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Biological information infrastructure for research

Graham Cameron

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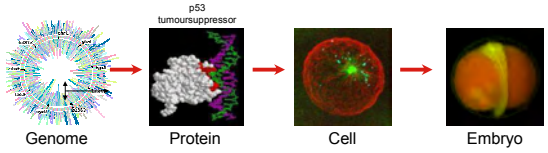
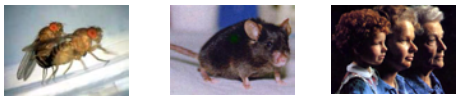
From Molecules, to Cell, to Organisms, to Physiology



Genome → Protein → Cell → Embryo



Fruitfly | Mouse | Human Development, Ageing Disease

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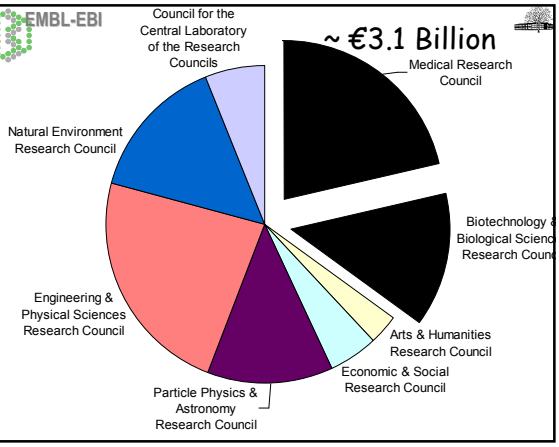
~ €3.1 Billion



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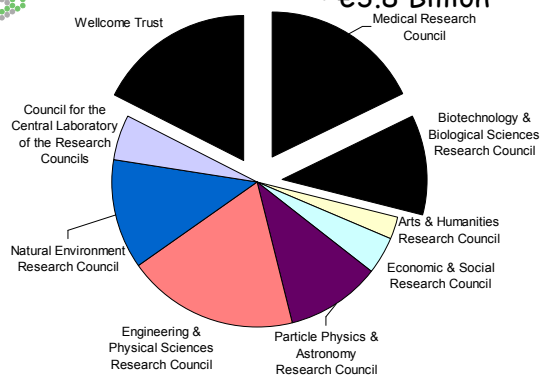
~ €3.8 Billion



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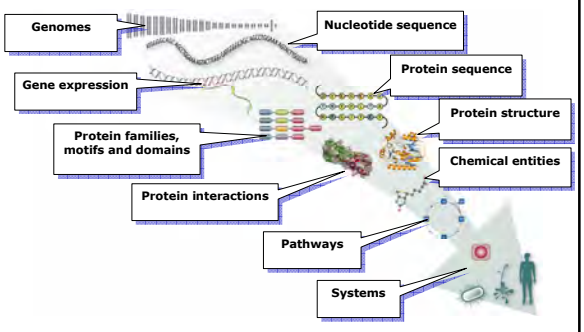
Molecules to systems



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We have amassed a wealth of knowledge about the molecular processes of living systems

- Biomacromolecules
- Biologically active molecules
- The behaviour and interactions of these molecules
- The phenotypic effects of molecular changes
  - Mutations
  - Drugs
  - Nutrients
- The molecular adjuncts of phenotypic changes
  - Disease
  - Aging

- Databases
- Web access
- Tools to explore the information
- Systems to capture the information
- Service centres

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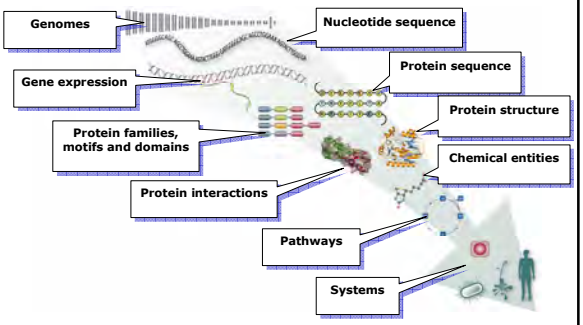
Databases: molecules to systems



