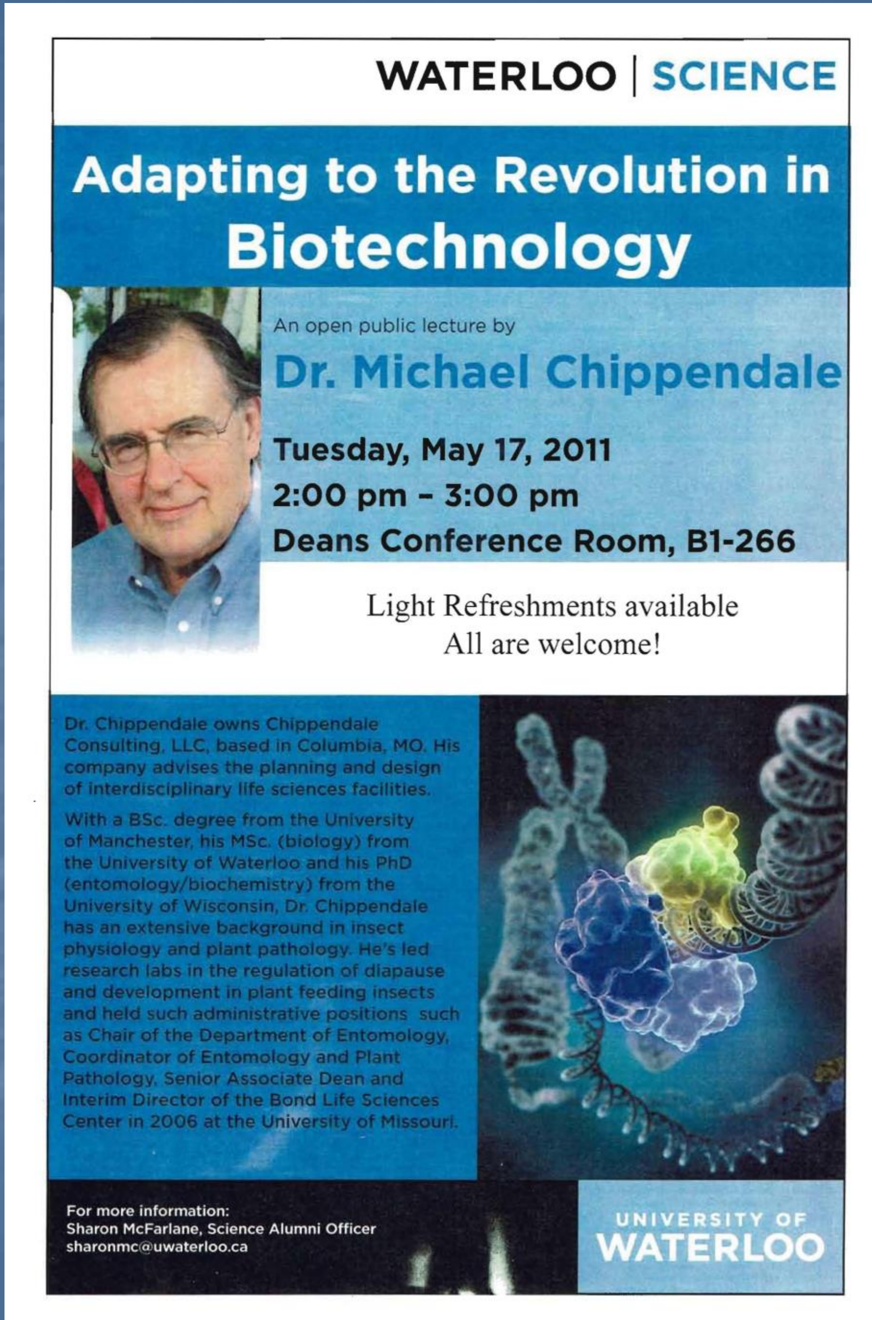
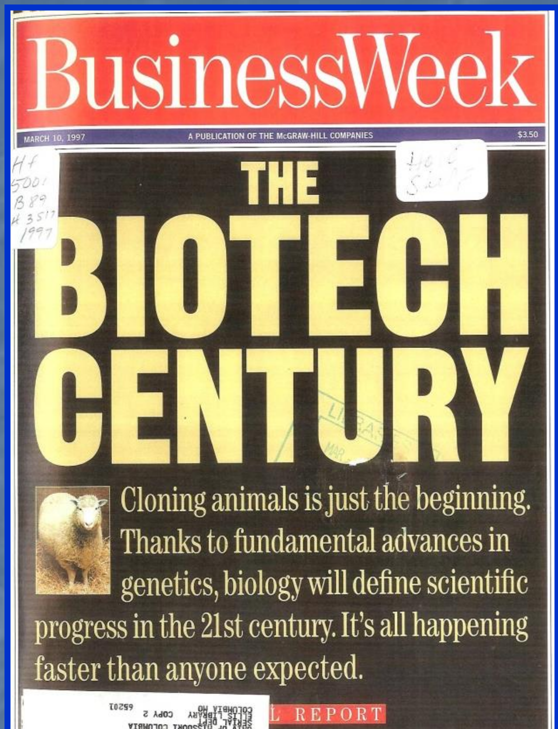
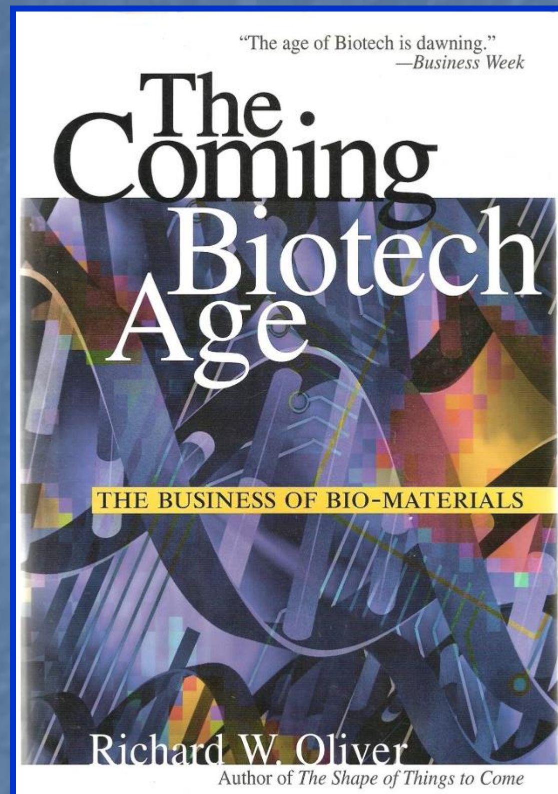


On May 17, 2011, G. M. Chippendale presented this seminar at the University of Waterloo on the occasion of the 50th anniversary of his attending this University as a master's degree student in the Department of Biology.

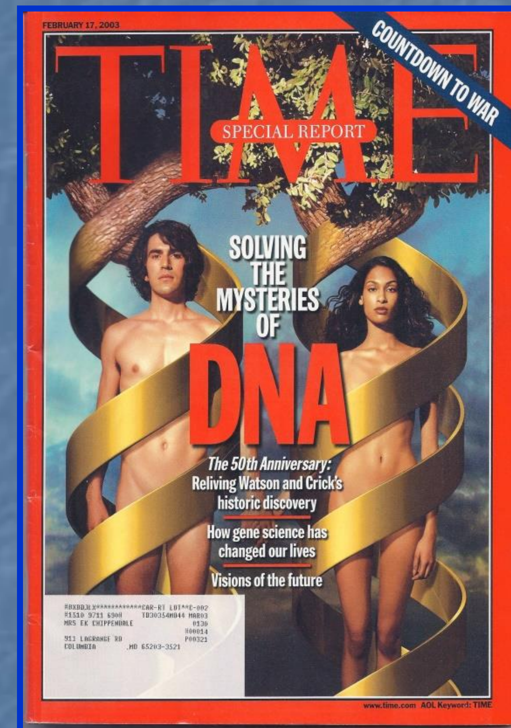
Adapting to the Revolution in Biotechnology



March, 1997



2000



February, 2003

Outline

- My 1961-62 connections to Dept of Biology, University of Waterloo.
- Developments in science and technology as we transitioned into the Age of Biology over the last 50 years.
- Implications of the need for scientific collaborations on the design of academic facilities for teaching and research.

