

Future Directions in Genetic and Genomic Research

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Inaugural Meeting of SACGHS

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Mendel discovers laws of genetics
1865



Rediscovery of Mendel's work
1900

Garrod formulates the concept of human inborn errors of metabolism
1905



Sturtevant makes the first linear map of genes
1913

Avery, McCleod, and McCarty demonstrate DNA is the hereditary material
1944



Watson and Crick describe the double helical structure of DNA
1953

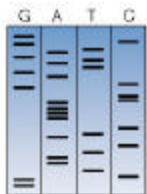
	U	C	A	G
U	Leu	Ser	Tyr	Cys
C	Leu	Pro	His	Arg
A	Ile	Thr	Asn	Ser
G	Val	Ala	Asp	Glu

Nirenberg, Khorana and Holley determine the genetic code
1966



Cohen and Boyer develop recombinant DNA technology
1972

Issuing of Belmont Report on the use of human subjects in research
1974



Sanger and Maxam & Gilbert develop DNA sequencing methods
1977

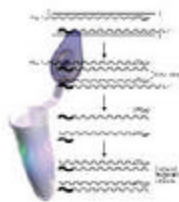


GenBank database established
1982



First human disease gene mapped with DNA markers --Huntington disease
1983

First public discussion of sequencing the human genome
1984



PCR invented
1985

International Nucleotide Sequence Database Consortium formed

Muscular dystrophy gene identified by positional cloning

First automated DNA sequencing instrument developed
1986



First-generation human genetic map developed
1987

National Research Council (U.S.) issues report on Mapping and Sequencing the Human Genome

Development of yeast artificial chromosome (YAC) cloning

Human Genome Organization (HUGO) formed
1988



Sequence-Tagged Sites (STS) mapping concept established

Cystic fibrosis gene identified by positional cloning
1989

HGP

1990

2003

1990

Human Genome Project (HGP) launched in the U.S.



Ethical, Legal, and Social Implications (ELSI) programs founded at NIH and DOE

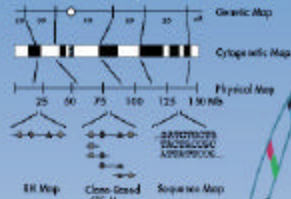


First gene for breast cancer (BRCA1) mapped



1991

First U.S. Genome Centers established



1992

Second-generation human genetic map developed



Rapid data release guidelines established by NIH and DOE

1993

New five-year plan for the HGP in the U.S. published



Sanger Centre founded (later renamed Wellcome Trust Sanger Institute)



The Wellcome Trust

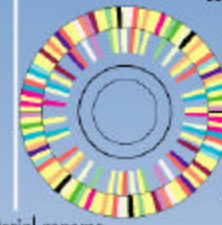
1994

HGP's human genetic mapping goal achieved



1995

HGP's human physical mapping goal achieved



First bacterial genome (*H. influenzae*) sequenced

U.S. Equal Employment Opportunity Commission issues policy on genetic discrimination in the workplace

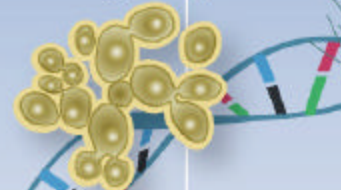
1996

First human gene map established

Pilot projects for human genome sequencing begin in U.S.

First archaeal genome sequenced

Yeast (*S. cerevisiae*) genome sequenced



HGP's mouse genetic mapping goal achieved



Bermuda principles for rapid and open data release established

1997

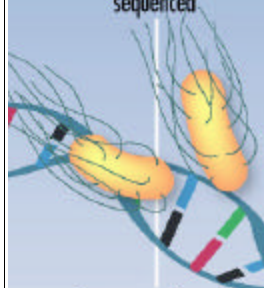
DOE forms Joint Genome Institute



NCHGR becomes NHGRI



E. coli genome sequenced



Genoscope (French National Genome Sequencing Center) founded

1998

Incorporation of 30,000 genes into human genome map

New five-year plan for the HGP in the U.S. published



RIKEN Genomic Sciences Center (Japan) established

Roundworm (*C. elegans*) genome sequenced



SNP initiative begins

GTGCT
GTCCT

Chinese National Human Genome Centers (in Beijing and Shanghai) established

1999

Full-scale human sequencing begins



Sequence of first human chromosome (chromosome 22) completed



2000

Draft version of human genome sequence completed

President Clinton and Prime Minister Blair support free access to genome information

