Bioinformatics In present And Its future

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Outline

- What is Bio informatics
- History of Bio informatics
- Why Bio informatics is necessary
- Application of Bio informatics tools in various areas
- Goals of Bio informatics Fields of Bio informatics (present time)
- Molecular Medicine Molecular medicine program The human Genome
- Gene therapy
- Drug development
- Microbial genome application
- Bio Technology
- New challenge for Bio informatics research
- A data centric view of the future
- Bio informatics & the future of Bio technology

What is Bioinformatics ?

- Bioinformatics is a hybrid science that links biological data with techniques for information storage, distribution, and analysis to support multiple areas of scientific research, including biomedicine.
- Bioinformatics is fed by high-throughput data-generating experiments, including genomic sequence determinations and measurements of gene expression patterns.
- Bioinformatics = Molecular Biology + IT

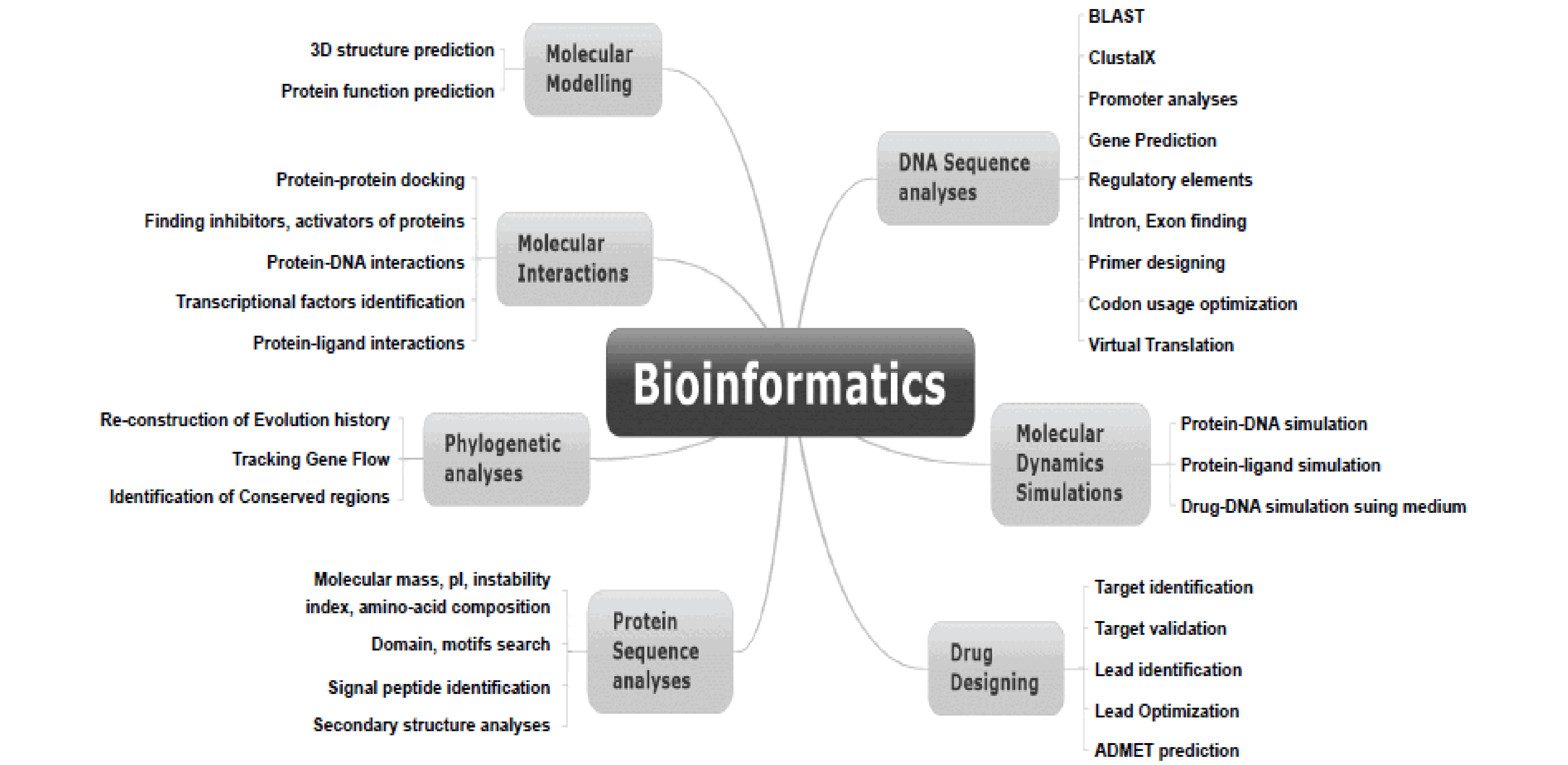


Figure 1: Application of bioinformatics tools in various areas of biological sciences.

History Of Bioinformatics:

- Robert Hooke published Micrographia in 1665
- Antoni van Leeuwenhoek discovered bacteria in 1683
- Richard Owen elaborated the distinction of **homology** and **analogy in** 1843**.**
- Gregory Mendel established the theory of genetic inheritance in 1865.
- The word "genetics" is coined by William Bateson in 1905.
- Genetic material can be transferred laterally between bacterial cells, as shown by Lederberg and Tatum in 1946.
- Sidney Brenner, François Jacob, Matthew Meselson, identify messenger RNA in 1961.
- Needleman-Wunsch algorithm in 1970.
- Smith-Waterman algorithm developed in 1981.
- National Center for Biotechnology Information (NCBI) created at NIH/NLM in 1988.
- BLAST: fast sequence similarity searching in 1990.
- First bacterial genomes completely sequenced in 1995.
- The human genome (3 Giga base pairs) is published in 2001.

Why Bioinformatics is Necessary?

- The need for bioinformatics has arisen from the recent explosion of publicly available genomic information, such as resulting from the human genome project.
- Gain a better understanding of gene analysis ,taxonomy & evolution
- To work efficiently on the rational drug designs and reduce the time taken for the development of drug manually

