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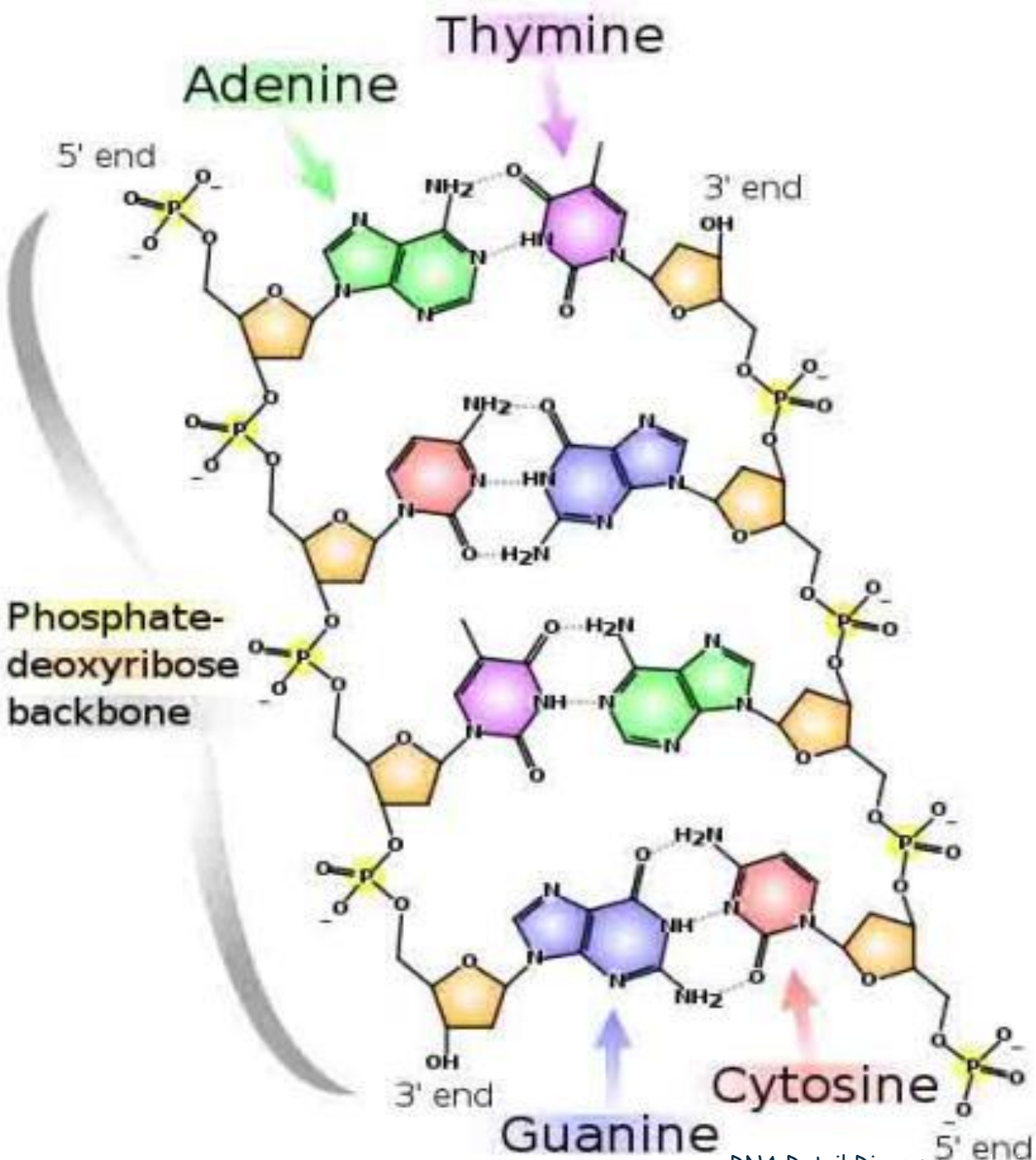
DNA and molecular genetics, chromosomes, genes and its functions and chromatin

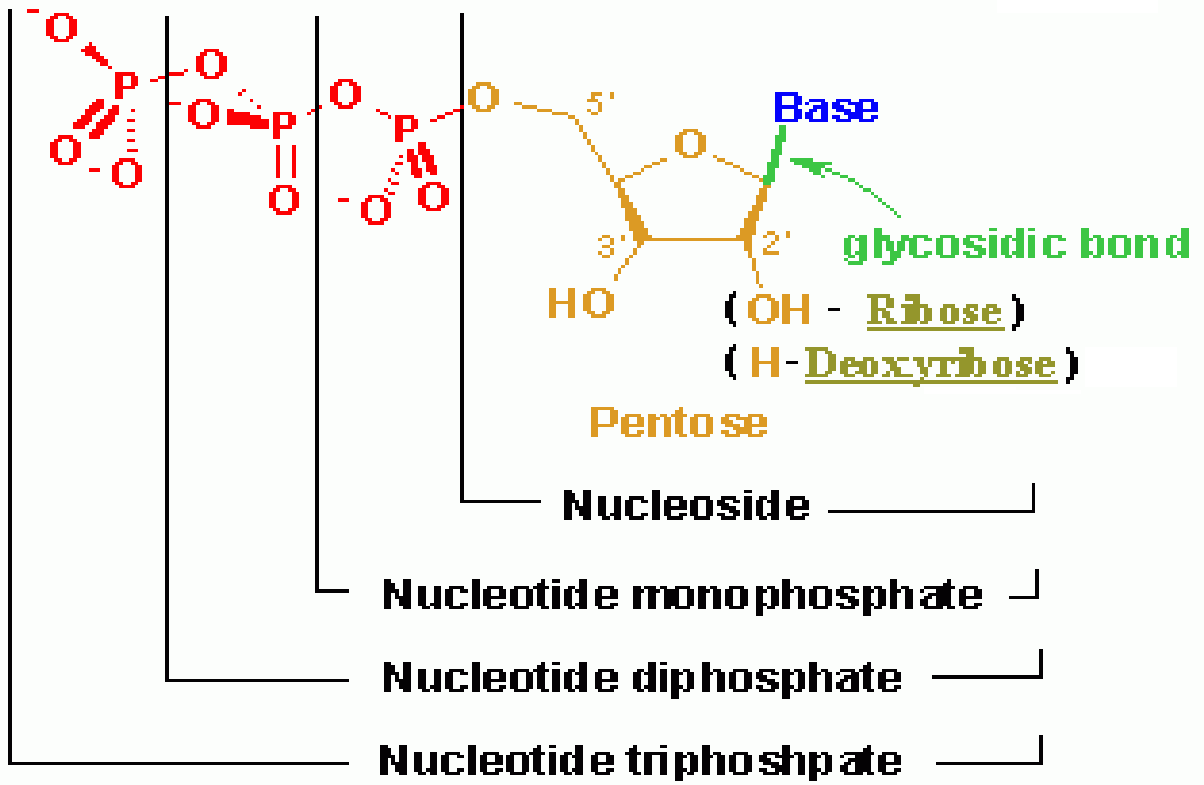
Nucleotides and Nucleic Acids



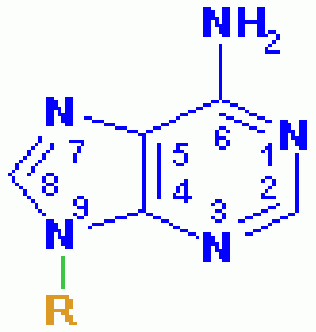
DNA Detail Diagram:

NUCLEIC ACIDS

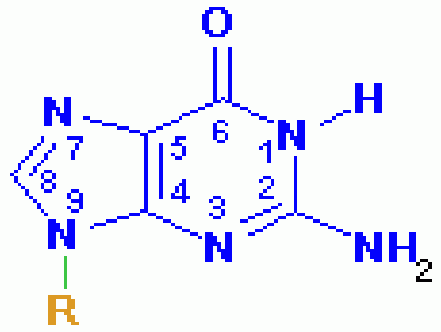
Q: What type of monomer are nucleic acids made of?



Purines

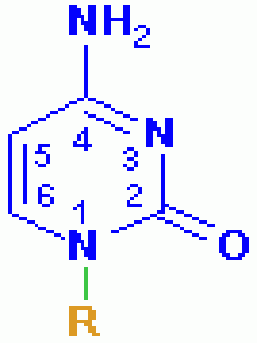


Adenine

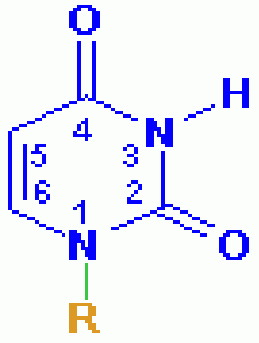


Guanine

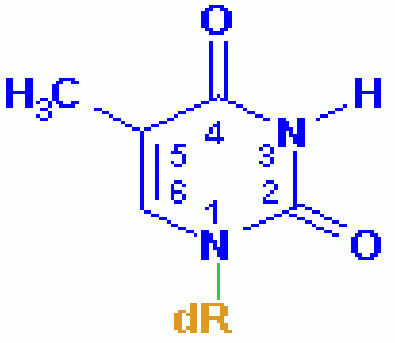
Pyrimidines



Cytosine



Uracil



Thymine

DNA STRUCTURE

- Double stranded molecule, analogous to a spiral staircase:

  - two deoxyribose-phosphate chains as the "side rails"

  - base pairs, linked by hydrogen bonds, are the "steps"

