The Promise and Challenges of the Human Genome Program

Aristides Patrinos
Sequence the 3.1647 billion base pairs of human DNA and identify the ~26,000 genes contained in the human genome.
First Genome
Sequenced 1995

25 thousand sequences

6.25 x 10^8 pair wise comparisons
“so we should venture on the study of every kind of animal without distaste; for each and all will reveal to us something natural and something beautiful.”

Aristotle’s “On the Parts of Animals”
Microbial Genomes

Burkholderia cepacia
Cytophaga hutchinsonii
Desulfitobacterium halfniense
Enterococcus faecium
Ferroplasma acidarmanus
Magnetospirillum magnetotacticum
Nitrosomonas europaea
Prochlorococcus marinus
Pseudomonas fluorescens
Rhodobacter sphaeroides
Rhodopseudomonas palustris
Sphingomonas aromaticivorans
Thermomonospora fusca
Trichodesmium erythraeum
Xylella fastidiosa
Nostoc punctiforme
Marine synechococcus
MagnetococcusMC-1
White House Announcement
Important Dates in Genomics

1986  DOE announces Human Genome Initiative

1990  DOE & NIH join forces and launch the Human Genome Project (HGP)

2000  Completion of the working draft by the HGP and Celera

2003  Finished human genome delivered on the 50th anniversary of the Watson-Crick paper
Genome Transplantation
Ethical, Legal, and Social Implications

An integral component of the Human Genome Project
Ethical, Legal, and Social Issues Raised by Advances in Genetics

- Genetics and race
- Genomics, stem cells, and cloning
- Germline gene therapy
- Use of genetic technology for “enhancement”
- Gene patenting
- Education of the public and health providers
There is no Shortage of Concerns

- Insurance
- Employment
- Criminal justice
- Patenting
- Medical diagnosis & therapy
The Sequence is Only the Beginning

- The rest of biology
- Medicine
- Data issues
- Informatics
- Intellectual property
- Ethical, legal, and societal concerns
2010

- Predictive genetic tests available for a dozen conditions
- Interventions to reduce risk available for several of these
- Gene therapy successful for several conditions
- Many primary care providers begin to practice genetic medicine
- Reasonably effective federal legislative solutions to genetic discrimination and privacy in place in U.S.
- Access remains inequitable, especially in developing world
Gene-based designer drugs for diabetes, hypertension, etc., available and highly effective

Cancer therapy is precisely targeted to molecular fingerprint of tumor

Dx/Rx pharmacogenomic approach is standard practice for many drugs

Mental illness diagnosis transformed, new therapies under study, societal views shifting
• Comprehensive genomics-based health care is the norm
  • Individualized preventive medicine available
  • Environmental factors and their interaction with genotype, pinpointed for many diseases
    • Illnesses are detected early by molecular surveillance
    • Gene therapy and gene-based drug therapy available for many diseases
• Full computer model of human cell replaces many laboratory experiments
• Average life span reaches 90 years, stressing prior socioeconomic norms
• Major anti-technology movements active in U.S., elsewhere
Proteins: The Workhorses of a Cell
Ari and Marista Patrinos at the HGP closure celebration, Smithsonian Institution, April 14, 2003

HUMAN GENOME ROW

Lyrics paraphrased by Ari Patrinos
from Bob Dylan’s “Desolation Row” (1965)

They're handing out pamphlets of the genome
With a smile on their face.
NPR is filled with geniuses.
The night is in town.
Here comes the great Jim Watson.
They've got him in a trance.
One hand's on the double helix
The other's on the tape.
And all the geniuses are restless.
They need somewhere to go.
As Francis Collins looks out tonight
From Human Genome Row.

Now, some of the gaps are stubborn.
Repeat regions are to blame.
Chemnitz's Prince Lipman
Will treat them all just the same.
All except some one and two and four.
Eight, seventeen and how.
Everybody has to do.
With what's in here for now.
And the great Francis, he's dancing.
He's getting ready for the show.
He's going to the convertible tonight.
From Human Genome Row.

So, at midnight imperial Ogden
And all his superhuman crew.
Come out and round up everyone.
Who knows more than they do.
And they bring them to Bethesda.
Where the know-it-all machine
Is dropped across their shoulder.
And then upon the screen.
Flash very tough instructions.
From program managers who go.
Check, check, check, nobody's escaping.
From Human Genome Row.

Dr. Mike, he wants the world
To fill inside Bernoulli's cup.
While all the moronic lovers
Are trying to blow it up.
Doe and Behemoth at Solomon are flitting.
They want to have a serious role.
While France and disciples
Chant “there's money on their side”.
They all play on pantomimes.
You can hear them blow.
If you lean your head out far enough.
From Human Genome Row.

Now, EOS is looking out the window.
For he feels so sad.
On her twenty-fifth birthday.
She already is an old road.
For her, nuclear waste is quite romantic.
She wears glamorous sunglasses.
Her profession is nuclear waste.
Her face is her mushroom cloud.
And though her eyes are flared upon.
From Francis' great rainbow.
She spends her time peeping.
Into Human Genome Row.

Across this town they pulled the curtain.
They're getting ready for the feast.
And the mighty Francis Collins.
A perfect song of a priest.
They're superfluous, Paulown.
To get him to feel more armed.
Then they'll kill him with self-confidence.
After conceiving into with words.
And Bernstein's leaning to Rubin.
Get exact data if you don't know.
Aristotle has been replaced.
For stealing Human Genome Row.