areas is rising faster than gross domestic product, magnifying gaps in budget deficits and spurring governments to look to the private sector for ways to get a better value for taxpayers' money.”

“Worldwide IT Spending outperformed expectations in 2010, reaching $1.5 Trillion”, according to IDC's Worldwide Black Book from February 09, 2011 08:03 AM Eastern Time
1. Approximately 12 million new cancer cases/year worldwide

2. Cure rates for most common forms of cancer have hardly changed over the last decades

3. Even the most advanced targeted therapies are typically only effective for a small fraction of the patients

4. Pharma development costs have dramatically increased, while the number of new drugs keeps dropping
1. A new, **data rich, computation-driven individualised medicine of the future**

2. Based on **new, revolutionary ICT:**

   A. integrating molecular, physiological and anatomical, self-organizing, self-learning, biomimetic computer models
   B. of every individual in the health care system, the “7 billion virtual patients”
   C. based on the integration of abundant **molecular** (“-omics”), **imaging**, sensor, clinical, epidemiological and existing medical understanding- **data**
Automobile crash test simulations as analogue of the intended human health crash tests

1. Automobile crash tests entirely by computer simulation.

2. These days -> at least 3 to 5 million equations.

3. Computer simulations safer than actual prototype car crash tests, because actual crash tests cannot simulate every possible situation.

Robert Lange, General Motors Executive Director for Vehicle Structure and Safety Integration

Cancer is a Network disease: Disease of the expressed Genome

Accumulation of mutations
Uncontrolled cell growth
Tumorigenesis
Out of Data Models...like this...
Create a virtual patient system

- Tumor sampling
- Tumor stem cell extraction/expansion
- Genome and Transcriptome sequencing
- Mutation Database
- The Cancer Model
- Drug Database
- Modeling Drug Response
- Drug treatment recommendation
- Patient Specific Model
ITFoM and the Innovation Union

ITFoM fulfils all criteria of the EC Innovation 2020 Strategy.

Knowledge  Good ideas to market  Regional and social benefits  Innovation Partnerships  International Cooperation
The project outcomes will enable the prediction of health, disease, therapy and its effects for individual patients and through application in the clinic will change the future of medicine.

For more information:
Website: http://www.itfom.eu
Email: info@itfom.eu
Twitter: @itfom
Facebook: I.T. Future of Medicine
LinkedIn: IT Future of Medicine
The combination of:

1. Detailed characterization of patient’s tumour material by deep sequencing
2. Global information on cancer relevant pathways

Allows the development of:

1. Predictive models of the onset and the progress of cancer as well as the drug response in individual cancer patients
2. The Virtual Patient System
1. Life is the translation of the information in the genome into the phenotype of the organism:

2. The organism computes this phenotype from its genotype, given a specific environment

3. ITFoM will make models that simulate this computation
1. Data-rich, individualised medicine poses unprecedented challenges for ICT, in hardware and software solutions.

2. We propose a data-driven, individualised medicine of the future, based on integrated molecular/physiological/anatomical ("virtual patient") models of every individual in the health care system, based on detailed molecular ("omics"), imaging and sensor data generated on every individual, as well as computer models ("virtual patients") derived from molecular/ physiological/ anatomical/ environment data from individual patients.

3. Individualised versions of the models, produced for each patient, will then be used to identify personalised prevention/therapy schedules and side effects of drugs.
The Grand Challenges

1. Global warming
2. Supplies of energy, water and food
3. Ageing societies
4. Public health
5. Pandemics and security

Swedish Presidency, Lund Declaration 2009
Translational Medical Research

Disease → Biospecimens Med. data → Molec. data → Knowledge → Diagnostics Therapies
Translational Medical Research
Emerging European Landscape
The Power of Many

FET-Flagship
FP7
I3
IMI
OECD

BioSHaRE
BioMedBridges

Disease
Biospecimens
Med. data
Molec. data
Knowledge
Diagnostics
Therapies
1. Increased speed (collaborative effort)
2. Reduced costs (less duplication)
3. More successful fund raising
4. Increased capacity to address key questions
5. Increased competitiveness
6. Implementation of EU Policies
7. Pre-requisite for global impact
1. Coordination of research programmes globally
2. Implementation of IT-FoM as “lead initiative“
3. Harmonized and R&D-supportive ethical and legal frameworks
4. New models for public-private-partnerships
5. Diagnostics and drug approval processes that consider latest developments
6. Global harmonization and integration
Need for Standardization

The garbage in – garbage out problem

Patient → Pre-analytics → Sample → Data

Computational modelling → Biomarker

Basic research

Targets for therapy

Knowledge
New Models for Public-Private Partnerships

1. Collaborative research to improve innovation
2. Better usage of finite resources
3. Basis for data sharing
- High Throughput Technologies
- Data for individuals
- Emphasis on systems, not reductionism
- Growth of translational biology – molecular medicine, agriculture, food, environmental sciences…

Example: RI for biology
From molecules to medicine

Molecular components
- Genomes
- Nucleotides
- Transcripts
- Proteins
- Complexes
- Pathways
- Domains
- Structures
- Small molecules

Integration
- Tissues and organs
- Cells
- Human individuals

Translation
- Biobanks
- Human populations
- Therapies
- Disease prevention
- Early Diagnosis
Research Infrastructures on the European Roadmap

- **37 ESFRI Member States** prioritized research infrastructures (RI) of pan-European interest – *increasingly global*
- Infrastructures provide facilities, resources or services used by the scientific community to conduct top-level research
- Offer unique research service, stimulate knowledge transfer, open access policy

- 262 projects evaluated
- 44 RI projects selected

10 Biological and Medical Sciences projects
10 Biological and Medical Sciences projects in preparatory phase
Meeting European Grand Challenges
Putting the pieces together
What is needed?
- Global Research infrastructure
- Pre-competitives models
- Regulation and clinical trials.