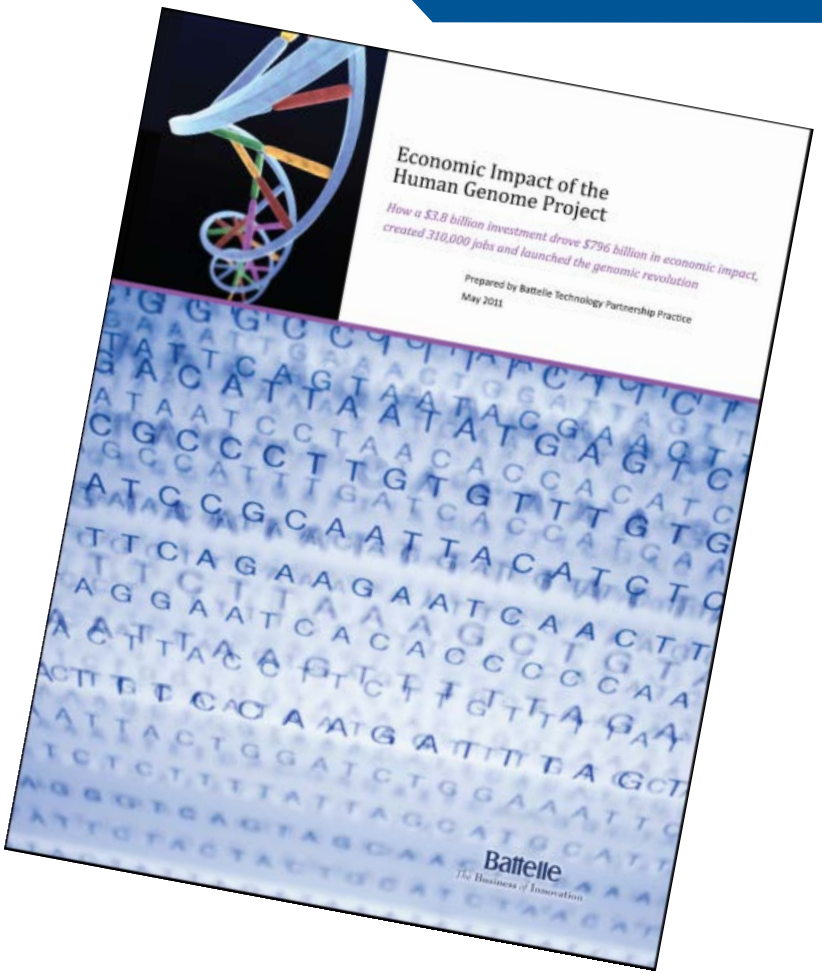
Battelle
The Business of Innovation

Research that Pays Off: The Economic Benefits of Federally Funded R&D

The Human Genome Project



Simon Tripp, Senior Director
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Technology Partnership Practice

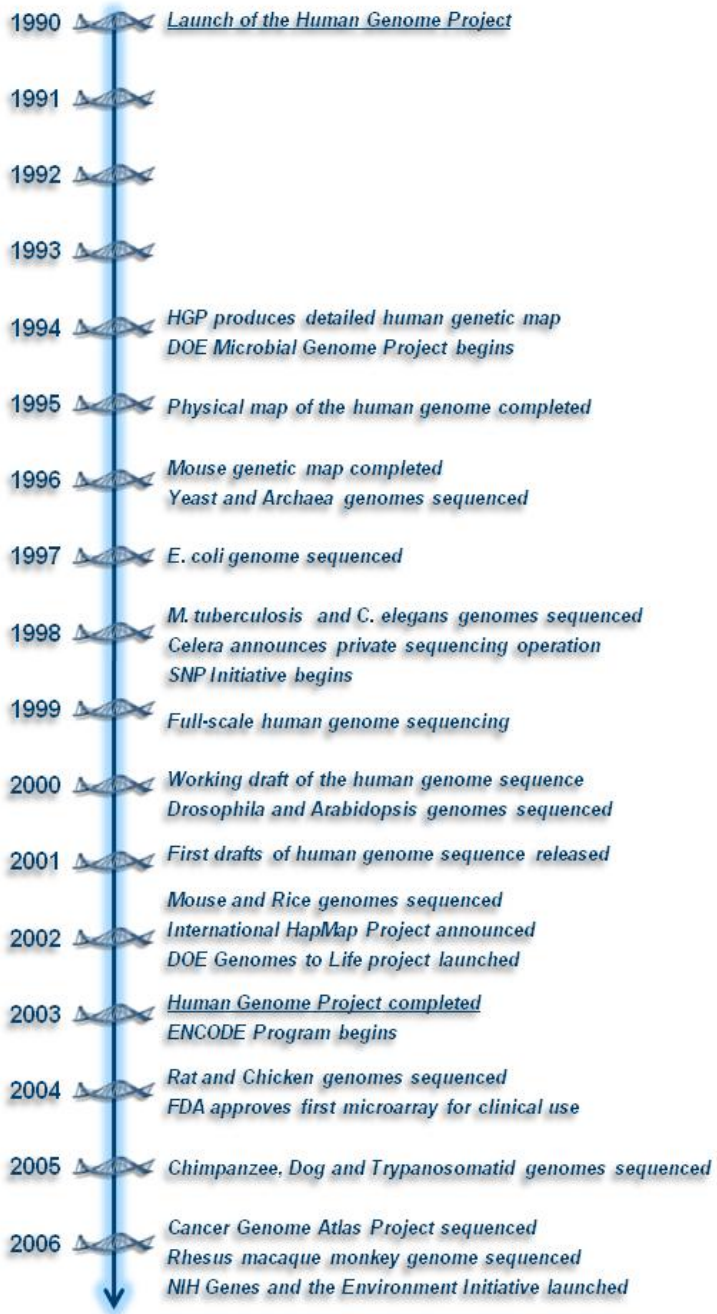
- DNA's chemical language of four repeated letters A, T, G and C produces the complete compendium of life, staggering in its scale, diversity and complexity. From single cell organisms drifting in our oceans to sentient self-aware human beings, DNA codes all life on Earth.
- Mapping the complete genome of a human would provide a new view into the inner workings of the most complex and advanced organism on the planet. Some thought it simply could not be done.
- It took a multinational team, $3.8 billion in federal funding, and 13 years…