Goal of Bioinformatics

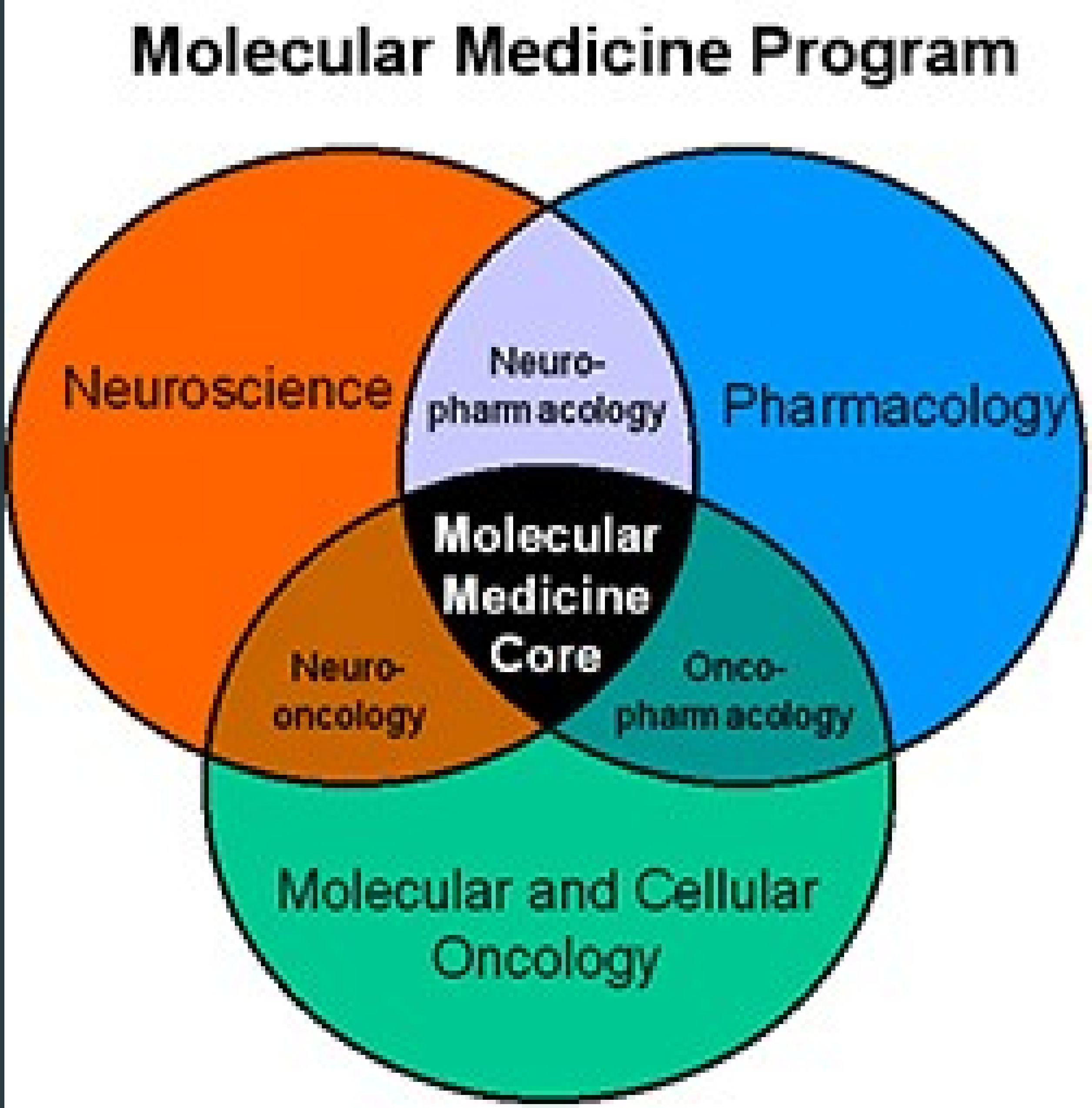
- To uncover the wealth of Biological information hidden in the mass of sequence, structure, literature and biological data.
- It is being used now and in the foreseeable future in the areas of molecular medicine.
- It has environmental benefits in identifying waste and clean up bacteria.
- In agriculture, it can be used to produce high yield, low maintenance crops.

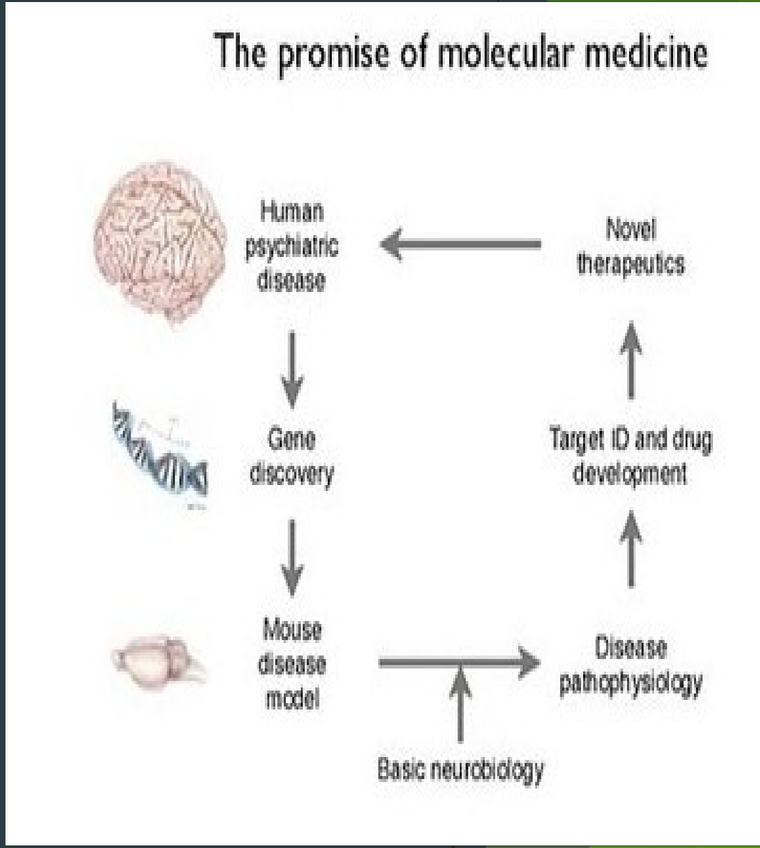
Fields of Bioinformatics(in present Time) :

