

Genome and Genetic Code

What is **Genome**?

- Genetic material of an organism, essentially the **instructions on making proteins and RNAs**.
- Inscribed in DNA: **complete DNA sequence**.
- Includes both the *genes* and the non-coding regions.

What is **Genetic Code**?

- The **set of rules** by which information encoded within DNA or RNA is translated into proteins.
- In general, the genetic code **specifies 20 standard amino acids by means of triple nucleotide *codons*** and is basically the same for all organisms on Earth.

What is **Gene**?

- The **portion of the genome that codes for a single protein or an RNA**.
- The molecular unit of heredity of a living organism.
- The size of a single gene may vary greatly, ranging from ~1,000 bases to ~1 million bases in humans.



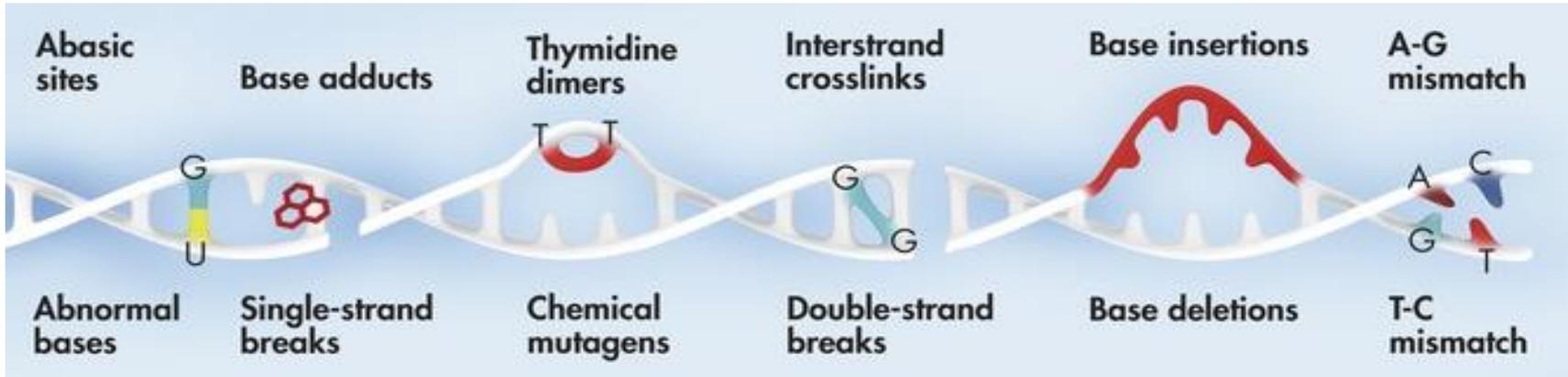
Human DNA

- The **Human Genome Project** (1990-2003) produced the first complete sequences of individual human genomes.
- Human genome contains **~3 billion bases** and **~20,500 genes**.
- Over 98% of the human DNA comprises non-coding repetitive sequences (the role, functions and descriptions of these sequences are currently being investigated by scientists).
- By 2012, thousands of human genomes have been completely sequenced.
- All humans have the DNA that is **99.9% similar**, however the **rest 0.01% is enough to identify** different individual DNA sequences (*i.e. tell apart which DNA belongs to whom*).
- Primary (and now standard routine!) applications include paternity testing as well as DNA profiling in criminal investigations.



DNA Damage

DNA is damaged up to 1 million times per cell per day.



- The cells have an **elaborate type-of-damage-specific system of DNA repair** that is constantly active.
- A cell that has accumulated a large amount of DNA damage, or one that no longer effectively repairs damage incurred to its DNA, can enter one of three possible states:
 1. an irreversible state of dormancy, known as *senescence*
 2. cell suicide (apoptosis) or programmed cell death
 3. unregulated cell division, which can lead to cancer

DNA Mutations

A mutation is a **permanent change** in the **DNA sequence**.

- Mutations can be:
 - *spontaneous* (by chance)
 - *induced* by **mutagens** (physical, chemical or biological agents)
- **Factors** that cause mutations:
 - external - environmental factors such as sunlight, radiation, and smoking
 - native - errors during DNA replication
- Mutations can lead to:
 - an *evolutionary advantage* of a certain genotype
 - disease, developmental delays, structural abnormalities, or other negative effects.



Example: Sickle cell anemia is a disorder in which the body makes sickle-shaped red blood cells as a result of DNA mutation.

