



# Introduction to Genetics

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Genetics-BIO 310

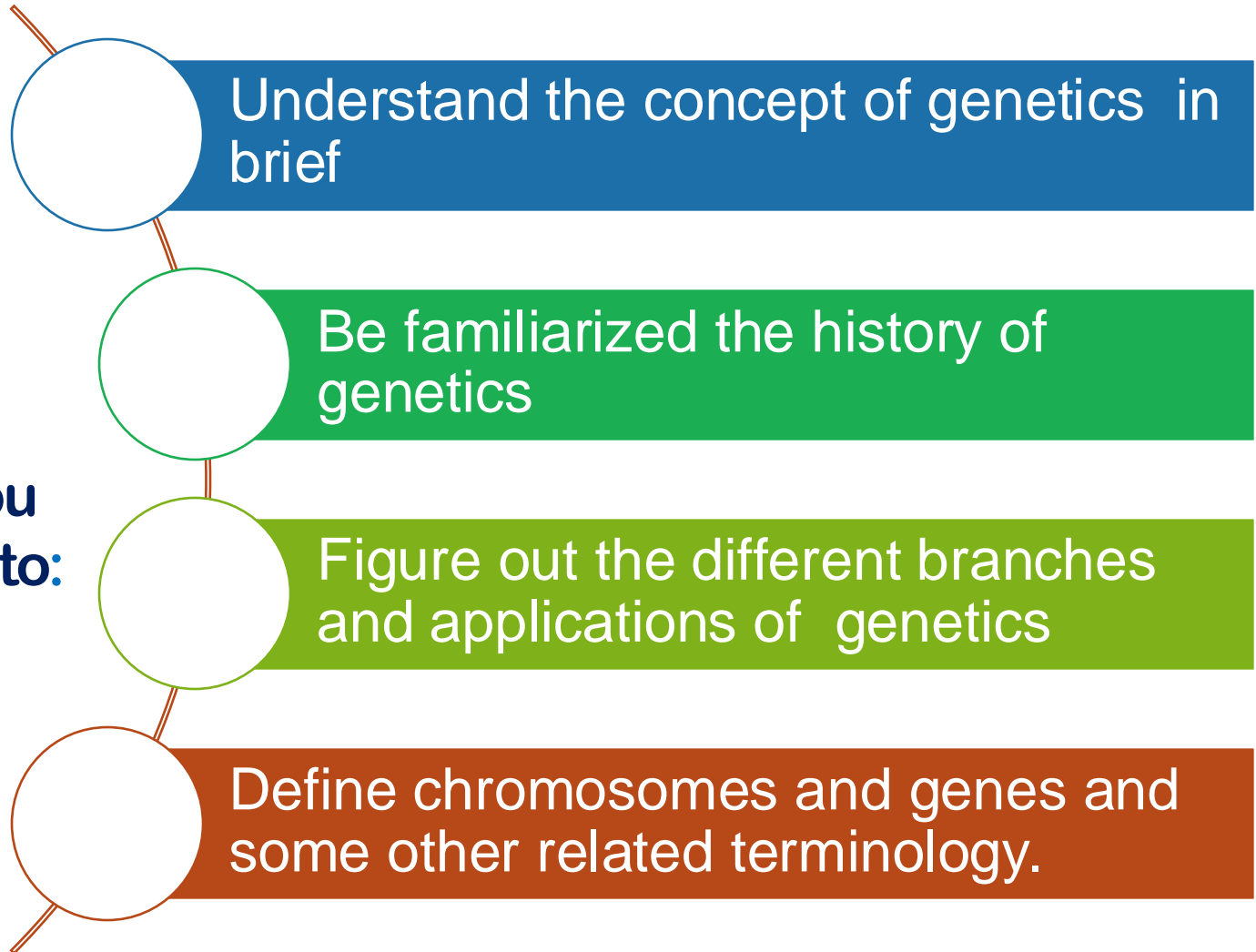
Spring semester

Second Week

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# Objectives:

