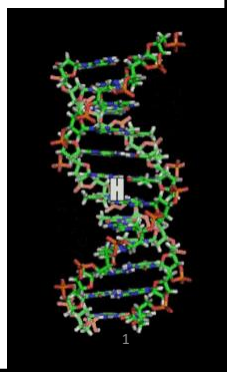
DNA



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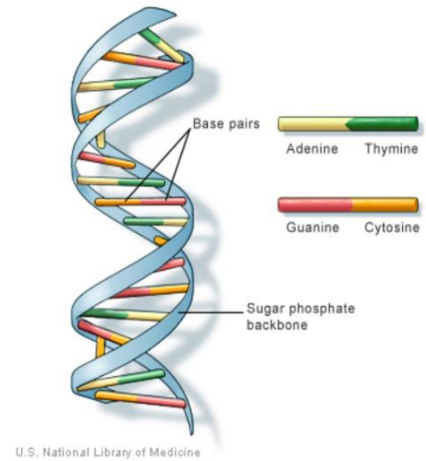
DNA -Deoxyribonucleic Acid.

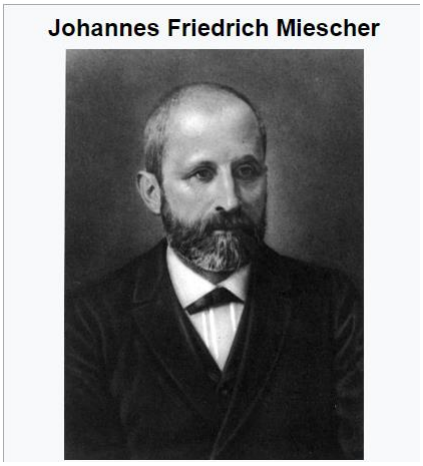


Credit: U.S. National Library of Medicine

- What is DNA?
  - ***DNA is a group of molecules that is responsible for carrying and transmitting the hereditary materials or the genetic instructions from parents to offsprings.***
  - It is found in all **prokaryotic cells and eukaryotic cells and also in some viruses.**

2

Who Discovered DNA?



DNA was first recognized and identified by the Swiss biologist **Johannes Friedrich Miescher** in 1869 during his research on white blood cells.

3

Rosalind Franklin, 1920–1958

Maurice Wilkins, 1916–2004

James D. Watson

Francis Crick, 1916–2004

Rosalind Franklin and Maurice Wilkins used X-ray diffraction to understand the physical structure of the DNA molecule.

James Watson and Francis Crick used stick-and-ball models to test their ideas on the possible structure of DNA.

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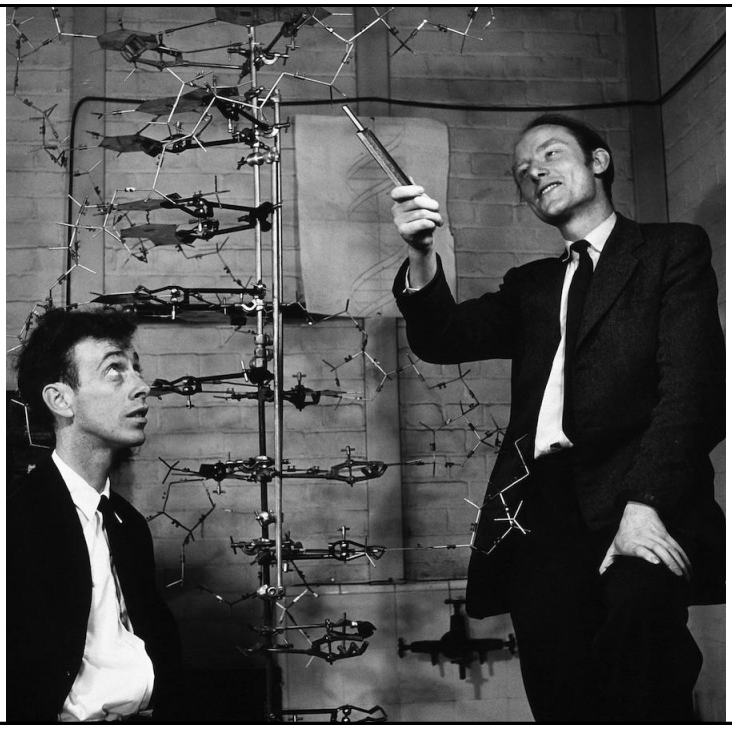

