



22BIO211: Intelligence of Biological Systems - 2

Genome Sequencing

Dr. Manjusha Nair M
Amrita School of Computing, Amritapuri Campus
Amrita Vishwa Vidyapeetham

Genome sequencing : Milestones

1953

DNA Double Helix



1977

Sanger Sequencing



Watson & Crick

1997

Craig Venter founds Celera Genomics



Craig Venter

1980

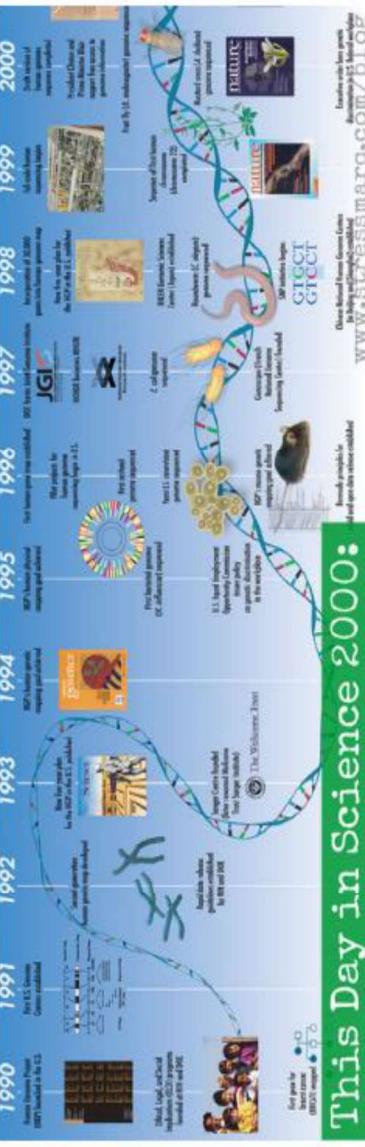
They share the Nobel Prize



Walter Gilbert

Frederick Sanger

2000



This Day in Science 2000:
First draft of the DNA sequence

BLOG

of the human genome is released

[Read more](#)

1990

The public Human Genome Project



Francis Collins

First DNA Sequencing Methods

Maxam-Gilbert sequencing

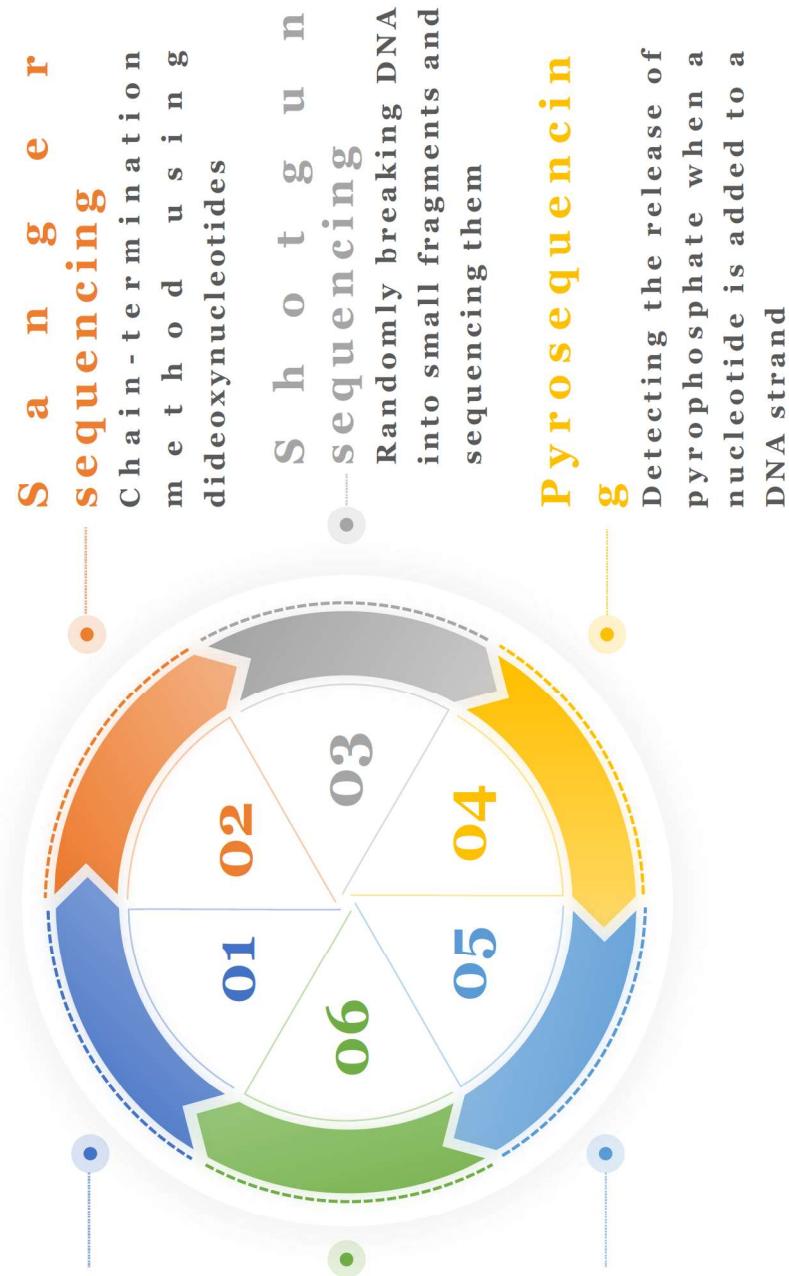
Chemical cleavage of DNA at specific bases