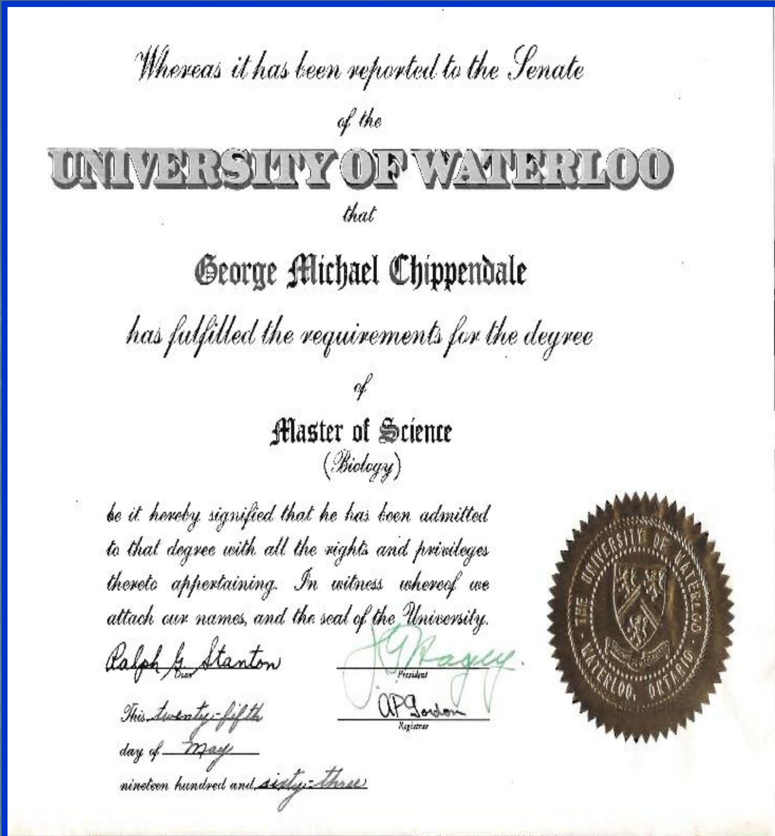
Dates and Places

Yorkshire 1940-61
1967-68

Waterloo, Ontario
1961-62

Columbia, Missouri
1968 to present

University of Waterloo MS Degree in Biology 1963



Whereas it has been reported to the Senate

of the

UNIVERSITY OF WATERLOO

that

George Michael Chippendale

has fulfilled the requirements for the degree

of

Master of Science

(Biology)

be it hereby signified that he has been admitted to that degree with all the rights and privileges thereto appertaining. In witness whereof we attach our names, and the seal of the University.

Ralph G. Stanton, Dean

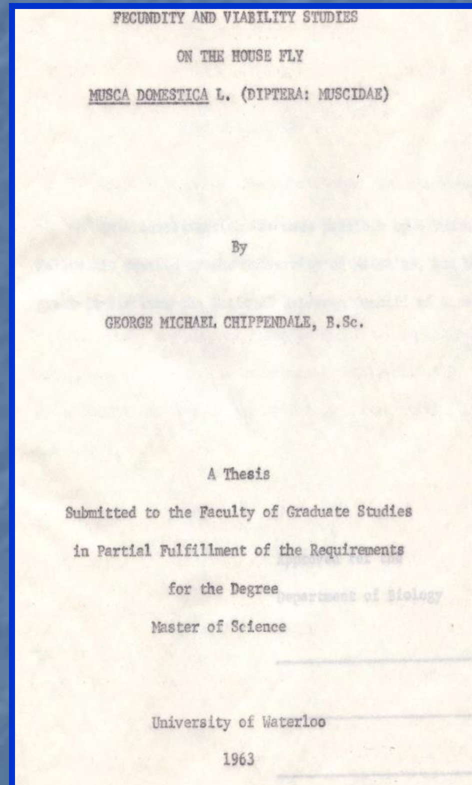
President

A P Gordon, Registrar

This twenty-fifth

day of May

nineteen hundred and sixty-three



FECUNDITY AND VIABILITY STUDIES

ON THE HOUSE FLY

MUSCA DOMESTICA L. (DIPTERA: MUSCIDAE)

By

GEORGE MICHAEL CHIPPENDALE, B.Sc.

A Thesis

Submitted to the Faculty of Graduate Studies

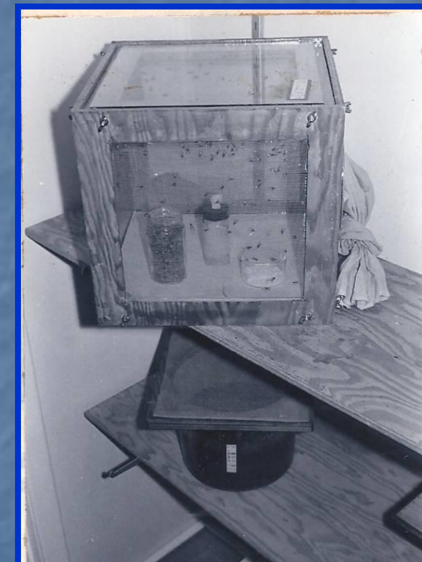
in Partial Fulfillment of the Requirements

for the Degree

Master of Science

University of Waterloo

1963



B.Sc. University of Manchester 1961. Univ. of Waterloo, Graduate Student in Biology, 1961-62

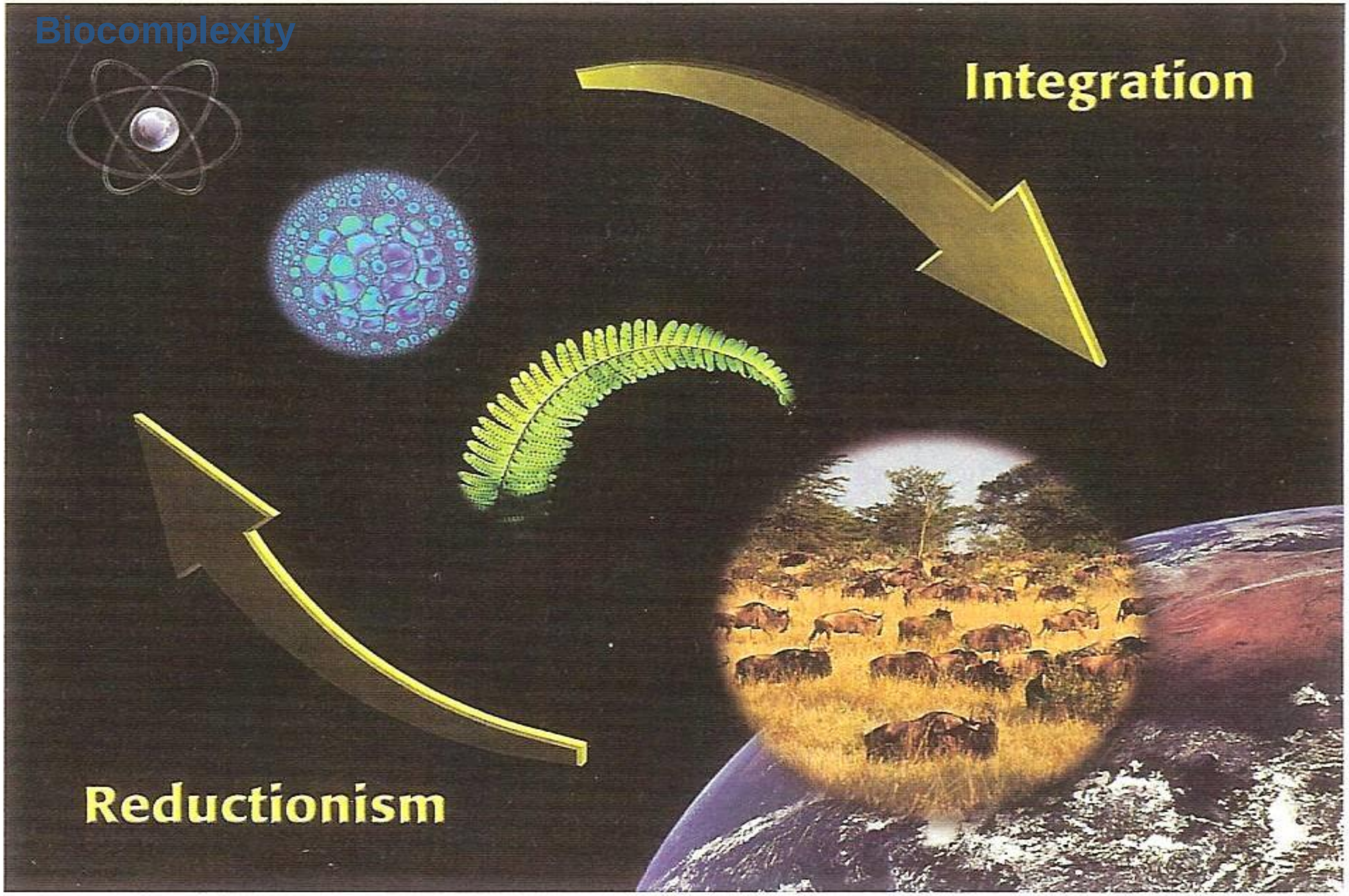
The Age of Biology

"The history of biology was forever altered a decade ago by the bold decision to launch a research program that would characterize in ultimate detail the complete set of genetic instructions of the human being."

