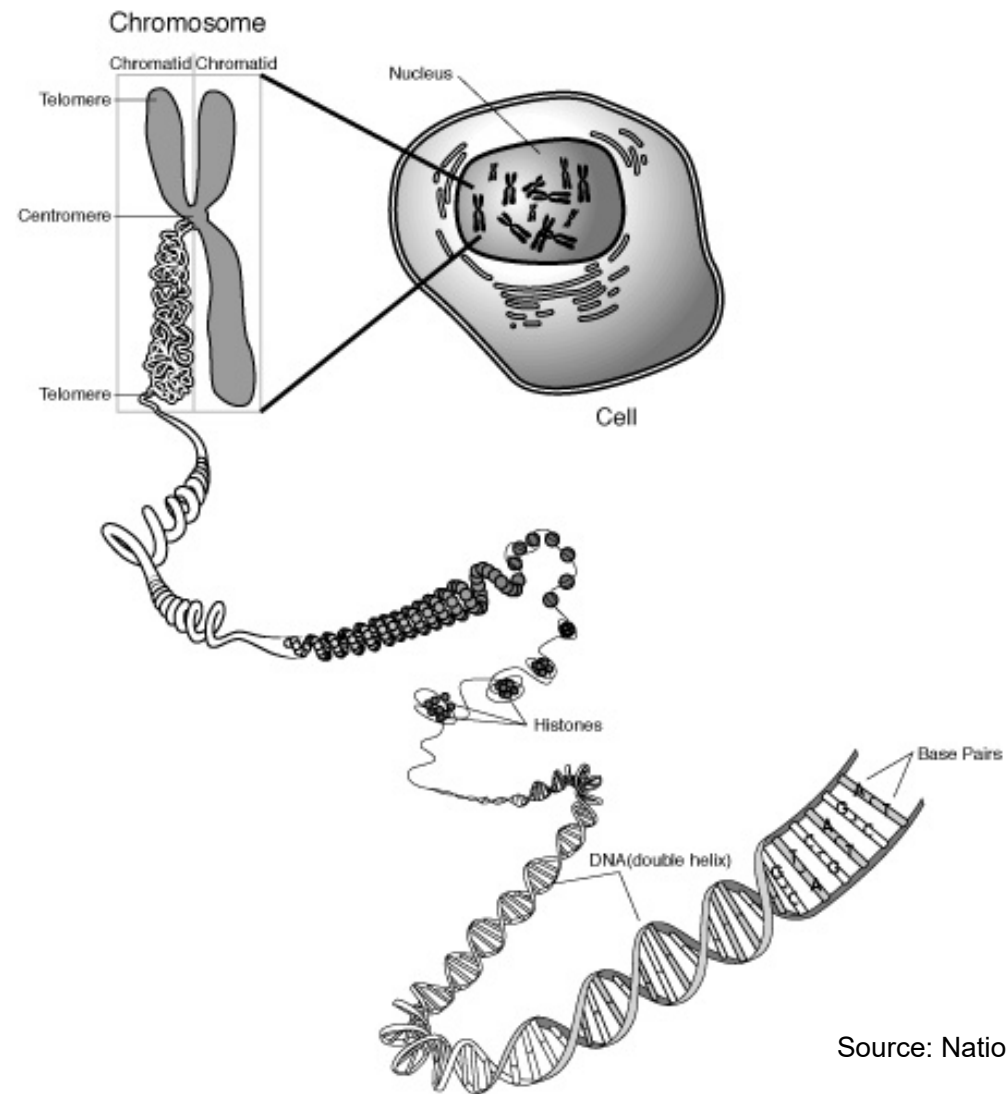


# Genomic Medicine

## A Brief Introduction

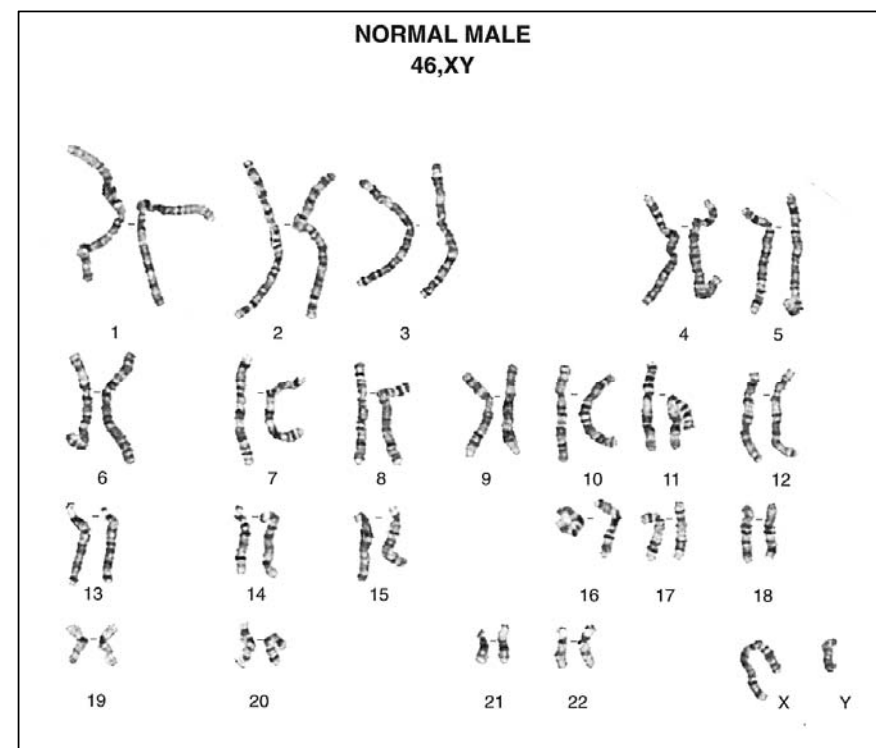