**By the end of  
this chapter you  
should be able to:**



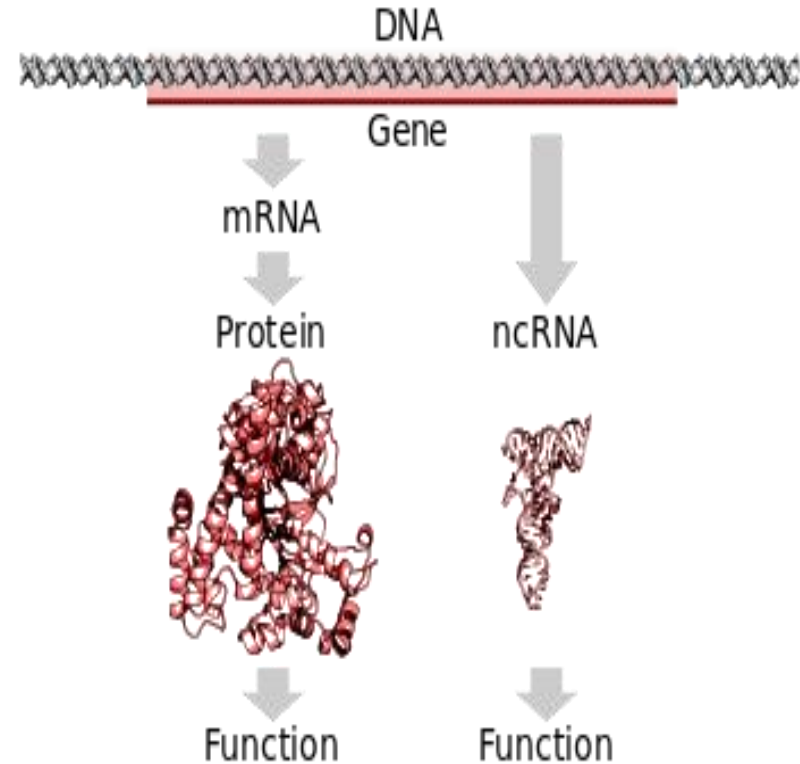
# What Is Genetics?

- Genetics is the field of science that examines how traits are passed from one generation to the next.
- Genetics is the study of **heredity**, the process in which a parent passes certain **genes** onto their children.”
- Genetics is the study of genes and how they function.



# Gene

- A gene is classically defined as a unit of heredity. At the molecular level, a **gene** is a segment of DNA that produces a functional product.
- An organism's **genes**, snippets of DNA that are the fundamental units of heredity, control how it looks, behaves, and reproduces.

