12.1- DNA: The genetic material

Discovery of the Genetic Material

Gregor Mendel's work with pea plants was rediscovered in the early 1900s and scientists began to look for the molecule involved in inheritance.

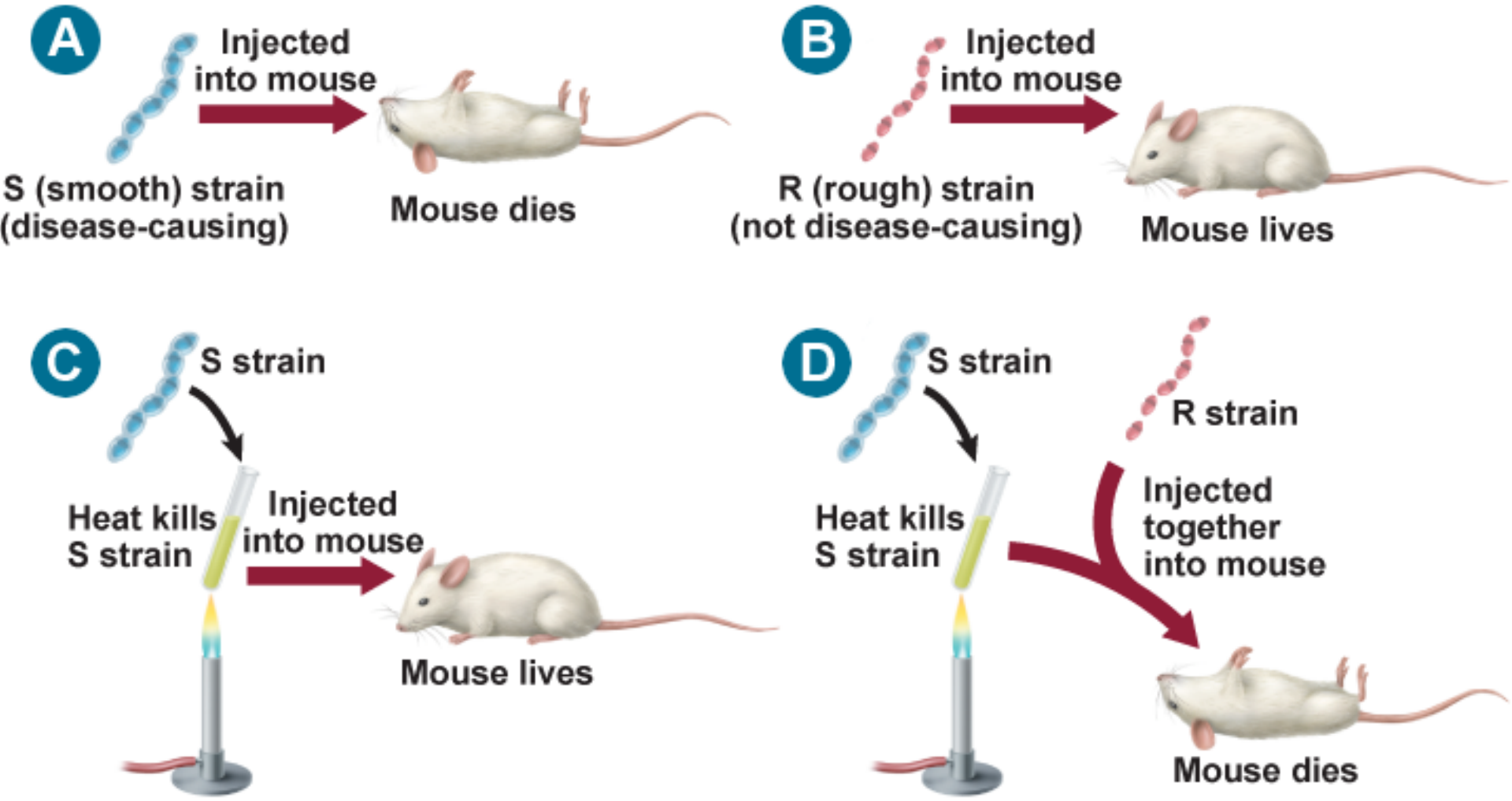
They knew **chromosomes** carried the genetic information, but struggled to determine if **DNA or protein** was the source of genetic information.