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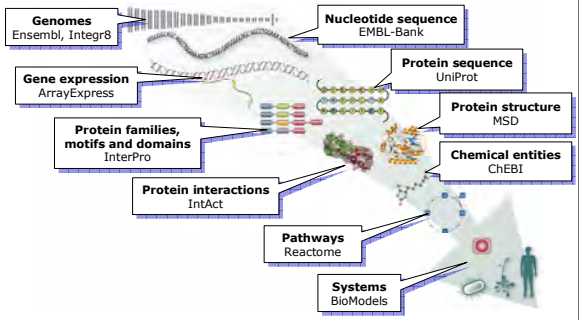
Databases: molecules to systems



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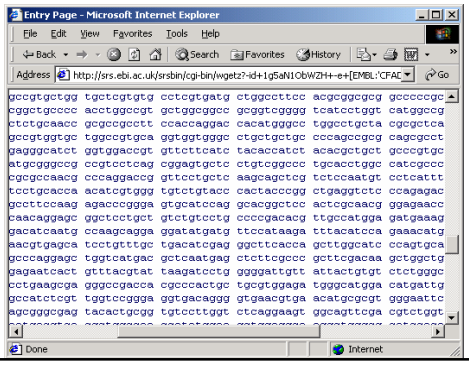
DNA



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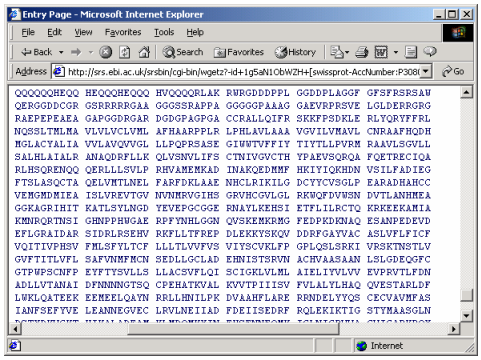
Protein Sequences



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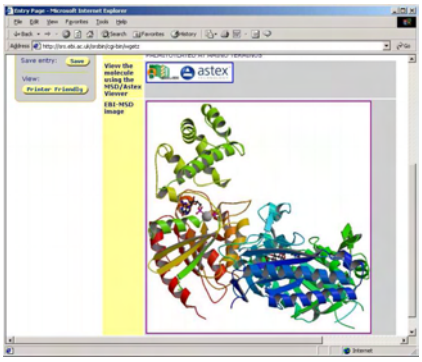
Structures



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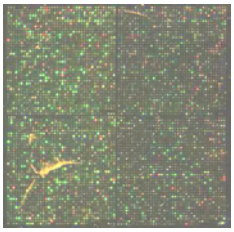
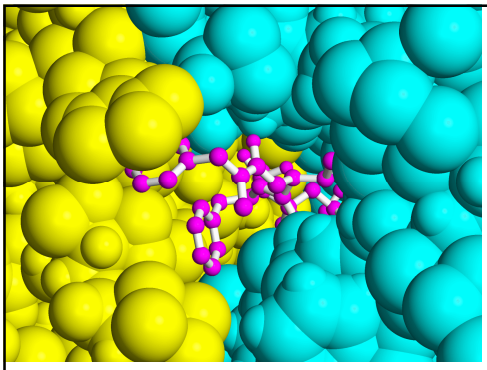
Expression