DNA Half-Life

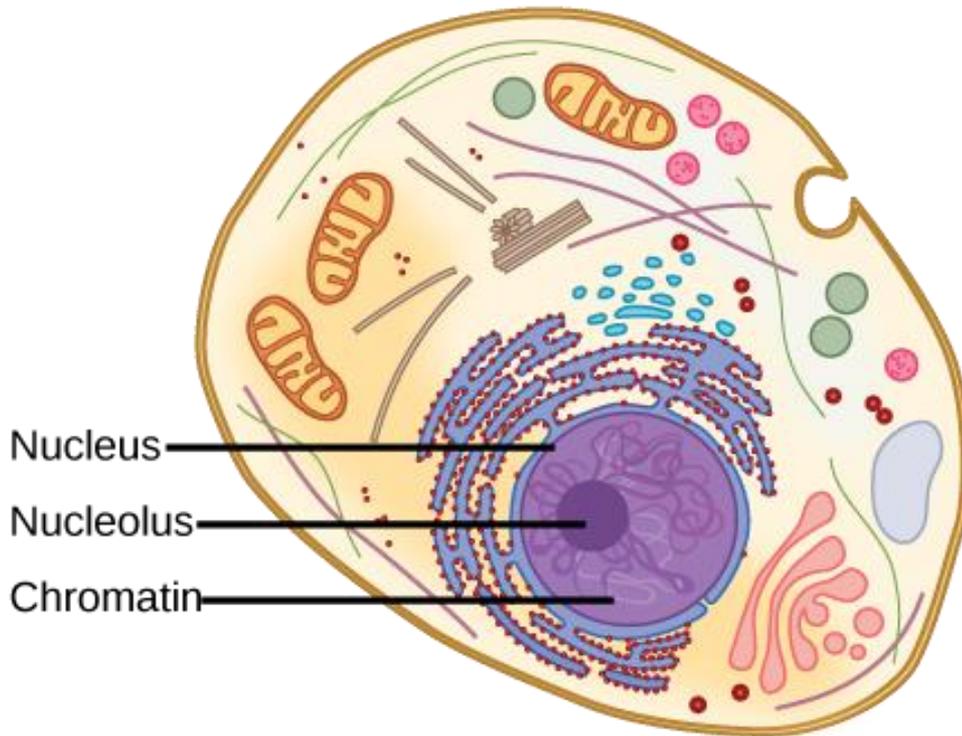
In 2012, researchers have calculated that **DNA from bones** has a **521 year half-life**, which means that the **oldest clone-able samples of DNA** could be no more than **2 million years old**.



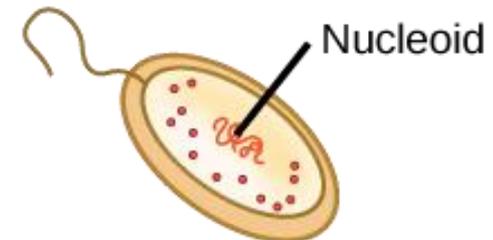
This result **rules out any possibility of ever replicating dinosaurs**, as the youngest dinosaurs were around more than 65 million years ago...

Basic Cell Types

All cells consist of a **cytoplasm** enclosed within a **membrane**.



Cells are typically categorized by how their genetic material is packaged:



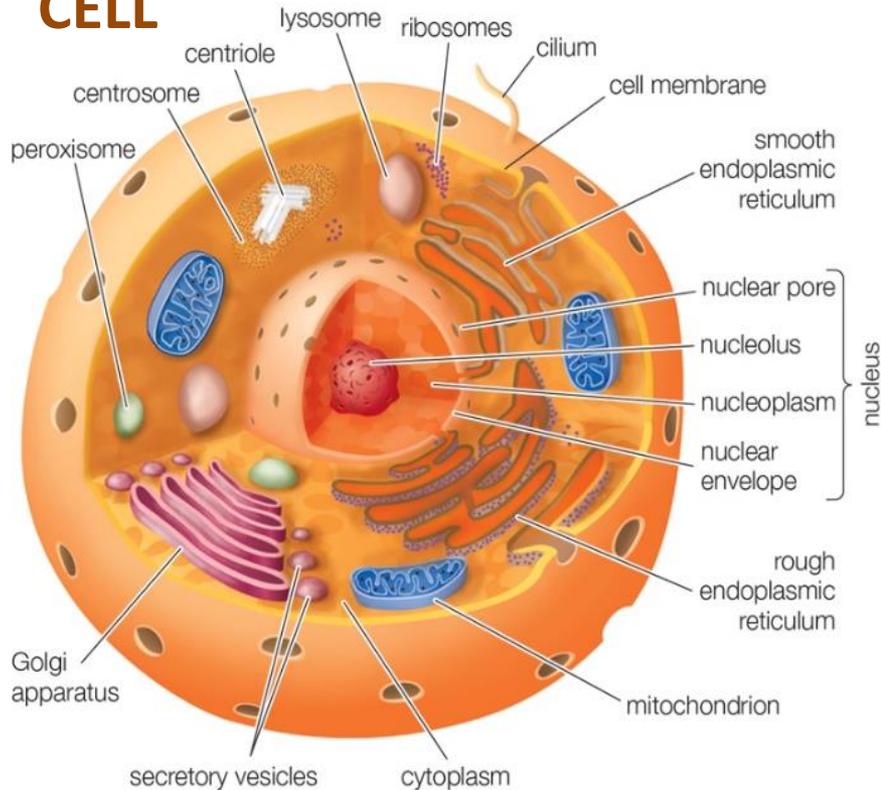
Eukaryote - the DNA is **partitioned off** in its own membrane-bound room called the **nucleus**.

Prokaryote - the DNA within a cell is **not separated from the cytoplasm**.

Organelles

Eukaryotic cells have **specialized interior compartments**, called **organelles** (“little organs”), that have specific functions.

ANIMAL CELL



PLANT CELL