Frederick Griffith- 1928

- First major experiment searching for the genetic material
- Involved bacteria *S. pneumoniae* and lab mice

Video clip

Frederick Griffith- 1928



S Strain Smooth	Mouse dies
R strain Rough	Mouse lives
S strain + Heat	Mouse lives
S Strain + Heat and R Strain	Mouse dies

Oswald Avery- 1944

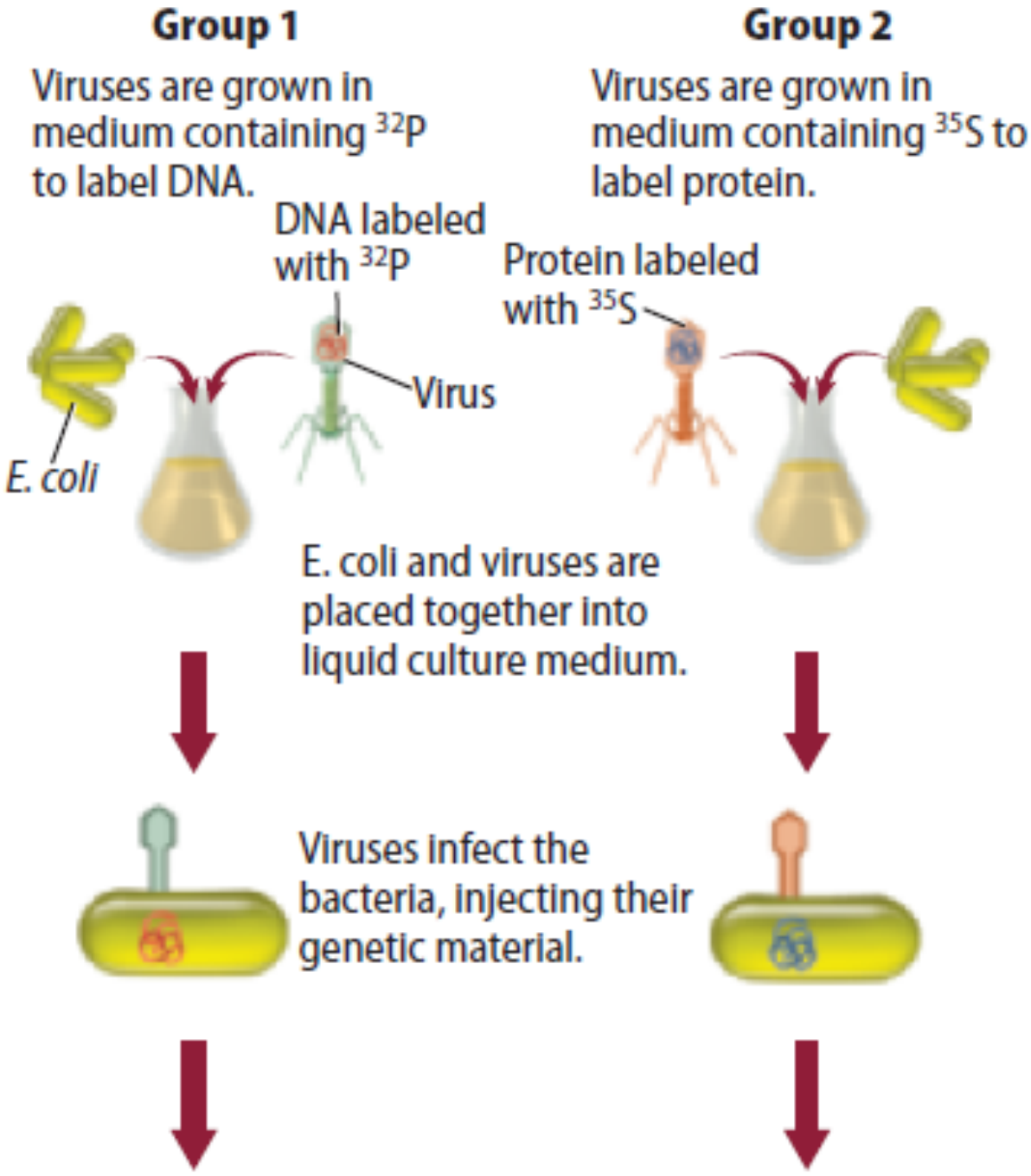
- Broke apart heat-killed Smooth strains into DNA, proteins, and lipids
- Adding proteins or lipids to the rough strain had no effect on the mice.
- When DNA was added to the rough strain the mice died