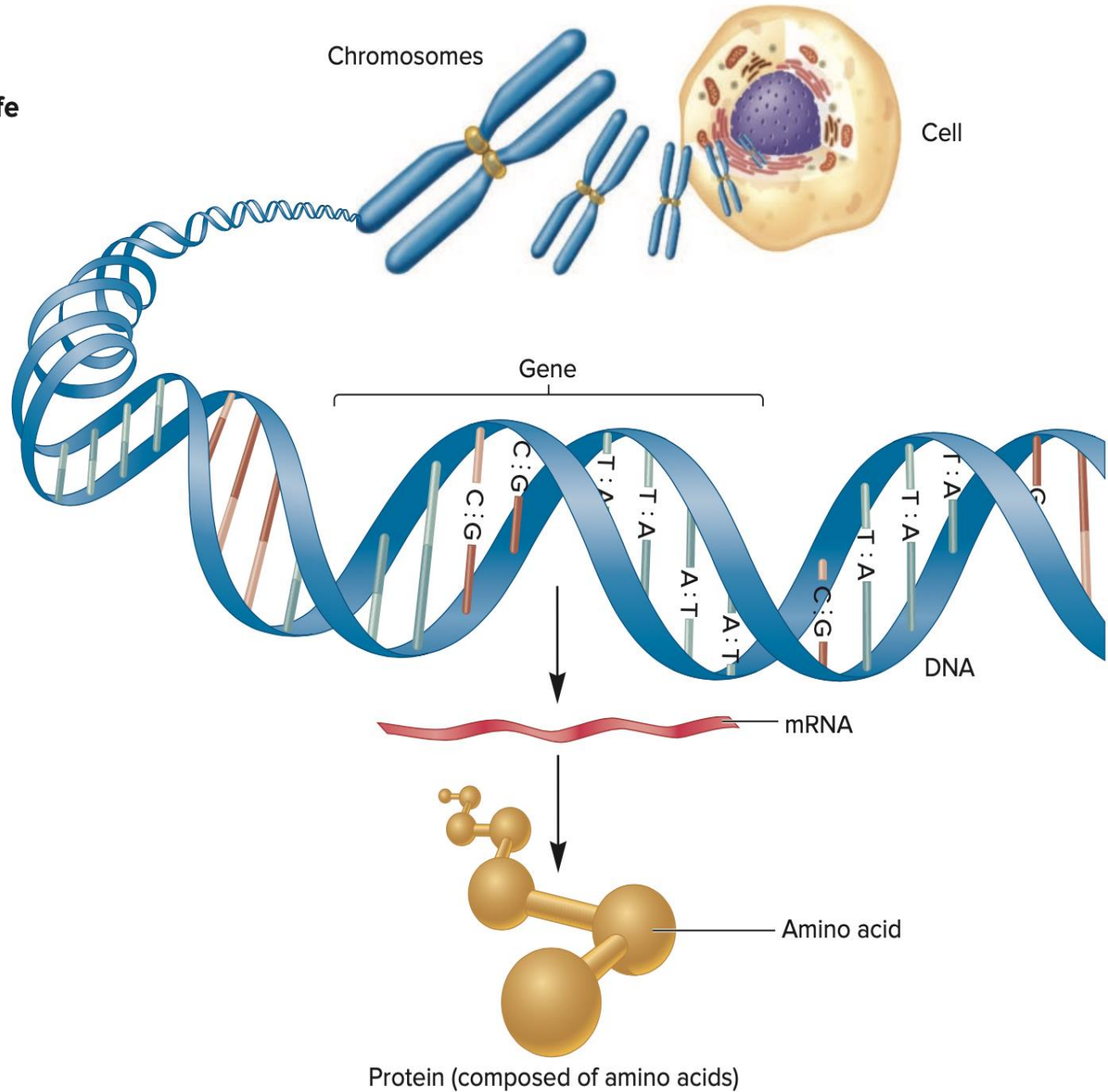


## DNA, the molecule of life

The adult human body is composed of trillions of cells.

Most human cells contain the following:

- 46 human chromosomes, found in 23 pairs
- 2 meters of DNA
- Approximately 22,000 genes coding for proteins that perform most life functions
- Approximately 3 billion DNA base pairs per set of chromosomes, containing the bases A, T, G, and C



# Why Genetic study?

- Technically it's a requirement of Biology degree!!! Why?!
- Genetics has become the backbone of all biomedical fields.
  - Molecular Biology.
  - Neurosciences
  - Pharmaceutical
  - Medicine
  - Cellular and developmental Biology.
- Who we are (although debatable)!
- Why we are doing, what we are doing!
- Social changes and policies will be revealed by genetics!
- How life sciences impacts on social change.



# History of Genetics



**ARISTOTLE**



*1859*

Charles Darwin

- Idea of natural evolution
- Pangenesis Theory

# Timeline of Genetics



1865

Gregor Mendel and  
Laws of Inheritance

- Father of modern Genetics
- He used *Pisum Sativum* (Garden Pea) in his study.
- There are 7 characteristics of pea in his study
- LAW: Mendelian Laws of Inheritance (Law of Segregation and Independent Assortment)

# Timeline of Genetics



1888

Heinrich Wilhelm Gottfried Waldeyer discovered the chromosome



1909

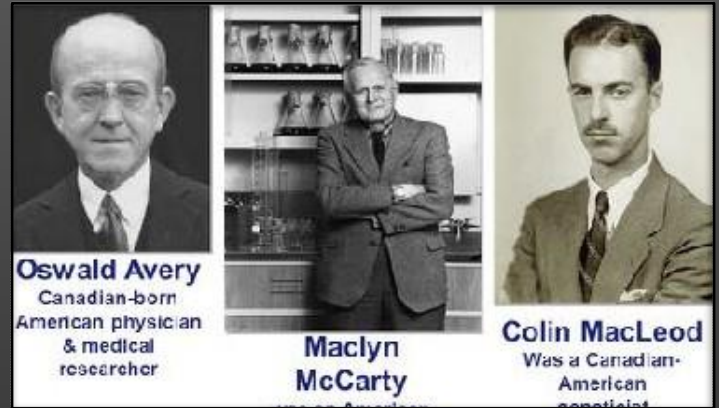
Wilhelm Johannsen- The term **gene** was introduced

