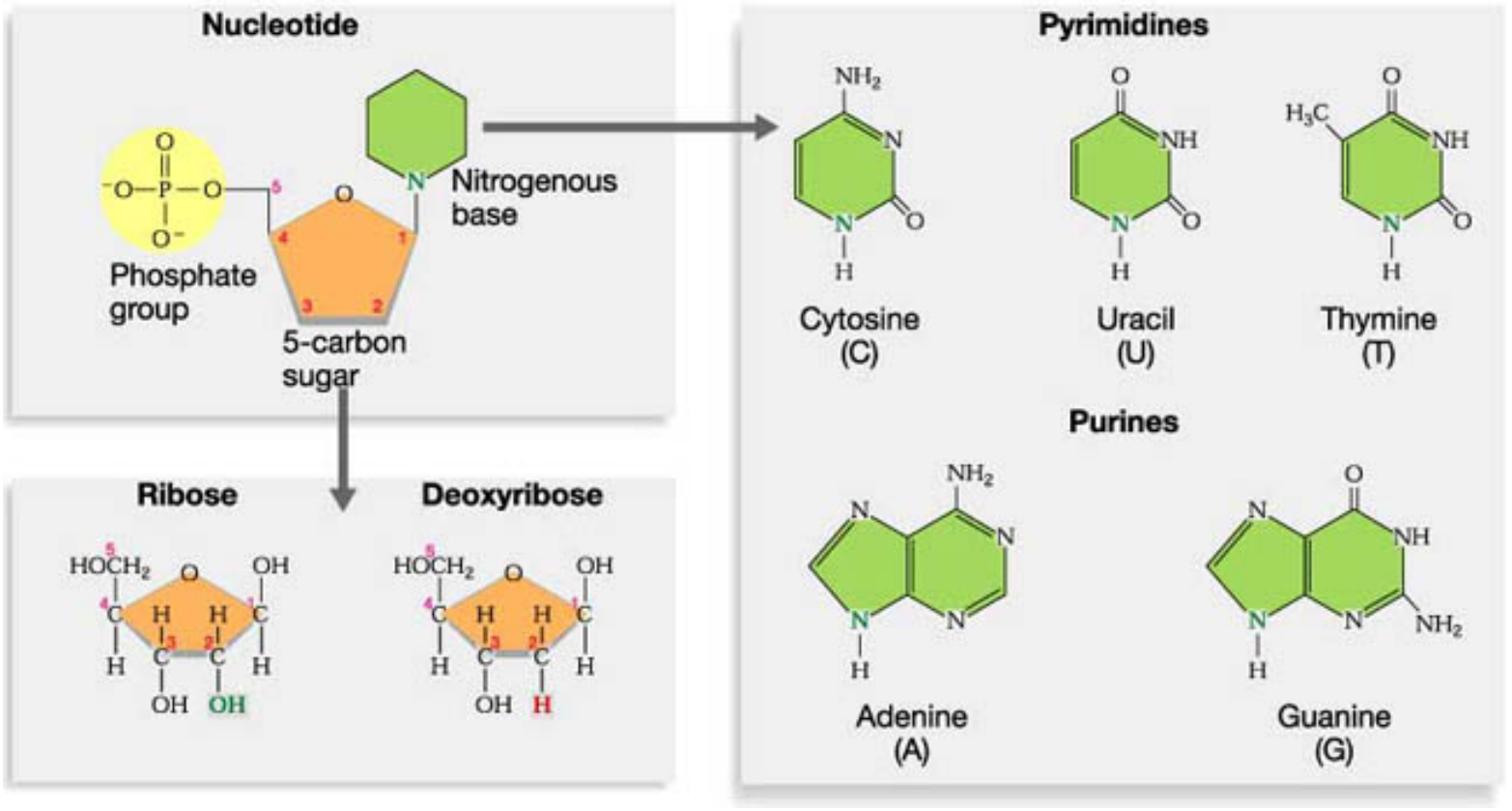
Students will be able to.... AKA I can.....

- Use experimental evidence to explain how we know the structure of DNA
  - Edwin Chargaff
  - Linus Pauling
  - Rosalind Franklin
  - Maurice Wilkins
  - Watson and Crick

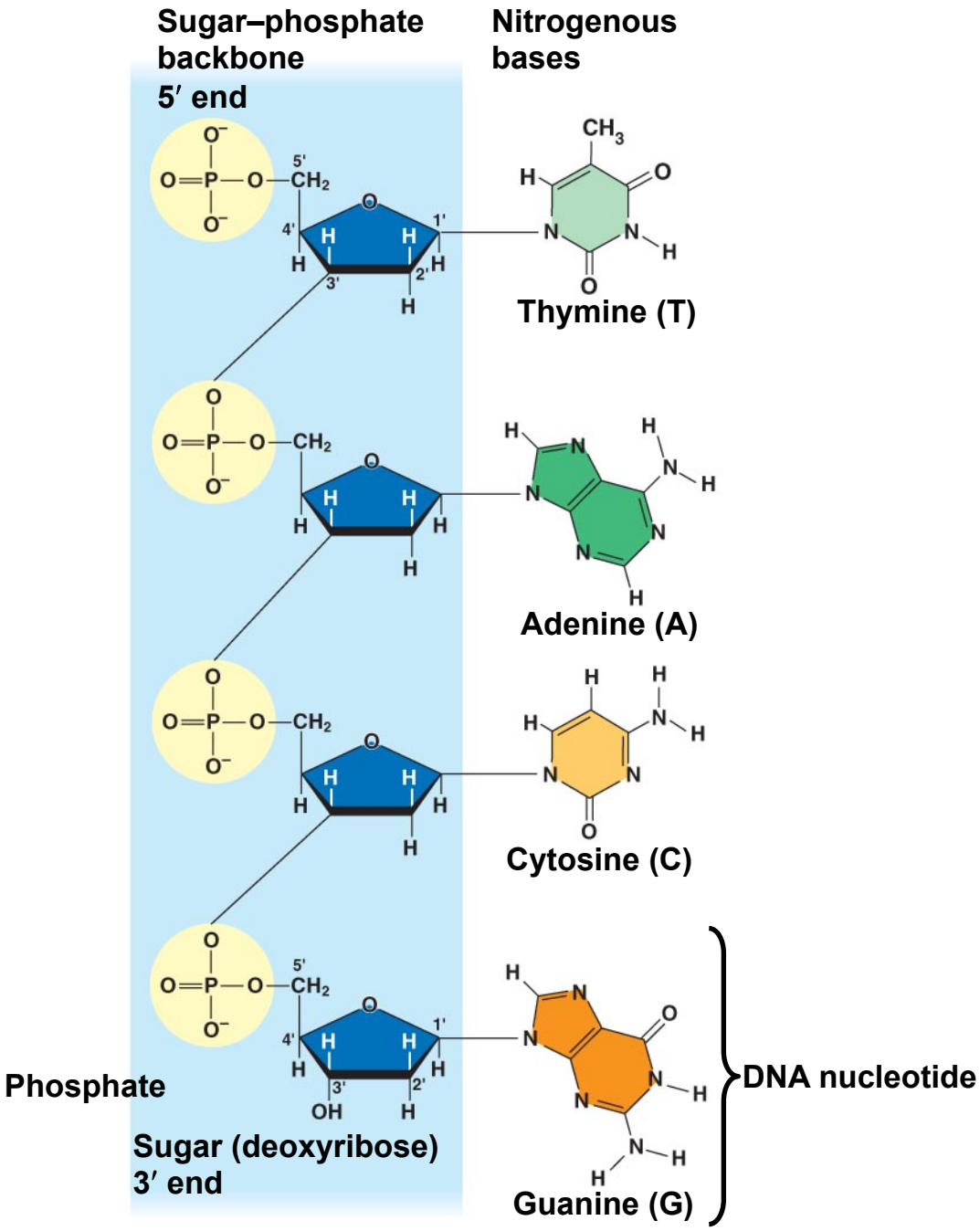
What we knew so far:

- There are 4 nucleic acids
- Purines (1 CN ring)
  - Adenine
  - Guanine
- Pyrimadines (2 C-N rings)
  - Thymine
  - Cytosine

DNA structure



DNA is made up of four bases. RNA also has four bases, but has uracil instead of thymine.