Fruit fly (*D. melanogaster*) genome sequenced



Mustard cross (*A. thaliana*) genome sequenced



Executive order bans genetic discrimination in U.S. federal workplace

2001

Draft version of human genome sequence published



10,000 full-length human cDNAs sequenced



2002

Draft version of mouse genome sequence completed and published



Draft version of rat genome sequence completed

Draft version of rice genome sequence completed and published

2003

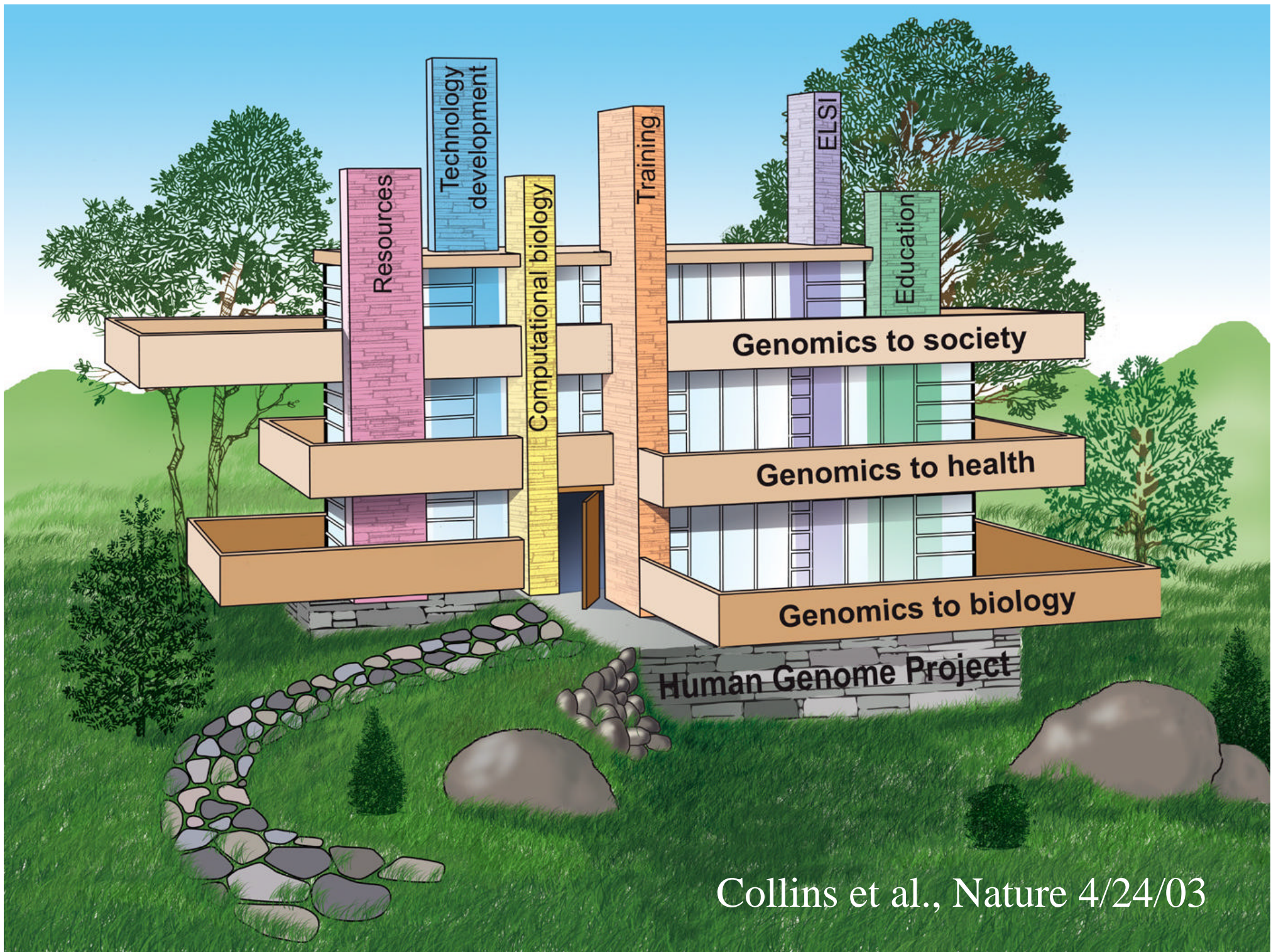
Finished version of human genome sequence completed