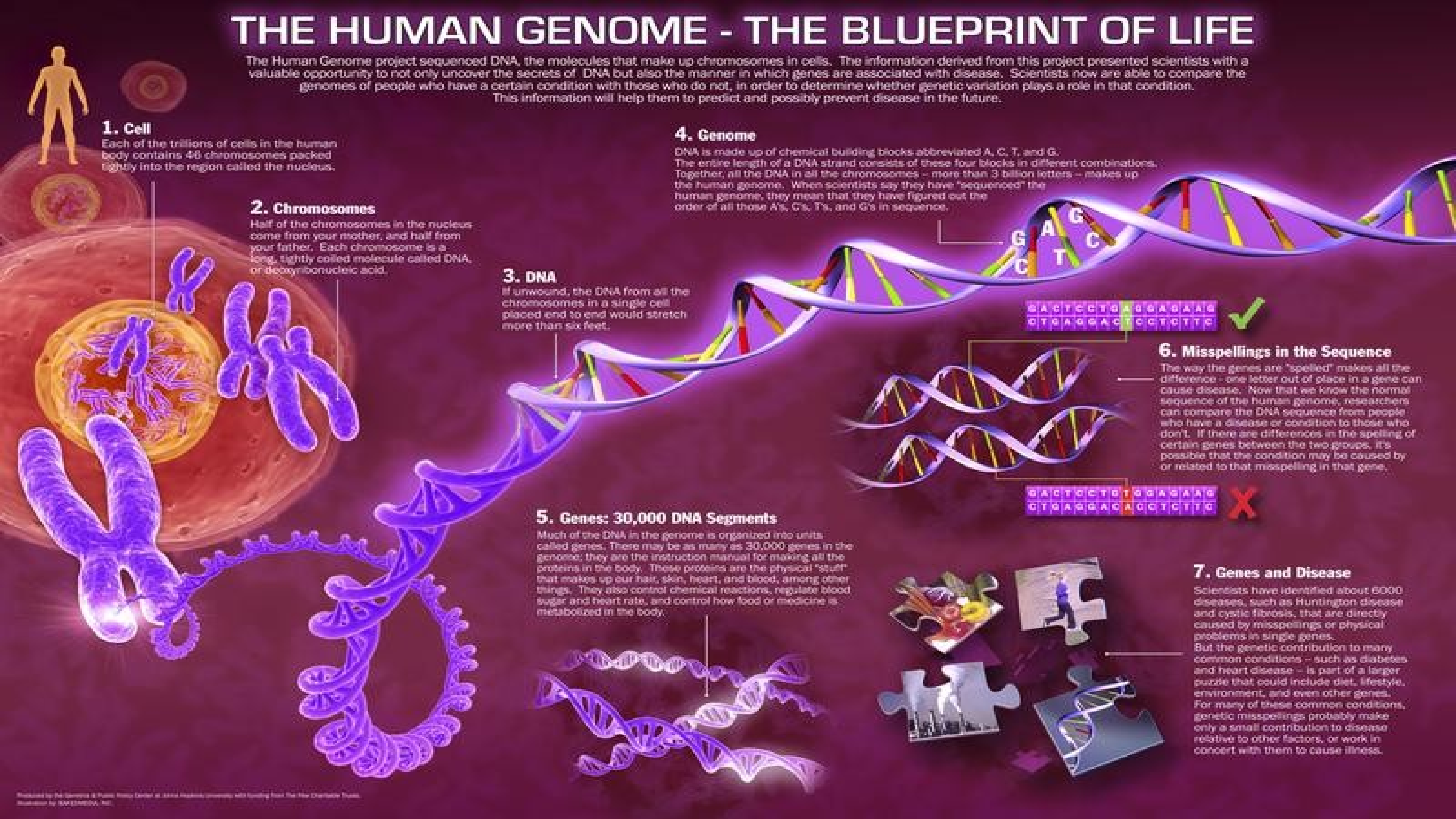
- Molecular Medicine
- Gene Therapy
- Drug Development
- Microbial genome applications
- Crop Improvement
- Forensic Analysis of Microbes
- Biotechnology
- Evolutionary Studies
- Bio-Weapon Creation

Molecular Medicine :

- Ayurveda + Modern Science + Technology = Molecular Medicine
- Human genome will have profound effects on the fields of biomedical research and clinical medicine.
- Every disease has a genetic component and inherited to body's response to an environmental stress which causes alterations in the genome (e.g. Cancers, heart disease ,and diabetes).
- The completion of the human genome means that we can search for the genes directly associated with different diseases and begin to understand the molecular basis of these diseases more clearly.
- This new knowledge of the molecular mechanisms of disease will enable better treatments , cures and even preventative tests to be developed .

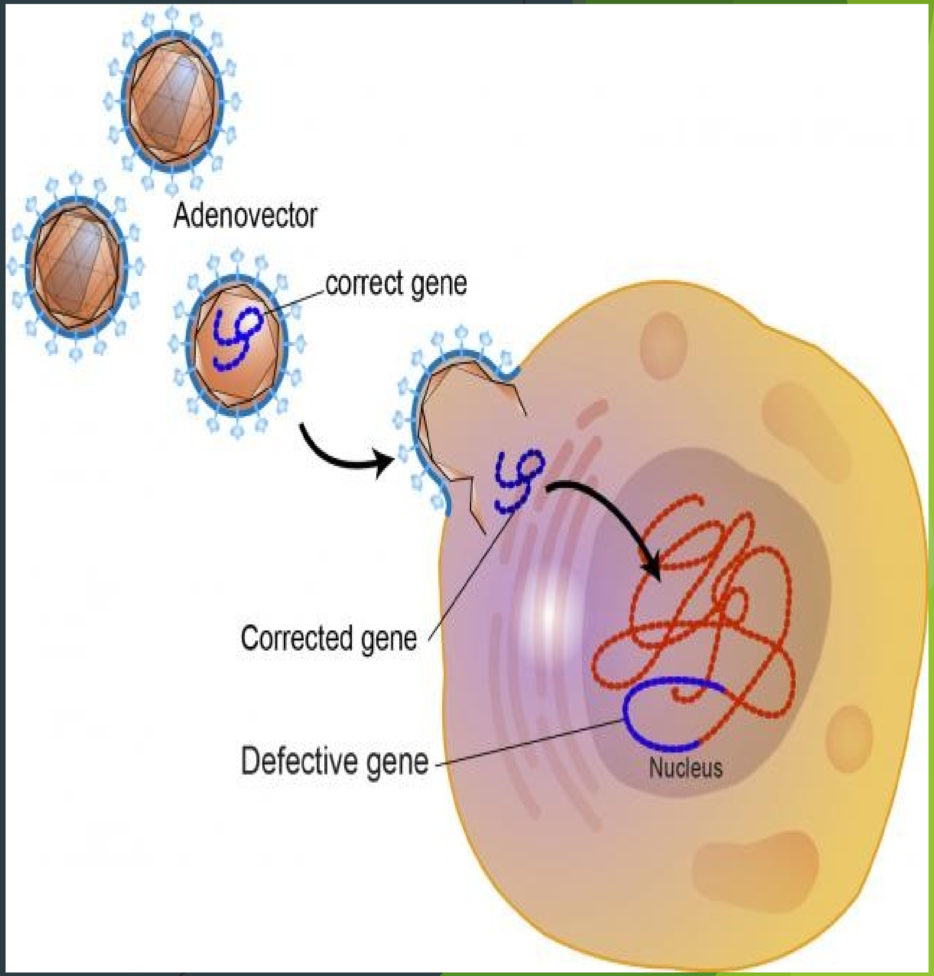

Molecular Medicine Program
Neuroscience
Neuro-
pharmacology
Pharmacology
Molecular
Medicine
Core
Neuro-
oncology
Onco-
pharmacology
Molecular and Cellular
Oncology


The promise of molecular medicine
Human
psychiatric
disease
Novel
therapeutics
Gene
discovery
Target ID and drug
development
Mouse
disease
model
Disease
pathophysiology
Basic neurobiology