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Erwin Chargaff

and his data, 1950

What pattern(s) do you notice?

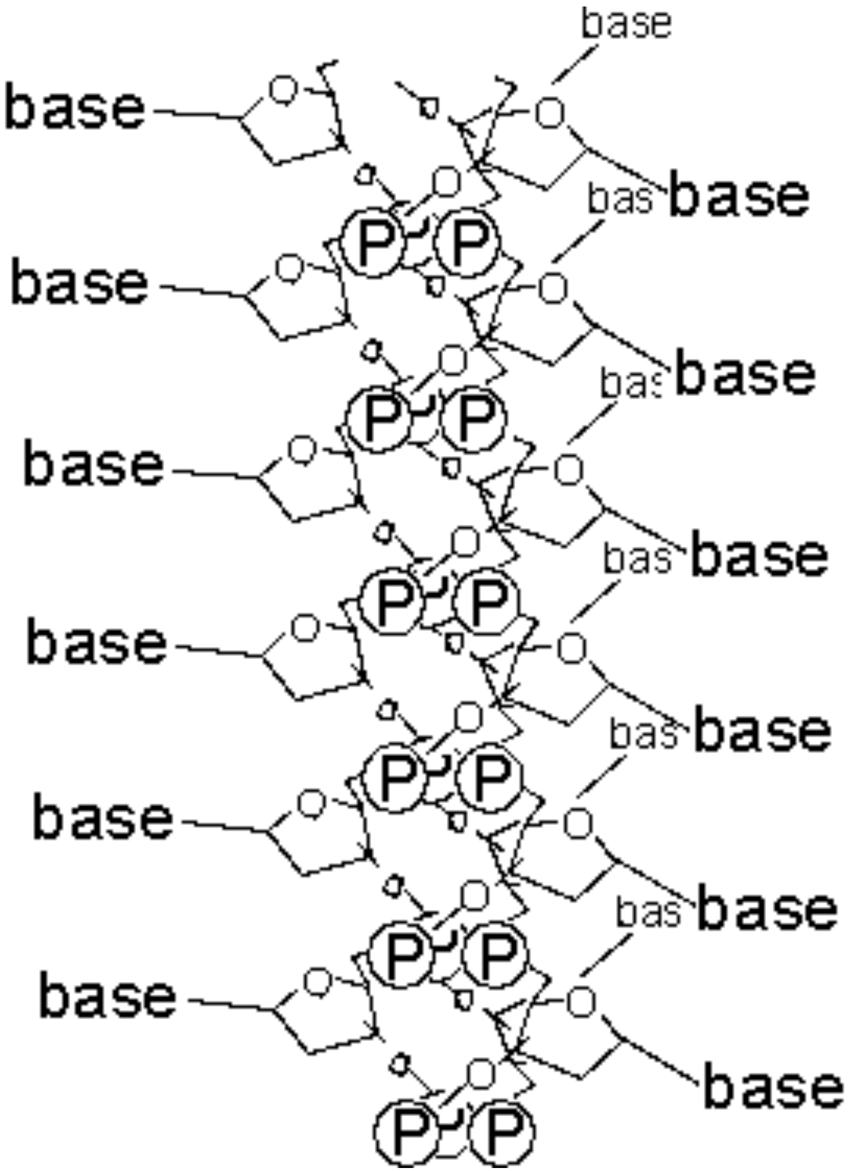
PERCENTAGE OF BASE IN DNA				
DNA orgin	A	T	G	C
Human (sperm)	31.0	31.5	19.1	18.4
Corn (*Zea mays*)	25.6	25.3	24.5	24.6
Drosophila	27.3	27.6	22.5	22.5
Euglena nucleus	22.6	24.4	27.7	25.8
Escherichia coli	26.1	23.9	24.9	25.1

Erwin Chargaff

PERCENTAGE OF BASE IN DNA					RATIOS		
DNA orgin	A	T	G	C	A/T	G/C	(A+T)/(G+C)
Human (sperm)	31.0	31.5	19.1	18.4	0.98	1.03	1.67
Corn (*Zea mays*)	25.6	25.3	24.5	24.6	1.01	1.00	1.04
Drosophila	27.3	27.6	22.5	22.5	0.99	1.00	1.22
Euglena nucleus	22.6	24.4	27.7	25.8	0.93	1.07	0.88
Escherichia coli	26.1	23.9	24.9	25.1	1.09	0.99	1.00

Conclusion: The amount of A = T and amount of C = G in each species, although the amounts differ from species to species.

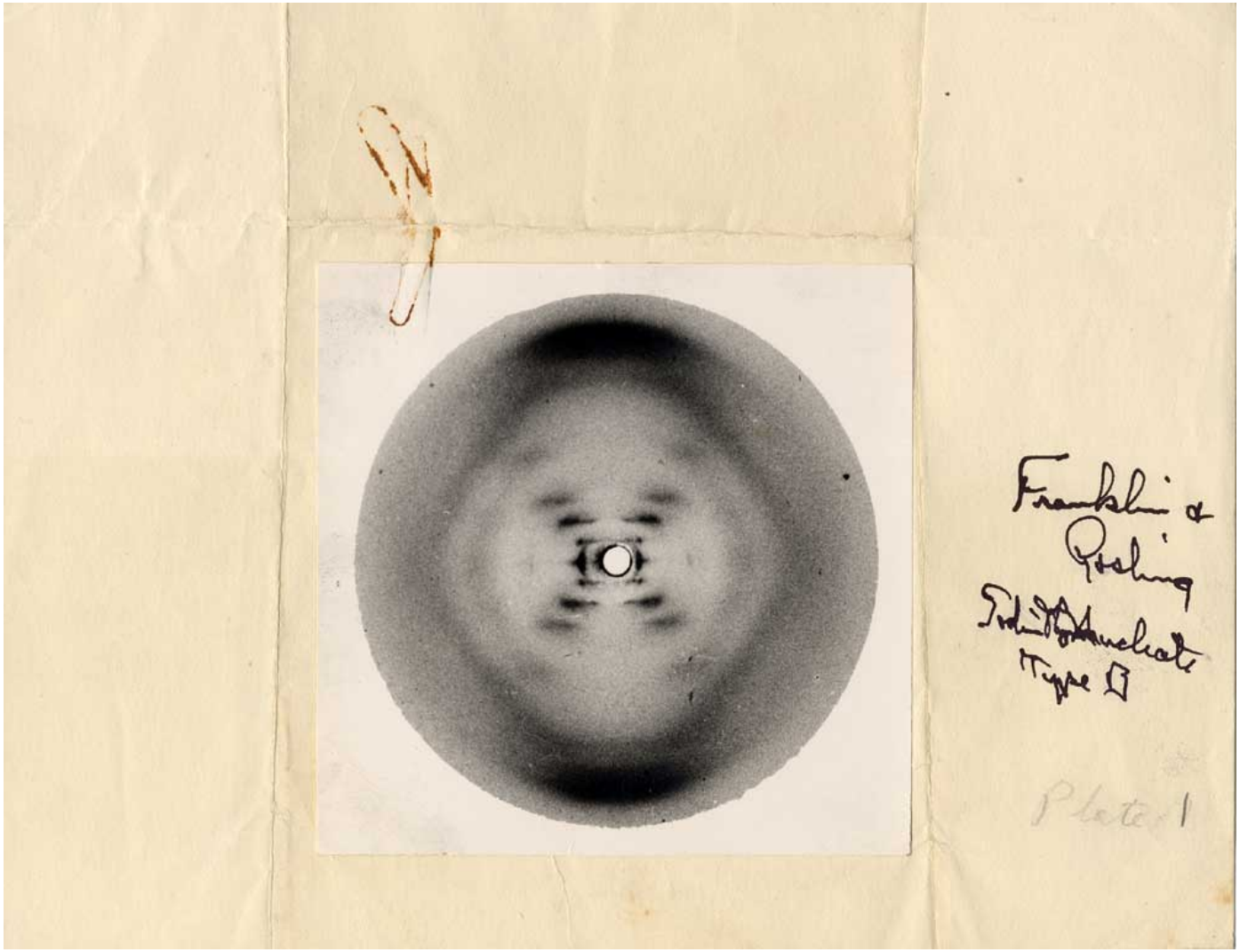
Linus Pauling



- His model did not quite work. Why not?