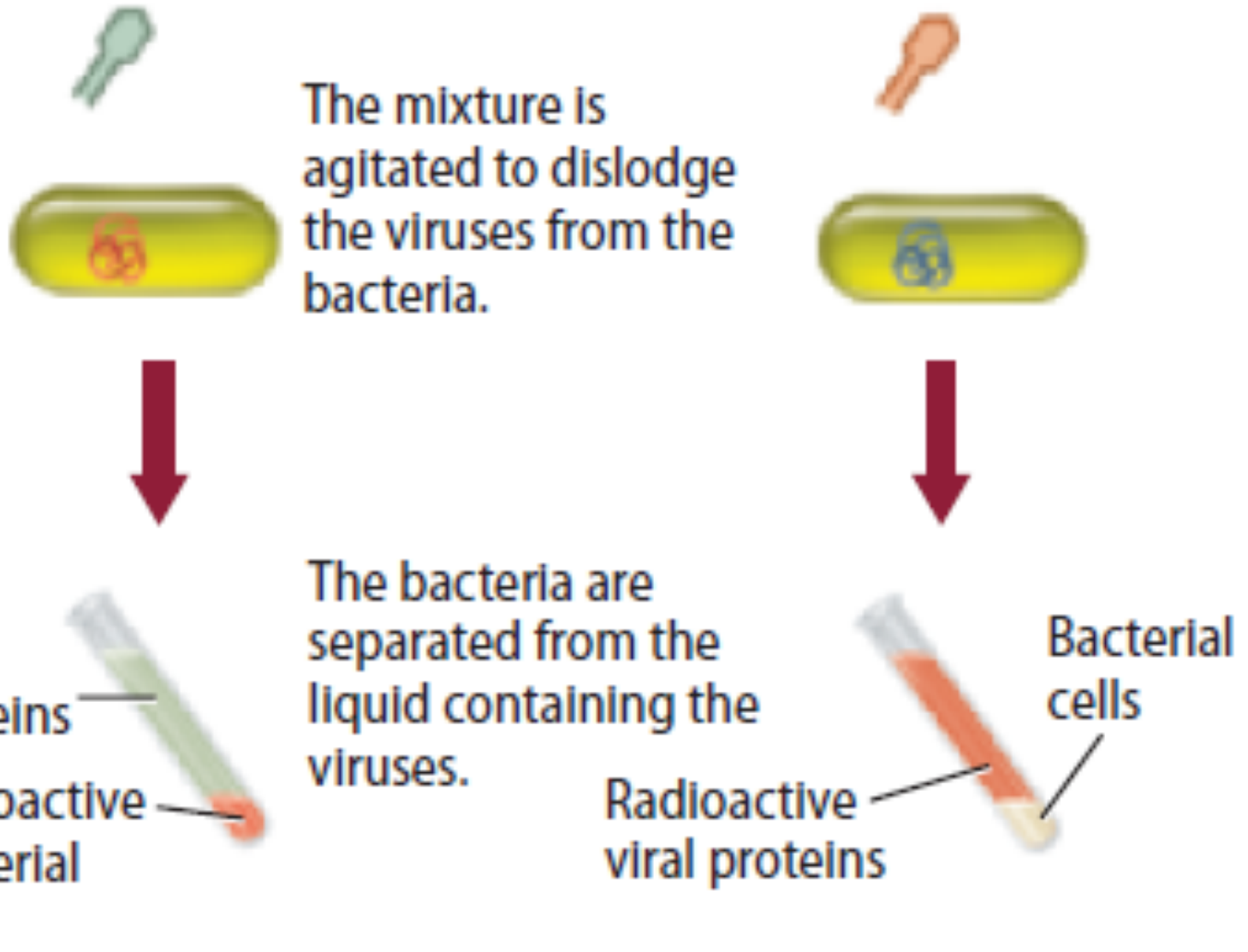
- Avery concluded that when the S cells were killed, DNA was released and Rough bacteria took this DNA in and changed into Smooth