# Timeline of Genetics



**1927**

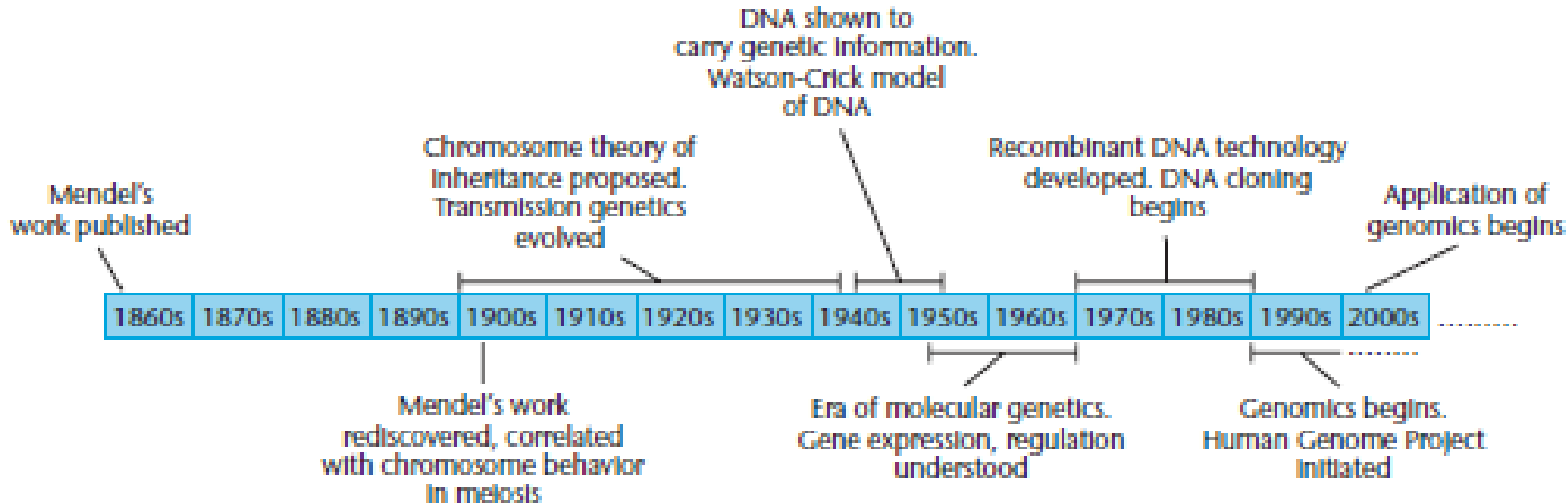
Herman Muller - radiation causes defects in chromosomes



**1944**

Oswald Avery, Colin MacLeod and Maclyn McCarty proved that the DNA carries the genetic information

# Timeline of Modern Genetics



timeline showing the development of genetics from Gregor Mendel's work on pea plants to the current era of genomics and its many applications in research, medicine, and society.