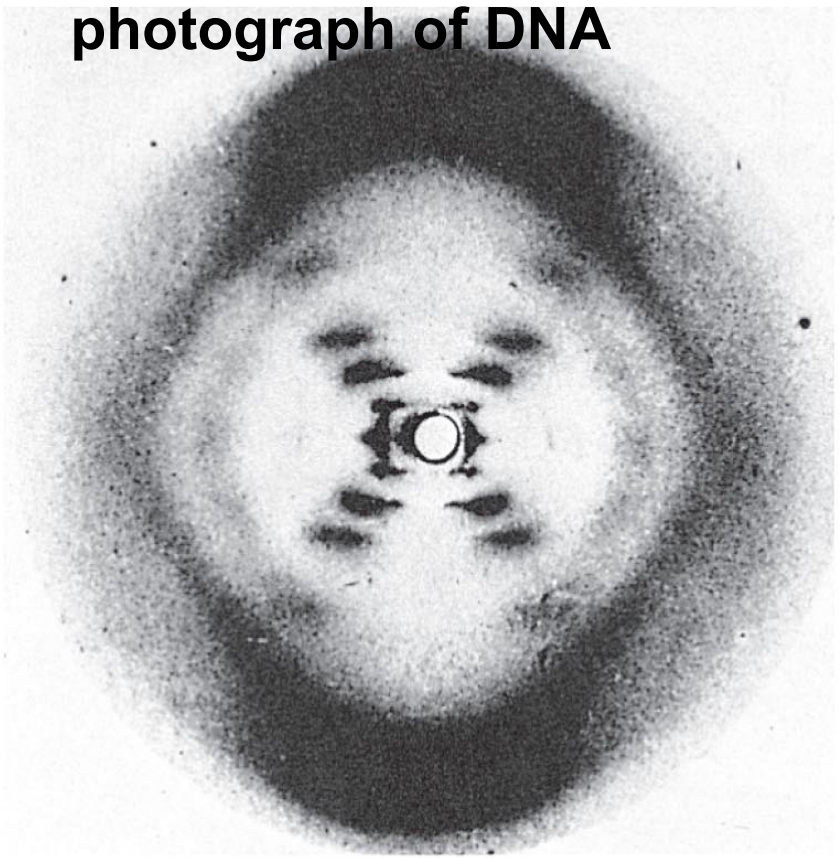
Rosalind Franklin

Photo 57



Rosalind Franklin

Franklin's X-ray diffraction photograph of DNA



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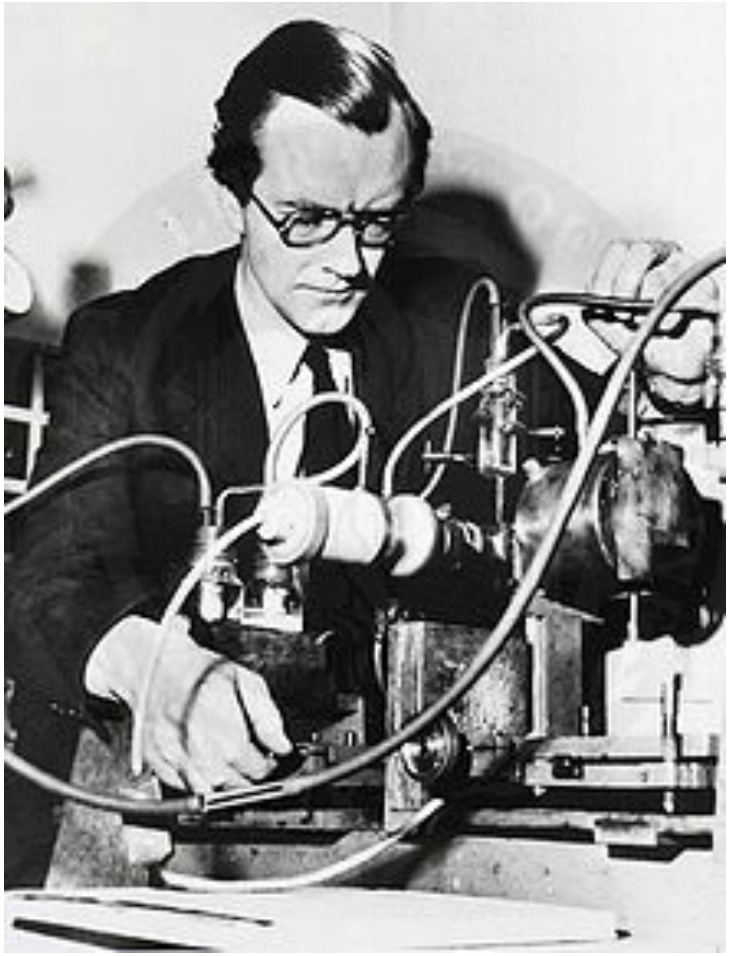
Franklin concluded:

- two antiparallel sugar-phosphate backbones
- nitrogenous bases paired in the molecule's interior

Maurice WIlkins

- King's College, London
- Was to collaborate with Franklin, but this didn't work out. Why not?

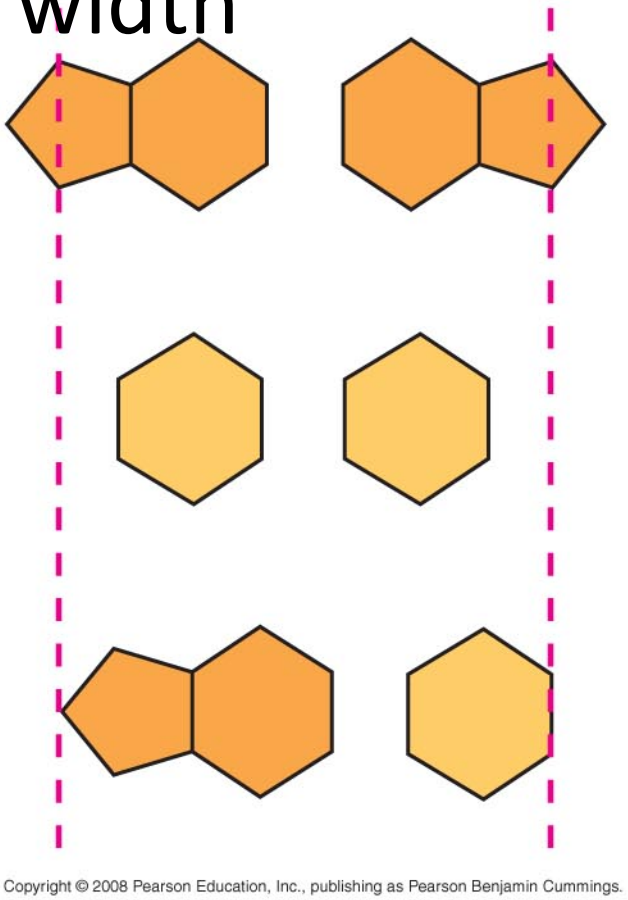


Watson and Crick

- Cavendish Laboratory, Cambridge
- Wilkins consulted with Watson and Crick. Without Franklin's knowledge, he handed them Franklin's data.
- Watson immediately recognized the significance of Photo 57. He and Crick went to work on a model of DNA.