- Purine Bases

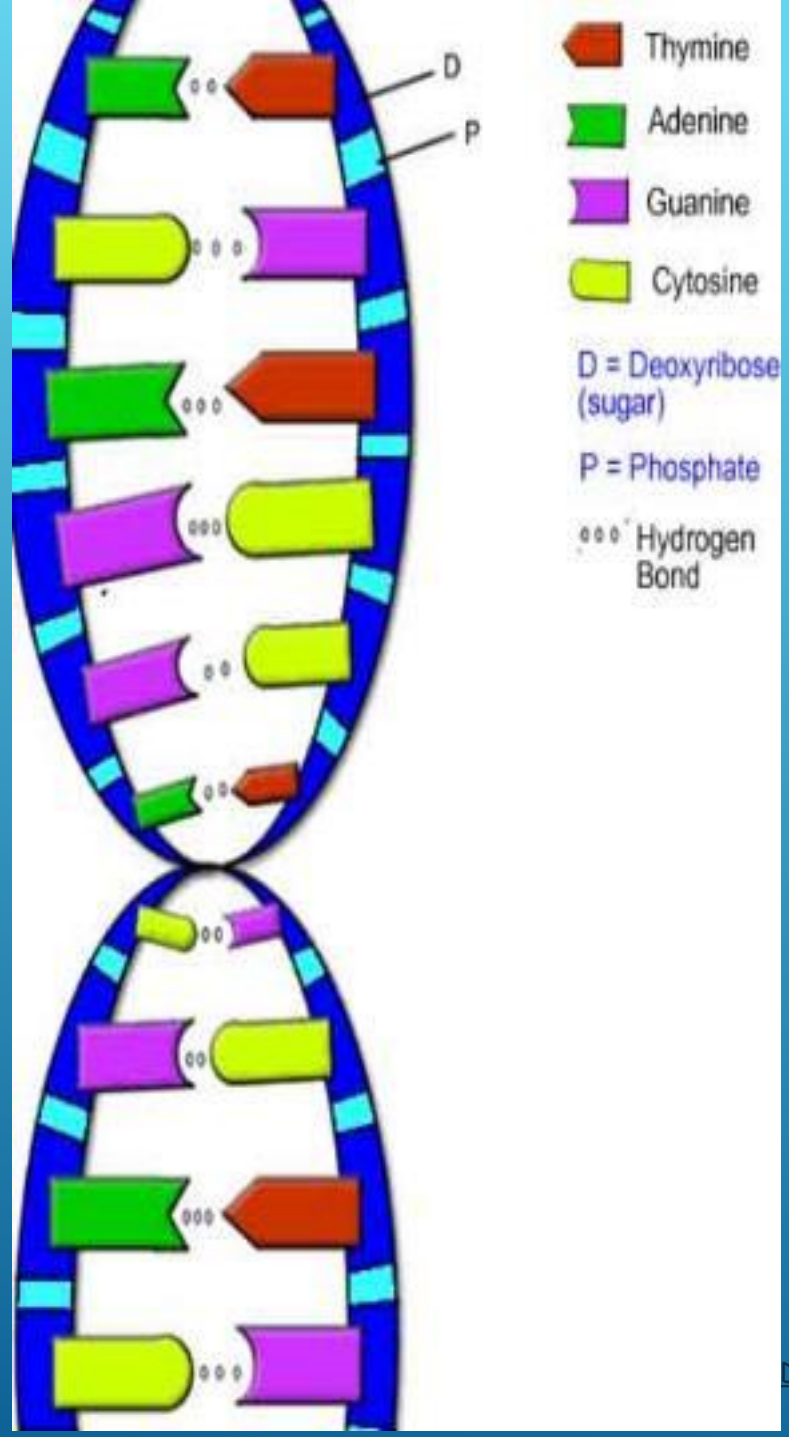
  (double ring)

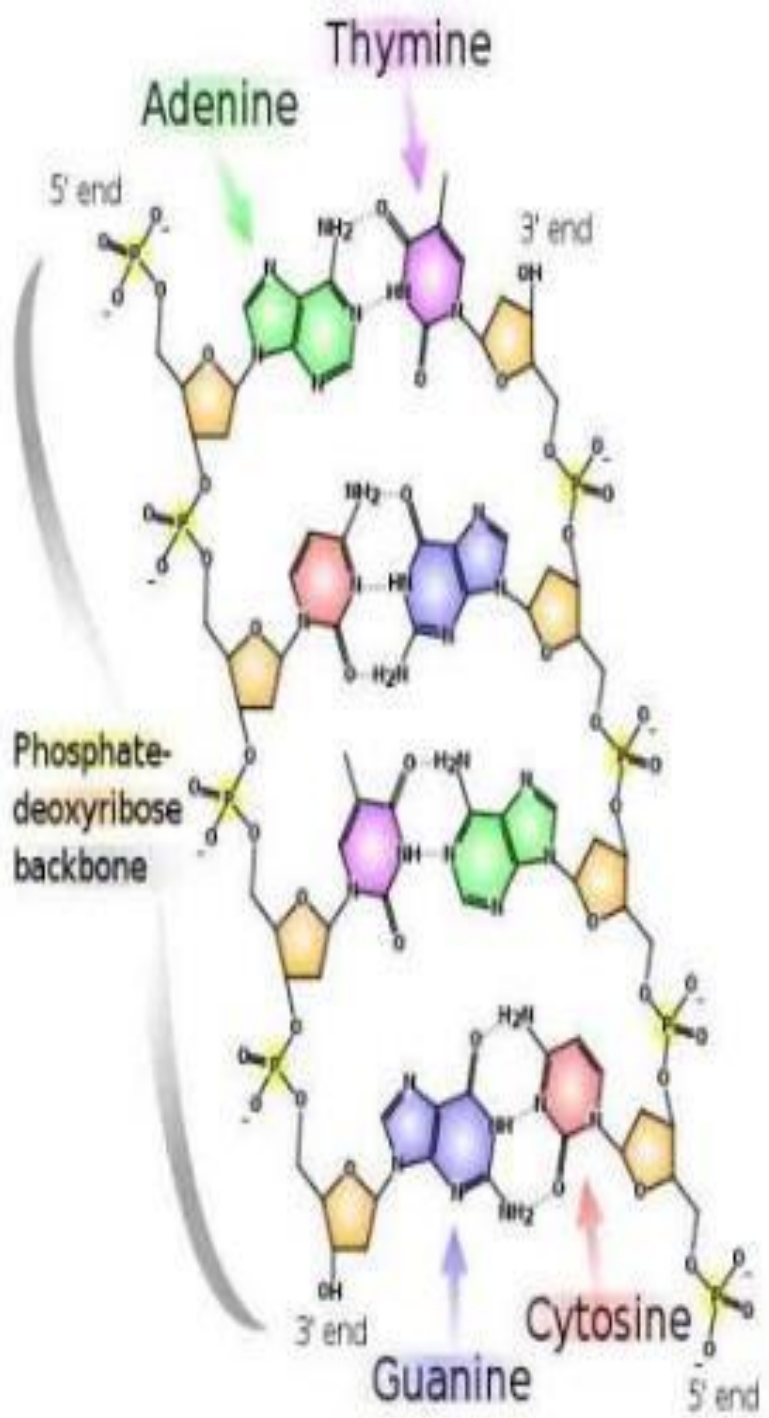
  Adenine & Guanine

- Pyrimidine Bases

  (single ring)