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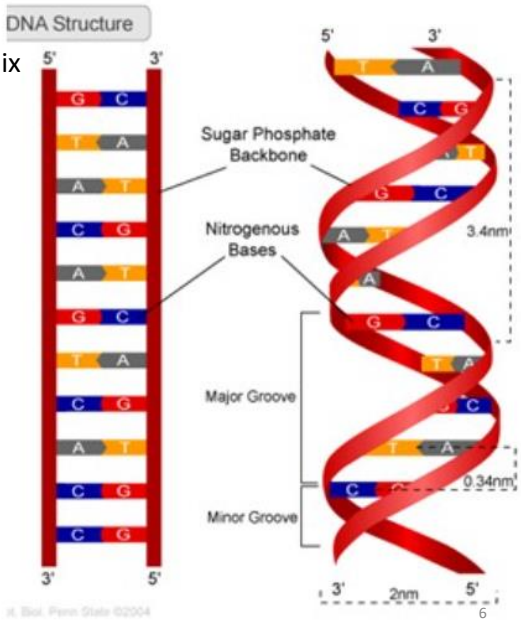
Structure of DNA

- "Twisted ladder" or "Spiral Staircase; Right-handed helix
- "Side of Ladder" – made of Deoxyribose (sugar) alternating with phosphates
- "Rung of Ladder" – nitrogenous bases
  - **Purines**: Guanine, Adenine
  - **Pyrimidines**: Thymine , Cytosine
- Adenine pairs with Thymine (A = T)
- Guanine pairs with Cytosine (G = C)
- Distance between adjacent bases is 0.34nm
- There are 10.5 base-pairs in one complete turn of the helix.
- The length of one complete turn of helix is 3.4nm
- The two strands of DNA are complementary and run antiparallel to each other.



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Chargaff rule

In all cellular DNAs, regardless of the species, the number of adenosine residues is equal to the number of thymidine residues (that is, A = T), and the number of guanosine residues is equal to the number of cytidine residues (G = C). From these relationships it follows that the sum of the purine residues equals the sum of the pyrimidine residue; that is, A + G = T + C

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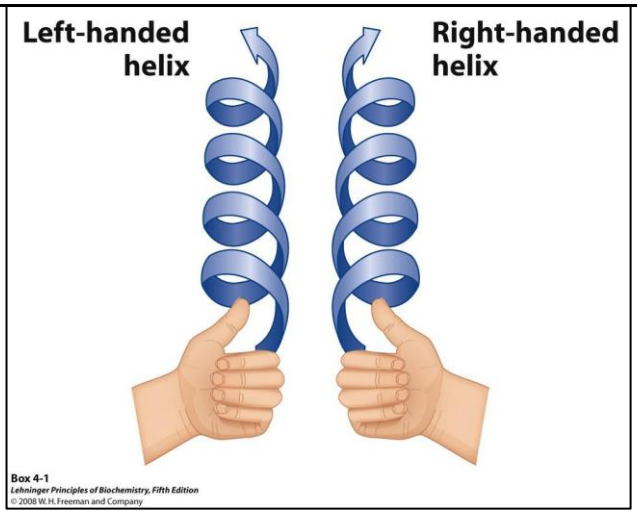