- Franklin's X-ray crystallographic images of DNA were used by Watson to deduce that DNA was a helix
- The X-ray images also enabled Watson to deduce the width of the helix and the spacing of the nitrogenous bases
- The width suggested that the DNA molecule was made up of two strands, forming a **double helix**

At first, Watson and Crick thought the bases paired like with like (A with A, and so on), but such pairings did not result in a uniform width



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Purine + purine: too wide

Pyrimidine + pyrimidine: too narrow

Purine + pyrimidine: width consistent with X-ray data

Fig. 16-UN1

- Watson and Crick reasoned that the pairing was more specific, dictated by the base structures
- They determined that adenine (A) paired only with thymine (T), and guanine (G) paired only with cytosine (C)
- The Watson-Crick model explains Chargaff's rules: in any organism the amount of A = T, and the amount of G = C

Instead, pairing a purine with a pyrimidine resulted in a uniform width consistent with the X-ray

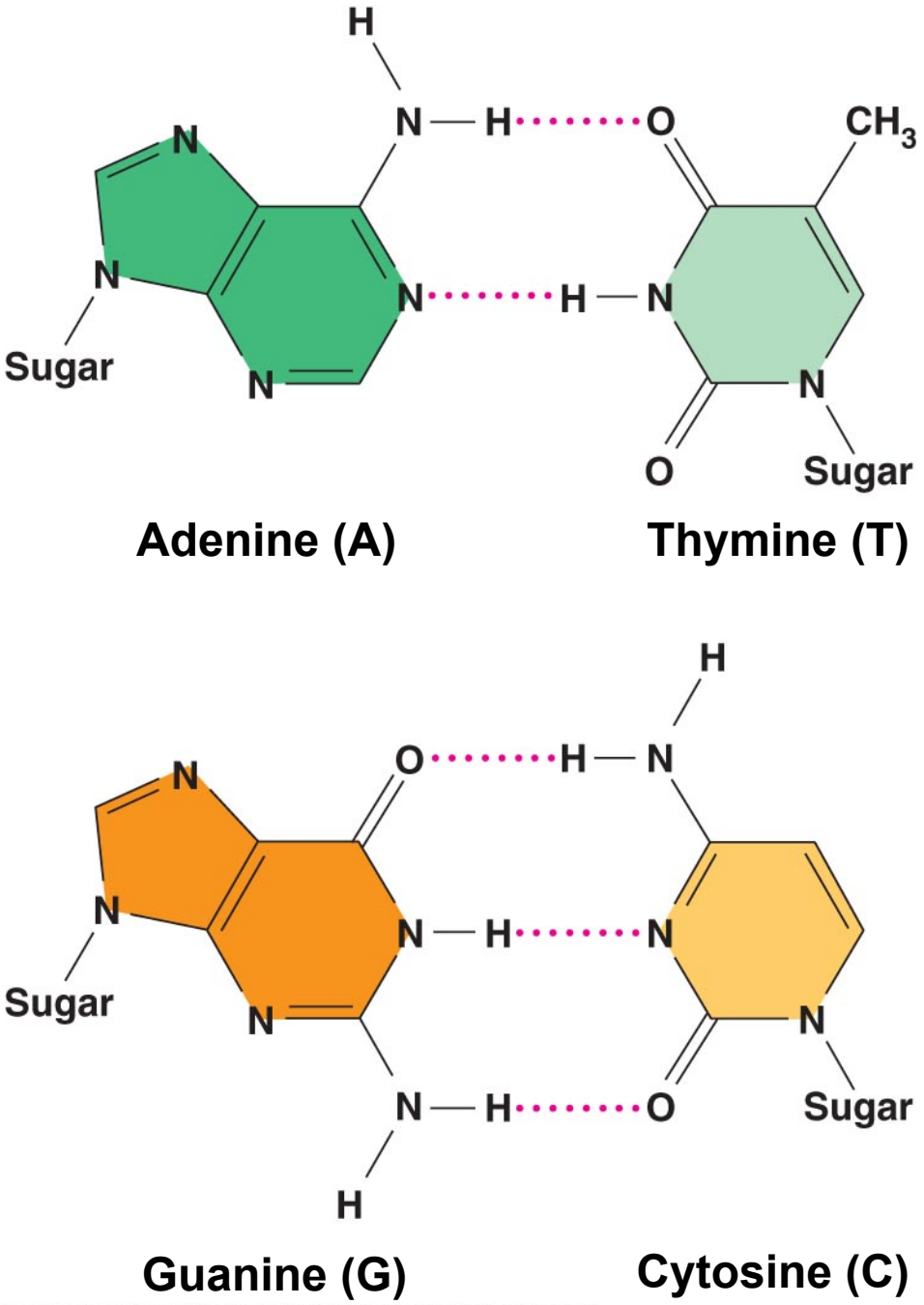

Fig. 16-8

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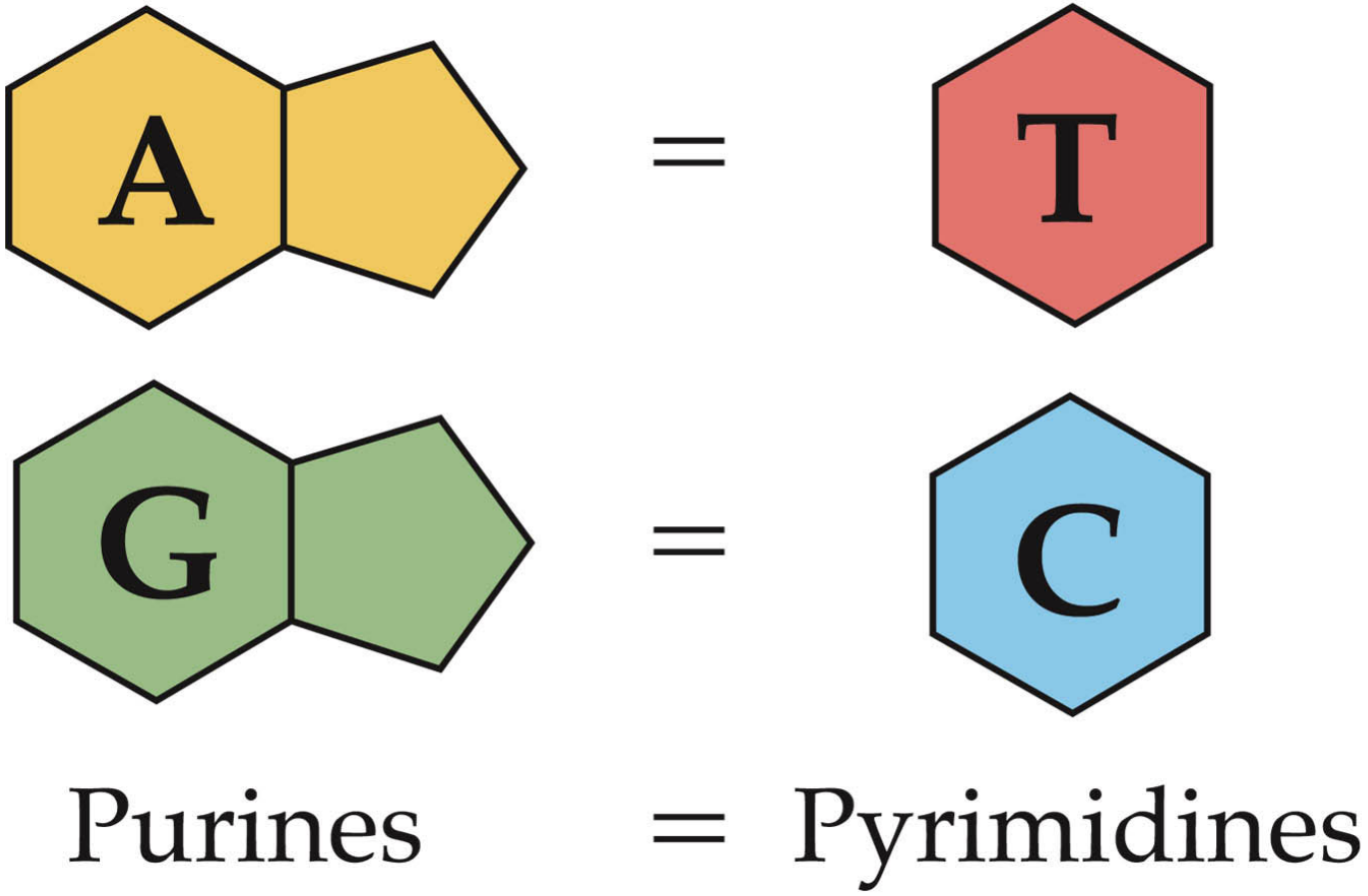
SO:



LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 11.5 Chargaff's Rule

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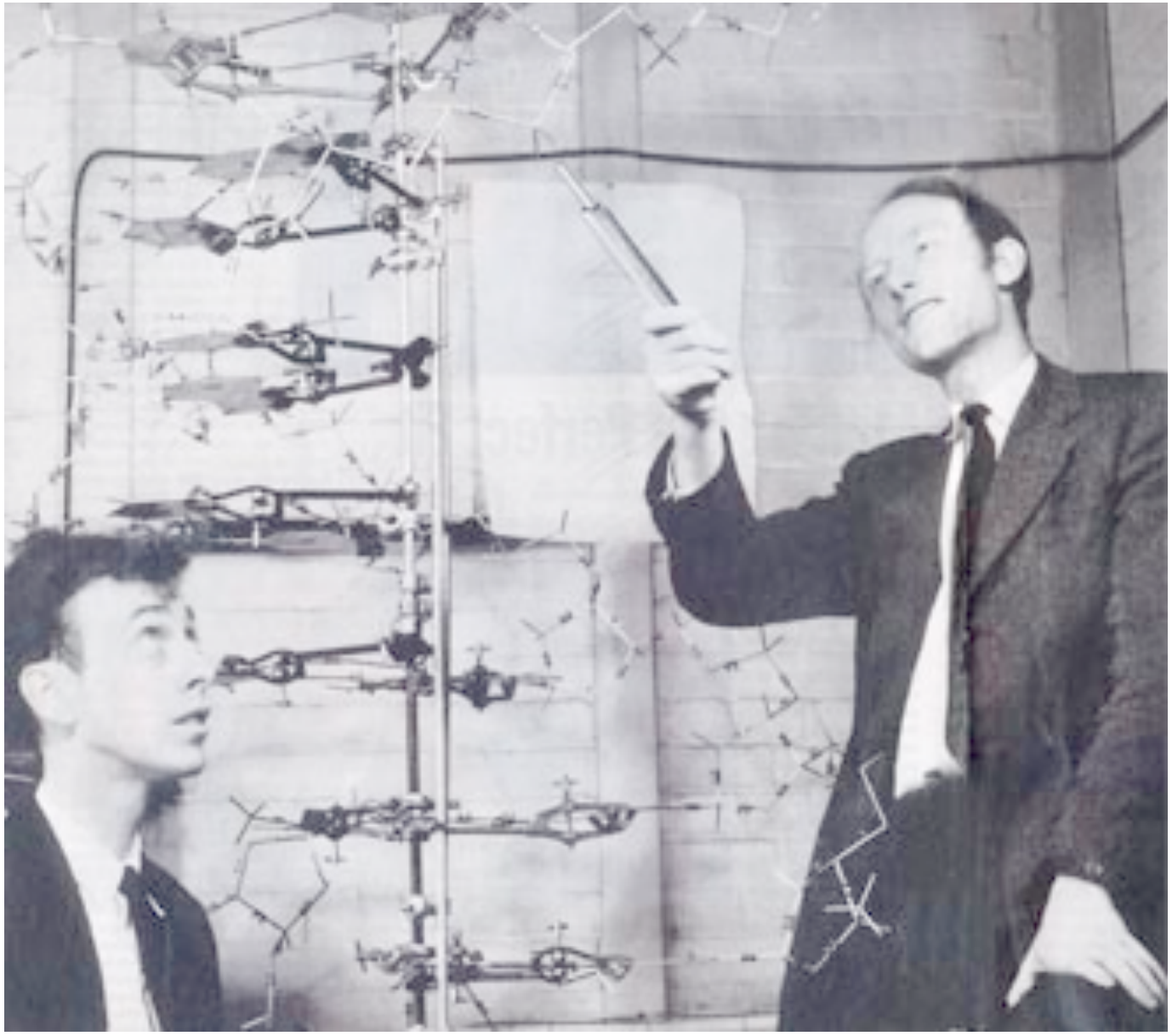
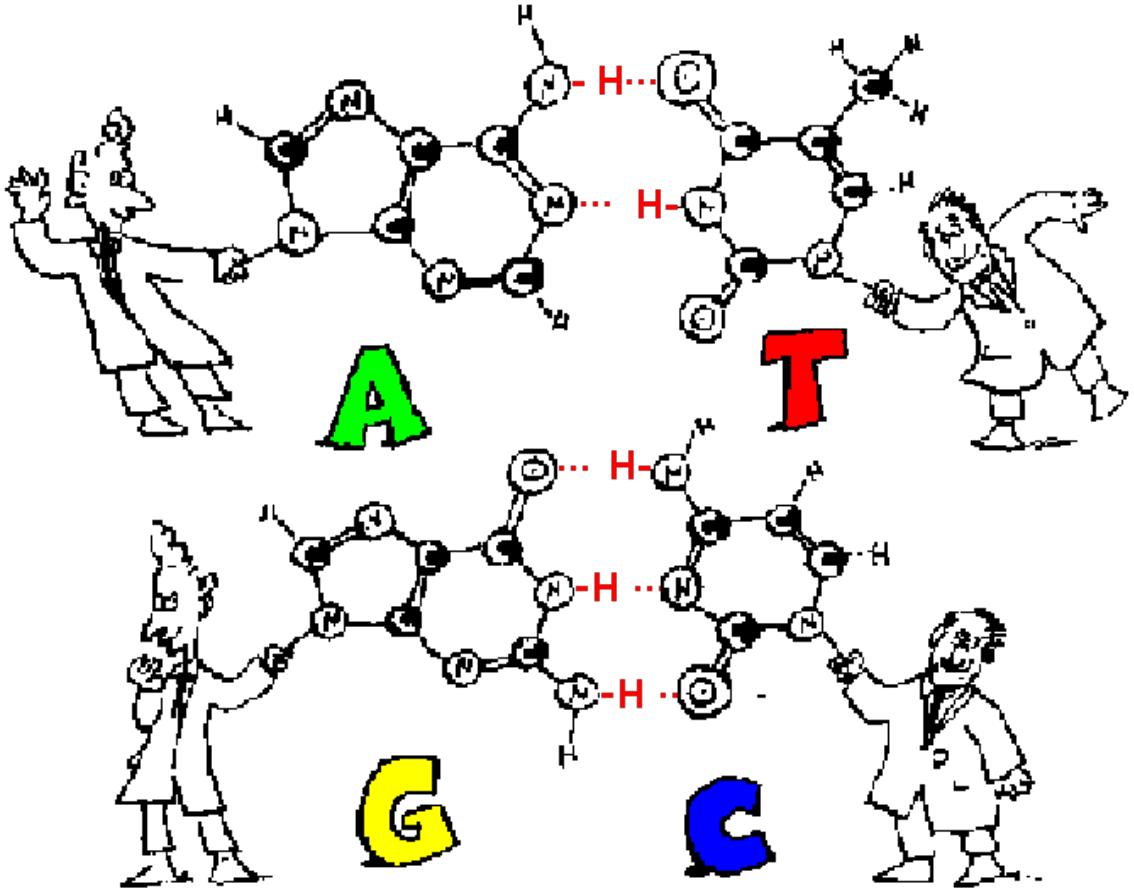
Many proteins work together in DNA replication and repair

- The relationship between structure and function is manifest in the double helix
- Watson and Crick noted that the specific base pairing suggested a possible copying mechanism for genetic material