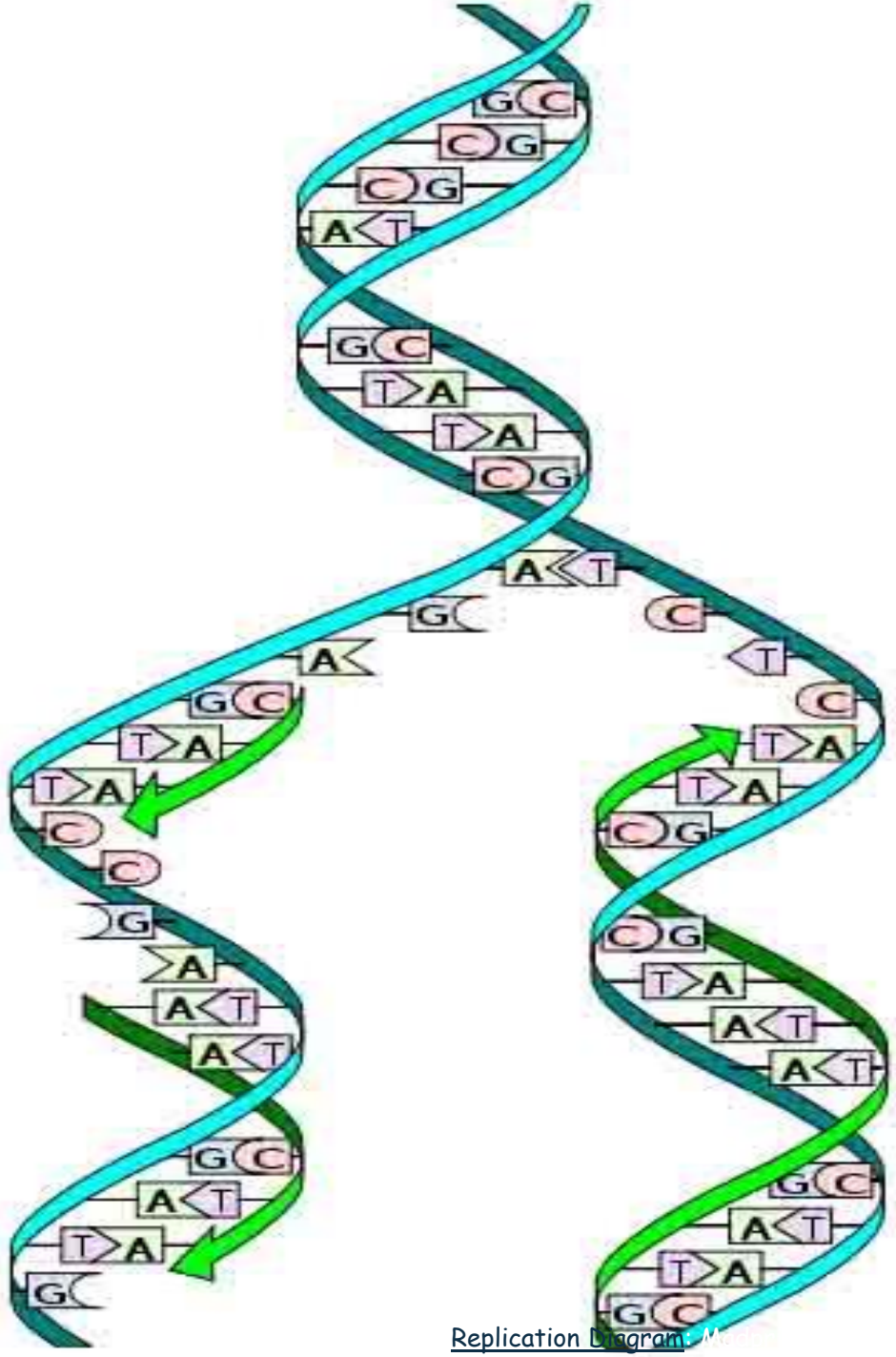
  Cytosine & Thymine





DNA REPLICATION

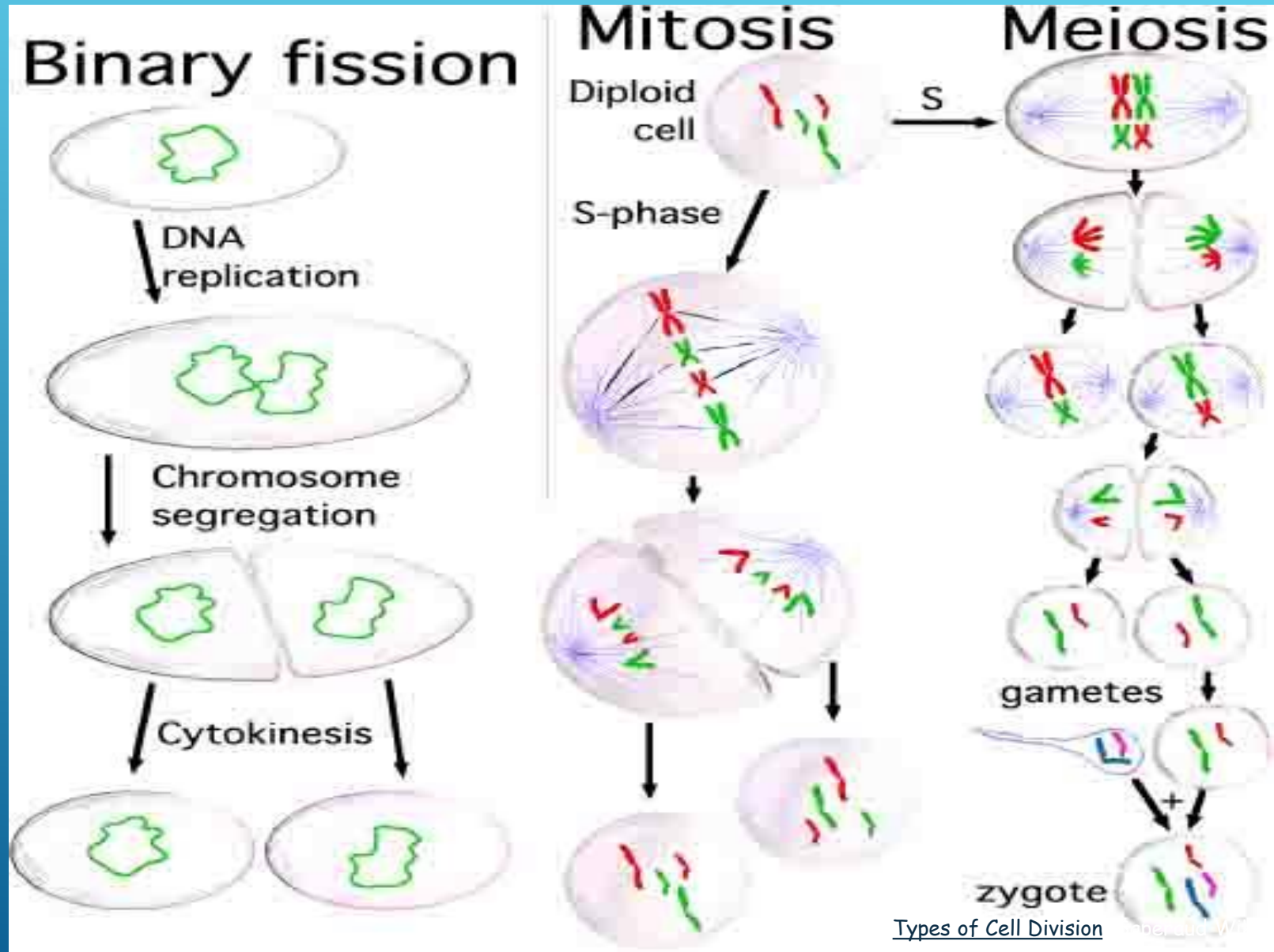
- Copying of a double-stranded DNA molecule.
- Each DNA strand holds the same genetic information, so each strand can serve as a template for the new, opposite strand.
- The parent (a.k.a. _____) strand is preserved and the daughter (a.k.a. _____) strand is assembled from nucleotides.
- This is called semi-conservative replication.
- Resulting double-stranded DNA molecules are identical.

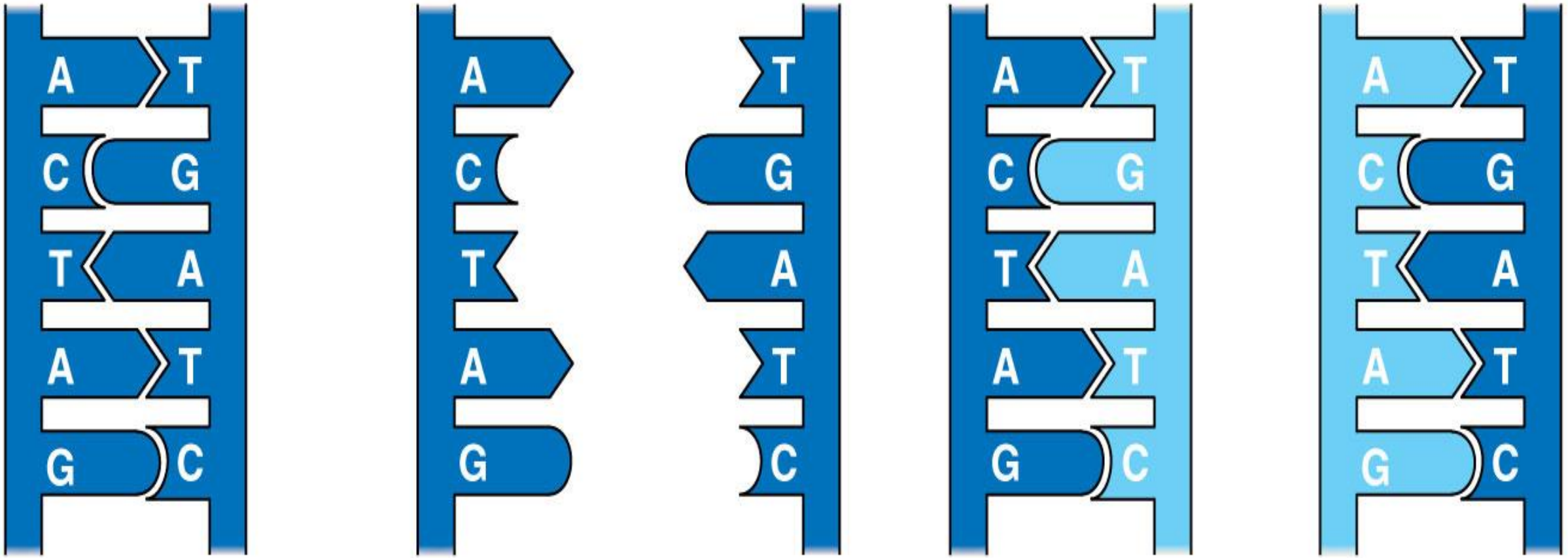


Replication Diagram

REMINDER…WHY IS THE DNA COPIED?

Replication occurs prior to cell division, because the new, daughter cell will also need a complete copy of cellular DNA.





(a) Parent molecule

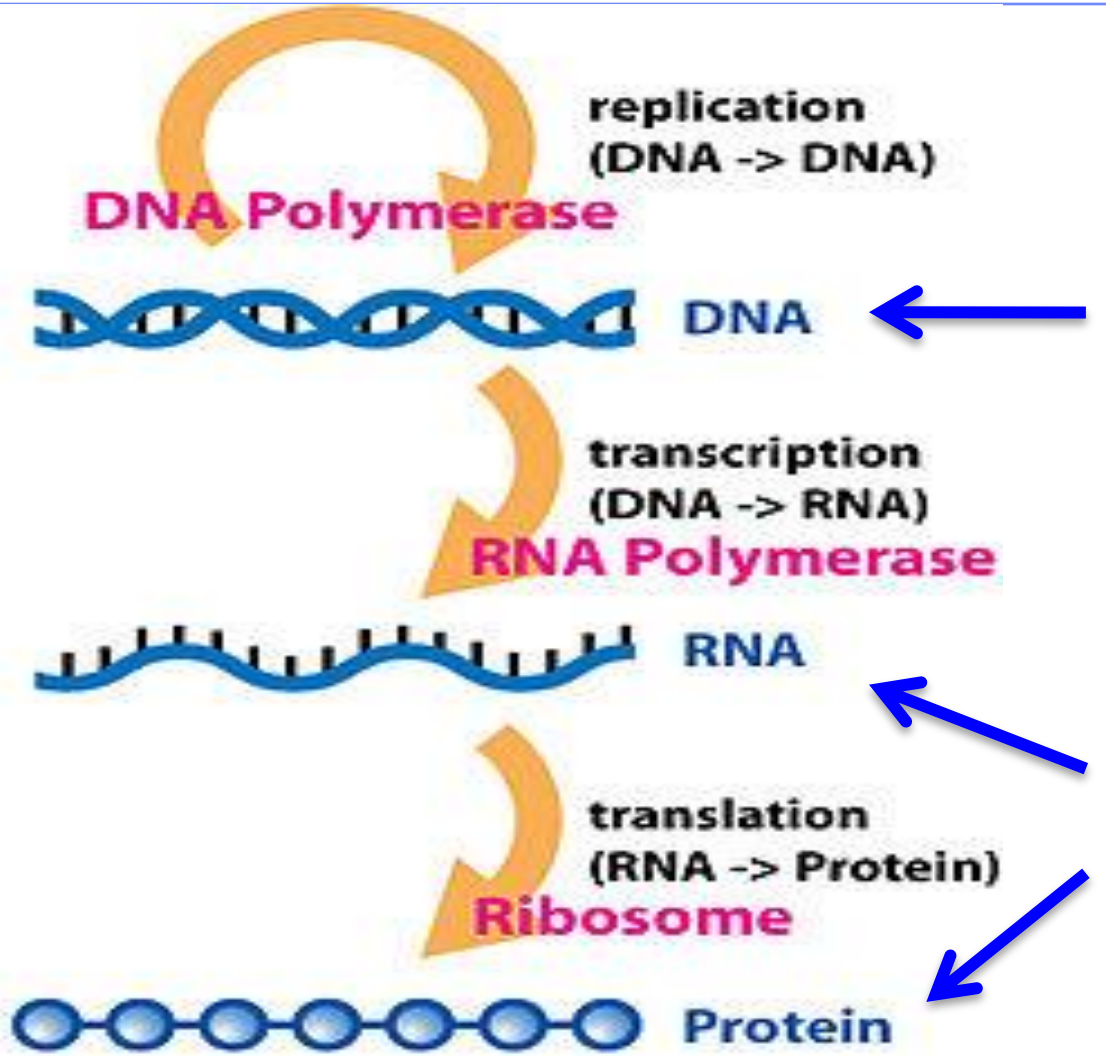
(b) Separation of strands

(c) "Daughter" DNA molecules, each consisting of one parental strand and one new strand

Scientific History

- to understanding that DNA is the genetic material
  - T.H. Morgan (1908)
    - genes are on chromosomes
  - Frederick Griffith (1928)
    - a transforming factor can change phenotype
  - Avery, McCarty & MacLeod (1944)
    - transforming factor is DNA
  - Erwin Chargaff (1947)
    - Chargaff rules: A = T, C = G
  - Hershey & Chase (1952)
    - confirmation that DNA is genetic material
  - Watson & Crick (1953)
    - determined double helix structure of DNA
  - Meselson & Stahl (1958)
    - semi-conservative replication

The Central Dogma



Mutations happen here

Effects play out here

The Genome

- Totality of genetic information of an organism.
- Encoded in the DNA (for some viruses, RNA).