Alfred Hershey and Martha Chase- 1952

- **Bacteriophage** (DNA and Protein) attack bacteria cells
- Used radioactive labeling to mark DNA in one group and protein in the other
- Concluded that the DNA provided the genetic information

video


Group 1
Viruses are grown in medium containing ^{32}P to label DNA.
DNA labeled with ^{32}P
Virus
E. coli
Group 2
Viruses are grown in medium containing ^{35}S to label protein.
Protein labeled with ^{35}S
E. coli and viruses are placed together into liquid culture medium.
Viruses infect the bacteria, injecting their genetic material.


The mixture is agitated to dislodge the viruses from the bacteria.
The bacteria are separated from the liquid containing the viruses.
Viral proteins
Radioactive bacterial cells
Bacterial cells
Radioactive viral proteins
Most ^{32}P is in the bacterial cells.
Most ^{35}S is in the liquid with the viral proteins.

Chargaff

Analyzed the amount of A, G, T, and C in the DNA of various species

Chargaff's Data

	Base Composition (Mole Percent)			
Organism	A	T	G	C
Escherichia coli	26.0	23.9	24.9	25.2
Yeast	31.3	32.9	18.7	17.1
Herring	27.8	27.5	22.2	22.6
Rat	28.6	28.4	21.4	21.5
Human	30.9	29.4	19.9	19.8

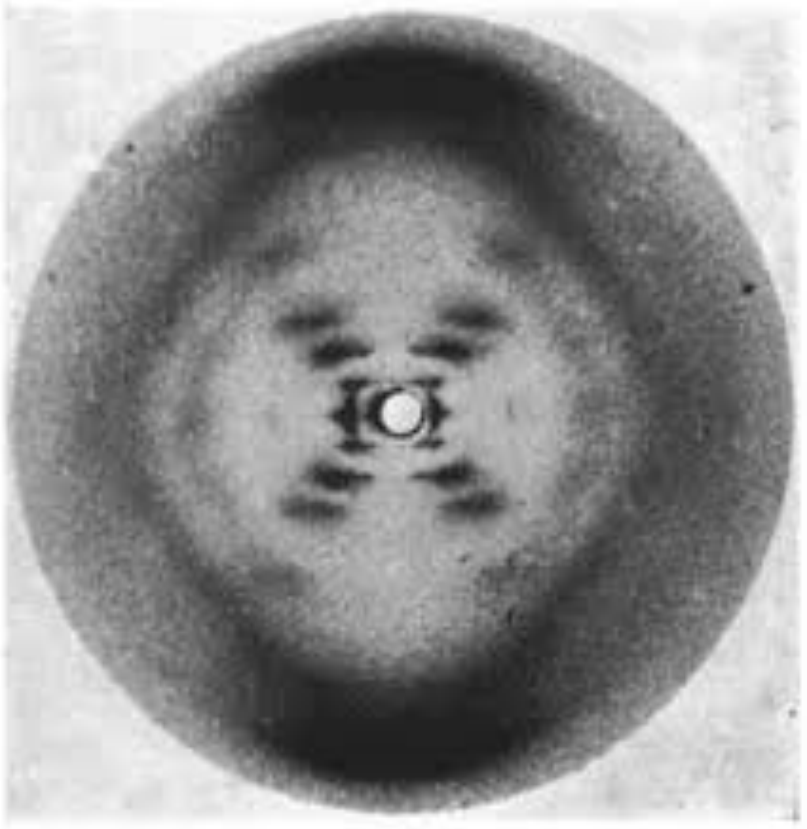
Chargaff's rule: C = G and T = A

Search for the structure of DNA was lead by four scientists:

- **Rosalind Franklin**, British chemist
- **Maurice Wilkins**, British physicist
- **Francis Crick**, British physicist
- **James Watson**, American biologist

X-ray diffraction (Franklin)

- Showed that DNA was a **double helix**, or twisted ladder shape.