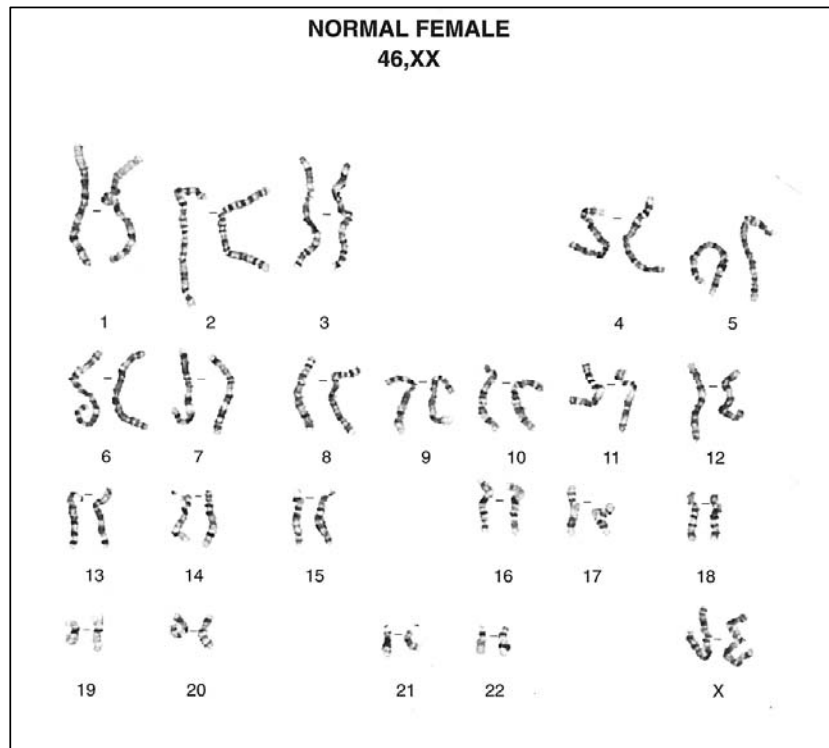
Dr. Ivan FM Lo  
Consultant Clinical Geneticist  
Department of Health  
21 Jan 2019



