ITFoM: Integrating for future medicine

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• Problems

• Solution:
  • integration of data through models
  • Individualized medicine
The problem for society

Definitive disease cures are lacking for rheumatoid arthritis, diabetes, heart disease, obesity, Parkinson, cancer, Alzheimer, ......

Health care costs are soaring
The problem for the pharmaceutical industry

- Patents are expiring
- New blockbusters are rare
- Late stage medicine withdrawal (toxicity for fraction of the population)
- Profits are evaporating
The problem for the life sciences

Success of science does not empower medicine
Promises without delivery
The problem for health care and medicine

>$1\text{tn/y}$ spent on biomedical research: Tower of Babel?

health
disease

Brueghel
Problems

Solution:

- integration of data through models
- Individualized medicine
The breakthrough

Discoveries by Systems Biology:

• *Networking* determines health and disease
If diseases are network malfunctions, then:

deal with the network

Since you know the components and their interactivities

reconstruct the network by computer
>$1\text{tn/y} \text{ spent on biomedical research: Tower of Babel?}

health

disease
Integration of all information through the ITFoM flagship into computable human models!

An ICT model of the human health and disease.
Complexity of the human model

A Boeing 747-400 has six million parts... Two 747-400’s are truly identical.

A human cell has $35 \times 1 + 50 \times 100 + 30 \times 4 \times 10000 + 1 \times 600 \times 1000000 = 600$ billion non-trivial molecules (not counting water and lipid).

4 trillion cells in the body

$2 \times 10^{24}$ non-trivial molecules in the human body

500 million people

$1 \times 10^{33}$ molecules to model and to assess experimentally

Worldwide data and modelling integration needed
This integration requires ultrasmart ICT....
The human body is Information and Communication Technology:

It is a computer
Integrating by projecting into *in silico* models of the *individual* humans…
(millions of individuals)
New ICT for medicine

Millions of virtual patients—“person simulators”
The virtual human; integration of models

Hepatosys (BMBF); Hoek et al.

Westerhoff et al.

T. brucei.....

brain

Hepatosys

D. reicell

Pancreas

muscle

Red blood cell

organism level

Lehrach et al.

Noble et al.

heart

pancreas

liver

tumor

This to repeat at all scales; molecules to body

Doyle et al.

Holzhütter et al.
ITFoM integration:

OF MODELS
OF DATA
BETWEEN EU AND USA:
BETWEEN ITFoM AND ‘TOWARDS PRECISION MEDICINE’
• Problems

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Ophthalmic acid as individualized biomarker for toxicity
Science fiction?
U.S. geneticist's genome sequencing uncovers his own condition

• U.S. systems biologist Michael Snyder
• Genome sequenced
• 40,000 molecules monitored
• Treatment well before onset of disease (low cost: diet + exercise)
Millions of M-Phones, M-TVs, M-Watches, running personal health models real time when? 2014?
Problems

Solution:

integration of data through models

Individualized medicine is here