Francis S. Collins
Director, National Human Genome Research Institute (NHGRI)

From: Medical and Societal Consequences
Of the Human Genome Project
New England Journal of Medicine
Vol. 341:28-37 (1999)

Biocomplexity

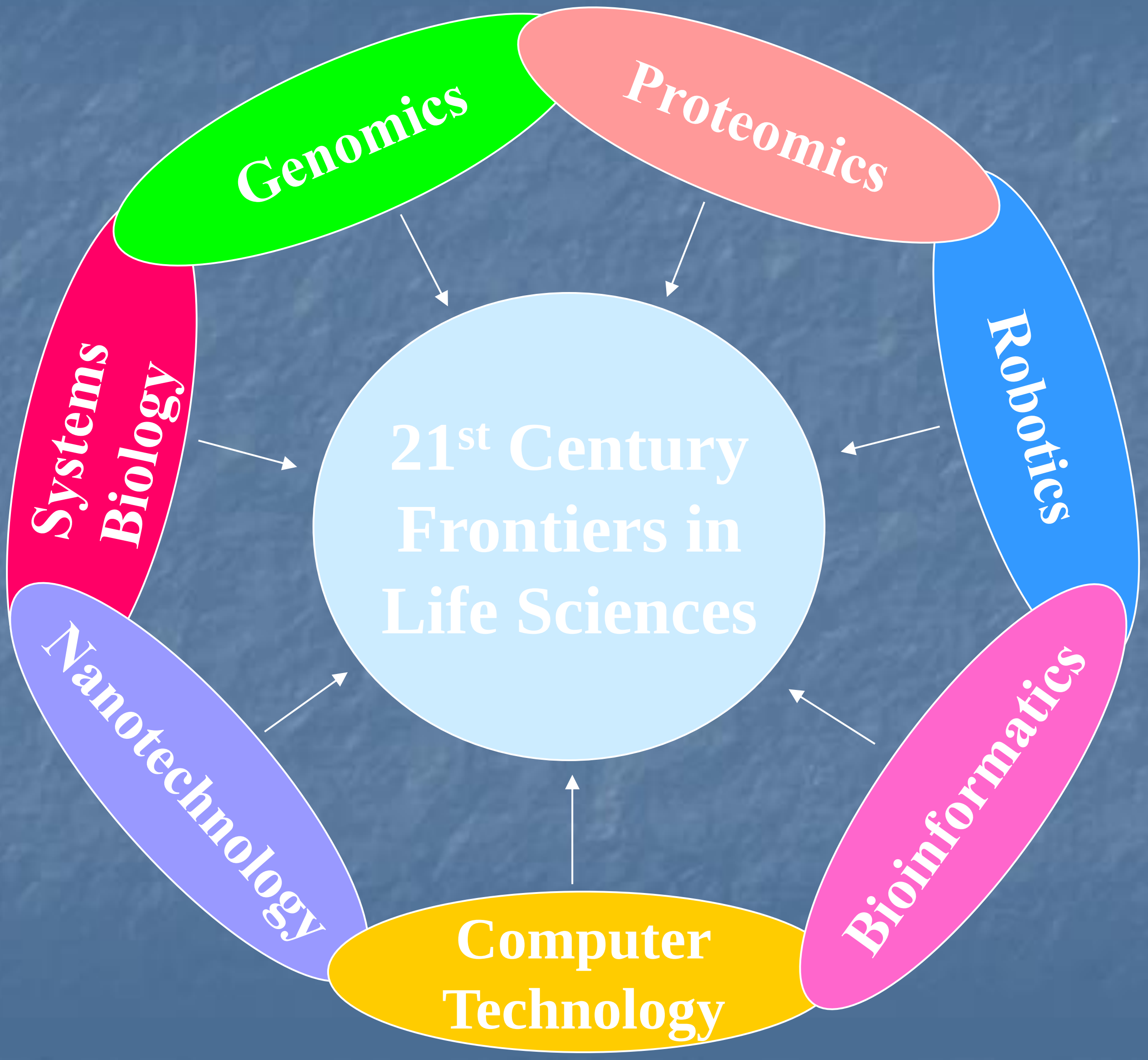


Synthesis & integration of information across temporal, thematic and spatial scales