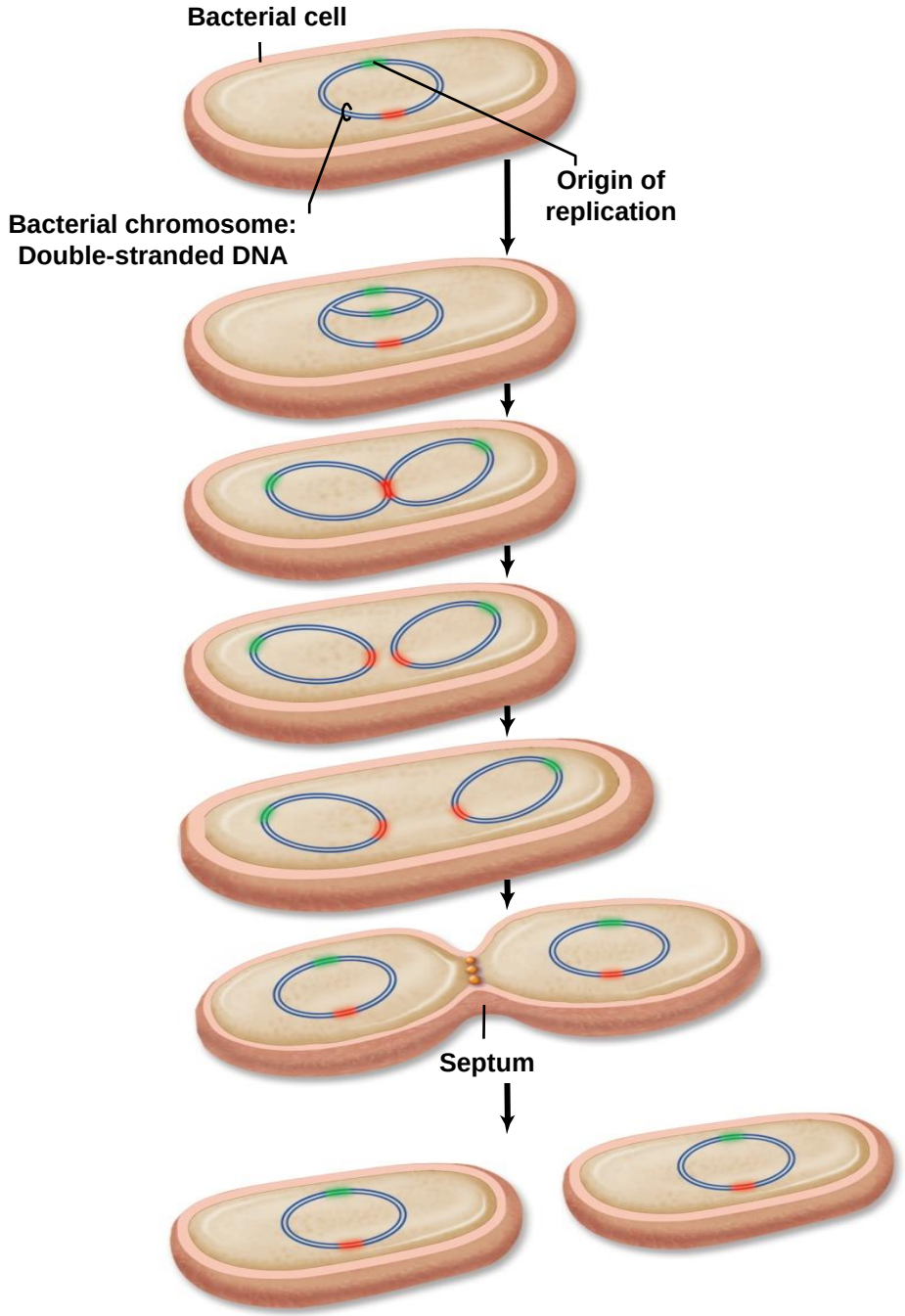
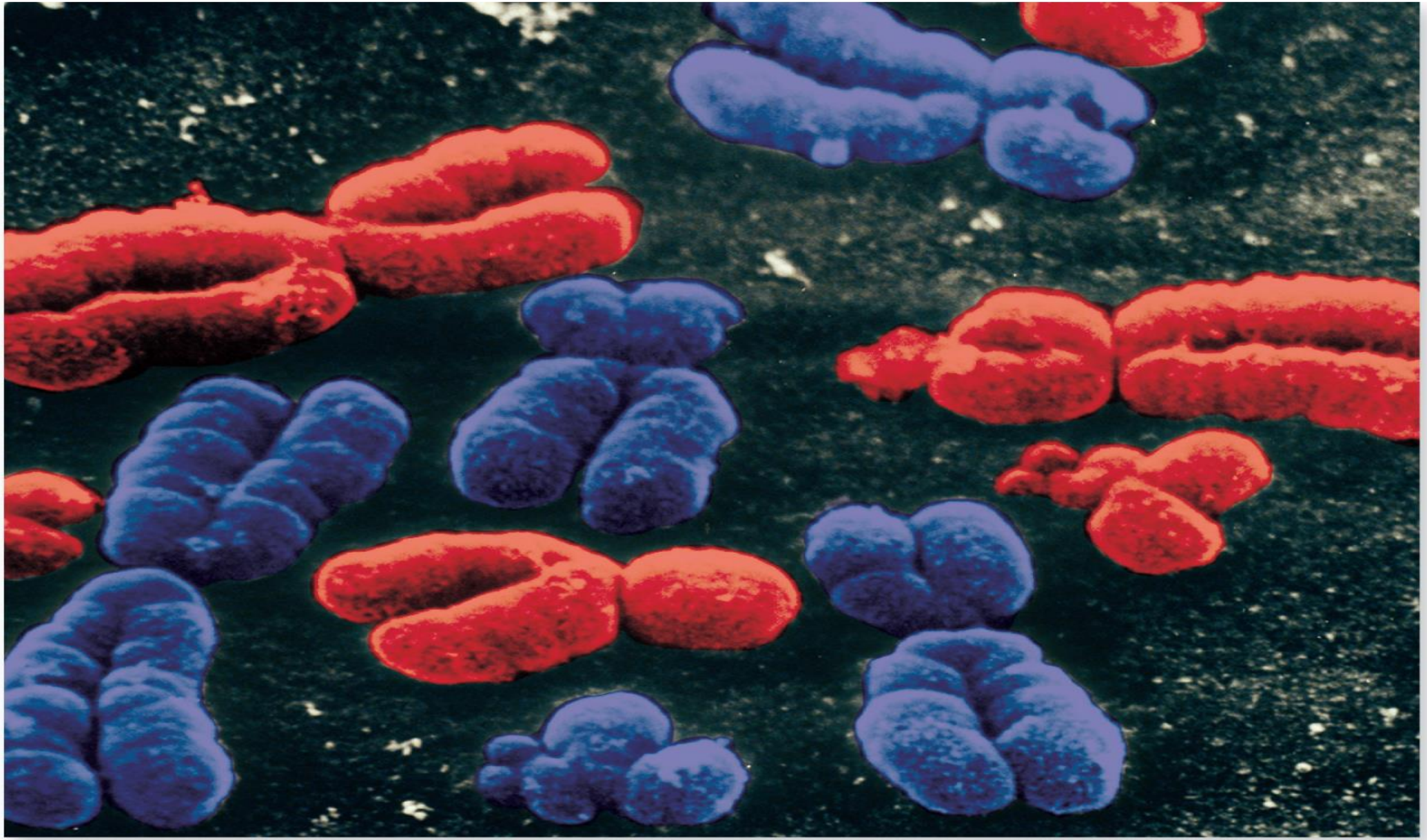


TABLE 10.1 Chromosome Number in Selected Eukaryotes

Group	Total Number of Chromosomes
FUNGI	
Neurospora (haploid)	7
Saccharomyces (a yeast)	16
INSECTS	
Mosquito	6
Drosophila	8
Honeybee	diploid females 32, haploid males 16
Silkworm	56
PLANTS	
Haplopappus gracilis	2
Garden pea	14
Corn	20
Bread wheat	42
Sugarcane	80
Horsetail	216
Adder's tongue fern	1262
VERTEBRATES	
Opossum	22
Frog	26
Mouse	40
Human	46
Chimpanzee	48
Horse	64
Chicken	78
Dog	78