The First DNA Model

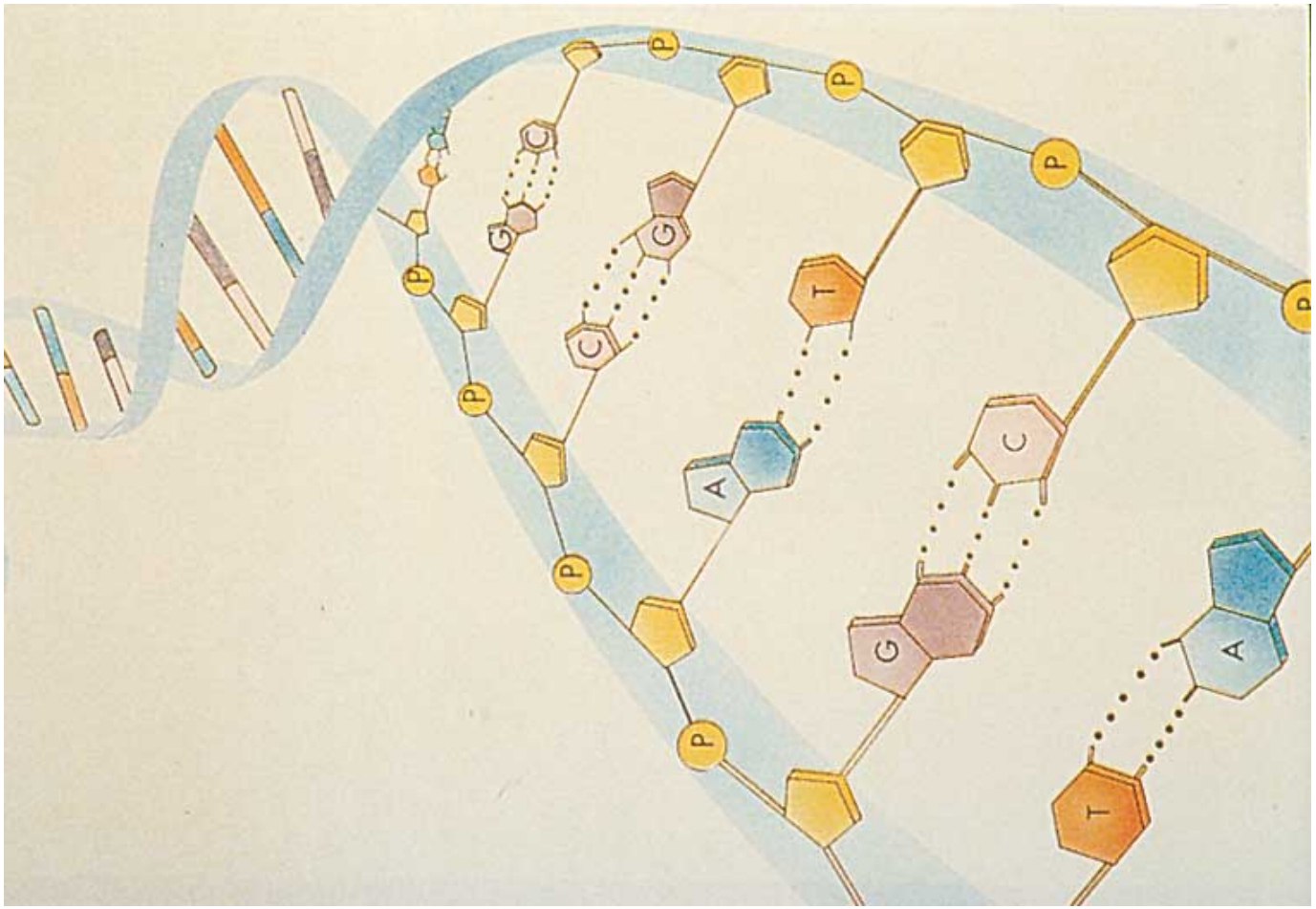


DNA structure

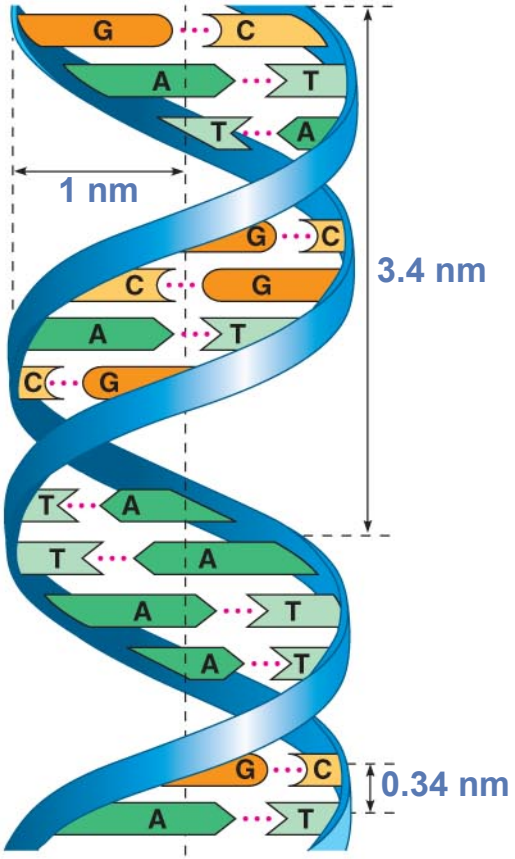


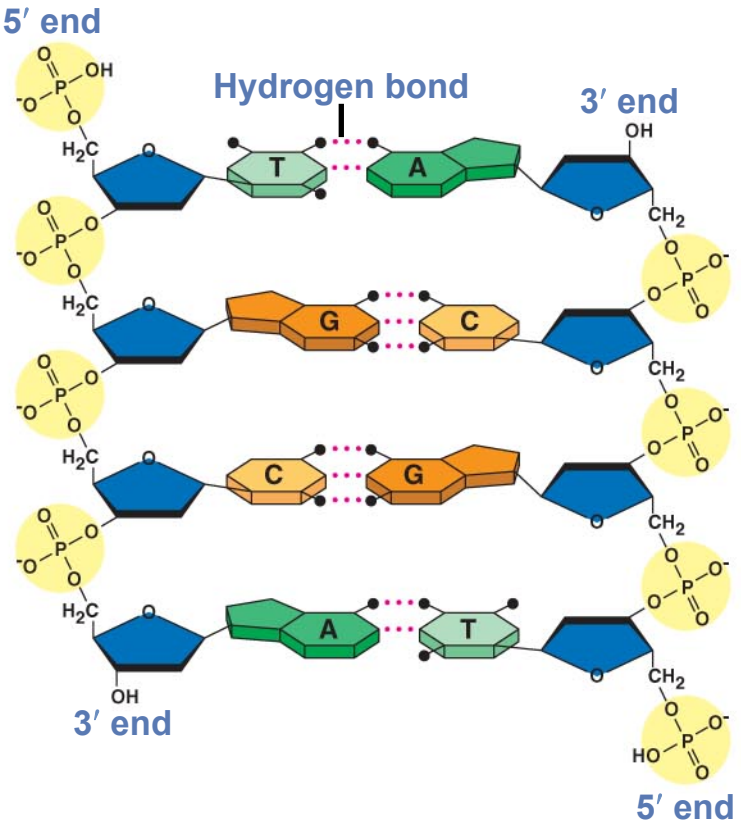
Across the DNA double-ladder, A always pairs with T, C always pairs with G because of the number of hydrogen bonds the bases form.

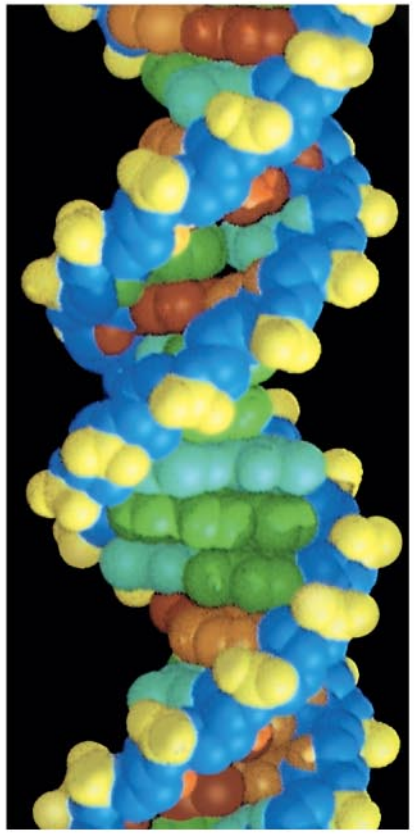
DNA structure



The DNA ladder forms a spiral, or helical, structure, with the two sides held together with hydrogen bonds.