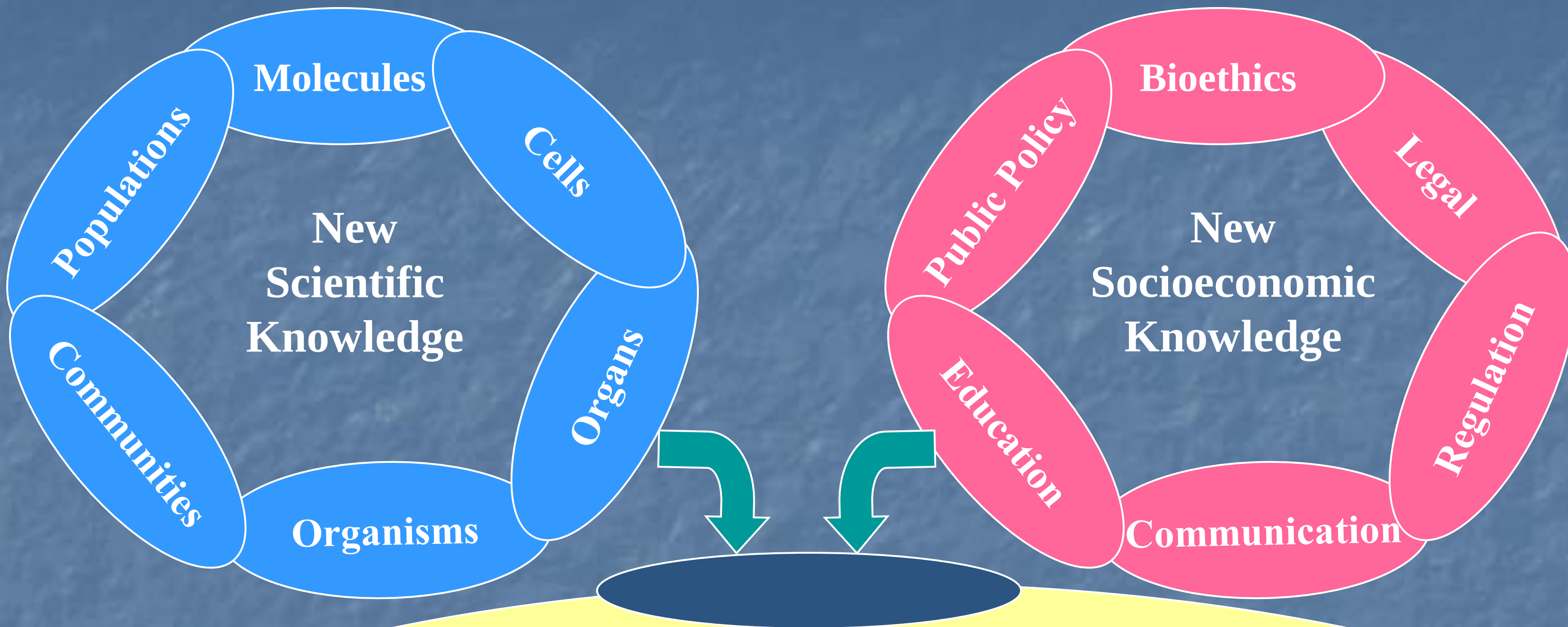
Earth ⇔ Ecosystem ⇔ Plant ⇔ Cell ⇔ Atom

Michener *et al*. (2001) BioScience, vol.51, p. 1018-1023

Integration of Science and Technology



Life Science Interrelationships



Harness Scientific and Socioeconomic Knowledge

Intellectual Property Rights

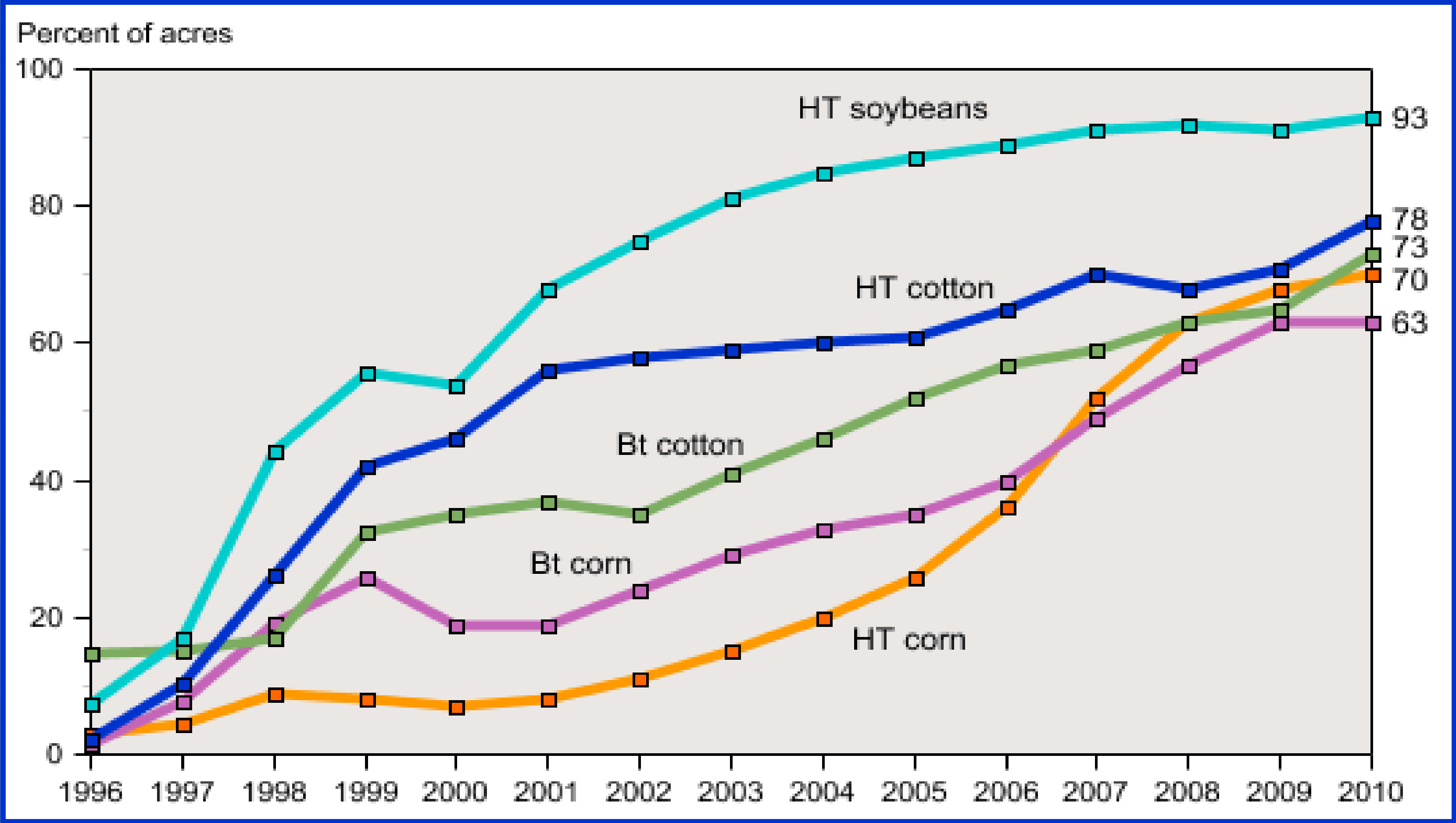
Technology Transfer

Public-Private Section Partnerships

New Processes/Products

Public Good

Adoption of Genetically Engineered Crops in US



www.ers.usda.gov/data/biotechcrops/

Determined base-line susceptibility of the southwestern corn borer to Cry1Ab protein of *Bacillus thuringiensis* to contribute to insect resistance management studies.

Trisyono, A. and G. M. Chippendale. 2002. **Pest Management Science** 58: 1022-1028

Pros and Cons Transgenic Crops

13 listed:

- environmental
- economic
- scientific
- food safety

www.maizecdna.org/outeach/tpe.html

The Maize Full Length cDNA Project

Home | FLcDNA Tutorial | Why FLcDNA | Transgenic Plants | Approach | People | Glossary | Resources

Arizona Genomics Institute ~ Arizona Genomics Computational Laboratory ~ Stanford University

Trangenic Plants Pages

- WHAT are transgenic plants and how are they created?
- CAN FLcDNAs help produce safer transgenic plants?
- HOW do transgenic plants benefit basic research?
- HOW do scientists think about transgenic plants?
- WHAT are the pros and cons of transgenic plants?
- WHAT are some examples of transgenic plants?
- WHO's in charge of regulating transgenic plants in the U.S.?

What Are the PROS & CONS of Transgenic Crops

To weigh the plusses and minuses of genetically engineered plants, one must evaluate a combination of environmental, economic, scientific, and food safety issues. In the following chart, we've coded an issue or argument as involving concerns about:

- ENVIRONMENTAL IMPACTS [ENV]
- ECONOMIC IMPACTS [ECON]
- SCIENTIFIC CHALLENGES [SC]
- FOOD-SAFETY [FS]

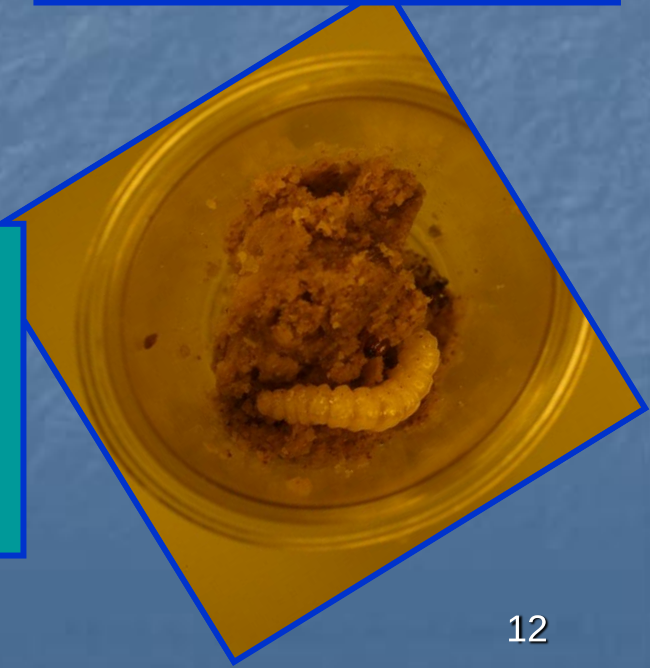
From the chart, it quickly becomes apparent that the issues are intertwined, making for murky public policy discussions. The table points out the value of case-by-case analysis of specific transgenic plant strategies.

The links to the left and in brackets below open a pop-up window with expanded topic descriptions

PROS	Common Counter-Arguments
Development of pest-tolerant plants can increase productivity while reducing pesticide use. [ENV] [ECON]	Not enough is known about whether pesticides built into plants are safe for human consumption. [FS] [SC]
With plant engineering, it's sometimes possible to develop pest-tolerant plants that safely target specific pests and are safe for human consumption while reducing pesticide use. (eg., Bt corn) [ENV] [FS]	Not enough is known about what other organisms might be harmed by a particular transgene. [ENV] [SC]
While pesticides can lead to the creation of pest-resistant "super-pests," pest-tolerant transgenic plants have been shown to reduce the incidence of pesticide resistance. [ENV] [ECON]	Not enough is known about whether pesticides built into plants are safe for human consumption. [FS] [SC]
Engineered plants have the potential to rapidly improve crop productivity. [ECON]	Claims are overblown. Traditional breeding has increased production many-fold without the need for genetic engineering of crops with unknown food safety. [ECON] [FS]
Potential improvements in nutritive value of plants, eg. golden rice could safely and inexpensively improve health in poor countries. [ECON] [FS]	Claims are overblown. Success in producing plants with significantly improved nutritive value has yet to be seen. [SC]
Potential to produce medicines inexpensively. [ECON]	Risk of accidental ingestion of medicines if raised in food crops. [FS]
Potential to improve food safety by removing allergens from plant products. [FS]	Claims are overblown. Success in producing plants with significantly reduced allergenicity has yet to be seen. [SC]

CONS	Common Counter-Arguments
The development of highly productive crops with improved nutritive value could make Third World farmers dependent on international seed companies. [ECON]	There are ways to avoid this problem such as developing transgenic plants from local varieties. [ECON]
If genes for pharmaceutical products are raised in food crops, they pose a risk of accidental ingestion. [FS]	Scientists can use non-edible plants for bio-pharma to avoid this problem. [SC]
Potential to inadvertently introduce allergens into foods. [FS]	Scientific measures can be taken to avoid this. [SC]
There's a risk that genetically engineered genes could be introduced into wild plants, reducing biodiversity and creating super-weeds while reducing pesticide use. [ENV]	The risk of gene flow into wild plants is the same for transgenic plants as for traditionally-bred plants. [SC]
Not enough is known about whether genetically engineered plants are safe for human consumption. [FS] [SC]	Because transgenic food plants are carefully designed to include select genes to produce proteins of known function from other plants, the risks are minimal. [FS] [SC]
In the U.S., foods are not labeled to show whether they contain genetically engineered plants. [FS]	Because the introduced genes and their protein products are GRAS (generally recognized as safe) food labeling is not necessary. [FS]