Source: National Human Genome Research Institute

# Chromosomes (染色體)

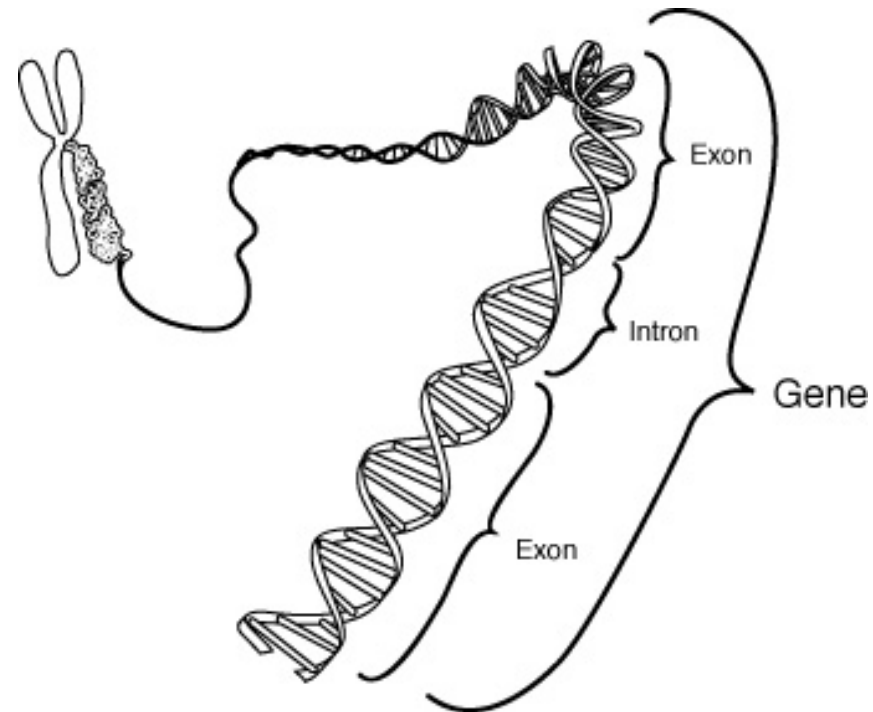
- 22 pairs autosomes (常染色體) + 1 pair sex chromosomes (性染色體)



Source: Clinical Genetic Service, Department of Health

# Gene (基因)

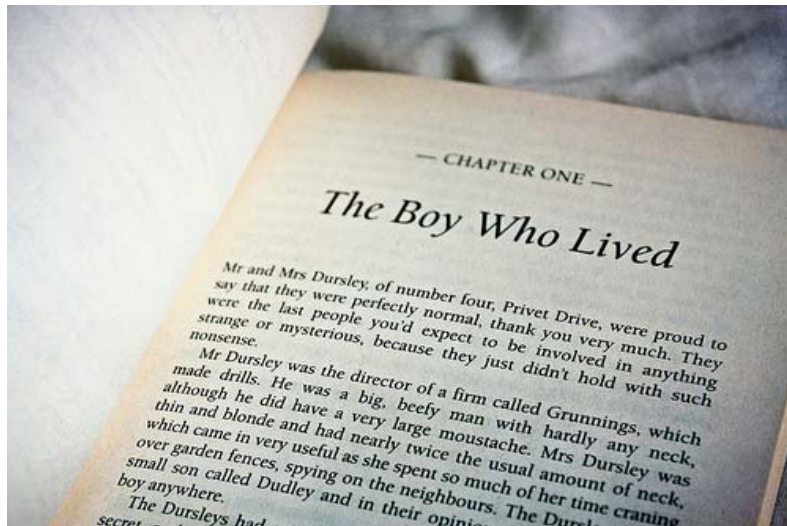
- A genes is a stretch of DNA containing a piece of information