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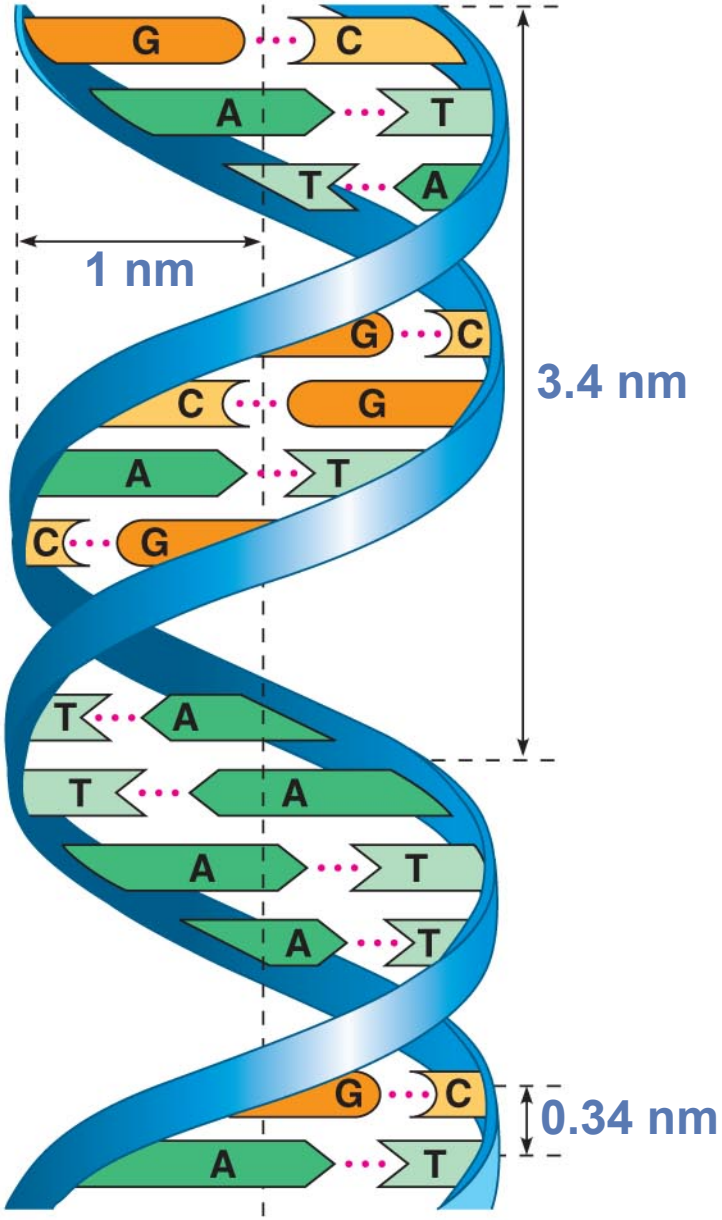
(a) Key features of DNA structure