Southwestern Corn Borer Susceptibility to Bt Corn

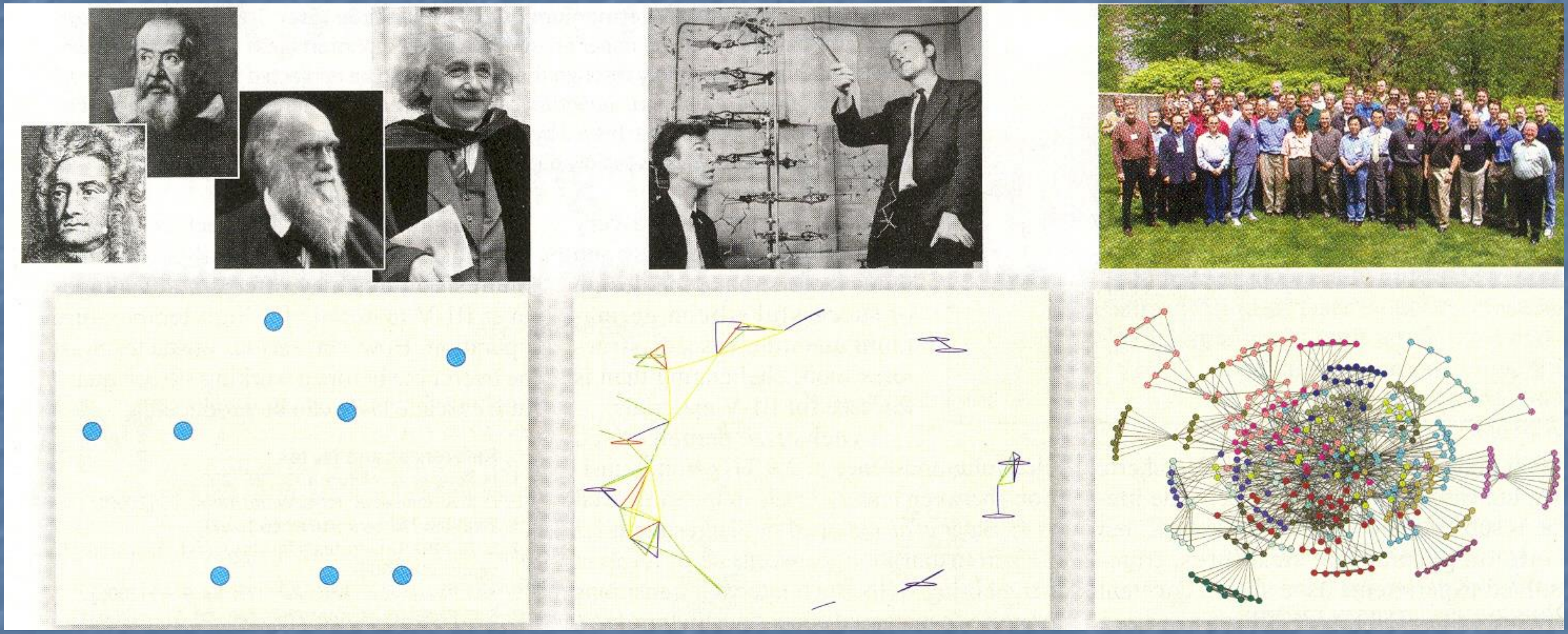


Established baseline susceptibility of the southwestern corn borer to Bt protein (CRY1Ab).

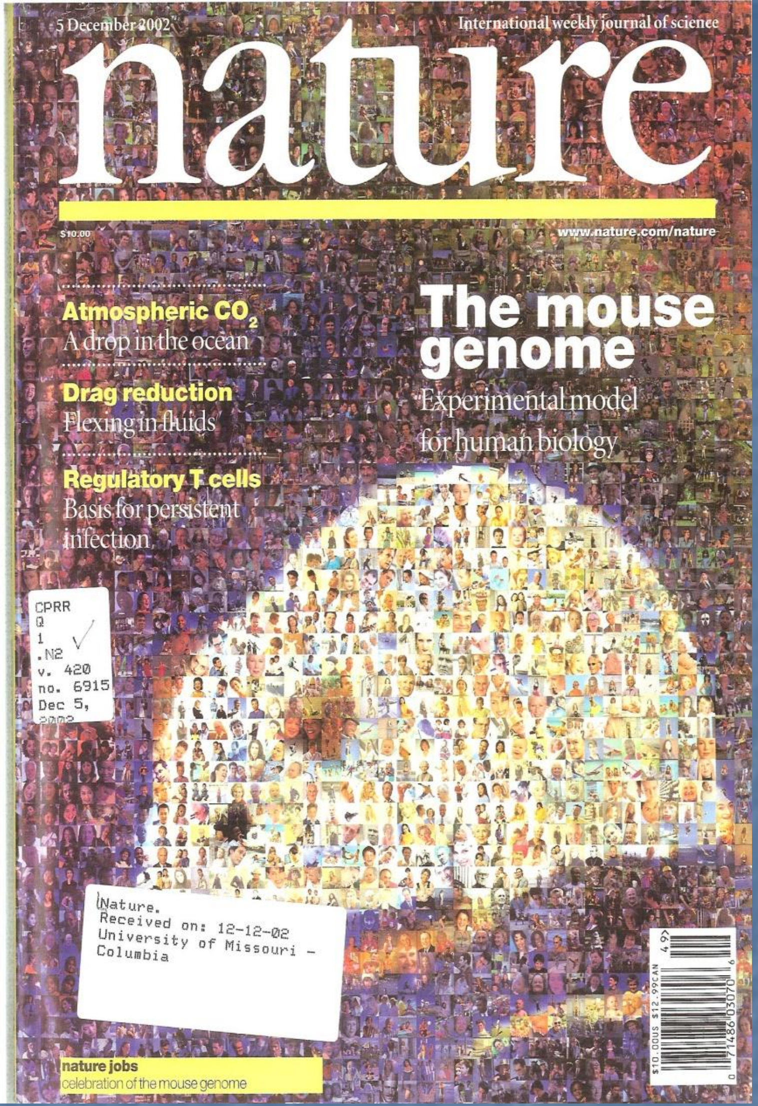
Provided a basis for comparing any shift in susceptibility in populations of the SWCB from continued exposure to Bt corn in the field.

Trisyono, A. and G. M. Chippendale (2002). Pest Management Sci. 58:1022-28.

Evolution of the Scientific Enterprise



Barabasi, A.L. (2005), *Science* 308:639-641



Initial sequencing and comparative analysis of the mouse genome

Mouse Genome Sequencing Consortium*

FANTOM Consortium: Y. Okazaki[1,2], M. Furuno[1], T. Kasukawa[1,3], J. Adachi[1], H. Bono[1], S. Kondo[1], I. Nikaido[1,4], N. Osato[1], R. Saito[1,5], H. Suzuki[1], I. Yamanaka[1], H. Kiyosawa[1,4], K. Yagi[1], Y. Tomaru[1,6], Y. Hasegawa[1,4], A. Nogami[1,4], C. Schönbach[7], T. Gojobori[8], R. Baldarelli[9], D. P. Hill[9], C. Bult[9], D. A. Hume[10], J. Quackenbush[11], L. M. Schriml[12], A. Kanapin[13], H. Matsuda[14], S. Batalov[15], K. W. Beisel[16], J. A. Blake[9], D. Bradt[9], V. Brusic[17], C. Chothia[18], L. E. Corbani[9], S. Cousins[9], E. Dalla[19], T. A. Dragani[20], C. F. Fletcher[15,21], A. Forrest[10], K. S. Frazer[9,22], T. Gaasterland[23], M. Gariboldi[20], C. Gissi[24], A. Godzik[25], J. Gough[18], S. Grimmond[10], S. Gustincich[26], N. Hirokawa[27], I. J. Jackson[28], E. D. Jarvis[29], A. Kanai[5], H. Kawaji[3,14], Y. Kawasawa[30], R. M. Kedzierski[30], B. L. King[9], A. Konagaya[7], I. V. Kurochkin[7], Y. Lee[11], B. Lenhard[31], P. A. Lyons[32], D. R. Maglott[12], L. Maltais[9], L. Marchionni[19], L. McKenzie[9], H. Miki[27], T. Nagashima[7], K. Numata[5], T. Okido[8], W. J. Pavan[33], G. Pertea[11], G. Pesole[24], N. Petrovsky[34], R. Pillai[17], J. U. Pontius[12], D. Qi[9], S. Ramachandran[9], T. Ravasi[10], J. C. Reed[25], D. J. Reed[9], J. Reid[19], B. Z. Ring[35], M. Ringwald[9], A. Sandelin[31], C. Schneider[19], C. A. M. Semple[28], M. Setou[27], K. Shimada[36,37], R. Sultana[11], Y. Takenaka[14], M. S. Taylor[28], R. D. Teasdale[10], M. Tomita[5], R. Verardo[19], L. Wagner[12], C. Wahlestedt[31], Y. Wang[11], Y. Watanabe[36,37], C. Wells[10], L. G. Wilming[38], A. Wynshaw-Boris[39], M. Yanagisawa[30], I. Yang[11], L. Yang[9], Z. Yuan[10], M. Zavolan[23], Y. Zhu[9] & A. Zimmer[40]