molecules interact

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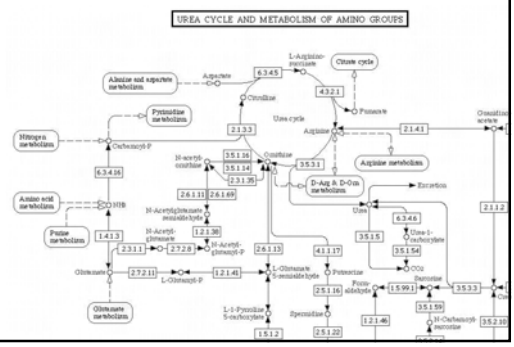
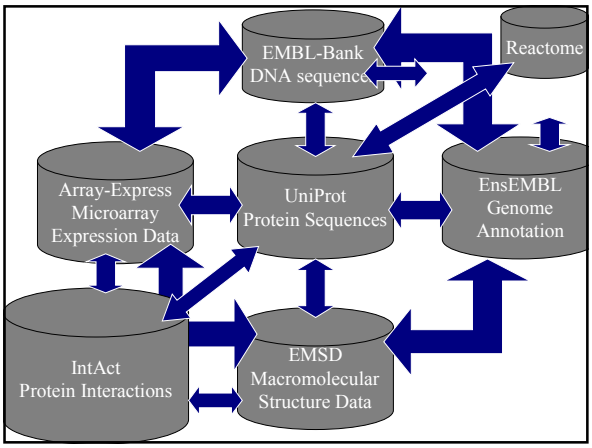
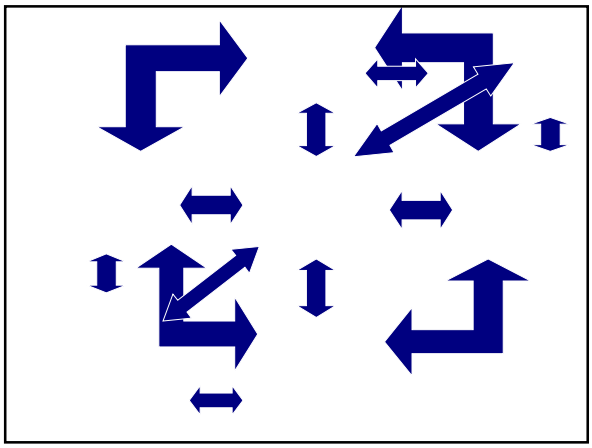
Pathways







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Usage

- Basic research
- Industry
  - Pharma
  - Diagnostics
  - Medical device research
  - Personal care
  - Nutrition
  - Agriculture
  - Forestries
  - Fishery
- Patent searching and provenance

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European Context

- BioSapiens
- EMBRACE
- ENFIN

- (and many others)

Biosapiens

- European Molecular Biology Laboratory - European Bioinformatics Institute, Hinxton, Cambridge, UK.
- European Molecular Biology Laboratory, Heidelberg, Germany.
- German National Centre for Environment and Health, Neuherberg, Münich, Germany
- Université Libre de Bruxelles, Brussels, Belgium
- Consejo Superior de Investigaciones Cientificas, Madrid, Spain
- Institut Municipal d'Assistència Sanitària, Barcelona, Spain
- Genome Research Ltd, Hinxton, Cambridge, UK.
- Max-Planck Institute for Informatics, Saarbrücken, Germany
- The Hebrew University of Jerusalem, Girat Ram, Israel
- Department of Biochemical Sciences University of Rome "La Sapienza", Rome, Italy
- University of Stockholm, Stockholm, Sweden
- University of Oxford, Oxford, UK.
- University College London, London, UK.
- Radboud University Nijmegen, Nijmegen, The Netherlands
- Swiss Institute of Bioinformatics, Geneva, Switzerland
- Technical University of Denmark, Lyngby, Denmark
- University of Helsinki, Helsinki, Finland
- University of Geneva, Geneva, Switzerland
- Institute of Enzymology, Hungarian Academy of Sciences, Budapest, Hungary
- University of Cologne, Cologne, Germany
- Institut Pasteur, Paris, France
- BioInfo Bank Institute, Poznan, Poland
- Max Planck Institute for Molecular Genetics, Berlin, Germany
- Genoscope, Evry, France
- University of Bologna, Bologna, Italy
- European Molecular Biology Laboratory - European Bioinformatics Institute, Hinxton, Cambridge, UK