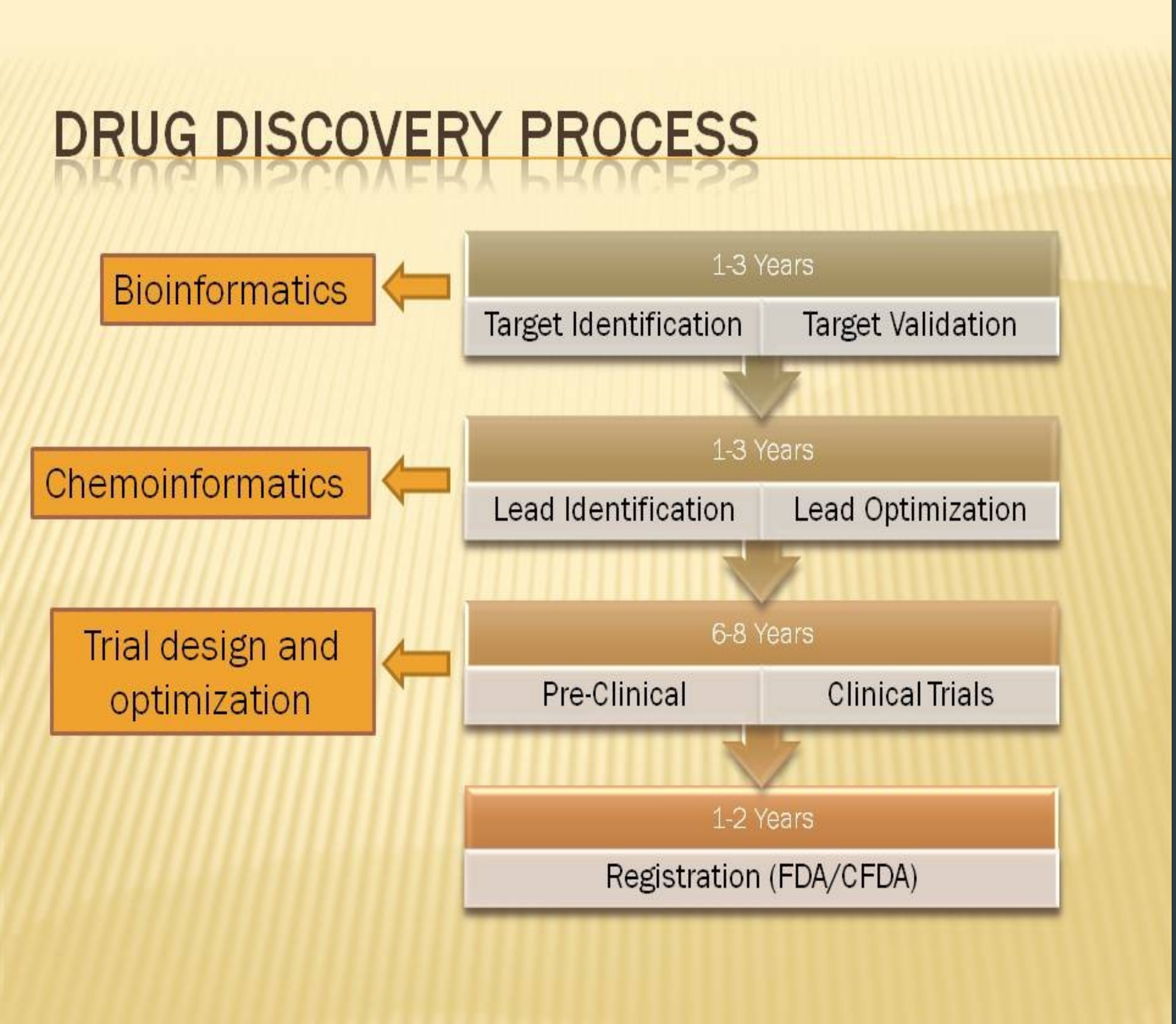

THE HUMAN GENOME - THE BLUEPRINT OF LIFE
The Human Genome project sequenced DNA, the molecules that make up chromosomes in cells. The information derived from this project presented scientists with a valuable opportunity to not only uncover the secrets of DNA but also the manner in which genes are associated with disease. Scientists now are able to compare the genomes of people who have a certain condition with those who do not, in order to determine whether genetic variation plays a role in that condition. This information will help them to predict and possibly prevent disease in the future.
1. Cell
Each of the trillions of cells in the human body contains 46 chromosomes packed tightly into the region called the nucleus.
2. Chromosomes
Half of the chromosomes in the nucleus come from your mother, and half from your father. Each chromosome is a long, tightly coiled molecule called DNA, or deoxyribonucleic acid.
3. DNA
If unwound, the DNA from all the chromosomes in a single cell placed end to end would stretch more than six feet.
4. Genome
DNA is made up of chemical building blocks abbreviated A, C, T, and G. The entire length of a DNA strand consists of these four blocks in different combinations. Together, all the DNA in all the chromosomes – more than 3 billion letters – makes up the human genome. When scientists say they have "sequenced" the human genome, they mean that they have figured out the order of all these A's, C's, T's, and G's in sequence.
G A G
C T C
GACTCCTGAGGAGAAG
CTGAGGACTCCTCTTC
6. Misspellings in the Sequence
The way the genes are "spelled" makes all the difference - one letter out of place in a gene can cause disease. Now that we know the normal sequence of the human genome, researchers can compare the DNA sequence from people who have a disease or condition to those who don't. If there are differences in the spelling of certain genes between the two groups, it's possible that the condition may be caused by or related to that misspelling in that gene.
GACTCCTGTGGAGAAG
CTGAGGACACCTCTTC
5. Genes: 30,000 DNA Segments
Much of the DNA in the genome is organized into units called genes. There may be as many as 30,000 genes in the genome; they are the instruction manual for making all the proteins in the body. These proteins are the physical "stuff" that makes up our hair, skin, heart, and blood, among other things. They also control chemical reactions, regulate blood sugar and heart rate, and control how food or medicine is metabolized in the body.
7. Genes and Disease
Scientists have identified about 6000 diseases, such as Huntington disease and cystic fibrosis, that are directly caused by misspellings or physical problems in single genes.
But the genetic contribution to many common conditions – such as diabetes and heart disease – is part of a larger puzzle that could include diet, lifestyle, environment, and even other genes.
For many of these common conditions, genetic misspellings probably make only a small contribution to disease relative to other factors, or work in concert with them to cause illness.