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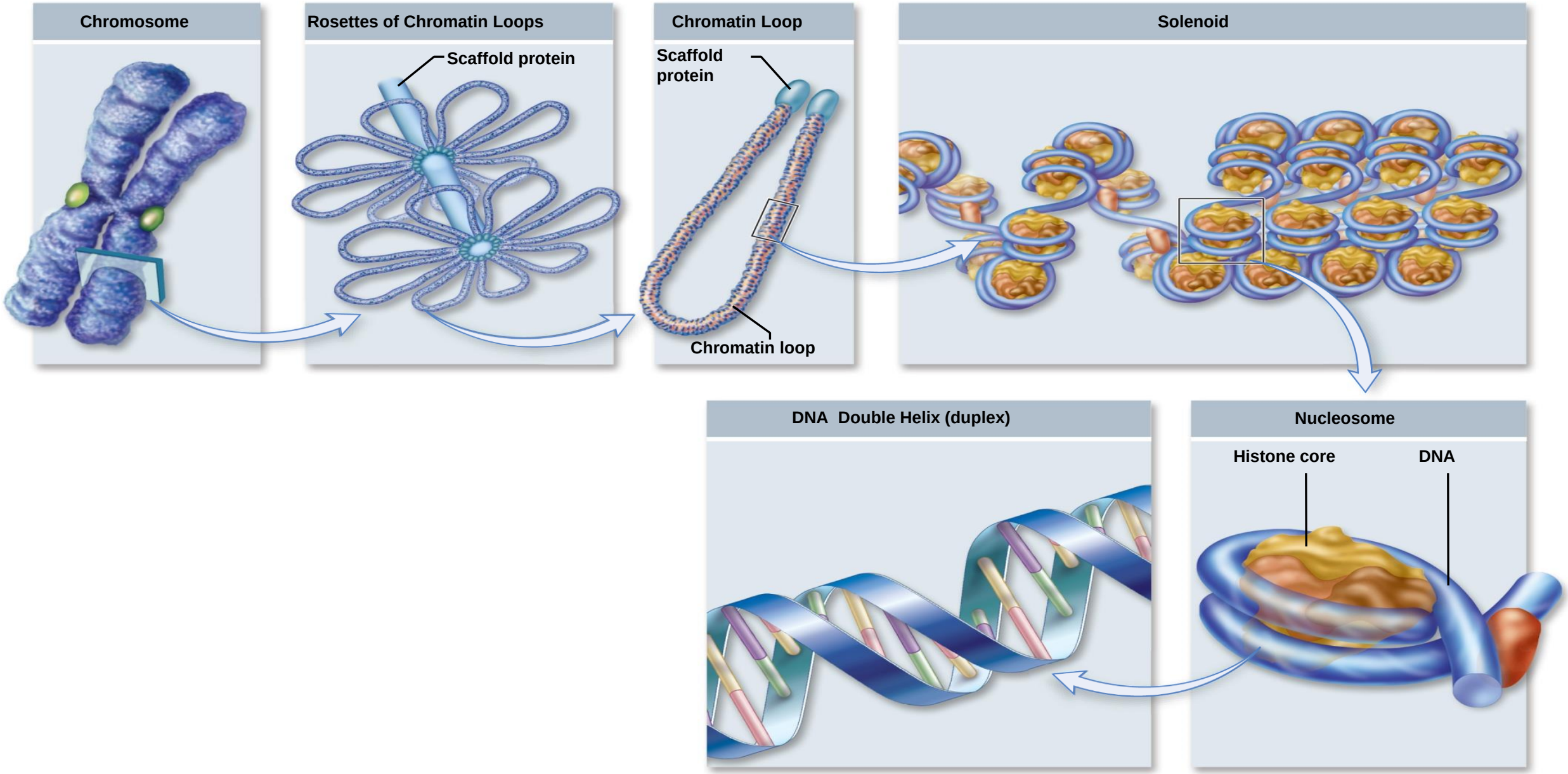
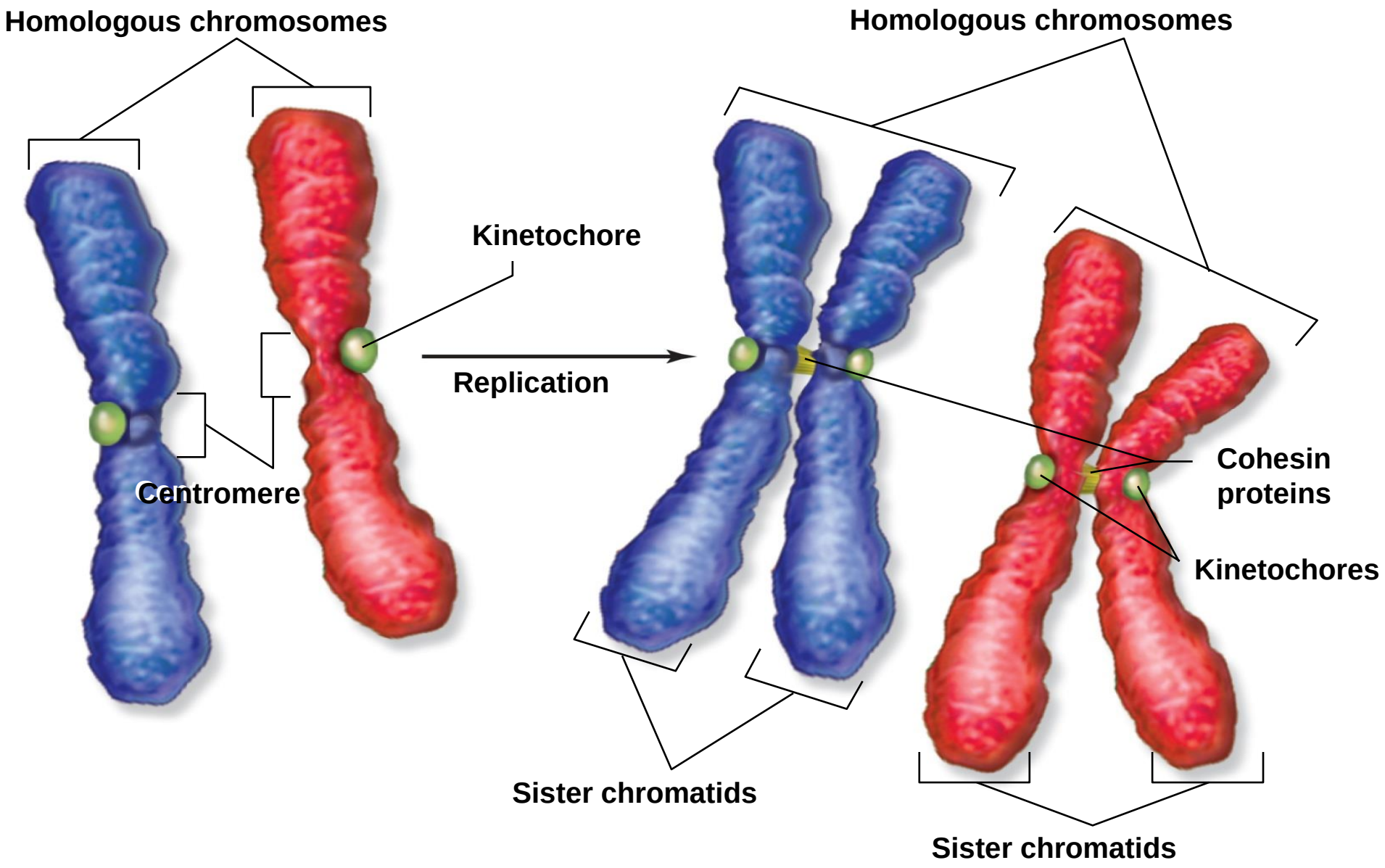
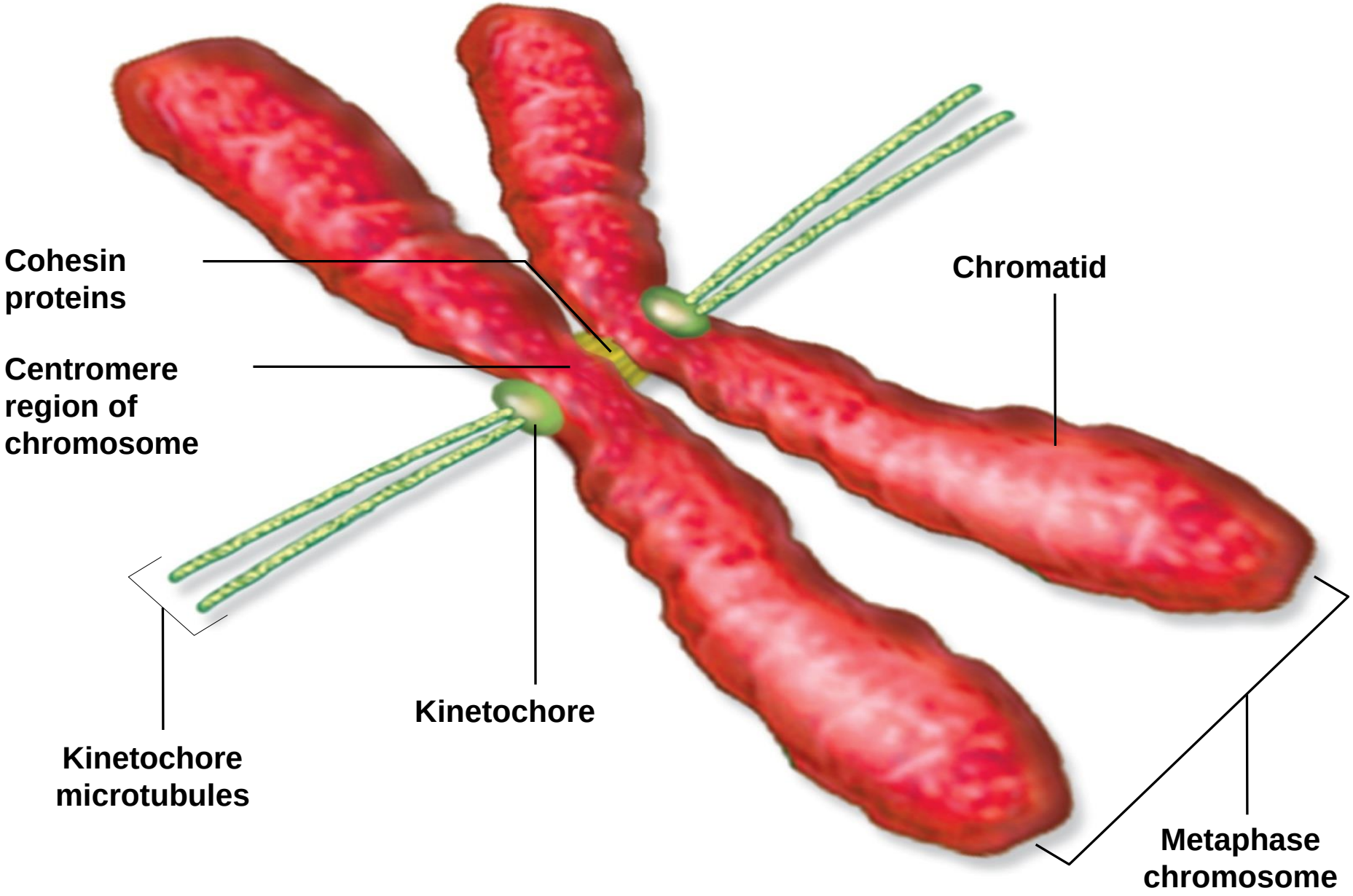
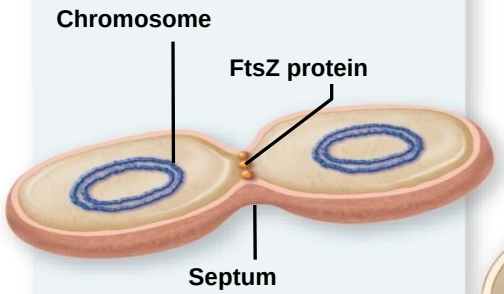






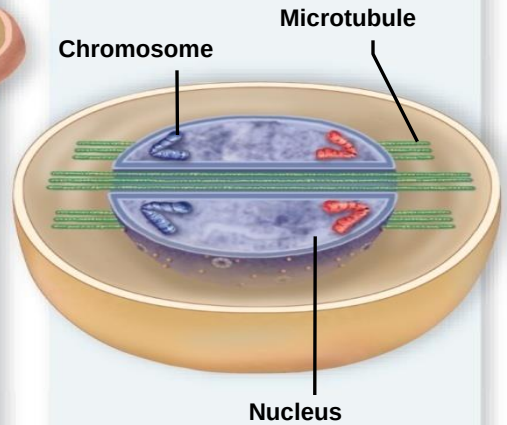
Prokaryotes

No nucleus, usually have single circular chromosome. After DNA is replicated, it is partitioned in the cell. After cell elongation, FtsZ protein assembles into a ring and facilitates septation and cell division.