Adapted from Concepts of Genetics, Klug, Cummings, Spencer, Palladino, 2012

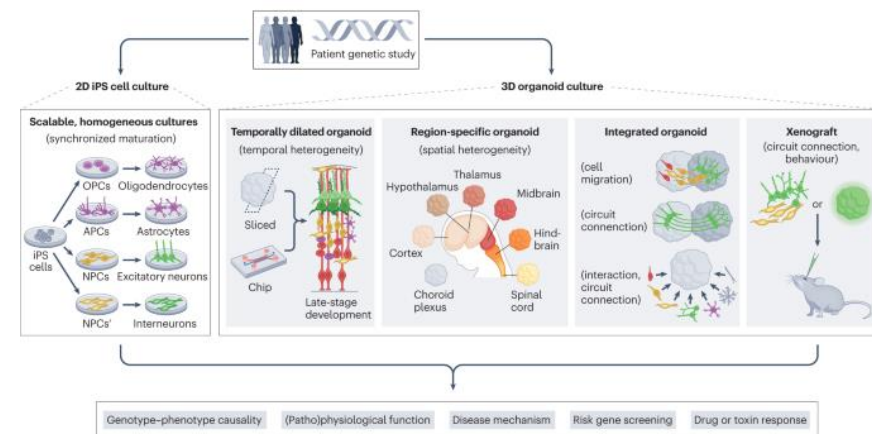
# Inheritance as we observe it

- Offspring resemble parents in broad terms i.e. same species.
- Offspring often share more similarities with their parents than with non-related individuals.
- But they are not identical to either parent or to their siblings (except in the case of identical twins).
- What is the mechanism that ensures both this continuity of inheritance and this variation?



# Inheritance and development

- Organisms are not born mature/complete: whatever is inherited has to go through a process of development to get from egg/sperm to mature individual
- The inherited material i.e. genes, guide development but do not entirely determine it !
- There are other factors acting throughout the organism's lifetime



# Inheritance of Organism and environment

- What is the environment in genetics?
  - Complex interaction between genes and environment
- Organisms with the same inheritance can develop in very different ways depending on the environment.
- Organisms in the same environment can develop differently under the influence of different genes.



# The major subdivision Genetics

## ➤ CLASSICAL GENETICS

- Study of analysis of offspring to mating (parents to offspring).
- Describes how traits (physical characteristics) are passed along from one generation to another.

## ➤ POPULATION GENETICS

- Deals with the transmission of trait with a large group of individual through a passage of time.
- Takes Mendelian genetics (that is, the genetics of individual families) and ramps it up to look at the genetic makeup of larger groups.



# The major subdivision Genetics

## ➤ Quantitative genetics

- A highly mathematical field that examines the statistical relationships between genes and the traits they encode.



## ➤ BEHAVIORAL GENETICS

- Study of behavior of an organism.



# The major subdivision Genetics

## ➤ **CYTOGENETICS**

Science that deals with the physical basis of heredity (cell)