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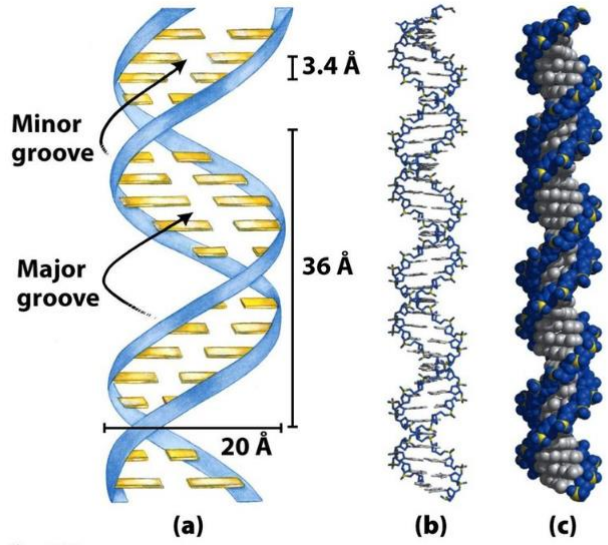

Figure 8-13
Lehninger Principles of Biochemistry, Fifth Edition

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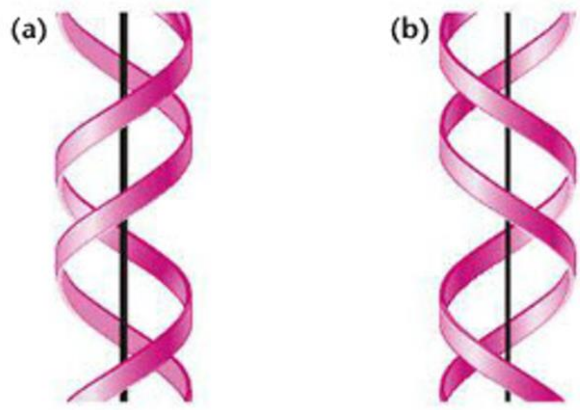
Which is right and left-handed helix?



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DNA Types

- There are three different DNA types:
- **A-DNA:** It is a right-handed double helix similar to the B-DNA form. Dehydrated DNA takes an A form that protects the DNA during extreme conditions such as desiccation.
- **B-DNA:** This is the most common DNA conformation and is a right-handed helix. The majority of DNA has a B type conformation under normal physiological conditions.
- **Z-DNA:** Z-DNA is a left-handed DNA where the double helix winds to the left in a zig-zag pattern. It is found ahead of the start site of a gene and hence, is believed to play some role in gene regulation.

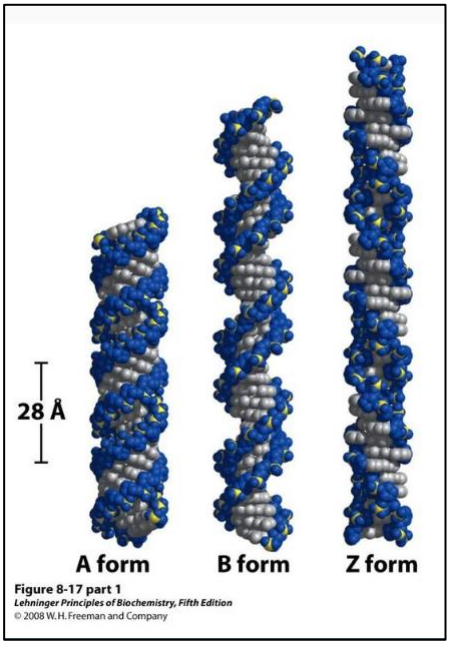

Figure 8-17 part 1
Lehninger Principles of Biochemistry, Fifth Edition

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Table 7.2 Properties of major foms of DNA

Particulars	A DNA	B DNA	Z DNA
Helix	Right handed	Right handed	Left handed
Base pairs per turn	~11	~10.5	~12
Helical Diameter (nm)	2.6	2.0	1.8
Helical length (nm)	2.6	3.4	3.7
Shape	Broadest	Intermediate	Narrowest
Major Grove	Narrow, deep	Wide, deep	Flat
Minor Grove	Broad, shallow	Narrow, shallow	Narrow, deep

