Sino-German Workshop on Multiscale Spatial Computational Systems Biology, Beijing, Oct 8-12, 2015

Computational Systems Biology in China

Ming CHEN (陈铭)

mchen@zju.edu.cn

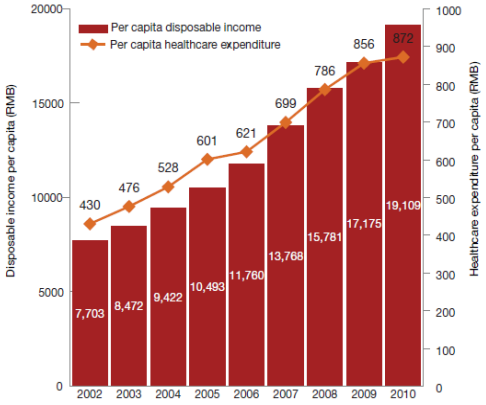
College of Life Sciences

Zhejiang University

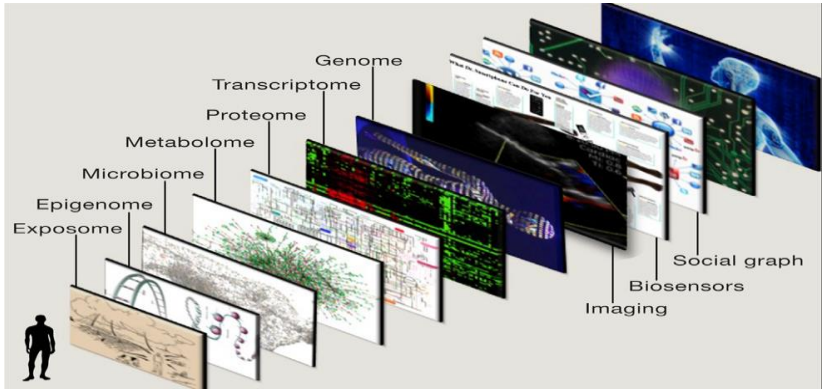
Big Data Era

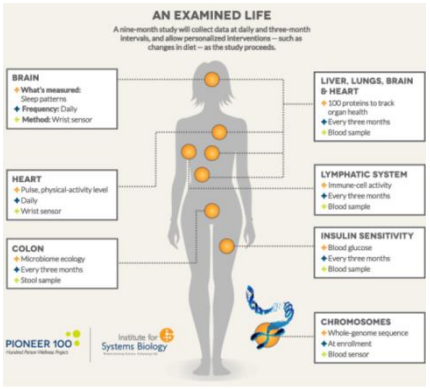
$1000/whole genome(2014)