## ➤ **MOLECULAR GENETICS**

Chemical basis of heredity  
Newest and most advanced field of Genetics

- Genomics
- Proteomics

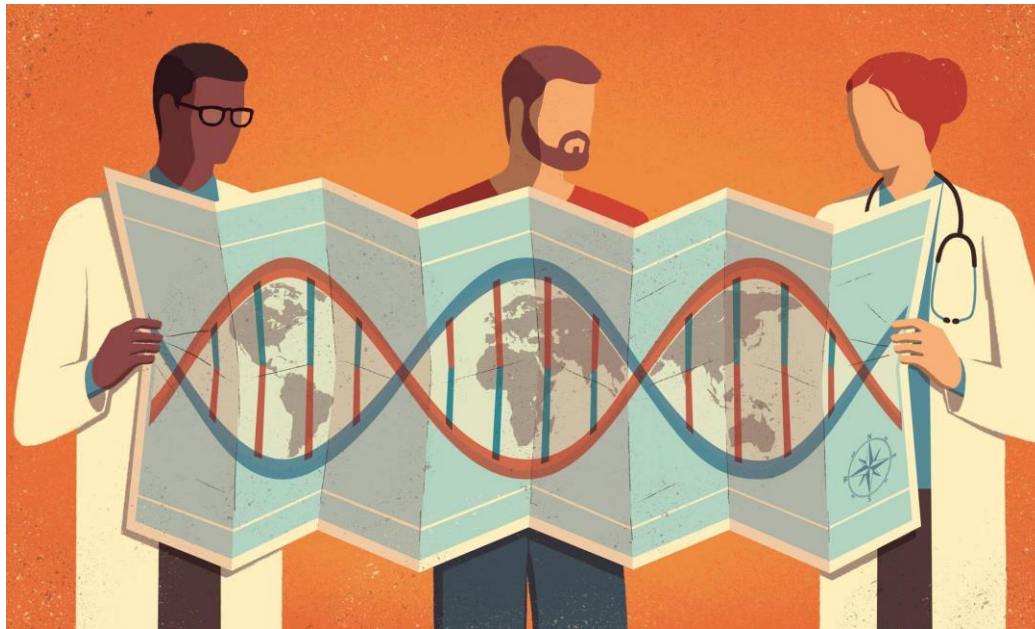


# Methods of Genetic studies

## 1. Planned Experimental Breeding

## 2. Pedigree Analysis

- Transmission of trait through the use of pedigree.
- Pictorial representation



# Methods of Genetic studies

## 3. . Karyotyping

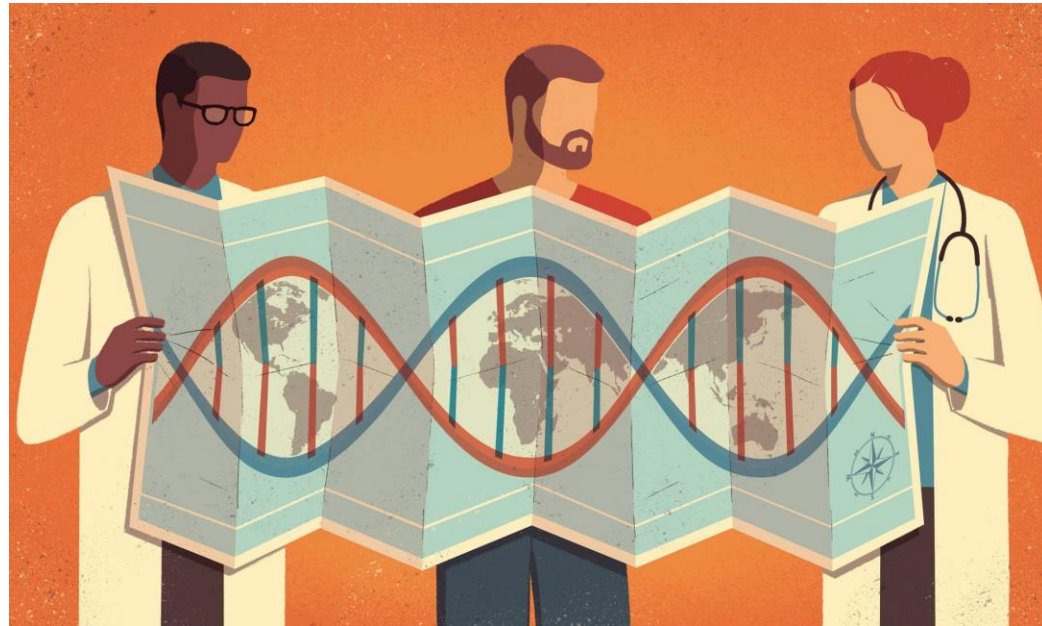
- Detect chromosomal abnormality
- karyogram/ karyotype (pictorial representation of chromosomes)

## 4. TwinStudy

- Study of twins

## 5. Statistical Analysis

- Make use of several data
- Use for population data



# Genetics Applications

- Genetics and agriculture
- Genetics and legality
- Genetics and eugenics
- Genetics and medical science
- Genetics in removing false concepts about heredity.