Source: National Human Genome Research Institute

# What is a gene?

- A chapter in a library of books



Source: <https://www.miifotos.com/> (muchos-libros), and Harry Potter and the philosopher's stone first page

Our genes are written in  
4 letters – **ATCG**

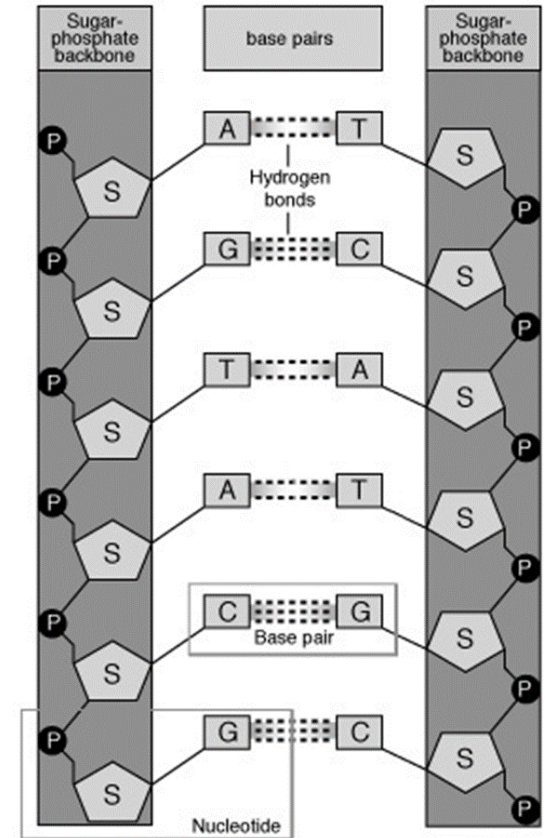
## DNA (脱氧核糖核酸)

- Discovered in 1869
- Chemical building blocks
  - Nucleotide (核苷酸):

**A**denine  
**T**hymine  
**C**ytosine  
**G**uanine



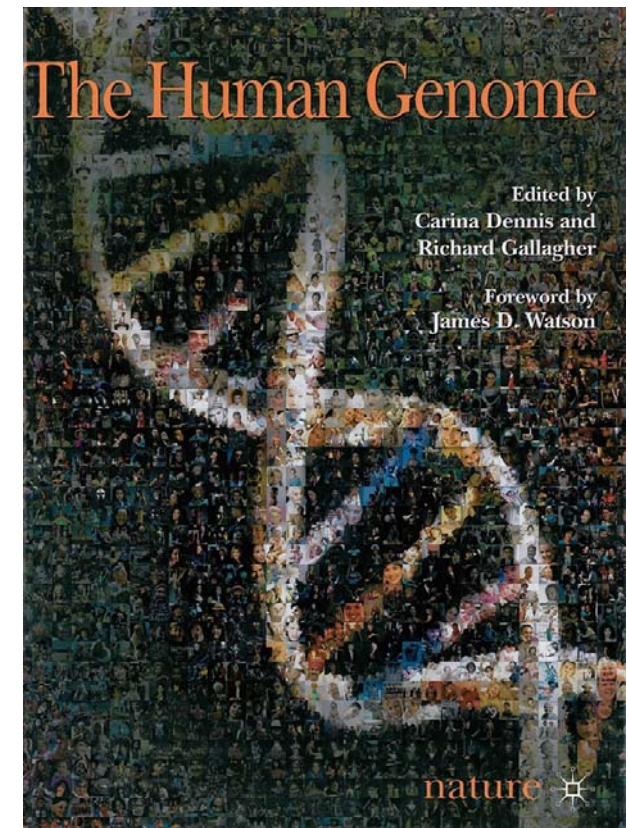
Source: Wellcome Trust



Source: Scientific Figure on ResearchGate

# Genome (基因組)

- All the genetic information needed to make a normal organism
  - The **blueprint**
- Human Genome Project (人類基因組計劃)
  - 1990 – 2003
  - To determine the sequence of the human genome and find all the genes
    - $\sim 3.2 \times 10^9$  base pairs
    - 20,000 – 25,000 genes