HGP ends with all goals achieved

to be continued..

**All of the original goals of the
Human Genome Project have
been accomplished**

What's next?



Collins et al., Nature 4/24/03

Genomics to Biology

- Define the structure of human variation
- Sequence lots of additional genomes
- Reduce the cost of sequencing a mammalian genome to \$1000 or less
- Identify all functional elements of the genome
- Identify all the proteins of the cell, and their interactions
- Develop a computational model of the cell

Genomics to Health

- Identify the genetic and environmental risk factors for all common disease
- Develop “sentinel systems” for early detection of disease and molecular taxonomy of illness
- Develop and deploy high-throughput robotic screening of small molecules for academic researchers
- Catalyze development of large human cohorts for genotype-phenotype correlations
- Elucidate the role that genomics can play in reducing health disparities
- Utilize genomics to improve health in the developing world

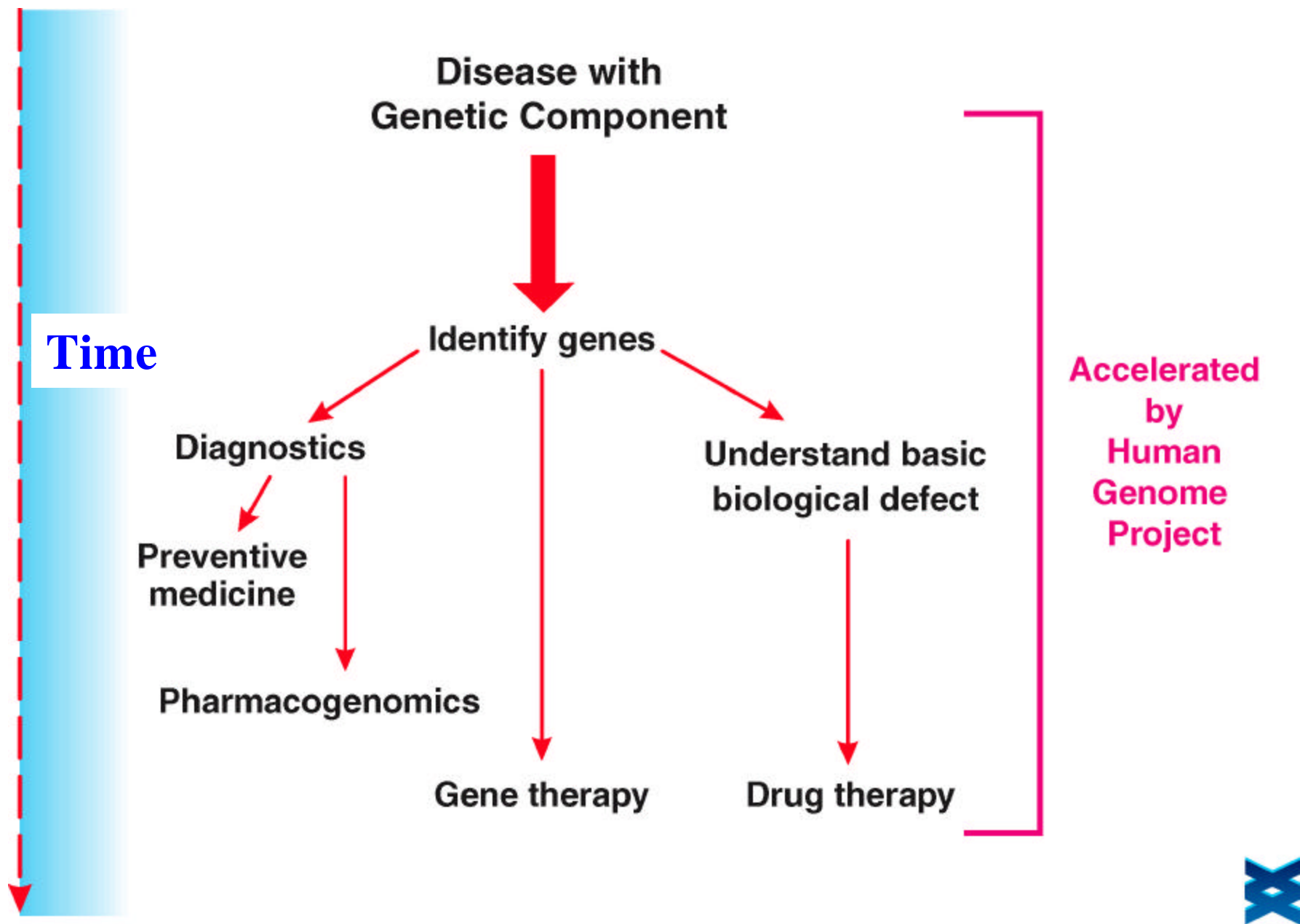
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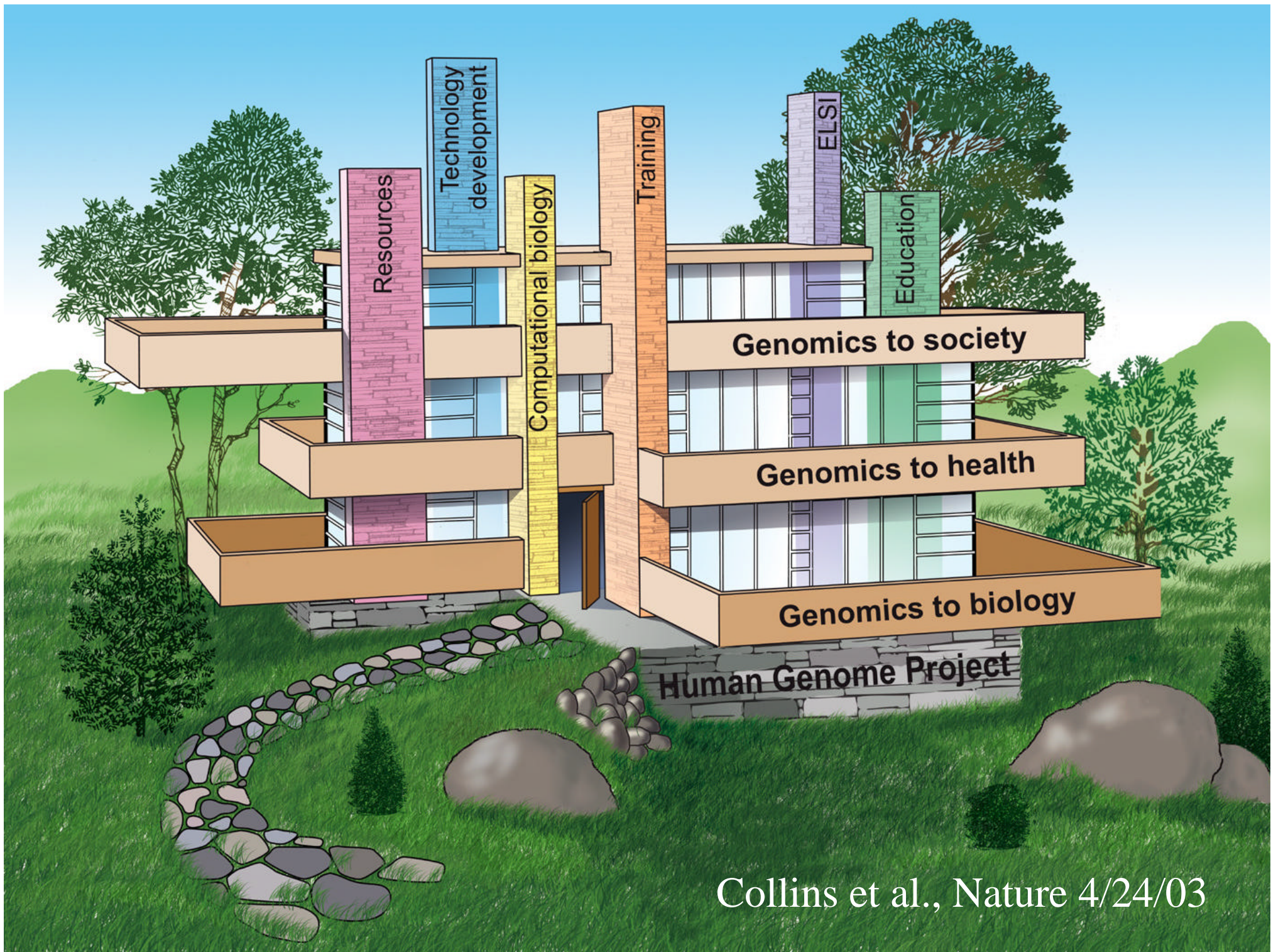
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What's needed to identify the causes of common disease