Ion semiconductor sequencing

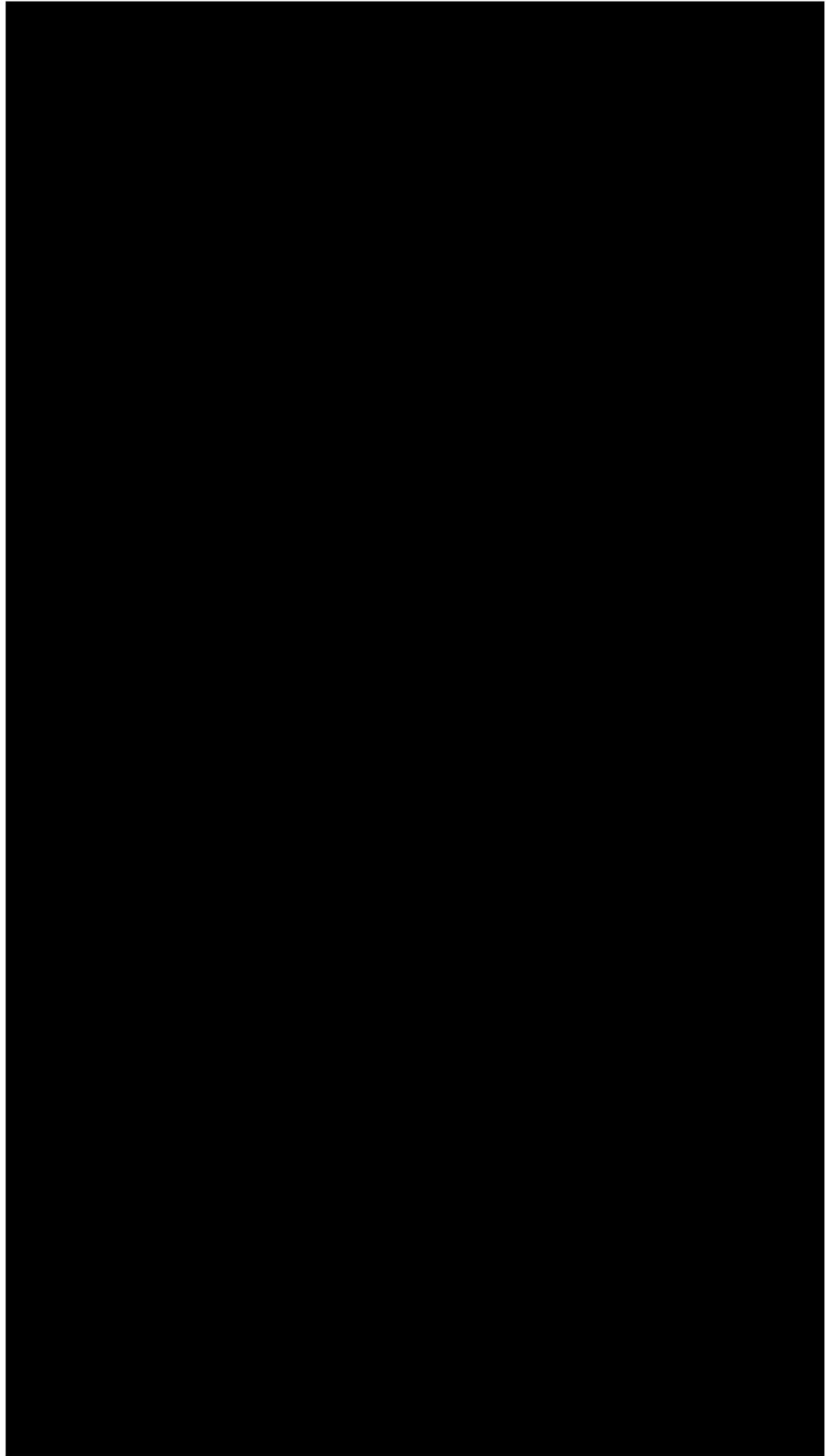
Detecting the release of hydrogen ions when a nucleotide is added to a DNA strand