RIKEN Genome Exploration Research Group Phase I Team: P. Carninci[2], N. Hayatsu[1], T. Hirozane-Kishikawa[1], H. Konno[1], M. Nakamura[1], N. Sakazume[1], K. Sato[6], T. Shiraki[1] & K. Waki[1]

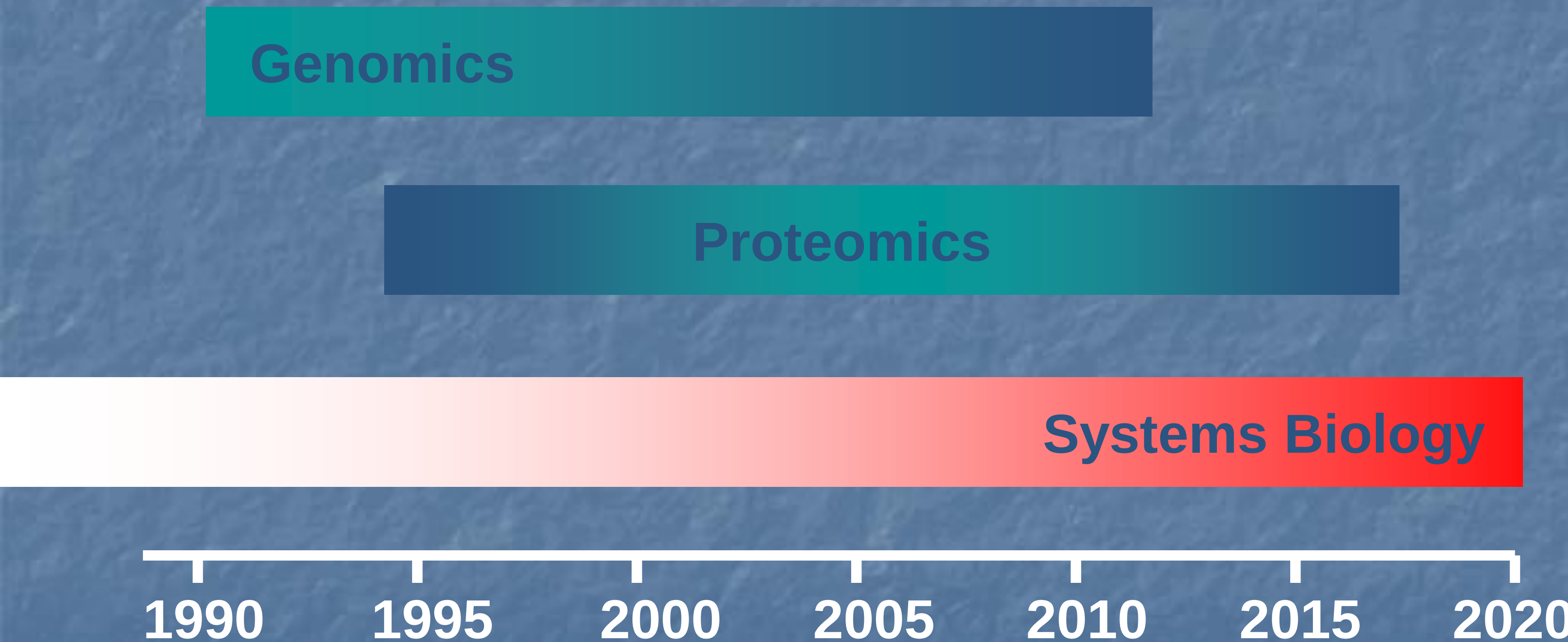
RIKEN Genome Exploration Research Group Phase II Team: J. Kawai[1,2], K. Aizawa[1], T. Arakawa[1], S. Fukuda[1], A. Hara[1], W. Hashizume[1], K. Imotani[1], Y. Ishii[1], M. Itoh[2], I. Kagawa[1], A. Miyazaki[1], K. Sakai[1], D. Sasaki[1], K. Shibata[2], A. Shinagawa[1], A. Yasunishi[1] & M. Yoshino[1]

Mouse Genome Sequencing Consortium: R. Waterston[41], E. S. Lander[42], J. Rogers[38] & E. Birney[13]

Scientific management: Y. Hayashizaki[1,2,4,6]

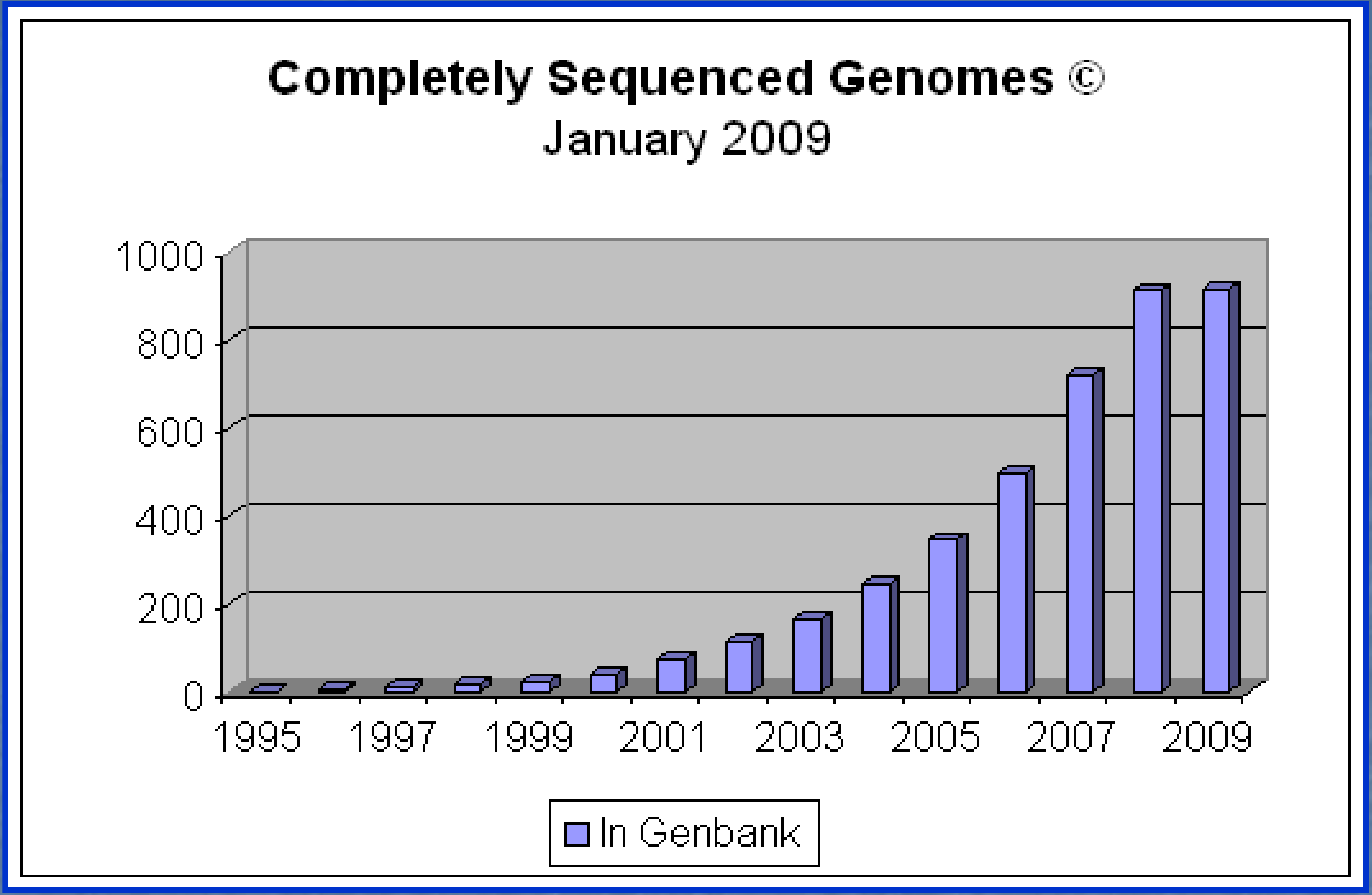
Nature vol. 420, p. 520 (2002)
International Mouse Genome Sequencing Consortium
Paper had 137 authors representing 8 countries

Genomics, Proteomics & Systems Biology



Source: Jonathan Wren, Univ. Oklahoma, Bioinformatics Applications ppt

Genomes onLine Database v 3.0



http://www.genomesonline.org/gold_statistics.htm#aname

Advances in High Throughput DNA Sequencing

Year	Bases Detected	Comments
1987	300/week	manual
1992	9,600/day	First Automated machines
2004	800,000/day	High Throughput (1st. Generation)
2008	300 million/day	High Throughput (2nd. Generation)
2011	40 billion/day	Super HT (2nd. Generation)


ABI 377


ABI 3730


Illumina GAIIx


Illumina HiSeq 2000

Source: J. Forrester, DNA Core Facility, University of Missouri

Advances in DNA Sequencing

Robert DePinho
Professor of Genetics
Department of Medicine and Genetics
Harvard Medical School, Dana-Farber Cancer Institute

"…one nine-day run on Illumina in a lab is equivalent to all of the sequencing that was done by all of the sequencing centers and (their) hundreds of sequencing platforms in 2009."