EMBRACE

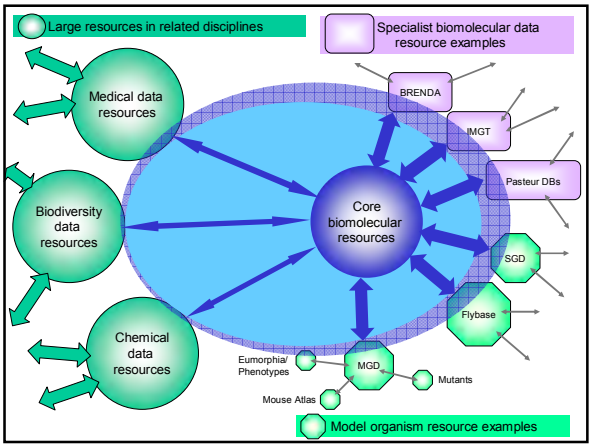
- European Molecular Biology Laboratory - European Bioinformatics Institute, Hinxton, Cambridge, UK.
- European Molecular Biology Laboratory, Heidelberg, Germany.
- Institute of Biomedical Technologies, Section Bari, CNR, Bari, Italy
- University of Manchester, UK
- Swiss Institute of Bioinformatics, Geneva, Switzerland
- Swedish University of Agricultural Sciences.The Linnaeus Centre for Bioinformatics, Sweden
- Centre National de la Recherche Scientifique, Clermont-Ferrand and Lyon, France
- Centre for Biological Sequence Analysis,Technical University of Denmark, Lyngby, Denmark
- Centro Nacional de Biotecnologia/Consejo Superior de Investigaciones Cientificas, Madrid, Spain
- University of Stockholm, Stockholm Bioinformatics Centre, Sweden
- Institut National de la Recherche Agronomiqu Toulouse, France
- Max Planck Institute for Molecular Genetics, Berlin, Germany
- CSC, the Finnish IT Center for Science, Espo Finland
- University College London, London, UK.
- The Weizmann Institute, Rehovot, Israel
- Centre for Molecular and Biomolecular Informatics, University of Nijmegen, The Netherlands
- Carretera de Ajalvir, km. 4, 28850 Torrejon de Ardoz, Madrid

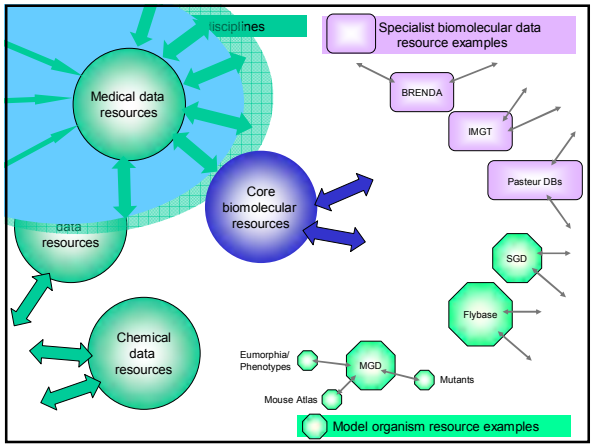
ENFIN

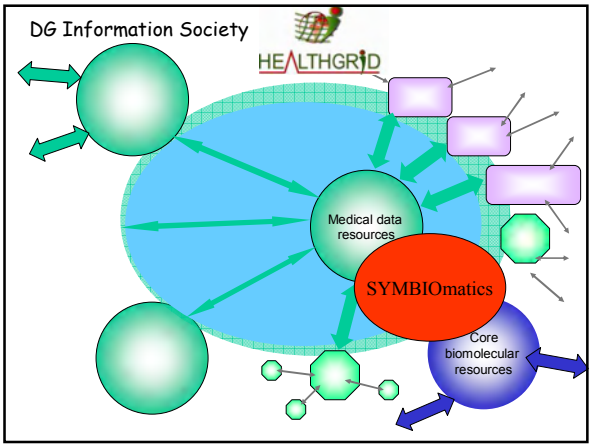
- The European Bioinformatics Institute / The European Molecular Biology Laboratory, Europe
- The University of Dundee UK
- Technical University of Denmark
- University of Rome Tor Vergata Italy)
- Medical Research Council Mammalian Genetics Unit (MRCMGU), UK
- Ludwig Institute for Cancer Research, Uppsala (LICR-UPP), Germany
- The Max Planck Institute, Germany
- University of Helsinki (UH), Iceland
- University College London (UCL), UK
- National Center for Research and Technology, Hellas (CERTH), Greece
- Universitaet zu Koeln (UNIK), Germany
- Weizmann Institute (Weizmann), Israel
- Egeen (EGEEN), Estonia
- Serono Pharmaceutical Research Institute (SPRI), Switzerland
- Consejo Superior de Investigaciones Científicas (CSIC), Spain
- Centre for Integrative Bioinformatics VU (IBIVU), Netherlands