Watson and Crick

- Built a model using Franklin and Chargaff's data for the width of the helix and the spacing of the bases

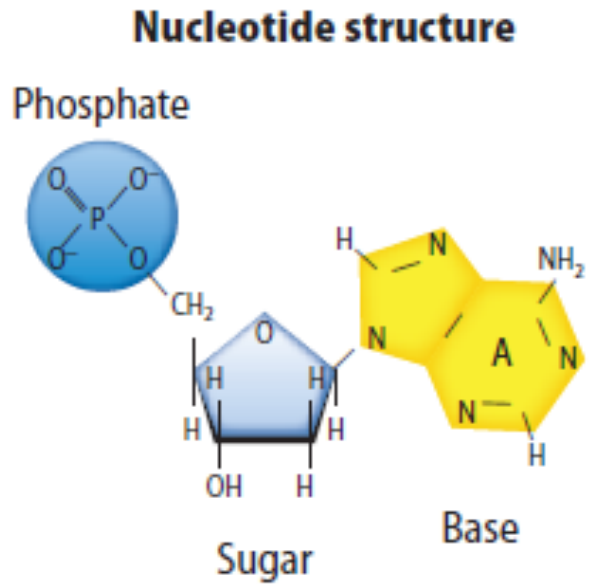
DNA structure

DNA's **double helix**= a twisted ladder.

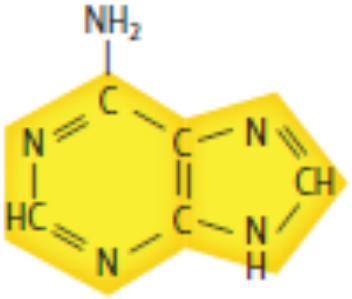
- "Rails" of the ladder are deoxyribose and phosphate.
- "Steps" are the pairs of bases (cytosine-guanine or thymine-adenine)

Nucleotides are the subunits of nucleic acids

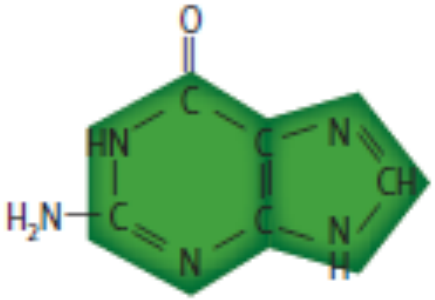
- 5-carbon sugar
- Phosphate group
- Nitrogenous base



Purine Bases

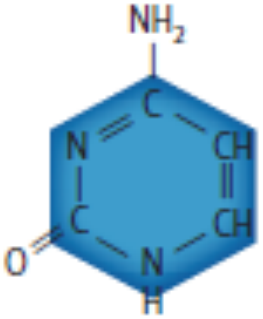


Adenine (A)

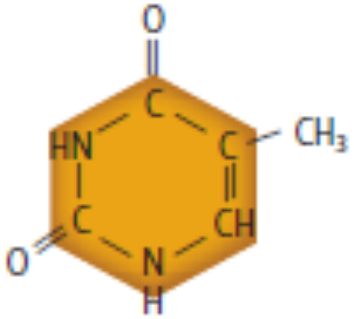


Guanine (G)

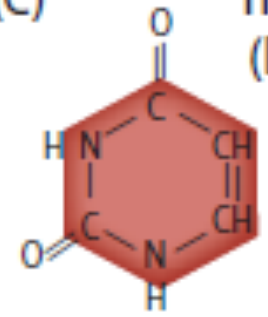
Pyrimidine Bases



Cytosine (C)



Thymine (T)
(DNA only)