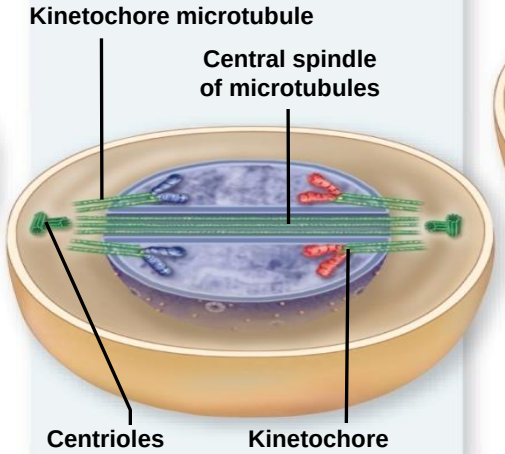
Some Protists

Nucleus present and nuclear envelope remains intact during cell division. Chromosomes line up. Microtubule fibers pass through tunnels in the nuclear membrane and set up an axis for separation of replicated chromosomes, and cell division.



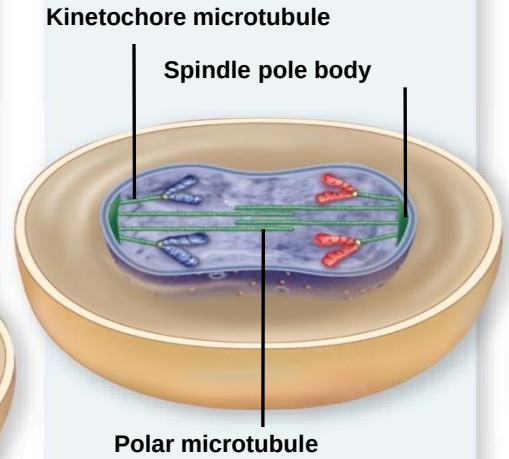
Other Protists

A spindle of micro-tubules forms between two pairs of centrioles at opposite ends of the cell. The spindle passes through one tunnel in the intact nuclear envelope. Kinetochore microtubules form between kinetochores on the chromosomes and the spindle poles and pull the chromo-somes to each pole.



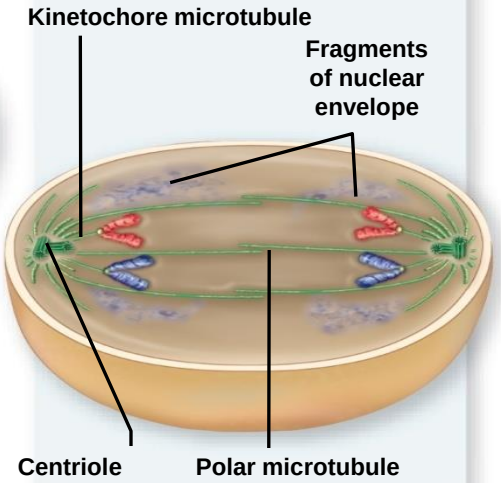
Yeasts

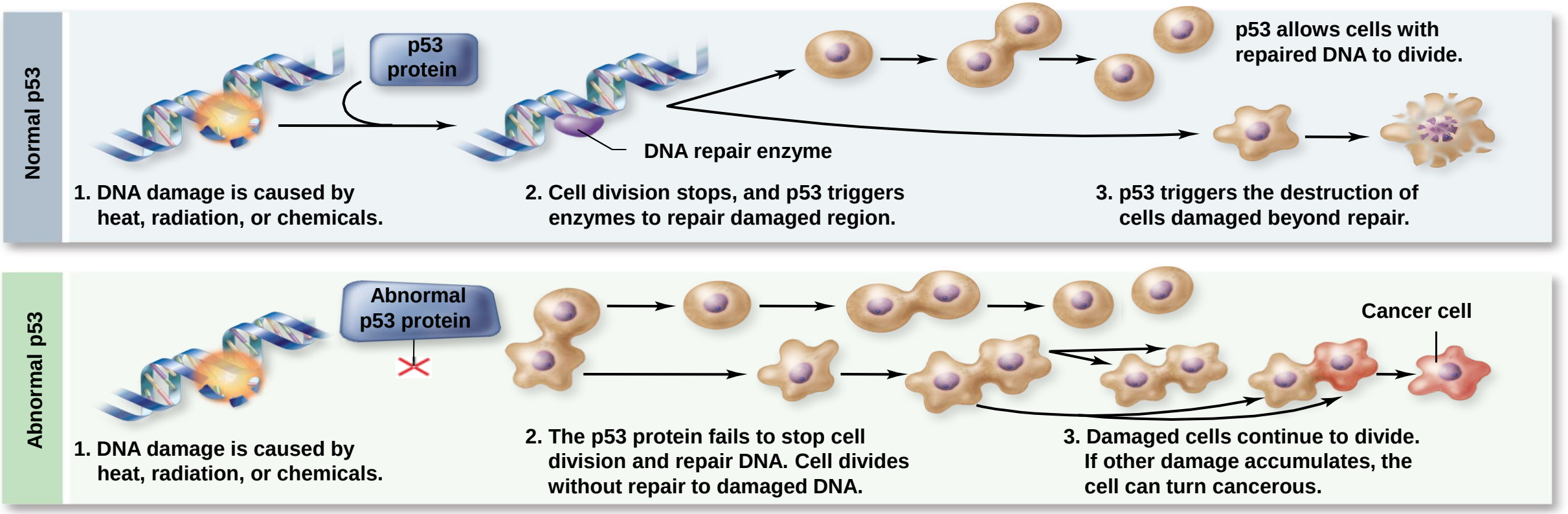
Nuclear envelope remains intact; spindle microtubules form inside the nucleus between spindle pole bodies. A single kinetochore microtubule attaches to each chromosome and pulls each to a pole.



Animals

Spindle microtubules begin to form between centrioles outside of nucleus. Centrioles move to the poles and the nuclear envelope breaks down. Kinetochore microtubules attach kinetochores of chromosomes to spindle poles. Polar microtubules extend toward the center of the cell and overlap.





Species/ Number of Chromosomes

Species	Number of chromosomes
Human	46
Mouse	40
Rat	42
Fruit flies	8
Bacteria	1

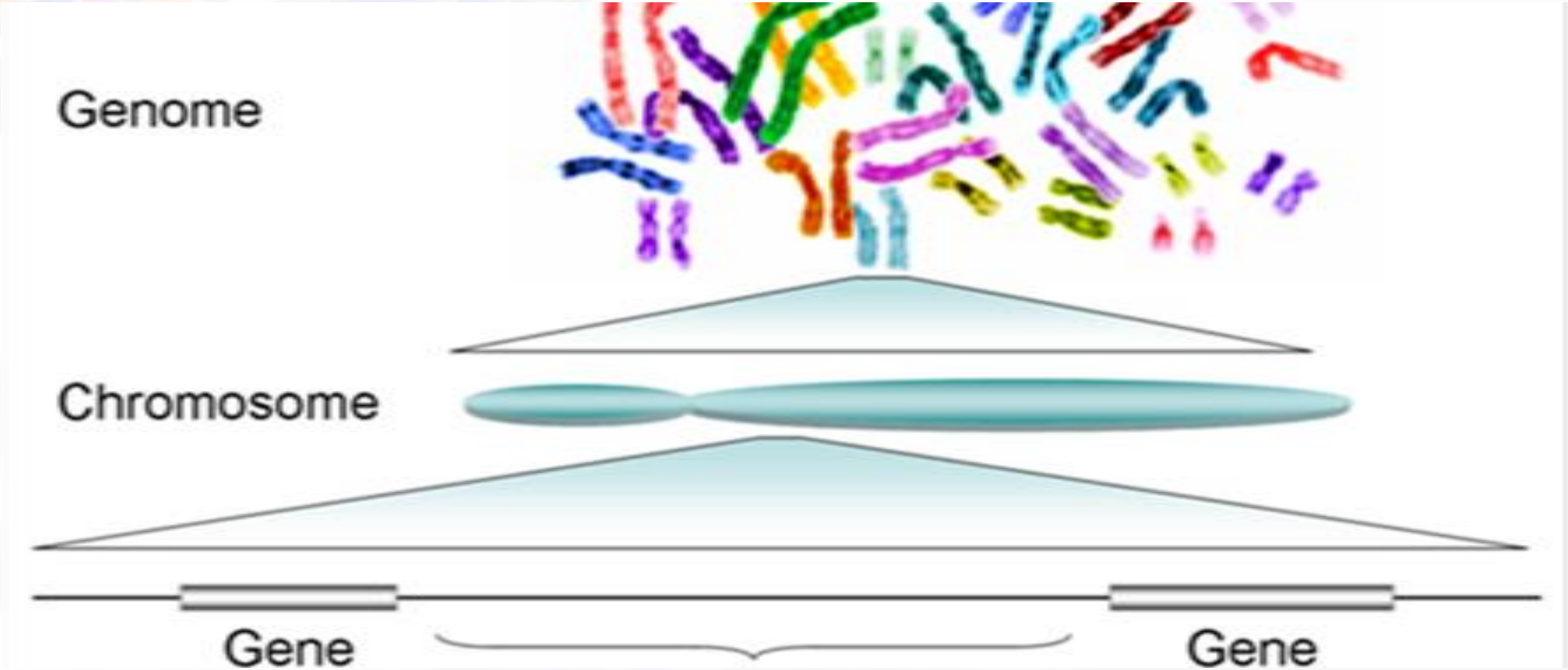
Human Genome

Human Genome; Arranged on multiple chromosomes; twenty three pairs of chromosomes;

- Twenty two pairs (autosomes).
- One pair (sex chromosome) (xx) (female) or (xy) (male).