The Human Genome Project

The Human Genome Project (HGP) refers to the international 13-year effort, formally begun in October 1990 and completed in 2003, to discover all human genes and make them accessible for further biological study. Another project goal was to determine the complete sequence of the 3 billion DNA subunits (bases in the human genome).

As part of the HGP, parallel studies were carried out on selected model organisms such as the bacterium E. coli and the mouse to help develop the technology and interpret human gene function. The DOE Human Genome Program and the NIH National Human Genome Research Institute (NHGRI) together sponsored the U.S. Human Genome Project."

Human Genome Project Information at
www.genomics.energy.gov.
Oak Ridge National Laboratory

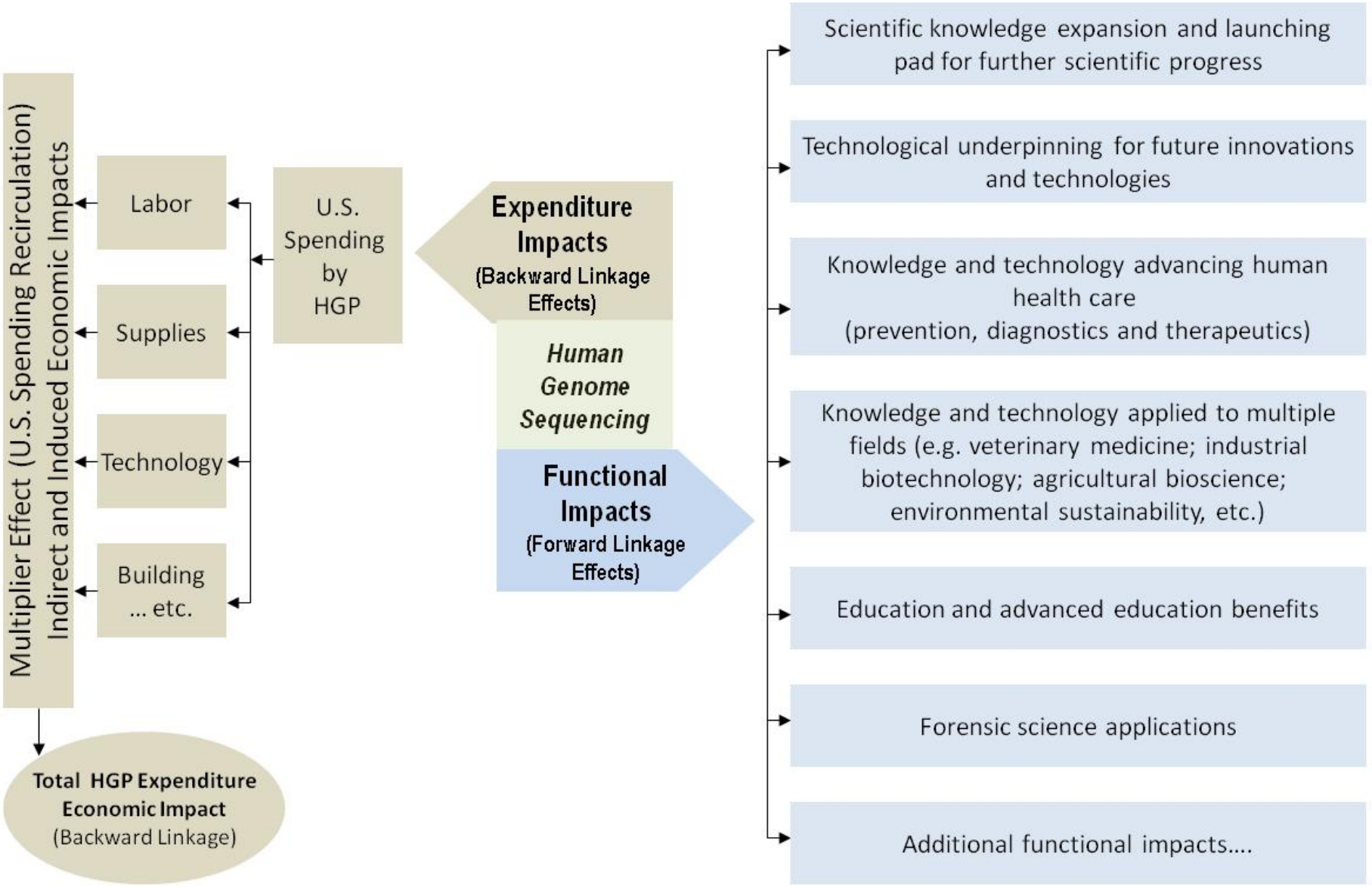


U.S. Human Genome Project Federal Funding (in Millions $)

Fiscal Year	DOE (Current $)	NIH (Current $)	U.S. Federal Total (Current $)	U.S. Federal Total (Constant 2010 $)
1988	10.7	17.2	27.9	54.0
1989	18.5	28.2	46.7	88.2
1990	27.2	59.5	86.7	160.0
1991				243.1