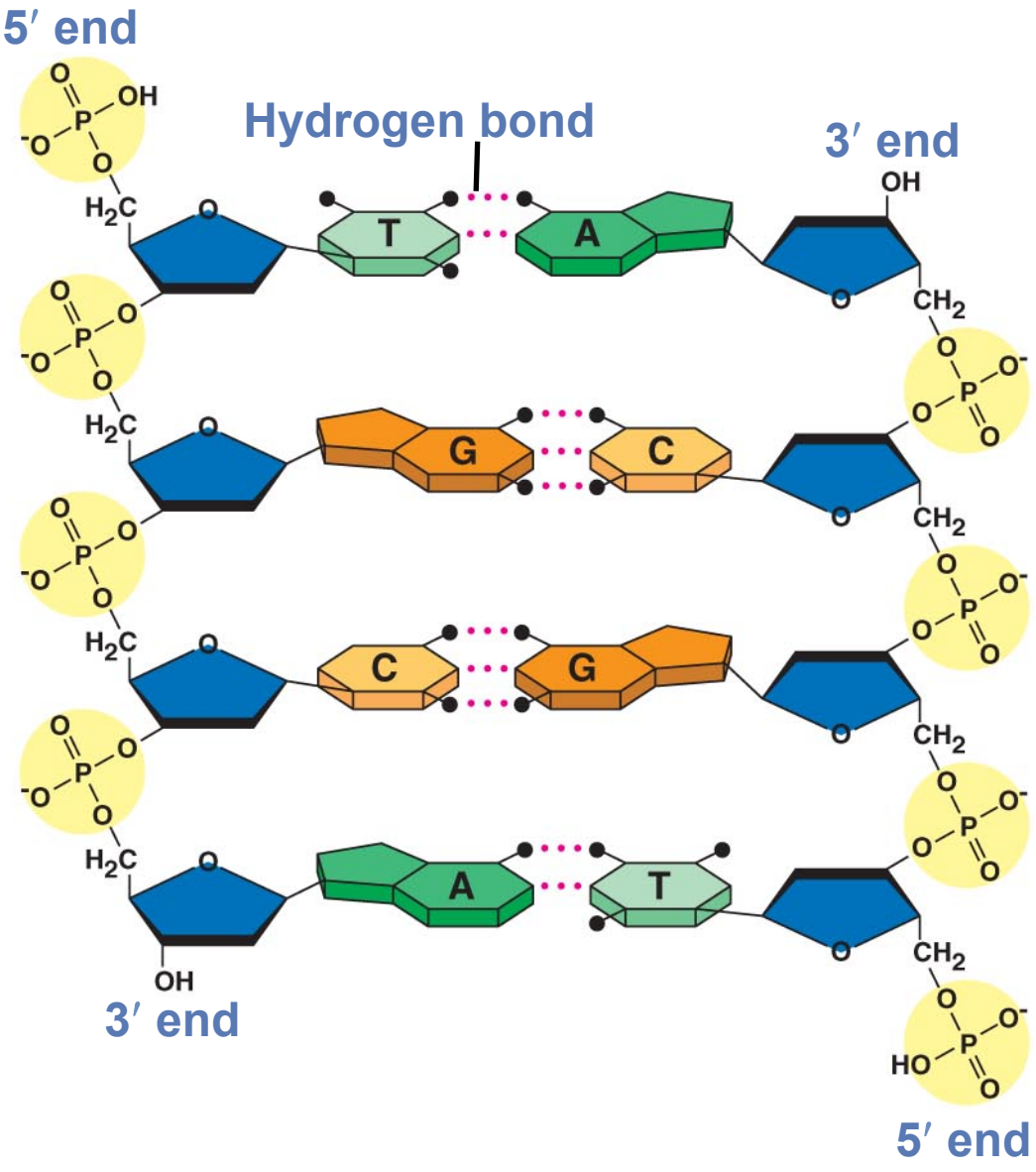
(b) Partial chemical structure

(c) Space-filling model

Fig. 16-7a



(a) Key features of DNA structure



(b) Partial chemical structure

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Fig. 16-7b

(c) Space-filling model

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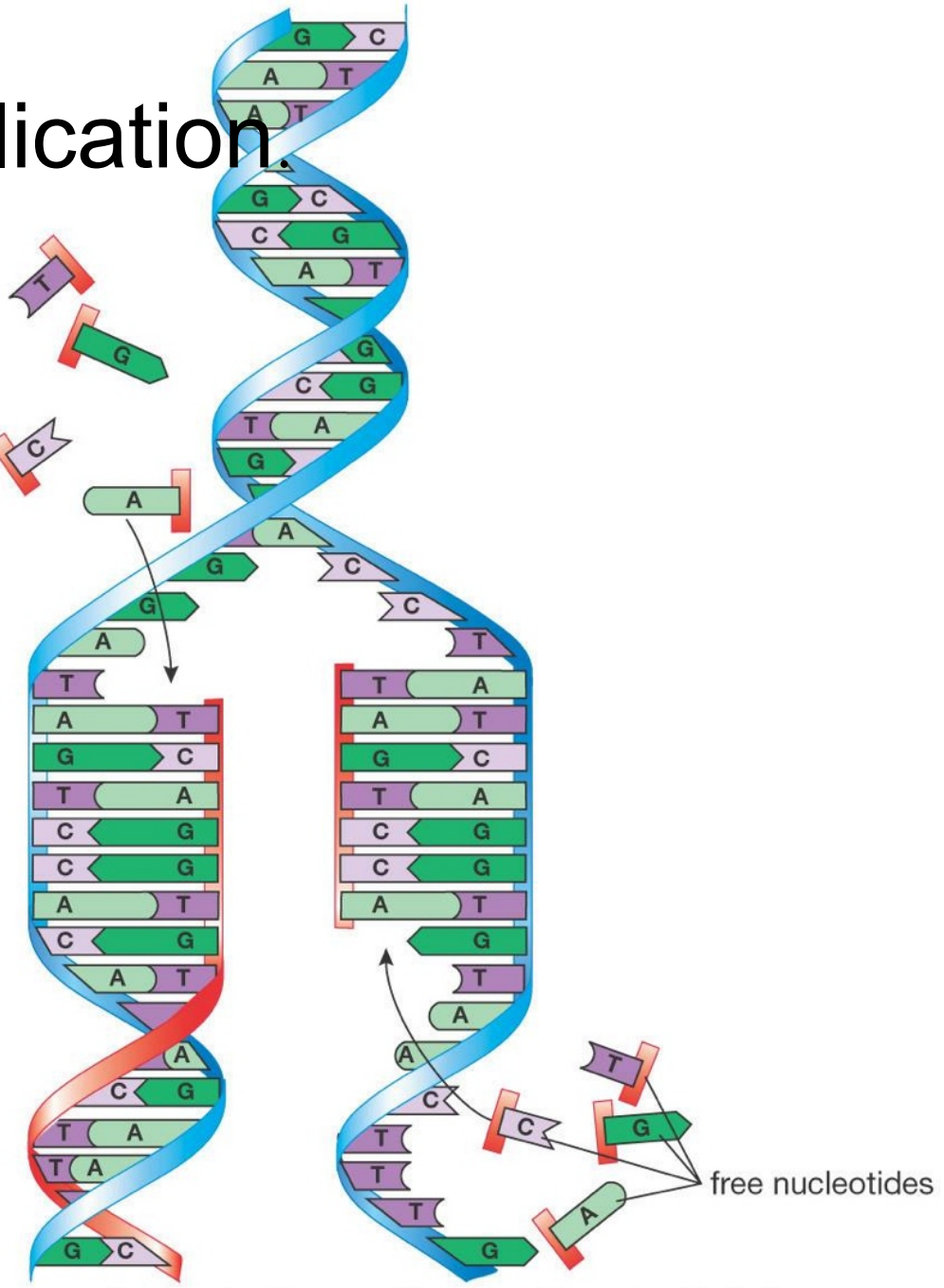
DNA Replication

- Before cells divide, they must double their DNA so that each cell gets identical copies of the DNA strands.
- DNA replication helps assure that the bases are copied correctly.
- Enzymes carry out the process.

Overview of DNA replication.

- Hydrogen bonds break to “unzip” the DNA strand.
- Enzymes guide free nucleotides to the exposed single strands and match the nucleotides.



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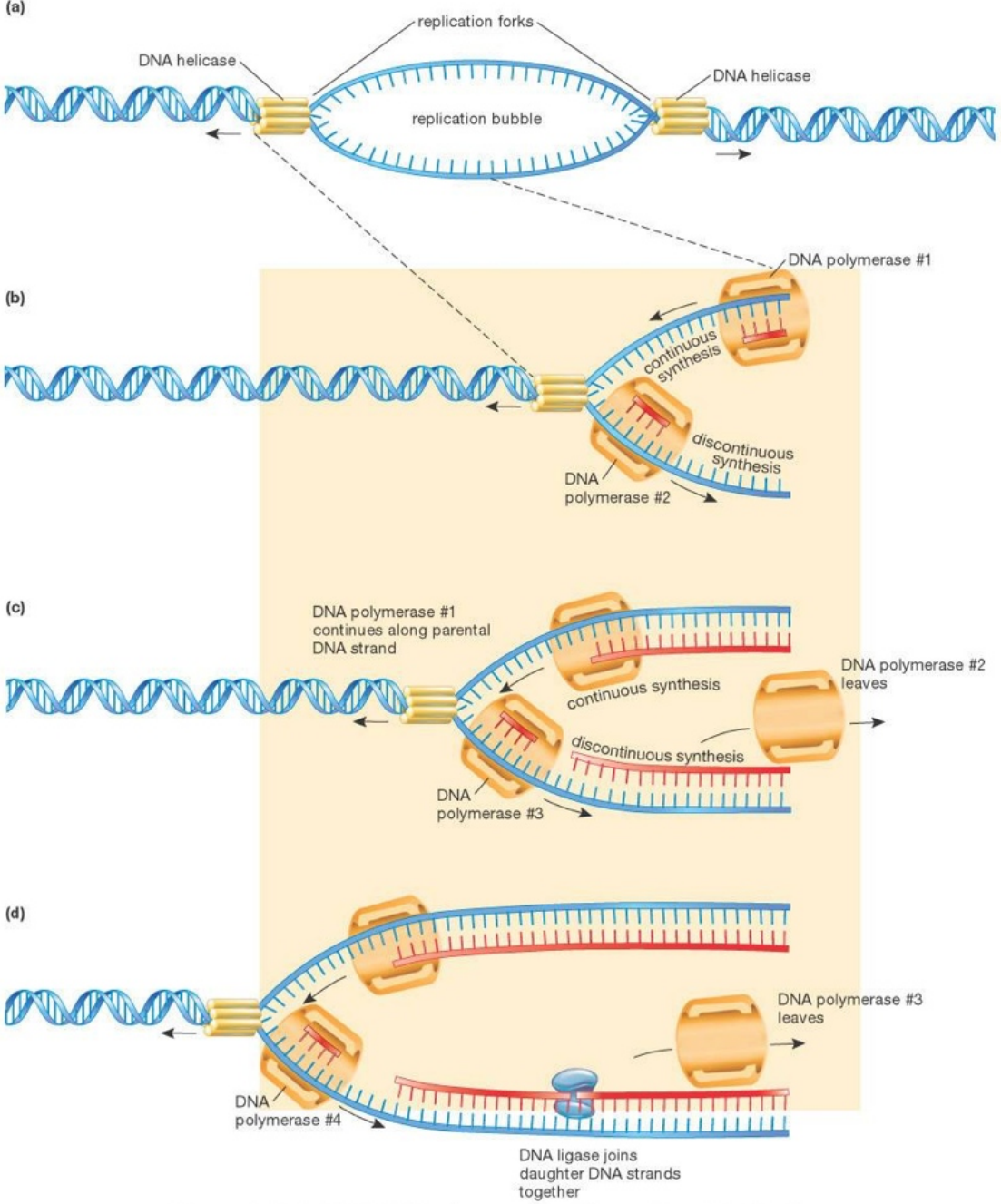
How enzymes carry out the replication process:

- DNA Helicase unzips the DNA. DNA Polymerase synthesizes the new strands, using the old strands as templates.



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DNA Replication

- Build a DNA Model interactive feature (web)
- DNA Replication animation (web)

Summary

- DNA is a nucleic acid made up of nucleotides.
- The order of the nucleotides is important, and is maintained by matching of bases across the DNA ladder (A-T, C-G), and by enzymes that patrol the DNA
- DNA replication occurs before cell division, and is an orderly, enzyme-driven process.

Students will be able to.... AKA I can.....

- describe the chemical structure of DNA, and explain how we know the structure.
- explain how the coiling of DNA into chromosomes takes place and why this is important.
- explain 4 differences between DNA and RNA, and why each is significant.
- explain the transcription of RNA from DNA.
- describe three types of RNA and explain the role of each in protein synthesis.
- explain how mRNA is translated into protein.
- trace the synthesis of protein from the transcription of DNA into RNA through the production of a finished protein.