Source: *Nature*

# We are 98.8% chimpanzee

- Share a common ancestor 6-7 Myrs ago



Source: *Scientific American*

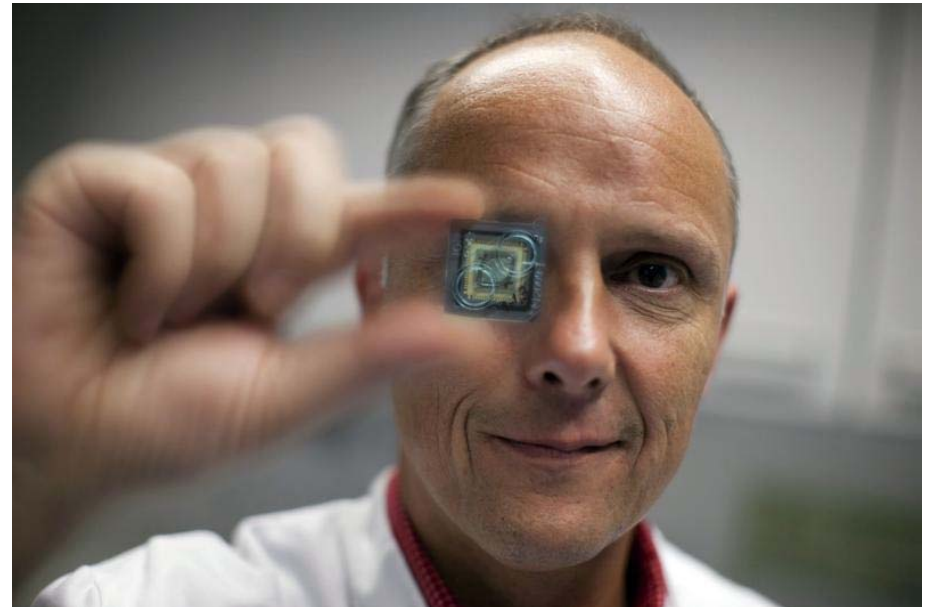


# Human genetic variation – Big or Small?

- All human beings are 99.9% identical in genetic makeup
  - Differences in the remaining 0.1% may hold important clues about the causes of health and disease.
    - 0.1% x 3.2 billion base pairs = 3.2 million variants

# Next generation sequencing

- No need of electrophoresis
- Produces gigabases of data in a week  
cf. sequencing the human genome with about 6 folds redundancy has taken over 5 years
- Capable of sequencing tens of millions of individual templates in parallel



Source: <https://www.zoonosen.net/News/articleType/ArticleView/articleId/1093/DNASequenzierung-der-zweiten-Generation.aspx>