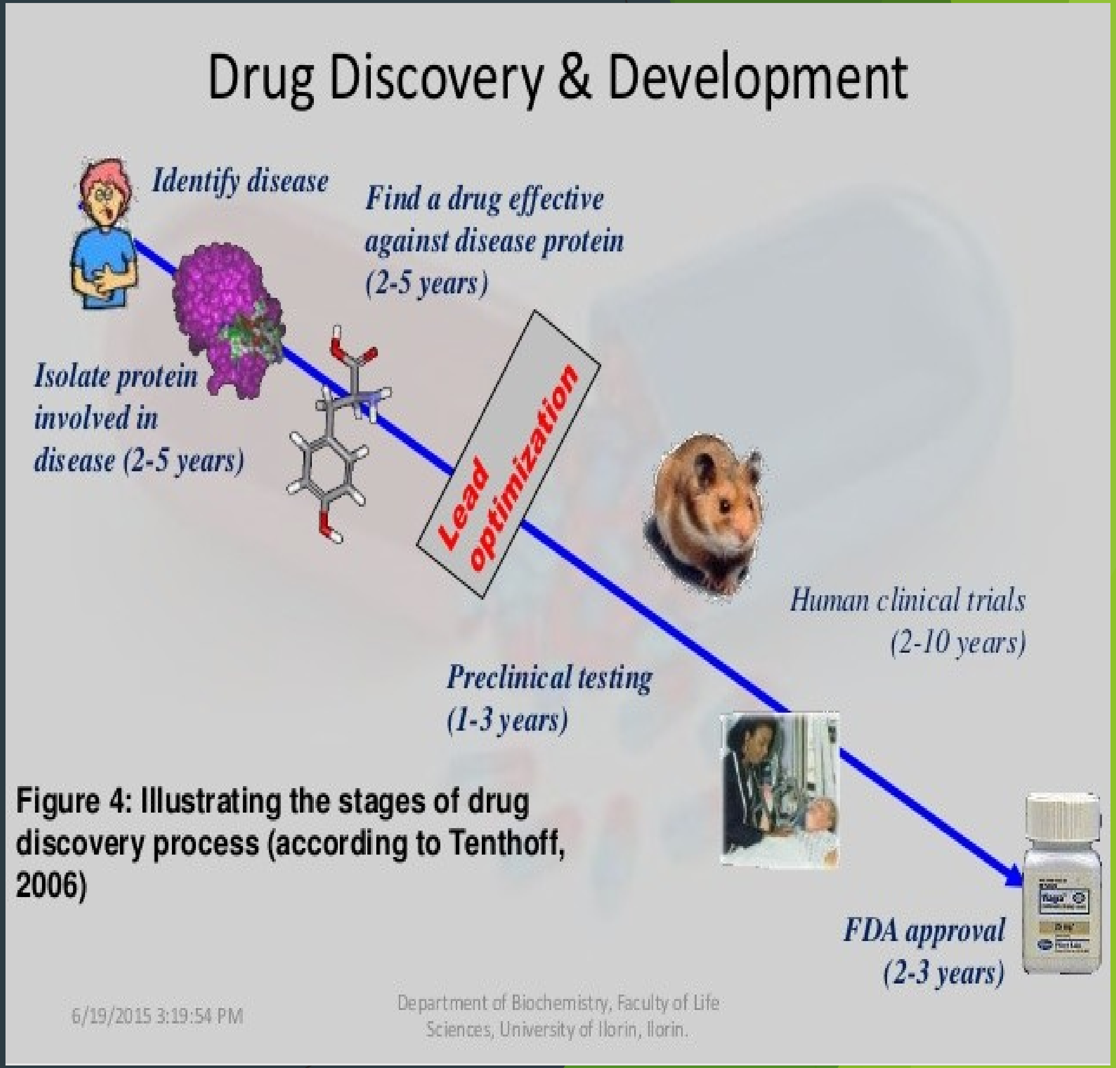
Gene Therapy

- Gene therapy is the approach used to treat , cure or even prevent disease by changing the expression of a person’s gene.
- In the not too distant future ,the potential for using genes themselves to treat disease may become a reality .



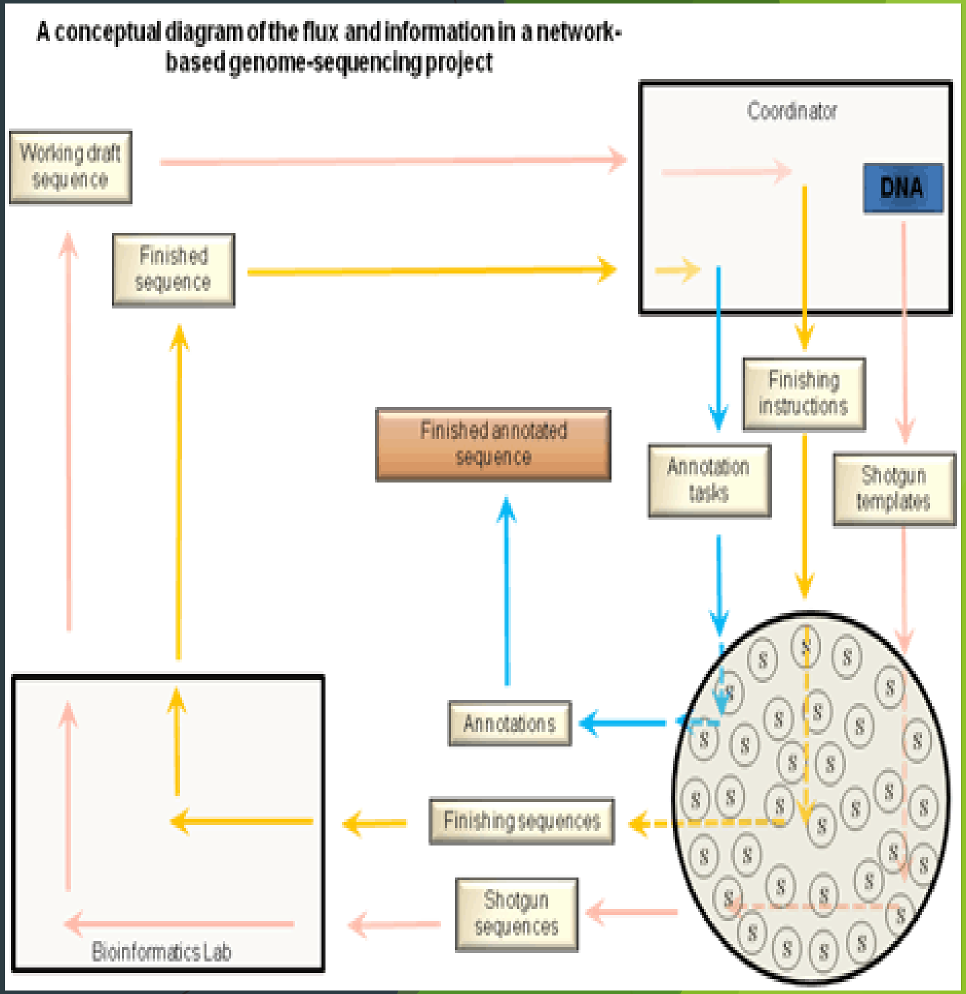
Drug Development :