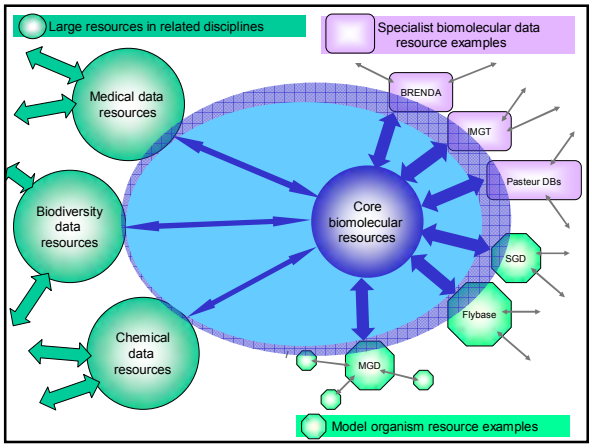
Global Picture

- DNA – tripartite international collaboration (including patent data acquisition)
- Protein sequences – Uniprot collaboration
- Macromolecular structures – tripartite international collaboration
- Intact international agreements
- Reactome – USA Europe collaboration
- Etc.









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Using the information

Healthy	Diseased
High Yield	Low Yield
Disease Resistant	Disease prone
Salt Tolerant	Not Salt Tolerant

Suppose a gene's variation seems important

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Using the information

Healthy	Diseased
High Yield	Low Yield
Disease Resistant	Disease prone
Salt Tolerant	Not Salt Tolerant

Look in databases for similar genes, their products, and functions, structures, interactions and expression patterns.
The processes in which they are involved.

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Using the information

Healthy	Diseased
High Yield	Low Yield
Disease Resistant	Disease prone
Salt Tolerant	Not Salt Tolerant

Can we influence the processes in which they are involved?

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Using the information

Healthy	Diseased
High Yield	Low Yield
Disease Resistant	Disease prone
Salt Tolerant	Not Salt Tolerant

Can we influence the processes in which they are involved?

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- Working out what in the lab what a gene does could easily be a year's work
- Searching databases can do it in half an hour

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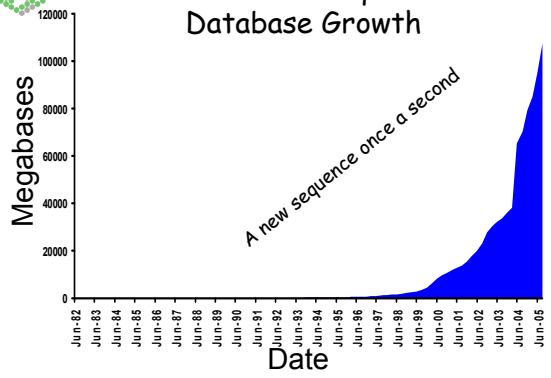
Nucleotide Sequence Database Growth



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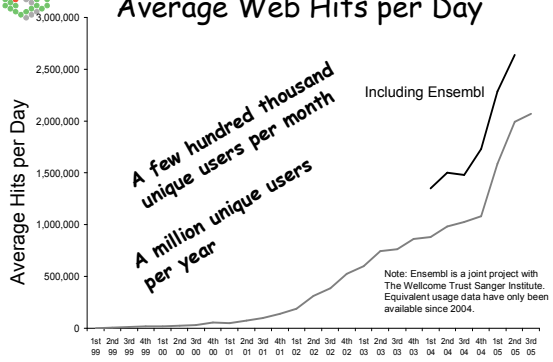
Average Web Hits per Day



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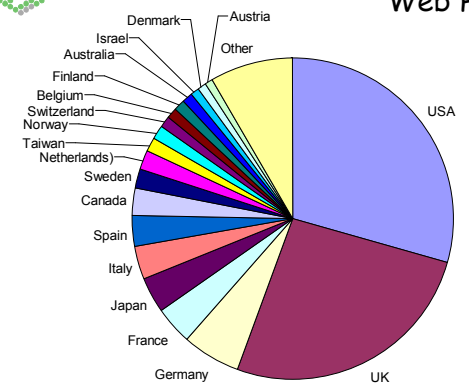
Web Hits



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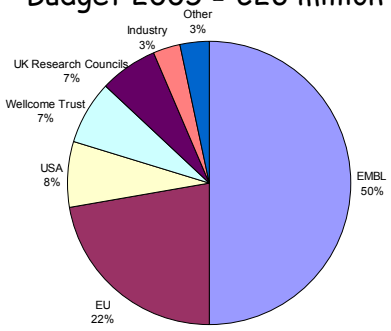
EBI Total Running Budget 2005 = €26 million