Economics



Research





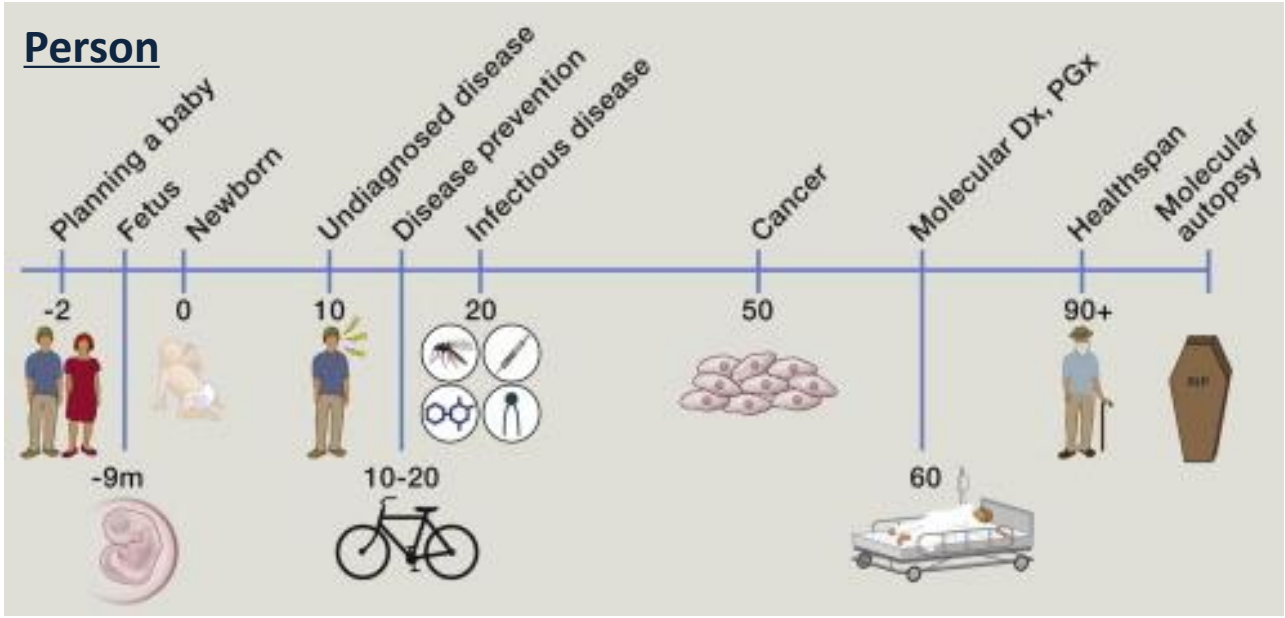
2020

Medial care 2000 RMB yuan / person

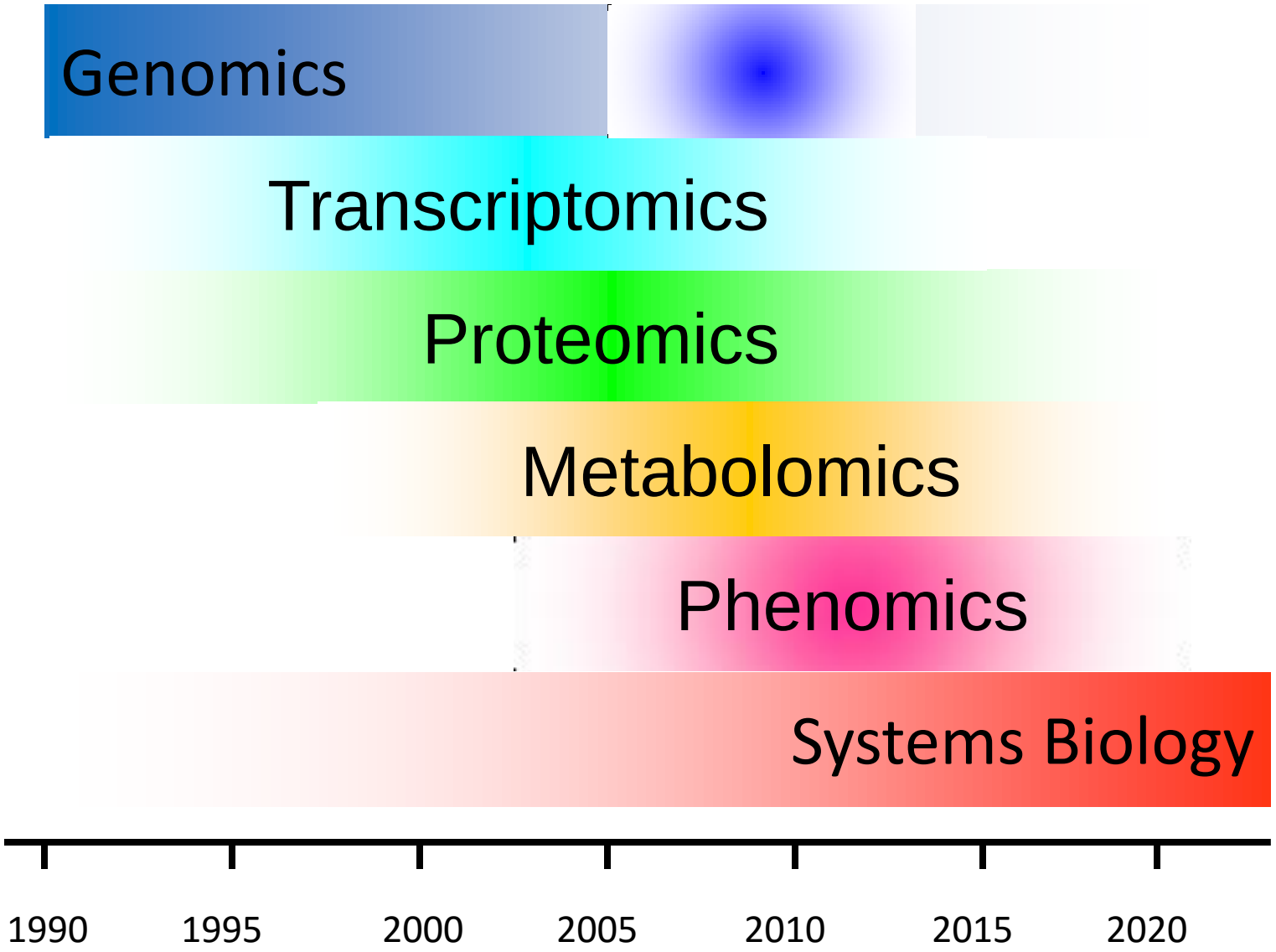