1992				289.5
1993				291.6
1994				321.2
1995				367.6
1996	73.9	169.3	243.2	390.5
1997	77.9	188.9	266.8	425.5
1998	85.5	218.3	303.8	448.5
1999	89.9	225.7	315.6	453.6
2000	88.9	271.7	360.6	490.1
2001	86.4	308.4	394.8	523.3
2002	90.1	346.7	434.3	548.4
2003	64.2	372.8	437.0	552.9
Totals	1,015.0	2,785.8	3,798.3	5,647.9

1988–2003 federal HGP spending totaled $3.8 billion

$5.6 billion in constant 2010 dollars



Impact of Genomics and Genomics-Enabled Industry Activity 2010

(in Millions, 2010 $)

Impact	Employment (Jobs)	Personal Income	Output	State/Local Tax Revenue	Federal Tax Revenue
Direct Effect	51,655	5,577.2	22,627.5	212.3	952.2
Indirect Impacts	109,520	7,593.1	22,725.9	922.5	1,522.8
Induced Impacts	149,185	6,835.7	21,792.6	1,244.0	1,468.4
Total Impact	**310,360**	**20,006.1**	**67,146.0**	**2,378.8**	**3,943.4**
Impact Multiplier	6.01	3.59	2.97	11.21	4.14

In 2010 alone, genomics and associated research and industry activity directly and indirectly generated:

- **$67 billion in U.S. economic output**
- **$20 billion in personal income for Americans**
- **310 thousand jobs.**