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The Organisation of Eukaryotic Genome

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DNA organization in the nucleus

- The length of DNA in a human cell is about **2 meters** if stretched end-to-end which is much longer than the nucleus of a cell, which is only about 6 micrometers in diameter.
- This is similar to packing 40 kilometers of thread into a tennis ball.
-

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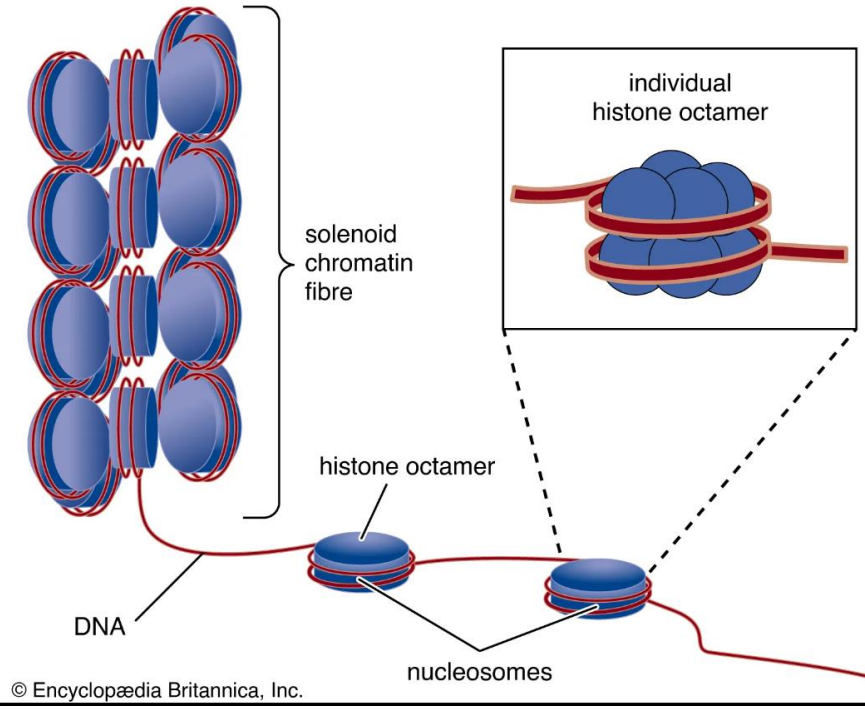
individual
histone octamer
solenoid
chromatin
fibre
histone octamer
DNA
nucleosomes
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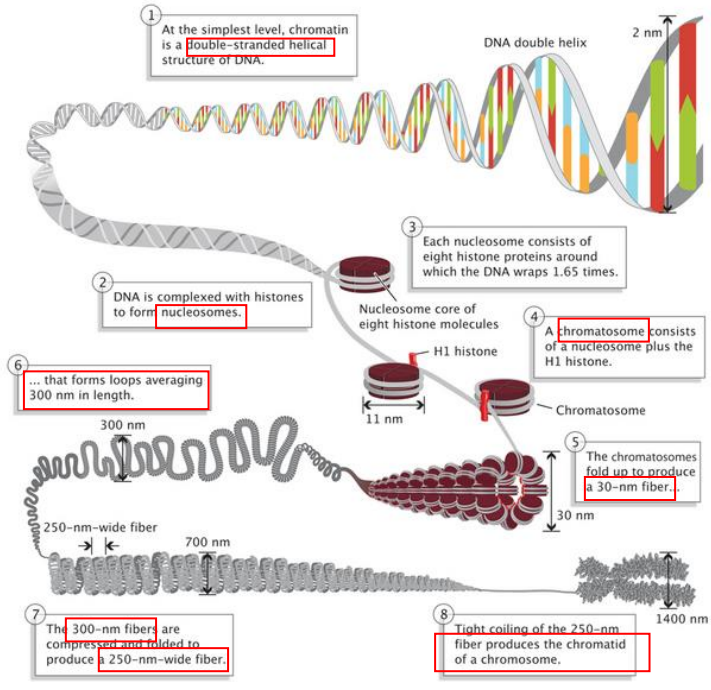
1 At the simplest level, chromatin is a double-stranded helical structure of DNA.
DNA double helix
2 nm
2 DNA is complexed with histones to form nucleosomes.
3 Each nucleosome consists of eight histone proteins around which the DNA wraps 1.65 times.
Nucleosome core of eight histone molecules
4 A chromatosome consists of a nucleosome plus the H1 histone.
H1 histone
11 nm
Chromatosome
5 The chromatosomes fold up to produce a 30-nm fiber.
30 nm
6 ... that forms loops averaging 300 nm in length.
300 nm
250-nm-wide fiber
700 nm
7 The 300-nm fibers are compressed and folded to produce a 250-nm-wide fiber.
8 Tight coiling of the 250-nm fiber produces the chromatid of a chromosome.
1400 nm