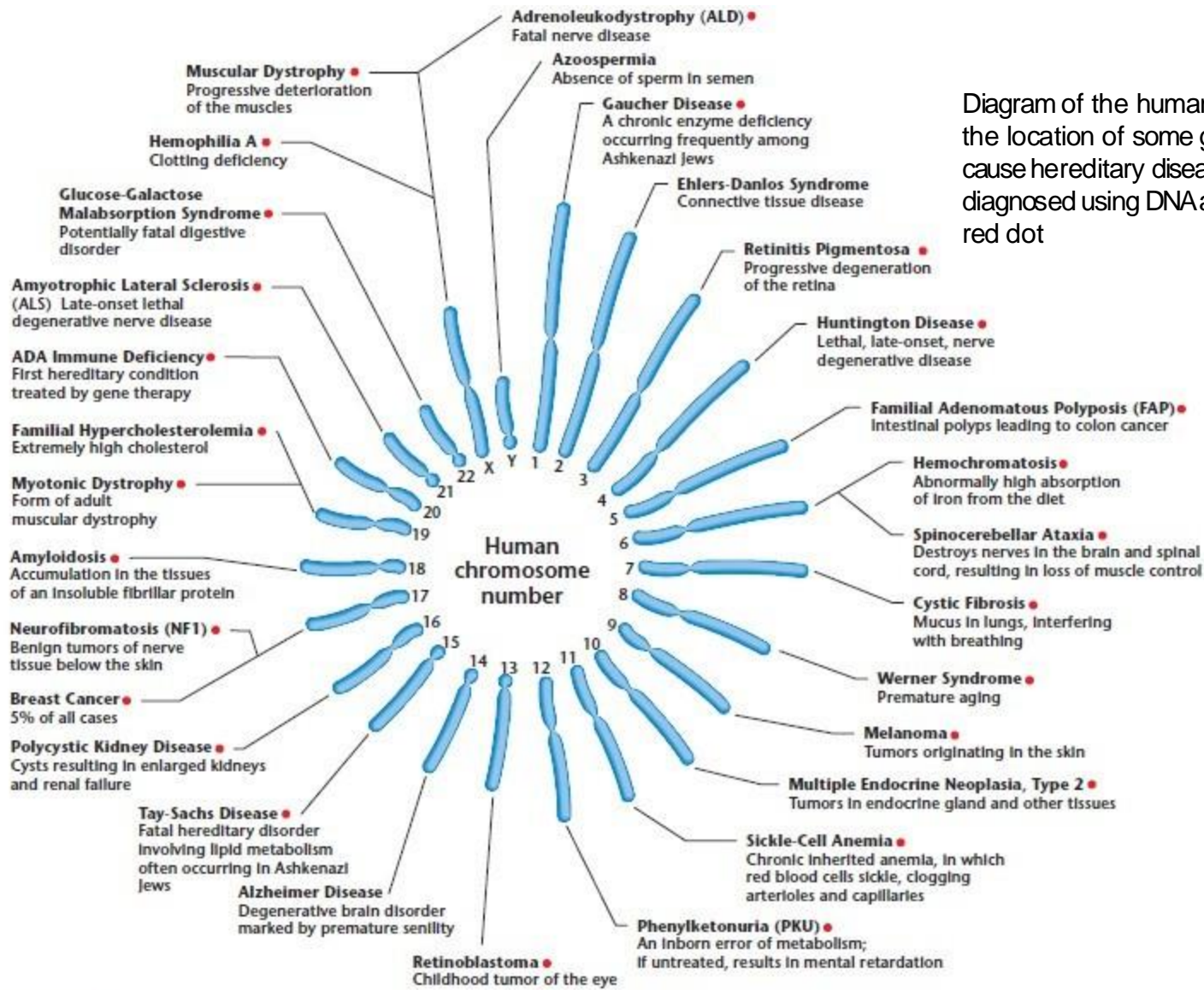


Diagram of the human chromosome set, showing the location of some genes whose mutant forms cause hereditary diseases. Conditions that can be diagnosed using DNA analysis are indicated by a red dot

Adapted from Concepts of Genetics, Klug, Cummings, Spencer, Palladino, 2012

# Some Genetic Terms

- **Trait** – Any feature or quantifiable measurement of an organism
- **Gene** – Functional unit of heredity (we will usually mean a segment of DNA)
- **Alleles** – One or more alternative variations of a particular gene that can exist at that gene locus e.g. A, B, and O alleles for blood groups
- **Locus** – Site on a chromosome where a gene is located. For instance, for ABO blood group the locus is chromosome 9, 9q34.1-q34.2.