Microbial genome applications

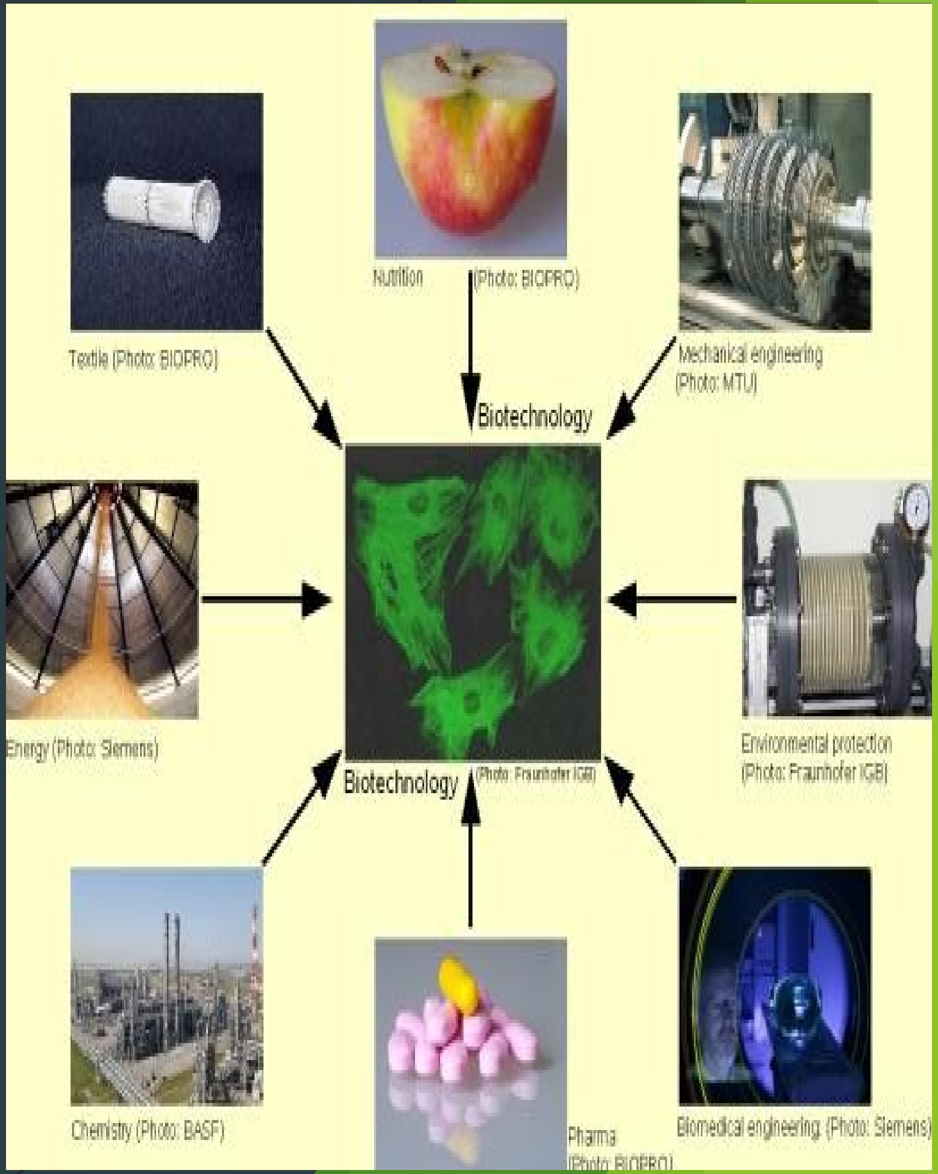
- Microorganisms are ubiquitous , that is they are found everywhere. They have been found surving and thriving in extremes of heat ,cold ,radiation ,salt ,acidity and pressure.
- By studying the genetic material of these organisms ,scientists can begin to understand these microbes at a very fundamental level and isolate the genes that give them their unique abilities to survive under extreme conditions.



Biotechnology :

- Biotechnology is technology based on biology - biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet.

- Modern biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner and more efficient industrial manufacturing processes.




FUTURE

Future of Bioinformatics

At least three trends are appearing with regards to bioinformatics :

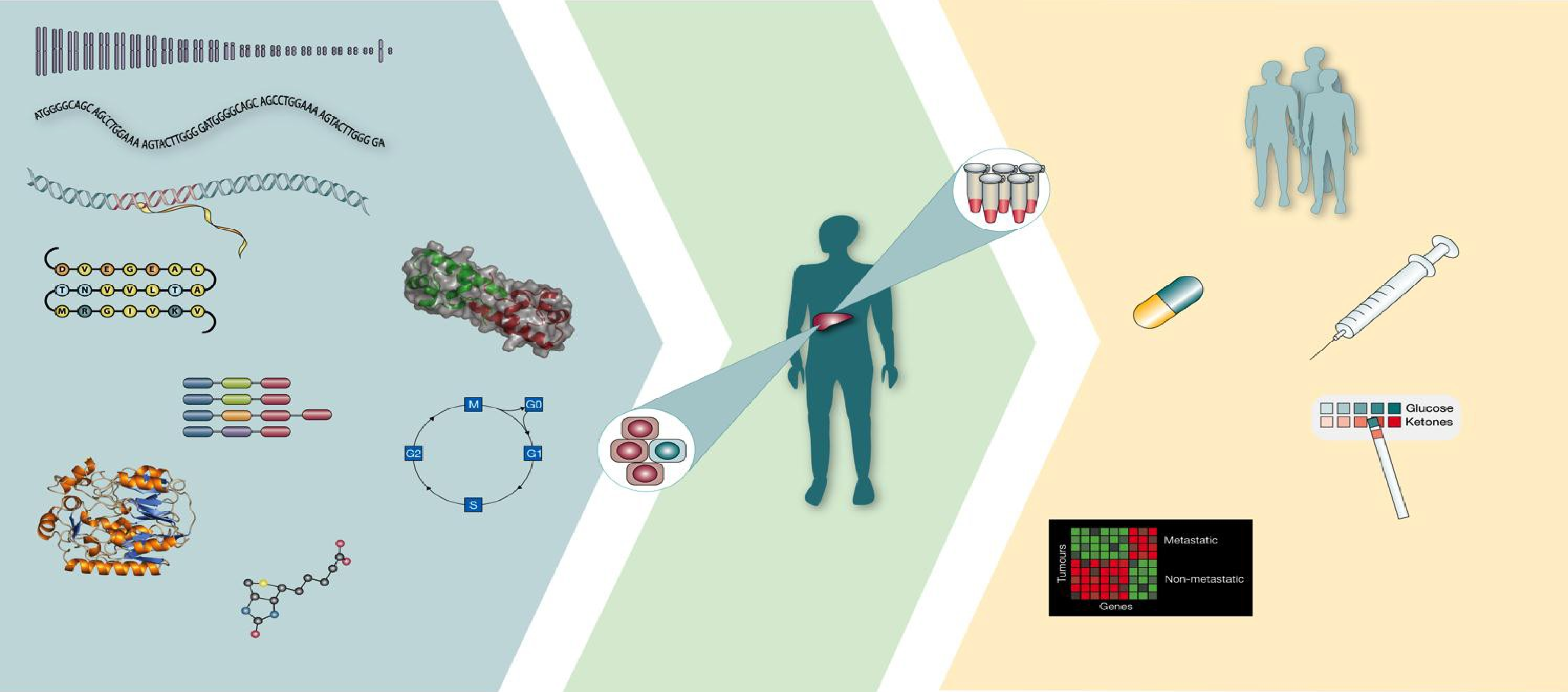
- Integrating genomic information with electronic health records
- Personal genetic services
- Population-based genetic data.

The translational challenge: From molecules to medicine:

Molecular components

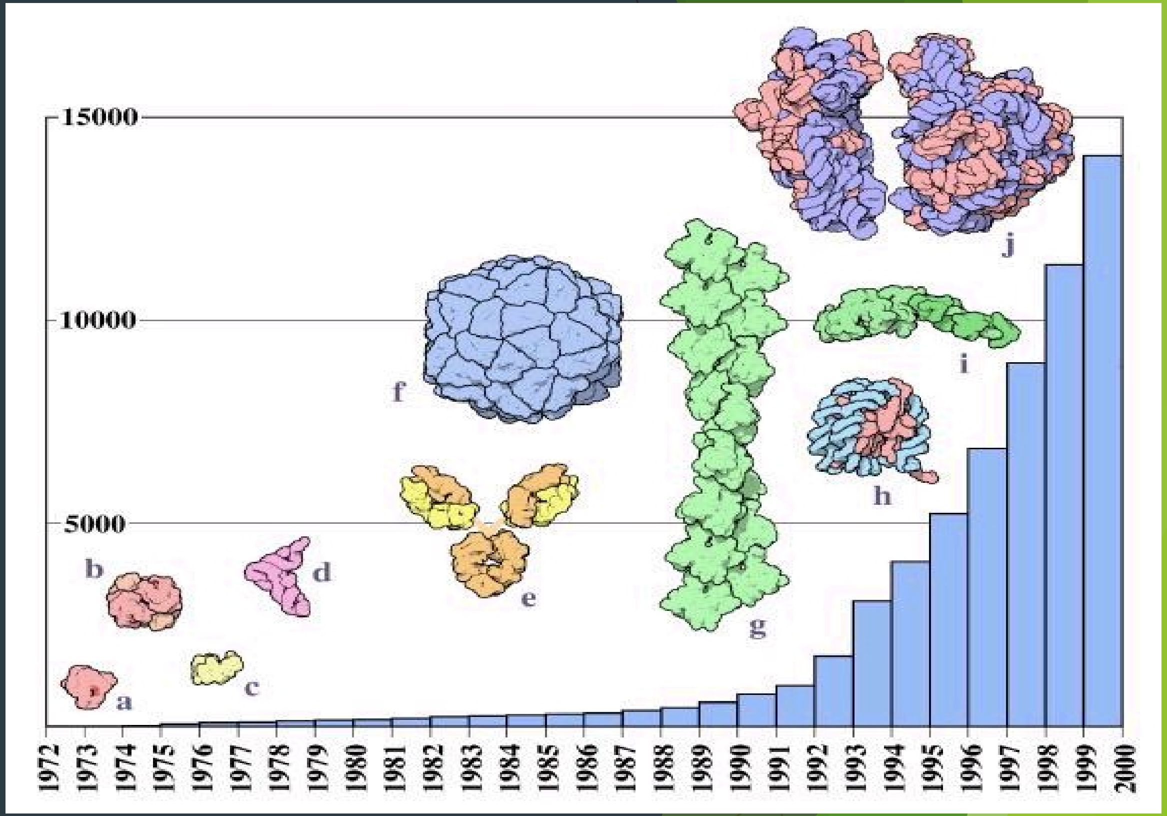
Integration

Translation



A Data Centric View of the Future

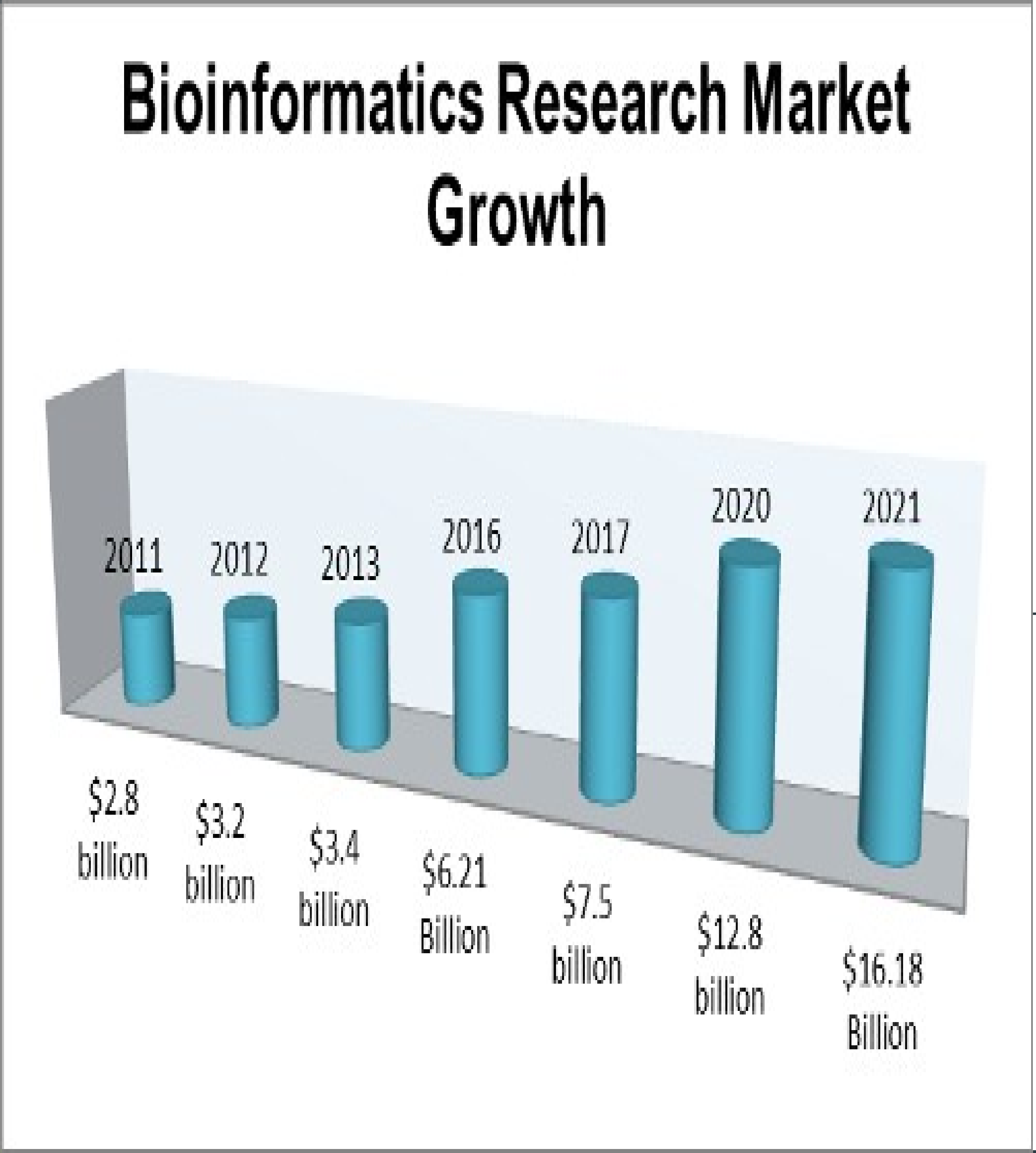
- Data complexity
- High throughput data collection
- Database vs literature
- Bioinformatics as data driver
- Data representation
- Data integration