Biomedical data: ~EB（=1000PB）

Personal genome sequencing to be routine

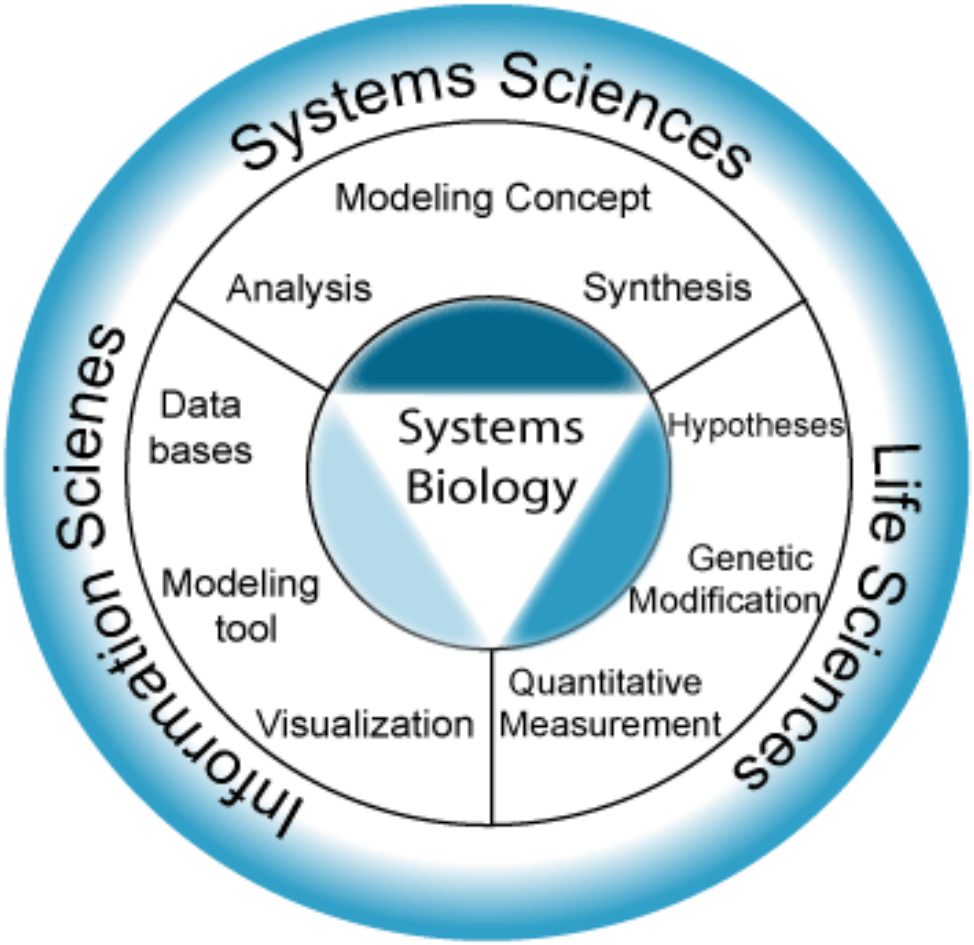
Person



Omics to Systems Biology



What is Systems Biology?