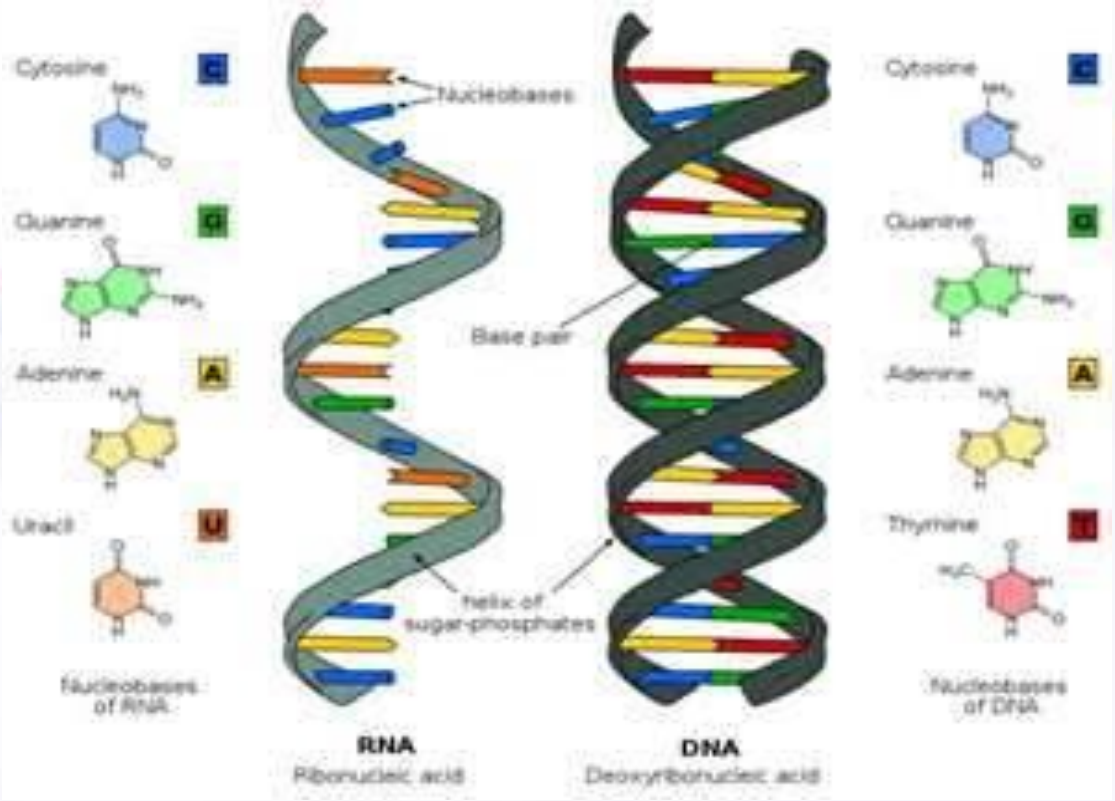
Humans have 23 pairs of chromosome in every cell (except mature red blood cells..); Gametes or sex cells (sperm and eggs) have half the normal complement of chromosomes.

Human Genome



General Structure of Nucleic Acid

DNA and **RNA** are long chain polymers of small chemical compound called nucleotides.



Nucleotides

Nucleotides; ring shaped structures composed of:

- Nitrogenous base; these bases are classified based on their chemical structures into two groups:
  - Purine; double ringed structure (Adenine and Guanine).
  - Pyrimidine; single ring structures (cytosine and thymine).

- Sugar

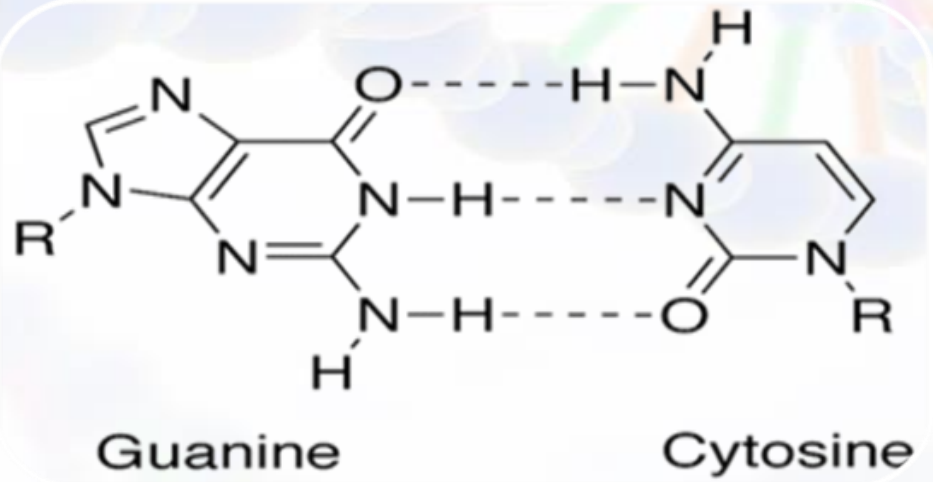
- Phosphate group

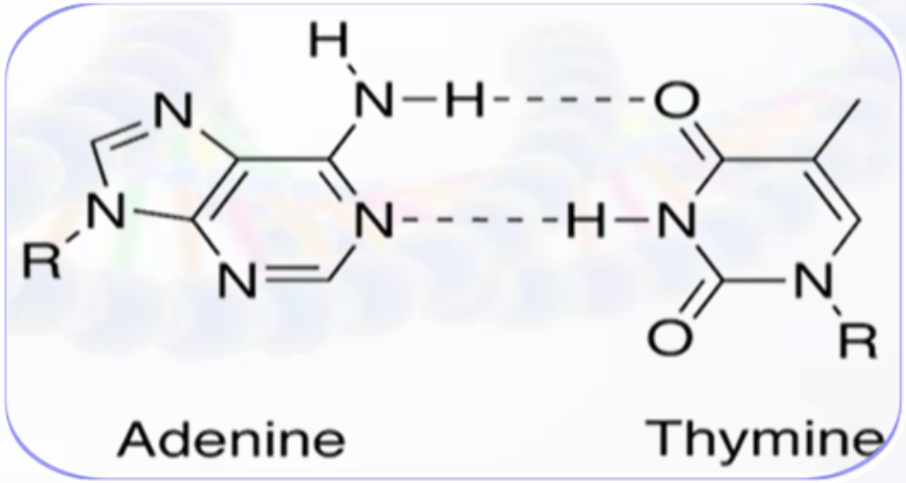
Nucleotides

- DNA: Four different types of nucleotides differ in nitrogenous base:
  - A is for adenine;
  - G is for guanine;
  - C is for cytosine and
  - T is for thymine.

- RNA: thymine base replaced by uracil base.

Nucleotides





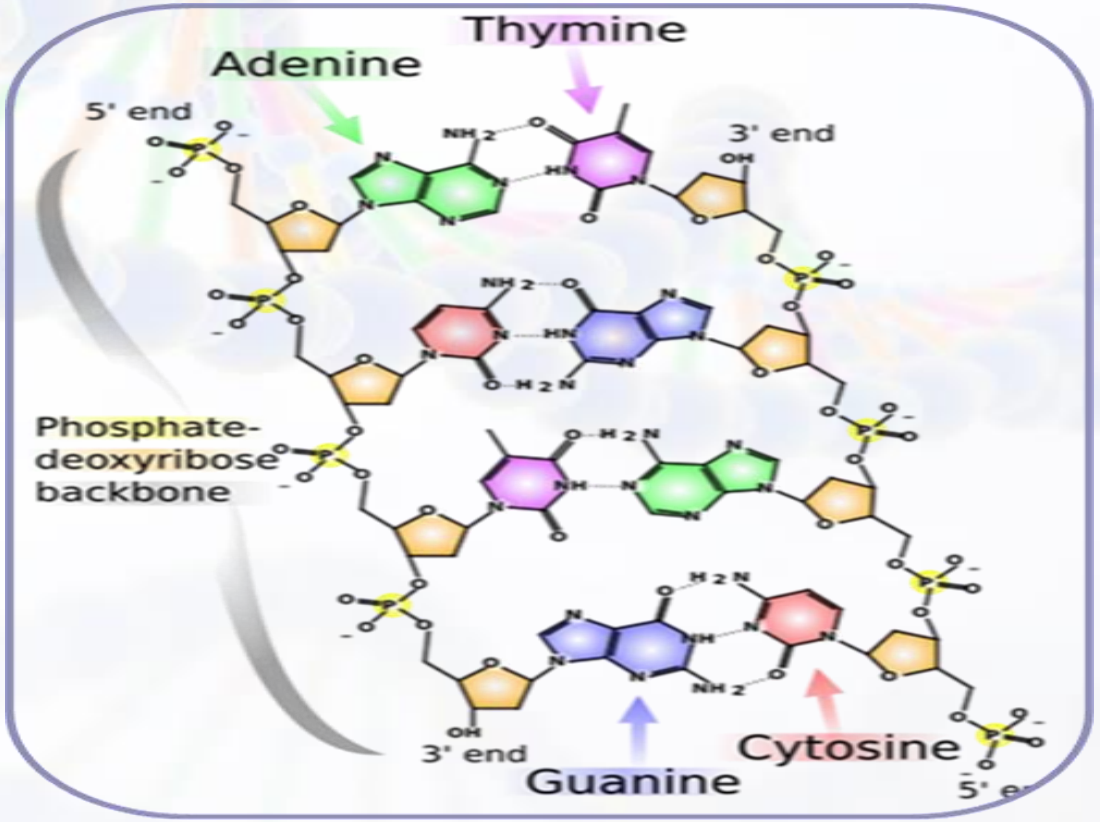
The DNA

- **Deoxyribonucleic Acid (DNA);** the genetic material of all cellular organisms and most viruses.
- **DNA**; the gigantic molecule which is used to encode genetic information for all life on Earth.
- A human cell contains about 2 meters of **DNA**. **DNA** in the body could stretch to the sun and back almost 100 times. So it is tightly packed.
- **DNA** responsible for preserving, copying and transmitting information within cells and from generation to generation.

DNA Double Helix

- Linked as a twisted ladder.
- The curving sides of the ladder represent the sugar-phosphate backbone of the two DNA strands; the rungs are the base pairs.
- Possess antiparallel polarity.
- Stabilized by hydrogen bonds between the bases.