Genome Technology
April 2011

365 days to 9 days in 2 years

These advances that have sharply reduced the cost of sequencing have made the **1000 Genome Project** feasible. This project is to sequence the genomes of a large number of people, to provide a comprehensive resource on human genetic variation.

Census of Marine Life 2000 to 2010

Lot’s more science to do!

2,700 scientists
80+ nations
540 expeditions
US$ 650 million
2,600+ scientific publications
6,000+ potential new species

•About 250,000 marine species have been described in the scientific literature.

•An estimated 750,000 more species remaining to be described.

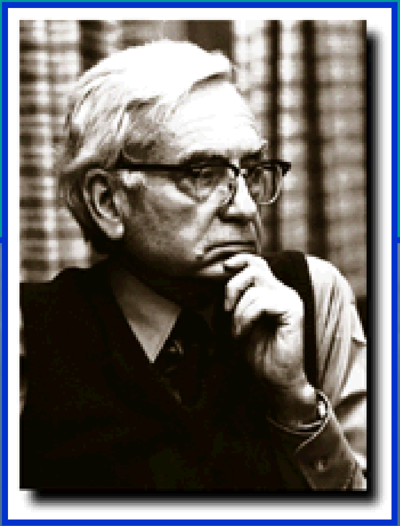
•These estimates do not include microbes.

www.coml.org/

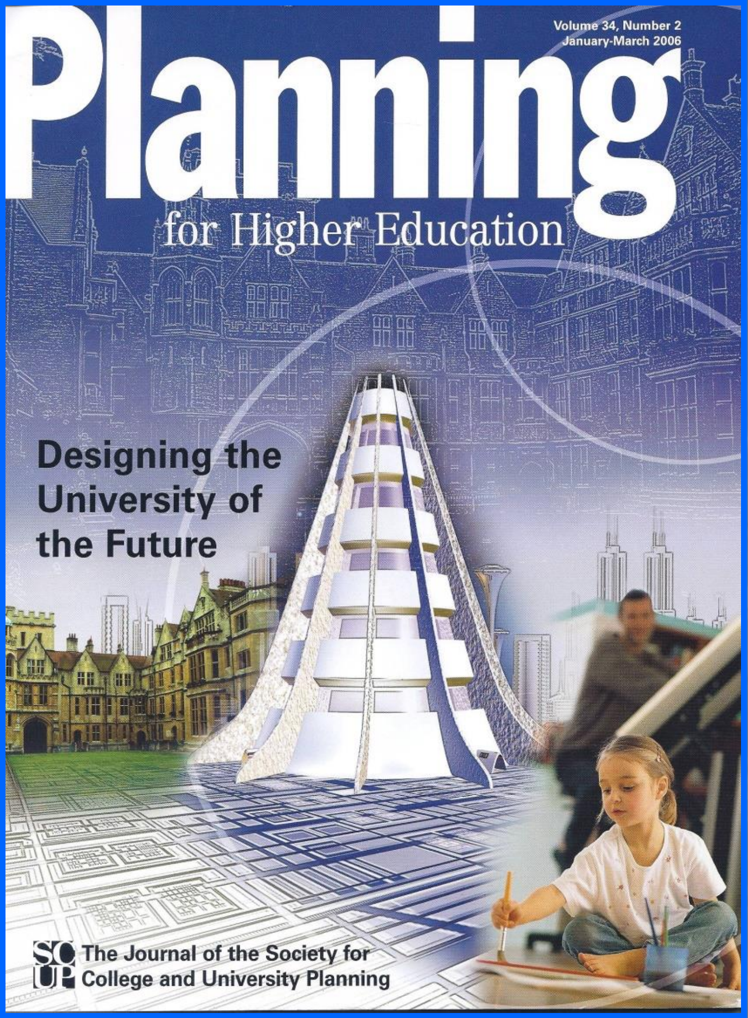
University-Society Connection

"Our society is mission-oriented. Its mission is resolution of problems arising from social, technical, and psychological conflicts and pressures ..... "

"The university by contrast is discipline-oriented. Its viewpoint is the sum of the viewpoints of the separate, traditional disciplines that constitute it….."



Alvin M Weinberg (1915-2006),
Nuclear Physicist & Administrator
Oak Ridge National Laboratory
From: *Science and the University*
Edited by B. R. Keenan,
Columbia Univ. Press (1966)



Factors Defining the Future University

- Financial challenges
- Collaboration with industry
- Increasing student population & greater diversity
- New patterns of teaching & learning
- Growth of interdisciplinary fields of knowledge
- Openness to the community

Hashimshony, R. & Haina, J. (2006) Designing the University of the Future. Planning for Higher Education 34(2): 5-19.

How Universities Foster Interdisciplinary Research

Stimulate interdisciplinary groups through financial and administrative support.

Direct institutional resources into initiatives to advance interdisciplinary research programs in high-profile resource–intensive fields.

Build modern interdisciplinary facilities that promise to establish new, flexible organizational arrangements for research.

Source: Sa, C. (2007) Planning for Higher Education 35(2): 18-28

Agriculture Building

Erected 1958-1960

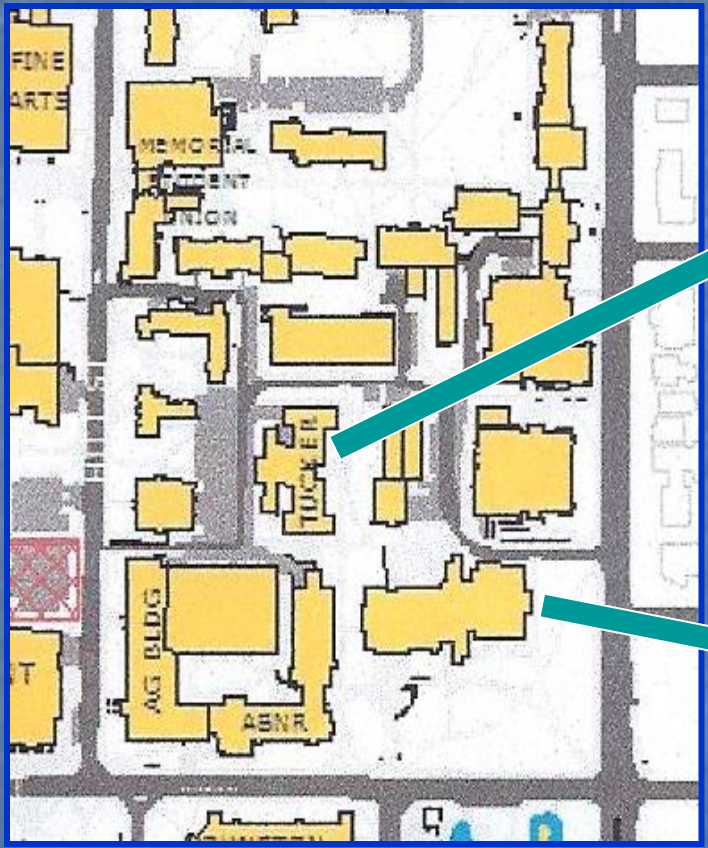
Science Building design Influences over 40 Years