Illumina sequencing

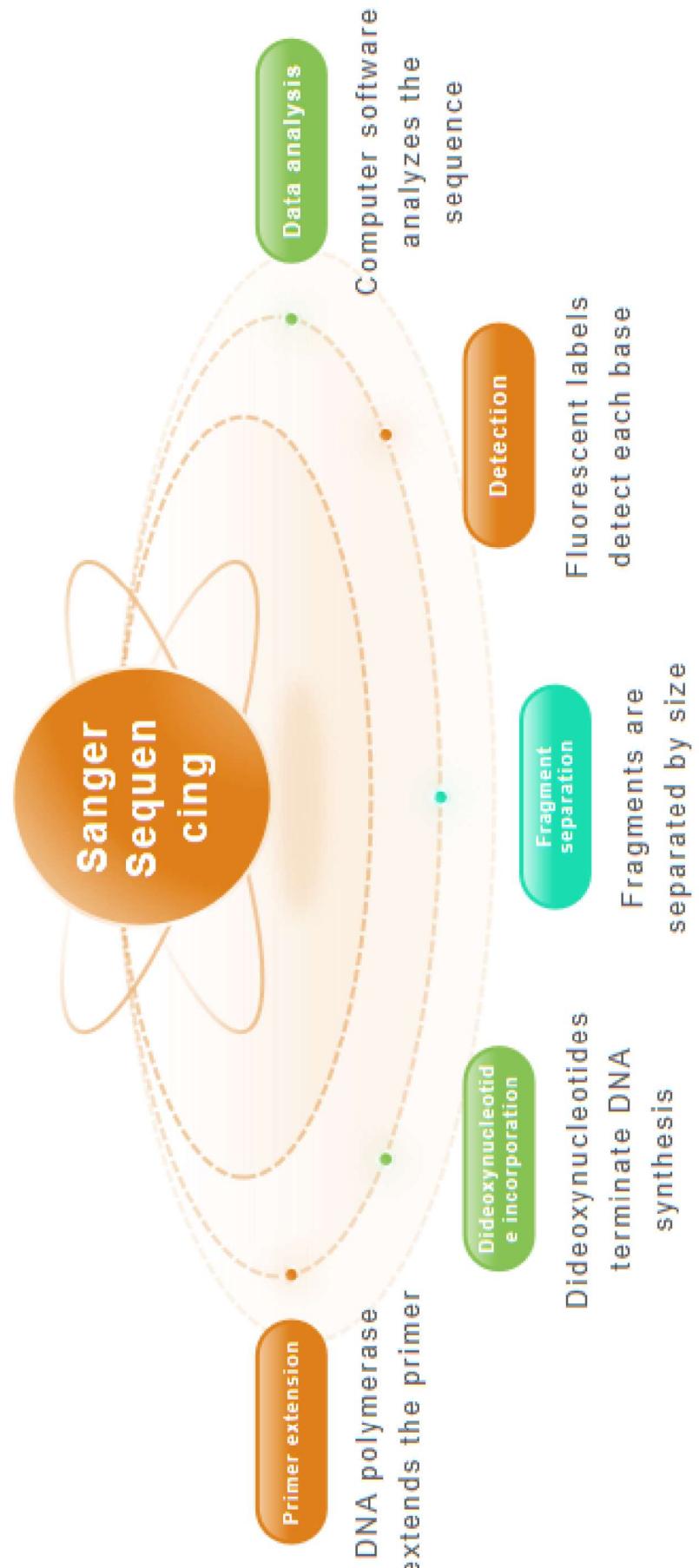
Sequencing by synthesis using reversible terminators