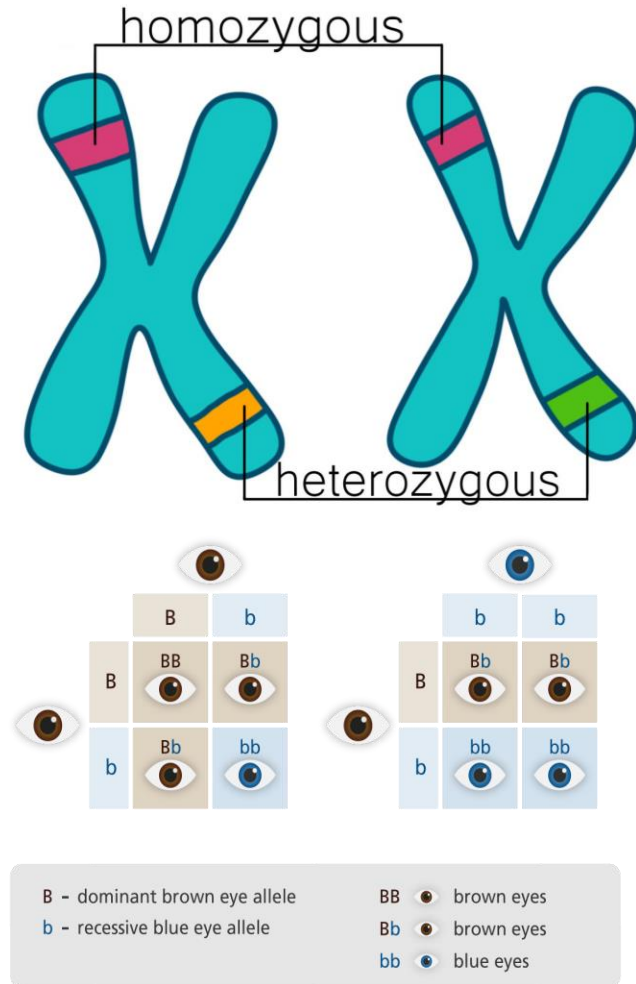
# Some Genetic Terms

- **Genotype**: the states of the two alleles at one or more locus associated with a trait
  
- **Phenotype**: the state of the observable trait

<b>Genotype</b>	<b>Phenotype</b>
BB (homozygous)	Brown eyes
Bb (heterozygous)	Brown eyes
bb (homozygous)	Blue eyes

# Some Genetic Terms

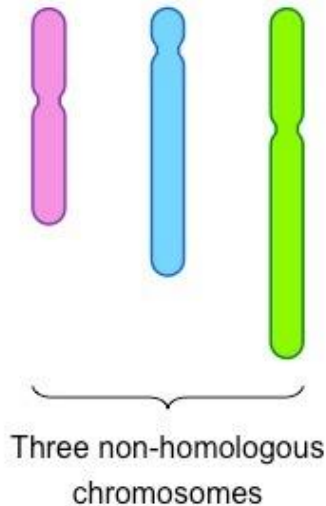
- **Homozygous** – Having two of the same allele
- **Heterozygous** – Having two different alleles
- **Dominant** – allele that expresses phenotype in heterozygous state
- **Recessive** – allele whose phenotype is not visible in a heterozygote



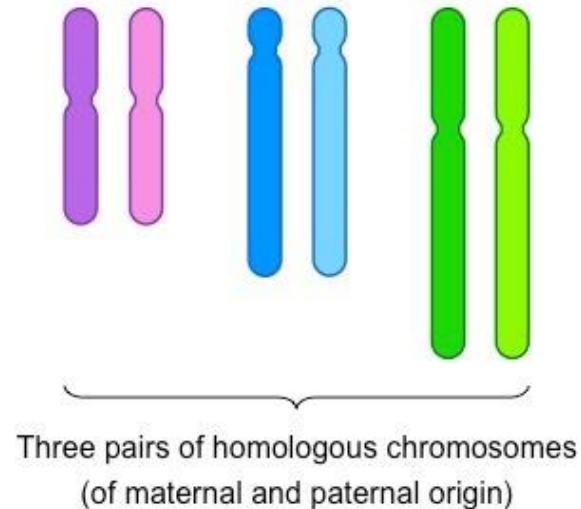
# Some Genetic Terms

- **Haploid:** containing one copy of each chromosome ( $n=23$ ).
- **Diploid:** containing two copies of each chromosome ( $2n=46$ )

**Haploid (n)**  
One copy of each chromosome



**Diploid (2n)**  
Two copies of each chromosome



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- Klug, W. S., Cummings, M. R., Spencer, C. A., Palladino, M. A., & Ward, S. M. (2009). *Concepts of genetics* (Vol. 9). Pearson.