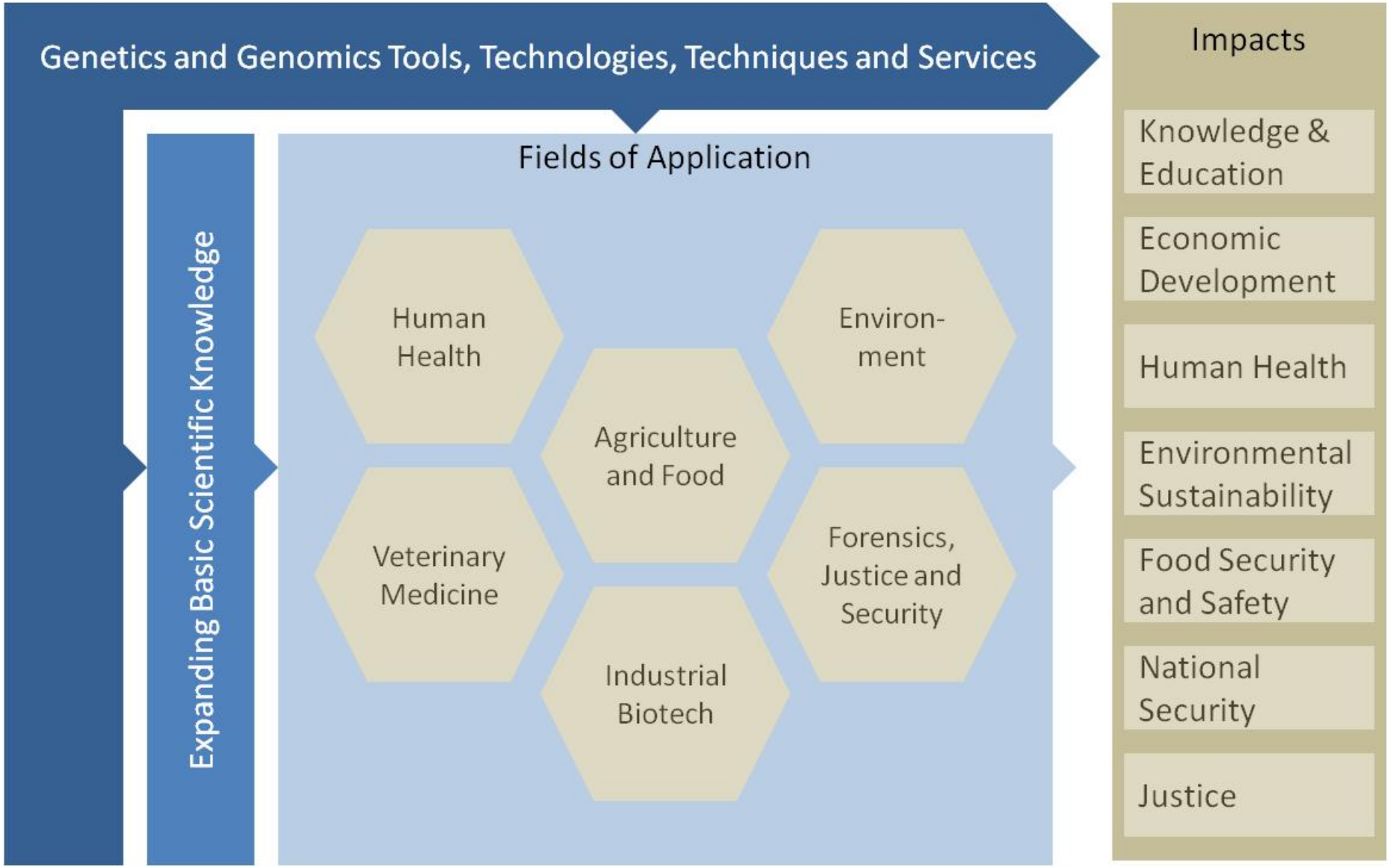
Cumulative Economic Impact of Human Genome Sequencing, 1988–2010 (in Billions, 2010 $)

Impact	Personal Income	Output	State/Local Tax Revenue	Federal Tax Revenue
Direct Effect	71.4	264.8	3.5	13.0
Indirect Impacts	89.2	265.8	10.8	18.0
Induced Impacts	83.3	265.7	15.2	17.9
Total Impact	**243.9**	**796.3**	**29.5**	**48.9**
Impact Multiplier	3.42	3.01	8.37	3.75

Between 1988 and 2010 the human genome sequencing projects and associated research and industry activity directly and indirectly generated:

- **$796 billion in U.S. economic output**
- **$244 billion in personal income for Americans**
- **$49 billion in federal taxes**

The Functional Impacts of Genomics



Molecular diagnostics

Pharmacogenomics and Drug Discovery

Regenerative medicine/ Stem cells

Tissue/Organ Donor Matching

Gene therapy

Human Remains Identification

Biosecurity (Pathogen ID/Detection)

Vaccines

Animal Models/ Comparative Genomics

Paternity Testing

Zoonotic Disease ID and Characterization

DNA Fingerprinting

Pedigree Establishment and Animal Improvement

Illegal/Endangered Animal Parts ID

Livestock Improvement and Health

Biodiversity Studies/ Metagenomics

Improved Crops (Input and Output Traits)

Pollution Control and Mitigation

Functional Foods and Nutraceuticals

Carbon Dioxide Capture

Plant Disease Diagnostics

Biofuels and Bioenergy

Mineral and Enhanced Oil Recovery

Food Processing Technologies

Biobased Chemicals and Biomaterials

National DNA Databank (CODIS)

BioPharming

Industrial Enzymes/ Biocatalysis

Drugs and Biologics Production

"An investment in knowledge pays the best interest."

Benjamin Franklin

The sequencing of the human genome has generated a startling advance in our knowledge of fundamental biological structures and molecular processes, and that knowledge is paying great dividends today and opens broad new horizons for future development. Federal funding made that possible.

Battelle's full report on the Human Genome Project is available online at:

http://www.genome.gov/27544383

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TPP Areas of Expertise

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- Core Competency Identification
- Cluster Analysis and Cluster Development
- Technology Talent & Workforce Development
- Entrepreneurial Development and Capital Planning
- Technical Assistance and Problem Solving
- Program Design and Implementation Services
- Benchmarking
- Economic Impact Assessment