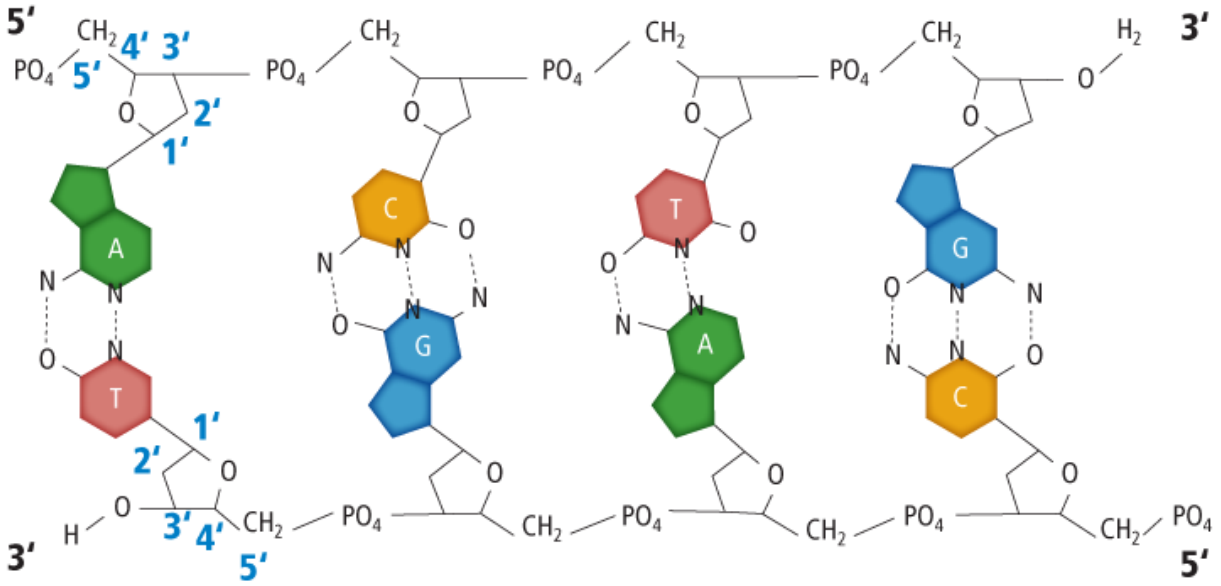


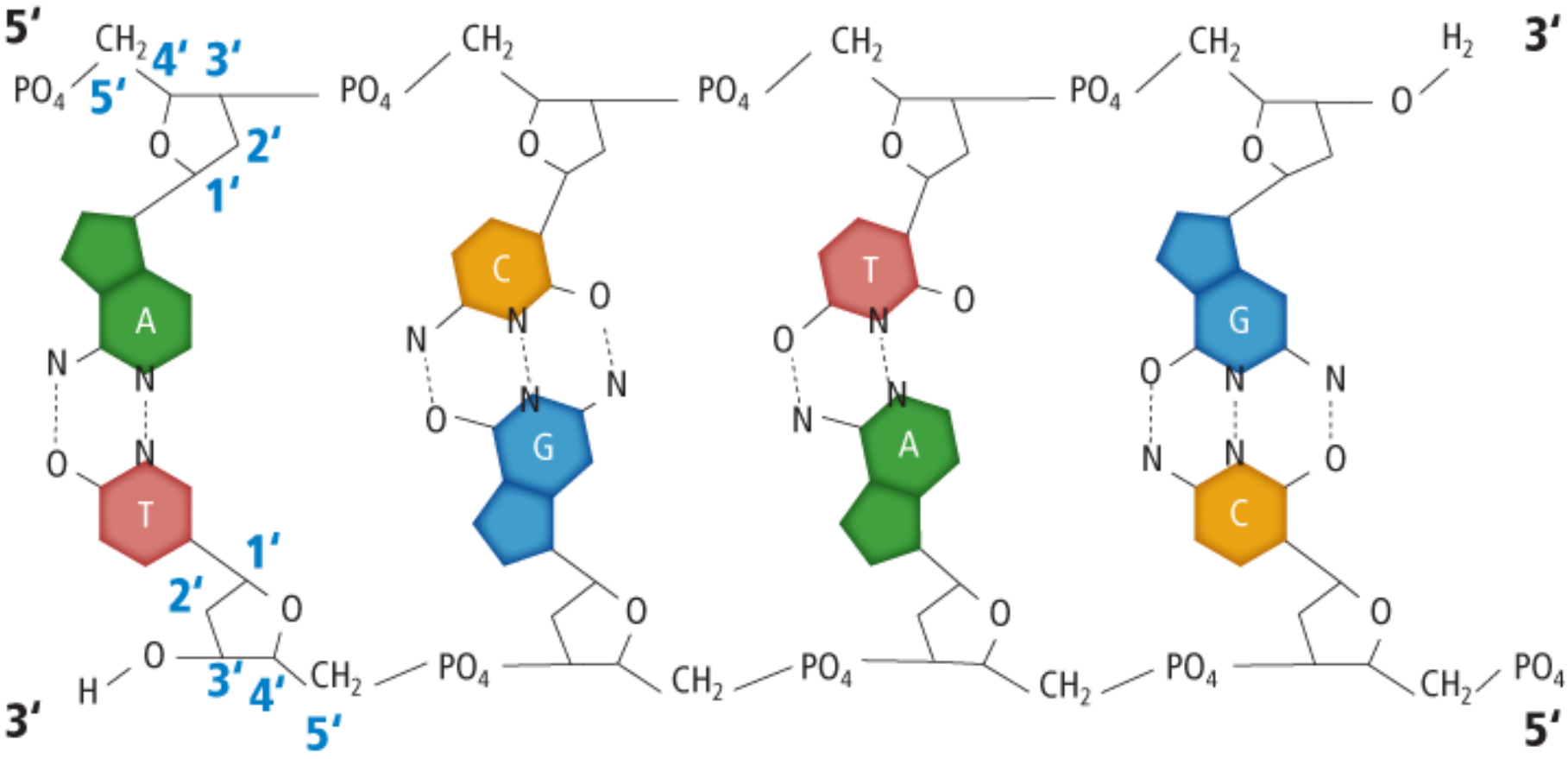
Uracil (U)
(RNA only)