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DNA Replication

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Definition

- Replication is the process where DNA copies are made in the nucleus of the cell.
- Before a cell divides, it must first copy (or replicate) its entire genome so that each resulting daughter cell ends up with its own complete genome.

The complete set of DNA (genetic material) in an organism.

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What are needed for DNA replication?

- DNA replication requires several components, including enzymes, DNA, and nucleotides:

1. **DNA:** A double helix made of two complementary strands that can be used as templates to create new DNA molecules
2. **DNA helicases:** Proteins that unwind DNA at specific points to separate the double strands so they can be copied
3. **DNA polymerase:** An enzyme that adds nucleotides to a growing strand of DNA, using the template strand to specify which nucleotides to add
4. **Primers:** Short strands of nucleotides that bind to the 3' end of the template strand, allowing DNA polymerase to add nucleotides
5. **DNA ligase:** An enzyme that joins DNA strands together through phosphodiester bonds
6. DNA single-stranded binding proteins: Proteins that stabilize the single-stranded structure created by helicases
7. **DNA gyrase:** An enzyme that may help with the unwinding process by catalyzing the formation of negative supercoils. DNA gyrase is a topoisomerase, a class of enzymes that control DNA's topological transitions.

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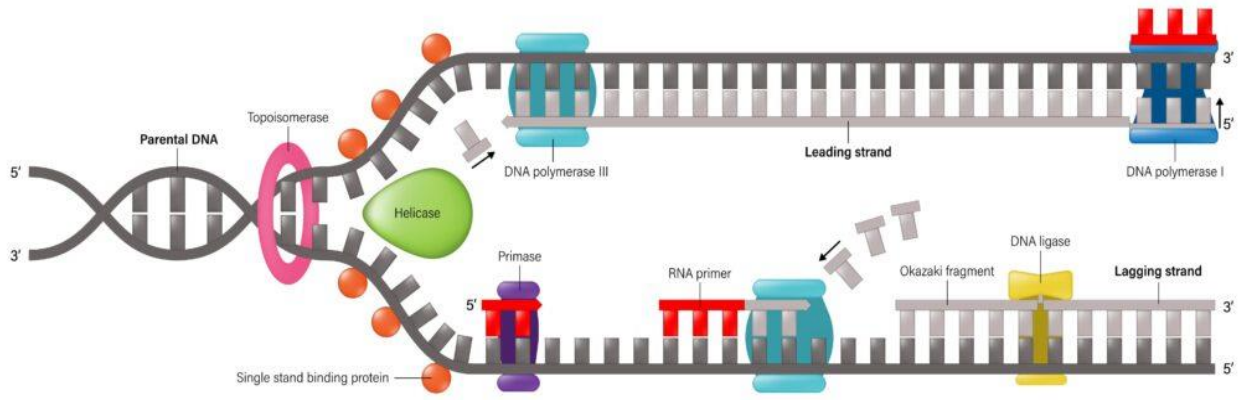
DNA replication



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