Projected budget 2011 = €43 million

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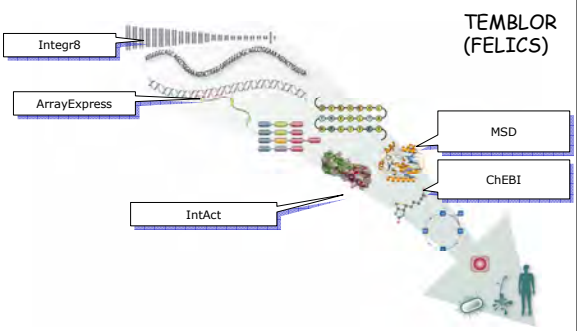
Commission Funding



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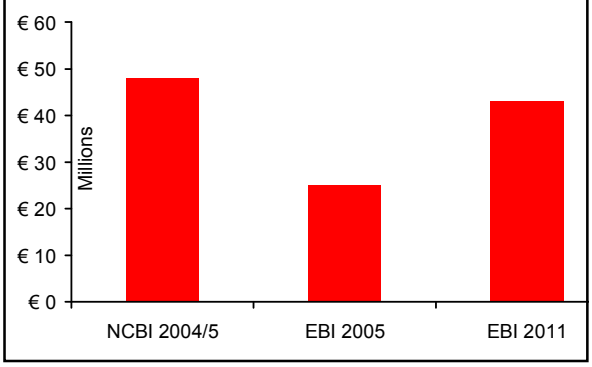

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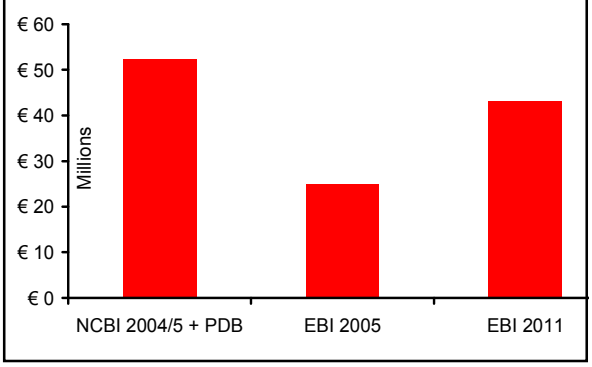

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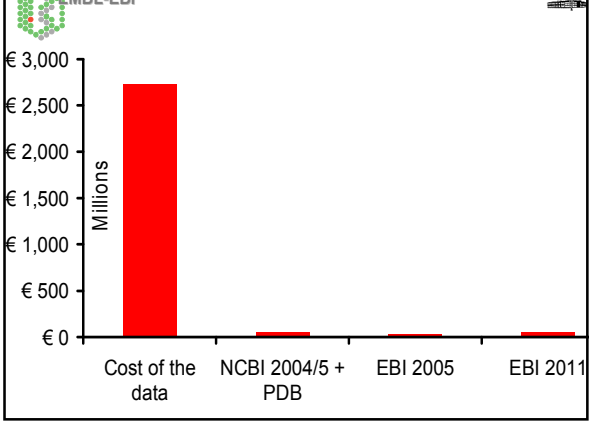

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Today's most optimistic costs

DNA Data	
Cost per read	€ 1
Read length	500
Coverage (X)	5
Cost per megabase	€ 10,000
Megabases (EMBL)	107,563
Database cost	€ 1,075,625,807
Structure Data	
Cost per structure	€ 50,000
Structures in PDB	30000
Cost of PDB	€ 1,500,000,000
Microarray Data	
Cost per hyb	€ 500
Hyb's in ArrayExpress	30000
Cost of ArrayExpress	€ 15,000,000
Percentage of data captured	10%
Value of all data	€ 150,000,000

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Bioinformatics Infrastructure

- Has captured the data from several billion Euros worth of science
- Serves a community of perhaps a million users
- Supports science on which the UK alone spends €3-4 billion a year
- Cuts years of lab work down to hours of computer work
- Is crucial to human well being from medicine to agriculture
- Sees data volume and usage growing exponentially
- Might cost a few tens of millions (at most a couple of percent of the cost of the science it supports).