Orientation

DNA molecules have a direction

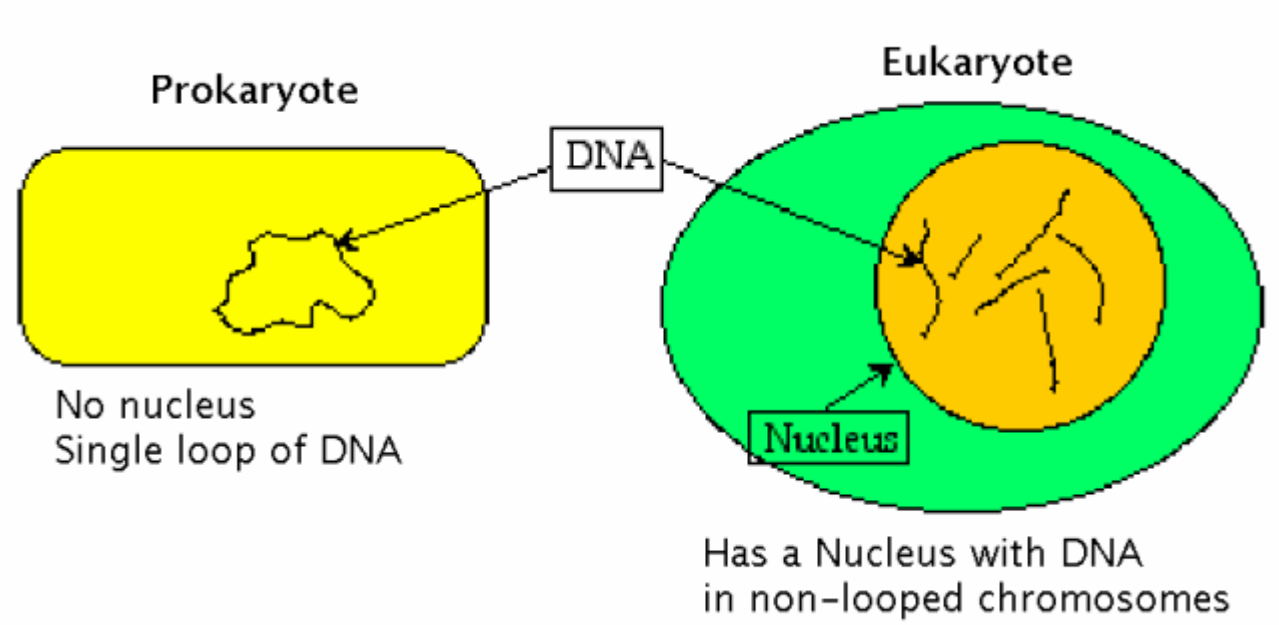
- The top is oriented 5’ to 3’.
- The bottom runs in the **opposite** direction 3’ to 5’.