Classic Sanger Sequencing

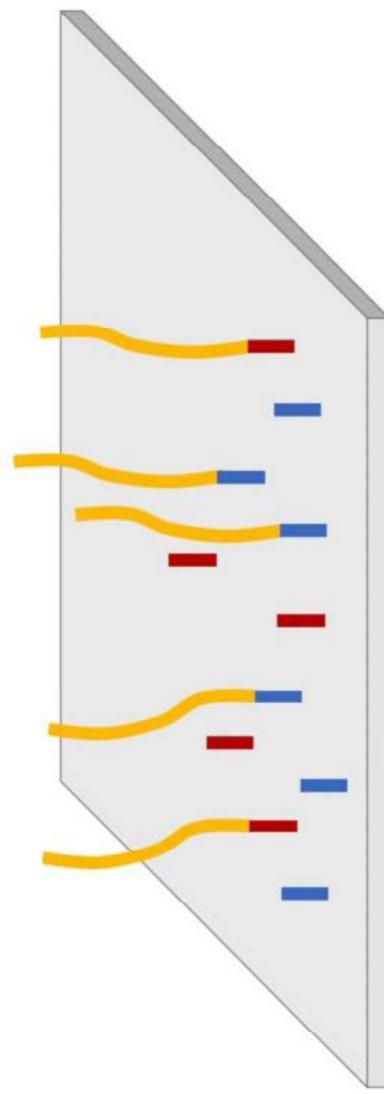


Sanger Sequencing



Next Generation Sequencing

Next Generation Sequencing



Next Generation Sequencing

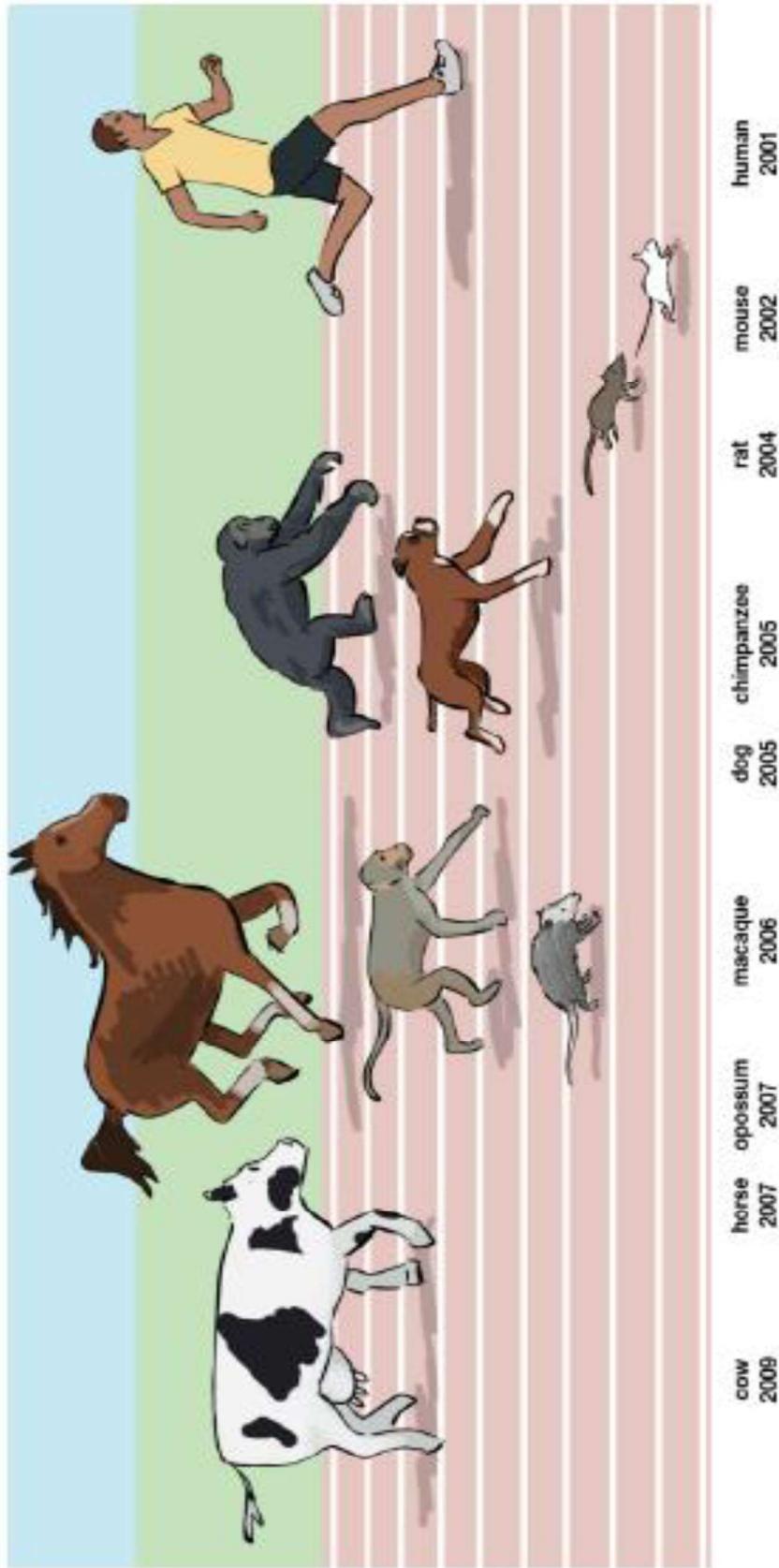
- Using capillary electrophoresis-based Sanger sequencing, the Human Genome Project took over 10 years and cost nearly \$3 billion.
- Next-generation sequencing, in contrast, makes large-scale whole-genome sequencing (WGS) accessible and practical for the average researcher.
 - It enables scientists to analyze the entire human genome in a single sequencing experiment, or sequence thousands to tens of thousands of genomes in one year

Sanger Vs NGS

- In principle, the concepts behind Sanger and NGS technologies are similar.
- In both NGS and Sanger sequencing (also known as dideoxy or capillary electrophoresis sequencing),
 - DNA polymerase adds fluorescent nucleotides one by one onto a growing DNA template strand.
 - Each incorporated nucleotide is identified by its fluorescent tag.
- The critical difference between Sanger sequencing and NGS is sequencing volume.
 - While the Sanger method only sequences a single DNA fragment at a time, NGS is massively parallel, sequencing millions of fragments simultaneously per run.