Leroy Hood, 1999

The study of the mechanisms underlying complex biological processes as integrated systems of many interacting components. Systems biology involves:

(1) collection of large sets of experimental data **Data science**

(2) proposal of mathematical models that might account for at least some significant aspects of this data set **Modeling**

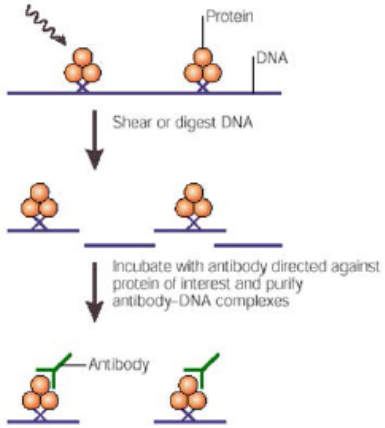
(3) accurate computer solution of the mathemcatical equations to obtain numerical predictions, **Simulation**

(4) assessment of the quality of the model by comparing numberical simulations with the experimental data. **Verification**

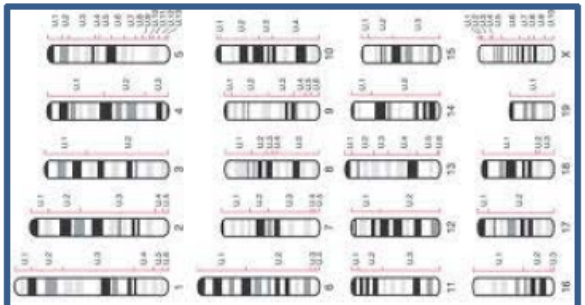
Data Science

- Data integration

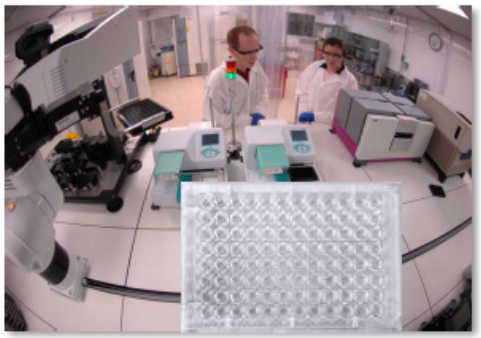
Integration



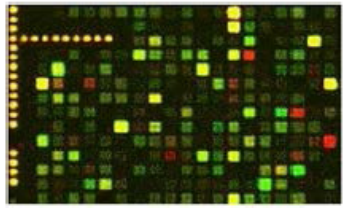
Genome regulation data



Genome variation data

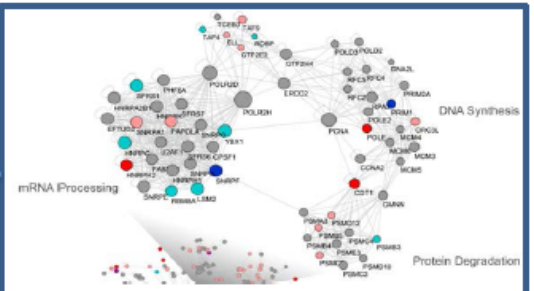


Drug screening data

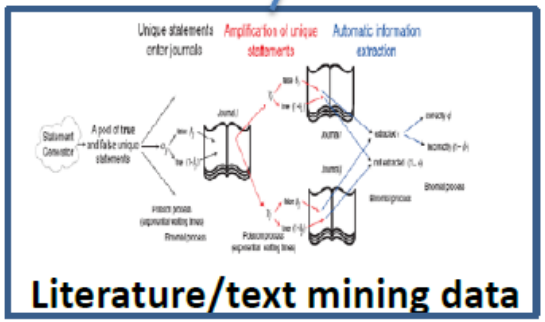


Gene expression data

Integration and building predictive models

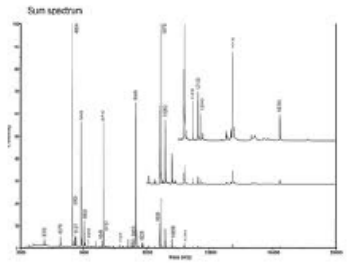


Proteome data



Literature/text mining data

Etc...