# Genetic approach vs. Genomic approach

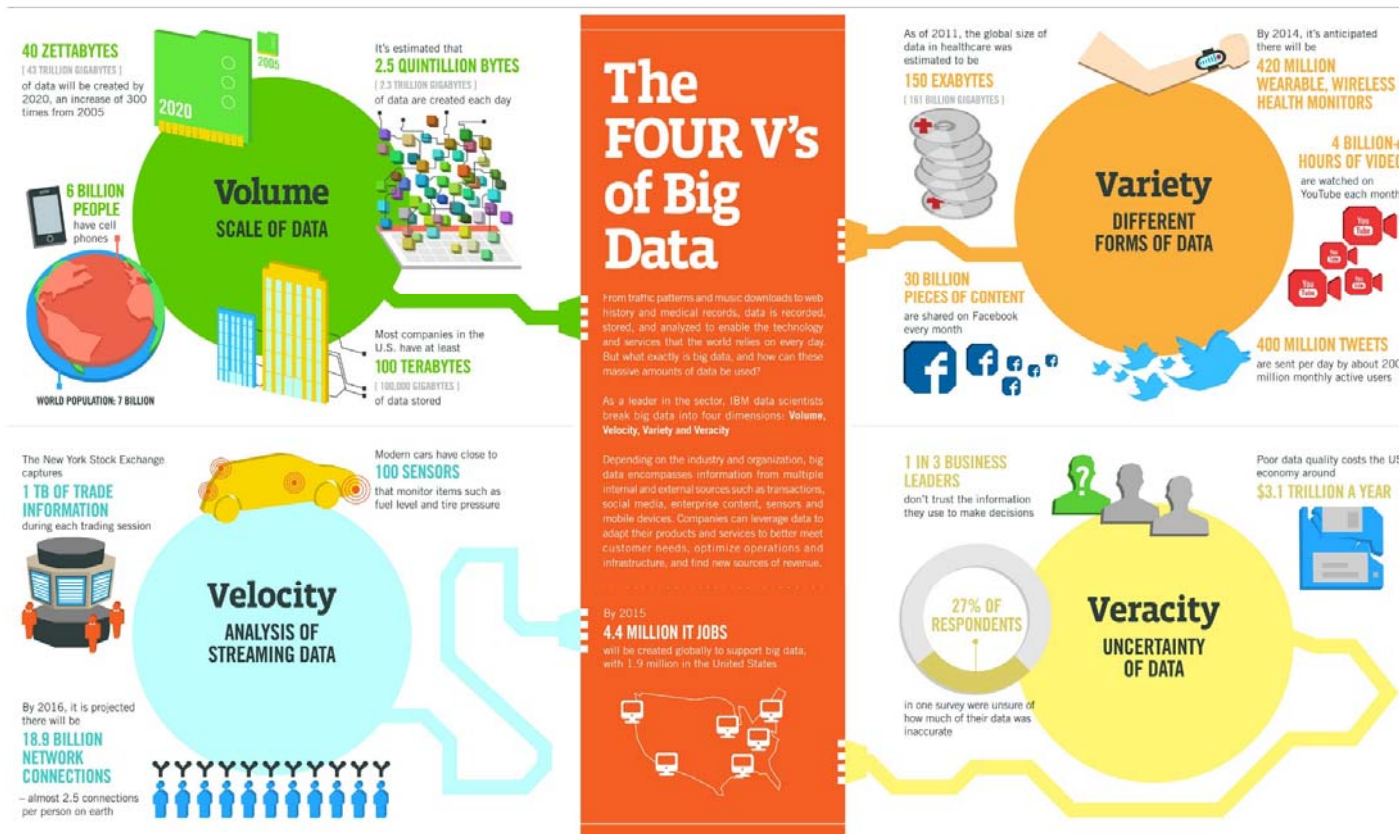


Source: Shutterstock.com



Source: Ronald de Hommel Photography

# The Era of Big Data



Sources: McKinsey Global Institute, Twitter, Cisco, Gartner, EMC, SAS, IBM, MEPEEC, GAS



Source: <http://magazine.good.is/infographics/infographic-the-four-v-s-of-big-data>

# Genes play a role in almost all diseases

Type	By 25 y.o.	After 25 y.o.	Lifetime Frequency
Chromosomal	1.8/1000	2/1000	3.8/1000
Single-gene	3.6/1000	16.4/1000	20/1000
Multifactorial (part-genetic)	46.4/1000	600/1000	646.4/1000
Somatic cell (cumulative)	-	240/1000	240/1000

Source: Rimoin DL, Connor JM, Pyeritz RE, Korf BR (2007) Emery and Rimoin's Principles and Practice of Medical Genetics. Page 49, 5th ed. Churchill Livingstone, Elsevier