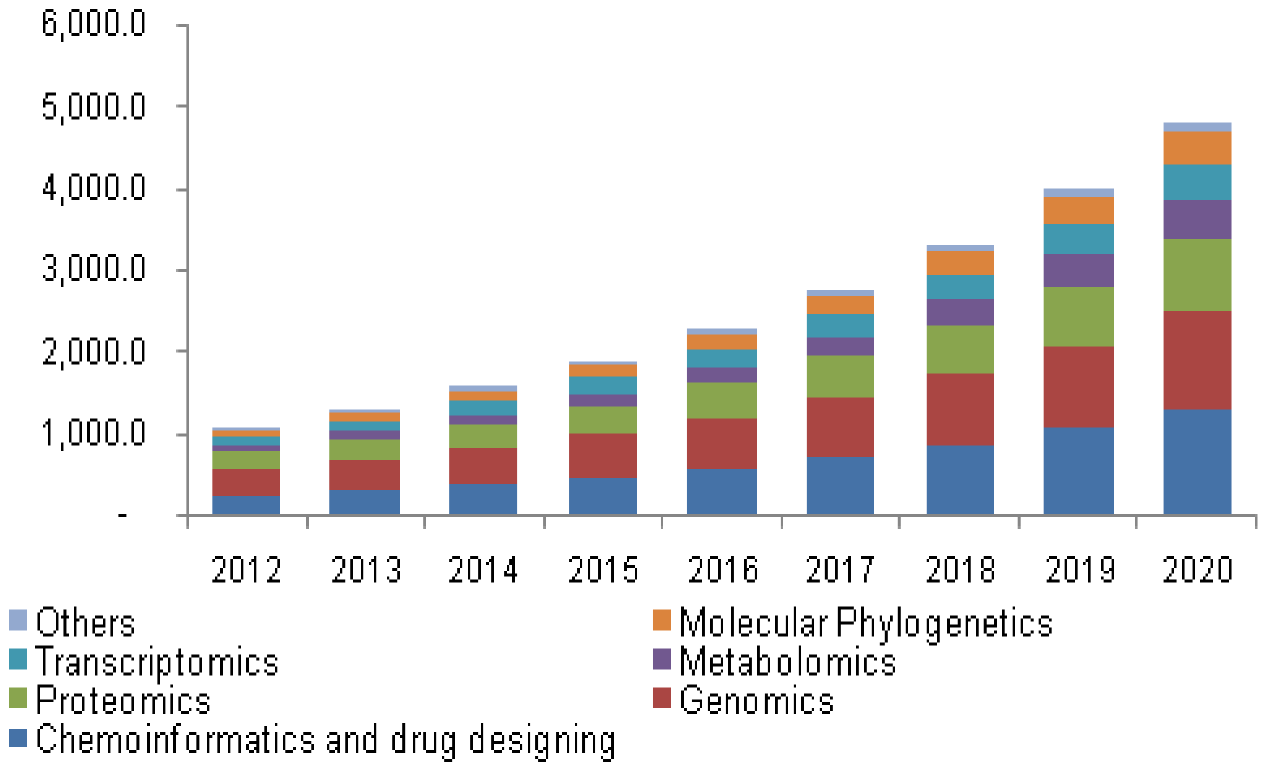


a) myoglobin (b) hemoglobin (c) lysozyme (d) transfer RNA
(e) antibodies (f) viruses (g) actin (h) the nucleosome
(i) myosin (j) ribosome

Bioinformatics and the Future of Biotechnology

- Fighting Infections with Bioinformatics
- Understanding Genetic Diseases with Bioinformatics
- Bioinformatics and Brain Power
- The Tip of the Iceberg
- Improving microbiome analyses
- Accelerating immunotherapy development


Bioinformatics Research Market Growth
2011
2012
2013
2016
2017
2020
2021
$2.8 billion
$3.2 billion
$3.4 billion
$6.21 Billion
$7.5 billion
$12.8 billion
$16.18 Billion


6,000.0
5,000.0
4,000.0
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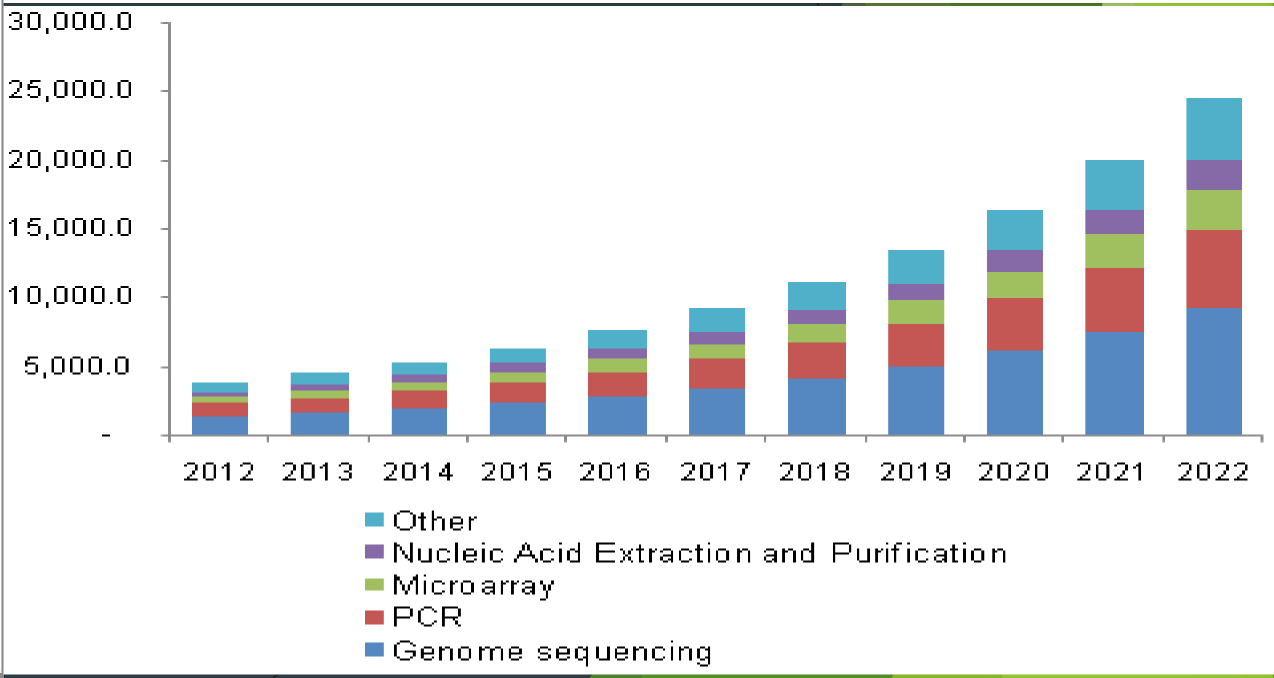
1,000.0
-
2012
2013
2014
2015
2016
2017
2018
2019
2020
Others
Molecular Phylogenetics
Transcriptomics
Metabolomics
Proteomics
Genomics
Chemoinformatics and drug designing


30,000.0
25,000.0
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-
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Other
Nucleic Acid Extraction and Purification
Microarray
PCR
Genome sequencing

New Challenges for Bioinformatics Research

New Sequencing Technologies

- Human variation
- Intra vs Inter species variation
- Linking population and molecular studies
- Variation & Disease
- Biodiversity
- Barcode for life
- Plant and animal breeding

Multi-"omics Data

- Data integration technologies
- Time series
- Atlases/Tissue and Cell type specificity

Biobanks

- Molecular and Phenotypic data
- „Molecular-based phenotypic studies
- Multi-omic data sets

New Challenges for Bioinformatics Research

- **Opening up of Literature**
  - Linking literature to databases and vice versa
  - Text Mining
  - The semantic web
- **Immense Complexity of Control networks**
  - New modelling techniques
  - Commissioning of experiments

- Development of Cloud Computing and Grid technologies
  - New methods for handling data
  - New Image Technologies
  - Analysis
- Move of Medicine towards Molecular Technologies
  - Molecular Diagnoses
  - Pharmacogenomics
  - Target Identification

Questions

- Bio informatics ?
- Bio informatics areas ?
- Human genome ?
- Molecular medicine ?
- Gene therapy ?
- Drug discovery & development ?
- Microbial Genome ?
- Biotechnology ?
- Challenge of bio informatics ?