5′
3′
3′
5′
A
T
C
G
T
A
G
C
1′
2′
3′
4′
5′

Chromosome Structure

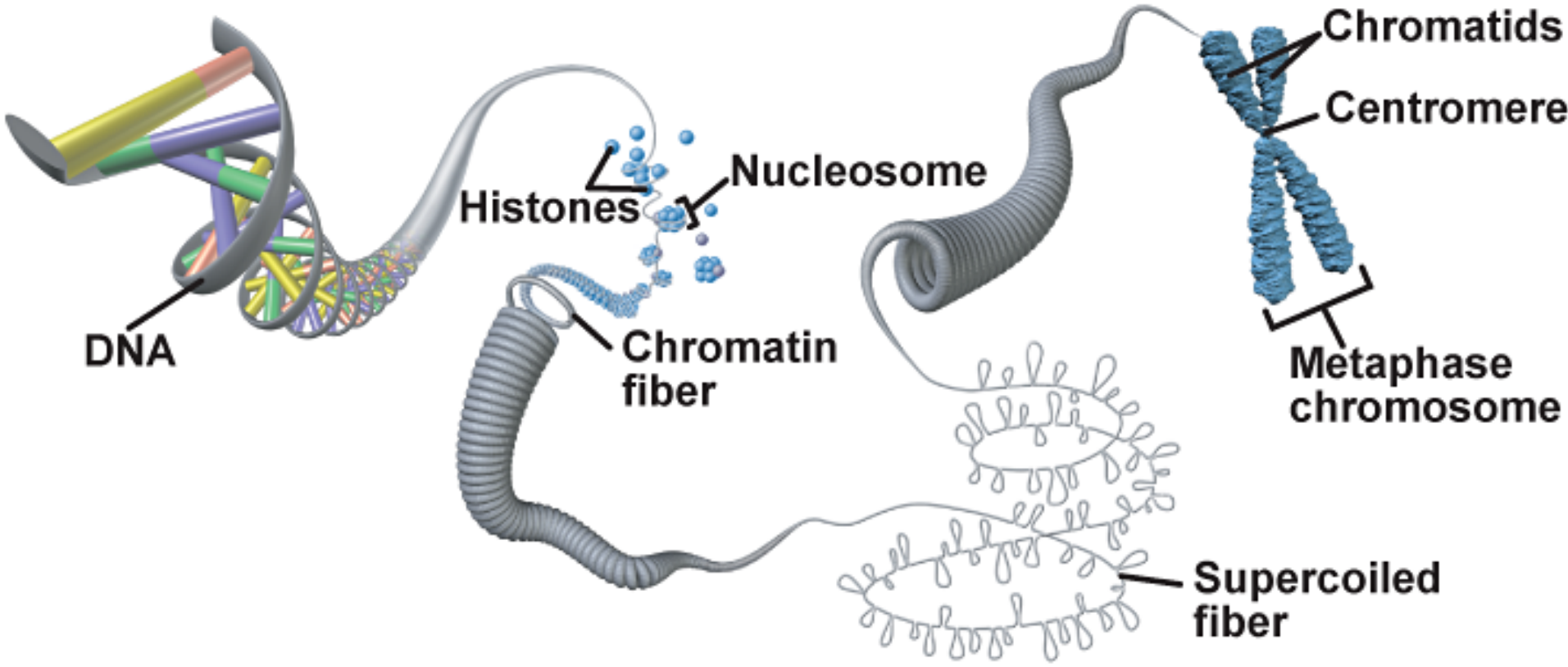
- In prokaryotes, DNA is in the cytoplasm, in a ring.
- In eukaryotes, DNA is in the nucleus in chromosomes.



Chromosome Structure

- To fit into a cell, DNA coils around proteins called **histones**.
- DNA + histones form a **nucleosome**

- Nucleosomes group together into **chromatin** fibers
- Chromatin fibers supercoil to form a **chromosome**


DNA
Histones
Nucleosome
Chromatin fiber
Supercoiled fiber
Chromatids
Centromere
Metaphase chromosome