Genome sequencing : Milestones

Early 2000: Many Mammalian genomes were sequenced



Genome sequencing : Milestones

Late 2000s : Next Generation Sequencing machines were introduced



Complete
genomics

华大基因
BGI

illumina

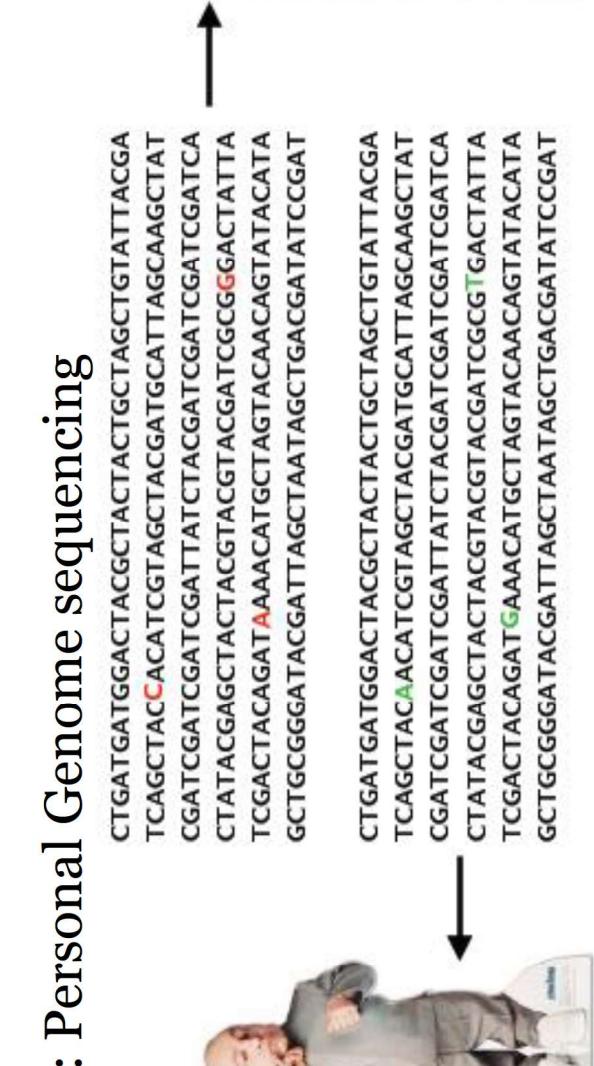
2009- Exploration of computational tools