- A catalog of human variation
- A map of how that variation is organized across chromosomes
- Improved technology for genotyping and DNA sequencing
- Advanced methods for collecting environmental exposure data
- Large numbers of well-characterized individuals, followed prospectively – including healthy people

If we do this right, the major contributing genes for diabetes, heart disease, cancer, mental illness, Alzheimer's and Parkinson's disease, asthma, and response to major drug classes will be identified within the next 5 – 10 years.





Collins et al., Nature 4/24/03

Genomics to Society

- Enhance genetic privacy and protection against genetic discrimination
- Encourage appropriate patenting and licensing practices to benefit the public
- Understand the relationship of genomics, race, and ethnicity, and bring this to bear usefully on the often contentious dialog about race
- Assess the ramifications of advances in understanding genetic factors that influence behavior
- Define boundaries of the appropriate application of genomics in the non-medical arena

Possible Areas for Focus by SACGHS

- Genetic discrimination
 - Achieving a legislative solution for health insurance and the workplace
 - Developing options for life, disability, and long term care insurance
 - Need for exploration of potential discriminatory uses of genetics in adoption, education, the military...
- Genetic testing
 - Oversight to ensure clinical validity
 - Special concern: direct to consumer marketing

Genetic services on the internet?



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SMOKING/TOBACCO

WEIGHT MANAGEMENT

ADHD / ADD

PMS



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Are you compulsive? Have you ever wondered why you crave certain things in an irrational manner? Would you like to know if you have the genetic trait that leads to disruptive and addictive personalities? DNA testing can help you to understand and manage a child's behavior before it gets out of control.

Imagene will test a panel of dopaminergic related Reward Deficiency Syndrome (RDS). This will allow you to know if there is a genetic predisposition towards RDS. The Reward product line is then available to treat the symptoms of RDS.

Imagene is an at home genetic testing kit that is simple to use. See the instructions.

1. Take Foam tipped applicator and rub the inside of left cheek 25 times. Repeat with second applicator.
2. Take foam tipped applicator and rub inside of right cheek 25 times.
3. Take applicator and place inside circle of the indicator card.
4. Press and hold for 1 minute.
5. Flip and reverse Applicator and repeat step 3 within the same circle of the indicator card.
6. The pink circle turns white when the test is complete.

“Are you concerned about your children’s future? Does your child have the genetic trait that leads to disruptive and addictive personalities? DNA testing can help you to understand and manage a child’s behavior before it gets out of control.”

Possible Areas for Focus by SACGHS (cont.)

- Minimizing roadblocks to genetic research while protecting human subjects
- Optimizing delivery of genetic services in the future
 - Workforce issues
 - Access issues
 - Cross-cultural issues
 - Reimbursement issues

Plans fail for lack of counsel,
but with many advisers they
succeed.

Proverbs 14:22