Metabolome data

Phenotyping data

Data Science

- Data integration
- Data quality
  - Understand how you got the data you have
  - Bias in your data means your conclusions are even more likely to be wrong
  - In domains with many possible relationships, most published results are false (Ioannidis, PLoS Medicine, 2005)

Big data and data mining

- Inductive Logic Programming
- Genetic Algorithm
- Statistical Methods
- **Support Vector Machine）sd**
- **Neural Network）md**
- **Bayesian Methods）ld**
- Decision Tree
- Hidden Markov Model
- 。 。 。

Are our traditional machine learning methods are suitable for Big Data?
Deep learning!

modeling approaches

- BN: Boolean Network
- BN: bayesian network, DBN: dynamical BNs
- Stochastic
- ODE: ordinary differential equation
- MCA: metabolic control analysis
- stoichiometric analysis, elementary fulx modes
- FBA: flux balance analysis
- **Petri net**
- S-Systems
- L-Systems
- Rule based
- Network reconstruction, visualization, comparison, structural & functional analysis…

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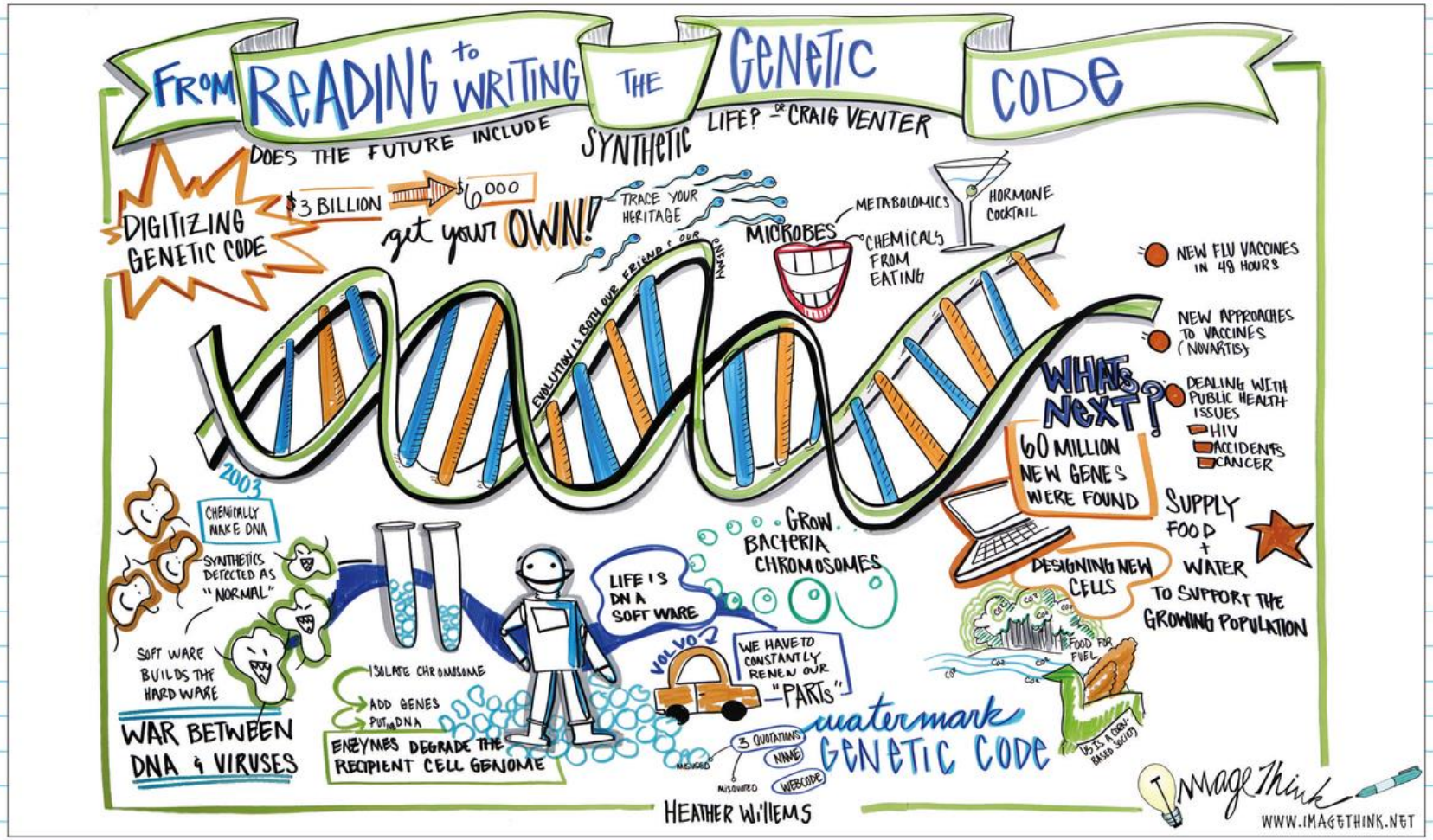
Special Issue