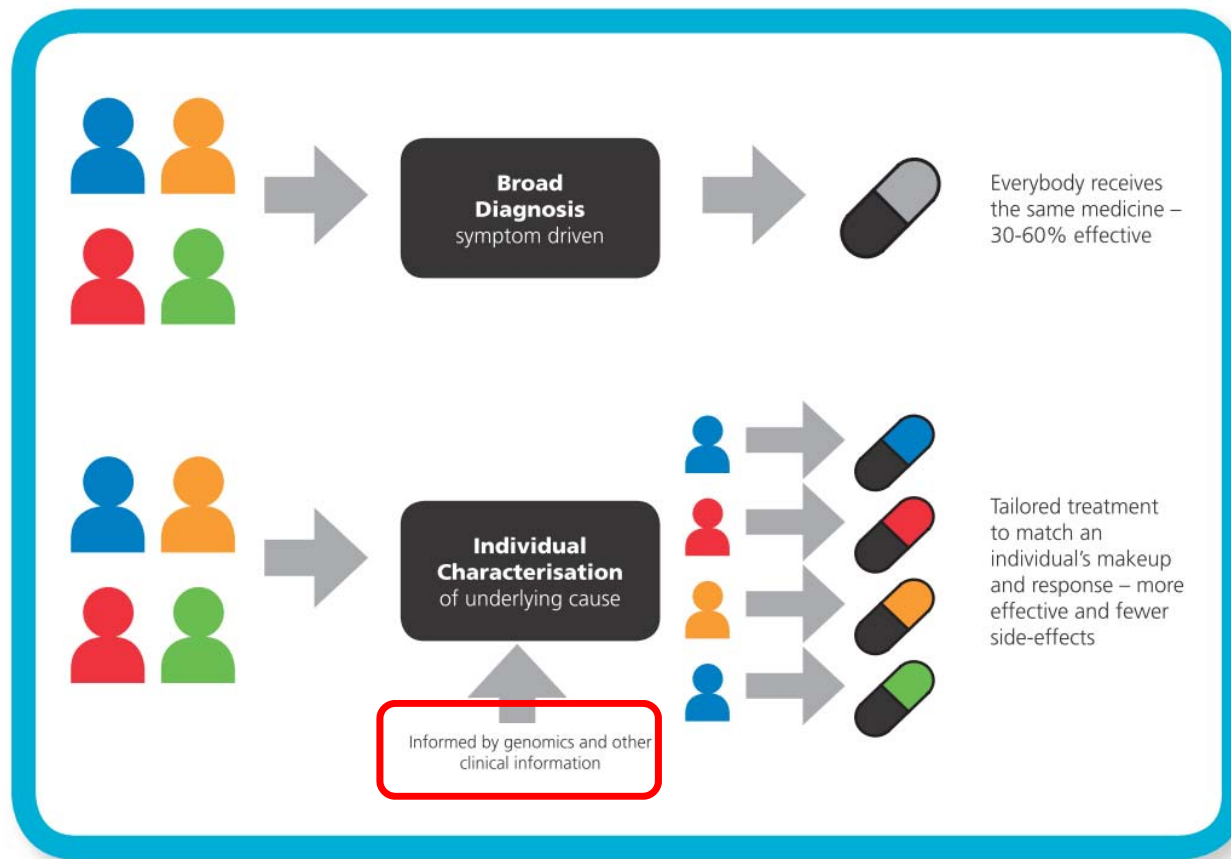
# Undiagnosed diseases

Up to 1/2019

Total 158 WES performed  
(150 probands, 8 parents)