University of Missouri Campus

Bond Life Sciences Center

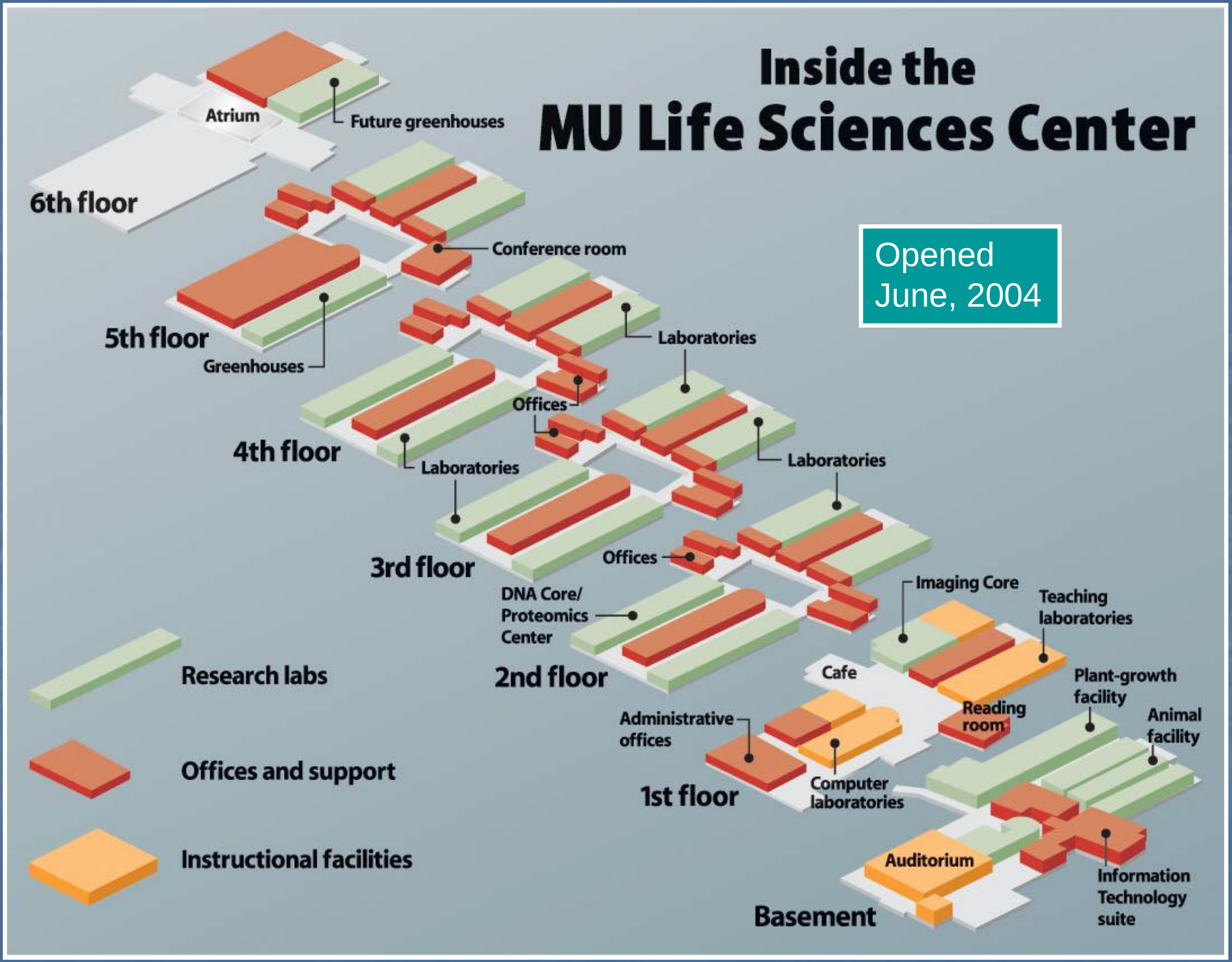
Erected 2002-2004

Science Building Design Influences Over 35 Years
University of Missouri Campus



Biological Sciences Building, opened 1969

Life Sciences Building, opened 2004



Opened
June, 2004

33 Researchers in the Bond Life Sciences Center

- **11 in Plant Biology**
  Use molecular techniques to investigate plant responses to stresses, plant growth and development, and evolution. Signaling systems and genomics are particular strengths.

- **18 in Biomedicine**
  One subgroup is interested in neuromuscular phenomena, and another in virology. Animal development and inflammatory processes are well represented, as is the study of signaling systems. Model organisms include: mice, rats, *Drosophila*, yeast, and zebra fish.

- **4 in Computational Science**
  Areas include bioinformatics and biostatistics, pattern recognition, predictive models of protein structure and protein-protein interactions, and bioinformatics algorithms for systems biology.

http://bondlsc.missouri.edu/

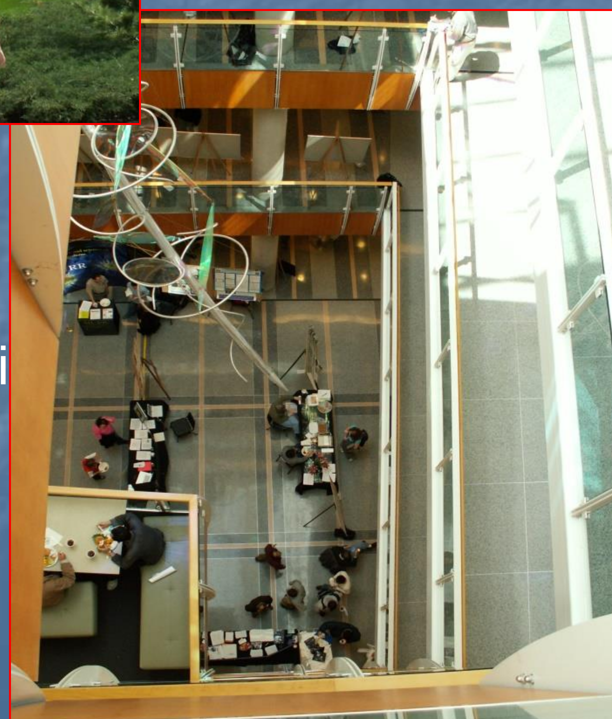
Campus Research Core Facilities, University of Missouri

- Cell and Immunobiology Core
- DNA Core*
- Electron Microscopy Core
- Informatics Research Core*
- Molecular Cytology Core*
- Nuclear Magnetic Resonance Core
- Proteomics Center*
- Structural Biology Core
- Transgenic Animal Core

* Located in Bond Life Sciences Center

Interdisciplinary BioCentre
University of Manchester

Christopher S. Bond
Life Sciences Center
University of Missouri



Recently Discovered

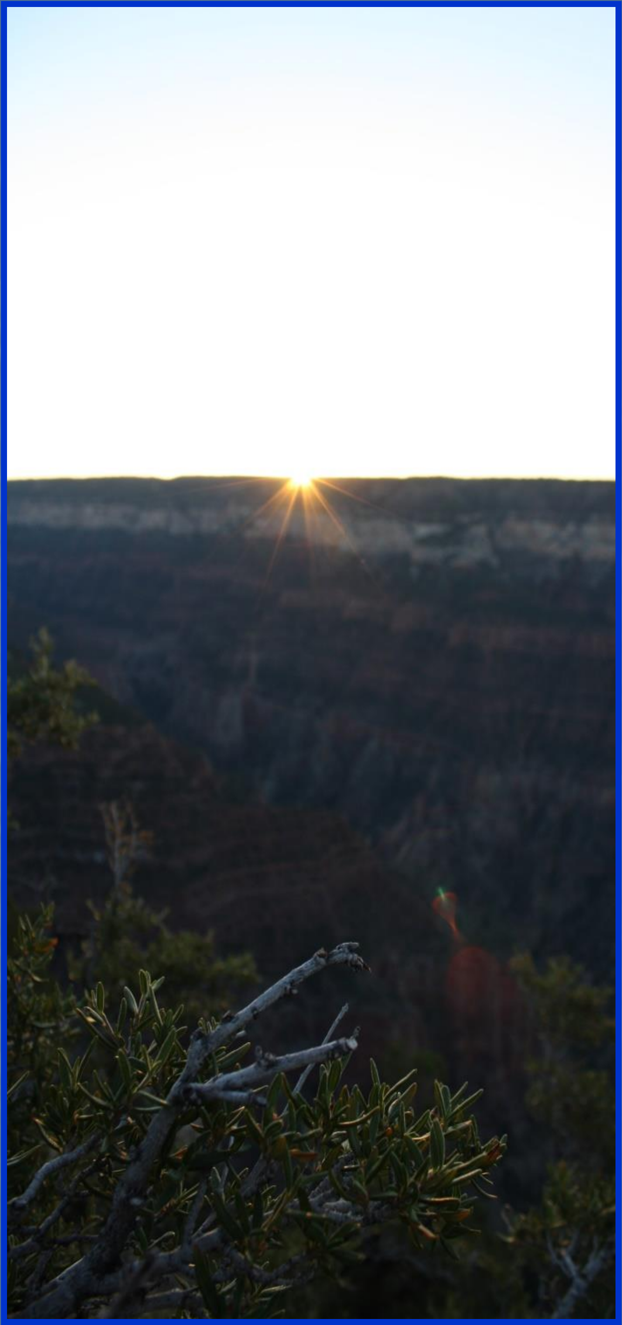
Largest Know Fossil Spider
Leg span of 15 cm

Female Orb-Weaver Spider
Nephila jurassica

Middle Jurassic 165 Ma
Inner Mongolia

Collaboration between Chinese and US Scientists

Seldon, P. A., Shih, CK, and Ren. D. (2011). A golden orb-weaver spider form the Middle Jurassic of China. April 20, 2011 Biology Letters
http://rsbl.royalsocietypublishing.org/content/early/2011/04/16/rsbl.2011.0228.full



The Age of Biology is Just Dawning

This is an exciting time to be in the field.

Sun rising over the Grand Canyon.
Photo taken from the North Rim.

June 21, 2010

Photo: Michael Chippendale

G. Michael Chippendale, PhD
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29, S. 9th. St., Suite 209
Columbia, MO 65201-4884
Cell (573) 881-5963
www.chippendaleconsulting.com

Acknowledgement

Authors of the publications & websites used to develop this presentation.

(Sources attributed and materials used under the fair-use provision for non-commercial teaching purposes.)