Ming Chen* and Ralf Hofestädt

Open problems in Petri net modeling and simulation of biological systems

- Structural analysis of Petri net models
- Multi-scale modeling
- Diversity
- Modularization
- Parameter settings and optimization in quantitative models
- Intelligence
- Data conversion and model construction
- Analysis and visualization of simulation processes
- Virtual cell modeling and computing power
- Cell-Cell Communication
- Software development

Systems Biology to Synthetic Life



Beijing&Tianjin Region

- **Beijing Uni**
- **Tsinghua Uni**
- **China Agri Uni**
- Beijing Normal Uni
- …
- Tianjin Uni
- Nankai Uni
- …

Yangtze River Delta

- Shanghai Jiaotong Uni
- Fudan Uni
- Tongji Uni
- East China Normal Uni
- Shanghai Uni
- …
- Nanjing Uni
- South East Uni
- Suzhou Uni
- …
- **Zhejiang Uni**

中华人民共和国教育部
Ministry of Education of the People's Republic of China

Pearl River Delta

- Sun Yat-Sen Uni
- South China Uni of Tech
- South Uni of Sci and Tech of China
- …
- Hongkong's
- …
- BGI in Shenzhen

China Mid and others

- Wuhan
- **Changsha**
- Chengdu
- Chongqin
- Xi'an
- …
- **Harbin**
- Changchun
- Dalian
- Jinan
- …

中國科學院
CHINESE ACADEMY OF SCIENCES

CAS-MPG Partner Institute for Computational Biology
Shanghai Institutes for Biological Sciences
Chinese Academy of Sciences

- **Inst. of Biophysics** (Computational and Systems Biology Center)
- Inst. of Genetics and Developmental Biology (Molecular Systems Biology Center)
- Academy of Mathematics and Systems Science (Key Lab of Systems and Control)
- …
- **CAS Shanghai Institutes for Biological Sciences** (Key Lab of Systems Biology)
- PICB
- …

中华人民共和国科学技术部
Ministry of Science and Technology of the People's Republic of China

Chinese government shifts science role

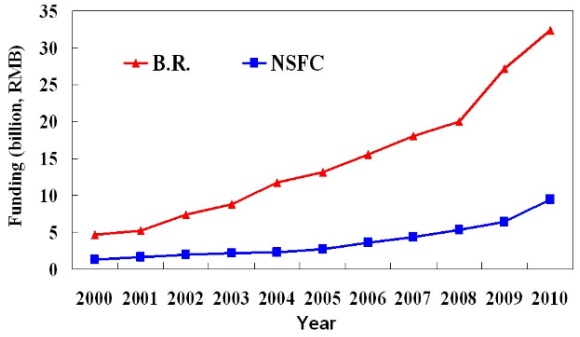
- Wan Gang (Minister of S&T): The government will no longer authorize or fund science and technology projects directly, but focus instead on making development plans, assessing projects and monitoring evaluation and research funds.
  1. **NSFC;**
  2. **Major Special S&T Projects;**
  3. **Key R&D Plans;**
  4. **Tech Innovation Funding;**
  5. **Talent and Base Plan**

MoST Budget：**43.5billion Yuan, 2012** 500billion in 2013

CAS launches new reform

- Reorganise all 104 CAS research institutes into four classes:
  - centres of excellence focused on basic research,
  - advanced institutes doing applied research and commercialisation,
  - big science centres running huge facilities,
  - institutes that will address problems specific to a region of China.

Budget： **24.7billion Yuan, 2014**



EU & China
Sino & German

Handshake between Wan Gang, Chinese Minister for Science and Technology , on the right and Carlos Moedas

European Research Council, and Ms. Nuria Sebastian Galles, Vice President of the European Research Council.