Diagnostic yield: 40%

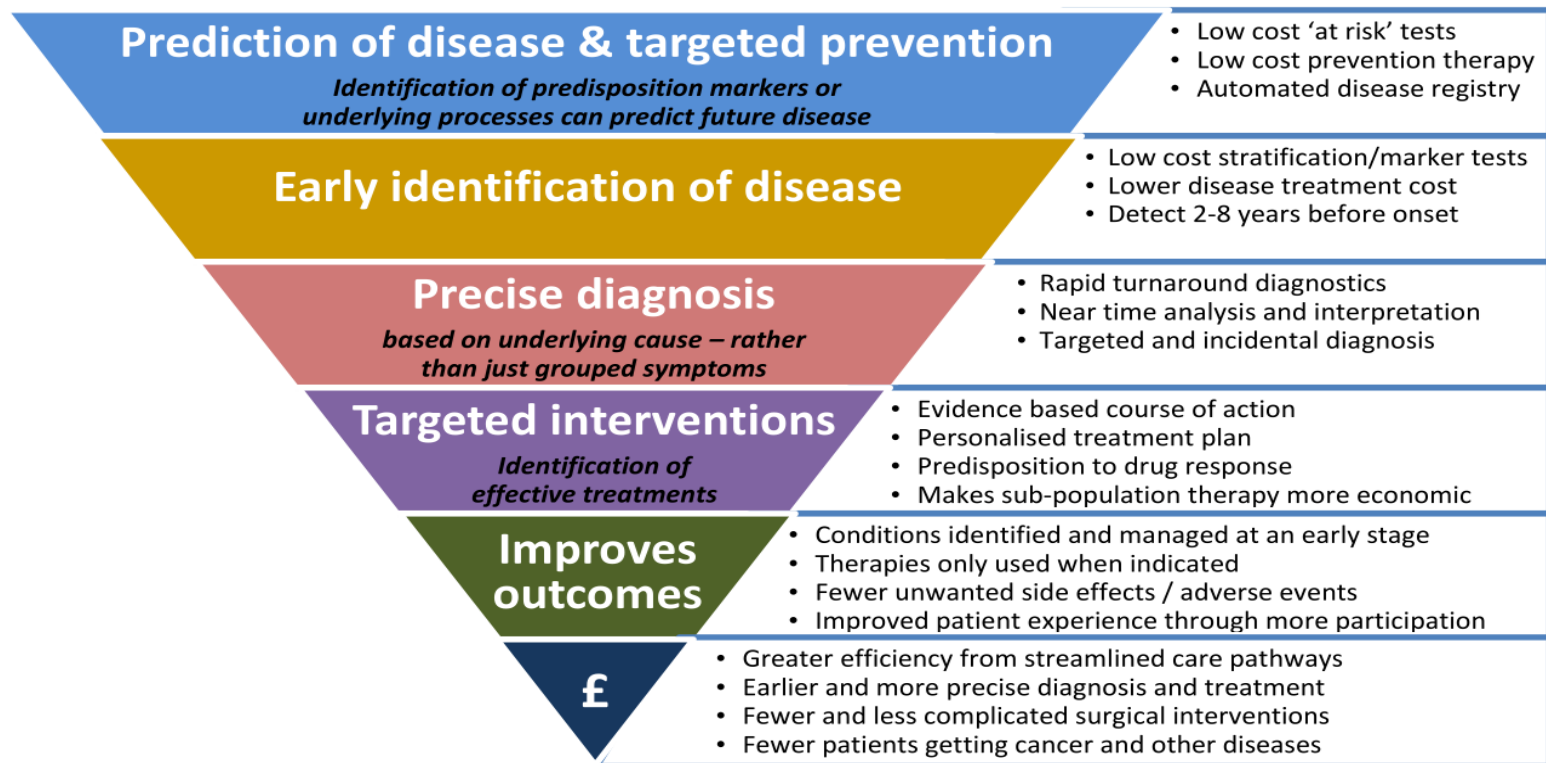
# Personalized/precision medicine



Source: NHSE Improving Outcomes through Personalised Medicine, Sept 2016

# Clinical applications

**Figure 1: Personalised Medicine – improving outcomes**



Source: NHS England. Personalised Medicines Board Paper