2010 : Genome 10K

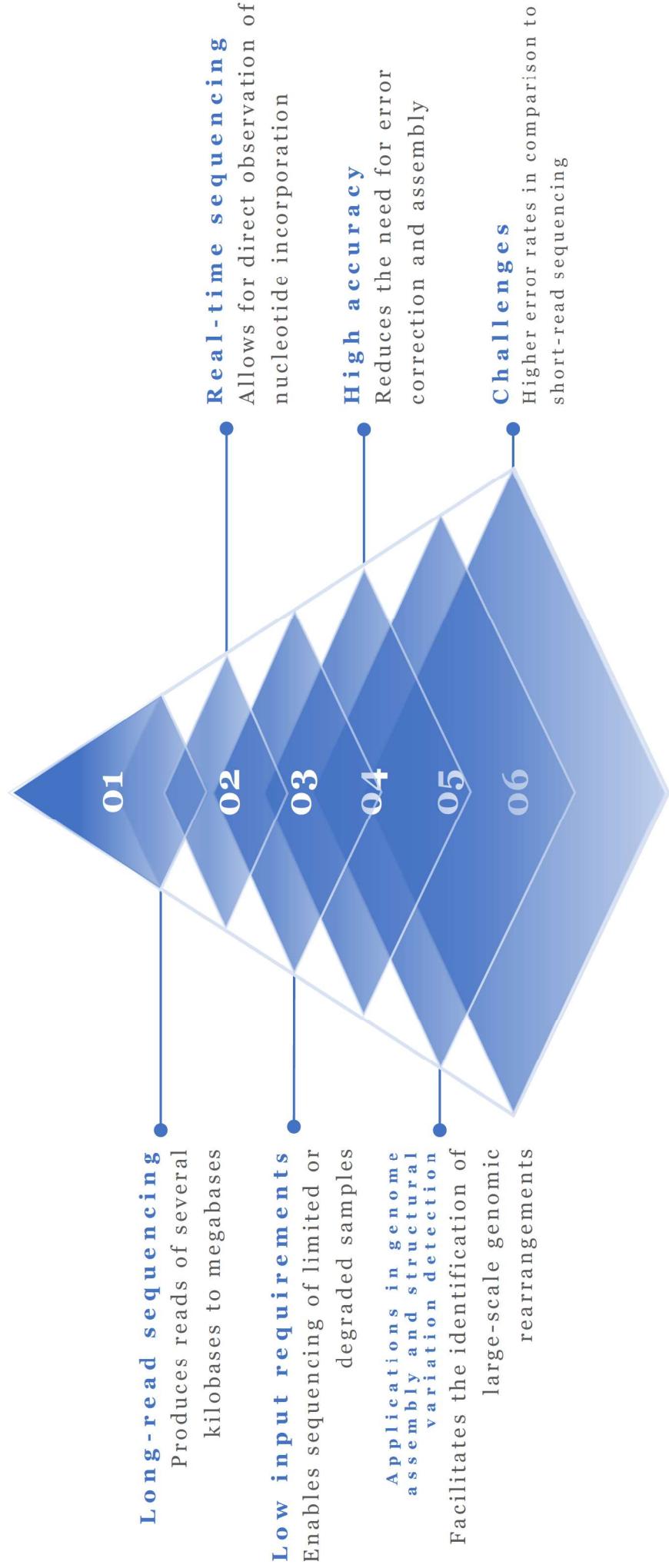
Now: Personal Genome sequencing

```
CTGATGATGGACTACGCTACTACTGCTAGCTGTATTACGA  
TCAGCTTACCACATCGATTACTAGCTACGGATGCATTAGCAAGCTAT  
CGATGGATCGATCGATTACTAGATCGATCGATCGATCA  
CTATACGGAGCTACTACGTAAGTACGGATCGCGGGACTATTA  
TCGACTACAGATAAAACATGCTAGTACAACAGTATAACATA  
GCTGCGGGATAACGATTAGCTTAATAGCTGACGATATCCGAT
```



```
CTGATGATGGACTACGCTACTACTGCTAGCTGTATTACGA  
TCAGCTTACAACATCGATTACTAGCTACGGATGCATTAGCAAGCTAT  
CGATGGATCGATCGATTACTAGATCGATCGATCGATCA  
CTATACGGAGCTACTACGTAAGTACGGATCGCGTGACTATTA  
TCGACTACAGATGAAACATGCTAGTACAACAGTATAACATA  
GCTGCGGGATAACGATTAGCTTAATAGCTGACGATATCCGAT
```

Single Molecule Sequencing



Genome Sequencing

- Whole genome sequencing: From sample to report
 - https://www.youtube.com/watch?v=rH6vsoyrc_U&t=10s
- Sanger Sequencing
 - <https://www.youtube.com/watch?v=loJWVVPt4vNw>
- Next Generation Sequencing - A Step-By-Step Guide to DNA Sequencing
 - <https://www.youtube.com/watch?v=WKAUttJQ69n8>

Genome Sequencing

- <https://www.youtube.com/watch?v=IXAmRS85hXU>
- What was the headline of the June 27, 2000 edition of the New York Times?
 - <https://movies2.nytimes.com/library/national/science/062700sci-genome.html>
- AI tailors artificial DNA for future drug development : November 25, 2022
 - <https://phys.org/news/2022-11-ai-tailors-artificial-dna-future.htm>

22BIO211: Intelligence of Biological Systems - 2