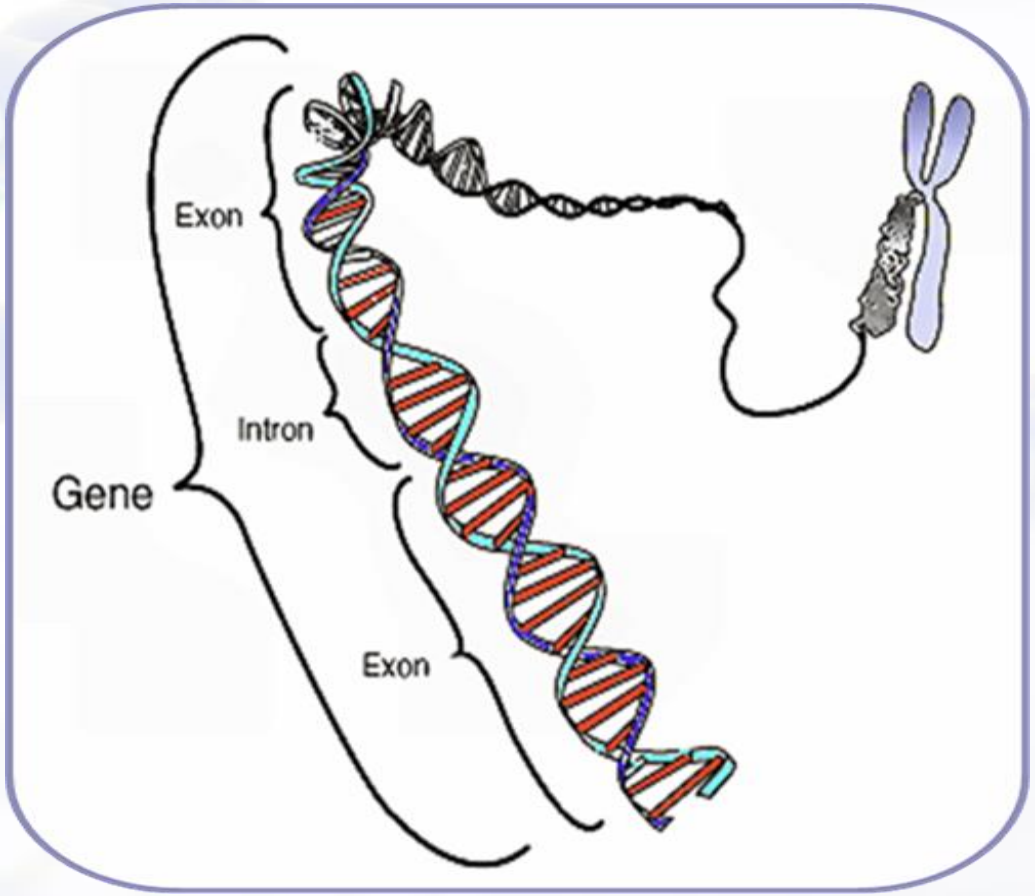
DNA Double Helix



The Gene

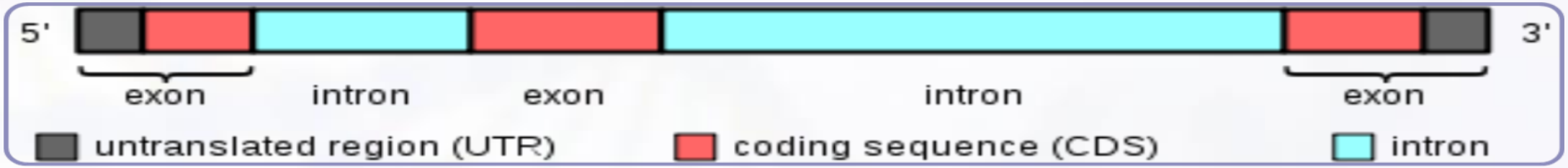
- **The gene;** it is a segment within a very long strand of DNA.
- **Genes** are the basic units of hereditary.
- **Genes** located on chromosome on its place or locus.
- **Allele;** a variant of the DNA sequence at a given locus. Each allele inherited from a different parent.

The Gene



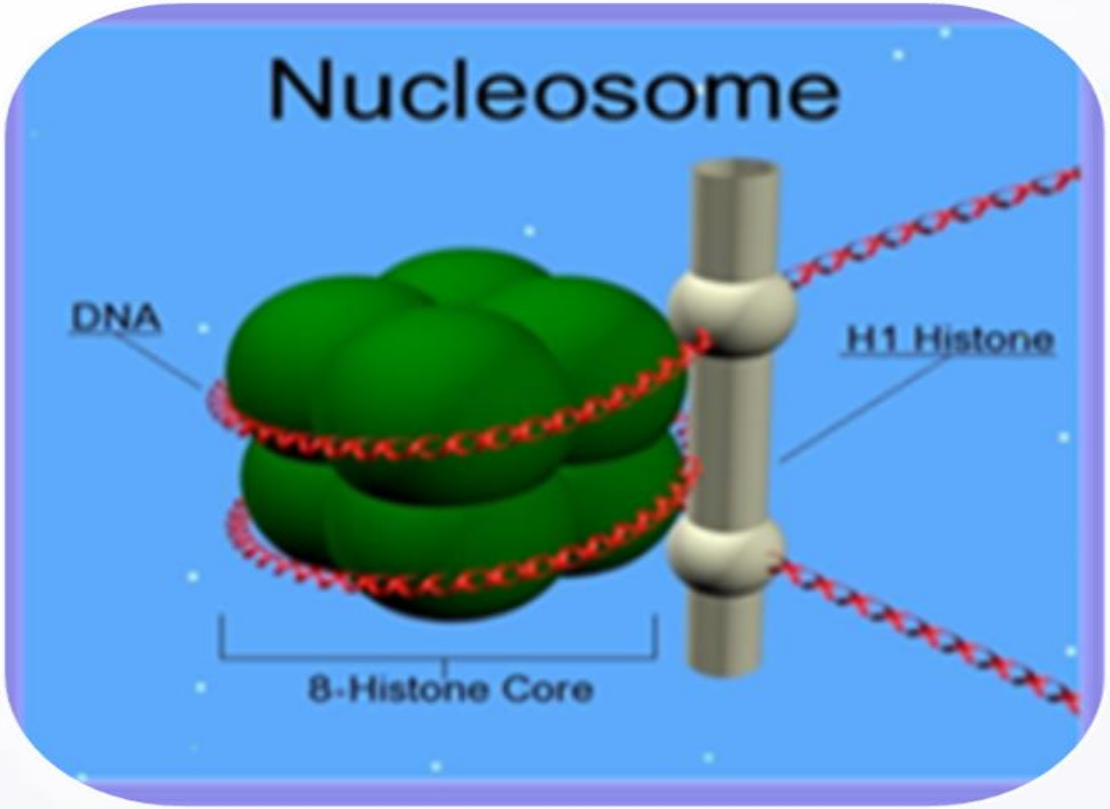
Gene Structure

- Most of the genes consist of; short coding sequences or exons are interrupted by a longer intervening noncoding sequence or introns; although a few genes in the human genome have no introns.

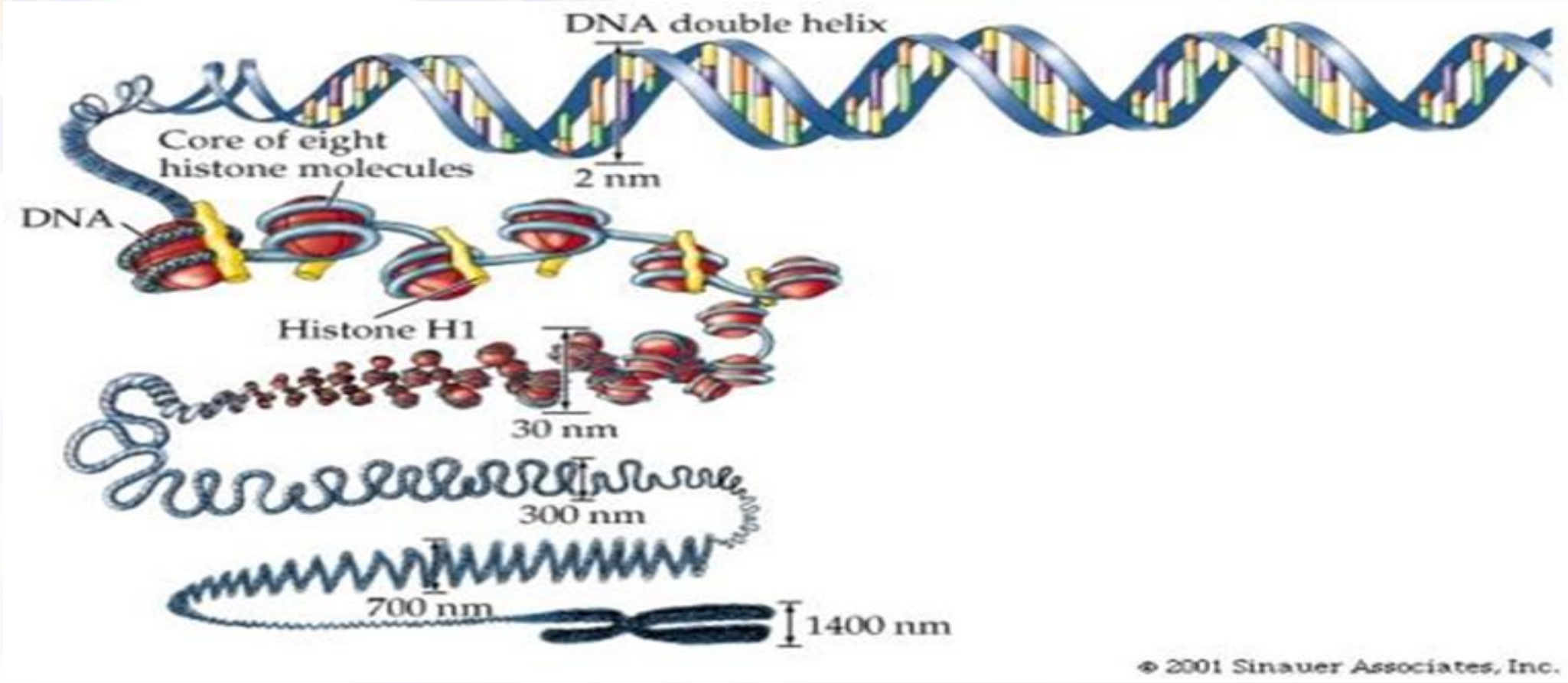


DNA Organization

DNA molecules complexed with other proteins, especially basic proteins called histones to form a substance known as chromatin.



DNA Organization

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